TRAINATHON LEAN SIMULATION GAME: DETERMINING THE PERCEPTION OF VALUE OF TRAINING AMONG CONSTRUCTION STAKEHOLDERS

A Thesis

by

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ABSTRACT

This research was prompted in part in response to a recent study by the Associated General Contractors (AGC) that there is a shortage of skilled labor in the construction industry and that this shortage is increasing. The QUESTION this thesis seeks to address is: Why aren't construction stakeholders perceiving the value of training and development of employees? The PURPOSE of the research is to develop and test a simulation that will help identify the way building stakeholders view the impact of employee training on their long and short-term profit margins. The RESEARCH METHOD used was two phased: (a) a preliminary phase involving the iterative development and testing of a 50-minute table-top simulation using readily available materials (i.e. paper and tape); (b) a mature phase where results from a "perfected" version of the simulation were subjected to statistical analysis from a larger participant pool. The trials each team went through financially at each round were recorded and results recorded via cash flow diagrams. FINDINGS suggest that players tend to underestimate the importance of upfront training and its impact on long-term cash flows. LIMITATIONS of this research include a restricted sample size and a limited number of industry professionals that were tested during this phase. IMPLICATIONS AND VALUE for this work are potentially larger than that of pure research—i.e. as an opportunity to serve as a change agent as well since a number of respondents suggested that the simulation made them think about the long-term value of training, illustrating the first principle of *The Toyota Way*. This dual-role for simulations fits easily within the culture of lean construction which historically has used simulations

both to understand impacts of certain types of stakeholder behavior as well as transfer comprehension of specific lean principles.

DEDICATION

I dedicate my thesis work to the most valued people in my life - my world:

Mr. Mohan Chandra

Mrs. Leela Bhatt

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Rybkowski, and my committee members - Dr. Solis, and Dr. Kalantar, Prof. Horlen for their guidance and support throughout the course of this research.

I would also like to acknowledge the support of my friends, colleagues, the department faculty and staff for making my time at Texas A&M University a great experience.

I would like to acknowledge all the team members Abhishek Shete, Sai A. Challa, Geethika Yarlagadda, Rajath Padmaraj, and Sachin Singh for helping conceptualize and develop Trainathon lean simulation.

Finally, thanks to my parents for their constant support and Karthik for encouraging me throughout my journey at A&M.

NOMENCLATURE

AGC	Associated General Contractors
PMBOK	Project Management Body of Knowledge
HRD	Human Resource Development
CII	Construction Industry Institute
LCI	Lean Construction Institute
LC	Lean Construction
PM	Project Manager

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CHAPTER I

INTRODUCTION

I A. PURPOSE OF STUDY

The purpose of the research is to develop and test a simulation that will help identify the way building stakeholders view the impact of employee training on their long and short-term profit margins.

I B. BACKGROUND

This research was prompted in part in response to a recent study by the Associated General Contractors (AGC) highlighting a growing shortage of skilled labor in the construction industry.

According to (Loosemore et al. 2003; Wild 2002) the construction industry exhibits a particularly dynamic and complex industrial environment. This creates a challenging situation for training & development in the construction industry (Loosemore et al. 2003; Raiden and Dainty 2006). The fast changing competitive environment requires effective development and management of human resources. Project managers, executives and supervisors have a vital role in creating a positive impact by transferring knowledge and training the employees (Jong et al. 1999).

Training and motivation of employees are two fundamental development practices included in Project Management Body of Knowledge (PMBOK). One of the essential aspect of the construction industry is the development of Human resources. Therefore, a high value is placed on Human Resource Development (HRD) applications to enhance the

performance of the industry. Despite this, construction industry's literature reflects inadequate consideration to staff training practices (Tabassi et al. 2012).

CHAPTER II

RESEARCH GOAL AND OBJECTIVE

The objective of this research is to understand how the construction industry stakeholders perceive value of training and development of their employees. The research aims at motivating construction stakeholders to foresee the long term benefits associated with pursuing training. Furthermore, the research looks to inspire employees to value training as a means to expedite learning and to bring them up to par with the industry's competitive standards. The research explores the importance of training and investigates the employer-employee perceptions about investing in the right kind of training by simulating long term profit margins and time savings training could yield for an organization. Finally, this research also explores the tendency to invest in training upfront and the impact this decision creates on both morale and on the cash flows of a project.

CHAPTER III

LITERATURE REVIEW

III A. DEFINING TRAINING

Training emerges from the realms of learning. “Training is an effectively outlined effort that develops knowledge, attitude, abilities and skills through learning experiences, helping people involved (trainees) to attain potent performance in an activity” (Garavan et al.1995; Reid et al. 1992). Additionally, McLagan (1989) defined training as a medium for development of expertise in key areas for better performance in jobs. Akdere (2003) describes it as a parameter for increased level of skills and self-realization leading to successful completion of tasks. Training is considered to be an effective tool that fosters individual improvement in organizational job performance.

Training and development practices must be recognized by companies as a vital means to enhance a company’s level of achievement (Huemann 2010; Latagana et al. 2010; Raiden and Dainty 2006) suggesting that employee training and development programs should be included in a company's Human Resource and Development (HRD) policy.

Training offers incremental adaptability and flexibility for employees and thus becomes essential for an organization to cultivate its proficiency (Tai 2006). It is critical for every construction organization to develop a learning environment for its employees (Raiden and Dainty 2006).

Training forms the cornerstone of human resource management practices and induces a reservoir of knowledge significantly improving trainee performance (Paton and McCalman 2000; Mullins 2004).

III B. NEED FOR TRAINING

A survey conducted by the Associate General Contractors of America (AGC) involving more than 1,000 construction firms across the U.S. indicated that 83% of firms currently encounter a challenge to find craft workers, including carpenters, equipment operators and laborers. This has increased from 74 % last year.

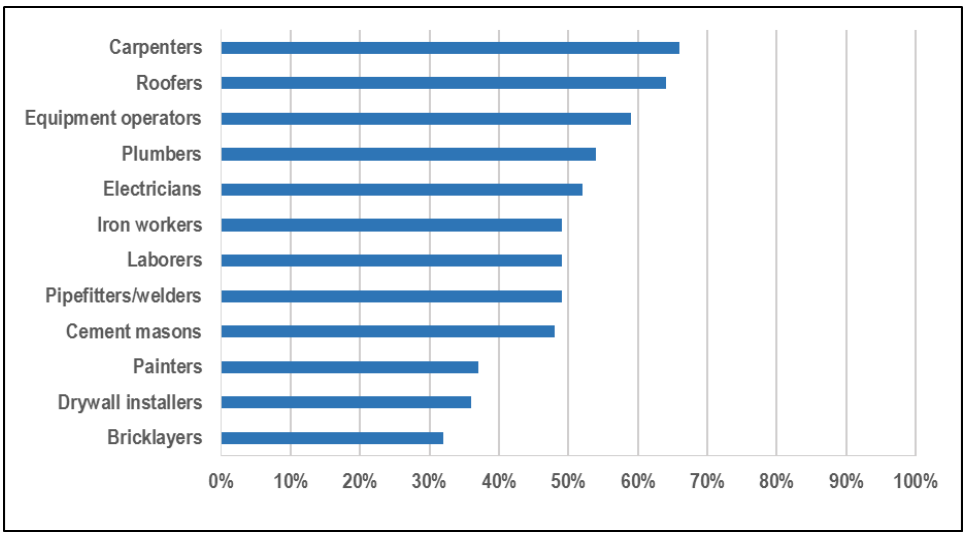

Figure 1: Craft workers shortage according to the survey conducted by AGC
Adapted from Skilled Labor Shortage (AGC, 2014)

The firms also face a dearth of experts while recruiting for executive positions. According to the survey, 61% firms confirmed they are facing strain to fill up executive positions such as project supervisors, estimators and engineers. This figure increased from 53% last year. 40 % of these firms affirmed that even in forthcoming year, it would continue to be hard to find skilled workers, while 30% expect it to become harder

compared to last year. This amounts to over two thirds of the industry facing trouble with the shortage of skilled workforce. Finding experienced workers in the industry is a primary concern for A/E and general contractors, while specialty trade contractors are distressed about the shortage of skilled workers.

The literature on training and development in the construction industry offers a pessimistic view of investment in this area. There is a need for effective planning to reduce uncertainty and introduce order, action and structure into the construction industry (Bramham 1988; Laufer et al. 1999). This environment requires the industry to develop relevant training for employees helping them learn faster. This will lead to productivity increase in construction projects.

There is a fundamental need to investigate the performance "gaps" of people in their jobs and identify what needs to be learned. To achieve this, Hassan et al. (2009) argues that training is a vital part of the job. In the construction industry, employee training and its benefits are undervalued, resulting in a lack of formal training practices (Kuykendall 2007). Jordan (2006) reports that in accordance with the US Department of Labor, every dollar invested in apprenticeship training yields approximately $54 return. Even though the return on investment is high, contractors remain averse to allocating time and money for worker training (Kuykendall 2007).

Jordon (2006) states that while the overall industry spends about 2% of their payroll on training, contractors invest only 1.83%. In a study conducted by Cox et al. (1998) 42% productivity increase was observed for companies that invested in employee training. This

testifies that investing in employee training increases productivity by reducing rework costs and time taken.

III C. IMPORTANCE OF ON THE JOB TRAINING

There has been an expansion of the construction industry over the last decade. This has led to requirement for a workforce that is equipped with technical and managerial skills. McGraw-Hill Construction (MHC), conducted a study on the use and importance of training by the A/E firms, General Contractors (GC) and the specialty trade contractors.

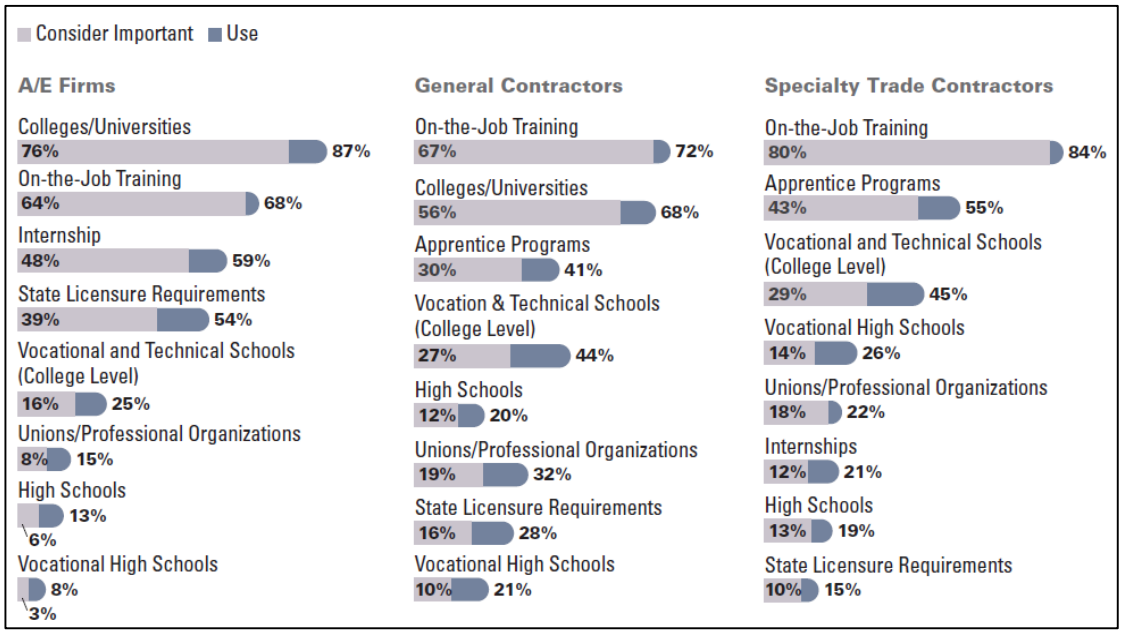

Figure 2: Use and importance of initial training sources
Reprinted from (McGraw-Hill Construction, 2012)

Figure 2, reflects the perception of the A/E firms, general contractors and the specialty trade contractors on the importance of training. The general contractors and the specialty trade contractors rank On-the-Job training as their top most priority. Almost 64% of A/E firms and 67% GC's indicated that on the job training is as important as college education.

A high score for on the job training reflects the relevance the industry places on the value of practical, real-world experience.

According to McGraw-Hill Construction's (2012) report, skilled labor shortage can be addressed by continuous education and training programs for workers to keep them updated with innovative technologies.

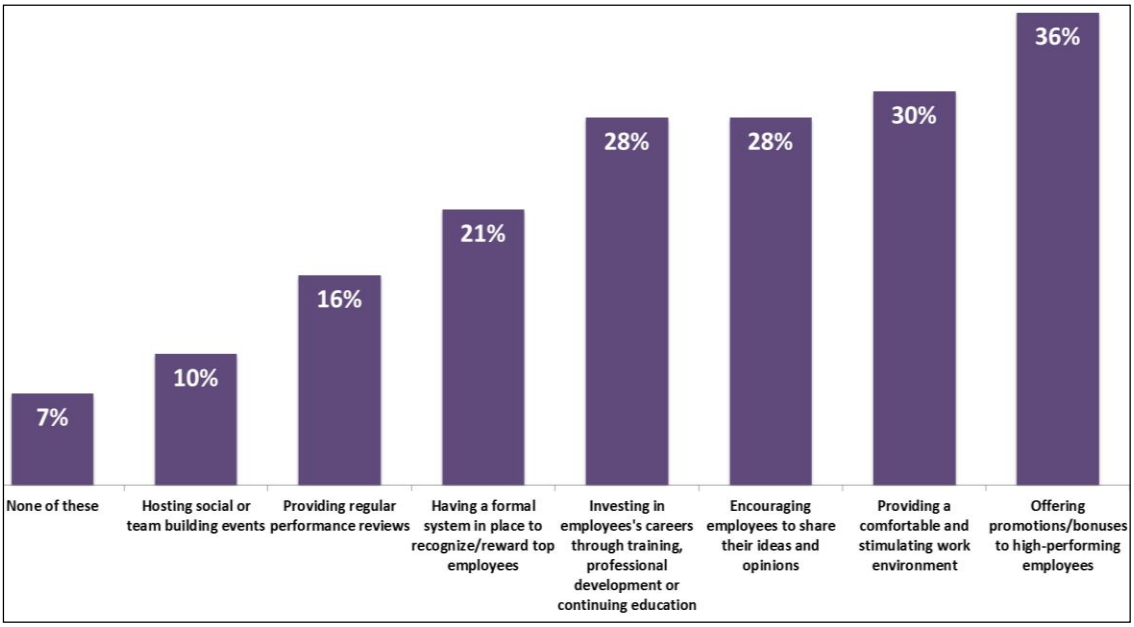

Figure 3: Effectiveness of employer's engagement activity: Adapted from (Randstad Engagement Index 2012)

According to Figure 3, it can be observed that investment in training, professional development or continuing education is one of the effective employee engagement tool. It was rated higher than hosting motivational team building events. The survey indicates that employees constantly enhancing their knowledge and skills through training feel satisfied and engaged at their workplace as they acquire new skills. This also raises their chances for future employability.

According to Fern Oram's employee training experience "the learner's buy-in at the onset is a hurdle", she believes that learner's engagement is crucial for continuation of training programs. Employees need to document a contrast in their work before and after training to boost their interest and make them less skeptical, developing a positive attitude to training. Constant rescheduling of training on a regular basis creates an impression that training is not important, thus defeating the purpose behind it.

Karen Holloway, Project Management Institute's Lead Instructional Designer says that it is essential that senior management supports training of the employees. The senior management must commit and communicate to the learner and his direct supervisor on the importance they place on training. The trainers must make stakeholders recognize the value of training by explaining the need for training, expected results and how these align with the organization's strategic goals. This type of collaboration helps grow employee buy-in.

According to Holloway, training boosts learning retention in a way that classroom learning is unable to do alone. She believes that when everyday work is combined with learning, the mind starts associating sights and sounds of the environment with skills being developed.

Erina et al. (2015) states that there is a need to implement training practices and seminars to improve productivity on construction projects. Trainings should be designed to emphasize increasing construction site productivity.

III D. RATIONALE FOR INVESTING IN TRAINING

According to a study by the Construction Industry Institute (CII), a return of $3.00 is expected for every $1.30 invested on craft training; The US Department of Labor also confirms a productivity increase of 16% on ongoing trainings.

Increasing employee engagement through training has resulted in a decreased turnover rate as per the study conducted by McGraw-Hill Construction (2012).

An engaged employee will:

1. Derive work satisfaction;
2. Feel proud to be associated with the organization;
3. Understand the organization's mission statement and work towards it;
4. Feel appreciated by their employer; and
5. Be committed and self-driven.

Cultivating an organizational environment that engages its workforce helps achieve a company's mission, execute its strategy and generate positive business results. The company's objectives, strategies and workforce define the way the company should invest in employee training (Randstand 2012).

Training enhances the innovative behavior of employees by creating a perpetual transformation in an individual, leading to better performance on the job (Thassanabanjong et al. 2009).

According to Arthur et al. (2003), the benefits of training are:

1. Increased process efficiencies;
2. Adaptability to new technologies, skills and processes;
3. Increased job satisfaction; and
4. Improved organizational behavior and increased employee innovativeness.

Consequently, higher profits can be achieved leading to a sustained economic position in the market.

According to Elnaga (2013), employee training builds uniqueness for the firm, distinguishing it from its competitors by sparking employee creativity that shapes the firm with sustainable knowledge. Training provisions must be able to satisfy the ever-changing needs at the workplace (Hassan 2005). Best practices include operating within a flexible framework that encourages re-thinking of the present approach, the exploration of different methods and/or processes to boost learning, while maintaining focus on continuous learning and adoption of innovation into management process (Dalkir 2005; Kozak 2004; Zairi 1998). For this to happen in training, the right paradigm in managing the organization and its people must be in place and the organization must place adequate emphasis on the appreciation and development of its people.

III E. THE RETURN ON INVESTMENT

According to research conducted by the Construction Industry Institute (2007), trained workers appear to have lower turnover and absenteeism rates than workers without training.

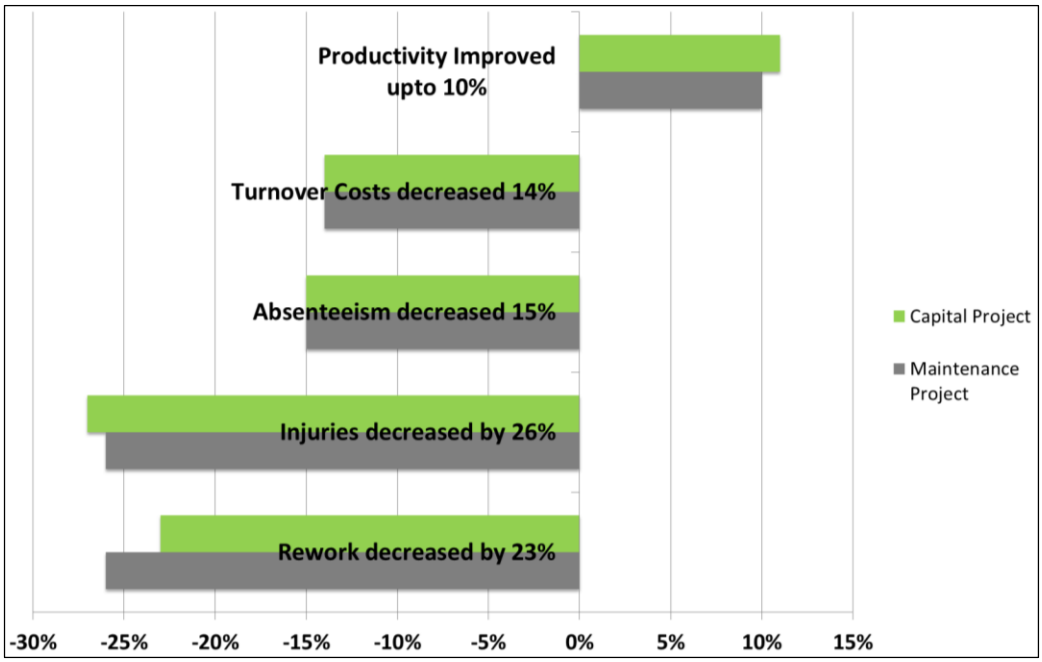

Figure 4: Increase in productivity after training.
Adapted from Construction Industry Institute, CII Research Summary, (August 2007)

Figure 4 indicates benefits highlighted by the study. It illustrates the fact that training caused a 23%-27% decrease in rework and injuries. Showing a substantial decrease in absenteeism and turnover rates, leading to 10% increase in productivity.

III F. LEAN GAMES AND ITS IMPACT

The Lean Construction Institute (LCI) perceives the use of lean games as a practice to teach lean concepts (Verma 2003). Simulations have played a crucial role in Lean

construction (LC) by successfully demonstrating the practical implications of lean principles.

According to Canizares (1997); and Walters et al. (1997), the simulated game environment helps in effective comprehension of real world scenarios, enabling students to easily understand lean concepts and their application in the construction industry. For instance, the Lego Airplane Game, the Parade of Trades game, the Red bead game etc. are regularly used lean simulations.

III G. SIGNIFICANCE OF STUDY

The potential of this work is larger than that of pure research—i.e. as an opportunity to serve as a change agent as well as highlight the long-term value of training, illustrating the first principle of *The Toyota Way*. This dual-role for simulations fits easily within the culture of lean construction which historically has used simulations both to understand impacts of certain types of stakeholder behavior as well as transfer comprehension of specific lean principles.

CHAPTER IV

RESEARCH METHODOLOGY

IV A. RESEARCH QUESTIONS

The question this thesis seeks to address is: Why aren't construction stakeholders perceiving the value of training and development of employees? What is the attitude of construction professionals towards training? Do employees or employers need to be motivated to participate in or initiate training programs?

IV B. RESEARCH METHODOLODY

A Lean Simulation to investigate perceptions training was designed and tested at Texas A&M University. It was facilitated with the graduate and undergraduate students of the Construction Science Department who are being prepared to enter the construction industry with the next one to five years.

Recruitment emails were sent to professors in the Department of Construction Science at Texas A&M University for their permission to facilitate the simulation in their classes. Following approval, designated dates and times were set to administer the simulation. The simulation facilitation required:

- Explanation of the Lean philosophy, the need for Lean simulations and their impact in transferring Lean principles;
- Explanation of the developed Lean Simulation, named "Trainathon";
- Facilitation of the Simulation; and
- Discussion of reactions and potential learning from participants.

The Research Method was two phased:

Phase I:

Phase I involved the iterative development and preliminary testing of a 50-minute table-top simulation using readily available materials (e.g. paper and tape);

Phase II:

Phase II represented a mature phase where results from a "perfected" version of the simulation were subjected to statistical analysis from a larger participant pool. The trials each team went through were recorded and the results presented via cash flow diagrams.

IV C. RESEARCH TOOL: TRAINATHON LEAN SIMULATION

1. Introduction

"Trainathon" is a lean simulation developed to illustrate the first principle of *The Toyota Way* - ***"Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals."***

2. Simulation overview

The simulation was played in accordance to the rules mentioned in Appendix F. At every round, data reflecting decisions made were collected by each team's Project Manager. The financial implications of decisions made were ultimately analyzed via cash flow diagrams. Trainathon lean simulation is a "perfected" version of a preliminary simulation concept that was developed in the *Advanced Productivity and Lean* (COSC 631) class conducted by Dr. Zofia Rybkowski during spring semester 2015. Those involved in the development

of the simulation's preliminary version included Abhishek Shete, Sai A. Challa, Geethika Yarlagadda, Rajath Padmaraj, Sachin Singh and Yamini Bhatt.

3. Objective of the simulation

This simulation is an effort to help the participants understand how companies' decisions, if based on a long-term philosophy with regard to employees training and development, might prove costly initially but can benefit the company long-term by increasing the productivity.

This lean simulation is based on Kirkpatrick's model of evaluation of formal training, which has received wide acceptance. The frame-of-reference is the assumption that majority of firms fail to see the direct relationship between training and long-term productivity gains (Alder 1994; Kirkpatrick 1996; and Phillips 1997).

Kirkpatrick's four leveled approach involves:

a) **"Reaction"** measures how the trainees reacted to the training. Reaction was measured by the surveys distributed at the end of the simulation.

b) **"Learning"** tests the skills gained in training. This was analyzed through pre and post simulation results.

c) **"Behavior"** involves evaluation of change in behavior of employees after training.

d) **"Results"** includes the analysis of the final results of training. The financial scorecard and the exit surveys were parameters that defined the success of the simulation.

IV D. DATA ANALYSIS

The data collected for Trainathon lean simulation was evaluated through the financial statement sheet and the demographic survey filled by each team and player respectively. The financial statement sheet provided information about the cost and the time taken in each round to finish the project.

Based on the financial trials of each team per round and the tendency of participants to request training upfront, 14 case scenarios were created. This was further evaluated through cash flow diagrams and bar graphs. Additionally, other factors such as gender ratios, age and experience of the participants were documented. Details from the data analysis are discussed later in the Results and Discussion sections.

IV E. ASSUMPTIONS

An assumption made for this study is that undergraduate and graduate students in the Department of Construction Science at Texas A&M University accurately represent future stakeholders of the construction industry. Their mindset is assumed to reflect the mindset of the industry; hence they were chosen for this research.

IV F. LIMITATIONS

This research has the following limitations:

1. It includes a restricted sample size (N=201) students from Texas A&M University were tested during this phase.
2. It is limited to the context of the US construction industry and this research may not produce the same results outside the United States.

3. It is limited to the state of Texas and employee/employer perception may vary depending on the geographic location within the United States.
4. It does not consider the cultural differences among participants.

CHAPTER V

RESULTS

This chapter summarizes the results and the observations made during administration of "Trainathon". The game was administered to graduate and undergraduate students in the Construction Science department at Texas A&M University during December 4th, 2015 - February 10th, 2016. The simulation underwent modifications with successive trials and 201 students were selected for testing the mature version of this simulation.

A total of 67 teams were formed, each comprising 3 players that included one project manager and two team members per team. The Project Manager (PM) was responsible for deciding if his/her team required to be trained to complete the project.

14 case scenarios were created based on the patterns observed of decisions made by the project manager and corresponding consequences after completion of each round these are detailed in Table 2. Based on the frequency of occurrence, 4 case scenarios (case 6, case 12, case 5 and case 9) were selected for further analysis. From Table 2 it can be seen the 4 selected scenarios constituted a total of 46.25% of all scenarios.

The acronym mentioned in the Table.1 stand for the following:

NT: No Training | T: Training | NS: No Success | S: Success

Table 1: Explaining the 14 case scenario generated through the Lean simulation

Case No.	Round 1	Round 2	Round 3
Case 1	T:S	S	S
Case 2	T:NS	NS	S
Case 3	T:NS	S	S
Case 4	T:NS	S	NS
Case 5	**T:NS**	**NS**	**NS**
Case 6	**NT: NS**	**T: S**	**S**
Case 7	NT: S	NT: S	NT:NS
Case 8	NT: NS	NT: NS	NT: NS
Case 9	**NT: S**	**NT: NS**	**NT: NS**
Case 10	NT: NS	NT: NS	T: S
Case 11	NT: NS	NT: NS	NT: S
Case 12	**NT: S**	**NT: S**	**NT: S**
Case 13	NT: NS	NT: S	NT: S
Case 14	NT: NS	NT: S	NT: NS

Case 6: "*The pragmatic case scenario*" (34.32% of all scenarios):

In this case after an unsuccessful attempt in Round 1, the teams realized that they needed to undergo training. The PM requested to train the team. This led to positive cash flows and increase in their profit margins over the next rounds. Additionally, this case constituted the maximum number of teams.

Case 12: **"*The ideal case scenario*" (4.47 % of all scenarios):**

It was observed that despite the PM never choosing training for the team, the team continuously completed projects. However, training would have helped them reduce the time taken to complete the project.

Case 5: *"The Worst case scenario"* (1.49 % of all scenarios):

In this case, the teams failed to successfully complete their projects despite undergoing training.

Case 9: *"No Training, no success"* (5.97 % of all scenarios):

In this case, the PM chose not to train the employees even though they were continuously unsuccessful in their attempts. In some teams, the employees asked for training but the PM refused.

Table 2: The number of teams opting for each scenario

Experiment #	1	2	3	4	5	6	7	Totals
No. of teams	**N = 10**	**N=11**	**N= 11**	**N=10**	**N=6**	**N= 8**	**N=11**	**N=67**
Total participants	31	33	36	31	22	26	22	**201**
Cases	% Teams in each case							
1	20% (*N=2*)	9% *(N=1)*	8.3% *(N=3)*	10% (*N=1*)			9.09% *(N=2)*	13.43%
2	10% (*N=1*)	18.5% *(N=2)*	2.7% *(N=1)*					5.97%
3					4.54% *(N=1)*			1.49%
4				10% (*N=1*)				1.49%
5		**9% *(N=1)***						**1.49%**
6	**30% (*N=3*)**	**27.5% *(N=3)***	**13.8% *(N=5)***	**30% (*N=3*)**	**13.63% *(N=3)***	**11.53% *(N=3)***	**13.63% *(N=3)***	**34.32%**
7						7.69% *(N=2)*	9.09 *(N=2)*	5.97%
8	10% (*N=1*)			10% (*N=1*)	4.54% *(N=1)*	3.84% *(N=1)*	4.54% *(N=1)*	7.46%
9		**9% *(N=1)***		**10% (*N=1*)**	**4.54% *(N=1)***		**4.54% *(N=1)***	**5.97%**
10		9% *(N=1)*	2.7% *(N=1)*	10% (*N=1*)		3.84% *(N=1)*		5.97%
11	10% (*N=1*)						4.54% *(N=1)*	2.98%
12		**9% *(N=1)***		**10% (*N=1*)**			**4.54% *(N=1)***	**4.47%**
13	20% (*N=2*)	9% *(N=1)*						4.47%
14			2.7% *(N=1)*	10% (*N=1*)		3.84% *(N=1)*		4.47%

CHAPTER VI

ANALYSIS

The results for the simulation were analyzed through cash flow diagrams. While field testing the simulation, three demonstrative rounds were conducted. The data has been extrapolated for the cash flow analysis.

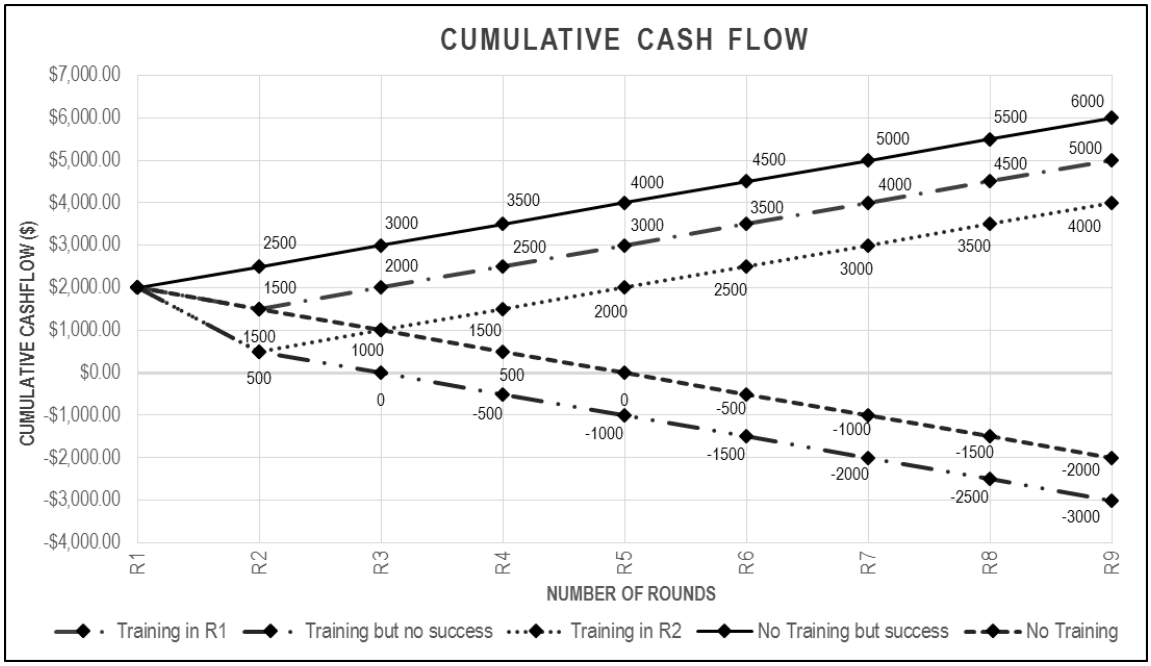

Figure 5: Displays the cash flow of each team at every round.

The observation made through the cash flow diagram is that, teams that opted for training after round 1breakeven in Round 3, after which they start making profits, visible by a uniform positive gradient. Teams that delayed the decision to train, suffered loses and recouped from the loss only after Round 5. The profit margins decrease by $1000 due to the delay in adopting training.

Figure 5 represents the case scenarios discussed below:

● ***"The Ideal case scenario":*** This case required no investment in training by the company. It was observed that the graph was uniformly straight and the team continued to earn until successful project completion. By the end of Round 9, the teams earned $6000. This case is an outlier as only 4% team's fall under this category. While determining the need for training in the real world scenario this case cannot be taken as a sole criterion for the decision.

● ***"The pragmatic case scenario"*****:** The majority of participants followed this decision making scenario. In this scenario teams did not opt for training initially and were unsuccessful in completing their project during round 1. This lead to a loss of $500 (seen as a dip in Figure 5). For the second round the PM asked to train the team and the team progressed towards positive cash flow. By the end of the rounds the teams ended up with $5000. This is $1000 less than the ideal case scenario.

● ***"Training in the second round"*****:** The teams opted for training after two unsuccessful attempts. The continuous failure, declining cash flow and the competition lead the PM to ask for training for their teams. The final case ended with the teams earning $4000, which was $2000 less than the ideal case scenario.

● ***"The Worst case scenario":*** It is called so, because these teams invested in training and still were unsuccessful in completing the project. These were outliers but suffered with a negative cash flow which can be observed by the uniform downward gradient. It was observed that the concept was not well understood by team or they failed to collaborate.

● ***"No Training & No Success":*** There were two observations made in this case:

a) The PM were ignorant about training and the profits they could earn.

b) The PM thought that the employees could complete the project without any training. They were willing to go through trial and errors.

In both the cases, the team suffered a negative cash flow which can be observed through the uniform downward gradient.

Demographic analysis

The demographic analysis of the participants are listed below:

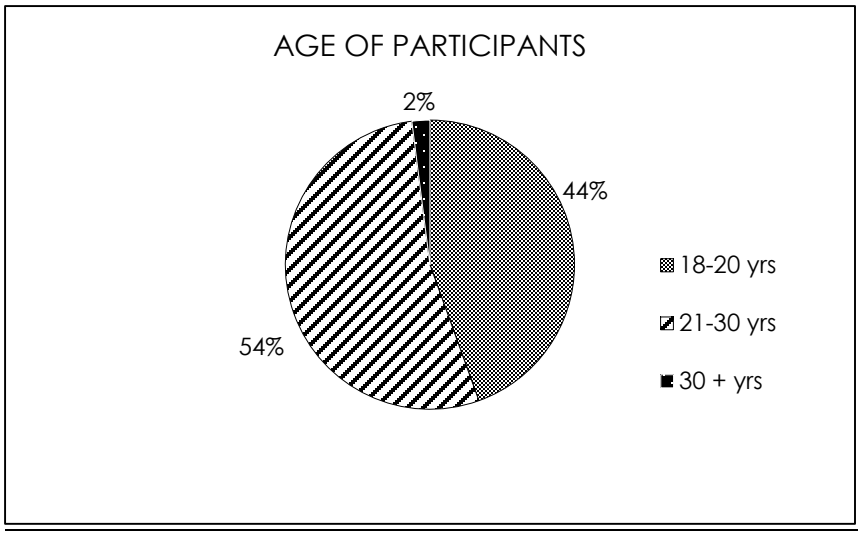

Figure 6: Illustrates the age range of participants

Figure 6 conveys the age range of the participants that took part in the research. 45% of the participants were in the age group of 18-20 years. All of them were undergraduate students pursuing Bachelor's in Construction Science. The majority i.e. 54% of participants were in the age range of 21-30 years. These students were a mix of undergraduate and graduate students. 2% of students who participated in the research were 30 years and above.

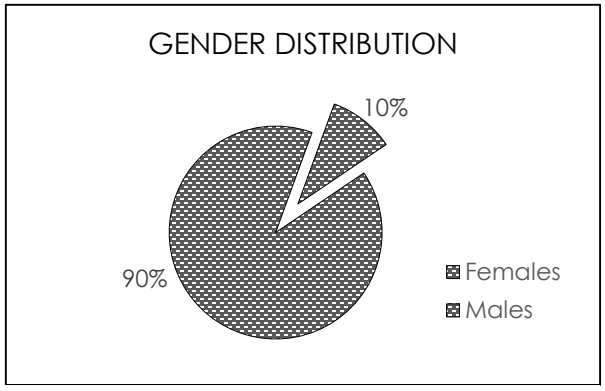

Figure 7: Percentage of Men Vs. Women

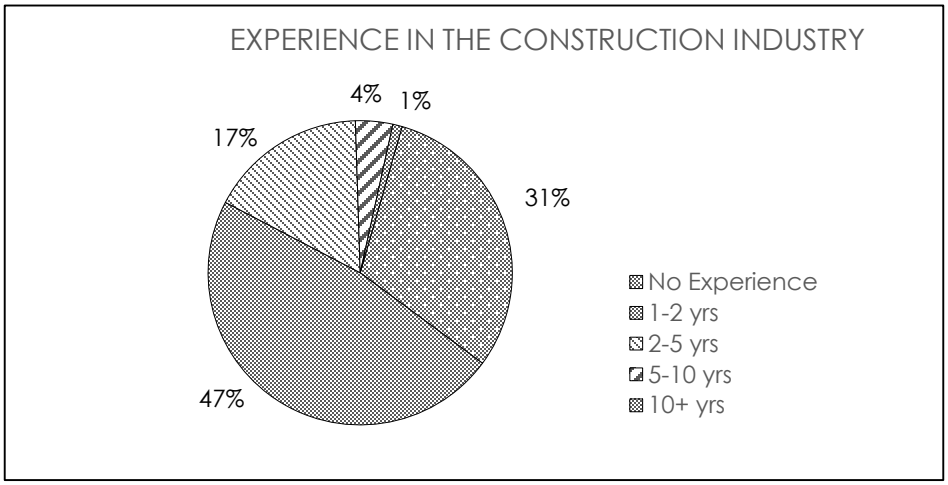

Figure 8: Illustrates the range of experience of the participants

Figure 8 conveys the broad set of experience of the research participants. 31% of the participants were on the onset of their career in the construction industry. They had no work experience. The majority i.e. 48% of the participants had 1-2 years of experience working in the industry. 17% of the participants had an experience of about 2-5 years and 4% had 5-10 years of experience. Only about 1% had an experience of over 10 years.

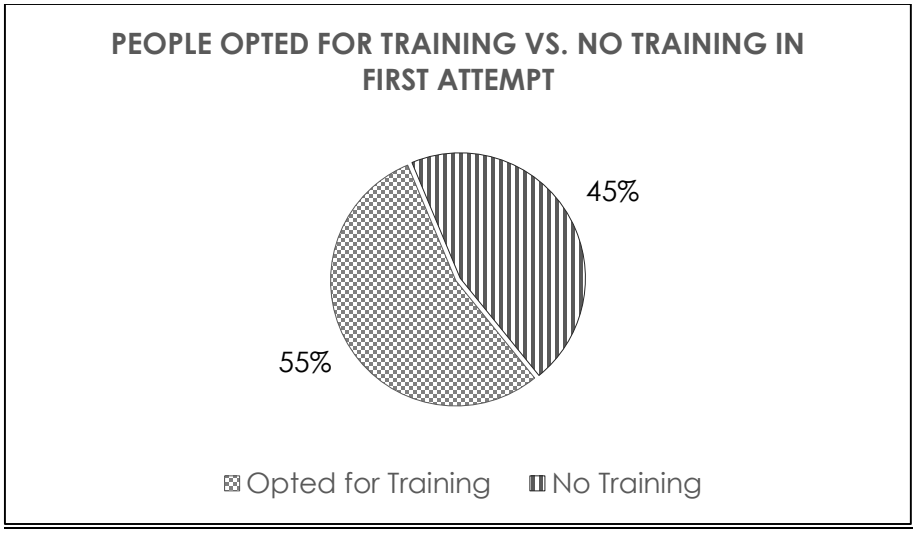

Figure 9: Shows the percentage of participants opting for training Vs. No training only for Round 1.

Figure 9 illustrates the teams that asked for training throughout the live testing of Trainathon. 45% of the teams did not ask for training even once in the three rounds. These teams were either successful in every round or were not successful at all. 55% of teams asked for training, at different stages during the duration of the simulation.

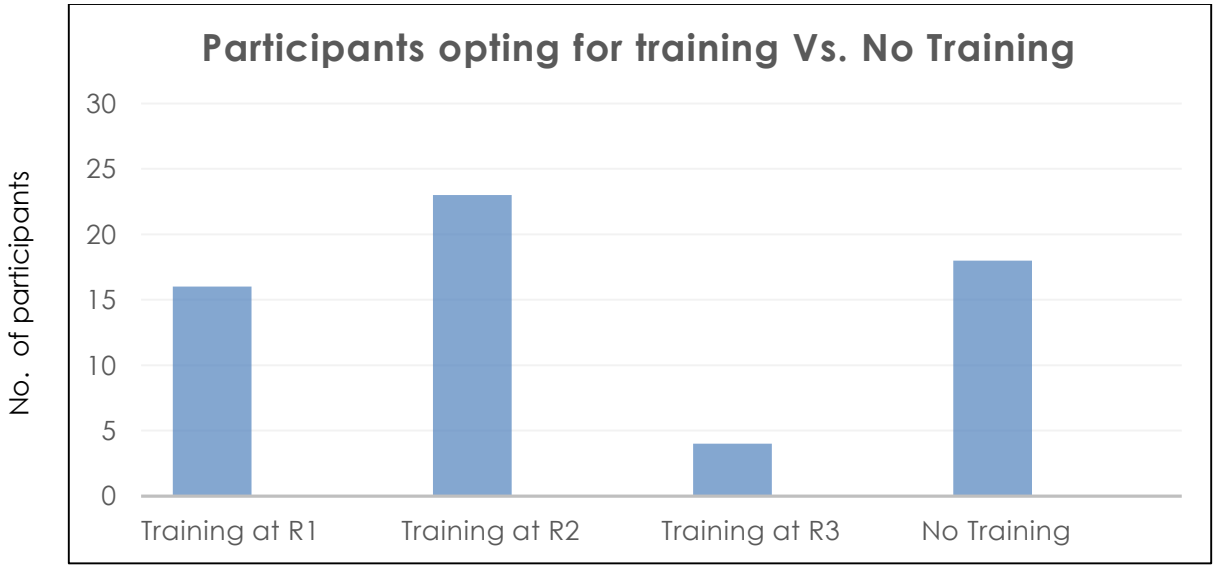

Figure 10: Illustrates the number of participants opting for training vs. participants without training.

Maximum number of teams took training after round R1. These teams fall under the ***"The pragmatic case scenarios".*** There was a noticeable number of teams that did not opt for training at all. The reasons stated by the teams for not asking for training were:

a) The PM estimated the project was easy and was not willing to pay for training. In certain cases, this attitude lead to discord between the PM and the team.

b) The team members were challenged by the project and were inclined to try it on their own.

c) Few teams concentrated on the upfront cost of training and ignored the long term profit they would've earned.

The ones who took training in Round 1 were the most profitable teams in the end. The majority of people who took training after R2 were almost $2000 behind the ideal case scenario. The ones with no training experienced a uniform downfall in gradient.

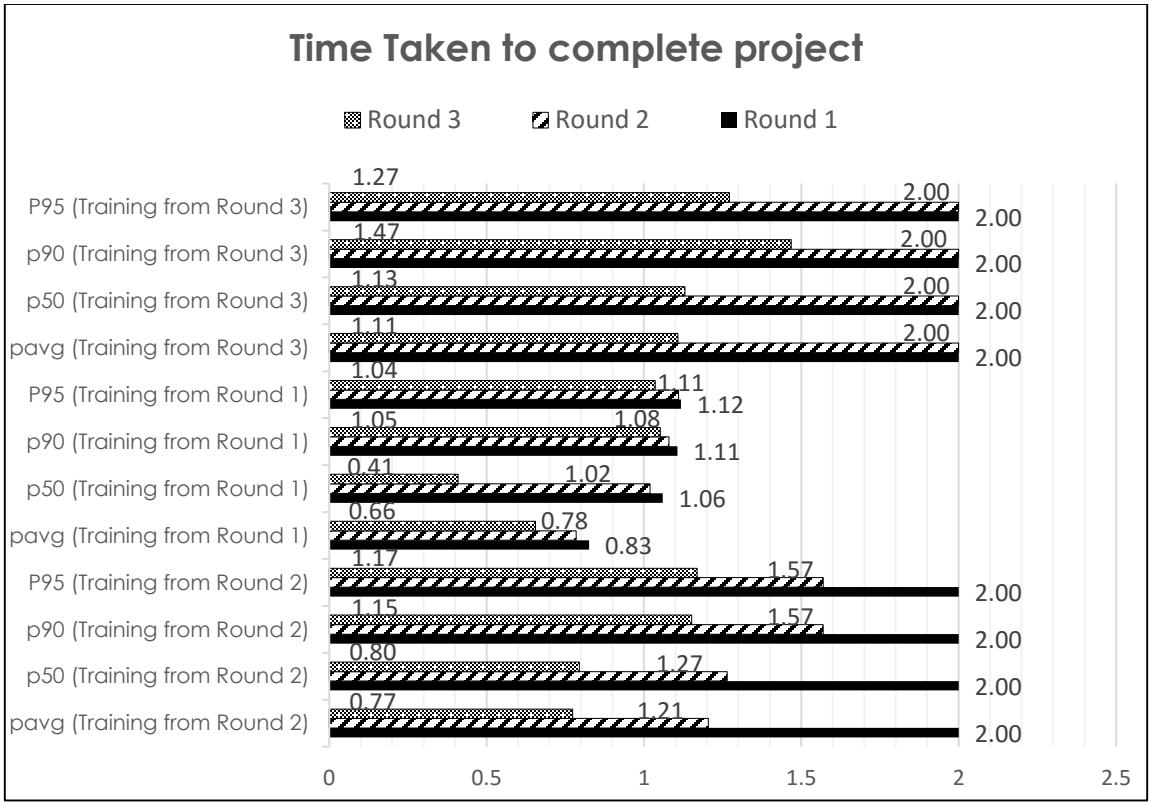

Figure 11: Illustrates the time taken to complete each round and the percentile

P_{avg} stands for average time taken by participants;

P_{50} stands for time taken by the 50^{th} percentile of the participants;

P_{90} stands for time taken by the 90^{th} percentile of the participants; and

P_{95} stands for time taken by the 95^{th} percentile of the participants.

To verify if training influenced the productivity of the teams, average time taken by teams at every round was calculated and their relative standing at different rounds in the game is explained in Figure 11.

Table 3: The time taken on percentile basis

	Training in R1	Training in R2	Training in R3
P50	0.41	0.88	1.13
P90	1.05	1.15	1.47
P95	1.04	1.17	1.27

Table 3 clearly signifies the substantial difference in time taken by teams at every round. The teams who decided to train in R1 finished faster than the ones who took training in R3. The 95th percentile for the team taking training in R1 is 1.04mins, which is 0.23 seconds less than the team taking training in R3. This clearly indicates an increase in productivity for a trained employee.

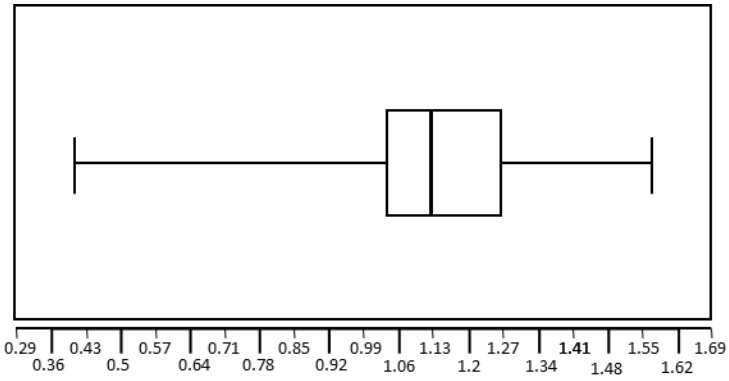

Figure 12: Shows the median and the upper and lower limit of time taken for the teams who took training.

The minimum time taken by teams who took training was 0.41sec and the maximum time taken was 1.57 min. The average time taken was 1.12 min. The people who did not take training and were not successful consumed the entire 2 mins that was allotted to them.

In conclusion, the data of the Trainathon lean simulation indicates that there is a significant difference in the productivity of employees who took training in comparison to employees without training.

CHAPTER VII

DISCUSSION

During the live playing of Trainathon several behavioral characteristics of participants emerged and these characteristics could be classified into "scenarios," most prominently:

"The pragmatic case scenario" This scenario represented the behavior of the majority of teams. These teams exhibited the attitude that people are willing to try and fail and then make a decision that seems like the best option.

"The Ideal case scenario" This scenario was played out by participants who believed in themselves and felt convinced they could complete the project without training. Some teams did, in fact, manage to complete the project successfully without training. This population represented only 4% of the total sample size. This situation is found in employers who seek the best graduates from premier educational institutions or among experienced professionals who do not require additional training.

"The Worst case scenario": These participants were forced to bear the decision made by their team leader to never purchase training. Team members in this scenario expressed feeling demotivated as they did not achieve success in any round. Participants of teams in this scenario became additionally demoralized as their competitors began performing with increased efficiency. For teams that found themselves in this scenario, there was a visible friction in the dynamics between the project managers and the team members. This reflects real world scenarios where affected team dynamics lead to productivity losses on a project (Santorella 2011).

Overall feedback from the participants suggested, *"The simulation was challenging"*. It made them think about the "*long-term value of training."* They felt demotivated in cases where the PM did not train them. The respondents who did not train felt, *"It was infuriating when the PM denied training as the people who trained finished their project faster while we struggled".*

The simulation reinforces the notion that teams in the construction industry are varied and each team member exhibits personal strengths and weaknesses. Because there is no common solution for everyone, Project Managers should identify the abilities of each team member and consider offering training to supply specific skillsets that individual requires for the task at hand.

CHAPTER VIII

CONCLUSION

As Trainathon teams postponed decisions to train, they lost $1000 repeatedly and this loss over time was recorded in cash flow diagrams. In the "real world," postponing a decision to train employees who do not already possess a critical skill can lead to a loss of millions of dollars on a construction project. It was additionally interesting to note that "trained" teams took 20% less time to complete a round, on average, than non-trained teams. It was also observed that the majority of teams only understood the concept of investing in training after they failed once**.**

After playing Trainathon, participants indicated they understood the lean principle associated with the simulation. The intent of this research was to develop and test a simulation to effectively highlight the value of training and its associated long-term benefits, thus helping to incentivize increased productivity in the construction industry. Student participants in this study were potential stakeholders in the construction industry and it would be worthwhile for a future longitudinal research project to investigate whether their understanding endures or is transformed as the student participants pursue careers following graduation.

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APPENDIX A

Trainathon

Team # _____

K = 15

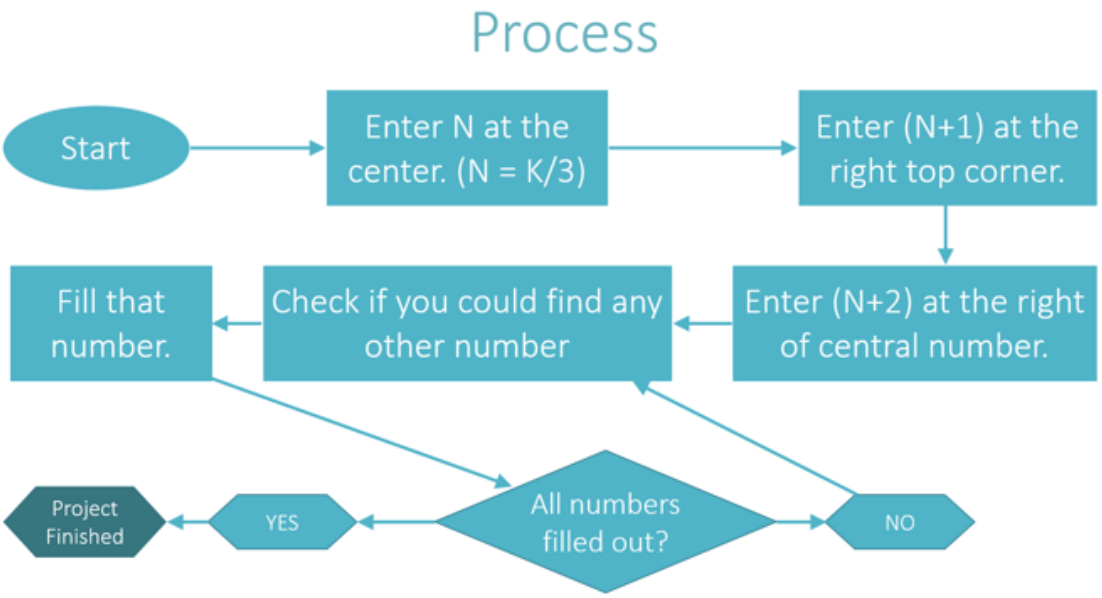
Completion Time _____

APPENDIX B

Trainathon

Tutorial

Training would be provided to the participants so that they could effectively deliver the projects.After the training the teams will be subjected to another round of the game.



APPENDIX C

K= #

*	*	(K/3)+1
*	K/3	(K/3)+2
*	*	*

* Fill out rest

APPENDIX D

Trainathon

Project Manager: _____

Employee 1: _____ **Employee 2:_____**

Financial Score:

	Initial Amount (Per Team)	**Cost of labor** (Per Team) (Per Round)	**Training Cost** (Per Team)	**Income** (Per Correct Card)	**Total Balance**	**Time Taken to complete**	**Success OR No Success**
R1							
R2							
R3							

APPENDIX E

Lean Simulation Survey Questionnaire

1. What is your age?
- ○ 18-20
- ○ 21-30
- ○ 30-39
- ○ 40-49
- ○ 50 or older

2. Are you a male or female?
- ○ Male
- ○ Female

3. What is/was your major or degree?
- ○ Construction management
- ○ Civil engineering
- ○ Architecture
- ○ Others (Please specify) _____

4. How important do you think training was for Project X?
- ○ Absolutely essential
- ○ Maybe
- ○ Could have managed without training

5. How much year(s) experience do you have in the construction industry?
- ○ No experience
- ○ 1-2
- ○ 2-5
- ○ 5-10
- ○ 10 or more

6. What do you think was the purpose of this game?

7. How effective do you think this game was in fulfilling its purpose?

0	1	2	3	4	5

Least effective Highly effective

APPENDIX F

GAME MANUAL

Game overview

The game consists of a scenario in which the players are put in a real world scenario, where they are assigned projects they will have to work on, and complete within the specified time.

In this game, each team consists of a Project Manager and two employees. Each team will be given a project (mathematical puzzle), which would need to be finished at the mentioned deadline. The teams can help earn profits and increase their net worth by completing the projects on time.

3.1 Objective of the game:

The main objective of the game is to observe perception of participants on training. The performance of each team is measured through the cash flow diagrams after the end of all the rounds.

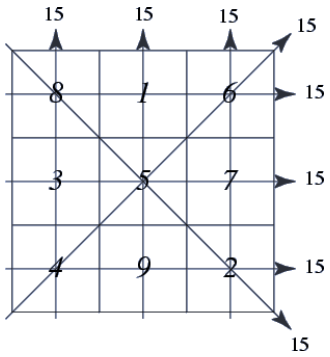
3.2 Materials

1. Paper with 3 X 3 puzzle template
2. Tokens with numbers written on it for each round
3. Pencil or Pen
4. Stop watch
5. Paper Tutorial and video

3.3 Rules

1. Sum of the continuous 3 blocks in every direction: whether horizontally, vertically or diagonally should be equal to the number assigned on the paper.
2. A number cannot be used more than once in the puzzle.
3. All the numbers used shall be greater than zero.
4. Only integers shall be used.
5. Time for each round is 2 minutes
6. PM can ask for training only at the beginning of the round
7. Timer will be made available on the screen that shall countdown to two minutes.
8. Once the game starts, no participant is permitted to use any electronic device such as a calculator or a cell phone.

For example, let's consider the number given to a team is 15. The picture shows how the project is supposed to be completed.



4. Game Execution

The game will consist of three rounds. At the beginning of each round the PM would be asked if they feel their employees require training. The game would be explained through a power point presentation (Appendix F). The PM would be handed with a financial Score sheet (Appendix D) and their responsibilities include the following:

Special instructions for the PM

- You are responsible for asking training for your employees
- Responsible for filling the financial score card
- Write names of each employee on top right corner
- **The Initial amount: $2000**
- **Training costs : $1000** ; It is a onetime cost
- **Cost of labor: $500**
- **Income for each success: $1000**

Round 1

Trainathon is played by all the teams and they have a maximum of 2 minutes to complete the puzzle. For each successful attempt they will earn $1000. In Round 1, teams are given the puzzle on a paper and expected to solve it in the least possible time. After the end of round 1, the participants are asked if they require training for the next round.

Round 2

In Round 2, the game is conducted similar to Round 1. Again, the objective is completing the puzzle in the least possible time. After the end of round 2, the participants are asked if they require training for the next round.

Round 3

Round 3 is a repeat of Round 2. The teams are now trained and should be able to deliver the projects (solved puzzle) on time.

Tutorial (Appendix B & C)

At the beginning of each round the teams are asked if they require training to explain the logic for successful completion of the project. A paper tutorial is handed out to the teams that require training. They are reminded not to share it with others.

Survey (Appendix E)

A post evaluation survey is distributed to all participants for their feedback.

SCRIPT

Howdy Ags!
Welcome to Lean game simulations. Today I am here to try out my lean simulation on you guys and by participating in it, you would help me in my research, Thank you all. I am glad you'll are here!

- What are lean simulations & why do we use them? < Slide 2>
- The philosophy my simulation is based on is the *Toyota Way's* 1st principle *"Base your management decisions on a long term philosophy rather than short term goals."*

Right now I do not wish to reveal more because I want you to join the dots for me. So we have 2-3 people in a team. One of you is the project Manager. All the PM raise your hand

Awesome!

- So what each team needs to do today is work on Trainathon and successfully complete the puzzle
- You would be handed over tokens which are in the envelope to do so
- You need to start only when I start the stop watch

The rules:

- Rule #1 : The sum should be equivalent to the given sum in all directions
- Rule #2: All numbers should be unique
- Rule # 3: 2 mins for each round
- Rule # 4: Training will be given only at the beginning

Special instructions for the PM

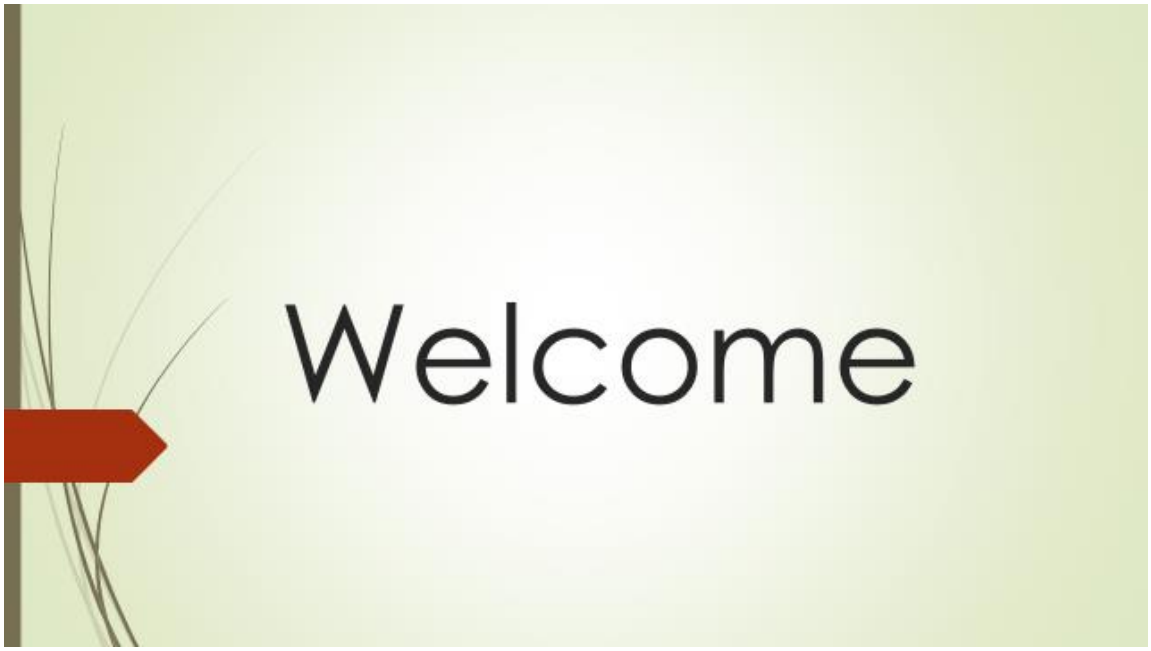
- You are responsible for asking training for your employees
- Responsible for filling the financial score card.
- Write names of each employee on top right corner
- The Initial amount assigned to you is : $2000
- Training costs : $1000: It is a onetime cost
- Cost of labor: $500
- Income for each success: $1000.

Any questions? Alright then let's start.

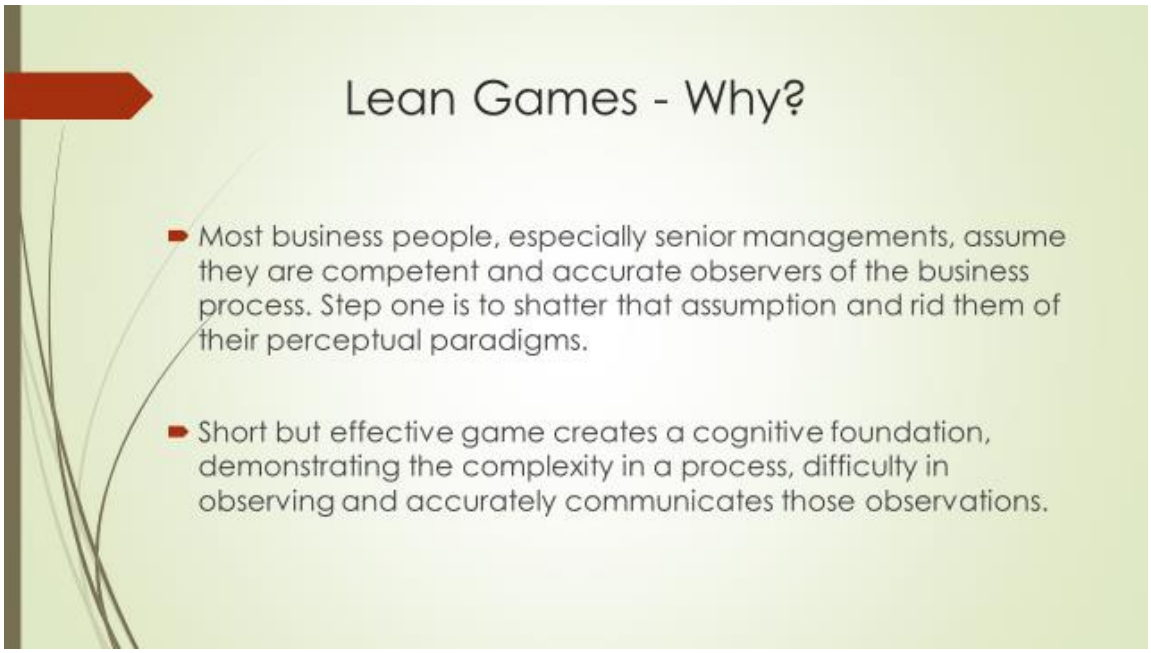
APPENDIX G

PRESENTATION SLIDES

Slide 1:



Slide 2:



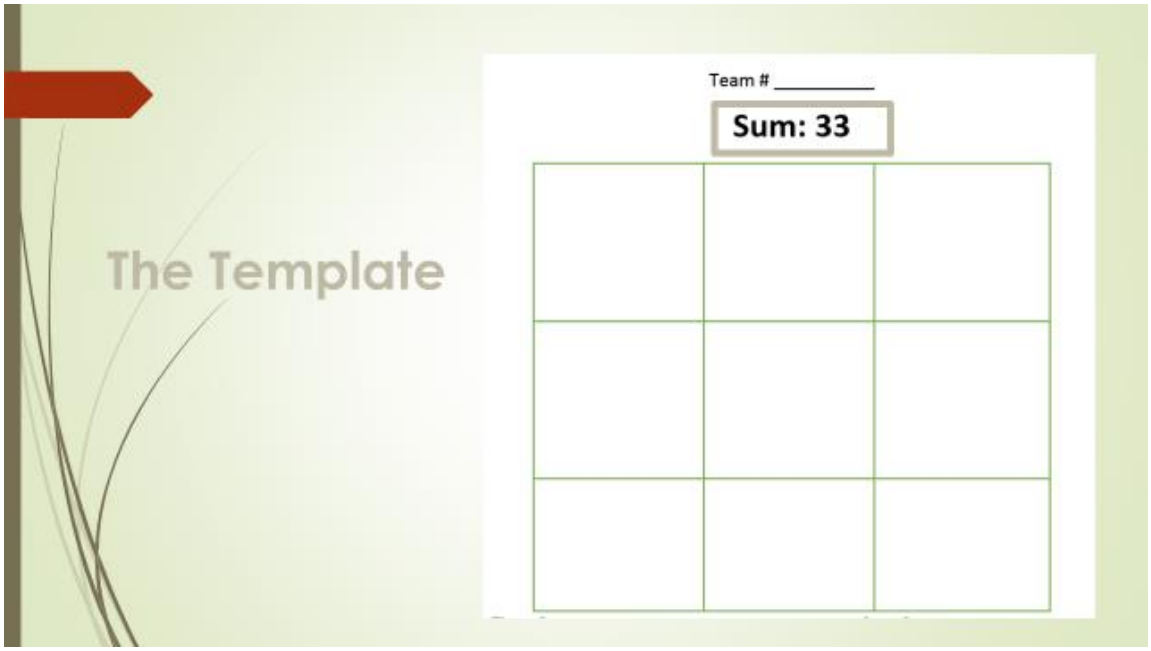
Slide 3


Principle #1 : Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

Slide 4


Trainathon

Slide 5



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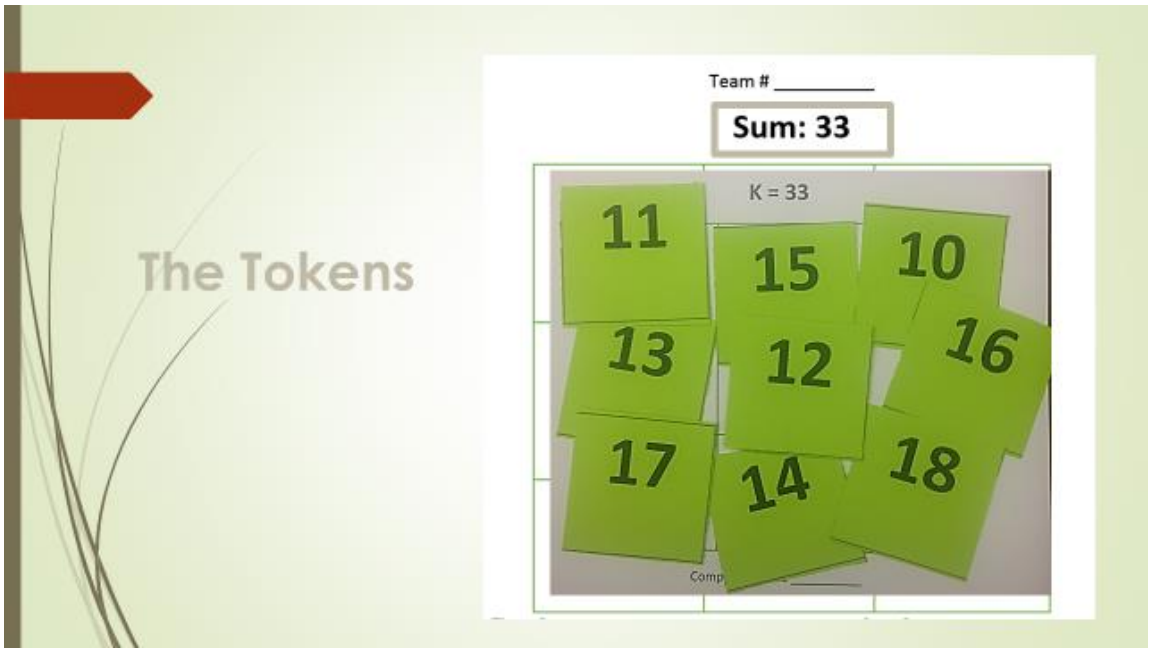

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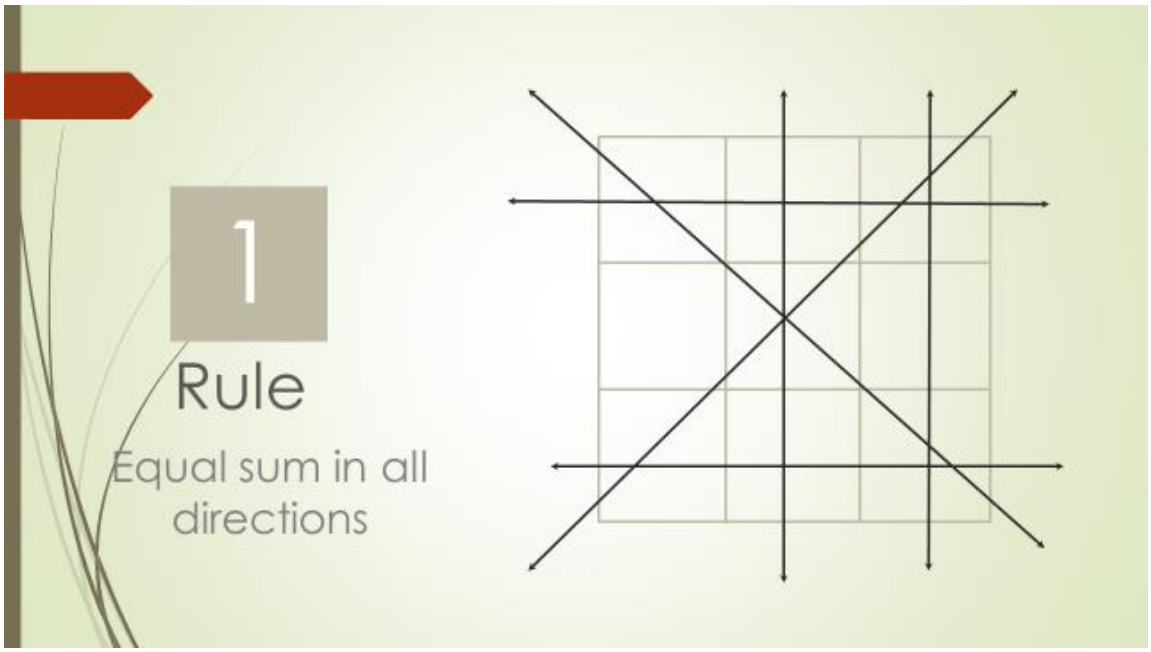
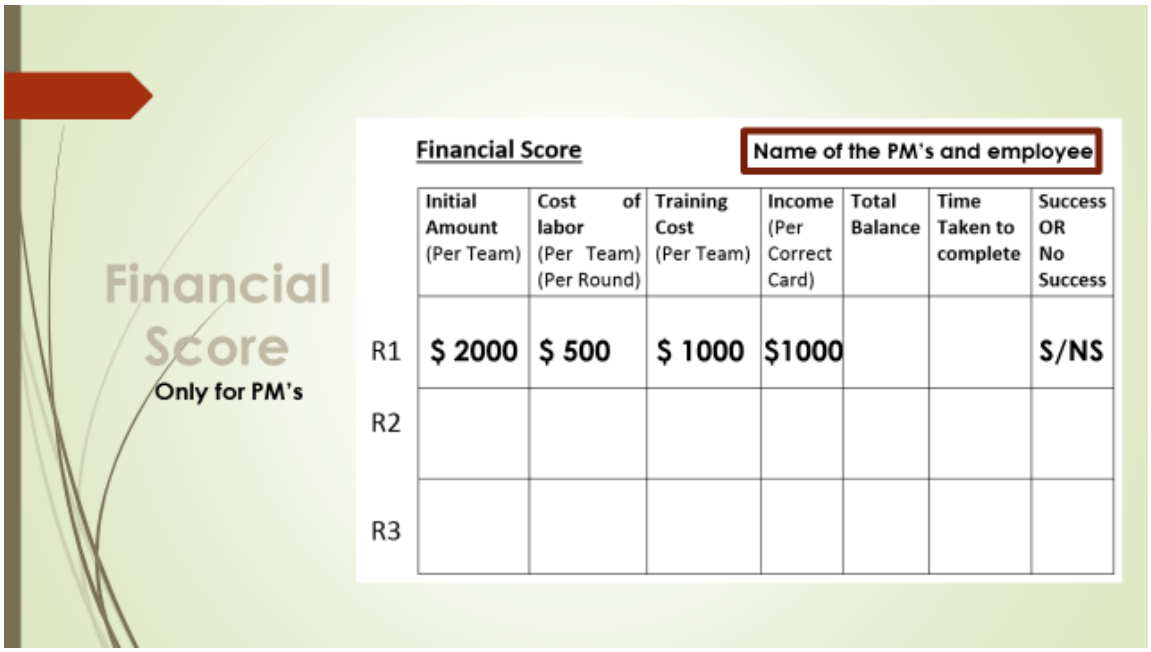


Slide 9

Slide 10

Slide 11

Slide 12



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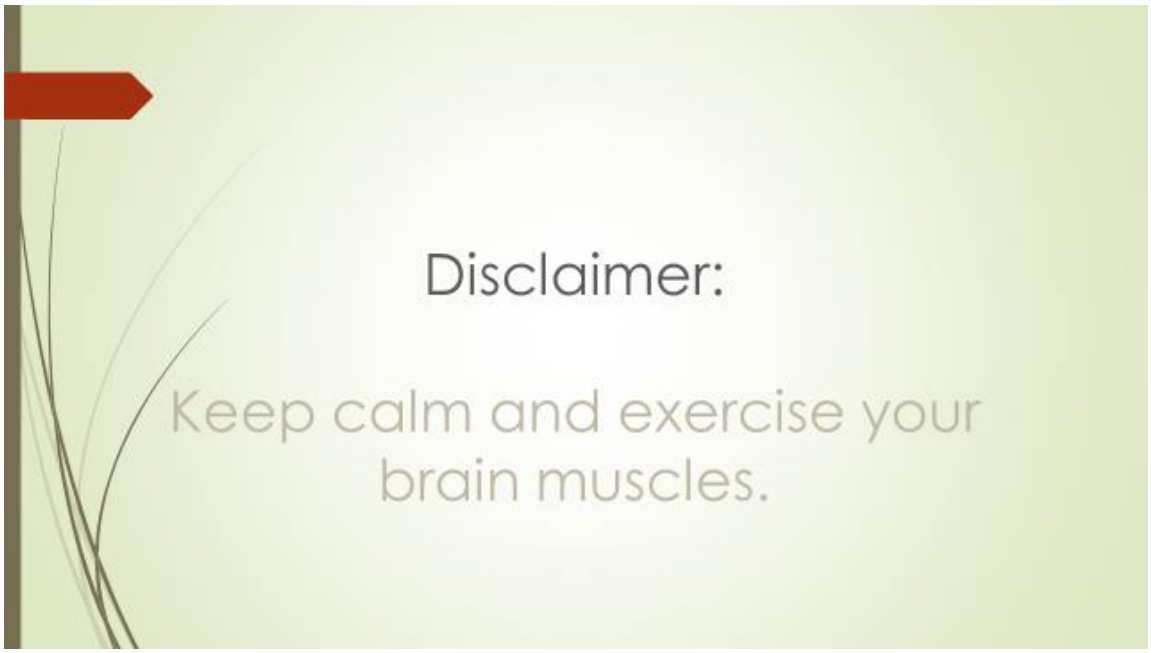

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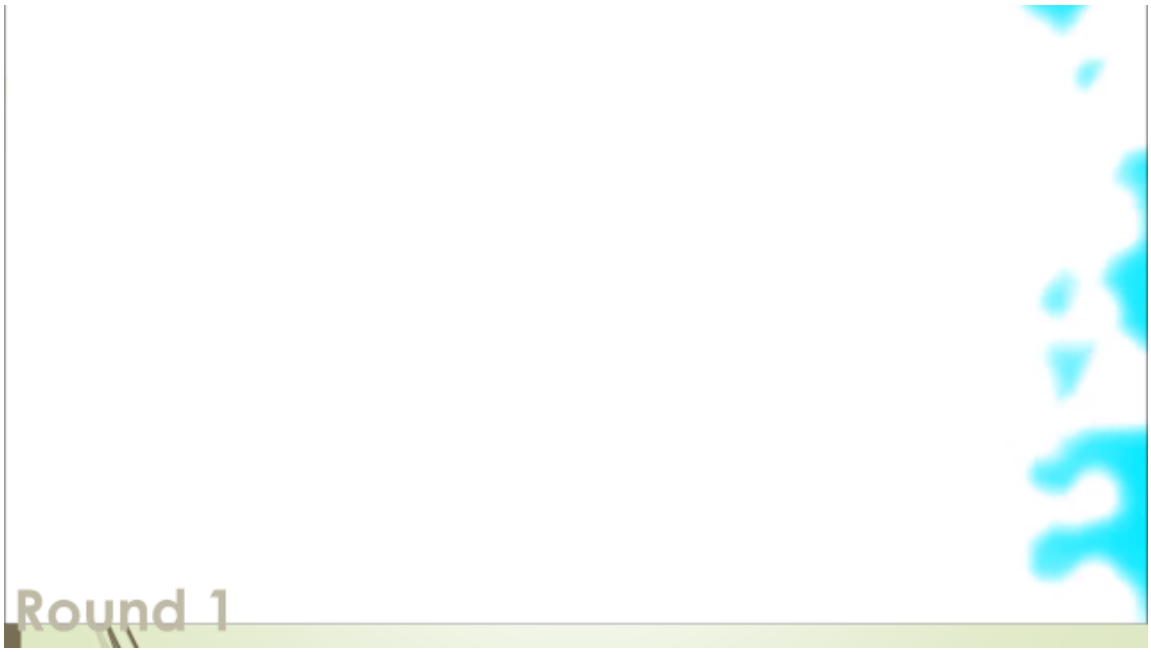

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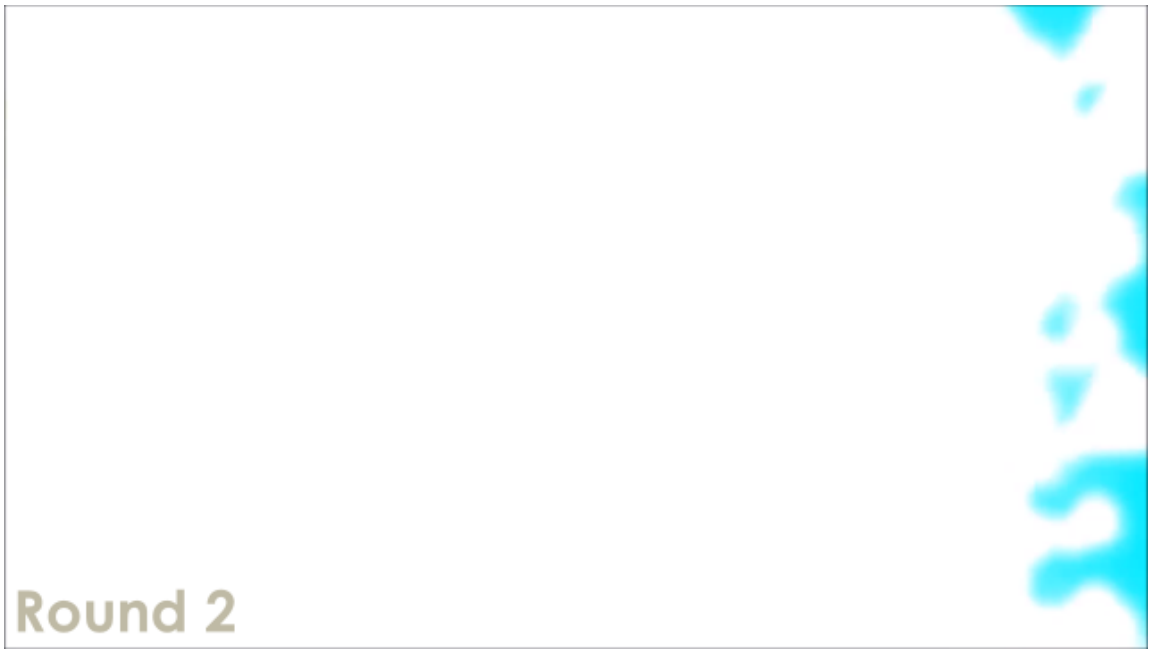
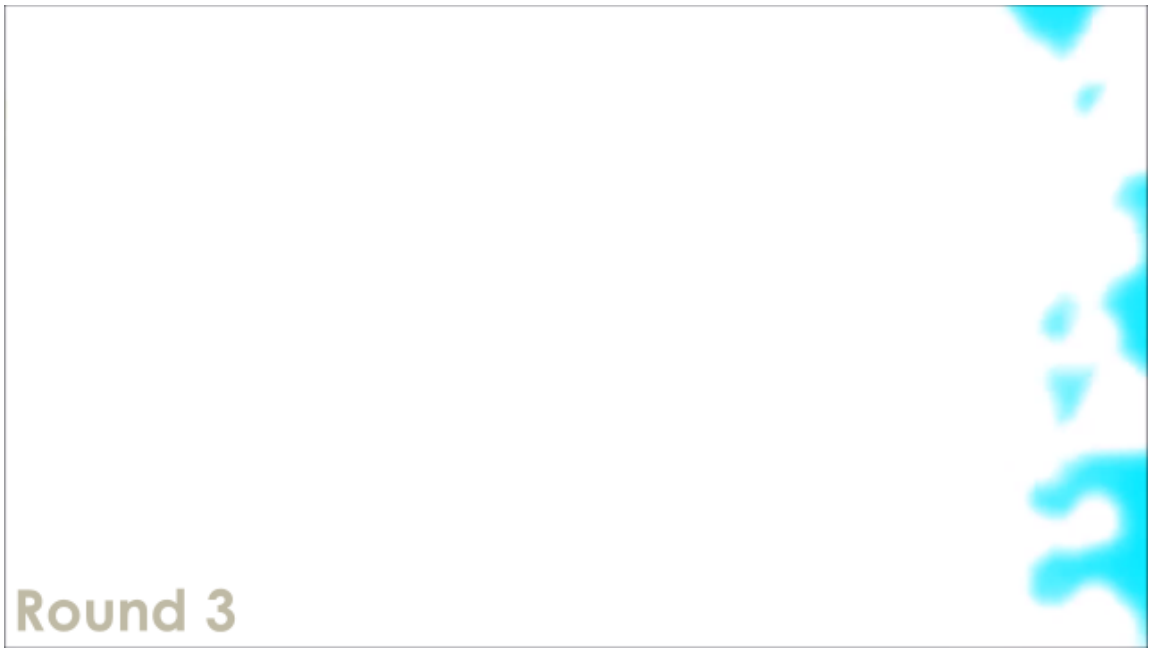
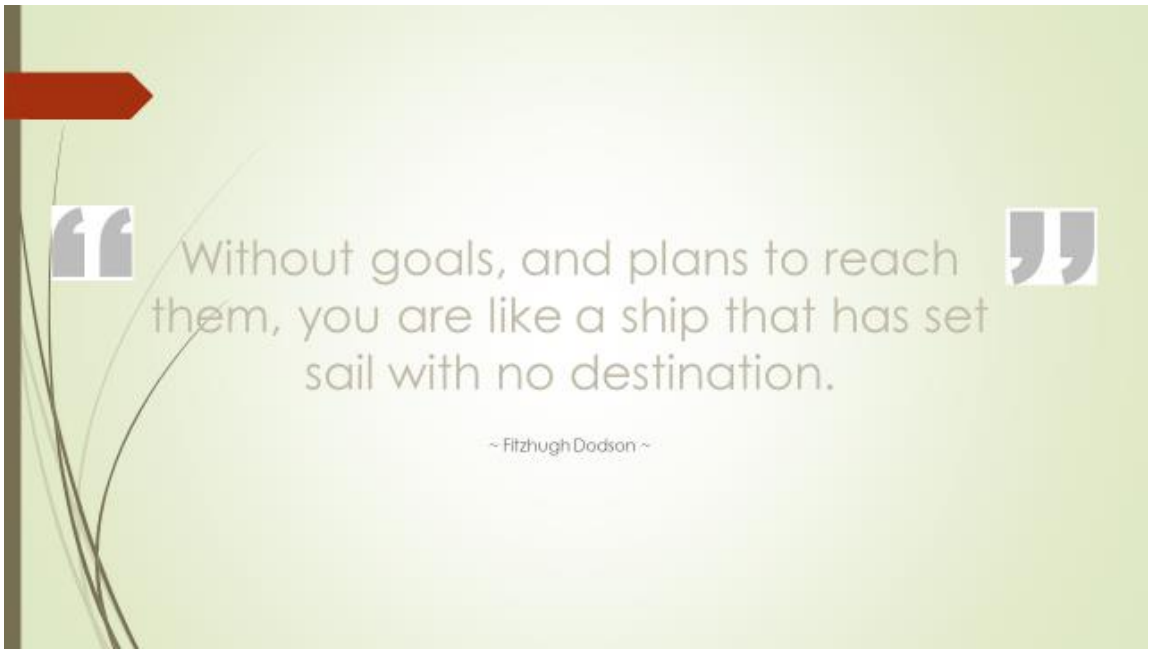


Slide 16



Slide 17



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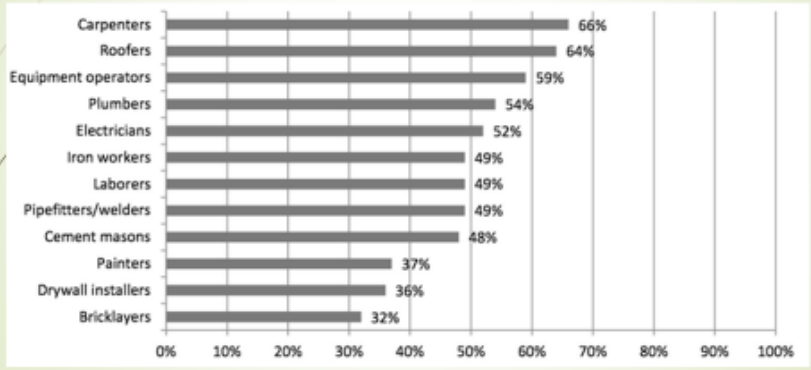
- Construction's skilled worker shortage intensifies
- 83% of firms confirm shortage of craft workers



Reprinted from (AGC, 2014) : Skilled labor Shortage

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- 61% indicate difficulty in filling professional positions including project supervisors, estimators and engineers
- 53 % increase from last year
- CII found a return of $1.30 to $3.00 for every dollar spent on craft training
- Creates a win-win situation for all the stakeholders

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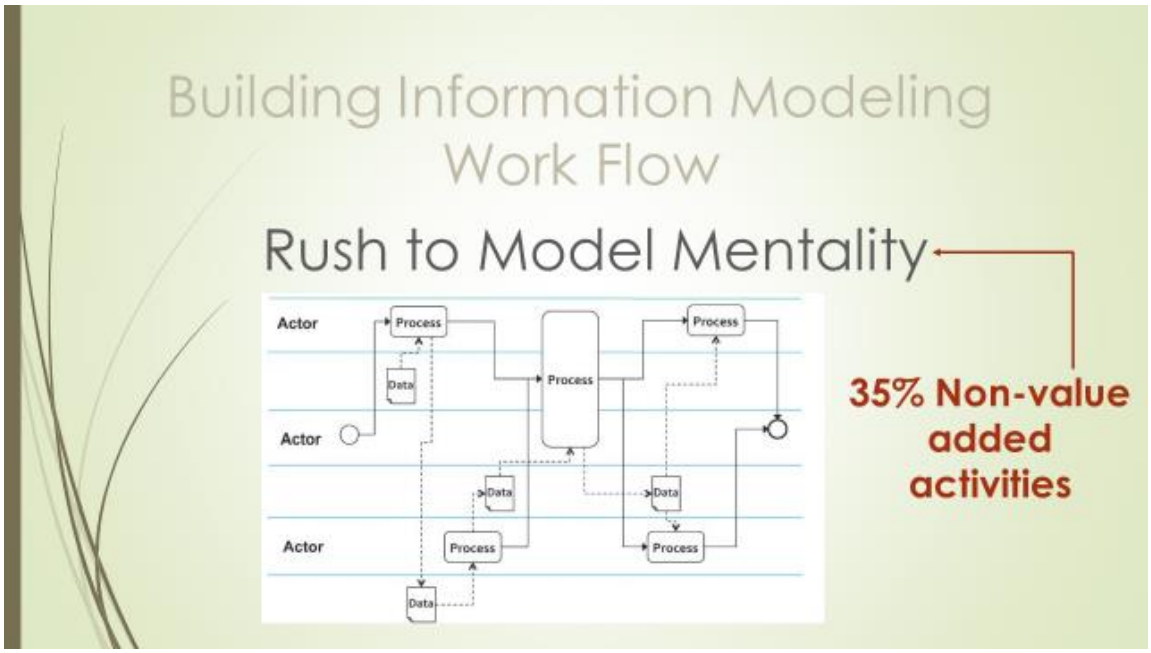

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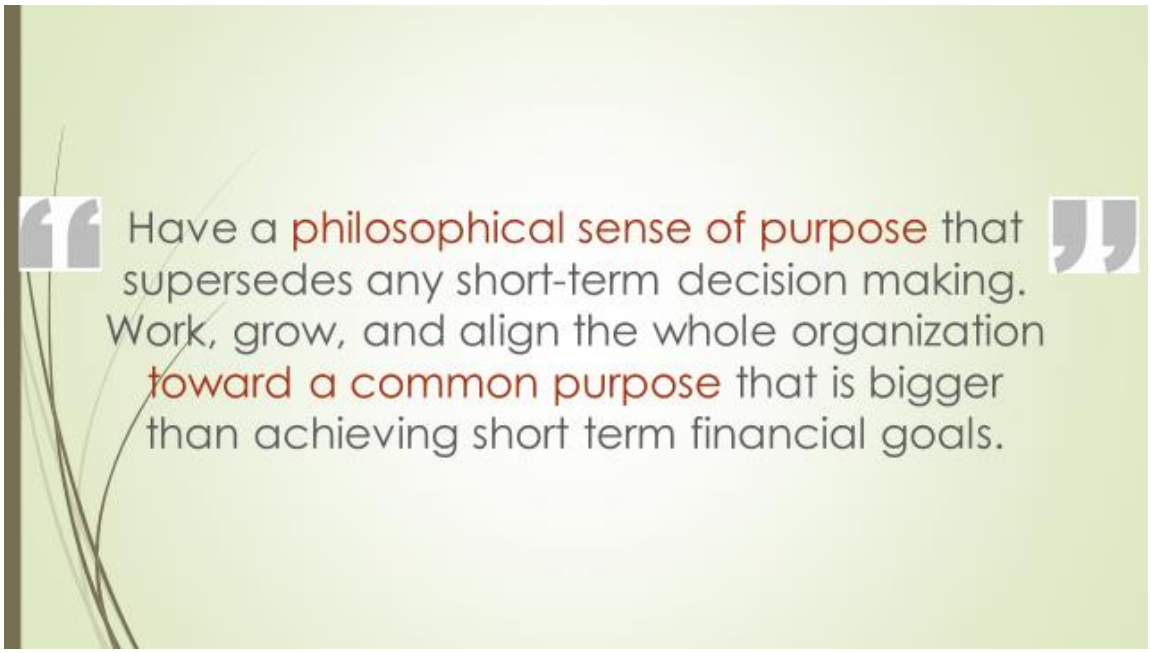

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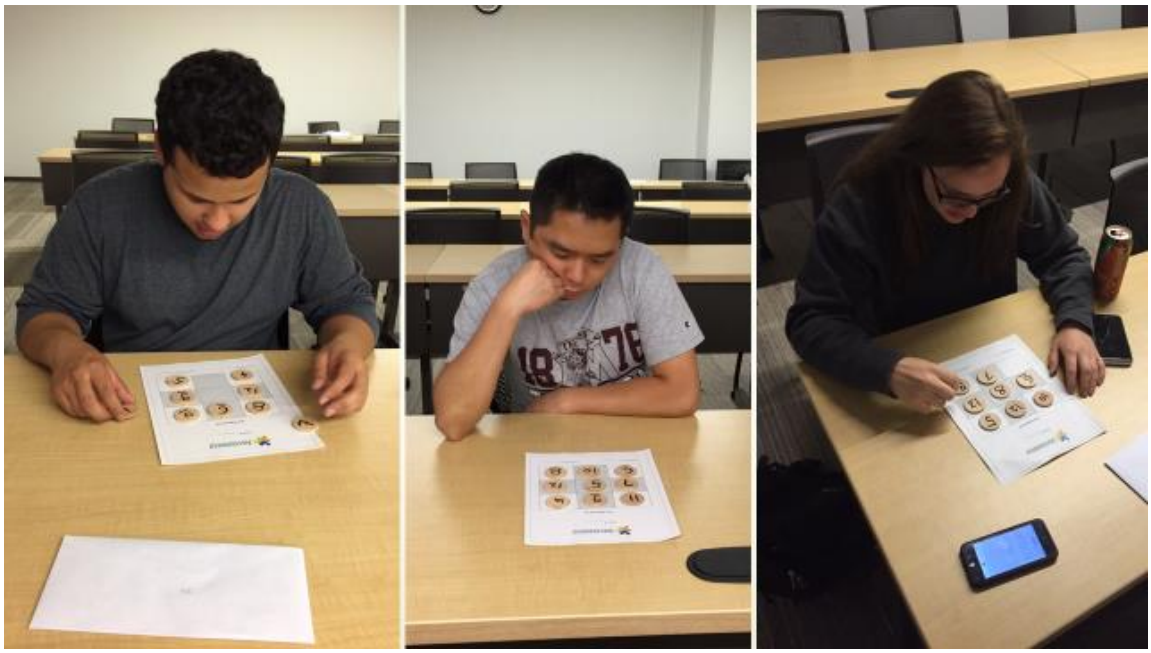
Slide 28: The team that helped in the concept development

Slide 29 : The game during its preliminary stages

Slide 30



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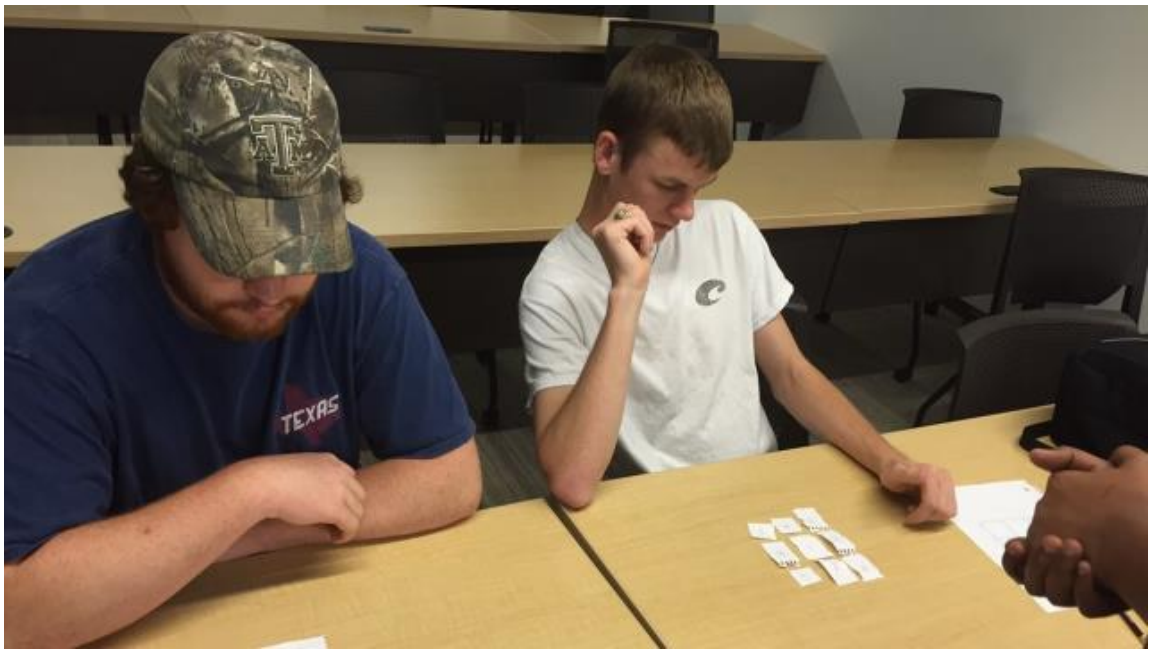

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Slide 33

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Slide 35