Lean Construction: Pull Planning Sessions in Two Different Settings

An Interactive Qualifying Proposal submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of the Bachelor of Science.

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This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.
ABSTRACT

Lean methods promote continuous improvement in the processes in many industries. Pull Planning sessions are an important component of the Last Planner method which is used in Lean Construction practices. This project explores how Pull Planning sessions are conducted and proposes a template to better structure the preparation, execution and follow-up of Pull Planning session based on expert interviews and observations from several sessions conducted by two different organizations.
ACKNOWLEDGEMENTS

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We would also like to thank Mr. Kurt Dettman, who is the Lean Construction Consultant of Strategic Enterprise Technology, for providing feedback on our Pull Planning and our Owner Architect and Contactor (OAC) meetings templates and giving us the idea to interview Lean gurus.

Furthermore, we would like to thank Mr. Christian Blomdahl the Lean Practices Manager of Suffolk Construction Company, and to Ms. Sue Klawans Director of Operational Excellence and Planning of Gilbane Company, for taking their time to answer our interview questions.

Last but not least, a thank you to our professors Guillermo Salazar and Sharon Johnson for making this project possible and guiding us through every step we took to have a successful project.
EXECUTIVE SUMMARY

Lean Construction applies Lean mindset values to the construction environment. Lean Construction uses different methods to achieve this goal than in other industries. Examples of these methods are the Last Planner System, Choosing by Advantage, Target Value Design, Value Stream Mapping, 5 Whys Quick and Easy Kaizen. This project focuses on how construction companies incorporate the Last Planner System into their construction activities. Pull Planning is one of the four components of the Last Planner System. Pull planning involves working from a milestone backwards to complete a task, ensuring that each task is done in sequence and each task properly contributes to the overall completion of the project. Some of the companies that have applied Lean Construction’s Last Planner System in their projects have not realized the positive results that are expected to be derived from the implementation of Lean Construction. They noticed that their Pull Planning sessions are not as effective as they should be. The goals of this project were to investigate the structure of Pull Planning sessions, to compare different companies’ application of the Last Planner System and to understand roadblocks that affect productivity of Pull Planning sessions. These goals were achieved by completing the following research tasks:

- **Conducted background research on Pull Planning, including:**
  - Reviewed the literature of Pull Planning, Lean Construction and emotional return on investment
  - Conducted a phone interview with a Lean Construction expert
  - Visited a project site in Worcester, MA

- **Developed a Pull Planning session template and Owner Architect Contractor meeting template**

- **Attended the following project meetings**
  - 2 Pull Planning sessions, run by 2 different companies
  - 1 Pre-Pull Planning session
  - 3 Owner Architect Contractor (OAC) meetings run by 2 different companies
  - 1 Pull Planning Review session
  - Weekly Work Plan Meeting

- **Interviewed a Lean Construction expert (guru)**
  - Developed an online survey using Qualtrics software
  - Contacted 3 experts; 1 response was received

- **Analyzed the data received from Pull Planning sessions, other meetings, literature, research and interviews**
The Key Findings of this study are as follows:

- **Time Preparation and Duration of Sessions**: Some companies’ attendees spend time preparing their sticky notes during Pull Planning sessions while others come to the Pull Planning sessions with pre-made stick notes. This affects the length of the Pull Planning session.

- **Software**: Some companies use software to run and organize their Pull Planning sessions while others do not use software. This affects the flow of the session.

- **Mood**: In the Pull Planning sessions we attended, one company’s attendees moods went from focused, semi-collaborative and semi-confused to barely amused, indifferent and impatient. While the other company’s attendees’ moods throughout the session were mostly focused, amused, collaborative and attentive. Mood can significantly affect the result of Pull Planning sessions and it possibly affects the result of the projects.

- **Materials Used**: Instructions about how to fill out sticky notes vary from one company to the other. Some companies use name badges while others do not. This can affect meeting timing and attendees’ engagement.

- **Pre and Post-Pull Planning Sessions**: Some companies utilize these sessions more than others. Pre and Post Pull Planning sessions are important to prepare for Pull Planning sessions and to review promises made during Pull Planning sessions.

- **Refreshment**: Both companies we attended offered refreshments, which had a positive effect on the Pull Planning meeting.

- **Ending of Meeting**: One company ended its Pull Planning session properly (as defined in the literature) by summarizing making sure the attendees left knowing what happened during the session and inviting them to other follow up meetings while the other company did not.

- **Big Screens on the Wall**: One company had big screens on the wall to keep the attendees engaged and to help with visualization while the other company did not have big screens on the wall.

**Recommendations and Considerations:**
Companies apply Lean Construction concepts differently; the structure, mood, materials and Lean knowledge during Pull Planning sessions can have a significant effect on the results of the projects. Although one limitation of this study is the small sample size, the following recommended good practices derived from the study can be considered by those managing Pull Planning sessions:

- Use of templates. The team developed a Pull Planning session template and an Owner Architect Contractor (OAC) meeting template to record observations in a structured manner during the meetings. These templates could be used in the future by firms in
their own Pull Planning meetings to record their own observations. The use of these templates may help them to improve the effectiveness of their Pull Planning sessions.

- Pre and Post- Pulling sessions are just as important as Pull Planning sessions. Studying best practices is valuable to the result of Pull Planning sessions.
- Each company should have or develop enough Lean expertise to properly educate and to properly apply Lean concepts, while doing Pull Planning.
- Companies should use software to run their Pull Planning sessions; it is effective and productive.
- Facilitators of Pull Planning sessions should plan for inserting 10 minute breaks into the session to allow the attendees to refresh and refocus and to reduce distractions during Pull Planning sessions.
- Every company should use name badges during Pull Planning sessions. This allows all participants to be familiar with each other and improves the speed of the Pull Planning session.
- Companies should have big screens on the wall during Pre-Pull Planning, Pull Planning and Post Pull Planning; it helps to engage attendees and allows them to see visuals related to the project.
- Companies should continue to serve refreshments during these meetings; refreshments encourage attendance.
- Companies should utilize Pre-Pull Planning sessions and Post-Pull Planning sessions such as Pull Planning Review, Owners Architect Contractors Meetings, Design meetings and Weekly Work Plan meetings because they valuable to the overall result of the project. These sessions help with project organization, project planning and project follow up.
AUTHORSHIP

Both Serra Onder and Nafisat Salman evenly contributed to the research, observation, and writing of this report. A more detailed explanation of what each person did for the preparation of the report is provided below.

Serra Onder was responsible for the Acknowledgements, Authorship, Introduction, Results and Discussion and Conclusion and Recommendations sections. Ms. Onder also compiled the Proposal.

Nafisat Salman was responsible for Abstract, Executive Summary, Background and Methodology sections.

Both Serra Onder and Nafisat Salman evenly contributed to prepare all the Appendices and to prepare the project’s PowerPoint presentation. Also, both Ms. Onder and Ms. Salman proofread each other’s parts and edited the grammar and structure.
# Table of Contents

ABSTRACT ................................................................................................................................. i  

ACKNOWLEDGEMENTS ......................................................................................................... ii  

EXECUTIVE SUMMARY ......................................................................................................... iii  

AUTHORSHIP ........................................................................................................................ vi  

1- INTRODUCTION .................................................................................................................. 1  

2- BACKGROUND ................................................................................................................... 3  
  2.1 Lean Construction Methods .......................................................................................... 4  
  2.2 Summary ....................................................................................................................... 8  

3- METHODOLOGY .................................................................................................................. 10  
  3.1 Conducted Research on Pull Planning ......................................................................... 10  
  3.2 Development of Pull Planning Session Templates and Owners Architect Contractors .... 11  
  3.3 Attended Lean Construction Meetings ........................................................................ 12  
  3.4 Interviews with Lean Gurus ......................................................................................... 14  
  3.5 Data analysis ................................................................................................................. 14  

4- RESULTS AND DISCUSSION .............................................................................................. 16  
  4.1 PULL PLANNING SESSIONS ....................................................................................... 16  
    4.1.1 Complexity ............................................................................................................. 19  
    4.1.2 Meeting Flow ......................................................................................................... 20  
    4.1.3 Number of People in Attendance ....................................................................... 20  
    4.1.4 Duration of the Session ....................................................................................... 20  
    4.1.5 Resources Used ..................................................................................................... 20  
    4.1.6 Mood ................................................................................................................... 21  
    4.1.7 Interruptions ......................................................................................................... 22  
  4.2 OTHER MEETING TYPES ............................................................................................. 22  
  4.3 SURVEYS ...................................................................................................................... 24  

5- CONCLUSIONS AND RECOMMENDATIONS .................................................................. 25  
  5.1 CONCLUSIONS .............................................................................................................. 25  
  5.2 RECOMMENDATIONS ................................................................................................. 26  

WORKS CITED ......................................................................................................................... 29
APPENDICES ....................................................................................................................... 31
  APPENDIX A: VISIT TO A CONSTRUCTION SITE .......................................................... 31
  APPENDIX B: PULL PLANNING TEMPLATE .................................................................. 32
  APPENDIX C: OAC MEETING OBSERVATION TEMPLATE ......................................... 37
  APPENDIX D: MASSPORT PRE-PULL PLANNING SESSION ................................... 38
  APPENDIX E: CONSIGLI PULL PLANNING SESSION .............................................. 43
  APPENDIX F: SUFFOLK-MASSPORT PULL PLANNING SESSION .......................... 44
  APPENDIX G: INTERVIEW QUESTIONS ....................................................................... 45
  APPENDIX H: INTERVIEW RESPONSES FROM LEAN EXPERT ............................... 46
  APPENDIX I: MASSPORT OWNER DESIGN MEETING .............................................. 48
  APPENDIX J: GLOSSARY .............................................................................................. 49
TABLE OF FIGURES

Figure 1: Last Planner Method ........................................................................................................... 5
Figure 2: Pull Planning Session Coordination Board (Courtesy of SKANKA USA Building) .... 6
Figure 3: Weekly Work Planning Session Coordination Board (Courtesy of SKASKA USA Building) .................................................................................................................................. 7
Figure 4: Planned Percent Complete Chart ...................................................................................... 7
Figure 5: IT/Security Coordination Meeting-Expected Outcomes .................................................... 42
Figure 6: Massport Owner Design Meeting ....................................................................................... 48
TABLE OF TABLES

Table 1: Comparison of Company 1 and Company 2.......................................................... 19
Table 2: Pull Planning Session Observation Form .......................................................... 36
Table 3: OAC Meeting Observation Form ....................................................................... 37


1- INTRODUCTION

Lean is a widely accepted method in manufacturing, which helps organizations to eliminate waste from systems and processes. To transform lean methods and tools into construction, the Lean Construction Institute was founded in 1997. The institute’s mission is to develop knowledge about how to apply lean in construction (“Welcome to Lean Design & Construction!” Lean Construction Institute, 2016).

The Lean Construction Institute defines lean construction as extending “from the objectives of a lean production systems - maximize value and minimize waste - to specific techniques, and applies them in a new project delivery process” (“What is Lean Design & Construction, Lean Construction Institute, 2016). Since construction projects are complex, lean methods help employers to coordinate between the different stakeholders, to communicate goals and roadblocks, and to achieve better results.

The principles of lean construction differ from those in lean manufacturing. There are 5 principles in lean manufacturing, which include identifying value, mapping value stream, creating flow, establishing pull, and seeking perfection (Lean Enterprise Institute, 2016). However, in lean construction, the 5 principles are defined as; “customer focus, culture and people, workplace organization and standardization, elimination of waste, and continuous improvement and built-in quality” (“Lean Principles in Construction”, Construction Industry Institute, 2016). Even though manufacturing and construction functions differ, and applying lean in construction is harder than applying it in repetitive manufacturing environments (Aziz & Sherif, 2013), Diekmann et al. (2016) noticed in their interviews with companies adopting lean construction that lean in construction increased value, security, scheduling representation, and reduced costs.

"The Last Planner (sometimes referred to as the Last Planner System) is a production planning system designed to produce predictable work flow and rapid learning in programming, design, construction and commissioning of projects" (Lean Construction Institute, 2016). The Last Planner was established by Glenn Ballard and Greg Howell in 1980s. There are five components of Last Planner: Master Scheduling, Pull Planning, Make Work Ready Planning, Weekly Work Planning, and Learning. Master scheduling helps employers to determine long term events and strategies. Pull Planning assists in finding practical conflicts between trade holders and their projects. Make Work Ready Planning is a planning component that assures the work is actually getting done according to what was agreed to at Pull Planning sessions. Weekly Work Planning provides employers and contractors a means of following the schedule in a structured way. Finally, Learning is a component that helps participants find the reasons that caused lack of success, and ways for improving the process as well as putting in practice those improvements.
The goal of this project was to understand differences in how Pull Planning sessions are conducted and to identify ways to run effective sessions and eliminate roadblocks. The project examined approaches, which were doing literature research on Lean Construction and talking to lean consultants, for conducting Pull Planning sessions and proposes a template to better structure the preparation, execution and follow-up of the Pull Planning session based on expert interviews and on observations from several sessions conducted by two different organizations.

This project was sponsored by the Massachusetts Port Authority (Massport), which operates airports and transportation services in the state of Massachusetts (“About Massport”, Massport, 2016). Massport is project owner and interested in contractors who use lean methods. Therefore, they sponsored for this project so we could observe how the lean is applied.

The report contains Background, Methodology, Results and Discussion, and Conclusions and Recommendations sections. The Background section of this paper covers Lean Construction, its history and its importance in the construction industry. We discussed the different decision making systems in Lean Construction, but with more focus on The Last Planner System. Within the Last Planner System, we focused more on Pull Planning. The Methodology contains reiteration of the goal, and discussion of the research methodology. We also discussed why we did this tasks and their limitations. The Results and Discussion section includes our observation about each meeting we attended and an explanation about our survey. Lastly, the Conclusions and Recommendations section covers conclusions from the findings and observations about good practices.
2- BACKGROUND

Lean Construction is a philosophy to continuously improve construction projects by shortening wait time, reducing cost, increasing safety and maximizing value. Lean Construction was developed by Greg Howell and Glenn Ballard in California in the mid-1980s (Beck Technology 2013).

The Lean Construction Institute, is a nonprofit organization that does research and educates people on Lean Construction, Lean is defined as a mindset that allows team members to trust one another, combined with methods that encourage predictability, eliminate waste, and add value. Lean is also a relentless and continuous method to improve processes. While Lean Construction is similar to Lean Manufacturing, there are many differences in how this concept is applied. In Lean, generally, there are seven different kinds of wastes: Overproduction, inventory, excess process, motion, defect, waiting, and transportation. Therefore, according to Lean Construction Institute, Lean Manufacturing is different from Lean Construction because both apply Lean principles differently. One focuses on process while the other one focuses on the project. Lastly, a major difference between Lean Construction and Lean Manufacturing is that waste is defined differently. In Lean Construction waste is associated with coordination whereas in Lean Manufacturing waste is associated with quality and batching.

The first Lean conference for Lean Construction was held in 1993. Howell and Ballad noticed that only 50 per cent of jobs planned were not getting done, so they wanted to improve work effectiveness. Each construction project involves three major partners: the owner of the facility, the designer and the builder. These partners need to come together to figure out how to improve the construction process.

According to Professor Salazar, “Construction projects are unique one-of-a-kind ventures that require relatively long time to produce.” However, there are some elements of the construction process that involve repetition. In order to make sure the construction is done properly and in a timely manner, construction companies have to manage the project. In construction usually trade workers know what needs to be done but the means and methods for executing the work are independently selected by them. Lean Construction encourages and promotes different trade workers to collaborate with each other. Some trade workers jobs depend on other trade workers, due to the fact that some jobs are done concurrently. Lean Construction encourages these conversations. The principle allows the trade workers to think about when and how long their specific job is going to take. As a result, the project contractor can predict much better how long the project is supposed to take. If a project gets done quickly, the trade workers will be able to take in new contracts and will be able to work more. Therefore, Lean Construction not only benefits the construction company, it also directly benefits the trade workers. This was observed during a visit to a construction site in which the contractor is
implementing Lean Construction practices (see Appendix A for more information on the visit to the construction site).

According to the Lean Construction Institute, the goal of Lean is to create a system where all actions provide value to the customer. In Lean Construction, the overall cost of the project and the duration of the project are more important than those of the individual activities. Lean Production focuses more on how value is gained from the activity rather than how to manage the activity.

2.1 Lean Construction Methods

There are many methods used in Lean Construction. Examples of Lean Construction methods are the Last Planner System, Choosing by Advantage, Target Value Design, Value Stream Mapping, 5 why Quick and Easy Kaizen (Beck Technology 2013).

This project focuses on The Last Planner System. This is a Lean technique that consists of several tools: Master Scheduling, Phase Planning also known as Pull Planning, Weeks Look Ahead Planning and Weekly Work Planning (WWP) (see Figure 1 which shows the Last Planner System).
Within the Last Planner System, the focus of this study is on Pull Planning. Pull Planning is a meeting focusing around one milestone of the larger project, for example the construction of the exterior of a building (or the “Shell”), requires tasks that different contractors need to complete as part of that milestone and how the work will be coordinated. Pull Planning organizers should inform all parties involved about it at least a week in advance, so they can come well prepared (Beck Technology 2013). Supplies needed for Pull Planning are a site plan, a white 15ft by 20 ft. paper, colorful post it for different trade workers, and a constraint paper to write all the constraints that may come up during Pull Planning. Each color post it represents different trade workers and their tasks. The group performing the work jointly creates the schedule. The group meets in a big room where work efficiencies are evaluated. The Pull Planning schedule is created backwards starting from the last task until the first task is planned. Sometimes the schedule is created backwards and then forward. Pull Planning may cover milestones within a project that takes 12 to 14 weeks to execute, each of the tasks may have a duration of 5 days (see Figure 2, an image of a Pull Planning session coordination board).
Weekly Work Planning is one of the elements of The Last Planner System. WWP plans out all the activities to be done for a week out of the 12 to 14 weeks duration. Some firms prefer to create a WWP for 6 weeks period, one week at a time because 4 weeks is too short and 8 weeks is too long for a project. Weekly Work Plan is set up by each day of the week. It is planned along with Pull Planning. For the Weekly Work Plan, tasks for each day are planned for each worker. The column for the Weekly Work Plan represents the days and the rows represents the tasks. A constraint sheet is also used to track anything constraining work, to plan inspection, to plan and schedule delivery. There are two ways in which Weekly Work Plan can be done through Excel spreadsheet or using post it notes. Both are very useful, but according to some Pull Planning event coordinators (See Appendix A) post it notes are easier to understand for people who are not as technical. The overall goal of Weekly Work Plan is to make predictable work flow for each day and to address problems beforehand without disrupting the workflow (see Figure 3, an image of Weekly Work Planning Session Coordination Board).
Percent Planned Complete used (PPC) is a tool used during Weekly Work Planning to remind Pull Planning sessions participants of time commitments made and help them stay on-track. Percent Planned Complete (PPC) is a tool to track each worker’s weekly efficiency. PPC shows the ratio of number of items completed in a week divided by the items planned to be completed in a week. Most companies have an average of 60 to 70 percent utilization and they try to continuously improve their utilization based off that (Beck Technology 2013). PPC is more of an analytical way to detect problems and eliminate problems. Any issue found in the constraint sheet may affect individual PPC (see Figure 4, an image of PPC).
Another decision making system used in Lean is Choosing by Advantage. This tool helps one make very educated choices. Choosing by Advantage can be used to make design choices and personal choices. The tool allows participants with differing values and preferences to work together as a decision making team. Choosing by Advantage focuses on values of decision by eliminating double counting so the decision factors are weighed accurately. This tool is important because it focuses on the advantage of the attribute not the attribute itself. The method does not have a Pros and Cons list, but it is rather used as a decision making system. In this system, the disadvantage of one alternative is the advantage of another alternative. For example, if one wants to buy a lightweight bicycle: Bicycle “A” weighs 30 lbs. Bicycle “B” weighs 25 lb. The advantage is bicycle “B” is 5 lbs lighter.

Target Value Design is a decision making system used in Lean Construction. This system allows contractors to engage deeply with the client to establish the target value. While executing this system, the group is asked to target which values they see as very important to the process. This is more useful in Lean Design. It enables designers to design a detailed estimate without wasting time and resources. The most important part of the process is analyzing how the design is done. During this process, all major trades working on project such as engineering, architect, designer are asked to move to the same location.

Another decision making system used in Lean in general is Value Stream Mapping. This method identifies the current process in place, the desired end product, and the places of waste at all levels in construction management process. The goals of this system are to communicate the new process, to analyze and eliminate unnecessary steps and to reduce steps. Value Stream Mapping is done by using Quick and Easy Kaizen. Quick and Easy Kaizen is a way to write down the ideas that the person who is doing the work has at the moment, then test the idea and come up with a report. Individuals or the group come up with ideas and test them.

Last but not least, another system used in Lean in general is the 5 Whys. In this method asks 5 why questions to get to the root of a problem. The answer to the first why question creates a new why question and so on and so forth until all 5 questions are asked and the root of the problem has been discovered. The 5 Whys method is not an interrogation method but a way to get to the root of the problem.

2.2 Summary

Overall, Lean Construction seeks to improve construction management, which is based on activity or contract. It focuses on the synchronization between organizations and workers, mainly to create a system and to determine when an activity will start, how long it will take, the cost of the activity and possible errors within the activity. Construction management improves
productivity and reducing project duration by speeding up activity or changing work logic so
they are done simultaneously. However, some of the companies that apply Lean Construction’s
Last Planner System in their projects have not realized the positive results that they expect to be
derived from the implementation of Lean Construction. They noticed that their Pull Planning
sessions are not as effective as they should be. Therefore this project investigates the structure of
Pull Planning sessions and compares different companies’ application of the Last Planner System
to better understand roadblocks that affect productivity of Pull Planning sessions.
3- METHODOLOGY

The goals of this project are to investigate the structure of Pull Planning sessions, to compare different companies’ application of The Last Planner System and to understand roadblocks that affect productivity of Pull Planning sessions. In order to achieve these goals, we developed the following research methodology:

- **Conducted background research on Pull Planning as follows:**
  - Reviewed the literature of Pull Planning, Lean Construction and Emotional Return on Investment
  - Conducted Phone interview with Lean Construction experts
  - Visited a construction site in Worcester, MA
- **Developed a Pull Planning session template and Owner Architect Contractor meeting template**
- **Attended the following project meetings**
  - 2 Pull Planning sessions run by 2 different companies
  - 1 Pre-Pull Planning
  - 3 Owners Architect Contractor (OAC) meetings run by 2 different companies
  - 1 Pull Planning Review session
  - 1 Weekly Work Planning meeting
- **Interviewed with Lean Construction experts (gurus)**
  - Developed an online survey using Qualtrics software
  - Contacted 3 experts; 1 response was received
- **Analyzed the data received from Pull Planning sessions, other meetings, literature, research and interview**

This chapter describes the methodology and corresponding tasks that helped achieve the goals for this study.

3.1- Conducted Research on Pull Planning

As a first step, published literature research on Pull Planning was reviewed. This work revealed the importance of Lean Construction and the different methods and tools currently used. It also provided information about the Pull Planning method within the context of Lean Construction. Relevant videos posted on YouTube were also watched (Beck Technology, 2013; Construction Overview, 2013). Dr. Cynthia Tsao also provided references to relevant articles posted on the Lean Construction Institute website such as "The Last Planner (R).", "Lean Construction.", "Lean Principles in Construction." and many more. This research was a valuable resource as preparation for attending actual Pull Planning sessions. Still there were questions related to the way actual meetings are conducted that were gradually answered by direct
observations made at the meetings attended. Additional questions were directed to the people that performed the Pull Planning sessions.

The literature was also reviewed on meeting roadblocks and their effect on project results. The concept of Emotional Return on Investment complemented this research to better understand which emotions and behavior patterns to be observed during a Pull Planning sessions (see *Mood* under Results and Discussion, specifically the discussion of a human’s level of concentration based on Kohn’s work).

On December 8, 2015, a visit hosted by SKANSKA USA building was conducted at the construction site of the new operations and maintenance facility for the Worcester Regional Transit Authority. The host company presented a very informative review as to how apply Lean Construction practices in this project (see Appendix A). This visit provided the team with a much better practical understanding of the lean construction methods documented and reviewed in the literature. The presentation provided the team with a background for the development of the project using pictures and their BIM model. A detailed description about how Lean Construction was applied in the project for the coordination and planning of work in the construction of the structural floor slabs was given. The Project Executive, the Project Manager and the Project Superintendent presented their personal views about the adoption, use and results of Lean Construction and in particular of their Pull Planning sessions in this project. Emphasis was given to the motivational techniques used by the staff and the subsequent positive behavioral responses of the construction trades involved in the execution of the work coordinated through Lean Construction. Of special interest to this study was the opportunity to visit the room and experience the physical environment in which these Pull Planning sessions are conducted.

3.2- Development of Pull Planning Session Templates and Owners Architect Contractors

Session Templates

Prior to the attendance at any Pull Planning and Owners Architect Contractors (OAC) sessions, the team prepared a template for each type of meeting. Two templates were gradually developed based on direct observations from meetings attended and with suggestions given by Dr. Burdi (Deputy Director of Capital Programs and Environmental Affairs at Massport), Dr. Tsao (Consigli Lean expert), Kurt Dettman (Lean Construction Consultant of Strategic Enterprise Technology) and Mr. Chris Barrett (Dr. Tao’s intern). The Pull Planning session templates and the OAC templates were created to record observations in a structured manner during the meetings. The recorded information on these templates were used to compare the approaches followed by two different companies. The results of the templates are documented under the *Results and Discussion* in Chapter 4. These templates are based on observations from three Pull Planning sessions and two OAC meetings thus limiting their general applicability. Additionally, the researchers did not use their own meeting templates during the OAC meetings.
because the moderator of these meetings gave every attendee a pre-formatted meeting minutes/pamphlet that was almost identical to the template we made. It was helpful to know that if we were not given the pre-formatted meeting minutes, the OAC templates would have been very useful (see Appendix B).

3.3- Attended Lean Construction Meetings

The team attended different kinds of Lean Construction meetings. This section discusses the type of meetings, their importance, their logistics, and their limitations. The meetings the team attended included:

- 2 Pull Planning sessions run by 2 different companies
- 1 Pre-Pull Planning session
- 3 Owners Architect Contractor (OAC) meetings ran by 2 different companies
- 1 Pull Planning Review session
- Weekly Work Plan Meeting

The team attended a Pre-Pull Plan session with Massport on January 21st, 2016 to understand how Massport prepares for a Pull Planning session. The meeting took place in a Pull Planning session environment and some of the people who were supposed to attend the upcoming Pull Planning session were at this meeting. The purpose for attending the meeting was to observe the mood of the attendees of the Pre-Pull Plan session and see how that reflects on the result of the Pull Plan sessions and the overall project. A couple of observations about this meeting:

1. This meeting was not related to an actual Pull-Plan session but it was held in preparation for the development of a Master Scheduling session which is the first phase of the Last Planner.

2. This meeting was not related to any of the Pull Planning meetings that were later attended by the research team, this making it challenging to connect what was observed in this particular meeting to what was to be expected to occur in a Pull Planning session. Nonetheless, attendance to this meeting provided an opportunity to better understand the issues related to the use of the Last Planner components. (see Appendix D for more information on this meeting visit).

The team also attended two Pull Planning sessions one conducted by Consigli Construction on February 2nd, 2016 at Framingham State University and one with Suffolk Construction on February 3rd, 2016 at Massport. These meetings provided an opportunity to observe how each company practiced Pull Planning and to observe the mood and interactions of the attendees. These meetings also provided a perspective and understanding of how different companies can practice the same philosophy differently but have common guidelines to follow. The templates developed by the researchers were used for the first time at these meetings (see Appendix B). While attending these Pull Planning sessions was vital to accomplishing the project’s overall
mission, attending more sessions from each company would have yielded additional research data and a more thorough analysis. Nevertheless, the information gained from these two meetings were essential in arriving to conclusions and recommendation from this study (see Appendix E and F for more information on these visits).

The team also attended there other types of meetings that were not Pull Planning sessions but were still useful for deriving results for this study. The first was a Pull Planning Review meeting. During Pull Planning sessions the trade workers filled out their tasks on their sticky notes and suggested duration time for each task. However, the company contractors needed to recheck the duration of the tasks and make sure they are feasible and in aligned with the amount of time they had schedule for the entire project. Task duration recheck happens during a Pull Planning Review meeting, so the team observed one Pull Planning Review session. This review meeting was interesting because we were able to see how the contractors negotiated with the subcontractors if they saw that some task durations were inappropriate for the entire project.

The second type of non-Pull Planning meeting we attended was an OAC meeting. The three OAC Meetings (2 with Massport-Suffolk and 1 with Consigli) which allowed us to see the role of organizations who were managing the project and to observe a wider scope and number of professionals who participate in these meetings and who manage the project at a higher level. The trade workers did not participate in these meetings; the meeting was more about managing each subcontractor and making sure the subcontractors gave their updates on what they were supposed to be do. The Massport-Suffolk OAC meetings were follow up meetings for Suffolk Construction’s February 3rd, 2016 Pull Planning session and the Consigli OAC meeting was a follow up meeting for Consigli’s February 2nd, 2016 Pull Planning session. These OAC meetings relate to the Last Planner System because they are the Look Ahead Planning part of The Last Planner System (see Figure 1 for the Last Planner Method).

The third type of non-Pull Planning meeting we attended was a Weekly Work Plan (WWP) meeting for Consigli; the meeting was a follow up meeting for Consigli’s Feb 2nd, 2016 Pull Planning session. The Weekly Work Plan meeting was different from the OAC meetings because during this meeting the trade workers, superintendent and the project managers were there. This meeting was more detailed it allowed us to see how they check the plan and they check the things that are supposed to be done every day and in the 6 weeks length of the project. The Weekly Work Plan meeting is another follow up meeting after Pull Planning sessions. The meeting is the last step in the Last Planner Method (see Figure 1 to understand the role of WWP in the Last Planner Method).

Furthermore, we attended these meetings to understand the function of each of these meetings to the overall result of the project and also to see the mood of the attendees of these meetings. One of the biggest issues we encountered when it came to the construction projects is
that there are promises made in Pull Planning sessions but some of these promises are not fulfilled. This is either because these promises were not clear doing the Pull Planning sessions, the attendees were not fully convinced on what was discussed or there were no follow ups after the Pull Planning sessions to make sure that they are all doing what they promised to make sure that the time duration are aligned. These Post-Pull Planning sessions are the extra efforts to ensure promises are being fulfilled. It is important to note that we did not attend all of the different kind of meetings for each company due to schedule conflicts and due to the fact that both of the companies did not have all of these Post-Pull Planning sessions. Nevertheless, we attended one of each of these meeting, so we have a general idea of function of each meeting.

3.4- Interviews with Lean Gurus

The team developed interview questions for Lean gurus from different companies using Qualtrics. We formulated survey questions for 3 Lean gurus, encouraged by Kurt Dettman to get direct answers from experts in the field on their role in Pull Planning sessions, their roles in the company they work for or with in order to understand their views on the importance of Pre-Pull Planning, Pull Planning and Post-Pull Planning. Each construction contractor runs Pull Planning sessions differently. Having a basis for comparison is important because some of the Lean gurus work for companies while others are consultants to the companies. These interview questions sought to clarify the role of the gurus and to provide a better understanding of the logistics behind the way companies apply Pull Planning and how this might affect the result of the Pull Planning sessions.

The limitations of these survey are these questions were formulated based on the researchers’ understanding of Pull Planning, so with further research the survey can be updated. Another limitation is only one Lean guru provided input to the survey questions. Also, the survey questions are tailored to the interviewee’s expertise, so only someone in that field can answer these survey questions. Lastly, although there were 16 questions in the survey, the researchers gave the interviewees the option to decide whether or not to answer all of the survey questions based on their preferences or experiences (see Appendix G and H for the interview questions and its responses).

3.5- Data analysis

To analyze our results from our templates, we determined the categories we would use to compare the different approaches we observed. These categories are time of session, software, sticky notes, mood, interruptions, refreshments, Plus/Delta and ending of the meeting. To analyze our interviewer’s response, we focused more on the questions that gave us a better understanding of our interviewee’s role in the company that he represents, questions that explain how the company applies Pull Planning and questions that show how the company applies Pull Planning might affect the result of the Pull Planning session. Examples of these questions are
“What is your role in a Pull Planning session?”, “Describe the general training for people who support the Pull Planning system”, “Has your approach changed or evolved over time?” and “Does your company follow a documented practice or have you developed your own approach or both?” Answers to these specific questions are the most important out of the 16 questions in the survey because answers to these questions give us the logistics we needed. Lastly, our research and the construction site visit served as theoretical references. Therefore we derived our conclusions and recommendations from both our theoretical understanding and our practical experiences (see chapter 4 and 5 in this paper for more information on our data analysis).
4- RESULTS AND DISCUSSION

This chapter contains results and discussion of our research. A discussion about Pull Planning sessions is presented with a comparison table in Section 4.1. Section 4.2 describes the results from other meetings our team attended. Finally, we discuss the results of our survey questions in Section 4.3.

4.1- PULL PLANNING SESSIONS

For the Pull Planning sessions of both companies, we used a template that we created with the help of lean consultants from those companies. This template can be found in Appendix B and the observations for the sessions can be found in Appendices E and F.

After our observations, we came up with some general knowledge that should be known about Pull Planning sessions. Superintendent has to be at the Pull Planning sessions because they run each session. Trade workers must also attend to the sessions. Other than Superintendent and trade workers, the attendance of other people depends on the need for each session. Lean Coach does not have to be in each Pull Planning session, but when they are at the sessions, they observe the meetings and then give their feedback to improve the Pull Planning sessions. The flow of the meeting should start with an introduction of what the project is about and what they are going to be focusing on during the session. It should continue with the sticky note process, and conversation about Plus/Delta. The session should end with a conclusion about what has been done at the meeting and what are the next steps. Backward and forward passes depends on each company. It might affect the value of the results because doing both backward and forward passes might help trade workers to go over sticky notes and fix them, if necessary. However, only concentrating on backward pass might make the decision process of organizing sticky notes more efficient since the trade holders need to concentrate on only one pass.

Based on our findings from the observations made at the two Pull Planning sessions we attended, the comparison in Table 1 was developed. The first column shows the type of factors that contribute to the effectiveness of the meetings. Columns 2 and 3 show the specific observations made for each of these factors from the two different companies.

We separated our factors into 7 categories: Complexity, Meeting Flow, Number of People in Attendance, Duration of the Session, Resources Used, Mood, and Interruptions. These categories are discussed in Table 1. After our observations of two Pull Planning sessions, we decided to separate our findings into categories to be able to see the differences of the two companies’ Pull Planning sessions. Separating our findings also help us to see the effectiveness of Pull Planning sessions at each company. The Complexity category includes how complex the project is and the way the project is considered. Meeting Flow explains how the meeting was organized and the preparation of the meeting. Number of People in Attendance contains how
many people there were at the meeting and if there was any Lean Coach. Duration of the Session shows how the meeting time was used. Resources Used indicates the resources that were used at the meetings. Mood category explains the mood of people at the beginning, in the middle, and at the end of the session. Finally, Interruptions category shows what type of interruptions there were throughout the meeting.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Company 1</th>
<th>Company 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Exterior part of the dorm. (External Façade)</td>
<td>Exterior Terminal Expansion (External Façade)</td>
</tr>
<tr>
<td></td>
<td>There was no repetition.</td>
<td>There was repetition because there were 3 parts to the Pull Planning.</td>
</tr>
<tr>
<td>Meeting Flow</td>
<td>The trade workers didn’t have a clear understanding of how to fill out sticky notes.</td>
<td>The trade workers had a better understanding of how to fill out the sticky notes.</td>
</tr>
<tr>
<td></td>
<td>Trade workers came to the meeting less prepared. They prepared their sticky notes during the meeting and some of them were confused about how to fill out the sticky notes.</td>
<td>Trade workers came to the meeting more prepared; their sticky notes were already ready.</td>
</tr>
<tr>
<td></td>
<td>The ending of the meeting was unclear to everyone.</td>
<td>The ending of the meeting was very clear to everyone.</td>
</tr>
<tr>
<td></td>
<td>They didn’t talk about Plus/Delta at the end of the meeting.</td>
<td>They talked about Plus/Delta at the end of the meeting.</td>
</tr>
<tr>
<td></td>
<td>Both of the meetings were led by Superintendent.</td>
<td>Both of the meetings were led by Superintendent.</td>
</tr>
<tr>
<td>Number of People in Attendance</td>
<td>There were around 10-12 people at the meeting.</td>
<td>There were around 14 people at the meeting.</td>
</tr>
<tr>
<td></td>
<td>There was no Lean Coach at the meeting. Therefore, there was no one to give them feedback about the Pull Planning Session.</td>
<td>There was a Lean Coach at the meeting.</td>
</tr>
<tr>
<td>Duration of the Session</td>
<td>Pull Planning Session lasted around 2 hours 15 minutes.</td>
<td>Pull Planning Session lasted around 1 hour 45 minutes.</td>
</tr>
<tr>
<td></td>
<td>They spend 45 minutes only on</td>
<td>They came with prepared sticky notes;</td>
</tr>
<tr>
<td>Categories</td>
<td>Company 1</td>
<td>Company 2</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>developing sticky notes.</td>
<td>therefore, they did not spend any time on creating them during the Pull Planning session. They only took around 3 minutes to look at their sticky notes one more time and prepare them to put them on the wall.</td>
<td></td>
</tr>
<tr>
<td>They put the first sticky note around 9:01 and the time trade partners took to put all the sticky notes is around 10 minutes.</td>
<td>First sticky note was put on the wall around 8:23.</td>
<td></td>
</tr>
<tr>
<td>Firstly, they did backward pass which took them around half an hour. Then, they did forward pass, which took them around 45 minutes.</td>
<td>They only did backward pass; they did not use forward pass. This took them around one and a half hour.</td>
<td></td>
</tr>
<tr>
<td>Total rearranging time was one hour and 15 minutes and total time devoted at the end of the meeting to review the resulting Pull Planning was 50 minutes. The session was ended at 10:27 am.</td>
<td>While they were putting their sticky notes on the wall, they were also rearranging them. After putting all the sticky notes, they took around 10 minutes to review their Plus/Delta and then finished the session. The session was ended around 10:00 am.</td>
<td></td>
</tr>
<tr>
<td>Resources Used</td>
<td>They used grid paper.</td>
<td>They didn’t use grid paper.</td>
</tr>
<tr>
<td>Laptops only to take down notes</td>
<td>Laptops to control the Pull Planning and to take notes</td>
<td></td>
</tr>
<tr>
<td>No TV Screens</td>
<td>3 TV screens to view any necessary image</td>
<td></td>
</tr>
<tr>
<td>They did not use any software during Pull Planning or Post Pull Planning Sessions.</td>
<td>They used software during their Post-Pull Planning Session.</td>
<td></td>
</tr>
<tr>
<td>No Project Management tools</td>
<td>Project Management tools from Pre- Pull Planning session</td>
<td></td>
</tr>
<tr>
<td>3 inch x 3inch multi-colored sticky note</td>
<td>4inch x 6 inch multi-colored sticky note</td>
<td></td>
</tr>
<tr>
<td>Name badges</td>
<td>No name badges</td>
<td></td>
</tr>
<tr>
<td>They had pre-made unfilled sticky note outline stamp.</td>
<td>They didn’t have pre-made unfilled sticky note outline stamp</td>
<td></td>
</tr>
<tr>
<td>Categories</td>
<td>Company 1</td>
<td>Company 2</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>There was Dunkin Donut refreshments.</td>
<td>There was Dunkin Donut refreshments.</td>
</tr>
<tr>
<td></td>
<td>Both of them had sticky note outline which explains how to fill out each</td>
<td>Both of them had sticky note outline which explains how to fill out each</td>
</tr>
<tr>
<td></td>
<td>sticky note.</td>
<td>sticky note.</td>
</tr>
<tr>
<td></td>
<td>No Constraint Sheet</td>
<td>No Constraint Sheet</td>
</tr>
<tr>
<td></td>
<td>They only had one map.</td>
<td>They had maps in different categories.</td>
</tr>
<tr>
<td>Mood</td>
<td>At the beginning of the session, there were a lot of focused, confused,</td>
<td>At the beginning of the session most of the people were focused and</td>
</tr>
<tr>
<td></td>
<td>and collaborative people.</td>
<td>collaborative and there were only few amused people.</td>
</tr>
<tr>
<td></td>
<td>At the middle of the session, focused, confused and collaborative people</td>
<td>At the middle of the session, most of the people were still focused and</td>
</tr>
<tr>
<td></td>
<td>decreased to half and there were few amused, indifferent, and half</td>
<td>collaborative and only few of them were amused.</td>
</tr>
<tr>
<td></td>
<td>impatient people.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>At the end of the session, focused, confused and collaborative people</td>
<td>At the end of the session, most people were still collaborative but the</td>
</tr>
<tr>
<td></td>
<td>decreased to few while amused, indifferent and impatient people</td>
<td>number of focused people decreased to half and the number of amused</td>
</tr>
<tr>
<td></td>
<td>increased.</td>
<td>people increased to half. There were also some impatient people.</td>
</tr>
<tr>
<td></td>
<td>There were jokes, side conversations, and technology interruptions</td>
<td>There were jokes, side conversations, and technology interruptions</td>
</tr>
<tr>
<td></td>
<td>throughout the meeting.</td>
<td>throughout the meeting.</td>
</tr>
</tbody>
</table>

Table 1: Comparison of Company 1 and Company 2

Our table includes all the observation we made from the two Pull Planning Sessions. However, our team concluded that were important than others in affecting the flow of a Pull Planning Session; these observations are discussed in more detail in the following sections.

4.1.1- Complexity

Complexity of a project is important to know in order to make a better comparison because sometimes complexity of a project might change the way it is considered during a Pull Planning session. However, this is not always the case. For example, even though the goal of both Company 1 and Company 2’s Pull Planning sessions was dealing with exterior parts,
Company 2 had repetition because there were 3 parts to the Pull Planning while Company 1 had no repetition.

4.1.2- Meeting Flow

Plus/Delta is a method that helps companies to come up with improvements for their projects. The Plus states what is going good at the company and the Delta states what can be changed to improve the process. Company 2 talked about Plus/Delta at the end of the Pull Planning session. Unlike Company 2, Company 1 did not mention any Plus/Delta.

Summarizing what was talked about at the meeting at the end of each session is important to make sure all attendees are on the same page. While the Superintendent made a closing speech at the end of Pull Planning session in Company 2, the end of the meeting was unclear in Company 1’s Pull Planning Session. After putting all the sticky notes on the grid paper, people just left the room.

4.1.3- Number of People in Attendance

For the companies that are new in lean construction, having a Lean Coach at the meetings is helpful for them to get a feedback about how the session was held and to improve it. For example, while Company 1 did not have a Lean Coach at their Pull Planning session, Company 2 had a Lean Coach and they got a feedback after their Pull Planning session to make the session more efficient.

4.1.4- Duration of the Session

The way companies organizes their times during Pull Planning sessions is important to hold efficient sessions. Using their time inefficiently might affect people’s moods and the process of the projects. Based off of our observations, our team realized that Company 1 spent considerable time preparing sticky notes during the Pull Planning session while that could be done before the meeting, as Company 2 did. Even though Company 1 spent so much time preparing sticky notes, both companies’ Pull Planning sessions were around 2 hours.

4.1.5- Resources Used

Software is a helpful tool that assists people to keep track their project on a daily basis. The Superintendent of Company 2 mentioned that the way they hold their Pull Planning Sessions is based on software they use. After the Pull Planning Session, they take a photo of the sticky notes, and then put it in their software. After the Pull Planning Session, they hold a Pull Planning Review meeting to analyze each trade holder's work flow. The software works like sticky notes. It shows each trade holder with a different colored box and the length of each box depends on the
work time. The boxes are lined up one below of the box before and it goes from left to right. The software also shows them which trade holder has what work to do when they click on the trade holder. Also, the software allows them to see how many days a trade holder is behind of their schedules, if there are any.

Pull Planning sessions usually happen in the morning and take a long time. The meetings that we observed lasted an average of 2 hours. Therefore, it is important to have refreshments throughout the session to make sure nobody is hungry and to encourage attention is during the session (“Serving Refreshments at a Meeting”, Berea College, 2016). Both Company 1 and Company 2 had Dunkin Donuts refreshments, which allowed people to eat and drink whenever they wanted to during the sessions.

Sticky note process is one of the main parts of Pull Planning session and following an efficient order is important to fill sticky notes out in order to avoid waste in the process. While Company 1 used Grid paper to put their sticky notes on, Company 2 used a pin board to put on their sticky notes. If the pin board was not enough then they continued to put their sticky notes on the wall. Company 2 didn’t need any grid paper at all which we found interesting.

All of the trade holders in Company 2’s Pull Planning Session came with prepared sticky notes. Therefore, they knew what to do during the session and they did not lose time on preparing them. Unlike Company 2, Company 1 prepared their sticky notes during the session. While some people were done making their sticky notes, some people were still trying to figure out their sections and which section needs to come first.

4.1.6- Mood

Observing attendees’ mood is important in order to understand how efficient the meetings are. Also, it is important to note that there were around 11 people at the Company 1’s meeting and 14 people at Company 2’s meeting. Around 2-3 people came late to both companies’ meetings and around 3-4 people left early from both meetings.

When we observed the moods of people throughout the Pull Planning sessions, it appears we almost have the same results. In Company 1’s Pull Planning Session, we observed that at the beginning of the session, people were mostly focused and collaborative but also confused because for some of them it was their first time filling out sticky notes. In the middle of the session, while the number of focused and collaborative people decreased by half, the number of confused people also decreased by half because they were comfortable making sticky notes. However, during the middle of the session, we also started seeing several amused and indifferent people and several impatient people. At the end of the session, the number of focused, collaborative, and confused people decreased to only few people, while the amused, indifferent, and impatient people increased.
In Company 2’s Pull Planning Session, there were no confused people throughout the session because they came with prepared sticky notes. At the beginning of the session, most people were focused and collaborative and a few of them were amused. During the middle of the session, people were still mostly focused and collaborative, while a few of them were amused. At the end of the session, while there were still a lot of collaborative people, focused people decreased to half, amused people increased to half and there were few impatient people.

According to our results, it shows that in general people lose their focus over time and start getting impatient. As stated in Kohn (2014), an average adult has 10-20 minutes of concentration. Afterwards, they start losing their focus. Because of this reason, having short sessions are important to keep them effective.

4.1.7- Interruptions

Interruptions throughout a session can affect the flow of the session which will affect the project. Checking emails and phones is an important part of work, specifically in construction. During the Pull Planning sessions, people were using their computers and/or their phones. In the middle of the sessions, some joking and side conversations began to occur. At the end of the Pull Planning session, jokes, side conversations, and technology interruptions increased. Our team also observed that some people left the meeting to talk on the phone, or they talked on the phone at the meeting while others were preparing and putting on their sticky notes.

4.2- OTHER MEETING TYPES

Our team attended one Pre-Pull Planning Session, one Owner Design Meeting, one Pull Planning Review Session, two OAC meetings with Company 2 and one OAC meeting with Company 1.

The Pre-Pull Planning Session was about IT/Security Coordination. People talked about technical issues they were having and how to fix those before the due dates. It was important for them to have this meeting before the Pull Planning session to know what the due dates are and what needs to be done first before finishing other technical issues in order to minimize waste.

During the Owner Design Meeting, people talked about how to decorate the airport. The inside of the airport was designed on software and as they were going through, they talked about the outline and made some changes on the design. It was critical for them to know if anything needed to be changed on the design so that they could plan other projects of the airport and the Pull Planning sessions according to that.
The Pull Planning Review session was a follow up meeting for one of the Pull Planning Session that we attended. They had sticky notes from the Pull Planning session in the software and they discussed what they actually need vs. what they have right now. They are discussed having weekly meetings to review every week’s schedule. These meetings prepare them for Pull Planning sessions. They also had a constraints discussion at the meeting.

At Company 1’s OAC meeting, they had a Microsoft Excel sheet which they projected on a big screen in the room. They also handed out the Excel sheets. On the handouts, there was an attendance page which showed who was at the meeting last time, and then each section showed what they talked about the last past meetings related to that section, including which company is responsible from that section, its start date, status, due date, if applicable, and completion date. Besides that paper, there is also another sheet that shows all the sections with their numbers, and titles, date created, date required, days held, trade, status, and who is responsible in the company. For date required section, if the return date is overdue, that date is shown as yellow, and if the days held section is 10 days or greater, then that section is red. There was another big TV on the wall showing some pictures of where they are at for some sections on the handout. While they were talking about the pictures, they realized that they should have one more section on the excel sheet to talk about. Thus, the guy that was editing and adding that day’s comments on the excel sheet on the TV added another section. This company also had Dunkin Donuts refreshments, which increased the attendance to the meeting.

At the Company 2’s OAC meeting, they also handed out a paper that was showing each section they needed to talk about. Each section had some dates on them showing what was talked in the last few meeting about that section. Unlike Company 2, Company 1 did not have TVs on the walls. Therefore, everybody was just looking at their handouts to follow the meeting.

Both companies had an OAC meeting template. Therefore, our team ended up not using the template we created for OAC meetings (see Appendix C).

The common element of all of these meetings was to be more organized and to be on the track for their projects. The decision of having another Pull Planning sessions depends on how well these Pre and Post Pull Planning meetings go. If they are behind the schedule, then they decide to have another Pull Planning session to see where they are at the moment and how they can be on the track again. If they are on the schedule, then instead of holding another Pull Planning session, they keep holding these meetings for the follow ups. All of these meetings are connected to each other and help the company to apply lean in their projects more efficiently.
4.3- SURVEYS

The team prepared 16 survey questions for Lean gurus to answer from different companies. We received only one response but the response showed several important ideas that complemented what we learned at meetings. For example, the interviewee said that “The "pull" is to force the conversation to stay around hand offs between parties. "What do you need?" is a better question than "When will you be done?" as it eliminates more assumptions.” This shows our interviewee's perspective on Pull Planning. Our interviewee also mentioned that “Pre-Pull Planning is now not a best practice but a requirement” which indicates that each company that is applying lean in their projects needs to hold Pre-Pull Planning sessions. Finally, our interviewee said that he/she follows the Last Planner systems developed by Glenn Ballard and Greg Howell which means our interviewee is following a documented practice rather than his/her own approach.

Our template was created to observe the Pull Planning sessions and attending to the meetings were also about observing all of the meetings. However, there are some information that could help us for our project but could not be observed at the meetings. Therefore, even though we only got one answer, interviewing with lean guru helped us to learn more about our interviewee’s company and his/her approach on lean.
5- CONCLUSIONS AND RECOMMENDATIONS

The goal of this project was to understand differences in how Pull Planning sessions are conducted and to identify ways to run effective sessions and eliminate roadblocks. The project examined approaches, which were doing literature research on lean construction and talking to lean consultants, for conducting Pull Planning sessions and proposes a template to better structure the preparation, execution and follow-up of the Pull Planning session based on expert interviews and on observations from several sessions conducted by two different organizations. This chapter includes conclusions from the project in Section 5.1 and recommendations in Section 5.2.

5.1- CONCLUSIONS

After attending several Pull Planning sessions, OAC meetings, and other meetings related to our project, we concluded some results. In general, there are two types of conclusions; on the value of observing meetings and best practices for Pull Planning. Observing each meeting gave us a better understanding of how each company held their Pull Planning sessions, what type of tools they used, and the mood of participants throughout the session.

To observe the meetings, the team created a Pull Planning (Appendix B) and an OAC meeting (Appendix C) templates. We only ended up using Pull Planning session template. The template was helpful to compare two Pull Planning sessions held by different companies. Since we got help from lean consultants for our Pull Planning session template, it had everything needed to observe a full Pull Planning session. This template could be used by Lean consultants to observe the Pull Planning session and then give feedback to Superintendents. The template helps not to miss any important observation during a Pull Planning session. Therefore, those feedbacks from the template could show the company their improvement template by template over time and help them to be an expert in lean.

The way companies apply their knowledge of lean within their projects is different. For example, Company 2 used software to organize their sticky notes after their Pull Planning session while Company 1 did not use any software to do that. Another example could be Plus/Delta. Company 2 talked about Plus/Delta at the end of their session but Company 1 did not mention it.

Our observations and research shows that people lose their attention after 20-30 minutes. Therefore, having critical conversations when everybody’s attention is 100% there is really important. To support this, both Company 1 and Company 2 Pull Planning sessions had refreshments throughout the session. This motivated people to attend to the meeting and helped them to stay a little more focused during the meeting.
Each company can determine their own way to lead a Pull Planning session depending on their needs and the equipment they are using. Some of the equipment must be used by each company such as sticky notes. However, some of the equipment is optional such as big screens or grid paper. The number of Pre and Post Pull Planning sessions also depends on the company. All of these meetings are connected to each other and help the company to apply lean in their projects in a more efficient way.

Consequently, our observations from Pull Planning sessions and related supported the development of several recommendations. Our team observed that Pre-Pull Planning and Post-Pull Planning sessions are as important as Pull Planning sessions. They are also valuable for studying best practices.

5.2- RECOMMENDATIONS

After attending all of the meetings and observing them, our team developed several observations about good practices. These recommendations are outlined below.

For some companies, lean is still a new method. They need to learn and develop their processes. Sometimes these companies have a lot of projects but not enough Lean Consultants to teach them how to apply lean in construction or to check if everything is done well during a Pull Planning session. This can affect the learning process about Lean and Pull Planning. Therefore, our team recommends having enough Lean Consultants in a company to run efficient Pull Planning sessions.

From our observations, we realized that some companies use software and others do not. The companies that do use the software, hold their Pull Planning Sessions according to the structure and schedule imputed in the software. We suggest that companies use these scheduling and planning software because with them they can create various tasks and schedules, while maintaining the large scope of a particular project. Plans and goals can be easier to input and made more accessible to members of the company. Progress of any tasks can be observed as well as whether there may be any delays. Using planning and scheduling software would make a company's planning process more productive.

Companies should hold a Pre-Pull Planning session the same week as their Pull Planning sessions, or at least a week before their Pull Planning sessions to prepare their sticky notes. Our results for moods show that people lose their attention over time which does not make the sessions effective. Instead of holding long Pull Planning sessions, if they have one Pre-Pull Planning session to prepare the sticky notes and then a Pull Planning session to put the sticky notes on a grid paper in the same week, the time spent in the entire process will be shorter and more effective.
For meetings that are more than 1 hour long, our team recommends including a 10 minute break in the middle of the session. A break would help people to focus on the meeting more and it might even decrease the number of interruptions and distractions, because people might decide to wait until the break to have their conversations or phone calls. A break would also help them to refresh themselves and increase concentration.

While one company we observed used name badges, the other company did not use any name badges. They just introduced themselves at the beginning of the meeting, which company they are coming from and what their work is. However, people might not know each other during these sessions. Therefore, our team recommends that everyone have a name badge during the Pull Planning Sessions to help them to see who is who. On each name badge, they need to have their names, the company they are representing and their job at their company.

From what our team observed during the meetings we attended, some companies talk about Plus/Delta at the end of their Pull Planning sessions. However, as we noted in Section 4.1.4 (page 18), people typically can focus for around 20 minutes maximum. If we consider the interruptions and technology they have during sessions, concentrating on the Plus/Delta is probably hard for them. Besides talking about it at the end of the Pull Planning sessions, they can hold another meeting just to talk about Plus/Delta, which will take maximum an hour. Plus/Delta helps everybody to be on the same page and decrease the probability of not having people’s concentrations.

During OAC meetings, one of the companies showed a Microsoft Excel sheet, which had requirements and their deadlines, on a big screen on the wall and editing it throughout the meeting. The company hid the requirements that were completed on an Excel sheet. Instead of hiding them, our team suggests highlighting them with color at the meetings. We also recommend using a different template for the completed requirements and putting those colored requirements on the new template with their beginning and due dates. Those colored requirements can then be deleted from the Excel sheet used by all participants before the next OAC meeting. This process will help meeting attendees to not to think or talk about the same requirements and move on more efficiently in the project.

For OAC meetings, our team realized that having TVs on the wall is helpful so while people are talking about a section or a part, they could show some pictures that would help other participants understand where they are at the moment.

Consequently, observing several meetings and talking to experts helped us to come up with recommendations for companies using lean construction and holding Pull Planning sessions to hold more efficient and effective meetings. These recommendations were not implemented or
tested in this project; they are suggestions based on our findings and observations. With these recommendations, we believe we achieved our goal which was to identify different techniques to run effective Pull Planning sessions and minimize roadblocks by developing templates and observing meetings at different companies.
WORKS CITED


Construction Overview (January 2013).https://www.youtube.com/watch?v=P9UIZA1Kb2s

Benefits of Lean Construction.(2015)


APPENDIX A: VISIT TO A CONSTRUCTION SITE

Date: December 8, 2015
Time: 12pm-3pm

The team visited a construction site to learn more about Pull Planning and to understand its purpose in Lean Construction. During our visit the site coordinators gave us a visual presentation of the construction site as a whole. They talked about the issues of the construction sites and showed us pictures of what the construction site looked like before they started the project. The team learned that there are no contract that binds subcontractors to use Pull Planning. It is the company’s job to convince the trade workers that Pull Planning is important to their jobs. Companies sway contractors by showing them how participating in Pull Planning helps the trade workers. For example, Pull Planning helps reduce the amount of time trade workers have to work on specific project. As a result, they are able to take in more project and they have more opportunities to earn money. The session Superintendent told us that the company usually give its workers refreshments to motivate them to participate Pull Planning. During this visit we saw a Weekly Work Plan poster, a Pull Plan for a slab poster on the wall and the super intendant explained to us how these posters are used and their importance. The Superintendent also talked about safety, its importance, and the daily safety drills the workers have to do. He also said that they use Planned Percent Complete (PPC) to check on their workers’ weekly progress. Overall, the construction site visit was insightful because we saw what a Pull Planning room looked like, and we learned how important Pull Planning is to the construction industry.
APPENDIX B: PULL PLANNING TEMPLATE

Project:
Date:
Location:
General Contractor (and other attendees to the session):

### PULL PLANNING SESSION OBSERVATION FORM

<table>
<thead>
<tr>
<th>Goal of the session:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time meeting started?</td>
<td></td>
</tr>
<tr>
<td>Time meeting ended?</td>
<td></td>
</tr>
<tr>
<td>How was the goal of the session communicated to attendees?</td>
<td>Email sent out in advance ___\nVerbally at the start of the meeting ___\nDeveloped during the meeting ____\nNot addressed ___</td>
</tr>
<tr>
<td>Level of preparation</td>
<td>Did anyone bring in homework? Have any trade partners prepared notes in advance due to email sent out in advance? If so, how many? Trade Partners ___</td>
</tr>
<tr>
<td>How many people are attending the meeting?</td>
<td>Owner ____\nOwner’s Rep ____\nArchitect ____\nEngineers ____\nCM/GC ____\nTrade Partners ____</td>
</tr>
<tr>
<td>Refreshments</td>
<td>Did the session host provide refreshments to meeting attendees? If so, what did they provide and at what time were the refreshment available?</td>
</tr>
<tr>
<td>Name badges</td>
<td>Did the session host make name badges for all attendees? If so, what was noted on each name badge? When were the name badges created? Who created the name badges?</td>
</tr>
<tr>
<td>What tools are being used for the session?</td>
<td>Sticky notes ____\nBlank plotter paper on the wall _____\nGrid paper ____</td>
</tr>
</tbody>
</table>
| Display of project design drawings on large screen ____  
Display of project design on laptops ____  
Other tools (please specify): |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Request 2. Negotiation 3. Promise</td>
</tr>
</tbody>
</table>
| 1. Request _____  
2. Negotiation _____  
3. Promise _____ |
| What are the commitments? |
| Does this meeting link up to the other thesis of the project? |
| What is the mood of the attendees at the start of the session? For each mood, please specify if the mood exists amongst a few attendees, half of the attendees, most of the attendees, or none at all. |
| Focused – few, half, most, none  
Confused – few, half, most, none  
Hostile – few, half, most, none  
Amused – few, half, most, none  
Indifferent – few, half, most, none  
Impatient – few, half, most, none  
Collaborative – few, half, most, none |
| What is the mood of the attendees half-way through the session? |
| Focused – few, half, most, none  
Confused – few, half, most, none  
Hostile – few, half, most, none  
Amused – few, half, most, none  
Indifferent – few, half, most, none  
Impatient – few, half, most, none  
Collaborative – few, half, most, none |
| What is the mood of the attendees at the end of the session? |
| Focused – few, half, most, none  
Confused – few, half, most, none  
Hostile – few, half, most, none  
Amused – few, half, most, none  
Indifferent – few, half, most, none  
Impatient – few, half, most, none  
Collaborative – few, half, most, none |
| At what times and how long did the group work on backward passes – that is, pulling from an end milestone? |
| Times and durations:  
How many people were involved in this activity?  
Owner _____  
Owner’s Rep _____ |
<table>
<thead>
<tr>
<th></th>
<th>Architect _____</th>
<th>Engineers _____</th>
<th>CM/GC _____</th>
<th>Trade Partners _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>At what times and how long did the group work on forward passes – that is, pushing from a start milestone?</td>
<td>Times and durations:</td>
<td>How many people were involved in this activity?</td>
<td>Owner _____</td>
<td>Owner’s Rep _____</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>At what times and how long did the group work on tightening passes – that is, identifying opportunities for organizing trade activities to occur concurrently and / or reduce activity durations?</td>
<td>Times and durations:</td>
<td>How many people were involved in this activity?</td>
<td>Owner _____</td>
<td>Owner’s Rep _____</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are the roadblocks in this meeting?</td>
<td>Owner _____</td>
<td>Owner’s Rep _____</td>
<td>Architect _____</td>
<td>Engineers _____</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow up for the roadblock</td>
<td>Owner _____</td>
<td>Owner’s Rep _____</td>
<td>Architect _____</td>
<td>Engineers _____</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>How many times the meeting got off the topic?</td>
<td>Electronics_____</td>
<td>Side conversation_____</td>
<td>Jokes_____</td>
<td>Interruption_____</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During sticky creation, how many people (look lost/stuck?)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>What time did the Trade Partners spend to develop sticky notes?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who was involved in developing the sticky notes? Meeting facilitators and / or trade partners?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the time first sticky is put on the board?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What time did the Trade Partners spend to put the sticky notes on the wall?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who placed the sticky notes on the wall? Meeting facilitators and / or trade partners?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What time did the Trade Partners spend to rearrange the sticky notes on the wall?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who was involved in rearranging the sticky notes on the wall? Meeting facilitators and / or trade partners?</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>How many sticky notes were on the board at the end?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much time was devoted at the end of the meeting to review the resulting Pull Plan?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were all attendees asked, does this look good? Did we forget anything? Can we do better? If so, at what times in the session and how long did these discussions last?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did any intensive discussions happen during the session? If so, what time did they occur and how long did they last?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are the next steps?</td>
<td>Owner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Owner’s Rep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Architect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>CM/GC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trade Partners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For each of the intensive discussions, who was involved?</td>
<td>Time and duration of Intensive Discussion #01:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>How many people were involved in that intensive discussion?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Owner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Owner’s Rep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Architect</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Engineers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>CM/GC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trade Partners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the facilitator close with a Plus / Delta? If so, please record the Plus / Deltas for the meeting.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did meeting have a clear end?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Pull Planning Session Observation Form
### APPENDIX C: OAC MEETING OBSERVATION TEMPLATE

**Observation Table**

<table>
<thead>
<tr>
<th>WHAT IS NEEDED?</th>
<th>CHECKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Division</td>
<td>Who’s working?</td>
</tr>
<tr>
<td></td>
<td>Resource Needed</td>
</tr>
<tr>
<td></td>
<td>Safety Cautions</td>
</tr>
<tr>
<td></td>
<td>Constraints</td>
</tr>
<tr>
<td></td>
<td>Budget</td>
</tr>
<tr>
<td></td>
<td>Deadline</td>
</tr>
<tr>
<td></td>
<td>Done? If not Why?</td>
</tr>
<tr>
<td></td>
<td>Improvement/Notes</td>
</tr>
</tbody>
</table>

Table 3: OAC Meeting Observation Form
APPENDIX D: MASSPORT PRE-PULL PLANNING SESSION

Observation Form for Pre- Pull Planning meeting at Massport
By: Nafisat Salman and Serra Onder
Date: 1/21/16
Time: 8:00-9:30 am

- **Goal of Project:** To get plane to fly from C9 and C10 by May 1st 2016
- **Goal of Meeting:** To outline who was in charge of what and to see if they had what they needed to move forward

- **Who is at the meeting?**
  - Lean consultant, Installer, Massport IT Network, Superintendent, Architect, Project Engineer, Massport IT, Intern
  - Project manager
  - IT Project Manager
  - Project Executive (she ran the meeting)
  - More

- **What is their relationship?**
  - Different trade workers, stakeholders and implementers

- **What tools are being used?**
  - Laptops, tablet computers, notebooks, and cell phones for notes, reference, and calendar

- **What are the barriers? ➔ How will we know if something is a barrier?**
  - By March everything should be approved so they will have plenty of time to get work done.
  - Everything must be done before April first 1st because they need a 30 days inspection period
  - They said that elevator would not be ready by May 1st which is when plane must be ready to take off
  - Badge Officers need to apply for their jobs at least 30 days before April 1st
  - Condo Room 227 needs to be relocated and it is very important for the project but not much has been done about it or said about it. The room requires its own mini pull plan because it requires a lot of work, coordination, and time. The logistics of how long it will take and the number of people it requires have not been finalized. It requires at least 2 weeks and at most 4 weeks.
Cable tray is going through Griffin’s wall so it needs to be changed.
Access control cameras
Dpip cameras
Once the ceiling is up, they cannot change anything else. If they do, then they need to take off the entire ceiling and do it all over again. Therefore, it’s important to plan everything about it before. (To clarify, this is because the ceiling design is made of unique individual ceiling tiles so once they drill or modify a tile for installation, it is final and there is no spare ceiling tile to replace it)

Once the screens are up, it’s not going to be easy to change them
- They want to order one
- Dates that are inconvenient to work
  - Feb 6th – Feb 7th, 2016: Can’t work because the place can’t be interrupted and the workers don’t have access control
  - Feb 15th and Feb 22nd: Busiest days and shut down will be hard to do. Most will have to be done at night. Safety is important!

Risks
- Surprises unbundling cables
- Media player
- ASP modification by March 1st
- AVU scope delivery
- JetBlue coordination
- Fiber Sawyer, Schneider

North Area is going to be really busy because a lot of stuff will be done (food courts, Victoria Secret…)
- Pay attention how many people are going to be there that are working

What’s the focus of the planning session?
- IT /Security Coordination.
- Pull Plan Preparation

What is the mood of the meeting participants?
- They are assigning responsibilities to the subcontractor (Griffin) and it is not there
- Some members make jokes here and there to reduce the tension in the room. Sometimes people joke when they don’t know what to do about something and want to move on. That being said some of the joking got off topic and seemed to be adding unnecessary time to an already inefficient meeting
- One Specific person was talking too much
- Most of them were focused and attentive, while some looked lost, dazed out, confused, overwhelmed I struggle with discerning the difference between “dazed out” and “thoughtful”
There were a few side conversations 2 people came in late while, 2 left early before the entire meeting was done because the meeting was had been scheduled for 8-9 am and it ran overtime.

- **Look for the agreement part of the contract**
  - There is a contract but not everyone is aware of what’s on the contract

- **What are the similarities of this Pull Planning with SKANSKA?**
  - Pull planning tools on the walls
  - Group meeting
  - Working on a big project and the project has subsections

- **What are the differences of this pull planning with SKANSKA?**
  - More technical people / experts were in the meeting
  - It is a pre-pull plan meeting not a pull plan meeting
  - More back and forth discussion
  - Square table meeting
  - More women and men in attendance

- **How do they record the sessions?**
  - Each member of took his or her own minute

- **Metrics for performance**
  - Do they use methods like PPC…?
  - They didn’t talk about metrics like PPC because it is a pre-pulling session

- **Do people volunteer for things? Or do they just assign people?**
  - Most responsibilities are already assumed based on skills, but there was one assignment that one of the attendees volunteered to do something (buy media player)
  - Responsibilities seemed to be well outlined before the meeting

- **Is someone missing at the meeting?**
  - Most important men in the meeting: Griffin (Implementer) is not in the meeting
  - Someone will have to tell Griffin what happened in the meeting and its responsibilities
  - Major stakeholder Jetblue was not present at meeting. They were invited but not able to make it. Seems like meeting should have revolved around them being able to make it. As a result, a separate meeting was to be held later to work with them on the meeting developments.
General Observation

- Actual Pull Planning starts in 2 weeks
- Next week they will start putting grids, which will take up to 4 to 5 weeks
- Everyone is expected to come to the pull planning sessions prepared, if possible come with completed sticky notes.
- Note that Jet Blue has a different way of doing things so workers should pay attention and make sure they do it correctly
- Someone should confirm if CNN will come to install anything because they usually take a lot of space and a lot of time
- They asked what Griffin’s schedule is
- Wifi → Boingo & AT&T
- Scope → The were going to move a wall to make more room
- Jetblue ticketing location is all set
- Another general body meeting will take place next week
- At the end of the meeting, the lean consultant summarized what was said and everyone left

  ■ This was a really important step in the meeting. Without this everyone wouldn’t have known what the actionable responsibilities that were decided upon were. He also facilitated during the meeting by clarifying and boiling down lots of unfocused back and forth between other team members

- The scope of the project had changed recently before the meeting started. This was news to some meeting participants. Not sure if that was one of the goals of the meeting, or if communication failed somewhere before the meeting. I think if it is a goal of the meeting it should be outlined as such.
- It often seemed like participants were often left wondering, what they are trying to accomplish with this specific part of the discussion. Lean consultant always seemed to be able to clarify that from one conversation to the next.
- Positive part was they all well aware that the gates themselves were the critical part of the work

- There was a good amount of people interrupting and cutting each other off. I think this a problem in everyday conversation but obviously hurts the productivity of a meeting and the implementation of lean
- Meeting schedule/outline seemed good to begin with but it was not held to
- Multiple issues were discussed that had “already been decided” upon
- Positive: The meeting identified risks that were not widely known previously
- Negative: Meeting ran over
- Positive: Good Wrap and Summary at the end
IT / SECURITY COORDINATION MEETING
January 21st, 2018
08:00am to 9:00am

Expected Outcomes

1. Stakeholders
   - Massport IT, JetBlue, Massport Security

2. Implementors
   - Griffin, AVI, Schneider

3. Define Expectations
   - Massport IT — WHAT DO YOU NEED, WHEN DO YOU NEED IT?
     - Info bar
     - DRRPs
     - Media wall
   - Massport Security — WHAT DO YOU NEED, WHEN DO YOU NEED IT?
     - Security devices
     - Doors
     - Cameras
   - JetBlue — WHAT DO YOU NEED, WHEN DO YOU NEED IT?
     - Podiums
   - Trades — WHAT DO YOU NEED, WHEN DO YOU NEED IT TO GET IT TO STAKEHOLDERS ON TIME?

4. Identify Risks
   - SIDA Wall Location — Construction in Active Sterile Area & above finished ceiling and finished office
   - JetBlue Gate Podium coordination
   - SIDA desens
   - Massport IT Turnover expectations
   - JetBlue expectations
   - DRRP design locations

5. Next Steps
   Date for the next confirming call plan

6. Plus/Delta

Figure 5: IT/Security Coordination Meeting—Expected Outcomes
APPENDIX E: CONSIGLI PULL PLANNING SESSION

“Appendix removed for confidentiality reasons.”
APPENDIX F: SUFFOLK-MASSPORT PULL PLANNING SESSION

“Appendix removed for confidentiality reasons.”
APPENDIX G: INTERVIEW QUESTIONS

We created our interview questions on WPI’s Qualtrics page. The link that is below shows our questions. The questions can also be found below.
Link: http://wpi.qualtrics.com/SE/?SID=SV_6sszmgliusUPidf

Interview Questions

Intro.
There are 16 questions in this survey. We are looking for answers that are based on your preferences or experience. It is fine not to answer some questions. Also, please note that by “the company”, we mean the company you work for or the company you are consulting to, depending on your role.

Full Name:
1. Are you a consultant for the company or are you an employee of the company?
2. What is your definition of Pull Planning?
3. Does your definition of Pull Planning differ from that of your company? If so, how?
4. What is your role in a Pull Planning Session?
5. How long have you worked with the company?
6. How many Pull Planning sessions have you conducted while you have worked with the company?
7. What are the main functions of the people supporting the Pull Planning sessions and how many people are needed for each function?
8. Describe the general training for people who support the Pull Planning system.
9. How long does it take to train employees about Pull Planning before a company starts to implement it? Please indicate an approximate number of days or hours.
10. Are there any meetings you conducted prior to or after a Pull Planning session?
11. How do you track the commitment of participants?
12. What kind of equipment and tools do you need to support Pre-Pull Planning, Pull Planning, and Post-Pull Planning sessions (boards, sticky notes, etc.)? Please include any software.
13. How important are these tools for Pull Planning Sessions?
14. Has your approach changed or evolved over time? If yes, describe how and why?
15. Do Pull Planning sessions have to be structured; if so, please explain how?
16. Does your approach follow documented practices or have you developed your own approach? Or both?
APPENDIX H: INTERVIEW RESPONSES FROM LEAN EXPERT

Intro.
There are 16 questions in this survey. We are looking for answers that are based on your preferences or experience. It is fine not to answer some questions. Also, please note that by “the company”, we mean the company you work for or the company you are consulting to, depending on your role.

Full Name: 

1. Are you a consultant for the company or are you an employee of the company?
   Employee

2. What is your definition of Pull Planning?
   A session to plan for a certain activity with all stakeholders present. The “pull” is to force the conversation to stay around hand offs between parties. “what do you need?” is a better Question than "when will you be done?" as it eliminates more assumptions.

3. Does your definition of Pull Planning differ from that of your company? If so, how?
   No- perhaps good to ask someone else. I created the definition for the company...

4. What is your role in a Pull Planning Session?
   Either as the organizer and leader, or as an observant, or as a coach.

5. How long have you worked with the company?
   2 years +

6. How many Pull Planning sessions have you conducted while you have worked with the company?
   Between 20 and 30.

7. What are the main functions of the people supporting the Pull Planning sessions and how many people are needed for each function?
   A Superintendent to (1) make sure that stickies are filled out correctly and (2) question duration, manpower, and missed activities.
   A session schedule recorder proficient with the software that you use.
   A person to write up additional stickies if activities are missing
   A person to identify and write stickies for quality management related activities
   A person to identify and write stickies for safety related activities
   Some functions can be done with the same person....

8. Describe the general training for people who support the Pull Planning system.
   At this company we have a 2 day training for PMs, Superintendents and PX's in the company. In the training we practice the Why What and How of Pull planning with practical training in how to conduct one.
   This is changing to become more e-learning and less classroom style training.

9. How long does it take to train employees about Pull Planning before a company starts to implement it? Please indicate an approximate number of days or hours.
   It completely depends. I had no training and was forced to do it. Others need several hours of training. In general 2-4 hours should be enough to go through the principles and a quick practice round. Then they just have to do it!
10. Are there any meetings you conducted prior to or after a Pull Planning session?
   Two prior. One internal Pre Pull meeting, and then one with the trade partners or stakeholders to help prepare them. Sometimes a follow up meeting is necessary after a session but not always.

11. How do you track the commitment of participants?
   Baseline Schedule, Constraint Log, Weekly Work Plan. Meetings around the documentation listed...Anything the team needs to make sure they can execute and remove issues to get work in place.

12. What kind of equipment and tools do you need to support Pre-Pull Planning, Pull Planning, and Post-Pull Planning sessions (boards, sticky notes, etc.)? Please include any software.
   Software is not necessary but could be useful. A wall, some sharpies, colored stickies, preparation from participants and the right attitude is all that is needed.

13. How important are these tools for Pull Planning Sessions?
   Important but in theory you can get to the same outcome without any tools, just the right conversation.

14. Has your approach changed or evolved over time? If yes, describe how and why?
   Yes. Pre pulling is now not a best practice but a requirement. Taking one backward pass to focus on the hand offs, but when planning work, figuring out dates, stacking trades etc. I do that going forward in a grid type board. Before it was a bit muddled- going back then forward then back...

15. Do Pull Planning sessions have to be structured; if so, please explain how?
   Not sure I understand the question. Any meeting to be successful needs to have an agenda and a goal and rules etc. Same with a Pull Planning Session.

16. Does your approach follow documented practices or have you developed your own approach? Or both?
   The Last Planner System developed by Glenn Ballard and Greg Howell
APPENDIX I: MASSPORT OWNER DESIGN MEETING

Date: February 12, 2016
Time: 2:00-3:00 pm

The purpose to attend this meeting was to observe more Post Pull Planning session.

Figure 6: Massport Owner Design Meeting
APPENDIX J: GLOSSARY

**Massport:** It is a port authority in Massachusetts. It owns and operates three airports: Boston Logan International Airport, Hanscomfield and Worcester Regional Airport. Massport is also a construction contractors and it works with different subcontractors to plan and construct the airport. Additionally, Massport is also our sponsor for the Inquiry Qualifying Project. They provide us necessary resource that allow this project to be possible. Serra and Nafisat have attended numerous meetings in Massport and have been in contact with many of the Massport employees.

**Consigli:** A construction company that implements Lean Construction into its construction work.

**Sulffolk:** A construction company under Massport that also implements Lean Construction into its work.

**Gilbane:** Another construction company under Massport that also implements Lean Construction into its project.

**Pre-Pull Planning Session:** A meeting before a Pull Planning session to plan out how the Pull Planning session will go.

**Post Pull Planning Session:** A meeting after a Pull Planning session to ensure that everything discussed during pull planning is feasible and that the durations are logical otherwise the contractors try to negotiate with the subcontractors to fix any error or inconsistency.

**Owners Design Meeting:** A meeting outside a Pull Planning session that the allows the owner of the project to see the design and the implementation of the design before all things are put in place

**Owners Architect and Contractor (OAC) Meeting:** A project management meeting to discuss the overall plan of the project and make sure everything is feasible