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The future of the construction industry and the implications for construction project management and education

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The future of the construction industry and the implications for construction project management and education

by

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Abstract

Developing an understanding of the future is an important aspect of every planning process; planning in the construction industry is no different. Construction is an industry that is very closely linked to the economy and society as a whole. As such, when developing an understanding of the future of the construction industry, it is important to understand the future of the economy and society as a whole. This document puts forth visions for the construction industry based on an understanding of economic, social, and environmental factors. The world is at an interesting crossroads. There are great problems being faced throughout the world while simultaneously amazing new tools are being developed. The construction industry has often been characterized as a fragmented industry that is slow to change. Given the state of current and probable future affairs, the construction industry may begin to experience change at unprecedented levels. It is important for organizations within the construction industry and institutions for construction education to remain constantly cognizant of the state of the future. This study provides a look into the future and serves as a foundation for additional research into the future of the construction industry.

Chapter 1: Introduction

1.1 - Overview

Construction is a very diverse industry that is heavily interconnected with the economy as a whole. In fact, many of the key US economic indicators are derived solely from the construction industry (Economics and Statistics Administration, 2009). Even while this document maintains a United States focus, the construction industry is impacted by global events and trends. The construction industry is inextricably linked to the course taken by the economy and society at large. Nearly all people in modern mainstream society maintain a very close relationship with the built environment. In fact, “Americans spend on average 90% of their time indoors” (USGBC, 2005).

Change is a force constantly shaping the economy, society, and construction. In order to be successful, it is important for organizations involved with the construction industry to stay abreast of the current state of affairs, both locally and globally, as they develop their strategic plans. In order to have a truly accurate portrayal of the current state of affairs, one must also understand the impacts of the likely future. As such, a critical part of the strategic planning process involves developing visions of the future and attempting to predict and understand the future conditions facing the industry.

This document attempts to communicate broad visions for the future facing the construction industry. Of course, any attempt to make predictions about the future will inherently assume a certain level of uncertainty. Acknowledging this uncertainty, it is still possible to develop important findings by working to understand the potential future.

The author of this thesis, written for requirement of Masters of Science Degree at Iowa State University in the Department of Civil, Construction, and Environmental Engineering, served for 18 months on a Construction Industry Institute (CII) task force to study the future from the perspective of the construction industry and specifically CII and its member companies. The taskforce was part of CII's Strategic Planning Committee. Following is an overview description of CII taken from the organization's website:

> "CII is a consortium of leading owners, engineering and construction contractors, and suppliers who have a singular mission: to improve the cost effectiveness of the capital facility project life cycle, from pre-project planning through completion and commissioning. By collaborating on important industry issues and by providing guidance on best practices discovered through research, the CII members are collectively an industry forum for the engineer-procure-construct process" (Construction Industry Institute, 2009).

1.2 - Problem Statement

It is recognized that developing a working understanding of the future is important to the success of any organization associated with construction industry. Even while it is an important aspect of strategic planning, it is very difficult to accurately construct visions of the future facing the industry. Construction is known to be a diverse and fragmented industry. Construction is a difficult business environment for many organizations. Failure rates for construction "account for approximately 12 percent of all business failures" (Hinze, 2001). Construction organizations must be mindful of the future while operating in the market conditions of the present. These very real current market conditions can at times make it especially difficult for organizations to make successful predictions and prepare for the future.

Institutions for construction education also have the task of understanding the future of the construction industry. These institutions must understand the possible future in order to

effectively train and educate the future professionals who will enter the industry. Institutions of higher education must develop their course catalogs many years in advance of actual implementation. Without staying abreast of the likely future, construction educators may find that their programs do not fully meet the needs of their students. This thesis recognizes the difficultly of the task with which decision makers in construction education face and aims to aid them in that task.

1.3 - Objectives

The broad objectives of this study are to better understand the state of future facing the construction industry as it relates to construction project management and give recommendations to improve upon construction education programs (Figure 1).

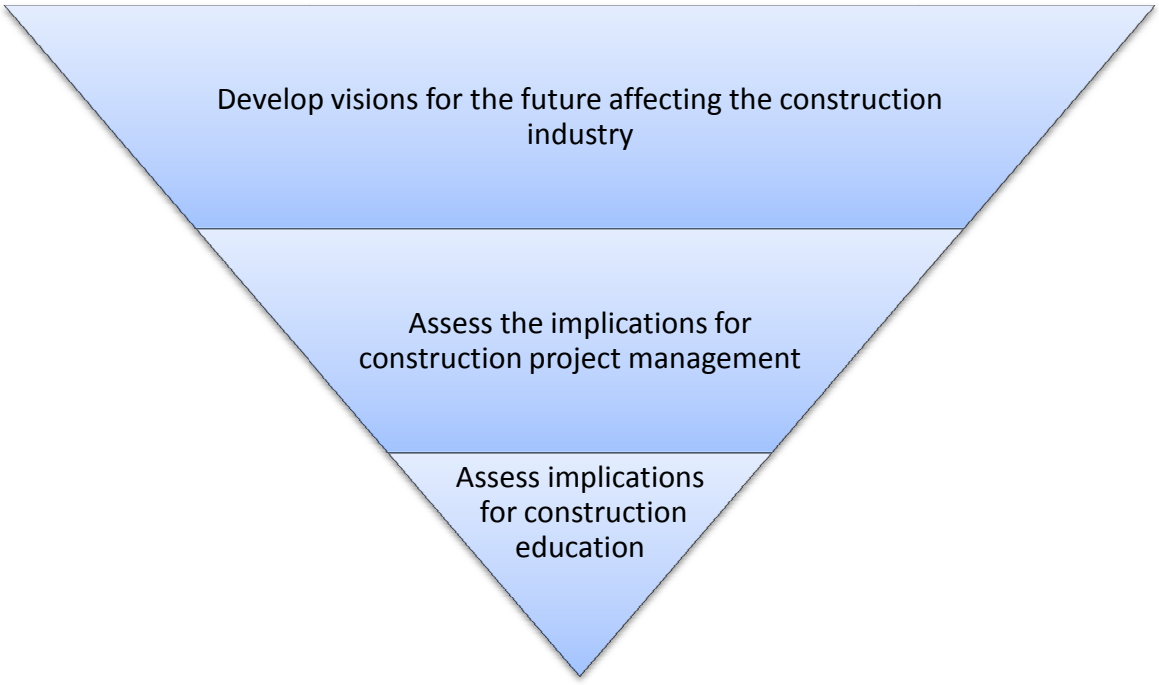

Figure 1: Graphic representation of thesis objectives

Specifically, this thesis aims to develop visions of the future facing the US construction industry, beyond short-term fluctuations in the business cycle and market conditions. The visions presented in this document are broad in nature so as to address key universal issues facing the majority of US construction organizations. It is always the responsibility of the individual organization to understand the specifics of its own strategic planning process. From these visions of construction's future, it is possible to draw conclusions about the future of project management and the role of the future construction professional. After assessing these implications to the future construction professional and the future of project management, it is possible to draw inferences as to how construction education programs can realign to better prepare their students.

Using the findings of the future visioning process, implications to construction education curricula are assessed. Furthermore, recommendations are made to the specific undergraduate curriculum of the Iowa State University Construction Engineering Program and how it can better prepare students pursuing Bachelor of Science Degrees in Construction Engineering from Iowa State University. These examples are given in order to illustrate further examples of application. The Construction Engineering Program at Iowa State University is accredited by the ABET Inc. (formerly known as the Accreditation Board for Engineering and Technology) and is a unit of the Department of Civil, Construction, and Environmental Engineering.

1.4 - Thesis Organization

This thesis is organized based on the chronological process necessary to understand the future and make realistic recommendations to construction education programs. Chapter One gives an introduction to the thesis giving broad overviews of the document and process used to arrive at

the conclusions put forth. Chapter Two is a literature review of pertinent literature that was used to decide on an appropriate research methodology and characterize some previous related studies. Chapter Three outlines the methodology used in the research process. The next two chapters discuss the findings of the future visioning processes for both medium-term and long-term and give descriptions of the respective visioning methodologies. The focus of Chapter Four is centered on the medium-range future while Chapter Five deals primarily with the long-range future. Chapter Six gives an analysis of the implications of the future visioning process to the future of construction project management. In Chapter Seven, implications are asessed for construction curricula based on the summary findings of the future visioning process and the suggested implications of construction project management. The final three chapters discuss the document limitations, future research recommendations, and overall conclusions.

Chapter 2: Literature Review

The purpose of this literature review is to understand some of the theory of future visioning in order to determine a suitable methodology for the study. It begins with an overview of theories of future visioning. Next is a synopsis of some past efforts to develop visions for the future of the construction industry. The literature review concludes with a discussion of a few past CII endeavors into future visioning.

2.1 - Theories of Future Visioning

Looking into the future with the attempt to understand and make predictions is an age-old process. Arguments have been made that all human decisions are based around some expectation of a future. Even those who decide to maintain their current actions seem to be acting under the assumption that the world they will face in the future will be similar to the world they are facing now (Rescher, 1998). Throughout history, people have looked for ways to help them predict their uncertain future. One of the most famous attempts of a society to understand its future can be seen in the Greek Oracle at Delphi (Kunstler, 2008). This is a classically cited example of people looking to predictions to determine their own course of action. In the United States, The Old Farmer's Almanac has been in publication since 1792 (Hale, 1991). The Old Farmer's Almanac does not necessarily represent a cutting edge scientific futurist study, but the consistency with which it's been published helps to illustrate, in some sense, an American desire to understand the future in order to make better decisions.

Forecasts of the future are all around us and have become a major part of everyday life. One very commonly used forecast in modern society is the weather forecast. In the recent past,

much research has been done in the field of meteorology and dramatic advances have been made with the aid of modern computer technology (Harper, 2008).

> "Meteorology has undergone significant disciplinary changes in the past 100 years. Early-twentieth-century meteorologists would be amazed by today's practice of their science. Once an art that depended on an individual forecaster's lifetime of local experience, meteorology has become a sophisticated, theoretical atmospheric science" (Harper, 2008, p. 2).

While the methodology employed has changed dramatically, the basic goal of being able to understand weather phenomena has remained the same. However, as methodologies have become more advanced, additional uses for weather forecasts have been realized. For example, adverse weather forecasts from around the world can have impact on the price of US domestic agriculture prices. This is a relatively recent phenomenon that can be linked both to the increasingly globally linked agriculture system as well as more reliable weather predictions(Letson, Podestá, Messina, & Ferreyra, 2004).

Forecasts of the future are also common in engineering. For example, In civil transportation engineering, it is crucial that designers consider projected future traffic flows as they plan for new transportation projects. Transportation projections, like forecasts in many other disciplines, have been greatly improved because of advancements made in computer modeling.

One of the goals of any futuring exercise is to answer the question: 'How is the future different from today?' Edward Cornish argues that "The goal of futuring is not to predict the future, but to make it better" (2004, p. xii). A very closely related question is: 'What should my organization do to react to these changes?' These questions correctly imply that studies of the future do not have the goal of predicting exactly how future events will unfold. The goal should really be to

understand the range of potential future scenarios and how those predictions impact the individual or organization conducting the study.

In order to meaningfully identify how the future is different from present conditions, the environment of the present must be understood. Present conditions represent a critical step in the journey toward the future. As Dr. Kris Nielsen of Pegasus Global Holdings recognize, “The future will be primarily a derivative of what we have today” (personal communication, 2008).

Generally, the path to the future is made up of many incremental steps and occasional major breakthroughs. Dr. Peter Bishop makes the observation that those conducting futurist studies, unlike science fiction authors, must draw a plausible line of action from present conditions to possible future conditions. One way of visualizing the timeline of scenarios from the past to the future is presented by Dr. Charles Taylor as ‘The Cone of Plausibility.’

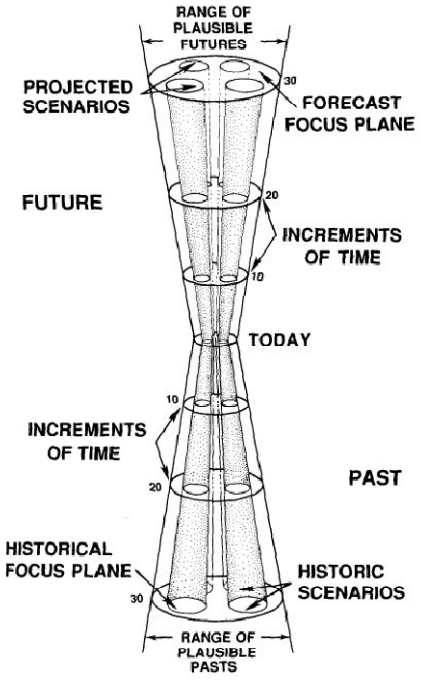

Figure 2: The Cone of Plausibility: Past and Future (source: Dr. Charles W. Taylor)

The Cone of Plausibility implies that there is inherent uncertainty not only in projections of the future, but also in the understanding of the present and past. Especially in today's complex society, the amount of information that individuals can process is fairly low in comparison to the amount of information available. Our understanding of the present is limited; researchers must remain cognizant of this fact (Cornish, 2004).

Efforts to study the future, often termed 'futuring' have developed from an esoteric and philosophical study to a more mainstream science. Futures studies programs are in place at many institutions worldwide. In the United States, the University of Houston offers a Master of Technology in Futures Studies in Commerce(University of Houston, 2009). The term 'futures' is preferred because futurists want to communicate that there are many possible futures rather

than imply that there is only one future that should be viewed fatalistically (P. Bishop, personal communication, 2008) .

2.1.1 - Specific Futuring Methodologies

There are a great number of futuring methodologies that have been developed and implemented by people all over the world. They can vary in their level of complexity and accuracy of results obtained. The best methodology must be determined by the individuals conducting the future study based on their needs and the available resources. Cornish presents a good overview of futuring methods in his 2004 book. A listing and summary of the methods presented in the book follows in Table 1. Many of the methods overlap and are interrelated. An effective futuring study would typically make use of several of the methods suggested in Table 1.

Table 1: Overview of futuring methods presented in Cornish, 2004

Method	Summary Explanation
Scanning	Scanning typically consists of a continued review of selected literature and publications in order to understand changes and trends.
Trend Analysis	A specific trend is selected for analysis. Generally this method relies on past data in order to understand how the trend has progressed.
Trend Monitoring	A specific trend is selected to be monitored. Continuing efforts are made to keep the record of the trend up to date.
Trend Projection	When numerical data are available, it can be possible to project a given trend into the future. This type of projection often assumes continuity.
Scenarios	Scenarios usually develop after asking the question 'what if…?' Scenarios are often presented in narrative form as a way to explore possibilities
Polling	Polling relies on asking individuals for their input on their thoughts of the future. This method often consists of surveys and interviews.
Brainstorming	Brainstorming is related to polling but differs because it relies on group discussion to develop findings
[illegible]	[illegible]

2.1 - Past Efforts to Develop Visions for Construction's Future

Many future studies have been completed for the construction industry. Developing a better understanding of the future affecting an industry has large appeal among industry professionals. Each study has the goal of developing a better understanding of the future, but the approach used can vary dramatically. Really, there is no standard model of how to conduct a study of the future of the construction industry. This should not be seen as an indictment of the industry, but rather an acknowledgement that each study is undertaken with a different set of circumstances,

with different objectives. Future studies of all types have some bias of the researchers involved embodied in the findings. Researchers can do their best to minimize their own biases in the results of the study, but some level of bias is inherent.

A study produced by the American Society of Civil Engineers (ASCE) naturally contains a perspective associated with the Civil Engineering profession. This is not a criticism of any ASCE effort. However, it is certainly possible that another organization made up of construction contractors, such as the Associated General Contractors (AGC), could analyze the same data-set as ASCE researchers but arrive at quite different interpretations of that data. This discussion may seem intuitively obvious, but it illustrates that fact that there cannot be a universally accepted construction future visioning methodology. Furthermore, because future vision studies are undertaken by organizations with certain strategic goals, it is not possible to produce a single, fully complete document that relates to the future affecting the construction industry.

One interesting study was undertaken to conduct a critical review of efforts to document the future of construction. The findings of the various studies along with their respective methodologies were compared. The researchers determined that most of the future studies they reviewed didn't produce results that were dramatically different than non-futurist studies. They made a judgment that the reports were "less about the future than the present." One of the key recommendations found by the report was that organizations conducting future studies must be constantly aware of their ability to influence the scenarios of the future (Harty, Goodier, & Soetanto, 2004).

ASCE raises the question of how their profession will react to the changes of the future. With the increasingly wide spread availability of computing technology, traditional civil engineering

tasks can be completed very rapidly and accurately with computer software. They foresee two major alternatives. One alternative has Civil Engineers functioning from a higher level, better able to manage the whole system while the other alternative relegates civil engineering to a commoditized profession (American Society of Civil Engineers [ASCE], 2007). ASCE recognizes that they cannot and should not view these alternatives fatalistically. There is no one better to answer the question of which alternative becomes reality than the leaders within the civil engineering profession.

Conferences often try to address the state of affairs of the future. They have the advantage of being in an environment with some of the people responsible for making decisions present at the conference. One such example is an effort conducted by Chinowsky and Songer as they attempted to develop a vision for the construction engineering professional of 2020. One of their key findings was that the construction engineering professional of the future will increasingly fit into the role of integrator. This individual will need to have an even greater balance of skills between leadership, management, and technical understanding (Chinowsky & Songer, 2005). Others might argue that the construction engineering professional of today already fulfills that role.

Whenever any study of the future is published, it will be met with varying reactions. Some will view the findings as being farfetched while others claim to be already experiencing the findings presented. The key point for any individual or organization to keep in mind when conducting or reviewing future studies is that no document can present a fully informed view of the future. It will always be the responsibility of the individual organization to determine how the future impacts them specifically.

2.2 - Past CII Efforts of Future Visioning

CII in the past has conducted studies to develop visions for the future impacting the construction industry at large with a specific focus on the CII members. Recently, the CII Strategic Planning Committee (SPC) has conducted an annual environmental scan to identify key issues and trends with the potential to affect CII's members. In recent years, the findings of the have been termed the Emerging Trends Report. The findings of this scan are analyzed to assess the impact on CII's strategic plan and are distributed to CII members. It is the goal of CII to continually revisit this effort so as to remain continuously aware of the changing state of the future. Since the research for this thesis was conducted in conjunction with CII, past CII studies served as a basis for much of the research efforts.

Because of the nature of the study and the diverse makeup of CII, trends must often be analyzed at a broad level. The issues identified in their reports represent key issues with potential to impact the capital facility development process. It is best left to individuals and organizations to react and bring about the change that matches their strategic vision. Even though most trends and visions represent organizational challenges, they can often be viewed as potential opportunities. Their report should be utilized in the context of other references and indicators to identify key areas for potential impact.

2.2.1 - 2007 Emerging Trends Report Discussion

In 2007, CII released an Emerging Trends report which served as a foundation for much of the research effort for this thesis. The primary research methodology used to compile the document was to analyze the 2006 Emerging Trends Report and compare it with articles and personal experiences of the report authors. The primary focus was on looking at trends from a broad

level and determining if there was any way that the CII strategic plan needed to be modified. When the thesis author worked with the CII team, it was a goal to develop a more formalized methodology.

Chapter 3: Methodology

3.1 - Overview

In conducting the futuring study, it was determined that it would be useful to look at the future in terms of medium-range and long-range. In order to accomplish this goal, two separate time horizons were selected.

In most cases, the aspects of the potential future identified in this document are relatively broad in nature. By maintaining a broad perspective, it is possible to maintain an understanding of how the system functions as a whole without getting too caught up in the detailed workings of that system. While it may have been possible to single out specific industry sectors, the authors found it to be more prudent in this instance to focus on themes affecting vast sectors of the industry.

3.2 - Two Time Horizons

Two time horizons were selected for focus when developing future visions, medium-range and long-range. Researchers expected that the each of the two time horizons would allow for different, but overlapping conclusions and findings to be realized. Different methodologies are appropriate for studies at each time horizon.

3.2.1 - Medium-Range Future: Emerging Trends

It was recognized that the medium-term future plays a critical role in the strategic planning process of organizations associated with the construction industry. For the medium-range future, the researchers selected a target time horizon of three to five years into future, the years 2011-2013. It was hoped that this time horizon would be near enough to allow for

somewhat realistic predictions while at the same time being distant enough into the future that visioning could proceed without specific references to present market conditions. It was also helpful to set a target time horizon of three to five years into the future because that is the time horizon selected by previous CII task forces and. It is preferred to maintain uniformity from year to year whenever possible.

After deciding a time horizon, it was necessary to determine what the focus of the researchers would be. One of the goals of the study was to identify issues that could potentially have wide impact, but were not yet widespread throughout the construction industry. However, it was also necessary to target issues that are broad enough to affect a large cross section of the construction industry, specifically the member companies of CII.

The process of looking at the medium-range future in terms of broad issues with the potential to have an impact in the next three to five years was termed the 'emerging trends process.' In the context of this thesis, emerging trends are those issues or forces with the potential to have impact in the next three to five years. Emerging trends by their nature have not presently been adopted by much of the construction industry. There may be pockets within the industry that are experiencing or facing aspects of these trends, but the effects have not yet been fully realized across the industry.

3.2.2 - Long-Range Future: Blue Sky Visioning

Another component of developing visions for the future of the construction industry was looking into the longer-range future. The time horizon selected for the long-range future was seventeen years into the future, at the time of publication the targeted year for the visions was 2025. 2025 was selected as target for the long-range for a few reasons. First, it is far enough into

the future that current economic fluctuations can almost certainly be ignored. Second, 2025 isn't so far into the future that it can't be understood at all. For example, a target time horizon of 2100 would have most likely been entirely too far into the future to give meaningful results for the type of study being conducted. Third, CII was also committed to work on a book chapter discussing construction project management in the year 2025, this made 2025 convenient selection. The researchers termed this visioning process for the future affecting the construction industry in the year 2025 the 'blue sky visioning process.'

Similar to the focus of the medium-range visioning process, the focus of the blue sky visioning process was on developing an understanding of the future affecting broad swaths of the industry, particularly CII member companies. Blue sky visions by their nature have a great deal of uncertainty. In fact, it can be argued that visions of this sort cannot be predicted with any more than a vague level of accuracy. Especially, when developing such long- range visions for something as complex as the entire construction industry, there are a whole host of factors that can dramatically alter the predictions.

Even though the blue sky visioning process is unlikely to produce exact results, it is still a helpful exercise in identifying potential future scenarios so organizations can remain aware of future threats and opportunities. As previously discussed, accuracy of predictions is only important as it relates to the planning purposes of an organization. Most often, blue sky visions are presented as a range of possibilities, contingent upon a great deal of external factors. What this document aims to do is develop a working set of blue sky visions that can be reevaluated as time progresses. It may be found that past predictions hold true as new events occur. However, it is much more likely that blue sky visions will need to be updated to reflect changing events.

3.3 - Trend Maturity Curve

Before determining the exact methodology to use, the researchers hypothesized how trends might progress in the construction industry. The research team has visualized a Trend Maturity Curve (Figure 3) adapted from a traditional technology adoption curve. For a given technology, the percent household market penetration on the vertical axis with time on the horizontal axis(Hartig, 1998). The maturity of a trend on the Maturity Curve relates to the development of that individual trend with respect to its full potential. Some trends can become fully 'mature' without necessarily being implemented by 100% of the construction industry. For example, cable TV is a considered to be a fully matured US cultural trend even though it has only 70% US household penetration (Hartig, 1998).

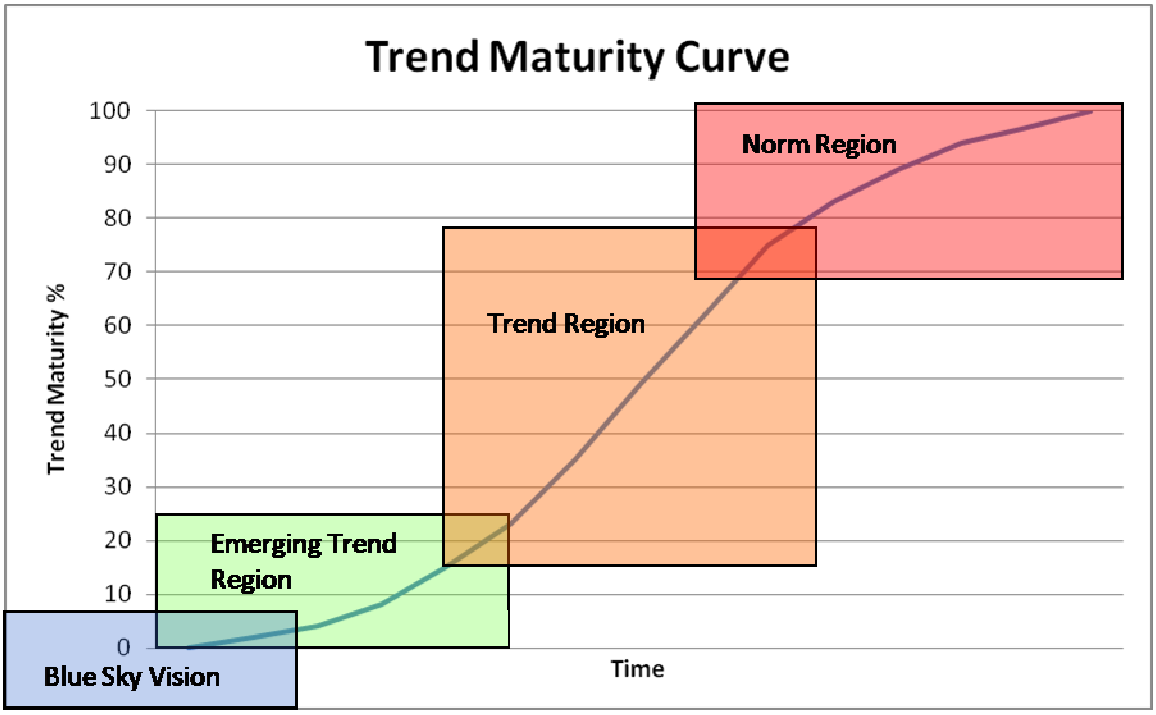

Figure 3: Trend Maturity Curve

Emerging trends can be thought of as being at the early stages of the Trend Maturity Curve. Some trends fit this characterization better than others. As an example, it is more fitting to characterize the adoption of three-dimensional project visualization software on this Curve than it is to characterize demographic and labor trends on the same curve. There is some applicability, but the fit is far from perfect. It must be made clear that the trends identified in this document have not been assigned a specific location on the Trend Maturity Curve; that type of analysis is beyond the scope of this study. It would take a much longer study with ongoing targeted standard data collection techniques to achieve such results.

The visualization of the Trend Maturity Curve gives one potential path; individual trends may develop faster or slower. Individual trends can also recede off the maturity curve without ever fully maturing. The region boundaries identified on Figure 3 suggest a general classification and are subject to individual interpretation. Because of the inherent uncertainty of trend analysis, it is impossible to objectively characterize any particular trend within strict borders.

3.4 - Emerging Trends Methodology

The researchers determined it would be most effective to use the 2007 Emerging Trends Report as a foundation for the 2008 research effort. The 2007 report identified many trends separated into six distinct categories:

- Workforce and Human Capability
- Project Delivery
- Corporate Strategy
- Technology and Innovation
- Markets and Demand Drivers
- Social and Political Influences

For purposes of convenience and clarity of analysis (Cornish, 2004), the researchers maintained the categories of the 2007 report during initial stages of analysis.

The methodology consisted of three main components:

1. Release survey to construction professionals from CII member companies to get feedback on their thoughts about the trends.
2. Conduct interviews with individuals associated with the construction industry in order to provide anecdotal evidence and clarification of survey responses.
3. Perform comprehensive literature review.

At the onset of this study, researchers envisioned a much more involved research methodology. This original methodology was unable to actually be implemented because of time and resource limitations. Also, CII demanded results earlier than could be delivered utilizing the originally intended methodology. The initial methodology was, in hindsight, overly ambitious as CII transitioned from past emerging trends efforts to 2008 study.

While the actual methodology implemented in the study was less elaborate than originally anticipated, the results obtained with the reduced scope methodology were appropriate given the goals of the study.

3.4.1.1 - Survey

In 2008 a survey was developed to reflect the emerging trends identified in the 2007 Emerging Trends Report. It is included in this report as Appendix A: 2007 Emerging Trends Validation Survey. This survey was distributed to CII Board of Advisors (BoA) members and they were asked to give feedback for each emerging trend and identify new trends in each trend category. The CII BoA is made up of representatives from across CII. It's makeup reflects the balance of owners

and contractors that make up CII. It is the hope of the researchers that the survey will be revised each year to reflect the previous year's Emerging Trends Report in order to monitor trend development. Respondents were asked to rank the likelihood and impact of each emerging trend. Likelihood corresponds to the probability of each emerging trend becoming a significant force in the construction industry, ranked on a scale from 0-100%. Impact corresponds to the potential impact a given emerging trend would have on the industry if it was to become an industry trend, ranked on a scale of 1-5 (1: Low, 5: High). The results of the 2007 Validation Survey are summarized in the report section titled '2007 Emerging Trends Validation Survey: Summary'. Additionally, a more detailed survey analysis is included as: Appendix B: 2007 Emerging Trends Validation Survey Analysis.

3.4.1.2 - Interviews

One of the final questions on the survey asked if the respondent or someone else in their organization would like to participate in an interview with the research team. After the survey was analyzed, interviews were conducted with selected individuals and typically lasted 45-60 minutes. Interviews were documented so responses could be analyzed categorically. It was intended to contact additional industry leaders, not members of CII, but this wasn't possible given the realities faced by the research team. In all, 17 emerging trends interviews were conducted. Summary Transcripts of the Emerging Trends Interviews can be found in Appendix C.

The purpose of these interviews was to provide additional insight and anecdotal evidence for the survey findings. It was recognized that these professionals are individuals who will be making decisions that will bring about the change predicted for the future. These interviews followed a standard format so that results could be compared between interviews. The format

was to ask each interviewee a set of questions and then discuss trends which had overall importance as well as questions which the survey respondent felt strongly about. Even with a standard format, the interviews ended up being somewhat nonstandard because each of the industry professionals had different experience and interest with the various trends.

Additionally, it was decided that it would be best to maintain the confidentiality of each of the interviewees so that they could provide open and honest information without compromising the competitive advantage of their respective organizations.

3.4.1.3 - Literature review

The interview process and survey results provide a frame of reference for a literature review. The literature review served as a way to validate and enhance interview responses and provide additional understanding.

While it was originally intended to conduct an involved comprehensive literature review and to engage in a data collection effort, this proved to be beyond the scope of this study. If this study was to continue into the future, it would be possible to collect objective data that could serve as a way to predicate and validate trend findings.

3.5 - Blue Sky Methodology

Referencing the Trend Maturity Curve developed by the research team Figure 3, blue sky visions are at the very low end of the curve. Even now, some visions have begun to be implemented and realized in minor or experimental stages. Other visions, however, have not yet been felt by any organizations within the construction industry.

The Blue Sky Visioning process is similar in many respects to understanding emerging trends. The key difference between emerging trends and blue sky is that the blue sky visions are virtually unquantifiable. As previously discussed, it was recognized that the methodologies employed to conduct the blue sky visioning process needed to be different than the methodology employed for the emerging trends analysis. The findings would be more abstract in nature. There couldn't be conclusive evidence that could necessarily prove a given point. Surveys are less relevant with this analysis. After some deliberation, it was determined that the blue sky methodology would consist of two main components:

1. Interviews were conducted with industry thought leaders from across the construction industry. These people would be individuals intimately familiar with how the construction industry interacts with its surrounding economic, social, and physical environment. Examples could include: educators, politicians, consultants, construction professionals, professional futurists. It was also hoped that interviews could be conducted with people from the United States and abroad. It was theorized that with these diverse perspectives, a rich portrayal of the future could be presented.
2. A literature review was conducted. Similar to emerging trends methodology, the blue sky literature review would be conducted with the aim of adding additional understanding and validation to interview findings. Also, it was hoped to document past visioning efforts to understand how past visions had been developed and to critically analyze them.

For the blue sky visioning process, there was no prior CII report to serve as a foundation. This was the first recent effort to develop long-range visions by CII.

3.5.1.1 - Interviews

Interviews were conducted with individuals identified in the 2007 Emerging Trends Validation Survey as well as individuals targeted by CII's Strategic Planning Committee. It was recognized

that individuals who are interested specifically with strategic decisions of the next 3-5 years are often not the same people within an organization who are most concerned with or most adept at blue sky visioning. Blue sky interviews were conducted with futurists and visionary thinkers and typically lasted 45-60 minutes.

Researchers tried to maintain some level of standardization between interviews. However, because of the nature of the study and it being the first of its kind within CII, it was essentially impossible to maintain a rigorously standard format. A general line of questioning followed from the individual's background to their visions for the future and what they thought all this would mean for construction project management. In all, nine Blue Sky interviews were conducted. Four were conducted with individuals from CII member companies and five were conducted with individuals from outside organizations.

In future revisions to this study, it would be possible to make a more standardized interview because researchers would most likely have a better idea of the results they were targeting. The blue sky interviews conducted for this study were more exploratory in nature rather than specifically formulated to question a targeted hypothesis.

3.5.1.2 - Literature review

To serve as validation for interviews and to further develop the Blue Sky Vision, a literature review was conducted. Due to the uncertain nature of the long range Blue Sky Visioning process, it is nearly impossible to conduct a 'detailed' literature review because the range of Visions and forecasts varies dramatically. Despite the wide range of forecasts, obtained from the literature review and interview process, a few common themes emerge. Each forecaster may have a different prediction, but there are common topics and themes of discussion among forecasters.

Chapter 4: Emerging Trends, Medium-Range Future

4.1 - Overview

In 2008, the construction industry can best be characterized as year in which existing trends were developed and strengthened with a few major events. Two of the major events have been at the forefront of construction industry are:

1. The continued impacts of the US housing slump as it impacts credit markets and the global economy.
2. Continued fuel and commodity price fluctuation.

Even those two events represent continuing developments of preexisting trends. This study had the goal of looking beyond those market conditions. The researchers wanted to look out farther into the future at the three to five year time horizon. While it is the goal to look farther into the future, it can be difficult to look beyond current conditions. It is challenging to determine whether current conditions represent cyclical fluctuations or meaningful and lasting change. The only way to gain more understanding is to continually revisit and review the trends put forth in this document.

While it was intended to maintain the same categories in this document as the 2007 CII Emerging Trends Report, the original trend categories proved to be a somewhat cumbersome classification method. In this document, the emerging trends are categorized by underlying forces acting as key drivers of trends.

This chapter is comprised of three subsections. In the first, four key drivers of overall construction change are identified and described. The next is a brief summary of the findings

from the 2007 Emerging Trends Validation Survey. The chapter concludes with a more detailed discussion of the trends categorized by each of the four primary forces.

4.2 - Key Drivers

When analyzing the trend environment of construction, the authors realized that there was a better way of classifying trends than the original trend categories from the 2007 CII Emerging Trends Report. A few underlying forces emerged to provide a context for each emerging trend discussed in this report. Typically, individual trend observations were manifestations of these broad-sweeping forces. Presently, the following four issues are the major key drivers impacting the construction industry:

- Workforce and Human Capability: Labor Shortages
- Environmental Considerations
- Global Growth and Interconnectedness
- Productivity and Efficiency Improvements

There was an additional set of trends that were classified as being corporate strategy trends. These trends were not so much trend drivers themselves but rather broad organizational responses to the trends identified in the rest of the report.

4.2.1.1 - Workforce and Human Capability: Labor Shortages

Workforce issues are certainly not a new force impacting the construction industry. However, they do continue to represent a key component in the analysis of nearly all other emerging trends. Even with conditions of US economic uncertainty, workforce shortages have remained

pervasive. Looking further into the future, it is expected that there are systemic and demographic issues with that will adversely affect construction workforce availability.

4.2.1.2 - Environmental Considerations (Energy & Global Warming)

Environmental considerations vary dramatically by industry sector and geographic location. However, nearly all areas and sectors have reported incremental growth in the past few years. Recent spikes in global energy prices have brought the sustainability discussion to the forefront of nearly every American home. Whether it is concern over fuel prices or the attempt to live a carbon-neutral lifestyle, environmental concerns are seldom dismissed as marginal factors. These issues will continue to become increasingly important as dwindling supplies of traditional materials continue to be taxed by an ever-increasing demand for capital facility projects.

4.2.1.3 - Global Growth and Interconnectedness

The drive toward globalization has been affecting the construction industry for decades. However, recent forces have been increasing that rate at which globalization is expanding. Some of the most important factors driving globalization are significant advancements in communication and information technologies coupled with expanding infrastructures (Friedman, 2006). Impacts from globalization have manifested in a multitude of ways including: resource price pressure, emerging labor markets, new project locations, and overall increased competition. While globalization was once a force only having significant impact on organizations operating internationally, increased global competition is affecting all players in the global economy.

4.2.1.4 - Productivity/Efficiency Improvement Methods

For years, the construction industry has lagged behind other industries in terms of overall productivity gains. Some recent studies even suggest that construction productivity has fallen while other industries have seen productivity improvements (Rojas & Aramvareekul, 2003). The specifics of this claim are certainly open for debate. In any case, construction professionals are beginning to experiment with new technology and methods to remedy these issues. There is no standalone simple solution, but taken together, the construction industry has the opportunity to experience significant productivity increases in the next 5-10 years.

4.3 - 2007 Emerging Trends Validation Survey: Summary

As mentioned in the Methodology section, to begin an ongoing data gathering effort, the research team released a survey to the CII Board of Advisors (BoA) in late February of 2008. It is included in this document as Appendix A. This section provides an overview of that survey. A more detailed analysis can be found in Appendix B. The survey was released to the entire BoA. 64 responses were received: 59 complete, 5 partial. The survey respondents had a balanced makeup of owner and contractor organizations: 35 contractors, 29 owners. Survey respondents were mainly individuals in upper management positions. Figure 4 shows the general breakdown of the job titles of the survey respondents. A more detailed listing of respondent job titles can be found in Appendix B.

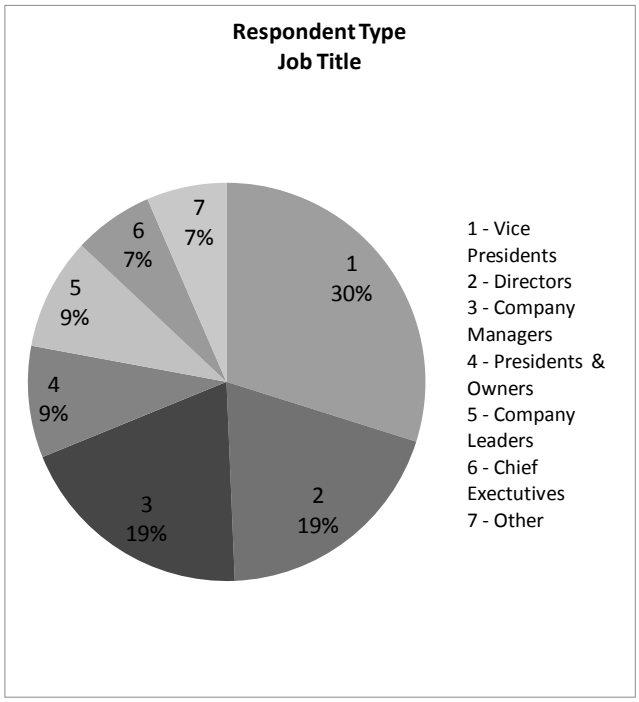

Figure 4: Survey Respondent Type

In general, respondents ranked all previous trends relatively high. This seems to indicate that the trends identified in the 2007 Emerging Trends Report were appropriate after considering the likelihood and potential impact indicated by the respondents. It should be noted that a single snapshot cannot wholly capture all the intricacies of trend analysis. Ongoing study of the development of these trends is necessary to fully understand them. The average likelihood and impact were calculated in order to plot each ordinate on Figure 5. The labels of Figure 5 correspond to the labels shown in Table 3. Equation 1 was used to determine the weight of each trend to determine the ranking of each trend.

$$\boldsymbol{weight} = \frac{\left(\frac{\boldsymbol{Impact}}{\mathbf{5}}\right)+\left(\frac{\boldsymbol{Likelihood}}{\mathbf{100}}\right)}{\mathbf{2}} \quad \textbf{Equation 1: Weight Formula}$$

The validation survey is not the only factor involved in the trend analysis, but it is quite indicative and sets the tone for the rest of the discussion.

While all trends were ranked relatively highly, the category of trends pertaining to workforce issues stuck out as being an area of intense focus. Three of the top four ranked trends pertained to expected labor shortages.

Table 2: Raw survey results -trends arranged by category

Individual Trend Survey Statistics

	Trend	Mean: Likelihood	Mean: Impact	Rank	Weight
Workforce and Human Capability	Lack of Qualified Contractors available to meet current industry demands	67.38	4.33	4	0.77
	Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	70.55	4.38	3	0.79
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	72.75	4.41	1	0.80
	Firms are developing new ways to utilize older workers	57.10	3.19	24	0.60
	Increased emphasis on 'turnover' of knowledge within organizations	64.39	3.63	14	0.69
	More training of unskilled workers to meet labor needs	67.44	3.78	12	0.72
Project Delivery	Modular and prefabrication are becoming increasingly important construction methods	68.90	3.81	11	0.73
	Increased use of integrated data models - design/fabrication/construction	70.58	3.81	10	0.73
	Greater use of 'Lean' principles in construction	59.69	3.47	20	0.65
	Increased emphasis on sustainability	66.03	3.50	16	0.68
Corporate Strategy	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	39.67	2.75	31	0.47
	Companies incorporating sustainability into their Strategic Plan	64.32	3.20	23	0.64
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	64.68	3.20	21	0.64
	Increased use of Joint Ventures to complete capital projects.	66.22	3.45	17	0.68
	EPCs becoming more selective in the projects they pursue	71.03	3.83	7	0.74
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	59.88	3.82	15	0.68
Technology & Innovation	Increase in Clean Energy Initiatives	71.64	3.78	8	0.74
	Increased use of Integrated Project Information Systems	75.59	3.88	6	0.77
	Engineering increasingly using BIM and Rule based Design	64.36	3.36	19	0.66
	Increased use of Trenchless Technology	46.11	2.30	32	0.46
Markets and Demand Drivers	Increased investment in new & renewable energy	76.71	3.83	5	0.77
	Nuclear power returning as a viable energy alternative	66.88	3.41	18	0.68
	Increased emphasis on Clean Energy Technology – CO2 emissions	78.05	4.12	2	0.80
	Increase in the use of Solar Power	54.42	2.66	28	0.54
	China and India continue to demand increasing amounts of EPC resources	73.27	3.69	9	0.74
	New geographic locations emerging as energy exporters	60.26	3.00	25	0.60
Social and Political Influences	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	43.93	2.77	29	0.50
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	65.39	3.16	22	0.64
	Continuing restrictions placed on emissions for developing and industrial countries	70.26	3.56	13	0.71
	Climate Changes are causing significant changes in the construction industry	57.14	3.12	26	0.60
	Regional Warfare causing an increasing need for reconstruction	50.51	2.28	30	0.48
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	57.21	3.09	27	0.59

Table 3: Survey trend listing – trends arranged according to rank

(Table 3 to Accompany Figure 5)

Individual Trends - Arranged by Rank (#-Label Corresponds to Scatter Plot)

Trend	# - Label	Rank	Weight	Mean: Likelihood	Mean: Impact
Decreasing availability of Labor – Trades (Foremen, Craftworkers)	3	1	0.80	72.75	4.41
Increased emphasis on Clean Energy Technology – CO2 emissions	23	2	0.80	78.05	4.12
Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	2	3	0.79	70.55	4.38
Lack of Qualified Contractors available to meet current industry demands	1	4	0.77	67.38	4.33
Increased investment in new & renewable energy	21	5	0.77	76.71	3.83
Increased use of Integrated Project Information Systems	18	6	0.77	75.59	3.88
EPCs becoming more selective in the projects they pursue	15	7	0.74	71.03	3.83
Increase in Clean Energy Initiatives	17	8	0.74	71.64	3.78
China and India continue to demand increasing amounts of EPC resources	25	9	0.74	73.27	3.69
Increased use of integrated data models - design/fabrication/construction	8	10	0.73	70.58	3.81
Modular and prefabrication are becoming increasingly important construction methods	7	11	0.73	68.90	3.81
More training of unskilled workers to meet labor needs	6	12	0.72	67.44	3.78
Continuing restrictions placed on emissions for developing and industrial countries	29	13	0.71	70.26	3.56
Increased emphasis on 'turnover' of knowledge within organizations	5	14	0.69	64.39	3.63
Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	16	15	0.68	59.88	3.82
Increased emphasis on sustainability	10	16	0.68	66.03	3.50
Increased use of Joint Ventures to complete capital projects.	14	17	0.68	66.22	3.45
Nuclear power returning as a viable energy alternative	22	18	0.68	66.88	3.41
Engineering increasingly using BIM and Rule based Design	19	19	0.66	64.36	3.36
Greater use of 'Lean' principles in construction	9	20	0.65	59.69	3.47
Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	13	21	0.64	64.68	3.20
As public infrastructure continues to decay, public funding alone won't increase to meet needs	28	22	0.64	65.39	3.16
Companies incorporating sustainability into their Strategic Plan	12	23	0.64	64.32	3.20
Firms are developing new ways to utilize older workers	4	24	0.60	57.10	3.19
New geographic locations emerging as energy exporters	26	25	0.60	60.26	3.00
Climate Changes are causing significant changes in the construction industry	30	26	0.60	57.14	3.12
Increasing integration of undocumented workers into the workforce to alleviate labor shortages	32	27	0.59	57.21	3.09
Increase in the use of Solar Power	24	28	0.54	54.42	2.66
"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	27	29	0.50	43.93	2.77
Regional Warfare causing an increasing need for reconstruction	31	30	0.48	50.51	2.28
Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	11	31	0.47	39.67	2.75
Increased use of Trenchless Technology	20	32	0.46	46.11	2.30

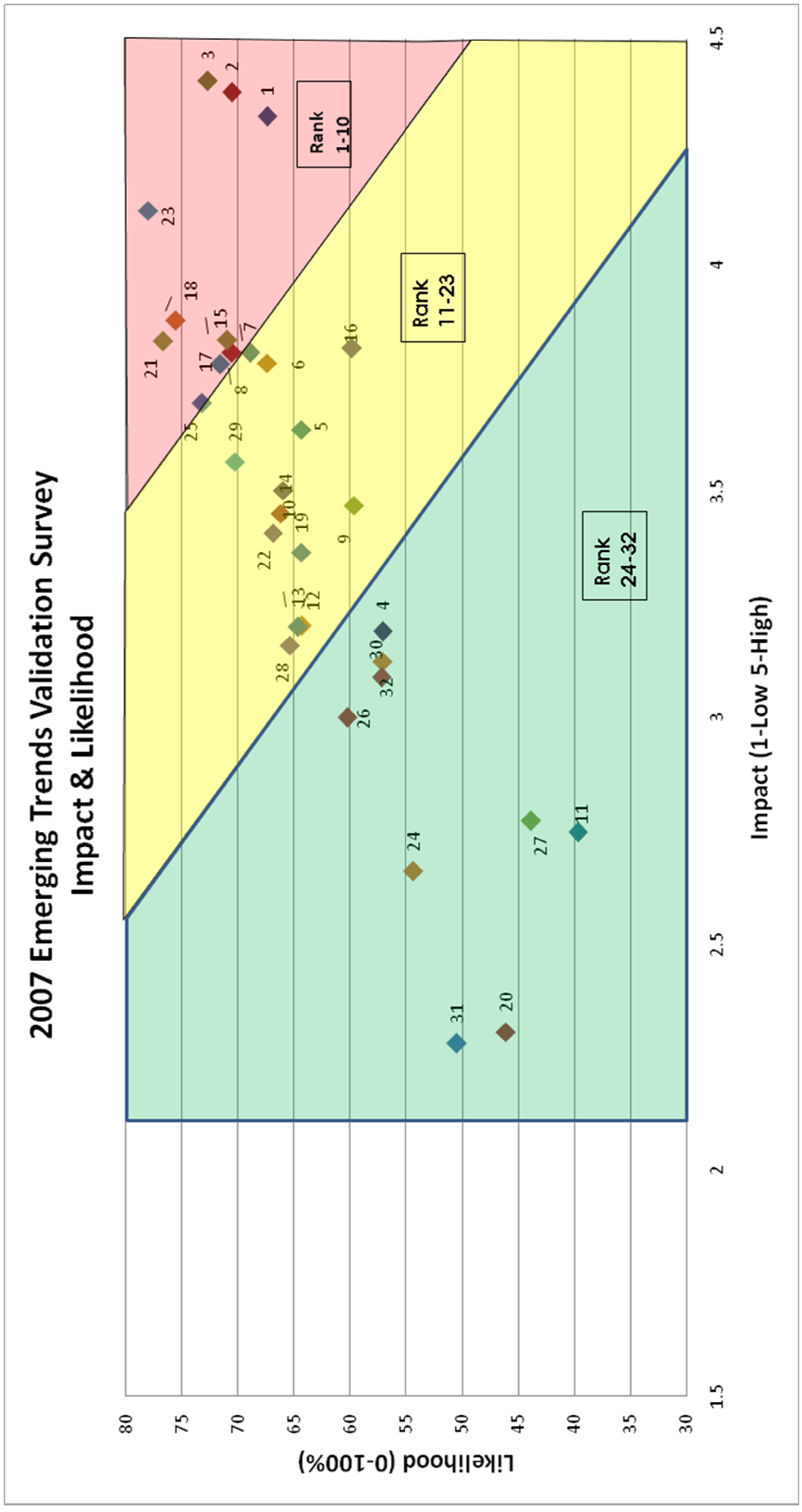

Figure 5: 2007 validation Survey - summary scatter plot (Rank Groupings)

4.4 - Discussion of Each Trend Driver

In this subsection, each of the four underlying forces is discussed. For each force, there is a general discussion followed by a more detailed discussion of the trends associated with that driver. After discussing trends related to each of the four drivers, there is a section discussing trends related to corporate strategy.

4.4.1 - Workforce Issues: Labor Shortage

For the past several years, labor force issues have been a major area of concern and a significant topic of conversation among construction industry leaders. Labor force issues, by their very nature, tend to be cyclic trends that reflect current market sector conditions and business cycle considerations. For the past five years labor force shortage issues have been amplified by a booming construction market. Now, with the current 'credit crunch' and the lagging US housing market, labor shortage issues may be somewhat alleviated. However, there are still underlying factors that continue to impact workforce availability. Figure 6 outlines the relationship of the trends identified in the workforce section. The discussion of workforce issues is separated into two subsections, one addressing the labor shortages themselves and a second subsection addressing organizational responses to these shortages.

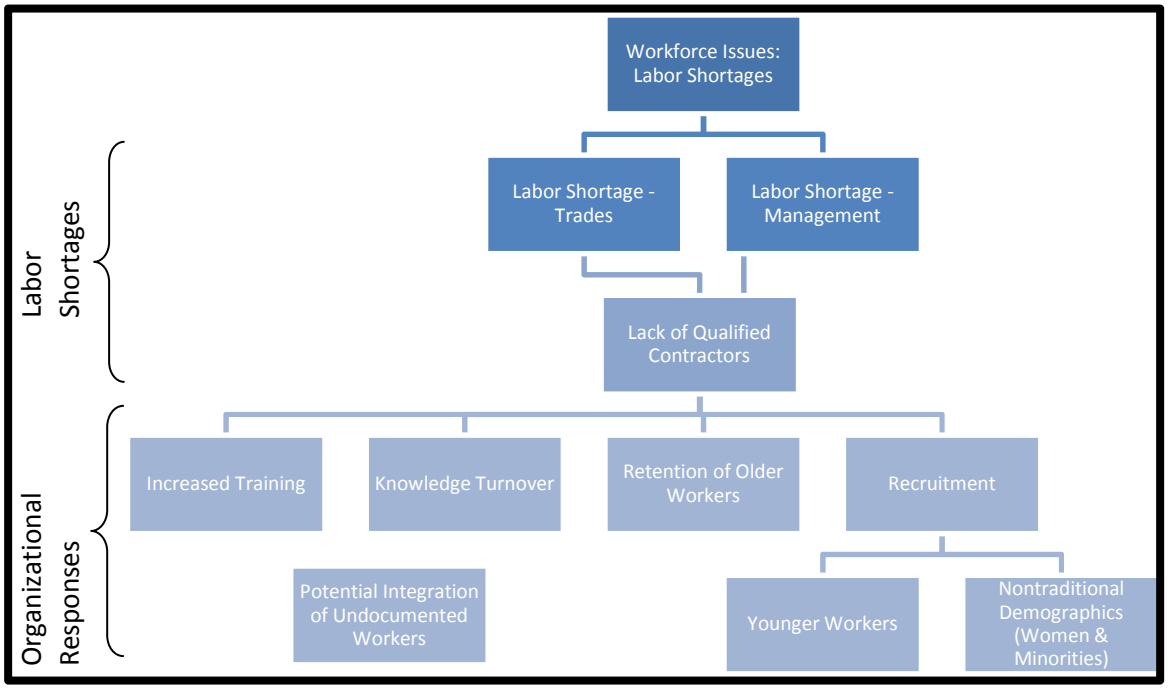

Figure 6: Workforce Issues – Visualization

There is some sentiment that the construction industry simply isn't as appealing to potential workers and therefore the workforce is not being replenished at a sufficient rate to make up for the significant portion of the industry entering retirement. Some commonly cited reasons for this lack of appeal are as follows:

- Lower wages compared to similar industries
- Perceived lack of prestige
- Long working hours
- Potential and frequency of relocation
- Perceived to be less innovative compared to other industries
- Dirty working conditions
- Industry seems slow to change

Some of the above referenced reasons people give for not entering the construction industry could be considered perceptions rather than views factually supported evidence. Nearly all professionals with substantial industry experience are truly passionate about their work as indicated during the interview process. They are eager to share their positive experiences with

others. There is a tremendous opportunity to convey this palpable excitement to individuals who may potentially be integrated into the construction workforce.

4.4.1.1 - Labor Shortage Issues

4.4.1.1.1 - Decreasing availability of labor: trades (foremen, craftworkers, laborers)

When evaluating all of the trends impacting the construction industry, this trend is very often recognized as the single most important force impacting the industry. Decreasing labor at the trade level was top ranked trend by 1/6 of survey respondents. This trend is pervasive throughout many geographic locations and nearly all industry segments.

This trend is expected to intensify in the near future. Trade worker numbers are not sufficient to replenish the aging workforce who has begun to retire according to several interview respondents. This trend has differing levels of impact for different trades. The problem is especially severe in trades requiring more training: plumbers, electricians, carpenters. However, there are also issues in more labor intensive trades: iron workers, masons, concrete workers.

Current market conditions in residential and light commercial have only slightly alleviated the labor shortage of most of CII's member companies. In fact, craft workers have been exiting the residential sector and attempting to integrate into the rest of the construction market. This transition has not been easy or simple. Residential trades workers are often not accustomed to the rigorous code standards encountered by most projects associated with CII members. While the work may be similar, there are key differences in the skill set required for work on complex petrochemical refinery compared to a stud-framed single family residential home. It has also

been noted than many of these new workers entering from the residential market are not used to the strict safety guidelines of most US commercial and industrial projects.

This trend is pervasive throughout most of the United States and Canada with some of the hardest hit areas being areas not having as much access to immigrant labor.

4.4.1.1.2 - Decreasing availability of labor – management (executive, project management, superintendent)

The discussion of this trend is a continuation of the discussion regarding labor shortages at the trade levels. For many of the reasons listed in the opening discussion of the Workforce Issues: Labor Shortage section, a decreasing availability of management level labor is pervasive throughout most construction sectors and geographic locations. This trend was ranked as the third most significant trend on the 2007 validation survey, close following the top ranked labor shortage identified at the trade level. The two labor shortage trends, at trades and management levels, have a great deal of overlap. However, they have been kept separate so as to acknowledge their unique intricacies and solutions to the two issues.

Many interviews revealed that organizations are facing major constraints on their management resources. Project managers are being asked to take on increasing amounts of responsibility. Contractor firms indicated that they were bidding less work than they would like because their managerial resources are constrained. Some owner firms even indicated that lack of staff was a reason for delaying or cancelling projects. Some companies have found offshoring of detail engineering to alleviate some of their staffing difficulties. This offshoring of management and traditional engineering work might actually be considered a trend all to its own (Friedman, 2006).

In recent years, there has been much discussion about decreasing numbers of US engineering graduates, especially when compared to India, China and now Mexico. A 2005 study released by Duke University calls into question some commonly referenced statistics and argues that the state of the US engineering class isn't as bleak as once thought by critics(Gereffi, Wadhwa, Rissing, & Ong, 2008). Most CII firms have had recent success recruiting college age students, partly due to an increased emphasis on recruiting.

In the management levels of the construction industry, voids left by retiring workers seem to be being replaced by young, inexperienced new hires. This provides insight into an interesting phenomenon. Many firms indicate that they are currently lacking mid-level management experience. Their organizations seem to have adequate numbers of experienced individuals who are 55 years old and older. They seem to be sufficiently replenishing their younger ranks with new-management who are 35 years and younger. However, there seems to be a gap in the 35-55 year range which could be caused by a range of factors.

This gap is in part caused by demographic trends as the US economy moves from the 'baby boom' generation to the subsequent 'echo-boomers.' Also, many interviews recognized that the difficult market conditions that were common in the 1980's discouraged many would-be project managers from entering into or staying in the construction industry. As technology was advancing rapidly during the 1980's, organizations were able to develop higher levels of productivity with their already experienced management staffs. These, along with many other potential factors have led to this current experience gap. Additional research could be done to gather empirical data on this aspect of this trend.

This gap in experience may turn into a net-positive experience for the industry. It is forcing many organizations to focus more on knowledge turnover from their very-experienced management staffs to the new generations looking to fill big shoes. Getting these two age groups to communicate is not necessarily easy or straightforward. The two generations have grown up with very different communication technologies and have different ideas about work-life relationships. Translating industry wisdom to individuals born with a joystick in hand may lead to new ways to confront and overcome obstacles (BS: interview F). Interaction between these two age cohorts also brings new dimensions of diversity to the construction problem solving process and may lead to significant breakthroughs in the next five years.

4.4.1.1.3 - Lack of qualified contractors available to meet current industry demands

For the past few years, there has been a lack of qualified contractors available to provide services for the development and delivery of capital facilities. This trend continues to be significant. It was ranked as the 4th most important trend based on the 2007 trends validation findings. This is a complex issue that may be shifting with uncertain economic conditions facing the United States. Thus far, large and industrial contractors have not been impacted significantly by the downturn in the rest of the economy. Demand for projects remains high due to a variety of market forces including: emerging economies, current high oil prices, retrofitting existing facilities for sustainability concerns.

This trend was ranked more important by owners compared to contractors. The average ranking by owners was 8.2 compared to 11.3 by contractors. This shows that owners felt this trend was of a higher impact and likelihood. Some of the employees of owner companies interviewed by

the research team indicated that they have seen fewer contractors bidding on their recent projects.

This trend is very closely related to the prevailing labor shortages. Survey respondents who ranked this trend as having a high impact also indicated significant labor shortages. This implies that one of the main resources that construction teams are lacking is qualified people. This trend seems less like a standalone trend and more like an indicator of the current and future labor force issues.

4.4.1.2 - Organizational Responses to Labor Issues

4.4.1.2.1 - More training of unskilled workers to meet labor needs

As the labor shortage at both the trades and management levels is expected to continue, firms are constantly looking for new ways to deal with these resource constraints. One option that many firms have turned to is increased use of company training programs for workers who lack the skills to work effectively. Much like traditional union apprenticeship programs, firms have developed company skills development training. This training ranges from safety training, to training in new information technologies, to cross discipline development so workers get exposed to the whole building system and learn how the process is interrelated. Some organizations are emphasizing a training called ‘multiskilling’ in which workers are trained in multiple work processes that occur on a given project type.

While many firms have developed in-house training, some have also turned to local organizations to help with this training. For some, it is as simple as continuing support for local union worker development. Others have begun to partner with more traditional educational

institutions (high schools, community colleges, vocational schools) to develop specific skills that are required in the current construction climate. It is expected that the trend toward more training is going to increase as the technical demands placed on the average worker continue to increase. There have already been studies that have shown positive correlation between computer knowledge and worker pay.

4.4.1.2.2 - Increased emphasis on 'turnover' of knowledge within organizations

As previously mentioned, many organizations operating within the capital facility development process are experiencing an experience gap. In recent years, the need to retain lessons learned has become very apparent. Each project represents valuable earned experience. Organizations that have been able to integrate successful knowledge management practices have been able to notice significant advantages.

4.4.1.2.3 - Firms are developing new ways to utilize older workers

Utilizing older workers in nontraditional ways is by no means a new concept. As long as people have been retiring, companies have been looking to retain the great experience these individuals have. However, with current demands on management resources and continual development of information and communication technologies, companies have developed some very creative ways to culture and maintain healthy involvement from their experienced management staff. US Bureau of Labor Statistics expects the labor force made up of individuals over the age of 55 to have a growth rate of nearly four times the overall workforce (Toossi, 2004, p. 13).

Many of the construction professionals interviewed by the research team indicated that they are very happy with their jobs. They have all worked a lifetime to get to their current level within in the industry. The concept of a forced retirement at age 65 is simply not appealing. However, many of these experienced workers are beginning to look for less strenuous or taxing roles within their respective organizations. Firms able to implement ways of retaining the expertise of their aging workforce, while being mindful of their changing needs, will have a competitive advantage over competitors. Often, companies move some of their most experienced human assets into training roles within their organizations, either formally or informally. Interviews and survey respondents indicate that there has been an emphasis placed on 'training one's replacement.' This shows a shift away from individual protectionist views. Organizations have realized and communicated that need for collaboration of information.

4.4.1.2.4 - New recruiting efforts: younger students and nontraditional demographics

Construction organizations have been recruiting at the university and vocational school level for many years. However, recently, companies have begun to reach out to younger and younger individuals. It is not uncommon for individual organizations to partner with local high schools to offer programs to students emphasizing engineering skills and leadership training. However, outreach is not limited to high school age students. Some companies have even been working with elementary and middle schools to offer programs that introduce the engineering profession and their specific industry. Significant recruiting directed toward this young age group is a relatively new phenomenon. It will be some time to determine the outcomes of these efforts.

Also, companies are beginning to reach out to demographics traditionally overlooked by the construction industry. Minority students have traditionally had less presence at the engineering and construction management levels. Women have often had low presence at the trades and management levels (Galloway, 2008). As the industry continues to experience workforce shortages, these groups may play key roles in filling voids in the labor resource pool.

4.4.1.2.5 - Potential integration of undocumented workers

The issue of immigration is not new to the US political setting. Politicians have been discussing possible solutions to the issue with increased focus over the past decade. As construction labor markets continue to face shortages, there may be increasing pressure placed on government to reach a solution that relaxes the nation's immigration policy while maintaining necessary national security measures. Survey respondents were quite mixed on this issue. Reflecting the political divide on this issue in America (Longworth, 2008), construction professionals are divided as to how to best utilize immigrant labor in the United States. Some consider an immigrant workforce critical to the future success of the construction industry and the larger American economy. They claim that measures need to be taken to change immigration laws to allow for more foreign workers. Others take a more hard-line approach and say that anything short of deportation of illegal and undocumented workers amounts to amnesty for law breakers. The outcome of this controversy could have major ramifications for the state of the construction economy.

With an increased labor supply, downward pressure is placed on wage rates. While there is downward pressure on wage rates, there can be less incentive to invest in new productivity

increasing technology. There will always be competitive advantage for productivity gains, but low wage rates lessen those advantages.

4.4.2 - Increased Environmental Considerations (Energy & Global Warming)

The discussion on sustainability has grown increasingly important in recent times. Throughout much of the latter part of the 20th Century, environmentalism had a presence, but its presence was at the margins of society. Its impact on decision makers was correspondingly marginal. However, recent developments such as the global warming discussion and rapidly rising energy costs, environmental concerns have taken the stage as a component in the decision making process. While sustainability concerns have increased, they have not become critical to the overall decision making process.

With this trend, it is especially difficult to define a consensus across the entire construction industry because of the many differing viewpoints. Some survey respondents indicated that these trends were among the most significant while others communicated that environmental issues have had a very negligible impact on their routine business operation. Two of the highest ranking trends of the 2007 Validation Survey were ‘increased emphasis on clean energy technology’ and ‘increased investment in new & renewable energy.’ While some of the lowest ranking were ‘increased use of solar power’ and ‘climate change to have significant changes in the construction industry’.

Overall, the only consensus found between CII members is that world has not yet found a comprehensive energy solution that will truly revolutionize the power generation industry. Even with technological advancements coming from across the globe in all sectors of the economy,

many construction professionals indicated that today's energy production systems will remain fundamentally unchanged for the next several decades.

4.4.2.1.1 - Increased investment in new and renewable energy sources emphasizing low CO_2 emissions

This report is not designed to be a complete forecast on emerging energy technologies related to the construction process. In order to fully discuss those technologies, a much more focused report would be necessary. Hosts of books, publications, and reports exist that discuss the current energy climate and how it progresses to the future. This report can only give a limited overview of some of the main ideas being discussed with regard to new energy solutions.

Even while many remain skeptical of the energy policies in place in the US, there has been increased demand for clean energy projects(McGraw-Hill Cosntruction, 2008). Many contractors have formed new business units to deal with these new project types. Some contractors have also seen increases in work orders for retrofits on existing facilities to modernize these projects to conform to new environmental policy issues. The current drive toward new and renewable energies has been a strengthening project demand driver.

4.4.2.1.1.1 - Nuclear power returning as a viable energy solution

Nuclear power is returning as a viable energy solution throughout the globe, but it is especially true in Canada where some regional governments have stated policies to decrease power generation from coal generation facilities. Ontario Power Generation already operates three nuclear plants with new projects in the works (Emerging Trend Interview I). The US has seen increased interest in nuclear power, but at the time of publication, no new permits have been approved for construction. The debate remains as to the fate of nuclear power generation and

its contribution to the US energy supply, but it is certainly re-entering the discussions of decision makers.

One interesting observation about nuclear power is in regard to the workforce. Since no new nuclear plants have come online in the US since the mid 1990's, there is a significant experience gap as individuals with nuclear construction experience enter retirement. Workers who do have knowledge about the construction of nuclear power generation facilities will become increasingly valued. This will be an area where organizations will focus their training and knowledge-turnover efforts.

4.4.2.1.1.2 - Increase in the use of solar power

Many people remain skeptical of the role solar power will play in the overall energy supply market. A general consensus is that investments will likely continue to be made into solar generation capacity but it will remain a relatively insignificant source of overall power generation. Most agree that solar power will play a minor but supportive role in the overall solution to energy demand but will not ever be a truly major source of energy (Grundy, 2008).

4.4.2.1.1.3 - Other alternative energy solutions

As stated earlier in this section, this report cannot begin to examine all of the energy solutions being discussed throughout the world. Most estimates suggest that future power generation will remain a combination of:

- Oil
- Coal
- Biomass
- Wind
- Gas
- Nuclear
- Solar
- Other Renewables (geothermal, tidal, etc.)

In the next three to five years, the world will begin to progress toward its future energy solutions but it will mostly remain a close derivative of the conditions of the present (Grundy, 2008).

4.4.2.1.2 - Climate change continues to play a role at corporate and project levels

Significant climate trends are now being acknowledged by some of the most ardent detractors. Debate remains as to its causes and the impact of human activity. Regardless, of individual perceptions, CO_2 reduction technologies are becoming a more widespread market force as indicated by interviews with CII professionals. Companies are reporting project investment in CO_2 monitoring and capture technologies.

Drastic impacts remain to be seen but some models suggest significant environmental impacts by relatively minor changes in average temperatures (Bates, Kundzewicz, Wu, & Palutikof, 2008).

a. Potential major shifts in population centers

b. New transportation routes

c. Increased need for potable water resources and backup sources

d. Changes in codes, standards and design criteria

These are consequences that would happen regardless of whether human activity is to blame for climate shifts. These issues should and are being addressed by individuals throughout the global economy.

4.4.2.1.3 - Increased emphasis on project sustainability

Current thoughts on project sustainability generally treat the concept as a differentiator only when other performance aspects are comparable. For example, retailers are often willing to pay a slight cost premium to implement 'green' elements into a project so long as these costs do not become burdensome. Developers of projects across industry-sector are becoming more aware of life-cycle cost analysis and making more decisions based on life cycle cost and not first cost alone.

The concept of life-cycle cost analysis and efficiency maximization is not a new concept for CII's members who deal with the development and operation of major capital facilities. CII member organizations have always understood the value of minimizing operating costs over the life cycle of a facility. This new emphasis on project sustainability goes beyond the idea of increased efficiency. Sustainability takes into account a wide range of factors including: energy usage, occupant health, impact on the surrounding area, and the environmental impacts of the construction process. These factors are often not manifested in discrete costs encountered by the operators of the facility. As an example, it is very difficult to measure the exact financial impact of the effects of building environment worker productivity. One can draw a general conclusion that more healthy workers are more productive, but it is nearly impossible to gauge in terms of a strict return on Investment calculation. Some references make claims about the relationship between sustainably construction and worker productivity (USGBC, 2005; Watson & Balkan, 2008). Additional studies would be helpful in developing a better understanding of the relationship between sustainable construction and worker productivity.

Some commonly cited reasons for increasing focus on sustainability are as follows:

- Financial incentives in terms of decreased operating costs
- Increased worker productivity
- Pressure from clients and/or consumers
- Government pressure (mandates/subsidies/taxes)

Regardless of an organization's current standing with respect to sustainability, it is almost certain that this emphasis will continue to increase in the future.

4.4.2.1.4 - Growing demands placed on decreasing water supplies

Many organizations have released reports on worldwide growing water shortages and infrastructure issues (Bates, Kundzewicz, Wu, & Palutikof, 2008). The US has a few prime examples of these shortages. Three such examples are the Atlanta droughts of 2007, depletion of underground aquifers, and declining water levels of Lake Mead in Las Vegas. These three examples do not display conclusive evidence of a water crisis, but they do show powerful examples in the growing debate on the water situation of the United States.

4.4.3 - Globalization: Growth and Interconnectedness

Like no other time in the history of mankind, the earth is interconnected in deep and meaningful ways. With gaming technologies considered quite common by today's standards, four teenagers can play war strategy games in which teams of two can cooperatively coordinate complex attacks and maneuvers against their opponents. All this is done with individuals physically located all over the globe and perhaps having never met one another in person. This anecdotal evidence is only one small example of the role globalization is playing on the changing perceptions of societies across the globe.

One doesn't need to look very far to see the effects globalization has had on the construction markets. Interviews with professionals indicate that their corporate project portfolios are no longer limited to one geographical region. Project portfolio diversity comes from varying projects by industry and by maintaining business relationships around the world. Increasingly 'backroom engineering' functions are being exported to low cost engineering centers across the globe. Globalization is a force that has been emerging for decades and its importance is continuing to grow (Zakaria, 2008).

4.4.3.1 - Growth

It is undeniable that global populations continue to grow and demand increased amounts of resources. The effects of this global growth are both complex and significant.

4.4.3.1.1 - India and China continue to demand increasing amounts of EPC resources

This trend was ranked within the top 10 by survey respondents. Estimates indicate that these two countries represent 2.4 billion out of the world's 6.6 billion human population (United Nations, 2009). These broad numbers barely begin to tell the complex story of these two emerging economies (Zakaria, 2008). However, the key effect of those numbers is that relatively small percent changes multiplied across these entire populations represent massive global changes.

World commodity prices have already experienced significant shocks as these two countries have experienced growth. Just as entrepreneurs in these countries are able to compete for scarce material resources, they will begin to increase demands on EPC resources. Since EPC

resources are already scarce in traditionally strong economies primarily due to labor shortages at management and trades levels, expect these shortages to continue into the near future.

4.4.3.1.2 - Continuing restrictions placed on developing countries

As discussed in the previous section, environmental concerns are reaching the stage of discussion across the globe. There will be continued debate on how to manage the transition and development of developing countries. The world most likely can't afford to watch as developing countries take the same path current industrialized countries took a century ago. It can be argued that the world was large enough and had enough resources to accommodate the development of the 20th century; the same can not necessarily be said for the global development (Bates, Kundzewicz, Wu, & Palutikof, 2008). This struggle may cause conflict as emerging economies desire to develop freely and there global pressure for them to grow 'sustainably.'

4.4.3.2 - Interconnectedness

Because of global growth and advancements in technology, global economies are becoming increasingly interconnected. The 20th century saw dramatic increases in the global transfer of manufactured products and the 21st century is experiencing dramatic increases in the transfer of knowledge resources (Friedman, 2006).

4.4.3.2.1 - Continued shift of engineering centers

Offshoring of 'backroom engineering' is not a new concept. Interviews with CII construction professionals indicated that US firms have been using non-US engineering firms to do some of

the less design-intensive engineering functions for decades. As these non-US engineering centers become more experienced and capable of handling more types of work, it follows that increasing amounts of work will be offshored. These existing engineering centers will continue to develop. New low-cost engineering centers will emerge as their economies develop.

4.4.3.2.2 - Increased global competition

As the global market becomes interconnected, all firms will need to become more aware of their role in the global economy. Firms who have been able to operate traditionally as regional organizations within their country of origin, may begin to feel increased economic competition from international firms who offer competing services. Thus far, construction has remained a relatively fragmented and geographically locally centered industry. Emerging technologies and international markets will invariably lead to increased global competition.

Some firms have found that the best way to deal with this increased global competition is to develop relationships with global partners. Through the sharing of ideas across cultures, all parties of the collaboration effort can experience benefits.

4.4.4 - Productivity/Efficiency Improvement Methods:

A claim made by many construction professionals interviewed by the researchers is that delivery methods of construction projects have remained relatively unchanged for the past ten years. While the point can be debated, most industry leaders don't foresee major shifts in the way projects are delivered in the next three to five years. The construction industry has traditionally lagged behind most other industries in terms of major productivity improvements. Many productivity improvements have been imagined and discussed for many years, but difficulties

with implementation remain. One common example is onsite construction robotics. The use of robotics on construction sites has been predicted for years by individuals in CII, but thus far, it has been more speculation than reality.

At this time, while there are no new project delivery methods that are set to revolutionize the construction process, there is potential for significant improvements in the delivery of capital facilities. Most of these new techniques have been made possible by a shift toward increased collaboration and new information/communication technologies.

4.4.4.1.1 - Modularization, Prefabrication and Preassembly are Becoming Increasingly Important Methods

Modularization, prefabrication, and preassembly (MPP) are recognized by many construction professionals as having the potential to bring about significant improvements in construction productivity. These methods used alone or in conjunction with one another represent a shift from traditional onsite construction methods towards that of a more factory-type setting. Construction in a more controlled environment helps address some of the commonly identified productivity barriers of traditional construction methods such as: weather, lack of material, and difficult automation potential.

It should be noted that among the interviewed firms, there were substantial differences in how well they were able to implement MPP construction methods into their typical projects. Some firms indicated that modular construction has been a best practice for over 20 years while other firms indicated they are just now beginning to implement modularization. These widely varying responses stem from a few factors:

- Project Type: Projects such as offshore drilling facilities have been excellent candidates for modularization
- Geographic location: Geographic location can dramatically alter the
    - Climate conditions can necessitate increased use of prefabrication
    - Projects can be far from necessary labor centers
    - Workforce ability and availability can determine if onsite construction is feasible
- Contractor Structure: Contractors who self-perform significant amounts of work are often able to make better use of prefabrication on modularization.

Regardless of their current experience with these methods, most organizations understand the potential for modularization, prefabrication, and preassembly to positively impact the delivery of capital facilities. There will always be factors impacting each organization's decision to utilize these methods on a per-project basis. Current industry conditions of shrinking labor supplies and ever-more compressed schedules continue to make MPP more attractive options.

One barrier to MPP is the difficulty of coordination between trades. As previously mentioned, when contractors are able to self-perform higher percentages of projects, they seem to have more success with MPP. This area deserves more research, but it is logical to conclude that projects utilizing multiple subcontractors throughout the project encounter difficulties fabricating offsite modules. This may indicate that traditional subcontract scope breakdown could be acting as a barrier to the implementation of effective MPP methods.

4.4.4.1.2 - Building Information Models - design/fabrication/construction

As technology has improved, Building Information Modeling (BIM) has been a natural progression. For ages, construction projects have been plagued by the fact that each project is

unique. Productivity has been less than the full potential because each project represents a new learning curve that must be overcome by project teams. Projects not only encounter unique designs and site conditions, but they also have different contract parties and stakeholders on nearly every project. These factors give rise to the potential for significant risk. By constructing a project virtually, teams can begin to overcome some problems that were traditionally not encountered until the physical construction process. Just as ‘procurement’ is built into today’s capital facility project schedule, there may come a day where ‘virtual construction’ is a separate scheduled phase.

Current workers in the global economy have access to unprecedented levels of information. A very significant issue people must now deal with is how to manage the vast amounts of available information. Data models are just one such way of displaying and communicating this information. The first integrated data models were used to detect clashes between the building systems of various trades. That once cutting-edge technology is now pervasive throughout the construction industry.

4.4.4.1.3 - Greater use of 'Lean' principles in construction

Lean principles are a whole group of concepts that represent an overall shift in the delivery of capital facilities. There is no single action an organization can make to automatically make the jump to lean construction. Despite all of the discussion regarding lean construction, no single clear definition has been presented. Lean principles seek to eliminate waste from the construction process through design, both at the functional level as well as the implementation level (Ballard & Howell, 2008).

Lean construction methods encompass all the trends listed in this category of 'Project Delivery'. The survey indicates that individuals who ranked Lean construction more important also ranked the other trends in this category as being important (Appendix B). This trend can either serve as a summary for other project delivery trends or be a leading indicator describing company's strategy.

4.4.4.1.4 - Greater use of RFID technology

Radio Frequency Identification (RFID) technology is beginning to be used on construction projects for material tracking and jobsite location. The industry is still on the very leading edge of RFID implementation with cost considerations keeping RFID from becoming more widespread(Wang, 2008). Technology continues to increase the RFID performance while simultaneously decreasing cost. As more of the construction industry begins to utilize building information modeling along with modularization and prefabrication, RFID can be a tool to link real-world objects to their representations in virtual models.

4.4.5 - Corporate Strategy Trends

4.4.5.1.1 - EPC firms more selective of projects they pursue

Because of the current market dynamic with a lack of qualified contractors because of labor shortage issues, almost all interview candidates have described the current construction climate as a 'contractor's market'. Some owners have indicated that they are getting fewer bidders on their projects. Contractors are tending to only pursue projects with more well defined risks and rewards. This is an example of a trend that is difficult to distinguish as either being a cyclical market fluctuation or a more sustained aspect of the construction industry.

4.4.5.1.2 - Changing risk structure

Many industry professionals recognize that there is a changing risk structure between owners and contractors. It is too simplistic to say that risk is simply being transferred away from the contractor and toward the owner. On the surface, this is true; contractors are tending to take on less risk. This may be primarily because of market conditions.

However, a more accurate explanation, gleaned from the interview process, of the current market conditions would be to say that risk is being reallocated for a variety of reasons. When the market shifted from being an 'owner's market' to being a 'contractor's market' there was at first a tendency for contractor organizations to shed much of the risk that had long been pushed on them. Market conditions allowed them to do this, at times contractors shed more risk than many owners wanted. Now however, contracting parties are realizing that there can be cooperative gains made from equitable risk sharing. CII has released research studies on this very topic, but it seems that the practice is now beginning to catch on

4.4.5.1.3 - Increased use of joint ventures

In the current climate of contractor shortages, many projects have used joint ventures to make up for organizational resource insufficiencies. This is especially true on large and complex projects. Since there is a trend that projects are growing larger and more complex, it follows that there is an increased use of joint ventures.

4.4.5.1.4 - Sarbanes-Oxley Act

The Sarbanes-Oxley Act (SOX) is recognized throughout the industry has having major impacts in the way organizations account for their financial situations. There is also consensus that it

causes significant increases to organizational accounting costs. Because it is so widespread, it should probably no longer be considered an emerging trend. There are some arguments that SOX contributes the short sighted visions of the corporate economy as increasing attention is paid to quarterly indicators by stakeholders.

4.4.5.1.5 - Increased use of Build Operate Transfer (BOT) contracts

While some projects in some industries may have seen increases in these types of contracts, most CII member companies operate in market sectors where this is not a popular form of contracting.

4.5 - Summary

Many trends were discussed in this chapter, all of which have the potential to impact the construction industry. As discussed, some are already beginning to affect the industry. The development of the trends identified in this chapter will continue to affect the path the construction industry takes into the future. The present and medium-range future represent critical paths on the journey toward the long-range future.

The next chapter addresses that long-range future. That discussion of the long-range future is undertaken with the understanding that there is a level of uncertainty even in the understanding of both the present and medium-range future. When developing those blue sky visions, it was expected that the trends discussed in this chapter would play a key role in their development.

Chapter 5: Blue Sky, Long-Range Future

5.1 - Overview

When examining the vision for the year 2025, it is important to think about the future on various levels of depth. Figure 7 shows one particular model of visualizing future trends developed by the researchers. The Ocean Model means to imply that there are deep underlying forces that drive the changes of a population or industry. Then there are some medium depth ideas that flow from those deep ideas. At the very top are the ideas and breakthroughs that are actually felt by the group in question. One possible example of this Ocean Model is shown in Table 4. Because of the broad nature of this document, the focus of the discussion will be on the discussion of the deep underlying themes and the medium range visions.

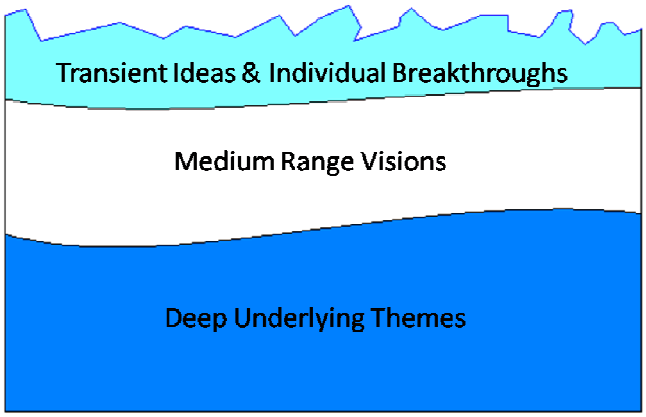

Figure 7: Ocean Model of Trends

Table 4: Example of Ocean Model

Ocean Component	Outcome
Individual Breakthrough	Personal Communication Implants
Medium Range Visions	Breakthroughs in communication technology
Deep Underlying Themes	Technology, Global Society, Complex Model of Interdependence

In conducting the CII blue sky research, a few interrelated deep themes have emerged. The relationship of these themes is approximately illustrated in Figure 8. It is impossible to analyze any of these themes within a vacuum; they are all interconnected in very complex ways. The following sections present and discuss the deep underlying themes that are bringing about the road to the future along with a few medium range visions.

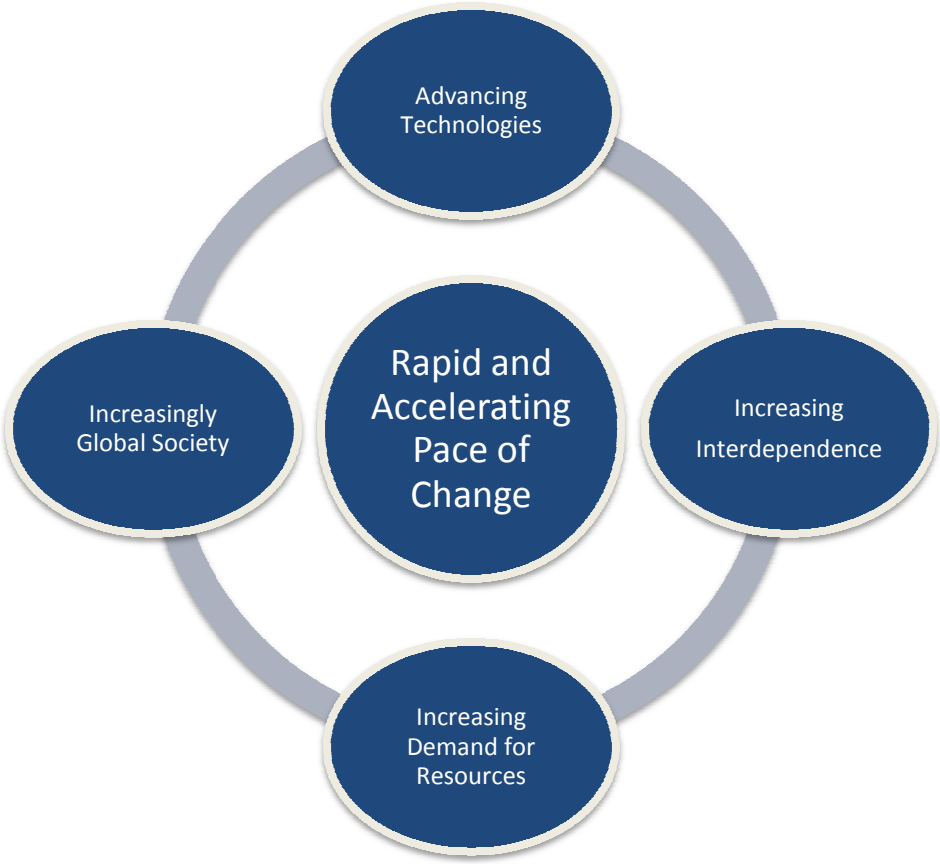

Figure 8: Blue Sky Deep Themes

5.2 - Deep Underlying Themes

5.2.1.1 - Rapid and accelerating pace of change

The one theme that is persistent throughout the entire blue sky visioning process is the fact that change is occurring at an ever-increasing pace. A whole host of factors contribute to this rapid pace of change. Clear and comprehensive ties can easily be drawn between this key concept and the four other themes presented in Figure 8. Because of humanity's constantly increasing demand for resources, heightened by the emerging global economy, new technologies are continually being developed. These technologies can be developed at an escalating pace because of advancements in communication technologies and ties to the global body of knowledge and expertise. This development brings the global community into closer contact and impacts the physical environment and global social structure in ways that are impossible to fully comprehend. In turn, problems are encountered that necessitate the development of new technologies. This whole process is a feedback loop that acts as a spiral to generate accelerating change.

5.2.1.2 - Increasing interdependence

As illustrated in the previous example, compiling and discussing a vision for the future requires a complex cause and effects analysis. Much as the themes identified in Figure 8 are deeply interconnected, nearly all aspects of human society are interconnected and are becoming increasingly intertwined. The progress demanded by modern society requires an intricate division of labor. The very same specialization that allows for the greatest efficiency is one of the main contributing factors to this extremely interdependent society.

It is highly unlikely that any one individual can fully understand all the products, processes, and theories he or she utilizes in a given day. Even if an individual lived the most basic existence in modern society it seems impossible to comprehend the full complexity of interdependence. It scarcely seems possible for the average individual to understand all the intricacies associated with areas such as: food production, auto mechanics, communication technology, natural resource acquisition, power generation, and construction, to name a few. This example shows how complicated economic and social structures become even when considering a few fundamental processes encountered by nearly every individual throughout any given day. It is through this lens of interdependence that all trends and visions must be analyzed.

5.2.1.3 - Advancing technologies

Technology is a term that represents the entire body of human knowledge and understanding employed to address problems facing some aspect of human society. Considered at this extremely broad level, all technology is advancing at an unprecedented rate. Individuals have access to more information today than was ever thought possible. Some of the most critical questions needing solutions regard how individuals and organizations can best use and manage this abundance of information.

Cutting edge technology is being developed in almost every imaginable area: materials science, communication, computing, agriculture, alternative fuels, health, medicine, and transportation. This technological development plays into a feedback loop that allows additional advances in technology.

5.2.1.4 - Increasingly global society

Among other factors, advances in technology have given rise to what is now known as the global economy. It is now possible to interact and coordinate with team members from around the globe on a single project. Face to face interactions are being supplemented with video conferences and virtual meeting spaces. No one is sheltered from this new global society. Some may be more or less affected than others, but no one is completely sheltered from its implications.

5.2.1.5 - Increasing demand for resources

As this global interaction increases, so does the global demand for resources. Because of global collaboration, overall standards of living have increased thereby increasing the demand for raw materials to provide goods and services to new consumers. These new sources of demand tend to put severe strain on resource supplies that had already been stretched thin. The resource strain goes beyond obvious examples such as water and oil to more obscure (but significant) examples like molybdenum and hafnium. Society's increased resource demand serves to pull the discussion full circle, back to the complex model of interdependence. Humankind's demand for raw materials and the associated processes have considerable affects on the environment that can be difficult to identify and nearly impossible to predict.

5.3 - Medium Depth Visions

Following are some examples of trends drawn from the CII Visioning process. Though they do have implications for society as a whole, these trends are generally more specific to the construction industry and field of project management.

5.3.1.1 - Changing workforce composition

Many industries in recent years have been encountering drastically changing workforces. Many industries have been experiencing aging workforces; construction is not excluded from that group. Additionally, the construction industry may not often be the first choice for potential employment by individuals entering the workforce. One of the most consistently cited recurring issues by construction professionals is a decreasing availability of labor at both the trades and management levels. The project manager of the future will have to deliver projects utilizing a smaller pool that may contain less skilled workers. These labor shortages might provide one of the strongest incentives for organizations in the construction industry to change.

Many construction professionals have noticed an experience gap. Firms have sufficient numbers of people at the top levels of management and sufficient numbers of employees at entry-level management ranks. They do however lack experience at the mid-level management ranks. Firms are dealing with this phenomenon in two primary ways. The first way is to train less-experienced employees with strong potential to rise through management ranks faster than was common in recent years. The second way is to have more experienced people to delay retirement and take on roles in non-traditional work roles. These two methods have been able to ease its effects, but they still have not been able to fully address the problem; the industry continues to seek new solutions.

5.3.1.2 - Changing roles of engineers to systems thinkers

In a world with very complex problems that cannot be defined as belonging to one particular engineering discipline, the engineering process will be fundamentally changed. In the future,

individual problem solvers will have tremendous access to information as more and more 'expert knowledge' is able to be encoded into computer software. Similar to the engineers of past generations, today's structural engineer needs a fundamental understanding of the physical properties affecting structural design and analysis. However, today's structural engineers have access to common software that allows extremely complex analysis that would have been all but impossible just ten years ago. It will increasingly become the role of the engineer to develop solutions to challenges using a wide variety of expert knowledge. Engineers will best be able to add value by understanding and optimizing the complex relationships between various systems.

5.3.1.3 - Era of 'Insufficient-Plenty'

It is not difficult to imagine a situation in which society makes a fundamental shift to an era of 'Insufficient-Plenty.' Today and in the past, with enough money, any resource can and could be obtained. In this future era of 'Insufficient-Plenty,' some of today's resources will be unable to be obtained at any price. This situation has many implications that are difficult to predict exactly (Voeller, 2008). Even if the exact outcomes are unknown, it is clear that an era of 'Insufficient-Plenty' would result in great hardships to modern society.

5.3.1.4 - New levels of global sustainability

Depending on the severity of future resource needs, global sustainability could take on a dramatic new meaning. There may be a world where everything is reused and nothing is wasted or thrown into landfills. One such presentation of this new sustainability is presented in the book *Cradle to Cradle* (McDonough & Braungart, 2002). The authors not only describe

sustainable solutions, they present a potential business case by which these systems may be implemented. At present, sustainability has not been able to be fully embraced by society because sustainable systems have not become economically competitive with traditional systems. If measures are implemented in such a way that make sustainable options economically competitive to current methods, the drive toward sustainability will have a true business incentive and rapid change will occur. With the Clean Air Act of 1990, a limit for Sulfur Dioxide (SO_2) emissions was established and a market for SO_2 emerged. If such a system is implemented for other types of emissions and environmental effects, there could be dramatic changes in the flow of economic capital.

5.3.1.5 - Decreasing significance of individual governments compared to private entities and global collaborations

At present, the influence of national and regional governments is limited by geographic boundaries. Conversely, some private corporations have a truly global presence and influence that goes beyond national borders. Some business entities have operating revenues larger than the GDP of entire nations. According to the International Monetary Fund, in 2007, US based Wal-Mart had higher revenue than the GDP of Austria.

As the world moves toward global economic interconnectedness, individual governments are less able to impose strict regulations on organizations operating and conducting business within their jurisdictions. Corporations are able to direct production resources away from the jurisdiction in which regulations are imposed. The individual government, when faced with the possibility of losing production from such corporations, may be reluctant to impose such types

of regulation. In the future, political, economic, and technical solutions will continue to be increasingly intertwined.

5.3.1.6 - Seamless flow of global ideas for solutions to problems

With increasing collaboration made possible by instant worldwide communication, more minds will have access to more problems. Solutions will be able to come from those with the best ideas rather than those who are located geographically close to the problem or those who work for the organization experiencing the problem. The single clearest example of this phenomenon is the rapid rise of the internet as a mode of communication and medium for the exchange of ideas. Web communities are connecting people and producing markets in profound ways never seen before. These communities go beyond the markets of Amazon or EBay. Pokono.com allows users to buy, sell, trade, and share design ideas created by other users. Mfg.com is an online community where users can submit orders to fabrication shops in order to create specialized parts. Yet2.com provides a platform that is 'focused on bringing buyers and sellers of technologies together so that all parties maximize the return on their investments.' These are just a few examples of a countless number of communities engaging in groundbreaking collaboration.

Many non-construction organizations are moving away from the traditional institutional model of information development and management. Companies are using more collaborative efforts to gain new insight into their business approach. One such example is the open source software movement. IBM is a major contributor to the Linux movement and spends millions of dollars each year developing this free software. In turn, IBM gets to reap the benefits of being part of this global community. Social networking, photosharing, news story sharing, and collaborative

wiki internet communities represent a shift in the way information and ideas are gathered, shared, and analyzed (Tapscott & Williams, 2006).

CII itself is an important example of the benefits achieved by competitors engaging in a collaborative effort. The research efforts of the organization have benefitted not only its member organizations but the construction industry at large. While there are a large number of collaborative trade organizations within the industry, construction has seemed to lag behind on this drive toward mass collaboration. The industry could see major gains by experimenting with a more collaborative approach to idea sharing.

5.3.1.7 - Heightened awareness of global security issues

As global interconnectedness increases, so also do security concerns. Since September 11, 2001, the world has entered a new level of awareness regarding global security issues. Security issues, however, entail more than dangers associated with physical acts of terrorism. Security issues apply to impacts of natural disasters, digital information security, and other localized issues (Wible, 2007). Currently, there is dramatically heightened awareness of security issues. The analysis of insecurities and potential design solutions will continue to be an increasing trend. Security analysis will continue to expand to the forefront of project decisions.

5.3.1.8 - Comprehensive energy and infrastructure solutions

Currently there is much uncertainty with regard to the future of global energy and infrastructure. There are many competing interests to develop a comprehensive solution. By the year 2025, the world may not have fully solved its energy and infrastructure problems, but there will be a plan in place. It will then be possible to make more informed decisions.

Chapter 6: Implications for Construction Project Management

The previous chapters discussed the factors predicted to influence the future of the construction industry. This section details some of the specific ways the construction industry is expected to react to those changes. Table 5 gives an overview comparing present day construction project management to the changes envisioned for the year 2025. The overview presented in Table 5 is a simplified analysis of the path from present and future for a general comparison. These changes represent one of the potential visions of project management. The actual future state of project management will be the product of progressive change in a fragmented industry that is historically resistant to change. The visions put forth in this section represent ideas voiced by many construction professionals. However, in this discussion it is impossible to cover all dissenting viewpoints.

Many of the findings in this chapter have been developed with aid from a CII focused roundtable discussion on the issue of the future of project management. This roundtable discussion took place on October 30, 2008 at the CII Annual Board of Advisors meeting held in Chicago, Illinois. These professionals were presented with the findings from the emerging trends and blue sky studies, and asked to further discuss the implications they predicted for the future of project management. Their professional understanding of the issues was determined to be a critical piece of the puzzle because they have the potential and ability to affect change within the industry. A summary transcript of the roundtable discussion is included in this document as Appendix E.

Table 5: Comparing Construction Project Management: Present Day to 2025

Construction Project Management - Current	Construction Project Management - c2025
Role of the Project Manager	
• Reactive problem solver • Emphasis on technical knowledge • Known stakeholders	• Proactive system designer • Emphasis on interpersonal skills • Many stakeholders
Location	
• Mostly onsite management • Largely regionally focused	• Centralized Location • Global Teams
Project Design	
• 2D contract drawings • Non Standard Design • BIM for coordination and planning	• BIM for integrated information • Rule based design
Project Execution	
• Onsite fabrication • Physical Labor • Paper Documents	• Prefabrication, modularization • Automation techniques • Digital and virtual documents • Automated knowledge management • RFID
Sustainability	
• LEED • Efficiency	• Tracking of environmental issues • Mandates for Social Welfare • Site specific design solutions
Organizational Structure/ Corporate Strategy	
• Adversarial relationships • Contracts often split by trade • Fragmented industry • Project-based metrics	• Collaborative partnerships • Contract structure to allow new techniques • Constant training and education • Program and portfolio management metrics

6.1 - Role of the Project Manager

At its core, construction project management is a decision making process based on risk analysis of project specific information. The project manager of the future will have access to

tremendous amounts of information. As such, there will be more tools to utilize this information to properly analyze risk and make correct decisions.

Throughout history, construction projects have been challenging in their uniqueness. Each project represents new challenges. Even when the design and layout of a capital facility remain the same, key variables of the project change. Some examples of these variables are: project location, soil conditions, project team, contract type, and contact parties. With these and many other variables changing on every project, construction project managers have not been able to truly implement a standardized process for management. Many view the primary role of the construction project manager as being a reactive problem solver. They encounter unforeseen issues on projects and react to them as quickly as possible. In this role, construction project managers have become extremely adept. The project manager is responsible for key decisions that impact many players of the project team. In the future, the project manager will continue to play a key leadership role, but they will have tools, discussed in later sections, to exercise this leadership more proactively and less reactively.

As the role of the project manager changes to be more proactive, they will enter into a role that emphasizes interpersonal skills over technical skills. Technical skills will remain important, just as present day interpersonal skills are important. However, the balance will shift. Today's project managers are often forced to react to unforeseen project conditions with the technical prowess to understand cost, schedule, and quality impacts for all of the project stakeholders. As such, they also require a great deal of interpersonal ability to come to solutions that are acceptable to all, or nearly all, stakeholders. As tools are developed to allow more front-end planning, project managers will have to focus more on appeasing stakeholders and less on hastily developing a technical solution.

As the world becomes increasingly interconnected and globalized, additional stakeholders will be involved on construction projects. There was once a time when the effects of a construction were only felt in the immediate geographic vicinity of the project. Today the world is interconnected. Nearly all construction professionals can point to increasing global demand as causing rising commodity prices. As environmental concerns continue to increase, more and more regulatory agencies will be involved on construction projects. It will be the role of project managers to assess all of the risk associated with each of these stakeholders and develop suitable solutions.

6.2 - Centralized Location

A current trend shaping the progression to the future is a lack of people at the mid levels of management for construction organizations. As project managers with the necessary management skills become less available, the manner in which projects are managed will change. Project managers, in the future, will operate from more centralized locations, managing even more projects than those of the present day. There may be an increasingly tiered project management system in which 'super project managers' manage less skilled project managers who oversee and lead daily onsite construction operations. This centralized model also allows flexibility to accommodate older workers who may be looking to continue their careers, but in less involved ways. In order to allow this transition, new technologies must be developed and organizations who can embrace and effectively implement these technologies will gain competitive advantage.

The project manager of the future will undoubtedly have access to much more advanced technologies than are available at current times. Exactly how this technology will be utilized is

the pivotal question. The past fifteen years have seen unprecedented levels of advancement in communication technologies. The adoption of cell phones throughout the construction industry is a very commonly cited example of a technology that led to dramatic changes to the operation of an industry. In order to enable further change, additional advances in communication technology will be necessary. Current standard video conferencing technology does not allow for fully personal interaction. In the future, holographic technology may allow for a more interactive communication venue. Advances have also been made in streaming video technology that allow people offsite to view jobsite conditions, but their use is far from commonplace. If the vision of offsite project management is to become a reality communication technologies will need to continue to experience dramatic progress.

In 2025, a significant portion of construction project management may be conducted from a project management command center similar to the Mission Control Centers used by NASA. Not only will the project management command center model require major advances in communication technology, it will also require major advances in virtual modeling and integrated information management.

6.3 - Globalization

The current construction industry can be characterized as having many organizations working together for the successful completion of a project. Increasingly, these organizations are spread across the globe. Engineering and design firms continue to make for use of global teams. Components of design can be executed around the clock by taking advantage of time zone differences. Much of this has been made possible by the widespread use of advanced information technologies and the decreasing costs associated with transporting digital

knowledge. Similarly, engineering firms have had to rethink the way they design projects to take advantage of differing wage rates and currency risk throughout the world. This increased level of global interaction may have a variety of unintended consequences. Project managers are not only managing teams from multiple locations, they may also be managing teams with very diverse cultural backgrounds.

The project manager of the future will make much greater use of global teams, especially if some of the communication technologies mentioned earlier come to fruition. Currently, most US design firms export their detailed, labor intensive, design work offshore. As education of engineers and designers improves in developing countries, there will be even greater opportunities to create global teams to develop engineering and design solutions. The requirement of understanding multicultural business communication will cause an even greater importance of interpersonal skills for the future construction project manager.

However, with all the potential to make use of global design teams, project teams may determine that global teams are not fully aware of suitable design solutions for the local application. For example, the soil conditions of the American Northeast are dramatically different from those of Texas. Similarly, temperature and precipitation levels are quite different comparing Minnesota to Florida. These two examples only begin to address the differences arising from project location. Other factors that need to be considered are material availability, manufacturer location, local skill and expertise, and local preference.

6.4 - Project Design

It was discussed that project design teams are becoming increasingly spread across the globe. There are many more developments that are changing the way future projects will be designed.

It was common practice in the not so distant past to design a project from start to finish using only hand drafting materials and engineering equations. Designers then progressed to utilizing two-dimensional Computer-assisted design (CAD) and shortly thereafter three-dimensional software packages were created to help designers communicate their designs to project teams. Now software packages exist that allow anyone with moderate understanding of computer software to properly size a structural member for a given application if they know the loads acting on the member. There are also software packages that will check a building design for compliance with local building code requirements. These developments raise the question, 'what is the role of engineers and designers in the future?' The role of designers and engineers is to apply their expert understanding of the project design considerations and how various systems interact in order to make the best design decisions. Even as technology may be giving designers tools to be better designers, the human thought process interacting with this technology will remain critical in 2025.

Another departure from present design will be much greater use of standardized design solutions. Very frequently it is noted that construction has lagged behind productivity advances experienced by other sectors of the economy. Exact productivity metrics differ in measurement, but anecdotally it is clear that construction has yet to take full advantage of large scale manufacturing and automation techniques. A commonly cited reason for this lack of productivity gain is the design uniqueness of every project. While some construction projects will remain signature features, there is a great deal of promise for standardized design.

6.5 - Project Execution

There is a great deal of overlap in the construction industry between project design and project execution. Design solutions always, by definition, impact project delivery. The process of erecting a steel structure is very different from erecting a cast in place concrete structure. Great strides are being made in one area of the construction industry that allows project teams to better coordinate project design and execution.

6.5.1.1 - BIM

The technology that has allowed for better coordination between project design and execution is building information modeling (BIM). BIM has been a popular topic of discussion in the construction industry since the early 1990's. The basic concept with BIM is to assemble as much project information tied to a visual three-dimensional model as possible prior to a project actually being constructed. In recent years, great strides have been made in the way of advancing the implementation of BIM into the construction industry. A recent publication describes the construction industry as being "in the midst of an unprecedented revolution." (McGraw-Hill Construction, 2008, p. 2) A large-scale move toward BIM would represent a step-change in the way construction projects are delivered. As BIM becomes adopted by more and more players within the industry, its uses and applications may have major impacts to construction project execution.

By making a large scale implementation of BIM, the construction industry may begin to realize increases in productivity experienced in many other sectors of the economy. Already, BIM has had applications in 'clash detection' that indicate locations where building system components intersect. On some projects, when these clashes aren't noticed until field installation, serious

costs can be incurred. By constructing the project virtually, various building trades can be better coordinated.

Similarly, accurate building models can allow individual subcontractors to fabricate components offsite in controlled manufacturing facilities. Some subcontractors have experienced substantial decreases in labor costs through effective implementation of this BIM technology. However, coordination with BIM still has drawbacks. If the project is not modeled completely, clashes can still be experienced in field installation. For example, if pipe supports are not implemented into the model, problems can be experienced during installation.

Clash detection is only the beginning of the advances that can be experienced with the implementation of BIM. Many predict and have begun to develop BIM applications in areas such as scheduling, cost estimating, logistics planning, supply chain management, energy modeling, code analysis, and many others. However, in order for these possible applications to be realized, large scale adoption needs to occur and problems with interoperability and usability need to be overcome. Currently, most BIM software packages are quite cumbersome to actually use, especially for those not exceptionally proficient with computer applications. As the technology matures, software designers will determine how to make BIM software technically more user-friendly. While some of the issues with BIM are technical in nature, the major problems associated with interoperability and large-scale adoption do not represent technical obstacles, they are operational (Fiatech, 2009). These operational obstacles can be attributed in part to the fragmented model of the construction industry. While many are convinced that BIM will revolutionize the construction industry, others are more hesitant to fully embrace this technology. This begs the question, if systematic issues are holding the industry back from implementing project management solutions that could lead to dramatic advances in

productivity and effectiveness, will new systems be developed? On some levels, these systematic changes are already occurring. These changes will be discussed later in this report.

6.5.1.2 - Advanced project delivery methods

As players within construction industry make advances in the way information is shared and have more front-end planning through the use of BIM and other techniques, dramatic increases in productivity could be seen. At present, there is a wide variation in the type of delivery methods employed for construction projects. In some applications, project teams have been able to use fully modular construction in which projects are constructed in a controlled environment using manufacturing and factory techniques. These large modules are then lifted into place and installed with minimum field labor. Conversely, some project applications still rely very heavily on field labor for the physical construction of projects. Craft workers are given schematic layouts but they must determine the exact finish installed location.

Much of this difference in installation methods stems from a lack of standardization between construction projects. As previously discussed, construction project teams will be able to experience improvements by implementing more standardized designs. Especially as digital design software continues to make advancements, designers will have more standard and accepted design solutions for certain applications. If the construction industry continues to utilize more standardized design and modular construction techniques, the role of the construction project manager will continue to be transformed to that of a facilitator and integrator.

6.5.1.3 - Integrated information and knowledge management

Many predict great advances from integrated information management. Currently a great deal of time and effort is used to track documentation and input information into each organization's project management system. Further work is encountered when duplicate information needs to be input into the company accounting system even after it has been logged into the company project. Internally, companies are beginning to employ software systems that eliminate the need for duplicate data entry for interdepartmental information management. However, interoperability continues to plague true integrated information management for various contract parties on construction projects. Some projects have begun to employ project management software packages that do allow for integrated information management, but this is not yet an industry-wide practice. Additionally, systems for knowledge management are being developed. These systems allow for computer systems to identify and track relationships present in construction contracts.

Radio Frequency Identification (RFID) technology is just beginning to have serious applications on construction projects. Current applications have used RFID for material tracking and managing site deliveries. As this technology grows, project managers will have access to vast amounts of information and they will be to more accurately monitor project inputs. This standardization will allow project managers to make better predictions on production rates. As RFID becomes more cost effective, vast amounts of construction materials may be tagged and tied back to the project's building information model. This will allow project teams to maintain a model that reflects the actual construction sequence. This will help with productivity analysis and may help in knowledge transfer at the end of construction projects. Onsite weather data

might be implemented into the model and used evidence for claims of weather delay and more accurate portrayals of productivity.

6.5.1.4 - Future of onsite construction

On the physical construction site, there will also be developments. Since the early 1980's, predictions have been made that robotics would be used commonly on construction projects. As of yet, that prediction has not become a reality. Even though the predictions may not come to fruition it can be exciting to envision the construction site of the future.

One can envision Head-up Displays (HUDs) on construction hardhats like those currently used in military application. In this world, workers no longer need to use two-dimensional paper drawings to communicate project design. The HUD system maps where the worker is along with his or her viewing direction and superimposes a virtual image of the finished construction on the real landscape. Changes no longer need to be updated in the construction drawings of craft foremen; the building information model automatically updates the HUDs of all the workers construction the project.

Another breakthrough technology could be ground-penetrating radar that is capable of giving a fully three-dimensional representation of underground soil conditions and corresponding physical characteristics. Construction project teams would no longer be surprised at finding 100 ton boulders underground that interfere with their foundation installation.

Construction craft workers may have personal assistant machines that eliminate much of the physical exertion they endure on a daily basis. The tasks of these machines could be overhead

pipe fitting and welding, transporting and lifting materials, as well as operating vibratory equipment that can lead to physical damage after extended periods of use.

Construction sites may also implement integrated safety systems in which all personnel are outfitted with communication equipment to track safety. When one worker spots a situation that may create a safety hazard (i.e., a low hanging pipe support) they can create an electronic tag in the location that alerts other workers when they approach that location. The system would also be equipped with proximity sensors that could detect equipment locations and other hazards.

6.6 - Sustainability

As previously discussed, Sustainability and environmental concerns have been seen as significant trends affecting both construction and the world at large. Sustainability will continue to take on greater and greater importance in the development, design, and execution of construction projects. Currently, in the building construction industry, there are major developments in sustainable construction. There is a greatly increased focus on the Leadership in Energy and Environmental Design (LEED) rating system. It is a third party rating system that provides certification for a wide range of construction projects as well as professional accreditation for construction professionals. LEED has been able to provide a forum on sustainability in construction as well as inducing demand for certain products that are deemed sustainable by the developers of the system (USGBC, 2005).

LEED represents an important step on the movement toward the much enhanced role that sustainability concerns play in the construction industry. Right now the system is largely voluntary that project teams can decide if and how they will apply the sustainable guidelines.

Even now, the LEED system has been mandated for some public and private entities and target for others. However, as the resource requirements of society are stretched ever-more thin, design will begin to be based on the entire life cycle of products: production, transportation, utilization, and decommissioning. Whole life cycle analysis continues to have increased emphasis over simple first cost analysis.

In the future, environmental factors may be implemented into building codes. Carbon taxes might be imposed. Anything that the public deems important enough to monitor may have an associated cost. For example, if the public demands that child labor not be used on the production of goods, a severe tax may be imposed on these products. What all this means is that the project manager of the future will have even more factors to consider when making decisions. They may need to better understand the process and energy required to manufacture a given product. They will need to understand where a product is manufactured and how it is transported so the carbon emissions can be monitored. All of these factors may be internalized in the price of a product or they might be factors in addition to price that need to be monitored.

It was also previously discussed that there may be a movement to more standardized design. There is also a competing notion that design should become even more site specific in order to better take advantage and operate within local natural ecosystems. There are certainly competing viewpoints as to what is the better design solution: standardization vs. site specific.

6.7 - Organizational Structure/Corporate Strategy

As discussed in previous sections, in order to accommodate many of the predicted changes to construction project management, new organizational structures need to emerge.

6.7.1.1 - Contract organization

This drive toward standardization and manufacturing techniques for construction projects may lead to new interactions with subcontractors and material suppliers. Contractors might find it advantageous to subcontract projects differently that allows their suppliers to take advantage of new modularization techniques. There is only so much of a construction project that can be constructed in a manufacturing facility when the physical project location is the only place various subcontractors interact. Multiple interfaces between various subcontractors is currently one of the limiting factors to advanced construction techniques.

One example where improvements could be seen through different contracting methods could be for Mechanical and Electrical subcontractors in building construction. For many years, it has been a standard practice in the building construction industry to select separate subcontractors for both mechanical and electrical scopes of work for projects. This was a natural separation because the two trades have different union jurisdictions and involve different skill sets. However, as the building construction industry attempts to develop greater use of modularization technology, firms may find it advantageous to subcontract both mechanical and electrical scopes to a single contractor so that they might better be able to make use of manufacturing techniques.

6.7.1.2 - Collaboration

Across industries, collaboration is leading to increased gains. Collaboration among competitors has brought about success in the Human Genome project that will lead to life-saving breakthroughs in medicine (Tapscott & Williams, 2006). Many firms in the construction industry

have seen benefits from Design Build. With Design Build, more of the key players of the construction industry are brought onboard earlier in the project development phases. Projects are seeing success by getting design input from major subcontractors material suppliers. This new kind of collaboration among contracted entities could lead to the advances necessary for large scale adoption of BIM.

These collaborative teams could then have access to increasingly integrated information systems. At present a great deal of time is spent managing information and inputting data into software and management systems that aren't on the same platform. By getting the systems of various contracting parties to 'talk' to one another, project managers will have access to more and better information that will help them to make more effective decisions for project success.

6.7.1.3 - Program management

Construction project management is an application that is very project centered. Many organizations base their measurements and metrics on the success of an individual project. Project teams within a single organization often compete for the same resources. While this competition can lead to overall growth for an organization, it can also lead to inefficient allocation of resources. There is emerging emphasis on process that some term 'program management' or 'portfolio management.' However, industries will find competitive advantage if they are able to restructure their organizations to make better use of new project delivery methods and market conditions.

Chapter 7: Implications for Construction Education

The world is a changing place. The future is uncertain for the construction industry, just like it has always been. Decision makers can't know exactly what the future will present but they can work to better understand it. This chapter makes recommendations as to how construction education programs might best prepare their students for the future industry in which they will be working.

Like so many of the issues identified throughout this document, most of the recommendations presented in this chapter are already being implemented by individual educators in the system. The list should not be viewed as comprehensive. It is more of a foundation from which to base the creativity of the educator.

7.1 - General Implications

7.1.1.1 - Work to understand the rapid and accelerating pace of change

It has been talked about time and time again that the world is advancing at an ever more rapid pace. Ironically, the majority of construction future studies seem to look too closely at the present without really directing their focus into the future (Harty, Goodier, & Soetanto, 2004). Educators must engage in the process of looking to the future alongside industry professionals to be constantly cognizant of the likely future. They must keep in mind that as educators, they perhaps play a greater role in creating the future than anyone else in the industry since they are responsible for preparing the next generation of construction professionals.

Some of these changes impact the overall structure of the institute. Educational institutions need to become more robust to allow for their programs to change as it is necessitated by

future events. Course format may need to be shifted from the instructor as being the primary source of information to the instructor being a facilitator for student directed learning.

7.1.1.2 - Develop a greater global focus

Additionally, there has been an increasing focus on the global society that is developing. With developments of social networking sites, individuals are able to maintain relatively close ties with people from around the globe. There are global media outlets. Internet communities have been able to spread ideas more quickly than ever before. Students are beginning to adventure into the global society on their own and educational institutions don't seems to be keeping up with their demands. In an unscientific survey released to the Construction Engineering student population at Iowa State University, 24 out of 28 Junior and Senior respondents indicated that they did not feel the topic of globalization is sufficiently addressed in the curriculum. While this survey was not scientific, it seems to indicate that students are interested in globalization and do not feel that they have a sufficient understanding of the subject.

Educators have a difficult task of teaching globalization because there is still little agreement among construction industry professionals on the role of globalization to the future of the industry. Programs could take the first steps to get students to look at international business methods and how culture and geography impact the business methods selected. They can begin to analyze global supply chains and how they can be impacted by global events even if they are working domestically in the United States.

7.1.1.3 - Understand the interconnectedness

The world is becoming interconnected in deep and meaningful ways. This is not just in terms of globalization, but also domestic interconnectedness. New regulation brings government ever-closer into the project team. Increased emphasis of the benefits from diversity is leading to heightened focus on team building and understanding people from different cultural backgrounds. Products and projects have rapidly changing supply chains that can have impacts on business operations.

Additionally, among all this interconnectedness is a heighted awareness of sustainability issues. The new generation seems to be more receptive of environmental concerns and issues. Sustainability, in a broad sense, that implements environmental, social, and economic concerns may prove to be one of the greatest challenges of the next generation of industry professionals.

7.1.1.4 - Teach a system of understanding and fixing insecurities

Very closely associated with developing an understanding interconnectedness is an advanced understanding of the risks and insecurities of that interdependence. As systems become more complex, there is often a heightened risk of a breakdown in that system. Students need to understand how they fit into the greater system and the risks and insecurities associated with the system.

7.1.1.5 - Develop a drive for lifelong learning

The ASCE has made a recent drive to encourage more students to pursue Masters Degrees in order to respond to the increasing amount of knowledge and skills required by the demands of

the modern profession (American Society of Civil Engineers [ASCE], 2007). While a Masters program may work for many students, it most likely will not be embraced by all. Educators may achieve better results by continuing to emphasize the importance of lifelong learning. All too often, students develop an understanding that learning at their education institution and the work that they do in their profession are two separate worlds. Students must understand that in order to be successful, they need to engage themselves in a constant learning process, especially in the changing professional environment of the future.

7.1.1.6 - Use technology as a tool, not an end in itself

There have been many claims, especially in times of economic uncertainty that 'technology will bring about the change we need to meet the challenges of the future.' Others argue that technology along with an understanding of how and why to use that technology can bring about the change necessary. At the fundamental level, students need to understand the complexities of the system in which they are operating before they are presented with the tools available to work in that system. This is a learning theory that appeals to the innate creativity of people. Once they have become engaged and understand the need for the tools, they will have a greater appreciation for the tools after they have been presented.

7.2 - Specific Recommendations

Without engaging in a thorough discussion of the baccalaureate Construction Engineering Program at Iowa State University, it is still possible to give insight as to how construction education programs can implement some of these recommendations into their programs. One of the major aspects of the planning process for the undergraduate Construction Engineering

Program at Iowa State is an adherence to the standards of ABET, Inc. (formerly Accreditation Board for Engineering and Technology). Before engaging in a discussion regarding specific program recommendations for Iowa State, a brief outline of ABET requirements is presented.

7.2.1.1 - ABET requirements

The Iowa State Construction Engineering Program is accredited by ABET. In order to maintain this ABET accreditation status, the program must comply with certain guidelines, the specifics of which are beyond the scope of the discussion of this document. An outline of the ABET curriculum requirements is as follows:

> The program must demonstrate the graduates have: proficiency in mathematics through differential and integral calculus, probability and statistics, general chemistry, and calculus-based physics; proficiency in engineering design in a construction engineering specialty field; an understanding of legal and professional practice issues related to the construction industry; an understanding of construction processes, communications, methods, materials, systems, equipment, planning, scheduling, safety, cost analysis, and cost control; and an understanding of management topics such as economics, business, accounting, law, statistics, ethics, leadership, decision and optimization methods, process analysis and design, engineering economics, engineering management, safety, and cost engineering. (ABET, Inc., 2008, p. 9)

ABET requires all students of accredited educational programs to attain a certain set of outcomes regardless of their specific program of study. ABET has recognized certain outcomes as being universal to the fields of engineering and the technological sciences. Many of these general outcomes overlap with the implications determined by the research team after engaging in the studies of the future of the construction industry.

> Engineering programs must demonstrate that their students attain the following outcomes:
>
> (a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. (ABET, Inc., 2008, p. 2)

It is important to present these ABET outcomes because in order for construction education institutions to maintain their accreditation status, they must adhere to the outcomes put forth by the organization.

7.2.2 - Example program recommendations

Many of the recommendations presented in this section call for a more subjective exchange of ideas among students. These types of discussions not only help students to better understand course content, they engage students to critically analyze that course content as future construction professionals with their professional peers. Students may not always possess a deep understanding of the material, but experienced instructors can frame discussions and help to provide expert knowledge on various topics.

7.2.2.1 - Discuss cultural context for construction methods

In order to understand methods and techniques of construction, courses are taught on Construction materials and methods. The technical aspects of the methods and materials are the primary focus of these courses. Often, the cultural and societal appropriateness of these methods are overlooked. It is impossible to fully cover the cultural suitability of all construction methods in a single course but efforts could be made to address the issue. Students could be engaged in discussions of how various construction methods are appropriate in a given location for a particular culture. This type of discussion could do more than give a better understanding of the culture being discussed. It would also require students to look deeper at a given construction method to critically analyze its appropriateness in a given context.

7.2.2.2 - Engage students to explore the future

When presenting content related to contracting methods or construction method selection, instructors should engage students to ask the question of, 'how might this application change in the future?' This question gives rise to other related questions:

- What are some of the barriers to developing this future application?
- What are the implications of this future application for another application?
- Which groups would benefit from this application and which groups would be negatively impacted?

This type of analysis encourages students to engage in a more critical analysis of the material being presented. By looking into the future in a class directed environment, also students begin to develop an appreciation for lifelong learning. Much of the content delivered in physical sciences is presented in its final form; classes on the fundamentals of chemistry, statics, and

structural analysis and design, and others have remained relatively unchanged for the past several years. That is not to say that nothing new is happening within these fields. However, from the student perspective, this can be the perception of this content. Content related to the specifics of the construction on the construction industry is always changing; it is important for students to understand the system that drives the change experienced in the construction industry.

7.2.2.3 - Engage students in reflection

The baccalaureate Iowa State Construction Engineering program does an excellent job at conveying technical knowledge to students. However, there is often a piece missing from the teaching. Students do not often engage in reflection about their learning. Reflection is a critical aspect of student learning (National Research Council, 2000), yet it is a piece often missing from many courses.

For example, in a course teaching construction estimating skills, students are able to practice real life estimating skills in a classroom setting. Students are usually split into small groups to develop an estimate for a given scope of work. Each group struggles through the process of estimating the same project using the same set of construction documents, but each group approaches the task differently. In this process, each student group develops understanding and often realizes ways that they could have improved their overall technique. Students should consistently engage in this type of reflection and share their findings with their classmates. This sharing of understanding could take place in a variety of settings. Student groups could make presentations to the class. Representatives from each estimating group could share their reflections with other 'reflection groups.' Each of these 'reflection groups' could then identify

and analyze a better process for developing the estimate based on their new found collective understanding.

Along with the process reflection, students could try to identify tools which could have aided them in their estimating process. These tools could range from digitizing software, to cost database selections, to advanced building information modeling techniques. These are some of the tools being constantly developed by segments of the construction industry. If students can identify potential tools to make their own estimating process more effective, they begin to develop a context into which new technologies can be implemented. Having a personal context toward which an individual can apply learning makes learning more effective (National Research Council, 2000). This also helps students to understand that technology is a tool for better performance in real-world application, not an end in itself.

7.2.2.4 - Look for existing courses outside the department

Iowa State Construction Engineering curricula need not be limited to course selections within the Department of Civil, Construction, and Environmental Engineering. Excellent courses are already in place in other departments; once such example is a Mechanical Engineering course on the topic of 'Technology, Globalization, and Culture.' Courses such as this present issues facing not only construction engineering, but issues affecting all areas of engineering and society at large. Involvement by construction students in these types of courses can allow construction students to better understand these larger issues as they affect multiple groups as well as the significance they hold for the field of construction.

Chapter 8: Limitations

This report is very broad in nature, so as to identify the future affecting broad cross-sections of the construction industry. This document can serve as a source for decision makers, but it is impossible for any overview report to convey all the intricacies that make up the path toward the future. Recognizing the fact that the document is broad in nature is not an indictment of the study, it is a realistic assessment.

It should also be acknowledged that the information for this study was gathered for a relatively short period of time. In order to develop a more accurate portrayal of the path to the future, the study would need to be undertaken for a longer duration. The visions and claims about the future presented in this document are, by their nature, inexact. Much of the data collection in this study took place prior the recognition of the 2008 US economic recession. The findings of this report should be revisited to determine the impact, if any, economic conditions have made to the conclusions.

Should more precise results be desired, additional objective data could be gathered and analyzed statistically. Almost all of the trends and visions discussed in the document have objective data which could serve as indicators. For example, a discussion on the role of modularization as a construction delivery method could be an in-depth research study all by itself. Some quantitative data for this study could be: how many projects are utilizing modularization techniques, which categories of projects are more suitable for modularization, geographic locations more inclined to utilize modularization, historical analysis of modularization technology development, and many more. Such a discussion for the trends identified in this report was beyond the scope of the document.

Chapter 9: Recommendations for Future Research

This research effort could be viewed as an early step in a much more involved effort of construction futuring research assignments. The research conducted in this study had a goal of accommodating CII's requirements within a relatively brief period of time. The findings put forth in this document, while valuable on their own, could serve as a strong foundation for a series of construction futuring studies. In this chapter, recommendations are made to future studies into the future of the construction industry.

9.1.1.1.1 - Engage in a more collaborative research process

The 2008, emerging trends and blue sky research effort represented an important shift from previous years' research efforts. The research effort engaged a team of individuals to lead the study while getting input from CII members as well as professionals with an outside perspective. This approach, while effective, doesn't fully make use of a truly collaborative framework. This product should not be viewed as an 'end milestone' but a steppingstone to begin an ongoing discussion among CII members and outside construction professionals. There are many models for collaborative research studies, this type of study could be a prime candidate for a more collaborative research methodology.

9.1.1.1.2 - Utilize focused roundtable discussions as a more prominent information gathering method

Discussion among experts has long been a tool used by professional futurists. Since experts are frequently the individuals responsible for bringing about the changes forecast by futures research, it is important value their opinions to learn about various trends and visions. These

roundtables could either be held in-person or via a teleconference service moderated by the research team.

These discussions would ideally take place midway through the research process so moderators could be relatively informed of the overall trend environment. In addition to providing valuable insight into the nature of many trends, these roundtables could promote commitment to the overall research process by professionals.

What differentiates roundtable discussions from the interviews conducted individually by researchers is debate and consensus. In conducting an interview with a top organizational leader of the construction industry, it is seldom the role of the interviewer to disagree with the individual being interviewed. By conducting discussions with multiple industry leaders, researchers will be able to better understand the disagreements that represent key factors in the uncertain nature of the future visioning process. These roundtable participants could benefit personally by understanding first hand some of the key issues impacting their business now and in the future.

9.1.1.1.3 - Use a survey as a way to continuously monitor progress of emerging trends

With continued monitoring, an authority on future construction trends could emerge. A one year snapshot serving as a forecast for the future of the construction industry, is essentially an exercise in gathering and summarizing information released by many other organizations. While this is a valuable service on its own, the ability to track a set of relevant trends provides metrics that does not currently exist and could prove to be very valuable.

Each year, a survey should be developed to reflect the trends identified the previous year. This survey asks respondents to rank the likelihood and impact of each trend as well as provide comments. Two versions of the survey could be sent to respondents:

- The first half receives a standard validation survey.
- The second half receives a Modified Delphi in which respondents are given the average ranking of each trend in last year's survey.

The Modified Delphi could give insight into the change of each trend while the standard validation could provide a more general overview of the impact and likelihood of each trend.

In addition to monitoring the progression of trends, this continuing analysis might allow a set of leading indicators to be developed for each trend by building statistical models to correlate objective data to the maturation of various trends. With continued monitoring, a clear presentation of data could be developed such as seen in Figure 9.

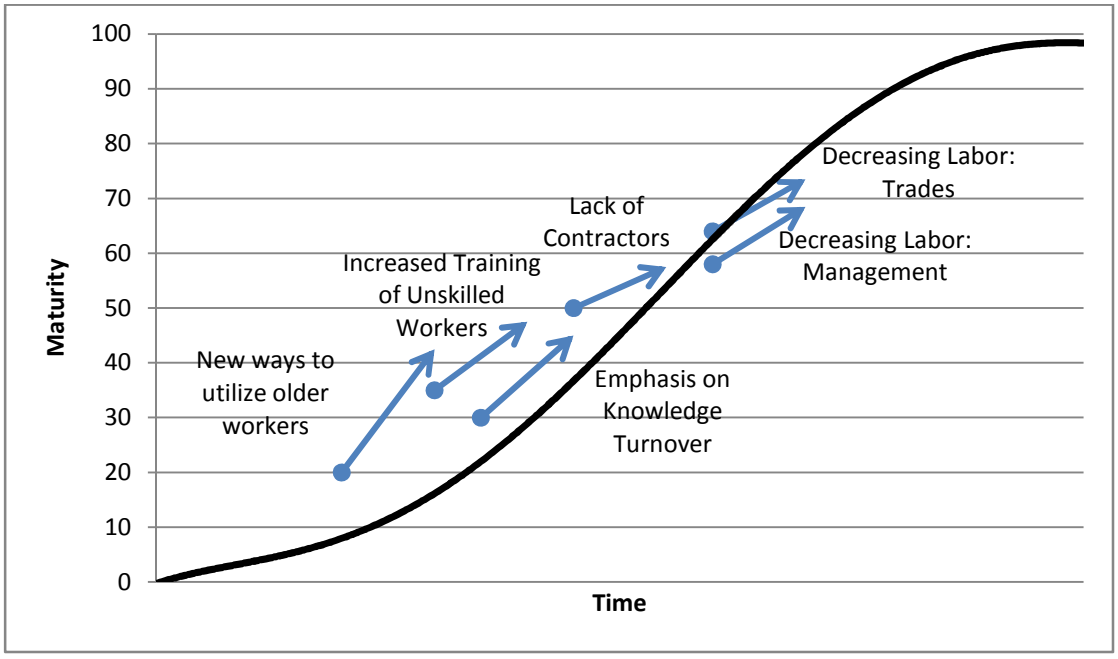

Figure 9: Potential trend presentation in future studies

9.1.1.1.4 - Build an online database of construction industry objective data

In the current age, construction professionals have access to more information than ever before. This provides a great opportunity for professionals but can also lead to confusion. How can an individual make sense of this abundance of data, especially when this data is spread across hundreds of sources? A central research team could be responsible for compiling this data on a regular basis. Some data acquisition might even be able to be automated with current RSS and XML technology. This could be an important factor in developing a more collaborative research process.

9.1.1.1.5 - Use online communication to engage the construction professional community more actively in the identification of trends

As stated previously in this report, it is a constant struggle to maintain an unbiased, objective perspective when compiling a vision for the future. One of the best ways to mitigate the effects of subjectivity is to engage a large number of people in the research process. Thinking about the future is an endeavor that appeals to the curiosity of many individuals. Great futures thinking requires a very large scale dialogue that thus far has not happened in the construction industry. Some industry organizations like the Construction Industry Round Table (CIRT) and The Construction Users Round Table (CURT) are conducting these truly valuable discussions but they are somewhat limited by their self-selecting nature.

The research team could set up discussion boards, wikis, and blogs that construction professionals could use to share information. This type of dialogue could help to broaden the

focus while giving a greater depth of discussion. By collectively engaging individuals operating within the construction industry, the research team could gain powerful insight into many key issues.

9.1.1.1.6 - Develop standard methods for sharing information

There is a vast amount of information available for research into the future of the construction industry. It is nearly impossible to convey the full depth of that information to stakeholders without making that information available in its entirety. All sources have some degree of bias and uncertainty and it is important to have access to the data from which researchers draw their conclusions.

Chapter 10: Summary and Conclusions

10.1 - Summary

In conducting this study of the future of construction industry, several important findings emerged. The researchers were able to develop a vision for the future that focused on key drivers and deep themes. It is these key themes and drivers that will lead the way on the path to the future.

In the three to five year time horizon, four key drivers affecting the construction industry were recognized. The most significant driver was in the area relating to workforce issues. Many sources have identified labor force issues as having the most impact as they plan for the future. Other important key drivers were also recognized: increasing environmental considerations, global growth and interconnectedness, and productivity and efficiency improvements. The specific outcomes stemming from these key drivers can be debated, but they will certainly play a key role in determining the state of the future.

Looking to year 2025, there was a set of deep themes that emerged that seemed to be shaping the future. The deep themes are interrelated in deep and complex ways. The interaction of these deep underlying themes will shape the actual outcomes of the future. Many of the deep themes affecting the long-range future are similar to the drivers affecting the medium-range future. At the core of the move toward the long-range future is a rapid and accelerating pace of change. As humanity continues to advance, developments are discovered that allow an even faster rate of advancement. The implications of this observation are vast and it represents a key characteristic on the path toward the future. The remaining themes identified for the long-range

future include: advancing technologies, increasingly global society, increasing interdependence, and increasing demand for resources.

The findings of the future affecting the construction industry were used to determine implications to project management. Construction project management is a constantly evolving function that responds to the environment in which it functions. One of the most important implications involved questions regarding the role of the project manager and how it will change. As technology continues to progress and if workforce and resource shortages persist, project managers will placed in a role of increased importance. Essentially, they will function less as troubleshooters and more as overall project leaders. Additional implications for project management involve location, project design and execution, sustainability concerns, and the organization structure affecting project management.

All of the future findings and implications for project management have important significance for construction education. Essentially, educational institutions must prepare students for problems that don't yet exist. As the world continues to advance with a rapid and accelerating pace of change, the role of the educational institution becomes ever-more difficult. In order to best accommodate this characteristic of the future, educators need to instill lifelong learning for their students. Gone are the days that students could be trained in an academic setting to use specific tools to solve problems they would encounter in their future. Being cognizant of this dynamic, educators must also focus on the interconnectedness of society and its increasingly global focus. This must all be accomplished while making students aware of the insecurities that are pervasive throughout the economic and social structure.

One of the most important implications to educators involves the appropriate use of technology. Advancing technology can certainly help to solve many of the world's most pressing issues. With such rapidly advancing technology, it may prove more important for students to understand the applications of how technology can be utilized, rather than fully understanding the actual use of the technology.

10.2 - Conclusion

Additional research studies into the futures of the construction industry could prove to be very valuable. Developing common visions for the future could help the construction industry to speak with a common voice as it determines its place in the future. Even as this type of futuring effort can be seen as being beneficial, a trusted source for ongoing construction futures research has yet to emerge. It will mostly likely remain impossible for a single organization to effectively communicate a vision for the future of the construction industry, but great improvements can be made.

The findings of this research effort were drawn with a research methodology that did not take advantage of the full range of advanced techniques available to professional futurists who specialize in other disciplines. It is an exciting time for those looking to engage in construction futuring efforts. Past efforts have only begun to scratch the surface of the possibilities that remain for this type of research. Few studies have so far been able to commit the resources necessary to effectively utilize technically complex models to develop practical scenarios for the future of the construction industry.

10.3 - Author Statement

As the author of this thesis, I have done my best to keep my own personal bias out of the findings presented throughout the document. It is the nature of futuring studies that uncertainty exists, this study is no different. Some of this uncertainty is caused by systemic uncertainty like incomplete information or subjective sources that make up a significant portion of this type of research. There can also be shocks from totally unforeseen events such as natural disasters, terrorist attacks, and game-changing technological breakthroughs that bring about more change than anyone can reasonably forecast.

There is also one more cause of uncertainty – a lack of understanding of our own capacity to affect change. In my future I plan to influence the world to bring about positive change. The future I hope to create is not necessarily the future I have portrayed in this document. I may believe that we need great systemic change in the areas of economics, governance, and environmental policy and that unbridled advancement of technology without regard to psychological consequences could have major unforeseen implications. However, this is not the future I see being discussed by the top decision makers of today and therefore it has not made its way into the discussion of the body of this thesis. From this process, I do believe that understanding the likely future is one of the first steps toward creating a better future.

10.4 - Acknowledgements

Until writing this thesis, I never understood why authors felt the need to include a lengthy discussion of acknowledgements. I now realize that every major document represents not only the creative talents of an individual, but also a great investment by an unsung support structure of advisors, friends, and family.

The first group of people I need to thank are my friends and family. Without their constant support and encouragement, this thesis would not have been completed. Often times their support came in the form of understanding my not-so-infrequent need to lock myself in my office for weeks on end in pursuit of an impossible, and at times seemingly selfish, endeavor. Especially from this group I need to thank Stephanie who has always had knack for telling what I don't want to hear and giving deep insights, even if I never let her read the document in progress. She was usually quick to remind me that I am my own harshest critic and that the document probably isn't as bad as I make it out to be.

Professionally and personally, I extend my gratitude to my POS committee and other faculty advisors. Their experience in guiding me through the process of composing this document was invaluable. I especially thank my major professor, Dr. Ed Jaselskis. In addition to providing wisdom and guidance for the past year and a half, he made possible the opportunity to work on the CII task force that made my graduate studies possible.

Finally, I need to thank the CII professional community for allowing this research study. Our task force industry advisors Peter Van Nort and Virgil Barton provided me with appreciated guidance and essential confidence to complete the study. I thank the countless professionals who contributed their valuable time in completing survey and discussing the future.

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Appendix A: 2007 Emerging Trends Validation Survey

Questions marked with a * are required

CII: 2007 Emerging Trends Validation Survey

Hello:

The Emerging Trends Team thanks you for taking the time to participate in this survey. It will help provide valuable insight into the trends identification and analysis process. This survey should take approximately ~20 minutes to complete.

*Please do not navigate away from the survey once you begin or you will have to restart from the beginning.

The Emerging Trends Team has defined the term 'emerging trend' as the following:

A developing practice or force that has the potential to influence an industry and/or the individual units of that industry. 'Emerging trends' differ from 'trends; in that 'emerging trends' have not yet become widespread throughout the industry.

If you should have any questions throughout the survey, please contact Cory McDermott:
Direct - 563.590.4214
Email: cmcdrmtt@iastate.edu

Thanks Again.

Personal Information

First Name

Last Name

With which company are you currently employed?

What is your your job title with that employer?

What is your email address?

Evaluation of 2007 Emerging Trends

In 2007 the Emerging Trends Team, a subset of the CII Strategic Planning Committee, released a report outlining the emerging trends of 2007. The following set of questions is meant to monitor and measure the effectiveness of that report.

Each section of the 2007 has been integrated into this survey. Each section has three questions:

-Rate the Likelihood of each trend

-Rank the Impact of each trend

-Provide comments about trends in the category

Workforce and Human Capability: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

Lack of Qualified Contractors available to meet current industry demands	
Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	
Decreasing availability of Labor – Trades (Foremen, Craftworkers)	
Firms are developing new ways to utilize older workers	
Increased emphasis on 'turnover' of knowledge within organizations	
More training of unskilled workers to meet labor needs	

Workforce and Human Capability: Impact

Assuming the following events and activities emerge as trends, evaluate the impact of each on your industry?

	Low		Medium		High
Lack of Qualified Contractors available to meet current industry demands	○	○	○	○	○
Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	○	○	○	○	○
Decreasing availability of Labor – Trades (Foremen, Craftworkers)	○	○	○	○	○
Firms are developing new ways to utilize older workers	○	○	○	○	○
Increased emphasis on 'turnover' of knowledge within organizations	○	○	○	○	○
More training of unskilled workers to meet labor needs	○	○	○	○	○

Workforce and Human Capability: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Project Delivery: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

Modular and prefabrication are becoming increasingly important construction methods	
Increased use of integrated data models - design/fabrication/construction	
Greater use of 'Lean' principles in construction	
Increased emphasis on sustainability	

Project Delivery: Impact

Assuming the following events and activities emerged as trends, how much would each impact your particular industry?

	Low		Medium		High
Modular and prefabrication are becoming increasingly important construction methods	○	○	○	○	○
Increased use of integrated data models - design/fabrication/construction	○	○	○	○	○
Greater use of 'Lean' principles in construction	○	○	○	○	○
Increased emphasis on sustainability	○	○	○	○	○

Project Delivery: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Corporate Strategy: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	
Companies incorporating sustainability into their Strategic Plan	
Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
Increased use of Joint Ventures to complete capital projects.	
EPCs becoming more selective in the projects they pursue	
Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	

Corporate Strategy: Impact

Assuming the following events and activities emerged as trends, how much would each impact your particular industry?

	Low		Medium		High
Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	○	○	○	○	○
Companies incorporating sustainability into their Strategic Plan	○	○	○	○	○
Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	○	○	○	○	○
Increased use of Joint Ventures to complete capital projects.	○	○	○	○	○
EPCs becoming more selective in the projects they pursue	○	○	○	○	○
Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	○	○	○	○	○

Corporate Strategy: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Technology & Innovation: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

Increase in Clean Energy Initiatives	
Increased use of Integrated Project Information Systems	
Engineering increasingly using BIM and Rule based Design	
Increased use of Trenchless Technology	

Technology & Innovation: Impact

Assuming the following events and activities emerged as trends, how much would each impact your particular industry?

	Low		Medium		High
Increase in Clean Energy Initiatives	○	○	○	○	○
Increased use of Integrated Project Information Systems	○	○	○	○	○
Engineering increasingly using BIM and Rule based Design	○	○	○	○	○
Increased use of Trenchless Technology	○	○	○	○	○

Technology & Innovation: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Markets and Demand Drivers: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

Increased investment in new & renewable energy	
Nuclear power returning as a viable energy alternative	
Increased emphasis on Clean Energy Technology – CO2 emissions	
Increase in the use of Solar Power	
China and India continue to demand increasing amounts of EPC resources	
New geographic locations emerging as energy exporters	

Markets and Demand Drivers: Impact

Assuming the following events and activities emerged as trends, how much would each impact your particular industry?

	Low		Medium		High
Increased investment in new & renewable energy	○	○	○	○	○
Nuclear power returning as a viable energy alternative	○	○	○	○	○
Increased emphasis on Clean Energy Technology – CO2 emissions	○	○	○	○	○
Increase in the use of Solar Power	○	○	○	○	○
China and India continue to demand increasing amounts of EPC resources	○	○	○	○	○
New geographic locations emerging as energy exporters	○	○	○	○	○

Markets and Demand Drivers: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Social and Political Influences: Likelihood

Please evaluate the likelihood of each of the following becoming industry trends (0-100%)

"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	
As public infrastructure continues to decay, public funding alone won't increase to meet needs	
Continuing restrictions placed on emissions for developing and industrial countries	
Climate Changes are causing significant changes in the construction industry	
Regional Warfare causing an increasing need for reconstruction	
Increasing integration of undocumented workers into the workforce to alleviate labor shortages	

Social and Political Influences: Impact

Assuming the following events and activities emerged as trends, how much would each impact your particular industry?

	Low		Medium		High
"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	○	○	○	○	○
As public infrastructure continues to decay, public funding alone won't increase to meet needs	○	○	○	○	○
Continuing restrictions placed on emissions for developing and industrial countries	○	○	○	○	○
Climate Changes are causing significant changes in the construction industry	○	○	○	○	○
Regional Warfare causing an increasing need for reconstruction	○	○	○	○	○
Increasing integration of undocumented workers into the workforce to alleviate labor shortages	○	○	○	○	○

Social and Political Influences: Comments

What action has your organization made to address the emerging trends in this category?
Please list any additional emerging trends that could be included in this category.
Please provide any additional comments about this category:

Response to Emerging Trends

This section addresses your organization's reactions to the industry's Emerging Trends.

Have you reviewed the CII: Emerging Trends Team 2007 Report?

Yes ○ No ○

How helpful was the CII: Emerging Trends Team 2007 Report?

Not Helpful ○ Moderately Helpful ○ Very Helpful ○

Would you or someone else in your organization be willing to be interviewed to share your thoughts on the emerging trends in your industry for 2008? This interview would take approximately 30-45 minutes.

*

○ Yes ○ No

Contact Information

Please provide the contact information of the individual to be contacted by the CII: Emerging Trends Team.
This person will be contacted in the next few days to set up an interview appointment.

Name

Phone Number

Email Address

Is there an individual in your organization who could be classified as a futurist (someone involved with forecasting market forces 25 years in the future)?

*

○ Yes ○ No

Could this futurist be interviewed by the CII Blue Sky Team? This interview would take approximately 30-45 minutes.

○ Yes ○ No

Contact Information

Please provide the contact information of the individual to be contacted by the CII: Blue Sky Team. This person will be contacted in the next few days to set up an interview appointment.

Name

Phone Number

Email Address

Please give any questions or comments about the 2007 Trends Validation survey in general.

Please contact cmcdrmtt@iastate.edu if you have any questions regarding this survey.

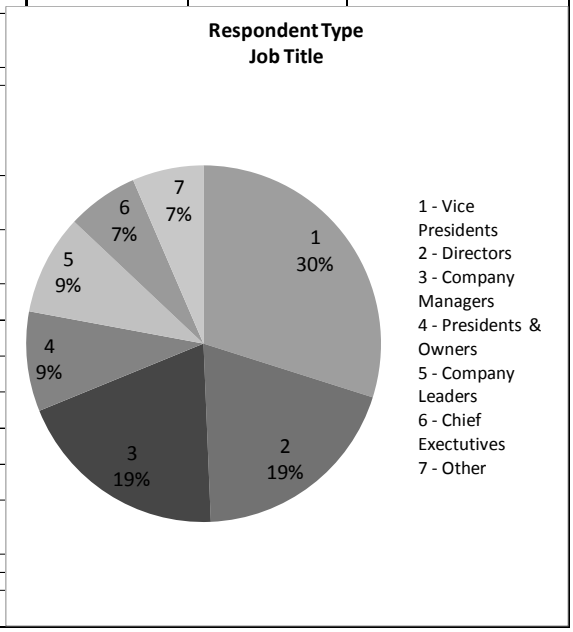
Appendix B: 2007 Emerging Trends Validation Survey Analysis

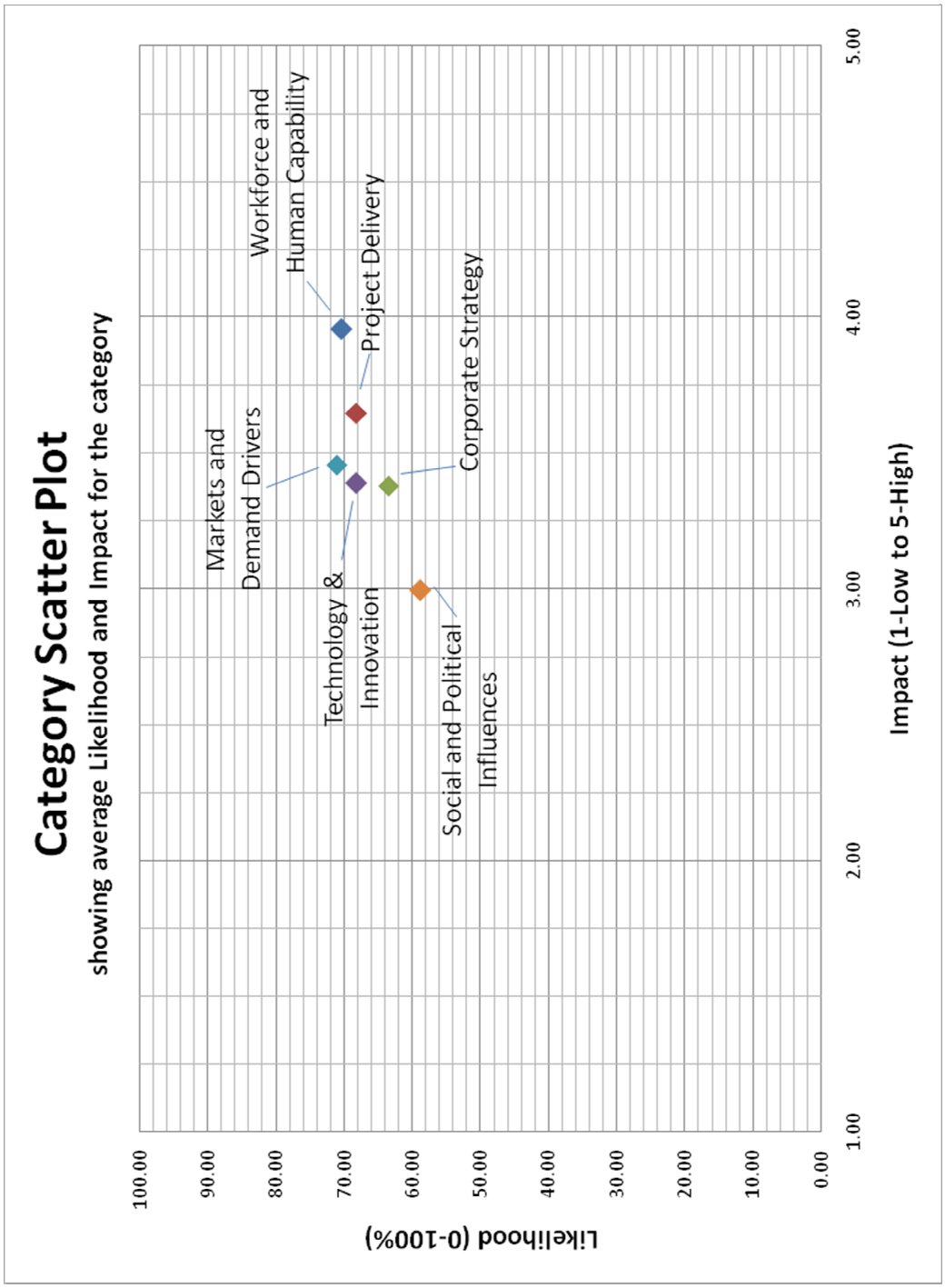
Organizations Contributing Responses to the Survey

Abbott
Adolfson and Peterson Construction
AirProducts
Aker Kvaerner
Alcoa
Alstom Power Inc
Anheuser-Busch
AZCO INC.
Baker Concrete Construction
BE&K
BIS Frucon Industrial Services Inc.
Bowen Engineering Corporation
BP
Burns and McDonnell
Cargill, Inc.
CCC Group, Inc.
CH2M HILL
Chevron
CITGO Petroleum Corporation
ConocoPhillips
CSA Group
DOE
Dresser-Rand Co.
Dresser-Rand Group
dupont
DuPont
Eastman Chemical Company
Eli Lilly and Company
Emerson Electric
Emerson Process Management
Fluor Corp
Ford, Bacon & Davis, LLC
General Motors
GS Engineering & Construction
Hargrove and Associates, Inc.
HARPER INDUSTRIES, INC.
Hill International
Hilti inc.
Intel
J. Ray McDermott
Jacobs
Kaiser Permanente
KBR
Marathon Oil Company
NASA HQ
National Institute of Standards and Technology
NAVFAC
NOVA Chemicals
Ontario Power Generation
OPG
Parsons
Pathfinder LLC
Procter & Gamble Company
Progress Energy
R.J. Mycka, Inc.
Rohm and Haas
Smithsonian Institution
SNC Lavalin-GDS
SUNOCO, INC.
Technip USA
The Dow Chemical Company
The Nielsen-Wurster Group
The Shaw Group
Tyson Foods, Inc.
U.S. Army Corps of Engineers
Walbridge Aldinger
Zachry

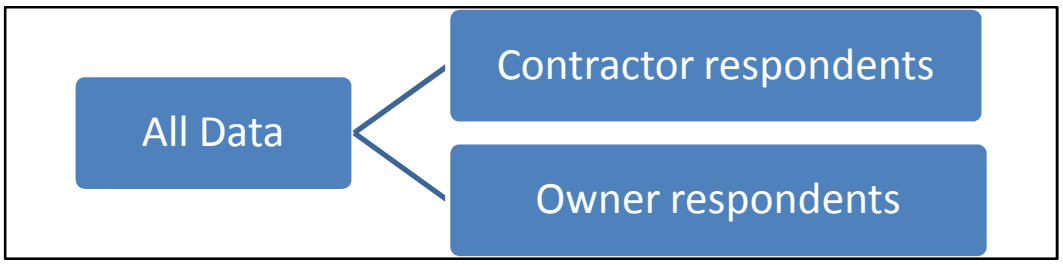
List of Survey Respondent Job Titles

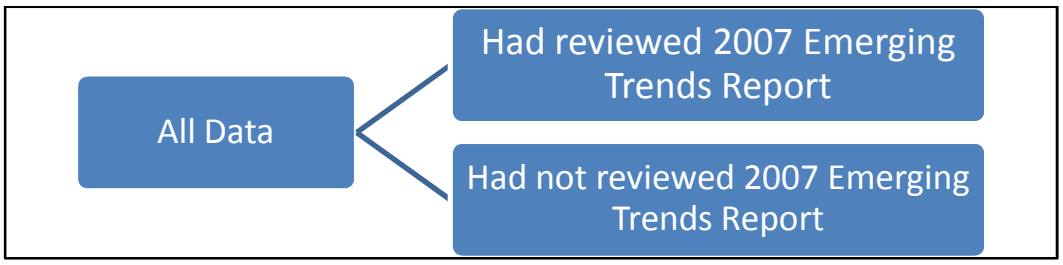
Vice Presidents	Directors	Company Managers	Presidents & Owners	Company Leaders	Chief Exectutives	Other
1	2	3	4	5	6	7
Senior Vice President	Director of Projects	Manager - Project Management Office	President	Team Leader, E&C IT Systems	Chief Executive Officer	Project Assurance Consultant
Executive Vice President	Director, Diagnositcs Engineering	General Manager of Project Services	President, Process Systems and Solutions	Global Staff Network Leader - Project Management	Deputy Director/Chief of Staff Ofc of Fac. Engrg and Opns	Consultant
VP Quality Management	Group Director, Project Management & Planning	Corp. Eng. Global Construction Manager	President	WW Capital Project Management Leader	CEO	Program Manager
Sr. Vice President Strategic Business	Director Project Support Services	Manager Project Management	President E&C US Inc.	QHSE Management Team Leader	CHIEF ORGANIZATIONAL OFFICER	engineer
Vice President	Director Construction - Americas	WWEC Manager	OWNER	Capital Effectiveness Implementation Leader	CEO	Senior Project Manager
VP and Chief Marketing Officer	Director - Corporate Engineering Business Support	Manager Metrics	President - BE&K Engineering	Lead, Design and Construction		
Vice President, Sales	Executive Director Global Facilities Delivery	Construction Enterprise Engineering - General Manager	President, PM	Business Operations and Program Support		
VP & CTO	Director of Construction-Life Sciences Group	Manager - PMO				
Vice President, WW Engineering and Construction	director	Manager - Global Facalities Delivery				
VP of Construction	Director	General Mgr.				
VP	Director - Strategic Project Services	MANAGER, ENGINEERING SPECIALISTS & CONTRACTOR ENGINEERING				
VP Project Controls	Capital Projects Global Director for Worldwide Facility Group	Southeast [US] Regional Manager				
Vice-president	Director, Process Innovation	Strategic Planning and Capital Projects Manager				
Associate Vice President	Director - Program Management	Project Engr Department Manager				
Group Vice President	Dir of Capital Speciality Materials	Manager Project development				
Senior Vice President, Operations						
VP Project Execution Services						
Vice Presdient Global Project Services						
Senior VP - Business Development/Chemicals						
Vice President, Engineering, Energy Businesses						
Sr. Vice President						
Vice President						
Vice President, Construction						

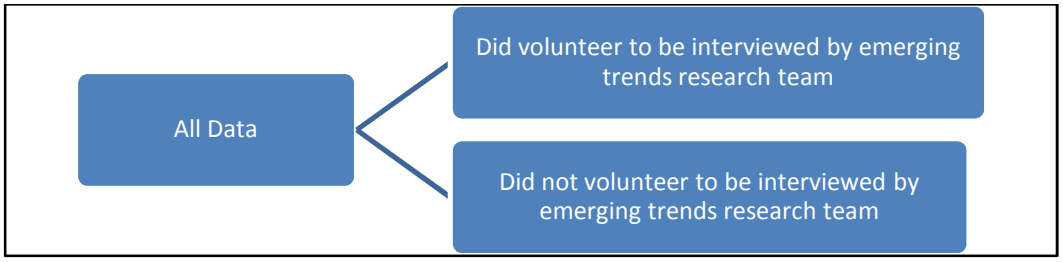


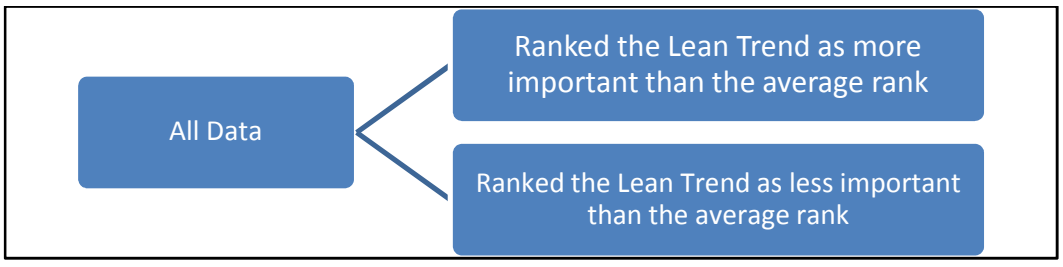

Category Scatter Plot
showing average Likelihood and Impact for the category
Likelihood (0-100%)
Impact (1-Low to 5-High)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1.00
2.00
3.00
4.00
5.00
Markets and Demand Drivers
Workforce and Human Capability
Technology & Innovation
Project Delivery
Corporate Strategy
Social and Political Influences

This section of Appendix B contains statistical TTests of the data of the 2007 Emerging trends Validation Survey. For each TTest, a split was made according to a certain characteristic of the data. The TTests compared the average ranking of each trend by each of the split groups. The mean value of the rank for each trend is shown for each group. The following figures show the data splits for the TTests included in this appendix.









Ttest:	Contractors vs. Owners		Average Ranking	
	Trend	TTest Value	Contractors	Owners
Workforce and Human Capability: Likelihood	Lack of Qualified Contractors available to meet current industry demands	0.0911	11.34	8.21
	Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	0.7903	7.57	8.10
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	0.5899	6.49	7.52
	Firms are developing new ways to utilize older workers	0.2472	16.14	18.62
	Increased emphasis on 'turnover' of knowledge within organizations	0.7573	13.89	14.55
	More training of unskilled workers to meet labor needs	0.0997	10.77	14.03
Project Delivery: Likelihood	Modular and prefabrication are becoming increasingly important construction methods	0.9696	11.11	11.03
	Increased use of integrated data models - design/fabrication/construction	0.9301	11.74	11.93
	Greater use of 'Lean' principles in construction	0.3815	14.54	16.45
	Increased emphasis on sustainability	0.9506	13.66	13.52
Corporate Strategy: Likelihood	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	0.0015	19.69	26.34
	Companies incorporating sustainability into their Strategic Plan	0.3087	16.71	14.55
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	0.6906	15.00	15.86
	Increased use of Joint Ventures to complete capital projects.	0.7431	14.20	13.48
	EPCs becoming more selective in the projects they pursue	0.1751	12.34	9.55
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	0.6332	14.69	13.62
Technology & Innovation: Likelihood	Increase in Clean Energy Initiatives	0.3948	9.71	11.55
	Increased use of Integrated Project Information Systems	0.2150	9.20	11.69
	Engineering increasingly using BIM and Rule based Design	0.4357	14.83	16.55
	Increased use of Trenchless Technology	0.4468	24.00	25.41
Markets and Demand Drivers: Likelihood	Increased investment in new & renewable energy	0.8298	9.77	9.38
	Nuclear power returning as a viable energy alternative	0.5794	13.54	14.79
	Increased emphasis on Clean Energy Technology – CO2 emissions	0.9047	7.83	8.03
	Increase in the use of Solar Power	0.2714	20.80	18.48
	China and India continue to demand increasing amounts of EPC resources	0.2521	11.57	9.28
	New geographic locations emerging as energy exporters	0.1201	17.06	20.17
Social and Political Influences: Likelihood	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	0.9146	22.11	21.90
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	0.4632	15.11	16.79
	Continuing restrictions placed on emissions for developing and industrial countries	0.3923	14.57	12.76
	Climate Changes are causing significant changes in the construction industry	0.4844	18.57	17.00
	Regional Warfare causing an increasing need for reconstruction	0.8935	22.89	22.66
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	0.2627	16.31	19.00

Ttest: Reviewed 2007 Trends report vs. Not Reviewed

	Trend	TTest Value	Average Ranking Reviewed	Not Reviewed
Workforce and Human Capability: Likelihood	Lack of Qualified Contractors available to meet current industry demands	0.2860	8.96	11.14
	Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	0.0080	5.00	10.63
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	0.0767	4.83	8.54
	Firms are developing new ways to utilize older workers	0.2287	16.65	19.31
	Increased emphasis on 'turnover' of knowledge within organizations	0.0031	11.09	17.57
	More training of unskilled workers to meet labor needs	0.5828	12.13	13.31
Project Delivery: Likelihood	Modular and prefabrication are becoming increasingly important construction methods	0.4445	10.30	12.09
	Increased use of integrated data models - design/fabrication/construction	0.5890	13.09	11.83
	Greater use of 'Lean' principles in construction	0.5455	15.22	16.63
	Increased emphasis on sustainability	0.3981	13.09	15.11
Corporate Strategy: Likelihood	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	0.4693	23.00	24.57
	Companies incorporating sustainability into their Strategic Plan	0.0743	13.83	17.91
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	0.4847	15.09	16.71
	Increased use of Joint Ventures to complete capital projects.	0.1446	16.39	12.91
	EPCs becoming more selective in the projects they pursue	0.6877	11.74	10.83
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	0.9796	14.57	14.63
Technology & Innovation: Likelihood	Increase in Clean Energy Initiatives	0.3779	9.22	11.31
	Increased use of Integrated Project Information Systems	0.1771	8.87	11.86
	Engineering increasingly using BIM and Rule based Design	0.5151	14.91	16.49
	Increased use of Trenchless Technology	0.3282	24.78	26.46
Markets and Demand Drivers: Likelihood	Increased investment in new & renewable energy	0.0367	12.09	8.00
	Nuclear power returning as a viable energy alternative	0.2295	16.35	13.40
	Increased emphasis on Clean Energy Technology – CO2 emissions	0.8728	7.30	7.60
	Increase in the use of Solar Power	0.8444	20.70	20.26
	China and India continue to demand increasing amounts of EPC resources	0.1058	8.43	12.00
	New geographic locations emerging as energy exporters	0.4097	20.43	18.74
Social and Political Influences: Likelihood	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	0.4230	23.87	22.23
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	0.3439	17.52	15.17
	Continuing restrictions placed on emissions for developing and industrial countries	0.6046	14.48	13.29
	Climate Changes are causing significant changes in the construction industry	0.0074	22.09	15.80
	Regional Warfare causing an increasing need for reconstruction	0.2915	22.70	24.40
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	0.5510	18.87	17.31

Ttest: Did Volunteer for Interview vs. Didn't Volunteer

	Trend	TTest Value	Average Ranking Did	Did Not
Workforce and Human Capability: Likelihood	Lack of Qualified Contractors available to meet current industry demands	0.2313	11.00	8.77
	Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	0.3105	8.79	6.77
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	0.9074	7.06	6.84
	Firms are developing new ways to utilize older workers	0.7210	17.64	16.87
	Increased emphasis on 'turnover' of knowledge within organizations	0.4000	15.06	13.26
	More training of unskilled workers to meet labor needs	0.8816	12.39	12.10
Project Delivery: Likelihood	Modular and prefabrication are becoming increasingly important construction methods	0.0871	12.79	9.26
	Increased use of integrated data models - design/fabrication/construction	0.2551	13.00	10.58
	Greater use of 'Lean' principles in construction	0.2071	16.73	14.00
	Increased emphasis on sustainability	0.7091	14.00	13.16
Corporate Strategy: Likelihood	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	0.7347	23.06	22.32
	Companies incorporating sustainability into their Strategic Plan	0.3956	16.61	14.81
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	0.0637	17.30	13.35
	Increased use of Joint Ventures to complete capital projects.	0.1950	12.52	15.32
	EPCs becoming more selective in the projects they pursue	0.3395	12.03	10.06
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	0.1712	15.67	12.65
Technology & Innovation: Likelihood	Increase in Clean Energy Initiatives	0.3663	9.61	11.55
	Increased use of Integrated Project Information Systems	0.4391	9.58	11.13
	Engineering increasingly using BIM and Rule based Design	0.1362	14.03	17.29
	Increased use of Trenchless Technology	0.2511	25.67	23.55
Markets and Demand Drivers: Likelihood	Increased investment in new & renewable energy	0.8743	9.45	9.74
	Nuclear power returning as a viable energy alternative	0.3629	13.12	15.16
	Increased emphasis on Clean Energy Technology – CO2 emissions	0.3909	7.21	8.68
	Increase in the use of Solar Power	0.0701	21.58	17.81
	China and India continue to demand increasing amounts of EPC resources	0.0857	12.18	8.77
	New geographic locations emerging as energy exporters	0.0056	21.09	15.68
Social and Political Influences: Likelihood	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	0.7223	22.36	21.65
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	0.5304	15.18	16.61
	Continuing restrictions placed on emissions for developing and industrial countries	0.7732	13.45	14.06
	Climate Changes are causing significant changes in the construction industry	0.9920	17.85	17.87
	Regional Warfare causing an increasing need for reconstruction	0.9645	22.82	22.74
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	0.2126	16.09	19.06

Ttest: Ranking of Lean Above Average vs. Below

	Trend	TTest Value	Average Ranking Above	Below
Workforce and Human Capability: Likelihood	Lack of Qualified Contractors available to meet current industry demands	0.6039	10.41	9.44
	Decreasing availability of Labor – Management (Executive, Project Managemer, Superintendent)	0.2986	6.78	8.84
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	0.6819	7.34	6.56
	Firms are developing new ways to utilize older workers	0.6936	16.84	17.69
	Increased emphasis on 'turnover' of knowledge within organizations	0.6411	13.69	14.69
	More training of unskilled workers to meet labor needs	0.7068	12.63	11.88
Project Delivery: Likelihood	Modular and prefabrication are becoming increasingly important construction methods	0.1603	9.63	12.53
	Increased use of integrated data models - design/fabrication/construction	0.0447	9.72	13.94
	Greater use of 'Lean' principles in construction	0.0000	7.75	23.06
	Increased emphasis on sustainability	0.0003	9.75	17.44
Corporate Strategy: Likelihood	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	0.0426	20.53	24.88
	Companies incorporating sustainability into their Strategic Plan	0.0346	13.53	17.94
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	0.6324	14.88	15.91
	Increased use of Joint Ventures to complete capital projects.	0.3137	14.97	12.78
	EPCs becoming more selective in the projects they pursue	0.0892	12.81	9.34
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	0.3447	15.25	13.16
Technology & Innovation: Likelihood	Increase in Clean Energy Initiatives	0.3013	11.66	9.44
	Increased use of Integrated Project Information Systems	0.5235	10.97	9.69
	Engineering increasingly using BIM and Rule based Design	0.2488	14.34	16.88
	Increased use of Trenchless Technology	0.0008	21.66	27.63
Markets and Demand Drivers: Likelihood	Increased investment in new & renewable energy	0.1449	10.91	8.28
	Nuclear power returning as a viable energy alternative	0.7917	14.41	13.81
	Increased emphasis on Clean Energy Technology – CO2 emissions	0.2328	8.94	6.91
	Increase in the use of Solar Power	0.1269	18.16	21.34
	China and India continue to demand increasing amounts of EPC resources	0.3323	9.56	11.50
	New geographic locations emerging as energy exporters	0.1330	16.97	19.97
Social and Political Influences: Likelihood	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	0.4665	21.28	22.75
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	0.9128	16.00	15.75
	Continuing restrictions placed on emissions for developing and industrial countries	0.2991	14.84	12.66
	Climate Changes are causing significant changes in the construction industry	0.2809	19.06	16.66
	Regional Warfare causing an increasing need for reconstruction	0.3052	21.91	23.66
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	0.3467	18.66	16.41

Appendix C: Emerging Trends Interview Summary Transcripts

Emerging Trend Interview: A

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Clearly it is a good time for energy and process side. Not enough qualified resources. It is an industry of boom or bust. You drive them out of the industry and they don't come back. The cyclical nature of our business really hurts us. Something we can't change. We don't collaborate as an industry looking at this industry. CII is a good example of a collaborative, it is predominately research based, these are some predominantly socioeconomic situations. Better understand where the market is headed.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Biggest challenge of craft workforce
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	Identifying gaps and
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Greatly increased training. Aggressively hiring Piloting knowledge retention processes Placing people in stretch positions with mentor.
	Please list any additional emerging trends that could be included in this category.	Projects are larger and more complex requiring to be executed in several locations requiring more experienced workforce and leadership putting greater pressures on the capabilities of the key resources. Increased collaboration is going to be necessary, but not easy. New engineers are more collaborative
	Please provide any additional comments about this category:	Technology is lagging the demands of our industry especially in the area of collaboration Newest generation has become a bit complacent.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Modular construction has been around for a long time. More acceptable. Cultural Change. It's just like building a home, custom built. Offshore guys have been doing it for a long time. Was on the ship building team. Think about components if they can be built as modules. Union backlash, look to the auto industry. The consequence
	Increased use of integrated data models - design/fabrication/construction	not really affecting us now-frustrating. We are document and drawing centric not data. We have the tools and technology. Integrated fabrication and design process with shipbuilding. We need to engage suppliers and fabricators. Do a feasibility study design and construction.
	Greater use of 'Lean' principles in construction	

Emerging Trend Interview: A

	Trend	Comment
	Increased emphasis on sustainability	Can we continue that progress? I'd like to think so, but we do not destroy society and the moral fibers of society. If you are brought up in an environment of abundance. Moral fiber: things are easy, no value. When you lose sight of value, you become a poor custodian of resources. Life when I was a kid, it was safe to walk around the streets. We've lost a lot of respect for others, driven by luxury items.
	What action has your organization made to address the emerging trends in this category?	Executed several large modular projects and created a knowledge center for modular execution. Large initiative underway to evaluate data centric execution and data integration. Have a Lean Process in place Sustainability is now being addressed on most of our projects What is project manager of 2025 going to look like? Chinese. A lot more of a greater business manager, developing business relationships
	Please list any additional emerging trends that could be included in this category.	We aren't taking advantage of modularization or factory environments
	Please provide any additional comments about this category:	When times are good, too busy, when they're bad, not enough money.
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	focus on price rather than a good focus on industry, One of the problems is the way we reward quarter by quarter. The American empire is capitalism, and the times are changing
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	Currently operate in the build operate arena to a limited extent but could grow. Sustainability is a part of our strategic plan. Have in place SOX compliant practices and procedure Have a selectivity process. Other countries don't have as much to risk so there is only one way to go. We have a disposable attitude. We need to go through a famine.
	Please list any additional emerging trends that could be included in this category.	Very combative industry compared to collaborative.
	Please provide any additional comments about this category:	

Emerging Trend Interview: A

	Trend	Comment
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	Have initiative in place that address clean energy and rule based design
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	There is an abundance of energy outside of hydrocarbons and he's in that market. Solar cells and wind. Nana filament.
	Nuclear power returning as a viable energy alternative	Frustrated that neither party has an energy policy. We try to please too many people. We've had it too easy.
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	This is playing a big part. US produces accountants and lawyers. At the end of the day, we need to produce goods and there needs to be a balance. Built by us firms, but national companies will emerge.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	Established focus groups for renewable energy, new nuclear and solar power.
	Please list any additional emerging trends that could be included in this category.	global execution centers
	Please provide any additional comments about this category:	
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	We are still having to widen freeways that were built 10 years ago. This is more driven by economics and cost rather than looking into the future. We really need mass transportation. No matter where it comes from, it comes from the public. I am in favor for making people accountable for where the money goes.
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	

Emerging Trend Interview: A

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	Try to maintain a diverse project portfolio across several regions
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: B

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	Worldwide. Not just the US by the golf coast. Compete for Chinese EPC firms. Become a seller's market. Clear in 2006, one project had to fire an EPC
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Interesting how global it is. Thought we could just go to India and other countries. It is going to be difficult. We could do better with this rather than forcing tradition and companies have been unprepared. The way to respond is through management methods
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	We exploring use of medium-size EPC firms instead of going with the standard giants.
	Please list any additional emerging trends that could be included in this category.	Decreasing # of engineering graduates in US. Operations in India becoming more economical. Add more flex time and increased salary still not a significant business cost. Compare engineering costs to benefit.
	Please provide any additional comments about this category:	I don't think we always recognize the risk of utilizing inexperienced, unproven Management until it is too late. Takes awhile to address and fix these problems. CII can give tools to address problem.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	
	Increased use of integrated data models - design/fabrication/construction	
	Greater use of 'Lean' principles in construction	Used in schedule critical projects.
	Increased emphasis on sustainability	In China you can see them responding to the environmental issues. Your company is focusing on sustainability. Project to find balance between EPC and financing. World Bank now requires consultant. May come from lenders.
	What action has your organization made to address the emerging trends in this category?	We are actively working on implementing lean construction techniques. We have always had a significant focus on sustainability and continue to do so.

Emerging Trend Interview: B

	Trend	Comment
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Using industry tools becomes more critical as use of integrated data model becomes more prevalent. Companies will need to stay current to be able to attract and use limited resources.
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	Not their focus
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	Used as the asset life strategy. Effective but it can be difficult to compromise with multiple stakeholders. We are still learning.
	EPCs becoming more selective in the projects they pursue	Probably won't ever get back to the levels where it used to be.
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	JV's are a clear part of our corporate strategy so we have developed tools to be able to effectively scope and manage capital projects within that structure. We are also gearing up to deal with the current EPC market environment - identifying tools and practices to respond to the unique dynamics.
	Please list any additional emerging trends that could be included in this category.	Equator principles increase emphasis on sustainability.
	Please provide any additional comments about this category:	
Technology & Innovation	**Increase in Clean Energy Initiatives**	Sustainability drivers
	Increased use of Integrated Project Information Systems	Examples include process design: single data entry - tools still aren't there. When you go global, using visual communication is key. Net meetings
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	We are actively pursuing integrated project information systems.
	Please list any additional emerging trends that could be included in this category.	Pipe scanning - 3D laser scanning. Used to have people go out and validate design docs.
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	Is it economical? Impact on food prices.
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	Interesting because the US is not becoming the dominant country. In order to have an effective impact. Haven't invested as much in India - company needs to be agile.

Emerging Trend Interview: B

	Trend	Comment
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	We continue to maintain focus on Clean Energy technology. We are actively studying capital effectiveness in emerging regions, including India and China.
	Please list any additional emerging trends that could be included in this category.	Trend of expats.
	Please provide any additional comments about this category:	Water Extra cost now. Seawater is being used. As a country they are looking at the Yangtze river. Need is significant and supply is limited. Design systems to use air fin, tradeoffs. Water solutions: filtering and supplying. Blue Planet. Look at the system as a whole
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	Hasn't impacted them nearly as much as they would have thought. Australian CEO. Global representation. Not everyone wants to go to Libya. Companies where we are global is that it takes you to a higher level of professionalism. US Global firms
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	We need more infrastructure; citizens will in the end always bare the cost. Shocked the world with MN, also Katrina. New Trend that How to bring someone back to construction industry and engineering.
	Continuing restrictions placed on emissions for developing and industrial countries	Ex: China, slows down schedules and you need to go through multiple permits. Invest in more environmental technologies. Make sure organizations can meet global initiatives
	Climate Changes are causing significant changes in the construction industry	CO2 mostly. We need to address it but we still aren't sure.
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	Information flows - all news transfers around the world in minutes. Forces companies to be MUCH more cautious.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Closing thoughts: support CII and industry to solve these problems. We have hope for the future. Don't ever be suddenly swamped by the short term.

Emerging Trend Interview: C

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	Much of this is driven by demands of energy & infrastructure.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Their service is people. Work on 6 continents. They work on a global scale. They work for customers and they are desperate for people. Good percentage of time spent dealing with labor issues. Better planning of work; moves down to the grassroots level. Continuing to develop those management ranks. Less of a gap to develop managers.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Are we investing enough in technology. General need to fill a gap.
	Firms are developing new ways to utilize older workers	Aggressively applying any new best practices. Spent a board meeting talking about how they had a one size fits all for workers. New strategies to develop individuals with recruitment.
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Active programs from K12 schools to internships / college recruiting to older workers. Paying great attention to individual cohorts (age groups) and their expectations in the work place. Different modes of communication between cohorts. Different levels of technology.
	Please list any additional emerging trends that could be included in this category.	Trends of younger worker expectations are opposite of industry needs! Rapidly growing company investing in training. Workplace more rewarding - people focused. Career of choice, not of last resort.
	Please provide any additional comments about this category:	
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Already widely used. Current best practice in many parts of the world.
	Increased use of integrated data models - design/fabrication/construction	Inhouse project management systems. Still obstacles coming from large software manufacturers. How does the
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	Their company has been a sustainability culture for years. Now it gets lip service. There has been a change.
	What action has your organization made to address the emerging trends in this category?	Active programs in each of the four points above. Working on taking them from occasional or sporadic usage to institutional usage.
	Please list any additional emerging trends that could be included in this category.	Seeing a lot more structured delivery with workbreakdown structures. Program contractor - who divides contracting risk. Bring more predictability to mega-projects. More complex relationships - additional relationships.
	Please provide any additional comments about this category:	

Emerging Trend Interview: C

	Trend	Comment
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	They did a lot of these and what they saw was 'why would they want to do this?' What is the economic sense to do this. They become risky to build. Expensive to bid.
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	These are an ebb and flow. Joke: client will swing back and forth - reactionary mode.
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	Actively working on each. Do not see strong trend toward build operate transfer - costs more money, does not always solve the real issues. If we couple larger, more complex projects - there are fewer companies able to these projects on their own. Need to balance risk and sheer numbers. Smaller company, in order to qualify, they need partners
	Please list any additional emerging trends that could be included in this category.	Long term relationships and alliances delivering safer, faster and lower cost projects vs. transactional model.
	Please provide any additional comments about this category:	
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	Extend back to the low bid mentality - reduced emphasis in technology. Now we are too busy to move forward with technology. Great things CII does is to leverage $'s and people and the ability to participate in the evolution of technology and best practices.
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	Active initiatives in each area
	Please list any additional emerging trends that could be included in this category.	yes, impacts. They market and help use RFID to monitor projects and develop software to analyze data that is received. Equipment and materials. Productivity arena. Standardized offering - institutionalize technologies.
	Please provide any additional comments about this category:	CII - There are lots of organizations, form alliances with various organizations. Tying them together and leverage. Looking for the best of the best and giving it to the members. Nature of the process makes it weaker - benign. How to manage something without endorsing. That kind of information is important: constructability 10:1 payback and it took off like a rockets

Markets and Demand Drivers	**Increased investment in new & renewable energy**	
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	Cover enough acres. Does it make a difference. Not enough baseload power
	China and India continue to demand increasing amounts of EPC resources	Now they can have a great life living at home.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	Active business in each trend
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	We see lots of people who dislike current leadership. It's not that contracts are leaving because they are an 'American' country. In Iran, US sanctions have NO impact. American arrogance that since….
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	Climate change is a business opportunities. We need to have mitigation strategies. There will be projects 50 years out, but not yet.
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: D

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	On the management side, there are plenty of resources going into the management side, we will always be able to further educate those resources. Non union regions are having much more difficult times finding. The labor force is attracting untrained workers who are being trained on the jobsite: quality issues arise.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Sometimes work needs to be reworked that they haven't had before. They've raised their standards as well as have the top 200 by ENR. What do we need to do? Use of technology in the field can attract. Currently we don't have the glamour associated. Perceptions have not changed as quickly as the industry has changed
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	It starts with every sup->foreman->skilled trades->unskilled
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	We are actively encouraging the turnover of knowledge from the older workers to the younger workers through an active encouragement program to share best practices. We do not want to see the many lessons learned leave our company through retirement or lay-off.
	Please list any additional emerging trends that could be included in this category.	Work force declining in more strenuous trade requirements like iron workers, masons and millwrights. Less trained people entering into the construction trades. Not as safety oriented and not as trained. A residential contractor doesn't take the same precaution. Code requirements: much stricter than in residential.
	Please provide any additional comments about this category:	more training required through all the trades, more structured on the jobsite training. Unions who are providing apprentice programs are dwindling and going by the boards
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Construction under stricter schedules, only way work can get completed in allotted timeframe. Offsite products ->leading to better quality. It's not left up to the individual. Standardize
	Increased use of integrated data models - design/fabrication/construction	Prior to on the job, conflicts are being determined ahead of time. No more 1st person in decides. Doing it on the major projects with lots of integration. More embracing by the constructor. New generation computer is our tool.
	Greater use of 'Lean' principles in construction	

Emerging Trend Interview: D

	Trend	Comment
	Increased emphasis on sustainability	Increased emphasis on sustainability. Not about satisfying a LEED point. Making the right decisions to work the environment; the cost overall is higher. This is a potential shift.
	What action has your organization made to address the emerging trends in this category?	We are providing a high emphasis on all of these four areas as a proven method to increase production, avoid re-work and protect our environmental resources. Training in all areas are provided with champions selected for each.
	Please list any additional emerging trends that could be included in this category.	BIM as a predesign and post design tool to avoid costly re-do of conflicting mistakes. It's going to change with the economy,
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	Larger projects require more people. If they have the guts, we'll share the risk with you. Only 2 owners have done it.
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	The cost of the building
	What action has your organization made to address the emerging trends in this category?	We have already incorporated a separate group to indentify and offer additional services to clients to help them maintain and proactively manage the care of their facilities.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	We are lending that to the partnership of owner, designer, constructors ->only in healthcare. Owners are dictating, contracting because they are hungry
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	We are currently looking into and obtaining training or actively practicing all of the above regarding clean energy, IPIS and BIM.
	Please list any additional emerging trends that could be included in this category.	Technology is going to make the industry better. We will ease the whole delivery process. Technology is improving materials. We aren't seeing the fly by night orgs. Production rates have gotten so much better.

Emerging Trend Interview: D

	Trend	Comment
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	I think we are using up our natural resources too fact. We need to be good stewards of our natural resources. Biggest resources that we aren't paying enough attention to is water. Dealing only with the immediate task, that we don't care about the future. There are other ways to provide electricity; learn from it. Very protective, as much as they can be. Increased use of recycling
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	This is an area that we have not placed enough emphasis on at this time. We are only researching slightly.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	They've seen it 1st hand with I-35W. More and more bridges are inspected to be borderline at best. It takes a disaster for us to come to the mind. Without government saying, we have to do this, public says: it doesn't directly affect me.
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	No action at this time. We are slowly becoming more aware of our surroundings and how we impact because we can get by
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: E

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	There are sufficient qualified engineering firms, there is an issue with qualified individuals.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Very much, human capital. Positive standpoint is that it is the #1 factor for growth. D-R continues to employ programs starting in high school, sometimes grade school- oil & gas petrochemical.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Also for the trades people. Key is technical training, mechanical sides of the business. They have gone to other industries and brought in people from almost unrelated fields. This has been relatively successful
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	cooperation/investment with trade schools. Increased focus on leadership and organizational development.
	Please list any additional emerging trends that could be included in this category.	Going outside of the Country, not only for LCC labor reasons, but also intellectual capital tapping regional universities, etc.
	Please provide any additional comments about this category:	downturn in the US economy not really effecting.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Need to continue with innovation and project delivery. It would ease those workforce issues if we could make a step-change. Reduce cycle times and front end load. Long lead, capital equipment. EPCs and End-users are working with them collaboratively, looking at modularization. Ex: Canadian tar-sands.
	Increased use of integrated data models - design/fabrication/construction	Yeah, they are being asked. They use a corporate software. They provide more accurate, detailed drawings. At the very front end of integrating, file sharing with electronic, still a manual step to integrate
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	They are a fairly young publicly held company. Corporate responsibility. Marrying their corporate strategies to that of their clients.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	PM 2025: not a lot of thought, but has both a skillset and toolkit, not only project management but also financial management. There was a weakness on the financial side of management.

Emerging Trend Interview: E

	Trend	Comment
Corporate Strategy	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	not seeing that as a trend on major projects. On very large complex projects, they need to be managed both at a very high level. No contractor stepping up to take all the risk. There have been some offshore projects where there was one contractor taking on the whole thing. They took on too much risk and it ended poorly.
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	yes for very complex projects.
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	in the short term it is market driven. In the long term, there is a more appropriate risk structure. In lean times,
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Hopefully we won't just follow the historical trend of jockying back and forth. When the project goes over budget, when a project is. It needs to be more callaborative and hopefully we can stand by that when economic conditions change. Alliance relationships have been helpful in all economic conditions.
Technology & Innovation	Increase in Clean Energy Initiatives	It is one of our key growth platforms today. There is a huge focus on clean energy. They are in the energy infrastructure business. Spending a lot of time on energy tech. Part of their value is going back and finding ways to make existing assets more efficient and cleaner. Designing for the upgrade process. They are designing for potential upgrades. Clean coal technology: when power plant is installed, it has the ability to be outfitted with carbon sequestration.
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	Increased investment in new & renewable energy	coming on strong
	Nuclear power returning as a viable energy alternative	there will be some resurgence in nuclear.
	Increased emphasis on Clean Energy Technology – CO2 emissions	Very important
	Increase in the use of Solar Power	just not as dramatic of an effect. There isn't enough there to support the gigawatts of energy. BIA studies

Emerging Trend Interview: E

	Trend	Comment
	China and India continue to demand increasing amounts of EPC resources	From the absorption of raw materials. We talk about LNG coming to the US. However, the US population is not use to pay high energy prices, energy will go to places who are willing to pay.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	Biofuels: corn-based ethanol was a bit of misconstrued economics. Cellulostic
	Please provide any additional comments about this category:	We are not going to be able to supplant fossil fuels. We won't be able to get out of the oil based transportation economy for 30-40 years. 2050 is the hydrogen economy.
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	Really don't see this very much. There is almost always a willingness to cooperate with US based companies
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	Yes it will have a significant impact. The amount of capital required to address these issues. 100 new coal plants being built in the next 20 years.
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	US issue
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	There is some uncertainty around the November elections: our position on environment, carbon cap and trade, the next 4 years
	Please provide any additional comments about this category:	

Emerging Trend Interview: F

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	There are fewer and fewer people going into engineering. 50-60% of engineers aren't even going into construction. They are paying extremely good wages. Construction is not an attractive industry. There is no real perceived rewards to it, less prestige, it is an environment without flexibility. The one area where we could have a huge availability. in 1978 10% women in eng. workforce. because there are less and less. There will be several years of not only knowledge gaps. Construction is going.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	there are even fewer people going into the labor pool. There are fewer and fewer certifiable people entering the industry. There are a projected 2 trillion in infrastructure.
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	More mentoring programs to get younger people up to speed faster. Promotion of those earlier who show signs of 'becoming a shining star', no longer requiring a retirement age
	Please list any additional emerging trends that could be included in this category.	less women entering the engineering and construction field which could serve as a resource for filling the gaps There needs to be a closer partnership between: Industry, academia. CII does have an opportunity because they have such large organizations. They may be able to have in-house certified university type classes. The 3 units don't necessarily play together. Science vs eng/construction. Scientific community speaks as one, engineering is so splintered.
	Please provide any additional comments about this category:	This trend is probably the biggest factor affecting the world's projects today and is already manifesting itself as a crisis in many current projects. The National Science Board also sees this trend as a major factor limiting the US Competitiveness Our engineering training schools are not training properly. We have a PR problem. We need to figure out how to train them as well as how to manage. Still the largest construction market in the world is in the USA. Increasing. Deans have finally woken up to the fact. How in the world do you rethink the way the university works. On September 21st, Purdue University is hosting a forum. How do we come together and speak with one voice. We may have to partner with other organizations. Workforce goes across all industries. Basic issue is the same.

Emerging Trend Interview: F

	Trend	Comment
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	It is applicable for certain industries, but not others. We go to the subcontracting community. As more sophisticated GCs and CMs. This is absolutely the way and there is a major opportunity. In the public sector, this is very difficult. Leadership is another issue. These become barriers to making it work in these types of situations. lots of demand, but a capacity. Prefab and modularization could get credit from sustainability.
	Increased use of integrated data models - design/fabrication/construction	
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	We are reaching an area where carbon neutral. These are no longer some greenies crazy idea. What a lot of people don't realize is that it isn't just carbon emissions. Construction is highly energy intensive. Much of the equipment is not state of the art. Energy costs are way up. The top road constructor because he just cant bid because he can't lock a price.
	What action has your organization made to address the emerging trends in this category?	teaching about sustainability and the ethical responsibility as defined in professional society code of ethics as well as many state licensing board requirements
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	The very next thing is a new energy policy. Carbon credits and carbon tax. The public is really beginning to care about and kids. Whoever did it, it far overtook it. The public up-driven.
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	In the litigated environment. No one wants to shed any risk. Right now you have a lot of publicly traded companies so they are in a much higher scrutiny. When things do go wrong, there are no 'small claims'.
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	Depends on your perspective. The best way to get. Execution risk should be on the part of the contractor. She has seen everything. Contractor can't 'shed' risk. Some owners. They will end up paying more later.
	What action has your organization made to address the emerging trends in this category?	More training of employees in all these areas. Working with Owner companies on how to restructure their contracts and risk management programs
	Please list any additional emerging trends that could be included in this category.	Increase in collaboration on projects when parties have had more experience
	Please provide any additional comments about this category:	

Emerging Trend Interview: F

	Trend	Comment
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	There are enough abilities and software out there who just don't use them or they don't use them to their full capacity. They have the most sophisticated.
	Engineering increasingly using BIM and Rule based Design	The sophisticated people, how is it possible that some people aren't using 3D.
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	Sit on the national science board task force
	Nuclear power returning as a viable energy alternative	Since the nuclear industry died, when
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	more solar units
	China and India continue to demand increasing amounts of EPC resources	We need to learn from other areas. We see much different techniques. This is a contractor and architect's dream. We don't have the mechanism or culture to do these things. Just with the Korean technology Institute. Learning from our global competitors. We will have global countries coming to compete in the US. It is beginning to happen now, when we open the flood gates. This could happen sooner than we think.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	getting up to speed on alternative energies and carbon pricing and its affect on the way construction is performed today
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	The National Science Board has initiated a task force (upon which I sit) that is looking at sustainable forms of alternative energies. Carbon emissions will become the largest driving factor in how companies operate along with carbon credits, taxes, etc. The cost of doing business will rise sharply for those that continue to use equipment that has large carbon emissions. huge surge in power construction. Potential for brownouts this summer. We're out of capacity.

Emerging Trend Interview: G

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	Not quite as much on the contractor levels. Aren't getting near the replies over the past year and half.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Impacting in several different ways. Don't have the resources for projects. Leads to some inefficiencies, delaying. Characterizes them pretty well
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	
	Firms are developing new ways to utilize older workers	developed ongoing training programs. Decentralized. Consistent approach. Getting people together across business sections. Been ongoing for the past few years. Project leadership.
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Work to improve development and retention of employees. Contractors perform most of the field activities and actions are left to them to improve these areas.
	Please list any additional emerging trends that could be included in this category.	Performing more work in Value Engineering Sights (India, China, etc.). Looking at bring in people/crafts from other countries.
	Please provide any additional comments about this category:	None Expose beyond specific disciplines. Not intended to make an expert, understand the upstream downstream.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Depends on the business area. We do a lot of it on the offshore. Them as an owner tend to lead this change. Some of this gets down to understanding the various business drivers. When you look at preassembly and modules.
	Increased use of integrated data models - design/fabrication/construction	
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	

Emerging Trend Interview: G

	Trend	Comment
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	In reality, it is a bit more collaborative. A bit driven more by the environment. The personal hope is that we retain it. We will be in this realm.
	What action has your organization made to address the emerging trends in this category?	More technical and more complex, larger.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	Becoming very important to critical. Significant amount of work, there should be significant rewards.
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	They have one area of the
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	Becoming industrialized. Middle East trying to capitalize on fully upstream downstream integrated.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	There are significant issues here. It is not as big of an issue for the work they do.
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	

Emerging Trend Interview: G

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	Their own company personnel issues
	Please list any additional emerging trends that could be included in this category.	Contractors and their quality of work: 3 levels. Interface management between all the parties
	Please provide any additional comments about this category:	Globalization: In reality, you might be right to say that it doesn't directly affect you. It brings people in who can work for lower wages.

Emerging Trend Interview: H

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Less experienced people in project management roles.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	In their business, large blocks of work in short amounts of time. Union process doesn't guarantee best labor. Average trade worker age is ~40.
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	More of what we are already doing.
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Pre-hiring' of staff in some areas in anticipation of attrition. Re-introduction of structured training programs.
	Please list any additional emerging trends that could be included in this category.	Unwillingness of workers to move to some locations.
	Please provide any additional comments about this category:	
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Noticeably shorter cycle times. Also facing labor issues. In Toronto, they used REALLY big pipe rack assemblies. Saved time and money.
	Increased use of integrated data models - design/fabrication/construction	
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	
	What action has your organization made to address the emerging trends in this category?	Nothing specific, but monitoring available technologies.
	Please list any additional emerging trends that could be included in this category.	Earlier involvement of contractors in the project to help optimize project delivery strategies.
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	Because they are a government owned business and their area. No Coal in Canada. The way they design and select. Recycled materials, designing for cradle to Grave not so much important

Emerging Trend Interview: H

	Trend	Comment
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	Much greater emphasis on early and continual risk analysis of projects.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Corporation becoming aware that we cannot transfer all risk to an EPC contractor; better understanding that 'the owner always pays.'
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	On the nuclear end. $9MM project in progress to monitor project development. Most are less ambitious than that.
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	They aren't allowed to be in that business. Nanotech effecting solar technology. Decentralized power generation.
	China and India continue to demand increasing amounts of EPC resources	Not competing for the same EPC resources (contractors) they do see it in the same equipment and materials.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	Doing front end work on new Nuclear facilities. Evaluating CO2 capture technologies.
	Please list any additional emerging trends that could be included in this category.	Conservation and energy efficiency as key components of new industrial and commercial facilities.
	Please provide any additional comments about this category:	High fossil fuel prices, scarcity, and carbon taxes will lead to major shifts in consumer and industrial customer behaviors.
Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	

Emerging Trend Interview: H

	Trend	Comment
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	Changes in two respects. 1) nature of projects that we are working on. Certainly in the electrical and power industries. 2) There will be restrictions starting to effect the way construction is done. Concrete, cement production is leading to global warming. Contractors will need to alter way of doing business
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: I

	Trend	Comment
Workforce and Human Capability	Lack of Qualified Contractors available to meet current industry demands	this is improving. Requires a VERY safety oriented contractor. Contractors have a difficulty attracting the cream of the crop. There is still a quality. The contractors are becoming more trained. There really isn't the talent pool
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Why isn't it being replenished? Not attractive to young people. Starting to have some barriers to entry. At the entry level, it is being replenished. Current midlevel.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	In the near-term, people from manufacturing will come to construction. You can have a safe 35-40 yr career. "This isn't your grandfather's construction anymore."
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Initiated a engineering graduate hiring program in 2003. Initiated a knowledge retention program within the design engineering function. Increased the level of training of new staff. They are trying to hire 70-80 Canadian graduate engineers. Starts with a marketing campaign to the schools, ads. 1500 applicants for 80 positions

Emerging Trend Interview: I

	Trend	Comment
	Please list any additional emerging trends that could be included in this category.	Contractors and vendors not familiar with the technical requirements of our industry (nuclear power). Trying to be proactive about everything. Look at demographics and skillsets required, compared to what is being provided. We will try new strategies, we don't know what they are yet. Owners need to influence it, and they are depending on owners to know what to provide.
	Please provide any additional comments about this category:	Key issue in our company that will become increasingly impactful as new emergent projects take hold.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	Building 2 new nuclear plants.
	Increased use of integrated data models - design/fabrication/construction	Sat in on vendor presentations. Lots of marketing information about how they are integrating and whatnot. Still not enough meat behind the marketing info.
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	more sustainable practices and emphasis on waste reduction and management.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	new control methods and software
	Please provide any additional comments about this category:	Construction is an industry that is very slow to change. We could be using BIM and retrofitting it. It could have high benefit. There is opportunity, but attitude remains a major barrier to entry. Barriers to entry still remain, get some ideas about cost benefits.
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	sustainability is driving development. Ontario gov. said they will stop using coal altogether. Business is being driven by initiatives involving sustainability. They have an environmental certification process that is ISO 0113. May not get translated to project level. Key theme
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	

Emerging Trend Interview: I

	Trend	Comment
	Please list any additional emerging trends that could be included in this category.	Program Management not on the nuclear side yet. They are building new hydroelectric plants. Extensive use of program management contractors in more proven. Risk determines whether a program management contractor is used. Program contractor can't quite be trusted with all the risk that OPG has already defined. Native Affairs risks, public franchise risks.
	Please provide any additional comments about this category:	
Technology & Innovation	Increase in Clean Energy Initiatives	
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	Increased investment in new & renewable energy	
	Nuclear power returning as a viable energy alternative	OPA: Ontario Power Authority.
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	We are already seeing it with commodity pricing: cement, steel, copper. They don't outsource, but there is a demand for services and construction services that there hadn't been in the past. The availability simply isn't
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Social and Political Influences	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	main impetus for change from coal. The shutdown of coal plants will help, but not fix.
	Regional Warfare causing an increasing need for reconstruction	

Emerging Trend Interview: I

	Trend	Comment
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Early discussion in the campaign about a retraction of free trade…pretty much business as usual. How to get out of Iraq. The best we can hope for is a reduction in the fear quotient. Reduction in stress level around the world, no significant impacts.

Emerging Trend Interview: J

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	Anybody can out and rent computers and office space; construction ALWAYS gets back to the people. Washington group and before they were bought by USR - amount of money invested in people.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Rated just above being a farm laborer. Now the perception is beginning to change. Wages are beginning to increase.
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	We are looking more into this. Don't confuse style with substance
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	We don't have the productivity gains. Robots can't move around on a construction site
	Increased use of integrated data models - design/fabrication/construction	not so much the delivery in the field as relationships between owners and contractors. Now because of the shortage of skilled labor; more cost reimbursable. Get the project going and adjust the price. Incentivize the project. Less time fixing blame and more time fixing problems.
	Greater use of 'Lean' principles in construction	Haven't been around many people who've been around it. Much is handled by accountants and not construction professionals. What is the rate of return on a project? We as contractors have 2 or 3 years to make money on a project. Owner always pays for contingency. We take risk, we aren't gamblers.

Emerging Trend Interview: J

	Trend	Comment
	Increased emphasis on sustainability	considerations, but it just isn't that big of a factor. We would like to say that the relationship based contracting are here to stay. Human nature says no.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Corporate Strategy	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Credit market is hurting. What does it mean for capital facility market?
Technology & Innovation	Increase in Clean Energy Initiatives	
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	Increased investment in new & renewable energy	If it's going on, it's more in the engineering and design side. In certain areas we need to use air curtains so we don't give fish headaches.
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	
	New geographic locations emerging as energy exporters	

Emerging Trend Interview: J

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	We don't produce things that people 'want.' Manufacturing sector isn't like the old days. Back when we had. Now we have service economy.
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	US has tremendous infrastructure. In Texas, farm to market roads come from certain fund. We need to build AND maintain. Decline of civilizations: certain things make it possible - ability to maintain goes away. 40-50% of taxes. We have all these systems and the same ones we were using for hundreds of years.
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	Not worried about the next 20 years, but beyond that, who knows?
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	Don't want to work as hard as they used to. In the 80s, people came down from the NE
	What action has your organization made to address the emerging trends in this category?	Wall street journal. Who moved my cheese.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: K

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	Smaller company than most. He views that as impacting me. Ohio Valley there seems to be plenty.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	it isn't affecting them on their scale
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	

Emerging Trend Interview: K

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	Ramped up efforts in Management recruiting and increased stock ownership opportunities for existing employees in order to decrease chances of them leaving us. Industry wide it is an issue that CII should be working
	Please list any additional emerging trends that could be included in this category.	Aging workforce, not backfilling with youth. Union contractor, haven't defined the opportunity. Work needs to be done in the trades
	Please provide any additional comments about this category:	
Project Delivery	Modular and prefabrication are becoming increasingly important construction methods	Comes from his prospective as small company. Some concrete, earthwork, steel work
	Increased use of integrated data models - design/fabrication/construction	seeing it out there but not important in the industries. Heavy industrial and power plants
	Greater use of 'Lean' principles in construction	Construction still lags behind other industries. Labor portion is huge and we're not attacking in an industrial engineering mindset. Competitors don't necessarily do the same thing
	Increased emphasis on sustainability	not necessarily in the markets they are in, industry as a whole. Hasn't been proven, still theory. Their whole business model is to be efficient, they've done a lot to tackle it.
	What action has your organization made to address the emerging trends in this category?	We have implemented a 'Production Management' philosophy and full scale training effort based on the Toyota Way to focus and improve productivity. We believe it is better than anything 'Lean' has to offer. Self made training modules. Looking at processes and how to make them more efficient.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Corporate Strategy	Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	Definitely current market situation, hopefully it serves to be so successful that it has lasting impacts.
	What action has your organization made to address the emerging trends in this category?	We have embraced the Alliance-type contracting methods and continue to learn how to operate under these types of risk-sharing arrangements. Teamwork and alliance contracting. Teaming up with publicly traded utilities. More team based atmosphere.
	Please list any additional emerging trends that could be included in this category.	

Emerging Trend Interview: K

	Trend	Comment
	Please provide any additional comments about this category:	Sophisticated owners are embracing the philosophy of both Risk Sharing AND Production Management and are driving costs out of their projects. Owners are becoming more sophisticated. Their attitude is changing. Getting smarter about taking risk off the contractor. Advisory committee at Purdue, reaching out to all disciplines. Need to cross train. Expectations of project managers is changing. Working in a team, not so much technical.
Technology & Innovation	**Increase in Clean Energy Initiatives**	All the stuff about global warming and ethanol. Too early to tell if it's flash in the pan. Heavy political influence - globally. How does it work with competition
	Increased use of Integrated Project Information Systems	Everything used to be hard drawings, plans and specs. Now you build a project with integrated information systems. At construction level, hasn't been hitting. Engineering side, more drawings and 3D models. Next 5 years for sure
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	We are active in the Power Industry and take advantage of seminar/conferences to keep up with all aspects of Power, including Clean Energy.
	Please list any additional emerging trends that could be included in this category.	Continue to be more computer based and PDAs. Computers on the jobsites, sups and foremen carrying mobile information. The whole supply chain will become more tech. advanced. Wal-mart type distribution
	Please provide any additional comments about this category:	RFID tool management. Heavy equipment has GPS locators. Only advancements in the equipment arena; GPS. Do not see as a factor affecting
Markets and Demand Drivers	**Increased investment in new & renewable energy**	Federal government is behind the movement, exceeding goals. Long lived trends
	Nuclear power returning as a viable energy alternative	NQA1 is in the infant stages. Environmental groups are warming up to nuclear. April 28th ENR pg 13, 9 nuclear operating licenses. 20,000 MW applications are in and then need to be processed
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	Doesn't have the bang for the buck in the current economic situations. Technology has a long way to go.
	China and India continue to demand increasing amounts of EPC resources	explained because of size of company and the markets they pursue. EPCs have been using offshore resources. Commodity prices increasing
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	We are on board with one of the first Carbon Capture projects in the US and are working toward Nuclear NQA1 certification.
	Please list any additional emerging trends that could be included in this category.	Water not an issue in his area. Some power plants can't run without enough water. More pressure on fresh water systems. Population growth not fast enough to effect it

Emerging Trend Interview: K

	Trend	Comment
	Please provide any additional comments about this category:	
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	Mostly federally funded, constant battle of federal and state funding. Social programs putting huge demand on tax dollars. Big problem. We might be in reaction mode. We need to invest $$$ into infrastructure, where is the money. Municipalities lease via PPP
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	They do foresee more pollution control projects; it is a positive factor. Creates projects. Half company revenue comes from federally mandated pollution control projects.
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	Most of these do not impact our firm as a regional US company. Depending on new president. If democrat president, we have dem. controlled contractor. Increased scrutiny on environmental issues. Utilities will be forced to deal with it, raising rates.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: L

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	They have a relatively small number of firms bidding on projects.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	A couple of things, middle east is sucking up capacity. Multinational organizations have picked up and pulled out. Management can screw up a project a lot quicker.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	More educated and less 'skilled' individuals. Right now we are relying on Latin Americans. Issues of illegal immigration. The substitute pool is under attack politically. We don't make headlines out of blue collar work. Remedies: import labor - at what cost?, how to approach internal labor supplies
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	

Emerging Trend Interview: L

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	None. We are 'owners.'
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	
	Increased use of integrated data models - design/fabrication/construction	
	Greater use of 'Lean' principles in construction	Starting to become used, entering into the discussion. It will get into the government side.
	Increased emphasis on sustainability	Uniquely in the job, they own cradle to grave. One of the first thing to go when cutting cost, are sustainable, efficient systems. It all depends on where you sit. Maintenance and operations.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	The talk is coming
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	Intent is to make everything more open, huge demand for accounting resources. Healthy and honest growth of businesses. If you are cooking your books, you'll get cost. Huge administrative burden
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	There has to be a balance. Herd mentality. Design Build sounds great, but it is not without its issues. More cyclical than any sort of trend. Depends on the industry. Many things contribute to risk, it will always be shared.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: L

	Trend	Comment
Technology & Innovation	Increase in Clean Energy Initiatives	Until we control the population's demand, we need more. If it is going to be accomplished.
	Increased use of Integrated Project Information Systems	More hopeful than saying that this is what it is. Our country has been great at information management. Keys to productivity is knowledge management. To be efficient, we need increased management.
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	Increased investment in new & renewable energy	Fossil Fuels are running out, other solutions need to be found
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	Right now, China has the economic structure to make it work
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Social and Political Influences	"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	Americans operate very well in crisis mode. We don't go through holistically. Like to think public funds will be there. Public - 'Don't tax me!' Skeptical of PPP
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	

Emerging Trend Interview: L

	Trend	Comment
	Regional Warfare causing an increasing need for reconstruction	If there is any hope for populations, we need infrastructure. If people don't have work, they are out making mischief. They join terrorist organizations. We are going to fix our infrastructure; double the cost of gas.
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: M

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	There are enough contractors, but not enough talent.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	There is an air gap a lot at 55 and older, 35 and younger (up and comers). Between, there is a huge gap in Engineering and construction. Mostly true on the management: there was a period where people didn't go into engineering and construction. They are trying to take up-and-comers and train them and focus. You can't spend enough time. The worst thing is, the 60 plus are going to leave the workforce. Fully plan to work FT until 70 because he really enjoys what he's doing .
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	The trade is very evident. Experience level is decreasing, older people are much more likely to get out because their bodies have been beaten up.
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	special emphasis on retention. Lessons Learned - More work Flow Process Diagrams. Turning to systems and automation wherever possible. TRAINING TRAINING TRAINING
	Please list any additional emerging trends that could be included in this category.	Emphasis to get technology to our people in the field. Technology, automated and simplified ways to CONNECT stuff may be key to improving productivity and quality. The untapped resource is women. Very surprised to see

Emerging Trend Interview: M

	Trend	Comment
	Please provide any additional comments about this category:	Owners must help with the training. Training is currently left in the hands of the contractors. Owners do not want to pay for training His observation is that workforce is not productive, 'We've seen the enemy and the enemy is us." We do a lot that frustrates workers. Referring to construction industry: safety, bad GM, small tools.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	two aspects, modularization is manufacturing but it controls the environment. If they are working in the modular fab shop, craft people don't need to move. Preassembly, on the job site within rock throw of final resting place. Reduces density of workers. They have looked more at preassembly. We've been talking modularization since the early 80s but it just isn't catching on. Last 2 years more than the last 20.
	Increased use of integrated data models - design/fabrication/construction	BIM is a very touchy animal. Definition, BIM is a 3D model that I am able to query and extract lots of information: schedule, drawings, material. Labeling is an issue. Tons of opportunities and we just aren't using it effectively. Not quite set up for the field. Definitely doesn't carry over into life cycle.
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	Right now it is really not effecting us at all. The high cost of energy is starting to open people's eyes. More pressure. This is a localized issue: CA & Canada. Refinery permitting is difficult
	What action has your organization made to address the emerging trends in this category?	We are purchasing a Modular company. Spending a great deal to develop DATA Centric Design and exchange information with shops and owners.
	Please list any additional emerging trends that could be included in this category.	Interoperability. The industry has not provided the tools to those in the field. Almost ALL, every owner system for lifecycle is set up to use paper documents. Haven't really seen any. Shell right now has a team trying to redesign their document system.
	Please provide any additional comments about this category:	Valves: the entire valve industry pdf and word doc based. Nobody has.
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	Changing mindset with collaboration. Difficult in today's world. We have a phenomenal ability to exchange information. They can't use the same systems that we do. Many people have 3rd party …. They don't talk to themselves internally. Things get rekeyed: E P C.
	EPCs becoming more selective in the projects they pursue	

Emerging Trend Interview: M

	Trend	Comment
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	Need to talk to the owners. They cannot sign 50% of the contracts that they bring in the door. They want shift. They can take owners to the cleaners. Very little shift, minimal.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	Integration and exchange information freely down the line. SAP with ERP.
	Please provide any additional comments about this category:	If you want to build the future, build information
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	We constantly improving our rule Based Data Centric Design and Integrating our information management systems into our design models.
	Please list any additional emerging trends that could be included in this category.	Great hopes for RFID. Fiatech is doing a lot. When you stop and think about the amount of time people spend looking for 'stuff'. RFID is the promise land. Next 3-5 years, figure out how we can use it. Look at where
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	Right now we are sending $700MM a year to Arabs and giving money to terrorists. We need to focus on every area of energy. We need to pull out all the stops for energy. Keep a dollar here and it doesn't go to our demise.
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	Because of the increased cost of oil and gas. India is bringing on refining capacity. Similar activities all throughout the world. If we aren't careful, we will have a glut in chemicals and moving more towards the energy source.
	New geographic locations emerging as energy exporters	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	Fish predicts that 3-4 years there will be a refining glut- more capacity than we have a demand for.
	Please provide any additional comments about this category:	Our economic situation: it will be much more difficult to get credit. Price of credit may increase.
Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	They don't do much internationally. So it doesn't really impact them.

Emerging Trend Interview: M

	Trend	Comment
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	Increasingly complex global economy that nobody fully understands.
	Please list any additional emerging trends that could be included in this category.	China is also a house of cards. Rules that get imposed within a week. All over Africa they just killing each other. The leaders in Saudi. We've made it a lot.
	Please provide any additional comments about this category:	Apocalypse in the 60s but we made it through. Every generation has its problems, and we're still here. Doomsday is always right around the corner.

Emerging Trend Interview: N

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	Labor shortages are affecting us in terms of schedule. Due to supply in demand.
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	we are short. Management. Professional gap.
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	Extremely large amount of work. We need qualified craftsmen
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	
	What action has your organization made to address the emerging trends in this category?	Paying for retention. Moving from one contractor to multiple. More company resources on the ground.
	Please list any additional emerging trends that could be included in this category.	Cost of materials and sourcing of same including global sourcing It is bringing fresh eyes. We ask a lot of good stupid questions.
	Please provide any additional comments about this category:	In rapidly developing countries, they aren't used to the constraints.
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	As it relates to talent. Really depends
	Increased use of integrated data models - design/fabrication/construction	The words say a lot. We do 3D modeling like everyone else. Allows opportunity to do better work. It does allow you to earn better.
	Greater use of 'Lean' principles in construction	
	Increased emphasis on sustainability	

Emerging Trend Interview: N

	Trend	Comment
	What action has your organization made to address the emerging trends in this category?	We are moving ahead with greater emphasis on sustainability in our programs and products.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	We've been sustainable for years. This company has always been sustainable in terms of projects. Not in terms of a vacuum.
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	You've got to be making money always
	Increased use of Joint Ventures to complete capital projects.	
	EPCs becoming more selective in the projects they pursue	
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	For sure the market plays into it. When you really get down to the brass tasks. Risk should be borne by those best. There is movement in that risks.
	What action has your organization made to address the emerging trends in this category?	Evaluating and using more contractors.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	Industrial wise hasn't changed
Technology & Innovation	**Increase in Clean Energy Initiatives**	
	Increased use of Integrated Project Information Systems	
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	
Markets and Demand Drivers	**Increased investment in new & renewable energy**	
	Nuclear power returning as a viable energy alternative	
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	This is affecting you tremendously. Intellectual property is maintained within the company somewhat.
	New geographic locations emerging as energy exporters	If you aren't concerned with globalization, you probably aren't very intelligent.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	

Emerging Trend Interview: N

	Trend	Comment
	Please provide any additional comments about this category:	35 years ago. We'll fiddle around. OK. CII would be a piece of non-governmental folks. France decided 35 years ago that 85% comes from Nuclear - check this stat
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	This country is aging. NYC is as good an example as any. We NEED to get our infrastructure modernized. There is a drain
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	Utilize folks in the US.
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: O

	Trend	Comment
Workforce and Human Capability	**Lack of Qualified Contractors available to meet current industry demands**	
	Decreasing availability of Labor – Management (Executive, Project Manager, Superintendent)	not really much trouble finding management resources. Low cost engineering centers. They've been set up for 20-30 years
	Decreasing availability of Labor – Trades (Foremen, Craftworkers)	not facing labor shortages, especially in the international settings. Emerging trends in that area are really lending toward non US workers. Mexican and Filipino workers.
	Firms are developing new ways to utilize older workers	
	Increased emphasis on 'turnover' of knowledge within organizations	
	More training of unskilled workers to meet labor needs	Within your company
	What action has your organization made to address the emerging trends in this category?	We have instituted new training programs at all levels. We have also begun implementing a 'knowledge management' system to capture knowledge from the more experienced work force before they retire.
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	

Emerging Trend Interview: O

	Trend	Comment
Project Delivery	**Modular and prefabrication are becoming increasingly important construction methods**	They build modular for years and years, modules are getting larger and larger and more complex. We don't know how to get any more efficient. We are building.
	Increased use of integrated data models - design/fabrication/construction	We use pdms and integrate all our software together, it's not flawless. Find your niche business and get to be one of the best.
	Greater use of 'Lean' principles in construction	It is in the initial stages, it has it's fits and starts
	Increased emphasis on sustainability	Very little, everything we do is steel and wire. Nothing as far as he can tell is sustainable construction.
	What action has your organization made to address the emerging trends in this category?	We have modular capability and we are actively participating in this industry. We have hired industrial engineers to bring us into the 'lean world. We are also focusing on integrating of data models and systems.
	Please list any additional emerging trends that could be included in this category.	more ways to automate to improve efficiencies
	Please provide any additional comments about this category:	
Corporate Strategy	**Increased use of Build Operate Transfer-Contractors becoming 'all around service provider'**	
	Companies incorporating sustainability into their Strategic Plan	Nope. If we were building. No, their business is absolutely booming.
	Sarbanes-Oxley Act to remain key focus and continues to influence risk analysis	
	Increased use of Joint Ventures to complete capital projects.	Projects are getting more complex and larger. Bigger teams. More subcontracting of specialty items. % subcontracted max 10%
	EPCs becoming more selective in the projects they pursue	Because of the robustness, we have been able to be more selective.
	Changing Risk Structure (Risk is being transferred away from the contractor and towards the owner)	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	Offshore markets that they are positioning to . It won't happen in his lifetime. 30-40 yrs before the difference in energy makeup of society.
	Please provide any additional comments about this category:	
Technology & Innovation	**Increase in Clean Energy Initiatives**	nope
	Increased use of Integrated Project Information Systems	There will be a lot more collaboration between industry
	Engineering increasingly using BIM and Rule based Design	
	Increased use of Trenchless Technology	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	RFID - A lot of problems. They are experimenting with it. The tech keeps improving. Steel tends to make RFID ineffective unless you are very close. Semi active
	Please provide any additional comments about this category:	

Emerging Trend Interview: O

	Trend	Comment
Markets and Demand Drivers	**Increased investment in new & renewable energy**	windmills are nice, but it is not the answer
	Nuclear power returning as a viable energy alternative	We've been talking about nuclear coming back for 30 yrs but it's been dead. Until I see the 1st construction permit. Not a whole lot of people
	Increased emphasis on Clean Energy Technology – CO2 emissions	
	Increase in the use of Solar Power	
	China and India continue to demand increasing amounts of EPC resources	not affecting your business at all. Not really
	New geographic locations emerging as energy exporters	nope, every area that we are expanding into, we had always planned. No oil company thinks this price is sustainable. Aren't going to overextend
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	
	Please provide any additional comments about this category:	While Nuclear may be on the verge of coming back, the first new license has yet to be issued. There is a long way to go on this one.
Social and Political Influences	**"Anti-Americanism" to slow growth of US International Firms, however their growth will still outpace US domestic-only firms**	
	As public infrastructure continues to decay, public funding alone won't increase to meet needs	Low impact for your business. Very few issues with public infrastructure for them.
	Continuing restrictions placed on emissions for developing and industrial countries	
	Climate Changes are causing significant changes in the construction industry	
	Regional Warfare causing an increasing need for reconstruction	
	Increasing integration of undocumented workers into the workforce to alleviate labor shortages	
	What action has your organization made to address the emerging trends in this category?	
	Please list any additional emerging trends that could be included in this category.	Project manager's roles really aren't going to change. He'll have better technology but the fundamentals
	Please provide any additional comments about this category:	

Appendix D: Blue Sky Interview Summary Transcripts

Blue sky: interview A

Water
- Is going to hit before oil.
- No more water now than 50 years ago.
- 13 gallons of water used for a single gallon of ethanol.
- Vast aquifers depleting
- Agriculture changing from the way we know it. They are using aquifers quicker than they can resupply
- Water from CO isn't making it to the Gulf
- Had to build a desalinization plant with Mexico
- 13 major cities a year in China. 20 new cities for next 20 years
- Water refugees - people who wander to next village
- Fossil Aquifers for irrigation - 1000m deep
- Lots of contractors are heading to China & India to do projects
- 1978, big slump in the economy. Companies doing work nationally had no problem.
    - US recession won't affect international companies
    - China largest user of resources
- Yellow River, Ganges, Nile - all rivers are drying up
- 40k people die every day,
- 1000 tons of water to make 1 ton of wheat
    - 450 tons water to make 1 ton of steel
- US entrepreneurs buying up all water rights throughout country
- Major cities are taking water from agriculture
    - farmers don’t have enough water to produce food
- Most of growth will take place in countries where water table is already falling
- Banned exporting grain to feed own population
- Rice prices are going crazy
- GREEN ROOFS
- Financial Times - #1 paper globally, economist, futures, fast company
    - Davos Report of Switzerland - Oil $500/barrel
- Massively rethinking architecture and design
- A building where only materials are 25 mile radius
- 400 of the worlds geeks, accelerating change
    - Increasing at an increasing rate.
    - 2015 1/3 of all jobs haven't been invented yet
    - 2030 2/3
    - Knowledge creators, not knowledge workers
    - Universities need to focus on future
- What aren't US people seeing the crisis?
    - They charge
- Global Business, I don't normally look over people's shoulders
    - Nice to know people are thinking about this.

Senior level graduates, what is the quality. Staying connected. Assembling random information.

Generational Gap in learning

National news, 8 year old reprogramming

1200 honors students

The whole audience gathered both messages. Multi tasking

In 15-20 years, one laptop per child, $100 laptop

Education needs to be, rethought.

"The world is flat"

China is extreme, India has a fastest growing middle class

JP Morgan moved 30% to India

Procter and Gamble, series of warehouses in England

1-2 years to market

Now, virtual allowing 2 months.

Virtual meetings, MIT

Accelerating Change conference Stanford

Holograph podium.

VERY FAST CHANGE!!!

Revit Models working round the clock

Engineers cheaper in India

China more English than any country - 2025

China investing in resources in Africa

China can pay more o

When between now and then will

What if they changed diet Japan, they will use entire world catch of fish

Nano factories on site

MIT can produce almost anything.

Everything is intertwined!

UPS, ordering it from UPS

insourcing

Not all steel is being produced in the US

Half-life is 3 years of college degree. 'Did you know' youtube. WFS

More honors students in China, than students in the US

One thing that we have is to encourage creativity.

Don't speak unless spoken to.

Patent office

Intel had a few dozen, 1.7 billion today.

Bio Computers, 2017, library of congress

Life Expectancy

Current life expectancy 75 -> 90

People can no longer retire at 65.

US social security keeps pushing back and back, until it's gone

We take care of parents longer than they take care of us.

Bio tech, nano tec,

only engineers out researching

need to be providing services
Energy project - invented first artificial lifeform
programmed to convert waste into energy
chips in the brain to fight Alzheimer's
MIT - modifying cells to be computers, manufacturing drugs
Stanford - installing implant to trigger auditory nerves
Illinois - gene therapy on mice
Nanobots powered by circulatory system
San Antonio had the purest aquifer
donated land, but now depleting water
Some countries worse off for us.
No schools of Construction are REALLY looking at the future.
Put them in teams, at aTm futurist teams.
1-4 patents coming out of the class
free patent service
Why do you go to any class to reproduce knowledge?
Global Practice class
I will work till I'm 85.
Medical Profession changing extremely rapidly.

Blue sky: interview B

By 2025
A fairly complete transformation of construction industry - more industrialized
    Fundamental realities the separate construction from other industries
    Design for PPAM
How to design so it can be shipped and installed
Higher use of automated techniques
    construction robotics
Another factor that is very important is xyz position
Globalization - send work all over the world.
    already doing more fabbed and shipped.
Hopefully we've figured out the clean energy and technologies to allow growth
Resource issues
    Drastically reduced our dependence on non-renewable energy sources
    rapid introduction of clean fuel technologies
    better materials
    energy consumption can be reduced.
China - no sense of urgency - they'll figure it out and they'll sell green tech to us.
    We need to solve the broader problem of clean energy.
    Humanity deserves growth
    Reliance on coal technology
Japanese managing US bridges??
    Who needs to take the lead
US Politics
    Fundamental changes probably won't happen
    Millennial voters, POV that is less confrontational and more collaborative
    How do we ultimately handle terrorism in a mature manner.
        Developing countries help to support extreme ideologies - generate support among impoverished

Software companies don't usually look 20 years in advance
    components are delivered in pieces. Pieces all over the communication spectrum
        Cloud computing
        application software
    Will desktop computers even exist?
    Smarter paper.
    Software as a service - standard model
        Infrastructure software - more the exception than the rule
    You really won't know exactly where applications are running
Wireless has leapfrogged in developing countries
power technologies could also leapfrog
still trying to get the ROI on copper cost
instead of huge roadways - rail systems

How does it affect the US system to have dated infrastructure?
- inefficiencies inherent in the system
- more difficult to attract workers to the us

In flux of students into the US used to stay here, now they go back.

we need to invest in broadly defined infrastructure
- How do we go about doing that.

In the longer term - water is going to be an issue
- clean water and access, conservation, will be an increasingly critical issue
- urbanization could help that when people are in the same spot

Expectations of people in the year 2025
- smarter buildings and how people manage energy
- combustion automobile will be a thing of the past
  - more seamless integration between modes of transportation
  - maybe there will be less travel required.

2nd life as an alternative for business not just pleasure
- if we have RFID in everything, we can make a digital universe.
- Big strides in that area - materials are actually smart

Wireless sensor networks - augmented reality
- Pointy end of the spear, applied so that the user.

Worker of the year 2025?
- Complete Transparency - what is going on.
- Where is he and does it even matter where he is.
- Projects will be somewhere, where people are matter less and less
- Cell phone: all around application

Knowledge workers
- controlling welding by directing machine

Blue sky: interview C

CEO's usually so quarterly report oriented
Recently rethunk the industry of mining
Tricotomy
3 legged problem set for construction
1 Era of sufficient plenty - you could get ANYTHING at a price
Now era of insufficient plenty - unavailable at any price
Intel stopped development because of halfnium - out by 2017
Integrated Sustainability model
We are huge resource consumers
2 Undiscussed Trade War
Biggest conflicts are driven by desire for resources
2000 study on worldwide consumption trends
China is procuring resources in order to become 1st world (avg income - $15,000)
How do we work in a certain area when resources have been denied?
Sustainable can't handle base load
Chemicals denial based on watchlist - trivial
access combined with security issues
raises real questions of efficiency
Robert Wible - McGraw Hill - Injection of Security into Construction
attached to Fiatech - expand upon the visibility
3 Most difficult - Gigantic opportunity - we know and others don't - this will be shifting
History has handed us the ability to rebuild our infrastructure
Can't use past or current techniques to repair infrastructure
Infrastructure costs (6-8 times 4 - 25) from operation
**How can CII fundamentally rethink the delivery of construction projects?
I don't have a group
One of the stupidest things we do is add layers on top of maintenance prone assets
Infrastructure piping
LEGO roads - beams
Some places where it would REALLY make sense
RETHINK the status quo
How do we enable our membership to fundamentally rethink our cumulative value proposition?
Life cycle costs are inevitable.
We need to make changes now!
Biggest engineering opportunities ever - we can be seen as leaders or the go-alonger.
This moment in time is pivotal
Man-Camps - Saudi Arabia importing Korean and Indonesian workers
World Situation

US doesn't give clearance to medical drugs because we don't know how to police them

How are people treated?

Latest round of medicare legislation

opportunity of getting an infection - kills 180,000 (4x car accidents) - all from post op infections

Responsibility of 'negligent hospital'

Patients suing hospitals

Biggest challenges

Mad Scientists - DOD - Intelligence community - 50 individuals - looks 15 years ahead

last year looked at biggest challenges

the ability of a grad student making virus in a beer brewing machine that would be unstoppable

National insecurities

Katrina

Deal with catastrophic situation

We don't understand our insecurities

We've lured ourselves into single source, works well when it works

We don't know 'crap' about protionics

10x more complicated than genetics

Brave New World

when they (China) go from 6 to 8/1000, they consume 50,000,000 gallons

They discovered that water temperature has gone up by 2º, the problem is WORSE than imagined

Las Vegas in INCREDIBLE jeopardy 500,000 condos in the past 5 years

pop. 4.5 million by 2015

NEED to manage our insecurities and not be a victim of them.

Autism 1 in 100 children, trend related to us.

Every nay-sayer in the planet agrees it is caused by the early use of vaccines

Regardless, this is a new trend that happened when we came into the picture

Blue sky: interview D

Often look into the future, not this far in advance
The future will be a derivative of what we have now,
There will be incremental combining of technologies.
major thing is recognizing how technologies can be combined
The things that will be shaping us for the next 15-20 years.
Look at the differences between the management generation/wireless generation
If we don't embrace young people's ideas, you will be left behind
Rapidly aging/decreasing populations
If there are rough economic times in the short term,
Wireless generation are connected 24/7
Senior management is from the office who needs to decompress
young people don't have the knowledge and experience, but they do have access to that knowledge and experience.
Go back 15 years ago, wrote a book with a Japanese professor and compare the business approach: jap, us, eur
no longer a big difference
I can't understand all this change in heart.
The short term attitude will HAVE to change
People are more concerned with near-term returns
The younger generation is able to look long term.
short term thinking as impact sustainability
Baby boomers are seeing their short-term assets dwindling away
publicly traded construction companies have a management profile that lasts 3-7 yrs.
What is going on with institutional management?
It goes away because they keep kicking people out.
The way to get over that is to judge how successful you can be with the
A lot of shortsightedness

ASCE has been promoting the degree that takes 5-6 years
Engineers can't write and can't speak - there is some true to the joke
legal judgment
economic and financial judgment
A lot of debate going on by those who want to protect status quo and those who want to expand
We still look to the guild concepts, we look at individuals as engineers, then look at the

From a resource standpoint, there is no question that the world is combining and becoming conglomerated
they are only looking on as bystanders.
The vendors and providers of commodities are dictating resource costs.
Demand comes from all sectors of the economies

different from 5 years ago: power industry - there was always a balance geographically.
Now, growth is exploding and will continue into the foreseeable future
Convergence of demand
We will hit a plateau: resources can not afford to fund all of the construction
Infrastructure not traditionally tied to petrochem: now earthmoving
power not traditionally tied to infrastructure & refining: engineers
Demand will be coming from all sectors
more localized providing of power
tying provider to community by
Technological breakthroughs
Sustainability and green movement
These technologies will result in new types of products
The needs of the next 20 years will be shaped by all sectors and merging of the sectors so they are indistinguishable.
Engineers need to become more well-rounded - Less of a Civil or mech or xxx
now back to more of a master builder
engineers are at the 'mercy' of the market
look at more holistically
this merging of all areas
in the more progressive firms, where you were born and educated means very little
increased global focus. People with a global focus become much more important.
It is the ability to look at different technologies, not just the ones developed for your particular industry.
Microsoft is a concept

They said in the 60's when he was in engineering about laptops being more powerful than supercomputers
When firms get larger, they have the financial muster to get the technology that is required.
When he talks to financial analysis
ex: top 15 investors in the world.
25-30yr olds don't have the street smarts of older people
this group came from all over the world, but there was a convergence
If the investment community
Seoul Korea
They have developed the most aggressive and successful project management tools
right down to the foremen, walks with a pda and uploads
This works well when everyone is Korean
trying to use it in the middle east
How to deal with people who are 25-30 yrs behind in technology.
Asymmetric gathering of technology will prove to be a major obstacle.
They have really had a horrible time trying to get this
The growth in greenfield construction is in the developing world where technology isn't as advanced.
Projects in the developed world are most emphasized on recycling and retrofitting.

Blue sky: interview E

What does the engineer of 2025 look like?
What is an engineer in the future going to need to do?
Integrate across multiple disciplines
Need to work across disciplines, organizations, across time
Different organizations are beginning, even though there may be a certain project, it is part of a facility that is going to last for 50-100 years.
Even though, we are very project focused, we work on the longest lived human creations.
Sustainability broadly defined, environ regeneration
Civil Infrastructure: is key
Construction is critical for having necessities for life, spaces to deal with productive activity (waste)
on the cusp of significantly transforming our industry.
1 soc equity
poor are most vulnerable
critically responsive, improve the water quality

2 degree to which we can regenerate
more productive set of human activities
in New England, taking advantage of wooded areas
"All bets are off when you put a shovel in the ground, it goes from construction to environmental"

3 Economics
what is the purpose of these facilities?
Are they using resources effectively?
Transformative aspects

Make the hospital a better place to *heal* in
Look at it in terms of the products we produce and our relationships

How will 2025 look? Specifically
Certain material usage will be changed
What we need to do is change out many of our built facility assets
Return on upgrades is wonderful, new chillers and heating, insulation, rethinking exterior enclosure
Disaster upgrades.
It doesn't make sense to frame in Florida, but in Maine it does.
Don't do things that aren't economically feasibly
is it responsibility of local communities?
We are going to see an advancement in a significant way of how we think out buildings
Needs to be on a local level

Recycling
- Recycle Everything
- Design for dissambly
  - Book: Cradle to Cradle - Mcdounnah and braungart
    - Earth is a closed system. There is only so much here, we continue to reuse
    - Need to be aware while we design, some designs easier to recycle
- Resilient coastal communities
  - 25 good years of research on remediation, economics haven't justified it.
  - In the wake of increasing disasters, we need to rethink preparedness & regeneration
  - Harvard: restore waterways, remaining land is much more stable
- We think about the action of OUR industry, need to think of everyone involved
  - Sloan School of management: Everyone paying more attention to how they are using resources as well as the environment they are providing
  - Construction, usually it is the architects who was the intermediary: owner -> construction process
  - We don't have time to waste, we need to urgently change?
  - Is there passion for that view?
    - commitment to sustainability broadly defined
    - Resistance from people who are scared of change.
    - Sustainability: CEO cares, the entire company cares
      - Can add to excitement - need to foster it
- Generation shift
  - Over the past 25-30 years, increasing tendency for people to look for answers outside our experience base.
    - Integrating new ideas.
- Sustainability is everything.
  - Deep reconsideration
  - Everything needs to be looked at through that lens of broadform sustainability
  - Haiti, food is expensive. Darfur & Somalia - water resources
    - Very worried about social unrest if we don't confront these challenges.
- Graywater vs. Blackwater - City of New York
  - Can't use treated graywater for flushing toilets
    - Why not? Policy. Speculative
    - need to significantly rethink
    - Decouple revenue stream from usage.
      - Government agencies who regulate utilities, decouple from quantity
      - How to do this and maintain effectiveness?
      - International discussions also
      - Construction is key to this process, we understand the SYSTEM!

Blue sky: interview F

What are the major factors effecting society?
**** is in a hot bed of sustainability and engineering issues and security
We need to be flexible.

How do we design for natural disasters?
Being conservative on resource use.

Broad form sustainability
Data Centers being built in the US
- Wherever they are built, they back up everything.
- Need to keep client technology safe and secure.
- Is the facility built to withstand natural disaster
    - What to do for backup and physical redundancy?
        - physical locations are varied

Complex model of interdependence gets even more complex and interdependent
- Past oopses have provided insight.
    - Data Centers in the bases of the twin towers during 9/11 failed
    - There is a domino effect

People need to build smarter
How do you balance this with all the issues
- Pay a little more now, or A LOT more later
- International oil shortage
    - band-aid or longterm problem
    - must be smarter about what we do it
- 170 participating businesses, national and global
    - people are beginning to talk about how you build smarter
        - new technologies are always more expensive
        - The challenge to higher education entities to make changes in beaureaucratic settings
        - with great challenges come great opportunities
    - expected to maintain good, challenges bring about leadership

Is this a tipping point
- Russians going into space was a tipping point
    - we are going to stress math, science, engineering and we are going to do it.
- We have an industry who hasn't jumped on band wagons
    - risk
    - liability
    - construction is a seemingly basic task
        - 500 years of wonderful design
- New generation of 'born-gamers'
- Bring in green concepts at younger generations
- We have the ability to create the bandwagon effect.

The time is right to innovate. The people willing to take educated risk and really take the leap forward
Design modules to do work in a medium that we are comfortable with
Load balancing and weight distribution
weather modeling
some companies are and it is proprietary
Do we have the will and the ability to commit the resources to develop the modules
The emergencies of the world will be the impetus
9 11
katrina
Utterly critical for business and industry to partner with academia.
know how to prepare for what is to come, not what has been
Engineers of tomorrow
need to have crystal balls
what an exciting time to be an engineer
Let's look at the stats that I'm sick of:
comparing China and India's engineering grads
US comp advantage is inventiveness and the ability to work on teams
some of the other cultures are good at improving existing technologies
We need more people in engineering and IT
Math & Science are the next levels
not only comforted but addicted to?
Embrace Risk Takers - Easier said than done
Robotics
Repeat of the Space Race
Business as usual is no longer acceptable'
Who makes the modules?
When there is a big corporate merger: put them in a room and give them water and bread crumbs. Don’t let them out till there is a solution.
Put the best minds in a room, and fix the problem.
Government and NSF funding could help.
Higher Ed doesn't hurry.
We need to rethink our education system
Education 2.0
Will Rodgers: you can be on the right track and in the right direction, but if you sit there, the train will run you over
What is it going to take to get our issues on the same level as the space race?
a sage leader
an absolute disaster
grassroots/top down approach
we are beginning to see this
still not to a rolling boil.
Every great idea starts in one small neighborhood
It is my work
it is the design of a planned community
How to get people vested?

Feel the pain
Feel the gain
Does the corps of engineers have the knowledge how to do it?
What goes into a bridge
Cost
Aesthetic
performance/life cycle
Even people in the most conservative companies are looking at new technologies to positively impact on the bottom line
How do we rely on technology right?
What makes a difference to the consumer?
it relates to the cost vs. sustainability
comprehensive life-cycle cost analysis
Interoperability
If the industry demands it, it will happen, quickly
Medical stuff
pros and cons for each package.
for the greater good, there needs to be a way to select the best features of everything
software modules to ultimately customize
young people, amaze me
120 days, NO PROBLEM
Whad do you mean it can't be done?

Blue sky: interview G

World Governments:
More privatized interests with private sector taking over the role of governments
Governments will have less and less control over policy changes
Large corporations
Only optimistic point is that it is in the interest of corporations has the world.
Make money and develop markets

Did you know?-YouTube
Last summer went to China.
Arguing that we in the west need to rethink our view of totalitarian governments on citizens
China's version of capitalism, is working well (differently). They affect change very quickly.
What does it mean to US?
What is our economic structure?
The world is flat
Longterm vision is to race the US to the top
"Wikinomics" - Argument here is that
Opening up what used to be private to VERY public, changes the interoperability
Website - inocentives.com P&G technical issues they wanted to overcome
A bit of an RFP
We'll pay for a solution, solve and we will pay you.

Think about impact on globalization?
Who is managing our intellectual property becomes most important
Knowledge workers - put yourself on Ebay, let people bid on your talent.
Definition of a job, worker, corporation, governments
The World is flat has already changed.
India and China are no longer just cheap labor pools
What does it mean? Didyouknow?
Name this country
When?
Complete faith in our education system at universities
Quality war with Japan
Now we are stuck with economy
Everything we do in the US, is affected by change
How do we respond to capitalism?
Decreasing importance of governments

Job, worker, corporation Changing - Construction
Where do workers come from?
Labor - Local workers

Knowledge will come from around the world
engineering
procurement

Personal assistants in India
Nanotech, AI, robotics
how to capture knowledge in a workforce
gets captured in some sort of a knowledge base
by 2025, $1000 laptop will surpass by 2014 - as capable as being smart as a human.
Less reliant on corporate knowledge
Free people's minds up to innovate, less RFP writing
Robotics
We gave up in US, Japan is still going well
Japan has always looked ahead.
Literature review of japanese technology
Prefab combined with onsite prefab
Small Factory - moving up the side of the building
Very clever thinking.
Nanotechnology
Body heat to power equipment and armor
Japan visions carbon nanofibers -7 years ago
Hotel in space - orbiting and tethered to ground using nanofibers
Not by 2025, but we will have nanofibers
Moor's law - computer doubles every 18 months
Line on a semi conductor - smaller lines
1 atom wide - this is the smallest line possible
no limit to the creativity
Belief in capitalism
Our interest to fix global warming
Poverty
NO limit to desire to improve one's lot in life.
If you can imagine a better world, it is construction who is going to build that world.

Blue sky: interview H

These aren't in any order
There will be much fewer 'developing' countries.
The standard of living is accelerating in other countries
China and India to be world leaders.
US will not be the world's leading superpower
    For us and our EPC projects on an international scale, we employ engineering from Mumbai, significant cost advantage.
        Chinese partner whom they use on other projects
            competition will be equalized
    All the resources are in India and China, where do we go next?
    Vietnam
    Where do we go next? Africa
Resources
    Development in China
        As countries like China become superpowers, those resources will be used to develop other countries

Maybe specific to our industry
Productivity is dramatically improved
Wireless control systems
Modularization
Repeat Engineering
    Reuse and standardize designs
The mechanism is the almighty dollar

Wireless controls
    until they pick it up and drive it
Modularization,
Universities are also driving the mechanism.

Construction Productivity may not necessarily catch up, but it will significantly improve
Role of the project manager?
    A good project manager has to be people focused, as always
    Going to have to be much more astute from a technological standpoint
        We already rely on technology a lot

Different Forms of Energy
Move away from fossil fuels
    solar
    wind
    tidal
A lot of money on development
Will we ever be not reliant on fossil fuels?

Biofuels?
- Non-food source biofuels
- Today it is viewed as competition
  - woodchips
  - weeds
- Corn-based ethanol plants? Not so much

Population increases, and food price increases

Environmental Drivers
More and more prevalent
CO2, current agreement from G8 to reduce greenhouse gasses, just released 7/8/2008
- Issue is not going away
- There are very competent engineers who don't believe it's caused by man.
  - Not totally, but some contribution

Look at all the petrochemical facilities around the world being developed.
- Plastics Plants: have we really come to grips with recycling efforts?
  - Do we understand the landfill issues
- Alternate Materials that are more recyclable
- Technology to enable more recycling

Head of steel and iron
- a lot of bad press about pollution

Development is a combination of government & private enterprise
- Government led
- Private enterprise comes in later
- People see sustainability from an economic perspective

More international collaboration
- As nations develop, they are more prone to collaborate over common causes.

Can it be done by private
- Post combustion Carbon capture, not the private drive

How do they stay on cutting edge
Capital projects
Technology products
Services

most R&D into technology & products
usually pockets of insight.

Blue sky: interview I

Mental Model they use is compiled from a all over
War room planning wall - 200 charts
# of futurists an visionaries:
- www.nowandnext.com
- Techcast project - 2045 - prof of DWU William hallai www.techcast.org
- Managing directors at Mckinzie - macroecon,
- Ed Barlow - speaks a lot to Fortune 500 www.creatingthefuture.com
  - populist view - other sources more insightful
- Waves of innovation from mid 1700's - naturaledge - www-globe.net.ca
  - 6 waves
  - next wave is
  - 1st wave, iron, water, textiles
  - 1845 - cotton
  - 1900 - internal combustion
  - 1950 - petro chem, elec
  - 1990 - tech
  - 6th wave - sustainability, nanotech,

There is no one vision that is being painted
One of the better things they've seen came out of entrepreneurialism tie
The Indus Entrepreneurs
- meeting in SD a few years ago
- New global business models
  - Drive a stake in the ground looking at everything and categorizing
- good description of these models
  - Industrialized
  - business technology model
  - what and how are epcs going to be affected?

**Better jimpentos.com
Several steps beyond Friedman
Globalization - genie is out of the bottle
- $200/barrel

The vision they have come to is:
2 or 3 of these
- oil and gas
- power
- pharm

other categories
- Government
- military

Sectors of the economy
- Next waves of innovation and the next changes that drive investment
  - Biofuels - we are now getting out of 1st generation,

What it really looks like is two pieces
- Mature economies
  - North American & Western Europe
    - Same ol, same ol industries - shifting away from these - going towards China, India, Middle East
    - new technologies - room temperature processes, much less capital intensive
- Developing economies
  - What investment are they making now and what are they going to be doing in the future?

Big Puzzle pieces
- Think tanks - all over
  - Focus on the ones we can find off the shelf and then form your own scenario
  - Form 3 different scenarios
    - Predicting/forecasting is not good
    - 3 scenarios
      - low price
      - high price
      - med price

Globalization and demographic changes in BRIC
Jean Paul Chavier
- What are the top 5 drivers of the past 25 years, how about the next 25 years?

Ultra Decentralized
Best sources - good investment analysts
- PwC
- Goldman Sachs

Lists on the wall
- Centers of economic activity shifts globally
- Public sector activities balloon
- consumer landscape

By each sector
- some people are technology.

Futurist and top trends
Other sources are:
- Economist
- Scientific American
- Once every year they'll put out an issue

Gather Data and initially
all this stuff will rattle around for a couple weeks and puzzle pieces will fit together in your head.

hypothesis	Once you get the vision - just write everything down as a working Does this conversation add to the mental model? Once 90% of the stuff falls into the model

Appendix E: CII Board of Advisors Project Management 2025 Roundtable Summary

*Note the following transcript has been made available to give a general outline of the discussion that took place in Chicago, Illinois with a CII Board of Advisors focused roundtable discussion on the topic of project management in the Year 2025. No names have been mentioned.

What are some of the differences in how we will deliver projects?

Fewer and fewer people with project management skills. 'Super project manager' who leads groups of unskilled workers. Increasingly limited resources.
Prefabrication and modularization is in use today. We have a long way to go and advance in modularization.
We are a slow industry to evolve. Too many small businesses.
Don't have the wherewithal to do it.
Disproportionate number of small compared to large industries.
Can we standardize our work across the construction industry? Do we maintain a competitive advantage with differences?
BIM and collaborative management is being used to solve problems.
Example of sending around a BIM and eventually reach a solution
Solve problems before they get to the field. Especially if we are doing offsite project management.
Standardization and things are just decisions and tools. Project management is a higher level.
Differentiate between techniques and project management decisions.
What is the definition of project management?
Giving the information to make decisions.
Still the people side
People in the end have to make decisions, but computers can help to get early information
Central 'control room' for project controls. All the information goes to the central planning area.
Mentor and trainer and communicator. This will be an increased role of the project manager.
As we continue to integrate, this will become even more important.
PM has the role of Facilitator and integrator.
Skills will shift from technical to managing people
need to manage the flow of information and stuff
set up assembly lines, systems so to speak
Construction has traditionally maintained a view of project management compared to PMI
A manufacturer's perspective. Manufacturing productivity compared to construction productivity increases.
Standardized work, lean: business systems as well as jobsite systems.
Currently, project managers are problem solvers. If we can construct projects virtually, this shifts earlier.
will become an issue of coordinating activities.

will be more able to proactively plan and less reaction.
orchestrating vs. problem solving
People used to say that we can't put construction into a process flow. We NEED to adopt process flows that work.
People haven't come to realize the importance of completely moving to modeling.
Estimating, procurement, logistics,
subcontract a process - modular subcontracts
more and more players earlier on. Boeing model of being more of an integrator
we are already seeing that with some subcontractors.
Pepsi model: define your supplier as a 'very early' supplier with design competencies. Influence design, engineering, and project execution
Very resilient to change. Emerging trends for 20 years.
Very likely that it won't be terribly different at all.
Deeper themes. Also Deeper Barriers
What kind of company structure organizations can we use to bring in the new systems of projects and project management
"Does my structure enable this kind of a flow?"
translate from senior managers to the engineering shop floor
not always easy. Somebody's eating out of my rice bowl
Specs that really don't accommodate innovation because we try to make it accessible for everyone.
Bring the providers of technology on earlier.
Balance technology with standardization
What is project management?
differences in Engineering and construction vs owners
Owners need to decide things earlier.
**Decision making and risk analysis
If we have less and less people being project managers, we will get into trouble. Need to put most skilled people in PM roles
Should portfolio management be included in project management?
If we don't understand projects next door, we are missing a key learning experience
What is your unit of measure?
Manage suppliers vs. managing the interface of suppliers
Nuclear power: module facilities, just like ship building
Modularization is still a method that depends on the labor/equipment equation.
Changes will also happen in materials and suppliers.
Subcontractors may be developing things that GCs aren't aware of.
Changing skillset
trend toward general degradation/specialization of knowledge
If we go offshore with management, more people will need to understand the business side of things
Are there different skillsets from project/program management - small pieces coming to the whole
Structure: organize the project execution team. Organize what needs to be done, not necessarily by teams
Need to have a task force.

Program vs. project manager
- program manager who manages the similar projects of a group for a client
- leading and managing: doing the right things vs doing things right
  - PM puts the right plan together.
  - Predict the future in time to alter what is going to happen, not just react
  - Project manager vs. project leader

Owner PM vs. contractor PM
- different costs: design, delivery, life cycle
- life sciences are definitely important role
  - manage expectations of a lot of people
  - manage the media and different parties - stakeholders who you don't even know who they are
  - leader who knows how to manage. This will be even more critical in the future because there will be more information to process

Sustainable Design
- Carbon footprint
- can't just look at post construction emissions

process in Mazda. Carbon footprint back to the manufacturer
Today's LEED platinum will be the standard in 10 years
this could hit us in the face if we aren't ready
We don't charge for water. Especially not at high enough levels to encourage conservation

Globalization
- Will this be a more diverse crowd in 20 years
- people in India managing projects in the US
- traveling workers bring their own supervises
  - 6 official languages, 4 on ours
- Camera crews, 4-5 cameras
- Age matters
  - who is the best at utilizing the computer technology that is going to be driving project management of the future
  - who is going to be the project managers in the future

no drawings
- virtual screens on hardhats
- extremely close on electrical, shows terminations
  - we have a solution that doesn't use terminations

Robotics
- why didn't it happen?
- Richard Tucker made this prediction 20 years ago. Now it's being made again.
- Maybe those 24 year olds solved it because they didn't know all the traditional ways
  - young people don't always use the old resources

We aren't giving our young people a chance. Idea that project managers need 30 years experience
- construction management and engineering need to come together in the education world

Education is better with teaching collaboration