Effectiveness and Cost Benefit Review of Multi-Media Training

by

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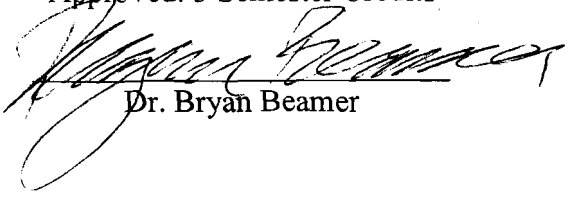

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ABSTRACT

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More than 100 Occupational Safety and Health Administration (OSHA) standards for hazard control in the workplace contain requirements for training of employees. Not complying with these training requirements can be a sizeable avenue of loss for a company, affecting both direct and in-direct costs. To reduce loss caused by inadequate training for Company XYZ, a review of safety training needs, structure and deficiencies has been performed to identify major concern areas. Time and resource constraints in Company XYZ's training delivery were found to be a significant problem area. In-house produced video modules were therefore deemed the venue of choice for Company XYZ training needs. The purpose of this study is to identify economically feasible means of properly completing safety training for the entire Company XYZ worker population; this

training was to meet all regulatory requirements while remaining effective. The in-house produced video used outperformed the pre-packaged commercially produced video for the specific topic of fall protection. Furthermore, the effectiveness of the video delivery system was found to be at least as good as the effectiveness of the current Company XYZ training practices. The cost benefit analysis showed that the long-term investment of resources into a video delivery training system has the potential not only to save the company money but also to save time for other important issues.

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Chapter I: Introduction

More than 100 Occupational Safety and Health Administration (OSHA) standards for hazard control in the workplace contain requirements for training aimed to reduce injury or disease risk factors. Also, additional standards limit the performance of specific jobs to persons deemed competent through virtue of specified training (Cohen, Colligan, 1998). Non compliance with training issues can be a sizeable avenue of loss for a company. Such company losses can be caused by a lack of training proficiency affecting many direct and in-direct costs. To illustrate the potential magnitude of non-compliance direct costs, between the months of October 2003 through September 2004 the construction industry received $636,566 in fines specifically for fall protection training non-compliance (OSHA Industrial Profile 1926.503). This amount does not include fines from other fall protection non-compliance issues. As the fines of training non-compliance can easily be seen as a direct cost, it follows that a large percentage of injuries sustained by the employees that received the deficient training are also directly related to employer non-compliant training practices. Therefore the incurred costs of those injuries can be related back to improper training, as well as any other direct and indirect costs of the injuries sustained as a result of substandard training practices.

To reduce such costs for Company XYZ, a review of safety training needs, structure and deficiencies has been performed to identify major concern areas. Company XYZ's Standard Operating Procedures manual has been reviewed to identify training needs and a company profile has been performed by interviewing key safety personnel within the company. The company profile was performed to establish the time and

monetary expenditures of Company XYZ toward safety training. It was established that the main safety training concerns of Company XYZ were:

1. Safety trainer to employee population ratio;
2. Not delivering training before the onset of work which breaks OSHA regulations;
3. Training delivery and performance standards established by OSHA and/or Company XYZ to ensure employee competence;
4. Monetary and resource availability from Company XYZ for safety programming and;
5. Overall adaptability of training procedures to include new employee orientation training and current employee retraining.

Through interviewing existing employees, it was discovered that Company XYZ may further benefit from the introduction of alternative media training aids in addition to what is currently in use.

Review of Company XYZ's profile discovered that five topics that demand training by OSHA need to be provided for all field employees. Educational training for an additional two topics was necessary for 50% of field population. To show the magnitude of deficiency, one company region (Area 1) was chosen and the trainer to employee ratio was established. It showed that Area 1 has one safety trainer and an estimated average of 160 mobile employees. An average of five employees are trained at one time and an average training session can be performed in about one hour. Using the established profile, it was found that the safety trainer needs 4 workweeks of 40 hours each to complete the needed safety training for the five required topics to the entire field

employee population. This estimate of 160 hours of training does not include varying travel time between employee groups.

An additional training issue dealt with the start of seasonal training and the amount of time it takes to properly train the employees for work. This has the ability to cause either a time gap of non-compliance for some of the employees or a delay in the start-up of work on certain projects. Review of Company XYZ's current practices show that a time gap in compliance is a more prevalent outcome of the training deficiencies than the delay of work start-up. Additional review of available information has shown that current training practices and resource allocations of Company XYZ result in safety compliance deficiencies for new employee orientation training and current employee re-training before the onset of work.

Purpose:

The purpose of this study is to review the training effectiveness of multimedia venues while identifying the economical ramifications of completing government regulated training for an entire worker population.

Objectives:

The study is designed to complete the following objectives:

- To evaluate resource allocations of Company XYZ's training program and compare them with estimated employee training needs.
- To review OSHA compliance regulations and training criteria for targeted construction regulation standards.
- To compare training style characteristics and effectiveness of program application.

- To identify needed components of effective multi-media video based training materials.
- To perform a cost benefit analysis of current training practices to evaluate multi-media video and computer based training as a possible technique.

Assumptions:

1. Due to expressed interest in updating current employee training material and further introduction of additional multi-media formats, it is assumed that Company XYZ would like the templates of the material produced through this study to be adaptable to different delivery media.
2. From review of past practices and current reported budgeting parameters, Company XYZ would not be increasing the number of safety trainers per area by the completion of this study.
3. Due to the job positions held and the responsibilities of those Company XYZ employees interviewed, all information on safety training practices and procedures contained within this study are accurate as of Fall/Winter 2004.
4. From the known trainer to employee ratio in combination with reported practices, it is assumed that Company XYZ has employees working while non-compliant with OSHA topic specific training regulations.
5. The data used for current and projected company employee amounts, hours spent for training, and costs associated are an accurate and up to date model of Company XYZ's current performance status.

Limitations:

1. This study is limited by the low to non-existent number of new employees that need orientation for Company XYZ during the fall/winter section of the 2004 Minnesota construction season. Due to the identified low number of new employees for Company XYZ during the duration of the study time period, the pool of respondents for the study had to be widened to include construction employees from other firms.
2. This study is limited by the non-ability to compare the effectiveness of various multi-media video styles to other multi-media video styles currently not available to Company XYZ for reasons of financial and confidentiality constraints of the company.
3. This study is limited by the fact that training was geared toward personnel already familiar with construction work. The performance effectiveness of an in-house produced video as a training tool would be better evaluated by testing a random set of the population.
4. The number of participants for potential training could not be fixed, therefore the number of participants used for the cost benefit analysis needed to be estimated. This averaging of participation groups causes a bias in information presented due to the inability for the cost benefit analysis to account for special projects and emergency situation training.
5. This study was limited by the incompatibility of the pre-packaged commercially produced video available to Company XYZ to the custom built testing tool which assessed the knowledge base necessary to fulfill the parameters of Company XYZ training.

6. The pre-test and post-test given were exactly the same content so a direct comparison of test performance could be made. The use of the pre-test before viewing the video turned the viewing of the video into an information delivery scenario where the subjects could recognize the information being tested as they viewed the video. This scenario negated the measurement of the in-house produced video as a direct instructional tool to an uninformed study population. In this manner, the study was able to measure the information delivery capabilities of the in-house video.

Definition of terms:

ACGIH – American Conference of Governmental Industrial Hygienists

Fall arrest system – Personal protective equipment used to abate a potentially harmful fall from and elevated area. A fall arrest system consists of a body harness, lanyard, and connecting anchor points all weight rated for 5000 lbs. or more.

Fall restraint system - Personal protective equipment used to abate a potentially harmful fall from an elevated area. A fall restraint system consists of a body harness, a restraint lanyard, and connecting anchor points weight rated for 3000 lbs. or more.

In-house produced video – A video prepared, filmed, produced, and directed by employees of the company for which the video is to be used.

NIOSH – National Institute for Occupational Safety and Health

OSHA – Occupational Safety and Health Administration

PPE – Personal protective equipment: safety equipment used to protect persons from hazards in their immediate environment.

Pre-packaged commercially produced video – A video that was prepared, filmed, produced, and directed by a company which professionally produces and sells video modules.

Chapter II: Literature Review

Multi-Media Performance Review

The purpose of this study is to review the training effectiveness of multimedia venues while identifying the economical ramifications of completing government regulated training for an entire worker population. Current Company XYZ practices include the use of written material and the use of qualified on-site training personnel. Interest in additional media includes mobile and on-line adaptable multi-media venues. According to the Gartner Group's website, "technology based, self-directed learning is fast becoming the training method of choice for successful organizations worldwide," and the use of these new technologies can introduce an efficient and cost effective means of training into an organization (Giles, 1997). Additional advantages of multi-media use in training can include the standardization of delivered material and the flexibility of providing the training in multiple languages. One such multi-media venue is video. According to researchers, video can have the potential to provide a standardized and complete presentation of concepts and skills while possibly enhancing overall teacher performance (Dusenbury, Hansin, Giles, 2003). This standardization would help to ensure that all employees receive the same level and amount of training. The standardization of safety training curriculum through video would also ensure that no subject was missed or forgotten about as long as the entire video program was seen. Due to the flexibility of video being provided in other languages, the standardization of curriculum should have the ability to be transferred across language barriers as long as the video translation was tested and reviewed for understanding. If translated correctly, the video could provide a valuable tool for raising safety training outcomes and

effectiveness for non-English speaking workers. A rise in safety training competency and effectiveness is shown in a study of Latin American employees that participated in a computer based training program. It was found that although the participants needed extra time to master the concepts in the second language, the employees were well prepared and confident after they had finished training (Giles 1997). This effectiveness and flexibility of multi-media training in other languages can prove to be an asset as well as a possible necessity for organizations like Company XYZ. Research has shown that in the US, the construction industry has a growing number of employees whose primary language is something other than English and this trend is expected to continue with a very consistent possibility of increase (Stromme 2001).

Although video and computer based training (CBT) style training have advantages, is the adoption of these multi-media styles an effective substitute for in-person training by an instructor? Thus far, video and multi-media have shown to be very promising but studies have been inconclusive about the degree to which video can substitute for a live instructor (Dunenbury et al.2003). One study by Botvin et al. compared video enhanced style of computer assisted learning to other types of computer assisted learning and found that the results were inconclusive (Quealy, Langan-Fox, 1998). Deductive reasoning suggests that if all variables other than the delivery medium were held as constants, the results of learning from the different programs would show little to no differences (Quealy, Langan-Fox, 1998). The inconclusive results of delivery media effectiveness comparison studies show that it is not known whether video is better or worse than live instruction. If current research cannot identify whether video is less or more effective than live instruction, it can then be concluded that video and multi-media

strategies may have the ability to be equal to live instruction and are thereby able to be substituted for live instruction when chosen. Some studies do give support that individuals trained through video means have performed at higher levels than those otherwise trained. Data analysis of 82 participants who completed both a pre-test and a post-test of survey knowledge questions showed that improvement between the pre and post test was consistently better among those participants who were exposed to video versus those participants who were not exposed to video (Dusenbury et al. 2003). In accordance with this, it was also realized that even though standard training had a positive effect on improvements, the video-enhanced training resulted in even greater improvements including nearly perfect understanding of the material within the normal setting employed by the study (Dunsenbury et al. 2003). Through other comparisons of multi-media delivery tactics, broad support was found to show that both audio and visual presentation delivery tactics lead to higher recall and better performance than the use of stills alone. This was found under all conditions tested (Quealy, Langan-Fox, 1998). The realization of harnessing multiple means of sensory perceptions as combined avenues to increase the impact and effectiveness of training can be used to the advantage of Company XYZ's safety training programs.

Training regulations and standards

Although there is no OSHA regulation that defines and delegates a step-by-step process that needs to be followed in an organization's training process, the need for accurate and timely training on compliance issues is a must. For the different topics that an organization must cover to stay in compliance with OSHA regulations, the minimum needed parameters of the training component are quite often listed within the regulation

itself. An example of this phenomenon can be seen in regulation 29 CFR 1910.132. The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following: when PPE is necessary; what PPE is necessary; how to properly don, doff, adjust and wear PPE; the limitations of the PPE; and the proper care, maintenance, useful life and disposal of the PPE {29 CFR 1910.132(F)(1) thru 29 CFR 1910.132 (F)(I)(V)} (OSHA General Requirements 1910.132). These types of regulation parameters provide a base of what is to be covered as a minimum of being compliant to this regulation. The process of the training is not delegated and is therefore defined by the organization and the perceptions of the training instructor. In addition, definitions of training outcome and measurement are also listed with the same type of perceptual expectations. OSHA regulation 29 CFR 1910.132(F)(2) thru 1910.132 (F)(3)(iii) state that each affected employee shall demonstrate an understanding of the training specified in paragraph (F)(1) of section 1910.132 and the ability to use PPE properly before being allowed to perform work requiring the use of PPE. In addition, the employer shall retrain each employee that the employer believes does not have the understanding and skill required by paragraph (F)(2) of section 1910.132 (OSHA General Requirements 1910.132). When terms like "demonstrate understanding" and "reason to believe" are used in a regulatory standard the avenue for perceptual defining can be used by an employer to customize training methods. This weakens the standardization of expected performance thereby creating unequally trained employees in the work population. To combat this problem from becoming a wide spread and prominent problem, OSHA has published an additional appendix to define some general criteria that may be used for assistance in developing

site-specific training curriculum which meets the requirements for other 29 CFR regulations (OSHA Training Curriculum Guidelines). Although these published criteria are well defined and thought out, the use of the criteria is listed as non-mandatory. Therefore the practices of non-standardized training can still exist. This phenomenon not only occurs from business to business but can also occur from instructor to instructor. The use of multimedia approaches can help bring training processes closer to standardization by ensuring that all recipients receive the same information. In relation to course materials, OSHA states that all written and audio-visual materials in training curricula should be peer reviewed by technically competent outside reviewers or by a standing advisory committee. The reviewers should possess expertise within disciplines applicable to occupational safety and health (OSHA Training Curriculum Guidelines). Once the listed criteria for the educational needs of a regulation are incorporated into a training program the delivery of the material can be chosen by the employer. Using the non-mandatory course material listed in 29 CFR 1910.120 AppE as suggested parameters, the employer can create and/or apply a multi-media based program that would be compliant to the needed standards and regulations that must be legally followed.

For Company XYZ, construction related topics to be trained include personal protective equipment (PPE) use, fall protection, aerial lift use, aerial basket use, respiratory training and lead training. Each of the topics listed have training component criteria listed with each standard found in the chapters of 29 CFR 1910 and 29 CFR 1926. Upon review of 29 CFR 1910.132 the general requirements for PPE training have no media delivery specifications present (OSHA General Requirements). Additional review

has shown that fall protection regulations also do not contain delivery media specifications (OSHA Construction Industry Fall Protection). Therefore, multimedia training can be used for both PPE and fall protection training needed by Company XYZ and using such training methods would meet OSHA regulations.

Training Video and Alternative Multi-Media Needs

Since it has been shown that multi-media training meets OSHA requirements, the next questions to be answered are: 1) what are the needs of effective video programming and 2) how can video be constructed so that effectiveness is not lost when adapted to different means of training delivery systems such as onsite video or web based training. According to the August 1996 issue of HR Focus, the worksite will replace the classroom as the delivery point of information with a focus on user-friendly interactive training programs and media (HR Focus 1996). An effectively constructed video must have the ability to adapt to other multiple means of delivery. An example of this is the incorporation of video clips into on-line training and in-house CBT training. Statistics cited show that 63% of US adults are now on-line and many have built internet use into their daily lives (Carter 2004). The statistic of 63% of adults on-line in conjunction with the high success rates found with on-line training and information delivery strengthens the motivation an organization may have to include safety training video streams into their on-line availability practices (Carter 2004). The useable video streams that a company employs can and will become more complete and operational in form due to the phenomenon of on-line video access fueling the wide scale spread of high-speed internet use by companies and individuals (Carroll 2003). The advancements of such technologies will make adaptation of training easier and more effective for continually growing

populations and organizational cultures. The incorporation of such mass multi-media components streamline the needed delivery resources needed and can increase interaction with the educational material by making it much more available at any time and any where.

An effective safety video, which can be adapted into a useable video stream or an on-site video trainer, has been shown to consist of many components. Style choices, user perceptions of delivery methods usability, and available access to the delivery media are all components that can be related to video effectiveness. Whether a video is made in-house or professionally produced, the style choices can be broken into the categories of: 1. A staged performance or 2. A realistic performance approach (Carlberg 17). For the in-house interest of Company XYZ, the focus will target the realistic approach. Due to the blue-collar classification of the worker population majority needing specified training within Company XYZ, realistic training videos can prove to be an asset in training. When Boeing experimented with an on-site filmed training module for their mechanics, the feedback Boeing received from the participants was positive and encouraging. The feedback included the mechanics preference of the realistic training because the mechanics were learning from peers in a familiar setting and managers liked the simple hands-on approach of the video segments (Kiser 1999). In addition, the US Geological Survey has developed skills training modules similar in production style to the realistic approach and uses the modules for on-site education of employees that are doing earth science investigations in the field (Kiser 1999).

A literature review prepared by Cohen and Colligan found that everyday experiences can be seen as a form of continual training (Cohen, Colligan 1998). In many

respects, the effective and applied use of realistic safety video production can be seen as framing these everyday experiences and making them available for learning and referencing any time and any place needed. When trying to accomplish realism there are some very specific components needed. The first considerations to be taken into account are audio needs. The background sounds and the dialogue must be consistent with the surroundings of the audience to relay a sense of realism, "The audience knows the dialogue isn't realistic; the vignette writer looks out of touch with the trainee's world," (Carlberg, 1985 p46). Carlberg defines what is needed for realistic dialog as: First, do not write all dialog in complete sentences, use natural conversation. Second, use everyday words whenever possible. This includes mildly rough but non-offensive languages. Third, incorporate pauses where they should naturally occur. Lastly, incorporate dialects if needed (Carlberg 1985). For authentic video Carlberg states that video should be filmed in authentic locations and settings to convey the feel of realism that is wanted. Additionally, Carlberg states that realistic lighting and natural movement within the locations and settings can prove to be a fundamental part of creating realistic video (Carlberg 1985).

In addition to the realistic filming characteristics needed during the video construction process, the safety training video must also be able to meet user educational needs in an effective manner. The in-house videos produced will only maintain effectiveness if the safety videos can maintain viewer motivation and interest while the user is viewing the material (Carter 2004). To truly maintain a high level of effectiveness, the safety training videos produced must be user friendly, up-to-date, adaptable, relevant and an established level of privacy must be maintained (Carter 2004). There must also be

assurance that the target audience has the necessary knowledge base to effectively participate in the training. Therefore the option of offering computer and/or technical training as possible pre-safety training needs may be considered. (HR Focus 1996). In relation to Company XYZ and other similar construction companies the interest topics for video and internet/video stream safety training can include but are not limited to personal protective equipment, hazard communication, equipment and machinery use and care, emergency action plans, scaffold use, set-up and precautions, excavation issues, fall protection and hazard recognition (Stromme 2001).

Summary of Literature Review

Mandatory regulations that must be followed by Company XYZ and other similar construction companies state that effective training needs to be done, but the parameters of how, what media, and the functional conduct of the trainers are not specifically designated by the governing regulations. The use of multi-media venues for safety program delivery can meet compliance regulations as long as identified expectations, records, and measurement tool parameters are met. Multi-media use within the safety training programs can add avenues of cost reduction, increased delivery speed, possible increases in effectiveness through the use of realism, the freedom of an anytime-anywhere training and the flexibility of multi-lingual programming. Furthermore, the incorporation of realistic video can prove to be a valuable asset for the safety training program by increasing effectiveness, adding positive feelings of peer mentoring and increasing believability of the safety training program messages. All positive effects of a video based safety program can be accomplished if training considerations, audience population and concept needs are taken into consideration at the onset of video design.

Chapter III: Methodology

This study was performed to review the training effectiveness of multimedia venues while identifying the economical ramifications of completing government regulated training for the entire worker population of Company XYZ. No specific site of Company XYZ was selected due to the mobile traveling nature of potential participants. The participants qualified for the study through parameters determined acceptable by Company XYZ and the study author. Choosing participants involved with or having past experience with construction was necessary as a qualifying participation parameter. This was seen as a necessity to measure the effectiveness of the in-house designed training video to be used as a re-training tool in addition to an orientation tool for Company XYZ.

Preparation of in-house video:

The subject chosen for the in-house video was narrowed down to the most common topic of concern for Company XYZ. Due to the commonplace need for fall protection/personal protective equipment (PPE) training for nearly all workers of Company XYZ, the fall protection/PPE subject was determined to be high priority. Filming location was chosen based on availability and an acceptable level of environmental and lighting control. Equipment used as props in the filming consisted of standard issue personal protective equipment of Company XYZ. Personal protective equipment used consisted of 1 Company XYZ hard hat, 1 set of hearing protection muffs, 1 set of eye protective safety glasses and 1 Company XYZ high visibility shirt. For the fall protection donning and doffing demonstration, 1 Company XYZ standard issued DBI SALA© fall arrest system harness was used. The video demonstration consisted of a

trained construction worker properly donning the DBI SALA© harness while demonstrating proper buckle, clip and harness fit safety checks. The process of fall arrest harness donning, safety checks and fit checks matched those of the manufacture's donning process suggestions. Dialogue was not used during the demonstration filming due to the planned use of an instructional voice-over in the final product.

After the video section was filmed, the video clip was downloaded into a Microsoft compatible computer and edited using a Microsoft compatible digital video editing and rendering program. The non-picture stills added to the video project consisted of informational slides created using a power point presentation program. The power point presentation information was taken directly from the educational material Company XYZ currently used for employee training. The power point slides were saved as Jpeg files and inserted into the video as individual stills. The amount of time each slide was visible during the video was adjusted to match the time needed to complete the voice-over for each slide. Once the full sequence of the video and stills were installed, a descriptive dialogue was written, recorded and installed as the voice-over. OSHA regulations and Company XYZ protocol standards not addressed in the video were provided in hard copy form. Initial production of the in-house training video for Company XYZ was completed using English as the only voice-over language. Once the voice-over was installed, the final product was rendered and burned onto a DVD.

Delivery and testing:

The Company XYZ in-house safety video was delivered on site using a portable Polaroid PDV-0801A DVD player. A Dell 2300mp projector with audio capabilities was used in conjunction with the portable DVD player when applicable. The participation

groups consisted of one to six workers per group. An estimated eight to ten groups were trained for a total population of 30 to 40 participants, additionally a single group consisting of 32 employees were trained for a total population of 62 to 72 participants. All participants of the single group were employed as foremen, superintendents, or project managers of Company XYZ at the time of the study. During a portion of Company XYZ's annual foreman / superintendent meeting for the division participating in this study, the inclusion of the fall protection / personal protective equipment video was used as a training and feedback session for the effectiveness of the in-house video produced. In regards to the entire study population, all participants taking part in the training are current Company XYZ workers, currently employed in other construction venues, or have an acceptable background in the construction field. The percentage of participants that have had past fall protection training were compared to the participants who have not had any fall protection training. This comparison was used to determine the effectiveness of the in-house video as a re-training tool versus a fall protection orientation tool. The process of video delivery consisted of participants viewing the entire video, taking a pre-constructed test on the information given, then checking the tests using the test correction section of the video. See Appendix A for a replica of the test and participation information given. The in-house produced video used was designed with a root menu, which automatically loaded upon entering the video player. The root menu consisted of 2 options: option 1 played the in-house produced training video; option 2 played a review of answers and brief explanations of each questions. The training video could be stopped, re-wound, or fast-forwarded at any time. Upon completion of the video training portion, video and audio directions instructed the next steps to be taken.

The questions on the test consisted of questions taken from Company XYZ's current fall protection/PPE training curriculum. The testing tool was designed with a pre-test and post-test within the same document. Directions of when to use the video to perform the needed training, fall protection training history of the participants, and permission of participation from those being trained were all included.

A statistical analysis of the safety training video's performance was completed using the data taken from the initial pre-test and post-test scores of the participants. A test score of 90% or higher would qualify the participant as showing acceptable mastery of the information given and thus certify the participant in the fall protection/PPE topic according to Company XYZ's standards. Anything less than 90% would indicate that the participant's performance as not acceptable and the topic information found wrong on the test would need to be reviewed by the participants until a 90% or greater test score could be achieved. The first viewing with the full pretest and post-test completed was labeled "Test 1". The need for an additional reviewing of the video for those participants that did not score at an acceptable level on Test 1 was noted. The testing tool used after the additional video review consisted of the post-test section of the original test. The post-test that followed the additional review was marked "Review 1". Any participant's Review 1 post-test that had not achieved a score of 90% or higher deemed the participation as a failure. The failure status was recorded, and no additional video review or testing was needed there after. All failure status scores recorded would be considered as non-acceptable performance by the training media.

A comparison of the in-house produced training video performance to a commercially produced pre-packaged video covering fall protection issues was

accomplished using an RCA VCR Plus 4-head video system, the Dell 2300mp projector with audio capabilities, and the constructed testing tool for this study. The participants eligible for this portion of the study needed to have the same background and qualifying parameters as the participants viewing the in-house produced video. The participants for the comparison portion of the study would take the pre-test, view the pre-packaged video, and then take the post-test. The participants for this portion of the study would only go through the viewing and pre / post testing once, regardless of achieved final post-test score. The results are to be used as a direct comparison of the single viewing effectiveness between the pre-packaged video and the in-house produced video. Test 1 scores of the pre-packaged video viewers were to then be compared to the Test 1 scores of the in-house produced video viewers. No comparison between the in-house review test scores and the pre-packaged video viewer Test 1 scores was to be performed.

Data Analysis

The statistical analysis of this study consisted of the direct comparison of the descriptive performance statistics for the pre-test and post-test scores. Through comparison the statistical performances and the average change in test scores an overall evaluation of the in-house delivery systems effectiveness was determined. The cost benefit statistics were analyzed through the direct comparison of the projected costs of current training practices and video delivery system estimated costs.

Chapter IV: Results and Discussion

This study was performed to review the training effectiveness of multimedia venues while identifying the economical ramifications of completing government regulated training for the entire worker population of Company XYZ. No specific site of Company XYZ was selected due to the mobile traveling nature of the employees and additional participants used for the study. The participants that qualified for the study through parameters determined acceptable by Company XYZ and the study author had taken the same set of test questions for both the pre-test and post-test. The questions used in the testing tool were considered the minimum of informational recall needed for employee qualification of successful training completion. All participants were tested with the same test questions to standardized test scores for direct comparison.

Choosing participants involved with or having past experience with construction was deemed necessary as a qualifying parameter to enable a focus of effectiveness by the in-house designed training video to be used as a re-training tool as well as an orientation tool for those in or planning to be in a construction field similar to Company XYZ. An economical cost benefit analysis was performed by using current and past training practices and costs of Company XYZ's safety department. The number of employees and estimated training needs were derived from the current population status of Company XYZ and projected Company XYZ employee needs in relation to the procured work contracts of Company XYZ.

Limitations

This study was limited by the incompatibility of the pre-packaged commercially produced video available to Company XYZ to the custom built testing tool which

assessed the knowledge base deemed necessary to fulfill the parameters of Company XYZ training.

This study was limited in the measurement of the in-house produced video as an initial instructional tool through the design of the pre-test to video to post-test scenario. The pre-test and post-test given were exactly the same content so a direct comparison of test performance could be made. The use of the pre-test before viewing the video turned the viewing of the video into an information delivery scenario where the subjects could recognize the information being tested as they viewed the video. This scenario negated the measurement of the in-house produced video as a direct instructional tool to an uninformed study population. Through this scenario the study was able to measure the information delivery capabilities of the in-house video.

Commercially Produced Pre-Packaged Video Review

Upon review of the commercially produced pre-packaged fall protection video currently in possession for use by Company XYZ, the pre-packaged video was determined to be insufficient in information to effectively be used as a participation tool for this study. After direct comparison of the pre-packaged video to the custom built testing tool used by Company XYZ and for the purposes of this study, it was concluded that the highest score achievable based on the information given within the pre-packaged video was an estimated 70% correct. The training information inadequacies of the pre-packaged video are due to custom grouping of safety topics needed for the type of construction and safety hazards Company XYZ employees are exposed to. For the Company XYZ fall protection / personal protective equipment training module, the topics of company specific personal protective equipment, ladder use, and rebar injury protection were inadequately covered

by the available pre-packaged video being considered for participation in this study. To adequately cover the topics in question an estimated additional 3 videos would need to be purchased and delivered as parts of the Company XYZ fall protection / personal protective equipment training module. Therefore, due to the disqualification of the available pre-packaged video, only the performance of the in-house produced video was tested.

Cost Benefit Analysis and Economical Justification of Programming

The cost analysis of current Company XYZ training practices show that an estimated average of $75,500 is spent on a consistent basis each year. This amount only includes the costs for the eight specified topics of concern, therefore the overall safety training cost can be assumed to be higher than this listed amount due to additional topics that need to be covered. The total number of employees and the training times used in the economic justification were based on the number of post participants. Company XYZ has three safety personnel that perform the training delivery tasks, only needed three complete sets of training materials may account for a lower total cost of prep/upkeep due to the updating of materials only being performed 3 times when needed. The total prep/upkeep cost for Company XYZ is $8,823.60 while the total delivery cost of Company XYZ is $66,726.11. Through this comparison it can be seen that the bulk of cost incurred is generated by how the product is being delivered and not by maintaining and preparing of the programming.

The cost analysis of creating an in-house produced video delivery system shows that the initial year costs incurred by Company XYZ are estimated as being close to, but not exceeding, the listed average costs of currently employed practices. The total initial

investment plus trainee costs of $57,054.50 compared to the current trainer to trainee practices costing $75,549.71 in year one shows that both styles of training delivery are comparable in incurred cost, with the cost saving advantage of $18,495.21 to the company through the use of in-house produced videos. The most prevalent economic advantages of producing an in-house video as a delivery system for safety training is identified in the cost saving incurred during long term investment into the video production systems. Although the initial costs of equipment may be considered substantial, through the depreciation of initial costs incurred transferred over a three year investment life span of the equipment, the overall costs projected for the equipment purchased can be reduced to $498.34 per year for each of the three years the video is estimated to be in service. The ability to depreciate costs over an investment period gives a cost savings advantage to the in-house produced video over the trainer to trainee style of delivery system. The trainer to trainee style has annually reoccurring direct costs with no investment into tangible items. This is why the projected three-year cost of the currently practiced trainer to trainee style employed by Company XYZ is $226,649.13 with no avenues of cost reduction. The projected 3-year cost of installing an in-house produced video delivery system is estimated at $158,104.50, showing an investment savings of $68,544.63 over the projected active life span of the produced videos being in service. The economic analysis also shows that the in-house video information can be transferred into a web page based delivery system for a one time estimated cost of $8,882.46. The transfer of the in-house produced video information into a web page format delivery system is accomplished by using the available components of the in-house video and writing the information into HTML format for publication onto the

Company XYZ web page. This greatly increases the availability of the video product to the employee population.

Advantages and Disadvantages of Training Delivery Systems

Through the implemented use of the in-house produced videos, the time that was spent by personnel on training the employees can be transferred toward other areas of concern for Company XYZ. Through the use of the video delivery system, Company XYZ can accomplish the training tasks needed to be in compliance with the regulations necessary. Since the training is being completed in a matter which does not use a large bulk of the safety personnel's time, additional time can then be utilized for the further advancement and study of current Company XYZ safety and risk issues. More time can be available for issues and concerns that mandate a more direct hands-on approach than simple informational training mandates. Examples of such topics include but are not limited to on-site hazard audits, industrial hygiene testing, accident and hazard investigation, and safety design and engineering practices.

The work hours still needed for proper upkeep and information up-dating can be reduced to equal the average time and cost being spent on current Company XYZ preparation and upkeep practices of the existing training modules. Additionally, portions of the video and web page upkeep may also be out sourced to other personnel at a lower cost per hour. This style of outsourcing has the ability to free additional time of safety personnel by reducing the amount of simple word processing, directory filing, and other office tasks that may be consuming work hours of the safety personnel. Furthermore, the out sourcing of certain upkeep tasks may prove to be beneficial to the quality of the training product by utilizing the skills and talents of other office personnel.

customized issues of Company XYZ could not be addressed and would thereby make the use of this tool ineffective for the needs of Company XYZ.

The in-house video was deemed as having many advantages as well. The ability to control and customize the educational material to emphasis issues of concern to Company XYZ proved to be an advantage. The information delivered in the in-house produced video covered all topics within the current fall protection and personal protective equipment training module in use. Additionally, since the video creation template is now on file, any up-dating or informational change needs can be performed by Company XYZ. The subjective observations about the in-house video were collected from the participants of the study through written recording of verbal comments. The in-house video advantages included a perception of being more personal toward Company XYZ employees through the use of Company XYZ worksite scenarios and photos of current workers within the video. A disadvantage of the in-house produced video consisted of additional work involved with obtaining the finished product when compared to simply buying the pre-packaged video.

Both styles of video can prove to have advantages over Company XYZ's current trainer to trainee practices. Video delivery system utilization can reduce costs and work hours spent on delivering training. Video can also standardize the information given by showing the same information each time. A major disadvantage of video when compared to trainer to trainee training is the inability of video to interact or spontaneously adapt to questions or perceptions that may arise during the training session.

When is video applicable?

For complex and interactive styles of employee training the utilization of trainer to trainee training modules still may prove to be the most effective means of employee education. For simple informational styles of employee training the utilization of video delivery systems can prove to be beneficial due to its easily controlled nature and the ability to be mass distributed. The use of video can also standardize the information relayed to the employee and ensure that each employee that viewed the module has had the same instructions and information.

What style of video is better?

A carefully produced in-house developed video can prove to be an acceptable and cost beneficial means of employee training and education. An in-house produced video can be tailor designed to accommodate company specific issues and can be altered and up-dated to stay current with company changes and evolutions. The in-house produced videos can also emphasize a safety topic or issue that is a problem issue or area of special concern to a company.

Is an in-house video cost effective?

The initial costs of an in-house produced video can be partially divided into a depreciable investment avenue for a company. Unlike trainer to trainee annually fixed program costs, the video delivery system initial costs are spread out over the active lifetime of the product. This makes the investment of resources into a video delivery training system more profit saving as the product active life term grows.

The general information found by this study shows that a cost savings can be seen by Company XYZ through the implementation of in-house produced safety videos. The information effectiveness can be increased due to the custom tailoring of the in-house

video to the specific topics that need to be covered annually through Company XYZ's safety training program. Overall OSHA regulated compliance issues can effectively be covered each year for Company XYZ's employees through the use of the different multi-media delivery systems available, and the information given through those delivery systems can be standardized to ensure that all employees receive the same information. Due to the comparable effectiveness and cost savings to the company, the implementation of an in-house produced safety video series is recommended.

Chapter V: Conclusions

Through review of the information gathered the following four points were found to be directly related to the needs of Company XYZ's safety training program:

- In-house produced safety training videos can have the same performance capabilities and level of potential training effectiveness that other means of safety topic training styles have. In-house produced videos can standardized the information which is given to all participants in the training programs and can prove to be a useful tool in re-education or topic review as needed, while keeping the confidence of the users that the information is the same as the information that was originally given.
- In-house produced videos can prove to be more effective than commercially produced pre-packaged videos. This is can happen because the in-house produced videos has the ability to be specified toward topics and scenarios directly related to what information is needed by the tasks to be performed.
- The cost effectiveness of using a multi-media venue for standard orientation and yearly review has been shown to save a significant amount of money over time compared to the current safety training practices employed by Company XYZ.
- Current regulations and Company XYZ training policy requirements can be met by employing multi-media venues as a single facet or in conjunction with current training practices for the work population covered by this study.

It is the recommendation of the author that the use of in-house produced multi-media video safety training venues be employed throughout the company. The initial investment return can be seen within the cost savings of the first year and the

additional cost saving after that can be moved into the profit margins of the company. The employment of the multi-media venue will speed up the training process and raise compliance with regulated training needs.

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Appendix A

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Participant Rights and Responsibilities for Participation in Research
Consent to Participate in UW-Stout Approved Research

Title: Effectiveness and Cost Benefit Review of In-house Designed Safety Training Fall Protection and Personal Protective Equipment Multi-Media Video.

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Description:
This study is focused on the effectiveness of an in-house fall protection video designed for fall protection orientation and re-training where necessary. This research is not a test of your personal fall protection awareness, it is a test of how well the in-house style of video can educate the target audience.

Risks and Benefits:
The risks involved with co-workers or employers being notified of substandard scores will be protected against through the use of confidentiality practices and anonymous testing.

Time commitment:
Video viewing and all testing has been estimated to take 45 min: 35 min video – 5 min pre-test, 5 min post-test.

Payment:
No payment is offered for participation.

Confidentiality:
No personally identifying information will be recorded and the investigator will be the only one to administer the test. Only your knowledge base about fall protection will be assessed in areas regarding the information covered by the in-house produced video.

Right to Withdraw:
You have the right to withdraw or stop participation with no adverse consequences to you and no need to inform the investigator why. However, if you choose to withdraw your participation after the testing is completed and turned in to the Investigator your information can not be removed because there is no way to identify your answers or score from the anonymous document.

If you have any questions or concerns reguarding this study please contact any single or combination of the following:

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This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Participation Consent Form and Quiz for Video Safety Program Review

Project coordinator - William Olson

Are you over 18 years old? YES NO

Do you currently work or have had at least 2 years past experience in a construction field? YES NO

Have you had Fall Protection training in the past from an employer? YES NO

By checking the YES permission box below, you give your permission to use the results from the following data for statistical data as participation in this study.

☐ YES, I give my permission to use my test results for statistical review of the safety video.

☐ NO, I do not give my permission to use my test result data in any way.

Date _____

Fall Protection and Personal Protective Equipment Quiz – **Pre-Test**

1. True or False. Hard-hat and eye protection are needed at all times while performing work duties on the job-site.

2. True or False. Both upper and lower body high visibility outer-wear with reflective striping is needed for all night work in traffic areas.

3. What is the rated capacity of the anchorage connectors used in the fall arrest system?_____

4. What are 4 dangerous concerns to look for while inspecting your personal fall arrest system?
   1.
   2.
   3.
   4.

5. To be rated as a qualified fall restraint system, what is the required anchor point (Anchorage connector) capacity weight? Circle one: 3,000 lbs
   5,000 lbs
   10,000lbs

6. True or False. Steel plated flat rebar caps are designed to provide protection from impalement form falls of 7.5' in height or less?
7. All floor and roof covers must be marked clearly with the word "HOLE" or "COVER". What weight must the floor cover be able to withstand?

A.500lbs B. 2 times the expected weight C. 10 times the expected weight

8. When building guardrails, what must the material used be able to support for load weight?
   100 lbs 200 lbs 400 lbs 1000 lbs

9. True or False. While building guardrails, the top-rail must be installed between 39 inches to 45 inches in height and a midrail must be installed at a level roughly at the mid-point between the floor and the toprail.

10. True or False. Ladders should be place at a 4:1 ratio and extend 3ft past the access point on the top, if this is done the ladder does not need to be tied-off or secured in any other way.

View Fall Protection and Personal Protective Equipment Training Video Here

Fall Protection and Personal Protective Equipment Quiz – **Post-Test**

1. True or False. Hard-hat and eye protection are needed at all times while performing work duties on the job-site.

2. True or False. Both upper and lower body high visibility outer-wear with reflective striping is needed for all night work in traffic areas.

3. What is the rated capacity of the anchorage connectors used in the fall arrest system?_____

4. What are 4 dangerous concerns to look for while inspecting your personal fall arrest system?

   1.
   2.
   3.
   4.

5. To be rated as a qualified fall restraint system, what is the required anchor point (Anchorage connector) capacity weight?

   Circle one: 3,000 lbs 5,000 lbs 10,000lbs

6. True or False. Steel plated flat rebar caps are designed to provide protection from impalement form falls of 7.5' in height or less
7. All floor and roof covers must be marked clearly with the word "HOLE" or "COVER". What weight must the floor cover be able to withstand?

A.500lbs B. 2 times the expected weight C. 10 times the expected weight

8. When building guardrails, what must the material used be able to support for load weight?

   100 lbs 200 lbs 400 lbs 1000 lb

9. True or False. While building guardrails, the top-rail must be installed between 39 inches to 45 inches in height and a midrail must be installed at a level roughly at the mid-point between the floor and the toprail.

10. True or False. Ladders should be place at a 4:1 ratio and extend 3ft past the access point on the top, if this is done the ladder does not need to be tied-off or secured in any other way.

Appendix B

Figure 1: New Employee Test Result Data

New Employees

Pre-Test	Post-Test	Change in test score
20	100	80
20	100	80
20	90	70
20	90	70
20	90	70
20	80	60
20	70	50
30	90	60
30	90	60
30	100	70
30	100	70
40	80	40
40	100	60
40	100	60
50	100	50
50	100	50
50	90	40
60	100	40

Average Pre-Test Score	32.8
Average Post-Test Score	92.8
Average Change in test score	60
Correlation Coefficient	0.38
Percent of participants achieving 90% score or higher post test	0.82

Figure 2: Current Employees Test Result Data

Current Employees

Pre-Test	Post-Test	Change in test score
30	100	70
30	70	40
30	90	60
30	90	60
40	100	60
40	90	50
40	80	40
50	100	50
50	100	50
60	100	40
60	100	40
60	100	40
60	100	40
60	90	30
60	90	30
60	90	30
60	100	40
60	100	40
60	100	40
70	90	20
70	100	30
70	100	30
80	100	20
80	100	20
80	100	20
80	100	20
90	100	10
90	100	10
90	100	10
90	100	10
90	100	10
90	100	10
100	100	0
100	100	0
100	100	0
100	100	0
100	100	0

Average Pre-Test Score	67.8
Average Post-Test Score	96.8
Average Change in test score	28.9
Correlation Coefficient	0.55
Percent of participants achieving 90% score or higher post test	0.95

Figure3: New Employee Pre-test and Post-test score

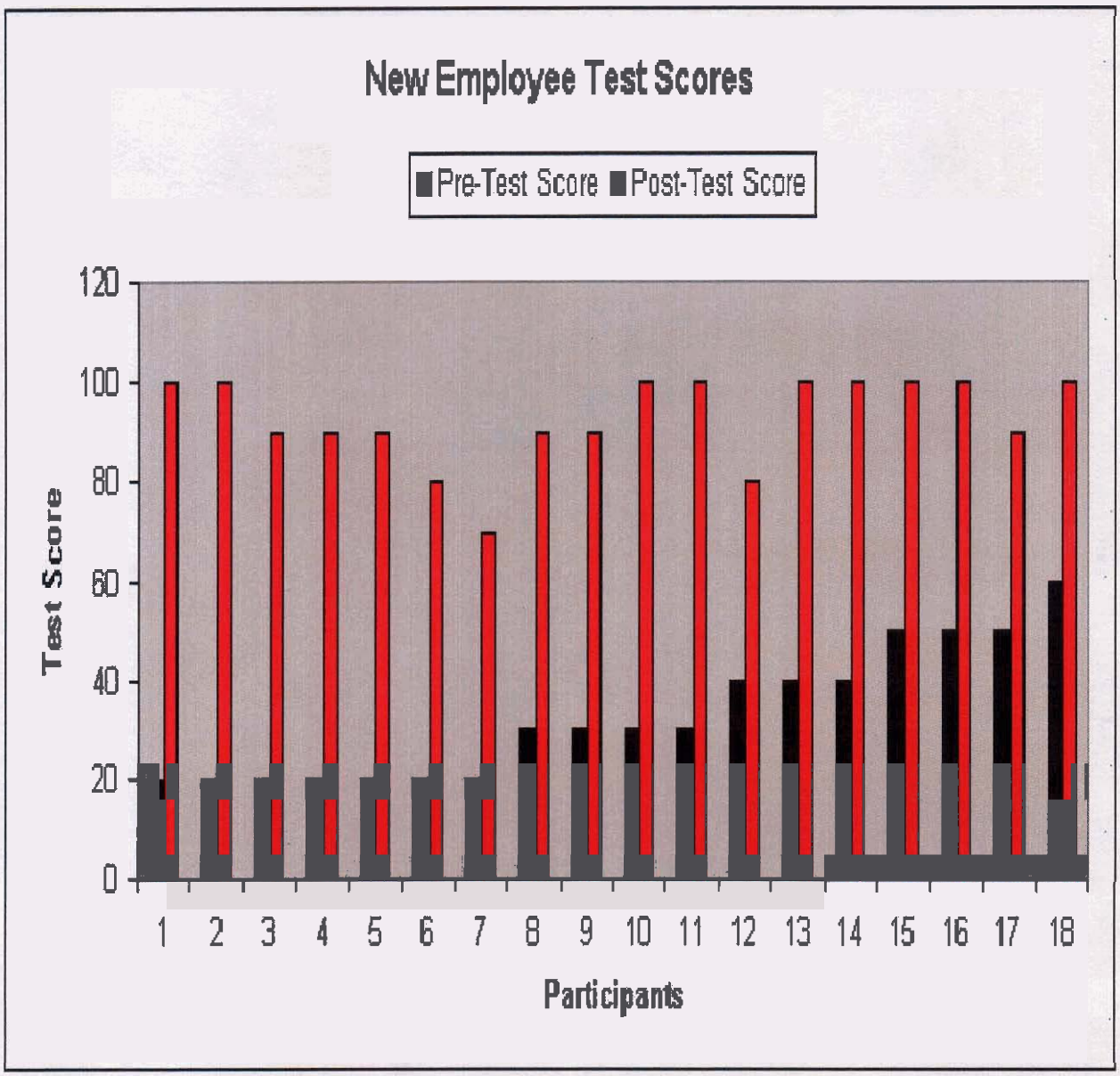
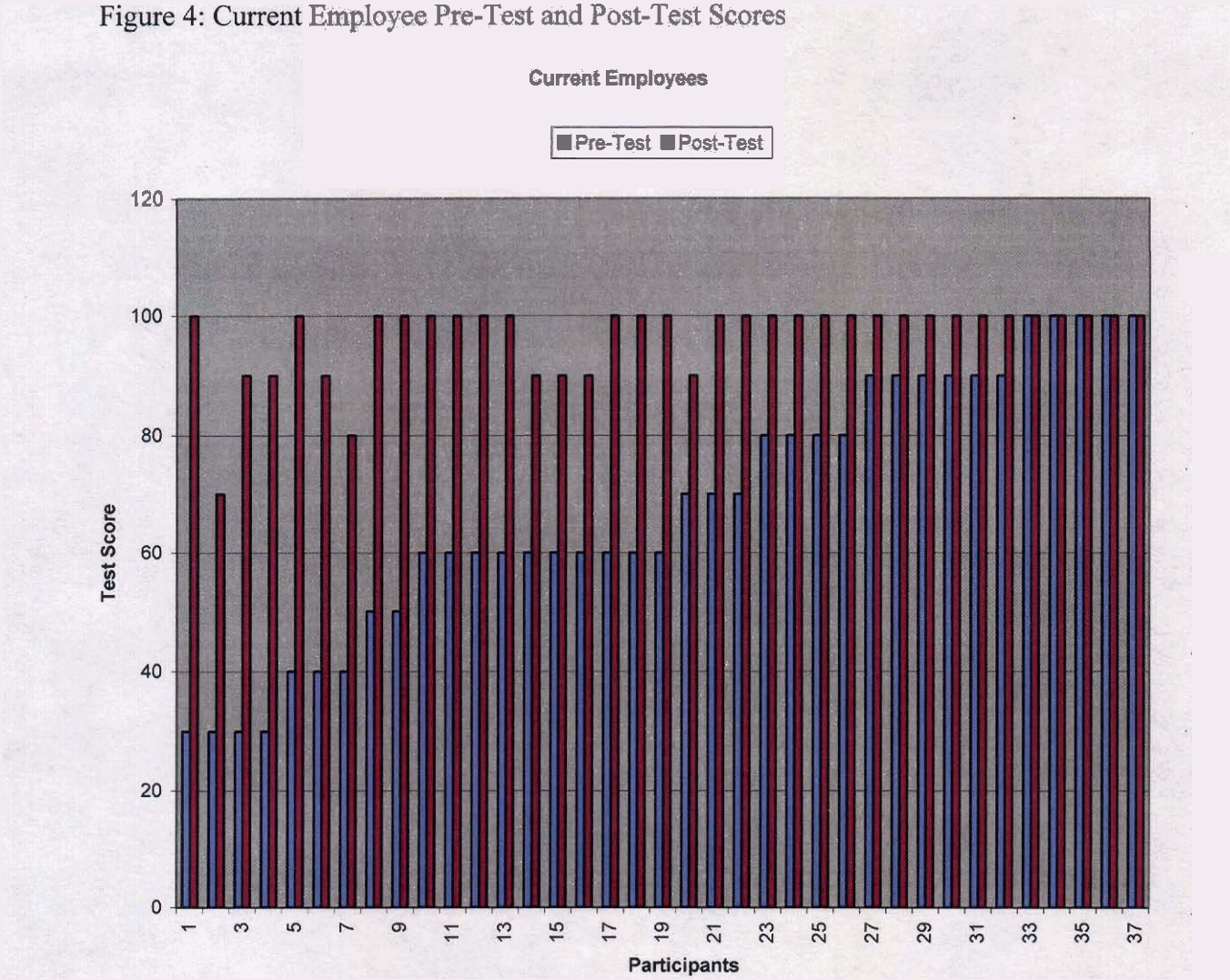


Figure 4: Current Employee Pre-Test and Post-Test Scores



Appendix C

Figure 5: Cost Benefit Analysis Data and Calculations

Company XYZ average time, costs per hour, and number of employees

Average hourly income for safety personnel:	$24.51 per hour
Average hourly income for Company XYZ participant	$21.50 per hour
Average time per training session:	1 hour
Total estimated number of employees trained annually in the 4 main topics:	510 employees
Total number of employees annually trained in participating region:	175 employees

Total estimated number of employees trained per year

Total estimated number of employees annually trained in lead abatement:	45 employees
Total estimated number of employees annually trained in lead abatement in participating region:	20 employees
Total estimated number of employees annually trained in silica abatement:	150employees
Total estimated number of employees annually trained in silica abatement in participating region:	65 employees
Total estimated number of new employees orientation trained per year:	115 employees
Total estimated number of new employees orientation trained per year in participating region:	45 employees
Total estimated number of sub-contractors orientation trained per year:	280 employees
Total estimated number of sub-contractors orientation trained per year in participating region:	110 employees
Average number of employees per training group:	4 employees

Average number of training sessions per year = Total number of employees / average number of employees per training group

Company XYZ total: 510 / 4 = 127.8 (rounded to 128 sessions per year)

Participating Region total: 175 / 4 = 43.75 (rounded to 44 sessions per year)

Average time spent by safety personnel toward updating, materials upkeep, training delivery preparation: 15 hours per year per topic

Prep/upkeep cost = time per topic X $24.51 X 8

Prep/upkeep cost = 15hours X $24.51 X 8 Prep/upkeep cost = $2941.20

Table 1: Total training cost of Company XYZ for 8 specified topics with an average session time of 1 hour

	1	2	3	4	
Topic	**Number of employees trained**	**Trainee cost (average/hour X number trained)**	**Average number of training sessions per year**	**Trainer cost (average/hour X 1 X time)**	**Total Cost (Column 1 X Column 2)+(Column 3 X Column 4)**
Fall Protection / PPE	510	$21.50	128	$24.51	$14,102.28
Hazcom	510	$21.50	128	$24.51	$14,102.28
Aerial Lift	510	$21.50	128	$24.51	$14,102.28
Aerial Basket	510	$21.50	128	$24.51	$14,102.28
Lead Abatement	45	$21.50	12	$24.51	$1,261.62
Silica	150	$21.50	38	$24.51	$4,156.38
New employee orientation	115	$21.50	29	$24.51	$3,183.29
Sub-contractor orientation	280	$0.00	70	$24.51	$1,715.70

Table 2: Total training cost for participating region of Company XYZ for 8 specified topics with an average session time of 1 hour

	1	2	3	4	
Topic	**Number of employees trained**	**Trainee cost (average/ hour X number trained)**	**Average number of training sessions per year**	**Trainer cost (average/hour X 1 X time)**	**Total Cost (Column 1 X Column 2)+(Column 3 X Column 4)**
Fall Protection / PPE	175	$21.50	44	$24.51	$4,840.94
Hazcom	175	$21.50	44	$24.51	$4,840.94
Aerial Lift	175	$21.50	44	$24.51	$4,840.94
Aerial Basket	175	$21.50	44	$24.51	$4,840.94
Lead Abatement	20	$21.50	5	$24.51	$552.55
Silica	65	$21.50	17	$24.51	$1,814.17
New employee orientation	45	$21.50	12	$24.51	$1,261.62
Sub-contractor orientation	110	$0.00	28	$24.51	$686.28

Three Company XYZ safety personnel need to stay up-to-date to train the 8 topics covered in this study. This is an average of 1 per region

Total delivery cost of Company XYZ training for 8 specified topics: **$6,6726.11**

Total delivery cost in participating area for 8 specified topics: $2,3678.38

Table 3: Total Costs

	Total Delivery Cost	**Total Prep/Upkeep Cost**	**Total Cost**
Company XYZ	$66,726.11	$8,823.60	$75,549.71
Company XYZ (Participating Region)	$23,678.38	$2,941.20	$26,619.58

Cost of In-house Produced Video:

Time spent by safety personnel on video filming, power point generation, video compiling, voice over, and video rendering for each: 25 hours

Total time spent on creation of the 8 specified topics: 200 hours

Total cost of in-house video creation for each topic = $24.51 X 25 hours =$612.75

Total cost of in-house video creation for 8 topics = total of each X 8 topics

= $612.75 X 8 topics **$4,902.00**

Estimated hardware computer system cost: $1,700.00

Estimated software computer system costs: $345.00

Estimated video camera with tripod cost: $515.00

Estimated digital still camera cost: $465.00

Total estimated cost of equipment needed for in-house video creation: **$1,495.00**

Long term equipment investment depreciation = 1/3 of initial cost over 3 years

Depreciation adjusted equipment cost for one year: **$498.34**

Blank DVD cost (each):$2.65 with an estimated need of 5 per topic: $13.25

Total estimated number of DVD's needed: 50

Total DVD cost = 50 X $2.65 **$132.50**

Time to transfer video into internet based web pages: 12 hours

Web page training module total cost for each: $24.51 X 12 hours = **$294.12**

Total first year projected cost of a single full production of an in-house video topic =

1 year depreciation adjusted equipment cost + person hours + blank DVD cost

$498.34 + $612.75 + $13.25 = $1,124.34

Total first year projected costs of all 8 topic full production:

$498.34 + (8 X $612.75) + (8 X $13.25) = $5,506.34

Average estimated time video product will be in service as constructed: 3 to 5 years

Projected cost range of 1 video for in service range: ($1,124.34 / 3) : (1,124.34 / 5) =

$374.78 : $224.86 per year

Projected cost range of all 8 topic videos for the in service range:

($374.78X8) : ($224.86X8)

$2,998.24 : $1,798.88 per year

Total initial investment the first year for 1 video with no equipment depreciation factor:

$612.75 + $1,495.00 + $13.25 = $2,121.00

Total initial investment + web page transfer cost for 1 video: $2,121.00 + $294.12 =

$2,415.12

Total initial investment cost for all 8 topics:($612.75 X 8) + $1495.00 + $132.50 =

$6,529.50

Total initial investment cost for all 8 topics + web page transfer cost:

$6,529.50 + (294.12 X 8) = **$8,882.46**

Comparison of in-house produced video to current trainer practices for all 8 topics:

Total initial investment + trainee costs : Total Trainer + Trainee costs

$6,529.50 + (2350 trainee hours X $21.50) : $75,549.71

$57,054.50 : $75,549.71

Comparison of in-house produced video to current trainer practices for all 8 topics over 3 years of videos in service:

Projected 3 year in-house video cost : Projected 3 year Trainer + Trainee costs

$6,529.50 initial cost + 3 X (2,350 trainee hours X $21.50) : $75,549.71 X 3

$158,104.50 : $226,649.13

Projected 3 year savings of in-house produced video replacing current training practices =

$68,544.63