Interactive Safety Training: A Technological Tool for Fall Protection on Construction Sites

Melissa Lynn Hrivnak, Ohio State University

Melissa Hrivnak has a Bachelor’s degree in Mathematics Education and a Master’s in Civil Engineering at The Ohio State University. Melissa worked as a Math Teacher for two years before deciding to go back to school. During her time as a Master’s student, she worked as a Graduate Teaching Assistant with the Department of Engineering Education teaching the Introduction to Engineering series for incoming freshmen. Melissa’s passion lies in teaching safety and the procedures that are associated. The ideal career for her would be as a building inspector. This way she can both teach and help enforce proper safety.

Ms. Sheena Nastasia Marston, Dynotec Inc

Sheena Marston field engineer at Dynotec Inc, in Columbus, OH and is working towards gaining work experience to gain her P.E. license. Her background includes studies which resulted in attaining a MSc degree in Civil Engineering, B.A degree in Architecture from the University of Technology, Jamaica and a B.Sc in Construction management from Ohio Northern University.

Dr. Lisa E. Burris, Ohio State University

Lisa Burris is an assistant professor of Civil Engineering at the Ohio State University. Dr. Burris’ expertise lies in the areas of cement and concrete optimization, durability of construction materials, forensic evaluation of structural and material deficiencies, and infrastructure construction and repair best practices. Dr. Burris holds a B.S. in Architectural Engineering and M.S. in Civil Engineering from Kansas State University, a Ph.D. in Civil Engineering from the University of Texas at Austin, and has over a decade of experience in construction materials research.

Prof. Fabian Hadipriono Tan Dr.Eng., Ohio State University

Fabian Hadipriono Tan has worked in the areas of construction of infrastructures and buildings, failure assessment of buildings and bridges, construction accident investigations, forensic engineering, ancient buildings, ancient bridges, and the ancient history of science and engineering for over 40 years. The tools he uses include fault tree analysis, fuzzy logic, artificial intelligence, and virtual reality.
Interactive Safety Training: A Technological Tool for Fall Protection on Construction Sites

Abstract

Technology is evolving at a rapid pace, yet the way individuals in the field of Civil Engineering are tested on their acquired knowledge has stayed relatively stagnant. Written tests on paper have evolved to tests on the computer, but this is just the start to a vast array of possible future testing methods. Additionally, people crave the interaction which technology provides, thus to ensure that individuals are getting the most out of their learning, we must embrace technology and move testing to the future.

Due to the familiarity with technology and daily game play, a tool focusing on fall protection on the construction site was developed using Unity. It focused on investigating the ability to increase users understanding of safety procedures, while testing knowledge proficiency. Portraying the importance of safety through this tool could be the key to lowering accident and death rates on the construction site. This will also be a means to improving individual’s understanding of what constitutes a successfully safe construction environment, while satisfying the craving for technology.

The assessment of the effectiveness of this tool was evaluated through a survey taken by undergraduate students, graduate students, and professors/academic instructors at The Ohio State University, as well as by professionals in the field. Testing gauged three items: errors in the tool, effectiveness as a learning tool through the level of interaction and engagement, and potential for expansion to multiple safety topics as an alternate testing format. Ideal results of the assessment include viable interest in the tool through engagement and ease of use. Simultaneously, the tool is geared towards seeking improvements for further development as a potential technological advancement for teaching and evaluating construction skill proficiency.

Introduction

In 1970, the Occupational Safety and Health Act was passed to address safety compliance responsibilities of employers and employees. The Act “requires employers to provide a workplace free from recognizable hazards” and requires workers to “obey all safety regulations” [1]. Within this Act, Occupational Safety and Health Administration (OSHA) was formed to be held responsible for worker safety and health protection through setting and enforcing standards and regulations through training and education. The standards and regulations are minimum requirements and can be found in Title 29 of the Code of Federal Regulations (CFR) Part 1926 [2].

The excerpts provided below specifically relate to OSHA topics of holes and covers. As per OSHA 29 CFR Subpart M: 1926.501, “each employee on walking/working surfaces shall be protected from”:

- “falling through holes (including skylights) more than 6 feet above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes”,
• “tripping in or stepping into or through holes (including skylights) by covers”, and
• “objects falling through holes (including skylights) by covers” [3].

OSHA 29 CFR Subpart M: 1926.502, states that “covers for holes in floors, roofs, and other walking/working surfaces shall meet the following requirements”:
• “all other covers [excluding covers located in roadways and vehicular aisles] shall be capable of supporting, without failure, at least twice the weight of employees, equipment, and materials that may be imposed on the cover at any one time”,
• “all covers shall be secured when installed so as to prevent accidental displacement by the wind, equipment, or employees”, and
• “all covers shall be color coded or they shall be marked with the word “HOLE” or “COVER” to provide warning of the hazard” [3].

Training is required by the employer for each employee who might be exposed to fall hazards as per OSHA 29 CFR Subpart M: 1926.503. As a result of this training, the employee should be able to recognize hazards of falling and follow necessary procedures to minimize the hazards [3]. Despite this training, the statistics report a great deal of evidence that indicates there is need for more effective training.

OSHA ranks falls as being one of constructions’ “Fatal Four”, also known as “Focus Four”, being that falls are the number one cause of fatalities in the construction industry; accounting for around one-third (38.8%) of construction fatalities each year. Although outside of the scope of this report, struck-by object, electrocution, and caught-in/between are the remaining three accidents resulting in only 9.6%, 8.6%, and 7.2% respectively [4]. Fall protection is also among the top most frequently cited OSHA Standards during jobsite inspections [4]. An OSHA Compliance Officer runs the inspection to check for compliance of construction standards. Violations which are found receive citations for which the employer is expected to pay a fine and resolve the violated issue [2]. There are approximately 2,100 Compliance Officers; each Compliance Officer conducts inspections for 59,000 workers. Moreover, there are more than 8 million worksites around the nation, employing a total of 130 million workers. Therefore, the task of ensuring compliance across all worksites is the responsibility of all stakeholders in the construction process [4].

From 1992 to 2010, the Center for Construction Research and Training calculated the deaths associated with falls to total 6,858, which equates to around 360 deaths annually. The highest being near 450 deaths in 2007 and the lowest being 267 deaths in 2010 [5]. In this same year, “the Bureau of Labor Statistics (BLS) reported that 751 construction workers died on the job, with 35% of those fatalities resulting from falls” [6]. This is about 263 fatalities. Although there are slight differences in the number, both account for close to one-third of the construction fatalities in 2010. OSHA has led the effort in reducing the amount of deaths in the workplace. Great strides have been made in the U.S. from “about 38 work deaths a day in 1970 to 13 a day in 2015” [4]. Yet, despite this statistic, the Bureau of Labor Statistics’ preliminary findings identified falls as “the leading cause of death in the construction industry” with 337 deaths in 2014 [7]. A shocking number that is up from that in 2010. Improving training through technology and interactive methods of training could be the key to not only reducing the deaths related to falls but reducing the overall number of deaths in the construction industry.
New training strategies need to be in place to combat these statistics. One strategy in particular is utilizing the advancement and power of technology. Technology is arguably evolving at a rapid pace. According to Craig Van Slyke, “Twenty years ago, 10 million computers were in use in the USA: they were beginning to appear on desktops in the workplace” [8]. As of 2013, the American Community Survey Reports that about 88.4% of people in the United States had a computer [9]. The population in the United States as of January 1, 2013 was estimated to be just under 315.1 million people [10]. Making the estimated 88.4% equate to just over 278.5 million people that owned a computer. By virtue of that assessment alone, the population who own a computer has increased by 2,685% since the 1980’s.

Conversely, testing in the field of Civil Engineering has remained relatively stagnant. OSHA provides videos and computer-based courses as can be seen on their website. However, these educational tools are not regularly updated or improved with technology [11]. Individuals hear the risks, learn about the safety protocols, and see the injuries and deaths associated with falls, but this is all occurring on paper or through videos. Being able to translate what is seen on paper, or through short video clips to a person’s life is a difficult transition to make. Currently, minimum interaction is taking place with either of these current options. Yet, the individual is expected to take what was learned and apply it to the job site. This can lead to a lack of direct experience and can cause a gap in the execution of the hazard preventions set forth by OSHA. “A little visualization may increase overall efficacy and provide player-learners with an arsenal of strategies that may later be engaged at will to reach specific goals and objectives” [12]. Thus, to ensure that individuals are gaining strategies needed for future implementation on the construction site, technology must be embraced to improve learning and move testing to the future.

Embracing technology to improve learning fits under the idea of gamification. Though gamification may be considered a new term, the idea of using game thinking and game mechanics to engage audiences and solve problems isn’t new [13]. “Gamification is the use of game mechanics and game dynamics to drive game-like engagements and actions in a non-game setting. As a teaching tool, gamification applies game mechanics, game dynamics, and frameworks to promote desired learning behaviors” [14]. When gamification is positive and effective at its core, learning is enhanced, and learners are engaged in the act of solving a problem [14].

Knowing this, technology has the potential to fill the gap left behind by lifeless pages of information and outdated videos and bring change in the form of an engaging and interactive learning environment. This is corroborated through the idea that, “a virtual learning environment can be the means of enhancing, motivating, and stimulating learners’ understanding of certain events” [15]. The individual is no longer limited to conceptual methods; they can now experience the safety and be immersed directly in the learning.

The focus of the project is to highlight hazard recognition and prevention, especially pertaining to fall protection through holes in floors on a construction site, and the development and use of a tool providing walk through of the learning and assessment of these skills. This paper provides an explanation of what choices were made in conceptualization and design of the tool and justification for the choices. Survey data evaluating variable interest in the tool through
engagement and ease of use was collected from users who interacted with the tool. Their perspectives will be reviewed, interpreted, and the findings discussed. The potential of the tool becoming an alternative format of testing will also be reviewed.

Software and Assessment Methods

Interactive Learning Tool Development and Use

A means of accomplishing this collaboration between safety training and technology is with the Interactive Safety Training Tool. This tool allows the user to interface with a construction environment generated using game play characteristics. The chosen method of gamification follows typical key features. Below is how the Interactive Safety Training Tool applies these methods [16].

- **Determination of learners’ characteristics**: In classroom settings, it is vital that instructors establish the skills required of participants to achieve the objectives—in the cause of the Interactive Learning Tool, it is assumed that all members of a construction crew has had appropriate levels of safety training. The questions chose are applicable for the site setting because too much ease or difficulty can affect participant outcomes.
- **Defining learning objectives**: This tool is designed with the specific learning goal in mind that users will learn to implement the proper protection for holes in floors.
- **Structuring the experience**: “Stages and milestones are powerful tools that enable instructors to sequence knowledge and quantify what the students need to learn and achieve by the end of each stage or milestone” [16]. In the Interactive Safety Tool completing each task associated with the respective cones is considered a milestone.
- **Adding game elements and mechanisms**: The main elements identified in gamification focus on the inclusion of tasks learners are required to perform. Quality of performance is linked to the accumulation of points, level transition and awards. The performance of tasks leads to accumulation of points, transition to higher levels, and winning awards. The elements in the platform focus on predetermined objectives associated knowledge and skills the user is required to acquire. Tasks which fall beyond the set objectives will yield individual rewards such as badges.

Though, the design of the Interactive Safety Tool applied the principles mentioned above and uses the game as the delivery method, the focus remains the implementation of techniques favorable to hole safety. This includes protection of a gap or a void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface as per OSHA 29 CFR Subpart M;1926.500 [3]. Doing so facilitates an easy transition when transferring these learned practices on site. In order to facilitate this experience, the tool was built as a standalone program which utilized the computer and keyboard. The tool is played on the computer screen with the user sitting and controlling the tool by the keyboard and mouse in first person. Therefore, the user interacts with the simulated environment created specifically for the tool by controlling a camera on screen. They experience the environment from their personal view, rather than through an on-screen character’s perspective, shown in Figure 1. This choice provides complete immersion of the user into the safety training and allows them to experience the training as if they are actually on the construction site.
As the user begins the training tool, instructions appear on screen to guide the user on how to proceed. Each time text is present on screen, a black background will appear behind it, enabling the user to easily view what is written on the screen. An example of before and after can be seen in Appendix A, while the instructional screen is shown in Figure 2.

The instructions explain to the user that the keyboard arrow keys will be used to navigate towards the cones on site. Fifteen cones are scattered throughout the construction site. Each cone contains a question pertaining to hole safety based upon OSHA Standards. The user must reach all fifteen cones and complete each question to finish the safety training, in no particular order. Also explained is the map of the site which can be viewed by clicking on the “Open Map” button.
on the bottom right corner of the screen. The “Open Map” button, as seen in Figures 1 and 2, can be pressed at any time throughout the learning tool. When the user selects the button, a site map appears and the button changes to read “Close Map”. This same button can then be pressed to close the map. An example of this can be seen in Appendix B, Figure 23. Items from the environment are present on the map to aid the user in locating their position and knowing with relative ease where to go next. Like the cones in the environment, the cones on the site map are dynamic and disappear as the user selects the corresponding cone in the environment.

The points the user earns throughout the safety training, along with the number of remaining cones can be seen at the top left of the screen, also shown in Figure 2. These stay on the screen throughout the duration of the safety training. Once the user presses the “Begin Training” button, the Interactive Safety Training will begin, and the user is free to move around the site. The user can move around prior to selecting the “Begin Training” button, however the cones will be unresponsive until the button is selected. The only other action the user can take other than pressing the “Begin Training” button is pressing the “Open Map” button, which will open the map, but still will not allow the user to select any cones. Upon closing the map, if the user has yet to press the “Begin Training” button, the instructions will appear again. This helps to ensure that the user has had the opportunity to read the instructions prior to beginning the safety training. A visual example of this sequence of events can be seen in Appendix B.

As the user approaches a cone and walks into it, the question will appear. At first the user will be told what task they are trying to accomplish based upon OSHA Standards. This can be seen in Figure 3. During this time, the user has the option of selecting “Confirm” to continue with the task or selecting “Exit” to try another task first.

If “Exit” is selected the cone will reappear next to the user, as shown in Figure 4. This is done so the user returns and completes all tasks to ensure corresponding skills are assessed.
If the “Confirm” button is selected, the question relating to the task will appear. Answer choices also appear, as seen in Figure 5. Each question only has one correct answer and is chosen by pressing the corresponding “Select” button. If this correct answer is chosen the first time, two points will be awarded, as shown in Figure 6. In the event that the correct answer is not selected on the first try, a hint will appear for the user directing them to the correct answer, shown in Figure 7. Once the “Continue” button is selected, the question will reappear with the answer choices rearranged, as shown in Figure 8. This allows the user a second chance to interact with the question and learn from the tool through review of the material versus through memorization or guessing. The method provides reinforcement instead of telling the user they are incorrect and moving forward.
Figure 6: Two points are awarded for the correct answer on the first attempt

Figure 7: A hint is generated when the user chooses incorrectly the first time

Figure 8: Question appears again with answer choices in a different arrangement
Achieving a correct answer on the second attempt earns the user one point, as seen in Figure 9. This way the user may earn points for the correct answer, but the attempt is not as heavily weighted as the first. If the resulting answer of the second attempt is incorrect, a score of zero will be awarded; as seen in Figure 10, the correct solution will then be revealed. Again, this reinforces the user’s learning by allowing the user to see what the correct answer is before moving on. During the design phase, it was considered to have the cone reappear to the user on their additional attempts to ensure learning of the material but was later reconsidered. If the user was provided another chance to answer, the point system would become more complicated. In addition, a true sense of “passing the training” would not be achieved because every user could pass simply by guessing until they answered correctly. Instead, the user has a chance at the end of the training to restart the tool.

Figure 9: One point is awarded for the correct answer on the second attempt

Figure 10: The correct answer is shown to the user after a wrong answer on the second attempt
Upon completion of each question, the user is free to move about the construction site. It is up to the user to choose when to continue to another question as there is no time limit or order of completion for the safety training.

Five of the fifteen questions directly affect the environment upon selecting the correct answer. For example, one question asks how a hole cover should be properly labeled so it meets OSHA Standards. Once the user answers correctly, the hole cover, previously unlabeled, is shown with the label “HOLE” on top. This process is illustrated in Figure 11 and Figure 12. This allows the user to feel as if they are executing the proper safety procedure set forth by OSHA. The remaining questions that affect the environment are set inside the building, they can be viewed in Appendix C.

Figure 11: The cover is without a label prior to answering the question correctly

Figure 12: The cover now has been properly labeled according to OSHA with the word "HOLE"
OSHA section numbers can also be seen on various questions throughout the environment. These are incorporated to assist with further learning on applicable questions. If a user wants to find out more information on a particular question, the section number can be referenced for ease of locating more information. An example of this can be seen in Figure 11.

Multiple items typically featured on a construction site are present throughout the learning tool including vehicles such as a roller, concrete mixer, and crane, along with dumpsters, lights, a porta-potty, crates, and extra building materials. In the middle of the site is the two-story building, nine cones are located within the building, with the remaining six cones residing around the site. City scenes are provided in the background to help set the location and further the user with a fully engrossed experience of being in a city while constructing. The elements featured on site can be viewed in Appendix D.

Upon completion of the Interactive Safety Training Tool, the user’s earned points are totaled and can be viewed by the user at the top left corner of the screen throughout the training. A score of greater than, or equal to 70% results in a passing score reflecting the pass requirement for the OSHA 10-Hour/OSHA 30-Hour tests. The total score is based on a calculation of 30 total points, from 15 questions, with a maximum of two points earned from each. As shown in Figures 13 and 14, text will appear letting the user know whether they passed and what percentage was earned. At this time, the user can try again, as mentioned earlier, or end the training. Trying again will reset the training for the user without having to exit and re-open the tool. This can be seen in Figure 15. The exit button will close out of the tool completely.

Figure 13: Text that shows when the user does not pass the training course
Software

Unity 5.3.4f1 personal software engineering platform was used for development of the tool. Having a low cost, large pre-developed image database, and simple use, enables the platform to be used by a wide audience for development of games and tools. Over 34% of the top 1,000 mobile free games are created using Unity. Unity, boasts such clientele as Ubisoft, Disney and Electric Arts - https://unity3d.com/public-relations), however, the platform is such that it may be used by lay persons. Unity also supports numerous gaming platforms, e.g. Playstation 4, Playstation VR, Xbox One, Linux, Mac and Windows [17]. There are also multiple sources that provide support for building with Unity and writing the code. For the purpose of this tool, coding was completed with C# using Microsoft Visual Studio. Due to these features Unity possesses,
creating a training tool that could be integrated into workforce training was made possible without being inhibited by encumbrances.

AutoCAD Civil 3D 2016 was used to design the site layout and complete all drafting requirements. This program was chosen due to its familiarity and wide usage in the field of Civil Engineering.

Existing Tools for Interactive Learning

Currently, there exists other tools providing education about falls in construction. Online courses, such as those provided through 360Training, ClickSafety, and Summit Training Source, are among these tools intended to be interactive and immersive by providing videos and quizzes throughout the course [18]. OSHA has a prevention video (v-Tool) titled Falls in Construction/Floor Openings. This is an animated video explaining the importance of fall protection through a true story about a worker’s death because of an unprotected stairwell opening. It runs through the video once with the true scenario, and again with how the death could have been prevented through proper protection of the open stairwell [19]. Another tool available is called Hazard Identification Training Tool where the “user must identify and mitigate hazards to maintain a safe workplace throughout three phases of a construction project” [20]. “The user is given 10 days for each phase of construction with a maximum of 480 minutes per day to address safety in the workplace and build profit” [20]. With the allotted time, the user can choose how to spend it, either by using it to make the workplace safe, or using it to make as much money as possible [20].

The Interactive Safety Training Tool builds off these interactive tools to create a new product in the learning tool community. This tool is interactive by allowing the user to do the tasks and not just watch safety prevention being implemented. It is simplistic by design and intended to be completed in a short span of time. As opposed to going through phases of a construction project, focus is placed on review of the regulations. Focusing on the standards and regulations allows for a check of understanding, a chance to learn and understand the material before it is applied. As the user’s knowledge is checked and expanded, the construction site in the environment becomes safe, and does not need to be maintained throughout the deration of the tool.

Tool Assessment Methodology

A survey employing a combination of both closed-ended and open-ended methodology was designed to assess the Safety Training Tool. Closed-ended questions focused on its ease of use, level of engagement, and effectiveness in communicating information. While open-ended questions were aimed at determining technical problems with the tool, benefits and drawbacks of using this as a testing format, and other suggestions for improvement. The sample group of 33 individuals included undergraduate students, graduate students, and professors/academic Instructors at The Ohio State University, as well as professionals in the field. Sampling these different groups allowed for a true representation of how each group would receive and assess the tool. Immediately following the test run of the tool, the survey was conducted. A sample of the survey can be viewed in Appendix E.
Results

Gamification Assessment

Gabe Zichermann, founder and chief executive at Dopamine Inc. discussed the fact that the use of game mechanics improves the abilities to learn new skills by 40%. Zichermann went on to state that game approaches lead to higher level of commitment and motivation of users to activities and processes in which they are involved. Game mechanics are familiar to consumers as most of them have played or continue to play different games. [21]. While this statement was focused on employers, case studies have proven that it is has applicability in the educational field.

An interview with Ben Leong, Assistant Professor at the School of Computing, National University of Singapore (NUS) and studying his publications provided insights into his creation of a game-like course called JFDI Academy. Through the application of game mechanics to a traditional scheme-based introductory programming course, it induced consistent behavior from students and identified gaps in each student’s learning progress. [16]. “The game-like curriculum showed impressive results with pain points being identified and tackled, and specific gamification strategies being implemented by Ben Leong and his team. 76% of 51 students found the system to be helpful in their learning and the ‘mission feeds’ improved interactions with the teaching staff. Motivation improved with 71% agreeing that the self-element of leveling up encouraged them to finish their assignments, while 33% were motivated by the social-element of the leaderboard and achievements” [16].

Interactive Safety Training Tool Assessment

Of those surveyed, 67% said that the tool was extremely easy to use, suggesting that familiarity and comfortability may have played a roll, as mentioned earlier. A total of 64% said the tool was effective in communicating information; showing success in being a tool for learning and possessing good potential as a technological advancement in the way of testing individuals in the field of Civil Engineering. Additionally, 52% said that the tool was extremely easy to navigate, while 18% where having some level of difficulty navigating. Results indicate that there is room for improvement, however, they also indicate that there is a strong potential for the implementation of these improvements. A combination of 94% of people said the tool was either engaging or extremely engaging, demonstrating that the Safety Training Tool is engaging as initially hypothesized. The remainder of the findings can be viewed in Figure 16 to Figure 19.
Figure 16: Ease of Use based upon percentage of participants

Figure 17: Tool effectively communicates information based upon percentage of participants

Figure 18: Ease of navigation based upon percentage of participants
Conclusion

In conclusion, the survey found that using the Interactive Safety Training Tool as a future testing format could be well received with 25 out of 33 people saying they would prefer this over a paper test. Some of the positive findings identified from research participants include:

- Reduces anxiety
- More enjoyable to sit through
- Leaves a bigger impact on the user
- Better for memory retention and recall of information
- Incorporates real-life relatability, which is essential for positive learning outcomes
- Gives a good overall sense of the environment that will be working in

Few drawbacks are also mentioned, which led the remaining individuals to prefer a paper test. These drawbacks include:

- Too much time can be spent on navigating around the site and not enough time on testing of the material
- Added anxiety to navigate the digital environment to reach the questions
- The user might need to learn how to navigate within the environment before testing, if they are not familiar with gaming

While there are pros and cons, the data suggests that the pros far outweigh the cons. Therefore, the potential of the tool becoming an alternative format of testing is promising. The Interactive Safety Training Tool pulls upon the knowledge and science that has shown what works and what individuals desire. This tool leads individuals towards a successful and safe construction environment; while simultaneously satisfying the craving for technology and immersion that individuals are now anticipating. Interactions with text-based documents and watching videos is no longer reaching audiences as originally intended. Technological advancements have made it such that in order to remain relevant instructional tools are expected to have cutting edge materials. Safety training on construction sites need to adapt to these
changes as well if companies expect individuals to be as prepared for executing safety procedures and requirements. The next step in advancing training with technology should be accomplished utilizing gamification through the Interactive Safety Training Tool.
References


Appendix A

Figure 20: Before black box was added to improve text visibility

Figure 21: After black box was added to improve text visibility
Appendix B

Figure 22: Opening view with instructional text

Figure 23: View when map is opened

Figure 24: View once map is closed and user has yet to begin training
Appendix C

Figure 25: Before cover is properly secured with bolts

Figure 26: After cover is properly secured with bolts
Figure 27: Before hole is properly covered

Figure 28: After hole is properly covered
Figure 29: Before hole is properly covered

Figure 30: After hole is properly covered
Covers for holes in floors, roofs, and other walking/working surfaces shall be capable of supporting, without failure, the exact weight of employees, equipment, and materials that may be imposed on the cover at any one time.

Figure 31: Before hole is properly covered

Figure 32: After hole is properly covered
Appendix D

Figure 33: Crane, porta-potty, dumpsters and roller seen from the second floor of the building

Figure 34: Portion of crane, site materials, dozer, and portion of crate seen from second floor

Figure 35: Lights and truck as seen on site
Figure 36: Two-story building and concrete mixer as seen on site

Figure 37: Portion of dozer and crates as seen on site

Figure 38: Both cranes, dozer, and two-story building as seen on site
Appendix E

Interactive Safety Training Tool Questionnaire

1) Which of the following best describes you?
   Undergraduate Student   Graduate Student
   Professor/Academic Instructor   Professional/Work in Field

2) How easy was the tool for you to use?
   1   2   3   4   5
   Extremely Difficult   Extremely Easy

3) As a learning tool, how engaging was this software?
   1   2   3   4   5
   Not at all engaging   Extremely engaging

4) How effective was the tool in communicating information?
   1   2   3   4   5
   Not effective   Effective

5) How easy to navigate was the software?
   1   2   3   4   5
   Extremely difficult to navigate   Extremely easy to navigate
6) Did you experience any technical problems when using the tool? If so, please describe them.

7) What suggestions do you have for improving this software as a learning tool?

8) Currently this tool is developed for learning. If it were to be used as a testing tool, what would be some drawbacks/benefits?

9) Would you prefer this tool as a format for testing over paper or other computerized tests? Why or why not?

10) Please provide any other comments you may have about this Safety Training Tool.