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Corporate Productivity Program
Purpose and Characterization

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Corporate Productivity Program:
Purpose and Characterization

by

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Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Engineering

The University of Texas at Austin

December 2017

ACKNOWLEDGEMENTS

ABSTRACT

Corporate Productivity Program: Purpose and Characterization

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Productivity improvement within the construction industry is a critical aspect of successful project implementation. Specific productivity practices have demonstrated improvements at the activity, trade, and project levels. However, results have been inconsistent and have not created significant productivity gains at the corporate or industry levels. This research studies the productivity challenge from the corporate level that influences entire project portfolios. The objective was to characterize and assess Corporate Productivity Programs, which are comprised of the people, processes, and technologies that support an organization's productivity improvement efforts. This study developed a framework to characterize Corporate Productivity Programs centered on their Elements and a method to evaluate programs based on the implementation of measurable Actions that lead to increased productivity practice utilization. Through improving the Corporate Productivity Program, a company should have increased utilization and consistency with implementation of productivity practices. These systemic productivity improvements have the potential to improve performance and predictability for portfolio management in the multi-trillion-dollar construction industry.

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CHAPTER 1: INTRODUCTION

The construction industry can leverage productivity improvement to enhance project and business outcomes. However, construction industry productivity has not demonstrated clear improvement over time (NRC, 2009) (Sveikauskas, 2016). Many productivity practices exist to support projects and specific scopes execute more efficiently, but the practices are implemented inconsistently (Goodrum, 2013) (Thomas, 2009).

In other areas, such as construction safety, corporations implement enterprise-level programs that ensure projects are properly managing safety to company expectations. Industry safety metrics reflect decades of improvement that may stem from this focused, formal, enterprise-level approach. If a similar approach is applied to productivity, organizations may be able to consistently implement proven practices and improve project and execution management. These improvements could result in improved portfolio management and project consistency, which would positively influence the effectiveness of trillions of dollars spent in construction around the world.

1.1   Problem Statement

This research sought to identify Corporate Productivity Programs and characterize them. Thus, the research focuses investigation on understanding the purpose of construction companies' enterprise-level productivity improvement programs. Then a method to characterize and assess program's strengths and weaknesses is developed to validate the characterization against utilization of practices proven to improve productivity. Finally, key Barriers and Program Practices to mitigate Barriers and enable successful implementation are identified.

1.2 Research Purpose and Objectives

The research purpose is to identify, characterize, and validate the concept of enterprise-level productivity improvement programs. In doing so, the most significant barriers to corporate productivity programs will be identified, and mitigation recommendations for those barriers will be developed. Effective corporate productivity programs should increase productivity practice utilization and success. The overarching purpose of this research is to provide companies a method to improve corporate-level engagement and management of construction productivity to improve portfolio predictability and project execution.

By characterizing and enabling assessment of corporate productivity programs, we intend to enhance companies' ability to identify and fill gaps that hinder construction productivity. By identifying methods to advance and promote productivity programs, the research goal is to enable enhanced project execution and productivity. The long-term objective is for organizations to implement effective corporate productivity programs that contribute to more predictable and competitive projects across company portfolios.

Specific objectives addressed by the research in support of that purpose are:

Objective 1. Identification and characterization of corporate productivity programs

Objective 2. Measurement and verification of corporate productivity characterization

Objective 3. Identify the productivity practices used by organizations

Objective 4. Identify Barriers to the successful implementation of corporate productivity programs

Objective 5. Identify Program Practices to mitigate barriers and improve program success

Improving construction productivity has been a permanent objective of the capital projects industry. Previous studies have demonstrated many methods and productivity practices that

improve construction performance at activity, trade, and project levels. However, corporate portfolio results remain inconsistent, and assessment of the construction industry indicate a lack of proven productivity gains.

To unlock the potential of corporate driven productivity improvement, companies need clear characterization of the purpose and responsibilities of corporate systems in construction productivity. Then, with understanding of industry status and norms regarding productivity, companies need a method to measure and improve upon performance. Within the defined system, Barriers to success are and enterprise-level Program Practices to overcome these Barriers need to be identified. This research addresses that challenge with the concept of Corporate Productivity Programs. These Corporate Productivity Programs manage company systems and interfaces affecting construction productivity while providing projects with specific guidance to improve performance. Additionally, the research identifies the productivity practices currently utilized by industry organizations as potential toolkits to initiate organizational programs.

The following definitions have been established to better describe the research:

Corporate / Enterprise: For the purposes of this research, corporate, corporate-level, and enterprise-level are used somewhat interchangeably. Each is defined as the organizational hierarchy of a company that acts in oversight or support of multiple or all company projects and construction. This level influences decisions of company leadership above projects in companies' organizational structures.

Productivity Practices: Practices that improve construction productivity.

Examples include constructability, activity analysis, training, and materials management, among others. The effective and consistent implementation of these practices is proven to contribute to productivity improvements in other research (Goodrum, 2013).

Corporate Productivity Program: Group within an owner or contractor organization that, working in conjunction with other corporate or project level entities:

- Defines the productivity practices that should be implemented on a project considering project specific circumstances and organizational objectives

- Provides guidance on how to plan and control the implementation of productivity practices

- Performs corporate level measurement, analysis, control, and improvement of the implementation of productivity practices across projects

Program Practices: Enterprise level solutions that allow organizations to successfully and consistently implement productivity practices across projects, leading to productivity improvements at the activity, trade, project, and corporate levels.

1.3   Scope Limitations

Construction productivity can be viewed in multiple ways, but it is often measured as basic ratio of input work-hours to output product or ratio of direct work to total hours when managing worksites' direct work rates. However, due to varying types of work, products, and compensations, it is often difficult to roll-up to high reporting levels, such as project or company averages. This results in limited firm data above scope-specific work to support a basis of best performing companies. Thus, the research to date does not address company or project comparisons.

Companies participating in the research primarily represent industrial construction and large-scale projects and operations. It is assumed the company data in both surveys and interviews

reflect the larger membership of CII's industrial construction sectors. Research findings may not be applicable across the whole construction industry beyond CII's industrial sectors. Data was not able to be collected for the entire construction industry, particularly residential or commercial construction companies.

1.4   Organization of the Thesis

In Chapter 2, the research methodology is described in broad terms. Each chapter provides additional detail on specific research objective methodology and findings. However, Chapter 2 provides the overall approach perspective and path.

Chapter 3 provides a background review outlining comparable construction programs and productivity practices checked for utilization in this research. The background focuses on addressing construction program systems and terminology. Finally, the background provides detail about some key issues guiding the research toward enterprise-level understanding, evaluation, and improvement.

Chapter 4 addresses corporate productivity program characterization. This chapter focuses on concept development, assessment methodology, and validation. The concept is developed through Element-level framework and Actions within each Element providing measurable details. The assessment methodology is tested through surveying the industry; the survey data is analyzed to understand existing industry systems and characterizations. Analysis is presented to validate the characterization method and scoring. Then the impact Corporate Productivity Programs may have on construction productivity is assessed.

Chapter 5 provides background on development of the Barrier and Program Practice lists. This summary of the interview process and findings provides additional understanding of

enterprise-level engagement with the Corporate Productivity Program, and it lays out some of the current industry challenges (Barriers) and mitigation methods (Program Practices).

Finally, Chapter 6 addresses overall conclusions and recommendations. These cover data-driven conclusions about Corporate Productivity Program characterization and assessment. Then recommendations based on the research learnings for future research, actions, and Corporate Productivity Program capacity to impact industry.

CHAPTER 2: RESEARCH METHODOLOGY

The research approach was established to address the research objectives outlined in Chapter 1. This approach outlines the path for methodology to strategically address objectives as hypotheses. Overall, leveraging background review of productivity and similar enterprise-level construction industry programs was planned to develop a conceptual characterization framework. This framework is expanded to a defined program model by establishing measurable characteristics called Actions, and the model is tested against industry existing systems. This enables evaluation of industry norms and validation of the feasibility of program assessment, meaningful variability between programs, and impact the program can have on construction productivity. The approach is outlined in Figure 1. Research Approach.
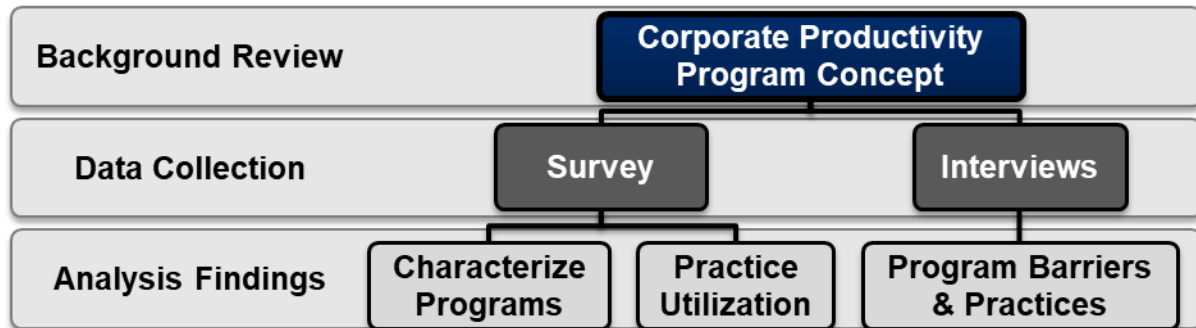
Figure 1. Research Approach

2.1 Background Review

The literature review was performed to understand the area of need for productivity research. Understanding the enterprise-level focus, existing construction programs, such as safety and lessons learned, were investigated for breadth of impact and methods used. Additionally, the literature identifies productivity practices that are used in construction to improve productivity. The detailed literature review is presented in Chapter 3: Background Review.

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2.1.1 Corporate Productivity Program Concept

These enterprise-level understanding of existing corporate programs will outline the Corporate Productivity Program concept. This investigation starts with how programs are developed and operated under formal systems that create a framework. Additionally, the long-term planning and continuous improvement aspects of existing programs serve as a method to assess a productivity focused program. Finally, the characterization of programs relies on identifying methods used measure, assess, and differentiate existing programs.

2.2 Data Collection and Analysis (Survey and Interviews)

The team refined the conceptual framework into a defined program with measurable details through additional literature review and feedback cycles. That conceptual characterization is tested through data collection on current industry systems.

2.2.1 Program Characterization

Following conceptual development of a framework to assess a Corporate Productivity Program, a survey was conducted. The conceptual characterization framework is tested by using it to assess existing programs. Through characterization of current industry systems, an understanding of industry status for the measurable characteristics is checked to verify the concept applies to varying companies' enterprise-levels (See Appendix C – Productivity Program Data).

2.2.2 Productivity Practice Utilization

Productivity practice utilization data was also collected through the survey (See Appendix C – Productivity Practice Utilization). The level of implementation of various productivity practices were questioned. This data enables understanding of current utilization levels of practices across companies, and allows for assessment of relationships between Corporate Productivity Programs and proven productivity practice utilization.

2.2.3   PROGRAM BARRIERS AND PROGRAM PRACTICES

Interviews were conducted with organizations that participated in the survey. Data collection through interviews was planned to better understand responses to the survey and to identify implementation Barriers and Program Practices. These were structured as conversations about each company's corporate organization and systems regarding productivity and program management. Then organizational productivity goals and objectives were addressed.

After the overall questions, each company was asked about facets of their survey responses. These detailed discussions about specific Corporate Productivity Program systems that had been self-assessed enhanced understanding of what companies are doing relative to the framework outline. It also identified Barriers to program implementation and Program Practices for mitigating Barriers and improving characterization facets. Interview findings are described in Chapter 5, and interview details are provided in Appendices D and E.

2.3   Research Methodology Conclusion

Overall, the research methodology is established to identify and test the concepts laid out in each Research Objective. The literature review also identifies the Corporate Productivity Program terminology by referencing existing enterprise-level programs. This produces a program concept that has familiar aspects for industry users by leveraging knowledge and framework of successful comparable programs. Additionally, utilizing familiar terms from similar corporate-level programs should enable survey and interview systems to be more relatable for participants and end-users.

The research survey and interviews engage industry to ensure the concepts and approach are reviewed by industry to evaluate implementation and feasibility in parallel with the academic

data and statistical analysis to validate concepts. This is critical since program overall, long-term impacts are better addressed if industry adoption is generated, and the Corporate Productivity Program is far more likely to be implemented with industry engaged early.

Most importantly, industry data collection provides specific characterization and productivity practice utilization data. These allow academic and statistical analysis of programs as they exist today – without formal structure or existing metrics. Over time, the structure provided by the program outlined is also intended to analyze and identify additional testing of enterprise-level productivity if systems adopt the formal approach and identify metrics. To that end, survey and interview validation generates a set of measurable characteristics needed for future evaluation and ongoing improvement.

CHAPTER 3: BACKGROUND REVIEW

Industry productivity performance is complex and spans many aspects of project management and industry challenges. There are proven means and methods, referred to as productivity practices, that promote success at activity, trade, and project levels (Goodrum, 2013) (Shan, 2016). However, industry-level productivity outcomes are unclear, and the construction industry has not realized significant productivity improvement (Sveikauskas, 2016).

Although productivity practices are frequently utilized in construction, most companies do not have defined, formal systems for managing productivity at enterprise or company-wide levels. Project management teams fail to apply known workforce management practices, and projects frequently run into the same issues generating negative project outcomes without long-term correction or intervention (Thomas, 2009).

However, other construction programs, such as safety, have had success addressing these large, industry-wide challenges (CII, 2017). The parallels focused by this research are corporate programs promoting long-term improvement and program management. Company programs provide a bridge for learnings to become a toolkit for portfolio-wide improvement (OSHA, 2016).

Typically, project teams exist to manage outcomes such as safety, cost, and schedule. However, productivity is entangled with many other aspects of project planning and engineering before construction starts. Additionally, interfaces between internal and external parties affect projects' productivity (see Figure 2. Project Participants (Tucker, 1986)). Thus, the scope often outpaces project teams' capacity to manage interfaces and plan execution. Communication is critical and efforts to reduce the routine

Figure 2. Project Participants (Tucker, 1986)

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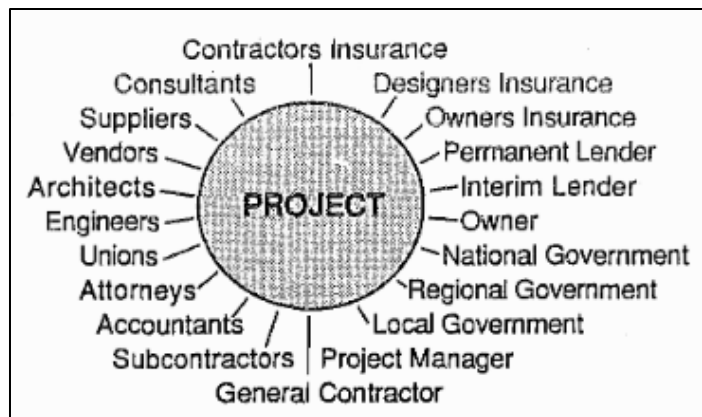
paperwork and tasks of project teams should be focused for long-term improvement (Tucker, 1986).

Ultimately, many of these interfaces may be more suited to long-term relationship management, rather than isolated project scopes and teams. Additionally, the improvements to systems and routine expectations may be better supported by corporate-level influences than each project team mitigating time burdens independently. Finally, the ability to influence these aspects across a company portfolio needs a framework that reaches across company projects. Thus, the key callings above suggest a corporate-level program be developed to help projects succeed. Other areas of project management employ corporate-level programs, and those will be investigated to develop the concept for construction productivity.

3.1   Corporate Programs

Productivity in construction faces a long history of lagging compared to other industries (Sveikauskas, 2016). Construction safety has addressed similar challenges with programs developed around company objectives and goals, and order of magnitude improvements have been seen over the past few decades (CII, 2017). The programs addressing those goals and objectives exists in order for companies to channel safety focus, resources, and learnings (Hinze, 2003) (OSHA, 2016). In lessons learned programs, companies attempt to repeat positive experiences and mitigate repetitive mistakes. To do so, a program manages organizational or enterprise-level knowledge management systems and training to improve company-wide information flow and experience transfer (Caldas, 2009).

These construction programs are assessed to identify systems, roles, and responsibilities that enable success at the enterprise-level. Additionally, the program management systems and measurement methodologies are reviewed. These detailed, measurable program frameworks and

structures that are currently in-use and provide common industry terminology and references for the development of Corporate Productivity Programs.

3.1.1 SAFETY

Construction safety metrics have improved by orders of magnitude over the past few decades (See Figure 3. CII TRIR (RIR) Rate, Aggregated Data, 1989 – 2015 (CII 2017)). Leveraging safety program methods to change workforce, company, and industry culture has been a major component of that long-term success. Through programs' systematic, corporate-wide approach, organizations and industry have achieved goals and continue to push for greater success. This is supported by both industry and government expectations (OSHA, 2016).
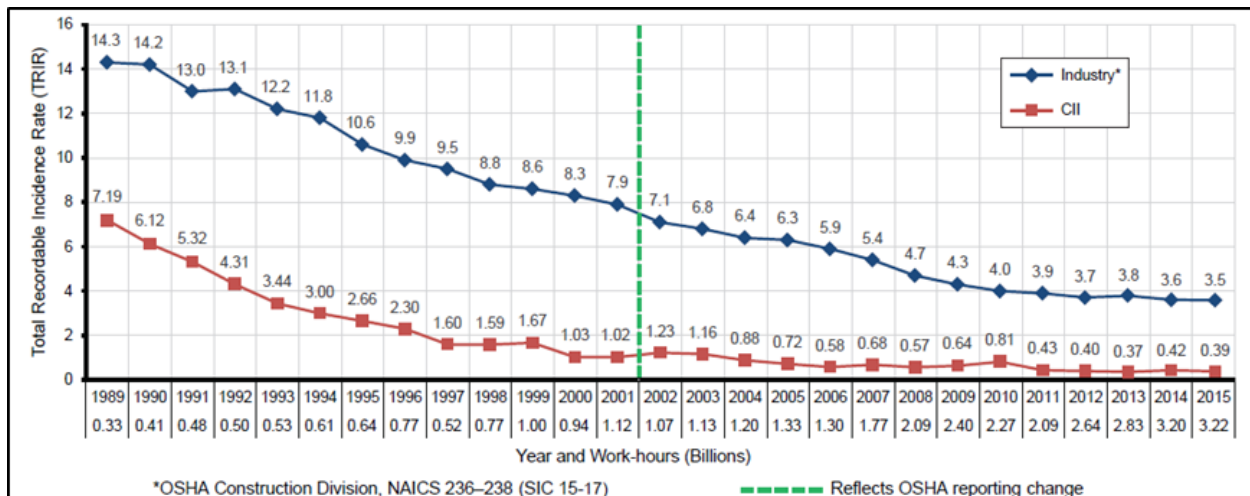
Figure 3. CII TRIR (RIR) Rate, Aggregated Data, 1989 – 2015 (CII 2017)

Industry communicates and demonstrates commitment to safety performance and improvement in many aspects, and safety programs are ubiquitous in the construction industry. The long-term commitment to safety improvement is also demonstrated in funding the advancement of industry knowledge and management of safety. Research pursues many avenues and approaches to accomplish the overarching goal of injury prevention. Research investment can

be observed with industry's funding of CII research over the past 15-years including research topics funded to focus on safety:

1. Annual performance (Annual Reports)
2. Safety programs (CII, 2003)
3. Precursor analysis
4. Near miss reporting
5. Hazard recognition
6. Leading indicators
7. Site leadership in safety
8. Specific injury programs (target safety)
9. Owner's role in safety
10. Design for safety

Construction safety programs are developed around company objectives and goals. The framework to address those goals and objectives needs to be established for companies to appropriately channel focus, resources, and improvements. These programs displayed great success in OSHA's study of small employers in Ohio, results documented in Figure 4. OSHA Study on Safety Program Adoption (OSHA 2016). These results were cited along with improved production, quality, employee morale, recruiting, retention, and reputation.

A study of small employers in Ohio found that workers' compensation claims fell dramatically after working with OSHA's SHARP program to adopt programs similar to those described in these recommended practices.

average number of claims DECREASED 52%

cost per claim DECREASED 80%

average lost time per claim DECREASED 87%

claims (per million dollars of payroll) DECREASED 88%

Source: Ohio Bureau of Workers' Compensation (2011), Ohio 21(d) SHARP Program Performance Assessment.

Figure 4. OSHA Study on Safety Program Adoption (OSHA 2016)

OSHA suggests programs include structured aspects of leadership, worker participation, education, training, communication, coordination, evaluation, and continuous improvement (OSHA 2016). These are categorized here as program management. Program management aspects set goals, organization, responsibilities and administration of the program from corporate and

project levels. Leadership and worker engagement influence culture and buy-in of organizations and projects, which is a major factor in safety performance and program success (CII, 2003). In addition, OSHA recommendations, self-assessment, and tools for all of these constructions safety programs aspects are available free online.

Construction companies have many means and methods for safety accumulated over decades of experiences, and that knowledge and experience faces the challenge of company and industry-wide circulation and adoption. These challenges and efforts to improve mitigations and overall performance are ongoing within organizations with formal programs providing mitigations, best practices, and guidance (OSHA, 2016).

Safety systems are the means and methods for directly improving safety performance. For example, hazard identification is able to weave into several aspects of the construction safety programs at both management and implementation levels. Other means and methods may include many items dependent on company norms and project specifics like scope of work and local cultures. CII and OSHA consider some best program practices to be hazard identification and assessment, hazard prevention and control, staffing for safety, pre-project planning, pre-task planning, incident investigation, behavior observation (CII, 2003), and other safety practices, such as design for safety and use of leading indicators (CII, 1996) (CII, 2012).

This thesis focuses program management aspects due to their ability to drive organizational change and improve utilization of means and methods. Because of the broad nature of these program aspects, the general systems are outlined and will be referenced later in Chapter 4: Corporate Productivity Program Characterization. (OSHA 2016) (CII, 2003)

Six Areas of OSHA's "Recommended Practices for Safety & Health Programs in Construction":
1) Management Leadership
2) Worker Participation
3) Hazard Identification and Assessment

4) Hazard Prevention and Control
5) Education and Training
6) Program Evaluation and Improvement

Nine Key Topic Areas from CII's "Safety Plus – Making Zero Accidents a Reality":
1) Demonstrated management commitment
2) Staffing for safety
3) Planning: pre-project and pre-task
4) Safety education: orientation and specialized training
5) Worker involvement
6) Evaluation and recognition/reward
7) Subcontract management
8) Accident/incident investigations
9) Drug and alcohol testing

In safety, the corporate program management ensures that experienced resources provide guidance on selection, implementation, and management of practices for projects across their portfolios (OSHA, 2016). Executive management displays commitment and remains engaged to ensure top-level attention and mitigations are provided to accomplish the goals and objectives laid out by leadership. Leadership engagement, worker participation, education and training, coordination, and continuous improvement (CII, 2003) .

3.1.2 LESSONS LEARNED

"Lessons learned programs consist of the people, processes, and tools that support the collection, analysis, and implementation of validated lessons learned in organizations" (Caldas, 2009, p. 2). Lessons learned programs are very common in the construction industry. These programs face the challenge of inconsistent ability to engage workers and leadership, broad communication streams, and difficult measurement of implementation impacts. Justifying implementation and management of lessons learned programs requires attention on long-term improvement and executive support. Thus, relative to lessons learned programs, "Consistent and aligned leadership action and communication throughout an organization is a key element in creating the environment for success" (Caldas, 2009, p. 5).

Industry needs for lessons learned are also based on a specific company's business goals and objectives. Companies then set a program toward the continuous improvement and knowledge retention systematically. Additionally, transmission of learnings is tailored to company, project, and situational needs (Kartam, 2006). To combat these challenges, a formal program assists with consistent lesson capture and distribution, roles, and responsibilities (Caldas, 2009).

Research found that programs performed best when they were formalized. This typically entails establishing the three steps of data collection, analysis, and implementation as a regular business process across the organization. Data collection and analysis was typically more advanced than the implementation step (Caldas, 2009) (CII, 2005).

Key program concepts in CII's "Research Summary 230-1: Effective Management Practices and Technologies for Lessons Learned Programs":

Key Characteristics
1) Leadership
2) Lesson Collection
3) Analysis
4) Implementation
5) Resources
6) Maintenance & Improvement
7) Culture

Tenets of Success:
1) Leadership
2) Teaching
3) Active Implementation Strategy
4) Organizational Culture
5) Technology
6) Quality over Quantity
7) Benefits to both Owners & Contractors

Lessons Learned Special Considerations:
- Human resources and IT resources are important in making sure a lessons learned program is successful.
- None of the surveyed organizations used "off the shelf" technology
  - Organizations generated similar, customized IT tools to facilitate their program.
- None of the surveyed organizations currently dedicates a full-time employee to facilitate their lessons learned program
  - Effort is typically beyond 1 FTE

Both programs suggest that formal systems with goals or expectations demonstrate greater success. These entail systems to communicate and measure program focus areas, objectives, and needs. The programs also call for feedback cycles and continuous improvement to ensure long-term improvement and learning.

To drive programs, focus areas are outlined to organize program aspects. Leadership and resources are examples identified in both safety and lessons learned corporate programs. These are developed into measurable program areas by detailing behaviors and actions within the areas to assess program performance and impact.

Finally, programs have unique aspects that are specific to purpose and engaged parties. For example, lessons learned has specific information technologies and communications to assist with distributing knowledge throughout the company. These will be important to identify for construction productivity focused programs.

3.2   Productivity Practices

Many research topics and publications address construction productivity. While the overall topic is integral to this research, the focus of productivity discussion in this background support is on productivity practices and their impact on productivity. While understanding productivity and the impacts of project lifecycles and strategic decisions have on it helps with detailed implementation of the program concept, understanding enterprise-level management and systems to support corporate programs is the focus.

To support that focus with the impacts on productivity, dozens of productivity practices are referenced and utilized in the research. The impact these practices have on productivity is used to relate the Corporate Productivity Program concept with improved productivity performance.

The practices span the full spectrum of project management, as construction productivity is impacted all along project lifecycles (Goodrum, 2013) (MGI, 2017) (NRC, 2009).

3.2.1 PRODUCTIVITY PRACTICES

Many productivity practices target activity or craft discipline productivity improvement. These practices are correlated to better project productivity results, such as safety practices, constructability, advanced work packaging, activity analysis methods, and materials management (NRC, 2009). These practices provide methods for a program to accomplish productivity improvement (Goodrum, 2013) (Shan, 2016).

These practices are typically implemented by projects to improve specific areas or trades. Practices frequently improve performance of specific tasks, such as modularization or pre-assembly to better control structural work. Other examples address site and workforce management practices, such as crew balancing and craft information systems. Other efforts refine performance, such as activity analysis that enable identification of issues causing travel, access to tools, and permitting to hinder direct work (Goodrum, 2013). These are important practices to utilize and work to achieve successful productivity, and projects span many phases and focuses that require specialized systems and practices to pursue consistent success.

Productivity practices are implemented to better plan, monitor, and control project execution aspects that heavily influence construction productivity. The Corporate Productivity Program should help companies improve utilization of project-level practices proven to improve productivity. Most of the practices investigated for the background review are explained in CII's Construction Productivity Handbook (Goodrum, 2013).

3.3 Conclusion

Both safety and lessons learned programs also emphasize the need for executive-level involvement for improvement through attention and goal setting. These systems also need resources, continuous improvement, and actions and behaviors that encourage adoption and establish a learning culture. These emphases in similar programs seeking change across corporate and industry performance directs this research to seek the status of these facets of industry status in construction productivity.

Corporate safety management emphasizes executive engagement, worker participation, education and training, communication, coordination, and continuous evaluation and improvement (Hinze, 2003) (OSHA, 2016). These existing corporate-level emphasis areas and evaluation systems will be leveraged to understand Corporate Productivity Program needs and to identify common terminology, see Section 4.2 – Corporate Productivity Program Elements.

Productivity practices exist that can act as a toolkit, similar to those managed by safety programs. These practices span across project lifecycle, interfaces, and organizational responsibilities, which may be difficult for a project team to manage. Thus, tools may need experts to manage company-specific kits and preferences. These experts need to provide projects with guidance on selection and implementation specific to project conditions, participants, and objectives. Safety programs have demonstrated success through addressing similar challenges at enterprise-levels that reach across full company portfolios.

The concept for a Corporate Productivity Program is developed using key findings. These key findings include the need for objectives and goals to support a formal program. The findings also led to the development of program Elements addressed in Section 4.2. These Elements create the framework to understand and assess program performance in defined areas, and they provide area of focus for the measurable Actions that are necessary for enterprise-level productivity success.

CHAPTER 4: CORPORATE PRODUCTIVITY PROGRAM CHARACTERIZATION

The background review supported that the construction industry uses corporate programs to impact the enterprise-level of project management and business outcomes. With the existing programs as a basis for concept and industry implementation methods, a Corporate Productivity Program was developed in concept. The first sections of Chapter 4 address the program purpose and Elements to explain the concept framework.

After explaining the program framework, Research Objectives 1 and 2 are investigated to verify the feasibility and applicability to construction productivity. Addressing these objectives begins with program identification and characterization. Characterization is then developed into a measurable framework in order to assess and validate it with industry. Finally, Objective 3 provides a basis for understanding industry utilization of the productivity practices identified during the background review.

Objective 1. Identification and characterization of corporate productivity programs
Objective 2. Measurement and verification of corporate productivity characterization
Objective 3. Identify the productivity practices used by organizations

4.1 Purpose and Objective

With the objectives outlined the identification step results in both a conceptual Corporate Productivity Program developed and companies from industry identified as checks against the concept. Characterization then establishes a set of measurable characteristics for the program focused on productivity improvement. The concept characterization is evaluated by testing the measurable characteristics against industry norms for corporate behaviors and productivity systems. Validation of the program framework is displayed through industry responses that are

demonstrably different while retaining internal reliability under the conceptual framework outlined. Then the program's purpose and role with productivity is validated through positive correlation of program assessment to the utilization of proven productivity practices, as displayed in Figure 5. Corporate Productivity Program Purpose.

The Corporate Productivity Program is conceptualized with models used for safety and lessons learned programs. Safety and lessons learned programs are industry developed and implemented by leadership with the purpose of corporate-level objective management. That basis gave support for a familiar program structure like the measurable areas, key characteristics, and tenets for success of safety and lessons learned programs. Thus, Elements of the Corporate Productivity Program were established. With input from RT-340's industry experts, alignment was established on six Elements: Leadership, Resources, Structure and Communications, Planning for Productivity, Productivity Monitoring and Control, and Continuous Improvement.

Due to lack of a reliable variable for company-wide productivity performance, the program capacity to impact productivity is tested indirectly. As mentioned before, this is done by assessing the measurable characteristics correlation to utilization of proven productivity practices. While indirect, this method leverages previous research on productivity systems and practices that are proven to improve productivity performance (Goodrum, 2013) (Shan, 2016) (Thomas, 2009). Additionally, these groupings of programs demonstrate the ability to differentiate between company programs based on the research measurement of scores.
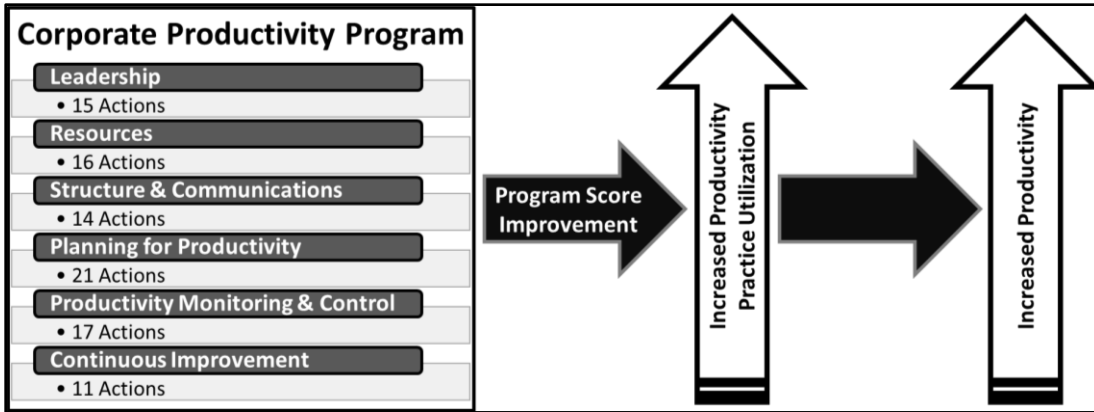
Figure 5. Corporate Productivity Program Purpose

4.2 Corporate Productivity Program Elements

In outlining the program, over a hundred Actions were identified by the eighteen experts on Research Team 340 and literature review. The experts engaged in this research can be found in Appendix A: Team Roster. These are measurable behaviors and systems influencing company productivity management and engagement. Actions spanned many aspects, such as, development of goals and objectives that focus company efforts, performance of project controls processes, and utilizing learnings and metrics for continuous improvement. They range across corporate management, company resources, and productivity practices needed for program success.

The underlying concept characteristics were refined to 94 action statements or "Actions" and grouped to Elements through three in-person feedback cycles with industry experts. These Actions will be listed under each Element description in Sections 4.2.1 through 4.2.6. Experts consisted of eighteen experienced personnel from large owners and contractors. Experts average approximately twenty-years of experience in construction projects.

Elements were identified to group the 94 Actions into six program-shaping segments based on existing construction program structures. The Elements are Leadership, Resources, Structure and Communications, Planning for Productivity, Productivity Monitoring and Control, and

Continuous Improvement. Element groupings each provide context for the underlying Actions and divide the program into manageable segments of 11 to 21 Actions. As the conceptual program is refined, Elements provide a framework for assessment to collect program data with context for participants and users. This framework of the program is displayed in Figure 6. Construction Productivity Program Diagram.

Actions: Measurable enterprise-level behaviors, methods, practices and systems of Corporate Productivity Programs to enable successful program management and implementation across company project portfolios

Elements: Groups of program Actions that assess similar areas and responsibilities of Corporate Productivity Programs for program management and improvement evaluation. These Elements formulate the program framework and summary areas.
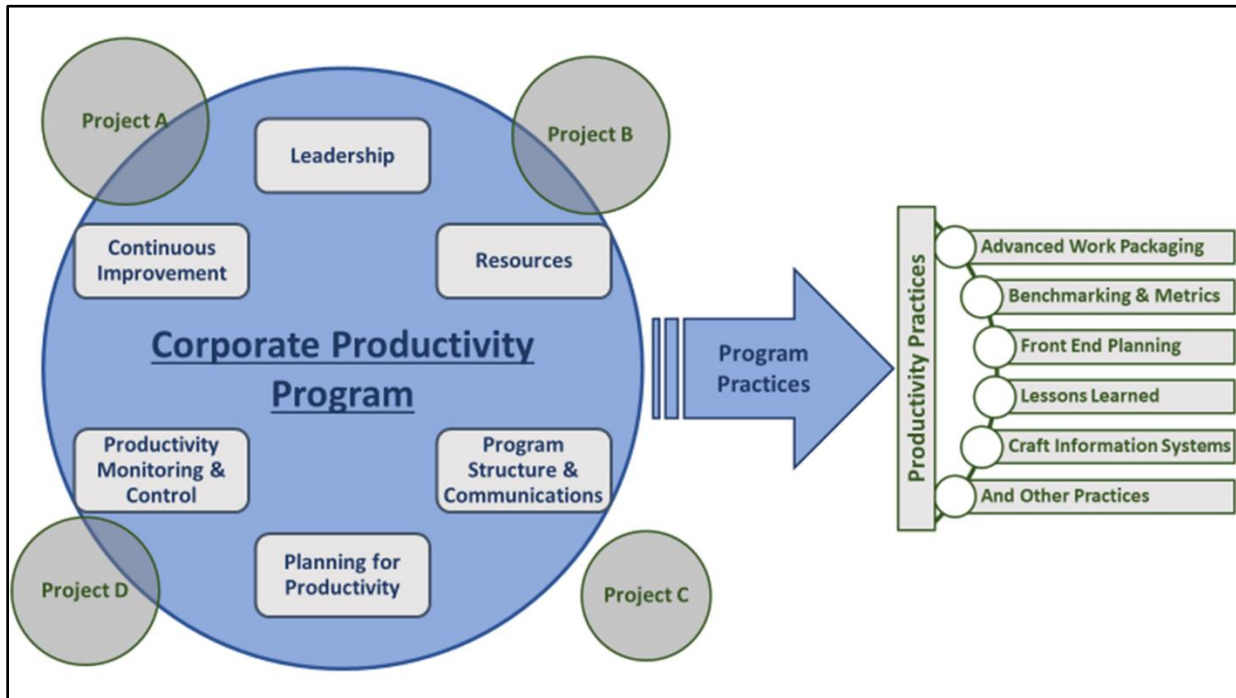
Figure 6. Construction Productivity Program Diagram

4.2.1 LEADERSHIP

Leadership is a critical facet of established corporate programs. Leaders' primary Actions for Corporate Productivity Programs are directing focus, ensuring accountability, and aligning stakeholders (Ellish, 2008). Similar to safety, leadership of productivity programs establishes goals, objectives, consistency, culture development, and stakeholder alignment (CII, 2003). The research actions center these behaviors on corporate leadership regarding productivity objectives, accountability, and leadership driven communication and commitment (Ellish, 2008).

Leadership Actions:

1. Corporate productivity objectives and goals are defined.

2. Corporate productivity objectives and goals support business objectives.

3. Business stakeholders are aligned on corporate productivity goals and objectives.

4. Corporate leaders take ownership of productivity practices and processes.

5. Corporate level decisions about productivity and productivity practices are routed for buy-in and feedback.

6. Projects leaders are aligned on corporate productivity plans and actions.

7. Corporate culture, such as employee mindsets and company risk-reward norms, supports implementation of productivity practices.

8. Corporate leaders display commitment to construction productivity objectives.

9. Corporate champions for productivity goals, practices or initiatives are identified and given leverage to support their productivity improvement work.

10. Corporate leaders promote implementation of productivity practices or initiatives across the company project portfolio.

11. Corporate leaders are consistent across the company in communication and support around productivity goals.

12. Corporate leadership provides recognition for personnel implementing productivity practices or projects that are successful with productivity improvement goal.

13. Project leadership provides recognition for personnel implementing productivity practices or projects that are successful with productivity improvement goal.

14. Project leaders set project productivity goals and measurements.

15. Project leadership is supported by corporate or functional levels with practices and standards when implementing productivity efforts.

4.2.2 RESOURCES

Resources are necessary to operate and support program goals. Personnel accountability, training, and qualifications are identified as resource factors influencing both program management and project implementation of productivity practices (Tabassi, 2011). Additionally, funding and technology are resources necessary to enable development of system interfaces (NRC, 2009). At the project level, site management knowledgeable and experienced in workforce management practices are critical to success (Thomas, 2009).

Resource Actions:

1. Corporate personnel are working to promote implementation of productivity practices.

2. Corporate personnel are held accountable for their roles with productivity goals and objectives.

3. Corporate personnel have allotted time to perform their duties relative to productivity objectives, practices, and initiatives.

4. Corporate personnel are provided training and development to properly address productivity in their scope.

5. Project personnel are provided training and development to properly address productivity in their scope.

6. Project personnel fully understand and support productivity practices.

7. Project teams and personnel implementing productivity practices are capable of defining, measuring, and controlling the data and scope decisions.

8. Qualifications to ensure individual capability are in place for positions that manage construction productivity practices.

9. Qualified personnel are available for positions that manage construction productivity practices and scope on projects.

10. Funding is provided for corporate productivity objectives.

11. Front-end cash flows invested toward productivity improvement are acceptable for project leadership, such as work packaging, or early involvement from construction.

12. Technology and tools needed for implementation or productivity practices on projects are available.

13. Productivity tools create reports or output information that are used in decision making on projects.

14. Data and history needed for productivity tools is available.

15. Productivity tools and systems are fit for purpose or adjustable - based on project size and complexity.

16. Interfaces between productivity systems and systems supporting other functions (e.g.: accounting, payroll, project controls, and safety) are established.

4.2.3 STRUCTURE AND COMMUNICATIONS

As identified in lessons learned, interfaces and knowledge transfer are critical to a program spanning across a company. The structure focuses on organizational aspects, such as departmental interfaces and program relationship with project teams. Communications addresses the need to connect those organizations across hierarchy, departments, and scope (NRC, 2009). Structure and Communications also address challenges common to construction projects, such as addressing cultural and language differences (Chinowsky, 2006).

Structure and Communication Actions:

1. Corporate functions or departments (e.g.: quality, safety, construction, engineering, IT) are aligned on company productivity objectives.

2. Project groups or teams (e.g.: quality, safety, construction, engineering, IT) are aligned on project productivity objectives.

3. Clear interfaces are established between the corporate departments regarding productivity practice changes and initiatives.

4. Other programs, such as quality, safety, construction, engineering, understand their impact and roles regarding construction productivity performance.

5. Construction productivity reports are shared across functions, disciplines, and groups.

6. Interdisciplinary or cross-function collaboration is established to enable achievement of productivity goals.

7. Corporate management communicates roles and responsibilities within productivity practices for corporate personnel.

8. Corporate personnel are held accountable for their productivity practice responsibilities.

9. Project teams have available corporate support contacts when implementing productivity practices.

10. The company hiring process enables construction productivity. (e.g.: craft skill and availability is evaluated or training is established to cover deficiencies in specific regions, trades, etc.)

11. Personnel from various countries collaborate well for productivity objectives.

12. Cultural backgrounds are considered when implementing productivity practices.

13. Language barriers to productivity practices are well managed.

14. There is a corporate organizational plan, structure, and/or group that supports the management of productivity plans and objectives.

4.2.4 PLANNING FOR PRODUCTIVITY

Productivity practices and behaviors are often established before construction commences. These plans mitigate productivity challenges, such as design conflicts and poor materials management. Program planning needs to be documented and readily available to project teams attempting to implement practices. Additionally, alignment of parties is needed to promote successful execution of plans from implementation guidance, control systems, and feedback cycles (Goodrum, 2013).

Planning for Productivity Actions:

1. Key processes and procedures for corporate productivity practices are documented.

2. Corporate productivity practices and processes are readily available to project personnel.

3. Corporate productivity processes provide enough guidance for project implementation.

4. Corporate expects project productivity efforts to be flexible based on project size and complexity.

5. Corporate ensures that project operating or owner organizations are engaged throughout project life cycles.

6. Corporate expects projects to conduct alignment meetings between groups and companies that interface with project productivity practices.

7. Company has contracting strategy practices to enable project achievement of productivity and business objectives.

8. Company has established that materials management plans and roles are consistently in-place on projects.

9. Company ensures project controls systems and roles are consistently in-place on projects.

10. Company has established that change management plans are consistently in-place on projects.

11. Construction teams on projects have systems established to enable on-site productivity, such as rapid response to critical RFIs.

12. Company ensures early project plans and design support are established to enable construction productivity.

13. Construction work is consistently packaged for project teams to enable construction efficiency and productivity.

14. Construction, commissioning, and start-up relationship is planned early and facilitated throughout the project life cycle for company projects.

15. Off-site fabrication or modularization evaluation is supported by company to capture productivity benefits for projects.

16. Safety relationship with productivity is evaluated and planned for relative to specific projects, sites, and conditions.

17. Quality processes are developed and consistently implemented early on company projects to enable construction productivity.

18. Risk assessments are performed prior to implementation or productivity practices.

19. Project site layouts are planned to increase craft time on tools and productivity.

20. Project materials management systems are established and run on company projects.

21. Project schedule sequencing is consistently performed and evaluated on projects.

4.2.5 PRODUCTIVITY MONITORING AND CONTROL

Productivity measurement, consistent tracking and reporting, and feedback cycles are integral to all other Elements. This operational segment of the program addresses a company's ability to identify and mitigate challenges related to construction productivity. It addresses short-term project needs, such as performance targets, project controls, and problem solving using productivity data (Goodrum, 2013). Additionally, the long-term organization need for benchmarks and data to support continuous improvement are also key aspects of this Element (Nasir, 2012).

Productivity Monitoring and Control Actions:

1. The company implements practices to check productivity performance on projects, such as benchmarking.

2. Corporate quality management is aligned with construction productivity objectives.

3. Corporate establishes key performance indicators for projects that enables projects to target and monitor specific project metrics.

4. On projects, key productivity performance indicators are tracked throughout the project life.

5. The company has resources to help projects reduce and manage rework.

6. The company drives that project recovery plans consider impacts on productivity.

7. The company has systems and recommendations for evaluation of craft time on tools or available work-hours.

8. The company expects projects to evaluate equipment utilization to validate equipment needs.

9. The company collects performance metrics data from projects.

10. Projects utilization of productivity practices is tracked to verify practice performance.

11. Projects decisions leverage productivity information for impacts and options.

12. Craft productivity, planning, and execution information is readily available and visible so craft teams know how they are performing.

13. Project decision makers are aware of productivity impacts.

14. Project decision makers are aware of productivity's subsequent cost and schedule impacts.

15. Projects evaluate craft time on tools or available work-hours to know how and where productive work-hours are lost.

16. Projects evaluate equipment utilization to validate equipment needs and productivity during project execution.

17. Benchmark data is provided to projects to monitor performance based on location and scope norms.

Formalized programs enable ongoing improvement in processes and efficiency. Actions about capture and communication of productivity lessons learned are measured here, and the systems to act upon learnings are assessed. Additionally, this Element checks a company's methods to identify new productivity practices, such as piloting practices prior to large-scale implementation. Lessons learned practices are leveraged from CII Research Summary 230-1, "Effective Management Practices and Technologies for Lessons Learned Programs" (CII, 2005).

Continuous Improvement Actions:

1. Productivity is tracked or improved through the continuous improvement program.
2. New or innovative productivity practices are encouraged or developed by the company.
3. Pilot projects are used to test new or innovative approaches to productivity improvement.
4. Risk-reward impacts of using or testing productivity practices are balanced by the corporate level.
5. Productivity metrics are measured for future planning and improvement.
6. There is an established feedback cycle for productivity practices performance.
7. Productivity practice performance is used to improve practice utilization.
8. Lessons learned related to productivity are captured and distributed.
9. Documentation of productivity practice improvements are disseminated to projects.
10. Productivity performance data is highlighted for distribution around company.
11. Technology investigation and innovation is enabled through the continuous improvement processes.

4.3   Data Collection Methodology

Data collection on Actions and Elements of program characterization and the utilization of productivity practices was gathered through RT-340's Phase I Survey (see Appendix B: Corporate Productivity Program Elements Assessment).

In characterization, role and functions of the program are to be clarified and made measurable. Thus, measurable program facets needed to be developed to establish an evaluation system for the program concept. These measurement systems' ability to assess and distinguish between programs must be verified to validate characterization. The Actions are measurable characteristics describing the detailed facets of each Element. These Actions became the Elements characterization scoring facets, and that provides the foundation of Corporate Productivity Program characterization and measurement.

4.3.1 CHARACTERISTICS OF COMPANIES SURVEYED

Companies surveyed were typically CII members or called upon by research team members. Thus, responses primarily represent owners and contractors from industrial construction sectors. These companies generally work in large-scale industrial projects, including greenfield, brownfield, turn-around, and operation expansion construction.

To this end, existing industry program maturity and characteristics are investigated to identify elements of strong programs under the categories and subcategories outlined during conceptual framework development. These maturity assessments and characteristics enhance understanding of industry focus and program implementation stages.

As stated in Section 1.3, Companies participating in the research primarily represent industrial construction and large-scale projects and operations. It is assumed the company data in both surveys and interviews reflect the larger membership of CII's industrial construction sectors. Research findings may not be applicable across the whole construction industry beyond CII's industrial sectors. Data was not able to be collected for the entire construction industry, particularly residential or commercial construction companies.

4.4   Data Gathered

To check industry norms regarding the Corporate Productivity Framework statements, a survey was distributed for them to perform self-assessment. Participants were asked to evaluate their companies' performance for each of the 94 characterization Actions. Through this self-assessment, individuals responded in terms of level of agreement that their company had leadership, resources, systems, practices, and behaviors in-place to support productivity.

Program characterization data was gathered from 51 survey participants. Participants were asked to focus on corporate level while assessing the 94 Actions with the program Elements providing context for the Actions area of influence. Then, they designated "Level of Agreement" with their company's corporate-level performance of each productivity program Action. These responses were for each Action in Likert scale of "Strongly Agree" to "Strongly Disagree."

Additionally, productivity practice utilization was assessed by each participant assessing their company's average use of productivity practices considering the company project portfolio. These were estimated by each participant in bands of 25% (e.g. – 0%, 1-25%, 26-50%, 51-75%, 75% or more). Individuals were able to skip if the practice utilization was unknown.

For detailed data, see Appendix C: Survey Data.

4.5   Analysis and Findings

Three analyzes were conducted to assess and validate the first three Research Objectives, and a fourth analysis assesses the ability to perform characterization with a shorter assessment to ease use of the characterization methodology.

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Analysis A – Objective 1, Objective 2 (measurement only)
Analysis B – Objective 3
Analysis C – Objective 2 (validation)
Analysis D – Shorten Characterization

In Analysis A, first, companies' Corporate Productivity Programs and Elements were demonstrated to be measurable. In Analysis A's second part, a statistical analysis using Cronbach's Alpha was performed to validate the internal consistency of Actions grouped under Elements. This validated that the Action statements under Elements were measuring a consistent topic.

Analysis B collected data on the productivity practices proven to improve productivity at project, discipline, and task levels. Analysis C demonstrates correlation of higher program scores with utilization of productivity practices using Kruskal-Wallis statistical analysis. This correlation to proven productivity practices is what gives productivity purpose to improving Program Scores.

4.4.1   ANALYSIS A – CORPORATE PRODUCTIVITY PROGRAM CHARACTERIZATION

Objective 1.   Identification and characterization of corporate productivity programs
Objective 2.   Measurement of corporate productivity characterization

Part 1: Demonstrate Measurable Characterization:

Characterization of programs is established to validate that company programs can be measured. This ensures that companies can manage and improve productivity programs. Differences in characterizations provides companies with understanding of different strengths and weaknesses in their Corporate Productivity Programs. The assessment should demonstrate measurable elements of corporate productivity programs in order to understand if a company's program is well established and mature or one of "lip service." These variances are displayed in Figure 7. Whisker Chart of Program Characterization Variability.

Action Scores: each Action response was converted to numeric value:
- Strongly Agree = 5
- Agree = 4
- Neutral = 3
- Disagree = 2
- Strongly Disagree = 1
- No Response = Blank

Element Scores: the average value of Actions within each Element

Program Score: the average value of Elements within each survey response
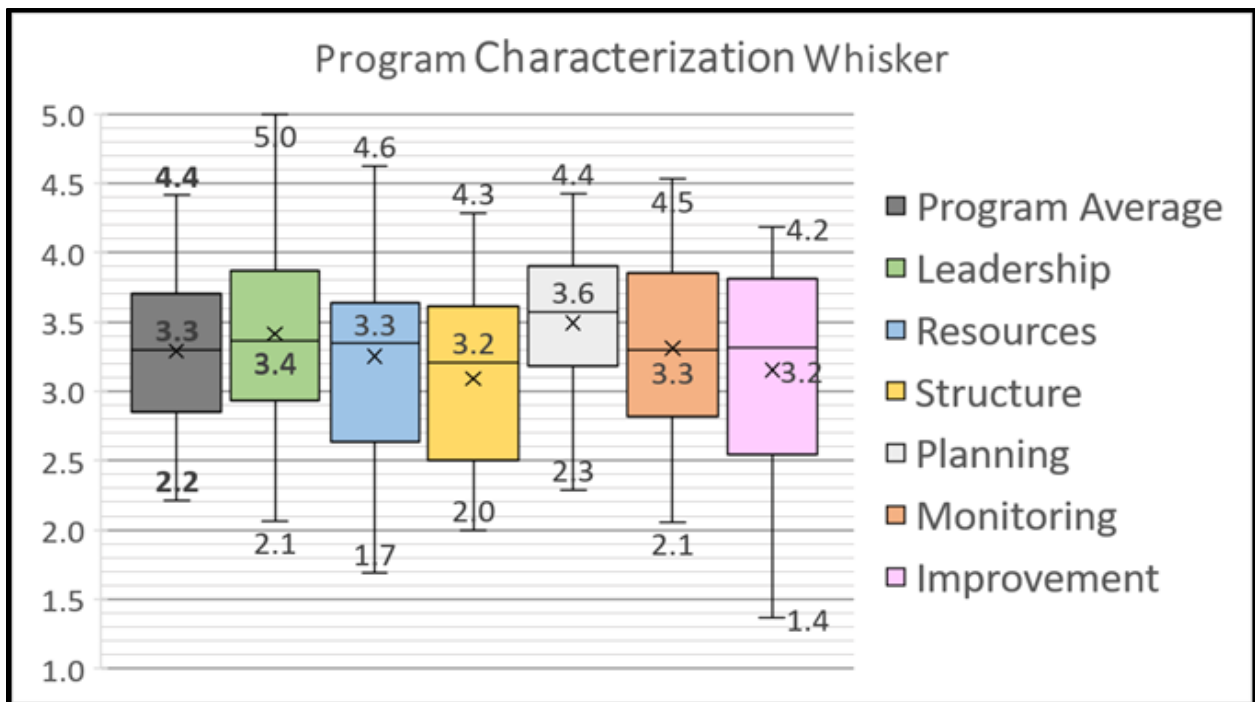
Figure 7. Whisker Chart of Program Characterization Variability

Part 2: Element Internal Reliability:

Elements' internal reliability were each validated using Action scores with Cronbach's Alpha. In this statistical assessment, the Elements had multiple Actions that made up an Element specific score. Each Element was tested to ensure Actions used to measure it were reliable relative to the overall Element responses. The chart of Cronbach's Alpha score to level of internal consistency is displayed in Figure 8. Cronbach's Alpha Internal Consistency Scale.

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In this analysis, Structure and Communications had good internal consistency (Cronbach's Alpha of 0.89) and the other five Elements had excellent internal consistency ($\alpha > 0.90$), as shown in Figure 9. Corporate Productivity

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Figure 8. Cronbach's Alpha Internal Consistency Scale

Program Internal Reliability Assessment Ratings. Internal reliability is critical because high internal consistency suggests measurement of a consistent topic for each Element. Because Elements and Actions are consistent, without significant outliers, the Elements and Actions that make up the program characterization are an applicable and reliable measurement system for construction companies' Corporate Productivity Programs.

Program Area	Cronbach's Alpha	Statement Count	Internal Consistency
All Program Statements	0.978	94	Excellent
Leadership	0.914	15	Excellent
Resources	0.917	16	Excellent
Structure & Communications	0.890	14	Good
Planning for Productivity	0.911	21	Excellent
Productivity Monitoring & Control	0.933	17	Excellent
Continuous Improvement	0.920	11	Excellent

Figure 9. Corporate Productivity Program Internal Reliability Assessment Ratings

4.4.2   ANALYSIS B – PRODUCTIVITY PRACTICE UTILIZATION

Objective 3.   Identify the productivity practices used by organizations

This survey analysis resulted in better understanding of the industry utilization of productivity practices identified through the background review. This also clarified the inconsistency of practice implementation. For example, only Zero Accident Techniques was indicated as a practice used more on the large majority of projects by over 60% of responders.

The utilization of these practices is summarized in Table 1. Productivity Practice Utilization.

Productivity Practices included:

1. Activity Analysis
2. Advanced Work Packaging (AWP)
3. Alignment
4. Benchmarking and Metrics
5. Best Productivity Practice Implementation Index (BPPII)
6. Change Management
7. Constructability
8. Craft Information Systems
9. Crew Balance Chart
10. Disputes Prevention and Resolution
11. Engineering Management Interface
12. Equipment and Tool Logistics
13. Financial Incentives for Productivity - Craft
14. Financial Incentives for Productivity - Supervisors
15. Five-Minute Ratings
16. Flow Diagrams and Process Charts
17. Foremen / Craft Input
18. Front End Planning
19. Human Resource Management
20. Implementation of CII Research
21. Interface Management
22. Lean Construction
23. Lessons Learned
24. Materials Management
25. Partnering
26. Planning for Modularization
27. Planning for Startup
28. Productivity Adjustment Factors
29. Project Controls
30. Project Delivery and Contract Strategy Analysis
31. Project Organization Planning
32. Project Risk Assessment
33. Quality Management
34. Rework Reduction Program
35. Team Building
36. Technology and Innovation Investigation
37. Workforce Development Assessment
38. Zero Accidents Techniques

Practice descriptions are in Appendix B: Survey Guide and Form – Productivity Practices.

Table 1. Productivity Practice Utilization (in order of highest utilization)

#	Practice	75+% of projects use	51 to 75% of projects	26 to 50% of projects	0 to 25% of projects	Practice not utilized	Do Not Know
36	Zero Accidents Techniques	83%	9%	0%	4%	2%	2%
27	Project Controls	57%	19%	21%	2%	0%	0%
29	Project Organization Planning	51%	9%	23%	11%	2%	4%
30	Project Risk Assessment	51%	19%	13%	13%	2%	2%
31	Quality Management	49%	19%	15%	9%	4%	4%
28	Proj Delivery & Contract Strategy	45%	17%	11%	15%	9%	4%
25	Planning for Startup	43%	23%	13%	15%	6%	0%
7	Constructability	38%	21%	21%	19%	0%	0%
17	Human Resource Management	38%	21%	9%	13%	11%	9%
6	Change Management	36%	23%	13%	23%	2%	2%
16	Front End Planning	32%	23%	28%	11%	4%	2%
19	Interface Management	32%	23%	15%	17%	9%	4%
22	Materials Management	32%	23%	15%	13%	9%	9%
3	Alignment	23%	19%	23%	21%	4%	9%
33	Team Building	23%	21%	30%	19%	4%	2%
4	Benchmarking and Metrics	21%	11%	19%	40%	2%	6%
24	Planning for Modularization	21%	26%	19%	23%	9%	2%
26	Productivity Adjustment Factors	21%	21%	15%	19%	13%	11%
10	Disputes Prevention and Resolution	19%	11%	15%	26%	13%	17%
21	Lessons Learned	19%	19%	28%	23%	9%	2%
11	Engineering Management Interface	17%	26%	21%	28%	4%	4%
12	Equipment and Tool Logistics	17%	19%	15%	19%	21%	9%
23	Partnering	17%	17%	34%	28%	0%	4%
2	Advanced Work Packaging (AWP)	15%	6%	11%	47%	11%	11%
32	Rework Reduction Program	15%	6%	28%	23%	21%	6%
35	Workforce Development Assessment	15%	21%	11%	26%	17%	11%
8	Craft Information Systems	13%	20%	15%	28%	20%	4%

#	Practice	75+% of projects use	51 to 75% of projects	26 to 50% of projects	0 to 25% of projects	Practice not utilized	Do Not Know
1	Activity Analysis	11%	9%	9%	36%	23%	13%
14	Flow Diagrams and Process Charts	11%	13%	13%	30%	23%	11%
15	Foremen / Craft Input	11%	9%	15%	32%	21%	13%
34	Technology and Innovation Investigation	11%	13%	30%	30%	13%	4%
20	Lean Construction	9%	13%	21%	32%	13%	13%
38	Supervisor Financial Incentives	9%	2%	13%	28%	36%	13%
9	Crew Balance Chart	6%	9%	11%	28%	28%	19%
18	Implementation of CII Research	6%	6%	26%	34%	11%	17%
37	Craft Financial Incentives	4%	2%	9%	34%	38%	13%
5	Best Prod. Practice Impl. Index	2%	6%	9%	34%	36%	13%
13	Five-Minute Ratings	2%	2%	2%	17%	60%	17%

Full charts of Productivity Practice Utilization by survey response and overall are displayed in

Appendix C: Survey Data – Productivity Practice Utilization Summary and Detail

4.4.3   ANALYSIS C – PROGRAM RELATIONSHIP WITH PRODUCTIVITY PRACTICE UTILIZATION

Objective 2.   Validation of corporate productivity characterization

Objective 4.   Assess the level of involvement of corporate productivity programs in implementation and management of productivity practices

After verifying the program is variable among companies and validating the measurement system, the link to improving productivity was validated. Programs Scores were split into Group 1 (upper 45%) and Group 2 (lower 45%). These groups thus demonstrating "Higher Program Score

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Responses" and "Lower Program Score Responses," with the middle 10% dropped to enable a 5-company gap between high and low Program Scores.

As cited in Section 4.4.2, each practice utilization was estimated for use across project portfolios in ranges of twenty-five percent (e.g. – 0%, 1-25%, 26-50%, 51-75%, 75% or more). Using Kruskal-Wallis non-parametric assessment, Program Score groups were checked against utilization of productivity practices. Twenty-five productivity practices displayed Group 1 (higher scores) having higher utilization of practices at a 0.10 significance or better. This statistical analysis can be seen in Figure 10. Productivity Practices Level of Correlation with Higher Program Score Group when using 94 Actions.

Full detail of Kruskal-Wallis analysis and data demonstrating Program Score Groups and Productivity Practice Utilization are displayed in Appendix D: Data Analysis – Program Score – 94 Actions.

Ct	Productivity Practice	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
	Kruskal-Wallis - Statistics of Group 1 vs. Group 2				
1	Activity Analysis	138	391	-2.198	0.028
2	Advanced Work Packaging (AWP)	185	438	-1.219	0.223
3	Alignment	221	474	-0.507	0.612
4	Benchmarking and Metrics	198	474	-1.084	0.278
5	Best Prod. Practice Implementation Index (BPPII)	135	366	-2.114	0.035
6	Change Management	158	434	-2.258	0.024
7	Constructability	198	474	-1.534	0.125
8	Craft Information Systems	107	338	-3.282	0.001
9	Crew Balance Chart	65	318	-3.608	0.000
10	Disputes Prevention and Resolution	36	207	-4.333	0.000
11	Engineering Management Interface	138	414	-2.531	0.011
12	Equipment and Tool Logistics	97	350	-3.344	0.001
13	Financial Incentives for Productivity - Craft	167	420	-1.240	0.215
14	Financial Incentives for Productivity - Supervisors	141	394	-2.153	0.031
15	Five-Minute Ratings	155	431	-1.518	0.129
16	Flow Diagrams and Process Charts	123	333	-2.540	0.011
17	Foremen / Craft Input	146	377	-1.963	0.050
18	Front End Planning	179	432	-1.740	0.082
19	Human Resource Management	136	389	-2.388	0.017
20	Implementation of CII Research	110	341	-2.387	0.017
21	Interface Management	214	490	-0.679	0.497
22	Lean Construction	109	299	-2.547	0.011
23	Lessons Learned	203	479	-1.397	0.162
24	Materials Management	106	359	-3.127	0.002
25	Partnering	188	464	-1.548	0.122
26	Planning for Modularization	197	473	-1.306	0.192
27	Planning for Startup	211	487	-1.222	0.222
28	Productivity Adjustment Factors	90	300	-3.345	0.001
29	Project Controls	163	439	-2.513	0.012
30	Project Delivery and Contract Strategy Analysis	151	404	-2.461	0.014
31	Project Organization Planning	158	411	-2.373	0.018
32	Project Risk Assessment	137	413	-3.018	0.003
33	Quality Management	207	483	-0.873	0.383
34	Rework Reduction Program	100	353	-3.447	0.001
35	Team Building	179	455	-1.745	0.081
36	Technology and Innovation Investigation	137	390	-2.745	0.006
37	Workforce Development Assessment	99	352	-3.129	0.002
38	Zero Accidents Techniques	262	538	-0.083	0.934

Groups

1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Colors

	<= 0.05
	<= 0.10
	<= 0.25

Figure 10. Productivity Practices Level of Correlation with Higher Program Score Group when using 94 Actions

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4.4.3   ANALYSIS D – STATEMENT REDUCTION FOR PROGRAM CHARACTERIZATION

Analysis D addresses the methodology used to reduce the number of Action evaluations needed to produce characterization outputs. The analysis is performed in two parts. Part 1 explains the methodology used to reduce from 94 to 54 total Actions. Part 2 displays the validation, which is a replica of Analysis A and C using the 54 Action data.

Purpose:

The statement reduction analysis is performed to make program characterization shorter for companies to perform. This is intended to make it easier for companies to perform self-assessment while retaining the value of characterization. It is also an opportunity to remove Actions that have less impact or criticality for the Corporate Productivity Program.

However, the reduced Action count that produces new Program Scores must maintain both internal reliability and correlation with productivity practice utilization. These are the underlying validation of the program, and they need to be analyzed for changes to the framework and characterization system.

Part 1: Statement Reduction

Eleven of Research Team 340's industry experts ranked each Action by "Level of Importance" regarding productivity management. These levels were set as values demonstrated in Table 2. Importance to Value Conversion, and the average of the 11 values were used as the Action score for statement reduction power.

Table 2. Importance to Value Conversion

Importance	Not Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Value Used	0.0	2.5	5.0	7.5	10.0

The level of importance of each Action was used to reduce statement counts in each Element. First, Actions with an average of 7.5 and above were kept. Then, Action statements were added back to ensure a minimum of eight characterizing Actions in each Element. These were added in order of highest Action score value. The results are displayed in Figure 11. Statement Reduction Summary. The detailed calculations and Actions can be found in Appendix D: Data Analysis – 54 Actions.

Element	Baseline Statements		Reduced Statements	
	Statement Count	Statement Average Importance	Statement Count	Statement Average Importance
Leadership	15	8.0	12	8.3
Resources	16	7.2	8	7.7
Structure & Communications	14	6.5	8	7.3
Planning for Productivity	21	7.3	9	7.8
Productivity Monitoring & Control	17	7.1	9	7.9
Continuous Improvement	11	7.0	8	7.3
Total	94	7.1	54	7.6

Figure 11. Statement Reduction Summary

Part 2: Validation of Program with Reduced Action Count

This reduced set of 54 Action statements were routed back through the data analysis to ensure internal reliability and relationship with productivity practices were retained. All Action and productivity practice utilization data used in this analysis is a subset of the data used for Analysis A and B. Using the same methodologies outlined in the 94-Action statement analysis, the reduced Action statement set of 54 continued to display internal consistency at "Good" or higher levels as seen in Figure 12. Reduced Statement Internal Reliability Assessment Ratings

Program Area	Cronbach's Alpha	Statement Count	Internal Consistency
All Program Statements	0.968	54	Excellent
Leadership	0.902	12	Excellent
Resources	0.850	8	Good
Structure & Communications	0.840	8	Good
Planning for Productivity	0.841	9	Good
Productivity Monitoring & Control	0.881	9	Good
Continuous Improvement	0.892	8	Good

Figure 12. Reduced Statement Internal Reliability Assessment Ratings

Additionally, Productivity practices displayed higher correlation with Program Scores produced by the 54-Action based characterization. The count of practices that demonstrate positive relationship increased to 30, as shown below. This correlation along with demonstrated internal reliability validates the characterization methodology using fewer Actions. This statistical analysis can be seen in detail in Figure 13. Productivity Practices Level of Correlation with Higher Program Score Group when using 54 Actions.

	Kruskal-Wallis - Statistics of Group 1 vs. Group 2						Groups	
Ct.	Productivity Practice	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)		1.0	2.0
1	Activity Analysis	130	383	-2.217	0.027		Higher 45% Program Scores	Lower 45% Program Scores
2	Advanced Work Packaging (AWP)	184	437	-0.995	0.320			
3	Alignment	230	506	-0.289	0.772			
4	Benchmarking and Metrics	171	447	-1.760	0.078			
5	Best Prod. Practice Implementation Index (BPPII)	143	419	-2.063	0.039			
6	Change Management	157	433	-2.283	0.022			
7	Constructability	180	456	-1.942	0.052			
8	Craft Information Systems	114	367	-3.097	0.002			
9	Crew Balance Chart	75	306	-2.962	0.003		Colors	
10	Disputes Prevention and Resolution	63	273	-3.657	0.000			<=0.05
11	Engineering Management Interface	138	414	-2.313	0.021			<=0.10
12	Equipment and Tool Logistics	105	381	-3.113	0.002			<=0.25
13	Financial Incentives for Productivity - Craft	166	397	-0.741	0.459			>0.25
14	Financial Incentives for Productivity - Supervisors	138	369	-1.787	0.074			
15	Five-Minute Ratings	144	397	-1.225	0.220			
16	Flow Diagrams and Process Charts	121	331	-2.411	0.016			
17	Foremen / Craft Input	136	346	-1.824	0.068			
18	Front End Planning	183	459	-1.647	0.100			
19	Human Resource Management	149	425	-2.048	0.041			
20	Implementation of CII Research	91	322	-2.770	0.006			
21	Interface Management	200	476	-1.020	0.308			
22	Lean Construction	130	320	-1.958	0.050			
23	Lessons Learned	183	459	-1.850	0.064			
24	Materials Management	118	394	-2.806	0.005			
25	Partnering	190	466	-1.501	0.133			
26	Planning for Modularization	167	443	-2.008	0.045			
27	Planning for Startup	187	463	-1.785	0.074			
28	Productivity Adjustment Factors	76	286	-3.721	0.000			
29	Project Controls	145	421	-2.908	0.004			
30	Project Delivery and Contract Strategy Analysis	130	406	-3.119	0.002			
31	Project Organization Planning	142	395	-2.782	0.005			
32	Project Risk Assessment	112	388	-3.579	0.000			
33	Quality Management	190	466	-1.301	0.193			
34	Rework Reduction Program	105	358	-3.305	0.001			
35	Team Building	147	423	-2.481	0.013			
36	Technology and Innovation Investigation	147	400	-2.517	0.012			
37	Workforce Development Assessment	100	353	-2.945	0.003			
38	Zero Accidents Techniques	243	519	-0.378	0.705			

Figure 13. Productivity Practices Level of Correlation with Higher Program Score Group when using 54 Actions

Full data and analysis is detailed in Appendix D – Data Analysis – Program Score – 54 Actions.

4.6   Conclusion

Through Corporate Productivity Program characterization and validation, Research

Objectives 1, 2, and 3 were accomplished and verified.

Objective 1.   Identification and characterization of corporate productivity programs
Objective 2.   Measurement and validation of corporate productivity characterization
Objective 3.   Identify the productivity practices used by organizations

Overall, Corporate Productivity Programs were identified and characterized in a
measurable fashion that demonstrated internal reliability. This measurement was enabled through
Program Scores derived from the characterization Actions identified as necessary for program
success. This concept was verified within existing industry organizations by demonstrating that
program frameworks exist in varying stages of maturity based on Program Scores from self-
assessment.

Productivity practice utilization data was gathered from organizations to understand
industry norms and priorities. Then, the Program Scores from characterization demonstrated a
positive correlation relationship with utilization of proven productivity practices. Per the research
approach, this validates the purpose of Corporate Productivity Programs, improving portfolio-wide
management of productivity practices and systems. The positive correlation also verifies
programs' capacity to impact construction productivity through improving corporate-level
systems, which generally relate with increased use of proven productivity practices.

Finally, the characterization process was shortened for ease of use. This enables companies
to focus on the program Actions that were surveyed to be the 54 Actions with the highest level of
importance for Corporate Productivity Program success. This shorter characterization retained
maturity variability and internal reliability of Elements, and the correlation between Program Score
and utilization of productivity practices was demonstrated to be even stronger than the 94-Action
characterization.

CHAPTER 5:   BARRIERS AND PROGRAM PRACTICES

The next step for research is identification of Barriers that prevent successful

implementation of Corporate Productivity Programs. In parallel, Program Practices to mitigate

these Barriers and improve programs' Action performance are sought. Additionally, research

intends to develop understanding of how programs are setup, administered, monitored, and

integrated within the broader organization. These are sought through interviews with

organizations that participated in the survey data collection.

Objective 4.   Identify Barriers to implementation and success of productivity programs
Objective 5.   Identify Program Practices to mitigate barriers and improve program success

5.1   Purpose and Objectives

Identification of Barriers can assist companies in understanding what issues may create

enterprise-level clashes and challenges for the productivity program. Due to the broad span of

productivity impacts and program characterization, Barriers are expected to exist across

organization groups and departments as well as vertically in company hierarchies. However, this

research endeavors to identify key and common themes.

In line with improving program implementation, Program Practices will also be identified.

Program Practices are captured as program means and methods to mitigate Barriers and improve

program performance. These are also expected to span organizations horizontally and vertically,

and the implementation strategies to succeed on that scale will be captured.

Through this process, the research targets improvement of Corporate Productivity Program

implementation. With Barriers recognized, companies should have capacity to identify which are

significant for their program. Then, program management and corporate means and methods to generate success are sought.

5.2   Data Collection Methodology

Due to the company-specific nature of organization structure, productivity focuses, and project portfolios, interviews are planned to enable a dialogue that includes those details. Interviews will also attempt to understand if program strengths and weaknesses based on characterization from survey data. Thus, each interview has similar questions about organizations and goals, and then a tailored series of discussion points around Elements and Actions that stood out in their characterization survey.

These areas are to be described and explained by interviewees to verify strengths and weaknesses and if the characterization system yields reasonable, accurate reflections of company norms. Following the characterization discussion, interviewees will be asked to describe what makes program strengths in specific systems work and what issues arise preventing success in weak areas. Barriers will represent and summarize the significant or commonly cited issues that are preventing companies' from being successful in weak areas of program characterization.

5.3   Data Gathered

The data gathered is a variety of understandings around in-place systems, means, and methods addressed as concepts in the Corporate Productivity Program characterization. Interviews are directed at capturing Barriers preventing programs from successful implementation and Program Practices to mitigate Barriers and improve Action performance. Thus, interviews are

established to understand key Barriers and Program Practices that appear in current industry organizations. These lists were also provided with review and feedback from RT 340 members.

The interviews were also used to understand survey responses about specific Elements and Actions within the programs. These were tailored to each interviewee's survey response, and overall provided better understanding of the survey response background. The interviews are summarized in Appendix F – Interview Summaries.

5.3.1   CHARACTERISTICS OF INDIVIDUALS INTERVIEWED

A total of 18 interviews were conducted. Each interview was approximately one-hour in length with individuals who completed the RT 340 Phase I Survey addressed in Chapter 4. Thus, characteristics of response sources reflect to those described in Section 4.3.1 - Characteristics of Companies Surveyed, typically CII members from industrial construction sectors. The typical company representation was from CII Sectors of Power, Utilities and Infrastructure, Downstream and Chemicals, Upstream, Midstream & Mining, and Manufacturing. Participants were typically in corporate positions managing or coordinating support for multiple projects, and their experience was between 10 and 30-years in projects and operations.

5.4   Conclusion and Findings

The interview findings are primarily summarized as the lists of Barriers preventing programs from successful implementation and Program Practices to mitigate Barriers and improve Action performance, Appendices G and H.

Additional data needs to be collected to verify or validate the Barrier impacts and significance to program performance. Similarly, Productivity Practices need to be evaluated for implementation maturity and effectiveness to support "best program practices" sought in the

research. These Program Practices will support future research and industry application by developing an understanding of how mitigations are initiated and executed between organizations, projects, and company interfaces.

In conclusion, it is unclear if true best Program Practices can be identified prior to industry adoption of enterprise-level productivity programs. True data on portfolio performance could then be compared before and after practice adoption, as well as differences between companies at different program maturity levels over time. Again, these are expected to be long-term results, and similar to construction safety, extended periods are needed for data collection, and multiple years of impact data may be required to evaluate changes in organizational and industry performance.

These lists serve as current industry-identified challenges to getting programs in-place. These lists can serve current programs by assisting company leadership with targeting focus on specific weak or strong characterization areas, Barriers to company-specific program, and Program Practices to assess against company needs.

These Program Barrier and Program Practice lists were generated by logging interview discussions around challenges and mitigations. These were reviewed as interviews were ongoing to identify items mentioned multiple times along with unique perspectives. Following the interview process, the list was reviewed to narrow the focus toward enterprise-level issues or items influenced heavily by corporate interaction. This was then reviewed by RT-340 team members to clarify the statements captured as Barriers and Program Practices. The team also identified additional overlapping concepts and reduced the count of both lists.

5.4.2 BARRIERS TO CORPORATE PRODUCTIVITY PROGRAMS

Sixty (60) Program Barriers were finalized based on interviews and feedback on initial lists by the RT 340 members. These Barriers span across the Corporate Productivity Program

Elements and the Barriers also address issues regarding horizontal and vertical interfaces within organizational structures, productivity management gaps, and personnel and industry challenges. However, more data is needed to assess conclusions about significance or root causes.

See Appendix G for the list of 60 Barriers as they group by Program Element and Titles

Program Barriers:

1. Energy to move productivity practices forward from project to project fades over time, losing support and emphasis.

2. Changing individual and departmental practices takes more time than the organization allows for improvement.

3. Lessons Learned are ignored or under-utilized.

4. Continuous improvement takes the company long periods with lacking celebration of interim accomplishments.

5. Organizational silos prevent productivity practice improvements because knowledge is not transferred.

6. Company fails to capture and resolve root causes of low productivity.

7. Corporate management struggles with staying aware of project status, challenges, and needs.

8. Corporate goals for productivity improvement become stale or overbearing as each year is, "Improve on last year."

9. Leadership changes directions too often on productivity related resources and objectives.

10. Goals developed at the department level without overarching corporate objectives as guidance.

11. Corporate managers unfamiliar with how to execute project scope fail to appropriately assist execution.

12. Productivity is not a focus of corporate leadership.

13. Corporate productivity framework makes projects feel micromanaged and hassled.

14. Company does not innovate construction practices without push from outside entities (owner, contractor, government).

15. Business units have different drivers and measures of success that create misalignment within the company.

16. Project schedules lead to being behind and rushing project phases, over staffing, and other adjustments that hinder productivity.

17. Change management is handled inconsistently within the company and creates confusion and rework.

18. Personnel on many company projects are inefficient because of extended work periods.

19. Company takes on contracts without incorporating terms that support productive execution.

20. Lack of consistent corporate work practices make transitions between groups and projects more difficult.

21. Contracting in varying locations creates challenges of contractor availability, experience, local work requirements, and familiarity.

22. Corporation is inefficient with integrating construction, engineering and installation work packages.

23. Company tends to have optimistic plans that fail to prepare and plan for improving productivity.

24. Company project teams are not convinced the benefits of implementing practices are worth the cost and effort.

25. Specific productivity practices are implemented inconsistently by each project team.

26. Construction scope boundaries are often mismanaged on company projects.

27. Low productivity worksites challenges and mitigations are not captured or transferred between projects.

28. Unable to consistently recreate high productivity performance on worksites.

29. On many projects, company contracts lead to confusion or unclear deliverables.

30. At the corporate level, craft are blamed for poor productivity without addressing other gaps to improve future projects.

31. Craft feedback is not used to capture productivity improvement opportunities on most company sites.

32. Different companies, execution types, and groups measure productivity in different ways - creating varying metrics.

33. In most worksites, craft lose too much time for travel, breaks, getting tools and materials, or other non-productive work.

34. Historical productivity impact of practices and methods often lack direct results that could engage more users.

35. Monitoring and reporting cycles run extended periods that create slow monitoring cycles.

36. Most company construction teams are unsure what caused high or low performance on specific jobs.

37. Improved productivity is not visible to most personnel on construction sites.

38. Rapid productivity improvement is difficult because monitoring, analyzing, solving, and implementing solutions is all parallel with continuing execution.

39. Monitoring cycles to improve productivity require lots of manpower and attention.

40. Company does not actively share productivity information with others.

41. Various craft disciplines make improvements difficult to manage due to split focus.

42. In most projects, poor cost estimates and funding result in management and contract behaviors that harm productivity.

43. Stockholders and funding sources create distraction and goals that are inconsistent with productivity performance.

44. High costs of construction technology and training prevent adoption of new technology by the organization.

45. Staffing projects appropriately is difficult due to limited experienced construction personnel.

46. Remote work frequently causes company personnel to lose sight of execution and productivity risks.

47. Project scales make productivity impacts too complex to consistently hold individuals accountable.

48. Performance in organizations is not well tied to recognition, especially at productivity scope levels.

49. Project personnel are overwhelmed with daily work, limiting identification and management of productivity impacts.

50. Qualified craft labor is not readily available for many company work sites.

51. Qualified foremen/ supervisors / project managers are not readily available on many company work sites.

52. Programs and systems cannot be accessed by people who need the information.

53. Inefficiency and waste due to poor interfacing of project management technology and systems.

54. Company has not updated organization and communications to match growth or market changes.

55. Consensus, approvals, and organizational hierarchy cause frustration and wasted efforts.

56. Corporate support functions have low influence on project utilization of productivity practices.

57. Projects frequently struggle to form relationships with craft labor interfaces.

58. Government regulations changing create issues for corporate planning. (e.g. - frequently delaying projects, compressing construction schedules)

59. Lack of trust with industry partners results in extra indirect personnel, increased reviews, and resistance to company productivity practices.

60. On many company projects, inexperienced project firms inhibit productivity performance.

5.4.3 Program Practices for Corporate Productivity Programs

Forty-five (45) Program Practices made-up the final list after interviews and research team feedback. Like Barriers, Program Practices reach each Element of the program, and they highlight methods to improve communication, interfaces, and implementation of programs. These practices also face the data limitations cited for Barriers.

See Appendix H for the list of 45 Program Practices grouped by Element and Title

1. Company utilizes continuous improvement methods for achieving company-wide capital efficiency objectives that motivate teams to achieve productivity improvements. (e.g.: Lean, Six Sigma, PDCA, etc.)

2. Company utilize continuous improvement methods on repeatable scopes across project portfolio to improve productivity.

3. Throughout the project execution lifecycles, the company capture, analyze, and share lessons learned related to productivity.

4. Company pilot productivity practices and strategies allows testing and correction that minimize potential negative impacts of learning curves.

5. Company provides performance history of practices to support utilization of productivity practices.

6. Corporate provides structure that enables use of new practices without negative impacts on perception of project or personal performance.

7. Utilize external benchmarking from 3rd party company to identify gaps in current process and generate opportunities for improvement through an objective lens.

8. Third party project reviews identify project issues, gaps, and learnings to improve project outcomes and future projects.

9. Document and enforce scope authority and cost decisions to control change.

10. Corporate management engaged with projects' status, risks, and needs that may require higher-level leadership.

11. Corporate leadership sets specific productivity improvement objectives and cascades responsibility to include functions and projects.

12. Corporation develop reports that highlight performance and organizational goals to engage team and pursue objectives.

13. Company documents and enforces change management processes.

14. Company seeks alliances or partnerships that can benefit the company by facilitating the implementation of productivity improvement initiatives.

15. Performance data on specific construction scopes is collected by the company to benchmark productivity basis for future projects.

16. Most projects utilize construction knowledge since the early phases of project life cycles to improve productivity as well as to increase the alignment between all project phases.

17. Projects utilize advanced work packaging to streamline their delivery

18. Contracting departments are able to establish consistent contracts while tailoring for project specifics to enable productive execution.

19. Corporate personnel provide guidance documentation to provide the background and purpose of practices, support implementation, and provide templates

20. Analyze project scope to consider the use of pre-assembly, modularization, and off-site fabrication that can improve productivity

21. Projects should be engaged with implementation and management of productivity practices on all phases of the project life cycle.

22. Company assesses productivity impacts in terms of direct cost and schedule results.

23. Corporate system to transfer successful efforts and productivity practices on a regular meeting / reporting cycle.

24. Corporate involvement with project alignment meetings to improve focus corporate, project, and organizational goals.

25. Senior management is consistently made aware of productivity performance against corporate goals on all projects.

26. Establish standard rules of credit for scopes of work to enable the company to be consistent with productivity measurement and continuous improvement data.

27. Conduct craft surveys to understand productivity impacts and opportunities.

28. Activity Analysis establishes consistent method for checking craft time utilization. Senior management should set targets to help projects recognize value of lost time and pursue improvement options.

29. Photographs and imagery supporting productivity practice accomplishments enables communication and utilization.

30. Corporate personnel supporting project execution need to establish alignment goals with project leadership to aid in implementation of productivity practices.

31. Corporate positions need personnel capable of managing and influencing varying risk exposures with limited experienced resources or direct authority.

32. Personnel with expertise and experience should be involved with multiple projects of similar scope to help implement and check productivity practice management.

33. Organizations able to resolve problems and improve productivity are able to generate benefits greater than the costs.

34. Consider varying learning styles when developing and delivering training, particularly where age and culture influences learning. (Instructor led, web-based, reading, etc.)

35. Develop training tailored to the intended audience, especially when varying departments and management levels are involved.

36. Train project personnel on how to implement productivity practices, including the purpose, potential impacts, implementation approaches, and contacts for future assistance

37. Corporate development and deployment of project innovations can reduce resource needs.

38. Assisting personnel with peer network relationships enables productivity knowledge sharing.

39. Provide a forum for personnel to share experiences, learn new practices, and demonstrate value of the Productivity Framework.

40. Define a group to identify best practices, manage improvements, and perform project health checks that can improve company-wide performance.

41. Enable productivity learnings to be shared across departments and management structures. (e.g. - productivity forums, knowledge sharing databases, key point of contact)

42. Promote consistent relationships between company and craft organizations (union or open shop) to allow for better interface and communication.

43. Company distribution of "highlights" from historical knowledge database can help with data utilization and capture of future productivity learnings.

44. Establish organizations of knowledge to manage specific work scope (sector, job type, project size, etc.) to streamline work and retain specialization.

45. Document expectations within organization to establish expectations and engage all involved groups.

CHAPTER 6:   CONCLUSION AND RECOMMENDATIONS

Overall, the five research objectives were accomplished. These objectives layout the major first steps in development of Corporate Productivity Programs, though program identification, measurement methodology, and common issues and practices. Additionally, the research demonstrates that the program has a positive relationship with utilization of productivity practices that are proven to improve productivity performance and collected data that represents a baseline for maturity of participants and the CII industrial sector.

6.1   Research Summary

Through the investigation and analysis, each of the five research objectives were accomplished. These consist of a foundation for identifying, characterizing, and improving an enterprise-level productivity program.

Objective 1.   Identification and characterization of corporate productivity programs

Through the background review and research team input, a framework for the Corporate Productivity Program was developed based on key program and productivity Elements:

1. Leadership
2. Resources
3. Structure and Communications
4. Planning for Productivity
5. Productivity Monitoring and Control
6. Continuous Improvement

These Elements outline the systems needed for an enterprise-level program to succeed. There are also productivity-specific areas to capture the unique facets of managing productivity both on projects and across a project portfolio.

Objective 2.   Measurement and validation of corporate productivity characterization

In refining characterization to a measurable concept, 94 Actions were identified as key to program success. These Actions provide measurable components of the Element framework. This measurement system was validated in two parts – verification and validation.

For verification, Analysis A was performed. This verified that programs measured through the Actions were variable and found differing program strengths and weaknesses. The analysis also confirmed that the measurement system was internally reliable. This means that each Element is made up of Actions that demonstrate internal consistency to the Element.

Validation of the measurement system was found in Analysis C. This validated that higher program scores were associated with higher utilization of proven productivity practices. This correlation demonstrates the program's ability to impact productivity. The difference demonstrated between lower scoring and higher scoring programs also displays the measurement system differentiates programs in a meaningful way.

Objective 3.   Identify the productivity practices used by organizations

Analysis B is detailed in Appendix C – Productivity Practice Utilization Summary. This identified productivity practice utilization by organizations, and it displayed the surveyed companies tendencies and norms relative to productivity practice implementation.

Objective 4. Identify Barriers to implementation and success of corporate productivity programs

As detailed in Chapter 4, interviews were leveraged to identify the significant Program Barriers to program implementation and success. There were refined and consolidated into a list of 60 Program Barriers through assessment by RT-340. Most Barriers represent common themes among most companies interviewed, but some Barriers that were uncommon were retained as significant challenges through RT-340 review and discussion.

Objective 5. Identify Program Practices to mitigate barriers and improve program success

Program Practices were identified and reviewed alongside Program Barriers. These focus on mitigation of issues that cause programs to struggle, including Barrier resolutions and methods to improve Action scores. The result consisted of 45 Program Practices that primarily focus on corporate-level solutions. However, Program Practices typically also require participation from projects and project teams to successfully be implemented.

Overall, the research flows along the outline of formulating a program concept and refining the concept into a measurable model. The model is tested and assessed as compatible with the construction industry through survey and analysis. The program model is then expected to have the capacity to influence productivity performance through better Program Scores correlating to increased utilization of proven productivity practices. Overall, this justifies the program concept and gives purpose to improving company Program Scores.

Finally, the research concludes with interviews to check these findings. The interviews also identify Barriers that challenge program adoption and success, and interviewee responses were reviewed to identify possible mitigations that are captured as Program Practices.

6.2   Research Limitations

Due to lack of comparison data for productivity at corporate and industry levels, the Corporate Productivity Program data is not directly comparable to productivity performance. The correlation with increased productivity practice utilization is used to show likely improvement in performance at activity and project levels, but this has not been shown to extrapolate to larger scales of portfolio and industry productivity improvement desired in long-term goals.

The assessment of Corporate Productivity Program characterizations was performed in order to validate the program concept and applicability. However, the real returns or value of program assessment in other sectors comes through continuous improvement across organizations. For the Corporate Productivity Program, the research has effectively gathered baseline assessment data for various companies and the CII industrial sector.

However, the long-term purpose of research is to improve project predictability and outcomes through more consistent management of project productivity efforts. This has been demonstrated to work within corporate-leadership driven safety (CII, 2017) (CII, 2003). This research is in support of the long-term hypothesis that implementing and improving enterprise-level productivity program management will yield better productivity practice use, and better project and business outcomes can result. However, the efforts to accomplish portfolio improvement through corporate programs in other areas has been demonstrated to need leadership engagement and long-term, formal approach to systematically improve.

6.3   Recommendations

Companies seeking enterprise-level improvement of construction productivity management can benefit by following the research approach conducted by RT 340. First,

identification of what productivity is to the company. That is, how does the company benefit and track productivity performance. That benefit needs to be identified and quantified in terms used by the company. This is a critical step toward engaging leadership at the corporate-level, who are often focused on performance influencing safety, project predictability, cost, schedule, or quality.

After identifying the role of productivity in improving performance metrics that garner executive leadership attention and support, the company needs to direct that leadership engagement. Thus, the company-specific Corporate Productivity Program should be conceptualized and outlined using organizational hierarchies and responsibilities. Industry members of RT 340 indicated the program framework was more complex and distributed than anticipated when reviewed, and the ability to direct support will require understanding of the company's program entities and interested parties.

Finally, the focus needs to take support and create an improvement plan. Thus, the conceptual program needs to be understood and measured in a fashion that enables assessment of strengths and weaknesses. Strengths should be identified and replicated across the organization, where possible, and weaknesses may merit mitigation or detailed evaluation. Essentially, performing the Corporate Productivity Program characterization is recommended to drive leadership engagement toward an improvement plan.

6.4 Conjecture on the Benefits of Corporate Productivity Program

Project teams shift and move between companies, projects, and responsibilities. The numerous interfaces and management aspects that teams are expected to address can be lost in the reality of competitive construction industry (Tucker, 1986). This research suggests a formal,

corporate-level system; Corporate Productivity Programs as a systematic approach to structure project considerations and promote productivity practices.

The program can help manage internal and external productivity interfaces above the project level and scope. This is powerful from the enterprise-level because it exists before and after specific projects, enabling long-term relationships and mutual benefit beyond specific project execution. Corporate interfaces and responsibilities are managed across the six Elements and within detail oriented Actions. In general, improved communication and understanding of group and individual impacts on construction productivity are a critical aspect of program interface management. However, these interfaces and the importance of them is company-specific.

Enterprise-levels typically focus on providing guidance, develop systems to improve project team resources through training, technology, and assistance with implementation of documented practices. Additionally, the program should improve project teams' routine paperwork and tasks through improvement of processes and technology. This is a lot of work, and without a formal program, much of that work falls to project teams that could be focused on delivering better project outcomes, if the program existed to manage and support these efforts.

For a given project, the degree of influence a program can have varies by project exposure and integration with the program (refer to Figure 6. Construction Productivity Program Diagram). However, the overall objective is to improve management of productivity and project outcomes across project portfolios. This is currently demonstrated through increased utilization and implementation quality of proven productivity practices (refer to Figure 5. Corporate Productivity Program Purpose).

6.5   Future Research

Overall, this research about corporate productivity program characterization is the definition and measurement methodology that companies may use to address their need for a formal system around construction productivity. Through characterization, companies have the tools assess their Corporate Productivity Program and identify company-specific issues and Barriers. Through implementation of Program Practices, guidance will enable corporate driven improvement of enterprise-level productivity programs.

Performing these mitigations and program improvements may create sources of data for Corporate Productivity Program impact, which could be assessed over years of implementation, improvement, and development of company metrics. Future research would benefit from implementation of Program Practices and companies understanding what Action focuses yield improvements across company portfolios in construction. Additionally, implementation would assist with identification of the most significant Barriers hindering the implementation of productivity programs and Program Practices.

Ultimately, that impact data and outcomes would drive decision-making around implementation and support for Corporate Productivity Programs. Without results, the informal systems, interfaces, and management of enterprise-level productivity programs would reflect the inconsistent utilization of more detailed productivity practices. However, if productivity program results in long-term performance improvement across portfolio-levels, as seen through decades of safety programs, the value to the construction industry is immense.

This research suggests assessment and improvement of the programs can lead to improved project portfolio management and implementation of productivity practices on construction jobs.

These systemic productivity improvements have the potential to reduce project costs and enhance

predictability for portfolio management in the multi-trillion-dollar construction industry.

APPENDICES

Appendix A: Team Roster

Construction Industry Institute – Research Team 340
Corporate Best Practices for Successful Productivity Improvement Programs

Current Members
Dale Adcox, Fluor / Bentley Systems
Daniel Beyer, CDI Corporation
David Butry, National Institute of Standards and Technology
Carlos Caldas, the University of Texas at Austin
Chet Carpenter, INVISTA
Ross Carroll, Zachry Group
Rama K. Challa, Matrix Services Company
Britt Freund, the University of Texas at Austin
Cameron P. Gaddy, the University of Texas at Austin
Dennis Hoguet, Benham Constructors, a Haskell Company
Angela Johnson, DTE Energy
Doug Omichinski, Bechtel Global Corporation
Mark Patterson, Andeavor
Ted Preston, Procter & Gamble Company
Brandon Shell, ExxonMobil
Juan GomezTagle, AZCO Inc.
Ilya Tlumach, Day & Zimmerman
Bobby Walters, Autodesk
Kelly Watson, Occidental Oil and Gas

Past Members
Mike Alexander, ExxonMobil
David Bucy, Zurich
Steven Hayhurst, Enstoa

Appendix B: **Survey Guide and Form**

Research Survey
CII Research Team 340 – Corporate Best Practices for Productivity Improvement Programs

Thank you for taking the time to provide information about your company.

This survey is issued by the Construction Industry Institute (CII) to support Research Team 340's investigation of "Corporate Best Practices for Productivity Improvement Programs." Our research goal is to improve construction productivity by providing industry with practices to mitigate corporate level barriers that currently hinder successful implementation and management of productivity practices.
This survey is directed toward understanding industry status, common practices, and assessment of corporate management systems currently in place. Interview follow-ups with some survey respondents are planned to identify the specific corporate level barriers and mitigation practices.

This survey has a different focus than other CII surveys that have been sent to member companies in the past. We are addressing corporate practices and organizational structures related to productivity improvement, and not on detailed task level practices. It is critical to maintain this perspective and, subsequently, it may affect who in your organization is best placed to complete the survey. Our objective is to understand at the macro level, not the work package or individual project level, how productivity programs are structured and administered across the industry.

Your response is completely confidential. All information gathered as part of this project will be treated in strictest confidence and kept under conditions of security at The University of Texas at Austin. We will provide participating organizations with a summary of general trends and statistical relationships from this research. Specific individuals, jobs, and organizations will not be named in this summary. The results of this project will be used to improve the competitiveness of the construction industry.

Survey completion is estimated at 45 minutes.
Please complete the survey by March 10, 2017.

Survey Outline	Estimated Completion (45 minutes)
Company and Survey Taker Information	5 minutes
Corporate Productivity Program Element Assessment	25 minutes
Productivity Practice Utilization	15 minutes

Thank you for your participation,
Members of CII Research Team 340

Research Overview:

There have been numerous prior studies, both internal and external to CII, that have focused on productivity improvement at the craft level. By and large, the industry has a good handle on what activities should be implemented. However, measurable benefits at the corporate and industry level are difficult to discern. Something is blocking progress; let's call them corporate barriers. The research objective is to identify those barriers and suggest best practices (at the corporate level) to overcome them. Ultimately, we intend to unleash the potential of productivity improvement practices in a manner analogous to the safety improvement seen over the past 20-years.

This research will characterize existing corporate productivity programs and determine the productivity practices being used on projects. Then barriers to successful productivity programs will be identified, and best practices for developing corporate productivity programs will be defined and documented.
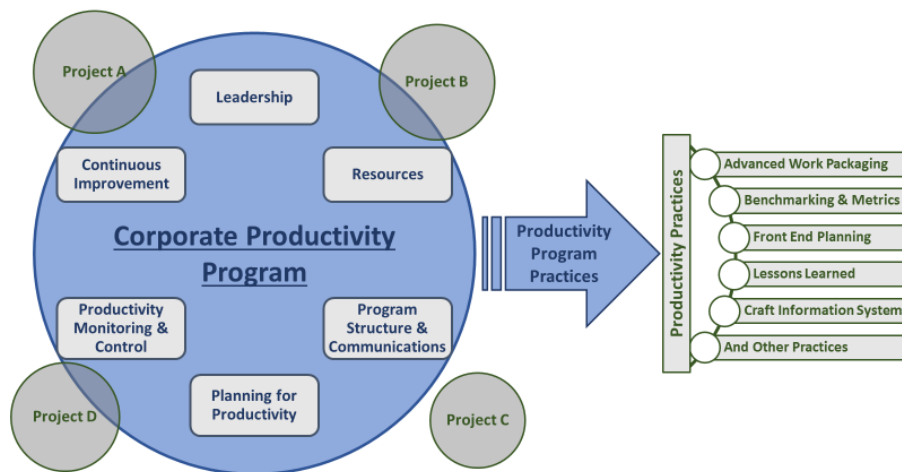
Definitions:
As you complete the survey, it is essential that you answer the questions based on a common understanding of key terms, which are defined below.

Corporate Productivity Program: Corporate level ownership of construction productivity goals and objectives for the company; responsible for company productivity interfaces, practices, recommendations, and improvement.

Corporate Productivity Program Element: Managed components that make up a corporate productivity program, which can be assessed and measured. These include Leadership, Resources, Program Structure and Communications, Planning for Productivity, Productivity Monitoring and Control, Continuous Improvement.

Corporate Productivity Program Practices: Enterprise level practices for successful implementation of construction productivity practices across the project portfolio by improving corporate productivity program elements

Productivity Practices: Practices impact construction productivity. The implementation of these practices contributes to productivity improvements. A few examples are Advanced Work Packaging, Constructability, and Craft Information Systems.

<u>Company and Survey Taker Information:</u>

    a. Company: _____

    b. Department (if applicable): _____

    c. Company Sector (select all that apply):
              i.   Power, Utilities & Infrastructure   ___
             ii. Upstream, Midstream & Mining   ___
            iii. Downstream & Chemicals   ___
            iv. Healthcare & Buildings   ___
              v. Manufacturing, Metals & Life Sciences   ___

    d. Your Name: _____

    e. Your Position: _____

    f. Contact Information – if sending interview request, how to contact
           i. Phone: _____
           ii. E-Mail: _____

CORPORATE PRODUCTIVITY PROGRAM ELEMENT ASSESSMENT

With focus on corporate level, this section assesses elements that form a company's productivity program. This program establishes and maintains company productivity practices and assessment systems to support project productivity practices, toolkits and practice implementation.

For your company's status, please select your "Level of Agreement," with each of the following statements:

Legend:
1 = Strongly Disagree
5 = Strongly Agree
N/A = Not Applicable or Do Not Know

Element: LEADERSHIP	Disagree - Agree					
1	Corporate productivity **objectives and goals** are defined.	1	2	3	4	5	N/A
2	Corporate productivity objectives and goals support **business objectives**.	1	2	3	4	5	N/A
3	Business **stakeholders are aligned** on corporate productivity goals and objectives.	1	2	3	4	5	N/A
4	Corporate leaders take **ownership** of productivity practices and processes.	1	2	3	4	5	N/A
5	**Corporate level decisions** about productivity and productivity practices are routed for buy-in and feedback.	1	2	3	4	5	N/A
6	**Projects leaders are aligned** on corporate productivity plans and actions.	1	2	3	4	5	N/A
7	**Corporate culture**, such as employee mindsets and company risk-reward norms, supports implementation of productivity practices.	1	2	3	4	5	N/A
8	Corporate leaders display **commitment** to construction productivity objectives.	1	2	3	4	5	N/A
9	**Corporate champions** for productivity goals, practices or initiatives are identified and given leverage to support their productivity improvement work.	1	2	3	4	5	N/A
10	Corporate leaders **promote implementation** of productivity practices or initiatives across the company project portfolio.	1	2	3	4	5	N/A
11	Corporate leaders are **consistent across the company** in communication and support around productivity goals.	1	2	3	4	5	N/A
12	**Corporate leadership** provides **recognition** for personnel implementing productivity practices or projects that are successful with productivity improvement goal.	1	2	3	4	5	N/A
13	**Project leadership** provides **recognition** for personnel implementing productivity practices or projects that are successful with productivity improvement goal.	1	2	3	4	5	N/A
14	Project leaders set **project productivity goals and measurements**.	1	2	3	4	5	N/A

15	Project leadership is **supported by corporate or functional levels** with practices and standards when implementing productivity efforts.	1	2	3	4	5	N/A

Element: RESOURCES		Disagree --- Agree					
Personnel							
1	Corporate personnel are working to **promote implementation** of productivity practices.	1	2	3	4	5	N/A
2	Corporate personnel are **held accountable** for their roles with productivity goals and objectives.	1	2	3	4	5	N/A
3	Corporate personnel **have allotted time** to perform their duties relative to productivity objectives, practices, and initiatives.	1	2	3	4	5	N/A
4	**Corporate personnel** are **provided training** and development to properly address productivity in their scope.	1	2	3	4	5	N/A
5	**Project personnel** are **provided training** and development to properly address productivity in their scope.	1	2	3	4	5	N/A
6	Project personnel fully **understand and support** productivity practices.	1	2	3	4	5	N/A
7	**Project teams and personnel** implementing productivity practices are **capable** of defining, measuring, and controlling the data and scope decisions.	1	2	3	4	5	N/A
8	**Qualifications** to ensure individual capability are in place for positions that manage construction productivity practices.	1	2	3	4	5	N/A
10	Qualified personnel are **available** for positions that manage construction productivity practices and scope on projects.	1	2	3	4	5	N/A
Funding							
11	**Funding** is provided for corporate productivity objectives.	1	2	3	4	5	N/A
12	**Front-end cash flows** invested toward productivity improvement are acceptable for project leadership, such as work packaging, or early involvement from construction.	1	2	3	4	5	N/A
Technology and Tools							
13	**Technology and tools** needed for implementation or productivity practices on projects are available.	1	2	3	4	5	N/A
14	Productivity tools create reports or output information that are **used in decision making on projects.**	1	2	3	4	5	N/A
15	**Data and history** needed for productivity tools is available.	1	2	3	4	5	N/A

16	**Productivity tools and systems** are fit for purpose or adjustable - based on project size and complexity.	1	2	3	4	5	N/A
17	**Interfaces** between productivity systems and systems supporting other functions (e.g.: accounting, payroll, project controls, and safety) are established.	1	2	3	4	5	N/A

Element: PROGRAM STRUCTURE AND COMMUNICATIONS		Disagree - Agree					
1	**Corporate functions or departments** (e.g.: quality, safety, construction, engineering, IT) are **aligned on company productivity objectives**.	1	2	3	4	5	N/A
2	**Project groups or teams** (e.g.: quality, safety, construction, engineering, IT) are **aligned on project productivity objectives**.	1	2	3	4	5	N/A
3	**Clear interfaces are established** between the corporate departments regarding productivity practice changes and initiatives.	1	2	3	4	5	N/A
4	**Other programs**, such as quality, safety, construction, engineering, **understand** their impact and roles regarding construction productivity performance.	1	2	3	4	5	N/A
5	**Construction productivity reports are shared** across functions, disciplines, and groups.	1	2	3	4	5	N/A
6	**Interdisciplinary or cross-function collaboration** is established to enable achievement of productivity goals.	1	2	3	4	5	N/A
7	Corporate management communicates **roles and responsibilities** within productivity practices for corporate personnel.	1	2	3	4	5	N/A
8	Corporate personnel are **held accountable** for their productivity practice responsibilities.	1	2	3	4	5	N/A
9	**Project teams** have available **corporate support contacts** when implementing productivity practices.	1	2	3	4	5	N/A
10	The **company hiring** process enables construction productivity. (e.g.: craft skill and availability is evaluated or training is established to cover deficiencies in specific regions, trades, etc.)	1	2	3	4	5	N/A
11	Personnel from **various countries** collaborate well for productivity objectives.	1	2	3	4	5	N/A
12	**Cultural backgrounds** are considered when implementing productivity practices.	1	2	3	4	5	N/A
13	**Language barriers** to productivity practices are well managed.	1	2	3	4	5	N/A
14	There is a **corporate organizational plan, structure, and/or group** that supports the management of productivity plans and objectives.	1	2	3	4	5	N/A

Element: PLANNING FOR PRODUCTIVITY	Disagree - Agree					
Corporate Planning						
1	**Key processes and procedures** for corporate productivity practices are documented.	1	2	3	4	5	N/A
2	Corporate productivity practices and processes are **readily available to project personnel.**	1	2	3	4	5	N/A
3	Corporate productivity processes provide enough **guidance for project implementation.**	1	2	3	4	5	N/A
4	Corporate expects project productivity **efforts to be flexible** based on project size and complexity.	1	2	3	4	5	N/A
5	Corporate ensures that project **operating or owner** organizations are engaged throughout project life-cycles.	1	2	3	4	5	N/A
6	Corporate expects projects to conduct **alignment** meetings between groups and companies that interface with project productivity practices.	1	2	3	4	5	N/A
7	Company has **contracting strategy practices** to enable project achievement of productivity and business objectives.	1	2	3	4	5	N/A
8	Company has established that **materials management plans and roles** are consistently in-place on projects.	1	2	3	4	5	N/A
8	Company ensures **project controls systems and roles** are consistently in-place on projects.	1	2	3	4	5	N/A
8	Company has established that **change management plans** are consistently in-place on projects.	1	2	3	4	5	N/A
Project Planning						
9	Construction teams on projects have systems established to **enable on-site productivity**, such as rapid response to critical RFIs.	1	2	3	4	5	N/A
10	**Company ensures early project plans and design support** are established to enable construction productivity.	1	2	3	4	5	N/A
11	**Construction work is consistently packaged for project teams** to enable construction efficiency and productivity.	1	2	3	4	5	N/A
12	Construction, commissioning, and **start-up relationship** is planned early and facilitated throughout the project life-cycle for company projects.	1	2	3	4	5	N/A
13	**Off-site fabrication or modularization** evaluation is supported by company to capture productivity benefits for projects.	1	2	3	4	5	N/A
14	**Safety relationship with productivity** is evaluated and planned for relative to specific projects, sites, and conditions.	1	2	3	4	5	N/A
15	**Quality processes** are developed and consistently implemented early on company projects to enable construction productivity.	1	2	3	4	5	N/A

16	**Risk assessments** are performed prior to implementation or productivity practices.	1	2	3	4	5	N/A
17	Project **site layouts** are planned to increase craft time on tools and productivity.	1	2	3	4	5	N/A
18	**Project materials management** systems are established and run on company projects.	1	2	3	4	5	N/A
19	**Project schedule sequencing** is consistently performed and evaluated on projects.	1	2	3	4	5	N/A

Element: PRODUCTIVITY MONITORING AND CONTROL		Disagree -- Agree					
1	The company implements practices to **check** productivity performance on projects, such as benchmarking.	1	2	3	4	5	N/A
2	**Corporate quality management** is aligned with construction productivity objectives.	1	2	3	4	5	N/A
3	**Corporate establishes key performance indicators** for projects that enables projects to target and monitor specific project metrics.	1	2	3	4	5	N/A
4	On projects, **key productivity performance indicators** are tracked throughout the project life.	1	2	3	4	5	N/A
5	The company has resources to help projects **reduce and manage rework.**	1	2	3	4	5	N/A
6	The company drives that project **recovery plans** consider impacts on productivity.	1	2	3	4	5	N/A
7	The company has systems and recommendations for evaluation of craft **time on tools** or **available work-hours**.	1	2	3	4	5	N/A
8	The company expects projects to evaluate **equipment utilization** to validate equipment needs.	1	2	3	4	5	N/A
9	The company collects **performance metrics data** from projects.	1	2	3	4	5	N/A
10	Projects **utilization of productivity practices** is tracked to verify practice performance.	1	2	3	4	5	N/A
11	Projects **decisions leverage productivity** information for impacts and options.	1	2	3	4	5	N/A
12	**Craft productivity, planning, and execution information** is readily available and visible so craft teams know how they are performing.	1	2	3	4	5	N/A
13	**Project decision makers are aware** of productivity impacts.	1	2	3	4	5	N/A
14	Project decision makers are aware of productivity's subsequent **cost and schedule impacts**.	1	2	3	4	5	N/A
15	Projects evaluate craft **time on tools** or **available work-hours** to know how and where productive work-hours are lost.	1	2	3	4	5	N/A

16	Projects evaluate **equipment utilization** to validate equipment needs and productivity during project execution.	1	2	3	4	5	N/A
17	**Benchmark** data is provided to projects to monitor performance based on location and scope norms.	1	2	3	4	5	N/A

Element: CONTINUOUS IMPROVEMENT	Disagree -- Agree					
1	Productivity is tracked or improved through the **continuous improvement program**.	1	2	3	4	5	N/A
2	**New or innovative productivity practices** are encouraged or developed by the company.	1	2	3	4	5	N/A
3	**Pilot projects** are used to test new or innovative approaches to productivity improvement.	1	2	3	4	5	N/A
4	**Risk-reward impacts** of using or testing productivity practices are balanced by the corporate level.	1	2	3	4	5	N/A
5	Productivity **metrics are measured** for future planning and improvement.	1	2	3	4	5	N/A
6	There is an established **feedback cycle** for productivity practices performance.	1	2	3	4	5	N/A
7	Productivity practice performance is used to **improve practice utilization.**	1	2	3	4	5	N/A
8	**Lessons learned** related to productivity are captured and distributed.	1	2	3	4	5	N/A
9	Documentation of productivity practice improvements are **disseminated to projects.**	1	2	3	4	5	N/A
10	Productivity performance data is highlighted for **distribution around company**.	1	2	3	4	5	N/A
11	**Technology investigation and innovation** is enabled through the continuous improvement processes.	1	2	3	4	5	N/A

4. Productivity Practice Utilization:

The following productivity practices that are used on projects. Please respond with how your company utilizes and manages these practices.

These questions asked about each practice:

1. Roughly estimate the percentage of your company's projects using this productivity practice.
   (check one)

Practice not utilized by company	0 to 25% of projects use	26 to 50% of projects use	51 to 75% of projects use	75%+ of projects use

2. Productivity goals and objectives are considered when this practice is implemented on projects.

Strongly Agree	Agree	Disagree	Strongly Disagree	Do Not Know

3. The following checkboxes are for basic understanding of how the practice is managed by the corporate level within your company. This is the level that assists various projects with practice implementation and/or updates practices based on feedback from multiple projects.

This is not a corporate level practice	Corporate resources are allocated to manage and support this practice	Practice use or non-use on projects is decided with input from the corporate practice owner	Metrics are used to track the performance of this practice	What group or department owns this practice at your company? (optional)
				Fill in the blank

PRODUCTIVITY PRACTICES

Practices were sourced from previous research topics. Most productivity practice descriptions below are summarized or directly cited from CII's Construction Productivity Handbook (Goodrum, 2013).

1. **Activity Analysis -** Activity analysis is a continuous process of measuring and improving the amount of time that craft professionals spend on actual construction. It is work sampling extended and revised with detailed observation that provides more detailed analysis.

2. **Advanced Work Packaging (AWP) -** The overall process flow of all the detailed work packages (construction, engineering, and installation work packages). AWP is a planned, executable process that encompasses the work on a capital project, beginning with initial planning and continuing through detailed design and construction execution.

3. **Alignment -** The condition where appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives.

4. **Benchmarking and Metrics -** The systematic process of measuring an organization's and/or project's performance against recognized leaders for determining best practices that lead to superior performance when adapted and utilized.

5. **Best Productivity Practice Implementation Index (BPPII) -** Measurement of a project's use of effective productivity improvement practices based on six categories of practice – materials management, equipment logistics, craft information systems, human resources management, construction methods, and environmental safety and health.

6. **Change Management -** The process of incorporating a balanced change culture of recognition, planning, and evaluation of project changes in an organization to effectively manage project changes.

7. **Constructability -** The optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.

8. **Craft Information Systems -** Information systems that promote the improvement of craft productivity and worker motivation by providing relevant and accurate information related to the task at hand being provided to workers in a timely manner. For example, providing workers with information about schedules, milestones, material availability, safety guidelines, and quality requirements, among other important considerations, can reduce non-value-added activity and consequently increase productive time.

9. **Crew Balance Chart -** Balancing resource usage by observing crews during cycle of high-cost and repetitive operations, identifying interrelationships among activities and equipment.

10. **Disputes Prevention and Resolution -** Techniques for addressing disputes in their early stages before affecting the progress of the work, creating adversarial positions, and leading to litigation.

11. **Engineering Management Interface –** Management of plans, specification, and other technical data and processes to make sure they are available on time and with the expected quality to support procurement, construction, and other phases of the project life cycle.

12. **Equipment and Tool Logistics –** Site tool management and machinery availability analysis with respect to tools and equipment tracking, maintenance, equipment positioning, and lift planning to improve the availability of construction equipment.

13. **Five-Minute Ratings -** Summing observations made in a short study period to sample work to make management aware of job delays and their order of magnitude.

14. **Flow Diagrams and Process Charts -** Visual diagrams of the physical processes on construction sites; modeling of process steps and resource usage to identify improvements.

15. **Foremen / Craft Input -** Craftsman questionnaires and foreman delays surveys that capture feedback on areas of inefficiency in on-site organizations and daily operations.

16. **Front End Planning -** The essential process of developing sufficient strategic information with which owners can address risk and make decisions to commit resources in order to maximize the potential for a successful project.

17. **Human Resource Management –** Leverage of human resources on a project, including practices centered on recruiting, training and development, motivation, retention, roles and responsibilities in the project organization, and employment strategies.

18. **Implementation of CII Research -** The comprehensive and effective use of proven CII products by member organizations as outlined in the CII Implementation Model.

19. **Interface Management -** Management of communications, relationships, and deliverables among two or more interface stakeholders.

20. **Lean Construction -** Construction utilization of the five lean principles – customer focus, culture and people, workplace organization and standardization, elimination of waste, and continuous improvement / built-in quality.

21. **Lessons Learned -** A critical element in the management of institutional knowledge, an effective lesson learned program facilitates the continuous improvement of processes and procedures and provides a direct advantage in an increasingly competitive industry.

22. **Materials Management -** An integrated process for planning and controlling all necessary efforts to make certain that the quality and quantity of materials and equipment are appropriately specified in a timely manner, are obtained at a reasonable cost, and are available when needed.

23. **Partnering -** A long-term commitment between two or more organizations as in an alliance or it may be applied to a shorter period such as the duration of a project. The purpose of partnering is to achieve specific business objectives by maximizing the effectiveness of each participant's resources.

24. **Planning for Modularization -** The evaluation and determination of offsite construction and modularization opportunities in the front-end planning phase to achieve specific strategic objectives and improved project outcomes.

25. **Planning for Startup -** Startup is defined as the transitional phase between plant construction completion and commercial operations, that encompasses all activities that bridge these two phases, including systems turnover, check-out of systems, commissioning of systems, introduction of feedstocks, and performance testing.

26. **Productivity Adjustment Factors -** Ratios and baseline comparisons for varying work conditions, schedules, practices, technology, and other factors to account for impacts on construction productivity.

27. **Project Controls -** Resources, procedures, and tools for the planning, monitoring, and controlling of all phases of the capital project lifecycle. This includes estimating, cost and schedule management, risk management, change management, earned value progressing, and forecasting.

28. **Project Delivery and Contract Strategy Analysis –** Analysis of project delivery methods and contracting strategies for project design and construction.

29. **Project Organization Planning -** Development of a clearly defined project organizational structure including roles, responsibilities, and scope ownership.

30. **Project Risk Assessment -** The process to identify, assess, and manage risk. The project team evaluates risk exposure for potential project impact to provide focus for mitigation strategies.

31. **Quality Management -** Quality management incorporates all activities conducted to improve the efficiency, contract compliance and cost effectiveness of design, engineering, procurement, QA/QC, construction, and startup elements of construction projects.

32. **Rework Reduction Program -** Rework tracking and cause classification, impact evaluation and trend analysis, corrective action planning, and intervention.

33. **Team Building -** A project-focused process that builds and develops shared goals, interdependence, trust and commitment, and accountability among team members and that seeks to improve team members' problem-solving skills.

34. **Technology and Innovation Investigation –** Investigating advances in construction material, equipment, and information technology and determining their potential for productivity improvement, as well as their costs and benefits.

35. **Zero Accidents Techniques -** Include the site-specific safety programs and implementation, auditing, and incentive efforts to create a project environment and a level of training that embraces the mindset that all accidents are preventable and that zero accidents is an obtainable goal.

36. **Workforce Development Assessment -** Strategy addressing issues such as shortages of skilled workers and shrinkage of the overall construction workforce.

Appendix C: **Survey Data**

Productivity Program Elements

- Leadership

- Resources

- Program Structure and Communications

- Planning for Productivity

- Productivity Monitoring and Control

- Continuous Improvement

LEADERSHIP STATEMENTS 1 THROUGH 8

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

CORPORATE PRODUCTIVITY OBJECTIVES AND GOALS ARE DEFINED. — 8, 24, 11, 4, 2, 2

CORPORATE PRODUCTIVITY OBJECTIVES AND GOALS SUPPORT BUSINESS OBJECTIVES. — 10, 23, 10, 5, 0, 3

BUSINESS STAKEHOLDERS ARE ALIGNED ON CORPORATE PRODUCTIVITY GOALS AND OBJECTIVES. — 6, 16, 13, 11, 1, 4

CORPORATE LEADERS TAKE OWNERSHIP OF PRODUCTIVITY PRACTICES AND PROCESSES. — 10, 19, 10, 10, 0, 2

CORPORATE LEVEL DECISIONS ABOUT PRODUCTIVITY AND PRODUCTIVITY PRACTICES ARE ROUTED FOR BUY-IN AND FEEDBACK. — 3, 20, 12, 13, 0, 3

PROJECTS LEADERS ARE ALIGNED ON CORPORATE PRODUCTIVITY PLANS AND ACTIONS. — 5, 25, 10, 7, 1, 3

CORPORATE CULTURE, SUCH AS EMPLOYEE MINDSETS AND COMPANY RISK-REWARD NORMS, SUPPORTS IMPLEMENTATION OF PRODUCTIVITY PRACTICES. — 5, 26, 6, 10, 0, 3

CORPORATE LEADERS DISPLAY COMMITMENT TO CONSTRUCTION PRODUCTIVITY OBJECTIVES. — 8, 25, 10, 4, 1, 3

LEADERSHIP STATEMENTS 9 THROUGH 15

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

CORPORATE CHAMPIONS FOR PRODUCTIVITY GOALS, PRACTICES OR INITIATIVES ARE IDENTIFIED AND GIVEN LEVERAGE TO SUPPORT THEIR PRODUCTIVITY IMPROVEMENT WORK.

CORPORATE LEADERS PROMOTE IMPLEMENTATION OF PRODUCTIVITY PRACTICES OR INITIATIVES ACROSS THE COMPANY PROJECT PORTFOLIO.

CORPORATE LEADERS ARE CONSISTENT ACROSS THE COMPANY IN COMMUNICATION AND SUPPORT AROUND PRODUCTIVITY GOALS.

CORPORATE LEADERSHIP PROVIDES RECOGNITION FOR PERSONNEL IMPLEMENTING PRODUCTIVITY PRACTICES OR PROJECTS THAT ARE SUCCESSFUL WITH PRODUCTIVITY IMPROVEMENT GOAL.

PROJECT LEADERSHIP PROVIDES RECOGNITION FOR PERSONNEL IMPLEMENTING PRODUCTIVITY PRACTICES OR PROJECTS THAT ARE SUCCESSFUL WITH PRODUCTIVITY IMPROVEMENT GOAL.

PROJECT LEADERS SET PROJECT PRODUCTIVITY GOALS AND MEASUREMENTS.

PROJECT LEADERSHIP IS SUPPORTED BY CORPORATE OR FUNCTIONAL LEVELS WITH PRACTICES AND STANDARDS WHEN IMPLEMENTING PRODUCTIVITY EFFORTS.

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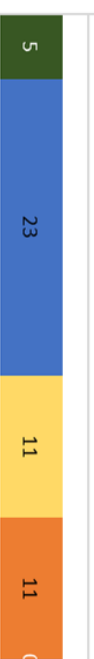
RESOURCE STATEMENTS 1 THROUGH 8

■ Strongly Agree   ■ Agree   ■ Neutral   ■ Disagree   ■ Strongly Disagree   ■ NA

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
QUALIFIED PERSONNEL ARE AVAILABLE FOR POSITIONS THAT MANAGE CONSTRUCTION PRODUCTIVITY PRACTICES AND SCOPE ON PROJECTS.	3	19	11	13	2	3
CORPORATE PERSONNEL ARE WORKING TO PROMOTE IMPLEMENTATION OF PRODUCTIVITY PRACTICES.	13	21	8	6	0	3
CORPORATE PERSONNEL ARE HELD ACCOUNTABLE FOR THEIR ROLES WITH PRODUCTIVITY GOALS AND OBJECTIVES.	4	14	13	14	1	5
CORPORATE PERSONNEL HAVE ALLOTTED TIME TO PERFORM THEIR DUTIES RELATIVE TO PRODUCTIVITY OBJECTIVES, PRACTICES, AND INITIATIVES.	5	14	12	12	2	5
CORPORATE PERSONNEL ARE PROVIDED TRAINING AND DEVELOPMENT TO PROPERLY ADDRESS PRODUCTIVITY IN THEIR SCOPE.	2	14	12	16	1	6
PROJECT PERSONNEL ARE PROVIDED TRAINING AND DEVELOPMENT TO PROPERLY ADDRESS PRODUCTIVITY IN THEIR SCOPE.	2	17	13	15	2	2
PROJECT PERSONNEL FULLY UNDERSTAND AND SUPPORT PRODUCTIVITY PRACTICES.	3	18	13	15	1	1
PROJECT TEAMS AND PERSONNEL IMPLEMENTING ARE CAPABLE OF DEFINING, MEASURING, AND CONTROLLING THE DATA AND SCOPE DECISIONS.	2	24	14	8	2	1

RESOURCE STATEMENTS 9 THROUGH 16

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
QUALIFICATIONS TO ENSURE INDIVIDUAL CAPABILITY ARE IN PLACE FOR POSITIONS THAT MANAGE CONSTRUCTION PRODUCTIVITY PRACTICES.	4	16	9	18	2	2
FUNDING IS PROVIDED FOR CORPORATE PRODUCTIVITY OBJECTIVES.	9	12	16	10	2	2
FRONT-END CASH FLOWS INVESTED TOWARD PRODUCTIVITY IMPROVEMENT ARE ACCEPTABLE FOR PROJECT LEADERSHIP.	4	28	15	1	2	1
TECHNOLOGY AND TOOLS NEEDED FOR IMPLEMENTATION OR PRODUCTIVITY PRACTICES ON PROJECTS ARE AVAILABLE.	7	21	10	10	1	2
PRODUCTIVITY TOOLS CREATE REPORTS OR OUTPUT INFORMATION THAT ARE USED IN DECISION MAKING ON PROJECTS.	4	24	12	6	3	2
DATA AND HISTORY NEEDED FOR PRODUCTIVITY TOOLS IS AVAILABLE.	6	21	10	10	2	2
PRODUCTIVITY TOOLS AND SYSTEMS ARE FIT FOR PURPOSE OR ADJUSTABLE - BASED ON PROJECT SIZE AND COMPLEXITY.	4	20	18	7	0	2
INTERFACES BETWEEN PRODUCTIVITY SYSTEMS AND SYSTEMS SUPPORTING OTHER FUNCTIONS ARE ESTABLISHED.	4	15	12	14	4	2

PROGRAM STRUCTURE & COMMUNICATIONS STATEMENTS 1 THROUGH 7

Legend: Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | NA

CORPORATE FUNCTIONS OR DEPARTMENTS (E.G.: QUALITY, SAFETY, CONSTRUCTION, ENGINEERING, IT) ARE ALIGNED ON COMPANY PRODUCTIVITY OBJECTIVES. — 6, 19, 4, 16, 2, 1, 3

PROJECT GROUPS OR TEAMS (E.G.: QUALITY, SAFETY, CONSTRUCTION, ENGINEERING, IT) ARE ALIGNED ON PROJECT PRODUCTIVITY OBJECTIVES. — 4, 25, 8, 10, 2, 1

CLEAR INTERFACES ARE ESTABLISHED BETWEEN THE CORPORATE DEPARTMENTS REGARDING PRODUCTIVITY PRACTICE CHANGES AND INITIATIVES. — 3, 16, 8, 19, 1, 3

OTHER PROGRAMS, SUCH AS QUALITY, SAFETY, CONSTRUCTION, ENGINEERING, UNDERSTAND THEIR IMPACT AND ROLES REGARDING CONSTRUCTION PRODUCTIVITY PERFORMANCE. — 2, 18, 12, 15, 11

CONSTRUCTION PRODUCTIVITY REPORTS ARE SHARED ACROSS FUNCTIONS, DISCIPLINES, AND GROUPS. — 1, 16, 12, 13, 7, 1

INTERDISCIPLINARY OR CROSS-FUNCTION COLLABORATION IS ESTABLISHED TO ENABLE ACHIEVEMENT OF PRODUCTIVITY GOALS. — 2, 20, 12, 12, 1, 3

CORPORATE MANAGEMENT COMMUNICATES ROLES AND RESPONSIBILITIES WITHIN PRODUCTIVITY PRACTICES FOR CORPORATE PERSONNEL. — 3, 16, 9, 17, 1, 4

PROGRAM STRUCTURE & COMMUNICATIONS STATEMENTS 7 THROUGH 14

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

CORPORATE PERSONNEL ARE HELD ACCOUNTABLE FOR THEIR PRODUCTIVITY PRACTICE RESPONSIBILITIES.: 3, 12, 17, 12, 2, 4

PROJECT TEAMS HAVE AVAILABLE CORPORATE SUPPORT CONTACTS WHEN IMPLEMENTING PRODUCTIVITY PRACTICES.: 4, 22, 12, 9, 1, 2

THE COMPANY HIRING PROCESS ENABLES CONSTRUCTION PRODUCTIVITY. (E.G.: CRAFT SKILL AND AVAILABILITY IS EVALUATED OR TRAINING IS ESTABLISHED TO COVER...: 1, 14, 16, 8, 3, 8

PERSONNEL FROM VARIOUS COUNTRIES COLLABORATE WELL FOR PRODUCTIVITY OBJECTIVES.: 3, 10, 17, 1, 1, 18

CULTURAL BACKGROUNDS ARE CONSIDERED WHEN IMPLEMENTING PRODUCTIVITY PRACTICES.: 2, 16, 11, 7, 0, 13

LANGUAGE BARRIERS TO PRODUCTIVITY PRACTICES ARE WELL MANAGED.: 3, 13, 14, 8, 0, 12

THERE IS A CORPORATE ORGANIZATIONAL PLAN, STRUCTURE, AND/OR GROUP THAT SUPPORTS THE MANAGEMENT OF PRODUCTIVITY PLANS AND OBJECTIVES.: 4, 14, 11, 12, 2, 7

PLANNING FOR PRODUCTIVITY STATEMENTS 1 THROUGH 7

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
KEY PROCESSES AND PROCEDURES FOR CORPORATE PRODUCTIVITY PRACTICES ARE DOCUMENTED.	7	20	11	7	2	3
CORPORATE PRODUCTIVITY PRACTICES AND PROCESSES ARE READILY AVAILABLE TO PROJECT PERSONNEL.	4	21	10	10	2	3
CORPORATE PRODUCTIVITY PROCESSES PROVIDE ENOUGH GUIDANCE FOR PROJECT IMPLEMENTATION.	4	21	12	10	1	2
CORPORATE EXPECTS PROJECT PRODUCTIVITY EFFORTS TO BE FLEXIBLE BASED ON PROJECT SIZE AND COMPLEXITY.	6	23	12	4	1	4
CORPORATE ENSURES THAT PROJECT OPERATING OR OWNER ORGANIZATIONS ARE ENGAGED THROUGHOUT PROJECT LIFE-CYCLES.	1	23	13	9	0	4
CORPORATE EXPECTS PROJECTS TO CONDUCT ALIGNMENT MEETINGS BETWEEN GROUPS AND COMPANIES THAT INTERFACE WITH PROJECT PRODUCTIVITY PRACTICES.	1	26	12	6	1	4
COMPANY HAS CONTRACTING STRATEGY PRACTICES TO ENABLE PROJECT ACHIEVEMENT OF PRODUCTIVITY AND BUSINESS OBJECTIVES.	4	27	10	6	0	3

PLANNING FOR PRODUCTIVITY STATEMENTS 8 THROUGH 14

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
COMPANY HAS ESTABLISHED THAT MATERIALS MANAGEMENT PLANS AND ROLES ARE CONSISTENTLY IN-PLACE ON PROJECTS.	6	22	10	9	1	2
COMPANY ENSURES PROJECT CONTROLS SYSTEMS AND ROLES ARE CONSISTENTLY IN-PLACE ON PROJECTS.	8	23	12	6	0	1
COMPANY HAS ESTABLISHED THAT CHANGE MANAGEMENT PLANS ARE CONSISTENTLY IN-PLACE ON PROJECTS.	5	23	10	8	3	1
CONSTRUCTION TEAMS ON PROJECTS HAVE SYSTEMS ESTABLISHED TO ENABLE ON-SITE PRODUCTIVITY, SUCH AS RAPID RESPONSE TO CRITICAL RFIS.	4	25	12	5	1	3
COMPANY ENSURES EARLY PROJECT PLANS AND DESIGN SUPPORT ARE ESTABLISHED TO ENABLE CONSTRUCTION PRODUCTIVITY.	2	26	15	5	1	1
CONSTRUCTION WORK IS CONSISTENTLY PACKAGED FOR PROJECT TEAMS TO ENABLE CONSTRUCTION EFFICIENCY AND PRODUCTIVITY.	3	12	15	13	4	3
CONSTRUCTION, COMMISSIONING, AND START-UP RELATIONSHIP IS PLANNED EARLY AND FACILITATED THROUGHOUT THE PROJECT LIFE-CYCLE FOR COMPANY PROJECTS.	3	24	13	5	2	2

PLANNING FOR PRODUCTIVITY STATEMENTS 15 THROUGH 21

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
OFF-SITE FABRICATION OR MODULARIZATION EVALUATION IS SUPPORTED BY COMPANY TO CAPTURE PRODUCTIVITY BENEFITS FOR PROJECTS.	6	31	5	4	1	3
SAFETY RELATIONSHIP WITH PRODUCTIVITY IS EVALUATED AND PLANNED FOR RELATIVE TO SPECIFIC PROJECTS, SITES, AND CONDITIONS.	13	26	6	4	0	1
QUALITY PROCESSES ARE DEVELOPED AND CONSISTENTLY IMPLEMENTED EARLY ON COMPANY PROJECTS TO ENABLE CONSTRUCTION PRODUCTIVITY.	3	27	15	5	1	1
RISK ASSESSMENTS ARE PERFORMED PRIOR TO IMPLEMENTATION OR PRODUCTIVITY PRACTICES.	3	27	12	5	1	2
PROJECT SITE LAYOUTS ARE PLANNED TO INCREASE CRAFT TIME ON TOOLS AND PRODUCTIVITY.	3	23	16	4	2	2
PROJECT MATERIALS MANAGEMENT SYSTEMS ARE ESTABLISHED AND RUN ON COMPANY PROJECTS.	4	22	13	7	1	3
PROJECT SCHEDULE SEQUENCING IS CONSISTENTLY PERFORMED AND EVALUATED ON PROJECTS.	5	24	12	8	0	1

PRODUCTIVITY MONITORING & CONTROL STATEMENTS 1 THROUGH 9

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

THE COMPANY IMPLEMENTS PRACTICES TO CHECK PRODUCTIVITY PERFORMANCE ON PROJECTS, SUCH AS BENCHMARKING. — 9, 19, 13, 6, 1 1

CORPORATE QUALITY MANAGEMENT IS ALIGNED WITH CONSTRUCTION PRODUCTIVITY OBJECTIVES. — 4, 18, 15, 9, 4, 0 3

CORPORATE ESTABLISHES KEY PERFORMANCE INDICATORS FOR PROJECTS THAT ENABLES PROJECTS TO TARGET AND MONITOR… — 8, 25, 9, 4, 1 2

ON PROJECTS, KEY PRODUCTIVITY PERFORMANCE INDICATORS ARE TRACKED THROUGHOUT THE PROJECT LIFE. — 6, 23, 9, 8, 1 2

THE COMPANY HAS RESOURCES TO HELP PROJECTS REDUCE AND MANAGE REWORK. — 1, 18, 14, 15, 0 1

THE COMPANY DRIVES THAT PROJECT RECOVERY PLANS CONSIDER IMPACTS ON PRODUCTIVITY. — 2, 15, 18, 9, 1 3

THE COMPANY HAS SYSTEMS AND RECOMMENDATIONS FOR EVALUATION OF CRAFT TIME ON TOOLS OR AVAILABLE WORK… — 4, 13, 9, 13, 4, 6

THE COMPANY EXPECTS PROJECTS TO EVALUATE EQUIPMENT UTILIZATION TO VALIDATE EQUIPMENT NEEDS. — 3, 20, 6, 15, 0, 5

THE COMPANY COLLECTS PERFORMANCE METRICS DATA FROM PROJECTS. — 9, 24, 9, 4, 1 2

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PRODUCTIVITY MONITORING & CONTROL STATEMENTS 10 THROUGH 17

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

PROJECTS UTILIZATION OF PRODUCTIVITY PRACTICES IS TRACKED TO VERIFY PRACTICE PERFORMANCE. — 2, 15, 10, 18, 2, 2

PROJECTS DECISIONS LEVERAGE PRODUCTIVITY INFORMATION FOR IMPACTS AND OPTIONS. — 1, 23, 12, 8, 1, 4

CRAFT PRODUCTIVITY, PLANNING, AND EXECUTION INFORMATION IS READILY AVAILABLE AND VISIBLE SO CRAFT TEAMS KNOW HOW THEY ARE PERFORMING. — 3, 14, 9, 10, 7, 6

PROJECT DECISION MAKERS ARE AWARE OF PRODUCTIVITY IMPACTS. — 7, 25, 11, 5, 01

PROJECT DECISION MAKERS ARE AWARE OF PRODUCTIVITYâ€™S SUBSEQUENT COST AND SCHEDULE IMPACTS. — 7, 28, 10, 3, 01

PROJECTS EVALUATE CRAFT TIME ON TOOLS OR AVAILABLE WORK-HOURS TO KNOW HOW AND WHERE PRODUCTIVE WORK-HOURS ARE LOST. — 3, 14, 16, 10, 3, 3

PROJECTS EVALUATE EQUIPMENT UTILIZATION TO VALIDATE EQUIPMENT NEEDS AND PRODUCTIVITY DURING PROJECT EXECUTION. — 2, 19, 11, 12, 0, 4

BENCHMARK DATA IS PROVIDED TO PROJECTS TO MONITOR PERFORMANCE BASED ON LOCATION AND SCOPE NORMS. — 3, 20, 12, 10, 2, 2

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CONTINUOUS IMPROVEMENT STATEMENTS 1 THROUGH 11

Legend: ■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree ■ NA

Each survey participant estimated practice utilization across company project portfolios in ranges of twenty-five percent (e.g. – 0%, 1-25%, 26-50%, 51-75%, 75% or more). These values are summarized for each company and practice below, where the range is averaged.

PRODUCTIVITY PRACTICE UTILIZATION

Legend: ■ 75+% of projects use   ■ 51 to 75% of projects   ■ 26 to 50% of projects   ■ 0 to 25% of projects   ■ Practice not utilized   ■ Unknown

Practice	75+%	51–75%	26–50%	0–25%	Not utilized	Unknown
ZERO ACCIDENTS TECHNIQUES	83%	9%	0%	4%	2%	2%
PROJECT CONTROLS	57%	19%	21%		2%	0%
PROJECT ORGANIZATION PLANNING	51%	9%	23%	11%	2%	4%
PROJECT RISK ASSESSMENT	51%	19%	13%	13%	2%	2%
QUALITY MANAGEMENT	49%	19%	15%	9%	4%	4%
PROJ DELIVERY & CONTRACT STRATEGY	45%	17%	11%	15%	9%	4%
PLANNING FOR STARTUP	43%	23%	13%	15%	6%	0%
CONSTRUCTABILITY	38%	21%	21%	19%	0%	
HUMAN RESOURCE MANAGEMENT	38%	21%	9%	13%	11%	9%
CHANGE MANAGEMENT	36%	23%	13%	23%	2%	2%
FRONT END PLANNING	32%	23%	28%	11%	4%	2%
INTERFACE MANAGEMENT	32%	23%	15%	17%	9%	4%
MATERIALS MANAGEMENT	32%	23%	15%	13%	9%	9%
ALIGNMENT	23%	19%	23%	21%	4%	9%
TEAM BUILDING	23%	21%	30%	19%	4%	2%
BENCHMARKING AND METRICS	21%	11%	19%	40%	2%	6%
PLANNING FOR MODULARIZATION	21%	26%	19%	23%	9%	2%
PRODUCTIVITY ADJUSTMENT FACTORS	21%	21%	15%	19%	13%	11%
DISPUTES PREVENTION AND RESOLUTION	19%	11%	15%	26%	13%	17%

PRODUCTIVITY PRACTICE UTILIZATION

Legend:
- ■ 75+% of projects use
- ■ 51 to 75% of projects
- ■ 26 to 50% of projects
- ■ 0 to 25% of projects
- ■ Practice not utilized
- ■ Unknown

Practice	75+%	51 to 75%	26 to 50%	0 to 25%	Practice not utilized	Unknown
LESSONS LEARNED	19%	19%	28%	23%	9%	2%
ENGINEERING MANAGEMENT INTERFACE	17%	26%	21%	28%	4%	4%
EQUIPMENT AND TOOL LOGISTICS	17%	19%	15%	19%	21%	9%
PARTNERING	17%	17%	34%	28%	0%	4%
ADVANCED WORK PACKAGING (AWP)	15%	6%	11%	47%	11%	11%
REWORK REDUCTION PROGRAM	15%	6%	28%	23%	21%	6%
WORKFORCE DEVELOPMENT ASSESSMENT	15%	21%	11%	26%	17%	11%
CRAFT INFORMATION SYSTEMS	13%	20%	15%	28%	20%	4%
ACTIVITY ANALYSIS	11%	9%	9%	36%	23%	13%
FLOW DIAGRAMS AND PROCESS CHARTS	11%	13%	13%	30%	23%	11%
FOREMEN / CRAFT INPUT	11%	9%	15%	32%	21%	13%
TECHNOLOGY AND INNOVATION INVESTIGATION	11%	13%	30%	30%	13%	4%
LEAN CONSTRUCTION	9%	13%	21%	32%	13%	13%
SUPERVISOR FINANCIAL INCENTIVES	9%	2%	13%	28%	36%	13%
CREW BALANCE CHART	6%	9%	11%	28%	28%	19%
IMPLEMENTATION OF CII RESEARCH	6%	6%	26%	34%	11%	17%
CRAFT FINANCIAL INCENTIVES	4%	2%	9%	34%	38%	13%
BEST PROD. PRACTICE IMPL. INDEX	2%	6%	9%	34%	36%	13%
FIVE-MINUTE RATINGS	2%	2%		17%	60%	17%

Each company had their 94 Action responses averaged to Element Scores, which then average to Program Scores. Groups are set by Program Score Rank and Owner/Contractor.

Company Program Scores, Type, and Groupings

Company	Company Type 1 = Owner 2 = Contractor	Program Score Group	Program Average
Company 1	1.0	1.0	4.4
Company 2	2.0	1.0	4.2
Company 3	2.0	1.0	4.1
Company 4	2.0	1.0	4.1
Company 5	1.0	1.0	4.0
Company 6	2.0	1.0	4.0
Company 7	2.0	1.0	3.9
Company 8	2.0	1.0	3.9
Company 9	2.0	1.0	3.8
Company 10	1.0	1.0	3.8
Company 11	1.0	1.0	3.7
Company 12	1.0	1.0	3.7
Company 13	2.0	1.0	3.7
Company 14	2.0	1.0	3.7
Company 15	1.0	1.0	3.6
Company 16	2.0	1.0	3.6
Company 17	1.0	1.0	3.6
Company 18	1.0	1.0	3.5
Company 19	2.0	1.0	3.5
Company 20	2.0	1.0	3.5
Company 21	2.0	1.0	3.5
Company 22	2.0	1.0	3.4
Company 23	1.0	1.0	3.4
Company 24	2.0		3.3
Company 25	2.0		3.3
Company 26	1.0		3.3
Company 27	1.0		3.3
Company 28	2.0		3.3
Company 29	1.0	2.0	3.2
Company 30	1.0	2.0	3.2
Company 31	2.0	2.0	3.2
Company 32	2.0	2.0	3.2
Company 33	2.0	2.0	3.2
Company 34	1.0	2.0	2.9
Company 35	2.0	2.0	2.9
Company 36	1.0	2.0	2.9
Company 37	2.0	2.0	2.9
Company 38	2.0	2.0	2.8
Company 39	1.0	2.0	2.8
Company 40	2.0	2.0	2.7
Company 41	1.0	2.0	2.7
Company 42	2.0	2.0	2.7
Company 43	1.0	2.0	2.6
Company 44	2.0	2.0	2.6
Company 45	1.0	2.0	2.5
Company 46	1.0	2.0	2.5
Company 47	1.0	2.0	2.5
Company 48	1.0	2.0	2.4
Company 49	1.0	2.0	2.4
Company 50	2.0	2.0	2.3
Company 51	2.0	2.0	2.2

PRODUCTIVITY PRACTICE UTILIZATION DETAIL

Each survey participant estimated practice utilization across company project portfolios in ranges of twenty-five percent (e.g. – 0%, 1-25%, 26-50%, 51-75%, 75% or more). These values are summarized for each company and practice below, where the range is averaged.

Company	Activity Analysis	Advanced Work Packaging (AWP)	Alignment	Benchmarking and Metrics	Best Prod. Practice Implem. Index (BPPII)	Change Mgmnt.	Constructability	Craft Info. Systems	Crew Balance Chart	Disputes Prevention and Resolution	Engineering Mgmnt. Interface	Equipment and Tool Logistics
Company 1			87.5			87.5	87.5	87.5			87.5	87.5
Company 2	0.0	87.5	87.5	87.5	0.0	87.5	87.5	87.5	12.5	87.5	87.5	87.5
Company 3	38.0	87.5	63.0	87.5	12.5	87.5	87.5	63.0	87.5	63.0	87.5	87.5
Company 4	87.5	63.0	87.5	63.0	38.0	63.0	87.5	38.0	38.0	38.0	63.0	12.5
Company 5	0.0	0.0	38.0	38.0	0.0	12.5	63.0	0.0	12.5	12.5	38.0	0.0
Company 6	87.5	63.0	63.0	87.5	38.0	63.0	87.5	63.0	63.0	38.0	12.5	63.0
Company 7	87.5	12.5	12.5	87.5	38.0	63.0	87.5	87.5	63.0	63.0		12.5
Company 8	87.5	38.0	63.0	63.0	87.5	87.5	87.5	63.0				63.0
Company 9	38.0	12.5	63.0	12.5	0.0	87.5	63.0	63.0	0.0	38.0	63.0	87.5
Company 10	12.5	12.5	12.5	12.5		12.5	12.5	12.5		87.5	63.0	63.0
Company 11	12.5	12.5	0.0	12.5	12.5	38.0	38.0	12.5	12.5	12.5	12.5	12.5
Company 12	12.5	12.5	12.5	12.5	12.5	38.0	38.0	12.5	12.5	38.0	12.5	38.0
Company 13	87.5	63.0	87.5	87.5	63.0	87.5	87.5	87.5	87.5	87.5	87.5	87.5
Company 14	12.5	12.5	63.0	38.0	12.5	38.0	38.0	12.5	12.5	12.5	63.0	12.5
Company 15	12.5	12.5	38.0	63.0	63.0	87.5	38.0	38.0	38.0	87.5	38.0	38.0
Company 16	12.5	12.5	38.0	38.0	12.5	63.0	12.5	12.5	38.0	63.0	12.5	63.0
Company 17		12.5	12.5	12.5	12.5	87.5	38.0	0.0			63.0	
Company 18	12.5	12.5	38.0	12.5	12.5	12.5	63.0	12.5	38.0	63.0	12.5	12.5
Company 19	38.0	38.0	63.0	12.5	0.0	87.5	63.0	87.5	63.0	87.5	63.0	87.5
Company 20			38.0	12.5	12.5	87.5	87.5	63.0		87.5	87.5	
Company 21	87.5	87.5	87.5	87.5	12.5	87.5	87.5	63.0	38.0	87.5	87.5	63.0
Company 22	0.0	12.5					87.5	63.0		87.5	12.5	38.0
Company 23	0.0	87.5	87.5	0.0	0.0	87.5	63.0	12.5	38.0	87.5	63.0	38.0
Company 24	63.0	87.5	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	38.0	38.0
Company 25	63.0	12.5	38.0	63.0	12.5	87.5	63.0	38.0	12.5	87.5	38.0	63.0
Company 26	12.5	87.5	87.5	87.5	0.0	87.5	87.5	87.5	12.5	0.0	87.5	87.5
Company 27		38.0	38.0	12.5	12.5	63.0	38.0	12.5		12.5	12.5	12.5
Company 28	12.5	12.5	63.0	12.5	0.0	12.5	63.0	63.0			87.5	87.5
Company 29	12.5	12.5	87.5	87.5	12.5	87.5	63.0	12.5	38.0	38.0	63.0	63.0
Company 30	38.0	87.5	12.5	38.0	38.0	12.5	87.5	38.0			12.5	
Company 31	0.0	12.5	87.5	12.5	0.0	87.5	87.5	0.0	0.0		63.0	0.0
Company 32	12.5	12.5	87.5	12.5	12.5	63.0	38.0	38.0	87.5	38.0	38.0	12.5
Company 33	38.0	12.5	38.0	12.5	12.5	38.0	87.5	38.0	12.5	38.0	63.0	38.0
Company 34	12.5	12.5	38.0	12.5	0.0	12.5	38.0	12.5	0.0	38.0	38.0	12.5
Company 35	0.0		12.5	12.5	12.5	12.5	12.5	38.0	0.0	12.5	12.5	12.5
Company 36	12.5	38.0	63.0	38.0	12.5	12.5	38.0	12.5	0.0	12.5	38.0	63.0
Company 37	0.0	63.0	87.5	12.5	0.0	87.5	87.5	12.5	38.0	38.0	0.0	12.5
Company 38	0.0	12.5	87.5	38.0	0.0	87.5	63.0	0.0	0.0		63.0	0.0
Company 39	0.0	0.0	12.5	38.0	0.0	63.0	87.5	0.0	0.0	12.5	63.0	0.0
Company 40	63.0	12.5	87.5	63.0	0.0	38.0	87.5	12.5	0.0	12.5	38.0	63.0
Company 41	12.5	38.0	38.0	38.0	38.0	63.0	38.0	12.5	12.5	12.5	12.5	38.0
Company 42	12.5	38.0	38.0	38.0	12.5	38.0	63.0	38.0	12.5	0.0	0.0	0.0
Company 43	12.5	12.5	63.0	38.0	12.5	38.0	38.0	12.5	12.5	0.0	12.5	0.0
Company 44	12.5	12.5	12.5	12.5	0.0	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Company 45		38.0	87.5	63.0		87.5	87.5		0.0		87.5	63.0
Company 46	0.0	12.5	12.5	12.5	0.0	12.5	12.5	0.0	0.0	0.0	12.5	0.0
Company 47	12.5	87.5	63.0	87.5	12.5	87.5	87.5		12.5	12.5	38.0	38.0
Company 48	0.0	0.0	0.0	38.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
Company 49	12.5	12.5	12.5	12.5	0.0	12.5	12.5	0.0	0.0	0.0	12.5	0.0
Company 50	12.5	12.5		12.5		12.5	12.5	12.5	12.5		12.5	0.0
Company 51	0.0	0.0	0.0	0.0	0.0	63.0	12.5	0.0	0.0	0.0	12.5	0.0

Company	Financial Incentvs. for Prod. - Craft	Financial Incentvs. for Prod. - Supervisors	Five-Minute Ratings	Flow Diagrams and Process Charts	Foremen / Craft Input	Front End Planning	Human Resource Mgmnt.	Implem. of CII Research	Interface Mgmnt.	Lean Construction	Lessons Learned	Materials Mgmnt.	Partnering
Company 1	0.0	0.0		38.0	63.0	63.0				38.0	63.0	87.5	63.0
Company 2	0.0	0.0	0.0	87.5	12.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5
Company 3	87.5	87.5	38.0	63.0	63.0	63.0	63.0	38.0	87.5	63.0	87.5	87.5	63.0
Company 4	12.5	12.5		12.5	12.5	63.0	12.5	38.0	38.0	38.0	38.0	87.5	12.5
Company 5	0.0	0.0	0.0	0.0	0.0	12.5	12.5	0.0	0.0	0.0	0.0	0.0	38.0
Company 6	38.0	12.5	0.0	63.0	38.0	38.0	63.0	38.0	38.0	63.0	63.0	38.0	12.5
Company 7	0.0	0.0	0.0	12.5	38.0	87.5	87.5	63.0	38.0	12.5	63.0	87.5	12.5
Company 8		87.5	63.0				87.5	63.0	63.0	87.5	87.5	87.5	12.5
Company 9	12.5	38.0	0.0	87.5	0.0	87.5	87.5	38.0	38.0	12.5	12.5	87.5	38.0
Company 10				63.0	38.0	63.0	63.0	63.0		63.0	63.0	63.0	38.0
Company 11	0.0	0.0	0.0	12.5	12.5	12.5	12.5	12.5	12.5	0.0	38.0	38.0	63.0
Company 12	0.0	0.0	12.5	12.5	12.5	63.0	63.0	12.5	12.5	38.0	38.0	38.0	38.0
Company 13	87.5	87.5		87.5	63.0	87.5	87.5	63.0	87.5		87.5	87.5	38.0
Company 14	12.5	12.5	0.0	12.5	12.5	63.0	63.0	12.5	63.0	12.5	12.5	12.5	12.5
Company 15	12.5	12.5	12.5	12.5	63.0	38.0	38.0	38.0	38.0	12.5	63.0	63.0	87.5
Company 16	12.5	38.0	0.0	38.0	12.5	38.0	63.0	38.0	12.5	12.5	38.0	63.0	38.0
Company 17	12.5	12.5		38.0	12.5	63.0			87.5	12.5	63.0		38.0
Company 18			12.5	87.5	12.5	63.0	87.5	12.5	87.5	87.5	12.5	63.0	87.5
Company 19	0.0	87.5	0.0	0.0	87.5	63.0	87.5		87.5	87.5	87.5	87.5	63.0
Company 20				63.0		87.5	87.5		87.5	12.5	12.5		
Company 21	12.5	12.5	12.5	87.5	87.5	87.5	38.0	38.0	63.0	63.0	63.0	87.5	12.5
Company 22	0.0	87.5	0.0	0.0	0.0	87.5	87.5	12.5	63.0		38.0	63.0	63.0
Company 23	0.0	0.0	0.0	12.5	0.0	63.0	12.5	0.0	63.0	38.0	12.5	38.0	87.5
Company 24	38.0	38.0	12.5	63.0	38.0	38.0	38.0	12.5	38.0	38.0	12.5	63.0	38.0
Company 25	38.0	0.0	0.0	12.5	12.5	38.0	63.0	38.0	12.5	38.0	38.0	87.5	38.0
Company 26	0.0	0.0	12.5	12.5	12.5	87.5	87.5	87.5	87.5	12.5	12.5	87.5	87.5
Company 27	12.5	12.5	0.0	0.0	0.0	63.0	87.5	12.5	63.0	38.0	38.0	38.0	38.0
Company 28						87.5	87.5		87.5		87.5	87.5	87.5
Company 29			38.0	12.5	12.5	63.0	38.0	63.0	63.0	63.0	63.0	63.0	12.5
Company 30	0.0	0.0	0.0	12.5	12.5	87.5	12.5	12.5	87.5	12.5	87.5	38.0	63.0
Company 31	12.5	0.0	0.0			87.5	87.5	38.0	87.5		38.0	87.5	12.5
Company 32	0.0	12.5	0.0	12.5	87.5	38.0	12.5	12.5	63.0	12.5	12.5	12.5	12.5
Company 33	12.5	12.5	63.0	12.5	38.0	63.0	63.0	12.5	63.0	12.5	12.5	63.0	63.0
Company 34	0.0	0.0	0.0	12.5	12.5	38.0	38.0	12.5	63.0	38.0	0.0	38.0	63.0
Company 35	0.0	0.0	0.0	0.0	12.5	38.0	87.5	12.5	63.0	12.5	0.0	12.5	12.5
Company 36	12.5	12.5	0.0	12.5	12.5	38.0	63.0		87.5		87.5	87.5	38.0
Company 37	0.0	0.0	0.0	87.5	0.0	12.5	0.0	12.5	63.0	0.0	12.5	12.5	38.0
Company 38	0.0	0.0	0.0			87.5	87.5	38.0	87.5		38.0	38.0	63.0
Company 39	12.5	12.5	0.0	0.0	0.0	87.5	12.5	0.0	12.5	0.0	38.0	63.0	12.5
Company 40	0.0	0.0	0.0	0.0	0.0	87.5	87.5	12.5	87.5	38.0	63.0	12.5	38.0
Company 41	0.0	0.0	0.0	12.5	12.5	38.0	0.0	12.5	12.5	12.5	38.0	38.0	38.0
Company 42	0.0	38.0	0.0	38.0	0.0	38.0	63.0	12.5	63.0	38.0	63.0	63.0	12.5
Company 43	0.0	0.0	0.0	12.5	0.0	87.5	12.5	12.5	12.5	0.0	12.5	0.0	12.5
Company 44	12.5	12.5	12.5	12.5	38.0	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Company 45	0.0	0.0	0.0		0.0				87.5		87.5		38.0
Company 46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	12.5	12.5	38.0
Company 47	0.0	0.0	0.0	38.0	63.0	87.5	87.5	38.0	63.0	63.0	87.5	63.0	87.5
Company 48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0
Company 49	12.5	0.0	0.0	0.0	12.5	12.5	0.0	12.5	0.0	12.5	38.0	38.0	12.5
Company 50	38.0	38.0	0.0	38.0	12.5	12.5	0.0	0.0	0.0	0.0	38.0	0.0	12.5
Company 51	12.5	38.0	0.0	0.0	0.0	12.5	12.5	12.5	12.5	0.0	12.5	0.0	38.0

Company	Planning for Modularization	Planning for Startup	Prod. Adjustment Factors	Project Controls	Project Delivery and Contract Strategy Analysis	Project Organization Planning	Project Risk Assessment	Quality Mgmnt.	Rework Reduction Program	Team Building	Tech. Innovation & Investig.	Workforce Devpmt. Assmt.	Zero Accident Technqs.
Company 1	87.5	87.5		87.5	87.5	87.5	87.5	87.5	87.5	87.5	12.5	12.5	87.5
Company 2	38.0	87.5	87.5	87.5	87.5	87.5	87.5	38.0	87.5	38.0	87.5	87.5	87.5
Company 3	63.0	63.0	87.5	87.5	87.5	87.5	87.5	87.5	63.0	87.5	38.0	63.0	87.5
Company 4	87.5	87.5	63.0	87.5	87.5	87.5	87.5	87.5	38.0	38.0	38.0	38.0	87.5
Company 5	0.0	0.0	0.0	38.0	12.5	38.0	12.5	12.5	0.0	12.5	12.5	12.5	12.5
Company 6	63.0	63.0	87.5	87.5	63.0	87.5	87.5	38.0	38.0	38.0	38.0	63.0	87.5
Company 7	63.0	63.0	87.5	87.5	87.5	87.5	87.5	87.5	38.0	63.0	38.0	63.0	87.5
Company 8	38.0	87.5	0.0	63.0	12.5	63.0	63.0		87.5		38.0		87.5
Company 9	63.0	63.0	63.0	87.5	63.0	87.5	87.5	87.5	38.0	63.0	38.0	63.0	87.5
Company 10	63.0	63.0	63.0	87.5	87.5	87.5	87.5	87.5	0.0	63.0	38.0	63.0	87.5
Company 11	63.0	12.5	12.5	12.5	12.5	38.0	12.5	12.5	0.0	87.5	12.5	0.0	38.0
Company 12	63.0	63.0	63.0	87.5	87.5	87.5	87.5	38.0	38.0	63.0	63.0	63.0	87.5
Company 13	38.0	38.0	63.0	87.5	87.5	87.5	87.5	87.5	87.5	87.5	63.0	87.5	87.5
Company 14	12.5	12.5	38.0	38.0	12.5	63.0	38.0	63.0	63.0	12.5	12.5	38.0	87.5
Company 15	87.5	63.0	38.0	87.5	87.5	63.0	87.5	63.0	12.5	63.0	38.0	12.5	87.5
Company 16	63.0	63.0	63.0	63.0	63.0	38.0	38.0	63.0	38.0	12.5	12.5	63.0	63.0
Company 17	38.0	87.5	63.0	87.5	63.0	38.0	87.5		12.5	38.0	12.5		12.5
Company 18	12.5	87.5	12.5	87.5	87.5	87.5	87.5	63.0	38.0	87.5	87.5	87.5	87.5
Company 19	38.0	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	38.0	87.5	87.5
Company 20		63.0	63.0	87.5	87.5	87.5	87.5	87.5		63.0	63.0		87.5
Company 21	38.0	63.0	63.0	87.5	63.0	63.0	63.0	38.0	38.0	63.0	38.0	38.0	87.5
Company 22	12.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	63.0	38.0	87.5	87.5
Company 23	87.5	63.0	0.0	87.5	87.5	87.5	87.5	87.5	12.5	87.5	87.5	63.0	87.5
Company 24	38.0	38.0	38.0	38.0	38.0	38.0	63.0	63.0	38.0	38.0	38.0	38.0	
Company 25	87.5	87.5	63.0	87.5	38.0	38.0	63.0	87.5	12.5	38.0	63.0	63.0	87.5
Company 26	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	0.0	87.5
Company 27	12.5	12.5	12.5	63.0	63.0	38.0	38.0	38.0	38.0	38.0	12.5	12.5	87.5
Company 28	12.5	87.5		63.0	38.0	87.5	38.0	87.5		0.0			87.5
Company 29	63.0	87.5	38.0	87.5	87.5	87.5	63.0	63.0	38.0	63.0	38.0	87.5	87.5
Company 30	38.0	87.5	38.0	87.5	87.5	87.5	87.5	87.5	0.0	87.5	38.0	87.5	87.5
Company 31	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	0.0	87.5	12.5	0.0	87.5
Company 32	12.5	12.5	12.5	63.0	87.5	87.5	87.5	87.5	12.5	12.5	0.0	12.5	87.5
Company 33	63.0	38.0	12.5	38.0	87.5	87.5	87.5	38.0	12.5	63.0	38.0	63.0	87.5
Company 34	63.0	38.0	12.5	87.5	38.0	63.0	63.0	63.0	12.5	38.0	38.0	12.5	87.5
Company 35	0.0	12.5	0.0	63.0	12.5	38.0	12.5	63.0	0.0	12.5	0.0	12.5	87.5
Company 36	12.5	87.5		63.0	12.5	87.5	63.0	87.5	0.0	38.0	12.5	0.0	87.5
Company 37	38.0	38.0	12.5	87.5	38.0	87.5	12.5	63.0	0.0	12.5	12.5	0.0	87.5
Company 38	63.0	63.0		63.0	0.0		38.0	87.5	0.0	87.5	0.0	0.0	87.5
Company 39	87.5	87.5	12.5	87.5	87.5	38.0	63.0	63.0	0.0	38.0	12.5	12.5	87.5
Company 40	38.0	87.5	12.5	87.5	63.0	87.5	87.5	87.5	12.5	38.0	12.5	63.0	87.5
Company 41	63.0	87.5	38.0	63.0	38.0	38.0	63.0	63.0	12.5	38.0	63.0	12.5	87.5
Company 42	12.5	38.0	38.0	38.0	0.0	38.0	38.0	87.5	87.5	87.5	63.0	87.5	87.5
Company 43	12.5	12.5	0.0	12.5	38.0	38.0	38.0	63.0	12.5	38.0	38.0	0.0	87.5
Company 44	12.5	12.5	12.5	38.0	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	87.5
Company 45	87.5	87.5		87.5	87.5	87.5	87.5	87.5		87.5			87.5
Company 46	12.5	12.5	0.0	38.0	12.5	12.5	12.5	12.5	0.0	12.5	0.0	0.0	63.0
Company 47	87.5	87.5	38.0	87.5	63.0	38.0	63.0	87.5	63.0	87.5	63.0	12.5	87.5
Company 48	0.0	0.0	0.0	38.0	0.0	0.0	0.0	0.0	0.0	38.0	0.0	0.0	0.0
Company 49	12.5	38.0	0.0	38.0	12.5	12.5	63.0	12.5	12.5	12.5	12.5	0.0	63.0
Company 50	38.0	12.5	0.0	12.5		12.5	12.5	0.0	12.5	12.5	0.0	0.0	63.0
Company 51	0.0	0.0	12.5	63.0	0.0	12.5	12.5	38.0	0.0	0.0	12.5	12.5	87.5

Appendix D: Data Analysis

PROGRAM SCORE – 94 ACTIONS

Data Analysis – Kruskal-Wallis Groups

Through Kruskal-Wallis, larger Z-Values indicate distribution difference between the two groups. Here, distributions are utilization of each practice, and the two groups are based on Program Score rankings.

	Kruskal-Wallis - Statistics of Group 1 vs. Group 2								
Count	Productivity Practice	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)				
1	Activity Analysis	138	391	-2.198	0.028		Groups		
2	Advanced Work Packaging (AWP)	185	438	-1.219	0.223		1.0	2.0	
3	Alignment	221	474	-0.507	0.612		Higher	Lower	
4	Benchmarking and Metrics	198	474	-1.084	0.278		45%	45%	
5	Best Prod. Practice Implementation Index (BPPII)	135	366	-2.114	0.035		Program	Program	
6	Change Management	158	434	-2.258	0.024		Scores	Scores	
7	Constructability	198	474	-1.534	0.125				
8	Craft Information Systems	107	338	-3.282	0.001				
9	Crew Balance Chart	65	318	-3.608	0.000				
10	Disputes Prevention and Resolution	36	207	-4.333	0.000		Colors		
11	Engineering Management Interface	138	414	-2.531	0.011				<=0.05
12	Equipment and Tool Logistics	97	350	-3.344	0.001				<=0.10
13	Financial Incentives for Productivity - Craft	167	420	-1.240	0.215				<=0.25
14	Financial Incentives for Productivity - Supervisors	141	394	-2.153	0.031				
15	Five-Minute Ratings	155	431	-1.518	0.129				
16	Flow Diagrams and Process Charts	123	333	-2.540	0.011				
17	Foremen / Craft Input	146	377	-1.963	0.050				
18	Front End Planning	179	432	-1.740	0.082				
19	Human Resource Management	136	389	-2.388	0.017				
20	Implementation of CII Research	110	341	-2.387	0.017				
21	Interface Management	214	490	-0.679	0.497				
22	Lean Construction	109	299	-2.547	0.011				
23	Lessons Learned	203	479	-1.397	0.162				
24	Materials Management	106	359	-3.127	0.002				
25	Partnering	188	464	-1.548	0.122				
26	Planning for Modularization	197	473	-1.306	0.192				
27	Planning for Startup	211	487	-1.222	0.222				
28	Productivity Adjustment Factors	90	300	-3.345	0.001				
29	Project Controls	163	439	-2.513	0.012				
30	Project Delivery and Contract Strategy Analysis	151	404	-2.461	0.014				
31	Project Organization Planning	158	411	-2.373	0.018				
32	Project Risk Assessment	137	413	-3.018	0.003				
33	Quality Management	207	483	-0.873	0.383				
34	Rework Reduction Program	100	353	-3.447	0.001				
35	Team Building	179	455	-1.745	0.081				
36	Technology and Innovation Investigation	137	390	-2.745	0.006				
37	Workforce Development Assessment	99	352	-3.129	0.002				
38	Zero Accidents Techniques	262	538	-0.083	0.934				

Data Analysis – Kruskal-Wallis Ranks

Kruskal-Wallis Ranks (for Program Score Groups)					
Count	Productivity Practice	Group Splits	N	Mean Rank	Sum of Ranks
1	Activity Analysis	1.0	20	26	513
		2.0	22	18	391
		Total	42		
2	Advanced Work Packaging (AWP)	1.0	21	24	508
		2.0	22	20	438
		Total	43		
3	Alignment	1.0	22	23	516
		2.0	22	22	474
		Total	44		
4	Benchmarking and Metrics	1.0	21	25	517
		2.0	23	21	474
		Total	44		
5	Best Productivity Practice Implementation Index (BPPII)	1.0	20	25	496
		2.0	21	17	366
		Total	41		
6	Change Management	1.0	22	27	601
		2.0	23	19	434
		Total	45		
7	Constructability	1.0	23	26	607
		2.0	23	21	474
		Total	46		
8	Craft Information Systems	1.0	23	28	653
		2.0	21	16	338
		Total	44		
9	Crew Balance Chart	1.0	17	27	463
		2.0	22	14	318
		Total	39		
10	Disputes Prevention and Resolution	1.0	20	27	535
		2.0	18	11	207
		Total	38		
11	Engineering Management Interface	1.0	21	27	577
		2.0	23	18	414
		Total	44		
12	Equipment and Tool Logistics	1.0	21	28	597
		2.0	22	16	350
		Total	43		
13	Financial Incentives for Productivity - Craft	1.0	19	23	441
		2.0	22	19	420
		Total	41		
14	Financial Incentives for Productivity - Supervisors	1.0	20	25	509
		2.0	22	18	394
		Total	42		
15	Five-Minute Ratings	1.0	17	23	389
		2.0	23	19	431
		Total	40		
16	Flow Diagrams and Process Charts	1.0	22	26	570
		2.0	20	17	333
		Total	42		
17	Foremen / Craft Input	1.0	21	25	526
		2.0	21	18	377
		Total	42		
18	Front End Planning	1.0	23	26	603
		2.0	22	20	432
		Total	45		

Groups	
1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Count	Productivity Practice	Group Splits	N	Mean Rank	Sum of Ranks
Kruskal-Wallis Ranks (for Program Score Groups)					
19	Human Resource Management	1.0	21	27	558
		2.0	22	18	389
		Total	43		
20	Implementation of CII Research	1.0	18	24	440
		2.0	21	16	341
		Total	39		
21	Interface Management	1.0	21	24	501
		2.0	23	21	490
		Total	44		
22	Lean Construction	1.0	21	25	522
		2.0	19	16	299
		Total	40		
23	Lessons Learned	1.0	23	26	603
		2.0	23	21	479
		Total	46		
24	Materials Management	1.0	21	28	588
		2.0	22	16	359
		Total	43		
25	Partnering	1.0	22	26	571
		2.0	23	20	464
		Total	45		
26	Planning for Modularization	1.0	22	26	562
		2.0	23	21	473
		Total	45		
27	Planning for Startup	1.0	23	26	594
		2.0	23	21	487
		Total	46		
28	Productivity Adjustment Factors	1.0	22	27	603
		2.0	20	15	300
		Total	42		
29	Project Controls	1.0	23	28	642
		2.0	23	19	439
		Total	46		
30	Project Delivery and Contract Strategy Analysis	1.0	23	27	631
		2.0	22	18	404
		Total	45		
31	Project Organization Planning	1.0	23	27	625
		2.0	22	19	411
		Total	45		
32	Project Risk Assessment	1.0	23	29	668
		2.0	23	18	413
		Total	46		
33	Quality Management	1.0	21	24	508
		2.0	23	21	483
		Total	44		
34	Rework Reduction Program	1.0	22	29	638
		2.0	22	16	353
		Total	44		
35	Team Building	1.0	22	26	581
		2.0	23	20	455
		Total	45		
36	Technology and Innovation Investigation	1.0	23	28	645
		2.0	22	18	390
		Total	45		
37	Workforce Development Assessment	1.0	20	28	551
		2.0	22	16	352
		Total	42		
38	Zero Accidents Techniques	1.0	23	23	538
		2.0	23	24	543
		Total	46		

Groups	
1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Statement Reduction Calculations

Values represent average response from RT-340 team members responding to each Action's "level of importance" for the Corporate Productivity Program success:

Level of Importance	Not	Slightly	Mod	Very	Extremely
Short-hand	N	S	M	V	E
Action Value	0	2.5	5	7.5	10

Rules Used:

      Include all Actions averaging "Very Good" (7.5 avg., 82.5 sum) or better

      Minimum of 8 Actions per Element (add highest scoring Actions first)

      Actions kept through statement reduction are highlighted.

Leadership		0.0	2.5	5.0	7.5	10.0		
#	Statement Importance	N	S	M	V	E	Total	Score
1	Corporate productivity objectives and goals are defined.	0	0	0	5	6	11	**97.5**
2	Corporate productivity objectives and goals support business objectives.	0	0	1	4	6	11	**95.0**
3	Business stakeholders are aligned on corporate productivity goals and objectives.	0	0	2	4	5	11	**90.0**
4	Corporate leaders take ownership of productivity practices and processes.	0	0	1	6	4	11	**90.0**
5	Corporate level decisions about productivity and productivity practices are routed for buy-in and feedback.	0	0	3	7	1	11	**77.5**
6	Projects leaders are aligned on corporate productivity plans and actions.	0	0	1	6	4	11	**90.0**
7	Corporate culture, such as employee mindsets and company risk-reward norms, supports implementation of productivity practices.	0	0	1	5	5	11	**92.5**
8	Corporate leaders display commitment to construction productivity objectives.	0	0	0	6	5	11	**95.0**
9	Corporate champions for productivity goals, practices or initiatives are identified and given leverage to support their productivity improvement work.	0	0	2	6	3	11	**85.0**
10	Corporate leaders promote implementation of productivity practices or initiatives across the company project portfolio.	0	0	2	6	3	11	**85.0**
11	Corporate leaders are consistent across the company in communication and support around productivity goals.	0	0	2	4	5	11	**90.0**
12	Corporate leadership provides recognition for personnel implementing productivity practices or projects that are successful with productivity improvement goal.	0	1	5	2	3	11	**72.5**
13	Project leadership provides recognition for personnel implementing productivity practices or projects that are successful with productivity improvement goal.	0	0	5	3	3	11	**77.5**
14	Project leaders set project productivity goals and measurements.	0	0	1	6	4	11	**90.0**
15	Project leadership is supported by corporate or functional levels with practices and standards when implementing productivity efforts.	0	1	0	4	6	11	**92.5**

#	Resources Statement Importance	0 N	2.5 S	5.0 M	7.5 V	10.0 E	Total	Score
1	Qualified personnel are available for positions that manage construction productivity practices and scope on projects.	0	2	3	3	3	11	**72.5**
2	Corporate personnel are working to promote implementation of productivity practices.	0	0	3	7	1	11	**77.5**
3	Corporate personnel are held accountable for their roles with productivity goals and objectives.	0	0	2	5	4	11	**87.5**
4	Corporate personnel have allotted time to perform their duties relative to productivity objectives, practices, and initiatives.	0	0	3	7	1	11	**77.5**
5	Corporate personnel are provided training and development to properly address productivity in their scope.	0	0	5	4	2	11	**75.0**
6	Project personnel are provided training and development to properly address productivity in their scope.	0	0	2	5	4	11	**87.5**
7	Project personnel fully understand and support productivity practices.	0	0	1	5	5	11	**92.5**
8	Project teams and personnel implementing productivity practices are capable of defining, measuring, and controlling the data and scope decisions.	0	0	4	4	3	11	**80.0**
9	Qualifications to ensure individual capability are in place for positions that manage construction productivity practices.	0	2	3	3	3	11	**72.5**
10	Funding is provided for corporate productivity objectives.	0	0	2	7	2	11	**82.5**
11	Front-end cash flows invested toward productivity improvement are acceptable for project leadership, such as work packaging, or early involvement from construction.	0	0	1	7	3	11	**87.5**
12	Technology and tools needed for implementation or productivity practices on projects are available.	0	0	3	6	2	11	**80.0**
13	Productivity tools create reports or output information that are used in decision making on projects.	0	1	1	7	2	11	**80.0**
14	Data and history needed for productivity tools is available.	0	0	4	7	0	11	**72.5**
15	Productivity tools and systems are fit for purpose or adjustable - based on project size and complexity.	0	0	3	7	1	11	**77.5**
16	Interfaces between productivity systems and systems supporting other functions (e.g.: accounting, payroll, project controls, and safety) are established.	1	0	4	6	0	11	**65.0**

#	Program Structure & Communications Statement Importance	0.0 N	2.5 S	5.0 M	7.5 V	10.0 E	Total
1	Corporate functions or departments (e.g.: quality, safety, construction, engineering, IT) are aligned on company productivity objectives.	0	0	2	6	3	11
2	Project groups or teams (e.g.: quality, safety, construction, engineering, IT) are aligned on project productivity objectives.	0	1	0	9	1	11
3	Clear interfaces are established between the corporate departments regarding productivity practice changes and initiatives.	0	0	6	5	0	11
4	Other programs, such as quality, safety, construction, engineering, understand their impact and roles regarding construction productivity performance.	0	0	4	6	1	11
5	Construction productivity reports are shared across functions, disciplines, and groups.	0	1	3	6	1	11
6	Interdisciplinary or cross-function collaboration is established to enable achievement of productivity goals.	0	1	3	4	3	11
7	Corporate management communicates roles and responsibilities within productivity practices for corporate personnel.	0	0	2	7	2	11
8	Corporate personnel are held accountable for their productivity practice responsibilities.	0	0	2	4	5	11
9	Project teams have available corporate support contacts when implementing productivity practices.	0	0	2	8	1	11
10	The company hiring process enables construction productivity. (e.g.: craft skill and availability is evaluated or training is established to cover deficiencies in specific regions, trades, etc.)	1	0	4	4	2	11
11	Personnel from various countries collaborate well for productivity objectives.	1	2	6	2	0	11
12	Cultural backgrounds are considered when implementing productivity practices.	2	2	6	0	1	11
13	Language barriers to productivity practices are well managed.	1	3	2	4	1	11
14	There is a corporate organizational plan, structure, and/or group that supports the management of productivity plans and objectives.	0	0	5	5	1	11

Planning for Productivity		0.0	2.5	5.0	7.5	10.0		
#	Statement Importance	N	S	M	V	E	Total	Score
1	Key processes and procedures for corporate productivity practices are documented.	0	0	0	8	3	11	**90.0**
2	Corporate productivity practices and processes are readily available to project personnel.	0	0	0	8	3	11	**90.0**
3	Corporate productivity processes provide enough guidance for project implementation.	0	0	2	8	1	11	**80.0**
4	Corporate expects project productivity efforts to be flexible based on project size and complexity.	0	1	4	5	1	11	**70.0**
5	Corporate ensures that project operating or owner organizations are engaged throughout project life-cycles.	0	1	4	5	1	11	**70.0**
6	Corporate expects projects to conduct alignment meetings between groups and companies that interface with project productivity practices.	0	0	6	4	1	11	**70.0**
7	Company has contracting strategy practices to enable project achievement of productivity and business objectives.	0	0	2	7	2	11	**82.5**
8	Company has established that materials management plans and roles are consistently in-place on projects.	0	0	3	7	1	11	**77.5**
9	Company ensures project controls systems and roles are consistently in-place on projects.	0	0	1	7	3	11	**87.5**
10	Company has established that change management plans are consistently in-place on projects.	0	0	0	10	1	11	**85.0**
11	Construction teams on projects have systems established to enable on-site productivity, such as rapid response to critical RFIs.	1	0	0	9	1	11	**77.5**
12	Company ensures early project plans and design support are established to enable construction productivity.	0	0	0	7	4	11	**92.5**
13	Construction work is consistently packaged for project teams to enable construction efficiency and productivity.	0	2	0	6	3	11	**80.0**
14	Construction, commissioning, and start-up relationship is planned early and facilitated throughout the project life-cycle for company projects.	0	1	1	8	1	11	**77.5**
15	Off-site fabrication or modularization evaluation is supported by company to capture productivity benefits for projects.	0	0	2	9	0	11	**77.5**
16	Safety relationship with productivity is evaluated and planned for relative to specific projects, sites, and conditions.	0	1	2	5	3	11	**80.0**

17	Quality processes are developed and consistently implemented early on company projects to enable construction productivity.	0	0	1	9	1	11	**82.5**
18	Risk assessments are performed prior to implementation or productivity practices.	0	0	1	10	0	11	**80.0**
19	Project site layouts are planned to increase craft time on tools and productivity.	0	1	1	7	2	11	**80.0**
20	Project materials management systems are established and run on company projects.	0	0	3	7	1	11	**77.5**
21	Project schedule sequencing is consistently performed and evaluated on projects.	0	0	1	8	2	11	**85.0**

Productivity Monitoring & Control	0.0	2.5	5.0	7.5	10.0		
# Statement Importance	N	S	M	V	E	Total	Score
1 The company implements practices to check productivity performance on projects, such as benchmarking.	0	0	0	8	3	11	**90.0**
2 Corporate quality management is aligned with construction productivity objectives.	0	0	5	6	0	11	**70.0**
3 Corporate establishes key performance indicators for projects that enables projects to target and monitor specific project metrics.	0	0	1	8	2	11	**85.0**
4 On projects, key productivity performance indicators are tracked throughout the project life.	0	0	3	4	4	11	**85.0**
5 The company has resources to help projects reduce and manage rework.	1	0	2	8	0	11	**70.0**
6 The company drives that project recovery plans consider impacts on productivity.	1	0	5	5	0	11	**62.5**
7 The company has systems and recommendations for evaluation of craft time on tools or available work-hours.	1	1	3	4	2	11	**67.5**
8 The company expects projects to evaluate equipment utilization to validate equipment needs.	1	0	5	4	1	11	**65.0**
9 The company collects performance metrics data from projects.	0	0	3	6	2	11	**80.0**
10 Projects utilization of productivity practices is tracked to verify practice performance.	0	1	2	6	1	10	**67.5**
11 Projects decisions leverage productivity information for impacts and options.	0	1	3	7	0	11	**70.0**
12 Craft productivity, planning, and execution information is readily available and visible so craft teams know how they are performing.	0	1	0	9	1	11	**80.0**
13 Project decision makers are aware of productivity impacts.	0	0	1	4	6	11	**95.0**
14 Project decision makers are aware of productivity's subsequent cost and schedule impacts.	0	0	0	6	5	11	**95.0**
15 Projects evaluate craft time on tools or available work-hours to know how and where productive work-hours are lost.	1	0	0	5	5	11	**87.5**
16 Projects evaluate equipment utilization to validate equipment needs and productivity during project execution.	1	0	2	5	3	11	**77.5**
17 Benchmark data is provided to projects to monitor performance based on location and scope norms.	0	1	1	7	2	11	**80.0**

Continuous Improvement	0.0	2.5	5.0	7.5	10.0		
# Statement Importance	N	S	M	V	E	Total	Score
1 Productivity is tracked or improved through the continuous improvement program.	0	0	2	8	1	11	**80.0**
2 New or innovative productivity practices are encouraged or developed by the company.	0	0	3	5	3	11	**82.5**
3 Pilot projects are used to test new or innovative approaches to productivity improvement.	1	1	4	3	2	11	**65.0**
4 Risk-reward impacts of using or testing productivity practices are balanced by the corporate level.	1	1	4	4	1	11	**62.5**
5 Productivity metrics are measured for future planning and improvement.	1	0	0	7	3	11	**82.5**
6 There is an established feedback cycle for productivity practices performance.	0	1	1	8	1	11	**77.5**
7 Productivity practice performance is used to improve practice utilization.	0	0	2	8	1	11	**80.0**
8 Lessons learned related to productivity are captured and distributed.	0	1	1	8	1	11	**77.5**
9 Documentation of productivity practice improvements are disseminated to projects.	1	0	0	8	2	11	**80.0**
10 Productivity performance data is highlighted for distribution around company.	0	0	1	7	2	10	**77.5**
11 Technology investigation and innovation is enabled through the continuous improvement processes.	0	1	2	7	1	11	**75.0**

54-Action Program Characterization – Actions

Leadership 1	Leadership 2	Leadership 3	Leadership 4	Leadership 6
Corporate productivity objectives and goals are defined.	Corporate productivity objectives and goals support business objectives.	Business stakeholders are aligned on corporate productivity goals and objectives.	Corporate leaders take ownership of productivity practices and processes.	Projects leaders are aligned on corporate productivity plans and actions.

Leadership 7	Leadership 8	Leadership 9	Leadership 10	Leadership 11
Corporate culture, such as employee mindsets and company risk-reward norms, supports implementation of productivity practices.	Corporate leaders display commitment to construction productivity objectives.	Corporate champions for productivity goals, practices or initiatives are identified and given leverage to support their productivity improvement work.	Corporate leaders promote implementation of productivity practices or initiatives across the company project portfolio.	Corporate leaders are consistent across the company in communication and support around productivity goals.

Leadership 14	Leadership 15	Resources 2	Resources 5	Resources 6
Project leaders set project productivity goals and measurements.	Project leadership is supported by corporate or functional levels with practices and standards when implementing productivity efforts.	Corporate personnel are held accountable for their roles with productivity goals and objectives.	Project personnel are provided training and development to properly address productivity in their scope.	Project personnel fully understand and support productivity practices.

Resources 7	Resources 10	Resources 11	Resources 12	Resources 15
Project teams and personnel implementing are capable of defining, measuring, and controlling the data and scope decisions.	Funding is provided for corporate productivity objectives.	Front-end cash flows invested toward productivity improvement are acceptable for project leadership.	Technology and tools needed for implementation or productivity practices on projects are available.	Productivity tools create reports or output information that are used in decision making on projects.

Strct & Comm 1	Strct & Comm 2	Strct & Comm 5	Strct & Comm 6	Strct & Comm 7
Corporate functions or departments (e.g.: quality, safety, construction, engineering, IT) are aligned on company productivity objectives.	Project groups or teams (e.g.: quality, safety, construction, engineering, IT) are aligned on project productivity objectives.	Construction productivity reports are shared across functions, disciplines, and groups.	Interdisciplinary or cross-function collaboration is established to enable achievement of productivity goals.	Corporate management communicates roles and responsibilities within productivity practices for corporate personnel.

Strct & Comm 8	Strct & Comm 9	Strct & Comm 14	Plan Prod 1	Plan Prod 2
Corporate personnel are held accountable for their productivity practice responsibilities.	Project teams have available corporate support contacts when implementing productivity practices.	There is a corporate organizational plan, structure, and/or group that supports the management of productivity plans and objectives.	Key processes and procedures for corporate productivity practices are documented.	Corporate productivity practices and processes are readily available to project personnel.

Plan Prod3	Plan Prod 9	Plan Prod 10	Plan Prod 12	Plan Prod 13
Corporate productivity processes provide enough guidance for project implementation.	Company ensures project controls systems and roles are consistently in-place on projects.	Company has established that change management plans are consistently in-place on projects.	Company ensures early project plans and design support are established to enable construction productivity.	Construction work is consistently packaged for project teams to enable construction efficiency and productivity.

Plan Prod 19	Plan Prod 21	Mon & Cntr 1	Mon & Cntr 3	Mon & Cntr 4
Project site layouts are planned to increase craft time on tools and productivity.	Project schedule sequencing is consistently performed and evaluated on projects.	The company implements practices to check productivity performance on projects, such as benchmarking.	Corporate establishes key performance indicators for projects that enables projects to target and monitor specific project metrics.	On projects, key productivity performance indicators are tracked throughout the project life.

Mon & Cntr 9	Mon & Cntr 12	Mon & Cntr 13	Mon & Cntr 14	Mon & Cntr 15
The company collects performance metrics data from projects.	Craft productivity, planning, and execution information is readily available and visible so craft teams know how they are performing.	Project decision makers are aware of productivity impacts.	Project decision makers are aware of productivity's subsequent cost and schedule impacts.	Projects evaluate craft time on tools or available work-hours to know how and where productive work-hours are lost.

Mon & Cntr 17	Cont Imprv 1	Cont Imprv 2	Cont Imprv 5	Cont Imprv 6
Benchmark data is provided to projects to monitor performance based on location and scope norms.	Productivity is tracked or improved through the continuous improvement program.	New or innovative productivity practices are encouraged or developed by the company.	Productivity metrics are measured for future planning and improvement.	There is an established feedback cycle for productivity practices performance.

Cont Imprv 7	Cont Imprv 8	Cont Imprv 9	Cont Imprv 10
Productivity practice performance is used to improve practice utilization.	Lessons learned related to productivity are captured and distributed.	Documentation of productivity practice improvements are disseminated to projects.	Productivity performance data is highlighted for distribution around company.

Program Score and Practice Utilization

Response	Program Score Group	Program Average	Activity Analysis	Advanced Work Packaging (AWP)	Alignment	Benchmarking and Metrics	Best Productivity Practice Implementation Index (BPPII)	Change Management	Constructability	Craft Information Systems	Crew Balance Chart
Response X1	1.0	4.4			87.5			87.5	87.5	87.5	
Response X2	1.0	4.4	0	87.5	87.5	87.5	0	87.5	87.5	87.5	12.5
Response X3	1.0	4.2	38	87.5	63	87.5	12.5	87.5	87.5	63	87.5
Response X4	1.0	4.1	87.5	63	87.5	63	38	63	87.5	38	38
Response X5	1.0	4.1	87.5	12.5	12.5	87.5	38	63	87.5	87.5	63
Response X6	1.0	4.0	0	0	38	38	0	12.5	63	0	12.5
Response X7	1.0	4.0	87.5	38	63	63	87.5	87.5	87.5	63	
Response X8	1.0	4.0	87.5	63	63	87.5	38	63	87.5	63	63
Response X9	1.0	4.0				87.5		87.5	87.5		
Response X10	1.0	3.9	38	12.5	63	12.5	0	87.5	63	63	0
Response X11	1.0	3.8	12.5	12.5	0	12.5	12.5	38	38	12.5	12.5
Response X12	1.0	3.7	12.5	12.5	12.5	12.5		12.5	12.5	12.5	
Response X13	1.0	3.7	12.5	12.5	12.5	12.5	12.5	38	38	12.5	12.5
Response X14	1.0	3.7	12.5	12.5	63	38	12.5	38	38	12.5	12.5
Response X15	1.0	3.7	87.5	63	87.5	87.5	63	87.5	87.5	87.5	87.5
Response X16	1.0	3.7	12.5	12.5	38	63	63	87.5	38	38	38
Response X17	1.0	3.6	12.5	12.5	38	38	12.5	63	12.5	12.5	38
Response X18	1.0	3.6	12.5	12.5	38	12.5	12.5	12.5	63	12.5	38
Response X19	1.0	3.5	0	12.5					87.5	63	
Response X20	1.0	3.5		12.5	12.5	12.5	12.5	87.5	38	0	
Response X21	1.0	3.5	38	38	63	12.5	0	87.5	63	87.5	63
Response X22	1.0	3.5			38	12.5	12.5	87.5	87.5	63	
Response X23	1.0	3.5	12.5	87.5	87.5	87.5	0	87.5	87.5	87.5	12.5
Response X24		3.4	63	12.5	38	63	12.5	87.5	63	38	12.5
Response X25		3.4	0	87.5	87.5	0	0	87.5	63	12.5	38
Response X26		3.3	87.5	87.5	87.5	87.5	12.5	87.5	87.5	63	38
Response X27		3.3	0	0	63	38	0	63	63	0	0
Response X28		3.3	38	87.5	12.5	38	38	12.5	87.5	38	
Response X29	2.0	3.3	12.5	12.5	87.5	12.5	12.5	63	38	38	87.5
Response X30	2.0	3.3	63	87.5	63	63	63	63	63	63	63
Response X31	2.0	3.3	0	12.5	87.5	12.5	0	87.5	87.5	0	0
Response X32	2.0	3.2	12.5	12.5	87.5	87.5	12.5	87.5	63	12.5	38
Response X33	2.0	3.2	12.5	12.5	63	12.5	0	12.5	63	63	
Response X34	2.0	3.2		38	38	12.5	12.5	63	38	12.5	
Response X35	2.0	3.0	38	12.5	38	12.5	12.5	38	87.5	38	12.5
Response X36	2.0	3.0	0		12.5	12.5	12.5	12.5	12.5	38	0
Response X37	2.0	3.0	0	63	87.5	12.5	0	87.5	87.5	12.5	38
Response X38	2.0	2.9	12.5	12.5	38	12.5	0	12.5	38	12.5	0
Response X39	2.0	2.9	12.5	38	63	38	12.5	12.5	38	12.5	0
Response X40	2.0	2.8	0	12.5	87.5	38	0	87.5	63	0	0
Response X41	2.0	2.8	0	0	12.5	38	0	63	87.5	0	0
Response X42	2.0	2.7	63	12.5	87.5	63	0	38	87.5	12.5	0
Response X43	2.0	2.7	12.5	38	38	38	12.5	38	63	38	12.5
Response X44	2.0	2.7	12.5	12.5	63	38	12.5	38	38	12.5	12.5
Response X45	2.0	2.6	12.5	38	38	38	38	63	38	12.5	12.5
Response X46	2.0	2.6	12.5	12.5	12.5	12.5	0	12.5	12.5	12.5	12.5
Response X47	2.0	2.5	0	12.5	12.5	12.5	0	12.5	12.5	0	0
Response X48	2.0	2.5	0	0	0	38	0	0	12.5	0	0
Response X49	2.0	2.4	12.5	12.5	12.5	12.5	0	12.5	12.5	0	0
Response X50	2.0	2.3	12.5	87.5	63	87.5	12.5	87.5	87.5		12.5
Response X51	2.0	2.1	0	0	0	0	0	63	12.5	0	0

Response	Program Score Group	Program Average	Disputes Prevention and Resolution	Engineering Management Interface	Equipment and Tool Logistics	Financial Incentives for Productivity – Craft	Financial Incentives for Productivity – Supervisors	Five-Minute Ratings	Flow Diagrams and Process Charts	Foremen / Craft Input	Front End Planning
Response X1	1.0	4.4		87.5	87.5	0	0		38	63	63
Response X2	1.0	4.4	87.5	87.5	87.5	0	0	0	87.5	12.5	87.5
Response X3	1.0	4.2	63	87.5	87.5	87.5	87.5	38	63	63	63
Response X4	1.0	4.1	38	63	12.5	12.5	12.5		12.5	12.5	63
Response X5	1.0	4.1	63		12.5	0	0	0	12.5	38	87.5
Response X6	1.0	4.0	12.5	38	0	0	0	0	0	0	12.5
Response X7	1.0	4.0			63		87.5	63			87.5
Response X8	1.0	4.0	38	12.5	63	38	12.5	0	63	38	38
Response X9	1.0	4.0									
Response X10	1.0	3.9	38	63	87.5	12.5	38	0	87.5	0	87.5
Response X11	1.0	3.8	12.5	12.5	12.5	0	0	0	12.5	12.5	12.5
Response X12	1.0	3.7	87.5	63	63				63	38	63
Response X13	1.0	3.7	38	12.5	38	0	0	12.5	12.5	12.5	63
Response X14	1.0	3.7	12.5	63	12.5	12.5	12.5	0	12.5	12.5	63
Response X15	1.0	3.7	87.5	87.5	87.5	87.5	87.5		87.5	63	87.5
Response X16	1.0	3.7	87.5	38	38	12.5	12.5	12.5	12.5	63	38
Response X17	1.0	3.6	63	12.5	63	12.5	38	0	38	12.5	38
Response X18	1.0	3.6	63	12.5	12.5			12.5	87.5	12.5	63
Response X19	1.0	3.5	87.5	12.5	38	0	87.5	0	0	0	87.5
Response X20	1.0	3.5		63		12.5	12.5		38	12.5	63
Response X21	1.0	3.5	87.5	63	87.5	0	87.5	0	0	87.5	63
Response X22	1.0	3.5	87.5	87.5					63		87.5
Response X23	1.0	3.5	0	87.5	87.5	0	0	12.5	12.5	12.5	87.5
Response X24		3.4	87.5	38	63	38	0	0	12.5	12.5	38
Response X25		3.4	87.5	63	38	0	0	0	12.5	0	63
Response X26		3.3	87.5	87.5	63	12.5	12.5	12.5	87.5	87.5	87.5
Response X27		3.3	87.5	63	0	0	0	0	0	0	63
Response X28		3.3		12.5		0	0	0	12.5	12.5	87.5
Response X29	2.0	3.3	38	38	12.5	0	12.5	0	12.5	87.5	38
Response X30	2.0	3.3	63	38	38	38	38	12.5	63	38	38
Response X31	2.0	3.3		63	0	12.5	0	0			87.5
Response X32	2.0	3.2	38	63	63			38	12.5	12.5	63
Response X33	2.0	3.2		87.5	87.5						87.5
Response X34	2.0	3.2	12.5	12.5	12.5	12.5	12.5	0	0	0	63
Response X35	2.0	3.0	38	63	38	12.5	12.5	63	12.5	38	63
Response X36	2.0	3.0	12.5	12.5	12.5	0	0	0	0	12.5	38
Response X37	2.0	3.0	38	0	12.5	0	0	0	87.5	0	12.5
Response X38	2.0	2.9	38	38	12.5	0	0	0	12.5	12.5	38
Response X39	2.0	2.9	12.5	38	63	12.5	12.5	0	12.5	12.5	38
Response X40	2.0	2.8		63	0	0	0	0			87.5
Response X41	2.0	2.8	12.5	63	0	12.5	12.5	0	0	0	87.5
Response X42	2.0	2.7	12.5	38	63	0	0	0	0	0	87.5
Response X43	2.0	2.7	0	0	0	0	38	0	38	0	38
Response X44	2.0	2.7	0	12.5	0	0	0	0	12.5	0	87.5
Response X45	2.0	2.6	12.5	12.5	38	0	0	0	12.5	12.5	38
Response X46	2.0	2.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	38	12.5
Response X47	2.0	2.5	0	12.5	0	0	0	0	0	0	0
Response X48	2.0	2.5	0	0	0	0	0	0	0	0	0
Response X49	2.0	2.4	0	12.5	0	12.5	0	0	0	12.5	12.5
Response X50	2.0	2.3	12.5	38	38	0	0	0	38	63	87.5
Response X51	2.0	2.1	0	12.5	0	12.5	38	0	0	0	12.5

Response	Program Score Group	Program Average	Human Resource Management	Implementation of CII Research	Interface Management	Lean Construction	Lessons Learned	Materials Management	Partnering	Planning for Modularization	Planning for Startup	Productivity Adjustment Factors
Response X1	1.0	4.4				38	63	87.5	63	87.5	87.5	
Response X2	1.0	4.4	87.5	87.5	87.5	87.5	87.5	87.5	87.5	38	87.5	87.5
Response X3	1.0	4.2	63	38	87.5	63	87.5	87.5	63	63	63	87.5
Response X4	1.0	4.1	12.5	38	38	38	38	87.5	12.5	87.5	87.5	63
Response X5	1.0	4.1	87.5	63	38	12.5	63	87.5	12.5	63	63	87.5
Response X6	1.0	4.0	12.5	0	0	0	0	0	38	0	0	0
Response X7	1.0	4.0	63		63	87.5	87.5	87.5	12.5	38	87.5	0
Response X8	1.0	4.0	63	38	38	63	63	38	12.5	63	63	87.5
Response X9	1.0	4.0			87.5	63	87.5		38	87.5	87.5	63
Response X10	1.0	3.9	87.5	38	38	12.5	12.5	87.5	38	63	63	63
Response X11	1.0	3.8	12.5	12.5	12.5	0	38	38	63	63	12.5	12.5
Response X12	1.0	3.7	63	63		63	63	63	38	63	63	63
Response X13	1.0	3.7	63	12.5	12.5	38	38	38	38	63	63	63
Response X14	1.0	3.7	63	12.5	63	12.5	12.5	12.5	12.5	12.5	12.5	38
Response X15	1.0	3.7	87.5	63	87.5		87.5	87.5	38	38	38	63
Response X16	1.0	3.7	38	38	38	12.5	63	63	87.5	87.5	63	38
Response X17	1.0	3.6	63	38	12.5	12.5	38	63	38	63	63	63
Response X18	1.0	3.6	87.5	12.5	87.5	87.5	12.5	63	87.5	12.5	87.5	12.5
Response X19	1.0	3.5	87.5	12.5	63		38	63	63	12.5	87.5	87.5
Response X20	1.0	3.5			87.5	12.5	63		38	38	87.5	63
Response X21	1.0	3.5	87.5		87.5	87.5	87.5	87.5	63	38	87.5	87.5
Response X22	1.0	3.5	87.5		87.5	12.5	12.5				63	63
Response X23	1.0	3.5	87.5	87.5	87.5	12.5	12.5	87.5	87.5	87.5	87.5	87.5
Response X24		3.4	63	38	12.5	38	38	87.5	38	87.5	87.5	63
Response X25		3.4	12.5	0	63	38	12.5	38	87.5	87.5	63	0
Response X26		3.3	38	38	63	63	63	87.5	12.5	38	63	63
Response X27		3.3	0	63		12.5	87.5	0	12.5	0	63	
Response X28		3.3	12.5	12.5	87.5	12.5	87.5	38	63	38	87.5	38
Response X29	2.0	3.3	12.5	12.5	63	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Response X30	2.0	3.3	38	12.5	38	38	12.5	63	38	38	38	38
Response X31	2.0	3.3	87.5	38	87.5		38	87.5	12.5	87.5	87.5	87.5
Response X32	2.0	3.2	38	63	63	63	63	63	12.5	63	87.5	38
Response X33	2.0	3.2	87.5		87.5		87.5	87.5	87.5	12.5	87.5	
Response X34	2.0	3.2	87.5	12.5	63	38	38	38	38	12.5	12.5	12.5
Response X35	2.0	3.0	63	12.5	63	12.5	12.5	63	63	63	38	12.5
Response X36	2.0	3.0	87.5	12.5	63	12.5	0	12.5	12.5	0	12.5	0
Response X37	2.0	3.0	0	12.5	63	0	12.5	12.5	38	38	38	12.5
Response X38	2.0	2.9	38	12.5	63	38	0	38	63	63	38	12.5
Response X39	2.0	2.9	63		87.5		87.5	87.5	38	12.5	87.5	
Response X40	2.0	2.8	87.5	38	87.5		38	38	63	63	63	
Response X41	2.0	2.8	12.5	0	12.5	0	38	63	12.5	87.5	87.5	12.5
Response X42	2.0	2.7	87.5	12.5	87.5	38	63	12.5	38	38	87.5	12.5
Response X43	2.0	2.7	63	12.5	63	38	63	63	12.5	12.5	38	38
Response X44	2.0	2.7	12.5	12.5	12.5	0	12.5	0	12.5	12.5	12.5	0
Response X45	2.0	2.6	0	12.5	12.5	12.5	38	38	38	63	87.5	38
Response X46	2.0	2.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Response X47	2.0	2.5	0	0	12.5	0	12.5	12.5	38	12.5	12.5	0
Response X48	2.0	2.5	0	0	0	0	0	0	38	0	0	0
Response X49	2.0	2.4	0	12.5	0	12.5	38	38	12.5	12.5	38	0
Response X50	2.0	2.3	87.5	38	63	63	87.5	63	87.5	87.5	87.5	38
Response X51	2.0	2.1	12.5	12.5	12.5	0	12.5	0	38	0	0	12.5

Response	Program Score Group	Program Average	Project Controls	Project Delivery and Contract Strategy Analysis	Project Organization Planning	Project Risk Assessment	Quality Management	Rework Reduction Program	Team Building	Technology and Innovation Investigation	Workforce Development Assessment	Zero Accidents Techniques
Response X1	1.0	4.4	87.5	87.5	87.5	87.5	87.5	87.5	87.5	12.5	12.5	87.5
Response X2	1.0	4.4	87.5	87.5	87.5	87.5	38	87.5	38	87.5	87.5	87.5
Response X3	1.0	4.2	87.5	87.5	87.5	87.5	87.5	63	87.5	38	63	87.5
Response X4	1.0	4.1	87.5	87.5	87.5	87.5	87.5	38	38	38	38	87.5
Response X5	1.0	4.1	87.5	87.5	87.5	87.5	87.5	38	63	38	63	87.5
Response X6	1.0	4.0	38	12.5	38	12.5	12.5	0	12.5	12.5	12.5	12.5
Response X7	1.0	4.0	63	12.5	63	63		87.5		38		87.5
Response X8	1.0	4.0	87.5	63	87.5	87.5	38	38	38	38	63	87.5
Response X9	1.0	4.0	87.5	87.5	87.5	87.5	87.5	38	87.5	12.5		87.5
Response X10	1.0	3.9	87.5	63	87.5	87.5	87.5	38	63	38	63	87.5
Response X11	1.0	3.8	12.5	12.5	38	12.5	12.5	0	87.5	12.5	0	38
Response X12	1.0	3.7	87.5	87.5	87.5	87.5	87.5	0	63	38	63	87.5
Response X13	1.0	3.7	87.5	87.5	87.5	87.5	38	38	63	63	63	87.5
Response X14	1.0	3.7	38	12.5	63	38	63	63	12.5	12.5	38	87.5
Response X15	1.0	3.7	87.5	87.5	87.5	87.5	87.5	87.5	87.5	63	87.5	87.5
Response X16	1.0	3.7	87.5	87.5	63	87.5	63	12.5	63	38	12.5	87.5
Response X17	1.0	3.6	63	63	38	38	63	38	12.5	12.5	63	63
Response X18	1.0	3.6	87.5	87.5	87.5	87.5	63	38	87.5	87.5	87.5	87.5
Response X19	1.0	3.5	87.5	87.5	87.5	87.5	87.5	87.5	63	38	87.5	87.5
Response X20	1.0	3.5	87.5	63	38	87.5		12.5	38	12.5		12.5
Response X21	1.0	3.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	38	87.5	87.5
Response X22	1.0	3.5	87.5	87.5	87.5	87.5	87.5		63	63		87.5
Response X23	1.0	3.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	0	87.5
Response X24		3.4	87.5	38	38	63	87.5	12.5	38	63	63	87.5
Response X25		3.4	87.5	87.5	87.5	87.5	87.5	12.5	87.5	87.5	63	87.5
Response X26		3.3	87.5	63	63	63	38	38	63	38	38	87.5
Response X27		3.3	87.5	87.5	0	12.5	12.5	0	87.5	12.5	0	87.5
Response X28		3.3	87.5	87.5	87.5	87.5	87.5	0	87.5	38	87.5	87.5
Response X29	2.0	3.3	63	87.5	87.5	87.5	87.5	12.5	12.5	0	12.5	87.5
Response X30	2.0	3.3	38	38	38	63	63	38	38	38	38	
Response X31	2.0	3.3	87.5	87.5	87.5	87.5	87.5	0	87.5	12.5	0	87.5
Response X32	2.0	3.2	87.5	87.5	87.5	63	63	38	63	38	87.5	87.5
Response X33	2.0	3.2	63	38	87.5	38	87.5		0			87.5
Response X34	2.0	3.2	63	63	38	38	38	38	38	12.5	12.5	87.5
Response X35	2.0	3.0	38	87.5	87.5	87.5	38	12.5	63	38	63	87.5
Response X36	2.0	3.0	63	12.5	38	12.5	63	0	12.5	0	12.5	87.5
Response X37	2.0	3.0	87.5	38	87.5	12.5	63	0	12.5	12.5	0	87.5
Response X38	2.0	2.9	87.5	38	63	63	63	12.5	38	38	12.5	87.5
Response X39	2.0	2.9	63	12.5	87.5	63	87.5	0	38	12.5	0	87.5
Response X40	2.0	2.8	63	0		38	87.5	0	87.5	0	0	87.5
Response X41	2.0	2.8	87.5	87.5	38	63	63	0	38	12.5	12.5	87.5
Response X42	2.0	2.7	87.5	63	87.5	87.5	87.5	12.5	38	12.5	63	87.5
Response X43	2.0	2.7	38	0	38	38	87.5	87.5	87.5	63	87.5	87.5
Response X44	2.0	2.7	12.5	38	38	38	63	12.5	38	38	0	87.5
Response X45	2.0	2.6	63	38	38	63	63	12.5	38	63	12.5	87.5
Response X46	2.0	2.6	38	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	87.5
Response X47	2.0	2.5	38	12.5	12.5	12.5	12.5	0	12.5	0	0	63
Response X48	2.0	2.5	38	0	0	0	0	0	38	0	0	0
Response X49	2.0	2.4	38	12.5	12.5	63	12.5	12.5	12.5	12.5	0	63
Response X50	2.0	2.3	87.5	63	38	63	87.5	63	87.5	63	12.5	87.5
Response X51	2.0	2.1	63	0	12.5	12.5	38	0	0	12.5	12.5	87.5

Data Analysis – Kruskal-Wallis Groups

Through Kruskal-Wallis, larger Z-Values indicate distribution difference between the two groups. Here, distributions are utilization of each practice, and the two groups are based on Program Score rankings.

Count	Productivity Practice	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
	Kruskal-Wallis - Statistics of Group 1 vs. Group 2				
1	Activity Analysis	130	383	-2.217	0.027
2	Advanced Work Packaging (AWP)	184	437	-0.995	0.320
3	Alignment	230	506	-0.289	0.772
4	Benchmarking and Metrics	171	447	-1.760	0.078
5	Best Prod. Practice Implementation Index (BPPII)	143	419	-2.063	0.039
6	Change Management	157	433	-2.283	0.022
7	Constructability	180	456	-1.942	0.052
8	Craft Information Systems	114	367	-3.097	0.002
9	Crew Balance Chart	75	306	-2.962	0.003
10	Disputes Prevention and Resolution	63	273	-3.657	0.000
11	Engineering Management Interface	138	414	-2.313	0.021
12	Equipment and Tool Logistics	105	381	-3.113	0.002
13	Financial Incentives for Productivity - Craft	166	397	-0.741	0.459
14	Financial Incentives for Productivity - Supervisors	138	369	-1.787	0.074
15	Five-Minute Ratings	144	397	-1.225	0.220
16	Flow Diagrams and Process Charts	121	331	-2.411	0.016
17	Foremen / Craft Input	136	346	-1.824	0.068
18	Front End Planning	183	459	-1.647	0.100
19	Human Resource Management	149	425	-2.048	0.041
20	Implementation of CII Research	91	322	-2.770	0.006
21	Interface Management	200	476	-1.020	0.308
22	Lean Construction	130	320	-1.958	0.050
23	Lessons Learned	183	459	-1.850	0.064
24	Materials Management	118	394	-2.806	0.005
25	Partnering	190	466	-1.501	0.133
26	Planning for Modularization	167	443	-2.008	0.045
27	Planning for Startup	187	463	-1.785	0.074
28	Productivity Adjustment Factors	76	286	-3.721	0.000
29	Project Controls	145	421	-2.908	0.004
30	Project Delivery and Contract Strategy Analysis	130	406	-3.119	0.002
31	Project Organization Planning	142	395	-2.782	0.005
32	Project Risk Assessment	112	388	-3.579	0.000
33	Quality Management	190	466	-1.301	0.193
34	Rework Reduction Program	105	358	-3.305	0.001
35	Team Building	147	423	-2.481	0.013
36	Technology and Innovation Investigation	147	400	-2.517	0.012
37	Workforce Development Assessment	100	353	-2.945	0.003
38	Zero Accidents Techniques	243	519	-0.378	0.705

Groups

1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Colors

(green)	<=0.05
(light green)	<=0.10
(yellow)	<=0.25
(white)	>0.25

Data Analysis – Kruskal-Wallis Ranks

	Kruskal-Wallis Ranks (for Program Score Groups)				
Count	Productivity Practice	Group Splits	N	Mean Rank	Sum of Ranks
1	Activity Analysis	1.0	19	25	479
		2.0	22	17	383
		Total	41		
2	Advanced Work Packaging (AWP)	1.0	20	23	466
		2.0	22	20	437
		Total	42		
3	Alignment	1.0	21	23	485
		2.0	23	22	506
		Total	44		
4	Benchmarking and Metrics	1.0	21	26	544
		2.0	23	19	447
		Total	44		
5	Best Productivity Practice Implementation Index (BPPII)	1.0	19	26	485
		2.0	23	18	419
		Total	42		
6	Change Management	1.0	22	27	603
		2.0	23	19	433
		Total	45		
7	Constructability	1.0	23	27	625
		2.0	23	20	456
		Total	46		
8	Craft Information Systems	1.0	22	28	623
		2.0	22	17	367
		Total	44		
9	Crew Balance Chart	1.0	16	25	397
		2.0	21	15	306
		Total	37		
10	Disputes Prevention and Resolution	1.0	19	27	507
		2.0	20	14	273
		Total	39		
11	Engineering Management Interface	1.0	20	27	532
		2.0	23	18	414
		Total	43		
12	Equipment and Tool Logistics	1.0	20	28	565
		2.0	23	17	381
		Total	43		
13	Financial Incentives for Productivity - Craft	1.0	18	21	384
		2.0	21	19	397
		Total	39		
14	Financial Incentives for Productivity - Supervisors	1.0	19	24	451
		2.0	21	18	369
		Total	40		
15	Five-Minute Ratings	1.0	16	22	344
		2.0	22	18	397
		Total	38		
16	Flow Diagrams and Process Charts	1.0	21	25	530
		2.0	20	17	331
		Total	41		
17	Foremen / Craft Input	1.0	20	24	475
		2.0	20	17	346
		Total	40		
18	Front End Planning	1.0	22	26	576
		2.0	23	20	459
		Total	45		

Groups	
1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Kruskal-Wallis Ranks (for Program Score Groups)					
Count	Productivity Practice	Group Splits	N	Mean Rank	Sum of Ranks
19	Human Resource Management	1.0	20	26	521
		2.0	23	18	425
		Total	43		
20	Implementation of CII Research	1.0	17	25	419
		2.0	21	15	322
		Total	38		
21	Interface Management	1.0	21	25	515
		2.0	23	21	476
		Total	44		
22	Lean Construction	1.0	21	24	501
		2.0	19	17	320
		Total	40		
23	Lessons Learned	1.0	23	27	623
		2.0	23	20	459
		Total	46		
24	Materials Management	1.0	20	28	552
		2.0	23	17	394
		Total	43		
25	Partnering	1.0	22	26	569
		2.0	23	20	466
		Total	45		
26	Planning for Modularization	1.0	22	27	592
		2.0	23	19	443
		Total	45		
27	Planning for Startup	1.0	23	27	619
		2.0	23	20	463
		Total	46		
28	Productivity Adjustment Factors	1.0	22	28	618
		2.0	20	14	286
		Total	42		
29	Project Controls	1.0	23	29	661
		2.0	23	18	421
		Total	46		
30	Project Delivery and Contract Strategy Analysis	1.0	23	29	676
		2.0	23	18	406
		Total	46		
31	Project Organization Planning	1.0	23	28	641
		2.0	22	18	395
		Total	45		
32	Project Risk Assessment	1.0	23	30	693
		2.0	23	17	388
		Total	46		
33	Quality Management	1.0	21	25	525
		2.0	23	20	466
		Total	44		
34	Rework Reduction Program	1.0	22	29	632
		2.0	22	16	358
		Total	44		
35	Team Building	1.0	22	28	612
		2.0	23	18	423
		Total	45		
36	Technology and Innovation Investigation	1.0	23	28	635
		2.0	22	18	400
		Total	45		
37	Workforce Development Assessment	1.0	19	27	509
		2.0	22	16	353
		Total	41		
38	Zero Accidents Techniques	1.0	23	23	519
		2.0	22	23	517
		Total	45		

Groups	
1.0	2.0
Higher 45% Program Scores	Lower 45% Program Scores

Appendix E: Interview Guide

Introduction:
Thank you for taking the time to talk to me about yourself and your company's productivity strategies.

This interview is conducted by Cameron Gaddy on behalf of the Construction Industry Institute (CII) to support Research Team 340's investigation of "Corporate Best Practices for Productivity Improvement Programs." Our research goal is to improve construction productivity by providing industry with practices to mitigate corporate level barriers that currently hinder successful implementation and management of productivity practices.
This interview is intended to understand how your company manages productivity practices and interfaces between corporate and project levels. We are also seeking to understand why those elements and practices are in place.

Your response is completely confidential. All information gathered as part of this project will be treated in strictest confidence and kept under conditions of security at The University of Texas at Austin. We will provide participating organizations with a summary of general trends and statistical relationships from this research. Specific individuals, jobs, and organizations will not be named in this summary. The results of this project will be used to improve the competitiveness of the construction industry.

Interviews are expected to last one hour.

Thank you for your participation,
Members of CII Research Team 340

Interview Discussion Agenda

1:00   **Introduction**
- Intent – understanding corporate level productivity barriers and practices
- Interviewee Questions

1:10   **Company Perspective on Corporate Productivity**
- How does the company define successful productivity?
  - Are there established productivity goals and objectives?
  - How does productivity success get measured?
- Please provide a high-level perspective of the company strategy.

1:25   **Company Productivity Program**
- **Leadership and Resources**
  - What drives selection of company goals and objectives?
  - How does your company select productivity goals and objectives?
  - What major resource challenges occur when pursuing these objectives?
- **Structure & Communication**
  - What are the major interfaces between programs, groups, and projects?
  - What are the key interface management practices used by your company?

1:45   **Productivity Practices**
- What productivity practices do projects consider key, essential, or mandatory?
- Which practices would be the first to drop, if resources were more constrained?
- What practices would you add or expand, given additional resources?

1:55   **Input and Feedback**
- What are the other highlights of productivity program operation and management?
- Feedback about the interview and research topic

Research Overview:

There have been numerous prior studies, both internal and external to CII, that have focused on productivity improvement at the craft level. By and large, the industry has a good handle on what activities should be implemented. However, measurable benefits at the corporate and industry level are difficult to discern. Something is blocking progress; let's call them corporate barriers. The research objective is to identify those barriers and suggest best practices (at the corporate level) to overcome them. Ultimately, we intend to unleash the potential of productivity improvement practices in a manner analogous to the safety improvement in the past 20-years.

This research will characterize existing corporate productivity programs and determine the productivity practices being used on projects. Then barriers to successful productivity programs will be identified, and best practices for developing corporate productivity programs will be defined and documented.
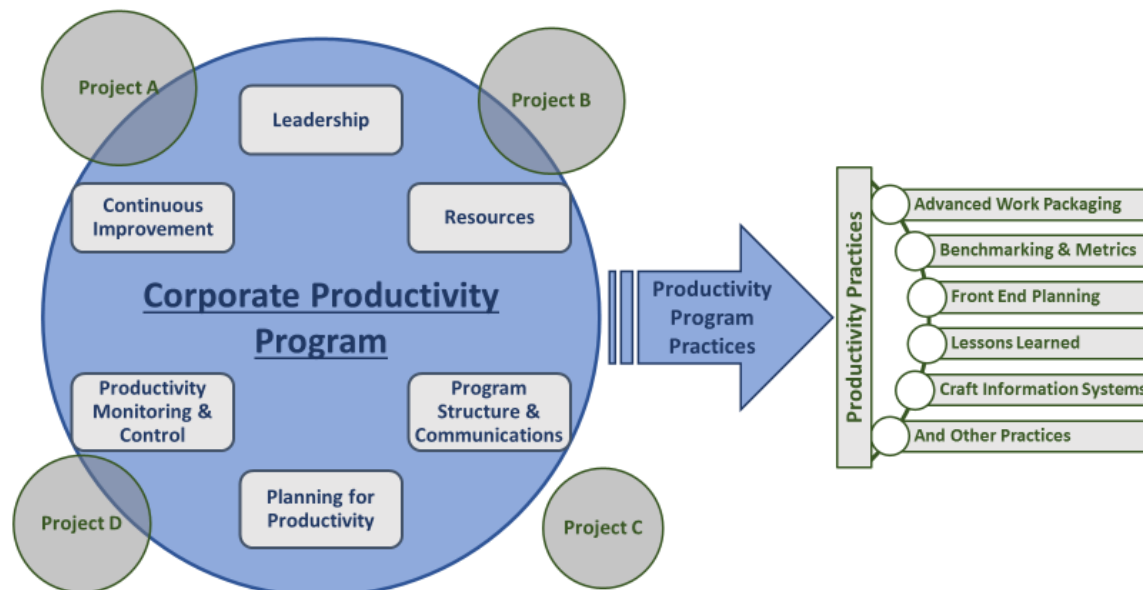
Definitions:

Corporate Productivity Program: Corporate level ownership of construction productivity goals and objectives for the company; responsible for company productivity interfaces, practices, recommendations, and improvement

Corporate Productivity Program Element: Managed components that make up a corporate productivity program, which can be assessed and measured. These include Leadership, Resources, Program Structure and Communications, Planning for Productivity, Productivity Monitoring and Control, Continuous Improvement

Corporate Productivity Program Practices: Enterprise level practices for successful implementation of construction productivity practices across the project portfolio by improving corporate productivity program elements

Productivity Practices: Practices that impact construction productivity. The implementation of these practices contributes to productivity improvements. A few examples are Advanced Work Packaging, Constructability, and Craft Information Systems

Also included in the information sent to interviewees -

Productivity Practices List – list of the 38 productivity practices with descriptions (see Appendix A: Survey Guide – Productivity Practices)

Appendix F: **Interview Summaries**

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**

Chemical engineer working in engineering and manufacturing management roles with experience in quality assurance and business management
- 31-years with current company which performs industrial projects
- Director of Engineering for a global business unit
- Large capital budgets – 300 to 400 projects in any 12-month period
    - $50k to whole plant development – small plant mods to very large projects
    - Same engineering team, which travels around the world
    - Half of time to travel – going to plants to review installation and major work; or new plant construction itself
    - On the ground from land purchase through development master planning
    - Engineering works end-to-end

Company Perspective on Corporate Productivity
- **How does your company define successful productivity?**
    - **What kind productivity objectives are established?**
    - **How is productivity success measured?**
- Capital effectiveness and execution excellence define successful productivity for company. Construction productivity is not as focused or discussed. Leadership speaks more to bringing value to the company.
- Execution excellence means doing the job right the first time. Bring the right tools, the correct mix of people, and use the right subcontractors and experts.
- Those are ultimately the value chain. However, safety is an overarching value. Other items are priorities, which may change. Safety of all personnel on-site is a value that must remain regardless of other priorities.

- **How are the objectives established?**
- Safety has always been the driver – integrity and safety have been core company values for many decades.

Does the company have any key strategies?
- Moving hours out of the field. Modularization and pre-fabrication are major focuses of the company.

- Modular building design is among the latest efforts.
    - Company is trying to move to 100% modular by brining fire protection and sprinklers into the modularized roof to create fully plug-and-play building construction. Stick build is now the last approach.
    - Stick-Build is now the last approach

- o This forces suppliers and construction contractors to evaluate their processes for designs that are constructible and how to setup supplies and methods.
  - ▪ How they can give input to design to make it buildable
  - ▪ How to setup supplies and methods
- o Proven that modularization saves time
  - ▪ Reduction of site information requests
  - ▪ Parallel construction
  - ▪ Assembly has ability to be done very quickly

- Strategic Alliances - Setup key suppliers of construction, engineering, and suppliers
  - o Able to evaluate on the global level – cross check supplier ability in multiple countries and evaluate large-scale relationships.
  - o Contractors benefit because they are more familiar with expectations due to regular work. They understand the safety requirements. They are familiar with the engineering practices, equipment, and utilities that the company operates on a regular basis.
  - o Vendors and suppliers are able to compete more globally.
  - o Key supplier relations help with production and execution
  - o These can also yield lower costs – execute Project A – then B, C, and D with similar scope help to find efficiencies.
  - o This yields a driver for productivity for contractors since they are able to demonstrate skillset and ability to improve over time and multiple projects.

- Lean Construction and Integrated Project Planning
  - o Beginning to get up to speed – perhaps lagging industry
  - o Getting setup with contractors and internal understanding of how to utilize at the PM level. Learning how to get everyone onboard as the same team, using all skillsets to streamline, sequence, and coordinate who is doing which tasks.
  - o Unexpected benefit – fewer engineering detailed packages for construction
    - ▪ Integrated team identified engineering deliverables that were not going to be used by construction. Engineering eliminated the deliverables to avoid creating packages that would not be utilized.

How is productivity measured?
- Time and capital.
- Company has moved away from efficiency charts, performance factors and craft measurements.
  - o Those are the end process measurements for contractors to manage their own house. The owner does not need to get into their business.
  - o Owners focus on schedule and overall cost – time is money. Owner is also checking capital affordability.
  - o The corporate level manages this by constraining how much capital business can spend – positive NPV projects, but balanced with affordable capital.

- o Limited capital requires the organization to get more done with less, and that pushes increases of productivity and efficiency.
- o A major aspect of this is learning to leverage the business unit and project-level understanding to become efficient across multiple units and projects.

- **How are responsibilities for productivity practices and interfaces managed?**
- Example, if 300 projects are ongoing –
  - o PM responsible for schedule, capital spend, and technical readiness
    - ▪ Able to deliver success criteria – e.g. – product required, on schedule, safety, etc.
    - ▪ Productivity is embedded in the PM responsibility for time and costs.
  - o PMs have the daily meetings, ongoing understanding of project, connecting subcontractors, and understanding how to get projects efficient
  - o Lean process (IPD) – getting contractors on even earlier
  - o Practices above are coached and advised if needed by PM
    - ▪ Can contact corporate office to get coaching
    - ▪ Get experts to setup workshop and get the project systems in place
      - • PMs need to know who, when, what they need help on

Corporate Alignment
- **How is alignment on productivity for varying management levels?**
- Corporate alignment – from director level – report to VP of Product Supply, and they report to the President of the business unit.
  - o Every year, plan out capital – review project portfolio
    - ▪ Prepare forecast and assign affordable capital by category area
      - • They get $X and they design how to use it
      - • That forecast drives the productivity discussion – e.g. which suppliers, modularization, IPD.
        - o This is done before the PM and team are assigned.
        - o Then business discussion linked to affordable capital and the timing that the program needs to be delivered.

  - o **Are there existing or historical barriers to alignment?**
- There is a lot of tension.
- Project management level feel they do not have enough money to get the work done, such as repair of roofs, parking lots, and other needed work.
  - o Interesting and difficult discussions because the work is needed and real. However, capital is never limitless; so some work must be left out of budgets.
  - o The allocations are made through a process that can be explained to folks, and the depreciation costs gets balanced with investment in current year – enables staying flat on depreciation

  - o **How has alignment been improved over time?**

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- Alignment over time has improved. This is shown in business and end of year reports.
- Business used to be run very local, but then it was moved to a regional system. Now, the company is trying to manage globally as a business. So alignment is a major challenge and facet of future business plans.
    - o Alignment process in the past used to be messy. Each plant developed sites building plans and submittals, but no process for how to make decisions about funding and priority across various locations – just facility specific.
    - o Now have a process and back-up for decision making across a region and moving to globally. This has generated improved transparency.

    - o **How has this effort to align come through the company?**
- President-level declaration of shift toward regional and now global business units.
- Challenging segments of the organization to understand brand and global market; attempting to get larger market capture, rather than each facility or region.
- Previously missing the opportunity to leverage equity, technology, and business plans (e.g. - Is it good to create new XYZ processes in one place? Then why isn't it good for the other 100?)
- President level declaration also identified a brand equity that is global instead of local. It calls for innovation that is global, not local.
    - o Better capture of strategic suppliers – doing the work multiple times, varying locations generates systems, packaging, transportation to handle that in a similar way. It also enables modular design that is proven because the scales are increasing if they may build several of the same facility.
    - ➔ End game is that the company is able to serve more countries and people with common systems under the global approach.

    - o **What future efforts do you expect to enhance performance?**
- Package and product innovation is typically driven by interfacing with the customer.
- Different with boilers and in-house maintenance / improvement; in those cases, innovation comes from suppliers or new designs.
- Hope that construction will join the world of going digital – get much smarter on how to automate tasks and activities
- Track and manage materials without having to walk in the field to check materials
    - o Improve laydown, digitize material flow
    - o Automate activities
    - o Reduce labor hours on-site and drive that concept
    - o Integrate craft into an assembly – 3D printing to get elements into structure so that it's not multiple mechanical and electrical phases
    - o Change the mindset of construction to be early adopters
- With enhancing performance, companies may be less threatened by opportunities and innovation since they may be needed to keep pace with competition.
    - o Taking better work is business building opportunity from construction.
    - o Need people who can bring change and combine it with existing experience.

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Company Productivity Program
- **Structure and Communications**
  - **How are corporate department or group interfaces setup to positively impact productivity?**
- Productivity is part of everyone's responsibility because the organization is given budget and ownership of scope. So, everyone has their responsibility because they need to execute their work.
- Corporate practices include lots of commercial systems – bid ratings, commercial work, purchasing partners to help with early communications.
- Higher value communications – assembling teams of owners with contractors early and co-locating the team to get the project underway.

    - **Are there barriers or challenges?**
- Barriers are often rooted in being misaligned on the commercial contract.
  - Corporate offices say to stop due to issues on payment, delivery of services, misalignment about the initial agreement.
  - Getting out of the commercial and contractual side can yield more efficiency once the team is formed and people are going through to execute on the same page and with the same goals.
- Challenges seem most common when practices are not used.

    - **Are there historical practices that worked or failed?**
  - **Are there corporate practices for managing interfaces and communications with contractors and subcontractors?**
    - **What key barriers exist between the owner and other stakeholders?**
- Did not reach these aspects of this segment during the interview; time constraints.

- **Resources**
  - **How are personnel taught roles and responsibilities related to productivity?**
  - **What corporate systems are in place to hold personnel accountable for their productivity related responsibilities?**
- Value creation is part of the core for resources and onboarding.
- Affordability of capital is the core responsibility of engineers, and that is part of the company vision, performance assessments, and how business is done.
  - Teaching is performed in many mediums and environments. The company uses teaching and training in classroom, on the job, workshop. On the job training is the typical focus.
  - It is important that individuals practice what is trained.
  - Mentors to help people move from advanced to expert in technical skills and strengthening resources.
  - Continuous learning and development is expected, and job responsibilities are part of that growth system.

- For example – start with small project, then success and applying learnings moves to next → $1M → $5M → $20M to continue applying skills and develop.
- Holding people accountable is critical.
    - Rigorous forecasting and budgeting – so high visibility on how capital is being spent and how programs are advancing
        - Cost and schedule assessments by management that goes to site
        - Regular reviews, tracking, and results publication
        - Management on-site to know what is going on
    - People are evaluated on success criteria – cost, schedule, and readiness
    - Goes back to the productivity questions – affordable and on schedule, is it giving the product needed?

Project & Contractor Interfaces
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- Major barriers or managing through challenges are normal parts of business.
- Losing expertise in the field → mentoring, coaching drop off
    - Especially where new field of people trying to come up to speed
    - Loss of talent is a huge barrier
    - Company is looking for people with the passion and willingness to work in the field managing the early stages of the project
        - Creating a pipeline of people for that and having them prepared is an ongoing barrier

    - **Does the company have mitigation efforts in place?**
- Continuing to bring in engineers and get them up to speed.
    - Real time experience, hands on, working with both construction and management of projects

- **What productivity practices do projects consider key, essential, or mandatory?**
- Safety – you will put in place the right people, procedures, roles to keep that managed from beginning to end
- Using key suppliers – heavily managed by purchasing organization
    - Risk when someone is new to the work, but doesn't know there are key suppliers. This is a major challenge to keep consistent as expertise continues to be lost.
    - Mitigated by having purchasing group for them to leverage for reference and understanding of how to use.
- Modular design is really business and brand dependent
    - Driven by project product, technology the business has used, and it is often decided based on the business level decisions.

-     ○ **How do these expectations get implemented with other stakeholders?**
- Coming in with productivity solutions is essential for contractors and suppliers to be competitive.
- Company is talking to contractors and suppliers about how they can gain productivity and increase by 5%. This way, the owner is pushing industry to start delivering and innovating, rather than setting the specifics, the company is setting objectives.
  - ○ An example is that one key supplier helped the company learn IPD.
    - ▪ Company identified that and leverages the strengths of external suppliers. IPD is generally talked about broadly, and if the supplier interested, they can seek inclusion and learn how to get involved in IPD-style projects, and the company can use their strengths to continue improving the IPD systems and processes.
- Another method to drive innovation is that the company sets innovators as partners.
  - ○ Those innovators continue to work with the company, even though the company is getting leaner and learner. So, relative to personnel counts, the key contractors with expertise, innovation, and new development are getting increased work and opportuntities.
  - ○ With the decreasing headcount for lean organizations, the company cannot do this alone or rely on its own resources, as they are stretched already.

Input and Feedback
- **What are the other highlights of productivity program operation and management?** - none

- **Feedback about the interview and research topic**
- It would be good to interview company suppliers. You would benefit from understanding their perspective on the company leveraging owner role to drive innovation and how suppliers feel about competition for strategic positions, enhanced performance, etc.
- CII should conduct an innovation or construction summit
  - ○ Bring together a mix of different companies from around the world
  - ○ Let them come together to show construction
    - ▪ Create a forum to come together to reinvent and innovate in the way construction is done today
    - ▪ Learn from each other to develop new concepts
    - ▪ Better products as competitors and key alliances
    - ▪ Open the world and mindsets to get out of trade secrets
      - • Move towards comparing and innovating together

Thank you for your time.

Introduction
- **Please describe your organization and position.**
  Manager of Construction in petroleum and chemicals
  One of four global units, which divide by industrial construction sectors

Company Perspective on Corporate Productivity
- How does the company define successful productivity?
- Delivering projects, safely, on time, within budget quality, for selves & customer.
  o Projects vary from reimbursable, lump sum, some direct hire, etc.

- **How are corporate productivity goals and objectives determined?**
  o **Who owns productivity goals and objectives?**
  o **How does productivity success get measured?**
- Base level – foreman and GF – breakout projects into work packages
  o 500 to 1500 hours of work in each work package
    ▪ For example concrete commodities, structural steel, electrical
    ▪ Track performance of each foreman on a daily, package by package basis – set targets for crew daily & WP focus
    ▪ Able to see in real time how they are doing
  o Challenge and support them to achieve schedule and cost
  o Earned vs. burned man-hours to measure
- Trying to go company-wide with goals and systems.
  o Each piece of the company has differing perspective – each project has different situations to manage and specialize.
  o Senior level personnel on projects often make the major productivity decisions; so they do things their way often and have sway to do so.
  o Trying to standardize across the company for level of detail in metrics.
    ▪ Sequence of work packages is captured in turnover skylines.
    ▪ Testing methodology in mind during early planning – e.g. – hydraulic and pneumatic plans for testing
    ▪ System completions need to be on time; so work backwards from the expectations to develop schedule – then push to them.
- Invest early in construction coordinators
- FEED stage of the project –
  o Construction plan how to build it, and engineering and procurement help to achieve
  o Used to have silo issues and engineering drove the plans
  o Now, construction work based planners determine the work packages with the focus on delivering for on-time delivery.
    ▪ Direct engineering needs from construction, rather than engineering priorities
    ▪ Direct procurement needs from construction, rather than in the engineering order of design

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- o Able to then breakdown construction packages to individual work packages by systems and then by disciplines
- e.g. – Ethylene cracker – goes into 50-100 work package areas
  - o Engineering designs to that methodology based on turnover skyline of the 50 areas, and they may produce 100 or more work packages
- Corporate-level identified these silo issues, lack of alignment, challenges of scope and schedule, and determined they needed more consistency.
  - o Engineering incentivized incorrectly, with focus on turning out ISO drawings each week to meet a large level curve, rather than delivering based on the needs of the construction phase of the project.
  - o Now replacing the ISO curve with construction work package areas
  - o Skylines provide the construction priorities and schedules for delivery into the engineering process.
- Procurement world is currently driven by PO count and budget. Therefore, they typically try to save money; so they sometimes deliver incomplete or late items, if they could do so cheaply. Procurement silo would look good, but total project cost may be lost due to construction delays and project delivery impacts.
  - o Redirecting procurement to total installed cost; so they can spend more procurement budget to save on schedule and performance.
- Methods are being driven from the corporate level, with information from construction personnel in the field and planning stages.
  - o Changing behaviors, methods – dealing with pride of project managers (PMs)
  - o Dealing with historical success excuses frequently. "My way works," is often a difficult perspective to get managers to move past to adopt new processes.
- Traction gathered by top-down instruction from the four global business presidents and business line managers (the 4 sectors global corporate structures)
  - o Management instruction to the PMs – "This is how we are doing business."
  - o Signed by their business unit supervisor, and then PMs fall-in-line, rather than having as much push-back and debate.

- **How are responsibilities for company productivity interfaces, practices, recommendations, and improvement established and managed?**
  - o **How was this developed?**
- Concepts were driven from construction staff, which filtered to a corporate area that performs plan development and new ideas – a think tank.
- Petroleum and chemicals business unit has construction execution team at the corporate level (in the global business unit), which determined how to adopt the concepts and distribute them to project-level management and teams.
  - o Previously forced to chase bulk quantities, instead of system skyline
    - ▪ Accomplish quantities, but miss system turnover dates
    - ▪ Huge punch-list
    - ▪ Failure to turnover project
  - o So, the organization is shifting to focus on System Turnover as described.

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Corporate Alignment
- **How is your company enabling alignment on productivity for varying management levels?**
- Top-level instruction from global business unit presidents, providing management instruction (and signed by president – written instruction)
    o This instruction then signed by next levels of corporate management, until received by project managers.
- Company has over-100 standard work processes and procedures for global construction alignment and consistency.

- **Are there Alignment Meetings?**
- Workshops to share new methods with site managers and PMs
- Now having emersion programs – call in team, show them examples, best practices, and purpose for it
    o Get buy-in and feedback
    o Working level and project level execution

- **Are there existing or historical barriers to alignment?**
- Breaking the habits of PMs
- Long tenure of company employees – 30 & 40-year veterans running jobs
    o Adjusting culture and changing older minds is especially difficult
    o Influencing at different age levels is a skillset being developed by corporate
    o Technology adoption requires the implementation team to garner support through proof of improvements in execution.

- **How has alignment been improved over time?**
- Realization that the company, as a construction company, had lost its way – became engineering and procurement driven rather than construction driven.
    o Getting back to total installed cost focus
    o Not short-term, early wins in procurement that have negative effect on construction lifecycle of project
- 15-20 year process to change the mindset – people understand the value of total installed cost and importance of construction driven schedule

- **What is being done to influence procurement and engineering and what future efforts do you expect to enhance performance?**
- Emersion programs – separate team that was working the AWP process, include engineering and procurement
- Foreman and General Foremen are identified as most important people on project; recognize they need to be the served parties of project organization.
    o Provide them with everything needed to do their job
    o 90% of problems are not craft fault

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- Procurement & engineering are service to construction, and the groups are starting to realize that and adopt the processes that enable construction.
- Construction are service to start-up, hence the focus on system completion.
- Workshops
- Emersion
- Years of "banging on 'em"
- Changes in leadership, younger leadership in positions of influence

Company Productivity Program
- **Leadership**
- **How do corporate leader display commitment to productivity objectives?**
    o **Are there barriers or challenges with displaying commitment?**
- Charged by CEO and CFO – improve performance by 20% and construction productivity by 30%
    o Direction through global business units, functions, and management
    o Not saying how, but setting the goal
- Implemented by senior-level think tank, which includes 6 or 7 teams to improve enterprise level project performance
    o Direct work improvement
    o Engineer with construction in-mind (easy erection, higher quantity)
    o New technologies & construction equipment optimization
    o Reduce distributable costs – e.g.:
        ▪ Are we buying the right things?
        ▪ Buy off the shelf instead of crazy specs, etc.

- **Resources**
- **How are corporate resources positioned to establish and disseminate productivity practices?**
    o **Are there known barriers to that process?**
- Senior level think tank are leading implementation concepts.
    o e.g. - Cost Competitive Task Force is one of the 6 or 7 teams
    o Global business unit staff are disseminating practices from corporate to projects
- REAL investment in trying to improve performance
    o Fund to allocate money to development of talent, estimated $60M over 5-years
        ▪ Managed by a committee that make suggestions to develop programs to improve superintendents and other talent growth
        ▪ Fund FTEs to pilot program, test, and roll-out to projects
    o Fund exists that allocates budget to submit innovative ideas to improve performance, estimated $100M over time
        ▪ Disruptive thinking around how to improve over and above the norm, such as break times, start-and-stop times – but attempting to identify what is materially different

- **What significant barriers exist for project teams and personnel attempting to implement, measure, and control efforts to improve productivity?**
  - o **How does the company's corporate-level mitigate those challenges?**
- Did not have time for these questions; some aspects in "Project Interface."

Project Interface
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
  - o **Does your company have mitigation efforts in place?**
  - o **How do these other challenges compare to the personnel challenges?**
- Active management that is engaged and aware of projects
- Challenging each project to list out lessons learned and initiatives
  - o Allocate what money will be saved by implementing the task force practices and systems; then measure from the project-level rolling up by business unit.
- Quarterly reviews to mitigate lack of alignment.
- Bi-Annual Reviews – twice a year reviews with board of directors on a project basis
  - o Report what innovations have been implemented and success levels
  - o Expectations set and communicated about it
    - ▪ Explain why other items were not implemented
    - ▪ Driven from the top
- Private company drives different mindset; the company is absolutely flexible in doing what they believe is right without pressures of trying to please external shareholders.
  - o Interviewee feels it is a key factor in company success.
  - o Massive differentiator from many other construction and project organizations
- Many senior vice presidents, who are effectively company-level partners that are empowered and accountable for the success of the company
  - o Expected to make the right decisions
  - o Must be at a level of detail that is higher to improve performance
  - o Pursue the right work to make money and stay in business
  - o Walk away from deals that do not feel right for company

- What productivity practices do projects consider key, essential, or mandatory?

Input and Feedback
- **Any other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Wrap-up:
  - o Good questions and CII focus areas are good
  - o Craft are not the issue
  - o Equipment and new technology is available
- Feel the issue is the culture and the adoption of change
  - o Willingness to take time to achieve the wins – not immediate wins

- 25-years ago, industry shifted toward mandatory safety glasses, but we still cannot get everyone to wear them. We have to recognize culture shifts take a lot of time and work.
  - Deterioration over 20-30 years takes similar time to improve

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
  Interviewee notes perspective and background is focused on European model.
  Europe's contractor model:
  o Often using time and materials contractors, and on those, the company would not perform as many checks
  o Lump sum contractors in Europe
    ▪ Quality focus
    ▪ Also schedule
    ▪ Also track hours – legally required for safety hours and other safety elements; also check staffing to complete projects on time

- **Please describe your organization and position.**
- Working on race tracks for NASCAR equivalent in Europe
  o Projects are on different scales – consolidating existing sites, new buildings on existing sites, and other revamp scopes
- Program Manager with focus in Germany and global facilities responsibilities
  o Building new facility for baby care in existing site
  o Engineering background – designed, built, start-up
  o Worked outside of region in Cairo, Istanbul, and other facilities
    ▪ Site Engineering Lead.to Program Manger roles, including most roles between.

Company Perspective on Corporate Productivity
- **How does your company define successful productivity?**
- Achieving schedule & quality – as an owner, target of minimized direct personnel and use of strategic partners as contractors and suppliers
  o Outsource construction management
    ▪ Still lump sum, but have a third-party take over CM where possible
    ▪ Design teams with engineering, project manager, and construction manager
    ▪ Move into construction with the engineering team available
    ▪ Construction organization takes over – can be only a CM and Safety Manager – rest contracted in from other companies (big or small)
    ▪ Can run very lean, e.g. – 8 to 10 personnel on construction team – quality, management, safety, controls
  o In the US – outsources / hire construction team in the factories, but cannot afford that approach in Europe

- **What kind productivity objectives are established?**
- Goals are around minimizing direct staff requirements
  o That is the corporate productivity program to keep shareholders happy.
  o Drives efforts to grow volume or improve cost structure.

- **How is productivity success measured?**
- Normally percentage reduction of direct FTE to overall size or budget
- Factory metrics of throughput per FTE
- Corporate offices metrics are in general focused on headcount, but metrics are also defined on if the business is growing or not to link to volume.

- **How are responsibilities for productivity practices and interfaces managed?**
- Director of global business line in Europe and Asia sets objectivess
    o Deploys the headcount targets, but not part of the decision-making process
- Business units – headcount making area is where the headcount gets imposed as well.
    o Top level imposes headcount – productivity needs to be at a certain level, but if increasing by 2%, then you can still hire
        ▪ Volume growth target = still able to grow organizationally
        ▪ Volume not outpacing growth would look for more efficiency from FTE count

Corporate Alignment
- **How is the company enabling alignment on productivity for varying management levels?**
- Not a lot of alignment patience or issues to debate it gets imposed
- Top level needs to be achieved – alignment is based on setting priority
- If reduction or production targets need to be achieved, groups develop strategy around achieving lower headcount for lump sum portion of contracts.
    o So, shifting scope or project needs to lump sum is a route to enable reductions
    o Bare minimum = 1 person from company to direct contractors and safeguard company interest, but the rest depends on how the contracting can be done (e.g. - contractor performance level, history etc.)
        ▪ Smaller projects will have single engineer at the PM, CM, and all other functions
        ▪ Bigger programs have PM, CM, cost controller in separate roles; could outsource CM if the right caliber personnel are there
            • However, quality and safety expectations are very high – so it is challenging to find people that can match and push for that expectation. Outsourced CM can be achieved, but typically need to build that within another company. However, that can tend to make the company non-competitive when they feel too comfortable.
            • This can also expose the company to being too dependent on other companies due to lost experience and ability to teach internal and external to the company.

- **Are there existing or historical barriers to alignment?**
- Strategic alliances can be problems due to comfort levels

- o For example, the US was using a long-term strategic supplier, and they found out that European counterparts were getting equipment 50% cheaper.
  - ▪ Felt the supplier, though engaged in a long-term relationship, was not working in the company's best interest since the company had lost material management flexibility and as largely locked into their supply.
- o Setting up with strategic suppliers is conceptually a fantastic route. However, the challenges is in keeping them competitive
  - ▪ Saves a lot when they are an all-in organization – capable of doing all the work without training them up
  - ▪ However, leaves a gap in oversight and improvement, and the company regularly needs to re-train personnel on how to interact and develop supplier relationships when going outside or setting up new alliance.
- o Europe has 4-5 major engineering companies to divide up the work and keep the engineering companies competitive and out of comfort-traps
  - ▪ Then goes to lump sum bidding, where each European country has its own set of construction organizations
    - • Workforce and suppliers are also limited in experience working in specific regions and countries.
    - • CM in Europe with local / country focus – construction has difficulty moving across Europe because its workforce and other facets are local to a country, but it's hard for them to move to others (e.g. – good German company may not be able to reach Italy)
    - • European countries have differing construction codes that also challenge these companies' transferability

- **How has alignment been improved over time?**
- **What future efforts do you expect to enhance performance?**
- In construction, the company wants to drive innovation and deliver programs faster
  - o Faster delivery makes company resources free more often to develop next projects
  - o Engineering and construction innovation in modularization
    - ▪ Instant capacity route → stick build, but moving to modules and installing complete frames
    - ▪ Larger pre-assembly areas, then lift is another method to cut schedule by a couple of months.
  - o Company is driving this modularization and introducing it to construction companies by showing videos of accomplishments – people look amazed.
    - ▪ Helping companies take the step to do modularization for their first time is a major effort of the owner company
- Also, doing Lean ITT – program for how to sequence construction in a better way (from B&W) – ensuring good communication between contractors
  - o Schedule optimization tool – improving communication and flow
  - o Plan things well to drive down the duration of project
  - o Communication and sequencing focus area

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Company Productivity Program

Structure and Communications
- **How are corporate department or group interfaces setup to positively impact productivity?**
- **Are there corporate practices for managing interfaces and communications with contractors and subcontractors?**

Interviewee felt this was covered in the first section to a good extent.

Resources
- **How are personnel taught roles and responsibilities related to productivity?**
- **What corporate systems are in place to hold personnel accountable for their productivity related responsibilities?**
- Structure – Global construction manager sets expectations
    - Construction Manager with each business unit that lead the network and unit with new practices and implementation
    - In principle, each business unit can decide use of new practices for themselves
        - However, the company likes standardization. So, the practices get pushed, but business unit needs may differ and the practices may need to be adjusted to make them practical.
        - Cannot drive certain levels of automation and innovation in a low cost country – technology may outweigh the cost of manpower
- Convincing other companies to perform is a major portion of the owner role

Project & Contractor Interfaces
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- Strategic alliances and CM outsourcing examples from before
- Europe also has historical setup – sites complete a lot of the work; they have developed their construction and engineering contractors because they're still around after having worked

- **Does the company have mitigation efforts in place?**
- Still have internal construction organization
- Established contractors at all sites – know the codes, know the regulations
    - Electrical, controls, civil structural, mechanical – have 2-3 so that there is competitive bidding
    - Introduce new suppliers to keep old ones on their toes
    - CMs that have been using for a long time, or design companies can deliver CMs
    - Also, backup for possible gaps, the company has internal resources to cover where contractors may not be able to deliver CMs that understand owner expectations for safety and other key areas.

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- Company does coordination from design to construction and manages the suppliers in-house and manages the contractors directly
  - This is an outcome of the extended time and the discipline contractors that have a great deal of experience with expectations, the site, quality and cost ---- keeps it critical for those firms to provide a good service and maintain long-term business goals. Long-lasting relationship with suppliers is a major facet of self-execution.

- **How do these expectations get implemented with other stakeholders?**
- That is hit by the relationship discussion – execution level is the rest of it.
- If required, force contractors to learn the hard way by being made to perform the work again – quote accordingly to get the right things.
- Big projects can better use strategic alliances
- Small projects may approach Lean ITT plan
  - Not all company organizations have the experience, staff, or relationships to activate those back-up plans
  - Depends on how busy the company is on a whole
    - Have the people, but not in abundance
    - Not trying to be a construction focused company

- **What productivity practices do projects consider key, essential, or mandatory?**
- Did not address this question.

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic.**
- Interviewee struggled with some of the survey because of Lump Sum business format and felt the survey was North American contract based.

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**
  Went to WVU – 34-years with large chemical company, and now with operations and construction with focus on chemicals and petrochemical, some pharmaceutical work
- Construction company section is with the North American sector, but the company and role are global.

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- Go back to estimate development – based on unit rates
  - Basis for estimate – apply factors based on region, labor, and other factors.
  - Best estimate and refined as it goes through toward +/-5%
    - Meet the work hours as defined in estimate – cost for summary
    - Per unit – e.g. by metrics of estimate and units
- What company and individual finds after 39-years of construction:
  - Planning and scheduling ability once project is approved is challenged
  - Middle-management are actually driving development of schedule and plan; however, the middle-management is lacking experience and clarity or contractors do not listen to the actual workers
  - Want contractors using Advanced Work Packaging (AWP) – level 5 schedule
    - Communicate with the people doing the work
    - Establish agreement and measure compliance
      - Schedule compliance – e.g. – Last Planner
      - Starting to see that is going to be a requirement soon
      - Thou SHALL use AWP or Workface Planning to drive items to worker level
        - And measurements on daily rather than weekly
- Another thing being driven – offsite fabrication and modularization
  - Move man-hours to a more productive and controlled environment
  - Interviewee's early career – turnarounds and shutdowns that had significant modularization because turnaround time was so valuable
    - Now the pendulum is swinging toward how to be more productive
    - Went nearly 15-years without a renewal plan, and that resulted in failing to educate and train up people to do the work
    - Pre-assembly line, the cars were out in random fields, and people haphazardly went and got materials to assemble the car
      - Seems parallel with assembly line construction elements

- **How are corporate productivity goals and objectives determined?**
- Goals with all projects to be 20% more capital efficient
  - Lots of pressure on personnel to be more efficient on projects

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- - o Causes drive for off-site construction, assembly line type processes, more controlled environments
- Company is public in home-country with government ownership and stockholders splitting the ownership and influence
    - o Private companies have more flexibly
        - ▪ E.g. – Interviewee visited a Chinese company that was wholly owned by one person – so when they commit, he has all the autonomy to complete commitments

- **Who owns productivity goals and objectives?**
- Driven by the global general manager
- Steering teams – set goals and then Senior Project Managers (PM) responsible for coming up with methods, contractor relationships, and ideas for how to meet the goals
    - o Steering Teams by engineering & project management within business units – governance structure defines steering team, but there are many stakeholders

- **How does productivity success get measured?**
- Estimate and budget against actuals

- **How are responsibilities for company productivity interfaces, practices, recommendations, and improvement established and managed?**
- PMs have flexibility project by projects → some autonomy
    - o Instructed to modularize and use AWP
        - ▪ In the future, these will be in all invitations to bid
        - ▪ Have had the conversation about how to treat other aspects of projects like they treat safety – core values, and driven by owners

Company Productivity Program
- **Leadership**
    - o **What drives selection of company goals and objectives?**
    - o **How does leadership display commitment to productivity objectives?**
- Increase capital efficiency by 20%
    - o Similar to IPA and benchmarking – want to be in the top quartile
    - o Most cost-effective, most quality, fastest to market
        - ▪ Petrochemical industry is now becoming a big item --- speed to market is becoming that way
        - ▪ In plastics, speed to market is critical; IRR takes huge hit
- Showing commitment:
    - o In meetings, reviews, monthly steering committee meetings
    - o Brought up at each meeting
- A lot of the times, the goals become part of individual performance plan
    - o Significant driver because bonuses are influenced by meeting objectives
    - o Driven by steering teams, but also tied to individual performance evaluations

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- One of the things in the company is that the steering team sets goals and objectives, and then stay engaged and support PMs in driving those
  - In previous and current company, interviewee's experience is that senior managers understand that PMs need support
- **Is there a home office for project support?**
- In the home country, there is a knowledge management center, and satellite offices in Houston and Europe.
  - Regional satellites of knowledge management centers
- One of the reasons interviewee was hired was for lean construction experience
  - Subject matter experts (SMEs) used now
  - On these items with productivity – still growing and making that shift

- **Resources**
- **What major resource challenges occur when pursuing these objectives?**
- Resource constraints – owner level is on development of competencies and subject matter experts for modularization, planning, and processes
- Want to go to contractor and buy a lot of that, but the contractor competency is challenged
  - Age attrition has pulled away SMEs from owner and contractor
  - And experience is lacking
- Middle managers that perform planning and driving field execution is very challenged currently
  - Critical people to make these things happen, and at a shortage right now
  - Fair amount that have moved to the next level, but they're not there yet

- **How are corporate resources positioned to establish and disseminate productivity practices?**
  - **Are there known barriers to that process?**
- For company right now, just limited resources – hired many people but so busy that they do not have opportunity to get them fully engaged in training
- Have training program, but people are challenged to get into the training
- In the process of trying to build staff, but finding people at the target level is difficult

- **What significant barriers exist for project teams and personnel attempting to implement, measure, and control efforts to improve productivity?**
- Discussed with SMEs, middle managers, and training time

- **How does company's corporate-level mitigate those challenges?**
  - **Shortage of resources – what does the company try to do?**
  - Constantly developing organization and redeveloping the org. structure
    - Sometimes over-examine the organizational structure
    - Essential vs. enabling roles → contractor, company employee, part-time, etc – still trying to learn the direction that best supports capital efficiency
  - And all dependent on project approval and full funding

- **Other resource items?**
- Still need to recognize some of the challenges, and agree to move forward
- Need to agree on staffing levels, what will be done in-house, and what will be contracted
    - o Need a solid business strategy to be defined
    - o Changes with the market and can create challenges to staffing plans

Project Interface
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- First – document called project execution instructions
    - o PEI written early to layout objectives and goals
    - o Work with contractor to align on those
    - o Establish key performance indicators (KPIs), and get alignment and agreement on those KPIs
- Monitor KPIs and correct for deviation
    - o Mitigation strategies for drivers of KPI performance
- **How does the company increase KPI visibility?**
    - o Reviewed on a steering team level, but also goes into corporate database for project performance
    - o Every month they report back to the corporate office in the home country
        - ▪ Get stop-light chart for each KPI
            - • Red means non-compliant, and that goes up to upper management to figure out why and how to improve
    - o However, in previous company experience, you could get overworked with "Help" from the corporate office, which was hit and miss with help vs. overburdened projects being asked too many questions by home office groups

- **Does company have mitigation efforts in place?**
    - o **How do these other challenges compare to the personnel challenges?**
- Reporting into global database, graded on KPIs, driven by Steering Teams, and get help if needed
- Topic was truncated to move forward with interview time constraints.

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Interviewee's opinion, starting out in turn-arounds using modularization for major work and small scale generated excellent experienced in modularization that has been leveraged through a whole career
- Go to one organization and one project team, implement best practices
    - o Did modularization, and it was bad – and will never do that again
    - o Lessons learned? – captured?

- - - Each time they went bad, it was very clear why it went bad
- - - Didn't follow the practices known
    - Earlier engineering
    - Earlier procurement cash-flows
    - On-time equipment deliveries
- High potential for cost savings, but also more sensitive to delivery schedule
- Keep open eyes even when practices fail, and understand why failure occurred
    - Without doing that, do not know how to improve, or do not know why they failed or what to improve

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Interviewee Questions**
  Interviewee is a mechanical engineer, MBA, PE, and took executive leadership with CII – career with company for 16-years
    o Utilities in southeast, though all over the country with utility work
    o Company also has an EPC firm with procurement and ability to sub out engineering
    o Most of career in construction and projects, though also commissioning and technical services; mostly working with projects –
        ▪ Brown and green field
        ▪ Union and non-union
        ▪ Have direct work management and contract management
        ▪ Built power plant and sold it
    o Suggests reading CII Research: Role of Field Level Supervision in Improving Craft Labor Productivity

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- **Please provide a high-level perspective of the company strategy.**
- Construction specific – couple of angles
    o 1. Estimates and pricing jobs – in-house estimating group
        ▪ Especially with SE union work had benchmark data for commodities and scope
        ▪ Also use other sources for benchmarks where they do not have as much historical data
        ▪ Home office has metrics and information on expected construction performance and method
            • Also have methods to measure and check against benchmarks
            • Manpower loaded schedules based on predicted installation rates
    o 2. Labor Productivity Studies
        ▪ Outside entity for time-on-tools observations
            • Watching work, lost time, indirect time
            • 30-40% time-on-tools, but poorer jobs down in the 20s – snapshots in time for 1-week periods
            • 3rd party does the observations, company shares the data with the engaged companies and contractors
        ▪ Time lost aspects – not always bad
            • Reports provide pie-chart type data
            • Travel time, safety, bathroom walks, etc.

- • Major projects get some additional attention – site layout adjustments (restrooms, break rooms), tool room spread over units (job boxes – gloves, glasses, grinders, etc.) – have to explain that investment
- **Are there established productivity goals and objectives?**
- Recommended studies – once beginning, middle, and end of outage
- Installation rate – reports showing man-hours per ton of steel, ft-pipe, etc. – lagging by a couple of weeks
    - o Helps to sound alarms to make improvements on project, contractor, or unions
        - ▪ Even there, less old-school – using QR Code Tags and RFID tags – software database that shows tonnage of each piece of steel, etc. – so
        - ▪ Reports almost automatic because man-hours recorded and data uploaded through coding
            - • Already had an in-house system for cable
            - • Have standard metrics for tracking many scopes
- Interviewee stresses the importance of standard rules of credit

- **How does productivity success get measured?**
- Standard rules of credit, options for recording with RFID, and other systems
- Monthly report with chart of trend on performance, installation, etc.
    - o Budgets and estimates based on a standards
        - ▪ e.g. – steel at 28-manhours per ton is expected → quickly able to see if you'll be over budget on specific scope
        - ▪ May have to increase staffing, address challenges, etc.
        - ▪ More gray on large piece of equipment, millwrights, etc.
- Pre-fabricated, modularization, lean construction
    - o One sore spot – electricians – going over budget based on metrics report
        - ▪ Planning, execution, attitudes, work-product, etc.
        - ▪ Able to react, use specialty contractor (cable pulls, etc.)

Company Productivity Program
- **Leadership and Resources**
- **What drives selection of company goals and objectives?**
- Project Management office – setup how company does business
    - o 2-3 people providing oversight structure for PMs across company
    - o Projects and construction interchangeable terms for interviewee
        - ▪ Project manager handles everything on-site for owner
    - o PM office has a very set template for how to manage the work
        - ▪ Contractor performing – standardized contracts
            - • What they will deliver
            - • Reporting requirements
                - o Productivity, etc.
                - o Help with historical
                - o Managing the project scope

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- - - o Understanding EPC contractor performance in various scopes, disciplines, claims.
  - o Can take exceptions – e.g. – once had a very small scope
    - ▪ So, didn't report on concrete (50-cubic-yards)
    - ▪ Flexibility for common sense – don't measure if it costs more to setup the reports and measurement than to do the work
- Project review board –
  - o They and PMs get metrics reports – prevent hidden knowledge
  - o 20-50 projects going on – everyone gets a hot-link to see data
  - o Projects early on get approval via presentations, etc.
  - o Every 6-months or so, give updates
- Labor department to help maintain relationships with unions
  - o 4-5 guys that work with unions, etc.
  - o Meetings every quarter or so – owner, contractor, and unions
    - ▪ Unions – pipefitters, electrical, etc.
    - ▪ Wholesale side is non-union typically
    - ▪ Most work is union craft – positive can make things go very well; labor issues can very quickly knock the project cost and schedule

- **How does your company select productivity goals and objectives?**
- **What major resource challenges occur when pursuing these objectives?**
- Most folks are onboard with the value of time-on-tools, union relationship
- Takes effort to produce the reports – time spent reporting
  - o Complaint can be the amount of time to generate the monthly metrics report
  - o Project has to put it together – so extra work for them
    - ▪ However, provides real-time work and management
    - ▪ Typically, a junior engineer or mid-level engineer's full time job
      - • QR Codes and RFID Tags – part of the beauty was database of information about the material
        - o Status it through the rules of credit, progressing the progress far more integrated through systems
        - o Reduction of quantity take-off walks, etc.
        - o Reduce the manual demand on junior engineer or senior field guy walking down
        - o Electrical side – kind of integrated into their systems because of pull cards and cable card – terminations and cable lengths have been more real time
          - ▪ Trying to get better on steel and pipe

- **Structure & Communication**
- **What are the major interfaces between programs, groups, and projects?**
- Project Review Board – has senior management (e.g. – interviewee as general manager (GM) has region of projects, and his boss as a vice president)

- o Departments such as labor, quality, audit
- o Monthly meetings of the board to talk about projects, etc.
  - ▪ Have projects come in to talk
- The structure for evaluation is also held more locally, (e.g. – region based)
  - o Able to talk, network, and commiserate on challenges
  - o Peer relationships – struggles and advice from PM to PM, etc.
    - ▪ Especially where pulling from the same union halls, etc.
- Network of friends and peers
- Quarterly meetings with unions going on
  - o Share 3rd party productivity studies with labor
- Staff meetings to connect assistant site managers up through PMs
  - o Encourage discussions and teambuilding by making it overnight
  - o Private sessions for site managers and PMs to go to separate spaces without the GM, etc.
  - o Encourage getting to know peers, etc.
    - ▪ Able to ask horizontal instead of upwards
- Not a formal thing – peer development plans that are more formal and mentoring
  - o In construction – more of a team sport, better bonds with people
  - o Stronger, more success with mentor-mentee relationships within the construction groups
  - o Having mentors as early-on, getting older – have peer network
  - o PM, Site Manager – need strong peer group that you feel comfortable contacting and working
  - o Do have corporate system for career development plan (that asks about mentorship, etc.)
    - ▪ Need people that you can rely on from a professional standpoint.
    - ▪ Need to start mentoring as well – get mentees that you talk to and share information with

- **What are the key interface management practices used by your company?**
- Lessons Learned System – not very effective, not referenced often
  - o Typically, more of an oral history in real practice
  - o Do lessons learned sessions, PDRI, project closeout process
  - o Capture lessons learned and put them into the system

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- Time-on-tools, benchmarking, standard rules of credit
  - o Monthly metrics reports
    - ▪ Aligns with estimate and methodology for estimation (e.g. – level of detail on material and sizing)
  - o Time-on-tools not mandated – very regular on a large project - $40-70M
    - ▪ Required on a $100M or higher project

- - - But not always going to track a less than $10M outage job
      - Typically give recommendations on what should be implemented, even if the number is good
- Sometimes modularization and prefabrication – not regular but trying to move toward that – more new school – try to get the execution and quality in shop before delivery
    - Do constructability reviews – try to shift work to shop from field
    - OEM – original equipment manufacturing (major suppliers of equipment)
      - Agreement on major equipment is that it comes on modules or skids with hook-ups completed, etc.
      - Moved toward ISOs of all pipe rather than 2" pipe being field-routed
      - Small bore pipe that has to be painted and shop fabricated – ends up being a big-time saver in the field
- Lean Construction – is another more "new school" system the company is investigating and may have some experience with using

- **What practices would you add or expand, given additional resources?**
- Projects are pretty well bought onto the process
    - Performance management can sometimes yield the trap of – "Ship it all here."
      - Get away from designing staircases each time – modularize
      - And have the designed, modular staircase that fits on a truck
        - e.g. – able to deliver a 2-piece of modular 90' stair tower in 2 days by using existing design, fabricator, and easy modules
- Corporate expectation has developed to send work off-site
    - Safety risk is reduced by sending work to a **controlled environment**
    - Captures the better work environment – climate control, consistent job site, better work conditions, etc.
    - **Cost more to have it shopped?**
    - "Ya, but you don't have to put it together in the field – cost are offsetting."
      - New benchmarking for installation of modularized equipment
      - However, this takes money from construction and puts it into procurement because shop is being paid instead of as many field hours

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Feels like we captured the company's perspective and input well
- Good topic for research

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Interviewee Questions**
- Survey – group of folks (an established committee) filled out the survey
    - World Wide Engineering and Construction
        - Organization spans entire corporation for engineering and construction
        - Focused on home location, but address 53 sites worldwide
        - Each site has the ability to determine their participation and content

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- One of the issues mentioned early on is that the company does not have a corporation-wide productivity effort. Nothing well structured that spans the whole corporation focused on all productivity – just engineering and construction
    - Defined very broadly – how efficient are we with all resources
    - Savings and improvement, better ways to engineer project, repair tank, etc.
- All of those captured corporate wide and measured as to how it looks at productivity
    - Interviewee is on the team because he led the corporation methodology on how to measure overall productivity through capital efficiency movement
    - Outside of the capital perspective – better operation of manufacturing plant
        - Accounting software that eliminates overhead positions
        - Corporate activities on capital efficiency – budgeting, engineering, scheduling and planning
- **Overall goal and measure?**
- Corporate wide program – not focused on construction
    - Goals set every year, measures, how to improve bottom line
    - Need a focused effort for company to pick the best tools for construction and capital efficiency on all projects
    - Need better way of setting up capital projects
- Corporate wide – strong buy in from high level to push improvements
- **How is it measured?**
- Basically, different levels of validation – avoid people throwing in numbers
- All things come into dollar savings over 12-month period
    - Small improvements – not a lot of validation
    - Moves up in validation for higher value claims
        - These flow into an accounting organization to validate
            - Real savings; impact on bottom line
            - Escalation of validation by value claim
    - Rolled up organization by organization
        - Budget effected is where credit for the value is given
        - E.g. – R&D → Manufacturing Line

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- Ways for folks to still get success, but accurately track where the impacts fit rather than by the improving employee's group only
- Running now for 4-5 years
  - Rolls up to high level, and folks have their goals for each department / area
  - Now have a sub-measure for the world wide engineering and construction

- **Are there established productivity goals and objectives?**
- **How does productivity success get measured?**
- **Please provide a high-level perspective of the company strategy.**
- Interviewee felt these were well captured during the discussion

Company Productivity Program
- **Leadership and Resources**
  - **What drives selection of company goals and objectives?**
  - **How does your company select productivity goals and objectives?**
  - **What major resource challenges occur when pursuing these objectives?**
- Corporate level setting of governance and operation
  - Basically increasing challenge each year to create a stretch goal
- Generally, folks make it – first year, drastically exceeded
  - Overall set by executive team
  - Allocated by business organization across corporation
  - And stair-steps down – flows down to group goals
    - Formerly, the kind of "Process Improvement Engineer"
    - 12-years of "O, new low hanging fruit."
- Accounting group to validate claims
- Organization to manage the measure – couple of resources corporate-wide to pull it together overall
  - Every department expected to feed the information upwards
  - Depending on level, goes to different level of approval
- Originally a team of about 20 people to develop
- Also 20 people on a Steering Team overseeing it
  - Still a Steering Team type of organization
  - Helps with managing goals that change and resources that measure
- Consistent form to gather the information; roll-up of data
  - Excel type of software – electronic form to fill out
  - Path that it flows into for approval
  - Setup of flow path, sheet, etc.
- Money to support the labor that keeps the measure is probably the only real capital expense – not many people, only a couple people truly assigned to the effort

- **Structure & Communication**
  - **What are the major interfaces between programs, groups, and projects?**
  - **What are the key interface management practices used by your company?**

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- Communication corporate wide, but not fully engaged
- Annual goal setting – major communication effort to drive the program
  - Very top people in the company – "hey, reach 200 million"
  - 2nd Boss – hey, you get "50m of this"
  - In interviewee's group, it is cascaded down to where value targets are given directly to specific individuals
- In research – there was an individual (engineer) collecting data across interviewee's organization. Engineer helping it go through the whole accounting process and validation of what is being captured
  - Department wide graph of what is going on through the year, monthly site-wide evaluation of groups and success
  - Top 10 listing to highlight the best value capture efforts, transfer knowledge, and recognize the work being done at high organization recognition levels
  - Other sites likely have their goals and reporting
    - Actuals vs. Objective
    - Encourage everyone to chase the goal
    - Reminder every month
  - "Originally many more dog-and-pony shows of what was going on, but now that it's in place, mainly the two major communications"
    - Big roll out of end of year
    - And start of new year
- Report issued to site – see whole site – click and see smaller departments

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- Majority of them are listed in procedures – constructability reviews performed on every project over $500K-or so
- Initial stages of AWP – expects growth
- 3-years ago it came to the project management department – first time the PMs, construction, and project engineers are all in one department
- Most practices are held, but decisions about which to use are selected by projects are up to the project managers
- 3rd party benchmarking every year
  - Other great thing – measured on how the process is being executed
  - Then – how are schedule results and project results compared to peers
    - Benchmarking against others
    - Costly, but very good
  - Analysis of projects and a method to say – this is how it should go
    - What it should cost vs. actual costs
    - Same with schedule
  - **How many people does this effort require?**
    - Last year, on interviewee's location – 10 projects that 3rd party and company decided worked as a random sampling

- - - Send 2-3 people that spend a week or two
    - Talk to teams, PMs, everybody on details of project
    - Validate that the information was done
    - Show constructability review was performed
    - Assess quality of reviews and steps
  - Look at key / major projects, but attempt to get random sampling
  - Some other sites but two major locations represent 80% of company spend

- **Which practices would be the first to drop, if resources were more constrained?**
- **What practices would you add or expand, given additional resources?**
- Not addressed due to time constraints.

Input and Feedback
- **What are the highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Interview process – great
- One of the things early on: road blocks
  - For company – roadblock has been home office "lack of a big stick"
    - Recommend and help, but the corporate-level does not have instruction authority
    - Do not have a program that can roll out to each project telling them to implement practices
    - Geographic distribution and independent silos
    - Inconsistent capital project program
  - Avoid micromanaging, but most people do not know the best way to execute a capital project
    - All of the things that could and should be done are unknown
    - Just doing things the way the last one was done
- Have a team trying to pull the different practices
- Every month gathering where folks can share ideas
  - Knowledge transfer, recognized need – trying to get the folks together on teleconference
  - Sharing positive things can help keep people motivated and engaged

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**
- Global-scale contracting organization
Interviewee leads a corporate-level construction division that assists global business units with identification and consistency; focus on industrial construction and pushing company's leading edge and use of existing systems and knowledge

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- Discussion in November – since then, strategy paper from CEO and CFO
    o Objectives – reduce cost of project delivery by 20%
    o Schedule by 30%, especially monthly starts and finishes
- So this has defined successful productivity for the company
- Companies, initiatives, practices (tool time) – links back to these objectives
    o New strategy planned in 2017 – Jan. 1, 2017 – at the 6-month period

- **How are corporate productivity goals and objectives determined?**
- Top – senior leaders and flowing down to everyone.
    o Then everyone falls in line to report to his or her level of management.
        ▪ Projects and individuals ask how they can accomplish these targets
        ▪ Using practices and identifying methods to chase goals
        ▪ Personal assessment of how to do job better.
- EPC evaluation – work packaging through to completion
    o Accelerating the data flow from engineering and procurement to construction and completion
    o Individual modules in EPC, but there is a lot of manual work to be done with data exchange

- **How are advanced work packaging initiatives distributed to business units?**
- Corporate group's job is to ensure that the global business units (GBU) use programs
    o Divided by business sectors, but with practices and knowledge shared
        ▪ Focus is completions
        ▪ Unable to take full credit for work packages until completions, rather than earlier
            • Earlier credit tends to yield huge punch lists, delays in completion, extra staffing costs, etc.
- Corporate level shares GBU lessons learned and practices
- Corporate makes sure that all GBUs use those tools
- Describing the corporate structure:
    o Corporate → GBU → Sector Projects → Project Teams

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- Corporate level can push through the GBU, but the projects still need to be worked through to get initiatives used and gain focus on productivity.
- Not all projects want to embrace those improvements and efforts – PMs challenge, but now projects are reaching out to corporate for how to improve their costs; getting introduced to the practices and systems

- "Taking down barriers by lessons learned can be done with two sentences from senior leadership," rather than years of pushing from lower-level management
    o "Panic – yields reaching out and efforts to improve"
    o Must set difficult targets – "vague statements would not drive change"
        ▪ The specific 20% cost and 30% schedule gets people's attention and they know it is not what is available in hidden buckets.
- Last year, productivity engineer did 11 productivity analysis
    o This year, have to hire another guy because productivity engineer is doing analysis every 2-weeks
        ▪ Rotating through power plants and others every quarter
    o Activity analysis is a more real time tracker on improvement of cost
    o Now getting so much data in AA – able to do correlations between craft performance, educate PMs on where to focus efforts, yields better decisions
        ▪ Have enough data to show them where their projects could end up at the end, and what their losses could be
        ▪ Real time information so they can adjust and make improvements
            • Real data instead of unit rate install and limited understanding
            • Indirect to direct ratios
            • Field engineer / super to craft ratios, etc.
            • Leading indicator from what was previously lagging
    o AWP really includes more from craft on what they need because it is now construction focused
        ▪ Gets GF and foreman on site more because of less sorting of design, material pursuit, and change management allows them to do the focused work of interfacing with crews

- **How does productivity success get measured?**
- Able to highlight performance in annual performance reviews.
    o E.g. – Engineer who does structures – how do they improve the cost by 20% and schedule for doing those tasks by 30%
    o Project returns; GBU returns, etc.

- **How responsibilities for company productivity interfaces, practices, recommendations, and improvement established and managed?**
- Strategy for accountability and tracking set by referencing the objective
- Enterprise level instead of project level is smart
    o CEO and CFO holding everyone accountable for that

- Not just projects – every single person.

Corporate Alignment
- **How is your company aligning on productivity across management levels?**
- Alignment through strategy
- Continual reinforcement by senior management – more communication to organizations and in presentations
    - Tying presentations and publications back to the 20/30 targets – becomes aligned by making it the forefront of conversations
- How it helped corporate functions:
    - Started program in 2015 – short interval tracking program
        - Focus on productivity improvement through activity analysis data
        - Improve elements and initiatives in a white paper
            - Historical data, hour-to-hour on projects by GBUs
            - How improvements at the activity analysis levels can sum to significant impact for the big picture
        - This focus has helped gain better focus on this concept
        - Everyone understand what a minute costs on their project – mental incentive for getting things done
        - Minute on project costs $100k – so delays in technical issues and responses are huge impact, and people can be made more aware of those delays
    - Short interval knowledge helps people value their work – etc. see safety report

- **Are there existing or historical barriers to alignment?**
- **How has alignment been improved over time?**
    - **Quarterly meetings or other systems?**
- Because things happen so quickly, software and tools are continuously updated to improve work-flow, which can be a struggle with older PMs
    - They do not want to use the tools as much, but as the older PMs start to exit, newer PMs are more accepting of change, and they are looking for better solutions
    - More meaningful discussions on productivity improvement because PMs understand change is going to happen, maybe also more tech savvy
    - Accepting of change and looking for ways to improve their project
    - Get to communicate tools, processes, and other aspects that they know, but are able to become truly familiar with
    - More front-end of project focus from these PMs – AWP, early project planning, etc. → message gets through for younger, but older entrenched
    - Older may reach out to improve by 20/30, but they may only take a small portion of what they are told, 5-10% adoption rate
- **Adoption rates are tracked?**
- Yes, collecting data on project use – initiatives being used on projects are tracked
- Forms program switched to develop and fill in forms to send quickly from field
    - How quickly could that data be collected to show new methods impact?

- o 5 pilot projects of new forms software – able to show the success quickly to new PMs in true data format
- o Able to help push that piece to enterprise wide instead of just a pilot or initiative
- Pushing it sooner to an enterprise system. Company wants projects to perform under common software and tools, but projects were performing under their own software and tools. Very inconsistent tools and execution.
- Data lakes go into huge systems, but because projects were inconsistent, the data scientists have much more difficulty with correlation of information
  - o Moving people to the same type of information to send, the corporate level can make much better improved trending and tracking

- **What future efforts do you expect to enhance performance?**
- IBM Watson and General Electric technology and data analytics teams came to company. However, the lack of reproducible projects means it is more difficult to provide data analytics because the sources are different. These projects are more difficult to predict due to varying scope and customer requirements.

Company Productivity Program
- **Leadership**
- How do corporate leader display commitment to productivity objectives?
  - o Are there barriers or challenges with displaying commitment?
- Highest level is pushing down requirements – without this, there would not be the push at the project level.
  - o Important to understand the senior leadership influence – highest level needed to get the positive response
  - o Need senior leaders to push these because projects are not the right level
- Private company – helps because they do not have the stockholder needs blended into the company. CEO and CFO are able to put initiatives out without interference
  - o Other companies are often driven by what stockholders want or approve for big initiatives because the money that is going to be used is taken from stockholders.
  - o "Private company is able to focus on what it feels will win more job and finish more jobs on time"

- **Resources**
- **How are corporate resources positioned to establish and disseminate productivity practices?**
  - o **Are there known barriers to that process?**
  - o **Why are senior project managers so influential?**
- Senior project managers make major commitments to senior management, and they are the only ones with those commitments and accountability
  - o Senior management is now also giving some leeway to help push using processes by relieving some of the commitment burdens

- Company pursues a project with PM involved – so when the project is won, the PM has negotiated the deal and gotten it approved by the senior leadership
    - So, the PM is responsible for delivering on commitments
    - So cost avoidance becomes a focus – not investing early in the project
        - So saving money early to meet those commitments, but that is backwards thought relative to the enterprise systems, etc.
- PMs have major ownership – and so they often want to execute in their way, rather than using tools, etc.
- New PMs that are more familiar with using tools and are ready for tools to change – so company is making progress on improving use and adoption

- **What significant barriers exist for project teams and personnel attempting to implement, measure, and control efforts to improve productivity?**
    - **How are challenges mitigated?**
- Senior leaders understood that new initiative adoption is needed, and they're pushing on the PMs to use them
    - So, pushing the processes and use to chase 20/30 – taking responsibility up through senior leaders, rather than only SPM
    - Partnering type of effort – PMs can pilot on project and senior leaders recognize that it as used
        - Understand improvements or toss out piloted practice

Project Interface
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- **Any key misses above?**
- Company recently introduced a construction emersion program for training personnel and quickly getting them as familiar as possible with company construction
- Highest levels are now onboard with emersion to bring employees up the curve
    - 4-week emersion program for college hires – done with experienced employees to share what the enterprise is and how it works
    - Breakdown for college hires and early career employees on how they add value to the company, and how they fit within the enterprise
    - Full education on enterprise, GBUs, project execution
- Fixing the lack of understanding of role within the big picture – understand the purpose of work and scope to enhance that performance
- Helps with retention because they understand how they are contributing
- And experienced teams being helped to align them

Advancing leadership quicker rather than focus on tools – helps future leaders understand sooner.

- **Does company have mitigation efforts in place?**

- **How do these other challenges compare to the personnel challenges?**
- **What productivity practices do projects consider key, essential, or mandatory?**
- Questions either addressed above or skipped due to time constraints.

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Interviewee is happy with structure of interview
    - o Having familiarity with the concept ahead of time helped with keeping it hit the pieces
    - o Suggest continuing to educate personnel about the concept to aide them in responding to surveys and interviews

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**
- A metallurgical engineer with 18-years' experience with a power generation plant, now working as a manager of performance and reliability
    o 4-regional guys executing plant outages
    o Engineering testing group – long-term service agreements
    o Asset maintenance, condition based maint., analysis – vibration, oil, etc.

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
    o **Are there established productivity goals and objectives?**
    o **How does productivity success get measured?**
- Common theme – executing on schedule and budget
    o However, checking of accuracy of schedule and budget
    o Folks tend to be happy with SPI and CPI performance
- Fan of productivity studies – work utilization more focus
    o Random sampling of workers, classify actions
    o Direct work being the focus
    o Correlation of direct work to higher output, lower cost
- Manufacturing background – outside of a regulated utility – less like competitive manufacturing facilities
- Regulated by most states – some deregulation, but SE still regulated
    o To get rate increase, must go through Public Service Commission
    o Largest tax state
    o Highly competitive market – so keeping cost down and retaining business to avoid exporting of business, lean work

- **Goals or Objectives?**
- Target about 45% direct work
- Consistent 3rd party assessment for consistency
    o Hands on tools, doing work
    o Industry avg. 26-28%
    o Nonunion in low 30s
- Over the years, has gone from 22 to 40% direct work
- Varies from plant to plant and organizations – mindset to manage that way, and typically –
- See – walk down a unit / outage – approach individuals – find that 80% of the time, they were put in the position to be stagnate
    o Failed to manage the outage well enough
    o People want to be successful; but they need to be positioned to perform their work
        ▪ Overmanning is toxic, but contractors want to do it to reach comfort levels
        ▪ 20% typically means overmanning

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- Folks need in mind – too many people beating on vendors for material costs, while craft labor is a huge challenge and lost value
- 10 contractors / year = $1M ($50/hour average)

- **How have you gotten that out to projects and groups?**
  o It is a struggle. It's really tough.
  o About 12-years ago, had an outage – first study as an individual while running the outage
    - Had hard working contractors, but 28% direct work
    - Guy made a bunch of suggestions – and they put them in place and wanted to run the contractor out of town
    - 6-Months later, similar scope and a lot of pieces in place from recommendations.
      • Up to 39.7% direct work
      • Exact same scope, 28 to 39% (huge improvement)
      • 100 less people, $1m less in spend
  o Savings on certain outages → So budget gets cut back
    - So much work performed efficiently, and now expectations are at that high-performance level

- **How do you sell that to everybody?**
  o At that time, Plant Manager and Asst. Plant Manager got to see results, visually able to see people not standing around or stuck at the elevator
  o Attitudes better, safety performance is better
    - Can look at site and roughly estimate the direct work %, but some folks are not as bought in and sometimes management has to work harder than they want to do
    - T&M work and hard-dollar work – have loss because of hard-dollar margin, and contractors often do not adopt lessons learned

- **Please provide a high-level perspective of the company strategy.**
- Whole thing – setting up for productivity – wish people could see the savings and understand better
  o Instead of 500 people having huge break in a place
  o Specifically place break room in the unit
    - Often in-unit break rooms are not enforced
    - Frontline supervisor is the biggest driver

Company Productivity Program
- **Leadership and Resources**
  o **What drives selection of company goals and objectives?**
- *Target of 45%?*

- o Have had crafts hit over 50
- o Best performance ever for overall average was 48%
  - Specific work can do slightly better, but other work, etc.
  - Used to target 40%, but started accomplishing it – so increased the target
  - Can't shoot for 65% because 6-days a week, 10/hr days
- o In manufacturing, can shoot for other goals
- *Engagement / development of target?*
  - o For plants, interviewee and regional planning managers & plant department level managers – Maintenance Manager / Operations Manager
    - Work with randy and try to set those standards
- That number is – have to understand the data – normally do a 2-week study in middle of an outage
  - o Target the large bulk of folks, rather than getting the continuous knowledge
  - o 12-day outage, around 35% direct work
    - Use the data, what is it telling you – rather than throwing out the info and the challenges
      - Improve access, LOTO, security, and know how to use the data

  - o **How does your company select productivity goals and objectives?**
  - o **What major resource challenges occur when pursuing these objectives?**
- Frontline supervisor
- Right now – qualified craft is a big issue
  - o Couple of folks working with industry on developing the craft labor force
  - o Not popular to not go to college; going to trades is not as valued
    - Looked down upon for craft
    - Struggle with the number; welders, quality of welders
    - Last 3-years – craft workers market if they're willing to travel and have a solid skillset
- Craft labor supervision
  - o Mistake to take the best worker and make them supervisor
    - Without leadership skills and training – hit twice
      - Bad supervisor and losing your best worker
    - Work on through training supervision, training contractors
  - o Biggest overall weakness with contractors – mid-level / superintendent management
    - Need know-how to get work done
    - Strong on process, logistics, tool plan, breakrooms, etc.
    - But – contractors do not have that handled as well
    - Do have the know-how and personnel that can get the work done
  - o Getting contractors to understand and value the process aspect is a struggle
- *Coaching contractors on process improvement?*
  - o Often the company is its own worst enemy – don't understand the contractor's business well enough to allow them to do things

- - - Think it is wasted cost or pinch pennies – allowing themselves to lose big opportunities because of pinches
  - Example – Contractor wanted to buy Safety Signs
    - People on site wanted to prevent the $600 signs
    - But there were boilermakers sitting around costing $500/day
  - Some contractors have good practices
  - Often best to use alliance type contractor on T&M work – getting them in early on with engineering and planning side
    - Work hand-in-hand on manpower work – labor or independent contractor – can always tell them how many people they can have
    - So, flex that muscle to pinch down how many people they can have, prevent the contractor comfort level
      - Union contractors tend to overman more because the schedule trouble solution is often hire more people
        - Sometimes the answer is adding more – but every other option should be assessed first

- **Structure & Communication**
  - **What are the major interfaces between programs, groups, and projects?**
- Have 4 regulated outfitters
    - All plants are managed under one parent company
    - Each facility belongs to one of the operating companies
  - Above PM is senior production officer
  - Each plant → Plant Manager
    - Engineering and maintenance department
      - Historically high churn in development roles
      - 80% stay in project group 4-years, then move onto a management position
      - PM at a plant, not heavy design
  - Engineering and Technical Services group
    - VP of tech and design
    - VP of construction
    - SMEs on maintenance and turnaround, etc.
    - Work hand-in-hand with those groups → regular meetings on productivity and project expectations
      - Construction has other metrics
        - Earned Value
        - Benchmark Metrics
        - Tie and relate those
    - Also have construction group for substantially large projects
    - Also have a design group

  - **What are the key interface management practices used by your company?**

- Formed regional maintenance about 8-years ago – helped bring things together
  - o Before that, had ex-contractors in 4 different plants, different contracts, different overheads → geographically bid out contracts
    - ▪ Huge variance in contracts, 6-11% overheads, etc.
    - ▪ Captured economies of scale
    - ▪ Helped get processes consistent and complete
  - o Big outage for the first time in a while, but practices consistent across clients and contractors
- Construction Group – now interfacing much more with the construction team
  - o O&M contractors vs. capital → Barriers starting to come down
  - o Reporting up through that group, Project Delivery Process
    - ▪ Helps get all big projects onto good tracks, consistency
    - ▪ Reviews and stops

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- Feel experience and books are critical to shutdown management
  - o A lot of low-hanging fruit out there for contractors if they were better focused on utilization, less knee-jerk reaction, and more detailed planning balance
  - o Some mega-projects going on right now, and most folks feel they are over-manned and running up the bill
    - ▪ Doesn't have to be that way
  - o Learned a lot over 15-years – formalized it, document it, and utilize it

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**
- Interviewee has worked in Oil and Gas and Mining and Metals with current company for 20-years as a construction manager and project manager.

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- Baselines and measuring against them relative to worldwide variability
    - Benchmarking; e.g. –indirect vs. direct man-hours
        - Booking 40% craft to indirect in Australia
        - In states, more around 20%
        - Lots of parts in the project were American workers
    - Difficult to get reliable regional benchmarks because of those kind of variances
    - Measuring against those baselines
        - QURI – strong focus on the direct accounts
        - Now getting improvements on indirect accounts
        - QURI – quantity unit rate report
            - Earnings basis of benchmark, rules of credit, etc.
    - Measuring out indirect & support activity
        - Getting better, but have not had a system like QURR
        - Cost blow-outs, especially on remote jobs & high cost indirect locations
- Mining and metals do a lot of remote work
        - Remote location costs like transportation, etc. as well
        - Not just man-power mark ups
    - Booking indirect craft relative to plot plans
- Years have led to world-wide standards
    - Schedule performance and focus on global measurement
    - Schedule start and stop has become a major focus

- **How are corporate productivity goals and objectives determined?**
    - **Who owns productivity goals and objectives?**
- Attempting to consolidate history, but inconsistently inconsistent
- Not a lot of direct hire work, largely EPCM style work
    - Work with subcontractors, set baseline, and then can run into lack of skilled craft
    - Attempt to assist the skilled craft, but less accountable
        - Work packaging, scheduling, and bring them up to speed on performance
- Very difficult to convince mining houses to allow for direct work
    - Owners do not view it as synergy of integration of systems
    - Perception that contractor is trying to grab extra work
    - "We struggle to demonstrate the value of direct hire vs. subcontracted work, and one of the issues is that they invariability convert the job over time to more direct hire"

- E.g. – company from 0 to 50%
  - Mitigation to avoiding drawdown on contingency – hard to prove savings against claims, change flexibility
  - Scope shifts and moving
  - Avoid impacts of engineering delays, etc.
- If those conversations do not occur up front, then planning is limited to best case scenarios
  - Do not want to consider risks up front, even when company puts the risk manage plans up front

- **How does productivity success get measured?**
- **How are responsibilities for company productivity interfaces, practices, recommendations, and improvement established and managed?**
- Reporting requirements flow down through subcontractors
  - Project controls, field engineering have procedures
  - Flow down in contracts typically flow down to the subs well – reporting requirements, earned values, weekly expectations, etc.
    - In some cases, can get contractors to have access to internal tools
    - Enable avoidance of validation and double-handling of data
      - Roll up of QURR – easier for everyone
      - Supers report on performance and declining focuses
        - Focused on the direct accounts
        - Starting to focus on the indirect accounts

Corporate Alignment
- **How is the company enabling alignment on productivity for varying management levels?**
- There is good alignment up the chain on how to measure progress
  - People with company for a long time; so they recognize the core strength of knowing where they are and where they're going
  - Contractors often try to adopt the process and the system
    - Know status, forecast finishes, check manpower
  - QURR – folks get it, etc.
- Cross functional barriers
  - Looking to streamline procedures to being more work process based instead of functional – e.g. – engineering procedure that directs procurement path
    - Mining and Metals – "Future Funding" for development of work plans that develop workflow based plans instead of functional
      - Procurement has a functional management silo
      - Engineering cannot know the commercial terms, etc.
        - Getting teams from the different functions operating together to break down barriers

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- o Future fund for innovation – quality manager got initiative over the line to start the process of cross functional work procedures instead of functional
  - ▪ Updating work procedures for ISO anyway – so good point
  - ▪ Mining and Metals is a smaller organization to effect change in
    - • Can do work with fewer committees
  - ▪ Mining & Metals, Oil & Gas, Infrastructure, NSE
- o Barriers –the company is not setup on geography
  - ▪ GBUs → Mining and Metals spread all over the globe, where regional focus can help coordination and concepts
    - • Has other challenges since regions create challenges as well

- **Are there existing or historical barriers to alignment?**
- Region vs. Scope of Work / Industry

- **How has alignment been improved over time?**
- More aligned around competency and scope of work
  - o Consistent approach around the world, rather than regional isolations
  - o Core office –consistent expertise to be drawn on
    - ▪ Regions can be very up and down
      - • Projects up and down, which mean offices by region disband and cannot necessarily sustain
    - ▪ Stability as personnel
    - ▪ Consistency of work
    - ▪ Reliable output
  - o Improved connectivity now than historically – access to people, etc.
  - o Better control of jobs and consistency
    - ▪ Regions no longer chasing work, more control of hurdles now
    - ▪ Business unit based hurdles
      - • People understand the work better than when switching between industries

- **What future efforts do you expect to enhance performance?**
- Cross functional work processes, rather than function based
- Procedures over time have become volumes
  - o Making those more risk based, rather than every project does the same items
  - o Scalability of work
    - ▪ Risk based scalability
- Do not distinguish critical / high risk – absolutes vs. nice to have category
  - o Provide that guidance to allow people to know which is critical
  - o Move to include that into systems
    - ▪ Helps when flowing down core processes to contractors
    - ▪ Understand what is really important to company vs. drowning in paper

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Project Interface
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- Biggest one in mining & metals – deploying them within EPCM
    - o Working with subcontractors
        - ▪ Easier on reimbursable / + fixed fee
        - ▪ Lump sum / unit rate can often prevent interface and driving behaviors
            - • Often end up playing catch-up when that happens
            - • Spend more field engineering hours to coach and guide contractors on how to execute
            - • Less execution competency within subs – so often run into challenges that drive up costs to coach
            - • Do not have direct hire tools deployed at outset – so very difficult to play catch-up

    - o **Does your company have mitigation efforts in place?**
    - o Behavior in the industry right now is to go to low-bid, so there is a lack of certainty in outcome; but this too depends on geographic location.
    - o Without seeing a bad job, it's hard to understand how it ended up there and why
        - ▪ Seeing that with client's due to generational change
        - ▪ Guys from the 90s saw jobs go bad
            - • If it's been smooth – hard to understand what happened before it was smooth
            - • E.g. – mining boom, and people don't know how things were done well because of lessons before the boom

- **How do these other challenges compare to the personnel challenges?**
- Had a lot of that challenge on a previous project – declining performance
    - o Safety challenges being addressed do yield less time on tools and correlate to less productivity
- Focused on now – job setup right
    - o Minimize travel time, access to locations
    - o Increase tool times on work faces
    - o Huge sites

- **What productivity practices do projects consider key, essential, or mandatory?**
- Boundaries in terms of company protocol – what will they do
    - o Case by case rather than solid check
- Interface dependency – pre-award not as considered as it should be with lump sum and unit rate contracts
    - o How clean will those break points be
    - o Experience based rather than formula or check to apply before contract award

- Subcontracts – site management and project management have key role in review and recommendation of contracts
  - Team work with procurement – making sure it is a balanced decision

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- More direct labor hires exist with other departments – so they have more focus on craft productivity
  - Mining is more using 3rd parties that aren't as highly skilled
  - ESP – execution scope packaging – higher level than work packaging
    - Help to build out project ownership levels
    - Geographical chunks that can be defined up-front

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**

Longtime employee with company; one of its earliest employees. Worked in Union operations before moving to open shop organization before becoming director of operations. Now works in project support organization as the pre-construction manager, applying experience to the various challenges the company faces while assessing needs and strengths for each project the company receives.
- Tying that back through support services; engaged through proposal process, execution plans, reviewing estimates, scope for subcontracts
    o Week-to-week variability; 300-ish projects per year on proposal
    o Deep dives into proposals – wins where the financial goals were not accomplished

Company Perspective on Corporate Productivity
- **Please provide a high-level perspective of the company strategy.**
- Primarily a maintenance contractor supplying outage support for the nuclear and fossil industries
- **How does the company define successful productivity?**
    o **What are the company's productivity goals and objectives?**
    o **How does productivity success get measured?**
- Productivity strategy is really driven by customer strategy
    o Industry customers that are budget driven; so, D&Z is more budget driven than performance driven
    o Grown as a company with high market share in nuclear power maintenance – growing in fossil maintenance.
    o Recognize that continued growth requires moving into projects.
        ▪ Neglected performance based / productivity project contracting, and probably need to pick that up to grow in projects org.
- **How do company objectives and goals interact with owner / customer expectations and systems?**
- The company needs to change, and is going through a phased approach to develop productivity
    o Implementation of worker utilization program
        ▪ Structure for developing the team, implementation of utilization program on site – training for coordinator, analysist, training for foreman and supervisors, etc.
        ▪ Increase cost-effective approach through internal approach
            • Commitment shown to customer base by in-house
            • Standard work day templates – craft survey
                o Gain insight into craft's sense of worker productivity
            • Also foreman delay templates with some structure for where time can be gained and prevention of progress

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- o Developing benchmark systems
- o Earned value reporting has been a difficult tool to get implemented from project controls stand-point
  - ■ 25-years of work, but have not really collected unit rates historically
    - • Customer has driven by setting budget limits on a given area, and company does the work to the budget → subsequently, the cost to perform work goes away
      - o Not at a work level description – work order level
      - o Collected cost by the area worked
      - o Strong driver to satisfy customer needs, and don't always get what is needed from a unit rate and performance based stand-point
- o Changing that model by implementing PC Lite with project controls organization
  - ■ Quick tools for small projects, recognizing the need for full-blown project controls effort as well as a smaller version that satisfies providing use for smaller outage projects
  - ■ Moving down parallel projects of measurement of new project and maintenance project
  - ■ Applying contingencies based on that
- With a current contract – customer with very clear need and want regarding project controls and prod.
  - o 8-years of weekly worker utilization execution – so interviewee feels strongly that it needs to be part of project work
  - o Miss many of the things that can impact how productive the industry can be
  - o With under 50% hands-on, there is a lot of space to improve
    - ■ Relocation of tool rooms to be near work being done, etc.
    - ■ Planning activities to help foremen with availability, planning, execution, etc.
    - ■ Travel time and reason for it
  - o Also utilized and developed capital and O&M baseline processes
    - ■ Equalize scope
    - ■ Evaluate actuals
      - • E.g. - $100M of maintenance work over a year
        - o As part of metrics and indicators, may need to take 10% (10M) – do a capital or O&M comparison estimate of actuals vs. perf.
        - o Well thought out evaluation of unit rates and performance – then required to reduce the cost by 10% each time they did a repeat project
        - o Using unit rates and continuous improvement process to drive that performance
  - o Company has not reached that point on their current project work and approach
    - ■ Part of the review process on-going about project performance
    - ■ Unit rate books established back in the 60s / 70s in the pipe fabrication in the nuclear power plant hay-day

- Shop work, etc. – direct work values, still good in new construction
  - Does not work well in maintenance.
  - Need to validate those unit rates – develop the best approach for maintenance type work
  - Processes still needed – baseline process and scope utilization processes to validate unit rates vs. actual
- Goals today – to work through phase I and phase II of their productivity improvement process
  - P2 – goals are to establish benchmark unit rates that apply to nuclear and fossil industry
  - Get earned value reporting in place for all work (in for some, but not all)
  - Better cost collection
  - Training and development
    - Problem when going 25-years without placing value on prod. Improvement – has been valued, but has not been a customer focus value → the company estimates that 90% of work had customers that were not placing value on productivity improvement
    - Increase business line and bottom line
      - Need to be more project focused
      - Need the tools to accomplish that by measuring and improving performance from a bid and execution standpoint
        - Get productivity processes fully implemented
          - Worker utilization
          - Metrics – unit rate level performance
            - Work activity level performance
            - Estimate & Proposals that were winning need evaluation

Company Productivity Program
- **Leadership and Resources**
  - **Who and what drives selection of company goals and objectives?**
- Company is looking for larger market share in project work to sustain growth
  - One of the company's biggest drivers
  - Moving from maintenance into projects – not as successful with projects as they want to be
  - Need to improve market share, and have to go into projects
    - Did not form around projects
    - Formed by customer needs for maintenance work
      - Utilities needed to reduce their costs under deregulation
      - Focus moved from fixing power plants to generating electricity
        - Dropped things that were beyond an 8-hour day

- The company has largely maximized that scope of work – has the lead and market share of nuclear power plants
  - Fossil is a harder area to get market share
  - Growth is focused on capital projects because fossil maintenance. Is harder to get market share
    - New to customers, etc.
    - Looking at $10-30M projects

  - **How does your company select productivity goals and objectives?**
- Those will be the output from some of the current evaluations

  - **What major resource challenges occur when pursuing these objectives?**
    - **Are there practices in-place to manage the resource constraints?**
- Customers are one of the biggest challenges – budget instead of performance based
  - Strategy does not heavily align
- Cultural change and change management when trying to instill different values compared to the past 25-years
  - Maintenance side of the organization is extremely different value section to the project side
    - 2 different sides of people
      - Customer focused and driven maintenance
      - Ability to manage lump-sum capital project
    - Difficult to move maintenance folks to capital project environment
    - Too focused on customer rather than the bottom line
  - Lots of employees, and employees that are long-term – but the employees' experience is in maintenance, and the company has not had good success moving them into project environment
    - Looking at training and support for that effort
    - Constraint by resource, and growing industry has those resources in short-supply
      - Hamstrung by limited available resources

- **How are those constraints managed?**
  - A capital projects organization formed
  - President of Projects → Director of Projects → Organization supporting proposal process
    - Not only implementing from a general, one-size fits all (e.g. – maintenance and projects have separate evaluation and support systems)
  - Have the organization structure today

- **Structure & Communication**
- **What barriers exist in aligning the company on productivity?**

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- So, focused on customers, that they were not as process driven as needed
    o Organization now has section that ticks on what is needed
        ▪ E.g. worker utilization process
        ▪ Procedures with metrics tied to them that keep them aligned to the procedure and expectations
            • Limited insight and evaluation of past procedures – unable to know benefits
            • Today, shift toward having metrics enables understanding of what is happening from an organizational standpoint
    o Becoming more process driven is a barrier
    o Change management process to get people following procedures and processes
    o In lump sum environment, need the ability to better manage

- **How does the company manage those barriers?**
    o **Interface barriers between programs, groups, and projects?**
    o **Key interface management practices used by your company?**
- Process tools and procedures being developed
- Training of internal organization
- Developing the metrics that validate the organization

Productivity Practices
- **How does the company incorporate productivity during change management?**
- Worker utilization – part of the key measures of effective execution
    o Used to be beating on craft and telling them they performed poorly
    o Now a tool to improve management → pay attention to it
    o Ability to enhance or take away from worker capacity to improve
        ▪ Fired folks for going into vendor area because they went into a "No Contractors Allowed" sign
        ▪ Highly negative perspective of customer to modern day focus and team work
            • Putting vending machines near the craft
- Unit rate measures – including capital and maintenance
    o Two different measures
    o One is a set of base metrics that do not really change in the time to complete a unit of work
    o But, different when you're in brownfield work
        ▪ Recognize and account for those differences
        ▪ But careful not to let each job build into the unit rate
        ▪ Base in reconstruction mode vs. new construction
- Procedures that include validation
- Baseline cost reductions that continuously monitor performance
    o Process that takes the work estimated and the work performed → Then validates that the units are good

- Scope equalization process – take scope from previous projects and equalize the change over time

- **What productivity practices do projects consider key, essential, or mandatory?**
- **Which practices would be the first to drop, if resources were more constrained?**
- Practices to drop – difficult topic for interviewee
    - Processes not liked in project environment are often needed by customers in the maintenance environment
    - Move money from one bucket to another to meet budgets
        - Contamination of budgets and spend make it hard to look back and get any value at the work order level
        - Collect costs on project and have good validation of the numbers
    - Probably would not be dropping any
    - Not fully in place, so hard to say any would be left off
        - Lacking currently → couldn't survive not doing those things
        - Basic things that are done and need to be done
- **What practices would you add or expand, given additional resources?**

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- Came at a time when corporate objectives and goals relating to productivity are in a state of change. There is some strong recognition for need to change, and the organization is going in that direction.
- So not speaking to "here's all the things we have in place" instead it is about "here is what we're putting in place"
- Benefit to research?
    - Work in progress because of the shift
    - And how to grow the business and gain market share
- Many challenges, but feels good about the shift to focus on productivity
- Internal challenge is change management → outcome will be process orienting

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position**

Interviewee worked in construction for 34 years across various industries including heavy industrial, food and beverage, and power plants (gas and coal). Duties and responsibilities included Project engineering – controls, schedule, cost, Project Manager, and EPC work as a construction director.
- 10-years with current company
    - o Director role
    - o 5-years focus on project controls

The company
- 100% union, with a varying work load from year to year.
- Many projects under $20M
- Primarily a contractor / GC – not capital project management
- Trim on resources and staffing
    - o Corporate – provides support to projects – help PMs and CMs and PEs on what cost impacts are, etc.
    - o Self perform most work
        - ▪ Focus on craft management
        - ▪ Productivity and unit rates
        - ▪ Drive cost management productivity – materials, etc.
            - • Subcontract out electrical, insulation, painting

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
    - o **What are the established productivity goals and objectives?**
    - o **How does productivity success get measured?**
    - o **Are there best practices or corporate / functional support for projects attempting to improve execution performance in place?**
- Maintaining visibility and work availability drives performance on the project
    - o Keep craft focused on hours per unit
    - o Same with supervision – hours rather than dollars
- Key to successful productivity monitoring program
    - o Put down chart of accounts so teams can manage it – site management teams are very lean
    - o Training to the PEs and PMs
    - o Establish roles through chart of accounts
        - ▪ Understand production rates needed to be successful
- 4-years ago – IWP – installation work package
    - o Breakdown work into smaller packages so that foreman can understand
    - o Associate the man-hours working each scope, etc.
        - ▪ Team will decide what level of detail will be developed

- E.g. – foundations installed – team will determine
- Total hours, materials, etc.
  - Develop package with set of drawings
  - Documents to review, resources required
    - Cranes, rigging, etc.
    - Before the foreman gets the package
    - Materials on site checks, etc.
- Provides structured mechanism to plan and manage the work
  - Performed for the majority of items, such as turbine install – more than a couple of weeks
- Corporate level importance of IWP
  - Executive management does not dictate, but they encourage use
    - Will question why it's not used
    - Controls group supports and helps teams develop
      - Have a table of all IWPs and status of them
    - Awarded a project & kick-off meeting after transfer of information
      - The IWP level of implementation is discussed
      - Director involved with project makes the call
      - Questioned if they do not want to use, but that is not a regular issue
  - Corporate level, monthly basis – project director meeting (3-ish projects)
    - Each director provides an update on productivity
    - Path forward, processes in the field that are good/bad
    - Use of IWPs
    - Key topics: safety, quality, performance (labor & dollars)
      - Overall cost with schedule
- Limited front-end time
  - Lead estimator

Company Productivity Program
- **Planning for Productivity**
- **What major barriers do you feel limit corporate level planning support, such as benchmarking, alignment, and consistent metrics?**
- **What practices are used to mitigate these barriers?**
- **Looking back, are there successful efforts that helped move the company forward with productivity practices? Or the opposite?**
- Barriers:
  - Letting projects know that from a Project Controls standpoint – the corporate level is there to support them
    - Have team members in the home office understand that being in the field is a challenge
      - Give positive, do not direct negative to them
      - Don't ding people for productivity in verbal discussions
      - Avoid confrontation

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- PMs will feel like the home office is out to get them
  - Resources helping to solve problems and working with PMs, directors, etc. on how to rectify
  - Give information, but also try to work with them
  - Large projects over the years (occasional)
    - General contractor
      - Large controls groups that they learned from
      - Identified focus areas
      - Take best practices, adopt them into company's processes
        - Training the field on different terminology
        - Earned value metrics, what they mean, how to interpret the data
      - Able to learn a lot by working with large orgs

- **Company Core Values?**
- Help the field with limited support resources
  - Try to avoid putting too much burden on them with things like developing chart of accounts, craft labor cost codes
    - Provide sufficient detail, but do not task them with unmanageable details and enable roll-up of data
    - Productivity numbers that roll down into granular detail instead of missing the manageable level
    - Dashboard report for the corporate level
      - Rolls up data to a higher level to see how projects are performing
      - Help executive management and directors
        - Cost & Schedule standpoints
        - Performance of subcontractors also involved
        - Dashboard has married schedule baseline against the cost report
          - Show early curve and late curve
          - Show cost report, plot that into the schedule
          - Show schedule plotted against cost

- **Continuous Improvement**
  - **How are successful projects' learnings shared across the company?**
  - **Are common challenges addressed from a corporate or strategic level?**
  - **For an ownership organization, how can the corporate level best improve project performance over time?**
- Monthly meetings of directors
  - Within that director of estimating (2 of them)
    - Also provided the weekly labor performance dashboard
    - Track how performance is going
  - End of every projects, post-mortem with lessons learned

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- Led by director of estimating and project director
  - Safety all the way to labor performance
- Some projects perform this after 2-years into projects
  - Help to avoid time-lost knowledge
- Done with owner and also performed internally
  - Help to keep internal discussions as options while being open with owners
  - Help to capture benefits of projects
  - Help to correct estimating and capture errors
- Challenges with post-mortem
  - Knowing folks will not be fired by being open and communicating
  - Focus on improving future performance
  - Corporate supporting that and understand that people are working
    - Severe performance issues need to be recognized, but do not take items to punish individuals

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- IWP
- Monthly meetings
- Roll-up and strategic cost reporting, progress, etc.
- Post-mortem
- Progress tracker
  - Consistent understanding of the earned value metrics
  - Understand how important the information is and why the metrics are kept
  - Kept on a weekly basis
  - Encourage projects and help them to do it consistently
  - Would not give up
  - On turnaround type work, this can sometimes be done every day
- Noticing in industry (sophisticated owners – industrial owners)
  - Watching the parent company at the higher level – seeing requirements for how company needs to explain how it will do work packaging
  - See that there is structure to that and explaining to owners how the process will be in place
  - Lean process is also part of what needs to be explained to owners
    - Be more productive; so, putting more emphasis on that

- **Which practices would be the first to drop, if resources were more constrained?**
- Do not feel that anything at the current level would be dropped
- Smaller projects still perform IWP – short time frame may limit how structured the package is, but the concept is still hit
  - Do a lot of work with local car manufacturing company
  - But still need to plan the work

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- ▪ Work in constrained periods of line shutdown
  - ➔ **Concepts still need to be hit even if practice is not fully used**
- Still working to expand IWP
  - o Young engineers can learn the process and how construction really needs to handle the documents and execution
  - o Learning process to develop into a PM and director level
    - ▪ Understand what goes into completing a task

- **What practices would you add or expand, given additional resources?**
- Training performed – not a scheduled IWP training or 6-month schedule
- Periodically have courses
  - o Training on labor productivity
  - o Then someone else is going to perform that with the field engineers
  - o Training with IWP process about 1.5-years ago
    - ▪ Big meeting, broken up into teams
    - ▪ Given small construction project to be worked on the table with a few pieces of equipment and pipe
      - • Bag of materials, etc.
      - • Other half of the room had just the drawings, only materials they needed
        - o Could see how the productivity was impacted by having IWP vs. just drawings and materials
        - o Got feedback on the impacts and benefits

- **How does your company try to fill the void and collect knowledge when an employee leaves or retires?**
  - o A lot of things are learned by hard-knocks – so hard to train that out
    - ▪ Training session is going to explain how and why the charter of accounts is developed
    - ▪ Understand quantities and rules of credit
    - ▪ Encourage them to ask questions back about how the team does that and why
  - o Measuring quantities – there is structure and industry standard, but how do you adjust for that if it does not apply?
    - ▪ Similar questions to that
    - ▪ Updating the team on technology
    - ▪ Updating the folks on processes
  - o Ask the questions to get the info out of the departing employee's head

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- **Feedback about the interview and research topic**
- One thing – discussion on chart of accounts
  - o Make sure you have the appropriate level of details

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- o Lots of people want to roll up to higher level, but without ability to roll down into granular level – you cannot get useful information
- You can only put so much detail into it without getting lost
  - o Put enough knowledge into it that it is useful
  - o But remember that garbage in is garbage out

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
  - **How does productivity success get measured?**
- The company's process as a whole surrounds profitability, with measurements based on policies and principles laid out in a corporate structure
  - Productivity = craft and direct labor productivity (e.g. construction)
    - Success = less than 1.0 in quantity based install
    - Unit work per unit time using extensive database of benchmarks from previous jobs
      - Broken down by job type (process, power, cement manufacturing facilities, etc.)
  - Ultimately – job needs to meet earning margins
- Project execution – means and methods on how to facilitate that happening
  - Practices and methods to reinforce and make production possible
  - Monitoring, defining, re-evaluation of metrics
  - Ensure fundamentals and metrics have solid foundation
  - Measured weekly, monthly, and overall job production rates
    - Also schedule productivity – S-curves, earned value curves
      - Schedule = how effective a team is being on sched.
      - CEI = Current Execution Index
        - Based on schedule activity – plan vs. completion; industry wide practice (utilization level and competence varies)
        - Ratio of completed vs. said would be comp.
        - Checks schedule validity
        - Drives project team to achieve schedule
        - Industry Standard = about 80% (going okay)
        - 80% or below = bad schedule / bad production / things are not working well
        - Works in various phases - Engineering, construction, and other phases
        - CII = using and getting to industry – planning and execution measurement
  - Measuring – fundamental things – Everyone recognizes that measuring productivity baseline definition is unit of work / unit of time. That figure is selected when bidding a project and it is a function of how well the project can be executed.
    - Conditions – location, project team, baseline of what effective productivity is, and common sense aspects
    - "Job is too high" ➔ adjusting rates to win bid = risk that the firm and company takes on to be more aggressive

- When companies want work, they need more aggression, and that impacts the bid and baseline metrics

- **Who has corporate level ownership of productivity goals and objectives?**
- **How are responsibilities for company productivity interfaces, practices, recommendations, and improvement established and managed?**
- Productivity ownership is based on operations folks (construction, engineering, procurement)
- Setting the goals – not a formal method in-place to specify project / job level productivity goals
- General programs, policies, and methods of execution are standard across the board
- Goals are set when contract is signed – yields margins, rates, and other fixed values; that sets "facts of life" and manage the job aside from scope changes (but that is minor relative to productivity overall)

Company Productivity Program
- **Leadership**
  - **What major (2-3) challenges exist for corporate leaders trying to take ownership of corporate productivity or productivity practices?**
    - **Do you have practices or methods to mitigate these challenges?**
  - Challenges for corporate. leaders
    - Empowerment of direct ability to provide an effective change catalyst
    - Being able to understand where the issues are; evaluate the root cause; effectively insert solutions or changes in real time
      - Workload is a challenge
      - Corporate level incremental change is difficult because it all needs to be figured out, solved, implemented, and monitored in real time
    - Industry business model – competitive marketplace means lean organizations ➔ limited resources to evaluate situation and implement effective changes
  - Mitigations - Establish set of means and methods for common / reoccurring productivity problems / issues rather than trying to figure it out every time
    - Overall project perspective – effect on productivity
      - Ensure right level of discussions happen with all stakeholders and yield efficient, productive project
      - Front end planning & constructability – consistent practices
        - However, cannot influence the craft level

  - **How has your company established a positive corporate culture for productivity?**
    - **A few key efforts, management tools, or communication practices**
    - **Are there specific barriers or challenges to positive culture?**
  - Leadership – overall strategy; we live and work within the business (exist) to build jobs and satisfy client needs – from a corporate perspective, sometimes companies change what they do from a corporate level delivery to meet client desires

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- - - Trying to satisfy clients
    - Construction company sets plans in the most efficient ways
    - Client is motivated to do their practices, methods, and ways
      - These can be inconsistent; thus construction companies' method of execution does not match what the client expects
      - More standardization from the owners' side can throw off contractors' methodology

- **What major practices exist to improve the corporate and project interface?**
  - **What major barriers exist between corporate and project levels?**
- Interviewee felt this was covered well already.

Structure & Communication
- **What major (2-3) barriers exist between productivity related groups?**
  - **Are there practices or methods to manage the group interfaces?**
- Practice – managing group interfaces with workshop
  - Series of workshops throughout life of projects to ensure engineer, constructor are sitting down to plan work on quarterly basis
    - Quarterly planning interface meetings
    - Client at end of quarter for communication workshop
- Barriers – non-compliance ability of project team / leadership to ignore some aspects of alignment programs

Planning for Productivity and Productivity Monitoring and Control
- **How has your company established systems or processes?**
- **How do you prepare projects for productivity practice implementation?**
- Practice – Initiative going on around advanced work packaging
- Creating scopes of work that a standard crew can understand and deliver on
- Any discipline barrier – establishment of discrete scopes of work with schedule is not defined at a detailed enough level for effective control
  - Craft, engineer, buyers – all face challenge
  - Company working to solve that challenge at the craft level
- Getting entire stakeholder team to understand the document and plan
  - PM down to crew level
- How did AWP initiative – corporate level initiative
- Reorganized and assigned a 3-member core team
  - That team is establishing the expectations and methodology
  - Capture the right model detail and information to get it to a craft team – and items do not populate into construction schedule until that detail is available
    - Intended to work upstream as well, and gives engineer a level of detail and scope of work to target with goal of meeting downstream need

- The team is both training new people on the jobsite and going to the projects to implement – also training the company itself – meet with engineering departments, supervisors, managers, etc.

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- **Which practices would be the first to drop, if resources were more constrained?**
- **What practices would you add or expand, given additional resources?**
- Front end planning & constructability – consistent practices
- Interface / alignment meeting quarterly
- Activity analysis is regular
- Engineering management interface is targeted for development through AWP
- Human resource management – challenge of targeting specific people for jobs, but very involved and developed method for HR items
    o Plus at the indirect level of getting the right teams to manage projects proactively
- Productivity Adjustment Factors included in bidding process
- Project Controls
- Quality Management
- Zero Accident Techniques
- Re-emphasize – the consistency of doing them on projects is not always the same
- Trend of focusing on new items, and then it fades
    o Loses effect as practices go away from the original plan
- Practices – re-energize when money is lost or performance goes poorly

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- Motivation around productivity
    o Performance in organizations is not always tied to recognition
        ▪ **Started annual bonus program years ago – diminished impact now**
            • Had detailed criteria, rules, etc. → you do this, company does this, group does this (performance) → recognized as successful → bonus
            • Structure of that diminishes over time, loses consistency → losing motivation for performing at the level when the criteria loses fixed terms
            • Reward programs are not formatted in a direct engagement and consistent performance is recognized and rewarded
            • Consistency & Effectiveness – both drift over time
        ▪ **No productivity recognition or reward program for the guys doing the work**
            • E.g. – piece of work / unit of time – no financial incentive
                o Do not believe this exists for foremen or crews throughout the industry

- **Feedback about the interview and research topic**
- Advice or Feedback
    - **Suggest sending prep information / suggestions to each interviewee**
    - Helped to be refreshed with the program elements and productivity practices
        - Agenda
        - Program Practices
        - Program Elements

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**

Company Perspective on Corporate Productivity
- **How does your company define successful productivity?**
- Corporately – not aware of set target number or metric
    - o Talk about productivity and productivity factor (PF) – lean more on PF to have target of 0.9 – earned / burned – 90% efficient
    - o Look at ways to make sure 0.9 is happening, but that's about it
        - ▪ Do not perform time-studies or verification processes
        - ▪ Do assessment after – if we run over on project, trying to evaluate why the overruns happened
    - o Even more challenging on lump sum (LS) contract
        - ▪ US has a broad mix of contract types; outside of US, LS is common
            - • Cost not to exceed, guaranteed max, etc.
        - ▪ Large projects try to be lump sum
        - ▪ Time and materials on on-site works can be performed
        - ▪ Asia, Latin American and Europe – tend to be LS

- **What kind productivity objectives are established?**
- **How is productivity success measured?**
- **How are responsibilities for productivity practices and interfaces managed?**
- Section was not addressed; interviewee did not feel these existed for the company.

Corporate Alignment
- **How is your company enabling alignment on productivity for varying management levels?**
- Do more with less, faster – increase productivity – lots of talk, but very few in upper management really understand the linkages and methods to increase productivity.

    - o **Are there existing or historical barriers to alignment?**
    - o Upper management experience and knowledge on how to drive productivity

    - o **How has alignment been improved over time?**
    - o Management's ebb and flow on focus toward productivity
    - o Trying a new Integrated Project Delivery (IPD) methodology
        - ▪ Save time and money, but management does not yet understand what they really need to do across the organization

    - o **What future efforts do you expect to enhance performance?**
    - o Aligning management on how to execute IPD – trying to get everyone above PMs to understand what that means, and how to support PMs

- o E.g. – People still don't understand why you would bring a contractor in before engineering is complete
    - People challenge why you need to have early spend, etc.

- o **Who challenges?**
- Upper management involved – director who owns capital, director of purchasing
    - o Won't get competitive bids, capital spend out of order
    - o Engineering issues with input from contractor before they've gotten base design
        - Constructability issue is the same in this case – want what it claims to do, but rarely support the upfront work and costs to get the bang for the buck
- Interviewee's current project – not started with IPD
    - o Associate director started the IPD dog-and-pony show; people bite at it
    - o Directors all want to see it suddenly on the project, but they're 2-years into it, but they cannot get the full implementation
    - o Start a project with IPD, but not halfway through and then start
    - o Want to have visuals to show they are using IPD, even though they are not doing it.

Company Productivity Program
- **Structure and Communications**
- **How are corporate department or group interfaces setup to positively impact productivity?**
    - o **Are there barriers or challenges?**
    - o **Are there historical practices that worked or failed?**
- Interviewee does not feel company is set up
    - o Procurement group – bidding, alliances – cost of scale without execution understanding
    - o Capital group – looking at large projects
    - o PM – stuck between project team and directors with purse strings
- Not setup to take a directive from a business leader and alignment with what the field is trying to drive
    - o Corporate procurement – not business unit
    - o Engineering doesn't have the money; it comes from other's
- No 1-stop-shop – everyone cannot be aligned quickly because they have to go through corporate routing instead of business unit
    - o Some positive conflict
    - o Some barriers
        - Not structured to be aligned from director / VP to field
        - Interfaces with cross organizations that have different yearly focus
            - Global procurement may be saying – bid everything this year, and take on the lowest price, regardless
            - BU – done the work for 10 years, Company A is a known source that provides a good value

       o Procurement still owns the decision, and BU would have to make a huge case to defend not using the lowest bid

- **Interviewee perspective:**
- Interviewee and colleague rolled out lean construction and IPD – died a horrible death
    - o Global Procurement said no – not doing alliances, bidding everything
        - ▪ Now global procurement wants to go with it because another director is bringing it up
        - ▪ Now people are listening
        - ▪ Lack of density of knowledge and results to sustain it
            - • May start the work, but shift of focus from global procurement could end the practice

Historical Practices
- Engineering thrown work to construction – incomplete or overbuilt engineering practices
- A couple of projects where construction driven engineering
    - o Company that was doing construction also won engineer
        - ▪ Able to do the construction focused engineering and work packaging
            - • Resulted in some of the best results the company has seen
            - • Project was an outlier, but nobody remembers it
                - o People and processes in the corporate system do not transfer
                    - ▪ People who were close to it move on to do something else
                    - ▪ New people hear about it, but were not involved
                - o New projects on a separate path, and the people cannot go back and work it now
    - o Interviewee on time in Asia – here's the money, go figure it out – no red tape
        - ▪ Had a design institute, but had construction people that could help form the design
        - ▪ Very successful back in 1995 – 2000 – but shortly after, the red tape came into China
            - • PM suddenly has 20-30 people to answer to, and you do it the way you're told
    - o Recent projects – people do them the way they've always done it
        - ▪ Recognize the failings, but do not have the historical practices to manage them – leverage good things from other projects doesn't happen
    - o No corporate knowledge base that gives PMs a toolkit; they use their last experience
- No corporate knowledge base or program to help with transfer of knowledge or alignment between groups
- EWP – engineering work process – engineering as the company looks at business engineering
    - o Has advice for PMs on how to approach projects
    - o No solid guidance on how to approach productivity
        - ▪ Had 270 check-items (things to think about)

- Constructability
- Modularization
  - Reduced down to 208 – added all of the PP
    - Boiled down to 180ish – only kept constructability
    - New PMs do not even have a roadmap that shows prod. Practices
      - Without being told to think about something, the PM doesn't even know that they don't know, nor do they have a question set to ask
      - Blind to what might help a project from setup
- E.g. – PM estimate and cost

- **Are there corporate practices for managing interfaces and communications with contractors and subcontractors?**
  - **What key barriers exist between the owner and other stakeholders?**
- Content was not specifically addressed due to time constraints.

Resources
- **How are personnel taught roles and responsibilities related to productivity?**
- **What corporate systems are in place to hold personnel accountable for their productivity related responsibilities?**
- Lack of solid, consistent process, training, or check-list – people being taught do not even know how to ask the question or use missing practices
- All they have is a list, and a director giving them the flavor of the day (e.g. – everything lump sum) – then they do not even look at the contracting strategies; just going to be LS.
  - Don't know to go evaluate the LS demands, such as engineering completion
- People tend to miss details
  - Naturally gravitate to – "Give me A, B, or C" – blinders prevent them from seeing that it can be any of those, depending on previous information
  - Some of that is being challenged with the new generational – culturally between Gen X, Y, and millennials –
    - People want the answer, but they do not know the process

- **How do people get held accountable in the current system?**
  - Safety, quality, cost, and schedule – we do not bend on safety
    - PM can over-spend to ensure no injuries, and no one will beat on them
    - PM can spend to ensure its high quality, and probably won't get beat on
    - But will consistently get beat on cost and schedule
      - Clear examples of cost and schedule going to safety and quality – good, but overspend and schedule get beatings
    - No discussion around maximizing efficiency of all 4 – understanding productivity is the key link between cost and schedule

Project & Contractor Interfaces

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- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- The company doesn't have a clear process for aligning engineering and construction on projects – owner's perspective
- Do not establish that early

- **Are mitigation efforts in place?**
- No, largely reactive mitigations
- E.g. – behind in engineering project – now paying to bring a bunch of construction resources to drive simplification of some of the engineering to get back on track
    o Instead of having construction early where it would have been fit for use on day-1

- **How do these expectations get implemented with other stakeholders?**
- They do when it's reactive – everyone is in the burning boat, everyone has the bucket in their hand
    o These expectations are not set early, and they get reaction when results are poor – then it's all hands-on deck
    o People are open to saying, "Let's go do that" rather than doing it at the beginning

- **What productivity practices do projects consider key, essential, or mandatory?**
- Right now, the focus is "How much modularization and prefab can a project go after?"
- Funny because it's trying to standardize buildings
    o Large sections of roof
    o Pre-assembled process equipment – save cost on lower cost labor
    o Still focused on lower cost – labor and such, rather than productivity
- Can do large lifts with the roofs having all of the HVAC, etc. installed
    o Works with warehouse, but to get with big-box type – you cannot do it
    o See preassembly or prefabrication in a regular labor market as a way to increase productivity – e.g. – assemble roof near ground
        ▪ But they do not always know how to apply it appropriately – like installing a roof that cannot be preassembled that way
    o Modularization is models – major construction
    o PPMOF – prefabrication, preassembly, modularization, offsite fabrication

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- Compared to most companies, we are probably doing an excellent job with PPMOF
    o Got good traction, and people know it
    o Slowly transitioning into 4-D execution
        ▪ Understand sequencing better, construction processes, etc.
    o Doing a pretty good job of taking PPMOF (also PPMSOF – modular and skid)
    o The company probably does this well and taking the lead on it
        ▪ Petrochemical took the lead because it had to be – ocean, arctic

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- - - Automobile with megaplants they built
      - Power industry with large boilers and unique locations
      - Pharmaceuticals – differing degrees – low skilled areas
      - Military
- However, the company is losing some of that – because people are not trained in how to make the decision; they are being told it is what they have to go do.
  - This could be mitigated in a knowledge base:
    - Director made a statement that we're "Skidding"
      - Skidding is an enhanced module
        - A skid stands alone – air compressor
        - Water treatment system
      - Module is an assembly of a skid – cannot operate on its own
- Understand the background and strategy of what you're doing, instead of just taking direction
  - You cannot know where you are heading, if you do not know where you've been.
- Technical experience barrier + (added to timing barrier to staffing challenge)
- Get the team that is available instead of the team you want/need – find balances between personnel – e.g. – low exp. PM, bring high exp. CM

- **Feedback about the interview and research topic**
- People are looking for the "I'm just buying something" instead of truly understanding what they are buying.
  - For example, one might need transportation, so instead of contemplating "I need a way to get from my house to school," which would allow for multiple answers from a tricycle to high-speed rail, they have an expected answer.
  - The same is true of contracts and contractors—they are upset when a contractor comes back with the unexpected.

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position**

A general contractor with background as a quantity surveyor (~10 years) with field experience in construction and sight projects. Currently works as a manager of project controls for a refinery organization.

- Processes, systems, standards, procedures
- Estimate and schedule assurance reviews on large projects
- In the states for about 25-years, primarily in mining type projects
    - Cogen, coal fire, LNG terminals, hospitals
    - 65-70% as owner, rest as contractor
    - Has an employee who just qualified as a black belt
        - 1% per year decline in productivity
        - Also decline in engineering
            - So, seeking options for what to do to correct
            - Strategic approach, lean methodology for execution, planning, and work packages

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
    - Total capital spend – how effective in those terms
        - Capital effectiveness – budget and performance against it ($ msmt)
        - Also perform man-hours productivity checks, and labor rates, etc.
        - CPI – cost performance index
    - SPI and others are also used, but often schedule driven – such as turnarounds – so projects must finish on time, but not always effective
        - Regulatory compliance constraints and turnaround constraints – typically generate schedule driven, but some things exist that are "finish when you finish" type work – relaxed and with cost driver

    - **Are there established productivity goals and objectives?**
    - Key Performance Indicators (KPIs)– measured and focused by functional excellence teams
        - Supplier management program with KPIs on their performance
        - Range of performance – 1 – 5 (5 is good) to score them and set expectations → poor performance yields programs to improve
            - Been for about 15-months – for major EP contractors
            - Now looking to move toward construction
            - And NPO and FET (Functional excellence team)
        - FET – project management, engineering, construction, project controls, quality, safety – and trying to establish document control
            - Working to improve PM programs

- Works for NPO (major projects) and also small projects, refineries

  o **How does productivity success get measured?**
  o Looking at – implemented – PDRI – project readiness, etc. With project score cards attached to funding requests.
    ▪ Estimate contingency, scorecards to improve behaviors, schedule and estimate performance, and contractor expectations
    ▪ Workshops with major contractors to introduce standards and trainings throughout organization on the standards
      - Over the past 18-months – kicked into gear and rolling out
        o Quality of estimates is improving, scheduling tools still need work
        o Important that those scorecards are accompanying funding requests
- **Does your company have best practices or corporate / functional support for projects attempting to improve execution performance?**
- Putting data into CII benchmarking and 10/10 program
  o More detailed internal benchmarking – estimate reviews to check key metrics at the specific sites and company on the whole
    ▪ Dashboard developed to compare project to other projects
- Next year's budget – relied fairly heavily on engineering companies to put together internal estimates
  o Now looking to rollout company estimating and improving overall quality
  o Internal Estimators in next year's budget
    ▪ Work with colleagues and with refineries to build estimates in-house
      - Reduce the reliance on engineering companies during planning phase – projects
      - Benchmarking templates from engineers – now able to make sense on ~15 projects to develop company trends on performance – less scatter

Company Productivity Program
- **Planning for Productivity**
  o **What major barriers do you feel limit corporate level planning support, such as benchmarking, alignment, and consistent metrics?**
- Just kicking off on a contract on Advanced Work Packaging
  o New initiative – implemented with intent to drive productivity
  o Engineering directed toward construction sequencing rather than engineering design preferences
    ▪ E.g. – reduce sequencing changes that have to be done by construction – get the process to be construction driven
- Starting to look at integrated project delivery – contractors onboard early in the project and more ownership from contractors

- Looking at IPA – just did review on refinery project management organizations – now getting recommendations on strengths and weaknesses
  - o How to correct based on input from them and resource allocation
- Internal contracting strategies on projects
  - o Lean seminar and came back with things like this
  - o E.g. – Best practices on how to improve projects – key metrics like early contractor engagement
    - ▪ Alliances with core contractors

- **What practices are used at your company to mitigate these barriers?**
- Those are largely in assessment phase – trying to determine which will be used and how
- Lean construction methodology
- Core planning approach – with foremen, daily work planning, contractors able to plan and work on weekly expectations
  - o Scoring of contractors and who is performing, and why
  - o Wanting to pilot it – asked tech managers at sites to get voluntary pilot of the approach

- **How does the interface with projects go?**
- Changes like this takes a lot of energy – using the FET network to endorse pilots and get it explained
- Seen in prior organization – used consultants to kick-off (less effective) – their guys in the field were far more capable of getting contracting entities on the same page
- Able to see improvements and planning through contractors getting onboard
  - o Working to get company enthusiasm and bringing people onboard

- **Looking back, are there successful efforts that helped move the company forward with productivity practices? Or the opposite?**
- Not really - Previously, only about 3 people in the NPO organization
  - o No program, no processes or standards around project management
  - o Procedures were written – but not followed – skipped project plans, reviews, etc.
  - o Embarking on a journey to really get everything really up
  - o In 2014 – first review and scored terribly (1.5ish)
    - ▪ Came back at the end of ~2015 – bumped up to 2.3ish
    - ▪ Working toward getting it engrained and normalized
  - o Will continue with assessments and performance improvement
- External reviews
  - o Review organization, standards, project management processes, assurance processes, etc.
    - ▪ Engaged periodically on other reviews, lessons learned workshops, etc.
    - ▪ The company 3-years ago was very different from 5-years before that and very different from today
      - • Significant growth trajectory

- $25M was a large project 5-years ago
- Now have $300-400M projects
  - $300M 8-years ago (projects)
  - To over $1.2B capital project spend today
  - o Major company spend changes → large efforts in improving project performance and focus

- **Continuous Improvement**
- **How are successful projects' learnings shared across the company?**
- Operational Excellence Management System / Group – documented OEMS process – 12 different fronts through the operational group
  - o One element is capital management
  - o Infrastructure for the group and program expectations have been rolled out through the organization
- Lean 6-Sigma and black belt trained personnel (bb projects)
  - o Rolled out standards about a year ago, and now rolling out revisions with updates from learnings over the past year
  - o Going through the FAT networks

- **Are common challenges addressed from a corporate or strategic level?**
- Project management process – updates to standards and conducting training
  - o Up through 12th floor executives becoming familiar with the
  - o However, still in infancy of getting them setup
- Turnaround integration / collaboration – challenges in resource management and project schedules
  - o Organization is using initiatives to ramp-up and keep with growth
    - 2 to 50 or 60 projects using these things today
    - Assurances and what is provided to projects over the past 3-years is a significant increase
    - Frequent hiring for specific initiatives- quick gains in improvements and processes
    - Driven from the top
    - CEO had a town hall → top 10 objective and goals
      - Largely around operations improvement
      - Vocal about endorsement of initiatives
      - Personal objectives and organizational alignment

- **For an ownership organization, how can the corporate level best improve project performance over time?**
- Still in infancy in terms of project performance
  - o Some of the requirements around FEL processes
  - o Scope freezing midway through select

- o Buy-in and signing of project alignment from stakeholders – understand business case and interfaces on projects
- Improving cost efficiency "ICE Plan"
  - o Value improvement processes over time
  - o Project will not proceed without XYZ – new VPs do not let projects change scope afterwards, and if they do – they return to select stage
  - o Scope definition is one of the biggest, heavy hitters
  - o Adherence to stage-gate
- Tier 3 Program – trying to design one and build 2
  - o Found there were too many differences, and solution at one location worked well, but not at the other location
  - o One is going to cost too much – alternatives came about and this moved them back to the select stage
  - o Now at different stages and recycling the one that needed significant changes

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- **Which practices would be the first to drop, if resources were more constrained?**
- **What practices would you add or expand, given additional resources?**
- Piloting AWP
- Internal Benchmarking
- Internal Estimating
- Issuance and reissuance of standards with lessons learned
  - o Key element – standards and procedures developed, maintained, and utilized – with feedback from lesson learned
  - o Always the challenge of push-back on change vs. others who see it as an opportunity and capture the value
  - o Change thrust upon individuals can yield organizational discomfort

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- Expanding the lean process into engineering
  - o Stop the engineers from being late → less artificial productivity hold
  - o Piloting lean methodologies
  - o Black Belt attending lean seminar in Chicago next month

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
- Looking at productivity to date – how effective are we in capital efficiency
    - First have metrics and measurements in place to understand status
        - Improving productivity / cap eff.
            - 1. Total Budgeted Amount of Contract / Project
            - 2. Granular level – cost loaded schedules to look at the information from a unit rate perspective
                - Have specific targets for more repetitive capital project work – setting benchmarks
                    - $/hp-compression, etc.
                    - Measurable units of high frequency
    - Productivity beyond 'wrench-time' –
        - Value measured more than just time on tools
            - Front end planning
            - Approval wastes

- **Are there established productivity goals and objectives?**
- Goals and objectives are established across the whole spectrum of work, however they are not known by all employees.
    - Trying to get the work done for less cost (5% less cost)
    - Spread of work – type of work, disciplines, units, and high exposure to O&M
- A financial request with the target of continuous improvement and productivity gains are a large part of achieving the 5% target
    - Negotiation of better contracts
    - Engineering efficiency
    - Not compromising scope, but setting up lean construction and engineering
- **How does productivity success get measured?**
- Beginning of year / cycle – established work scope
    - What to be accomplished and for what value
        - CPI, SPI, earned value (make sure scope is not lost to save cost – looking for efficiencies)
        - Metrics in place and starting to work
        - In process of maturing
    - Weekly checks on improvement gains
        - Conference call weekly across company – reporting out on capital efficiencies with all folks on board
    - Lessons learned and pilots shared via call
    - VPs checking CPI & SPI performance

- ▪ Drives action plan development and recovery
- Some weekly data is not set – trued up monthly based on financial system against field work accomplished

Company Productivity Program
- **Leadership and Resources**
  - o **What drives selection of company goals and objectives?**
- Business unit presidents accountable to COO
  - o COO president of utilities and another area
  - o BUPs sign off
  - o Overall umbrella is the value brought to rate-paying customers
    - ▪ Less spend on work being done improves the company position on future rate requirements
    - ▪ Fits within regulated – asset based system
    - ▪ Work must be performed within construct of customer affordability
      - • No more than 3% rate increases
      - • Also, equity – avoid dilution of stock by seeking equity

- **How does your company select productivity goals and objectives?**
- Mixed bag – depending on business unit
- Incrementally – from before starting capital efficiency. To now – burning 50 to 100 FTEs in support of reporting
  - o Part time work in reporting and tracking or added specific resources to funnel the work through

- **What major resource challenges occur when pursuing these objectives?**
- Systems do not provide the data – manual intervention required to extract things on the senior leadership team's timetable
  - o Want Monday to report on the previous week, but do not have a way to capture all of the earned value in the previous week on a week-to-week basis, including work completed or spend on labor, materials costs, etc.
  - o Manual effort of pulling data streams together
- Systems setup for monthly basis, especially financial
  - o Asked to provide weekly data for progress
  - o Contractors make weekly payroll – but payroll is not run until Wednesday of the following week
    - ▪ Craft and other payroll salary systems do not report on the needed basis
    - ▪ CI team is trying to pull together a lot of data that is not readily available or available at the time needed
    - ▪ Too big to do manually, but also too complex
- 700 to 1000 different capital projects in-flight across the company
  - o Vary from IT to Gas Main to Nuclear Modifications, Building wind turbines and solar arrays – spectrum is very broad within the electric utility and organization

- o $100k to $1B projects
- o All part of the heap of work
- o Capital projects defined by accounting
  - ▪ → Capital spend, front end planning, end time structure

- **Structure & Communication**
- **What are the major interfaces between programs, groups, and projects?**
- Internally speaking, the main tool is the SharePoint website
  - o Capital Effective Targets published
  - o Each BU and platform has a sub-page
    - ▪ Everyone in the capital efficiency program can review – mainly for executive leadership
    - ▪ All tied together to show overall trend-chart
    - ▪ Tracking against Target
    - ▪ Drill down to see where each BU falls into overall trend-chart
  - o Friday meetings to review information and status
  - o Thursday executive leadership meeting
  - o Every-other-week – specifically on Capital Effective Executive leadership
    - ▪ 3 Main <mark>comm</mark>. For all business units & discussion
    - ▪ Then separately – monthly and other reviews within BU leadership and team members
    - ▪ Weekly newsletter to share with the general masses within BU and teams
      - • Upcoming projects
      - • Completing projects
      - • Stakeholder management and plan
- Project Management Institute
  - ▪ Stakeholder Management Tool – trying to keep everyone aware
  - ▪ Excel sheet uploaded to update SharePoint – systems do not automate into SharePoint
- On very large projects – prime contractor has integrated deck to show owner and contactor earning rules and project execution plan
  - o Keep them in the room for very large projects

- What are the key interface management practices used by your company?
  - o In addition to previously mentioned strategies,
    - ▪ Weekly Metrics – "Yea, that's a manufacturing world. Project world operates on a monthly level. They look weekly, but not always."
      Manufacturing and construction worlds are different. Non-repetitive work is a huge challenge. Getting the work in front of the craft has repetition to it.
    - ▪ Trying to find the right balance to understand the right phase of two atmospheres between construction and operations / manufacturing.
    - ▪ Where can they pull some of the reporting resources back to direct work

> - Cost of reporting and cost of execution – avoiding over-toggle toward reporting

Productivity Practices
- **What productivity practices do projects consider key, essential, or mandatory?**
- Not specific standards for wrench time – require well defined request for proposal
- Estimator algorithms to check contractor bids and execution plan
- Lump sum contracts / fixed price contracts
    - Price vs. budget to tension appropriately
- Reimbursable costs
    - Formal productivity studies if the work is long enough to measure, implement corrective actions, and re-measure
    - Production as well as with pre-job checks, issue resolutions, other management tasks delaying craft
- Advanced Work Packaging – best practice, but deployed only with the right scalability and rigor of the project
    - Not pushed to low dollar projects

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**

Global Construction manager for a family care business
- 26-years with current company 36-years in construction
    - 36-years in construction; over $1B in large projects
    - Assignments all through capital projects world
    - 3 states and 25 counties

Company Perspective on Corporate Productivity
- **How does your company define successful productivity?**
    - **What kind productivity objectives are established?**
- Not measured on construction productivity on projects
    - Used to have measures, but today, do not really do that
    - Follows more traditional – estimate and earned values
        - Somewhat lost art for the company
        - Know costs and schedule –
    - First measure safety, 2nd quality, cost and schedule

    - **How is productivity success measured?**
- Not a traditional measure for productivity – so less direct to prod.
    - Heavily involved in front-end engineering
        - Experts in modularization – work how to build and constructability
        - Work those items up front – 4-D design, etc.
    - Non-traditional measurement of productivity – not checking craft personnel
    - Lack of industry standard – means no one measures the same way
        - Actual / Schedule – like earned value, but not there
- Measure touches – each time something is touched is considered loss
    - Measure movements, storage, and repositioning
    - Lean Construction – touches comes from lean manufacturing in the integrated work system
        - E.g. – touch a line that is not planned, that is a loss
            - In manufacturing
        - In Construction – plan is to handle each thing once
            - Goal of minimizing touches

Corporate Alignment
- **How is the company enabling alignment on productivity for varying management levels?**
- Current – library of things and how things are done
- Training session for project and CM
    - Experience and coaching as well

- o Depending on level of project and organization
- Current best approaches are detailed in knowledge sharing system

- **Are there existing or historical barriers to alignment?**
- People don't want to follow best approaches for alignment, are not being trained, are unqualified, etc.

- **How has alignment been improved over time?**
- Corporate systems based on lessons learned; they are performed but not highly shared.
    - o PM is the next assignment plan, and they take over projects without the right training and format
    - o New, less experienced, underqualified, and not familiar with the knowledge base and best practices

- **What future efforts do you expect to enhance performance?**
- Insisting on qualifications and training on PM level
    - o Have to go to training, coaching, and other processes

Company Productivity Program
- **Structure and Communications**
- **How are company corporate department or group interfaces setup to positively impact productivity?**
    - o **Are there barriers or challenges?**
    - o **Are there historical practices that worked or failed?**
- Peer reviews setup for projects including company experts before projects start
- Other items like – experiences and coaching sessions
- Each site or PM gets call on if they follow
    - o Review construction execution plans
    - o Staffing plans
    - o Reviewing projects with them, and give best opinion of what those will look like
- Typically just before the project – not really ongoing through projects
    - o Sometimes projects perform that quarterly, but up to project manager

- **Are there corporate practices for managing interfaces and communications with contractors and subcontractors?**
- Historically, structure has been to hire CM firms (approximately 4 firms in the US and others globally)
- Use the CM and company organization to manage the subcrontractors that the CM picks to perform work.
- High pre-qualification of safety, financial before CM can be on-site
    - o Design basis and requirements
    - o Industry standards in specs.
    - o Requirements for turnover and documentation

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- Construction people from company on each site held accountable for getting what was paid for

- **What key barriers exist between the owner and other stakeholders?**
- **What works for your company?**
  - On-site representation – works and doesn't work depending on person, but people in the field who are responsible for projects
  - Even though CM has contracts, the company has the responsibility and overall ability to influence
  - Directly involved daily in all projects
    - Safety, quality, cost, and schedule – handles change management
    - Heavily involved and not walking away
  - CM act as agents
    - On-site operations (e.g. – construction) – each plant will spend $2m – 50m of ongoing work and additional work and expansions of nothing to 200M
- Good job of pre-qualification of contractors
  - Entering college – daughter senior at Indiana
  - Getting into the company is like getting into a top 10 university
  - Weed out people who won't fit

Resources
- **How are personnel taught roles and responsibilities related to productivity?**
- **What corporate systems are in place to hold personnel accountable for their productivity related responsibilities?**
- That is the main thing – if done properly, they can get the work done
- Sometimes leveraging mentors and coaches from contractors because CMs know better than the available internal personnel in an attempt to mitigate 'learn by experience'
  - Setup with experience people who can help them
  - Match job with experience
    - Goal of project manager – safety, cost, schedule, and commitments
      - Advancement within organization
      - Ultimate goal is by delivering results and advancing
      - If not deliver
- Project by project reviews and advancement in responsibilities
  - Doing well → greater responsibility
    - Challenges because of over-estimation, scope mistakes
    - However, sometimes that is lost
      - $6m for a 15m budget
      - $202m on 200m budget
- Do not have consistent measure of productivity – manufacturing can give that for each line, but the construction cannot
  - E.g. - manufacturing at 85% reliability – below becomes red flag

- Issues such as bad projects/estimating, rushing, an unknown scope, large errors with larger budgets result in further difficulties. Unfortunately, the industry is broken, with a bad system becoming the norm
    - o Contractors have figured out how to make money, and owners are bearing the cost
    - o Owners now saying they cannot do that anymore, and it needs correction
        - ▪ If a guy gets paid for 8-hours
            - • Hour of walking, breaks, etc.
            - • But lost time is huge before even getting on the job
        - ▪ System is challenging at best
            - • Then add weather, heights, overlapping areas, etc.
            - • Productivity is roughly 40% on normal construction
            - • Company spends 100M -→ 40M of value
                - o Unsustainable
                - o Only way people know how at this point
        - ▪ This will fail eventually with 3-d printing and such
            - • Engineering and construction will have a serious shakedown
            - • If not, someone else will be able to do it better with more cost-effective execution
        - ▪ 2nd biggest cost for company is depreciation
            - • 60% capital inefficiency → higher cost to customers

Project & Contractor Interfaces
- **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
    - o **Does the company have mitigation efforts in place?**
    - o **How are these expectations implemented with other stakeholders?**
- **What productivity practices do projects consider key, essential, or mandatory?**
- **Biggest challenges to interface with subs?**
- System is broken, and everyone thinks that is the way to go
    - o Argue about change orders down the road → doesn't work
    - o Trying to share savings with contractors, but people do not want to do that → Where is the contractor's incentive
        - ▪ E.g. – cost-plus creates issues unless there is incentive
        - ▪ Purchasing and others refuse to give up the old system
- People believe they know what the market will bear – and given a minimum with contract
- But flipping it to where people can have incentive to get the contracts down
    - o The company does not like to go to court
    - o Supposedly, the expert on lean construction – makes $675/hr. or will make money on profit pull – LAWAYERS are expensive!
- Looking for contractors that are collaborative–
    - o Want contractors to make money and be successful – win-win
    - o Do not want the contractors losing or getting into adversarial relationships
    - o Make sure that the company sustains positive relationships

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Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- How the company conducts their projects – looking at how others think of them
    - o Fairly good at executing
        - ▪ Do things fast
        - ▪ But sometimes skip steps, which adds to cost
- Contracting relationship in the industry is broken
    - o Expect those that do not change to end up out of business
    - o CMOs will become an integrator
        - ▪ Go directly to trades
        - ▪ Will need to integrate those and work with them
    - o Trade partners will go to engineering – stamp the drawings and figure out how to do it
    - o No more going into a room to design and hand it to contractors
        - ▪ Have to be construction driven design
        - ▪ Engineers and architects often deliver a lot that isn't required, but it's got to become more collaborative

- **Feedback about the interview and research topic**
- Interview is going well
- Questionnaire – long and confusing, but not different than a lot of CII interviews
- Advice – too long of a survey, but did because someone within the company chased him on it
    - o Try to streamline that down
    - o Have a survey that is 15 – 30 minutes to get people to spend their time giving meaningful answers
    - o What is in it for the survey taker?

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**

Estimator working in project controls, largely on the front end, working at the semi-corporate level.

- o 15-years with an owner company
  - ▪ Large projects - $10-20M
  - ▪ Project planning / scoping
- o 6-years with an architecture, engineering, and design-build firm
  - ▪ Estimating side, but more exposure now to execution
  - ▪ Sweet spot of $20-40M project size
  - ▪ Smaller and bigger, but not mega - $200M
  - ▪ Average staff on site of ~5 people for CM
- o 2-years in between on a Power Plant project, working for an owner
  - ▪ Coal fire power plant, mega project

Company Perspective on Corporate Productivity
- **How does the company define successful productivity?**
  - o **Are there established productivity goals and objectives?**
- Productivity is measured in two simple ways
  - o Make schedule
  - o Make cost
    - ▪ Not heavily involved with time-on-tools, and specs
    - ▪ Subcontractor relationships and interactions
      - • Minimizing impact
    - ▪ Work planning, work sequencing

- **How does productivity success get measured?**
- Do not have good processes or success between PMs
- Do not have documented processes
- Not consistent communication across teams
  - o Trying to head down that path, but not in place
  - o 6-offices at current company; home office is starting to lead the effort in writing down utilized processes
- Process recently started (2-3 months at time of interview); recording feedback from owner/clients of company
  ➔ Individuals rather than processes are main reliance of firm; the ability to replace individuals needs to be in place
- Company felt a lot of truth to that statement and began writing down existing processes.
  - o What the team is getting and hearing in meetings
    - ▪ A lot of Alpha-types, leaders
    - ▪ 50 people ➔ 50 leaders = their ideas are the only way to do it

- - - Smaller team of 3-5 people struggle heavily with consensus
      - Get the ideas down to the best route, merging ideas
      - Getting change management outlined now
        - Simple things, but major changes to individual paths
        - Will take too much time and other typical excuses
  - Corporate level is about to start to get these ideas presented
    - Other offices have not been in good contact
    - Do not have their ways outlined

- **Barriers:**
  - Links are broken to a lot of the company website "processes"
  - Lack of continuity in the IT-world / webpages / core documents not stored well
    - Could exist, but it is not readily available
  - Alpha male discussion – people will not go with ideas, even if they're good because they were not their own way
    - Seen at the corporate level, lack of ability to build consensus
    - Individuals will listen, but will not abide by those instructions
  - Even items dictated by corporate level – programs
    - See a lot of individual groups not adopting those plans because the leader doesn't align
    - Lack of buy-in on corporate programs and processes
    - Told the new program; told the background – the why, how and other factors
- **Bought out last year**
- The new company process is very different from the previous
- Trying to merge the success of each company to yield additional success
  - The purchasing company also subs almost all work; self-perform some concrete
    - Procurement
    - Project Controls
  - The old model has individual groups to do each section – e.g. – schedule, procurement, etc. have their groups
  - New leadership does not have those individual groups, the PMs tend to do everything – build bid packages, buy it all out, track schedule, and push job to completion
    - Trying to merge these two areas
    - Some processes does not work for larger projects
      - Tend to do warehouses and buildings
        - Storage buildings, healthcare buildings, energy storage buildings, etc.
        - Trying to draw more into process side
    - The original company is more process based
      - Oil and gas
      - Food and beverage – not doing shell, doing more process
  - New company does the same method all over the country and Latin America

- - - Once an APM does the job with PM, they can repeat the method to build the next building
    - Lack of repetition in the original company's style scope of process
      - - Increased complexity, less repeatability
        - Need better expertise available
        - Focus area from core folks, but stretch those people to be more flexible
- **Barriers**
- Mindset – always done things their way; have been successful – how to adjust their ways to be more productive
  - What's the right type of manpower structure from corp. level
  - Mindset barriers is "my way is better" organizationally between the now merged companies.
- **How are they trying to merge?**
- Going down to mid-level management – up to the office of the CEO
  - Totally reorganized the company on Jan 1, initially dividing into 4 groups based on area of focus.
  - Now, further dividing groups based on type of client; yet trying to force groups to merge their thinking
    - - Has been a challenge
  - Further reorganization with responsible leaders to "make this work"
    - - Active engagement of the leader to try to make good work happen
    - Older groups have been trying to learn other process and understand leader
      - - Groups meet multiple times (procurement group) – to explain the role they served in the past
        - - How they did contracts, purchases, etc.
          - Adjusting contracting method based on feedback
- Has been occurring across all levels, but having lots of bumps, starts, and stops
  - But it is being pushed at all levels
  - All managers are interactive and working on it
- (The interviewee now works from someone from the other company). They are working together on some of the process, but what they do is so different that it's a struggle
  - Lots of repeatability in what they do, but it's not the same in others
    - - E.G. –struggling to understand that putting in units does not yield a consistent unit rate
    - Struggling to understand how to make the integration work for everyone since there have been difficulties with how to adopt ideas
- The new company has bought up several companies and has made it work in the past
  - Execution
  - Procurement
  - Estimating
  - Pre-Construction
    - - Going through all of those processes; had official meetings at the start to learn from each other

- **Does the purchasing company have practices or lessons on how to adopt to merger?**
- Very quickly sent someone from corporate to lead the integration
- Also sent people to reside in the larger offices of purchased company to help with transition and transition planning
  - Did not have large layoffs--probably not even 5% layoffs of corporate staff
  - Did not lose the overlapping HR, estimating, etc.
  - Main goal was to buy a company to continue expansion into other markets
    - Keeping the correct people around to expand their sales and skill-set
    - Had a game plan to get out to new employees to understand what they do; what they do to group
      - Who are the right people?
      - Right types of people
      - Lead to success and larger capacity

Company Productivity Program
- **Leadership and Resources**
  - **What drives selection of company goals and objectives?**
- **None of any kind?**
- **Goals and objectives → any type of objectives to improve overall productivity?**
- Trying to get the right dial of PM structure; common PM structure
- With effort of better cost and schedule performance
  - Trying to do more in-the-box work, process work
  - Main goal oriented toward better project management processes
- Long term goals are for revenue growth and profit growth with no schedule reduction
  - Working on executing
    - Owners are driving the schedule; owner's target is what the schedule is worked toward
    - Even where schedule compression is placed, the company executes to that target
      - Not generally the reason a project schedule is setup
      - Modified design-build when owner is ready to install it – owner has the equipment and delivery
      - Owner knows about how long it takes to install, and they push the release to facilitate quick paths
    - Since there are limited large projects and direct work
      - Schedule impacts are about relationships, work packaging, and getting engineering to use vendors and experience to make accurate assumptions
      - Correct times and methods and contractors
      - Suring up and making engineering more flexible

- **Goals of corporation: market share and new market focus**

- Corporate objectives around that kind of growth
- They're an EP-CM – will do EPC-wide and take that risk if wanted, but need to be clear and hire capable subcontractors
    - Flexible subs within capability
    - Adopt to change and new, late information – minimal cost impacts to company or owners
      → Superintendents in field to lead that relationship of cost and communication
        - Problems seen now
        - Problems a month out
            - Manage those early and communicate with subs to resequencing

- **Biggest statement from owners in EPC world –**
- What did I change?
    - Why is cost or schedule increasing?
- So, know that lowest bid is not always the right bid
    - Lump sum environment → need people able to adjust to change and not that will nickel-and-dime you, etc.

Thank you for your time.

Introduction
- **Intent – understanding corporate level productivity barriers and practices**
- **Please describe your organization and position.**

Project manager and Construction Manager for most of career with consumer goods organization responsible for company modularization, including efforts and cost from construction site to fabrication shops.
- 35-years with current company
- Significant experience with international assignments, mostly in Asia, for 22 years
  - o Returned to US within last 12 months

Company Perspective on Corporate Productivity
- **How does your company define successful productivity?**
  - o **What kind productivity objectives are established?**
  - o **How is productivity success measured?**
- Company goal to be an agile corporation; ability to change shelf products quickly in new and existing markets in addition to reducing schedule for work performed.
- Reductions in schedule reduce costs; large efforts to modularize reduce building construction from 18-month to 6-month periods and equipment installation from 4-5 months to 3-4 weeks.
- An internal network of project managers and construction managers to share success and knowledge; accelerating learning throughout the organization. Corporate offices sponsor annual learning sessions, inviting guest speakers and presenters to share experience and best practices.

- **How are responsibilities for productivity practices and interfaces managed?**
- Corporate offices consist of engineering leadership team: VP of engineering, director for each business engineering unit, associate director from corporate engineering organization. Sub teams of CMs and PMs from each region are included to provide inputs. These combined teams provide goals and objectives, as well as pilot programs to CMs and PMs globally
  - ➔ The combination of experience, contacts, learnings, vendors, PMS, network, and pilot programs provides a strategy for moving forward/accomplishing goals

Corporate Alignment
- **How is your company enabling alignment on productivity for varying management levels?**
- **Are there existing or historical barriers to alignment?**
- Getting 100% participation in networks and yearly meetings is challenging due to competing individual needs.
  - o Buy-in is easier when individuals understand the tasks and targets they are asked to work towards despite a larger company size (80,000). Individuals know whom to contact for best practices and system modernization and directors have access to the reports coming from PM & CM

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- **How has alignment been improved over time?**
- **What future efforts do you expect to enhance performance?**
- Proprietary – learning from experience and taking time to debrief after execution
    - How can we do this better, ways to improve that
    - Part of the corporate culture → not why it went wrong, find blame, instead focus on how to improve

Company Productivity Program
- **Structure and Communications**
    - **How are corporate department or group interfaces setup to positively impact productivity?**
        - **Are there barriers or challenges?**
        - **Are there historical practices that worked or failed?**
- Historical resource challenges, including getting those available to work on objectives has been difficult. All team members are busy and often need to relook at priorities. Teams need to reallocate resources and address priorities. Working with directors ensures awareness of outages/challenges and can make priority calls.

- **Are there corporate practices for managing interfaces and communications with contractors and subcontractors?**
- Developed internally to be followed on major execution projects
- In regards to international projects: following the EWP to ensure consistent execution by the company across projects globally
- Systems to audit work processes ensure they are executed consistently on every project performed
- Working with contractors and superintendents who have experience and are familiar with the needs of the company allows a jump start on the next generation of modularization while maintain standardization of expectations; consistently lifting plans and safety methods

- **What key barriers exist between the owner and other stakeholders?**
- Project execution itself – engineering work process
- Corporate level helps to set stretching targets for reassembly
    - Improve by certain percentage or amount of time
    - Cut installation time by a certain amount
    - And cost targets where reducing in-field costs, welding, safety
    - Safety – reduce overhead work, work at heights, etc.
- Experienced leaders can take the program and experience to pull on different levers to accomplish those goals
    - E.g. – pre-engineered building – setup a process to put the building together on the ground, put fire protection inside, lighting, HVAC, etc. ---all while it is on the ground
    - Pre-fabrication reduced construction costs from the start
    - Then try to efficiently and safely lift those to the heights

Resources
- **How are personnel taught roles and responsibilities related to productivity?**
➔ Education of individual team members on what they are doing and why is key; every PM has an execution plan for every project.
    o Driven by targets set by organization / leadership
    o EP covers everything from how the work will be done, org. needs, strategies to deliver targets, schedule, budget
        ▪ EP = living document
            • Starts with boundaries to help the team focus and understand scope
            • Open to take advantage of creativity and folks on-scene to improve the plan
- Start with a kick-off meeting (PM sets up the kick-off)
    ➔ **Standard agenda, standard topics – there is a kick-off work process**
        ▪ Global team space where all of this resides
            • Meeting Minutes
            • Agenda
            • Role Descriptions
                o All the pieces of the Kick-Off (and also the weekly meetings) are provided on the work space
                o Populated with the current best approach
    o Share what is being done, why, who is working, R&R
- Get into execution – give weekly updates from the leaders of the execution to move responsibility from PM to project fronts
    o Get updates on challenges and status
    o PM's job to break down the barriers
    o Have a certification process for PMs and CMs
        ▪ Qualify what they should know, experiences
        ▪ Ensure that the PM / CM is a master of their field
        ▪ Responsibilities when entering the roles is to deliver the project – but also teach everyone how it should be delivered
            • Right people on the right projects (E.g. - $300M is a different skillset than a $1M)
    o **What corporate systems are in place to hold personnel accountable for their productivity related responsibilities?**
- Global Team Space = EWP (Engineering Work Process)
    o Embedded in that is a flow-chart of each phase of the project
        ▪ What you should be doing within each page
        ▪ Double click each phase, get description, template, and examples of past projects
- Multi-Prong Approach
    o Online training
    o Stewardship

- o Good business practices
  - ▪ Obligated yearly to take online training with knowledge check to make sure people are following the practices supported by the company
- o Audits performed
  - ▪ By finance organization, purchasing organization
  - ▪ Audit to follow the right capital systems processes from work processes – normally done by 1 person from corporate office
    - • Looking for consistently applied across the globe
    - • People who are trying to get certified at the next level are brought in to see what is good and what needs improvement as part of their advancement / certification to levels
  - ▪ Audits are used for health checks within organization
    - • Called internal audit – to check things are operation as expected
    - • Encourage PMs on large projects to perform self-assessment

Project & Contractor Interfaces
- - **What major barriers exist between establishing corporate goals, expectations and practices and successful project implementation?**
- - Engineering – kick-off meeting participation, treat engineering portion like company's own employees, same targets and goals
  - o Engineering Manager from company meets with Engineering Contractor to ask how they can accomplish the goals and targets – achieve step changes within the organization
  - o Projects are a vehicle to try new things – 3 or 4 different things
- - Construction – contractor – written into specifications and contract
  - o Good understanding of what they're bidding
  - o Often different than what contractors have done in the past, and may be unfamiliar with what the company is trying to do
    - ▪ Example – modularization, especially building mods – companies overseas didn't know anything about that
      - • Months of travelling to top contractors to show concepts and educate them on expectations and targets for cost savings vs. standard or historic installation
      - • Same with Schedule and Safety
        - o Give all contractors that were educated the ability to bid on the quote
        - o Get bids back, select contractor
        - o Then help the contractor do the planning and execution strategy
          - ▪ Ensure alignment

- - **Does your company have mitigation efforts in place?**
- - Meeting with the contractor throughout execution and working side-by-side

- The company does not give the work and come and see – they live the adventure and challenges with the contractor
    - Help to solve problems and stay aligned
    - Keep on focus and reinforce what the company is trying to do and achieve goals

- **How are these expectations implemented with other stakeholders?**
- **What productivity practices do projects consider key, essential, or mandatory?**
- Remember – leadership sets goals and strategic thinking
    - Not how to do it; what they want to do
    - Based on learnings and past experiences → turn around the actions
        - Use all of the stuff
- Kick-Off
- Culture of continual improvement
    - Drives innovative thinking on how to get the next step and best performance
    - Good ideas and creative ideas are part of individual thought
    - Always trying something new, and come up with better ways

Input and Feedback
- **What are the other highlights of productivity program operation and management?**
- No other comments provided.

Thank you for your time.

Appendix G: **Program Barrier List**

Corporate Productivity Program Barriers List

Ct	Element	Barrier Title	Barrier Description
1	Continuous Improvement	Energy Around Improvement Fades	Energy to move productivity practices forward from project to project fades over time, losing support and emphasis.
2	Continuous Improvement	Improvement Needs Time	Changing individual and departmental practices takes more time than the organization allows for improvement.
3	Continuous Improvement	Ineffective Lessons Learned	Lessons Learned are ignored or under-utilized.
4	Continuous Improvement	Lack of Positive Reinforcement	Continuous improvement takes the company long periods with lacking celebration of interim accomplishments.
5	Continuous Improvement	Organizational Knowledge Silos	Organizational silos prevent productivity practice improvements because knowledge is not transferred.
6	Continuous Improvement	Root Causes Undeveloped	Company fails to capture and resolve root causes of low productivity.
7	Leadership	Corporate Management Disconnected	Corporate management struggles with staying aware of project status, challenges, and needs.
8	Leadership	Productivity Goals Become Stale	Corporate goals for productivity improvement become stale or overbearing as each year is, "Improve on last year."
9	Leadership	Inconsistent Leadership	Leadership changes directions too often on productivity related resources and objectives.
10	Leadership	Lack of Corporate Productivity Objective	Goals developed at the department level without overarching corporate objectives as guidance.
11	Leadership	Management Unfamiliar with Project Scopes	Corporate managers unfamiliar with how to execute project scope fail to appropriately assist execution.
12	Leadership	Productivity Lacks Leadership Attention	Productivity is not a focus of corporate leadership.
13	Leadership	Project Micro-management	Corporate productivity framework makes projects feel micromanaged and hassled.

14	Leadership	Reliance on Others to Drive Innovation	Company does not innovate construction practices without push from outside entities (owner, contractor, government).
15	Leadership	Varying Business Drivers	Business units have different drivers and measures of success that create misalignment within the company.
16	Planning for Productivity	Aggressive Project Schedules	Project schedules lead to being behind and rushing project phases, over staffing, and other adjustments that hinder productivity.
17	Planning for Productivity	Inconsistent Change Management	Change management is handled inconsistently within the company and creates confusion and rework.
18	Planning for Productivity	Inefficient Construction Work Schedules	Personnel on many company projects are inefficient because of extended work periods.
19	Planning for Productivity	Inappropriate Contracting for Productivity	Company takes on contracts without incorporating terms that support productive execution.
20	Planning for Productivity	Lack of Standardized Productivity Practices	Lack of consistent corporate work practices make transitions between groups and projects more difficult.
21	Planning for Productivity	Global Contracting Challenges	Contracting in varying locations creates challenges of contractor availability, experience, local work requirements, and familiarity.
22	Planning for Productivity	Inconsistent Work Packaging	Corporation is inefficient with integrating construction, engineering and installation work packages.
23	Planning for Productivity	Optimistic Planning	Company tends to have optimistic plans that fail to prepare and plan for improving productivity.
24	Planning for Productivity	Lack of Productivity Practice Buy-In	Company project teams are not convinced the benefits of implementing practices are worth the cost and effort.
25	Planning for Productivity	Inconsistent Use of Productivity Practices	Specific productivity practices are implemented inconsistently by each project team.
26	Planning for Productivity	Poor Management of Project Scope Interfaces	Construction scope boundaries are often mismanaged on company projects.

27	Planning for Productivity	Unable to Mitigate Low Productivity	Low productivity worksites challenges and mitigations are not captured or transferred between projects.
28	Planning for Productivity	Unable to Recreate High Productivity	Unable to consistently recreate high productivity performance on worksites.
29	Planning for Productivity	Unclear Contracts and Expectations	On many projects, company contracts lead to confusion or unclear deliverables.
30	Productivity Monitoring & Control	Craft as Scapegoats	At the corporate level, craft are blamed for poor productivity without addressing other gaps to improve future projects.
31	Productivity Monitoring & Control	Craft Input is Ignored	Craft feedback is not used to capture productivity improvement opportunities on most company sites.
32	Productivity Monitoring & Control	Industry Misalignment on Productivity Performance	Different companies, execution types, and groups measure productivity in different ways - creating varying metrics.
33	Productivity Monitoring & Control	Inefficient Site Layouts	In most worksites, craft lose too much time for travel, breaks, getting tools and materials, or other non-productive work.
34	Productivity Monitoring & Control	Lack of Historical Data	Historical productivity impact of practices and methods often lack direct results that could engage more users.
35	Productivity Monitoring & Control	Long Monitoring Cycles	Monitoring and reporting cycles run extended periods that create slow monitoring cycles.
36	Productivity Monitoring & Control	Performance Drivers Not Understood	Most company construction teams are unsure what caused high or low performance on specific jobs.
37	Productivity Monitoring & Control	Productivity Improvements Not Visible	Improved productivity is not visible to most personnel on construction sites.
38	Productivity Monitoring & Control	Challenges of Achieving Rapid Improvements	Rapid productivity improvement is difficult because monitoring, analyzing, solving, and implementing solutions is all parallel with continuing execution.
39	Productivity Monitoring & Control	Monitoring Resource Needs	Monitoring cycles to improve productivity require lots of manpower and attention.

40	Productivity Monitoring & Control	Resistance to Information Sharing	Company does not actively share productivity information with others.
41	Productivity Monitoring & Control	Inability to Manage Diverse Disciplines	Various craft disciplines make improvements difficult to manage due to split focus.
42	Resources - Funding	Poor Cost Estimating	In most projects, poor cost estimates and funding result in management and contract behaviors that harm productivity.
43	Resources - Funding	Stockholder Demands	Stockholders and funding sources create distraction and goals that are inconsistent with productivity performance.
44	Resources - Funding	Resistance to New Technology Adoption	High costs of construction technology and training prevent adoption of new technology by the organization.
45	Resources - Personnel	Limited Experienced Personnel	Staffing projects appropriately is difficult due to limited experienced construction personnel.
46	Resources - Personnel	Global Business Remote Work	Remote work frequently causes company personnel to lose sight of execution and productivity risks.
47	Resources - Personnel	Individual Accountability	Project scales make productivity impacts too complex to consistently hold individuals accountable.
48	Resources - Personnel	Lack of Personal Incentive	Performance in organizations is not well tied to recognition, especially at productivity scope levels.
49	Resources - Personnel	Busy Project Personnel	Project personnel are overwhelmed with daily work, limiting identification and management of productivity impacts.
50	Resources - Personnel	Limited Qualified Craft	Qualified craft labor is not readily available for many company work sites.
51	Resources - Personnel	Limited Qualified Craft Supervision	Qualified foremen/ supervisors / project managers are not readily available on many company work sites.
52	Resources - Technology	Technology Access Limitations	Programs and systems cannot be accessed by people who need the information.

53	Resources - Technology	Technology Inconsistent Between Companies	Inefficiency and waste due to poor interfacing of project management technology and systems.
54	Structure and Communications	Company Growth Outreaches Updates	Company has not updated organization and communications to match growth or market changes.
55	Structure and Communications	Corporate Bureaucracy	Consensus, approvals, and organizational hierarchy cause frustration and wasted efforts.
56	Structure and Communications	Corporate Experts Lack Project Influence	Corporate support functions have low influence on project utilization of productivity practices.
57	Structure and Communications	Difficulty Interfacing with Union Labor	Projects frequently struggle to form relationships with craft labor interfaces.
58	Structure and Communications	Government Market Regulations	Government regulations changing create issues for corporate planning. (e.g. - frequently delaying projects, compressing construction schedules)
59	Structure and Communications	Lack of External Trust	Lack of trust with industry partners results in extra indirect personnel, increased reviews, and resistance to company productivity practices.
60	Structure and Communications	Inexperienced Owners / Contractors	On many company projects, inexperienced project firms inhibit productivity performance.

Appendix H: **Program Practice List**

Corporate Productivity Program Practices List

Ct	Element	Solution Title	Solution Description
1	Continuous Improvement	Capital Efficiency Programs	Company utilizes continuous improvement methods for achieving company-wide capital efficiency objectives that motivate teams to achieve productivity improvements. (e.g.: Lean, Six Sigma, PDCA, etc.)
2	Continuous Improvement	Identify and Track Repetitive Scope	Company utilize continuous improvement methods on repeatable scopes across project portfolio to improve productivity.
3	Continuous Improvement	Identify Productivity Lessons Learned	Throughout the project execution lifecycles, the company capture, analyze, and share lessons learned related to productivity.
4	Continuous Improvement	Pilot Productivity Practices and Strategies	Company pilot productivity practices and strategies allows testing and correction that minimize potential negative impacts of learning curves.
5	Continuous Improvement	Prove Value of Productivity Practices	Company provides performance history of practices to support utilization of productivity practices.
6	Continuous Improvement	Share Burden of Practice Utilization / Pilot	Corporate provides structure that enables use of new practices without negative impacts on perception of project or personal performance.
7	Continuous Improvement	Third Party Benchmarks	Utilize external benchmarking from 3rd party company to identify gaps in current process and generate opportunities for improvement through an objective lens.
8	Continuous Improvement	Third Party Company Reviews	Third party project reviews identify project issues, gaps, and learnings to improve project outcomes and future projects.

9	Leadership	Adherence to Cost and Scope Authority	Document and enforce scope authority and cost decisions to control change.
10	Leadership	Corporate Management Actively Engaged	Corporate management engaged with projects' status, risks, and needs that may require higher-level leadership.
11	Leadership	Corporate Productivity Objective	Corporate leadership sets specific productivity improvement objectives and cascades responsibility to include functions and projects.
12	Leadership	Productivity Framework Reports	Corporation develop reports that highlight performance and organizational goals to engage team and pursue objectives.
13	Planning for Productivity	Adherence to Change Management Process	Company documents and enforces change management processes.
14	Planning for Productivity	Alliances / Partnering	Company seeks alliances or partnerships that can benefit the company by facilitating the implementation of productivity improvement initiatives.
15	Planning for Productivity	Benchmarking Specific Construction Scopes	Performance data on specific construction scopes is collected by the company to benchmark productivity basis for future projects.
16	Planning for Productivity	Constructability	Most projects utilize construction knowledge since the early phases of project life cycles to improve productivity as well as to increase the alignment between all project phases.
17	Planning for Productivity	Advanced Work Packaging	Projects utilize advanced work packaging to streamline their delivery
18	Planning for Productivity	Contracting for Productivity	Contracting departments are able to establish consistent contracts while tailoring for project specifics to enable productive execution.
19	Planning for Productivity	Guidance / Documents on Productivity Practices	Corporate personnel provide guidance documentation to provide the background and purpose of practices,

			support implementation, and provide templates
20	Planning for Productivity	PPMOF Reviews	Analyze project scope to consider the use of pre-assembly, modularization, and off-site fabrication that can improve productivity
21	Planning for Productivity	Project Engagement with Practices	Projects should be engaged with implementation and management of productivity practices on all phases of the project life cycle.
22	Productivity Monitoring & Control	Clarify Productivity Impacts	Company assesses productivity impacts in terms of direct cost and schedule results.
23	Productivity Monitoring & Control	Key Project Information Distribution	Corporate system to transfer successful efforts and productivity practices on a regular meeting / reporting cycle.
24	Productivity Monitoring & Control	Project Alignment Workshops	Corporate involvement with project alignment meetings to improve focus corporate, project, and organizational goals.
25	Productivity Monitoring & Control	Senior Management Monitoring & Control	Senior management is consistently made aware of productivity performance against corporate goals on all projects.
26	Productivity Monitoring & Control	Standard Rules of Credit	Establish standard rules of credit for scopes of work to enable the company to be consistent with productivity measurement and continuous improvement data.
27	Productivity Monitoring & Control	Systems to Capture Craft Recommendations	Conduct craft surveys to understand productivity impacts and opportunities.
28	Productivity Monitoring & Control	Activity Analysis	Activity Analysis establishes consistent method for checking craft time utilization. Senior management should set targets to help projects recognize value of lost time and pursue improvement options.

29	Productivity Monitoring & Control	Visual Capture Methods for Productivity	Photographs and imagery supporting productivity practice accomplishments enables communication and utilization.
30	Resources - Personnel	Corporate Office Relationship with Project Leaders	Corporate personnel supporting project execution need to establish alignment goals with project leadership to aid in implementation of productivity practices.
31	Resources - Personnel	Highly Regarded Corporate Staff	Corporate positions need personnel capable of managing and influencing varying risk exposures with limited experienced resources or direct authority.
32	Resources - Personnel	Productivity Practice Support Personnel	Personnel with expertise and experience should be involved with multiple projects of similar scope to help implement and check productivity practice management.
33	Resources - Personnel	Staff Projects for Productivity Improvement	Organizations able to resolve problems and improve productivity are able to generate benefits greater than the costs.
34	Resources - Personnel	Train for Varying Learning Styles	Consider varying learning styles when developing and delivering training, particularly where age and culture influences learning. (Instructor led, web-based, reading, etc.)
35	Resources - Personnel	Train for Varying Responsibilities	Develop training tailored to the intended audience, especially when varying departments and management levels are involved.
36	Resources - Personnel	Training on Productivity Practices and Systems	Train project personnel on how to implement productivity practices, including the purpose, potential impacts, implementation approaches, and contacts for future assistance
37	Resources - Technology	Innovation Development and Deployment	Corporate development and deployment support of project

			innovations can reduce resource needs.
38	Structure & Communications	Company Peer Networks	Assisting personnel with peer network relationships enables productivity knowledge sharing.
39	Structure & Communications	Company Productivity Forums	Provide a forum for personnel to share experiences, learn new practices, and demonstrate value of the Productivity Framework.
40	Structure & Communications	Construction Productivity Group	Define a group to identify best practices, manage improvements, and perform project health checks that can improve company-wide performance.
41	Structure & Communications	Corporate Business Unit Knowledge Transfer	Enable productivity learnings to be shared across departments and management structures. (e.g. - productivity forums, knowledge sharing databases, key point of contact)
42	Structure & Communications	Corporate Relationship with Craft	Promote consistent relationships between company and craft organizations (union or open shop) to allow for better interface and communication.
43	Structure & Communications	Highlighting Knowledge Sharing Systems	Company distribution of "highlights" from historical knowledge database can help with data utilization and capture of future productivity learnings.
44	Structure & Communications	Matrix Organizations	Establish organizations of knowledge to manage specific work scope (sector, job type, project size, etc.) to streamline work and retain specialization.
45	Structure & Communications	Organizational Productivity Roles and Responsibilities	Document expectations within organization to establish expectations and engage all involved groups.

REFERENCES

Caldas, C. &. (2009). Identification of effective management practices and technologies for lessons learned programs in the construction industry. *J. Constr. Eng. Manage.*, 531-539.

Chinowsky, P. e. (2006). *Leaadership in a Knowledge Era: Achieving the Learning Organization.* The University of Texas at Austin: The Construction Industry Institute, Research Summary 201-1.

CII. (1996). *Design for Safety, Research Summary 101-1. .* The University of Texas at Austin.: Construction Industry Institute .

CII. (2003). *Safety Plus: Making Zero Accidents a Reality.* The University of Texas at Austin: Construction Industry Institute.

CII. (2005). *Effective Management Practices and Technologies for Lessons Learned Programs.* The University of Texas at Austin: The Construction Industry Institute, Research Summary 230-1.

CII. (2012). *Measuring Safety Performance with Active Safety Leading Indicators, Research Summary 284-1.* The University of Texas at Austin: Construction Industry Institute.

CII. (2017). *2016 Safety Report.* The University of Texas at Austin: Performance Assessment Committee.

Ellish, A. &. (2008). *Leadership Can Be Learned, But How Is It Measured?* Management Sciences for Health, MSH Occasional Paper No. 8.

Goodrum, P. H. (2013). *The Productivity Handbook.* The University of Texas at Austin: The Construction Industry Institute.

Hinze, J. (2003). *Safety Plus: Making Zero Accidents a Reality.* The University of Texas at Austin: The Construction Industry Institute.

Kartam, N. (2006). Making Effective Use of Construction Lessons Learned in Project Life Cycle. *J. Constr. Engrg. and Mgmt.*

MGI. (2017). *Reinventing construction: a route to higher productivity.* McKinsey Global Institute.

Nasir, H. H. (2012). Development and implementation of a benchmarking and metrics program for construction performance and productivity improvement. *Can. J. Civ. Eng.* , Vol. 39.

NRC. (2009). *Advancing the Competitiveness and Efficiency of the U.S. Construction Industry.* Washington, DC: The National Academies Press. Retrieved from The National Academies Press.

OSHA. (2016). *Recommended Practices for Safety and Health Programs in Construction.* Occupational Safety and Health Administration.

Shan, Y. Z. (2016). Statistical Analysis of the Effectiveness of Management Programs in Improving Construction Labor Productivity on Large Industrial Projects. *J. Manage. Eng.*, 32(1):04015018.

Sveikauskas, L. R. (2016). Productivity Growth in Construction. *J. Constr. Eng. Manage.*, 142 (10) (Oct 2016), p.04016045.

Tabassi, A. R. (2011). Training, motivation and teamwork improvement: The case of construction firms. *African Journal of Business Management*, Vol. 5(14), pp. 5627-5636.

Thomas, H. H. (2009). Fundamental Principles of Workforce Management. *J. Constr. Eng. Manage.*, 132(1): 97-104.

Tucker, R. (1986). Management of Construction Productivity. *J. Manage. Eng.*, 2(3): 148-156.