IBEW 2085
EMPOWERING MANITOBA & NUNAVUT'S CONSTRUCTION ELECTRICIANS

Identification and Analysis of Safety Hazards on the Virtual Construction Worksite

December 29, 2017-March 30, 2018
Compiled by: Carol Paul, Project Manager

Final Report

I. Acknowledgement: IBEW acknowledges that the project is funded by WCB as per the statement provided. "Supported by a grant from the Research and Workplace Innovation Program of the Workers Compensation Board of Manitoba"

II. Executive Summary: IBEW is attempting to change safe work practices of new entrants in construction by identifying, controlling and reporting incidents of safety hazards on the worksite. There are 5 modules developed for the program that will use the latest virtual reality technology.

The five modules will include:

1. Slips, Trips and Falls
2. Struck by, caught between
3. Fire, explosion, toxicity and asphyxiation
4. Ergonomics, elements, noise
5. Electrocution

The outcome of the procedures utilized during the period of reporting will be:

- an increased awareness of safety hazards
- access to innovative safety tools by organizations who support youth transition to work in construction
- improved safe work practices of youth working on construction sites

Project Overview/Introductions

The International Brotherhood of Electrical Workers (IBEW) in partnership with boilermakers, pipefitters, painters, other affiliated unions of the MB Building Trades and the Construction Safety Association of Manitoba developed a series of virtual reality resources that will allow youth and new entrants in construction to spot hazards, assess risk and develop a plan to prevent injury. With the use of 360-degree imagery, youth virtually walk through a worksite. They look up, down and around the site using oculus lenses. They spot hazards and will be required to document what they see on the site. When youth click on the icon they learn about each hazard and what needs to be done to avoid injury. This is an interactive way to teach safety and one that is as close to real life situations without actually being there. It is not enough for youth to hear about the hazards on the worksite. They have to see it

and experience what it looks and feels like. This provides another tool for youth to learn about safety and one that is completely in line with the way youth learn today.

10 Hazards were Identified

- Falls, Slips & Trips
- Electrocution
- Struck By
- Caught in Between
- Noise
- Asphyxiation
- Fire and Explosion
- Elements
- Toxicity
- Ergonomics

It is important for youth to see hazards from trades outside of their own scope. This is because trades work collaboratively on the same site and youth may start in one trade and switch to another trade over time. Exposure to all hazards is of greatest importance. This will not replace current safety training only serve to supplement and enhance the way safety is taught to our youth and new entrants.

Review of Work Completed

IBEW in partnership with the Plumbers and Pipefitters and Boilermakers unions developed a virtual reality resource that places new entrants to construction in real-life situations but out of harm's way. Students virtually walk through Winnipeg construction sites including the Manitoba Clinic, Grace Hospital and McPhillips St. Station to learn about the hazards on the job. The modules highlight relevant information about each of the hazards. A team of industry experts from each of the unions, the safety association and Safe Work contributed to the development of the content.

How the Project Objectives were Met

The modules were addressed one at a time according to the set timeline for the project. At the beginning of each module, the advisory met to discuss the learning objects that needed to be considered for that module. 360-degree imagery was determined to be the best technology to support learning for all 5 modules.

Subject matter experts were then assigned by the advisory to be part of the working group. The working group met 2-3 times per module to decide on the appropriate content for each hazard. In-between meetings the working group would send additional resources to the project manager/digital team to support the VR modules.

The project manager worked with IBEW to book sites for the shoots. Glen Black, the safety manager at PCL took the lead. Other companies were approached but there was no interest. This was a financial commitment from the company and a safety concern to have the project team on the worksite. It was helpful to have a member of the working group on site as they were familiar with the construction

projects, they were safety experts themselves and they knew the safety representatives from PCL. Once we were on one site, PCL opened the doors for us to be at other locations. With pano shots complete and content submitted, the BIT Space development team got to work inputting the data into the pano shots. They worked on one module at a time.

The working group met to review the draft versions of each module. BIT made changes to the content at the meetings as feedback was received. When the working group was pleased with the outcomes of the module, the advisory committee met to review the completed work. Suggestions were made by the advisory and the modules were piloted with smaller groups of apprentices.

This process continued with each of the 5 modules. It was a tight timeline but the team was committed to completing the project within the set timeline. The team wanted this resource to be available as soon as possible. When subject matter experts became busy at work, the advisory was responsible for replacing the members. At one-point advisory members stepped in to help with decisions that had to be made by the working group when work became too busy for them to attend.

Presentation of Results/Evaluation

When students go through each module, they are required to read, look at pictures or listen to advice about each hazard. The student cannot proceed to the next module until all bullets have been opened. Modules include:

1. Slips, Trips and Falls
2. Struck by, caught between
3. Fire, explosion, toxicity and asphyxiation
4. Ergonomics, elements, noise
5. Electrocution

This resource has been piloted in multiple sites including apprenticeship programs, adult learning classrooms, career fairs, conferences, community events, colleges, and high schools. Students feedback has been encouraging. One young man suggested virtual reality is just like real life situations. You have to look up, down and all around to see the hazards on the job. This would suggest when students go to the worksite, the lessons they learned in virtual reality will resonate with them on the job because the situations look familiar.

A facilitator guide was created to guide the learning. Often instructors are not sure how to teach using technology. The guide provides an overview of the project, some usage information, learning outcomes, the VR content and discussion questions. There are guiding questions for each module to allow students a break between each hazard identification. Instructors from the unions had an opportunity to try out the facilitator guide in the pilots.

Approximately 30% of students can get dizzy using VR. This time for reflection reinforces learning and allows students time away from the 360-degree images. Instructors felt this was a guided discovery activity so assessment was not required. This resource will be used to complement existing safety training.

Electronic Copies of the Resources

The application has been fully released on Android and iOS. Any smart phone that utilizes a gyroscope and accelerometer can run the virtual reality applications. Each of the organizations that took part of in the application received a branded version of the app. The content inside the experience is the same for each company and the only difference is the branding for their membership.

Android VR:

- IBEW - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.ibew2085.safetyvr
- BM - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.bm555.safetyvr
- UA - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.pp254.safetyvr
- CSAM - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.csam.safety360

iOS VR:

- IBEW - https://itunes.apple.com/us/app/ibew-2085-safety-vr/id1287143848?mt=8
- BM - https://itunes.apple.com/us/app/boilermaker-555-safety-vr/id1287144014?ls=1&mt=8
- UA - https://itunes.apple.com/us/app/united-association-safety-vr/id1287144166?mt=8
- CSAM - https://itunes.apple.com/us/app/csam-safety-vr/id1287143852?ls=1&mt=8

To address accessibility and usage issues surrounding motion sickness we have also deployed non-vr 360 versions of the applications which are also compatible with tablets.

Android 360:

- IBEW - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.ibew2.safety360
- BM - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.bm555.safety360
- UA - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.pp254.safety360
- CSAM - https://play.google.com/store/apps/details?id=com.bitspacedevelopment.csam.safetyvr

iOS 360:

- IBEW: https://itunes.apple.com/ca/app/ibew-2085-safety-360/id1345796126?ls=1&mt=8
- US: https://itunes.apple.com/us/app/united-association-safety-360/id1348309289?mt=8
- CSAM: https://itunes.apple.com/us/app/csam-safety-360/id1345795693?mt=8
- Boiler: https://itunes.apple.com/us/app/boilermaker-555-safety-360/id1345795545?mt=8

IBEW Advisory Members

The advisory members have been overseeing the project activities, locating video shoot sites and providing support as needed throughout the length of the project. They supply working group members who are the subject matter experts on the project.

Members:

- Chris Taran, IBEW
- Steve Ducharme, Piping Industry Technical College
- Craig Beauchamp, Local 555
- Mike Jones, CSAM
- Doug McKay, IBEW
- Peter Malagus, Safe Work
- Carol Paul, MCSC
- Dan Blair, BIT

Meeting dates:

January 5th 2017: The advisory committee met with the digital team to discuss the most suitable technology to use for the project. It was determined the use of pano shots or 360-degree imagery would put the new entrant on the construction site virtually and would be the best option to teach safety hazards.

January 27th 2017: The advisory committee met to review terms of the advisory committee and decide how best to organize the ten hazards into modules. The modules were divided into related safety topics.

March 6, 2017: The advisory committee met to develop the knowledge transfer plan.

March 6, March 22nd meetings were cancelled until the advisory has a finished product to review. The next meeting to review module one will be held May 4th.

May 4, 2017: Advisory Committee Meeting: The advisory made recommendations on Module 1: Slips Trips and Falls. (See Appendix 1)

June 21, 2017: Advisory Committee meeting to discuss content for module 2. Reviewed Updated Timeline- Appendix 2

June 26, 2017: Tour of Boilermakers Union Hall and plans to disseminate resources

Reports to the advisory committee on the progress in the project:

- September 19th
- December 5th

IBEW Working Group

The working group has been passionate about the development work they are involved in. They believe in the project deliverables and know firsthand the audience who will benefit from these resources. Regardless of age, these members embrace the technology as a new way to engage youth in safety awareness.

Members:

- Ted Stark, Boilermakers
- Rob Fletcher, ABCO, IBEW
- Craig Gertley, Plumbers and Pipefitters
- Chad Wiebe, Plumbers and Pipefitters
- Jason Rice, McCaine Electric, IBEW
- Matt Lothian,, CSAM
- Steve Ducharme, Plumbers and Pipefitters
- Craig Beauchamp, Boilermakers
- Marc Lagasse, Boilermakers
- Doug McKay, IBEW

Meeting Dates:

February 1, 2017: Working group members met at BIT Space Development to learn more about how technology is used to teach safety in construction.

February 21 and 28, March 16, 2017: The working group met to determine what content was needed for modules one and two.

March 28, 2017: Photo Shoot at PCL for module one: New Manitoba Clinic Site

April 6, 2017: The working group reviewed and added content to the knowledge transfer plan developed by the advisory committee. The working group also reviewed the panos and decided which panos would be used for which hazard in module one. 16 panos are required for module one. This will include an introduction, three panos for each of the 5 hazard types to cover identification, control and incidents of each. The digital team began their work organizing the content to insert in the pano shots.

April 27th 2017: The working group met with the digital team to insert pictures, videos, signs etc. into each pano. The audio technician recorded the stories of the subject matter experts who spoke of the story behind each picture.

May 25, 2017: Working Group met from 9-12 to make recommended changes to Slips Trips and Falls.

BIT Space Development loaded Module one on the VR headsets in preparation for the Skills Canada Competition.

June 1-2, 2017: Steve Ducharme, Plumbers and Pipefitters Union piloted Module one at the Skills Canada Competition. Over 10,000 students from schools across Manitoba attended the event. See testimonials for comments on the event.

June 10, 2017: Pano shoot at PCL work site, McPhillips Street Station for Module 2: Struck By, Caught Between. Daniel Cuthbert, PCL was the subject matter expert designated by PCL to provide a safety orientation and tour of the site. Arrangements were made for this shoot by Glen Black, PCL. Dan Blair and Carol Paul were attending on behalf of the project.

June 13, 2017: Working group met to make final changes to Module one based on feedback from the pilot.

The Director of Education and Training, MCSC researched the technology needs of the project and ordered 15 Samsung phones, 15 VR headsets, 1000 cardboard oculus and 3 I-pads to support group training. Boxes were ordered for proper shipment.

Jason Rice, McCaine Electric designed and developed metal brackets to secure VR headsets at career fairs.

A student was contracted to assemble the cardboard headsets.

Arrangements were made to ship 40 cardboard headsets to the hotel in Montreal for the conference. The equipment ordered was couriered to the 3 unions to prepare for dissemination of the resources.

July 20, 2017: Working Group met to review panos for Module 2 and insert content. Advisory and working group members were contacted to request additional resources for Module 2.

PCL was contacted to request another site for module 3. Thomas Design Builders was contacted to request access to 2 sites for pano shots for modules 4 and 5.

August 9, 2017 Pano shoot at Grace Hospital PCL site for Module 3. Dan Blair and Jason Rice attended.

September 7, 2017: Working Group rescheduled to meet to start the development of content for Modules 3-5. Holidays interfered with the August meeting date.

August 2017: Creation of an invitation and distribution to guests for the Sept 21st technology event.

September 7th, 2017: PCL confirmed shoot sites for Module 3 at Grace Hospital and Module 5 at Manitoba Clinic. This was the second shoot at Manitoba Clinic but it looked very different as it neared completion. It was determined that there were many unused pano shots so Module 4 used panos from previous shoots. Once the pano shots were complete, the project development became much easier to manage. We weren't having to depend on others to move forward.

September 12, 2017: Content for modules 3-5 was approved by the working group and all content was inserted in the pano shots.

September 18th2017: Apprenticeship students from IBEW informally reviewed the materials and made comments on November 14th. One student felt dizzy (common of 30% of VR users) As a result, the project manager suggested a facilitator led discussion following each module. (See Appendix 4) A facilitator manual will be created in advance of the pilots. The audio in module one requires ear phones if several students are using in the same room. It was recommended the hot spots be ordered in sequence with the circle link turning from green to black once it has been opened and read. A strap around the head is best for the cardboard headsets. It's tough to hold the cardboard headset in place. The user should be able to move forward and back in the modules to review what might have been missed or not understood. Revisions were made to the game as students provided feedback.

October 11, 2017: Review and comment on progress

October 25, 2017: Review and comment on progress

November 14th, 2017: An app was developed and was branded for each project partner. This will allow for wide distribution of the resources and central access. As new versions are made for the app, all users will have updated versions as a result of this central access.
Dissemination began and plans were made for pilots in 2018.

Project Pilots

June 1-2, 2017: Steve Ducharme, Plumbers and Pipefitters Union piloted Module one at the Skills Canada Competition. Over 10,000 students from schools across Manitoba attended the event.

Re: WCB RWIP Technology program

This letter is to mention the success we had demonstrating to students at Canada Skills 2017 event held June 1 &2. Students were lining up to try the Virtual Reality job site and see what it really looks like. From this trial of Module 1, students were sparked to ask questions regarding the jobsite, and what it is like to work on a site. From there the students asked questions about what is needed to get into the pipe trades.
This project was great for our industry to engage the youth into our trades.

Yours truly,
Steve Ducharme GSC
Training Director
Piping Industry Technical College

June 29, 2017: Presentation at the Nova Scotia Sector Council to all sector councils across Canada to share best practices. Module one was shared with the 10 representatives at the conference.

Technology Event: September 21st 1000 Waverley

A technology event was held at 1000 Waverley to introduce participants to the use of VR in the classroom. Subject matter experts and members of the working group were on hand to guide the discussion and answer questions. 46 participants attended and included representation from industry, government, educational institutions, Apprenticeship, and immigrant settlement agencies.

November 22nd IBEW Apprenticeship Pilot with Webinar

Purpose:

Capture the reactions of the students using VR for the first time
Receive feedback about implementing this technology in a classroom setting
Show instructors how we are planning to use this technology in the class room

A newspaper article on the IBEW project was written by the Free Press in the Business Section on November 23rd 2017.

November 28th Daniel McIntyre School (50 students) Plumbers and Pipefitters Union

Carol McLeod, National Electrical Trades Council (NETCO) National Dissemination Intent:

To Establish NETCO as the national distributor of IBEW Local 2085 VR Safety. The product is in the final stages of development and approval. It will be available for national distribution in Q 1 of 2018.

Activities:

Concluded a formal distribution agreement with IBEW Local

Distributed a one-page notice announcing that it is the Canadian distributor authorized by IBEW Local 2085 and that the product will be available in Q1 of 2018.

Prepared a VR Safety Toolkit—a collection of information and resources that will assist training facilities in integrating the application into its training program.

Sponsored a webinar on VR Safety as a follow-up to the NETCO 2017 training conference, extending invitations to the 55 conference delegates

Consulted with NETCO's National Training Committee to identify learning needs that may be addressed by a VR or AR training resource and to secure feedback on including a workshop-style VR/AR professional development session delivered by Daniel at NETCO's 2018 training conference on June 9, 2018 in Mont Tremblant, Quebec.

Showcased VR and AR resources and related professional development (actual and in development) at NETCO's 2018 training conference on June 9, 2018 in Mont Tremblant, Quebec.

"The slips, trips and falls module is now complete. I have found this resource to have exceeded my expectations. It will be very valuable in teaching new trades persons by giving them as close to real world examples as possible in a controlled environment.

I am so pleased with this module that I will be giving a presentation about it and the technology used to create it at the upcoming National Electrical Trade Council (NETCO) conference which takes place in Montreal this August."

Chris Taran
Education and Training Coordinator/Vice President
International Brotherhood of Electrical Workers Local Union 2085

Plumbers and Pipefitters Union, Friday December 15th at 34 Higgins

Audience: 25 students/ 3 classes of level one apprentices

Students walked through module two: struck by, caught between. Facilitators of the Plumbers and Pipefitters Apprenticeship Program used the facilitator guide to continue discussions about what the students were seeing virtually. Students felt this type of learning was so much better than learning from a text. They would like to see it in a game format where points or levels were secured for successful completion of each pano shot. They would also like audio access. There is audio for the experience but the ear plugs on the VR headsets could not be shared as it is a health issue. The experience was surveyed and will be compiled for the next reporting period. Facilitators enjoyed the opportunity to pilot the VR and felt it would be a useful tool to use in the classroom.

December 16, 2017
Re: IBEW/UA/Boilermakers Virtual Reality Program

The Virtual Jobsite program was tested with three of our classes on December 15/2017 in our facility. The students were very intrigued by the virtual jobsite and the information they gained through the program. All students felt that it would be a good addition to the safety training. The instructors were among the test subjects, and they are planning on ways to incorporate into their classrooms. As a Training Director I feel that this will be a great tool to engage potential students and potential apprentices by showing him/her what a job site looks like and what to expect.
All in all, I feel that this project is a win for the students/potential apprentices!

Steve Ducharme GSC
Training Director
Piping Industry Technical College

January 18-19th The project manager went on a tour of the north visiting University College of the North in Thompson and the Pas and meeting with the President of UCN, Doug Luvstead, the VP of Academics, Dan Smith and the VP of the Trades and Technology Centre, Rob Penner. UCN will be

provided with VR and I-pad technology from MCSC to support the dissemination of resources in the north.

Jan 22-26th BIT Space Development was invited to attend the career fair in the Pas and Cranberry Portage. This provided an opportunity to pilot the resources with a variety of audiences
Day 1: Meet with UCN to discuss technology and potential partnerships in the north. Afternoon filled with technology pilots with UCN trades students from heavy machinery, auto mechanics, and mill writes. (80 students)

Day 2: Morning meetings with Margaret Barbour Collegiate Institute. These talks included technology pilots as well as discussions about trades and technology. (90 students). Afternoon demos with Mary Duncan Alternate School (20 students)

Day 3: Frontier Collegiate Institute (Cranberry). Open demonstrations with students coming and going, open Q&A and pilots. (approx 30 students)

Day 4: Hapon Collegiate (Flin Flon) for afternoon. 5 sessions with students including Q&A as well as technology pilots. (80 students) Evening demos back at Frontier Collegiate, (40 students)

Day 5: Morning meetings with instructors and school staff regarding technology and how to implement these apps in their classes and how to access the technology. Afternoon demos with MBCI again, this time an open session with kids coming and going, 20 students used the VR.

The week was very busy with demos and meetings, BIT considered this opportunity a success, as they reached a lot of students, teachers and administrators. Total: 350 students

January 25th 2018: **Honorable Ian Wishart, Minister of Education and Training and Lynette Plett, Senior Executive Director, Industry, Training and Employment Services, Government of Manitoba** stopped by BIT Space Development to try out the new technology. Lynette said out of all the technology tried that day, the construction resources developed for WCB RWIP, were the most engaging. A follow up meeting is planned.

February 1-2, 2018: Disrupted Conference: ***Work is evolving and technology is the driving force….*** the resources were on display at a booth at the conference to over 450 participants. The project manager presented to the audience of 450 about the value of technology to engage underrepresented groups in learning safety.

"…. we need to create a learning environment that is engaging, applies to practice, flexible, and allows students to learn at their own pace in a safe and relaxed environment. We are responsible for addressing the education and training needs of the construction industry. We have been working with subject matter experts in the industry to evolve the way we train new and existing workers. We are eliminating death by power point and looking at ways to engage learners and measure the application of new learning at work.

Students virtually walk through construction sites to learn about the hazards on the job. The text embedded in the 360-degree images, teaches them about what they need to know as a new or

returning worker. There is a facilitator guide to support the instructor. They too need to learn how to facilitate differently. A student recently said to me, you know virtual reality is just like real life. You have to look up and down and all around to identify the hazards……Check out our booth……"

February 7th Boilermakers Event: 8 students and the Director of National Training, Grant Jacobs from Edmonton attended the event. Dan Blair was not available and the BIT representative could not get the app to work. The Director of National Training rescheduled to a later date. Boilermakers cancelled a future date for the pilot. IBEW and Boilermakers spoke to BIT about the importance of the success of the pilots for the future of education and training for the unions.

This was a real lesson learned for the project. BIT Space development are a development team and sometimes struggle with the expectations dissemination can cause. Dan came to realize he can no longer operate as a one man shop in terms of dissemination. He needs to have others on his team who have the leadership and communication skills to pilot the resources with a variety of audiences. He thought his staff person could host an event in his absence but it did not work out well. Dan is making the necessary steps to improve his organization going forward.

February 8th: Jamie Grant, Executive Director of the Northern Manitoba Sector Council and Louis Ghiz, Executive Director of New Media Manitoba met to discuss plans for dissemination and support for facilitators who use technology to support learning.

Feb 13, 2018 Plumbers and Pipefitters Pilot 32 apprentices were in attendance. (see Appendix 6)
53% of students said they learned a little bit from this experience and 44% said they learned a lot.

When asked what they like about using virtual reality to teach safety? Students suggested it reels very realistic, it's better than sitting in a classroom and it gives a new way of teaching like you are really there.

When asked how this technology could be best used? Students suggested it could be used in a class to keep people interested in workplace safety.

When asked what changes would you recommend? Students suggested using 360-degree video.

Proposed Recommendations

1. Dissemination will continue beyond the timeline of the project across Manitoba and Canada. Boilermakers and International Brotherhood of Electrical Workers have already made steps to disseminate these resources nationally.
2. Impact on the use of technology to support safe work behavior will be measured over the course of the next two years (this cannot be measured in April 2018 as per the timeline)
3. Instructors need support on how to use technology to support learning. New Media Manitoba and the Province of Manitoba have been notified and have made note of this recommendation.

An Executive Summary of the Final Report

All deliverables were met for this project on time and within budget. The Electrical, Boilermakers and Plumbers and Pipefitters Unions worked in collaboration with Safe Work MB and Construction Safety

Association of Manitoba to improve awareness of workplace hazards and change safety behavior of new entrants working in construction.

The project stakeholders developed a better understanding of how technology can be used to engage learners. Dissemination of this resource is stretching beyond the province and recognition for this project's contribution to workplace safety has been identified by the construction industry, government and educational institutions. This project will have a long-term impact on how safety training is delivered in Manitoba in the future thanks to the support by a grant from the Research and Workplace Innovation Program of the Workers Compensation Board of Manitoba.

Appendix 1: Facilitator Guide

Appendix 2: Revised Timeline

Appendix 3: January 26, 2018 pilot

Appendix 4: February 13, 2018 pilot

Appendix 5: Disrupted Conference Pilot photos

Appendix 6: Event Pictures Northern Pilot the Pas

Appendix 7: Plumbers and Pipefitters Pilot

Appendix 8: Winnipeg Free Press Article

Note: Dissemination event photos, evaluations etc. held during the first three quarters of the project may be found in earlier reports along with additional details of project activities.