Sail Residential Building Development Project Exclusive Summary

Ferya Moayedi, Mahsa Banaei Esfahani, Meraj Mamorafshard, Zheng Xiang Qiu

University of British Columbia

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SAIL RESIDENTIAL BUILDING DEVELOPMENT PROJECT

EXCLUSIVE SUMMARY

This report is a study done on the productivity of the framing activity performed during the construction of the SAIL Residential Building. There is an overview of the project and the task, as well as the methodologies and concepts behind the productivity assessment performed. The findings in this report include quantitative and qualitative methods used for collecting data where comments by the superintendent, foreman, and the workers have also been considered. Suggestions for improving the productivity of the task have also been included in this report.

SAIL RESIDENTIAL BUILDING DEVELOPMENT PROJECT

This report is prepared for Dr. Thomas Froese as per the requirements of the course:

CIVL 521 – CASE STUDIES OF CONSTRUCTION METHOD

Prepared by:

Mahsa Banaei Esfahani
Meraj Mamorafshord
Ferya Moayedi
Zhengxiang Qiu

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PHASE ONE

1.0 PROJECT DESCRIPTION

The Sail residential building positioned in UBC peninsula is built with the latest west coast design of modern architecture. The sail community provides UBC students and their families with one, two, and three bedroom apartment homes designed to reduce eco-footprint and is constructed to REAP Platinum standards. The sail buildings are located close to the Westbrook Village features close by grocery stores, schools, and services. The building is situated on the southern section of UBC as illustrated in Figure 1.

Figure 1: Sail Site Location

The sail residential project consists of two buildings illustrated in the figure below, for our project we have done the analysis on Building 2. The two residential wood frame buildings are six stories high each and are one of the first ones in Canada; it is rare to have multi-story buildings made entirely out of wood, it is more common to have the main floor built out of concrete and the rest out of wood. In addition, these buildings are designed based on the latest

version of the National Building Code of Canada (NBCC) for seismic resistance. The six story wood frame building is the first one being constructed in UBC, making it a unique structure in UBC. The final product of the building will have a one of a kind architecture with brick and cedar cladding walls extending all the way to the sixth story. The suits will have substantial outdoor spaces with large patios and balconies. The wood material used in the construction of the building makes it a sustainable building, and incorporate the Residential Environmental Assessment Program (REAP) which will meet its standards.

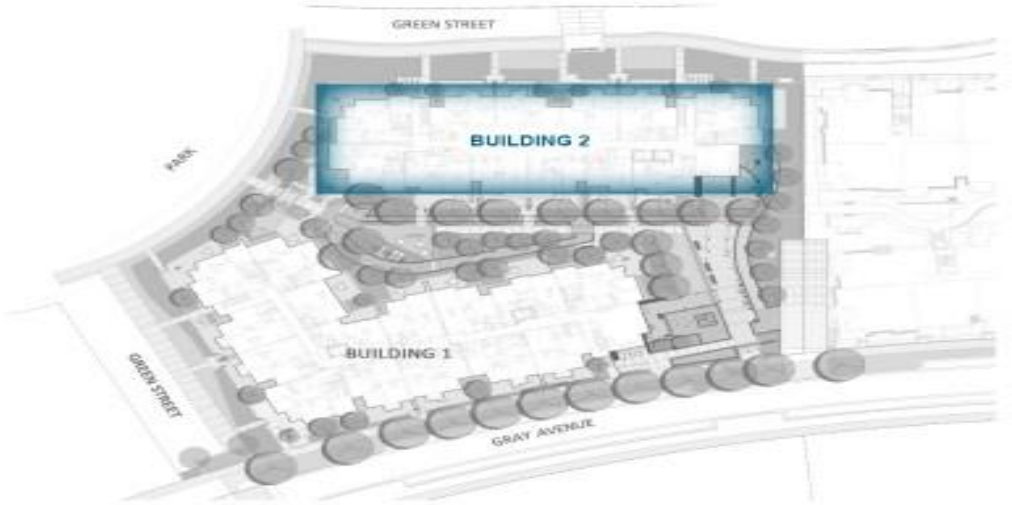

Figure 2: Sail Residential Buildings

1.1 Project Overview

This section provides the basic information about the project, and also includes the social and environmental aspect of the project.

1.1.1 Project Name

The project is called the SAIL Residential Building; it is a six-story wood frame structure. The foundation and the two story underground parking are constructed out of concrete; however, the stories above that are all constructed out of wood.

1.1.2 Business, social and environmental case for this project

The Sail residential building is located close to Westbrook Village where the area is condensed with stores and services; this will have a great positive impact on the businesses in the area. The west side of the Sail building will become the Mendel Park which will be constructed to enhance the social community in that area.

The building is being constructed based on REAP standards, which is a new standard set by UBC sustainable residential buildings. REAP ensures that the low or high rise buildings being constructed to have lower water and energy consumption, innovative heating systems, higher indoor environmental quality. The Sail residential building has implemented REAP standards to both of the Sail residential buildings.

1.2 Physical Description

In this section of the report some information regarding the selected construction site is provided.

1.2.1 Location

The building is located in southern part of UBC close to the Westbrook Village. The residential building is enclosed in the south by Gray Avenue, on the east by a four story building, to the north and west by greenways.

1.2.2 Size

The Table 1 provides the size and zoning of the building.

Table 1: Size of Building 2

Size	57,274 SQ.FT.
Height	6-Storey 21m
Zone	SC2-Medium Density Residential

1.2.3 Key design and construction Features

One of the main key design and construction features for the Sail residential building is that, it's the first six story wood frame structure with two story concrete parkade on UBC campus. This building implements a unique walls system which is has a fire stopping power, because in

wooden structure fire is one of the main issues. This was a new type of fire wall that was used in the project for the first time. One of the other design features was that the penthouse suits have their own rooftop lanais, which this create privacy for the homeowners and it was unique to have the rooftop lanais.

The building was constructed in a way to reduce the environmental foot print. The following has the following environmental benefits:

- 40% in direct savings in energy costs.
- 70% in reduction of construction waste
- 41% reduction in water use
- 210 tones reduce in greenhouse gases.

1.3 Organizational

The Sail Residential building is not design as a typical construction management delivery system. This section defines the parties involved in the construction process and project delivery form.

1.3.1 Participants

The parties involved in this project are many but the main parties involved in the construction of the Sail residential building are illustrated in Table 2.

Table 2: Project Participates

Company Name	Position	Individual Name
Adera Projects Ltd.	Owner/Developer	Bob Heaslip
Rositch Hemphil and Associates Architects	Architect	Bryce Rositch
Perry and Associates	landscape Architect	Michael Patterson

There are other sub-trades on the project which will be working on the interior design and the exterior design but Adera is the constructor for the whole buildings, while sub traders will do the drywall, tilling, painting, and etc.

1.3.2 Project Delivery Form

Adera Projects Ltd. is the developer of the project and the owner. The land that the Sail buildings are being constructed was bought by Adera from UBC. Adera did both the construction and the design of the Sail buildings. Adera as the owner and the developer they hire other sub traders and sub consultants to work on the construction of the project. Based on the interview by the site manager, he mentions that there is electrical, structural, architectural consultant and the sub traders are the plumber, electrician, and etc. which were all hired by Adera to work on the project.

1.3.3 Name and Position of Individual Contacted

The table below summarizes the names of the individual people contacted at the throughout the project.

Table 3: Individual Contacted

Name	Position/Organization
Chris Eddicott	Site Manager
Boris Wong	Safety Manager
Brenda Sawanda	UBC SEEDS
Kyle Reese	Community Energy Manager

1.4 Financial

The financial section of this report delivers the total project cost and the key issues in the financial aspect of a project. In a construction industry cost is one of the most important factors for the owner or the contactor depending on the construction delivery method. The owner is the investor in the project and pays for all the expenses in a project, therefore, it is extremely important for the owner to keep the construction cost to its set budget, but sometimes due to change in scope the construction cost will increases. It is vital for both the owner and contractor to manage the project cost, depending on the situation both the owner and the contractor may lose money during a construction of a project.

1.4.1 Total Project Cost

The total project cost was not shared with us by the site manager due to confidentially issue; however, the average cost of the six story wood frame projects ranges from $4.5 million to $6.5 million and this only the cost for construction of the structural components not the cost of non-structural components.

1.5 Process Description

The Sail residential building as mentioned in the first section consists of two buildings. These two buildings are at different stages of construction process, and this section provides duration and current status of the construction, also the key challenges involved in the construction.

1.5.1 Project Duration

Construction of Building 1 was initiated in March 2012 and it will be completed on July of this year. The second building will be completed in February 2013 and started September 2012. Figure 3 illustrates the schedule for the construction of the structural components of Building 2.

ID	Task Mo	Task Name	Duration	Start	Finish	Predecessors
1300		**Phase 2 / Building 2**	**494 days**	**Thu 3/1/12**	**Mon 2/24/14**	
1468		**Phase 2/Building 2 Structure**	**147 days**	**Fri 2/1/13**	**Fri 8/30/13**	
1469		Layout	3 days	Fri 2/1/13	Tue 2/5/13	1457
1470		1st Flr Walls	5 days	Wed 2/6/13	Tue 2/12/13	1469
1471		2nd Flr Joists	5 days	Tue 2/12/13	Mon 2/18/13	1470FS-1 da
1472		2nd Flr Walls	5 days	Mon 2/18/13	Fri 2/22/13	1471FS-1 da
1473		3rd Flr Joists	5 days	Fri 2/22/13	Thu 2/28/13	1472FS-1 da
1474		3rd Flr Walls	5 days	Thu 2/28/13	Wed 3/6/13	1473FS-1 da
1475		5th Flr Joists	5 days	Wed 3/6/13	Tue 3/12/13	1474FS-1 da
1476		5th Flr Walls	5 days	Tue 3/12/13	Mon 3/18/13	1475FS-1 da
1477		6th Flr Joists	5 days	Mon 3/18/13	Fri 3/22/13	1476FS-1 da
1478		6th Flr Walls	5 days	Fri 3/22/13	Thu 3/28/13	1477FS-1 da
1479		PH Flr Joists	5 days	Thu 3/28/13	Wed 4/3/13	1478FS-1 da
1480		PH Flr Walls	5 days	Wed 4/3/13	Wed 4/10/13	1479FS-1 da
1481		Roof Joists	15 days	Wed 4/10/13	Tue 4/30/13	1480FS-1 da
1482		Roof Top Walls and Stairs	10 days	Tue 4/30/13	Mon 5/13/13	1481FS-1 da

Figure 3: Building 2 Schedule

1.5.2 Current Status

The current stage for Building 1 is that the structural construction is done but the non-structural components are not done which includes the detailing of each apartment (interior and exterior). As it can be observed from Figure 3 the schedule for construction of building 2 is shown. The current status of building number two was the framing of the second floor (2nd Floor Joists), and this was the activity chosen for this report. The process for the framing of the walls and the joist are done based on five days increments.

1.5.3 Key Challenges

One of the main key challenges for this project is that the Sail building is one of the few six story wood frame structure and the first one in UBC, so this was new process to the construction team. The process involved different framing and structural details required and the team was learning as they were working through the project.

The south of UBC campus had soft soils so there was geotechnical challenges involved during the construction of the foundation. The soil consisted of 20ft of sand so they had to stabilize the site in order the foundation can be placed, this increased the price and also the challenges involved for the construction. This is a difficult process because they couldn't stabilize only the soil under the structure but they had to stabilize the soil across the site.

The final challenge they had was during the construction, when the crane operator had to lift the framed floor to the building number two. The challenge was during the winding days where the floor attached to the chains of the crane it sway around and difficult to control. This caused challenge in lifting the framed floor, and slowed down the project.

2.0 PROJECT-LEVEL PRODUCTIVITY ISSUES

Productivity is defined as a measure of the efficiency and effectiveness of an operation (Froese, CIVL 493/521 Course Notes, 2013). In other word, productivity is a measure of work performed over time, cost and man hours. The reasons for studying productivity is to address project concerns, industry concerns and in overall to improve the construction productivity.

For the past several decades, productivity in construction industry has been decreasing by 2-3% per year in contrast to other industries such as manufacturing. Accordingly, more pressure from the construction companies has been placed on improving productivity with the aim of decreasing capital spending and increasing the overseas competition (Froese, CIVL 493/521 Course Notes, 2013).

In project level, productivity measurement monitors the overall project progress and highlights project problem areas for correction. Increased productivity in project-level helps in decreasing cost, project duration and resource consumption (Froese, CIVL 493/521 Course Notes, 2013).

Construction managers have control over many factors affecting the productivity. Project level productivity issues can be broken down into the spatial, Safety and environmental Issues. These Project-Level Productivity issues are investigated at Sail project and are summarized in the following sections.

2.1 Spatial Issues

Factors affecting the Special condition of a construction site include construction site access, material storage, equipment layout and the location of facilities. For the overall Sail project, the site accessibility was not a major issue as the site was accessible through SW Marine Drive without disturbing the residential area in the University village. Figure 4 shows the location of the site and its accessibility route.

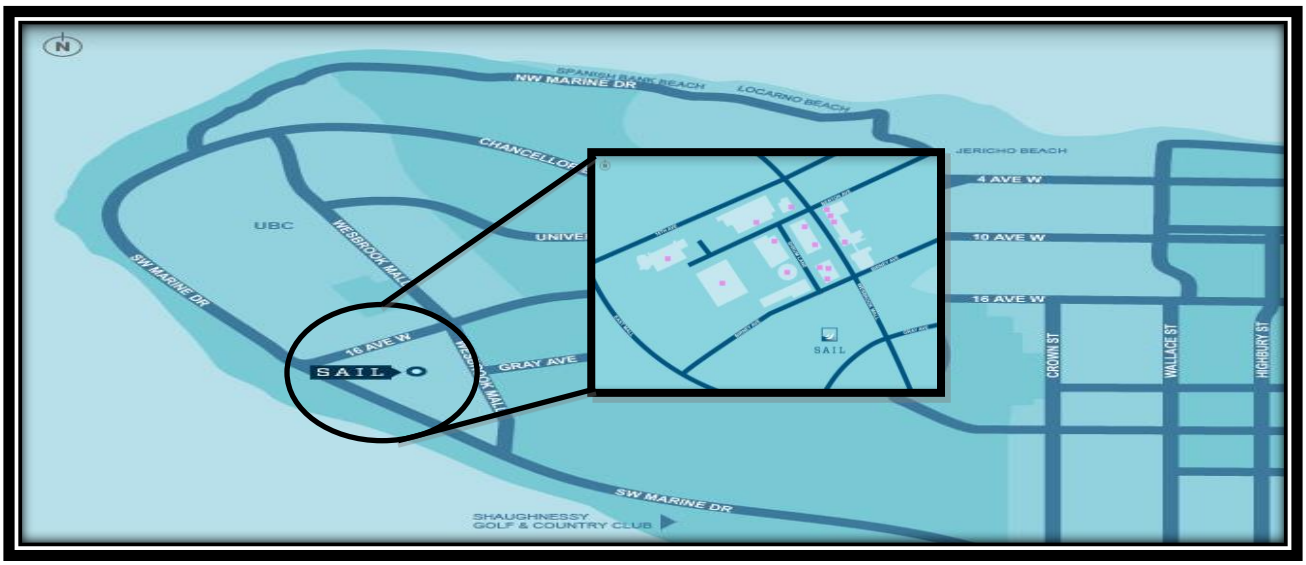

Figure 4: Site Accessibility Route

In general, the site was well laid out in regards to location of storage, disposal bins, and facilities such as washrooms, offices and disposal bin. Figure 5 shows the spatial condition of the Sail project.

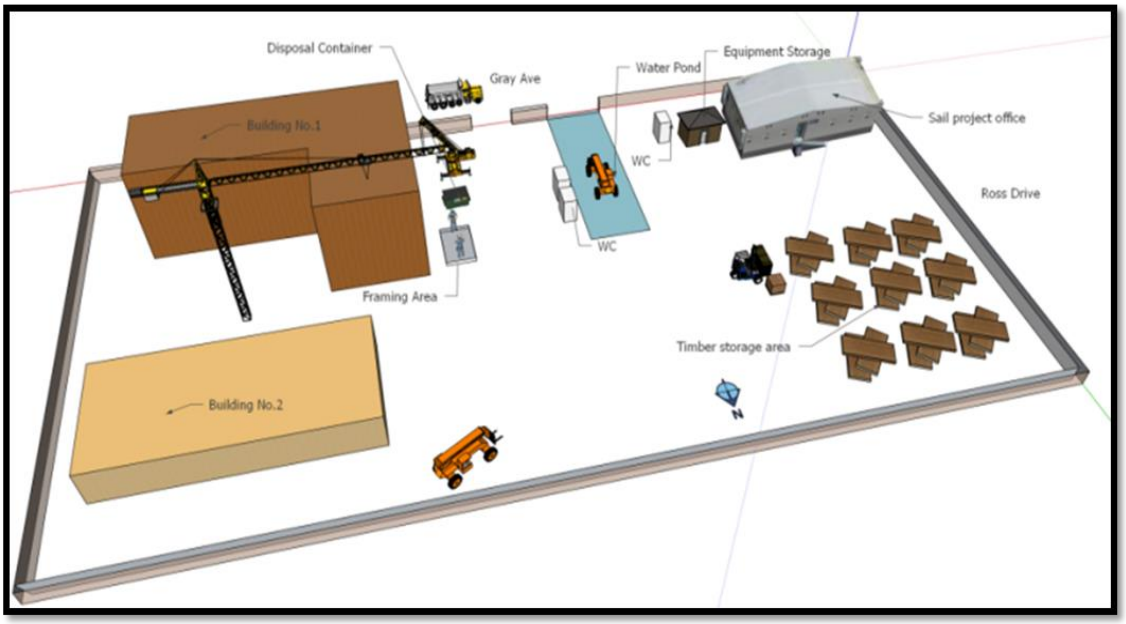

Figure 5: Spatial Condition of the Site

As shown on the previous figure, the general lay out of the site is well organized; however, when it comes to maneuvering machinery around the site, it creates a great deal of congestion. Maneuvering of large equipment around the site not only made it difficult for workers to move

freely around the site, but also in some cases, it was observed that they pass around objects with literally inches to space as it's shown on Figure 6.

As it is seen in Figure 6, two trucks are passing each other literally inches to Space. Accordingly, it's very important to have workers on the site with good experience and the ability to maneuver large machine in a confined space.

Figure 6 : Sail Project Spatial Issues

2.2 Safety Issues

Safety of the personnel at the site is the first priority for Adera Development Corporation. There are many safety rules and good practice procedures that are followed in Sail project to ensure safe operations. Followings are some of safety measures and procedures implemented on Sail project to prevent and reduce the accidents and injuries:

- Adera Statement of Worker Responsibility form that is required to be completed by all the workers before starting of work on the project.
- All workers are required to have his vests, hard hats and steel toes works all the time.
- All machines on site must have daily inspection log book.
- The site area is fenced all around to exhibit any public entrance to the site
- Barriers are installed in each floor for the safety of workers working in the balcony, and to prevent fall (I don't know how to say that)
- There are five First Aid attendants are available to assure the safety of the site. The first aid trailer is located on the site and well stocked. In addition, in case of emergency, the UBC hospital is located about 5 mints from the site.
- Safety reports for each site are made by the site officer (Boris Wong) every morning before the working hours to ensure the site is safe for workers
- It is the responsibility of all the workers on site to report any unsafe activities on site to the Safety officers.

Despite all the safety rules and regulations implemented on the site, some safety issues were observed during the site visits. These include fall hazard, crane operation, and maneuvering of heavy machinery. The following Pictures verify some of the safety issues observed at Sail Project.

This worker is measuring the edge of the second floor without having any fall Protection

Figure 7: Safety Issue - Fall Hazard

Two trucks are passing each other with literally inches to space.

Figure 8: Safety Issue - Maneuvering of Large Equipment

Figure 9: Safety issue – Crane Operation and Fall Hazard

This fall protection issue was also mentioned in the interview with Mr. Boris Wong "Typically, fall protection is the worst one in the construction site. Fall protection and people taking down guardrails from windows, and opening" he said. A pro-active approach to preventing accidents requires many ingredients (Froese, CIVL 493/521 Course Notes, 2013). According to Mr. Wong, the Sail Project site officer, the main component of safety system is compliance. "When you don't get that "compliance", you don't get the enforcement, you don't get the discipline. Without that enforcement and discipline, there is no safety, and without it, you just have unsafe work environment.

2.3 Environmental productivity Issues

The environment has an important effect on the productivity. The major environmental factor affecting the Sail project is the weather condition. The heat, cold, humanity and noise are all the environmental factors that can negatively affect the productivity of the operation. During the couple of site visits, it was observed that various weather conditions will not stop workers although would slow them out. According to the interview with the site superintendent, Chris Eddicott, The rainy weather will slow down the framing workers but will not stop them. "It takes incredibly high wind to shut down the crane, and that's when the framing stops" he said.

Table 4 inserted below, shows the environmental conditions at Sail Project during the couple of site visits.

Table 4 : Sail Project Environmental Condition

Date	Temperature
March 5, 2013	9^{o} (Cloudy)
March 6,2013	7^{o} (Rainy)
March 7, 2013	8^{o} (Sunny)
March 8, 2013	9^{o} (Cloudy)

In addition to the impact of the environment on construction projects, projects can have an important effect on non-workers, the public at large, and the environment (Froese, CIVL 493/521 Course Notes, 2013). The major environmental concern on Sail Project is the salty water "At the site level, I have to deal with all the salty watery, and being able to get the water offsite. That's my biggest headache" Chris said.

In conclusion, the rainy condition was considered to be the major environmental issues reducing the productivity level of all the site activities. The rainy weather causes the worker morale sinks, one's footing becomes less stable and visibility reduces.

3.0 ACTIVITY OVERVIEW

The activity chosen for this report is the framing of the floor, and this section provides an overview of the activity and also defining the equipment's and material used in the construction of the floors.

3.1 Equipment

The equipment's specified in this section are the ones used for the construction of the floor but not the equipment's used in throughout site.

Figure 10: Forklift truck

The forklift truck was used by the crew men at site to carry the lumber supplied by the lumber yard to the storage area. Also was used to carry the lumber from storage area to the framing area used for the construction of the floor.

Figure 11: Crane

The crane was used in the site to carry the materials around and also for the selected activity it was used to lift the constructed floor to the building number 2.

Figure 12: Nail gun

The nail gun was used by the crew men to attach the lumber together for the construction of the floor. This equipment is fast and efficient for the construction of the floor.

3.2 Materials

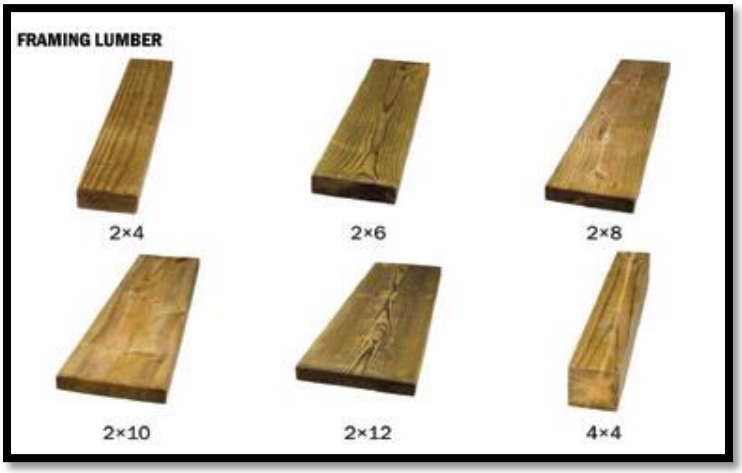

Figure 13: Dimension Lumber

Dimension lumber was used for the constructing the floor. The dimension lumber was used for the main carrying members and it was the skeleton of the floor and act as the primary members.

Figure 14: I-Joist

The I-joist is composed of two different sections. The web is made up of plywood and the flanges are dimensioned lumber. The I-joist were used as a secondary member in the framing the floor.

Figure 15: Plywood

The plywood was used for the activity, when the framing of the floor was done and want it to be lifted. The plywood was attached to give the bending strength for it to be lifted.

3.3 Activity Process

The activity chosen for this report as mentioned is the framing of the floor. Three crew men worked on this project, which two of the workers(senior and junior framer) where involved directly in the construction of the floor, while the other worker (crane/lift truck operator) only joined when the materials was needed for the site or the floor needed to be lifted. The activity steps from the start to the lifting of the floor are illustrated below.

Figure 16: Step 1 Activity

Step 1: The lumber is placed on the framing area by the crew men. Waiting more lumber to be brought by the lift truck operator.

Figure 17: Step 2 Activity

Step 2: The lift truck operator brought required the lumber from the storage area to the framing area.

Figure 18: Step 3 Activity

Step 3: The 2X8 are attached on the four corners of the floor which they are the primary members and the I-joist are the secondary members in the floor. The I-joist are placed at their specific position ready to be nailed to the primary members

Figure 19: Step 4 Activity

Step 4: The I-joist are nailed and glued to the primary members.

Figure 20: Step 5 Activity

Step 5: The plywood are brought and nailed to the floor in order the framed floor to have the strength for it to be lifted.

Figure 21: Step 6 Activity

Step 6: The framed floor is ready to be lifted and be placed on the building number 2. The crane chains will be attached to the floor.

Figure 22: Step 7 Activity

Step 7: The floor is being place on the building number 2. The crane operator is on the 2nd floor of the building and controlling the crane from that location.

Figure 23: Step 8 Activity

Step 8: The floor has been placed on the 2nd floor and it will be nailed to the other member for it to be connected.

4.0 DATA COLLECTION

Productivity data collection technique is a method of collecting data to make decisions influencing productivity (Froese, CIVL 493/521 Course Notes, 2013). A variety of productivity data collection methods have been employed during 8 visits to Sail project site with the aim of investigating the productivity of the framing activity performed for second floor. These techniques include the qualitative dada collection method to provide descriptive information and quantitative method to provide numerical data about the operations. This section discusses the different data collection methods employed at Sail project and their relative success. At the end, the issues arising in applying these techniques are discussed.

4.1 Data Collection Techniques

Table 5 summarizes the various data collection techniques implemented during the 8 site visits at Sail Project to study the framing process in the order they were initiated:

Table 5: Data Collection Techniques employed at Sail Project

General Observations/ Discussions with Chris Eddicott (Site Superintendent)	February 18
Meeting with Brenda Sawada (Manager, UBC SEEDS)	February 26
Adera Safety Training Orientation	February 18 & March 5
Work Sampling / Time Study	March 5,6,7,8
Photography	March 5, 6
Video Taping	March 5,6,7,8
Formal Interviews with Site Superintendent	March 18
Craftsmen and Workers Questionnaires	March 19

In should be noted that the general observation of the site is done in all the site visits in order to investigate the details relating to individual operations, as well as the factors influencing the productivity, safety and environmental impacts of the construction operations.

4.1.1 Qualitative Data Collection Methods

4.1.1.1 *Direct Observations/ Discussion with Site Personnel*

Site observation is a primary method of collecting information regarding the environmental influences and safety factors (Froese, CIVL 493/521 Course Notes, 2013). Table 4An introduction to the site is performed on February 18 and the initial conversation is conducted with the site superintendent, Chris Eddicott. As requested by the site superintendent, the study team were advised to work on this project through the REAP program and as a result, were referred to MS. Brenda Sawada, the manager of the SEED program on UBC. The first meeting conducted with Ms. Sawada was held on February 26, in CIRS Building UBC. She gave the team an introduction regarding the REAP program and the point recognition that could assign to the Sail project per our study.

The project proposal was submitted on February 27, and after all the arrangement and permissions required for the project, the first direct observation of the site and the data collection was started on March 5, 2013. An informal site discussion with site personnel and workers are conducted during all the visits to get a better understanding of the situation.

4.1.1.2 Adera Safety Training

As the condition of Adera Development Corporation, the study team attended a safety training orientation on February 18 and filled out the statement of worker responsibility form, a copy of which is attached Appendix E. The safety training orientation was consisting of an overview of the safe working procedures according to Work Safe BC regulations and company safety rules. The training orientation provides a great opportunity for the study team to understand the responsibility of the site workers in terms of safety and compare the applied safety procedure with what was applied in practice.

4.1.1.3 Indirect Observations /Formal Interviews/Questionnaires

To better understand the situation, the formal and informal interviews are conducted with different site personnel to get the different views on the project. Depending on the position and schedule of the interviewee, the questions are asked through the formal interviews, or the questionnaire from.

4.1.1.4 Formal Interview with Site Superintendent and Site Safety Officer

Due to the busy and tight schedule of the site personnel, the formal interview with Site superintendent and the site safety officer was delayed to March 18. Two team members performed the formal interviews. One member was responsible for asking question while the other for taking notes. In addition, the digital recording was employed for all the formal interviews, which are provided in the Appendix.

The formal interview with site superintendent, Chris Endicott, was centered about the overall information of the site, the challenges involved in the project, the productivity, safety and the environmental issues associated in this project as well as the communication and coordination in the project. Following table summarizes the main points discussed in the interview.

Table 6: The summary of main topics discussed in the Interview with Site Superintendent

General Overview	• The building is a six story wood frame building; it's one of the first ones in Canada. • The starting time for the second building was in September 2013, the first occupancy is in February of next year. • There is no primary contractor on this project. Adera is the developer and anyone else is a sub trader or a consultant.
Safety	• Typically, fall protection and people taking down the guardrails from windows and opening are the most safety concerns at construction site. • There are many safety procedures and rules in place at site to reduce safety concerns.
Environmental	• At the site level, the most environmental concern is the salty water at the site. • The waste from the site will be sent for recycling and a report will be received on the level of recycled material out of the site garbage.
Productivity	• The productivity level of the site is measured through the subjective comparison of progress with the planned schedule to indicate the productivity. • Rainy water will slow the activities down but it won't stop them. It takes incredibly high wind to shut down and that's when the framing stops. • There is a bonus program implemented to increase the productivity of the project.
Coordination	• Depending on the stage of the projects, the regular meetings are placed every two weeks to three weeks to ensure everything is on schedule.

The safety problems at the site and the safety system implemented at the site are discussed in more detail in the formal interview with Boris Wong, the site officer and First Aid Attendant. Table 7 summarizes the main points in this interview.

Table 7: The summary of main topics discussed in the interview with Site Safety Officer

Safety and Environmental Concerns	• There are 5 first aid attendants on the site, which is four more than most others. Requirement is only one. • There have been more than 800 safety orientations since the starting date of the project. • The major key factor in safety and environmental concern is compliance. • There is a regular safety meetings with sub-trades every two weeks to address the safety concerns at the site*

A copy of the latest meeting held at the project is attached in Appendix E.

4.1.1.5 Forman Questionnaire

Due to the tight and busy schedule of the foreman responsible for framing activity, he was not available for the formal interview. Accordingly, a questionnaire was prepared to get the foreman view regarding the productivity and safety issues at site. A copy the questionnaire is available in Appendix C.

In his view the building height is the most challenging part of the project in terms of framing and the factor affecting the productivity the most is weather condition.

4.1.1.6 Workers Questionnaire

To better understand the workers' morale, which would have a great influence on the productivity, a questionnaire was conducted for the workers, as they preferred to remain anonymous. Refer to Appendix C for a copy of the questionnaire forms submitted by workers.

4.1.2 Quantitative Data Collection Methods

4.1.2.1 Work Sampling

Work Sampling is defined as a method of random observation of workers over an extended period of time to get information about the ratio between direct work and time spent on the job (Froese, CIVL 493/521 Course Notes, 2013). Work sampling has been performed through 4-site visit consisting of 5 cycles to obtain a measure of the effective, contributory and non-contributory work in the framing activity of the second floor. Each cycle in this analysis was about 1.5-2.5

hours.. In this measurement, the effective work is considered as any activity that directly involves in construction of the floor frame. These activities include hammering, and nailing of the I-joists and lumber wood beams. The contributory work in this operation considered as the activity that is not directly effective by is a pre-requisite for effective work such as dimensioning of beams, reading plans, or transporting lumbers from the storage area. Accordingly, the non-contributory work is an activity that is neither effective nor contributory. This includes coffee or lunch breaks, the waiting times or removing of the incorrect previously built sections.

In work sampling study, a large number of observations are made over an extended period of time. During the four site visit, more than 250 sample points are gathered to ensure the accuracy of data analysis. A minimum of 5-10 minutes time interval is considered between the sample points to ensure that the observation samples are independent of each other. In each site visit, each group member was responsible for specific productivity measurement methods. The data collection methods assigned to each group member changed in each cycle and site visit to avoid any biases. A copy of work sampling sample points for each cycle is attached in Appendix B.

4.1.2.2 Time Study

Time study is defined as a method of continual observation of an activity to record interactions between crews and classifies time ratios (Froese, CIVL 493/521 Course Notes, 2013). This method is implemented using stopwatches, pen and paper. The target duration of each sample point is considered to be 5 minutes. The time study is employed during all the cycles and accordingly, more than 150 sample points of 5 minutes duration have gathered (total of 750 minutes). Refer to Appendix B for a copy of Time study raw sample points.

4.1.2.3 Video Taping and Photography

Videotaping is defined as a method of recording construction activities for detail analysis (Froese, CIVL 493/521 Course Notes, 2013). Videotaping technique have been employed in this study with the aim of obtaining the accurate duration of each cycle, sub-activities and major delays, investigating the productivity environment and safety issues in more detail, and collecting the permanent record of framing activity for time study data and productivity analysis. The camera was taken into the field on two different site visits and 2 complete cycles of framing activity is recorded. The recorded videos were very beneficial in determining the crew balance

charts, chart cycles, process charts and learning curve effects. There were some challenges in implementing this technique, these includes the difficulties in positioning camera in such a way to avoid being disturbed for many hours, changing the camera batteries frequently, protecting the camera lens from periodic bouts of rain and trying to capture the entire frame.

4.2 Correctness and Relative Success of Data collection Techniques

The data collection techniques implemented in this project has been broken down to qualitative and quantitative data collection techniques. The qualitative method was very useful for providing the general and descriptive information regarding the project and the activity; however, they were very subjective to the observer's knowledge and techniques. On the other hand, the quantitative methods such as work sampling vas very useful to provide numerical data regarding the project and enable one to get the facts without the need to watch everything and everyone all the time, but they do not tell why there are problems, although they can identify which areas are causing a problem to some extent.

Videotaping was very useful method for reporting site and documenting the progress as the record was permanent and related to real time. In addition, this method greatly eliminates observer bias as it mainly involves standing up on a tripod with a wide-enough view to see everyone involved in the operation. However, it does not reveal the communication, attitudes and personalities which could greatly affect the overall productivity. In addition, due to the difficulties in positioning camera in such a way to avoid being disturbed for many hours, changing the camera batteries frequently, protecting the camera lens from periodic bouts of rain and trying to capture the entire frame, it was difficult to implement this technique for all the cycles.

To conclude, different people on site have different ways of determining the efficiency or productivity of the work (Froese, CIVL 493/521 Course Notes, 2013). Variety of data collection methods is required for the collection and analysis of data regarding the productivity, safety and environmental issues on construction operations which are different depending on the project. Implementation of different productivity data collection techniques in this project were very

useful in providing descriptive and numeral data regarding the framing activity and the productivity analysis of the operation which is discussed in more detail in the next section.

5.0 ACTIVITY ANALYSIS AND DISCUSSION

As mentioned in the previous sections of the report the activity observed on the Sail Residential Building construction site was the framing of the second floor roof. The workers had a working platform on which they built the frame from scratch and once the frame was built the crane operator moved the built frame from the platform to Building 2 where the frame was to be installed.

5.1 Techniques/Methodology

From the above we can come to get an overview that the general information about the project, safety issues, environmental issue and the data collection techniques we used in observation for the activity-level productivity. This chapter will introduce these methodologies in detail.

- Sequence of Tasks – Process Charts
- Spatial description – Flow Diagram
- Crew Balance Charts
- Labor Utilization Factor
- Learning Curve

5.1.1 Process Description/Sequence of Tasks-Process Charts

The sequence of process charts is considered to be a kind of interaction diagram that presents how the activity process operates in time sequence and what order. In our project, the process charts depict the logical functionality of scenario to demonstrate the whole process of frame fabrication.

Symbol	Description
▼	Storage
⇨	Transport
□	Inspection
○	Operation
D	Delay

Symbol	Actvivity	Transportation(m)	Activity Category
▼	Timbers are stoaged in the storage area on site		Available equipments storage
	Fork lift truck and crane on site		
	Nail gun, glue gun and wood cutter in storage		
	2 hammers and 2 tape measures in storage		
	1 "L" shaped ruler and 1 recktanguler wodd model in storage		
⇨	Timbers are transported to the frame site by folk lift trunk	100	Transfer Timber
D	Material temporarily stored on ground		
⇨	Carpenter takes the wood cutter from the shed near site	15	
□	Inspect timber		Beam distribution and assemble
○	Carpenter measures the beams and marks them		
○	Carpenter cut the wood beam as he marks		
⇨	Deliver timber to the site	10	
D	Material temporarily stored on ground		
○	Carpenters lay the main beam as skeleton frame		
○	Measure the timer and mark them		
○	Cut the beam again		
□	Check the beam for alignment		
○	Distribute the metal bearings on first beam		
○	Nail the bearings on the beam		
□	Check the drawings		
⇨	Some wasted wood is transferred by crane to balanced the weight of frame when hoisted	45	
D	Crane operator talks with carpenters		
□	Inspect the "I" joists		"I" joists distribution and assemble
⇨	Transfer "I" hoists to the site and move them to right position	10	
○	Measure "I" joists and marks them		
○	Cut the "I" joists		
○	Distribute bearings on beam		
○	Nail the bearings on the sencond beam		
○	Distribute the metal bearings on third beam		
○	Nail the bearings on the third beam		
□	Check all beams for alignment		
○	Nails beams together		
○	Nail the metal bearings on the fifth beams		
○	Erect all beams		
○	Erect all the "I" joists placed between Beams		
□	Check the "I" joists for alignment		
○	Nail "I" joists to beams		Combination of beam, "I" joists and wood board
□	Inspect the whole frame		
⇨	Move wood board on the "I" joists	10	
○	Carpenter glues and nails the wood board on the joists		
○	Nail the wasted wood on the frame to balance the weight of the frame when hoisted		Transfer the finished frame to location
□	Check the frame and the wasted wood for security		
○	Bind the chains to the frame and adjust the weight		
⇨	Swing the frame to location	50	
○	Clean up the site		End of process
	Total	**240**	

Figure 24: Framing Sequence Process Chart

We category the whole process in to five parts: equipment storage, material transfer, beam activity, "I" joists activity, combination activity and delivery activity. The process starts the folk lift truck carries the wood beam and "I" joists to the framing site, carpenters distributes the beams as skeleton then attaches "I" joists to the beam by bearings and nails. It ends with hoisting the finished frame to the location by crane. The distance of transferring and carrying in the whole process is about 240m. The project manager and workers can get a better understanding on the activity and find out some futile process which lowers the efficiency from the flow charts. So the process charts contribute to improve the process and lean construction.

5.1.2 Physical/Spatial Description-Flow Diagrams

The overview of spatial flow diagram depicts the correlation of framing activity and other activities that might affect the productivity of observed objective. The diagram shows the movement of materials and equipment related to the framing activity.

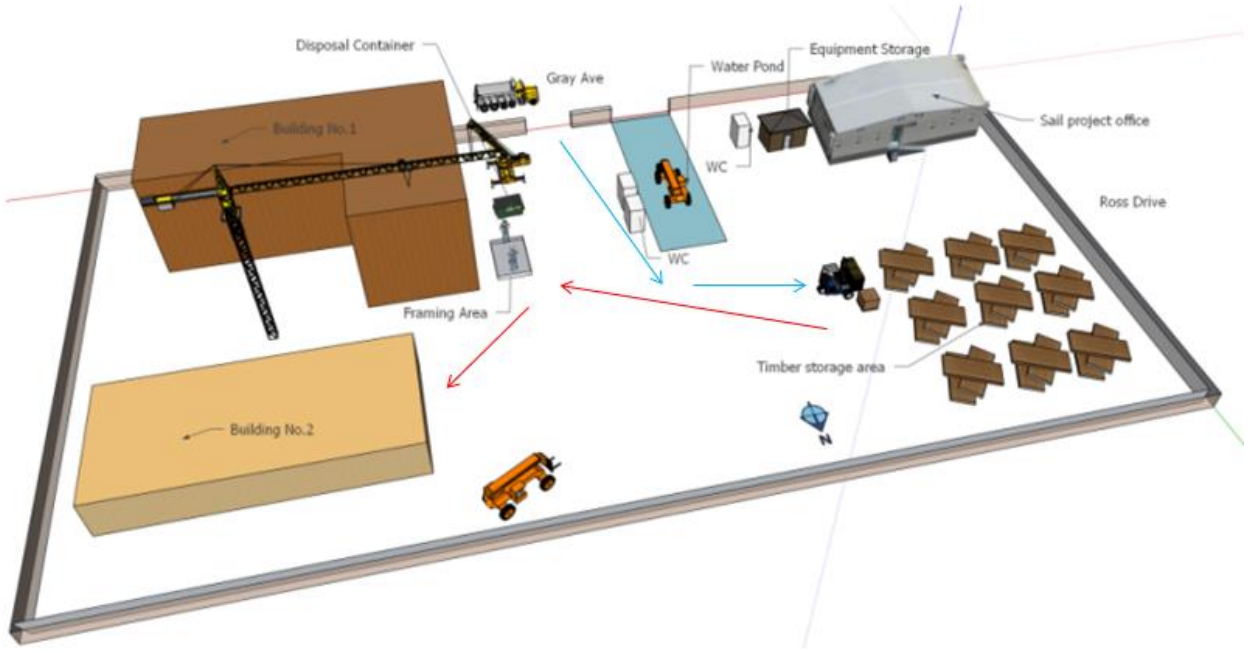

Figure 25: Framing Spatial Flow Diagram

As Figure 25 shows, blue lines describe the transportation of wood material is from the loading truck at the entrance to the storage area, then the fork lift truck loading the timbers to framing site, after finishing the frame, the crane delivers the frame from building 1 to the top of the building 2. We noticed that the distance between building 1 and water pond is about 15m, it is the only access way for material transferring and truck, the relatively narrow is likely to cause productivity reduction and safety issue.

5.1.3 Crew Balance Charts

The crew balance charts consist of series vertical bars to scale the activity process in terms of different types of workers and establish a performance mindset. In addition, the crew balance charts is a visual tool that evaluates a task and work condition to reduce activity duration and non-productivity time. Crew Balance Chart represents the performance of three workers in framing activity. Worker A is a senior carpenter, and worker B is junior carpenter and work C is crane operator. For a whole framing process, the worker A commits himself to cut and distribute the timber based on the requirements of the drawings at the beginning. In general he has a relatively stable and high productivity in all although he did a lot of contributory work at first, such as measured and marked the beams and joists as proper dimension for assembling later. By contrast, worker B performed well in the beginning, later his productivity begun to decrease with increasing of idle time, we observed that most of work he did is what told, and he was still in the learning stage without too much practice experience. We do not have a sequential record for Worker C, because he shows up only several minutes, even so, we find out that he had a negative effect on other two workers productivity. He would talk with two workers initiatively as long as come to the site. Typically, the contributory work and effective work of two workers are almost reverse. we can learned from the charts worker A move on assembling the beams, joists and wood broad after he finished primary measuring, marking and distributing tasks. On the contrary, the worker B turned to the distribution task, because he was not familiar with the drawings and skill.

Crew Balance Charts

Crew Balance Chart - Wood Frame Work with Crane (One junior labor, one senior labor, one crane operator)

TIME (%)	Worker A	Worker B	Crane operator
100	Watching hoisted frame	Watching hoisted frame	Hoist frame
	Inspection		
	Bind chain of crane to frame	Inspection	Watch bind frame
	Attach wasted wood on frame	Bind chains to frame	
90	Chat and wait crane operator	Idle	
	Carry wasted wood on frame		
	Attach wasted wood on frame		
		Bind frame to chain	
80	Take off coat and rest	Idle	
	Attach wasted wood on frame	Inspet	
		Attach wasted wood	
70	Stretch legs	Pack up cutter	
	Attach wasted timber on frame	Inspect	
		Attach wasted wood on frame for balance	
	Attach joist on the beam		Transfer wasted wood
60	Stretch legs	Reload glue gun	
	Carry board and unfasten cable	Attach board on frame by glue gun	
	Measure and cut joists		
50	Take nail gun	Text message	
	Cut the wood into small blocks	Carry board to frame	
		Take nail from storage	Hoist up timber
	Attach joist on the beam	Align wood board	
40	Check the drawings	Play cell phone	
	Distribute the joist and connet them with beams	Idle	
		Erect beams	
	Erect beams and nail them	Nail bearings on beam	
30	Leave to washroom	Chat with trunk driver	
	Check the drawings	Reload nail gun	
	Measure and cut "I" joists	Nail bearings on beam	
	Measure and cut beams		
20	Chat with B and crane operator	Chat	Chat
	Carry "I" joists to site	Take nail from storage	
	Check the drawings	Nail bearings on beam	
	Measure and mark beam		
10	Carry timber beam to site	Distribute the metal bearings and nail them on wood beam	Transfer timber
	Measure the timber beam and cut		

No data record | Effective | Contributory | Non-contributory

Figure 26: Framing Crew Balance Charts

5.1.4 Cycle Charts

Cycle charts is a duration measure tool which describes the time that workers spend on the specific activity. In the charts, each task is recorded by a timeline; it gave workers a clear mapping for schedule of each task through visual model and helps them improve the schedule and planning through identifying some conflicts and inaccurate sequence in the whole activity.

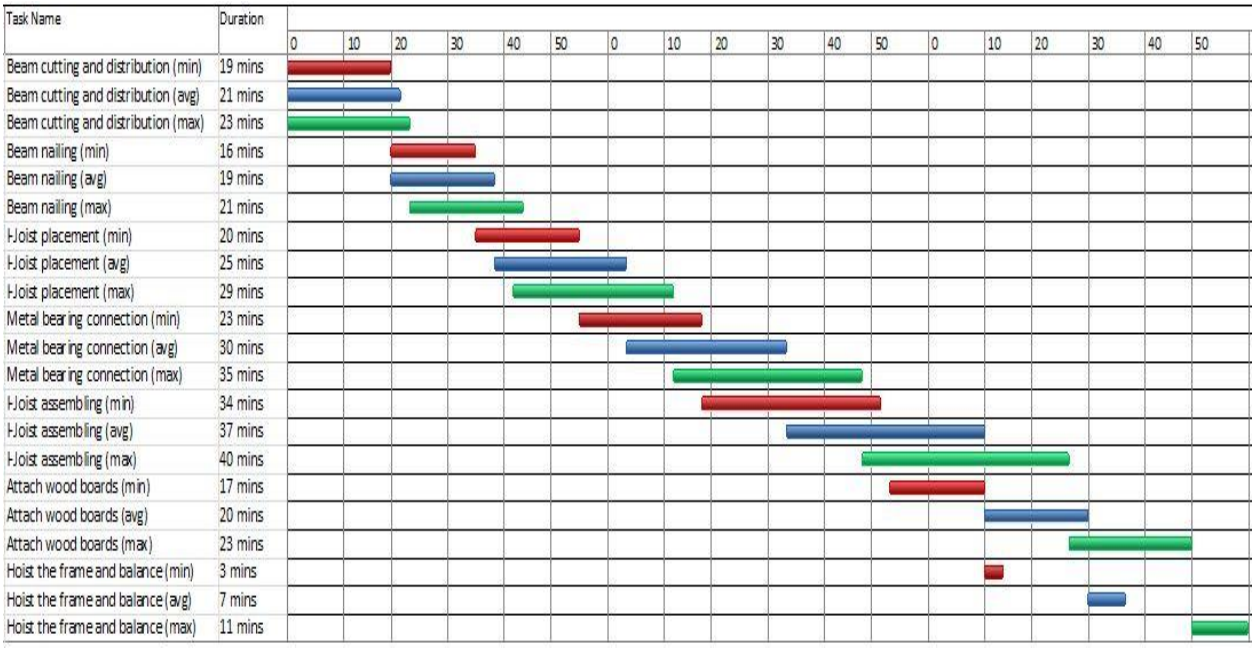

Figure 27: Framing Sequence process chart

As the cycle chart shows that we divided the whole process into several tasks based on the sequence, and lists the minimum, average and maximum duration for each individual task through statistical analysis for all 6 cycles observation. We noticed that all task duration has slight variation except "I" joists, metal bearing connection and hoist frame tasks because other tasks are primary finished by specific worker or team work. However, for "I" joists, the great change happens to the duration results from working in turn as well as metal bearing tasks. The duration of hoisting frame is likely depending on the dimension of the frame, it is easier for workers to attach wood on the small frame to balance the weight than a bigger frame. We can get the minimum duration for the whole framing activity is 132 minutes, the maximum is 182 min, and the average is 159 minutes. Actually the maximum duration gets involved some particular events. One was that the worker B ad to get nails from storage area because of deficiency of

material planning. The other was resulting from the poor schedule, worker A finished the frame early but had to wait for the crane operator almost half an hour. Hence, project manager and workers can figure out the problems imped the productivity and deal with it by cycle charts

5.1.5 Labor Utilization Factor

Labor Utilization Factor (LUF) is a basic technique to measure approximately the effective work time of the observed activity. Also the contributory work and non-effective work are mentioned as references to calculate the LUF. According to the CIVIL 521 notes by Dr. Thomas Froese, we get the definitions for three parameters.

- ✓ Effective work – is the actual process of adding to the unit being constructed.
- ✓ Contributory work – is that work not directly adding to, but essential to finishing unit.
- ✓ Non-contributory work – is defined as doing nothing contributory.

We discount the contributory work by 25% in the LUF calculation, as follows (Froese, CIVL 493/521 Course Notes, 2013):

LUF = (Effective + Contributory work * 0.25)/ Total observation time

Table 8: Framing Work Sampling

	Effective	Contributory	Non-Contributory	LUF
Worker A	569	131	48	80%
Worker B	517	170	63	75%

The total observation time we spent on the framing activity is 750 minutes, as the above table shows that, the average LUF of worker A is 80% and B is 75%. We found that the discrepancy of LUF results from some generic factors such as environment, weather, observed date, personnel performance during activity. As the work sampling presented in the Appendix B, we have complete 6 cycle data implies that two workers had highest LUF in the cycle 4, it was the middle of a week, they performed relatively well in LUF 84% and 78% respectively. On the contrary, the lowest is cycle 5 and cycle 6, 77% and 71%; it was evident that both workers did not work hard on Friday as previous days although the sunny day had contributed to their effective work time

already. The construction industrial LUF standards ranges from 40% - 60%.Obviously, the junior worker A is an excellent employee. Although the LUF of worker B is high as well, we noticed that the technique recorded work time has some serious deficiency which did not take consideration on the operation frequency. For example, when we recorded the nailing task, even though both A and B were working on the task for 10 minutes, the effective work time for both workers are 10 minutes, actually senior worker has faster operation frequency than B, the real discrepancy could not be presented based on the method we used and productivity. So we need to create another parameter to measure the operation frequency to make the LUF more precise.

5.1.6 Learning Curve

The learning curve is a graphical representation of a worker's ability to become "perfect" at the task that he or she is responsible for. The curve shows the ability of a worker to become progressively more efficient as the task is being repeated. The learning curve can give the management of a construction project a meaningful interpretation of the productivity of a task and how the crew are evolved through the construction process.

The framing activity gets repeated many times during a construction project and the crew are continuously exposed to the same activities such as measuring the wood pieces, cutting, nailing, and gluing the members during each cycle. Those of the activities which are human controlled can be modified in a way that each time the cycle is repeated the performance becomes much more efficient. However, sometimes the activity depends on the availability of the materials and their reach ability; for instance sometimes the activities depend on the crane operation and movement and thus restrict the learning curve's objective. Fortunately, the framing task contains mostly human controlled activities and the concept of the crew's learning throughout the progression of the project is visible.

It was explained by the foreman that the average time required for completion of a frame section similar in size and shape as to the second floor roof sections, would be approximately two and a half hours. The initial frame which was built by the two main workers consumed approximately three hours as mentioned by Worker A. This insight information from the workers along with the observed data have been combined and used to complete the learning curve shown in the following figure.

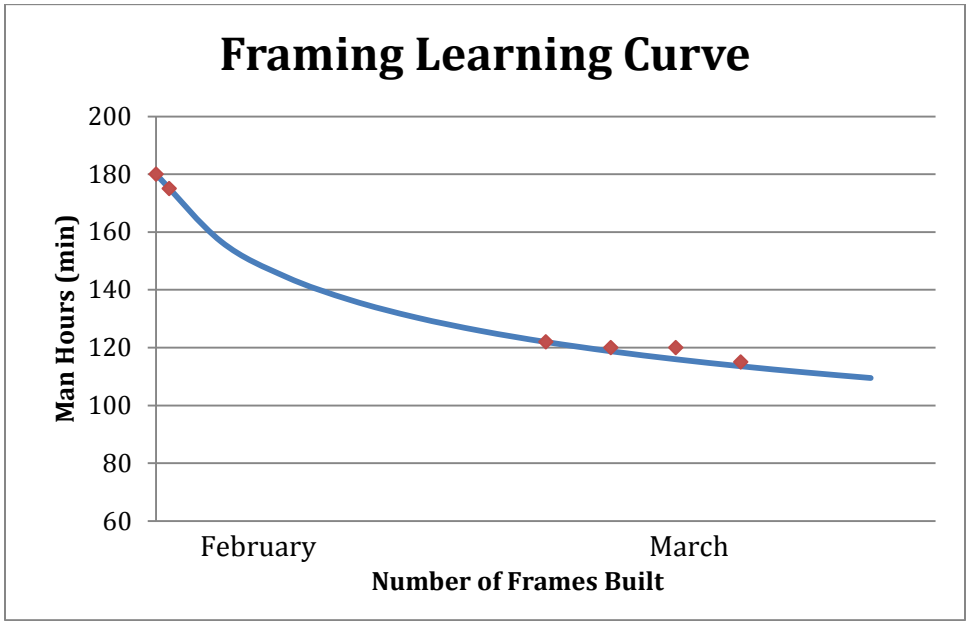

Figure 28: Framing Learning Curve

It is visible from the learning curve that there has been a noticeable change in the performance of the crew for assembling the frames. The same crew of workers have been exposed to the same tasks so many times that their efficiency has greatly improved over time. The curve's behavior also tells the observer that the efficiency of the crew is only modifiable to an extend and this is due to the fact that some of the factors in building the frame are beyond the control of the workers. For instance, the workers have to wait for the crane operator to bring supplies and wait for the material to be placed beside the framing platform in almost all cycles. This task takes a couple of minutes and there is a limit as to how fast the crane can be operated so there would be little improvement observed even after a number of cycles have been completed.

An interesting point to mention is the fact that one of the two workers who was always on site performing most of the work (previously mentioned as Worker A) has been doing this for a couple of years and is familiar with the process. However, due to the fact that each construction project has a different structural design, different member measurements, different material to be used, and different frame sizes, it would take time for workers to become familiar with the task. Hence, even the workers who are experienced would observe some perfection in their performance as they repeat the cycle.

Worker A explained that due to the unfamiliarity of the crew with the layout and measurements, they had to walk back to read the drawings many times and take notes to make sure their measurements were correct in order to avoid having their frames rejected by the workers who were assembling the frames together. These processes took a lot of times during the first few cycles but as time passed and the cycles were repeated, their efficiency was improved noticeably.

5.1.7 Factors Affecting Productivity

The productivity of the site in general is highly related to the productivity of the individual trades and workers and in construction projects such as the SAIL Residential Project there are too many trades involved who would be affected by different factors during the construction operation. Indeed the productivity of all activities is dependent on the management system of that trade and the experience of the workers involved and the distribution of tasks.

For the specific framing activity however, the productivity of the workers, as recorded from our site observations and as discussed during our interviews with the workers, was mostly dependent on the availability of materials and their accessibility. The framing activity was dependent on the crane operator and fork lift driver in order for them to bring in the material and place them beside the working platform. The availability of the equipment, such as the nailing gun, the glue gun, the hammers, and the air and power chords to get the equipment (i.e. nailing guns) working was also important in saving the crew some time.
The main worker, referred to as Worker A, performing the tasks in the framing activity was adequately experienced and trained however, worker B, who was very young and was easily distracted was significantly slower in performing the tasks and spent too much time going over the sketches and drawings.

The general factors affecting the productivity of the framing activity include the weather conditions which although have no direct effects on the work, may affect worker's mood and motivation (as also brought up by Mr. Chris Eddicott). Rain is the main weather issue observed in Vancouver and decreases worker efficiency by a minor factor which if observed during the long term can have significant affects on the overall productivity of the workers.

Site distractions such as the crew chatting, having extra breaks, or texting a number of times during the work hours also play a role in worker productivity.

6.0 SAFETY AND ENVIRONMENTAL CONDITIONS

As mentioned previously, Adera Development Corporations has well implemented safety procedures and guidelines for all workers working on their site.

6.1 Project-Level Safety Issues

They require all workers to wear the required safety personal protective equipment (PPE) and require anyone entering the site to wear steel toed shoes, high visibility vests, and hard hats. Additionally Adera requires workers to wear long sleeved shirts.

One thing that Adera can improve upon is the moving of large trucks and the congestion on site due to having so many trucks and heavy machinery and vehicles on site. The site did have a clear path for the vehicles to move through however due to having so many vehicles on site it was very tricky for them to move side by side of each other.

6.2 Activity-Level Safety Issues

The workers performing the framing tasks were wearing the required personal protective equipment and complied with the safety regulations of the site however, as we observed, there were some instances where one worker tried to get rid of wood blocks by throwing them onto the waste bin as other workers were working or walking around the waste bin. This throwing of the blocks was in our opinion a dangerous action and could cause harm to workers on the site.

Another issue which caught our attention was the fact that workers performing the framing tasks were not wearing gloves. Wearing gloves is not required however, it could prevent harm to the worker hands and fingers as they are working with wood pieces which could have splits, sharp edges or nails sticking out from them.

6.3 Environmental Impact Issues

The most important environmental issue which had concerned the site superintendent was the management of the rain water on site. As was mentioned by Mr. Chris Eddicott, and as it was apparent during our site visits, there was lots of rain water on site which converted the soil into a muddy state which was difficult to walk on and work on.

In order to deal with this issue the management system came up with a solution to have a small water pond where the equipment could move through and get rid of all the mud sticking to their wheels and sides. This would be considered as maintenance time for the vehicles and would improve their functionality on site.

Excessive dust was not an issue on this site however the site owners did receive noise complaints from the neighbors a couple of times. The management of the Sail construction project cannot find any solutions for this problem and their only answer to these complaints have been that they work during the hours and on the days that they have the permit for (which would be from 7am to 7pm, six days a week).

7.0 PRODUCTIVITY IMPROVEMENTS

The framing construction activity being done at the SAIL Residential Building project was well organized and planned for (considering the speed of the project and related activities). As seen from our observations and as suggested by the workers performing the operations and their foreman in our interviews, it was clear that there had been improvements made to the productivity and the process as the project progressed.

The framing activity is very much worker dependent and improvements can always be made in order to increase the efficiency of the work being done. If there is a need to improve the efficiency of the activity, then the farming foreman could decide to have better and stricter training for the workers performing the work. Training for this activity is not that critical, yet if done correctly, the workers are more comfortable using the tools and equipment, doing the measurement and cutting, and performing more trivial tasks such as nailing and gluing pieces.

For example, Worker B who was the younger worker did require some attention when he was performing some tasks. The issue of training goes hand in hand with experience, if required to improve the productivity of the work, then one could decide to hire more experienced workers as well.

Another way to optimize productivity would be to focus on activity specific improvements. For instance, one could decide to distribute time consuming but easy to perform activities to less effective workers, and the critical tasks to the experienced and more productive workers. An example of such time consuming and easy to perform work was the task of taking out the nails from recycled wood pieces for safety. This task could easily be performed by the less experienced and less productive worker.

An additional idea would be to check everything every day before leaving the site and making sure the material required for the next day is available and sitting close-by to the work platform. This would save some times the next morning as the crane is usually very busy in the mornings trying to get different tasks started for workers to work. These are only some of the improvements that one can make to improve the productivity of the framing activity and if there is unlimited budget and planning time one can keep on improving the work performance. However, it may not always be feasible to do so.

8.0 LEAN CONSTRUCTION

Lean construction is the concept of minimizing waste and maximizing the value of the project through saving time and resources during the construction phase. This can be done by having material delivered to the site by the time they are needed and implementing planning and controlling systems to improve project progress.

The SAIL project had a few aspects which considered lean construction methodologies. The first of which was the concept of having prefabricated structural and non-structural elements, such as precut and ready-for-use drywall partitions, which in fact did contribute greatly to the efficiency of the work since it was time saving. Other aspects such as minimizing waste was also considered

since the management at SAIL was responsible for shipping all the waste products to locations outside British Columbia and receive receipts for doing so.

9.0 WORK METHODS STATEMENT

Please see the attached work methods statement in the Appendix section.

10.0 ACKNOWLEDGEMENT

We wish to express our sincere gratitude and thank all those who have helped us throughout this project. We would like to thank Ms. Brenda Sawanda of the UBC SEEDS Program for her time and support while we were initiating the project and Mr. Kyle Reese, the Community Energy Manager, who familiarized us with the UBC REAP Program.

We would also like to thank Mr. Chris Eddicott, the superintendent at Adera Development Corporation and Mr. Boris Wong, the site safety officer, who kindly allowed us to enter the SAIL site and gather data for this project and patiently answered our questions during the interviews we had with them.

And lastly, we would like to acknowledge the help and guidance of Dr. Thomas Froese at the UBC Civil Engineering Department who provided guidance for the tasks completed in this project and thank him for his instructions and help throughout this project.

11.0 CONCLUSION

Development projects usually require a task to be repeated several times during the construction stage and the framing activity is a great example of such repetition. The project contractor or the developer in this case, always seeks ways to improve the speed of the project by increasing the productivity. According to our observations and data gathering it was found that the productivity for the framing activity was indeed improved throughout the course of the project; yet, there are more ways to keep improving the productivity of the task if it becomes a bottleneck for other parallel activities being performed on the site.

Quantitative and qualitative data collection techniques were used to gather data in order to assess the productivity of the task such as video techniques and time study. These data were then used to complete the crew balance chart, cycle chart, labor utilization factor, and learning curve. The labor utilization factor (LUF) computed was approximately 77% which was higher than the norm expected in the industry.

In addition to productivity, other factors such as site safety, environmental aspects, and lean construction methodology implementations were also examined and discussed. Suggestions for further improvements were also made which could be implemented in the future in order to increase the productivity of the framing task.

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APPENDIX A: SITE GENERAL DRAWINGS

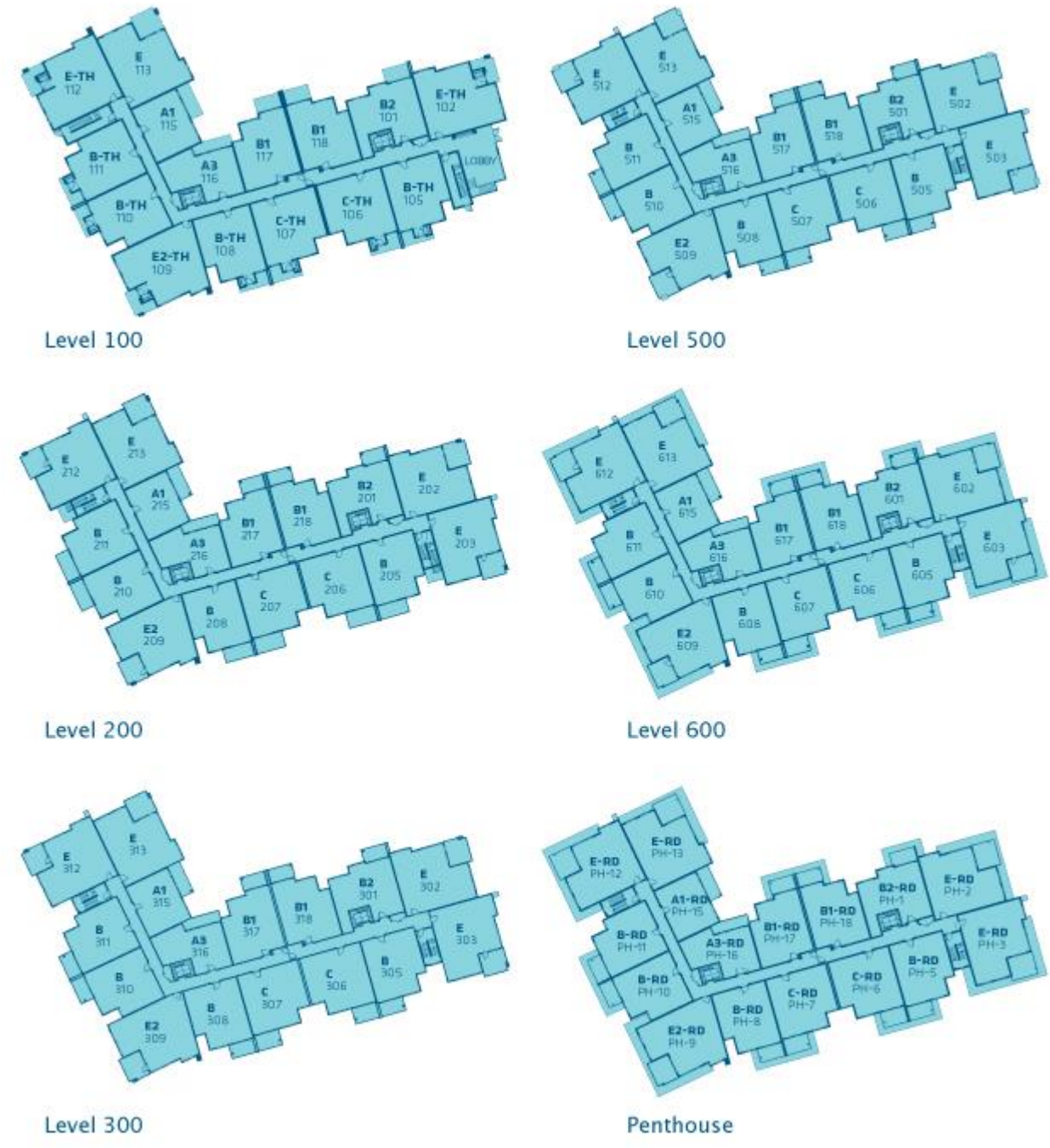

Figure 29: General Site Layout

APPENDIX B: RAW DATA

WORK SAMPLING

CYCLE 1

Date:	5-Mar-13
Time:	8:21 AM
Work Location:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Image Number
1	1 measuring wood / 2 chatting	1		2	3	8:21	4172
2	1 carring wood / 1 preparing to carry wood	1	1		2	8:30	4176
3	2 chatting			2	2	8:37	4179
4	1 measuring wood / 1 preparing to carry wood	1	1		2	8:40	4185
5	1 operating folklift to carry wood / 1 walking to carry wood	1	1		2	8:51	4186
6	1 operating folklift / 2 carrying wood	3			3	9:04	4188
7	1 measuring wood / 2 idling	1		2	3	9:11	4190
8	1 cutting th e wood / 1 measuring the wood	2			2	9:23	4193
9	2 checking the drawing		2		2	9:31	4202
10	1 nailing the metal bearing / 1 taking nail gun	1	1		2	9:34	4211
11	1 worker is measuring wood / 1 woker is loading nail	1	1		2	9:41	4218
12	1 measuring / 1 nailing / 2 chatting	2		2	4	9:50	4222
13	1 cutting the wood / 1 rolling the tap / 2 idling	1	1	2	4	9:17	4117
14	1 binding the chain to th finished frame / 2 chatting	1		2	3	9:22	4156
15	3 placing the finished frame on the ceiling	3			3	9:50	4165

CYCLE 2

Date:	6-Mar-13
Time:	7:52 AM
Work Loacation:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Image Number
1	2 bringing the wood		2		2	7:52	
2	1 measuring wood / 1 cleaning up the work area	2			2	8:00	4281
3	1 cutting the wood / 1 brining materials / 1 idling	2		1	3	8:11	4292
4	1 nailing / 1 loading nail gun	1	1		2	8:17	4298
5	1 meauring the wood / 1 nailing	2			2	8:21	4302
6	1 Nailing wood /1 holding the wood	2			2	8:27	4311
7	1 measuring wood / 1 attching joint connections	2			2	8:33	4316
8	1 perpearing the wood / 1 correcting the perviose work	1	1		2	8:41	4328
9	1 Nailing wood / 1 measuring wood	2			2	8:45	4334
10	1 nailing the wood / 1 looking around	1		1	2	8:50	4342
11	1 bringing wood / 1 perpearing section	1	1		2	8:59	Video
12	2 attaching the wood for strength	2			2	9:04	Video
13	2 chatting / 1 adding gule on wood	1		2	3	9:17	Video
14	2 attaching the crane cables / 1 controlling crane	3			3	9:22	Video
15	2 placing the wood floor on the building / 1 controlling crane	3			3	9:26	Video

CYCLE 3

Date:	6-Mar-13
Time:	9:30 AM
Work Location:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Image Number
1	2 Setting up the wood for the next flooring framing	2			2	9:30	
2	1 measuring wood/1 helping the lift truck with materials	3			3	9:45	
3	1 measuring wood / 1 cutting wood	2			2	9:55	
4	1 measuring wood / 2 helping the lift truck with materials	3			3	10:07	
5	1 cutting wood members / 1 nailing the joint connections	2			2	10:14	
6	2 chattting how to attach the members		2		2	10:20	
7	1 checking drawings / 1 nailing the bracket joint connection	1	1		2	10:29	
8	1 nailing the I joist to the 2X4(Primary members) / 1 checking drawings	1	1		2	10:37	
9	1 nailing the I joist to the 2X4(Primary members) / 1 putting glue in glue gun	1	1		2	10:43	
10	2 nailing the I joist	2			2	10:55	
11	1 nailing I joist / 1 cutting wood to place between members	2			2	11:03	
12	2 nailing the cut woods between the I joist	2			2	11:12	
13	2 discussing what to do next		2		2	11:19	
14	2 Cheking the floor to be square	2			2	11:22	
15	1 trying to fix the glue equipment / 1 carrying the plywood board to place on the floor		2		2	11:28	

CYCLE 4

Date:	7-Mar-13
Time:	7:38 AM
Work Location:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Image Number
1	2 carring wood / 1 operating folklift to carring wood	1	2		3	7:38	1071
2	1 carring wood / 1 measuring wood	1	1		2	8:10	1073
3	1 cutting wood / 1 carring wood / 2 chatting	1	1	2	4	8:31	1074
4	2 discussing the drawing		2		2	8:45	1078
5	1 strenthening the joint of frame / 1 watching	1	1		2	9:11	1042
6	2 watching / 1 operating crane	1		2	3	9:40	1047
7	1 operating crane / 1 watching / 1 hammering frame	2		1	3	9:52	1048
8	2 watching / 1 operating crane	1		2	3	10:02	1049
9	1 carring wood board / 1 playing cell phone	1		1	2	10:23	1051
10	1 laying board on frame / 1 walking to site / 2 playing cell phone / 1 taking cutter	1	1	3	5	10:39	1053
11	1 naling the board / 1 gluing the joint between two boards / 1 watching	2		1	3	10:52	1055
12	1 nailing the board / 1 cutting wood / 1 uploading nail	2	1		3	10:57	1056
13	1 operating the crane / 2 watching	1		2	3	11:07	1058
14	1 operating carne / 1 helding one corner of frame / 1 watching	1	1	1	3	11:14	1060
15	walking to carry wood board / 1 operating crane / 1 following crane operator / 2 chatting	1	1	3	5	11:20	1064

CYCLE 5

Date:	8-Mar-13
Time:	7:30 AM
Work Location:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Video Number
1	1 distributing wood bricks into frame grid / 1 getting cutter		2		2	7:30	Cycle 5_1
2	1 carring wood board / 1 nailing the frame	1	1		2	7:36	Cycle 5_1
3	2 nailing the frame	2			2	7:41	Cycle 5_1
4	1 nailing the frame / 2 chatting	1		2	3	7:55	Cycle 5_1
5	1 strenthening the frame / 1 taking a short rest	1		1	2	8:08	Cycle 5_2
6	2 chatting			2	2	8:10	Cycle 5_2
7	1 cutting the wood / 1 carring the wood components	1	1		2	8:19	Cycle 5_2
8	1 carring wood board / 1 checking the drawing		2		2	8:23	Cycle 5_2
9	2 hammering wood bricks on the frame	2			2	8:35	Cycle 5_2
10	1 attaching the joint / 1 laying the board on the site	1	1		2	8:41	Cycle 5_2
11	1 takingg a rest / 1 nailing the board	1		1	2	8:49	Cycle 5_3
12	1 measuring and cutting the wood component / 1 checking drawing	1	1		2	8:55	Cycle 5_3
13	2 binding the crane chain to the frame / 1 operating the crane	3			3	9:07	Cycle 5_4
14	1 operating crane / 2 watching	1		2	3	9:13	Cycle 5_4
15	2 helding the frame to the ceiling / 1 worker operating crane	3			3	9:27	Cycle 5_5

CYCLE 6

Date:	8-Mar-13
Time:	9:30 AM
Work Location:	Framing site
Work Activity:	Frame fabrication

Observation No	Activity Description	Effective	Contributory	Non-Contributory	Crew Size	Time	Video Number
1	1 carring wood / 1 nailing the metal bearing	1	1		2	9:30	1147
2	1 lifing wood with crane / 1 nailing / 1 watching	1	1	1	3	9:33	1150
3	1 carring board / 1 standing on frame	1		1	2	9:37	1151
4	2 discussing the work process		2		2	9:43	1153
5	1 cutting wood / 1 laying on the wood board	1	1		2	9:49	1154
6	1 hammering the fram / 1 idling	1		1	2	9:53	1156
7	1 nailing / 1 unfastening twining cable of cutter	1	1		2	9:59	1158
8	1 carring wood / 1 opearting crane / 1 hammering wood brick to frame	2	1		3	10:14	1159
9	1 taking nail gun / 1 cutting wood	1	1		2	10:27	1160
10	1 cutting the wood / 1 taking snack	1		1		10:38	Cycle 6 video
11	1 cleaning up the site / 1 carring the wood		2		2	10:40	Cycle 6 video
12	1 uploading the nail gun / 2 chatting		1	2	3	10:45	Cycle 6 video
13	1 attaching wood to frame / 1 carring wood	1	1		2	10:48	Cycle 6 video
14	1 measuring frame / 1 nailing	1	1		2	10:52	Cycle 6 video
15	1 checking the frame / 1 cleaning up site		2		2	11:20	Cycle 6 video

TIME STUDY

Cycle 1 LUF Summary		Worker A	Senior Worker	
		Worker B	Junior Worker	
Date:	5-Mar-13	E	C	N
Time:	9:05-11:00	**Effective Work**	**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
9:05-9:10	4	1		85%		4	1	20%
9:10-9:15	3	2		70%	3	2		70%
9:15-9:20	2	3		55%	4	1		85%
9:20-9:25	5			100%	4	1		85%
9:25-9:30	5			100%	5			100%
9:30-9:35	3	2		70%	2	3		55%
9:35-9:40	4	1		85%	3	2		70%
9:40-9:45	4		1	80%	5			100%
9:45-9:50	3	2		70%	5			100%
9:50-9:55	3	1	1	65%	3	2		70%
9:55-10:00	4	1		85%	4	1		85%
10:00-10:05	3		2	60%	3	1	1	65%
10:05-10:10	5			100%	3	1	1	65%
10:10-10:15	5			100%	4		1	80%
10:15-10:20	5			100%	3	2		70%
10:20-10:25	4	1		85%	3	1	1	65%
10:25-10:30	4		1	80%	4	1		85%
10:30-10:35	3	2	0	70%	3	1	1	65%
10:35-10:40	4		1	80%	4	1		85%
10:40-10:45	4	1		85%	3	2		70%
10:45-10:50	3	2		70%	4	1		85%
10:50-10:55	3	1	1	65%	3	2		70%
10:55-11:00	3	2		70%	1	3	1	35%
Total								
115	86	22	7	80%	76	32	7	73%

Cycle 2 LUF Summary		Worker A	Senior Worker	
		Worker B	Junior Worker	
Date:	6-Mar-13	E	C	N
Time:	7:50-9:30	**Effective Work**	**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
7:50-7:55	2	2	1	50%	2	2	1	56%
7:55-8:00	1		4	20%		5		40%
8:00-8:05	5			100%			5	0%
8:05-8:10	5			100%	5			100%
8:10-8:15	5			100%	4	1		88%
8:15-8:20	5			100%	5			100%
8:20-8:25	5			100%	5			100%
8:25-8:30	3	2		70%	5			100%
8:30-8:35	5			100%	4	1		88%
8:35-8:40	4		1	80%	4	1		88%
8:40-8:45	3	2		70%	4	1		88%
8:45-8:50	4		1	80%	5			100%
8:50-8:55	3	2		70%	3	1	1	68%
8:55-9:00	4	1		85%	4	1		88%
9:00-9:05	4	1		85%	5			100%
9:05-9:10	4		1	80%		5		40%
9:10-9:15	4	1		85%	4	1		88%
9:15-9:20	5			100%	5			100%
9:20-9:25	3	2		70%	3	2		76%
9:25-9:30	3	2		70%	3	2		76%
Total								
100	77	15	8	81%	70	23	7	79%

Cycle 3 LUF Summary		Worker A	Senior Worker		
		Worker B	Junior Worker		
Date:	6-Mar-13	E		C	N
Time:	9:25-13:00	**Effective Work**		**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
9:25-9:30	3	2		70%	3	2		70%
9:30-9:35	4	1		85%	5			100%
9:35-9:40	3	1	1	65%	1	1	3	25%
9:40-9:45	4		1	80%	4		1	80%
9:45-9:50	5			100%	2	3		55%
9:50-9:55	4		1	80%	3	2		70%
9:55-10:00	5			100%	2	3		55%
10:00-10:05	4		1	80%	4	1		85%
10:05-10:10	5			100%	2	3		55%
10:10-10:15	5			100%	2	3		55%
10:15-10:20	5			100%	5			100%
10:20-10:25	3	2		70%	2	2	1	50%
10:25-10:30	5			100%	5			100%
10:30-10:35	5			100%	5			100%
10:35-10:40	5			100%	5			100%
10:40-10:45	5			100%	2	3		55%
10:45-10:50	5			100%	2	1	2	45%
10:50-10:55	4	1		85%	3	1	1	65%
10:55-11:00	5			100%	5			100%
11:00-11:05	4	1		85%	5			100%
11:05-11:10	5			100%	5			100%
11:10-11:15	5			100%	3	2		70%
11:15-11:20			5	0%	0		5	0%
11:20-11:25	5			100%	4	1		85%
11:25-11:30	5			100%	4	1		85%
Lanch Time								
12:10-12:15	5			100%	5			100%
12:15-12:20		5		25%	5			100%
12:20-12:25		5		25%	5			100%
12:25-12:30	5			100%	5			100%
12:30-12:35	5			100%	5			100%
12:35-12:40	5			100%	5			100%
12:40-12:45	5			100%	5			100%
12:45-12:50	4	1		85%	2	3		55%
12:50:12:55	3	2		70%	3	2		70%
12:55:13:00	2	2	1	50%	2	2	1	50%
Total								
175	142	23	10	84%	125	36	14	77%

Cycle 4 LUF Summary		Worker A	Senior Worker	
		Worker B	Junior Worker	
Date:	7-Mar-13	E	C	N
Time:	9:05-11:05	**Effective Work**	**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
9:05-9:10	4	1		85%	4		1	80%
9:10-9:15	5			100%	4	1		85%
9:15-9:20	4		1	80%	3	2		70%
9:20-9:25	3	2		70%	3	2		70%
9:25-9:30	4	1		85%	4	1		85%
9:30-9:35	5			100%	4	1		85%
9:35-9:40	4		1	80%	4		1	80%
9:40-9:45	4		1	80%	4	1		85%
9:45-9:50	4	1		85%	5			100%
9:50-9:55	4	1		85%	5			100%
9:55-10:00	4	1		85%	2	3		55%
10:00-10:05	3		2	60%	3	1	1	65%
10:05-10:10	4	1		85%	5			100%
10:10-10:15	4	1		85%	4	1		85%
10:15-10:20	4	1		85%	4	1		85%
10:20-10:25	5			100%	4		1	80%
10:25-10:30	4		1	80%	3	2		70%
10:30-10:35	4	1		85%	5			100%
10:35-10:40	5			100%	4	1		85%
10:40-10:45	5			100%	3	2		70%
10:45-10:50	3	2		70%	4		1	80%
10:50-10:55	2	3		55%	3	1	1	65%
10:55-11:00	3	2		70%	3	1	1	65%
11:00-11:05	2	3		55%	1	1	3	25%
Total								
120	93	21	6	82%	88	22	10	78%

Cycle 5 LUF Summary		Worker A	Senior Worker	
		Worker B	Junior Worker	
Date:	8-Mar-13	E	C	N
Time:	7:30-9:30	**Effective Work**	**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
7:30-7:35		4	1	20%	3	2		70%
7:35-7:40		4	1	20%	4	1		85%
7:40-7:45	1	4		40%	4	1		85%
7:45-7:50	3	2		70%	3	2		70%
7:50-7:55	4	1		85%	2	2	1	50%
7:55-8:00	5			100%	4	1		85%
8:00-8:05	5			100%	2	3		55%
8:05-8:10	4	1		85%	4		1	80%
8:10-8:15	4	1		85%	5			100%
8:15-8:20	4		1	80%	4	1		85%
8:20-8:25	5			100%	4	1		85%
8:25-8:30	4	1		85%	4		1	80%
8:30-8:35	4		1	80%	3	1	1	65%
8:35-8:40	5			100%	5			100%
8:40-8:45	5			100%	4	1		85%
8:45-8:50	4	1		85%	5			100%
8:50-8:55	4	1		85%	3	2		70%
8:55-9:00	5			100%	2	3		55%
9:00-9:05	4	1		85%	3	1	1	65%
9:05-9:10	4	1		85%	2	2	1	50%
9:10-9:15	5			100%	3	2		70%
9:15-9:20	4	1		85%	3	1	1	65%
9:20-9:25	2	1	2	45%		2	3	10%
9:25-9:30	2	2	1	50%	2	1	2	45%
Total								
120	87	26	7	78%	78	30	12	71%

Cycle 6 LUF Summary		Worker A	Senior Worker	
		Worker B	Junior Worker	
Date:	8-Mar-13	E	C	N
Time:	9:05-11:05	**Effective Work**	**Contributory Work**	**Non-Contributory Work**

Time	Worker A				Worker B			
	E	C	N	LUF	E	C	N	LUF
9:05-9:10	3	1	1	65%	4	1		85%
9:10-9:15	3	2		70%	4	1		85%
9:15-9:20	3	1	1	65%	4		1	80%
9:20-9:25	4	1		85%	3	2		70%
9:25-9:30	4	1		85%	5			100%
9:30-9:35	5			100%	3	2		70%
9:35-9:40	4		1	80%	2	3		55%
9:40-9:45	4	1		85%	5			100%
9:45-9:50	4	1		85%	3	2		70%
9:50-9:55	4	1		85%	3	2		70%
9:55-10:00	3	2		70%	2	2	1	50%
10:00-10:05	2	2	1	50%	4	1		85%
10:05-10:10	3	1	1	65%	4	1		85%
10:10-10:15	5			100%	5			100%
10:15-10:20	4	1		85%	2	2	1	50%
10:20-10:25	4	1		85%	4		1	80%
10:25-10:30	4		1	80%	3	2		70%
10:30-10:35	4	1		85%	3	1	1	65%
10:35-10:40	2	1	2	45%	3	1	1	65%
10:40-10:45	3	1	1	65%	3		2	60%
10:45-10:50	4	1		85%	3	2		70%
10:50-10:55	5			100%	4		1	80%
10:55-11:00	4	1		85%	3	1	1	65%
11:00-11:05	1	3	1	35%	1	1	3	25%
Total								
120	86	24	10	77%	80	27	13	72%

VIDEO TAPING

APPENDIX C: INTERVIEWS/QUESTIONNAIRE

Date: March 18, 2013
Interviewee: Chris Eddicott (Site Superintendent)
Interviewer: Mahsa Banaei, Ferya Moayedi
Time: 10:00 am
Location: Sail Project Site Meeting Room

I. General Overview

- ***What is your position on this project?***
  Site Manager

- ***How long have you been in the construction business?***
  Close to 20 years

- ***How many participants are involved in this project?***
  There is envelop consultant, Electrical consultant, structural consultant, architects, Interior designers, water feature designer, all different trades are on site, all different designers are involved, everybody in their office. There are lots of different parties. There are potentially 150 people on site every day, and there is many different consulting involved. I don't know what you mean by how many participants involved. It's pretty huge.

- ***I mean the owner, the primary architecture company, and the primary contracture.***
  There is no primary contractor. There is a primary framing contractor, there is primary plumping, wire, electrical, tie. The is no primary contractor. Adera is the developer and anyone else is a sub trader or a consultant, so how many parties involved is a huge question.

- **What is the overall cost and duration of the project, and as of the current date, is the project on time and on budget? If not why?**
  Sorry, I cannot tell you anything about cost, I cannot get into the land, money, square feet cost, and it's never ganna happen. You can make it up and I cannot give the cost.

- ***Well, we don't need an exact number, we just want to know what the average cost for this type of project is?***
  I mean this is a six story wood frame, I don't understand by average cost, my last project was a four storey building on a one story parkade, this is a six story building on a two story parkade. Basicly, my owner was talking to me about a week ago, and this is sort of information he doesn't want me to give out to tours and visitors. Money is something that I don't wanna get into it. You can make it yourself, but I'm not going through any financial staff with you.

- ***What about the duration of this project, as of the current date, is the project on time and budget?***
  Yes, the first occupancy is in July of this year. We started the first building in the March of last year, and the first occupancy is in end of July of this year.

- **What about the second building which we were doing our study on?**
  The first occupancy for the second one is in February of next year. The starting time was in September.

- ***What is the contract type of the project?***
  Depends on the contract you are talking about, there is contract for ties, contract for frame, contract for excavation. They are all separate contracts. They are all individual trades, so I don't know what you mean by contract type.

- ***I mean is there any general contractor involved?***
  We are the owner and the developer, every other person is a sub trade. For example, for tie guy, what is doing is just tie, so there is no one over specific contract. (Min 7:30). There are all individual. We are not like Marcan who has the contract with Architect. This is our land and we are the developer. It's just like going and buy a house, it's just much more expensive. You just buy a land and build a house on it, it's exactly what is we are doing. Everybody here works for Adera, they are individual contractor with individual contracts.

- ***Is there any unique construction method on this project?***
  This is a six story wood frame building, it's one of the first ones in Canada.

- ***I heard it's a first six story wood frame building in UBC, is that right?***
  Yes, this is a first full wood frame, with a project up there which is one story of concrete and five story of wood, so this is the first six story wood frame.

- ***Any unusual features of the project. Any major issues and challenges facing the contractors.***
  There is all sort of thing. It's been a fix six story and yes, there is different framing details, different fire stopping, different structural details than we normally have, more time consuming, little more challenging. There is new type of fire wall that most people don't use it. It's new as well. There is lots of staff going here.

- ***Are there any notable design features that make this building unique?***
  It's pretty much the same question.

- ***Is there any major component that you are concerning about, like Sustainability, gaining LEED certificate or many REAP?***It's REAP, not LEED, but yes, we need to meet REAP standard definitely. I mean Adera is one of the leading companies in green

building, but its REAP standards. Other everything else would be internal staff as far as the tightness of the building; we are pushing to have some control over that. But it's not an unusual thing that we just do it for this project.

- ***How is the site laid out? Are there any designed work/Equipment areas, resource sharing, etc.?***
  Trades that need equipment normally bring their own equipment. …. (11:00)

- ***What are your arrangements for material handling? (Location of lay down area, delivery accessibility, measures to keep it dry/ Protected etc.?***
  Well, the materials that come with trades it's the trade responsibility to protect them. The only think that we have to worry about to dry is light fixtures and …. (12:30) and store them in the parades.

- ***What about the security issues? Is it up to trades to look after their own staff?***
  Well they are responsible for walking their own staff up, but we have 24 hours security. During the day, we have our own staff, and out of the working hours, there is a security guard monitoring the site.

- ***Were there any surprises during the excavation?***
  Yes, it was the worst ground I have ever had in UBC. It was very difficult geotechnically. There was basin and sand 20 feet down, so you need to stabilize the whole site, so there was a problem.

I. Safety

- ***What are the major safety concerns on this project?***
  Typically, fall protection is the worst one in the construction site. Fall protection and people taking down guardrails from windows, and opening.

- ***Are there any procedures in place to address safety concerns?***
  It depends. If someone sees something on site, they can talk to our safety staff and getting it corrected. If we see doing something dangerous, we either verbally warn them or throw them out site or get their bosses down. It depends on how bad is the safety concern and how many times they've been warned.

II. Environmental

- ***What are the major environmental concerns on the project? How are they addressed?***
  At the site level, I have to deal with all the salty watery, and being able to get the water offsite. That's my biggest headache. Everything else comes from the contracts and realistically at process level, I don't really care, I wanna get the project on time and make

sure we fulfill our contracts.

- ***Were there any major permitting issues during construction?***
  It's different for any time; it's different with every type of building you want to do. That's done by when they purchased the land. We don't deal with permit at site here.

- ***Where does the waste from the site go?***
  Into the red bins, and gets …..(16:50) and they recycle what they can, dispose what they can basically, and they report us with how much they can recycle out of our garbage.

- ***Is there any specific sort of waste to control them? I noticed there are some of buildings around this site that are occupied? Have you received any complain about noise or etc.?***
  Yes, always. I mean I have my working hours and I can't go outside of it. Other than that, we cannot do anything. All the building is built in the same way. When we were building their building, we may were pissing off the people on north of that. But that's what we do. There is no get around it. If we work out of our working hours, we're ganna getting very substantial fund but I can work from 7:30 to 7 during the week and 9 to 5 on Saturdays without any problem.

III. Productivity

- ***Hove you ever-participated in/ carried out a productivity study? When? In what context?***
  Well we do, we track our schedule. We track how many square feet someone can frame, how many units get ties. I mean that schedule that I got is ongoing, and is formal study that how fast we can build staff, and how many units you can do in five days and some sort of staff. But in that point, basicly you are a bit of …. (18:50) you assume that units are close enough. Well I can always do a five to seven units in a week alternates. Drywalls, wiring, everything, but beyond that no, I just track our schedule.

- ***How would the labors be aware of productivity expectations?***
  Depending on the trades, depending on what they are dealing with. Some workers are piece work. Like the tie guy gets paid by how much tie they installed, so they work well. But the workers that get paid hourly depends on the work, on the trade, the how productive they are really depends. But most of them know if they are not productive, they are not working very long, so there is a bit motivation to be productive.

- ***If you were doing the job again would you organize the project differently?***
  Sure, I never a project twice in a same way. I mean I'm not perfect. I make notes on how project goes and when I work on the next one, I look back at issues that came up and try to change things.

- ***Given the rainy weather we have in Vancouver, how the undesirable weather affects the progress?***

Depends. If it's waterproofing, it stops it, it it's tile and you have roofs. It has no effects. On the interior staff, it has zero effect. We

- ***What about the framing activity that we were recording considering they are working outside?***
  It will slow them out but it won't stop them. It takes incredibly high wind to shut down and that's when the framing stops. To work in a rain and cold definitely slow things down. When you try to line on a huge frame to where the floor goes, it's very difficult to do that in the rain. They keep doing it, but it will slow them out.

- ***Are there any incentives for the contractors to finish up their work ahead of the schedule?***
  We have a bonus program that at the end, when the project is done; we give bonuses to all the different trades, but realistically to the owners, to the ones dealing with all the contracts, for them, the fastest they ganna get out of here, it's better, so they can go and start on the next project and get money out of that one.

- ***Are you familiar with Lean Construction theory? Do you believe this theory is implemented in this project?***
  Well, Adera does very try as far as it's green initiative. Lean construction is a pretty massive topic that really depends on many things. Yes , we prefab all our walls, so there is a huge saving on walls up there and weigh lower percentages of the waste. But again, there are so many different trades involved. It really depends on them. For prefabrication wall, we do it because it's fast, we don't do it for Lean Construction.

IV. Coordination

- ***Do the workers communicate through you guys or do they communicate through each other?***
  Many of them, I don't even know their name or don't even know who they are. I'm ganna deal with former but not with all the workers on site other than safety concern. I don't have time to talk with very body on site other than social nice being. I talk pretty much with formers, the owner, and that's it. They deal with their own former. I don't deal with their hours and how they are getting paid. The only thing I need to know is that the drywall trade is working today, everything that happens between that trades could care less.

- ***How do you ensure proper communication is maintained amongst all parties on the project?***
  We have site trades meetings every two to three weeks for the site formen. It's very open-ended question. It really depends on the stage of the project. In early stage, It's a nonstop meetings with city staff and trying to get all the permits and later on it's as need kind of bases. But I mean at the site level, as far as making sure that everything's going

on schedule, meeting every two to three weeks with site formers.

- ***What is the overall nature of the working environment? How well do workers interact and communicate amongst them on site? How has worker relationships affected progress on the progress?***
  Again, how the individual workers communicate. It's crucial that trades' foremen communicate and collaborate with each other as much as possible as possible and that really varies with the trades. Some traders see the value in collaborating with someone. Either makes their job easier or possibly in the future that come back with some of them, but some care less. About two minutes remaining.

Interviewee: Boris Wong (Safety Officer/ First Aid Attendant)
Interviewer: Mahsa Banaei, Ferya Moayedi

- ***What is your position on this project?***
  Officially, I'm a construction safety officer

- ***How long have you been in the construction business?***
  7 years , but I was reading drawings for about 25 years and I was computer facility management, doing BIM, doing modeling, doing asset management, so kind of what you do.

- ***What are the major safety and environmental concerns on this project?***
  Compliance. Compliance is easy when you get from site superintendent, project manager. It's very easy when you get initial buy from them. You can have all other lip services from other organizations. When you don't get that, you don't get the enforcement, you don't get the discipline. Without that enforcement and discipline, there is no safety, and without it, you just have unsafe work environment. When we don't have time, we don't have commitment.,e.g. you say your full job is being a CSA first aid, but when push comes …., (4:35) you need …. (4:41) and I'm certified to drive and you know there is number of things I can do here. When they say no, safety comes second. The hard hat are safety first, everywhere when you look at the industry unless you don't get the orientations that are consistence. That's why it's challenging. It's like you guys are the new faces, I always ask. We do get lots of walk on, because not everyone complies and that's the main things, It's just compliance. We had about 800 orientations plus the ones at the site, which is pretty significant from what we had when we first got here, so the important thing is compliance.

- ***Are there any procedures in place to address safety concerns?***
  Yes, on my desk. They are very approachable, I come from a point of view that I don't yell, and I'm very quiet. As long as you good about the others, I tune it out. If there is a guy I see walk around with no hat, no vest, no boots on, or does not have any fall protection or gas mask on so there is, I'm very approachable

- ***Is there any safety record on site?***
  Yes, I do, totally, I ensure there is a manual on the box and how they are organized. We pretty keep all docs. I have a walk that I perform every morning, the initial walk is going into every floor, every room, go through everywhere…. (7:30) You know safety is kind of preventative, first aid is kind of immediate thing. So I document everything I do, I see, even the people I talked daily. I am here everyday about 6:30***.*** We don't officially start at 6:30, but I like to get things done and organize everything in quite before everybody starts.

- ***If someone is suffered from some accidents, how to handle this situation?***

I take control. First of all, we have 5 first aid attendants on the site, which is four more than most others. Requirement is only one. This is Adera, we work on the fact that we work safe.

Date:

1. What is your position on this work?

Carpenter - Hammer / Nail / Screw

2. Which company you work for?

3. What are the main processes of this framework? Can you give me a detailed step-by-step description of it?

1. Lay it out

2. Nail it

3. Fly it up to the building

4. What activities must be completed before this one can carried out, and what activities are waiting for this one to be completed?

CLEANUP, ORGANIZE

5. Can you tell me who supplied the materials, tools, and equipment's to you?

DICKS LUMBER, BOSSES AND PERSONAL TOOLS

6. Can you tell talk about some problems you met during construction?

7. How does the rainy weather condition in Vancouver affect the construction productivity?

SLOWS IT DOWN

8. What kinds of things or aspect do you feel satisfied or unsatisfied with?

finishing off a project

9. Did you go through any safety training/ orientation before working on this project?

YES

10. Have you ever been punished for not complying with safety instructions? How? How c impact your behavior?

NO

11. How do you perceive general attitude towards cleaning up after oneself on site? Are p generally good at this?

YES VERY GOOD

12. Do you feel that people in general are good at following the safety regulations/using t proper safety equipment?

YES

Thank You For Helping Us In Our Project With Completing This Questionnaire!

Date:
Interviewee: BLACKLINE CONST. (Foreman)
Interviewer:

1. What is your position on this project?

   FRAMING CONTRACTOR

2. How long have you been in the construction business?

   33 YRS.

3. What issues generally limit the productivity of workers in this project?

   WEATHER.

4. What kind of supervision is required for this kind of project?

   FULL TIME SUPERVISION.

5. What has been the most challenging aspect of this project?

   BUILDING HEIGHT.

6. What special technique is required for this activity (Framing)?

FITNESS.

7. How individual crewmembers affect Quality and Productivity of the project?

WORKERS MUST BE EXPERIENCED & PROFESSIONAL.

8. What do you think about the productivity of the framework crew? How do you motivate the crewmembers?

PRODUCTIVITY IS O.K.
THEY MUST BE SELF MOTIVATED.

9. How are the workers are informed about the work to be carried out? Are they fairly self-driven, or do they rely a lot on your instructions?

INSTRUCTIONS ARE GIVEN OUT REGULARLY

10. What do you believe are the biggest issues/ challenges on this project regarding productivity?

WEATHER.

11. What is the most productive activity on site, and what has the greatest impact on productivity on the site?

EVERYTHING MUST BE PRODUCTIVE

WEATHER.

12. What is the overall nature of the working environment? How well do workers interact and communicate amongst them on site? How has worker relationships affected progress on the progress?

ALL EMPLOYEES MUST ~~ACT~~ GET ALONG WELL.

APPENDIX D: PROJECT PROPOSAL

February 26, 2013 CIVL 521 Project Proposal

Brenda Sawada
Manager, UBC SEEDS
The University of British Columbia
3rd floor – 2260 West Mall
Vancouver, BC Canada V6T 1Z4

Re: Productivity Measurement & Improvement of a Construction Site

The objective of this project is to document the steps involved in executing a construction method, assess the effectiveness of a method and identify areas of improvement or alternative methods that would improve time, cost, quality or safety performance and/or how one can gain a competitive or proprietary advantage.

OVERVIEW OF THE PROJECT

The term project involves a group of 4 students to study the productivity of a construction operation on an active construction site. This project involves assessing the effectiveness of some particular construction operation and to give an evidence-based opinion as to the productivity and the potential for improving the efficiency of the operations. The results could provide significant profitability and competitive advantage implications for the contractor. In addition, this project has the potential for "industry-quality" results that can provide real benefit to the contractors.

The results will be submitted as a final written report (together with supporting material such as photographs and video), as well as a final oral presentation to the course instructor. We declare that any documents or drawings related to the project would be just used for academic research.

PROJECT ACTIVITIES AND WORK PLAN

The project activity should generally be an operation that is carried out by a crew of workers (e.g., 3 to 10), with each cycle lasting from approximately 10 minutes to 2 hours. The observation shall involve recording of several complete cycles or repetitions of the activity between one and six times (2 to 10 hours).

CONTACT INFORMATION

Course Information

Couse Title: CIVL 521: Case Studies of Construction Methods
Course instructor: Dr. Thomas Froese
Email: tfroese@civil.ubc.ca
Phone: (604) 822-2027

Team Member Contact:

Ferya Moayedi (Graduate Student- Civil Engineering), Team Leader
Email: [redacted]
Phone: [redacted]

Mahsa Banaei (Graduate Student- Civil Engineering)
Email: [redacted]
Phone: [redacted]

Meraj Mamorafshord (Graduate Student- Civil Engineering)
Email: [redacted]
Phone: [redacted]

Zhengxiang Qiu (Graduate Student- Civil Engineering)
Email: [redacted]
Phone: ([redacted]

APPENDIX E: STATEMENT OF WORKER RESPONSIBILITY FORM/ SAFETY MEETINGS

ADERA

Statement of Worker Responsibility

Your Company Name: _____

Employee Name: _____ Years of Experience: _____

Emergency Contact Name: _____ Contact Number: _____
Relationship to Emergency Contact: (circle one) Wife/Husband or other? _____

Are you are 25 years of age or younger? (circle one) Yes/No If yes, have you had a New Employee or Young Worker Orientation before? Yes/No

All workers shall observe Adera established safe work procedures, report unsafe conditions or acts and perform their duties in a manner which will meet the objectives to eliminate accidents and enjoy an injury free workplace.

I have received an Adera site safety orientation and I will observe all the safe working procedures accordin to WorkSafe BC regulations and company safety rules.

There's absolutely **NO SMOKING** on site. Do you understand Adera's site rule? Yes / No

By signing the below, I understand that any violation of the safe working procedures, rules and regulations may result in my suspension, removal from working at Adera sites or termination of employment.

Do you have First Aid experience: Yes/No
(circle one) If yes, OFA 1, OFA 2 or OFA 3. Expires when? _____

_____ _____
Employee Signature Date of Site Orientation

Do you have any allergies or currently taking medicine? (circle one) Yes/ No
if Yes, please specify _____

☐ Watched video without Fall Protection ☐ Watched video with Fall Protection

☐ Checked body harness for fit & comfort ☐ Watched Young Workers Orientation

Site Orientation given by site office personnel

All information gathered here will remain private and confidential.

APPENDIX G: WORK METHOD STATEMENT

SAIL Residential Building
Formwork construction for the second floor roof of Building 2
Date: March 2013

PURPOSE AND SCOPE

This methods statement provided in this report contains information for the construction of floor/roof segments of wood buildings according to the observed methods used at the SAIL Residential Building on the Vancouver Campus of UBC. The responsibilities of the workers performing the framing activity are outlined in this statement and this statement will be beneficial to project administrators in order to better prepare themselves for such similar activities and improve the productivity of the task.

RESPONSIBILITIES

It is critical before the activity starts to have the roles well defined and the tasks distributed logically between those responsible in the project.

The safety officers on site are responsible for going through this methods statement and making sure that all statements in this section of the report meet standard safety practices. The superintendant will be responsible for all the scheduling and planning going on in the project and the foreman will be responsible to follow those schedules and communicating the problems with the superintendant so all the other trades are aware of issues and concerns. The foreman is also responsible for instructing the workers and guiding them as to how the task gets done. The formwork workers are responsible for the construction of the frame segments and delivering them to the crane operator for installation.

PLANNING

At this stage it is recommended to introduce the concept of lean construction methodologies to the parties involved. Have sessions with the workers, specially the experienced ones, and hear their thoughts and suggestions in order to improve the productivity of the task. The parties should

also come to agreements regarding the scheduling, responsibilities, and sequence of work. Tasks should be broken down into smaller segments and responsibilities assigned.

It is critical to have the structural drawings and information ready for the workers before the process starts and give them advanced time to go through the specifications and communicate any concerns or questions. It is also necessary to have a work platform ready to be used for the formwork crew.

A waste bin is also necessary to be placed next to the platform to avoid buildup of waste on site. It would also be an environmentally friendly consideration to have a recycling bin there as well .

SCHEDULEING

It is critical to hold meetings with the parties involved and update them on the status of the tasks. It should be considered that communication is the key to the scheduling of all large scale projects. Have routine weekly or bi-weekly meetings according to the progress of the project and plan for the work to be done in next week.

Frames are to be constructed and moved to the final location according to the determined schedule. This requires all material and equipment to be ready before the construction of a frame begins. The foreman who has also the role of last planner will make sure the task is performed on time and will communicate with others the schedule of the activity.

WORKERS

Workers are to have adequate and the necessary training and experience required to perform the work. In addition they are to wear the personal protective equipment required by the site management and the workers safety board.

PROCEDURE

The wood beams and I-joists are to be ready beside the working platform. The required equipment such as the nailing guns are to be present and in working condition. The workers set

up the main skeleton of the frame with the wood girders according to the corresponding structural drawings.

Workers are to measure the wood pieces and cut them in order to be able to nail them to each other and build the frame. Once the skeleton is in place, the same processes continue for the I-joists and beams. After nailing in the pieces, flat wood panels are placed on top of the beams and glued to the beam members.

Once the frame is built and panels have been glued, recycled and re-usable wood beams are nailed in a cross-diagonal manner to the frame in order to increase the stiffness of the frame to secure it against bending once the crane lifts the frame.

The crane operator is called and the crane is brought to the platform. Chains are fastened to the frame and the frame segment is lifted up and carried to the designated area for installation.

QUALITY CONTROL

The quality of the work in all these processes should be controlled by the foreman and reported to the superintendant. It is critical to have the frames built to the correct size and measurements to avoid installation delays and problems.

IMPROVEMENTS

As the workers perform the work, the superintendant and the foreman should make the necessary observations and seek improvements. They should particularly look for bottlenecks in the task and improve on those. They are also responsible for making sure adequate equipment and materials are available on or near the working platform.

AGREEMENT AND ACCEPTANCE

SUPERINTENDANT:

PARTY NAME	TITLE	SIGNATURE
DATE		

FOREMAN:

PARTY NAME	TITLE	SIGNATURE
DATE		

SAFETY OFFICER:

PARTY NAME	TITLE	SIGNATURE
DATE		

WORKERS:

PARTY NAME	TITLE	SIGNATURE
DATE		

PARTY NAME	TITLE	SIGNATURE
DATE		

PARTY NAME	TITLE	SIGNATURE
DATE		