Virtual Reality Implementation for Public Engagement

ST-005

Final Report | July 2020

IOWA | DOT

IHRB
IOWA HIGHWAY
RESEARCH BOARD

STIC
State Transportation Innovation Councils

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the Iowa Department of Transportation or the United States Department of Transportation, Federal Highway Administration.

The sponsors assume no liability for the contents or use of the information contained in this document. This report does not constitute a standard, specification, or regulation.
The sponsors do not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objectives of the document.

Statement of Non-Discrimination

Iowa DOT ensures non-discrimination in all programs and activities in accordance with Title VI of the Civil Rights Act of 1964. Any person who believes that they are being denied participation in a project, being denied benefits of a program, or otherwise being discriminated against because of race, color, national origin, gender, age, or disability, low income and limited English proficiency, or if needs more information or special assistance for persons with disabilities or limited English proficiency, please contact Iowa DOT Civil Rights at 515-239-7970 or by email at civil.rights@iowadot.us.

Technical Report Documentation Page

1. **Report No.** STIC PROJECT ST-005	2. **Government Accession No.**	3. **Recipient's Catalog No.**
4. **Title and Subtitle** Virtual Reality Implementation for Public Engagement		5. **Report Date** July 2020
		6. **Performing Organization Code**
7. **Author(s)** Kimball Olson		8. **Performing Organization Report No.**
9. **Performing Organization Name and Address** Iowa Department of Transportation, 800 Lincoln Way, Ames IA 50010		10. **Work Unit No. (TRAIS)**
		11. **Contract or Grant No.**
12. **Sponsoring Agency Name and Address** Iowa Highway Research Board, Iowa Department of Transportation, 800 Lincoln Way, Ames IA 50010 Federal Highway Administration, State Transportation Innovation Council, 1200 New Jersey Avenue SE, Washington DC 20590		13. **Type of Report and Period Covered** Final Report
		14. **Sponsoring Agency Code** CFDA 20.200
15. **Supplementary Notes**		

16. **Abstract**

This project linked a Virtual Reality (VR) experience to the Iowa DOT's general driver safety messaging campaign and delivered this powerful combination to the general public at the Iowa DOT's 2018 Iowa State Fair booth and other venues. Two immersive VR displays were created: "Work Zone Safety" (by Intrans/Iowa State University's Virtual Reality Application Center) and "Seat Belt Safety" (by the University of Iowa's Center for Computer-Aided Design). Each is comprised of a full 3-dimensional environment, a detailed vehicle cabin, animated characters and content, and sound effects.

Virtual Reality (VR) tools, unlike any other available media, have the potential of providing information with the utmost clarity and with the potential for a high rate of user knowledge retention. This project helped increase the level of understanding of public safety in transportation by delivering priority information to the public in an engaging and memorable new medium. The project also implemented Iowa DOT investments in VR content development and deployed them directly to the public realm, rather than relegating them to a "behind the scenes" internal research venue. We also adopted parts of the process of creating VR media for future applications and additional public involvement activities.

17. **Key Words** Virtual Reality, Simulation, Traffic Safety, Highway Safety, Public Participation	18. **Distribution Statement** No restrictions.

19. **Security Classification (of this report)** Unclassified	20. **Security Classification (of this page)** Unclassified	21. **No. of Pages**	22. **Price**

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Virtual Reality Implementation for Public Engagement

By
Kimball Olson
Iowa Department of Transportation

Prepared for
Iowa Highway Research Board
State Transportation Innovation Council

July 2020

Final Report

ST-005

Acknowledgments

The financial support provided by the Iowa State Transportation Innovation Council, Federal Highway Administration and the Iowa Department of Transportation is gratefully acknowledged.
The author would like to thank the people listed below for participating in the project's Technical Advisory Committee (TAC):

Ahmad Abu-Hawash, Iowa DOT
Nola Barger, Iowa DOT
Mark Bortle, Iowa DOT
Tracey Bramble, Iowa DOTSteve Gent, Iowa DOT
Steve Gent, Iowa DOT
Vanessa Goetz, Iowa DOT
Andrea Henry, Iowa DOT
Annette Jeffers, Iowa DOT
Micah Loesch, FHWA
Hillary Marquardt, Iowa DOT
Vicky Stamper, Iowa DOT

Iowa State University PI - Dr. Nir Keren, Peter Carlson
University of Iowa PI - Karim Abdel-Malek, Chris Murphy, Rajan Bhatt

Table of Contents

Project Abstract:

Increasing the level of understanding of what it takes to build or rebuild major infrastructure and to maintain public safety in transportation is an important aspect of both justifying the work of the Iowa DOT and for explaining the reasons behind disruptions to the daily lives of constituents. Keeping up with new technology allows us to keep pace with a rapidly growing percentage of the driving public that are technologically savvy and expect the latest technical advances to be integral to every facet of society, including the transportation sector. Making available to the general public new resources that educate and inform is an important part of our outreach efforts. Virtual Reality (VR) tools, unlike any other available media, have the potential of providing information about the processes and priorities of infrastructure management and development, and the Iowa DOT's intense interest in public safety, with the utmost clarity and with the potential for a high rate of user knowledge retention.

Project Scope:

The Project pursued under this initiative will: deliver priority information to the public in an engaging and memorable new medium; implement Iowa DOT investments in VR content development and deploy them to the public realm in a variety of formats for maximum accessibility; employ and supplement VR technology hardware assets at the Iowa DOT; evaluate the efficacy of delivering information through VR, and; internalize parts of the process of creating VR media for future applications and public involvement activities.

Executive Summary of Project:

This project linked a Virtual Reality (VR) experience to the Iowa DOT's general driver safety messaging campaign, and delivered this powerful combination to the general public at the Iowa DOT's 2018 Iowa State Fair booth and other venues. Two immersive VR displays were created: "Work Zone Safety" (by Intrans/Iowa State University's Virtual Reality Application Center) and "Seat Belt Safety" (by the University of Iowa's Center for Computer-Aided Design). Each is comprised of a full 3-dimensional environment, a detailed vehicle cabin, animated characters and content, and sound effects.

The VR displays center around the viewer occupying the passenger seat of a virtual vehicle operated by a realistic digital driver. In each case, specific safety scenarios engage the viewer's attention, specifically focusing on the extra attention necessary to safely navigate a work zone, the dangers associated with driving distractions such as cell phone use, and the need to wear seat belts at all times, regardless of location, roadway speed or trip duration. The consequences of the driver not following appropriate safety precautions in each scenario are shown in very

convincing and memorable ways. Actual car seats with seat belts were deployed to the Iowa State Fair for users to strap into prior to experiencing the displays, which further reinforced the plausibility of the driving experience for viewers.

Thousands of Iowans have experienced the VR displays, and with overwhelmingly positive results in terms of feedback received. The Iowa DOT as an agency has decided that VR is a promising communication and education medium that is worth continued investment of resources. Additional immersive VR experiences are already in development for the 2019 Iowa State Fair.

Benefits

Virtual Reality (VR) tools, unlike any other available media, have the potential of providing information with the utmost clarity and with the potential for a high rate of user knowledge retention. This project helped increase the level of understanding of public safety in transportation by delivering priority information to the public in an engaging and memorable new medium. The project also implemented Iowa DOT investments in VR content development and deployed them directly to the public realm, rather than relegating them to a "behind the scenes" internal research venue. We also adopted parts of the process of creating VR media for future applications and additional public involvement activities.

Completed Project Tasks:

Task 1 – Assemble the Research Team

The following Technical Advisory Committee (TAC) was established to develop the implementation plan, determine the focus of the VR interactive displays, review content and interactions during display development, determine venues for deployment, assist in gathering public user experience data and determining the efficacy of messaging to the public through VR.

Kimball Olson (Aesthetics & Visualization Specialist) - Project Technical Monitor Annette Jeffers (Automation Engineer & 3D Implementation Coordinator)
Micah Loesch (Federal Highway Administration, Iowa Division) Andrea Henry (Director, Strategic Communications and Policy)
Tracey Bramble (Information Specialist, Strategic Communications and Policy) Hillary Marquard (Information Specialist, Strategic Communications and Policy) Steve Gent* (Director, Office of Traffic and Safety)
Vanessa Goetz* (Iowa Highway Research Board/State Transportation Innovation Council)
Ahmad Abu-Hawash* (Chief Structural Engineer)
Mark Bortle** (Traffic Safety Engineer, Office of Construction - "Work Zone" VR only)
Nola Barger** (Information Specialist, Strategic Communications and Policy)
Vicki Stamper** (Secretary, Highway Division) (others to be called upon as appropriate)
(* - added to TAC after kick-off meeting; ** - added to TAC after 1st meetings w/contractors)

Task 2 – TAC Kick-off Meeting (completed 12/14/2017)
The TAC explored some VR apps with different types of content interaction, in order to aid discussion about potential projects and features. Potential VR interactive display focus ideas and safety messaging initiatives were discussed and prioritized, and 2 VR displays were chosen to pursue under this initiative: "Work Zone Safety Demonstration" and "Seat Belt Demonstration". There was some preliminary discussion of potential deployment venues and external partners. There is a high level of interest in deploying to the 2018 Iowa State Fair if possible, given the scope, funding, and development timeline. For large group deployments, it was seen as desirable to limit the VR display experiences to 2 minutes or less. The proposed platform seen as the most desirable is smartphones with headsets and hand controllers or new generation standalone headsets, to eliminate tethering to a computer and to allow multiple users to view displays at the same time.

Smartphones were also seen as a more familiar way to deploy the technology, more portable than full PC-tethered headsets, and may offer more flexibility for the Iowa DOT in sharing the VR apps once complete. Publishing of the VR displays to multiple formats may be possible to support sharing of content via download.

Task 3 – Identify and Interview Potential Virtual Reality Project Contractors (completed 11/20/2017)
Qualified candidates must have proven ability to deliver all aspects of the implementation plan, including VR interactive display content creation and animation, user interactions with content, publishing to all available platforms, user data gathering, statistical analysis, communication effectiveness evaluation, and incidental technical training of select Iowa DOT staff in processes associated with VR interactive display development. A combination of experience in both education- and research-related work associated with cutting-edge visualization technologies was also a factor in identifying qualified candidates. Experience using VR in transportation-related applications was also considered advantageous. Identification and interviews of potential VR contractors was performed by Kimball Olson and Annette Jeffers. It was determined that the 2 qualified candidates for this Project are:

University of Iowa, Virtual and Augmented Reality Business Unit (VARBU) Iowa State University, InTrans/Virtual Reality Applications Center (VRAC)

Task 4 – Develop Requests for Proposals (completed 02/20/2018)

Due to the short timeline of delivery of the VR interactive displays (in time for deployment at the 2018 Iowa State Fair), and to give adequate time to prepare successful displays and to develop and implement strategies for evaluation, it was determined that if both contractors were qualified, it is possible that both might be used, one for each of the two proposed VR displays (contingent on successful proposals). On Feb. 20, 2018, each contractor was sent an RFP for each

of the 2 displays, requiring proposals to be developed by March 5, 2018.

Task 5 – Review Proposals and Assign Projects through Contract Agreements (completed 03/31/2018)

Proposals are due by March 12, 2018. TAC members who were involved in the contractor interviews will meet and review the proposals and assign VR interactive displays accordingly. Proposal review assistance from other TAC members will be as necessary. Contract agreements will be prepared, issued, and signed in a timely manner, to avoid delaying the start of VR display development.

UPDATE: Review of proposals was performed by Kimball Olson and Annette Jeffers (project monitors) and Tracey Bramble of the TAC. A scoring system using 4 weighted criteria was employed, and documentation created. Upon review of the proposals, it was determined that U of I would create the Seat Belt VR display, and ISU would create the Work Zone VR display. Reasons for the assignments were cited in a brief review document. The selection of the appropriate contractor for each VR display was made on the basis of the proposals. No single submitter achieved the highest ranking on both VR displays, and the highest ranking submitter was assigned to each respective display.

Task 6 – Meeting(s) of Contractors and TAC to Focus Display Content (completed 04/13/2018)

As soon as possible following the completion of Task 5, meetings between the TAC and the contractors will be held. Discussion will focus on the delivery of the desired messages via the VR interactive displays given the capabilities of the contractors, the timeline, the desired deployment format, the capabilities and any limitations of hardware and software to be employed, the characteristics inherent to the 2 VR display concepts, etc.

Brainstorming will enhance and expand upon concepts explored in the RFP and proposals. It is anticipated that the exact content of the VR interactive displays will remain somewhat fluid in definition during the early stages of development, which may require additional meetings to focus the efforts of the contractors.

UPDATE: Initial TAC meetings occurred on April 5th with U of I and on April 13th with ISU.

Task 7 – Monitor Project Contractors during VR Interactive Display Development Period (completed 07/27/2018)

VR interactive displays were completed by the contractors during the period since 06/01/2018. Included periodic meetings as necessary between Project Monitor, TAC, and the Contractors to ensure VR display content and messaging goals were being met. See meeting notes in the Appendix of this Report for details. Substantially complete VR displays were delivered by

contractors in time for State Fair booth attendant staff training which began on August 1st, 2018.

Task 8 – Purchase Virtual Reality Hardware (completed)

Equipment necessary to deploy the VR interactive displays to the Iowa State Fair was purchased. An additional 7 Oculus Go headset units were purchased at an approximate cost of $1750, so that a total of 8 headsets (including initial test unit) were available for deployment to the Fair. Two sets of accessory headphones (~$100 ea.) were also purchased, to be used for hearing impaired individuals or others who might have difficulty hearing the audio portion of the displays in the State Fair booth environment, which can at times be noisy.

Additional equipment was considered for purchase includes Oculus Go headsets to increase the total number available, both to support multiple concurrent deployments when necessary and to provide backup units in case of technical problems. Other equipment considered included next generation internal tracking headsets, and possibly a VR-ready laptop to support HTC Vive Pro or Oculus Rift headset deployments to remote sites. These purchases were not made due to lack of staff time to support additional deployments.

Task 9 – Determine Data Gathering Methods (abandoned)

The purpose of this Task was to gather information to assess the effectiveness of VR as an information delivery tool, as support for the Iowa DOT to make a decision whether to continue to invest resources into VR for future uses. As mentioned in the December 2018 report, due to the overwhelming success of the 2018 Iowa State Fair deployment as well as numerous additional uses of the VR displays with public participants, the Iowa DOT has decided to continue implementation of VR as a communication medium. As such, all Tasks associated with the further development of data gathering methods and the gathering of data have been abandoned as part of this project.

Task 10 – Deploy VR Displays to 2018 Iowa State Fair and other Venues (completed)

The VR displays were deployed to the **2018 Iowa State Fair** as originally planned. The Iowa DOT's Office of Strategic Communications provided additional equipment, in the form of car seats with seat belts, to enhance the immersive experience for booth visitors. The 2 different displays were offered on alternate days for the entire 10-day State Fair period. It is estimated that more than 10,000 people experienced the VR displays. See Appendix A for a compilation of comments from the booth attendants (DOT staff):

The VR displays were taken to the **2018 Iowa Farm Progress Show** on August 27-29. The VR displays were shared at the **2018 Innovations in Transportation Conference** on October 9th in Ames, IA. Approximately 16 to 18 people experienced the VR displays. The majority of participants expressed great interest in the technology for use in transportation

applications. Representatives from the Colorado and Idaho DOTs expressed particular interest, including a desire to use the Iowa-made displays for venues in their home states.

The VR displays have been shared with some DOT staff that were not involved in the STIC project, and the displays have been universally praised for their innovative approach to communicating general driving safety messages. Staff in various offices have expressed interest in developing displays specific to their areas of expertise, such as railroad crossing and bicycle safety topics.

Plans are being made to deploy the VR displays to the **2019 Iowa Driver's Education Conference**, and the Department of Public Safety's **2019 Governor's Transportation Safety Board (GTSB) Conference**.

Plans were made to offer the completed displays on the **Oculus Store** for access by the general public who have compatible headsets. It may also have been possible to publish the displays to additional viewing platforms (e.g. iOS and Android smartphones, HTC Vive, Oculus Rift). VR contractors were asked to study these topics on our behalf.
Ultimately, no displays were published due to some incompatibility issues with online publishing site, which is primarily set up for paid VR content. Also, outside services review resulted in this work being cut. This decision was not a reflection of the value the work could have on public education, but more a lack of resources to publish the simulations, continue to develop additional simulations, as well as staff bandwidth to promote their use.

Task 11 – Analysis and Report (abandoned)

This Task has been abandoned for the reasons described in Task 9 above.

Task 12 – Staff Training (on hold)

A subscription for one copy of the Unity 3D program was purchased by the Bridges and Structures Bureau to aid the internalization of VR project creation and publishing at the Iowa DOT. Due to a lack of staff time, the subscription was not renewed. Some staff time to date has been dedicated to training via utilization of a training course on Lynda.com and via YouTube video resources. Neither of the VR contractors were approached for further assistance in training of DOT staff due to time and budget constraints. Additional efforts in training are on hold until staff time and software resources can support them.

APPENDIX A - Final Report Summary by University of Iowa/VARBU

FY18 STIC Virtual Reality Implementation for Public Engagement/"Seat Belt Safety"

Design

Refine the problem, refine objectives, and discuss with the Iowa DOT.

During the early days of the project we attended a meeting with the Iowa DOT at their offices in Ames Iowa. During the meeting we defined the goals of the simulation and laid out a direction for its development.

Requirements

Timeline, input and output, Hardware specifications, OS, Software, and third-party systems.

Once a direction was established, we moved forward with identifying car models, city environment models, and the avatar. I was able to look at VSR/CCAD's catalog of 3D models and found a nice High quality car and it's interior. There was initial talk of using the VUZE VR camera to create VR film footage of a car and then simply composite the Santos avatar into that. The VUZE was found to produce a substandard video image quality and the impact of a car crash could not be feasibly recorded.

Develop

Car interior, environment models, Avatar modifications, Integrating all models into the same scene, lighting/texturing, and Animation.

I used Autodesk Maya software to model, texture, and/or optimize all assets for this project. First, I started with a review of all the 3D models that VSR has collected over the years. I was able to find an automobile with a suitable interior to act as our VR passenger 'hero' car. For the city scape, I found a detailed 3D model of a generic city block and was able to modify it to fit our needs. Purchased models can take a long time to prep for use. They are often too detailed for use in VR. In a virtual reality environment, the speed at which the sim runs can be the difference between a great experience and getting sick. High detail models take much longer to render in real-time; slowing everything down.
Sometimes the optimization can in the worst case take as long as simply creating a custom model. The animation process involved animating in layers. First, the hero car was animated traveling to the stop light. Then the two colliding cars were animated so that the blue car pushes the hero car into the intersection to be hit by the red car. Once the timing of the collisions was worked out, I went back and added character animations and extra crash effects. Once the animations we're all done, I submitted a video to the Iowa DOT for confirmation. Iterations were made based on the Iowa DOTs feedback. It was at this time that the final

decision was made to go with the Oculus Go VR platform for final deployment.

Implement

System integration, debugging, and testing.

Once the assets are finalized, they are exported to the Unity 3D game engine. This can be a difficult process as it is unpredictable how Unity will import those assets. Generally, it is an iterative process as a result. Once the assets are in, the VR camera is added and placed inside the car. There is also usually a need to modify the scale of items to feel life size. This is also when sounds are added. We purchased a catalog of sound effects and were able to choose complementary sounds (sounds recorded and/or filtered to sound as though they came from the same space) from there that worked well in the sim. I also recorded the dialog that Santos speaks to match the motions of his mouth. Note, this is the first time Santos has spoken in any of the applications we have ever created with him. Finally, we moved on to the controls for the sim which were by mandate, simple and easy to use. The need was for a volunteer to be able to cycle people through the simulation quickly and smoothly while not being able to see what is going on in the headset. The controls consist of a restart command that is mapped to all the buttons on the Oculus Go remote. There were a few iterations that we went through with feedback from the DOT as far as what was written on the image placards at the end. It was also at this point that we began deploying the simulations onto examples of the Oculus Go hardware.

Review - Test - Deliver

Iowa DOT review, refine, test, and deploy.

There was regular communication throughout the length of this project between the VARBU lab, the Iowa DOT, and the Iowa State team. Final deployment of the sim onto the Oculus Go headsets was handled at this point. We used individual accounts on the Oculus store to disseminate the simulations to multiple devices. These accounts did not involve full Oculus Store availability, but there is functionality to upload and share software builds with other account holders. Note: we did explore the option of a full public deployment of the two simulations on the Oculus store but the it was deemed that the simulations are too short, and the interactivity too limited to fit any of their extensive launch criteria. AT our initial meeting with the Iowa DOT, the Idea of having car seats for people to sit in while experiencing the simulations was put forth. For the final deployment, I was happy to see that the DOT and their dedicated group of volunteers were able to have actual car seats for participants to sit in to add to the immersion.

In conclusion, the project seems to have enjoyed great success and VARBU as well as the

University of Iowa were happy to be a part of a growing collaborative effort with the Iowa Department of Transportation.

Figure 1. Crash Simulation of unbelted driver

APPENDIX B - Final Reprt Summary by Iowa State University, Intrans/VRAC:

FY18 STIC Virtual Reality Implementation for Public Engagement for "Workzone Safety"

Background

Workzones create one of the most hazardous conditions in traffic. Reports from 2015 indicate that approximately 70 workzone crashes, where at least one person was injured, occurred daily. The Federal Highway Administration (FHWA) reports the following statistics for crash severity for 2015:

- 73.0% (70,499) of work zone crashes were Property Damage Only (PDO)
- 26.4% (25,485) of work zone crashes involved at least one injured party
- 0.7% (642) of work zone crashes involved at least one fatality

Although tremendous resources are invested to increase safety in work zones, safety in these zones is still a challenge. Beyond engineered solutions, FHWA deploys various measures to increase public awareness about work zone safety. For example, the FHWA regularly deploys campaigns in order to disseminate information on construction activities. However, literature demonstrates that public became desensitized to messages conveyed through traditional public campaigns.

The Iowa Department of Transportation (Iowa DOT) hypothesized that with advancements in technology and with today's technology savvy audience, Virtual Reality technology can be used to deliver prioritized information with high rate user knowledge retention. Iowa DOT charged the Iowa State University team (the Team) with developing a Work Zone Safety Demonstration virtual reality display.

The implementation and the simulation

The Team utilized the following three concepts of virtual reality in the development of the VR simulation:

- **Place illusion**: the strong sensation of being present in the space generated by the virtual reality environment, even though participants know they are not there.
- **Plausibility**: the component of presence that is the illusion that the perceived events in the virtual environment are really happening. In comparison to Place Illusion, which is a static characteristic, Plausibility is more concerned with the dynamics of events and the situation portrayed.
- **Virtual body ownership**: utilization of multisensory correlations to provide people the illusion that alien objects are part of their body.

The Team met multiple times with the Iowa DOT Technical Advisory Committee (TAC) during the design and development of the VR simulation. The meetings included discussions on the VR

simulation, developing practices that will allow convenient deployment in multiple public awareness venues, and evaluation plan. Once a concept was consolidated the team developed the VR simulation. The setting for the user experience was that the user in the simulation is a passenger seated next to the driver; the user can observe the driving scene and the driver's behavior as the car enters and drive through the workzone. The simulation was developed for the Oculus Go headset.

During the driving scene in the simulation, the driver receives two text messages: he ignores the first message and thus the driving experience continuous safely – see figure 1:

Figure 1. Safe behavior - First text message

When the second text message arrives, the driver diverts his attention to the phone (Figure 2) and thus he fails to notice the traffic, resulting in a collision with the car in front (Figure 3). It is this segment of the driving scene where significant attention has been devoted to implementing *Place Illusion*, *Plausibility Illusion*, and *Virtual Body Ownership illusion.*

Figure 2. Unsafe behavior - Second text message

Figure 3. Collision

Conclusion

Iowa DOT deployed the VR simulation in multiple venues. Iowa DOT reported the simulation was well received; users frequently react physically (jumped back in the seat) when the collision occurred in the simulation, validating proper utilization of the VR principles of *Place Illusion*, *Plausibility Illusion*, and *Virtual Body Ownership illusion.*

The Team developed a data management protocol and submitted a Data Management Plan to Iowa DOT. Further, the team created a video file for the simulation and shared it with the Iowa DOT team. Finally, the team prepared a publishing manual for posting VR simulations to the Oculus store. The manual was sent to the Iowa DOT team too.

APPENDIX C - 2018 Iowa State Fair Booth Staff Comments:

MEMO that was sent to the workers after the fair:
Thank you for volunteering to work a shift(s) at the Iowa DOT booth during the Iowa State Fair. The state fair planning team is constantly striving to improve the department's presence at the fair and better meet the needs of DOT staff who take time out of their normal duties to work the booth. We would appreciate it if you would take a few minutes to provide feedback on your experience working the booth this year. In addition to general feedback, we would specifically like to know about your impressions on the success and areas of concern regarding the virtual reality simulations that were featured in this year's booth. We've heard a lot of positive feedback on the use of virtual reality which has led to requests to use the simulations for other outreach opportunities and consideration of featuring new simulations in the booth again next year. This feedback will help us shape the future of how we are using virtual reality across the department.

RESPONSES:

- Overall I thought the virtual reality was great—people were interested and it was a great tool to start the conversation regarding safety. I think the virtual reality was great, in that it attracted a younger crowd—the next generation of drivers. The voting beads didn't seem to take off—people were mostly interested in checking out the VR.
- I think it was positive in all areas. I do think that most of the younger people that did the simulators did not care what the content was, they just saw virtual goggles and wanted to do whatever it was. Hopefully they will think about what they did experience. In a different setting I think the impact would really be much greater and it is a good idea to use them in other areas. I would sign up again. The lay out of the booth was really good because people could stop in and out without any effect what else was going on. It was very friendly.
- I think the fair booth worked very well and the public was really enthused about the VR aspect of it. The training was very helpful and the number lists and prep really made things go smoothly. Look forward to doing it again next year (:
- The booth was a great experience this year. I felt that the VR simulation was useful, however; to me it seemed like we were unable to have a conversation with the public. It felt like the VR simulation was the only point of interest and it did not lend itself to people asking questions about our projects, motor vehicle concerns, or other DOT issues. Perhaps we wanted a very focused message.
- Also, there was a booth along the same wall that was charging $10 for a VR simulation. Although that VR experience was likely interactive, I think it slowed down people's interest in try ours. I heard some people thinking we were charging money (beyond the gas tax collected) to experience our VR simulation. I understood the tie inwith the shirts to our Work Zone simulation, but I'm not sure the public understood it. Thanks for the opportunity to comment.
- The VR was definitely a hit, and I think we should keep doing it. However, one downside was that not many people stayed to just ask questions or learn more about other DOT

initiatives. Perhaps next year we could have a separate table that would be specifically for people to just ask questions or visit with our staff… or complain about whatever is bugging them. Just having someone listen to them is oftentimes a win for us, even if we can't do anything differently.

- We had a lot of good feedback people suggested that we do one that simulated a drunk driver. The last day of the fair we had run out of the protective covers and the simulators seemed to not be charging as well other than that I think it was a very successful, we were able to keep our lines moving very well. The questions I received were in regards to how long children needed to be in booster seats and then questions about semi's so it was very helpful to have enforcement officers there. People seemed to react to the construction simulation more so than the other simulation. Hope this helps.
- I feel like the Virtual Reality was a little weak, not real cutting edge or creative. I know the universities each helped with those but again feel there wasn't much creativity or realistic aspects. I know the intent was to make you feel like you were in the passenger seat but I don't think it translated well and definitely didn't feel like reality.
- People of all ages had fun watching the virtual reality presentation. Children, teenagers, young adults had the highest interest in virtual reality presentation. Unfortunately, many participants had not voted.
- I think the Virtual Reality simulations were big hit with the public. Everyone seemed to be impressed with the quality and length and message they gave. I worked 4 shifts and only had two families not allow their children to watch the simulations. Not sure why, and we were too busy to take time to ask. It was interesting to see that kids knew exactly what the Virtual Reality googles were and they would ask if there was a charge to watch the simulation. Generally, kids would watch the video before the parents and the kids would suggest that the parents also watch it, and they would. I never received any negative comments about the Virtual Reality simulation during any of the 4 shifts I worked. I was asked several times if this was going to be used in Driver Education classes. The booth was very popular and had lines most of the time but people seemed very patient and liked to watch the reactions of others that were watching the simulations.
- It did go over well with the kids. The masks were an issue. The safety messages were okay; scenario looked like 80s drivers ed.

STATE FAIR WORKER COMMENTS

Comment #1:

- Were attendees comments/reactions mostly positive or negative? **positive**
- What specifically were some positive comments that you heard? **In general most people found it interesting. Was a good learning tool for the younger/future drivers, to encourage safe driving behaviors.**
- What specifically were some negative comments that you heard? **No negative**

comments. Only a few people were startled during the VR.

- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Definitely yes. It was a good conversation starter, to get families talking about such issues.**
- Do you think the experience appealed to all audiences? **I felt that the elders were less likely to participate. The teens were more interested, which is a great target audience to reach out to.**
- Any comments you heard or have to improve the experience of the simulations?

Comment #2:

Good morning, as per the questions in your e-mail.

I saw very positive reactions and comments on the simulations. Especially with the age group between 8 to 20. It definitely made an impact on them.

"I'm not going to do that when I get to drive" "MOM, I'm not riding with you anymore" "Why do they do that"

"He was too busy with his phone" "Jennifer should watch this"

"So should Brandon"

As for negative comments, some said it made them a little dizzy. I believe it made a tremendous impact on people. They walked away and made them think about it I'm sure. I think it appealed to most of the people, some just weren't interested, but very few. I didn't hear any comments as to how to improve the experience.

I think it would be great to do it again next year and change the themes. Also have another chair. I think we could handle 3 of them easily enough.

As for new themes:

- *Have one of a driver on a 4-lane highway that is in the passing lane and not moving with the flow of traffic as per other vehicles are passing on the right rather than on the left. And in doing so causes an accident. It happens more often than people think.*

- *Also have a driver on a 4-lane highway that is approaching an Emergency vehicle on the shoulder and doesn't move over or slow down. (need more input on what could happen on this one) Just an idea*

That is all that I can come up with at this point, but I will keep thinking. Also I think we should go back to the previous dress code . I think it looks more Professional If I think of anything else I will let

you know. I look forward to participating again next year, I would love to do both Friday's *9-3 if possible*

Comment #3:

My responses…

- Were attendees comments/reactions mostly positive or negative? **Almost all positive.**
-
- What specifically were some positive comments that you heard? **People were impressed at how realistic it felt. Body language says a lot, and many people were clearly startled. Several people said it was a good reminder and good that we were doing this.**

- What specifically were some negative comments that you heard? **Some were a little more startled than others, but not mad/upset about it.**

- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Absolutely. Not only was it a reminder to some, but it gave us (the people facilitating the experience) the opportunity to ask them questions about safe driving, and also remind them of other distractions and unsafe things.**

- Do you think the experience appealed to all audiences? **Almost everyone. People that get motion sickness did not want to try it, which is understandable. But a lot of people were curious about virtual reality but equally curious about the content.**

- Any comments you heard or have to improve the experience of the simulations? **Definitely more simulations, more examples of unsafe driving choices.**

Comment #4:

- Were attendees comments/reactions mostly positive or negative? **Very positive.**

- What specifically were some positive comments that you heard? **Realistic but not too realistic. Attendees appreciated it was long enough to get the message but not too long to be boring.**

- What specifically were some negative comments that you heard? **People who knew they were**
  prone to motion sickness didn't want to participate.

- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Yes. It was a common comment from attendees that it drove home the point of the unsafe behavior that was demo'd.**

- Do you think the experience appealed to all audiences? **Yes with the exception of those**

who knew that VR caused them motion sickness.

- Any comments you heard or have to improve the experience of the simulations? **A take away item like a sticker would be a good addon.**

Comment #5:

It was my observation that the VR experience generally appealed more to younger (and not necessarily driving age) individuals. It was difficult to get older drivers to put on the goggles, since they are more unfamiliar as a group with the concept of VR. Other than that, I think the comments were generally positive. The only potential improvements I heard were adding more scenarios, and making the imagery a little more realistic (i.e. the VR human looked like a cartoon).

Comment #6:

Following are comments from Ellen Davidson and Tammy Hamilton

- Were attendees comments/reactions mostly positive or negative? **Comments were positive – we did not have any negative comments.**

- What specifically were some positive comments that you heard? **There were a lot of "wow's". There were a lot of folks that moved their body during the simulation and commented how real it was.**

- What specifically were some negative comments that you heard? **We didn't have any negative comments**.

- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **It definitely was; it made things seem real to people.**

- Do you think the experience appealed to all audiences? **Yes, all ages were participating and enjoying it.**

- Any comments you heard or have to improve the experience of the simulations? **It seemed some folks thought the program would last longer, but in a way, it's good it didn't because we had very long lines and were constantly busy, so we could get a lot of people through quicker with the shorter simulation program. (We worked the first Friday night.)**

Comment #7:

- Were attendees comments/reactions mostly positive or negative? ***Mostly positive.***
- What specifically were some positive comments that you heard? ***Realistic simulation. Made them think about distracted driving.***
- What specifically were some negative comments that you heard? ***Some felt the virtual human driver looked a little creepy.***
- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? ***Yes.***
- Do you think the experience appealed to all audiences? ***In general yes, we had a mixed of older and younger participants. However, I would guess most of the participants were under 18, so it definitely appealed more to the younger crowd, which is good I think.***
- Any comments you heard or have to improve the experience of the simulations?

Comment #8:

- Were attendees comments/reactions mostly positive or negative? **I personally didn't have any complaints all comments were positive.**
- What specifically were some positive comments that you heard? **They called their teenagers back over to watch I also encouraged them to watch both if there wasn't a wait.**
- What specifically were some negative comments that you heard? **NA**
- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Yes, more so the construction zone. To me it was more realistic of stopping quick with an unexpected action.**
- Do you think the experience appealed to all audiences? **Yes**
- Any comments you heard or have to improve the experience of the simulations**? I don't recall any.**

Comment #9:

- Were attendees comments/reactions mostly positive or negative? **Yes, mostly positive. Some thought it was too short, but most just had positive comments.**
- What specifically were some positive comments that you heard? **That it was effective and impactful.**
- What specifically were some negative comments that you heard? **That it was too short and some said something like "that's it?" Those folks didn't think it was impactful enough. Most negative comments concerned germs and not sanitary to use on so many people even with our precautions.**
- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Yes, I do. I felt one was more impactful than the other though.**

- Do you think the experience appealed to all audiences? **No, I don't think it appealed to all audiences. We had several people walk on by and were clearly not interested.**

Comment #10:

- Were attendees comments/reactions mostly positive or negative? **All positive.**
- What specifically were some positive comments that you heard? **I can't recall any specific comments at this time.**
- What specifically were some negative comments that you heard? **I can't recall any specific comments at this time.**
- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **Yes, I think it was at least a glimpse into the situation(s).**
- Do you think the experience appealed to all audiences? **yes**
- Any comments you heard or have to improve the experience of the simulations? **If possible, a simulated scenario which would track the response time of the viewer in both a distracted and non- distracted situation**.

Comment #11:

My experience was :

- Were attendees comments/reactions mostly positive or negative? **Very positive**
- What specifically were some positive comments that you heard? **Very real. "makes you think"**
- What specifically were some negative comments that you heard? **To real, a little scary**
- Do you feel it was an effective way to illustrate the impact driving behaviors can have on the safety of our roads? **yes**
- Do you think the experience appealed to all audiences? **Once I was able to let someone know that it was not JUST for young drivers, I think it was more effective. Some are more susceptible to an experience like the VR (young and old) but the response was great. I think in a location where distracted driving is the focus would really hit home better. At the fair there are so many things going on that I would think some had forgotten about it by the time they left that day.**

APPENDIX D - Meeting Notes:

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Seat Belt Demo VR Display/University of Iowa

1st TAC Meeting with U of Iowa - 05 April 2018

Attendees:

University of Iowa: Dr. Karim Abdel-Malek, Dr. Rajan Bhatt, Chris

Murphy FHWA: Micah Loesch

Iowa DOT: Andrea Henry, Tracey Bramble, Hillary Marquard, Steve Gent, Vanessa Goetz, Annette Jeffers, Ahmad Abu-Hawash, Kimball Olson

Discussion Points:

Some existing examples of video Public Service Announcements and the "itcanwait.com" VR distracted driving simulation created by AT&T were shared with the group, as a way to initiate discussion regarding VR display content, manipulation, messaging, interaction, etc.

Some discussion of content centered around the realism and amount of detail that should go into the car crash scene. Graphic bodily injury-type details will be avoided, but seeing the unbelted avatar's body in unnatural positions as a result of the crash is desirable for proper viewer reaction. Implying that the unbelted avatar dies as a result of the crash is not the aim. Awareness of some potential viewers' sensitivities to violent or disturbing scenes, previous experience with real crashes, and adverse or challenging health conditions (heart condition, pregnancy, anxiety, etc.) is important to consider when evaluating the directness and strength of the content and the message. "Hyper-realism" is not seen as necessary to convey a strong message in an immersive environment, and high textural detail would likely overwhelm a phone-based application anyway.

Minimum age of viewers was discussed, and it was determined that a disclaimer (such as a generalized rating and/or listing of content, e.g. "disturbing scenes") or minimum age recommendation is appropriate at the deployment site, but that no one would be purposefully excluded from using the VR display. UI staff suggested that small children may not be able to view the content properly due to their typically smaller pupil distance.

A supplementary screen-based display playing the VR experience could be added to the Fair

booth for those not interested in, or worried about, using the headset. Creating a recorded animation that could be looped on a monitor or tablet is desirable.

There was some discussion about whether the unbelted avatar should be the driver or the passenger. In either case, some verbal interaction with the avatar could result in the avatar providing common

excuses for not belting. The avatar could also be the cause of some distraction for the viewer/driver, or be distracted by something (cellphone in car, person/object outside vehicle, etc.) just before the crash scenario begins. If the viewer is the driver, it would be necessary for the viewer to have a virtual body with hands on the steering wheel. If the viewer is the passenger, a virtual body may not be required, but being able to look down and see that he/she is belted is a desirable feature.

An urban driving environment is desired. Potential crash scenarios were discussed in terms of maximizing the physical response in the unbelted avatar, and to represent realistic crash events. Discussion about the specifics of the planned crash resulted in a desire to have a multi-strike collision, such as an angled head-on strike followed by a third vehicle strike from the side, if possible. This may provide opportunity to show the greatest amount of response in the unbelted avatar within the cabin of the vehicle, and/or eject the avatar from the vehicle. The approximate speed depicted in the crash will likely be in the 35 to 45 MPH range.

It is desired to have some flying objects inside the vehicle during the crash to accentuate the chaos and disorientation of such an event. Sudden changes in viewframe and abrupt sound effects are also desirable. The flying glass debris shown at the end of the “itcanwait” VR demo were seen as particularly effective. The heartbeat sound effect used in previous safety PSAs was also seen as a strong component. Possible use of slow-motion during the crash could help the viewer see what’s going on and be more affected by the visuals. Airbag deployment during the crash would be a feature to add realism and to make it clear that belting is necessary even with airbag protection.

Techniques may be employed within the VR display to ensure that the viewer is looking in the right direction during critical message delivery events (e.g. interactions with the avatar, the crash, etc.). Peripheral view fading and view indication arrows were ideas mentioned.

The physical “car cabin” idea proposed by UI was discussed, and although the full idea doesn’t fit the Iowa State Fair deployment, the possibility of including 2-3 chairs with seat belts at the Fair booth is worth further investigation. UI staff feel that adding this physical component to the VR display will enrich the experience and make it more effective. Actual car seats and belts would be the most convincing. Obtaining this equipment is outside of the scope for UI, so will be pursued by Iowa DOT staff. The UI car cabin may be deployed at other venues after the Fair. Possible use in driver’s license stations was suggested. Actual physical movement of the chair(s) during the VR experience was discussed, but was recommended against by Iowa DOT staff.

It was tentatively decided that the 2 different VR displays (Seat Belt VR and Work Zone VR) would not be offered simultaneously at the Fair booth, but each would be offered individually

at different times of day (AM vs. PM) or on alternating days, etc.

VR platforms were discussed, and while the full-immersion headset is understood to provide the best quality imagery, ease of deployment to multiple people at once is key to success at the Fair, so phone- based VR application is still the desired platform. Good audio quality will be important, so accessory headphones are desired. UI will investigate the different quality/price levels available in phone VR platforms, and provide Iowa DOT guidance on equipment purchases. UI suggests that multiple builds of the VR display for different platforms is not problematic, so this may be pursued if full headsets with PCs and base stations may be used in future deployments and higher quality imagery/texturing is desired.

UI staff expect that minimal training of DOT staff will be necessary to prepare for Fair deployment. Devices and the application will be relatively easy to use.

It was suggested that some collaboration between UI and ISU may be appropriate when it comes to determining exactly how user experience data is gathered and analyzed.

UI to prepare some content and a preliminary storyboard of the VR display for TAC review at next meeting.

Next Meeting: TBD

Iowa DOT/OBS/KMO/kmo/09 April 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Work Zone Demo VR Display/Iowa State University

***Prep for 1st TAC Meeting* - (scheduled for 13 April 2018)**

Feedback Comments on ISU "Work Zone VR" Proposal

By focusing on the experience and behavior of the driver in their primary scenario, the ISU proposal showed the most relevancy to problems related to safety in work zones. The description of the proposed scenario is highly detailed, and shows the most promise in creating a memorable and effective message. ISU's understanding of the theoretical framework that underlies the VR user's psychological response to VR scenarios is considerable, and will help to guide the effort toward the most effective result. VR run-time constraints permitting, the addition of recorded user/driver behavior as viewed from the construction worker's point of view also fulfills the project's goal of building awareness of risk to those workers. The fact that ISU has already tested some programming of a smartphone headset's handheld controller to replicate a steering wheel/braking and accelerating device shows that deployment to this preferred platform may be achievable with good interactive capability. The user performance data proposed to be collected, while possibly useful to a future educational effort, does not appear to be supportive of the message delivery efficacy research desired, so must be refocused during development and implementation to meet the project goals. Some elements of the proposed scenario and data collection approach will likely have to be trimmed to meet the run-time limitations of the immersive VR experience.

Preparatory Materials for 1st TAC Meeting

The Iowa DOT has identified some examples of previous Public Service Announcement-style videos that have some relevance to this VR project. Please review the following prior to the 1st TAC meeting:

AT&T Distracted Driving VR Demo

"itcanwait.com" https://www.itcanwait.com/

"Don't Text and Drive" (YT)

https://www.youtube.com/watch?v=rClJW9g

nchc

Glee Distracted Driving PSA (YT)

https://www.youtube.com/watch?v=mnw_7xI5klM

“Drinking and driving can kill a friendship” (YT)

https://www.youtube.com/watch?v=MWCGIWDo-1Q

The following are some generalized comments about the VR application for the Iowa State Fair that came out of our first meeting with the University of Iowa on April 5, 2018:

Awareness of some potential viewers' sensitivities to violent or disturbing scenes, previous experience with real crashes, and adverse or challenging health conditions (heart condition, pregnancy, anxiety, etc.) is important to consider when evaluating the directness and strength of the content and the message. "Hyper-realism" is not seen as necessary to convey a strong message in an immersive environment, and high textural detail would likely overwhelm a phone-based application anyway.

Minimum age of viewers was discussed, and it was determined that a disclaimer (such as a generalized rating and/or listing of content, e.g. "disturbing scenes") or minimum age recommendation is appropriate at the deployment site, but that no one would be purposefully excluded from using the VR display. It was pointed out that small children may not be able to view the content properly due to their typically smaller pupil distance.

A supplementary screen-based display playing the VR experience could be added to the Fair booth for those not interested in, or worried about, using the headset. Creating a recorded animation that could be looped on a monitor or tablet is desirable.

Techniques may be employed within the VR display to ensure that the viewer is looking in the right direction during critical message delivery events (e.g. interactions with an avatar, a crash, etc.).
Peripheral view fading and view indication arrows were ideas mentioned.

There is a possibility of including 2-3 chairs with seat belts at the Fair to enrich the experience and make it more effective. Actual car seats and belts would be the most convincing. Obtaining this equipment will be pursued by Iowa DOT staff.

If the viewer is the driver in the VR scenario, it would be necessary for the viewer to have a virtual body with hands on the steering wheel. If the viewer is the passenger, a virtual body may not be required, but being able to look down and see that he/she is belted is still a desirable feature.

It was tentatively decided that the 2 different VR displays (Seat Belt VR and Work Zone VR) would not be offered simultaneously at the Fair booth, but each would be offered individually at different times of day (AM vs. PM) or on alternating days, etc.

VR platforms were discussed, and while the full-immersion headset is understood to provide the best quality imagery, ease of deployment to multiple people at once is key to success at the Fair, so phone- based VR application is still the desired platform. Good audio quality will be important, so accessory headphones are desired. UI and ISU will provide Iowa DOT guidance on equipment purchases. UI suggests that multiple builds of the VR display for different

platforms is not problematic, so this may be pursued if full headsets with PCs and base stations may be used in future deployments and higher quality imagery/texturing is desired.

UI staff expect that minimal training of DOT staff will be necessary to prepare for Fair deployment. Devices and the application will be relatively easy to use.

It was suggested that some collaboration between UI and ISU may be appropriate when it comes to determining exactly how user experience data is gathered and analyzed.

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Work Zone Demo VR Display/Iowa State University

1st TAC Meeting with ISU - 13 April 2018

Attendees:

Iowa State University: Dr. Nir Keren, Peter

Carlson FHWA: Micah Loesch

Iowa DOT: Tracey Bramble, Steve Gent, Annette Jeffers, Ahmad Abu-Hawash, Kimball Olson (absent TAC members: Andrea Henry, Hillary Marquard, Vanessa Goetz)

Discussion Points:

The TAC was made aware that some of the relevant notes from the first meeting with U of I staff had been shared with ISU in preparation for this meeting. Existing examples of video Public Service Announcements and the "itcanwait.com" VR distracted driving simulation created by AT&T were also shared with ISU for their reference. The features of these PSAs including their strength of message delivery, their brevity, and their manipulation of reality were pointed out to ISU as desirable goals for the Work Zone VR demonstration.

ISU commented on the statement made by U of I that publishing the VR demo to different platforms is not problematic. In ISU's experience, this is not as easy as U of I described. They may like to learn more from U of I about the specifics behind this statement.

Discussion of some of the details in ISU's proposal ensued, with Iowa DOT expressing that the runtime constraints of State Fair deployment will not allow for the "training time" (e.g. 30 seconds on a "test track") necessary for each user to get acquainted with the functionality of the handheld controller device, and that the SAGAT (Situational Awareness Global Assessment Technique) evaluation of user performance and data collection was not workable for that venue. ISU warned that the quality and applicability of data gathered will suffer if limited by a very short time duration within the VR demo. TAC mentioned that data collection may be done separately from the VR through the use of a tablet-based survey or similar technique. The TAC sees value in having some of ISU's proposed features retained for other deployment venues where time constraints are not as critical. ISU has interest in publishing data relative to user performance and response that goes beyond the evaluative goals of the project.
Multiple-length versions of the demo were discussed as a possible way of achieving multiple

goals with the evaluative approach. ISU will provide additional feedback when development is further along and the staff time necessary to create expanded capability in the demo can be measured.

Content of the demo was discussed. It is desired by the TAC that the work zone be on a rural two-lane highway, with typical signage installations, cones, etc. represented in the demo, but that the adherence to the realities of such conditions need not be rigorous. Manipulation or exaggeration of details to create unexpected or surprising scenarios is acceptable if it helps to deliver a strong message about work zone safety and driver attentiveness. Steve Gent agreed to provide ISU with the necessary signage, etc. information for typical work zones.

ISU expressed concern about car movement in the demo instigating motion sickness in users. Iowa DOT's experience with deploying the I-74 VR demo, which includes a drive-through sequence, has not shown much tendency to induce motion sickness. This may be due to the visual "anchoring" provided by a virtual car cabin within the view, which drivers are familiar with. The intent of delivering the demo to seated users should also decrease the potential for adverse reactions to the drive-through. Slower speeds associated with movement through the work zone may also help diminish this potential problem. It is also acceptable that the demo may not be appropriate for all users, and motion-affected users can simply remove the headset.

TAC agreed that the State Fair demo probably needs to be a fully-controlled scenario with prescribed events that will occur for each user, rather than having optional outcomes depending on user interaction (e.g. driving capability). Demo will involve a rear-end crash within or near the work zone, due to the typical nature of this type of crash in these conditions. ISU was reminded of the advice given to U of I regarding the nature, extent, and realism of any disturbing images or scenes. Consequences of the crash can involve avatar bodies in unnatural positions, but no graphic depictions of bodily injury are appropriate. It is desired to have some flying objects inside the vehicle during the crash to accentuate the chaos and disorientation of such an event. Sudden changes in viewframe and abrupt sound effects may also be desirable. ISU said these are achievable goals.

ISU was reminded of discussion point with U of I centered around allowing all potential users access to the VR demo, including small children. An advisory statement will be used to warn users of potentially disturbing scenes. There was some push-back from ISU on this, as related to data collection for an expanded version of the demo for future venues, and the applicability of the data gathered being reliable and appropriate for the research and publication they wish to pursue.

Determining whether or not the user of the State Fair (controlled) version of the demo would answer or ignore a text message as part of the scenario will be determined after some development has occurred, and the opportunity for this type of interaction evaluated both for time allowed, and for effect on the message delivery.

ISU asked about the possibility of extending the project with additional research funds. Ahmad

and Micah briefly discussed some mechanisms for this. If ISU feels that additional funding is necessary to expand on the project scope in the ways previously described, they will issue a recommendation to that effect and opportunities will be investigated at that time.

A supplementary screen-based display at the Fair booth was discussed as a means of sharing the demo with those not interested in, or worried about, using the headset. Creating a recorded animation that could be looped on a monitor or tablet is desirable.

Some information regarding U of I's early investigations into possible phone-based equipment was shared with ISU. ISU and UI will cooperatively investigate the different quality/price levels available in phone VR platforms, and provide Iowa DOT guidance on equipment purchases. The current equipment target is 6 phones with accompanying headsets, with 3 in use at any time and the 3 spare units charging. It is desirable for the phones to work for both the Seat Belt and Work Zone displays, but if not possible, separate equipment is also acceptable. ISU felt it would be unwise to plan on employing equipment (such as the Oculus GO, suggested as a possibility by U of I) that has not been released yet.

It was suggested that some collaboration between UI and ISU may be appropriate when it comes to determining exactly how user experience data is gathered and analyzed.

ISU to prepare some content and a preliminary storyboard of the VR display for TAC review at next meeting.

Next Meeting: April 23rd, 11AM to noon.

Iowa DOT/OBS/KMO/kmo/18 April 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Seat Belt Demo VR Display/University of Iowa

2nd TAC Meeting with U of Iowa - 03 May 2018

Attendees:

University of Iowa: Karim Abdel-Malek, Chris Murphy (absent: Rajan Bhatt)

Iowa DOT: Andrea Henry, Tracey Bramble, Steve Gent, Vanessa Goetz, Annette Jeffers, Ahmad Abu- Hawash, Vicki Stamper, Nola Barger, Kimball Olson (absent: Micah Loesch, Hillary Marquard)

Discussion Points:

New TAC members Nola and Vicki were introduced.

Important conclusions drawn during TAC meeting #1 were reviewed:

- An urban driving environment is desired
- A multiple-strike collision sequence is preferred to maximize response in unbelted avatar
- Flying debris, airbag deployment, strong audio track, and possible slow motion during crash
- Should the unbelted avatar (Santos) be the driver or the passenger? (unresolved in mtg. #1)

U of I showed the draft animatic they prepared for the sequence of events leading to the crash: the viewer's car is stationary at a controlled intersection, Santos (as the driver) is talking, providing an excuse as to why he's not wearing his seat belt; there is a screech of skidding tires and the car is rear- ended, which throws it into the intersection; another vehicle approaching with speed from the left strikes the driver's door, which spins the vehicle and causes more damage/flying debris inside the vehicle cabin, and throws Santos' body around inside or ejects it from the vehicle.

The sequence seems to be supporting a message that says, "even when your vehicle isn't moving while on the road you need your seat belt", which was seen as a positive by the TAC. The proposed scenario may also create a false sense of security in the viewer, because the car isn't moving at the time of the crash. This was deemed especially appropriate because of the lack of control the viewer will have over the situation on display, and should deliver a strong

message about personal safety at all times because you can be victimized by the actions of other drivers even when you're doing everything right. The scenario allows for minimal run time, prior to the crash, and probably offers the least amount of distraction for the viewer when the focus needs to be on Santos. The choice of Santos as the driver rather than the passenger makes good sense, given the sequence of events, and also reduces distraction

for the viewer since, as a passenger, he/she doesn't need to monitor the traffic light or any of the car's controls.

It was proposed by the TAC that a short drive occur prior to the vehicle stopping at the intersection, to create a better sense of immersion and plausibility for the viewer. This may allow for a slightly longer monologue from Santos, so he could possibly offer a couple of different typical excuses people use for not belting. UI warned that additional buildings visible in the urban context during the drive could add more data than the proposed phone-based platform can reliably handle. Some testing should be done to determine these limits. Detail could be reduced on the buildings to mitigate data saturation problems.

TAC requested that a seat belt warning chime be added, since it is a sound familiar to drivers, and it would draw the viewer's attention to the fact that Santos is not belted. The alarm chime could preface Santos' monologue of excuses. A flashing warning light on the car's dashboard could accompany the seat belt alarm.

TAC asked whether the viewer's car could be lifted or tipped forward during the rear-end collision, to avoid confusion by the viewer that the vehicle might just have suddenly accelerated forward rather than being struck from behind. TAC also asked whether the oncoming vehicle could be viewed in the rear- view mirror. Also, could the view camera be jolted backwards, as the passenger's head would be during a real rear-end crash. Santos' body should be pushed backward into his seat and his head forced back during the crash.

UI said they were working on indicating vehicle side damage during the second collision. Deformation of the driver's door would be a realistic addition that would reinforce the severity of the second vehicle strike and justify significant response in the unbelted avatar, including possible ejection from the vehicle.

UI noted that during the crash Santos can't be thrown too close to the participant's viewpoint camera, since the camera will go through any objects in close proximity. Smaller debris flying around the car cabin during the crash(es) does not necessarily need the same restriction.

TAC recommended seeking crash data from NADS program at UI for purposes of showing realistic and typical injury scenarios resulting from this type of crash.

UI asked whether it would be desirable, given time constraints, to replay the entire crash sequence as viewed from outside of the vehicle, with a voiceover narrative (possibly by Santos) explaining how using the seat belt would have been a good idea. TAC felt this would add too much time to the total VR experience, and might come across as too preachy or didactic. The message delivered by the crash scenario and the lead-up monologue should be strong enough without further explanation. TAC also felt that some confusion among the viewers wouldn't necessarily be a bad thing, since real crashes are chaotic and disorienting, and puzzled viewers

could seek out more information after the VR experience. People are expected to want to talk at least briefly about what they saw in the VR, anyway, so some additional time spent with some participants is not unanticipated.

UI suggested that it may take up to 60 seconds to get each new participant into the seat, get belted and get the VR headset on and adjusted, and be ready to start. With up to 30 seconds of lead-up activity

prior to the crashes, and with brief intro and credit scenes, this could result in roughly 2 minutes per participant.

Some discussion occurred around the question of whether the VR display, in whole or in part, should be looped on monitors within the Fair booth. Some felt this could ease the apprehension of reluctant VR participants, others felt this would compromise the strength of the message by eliminating the surprise factor inherent in the crash scenario. Even a view entirely external to the car would reduce the shock value of the experience. Still images may be an option, both of the subject project(s) and other applications of VR, or animated views of other unrelated VR content. Perhaps all the intro/credit information occurs outside of the VR headset on the monitors. More discussion needs to occur around this topic in future meetings.

UI recommended obtaining Oculus GO 64GB VR devices, since they were released on their original schedule and appear to be a workable and more affordable platform for the VR display(s) than phones/headsets. Iowa DOT Office of Strategic Communications will begin the purchasing process for 2 units to be tested by UI and ISU with their respective VR displays. If it turns out that the Oculus Go units are satisfactory, phone/headset units purchased will be returned, and additional Oculus Go headsets will be purchased to support Fair deployment.

Next Meeting: TBD

Iowa DOT/OBS/KMO/kmo/08 May 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Work Zone Demo VR Display/Iowa State University

2nd TAC Meeting with ISU - 23 April 2018

Attendees:

Iowa State University: Dr. Nir Keren, Peter Carlson

Iowa DOT: Andrea Henry, Steve Gent, Tracey Bramble, Annette Jeffers, Vicki Stamper, Nola Barger,
Kimball Olson

(absent TAC members: Micah Loesch, Hillary Marquard, Vanessa Goetz, Ahmad Abu-Hawash, Mark Bortle)

Discussion Points:

New TAC members Vicki Stamper and Nola Barger were introduced.

ISU had prepared a draft storyboard using a combination of 3D, 2D, and photo media to represent features of the VR display. ISU clarified that a phone-based deployment platform will not support high levels of detail and photorealistic textures, so a more stylized character is likely in the final displays.

The draft storyboard showed a proposed sequence of events similar to the following:

1. Viewer enters a work zone following another vehicle along a narrow 2-lane highway
2. Warning signage is passed, but a curve ahead obstructs the view
3. A text message arrives on dash-mounted phone with a large readable pop-up
4. Vehicle brakes suddenly as vehicle ahead has stopped just around the curve
5. Travel resumes through work zone, with construction vehicles and activity
6. A worker falls into roadway in front of the vehicle ahead, which abruptly brakes, resulting in a rear-end collision by viewer's vehicle
7. Flying debris, airbags deploy

TAC thought it was okay for the display to skip the transition zone ahead of the work zone, given the quest for a short total runtime for each user. TAC felt it was not necessary for a construction worker to fall into the path of traffic to cause the abrupt stop that results in the crash. A worker moving toward the travel lane after suddenly appearing from behind a piece of equipment would be enough of a surprise to justify the car ahead stopping suddenly. Other activity associated with moving construction equipment (swinging backhoe bucket, etc.)

would also be good ideas for this final event, as well as throughout the work zone to show how many distractions there can be.

TAC suggested that a second text message could arrive just before the final ahead vehicle stop and the crash. TAC felt that having the first text resulting in no consequences may illustrate a buildup of

confidence that texting is okay because people do “get away with it” and then feel more comfortable continuing this behavior. The type and frequency of distraction will be the subject of further discussion when development yields reviewable draft display(s). ISU warned about adding too many distractive elements, such that the scene gets too chaotic and the message gets lost or is confused by being stretched too far from real-life situations. Some testing during development should help to assess this.

Testing will need to be done once the display is drafted with moving vehicles and scenery to evaluate propensity of the display to induce simulation sickness. DOT staff could be a ready source of willing test subjects. The anchoring of the view with the interior of a car cabin should help alleviate this problem.

Discussion about whether the viewer is the driver or the passenger yielded a preference for the passenger position. Given the scripted condition necessary to keep display runtime short and the results identical for each user, this idea fits best with the lack of control the viewer will have over the situation. The avatar driver will exhibit risky distraction behaviors (handling phone, conversing, adjusting radio, etc.), which will put the passenger/viewer at risk. Message could be adjusted to say that it is everyone’s responsibility to be cautious in work zones, and/or to encourage passengers that it is okay to remind their drivers to be extra careful in work zones. Particulars of this message are to be developed, and recommendations made for final “taglines”, etc. by Strategic Communications staff. A front-end “splash screen” with appropriate information and credits also needs to be developed.

TAC expressed that a strong audio component is desired, with sounds of construction equipment, incoming text alert, screeching tires during braking, crash sounds, etc. ISU indicated that good, noise- canceling (Bose) headphones are available with standard phone jacks.

Hardware issues were discussed: hand controller will be necessary to restart or reset the displays, even if not being used by viewer. Booth staff will handle this; calibration of headset will also be done using the controller, and the user’s position (sitting, looking forward) will be important so that view inside headset is properly oriented once display starts; sanitary issues with the headset may be solved either by wiping down alternate rubber or vinyl facepad with sanitizer, or use of available disposable covers. ISU will investigate availability and function of disposable covers; ISU requested that Iowa DOT fund purchase of some test equipment soon (Galaxy S8 phone and Google Daydream headset); ISU suggested that Oculus GO (self-contained headset device, no phone required) may still be worth investigating, even though it is not available for a few weeks (at the earliest).

Discussion of data-gathering techniques showed a preference for tablet-based survey questions as a follow-up to the VR experience. ISU suggested careful choices of questions that encourage

the users to reflect on what they experienced, as a way of stressing the educational component of the display. Five questions or so, with “sliders” to select answers, was recommended by ISU, with questions worded such as, “How likely are you to remind your driver about…?”. ISU warned that VR may be seen strictly as entertainment, so careful consideration of all aspects of the display and the survey need to enforce the educational or messaging directive. Identification/classification of the survey respondents will also be important, especially as related to amount of driving experience. Evaluation of test subjects within research projects performed by ISU VRAC requires review by their Institutional Review Board (IRB), which can be cumbersome. ISU may be able to assist Iowa DOT with developing survey questions, but anything further may instigate a tedious regulatory process for them. More discussion may be needed to determine exactly what ISU can provide. Strategic Communications staff will work closely with ISU, since training of booth staff will be important. DOT will meet internally to talk about survey strategies, other

opportunities to share the VR, etc. Other deployment venues after the State Fair may also allow for a different approach to these issues.

ISU felt it would be a month or so before enough display content and functionality would allow for review. They will keep in contact with Iowa DOT as development progresses.

Next Steps (TAC):

- **organize internal Iowa DOT meeting to strategize survey(s)**
- **look into equipment purchases for testing**

Next Meeting: TBD

Iowa DOT/OBS/KMO/kmo/24 April 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement

TAC Meeting: Discuss Survey Questions - 07 May 2018

Attendees:

Andrea Henry, Micah Loesch, Vanessa Goetz, Annette Jeffers, Ahmad Abu-Hawash, Vicki Stamper, Nola Barger, Mark Bortle, Kimball Olson

Agenda:

Discuss survey questions and survey strategy for State Fair VR deployment

Discussion Points:

Time constraints for interaction with each visitor to the Fair booth are very limiting. The expectation is that a long list of survey questions would likely be ignored by many visitors, plus there is not a lot of room available for people to linger after they've been through the VR experience.

The question was raised about the depth of feedback sought as part of the implementation. Vanessa pointed out that the purpose of these projects is not research into participant response, or to prove changes in behavior as a result of experiencing messaging through VR, but simply to implement VR technology to the public realm. The original scope calls for evaluation of VR as an information delivery tool only. The universities may have goals of evaluating the VR that go beyond the scope, but we have no obligation to fulfill those goals.

Our purpose is to explore whether it makes sense, based on feedback gleaned from public participants, to continue investing in this technology for future strategic communication of general safety and other broad DOT messages. Design staff intend to use VR as a tool for project development (internal) and for sharing project-specific information (external) at meetings with project partners and the general public when data exists and it is appropriate. Some of these VR experiences could be exploited at annual conferences, STEM events, recruiting, outreach, etc. VR for general Iowa DOT messaging would be combined with or potentially replace other message delivery methods currently used (press releases, YouTube videos, social media, etc.) either at specific venues or through downloadable apps for remote, on-demand viewing.

The following draft survey questions were reviewed:

1. Please indicate the amount of driving experience you have:
    a. I am currently learning how to drive

b. 0 to 5 years
c. 6 to 10 years
d. 11 to 20 years
e. More than 20 years

2. As a direct result of this VR experience, how likely are you to (be more cautious in work zones/insist that everyone in your vehicle wears a seat belt)? - scale from “Not likely” to “Very Likely” or similar
3. As a direct result of this VR experience, how likely are you to encourage the driver of a car you are traveling in to (be more attentive and avoid distractions when driving through work
   zones/wear a seat belt even though it’s their car and their choice)? - scale from “Probably Won’t” to “Definitely Will” or similar
4. Do you agree or disagree with the following: “I have witnessed (inattentive driving behaviors by others I was traveling with through a work zone/unbelted passengers in a vehicle I was traveling in), and as a result of this VR experience I will say something next time.” - scale from “Strongly Agree to “Strongly Disagree”
5. Do you agree or disagree with the following: “The VR experience helped me to see the importance of (avoiding driver distraction in work zones/everyone in a vehicle always wearing a seat belt).” - scale from “Strongly Agree” to “Strongly Disagree”
6. After this VR experience, how much awareness do you have of (work zone/seat belt) safety issues compared to the awareness you had before? - scale from “More Awareness” to “About the Same Awareness” to “Less Awareness”
7. Do you agree or disagree with the following: “I consider Virtual Reality to be a good way to receive information, and I would like to see more of this in the future.” - scale from “Strongly Agree” to “Strongly Disagree”

TAC members were encouraged to draft any additional questions that come to mind, or wordsmith any of the above to suit the purposes of the State Fair deployment.

The survey strategy for the State Fair is proposed to be comprised of just one or two clear questions to measure the receptiveness of public participants to receive information through a VR format. Question 7 above (re-formatted toward a Y/N answer) was seen as a very direct way of assessing the receptiveness of the public to further VR-based communications. It was decided that any participant, regardless of age or driving status, would be allowed to provide an answer to the question(s). It was proposed that a traditional approach to gathering answers could be used, such as jars marked “Yes” and “No” into which an object could be dropped to place a “vote” (corn kernel, coin, etc.).

For future deployments beyond the Fair, it is expected that more time would be available from participants to gather more substantive feedback through a more in-depth survey or questionnaire. Our intent is to share our draft questions with ISU and UI for appropriate adjustments to support defensible reporting of findings at the conclusion of the project (~Fall 2019). At this time, it is not anticipated that any fully-controlled studies will be performed as part of this project to evaluate VR’s efficacy as an information delivery device.

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Work Zone Demo VR Display/Iowa State University

3rd TAC Meeting with ISU - 29 May 2018

Attendees:

Iowa State University: Dr. Nir Keren, Peter Carlson

Iowa DOT: Vanessa Goetz, Ahmad Abu-Hawash, Tracey Bramble, Annette Jeffers, Vicki Stamper, Nola Barger, Kimball Olson

(absent TAC members: Micah Loesch, Andrea Henry, Steve Gent, Hillary Marquard, Mark Bortle)

Discussion Points:

ISU brought a partially complete test VR file loaded to the Oculus GO headset, which was shared with the TAC. The car cabin interior, roadway, surrounding terrain, and some entourage (lane marking barrels, construction equipment, animated construction worker, etc.) were included in the draft display. The TAC was impressed with the visual quality of the Oculus GO headset.

Having tested both the Oculus GO and the Samsung Galaxy S8+/Google Daydream headset, ISU expressed their preference for developing the display for the Oculus GO platform. The TAC agreed this was the best choice. Some discussion about returning the phones/headsets occurred, and Vicki suggested the phones, if not returnable, could become equipment used by the Strategic Communications office. Vanessa pointed out that this would require the STIC project to be reimbursed by the DOT for this equipment. ***(UPDATE: In a follow-up conversation with U of I staff, it was discovered that the Oculus GO units must be paired with a smartphone or Bluetooth device in order to be functional. At least one of the Galaxy S8+ phones should be retained for this purpose, in order to dedicate a phone to the Oculus headsets.)***.

ISU brought some draft questions for the questionnaire/evaluation portion of the project. Their proposed approach is to avoid hypothetical questions, to make the evaluation experience-based, and to utilize questions both before and after participants experience the VR display to aid in evaluating efficacy of message delivery. The gathering of demographic data was proposed through 3 questions regarding gender, age, and driving experience. ISU proposes only including driving-age respondents in any study. TAC pointed out that the State Fair deployment would only allow 1 or 2 self-administered questions, and that booth staffing limitations would not support questioning of participants who are in line waiting their turn. TAC pointed out that the Farm Progress Show may accommodate more time with each visitor, allowing for more questions and possibly both before and after the headset experience. A paper survey was proposed due to the environmental conditions present at the FPS.

ISU proposed the possibility of a pilot study to help gauge the time necessary to get participants to provide feedback through a multiple question, before-and-after type of survey. More discussion will be

needed on this topic. It is possible that DOT personnel could be employed in this pilot study. TAC will further discuss the questions and format. It may be helpful to discuss these topics with U of I staff before determining survey strategy.

Vanessa mentioned issues associated with the required Data Management Plan, in order to keep ISU aware of these requirements, particularly around archiving of files associated with the VR display.

Next Meeting: TBD (roughly 1 month)

Iowa DOT/OBS/KMO/kmo/31 May 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Seat Belt Demo VR Display/University of Iowa

3rd TAC Meeting with U of I - 18 June 2018

Attendees:

University of Iowa: Chris Murphy

Iowa DOT: Andrea Henry, Tracey Bramble, Steve Gent, Vanessa Goetz, Annette Jeffers, Vicki Stamper, Nola Barger, Kimball Olson

Discussion Points:

As a group, the TAC watched a video capture from the draft VR display and provided the following feedback:

- The drive time/distance prior to arriving at the crash scene (intersection) seems appropriate, and will allow for some kind of monologue from Santos about ignoring the seat belt chime, providing an excuse for not wearing his seat belt, getting a false sense of security when stopped at the intersection, etc.
- The signal light at the intersection is currently green, so it needs to be changed to red.
- The response to the impacts from behind and from the side meet the basic goals of the display; objects (laptop, phone, coffee mug) thrown about the car's cabin are effective; more broken glass shards flying through scene would improve the chaotic effect of the crashes.
- Santos' body should probably be thrown about a bit more, showing more unnatural positioning throughout; partial ejection through driver's window during side impact is good, and might be an opportunity to bring his legs up out of the well, if he is momentarily ejected a bit further upward and to the left; the final resting position could especially benefit from moving Santos' waist out of the seat more, since his current ending position could be misconstrued as being lap- belted; the possibility was discussed of showing Santos' arm or leg in an unnatural position at the end for effect, as well, perhaps to indicate a broken limb.
- The interior of the car and Santos' clothing are mostly gray. Could Santos' clothing be a brighter or contrasting color to help exaggerate his body's movement during the crashes? This may also help keep the viewer's focus on Santos throughout the animation.
- Could there be some traffic crossing in front of the car at the intersection prior to the rear-end crash, to definitively show that cross traffic has the green light and that moving

forward would be very dangerous?

- Some street markings were inconsistent with standards (one TAC member noticed this after watching the video several times), and overhead signals have the same texture on the back as on the front, which could confuse some viewers.

After viewing the video and discussing the content, each TAC member then experienced the display in the Oculus Go. The effects of Santos' body movements during the crashes seemed somewhat greater when immersed, but could still benefit from some of the enhancements previously discussed. Chris
warned about moving any objects including Santos' body too far into the space occupied by the viewer, due to the risks of the view camera clipping the body mesh. TAC felt there was still opportunity for more displacement of Santos, including in his final position overlaying the console and passenger seat.

If parts of Santos' body must momentarily pass through solid objects such as the steering wheel or shifter in order to achieve a desirable body position, this was not seen as a tremendous problem if it is not easily noticed during the animation.

Santos' rigging may limit what is possible in terms of unnatural body positions, since his physiology is based on natural human body movement characteristics and limitations.

Some discussion occurred around giving the viewer a virtual body. No member of the TAC commented on the absence of a body being a particular problem while viewing the experience inside the Oculus Go. It may be that having a virtual body would distract the user from looking at/seeing what is intended.

Even without audio, the display was considered to be very effective. The planned audio component with Santos' voice, car sounds, seat belt chime, incoming text sound(?), screeching tires, crash sounds, etc. will enhance the immersive experience even further.

Equipment issues were discussed:

- Could the Oculus Go be used without the head strap, and be swapped out for a makeshift - possibly Velcro-affixed - hand strap? It was seen as a positive feature to have the user hold the headset during the display period, and easier to get users in and out of the display. The user is likely to instinctively lower the headset when the display is done, which will indicate to the booth attendant that the display has finished.
- The finishes on the Oculus Go are mostly hard plastic, so will be easily wiped down with sanitizing cloths. Face masks will likely still be necessary, since the padded interface is foam and not easily cleaned. It is not known at this time whether there is an alternate to the foam interface or if a cleanable accessory cover is available.
- The built-in speakers (though not tested with the draft display) may not be able to deliver audio of enough volume and fidelity to overcome the ambient noise present around the Fair booth, so the use of auxiliary head phones was discussed. The Oculus Go has a standard 1/8" audio jack for headphones, but we will need to find units that are robust enough for the usage and that can be easily sanitized between uses. Full noise canceling may not be desirable, since booth attendants need to verbally interact

with users as they prepare them for the start of the display.

- The Oculus Go has a tendency to go into “standby mode” if left idle for a short time, so booth attendants must be instructed in how to restore the display if this happens. Disabling this feature or extending the period of inactivity before standby should be investigated.
- Pairing headsets to a phone: the draft display was paired to Chris’ phone. We will need to pair the headsets to the phones that were previously purchased as potential display devices. it is not known if it is problematic not having the phone in close proximity to the Oculus Go at all times, or if the phone is just for downloading new content. Some investigation is warranted, so that our deployed units retain functionality at all times.

- Backup AA batteries will be needed to keep handheld controllers functioning throughout deployment.
- Chris mentioned that it is easy for the Oculus Go's power button to be inadvertently pushed while the unit is in storage or being transported. Hard cases or foam wrapping may be necessary to keep this from occurring, since the headset battery will be drained if the unit is left on.

Other:

The use of questionnaires or surveys at deployment venues was briefly discussed. For reference, minutes of previous meetings on this topic were sent to the UI team after the conclusion of the TAC meeting.

Next steps:

- **(UI) Make VR display content adjustments and add audio effects for draft review as soon as practicable. Note that it is desirable to have near-complete VR display(s) by mid-July for full State Fair deployment testing and booth staff training purposes, and for DOT management staff review.**
- **(UI/DOT) Investigate potential headphone equipment for purchase.**
- **(DOT) Purchase additional Oculus Go headsets, along with disposable sanitary face masks and sanitary wipes for the purpose of testing deployment strategy.**
- **(DOT) Strategic Communications staff will develop a message for the end of the display**. Project credits could either be part of the same screen or could follow the ending message.
- **(DOT) "Test subjects" derived from DOT staff will be invited to the next review meeting,** to gauge their responses to the display content, and to test the process of getting visitors in and out of the VR, headphones, and seat-belted chairs.
- **(DOT) Obtain completed car seats with seat belts.**
- **(DOT) Finalize plan for including an evaluative question for the State Fair**

venue. Next Meeting: TBD (see first "Next Steps" note above)

Iowa DOT/OBS/KMO/kmo/21 June 2018

FY 18 STIC Incentive - IOWA

Virtual Reality Implementation for Public Engagement Work Zone Demo VR Display/Iowa State University

4th TAC Meeting with ISU - 03 July 2018

Attendees:

Iowa State University: Dr. Nir Keren, Peter

Carlson FHWA: Micah Loesch

Iowa DOT: Andrea Henry, Vanessa Goetz, Tracey Bramble, Annette Jeffers, Mark Bortle, Kimball Olson

Discussion Points:

ISU brought their completed VR animated display to share with the TAC. All features except for the ending message screen (to be determined by Iowa DOT) were present in the display. TAC members individually experienced the VR through the Oculus Go headset, and were universally impressed with the results.

All critical components of the display as discussed in previous meetings were incorporated, with the exception of deployed airbags following the crash, which was determined to cause too much distraction and block views of the crash scene, if included. The TAC agreed with ISU's opinion on this item. It was also not the focus of this project to indicate any particular level of injury to the driver of the vehicle, as a result of the crash associated with the avatar's inattentive driver behaviors.

No TAC member suffered any disorientation, vertigo, or simulation sickness after viewing the display, which was carefully crafted by ISU to avoid these effects.

Discussion of whether or not to use headphones for each user resulted in testing by the TAC of the display using the built-in speakers of the Oculus Go at their highest volume setting with significant ambient noise in the room, versus using a pair of external headphones attached to the headset. The TAC decided that the built-in speakers were likely to be adequate for use at the State Fair booth, but that at least one pair of noise-canceling headphones should be on hand for the occasional user that may benefit from them, such as hearing impaired individuals.

Concerns over inadvertent powering-on of headsets in storage due to their sensitive power buttons were offset by ISU's opinion that the standby mode uses very little battery power. Care will still need to be taken when storing units overnight during deployments.

ISU will write up a brief user manual for the Oculus Go to aid setup and usage at the Fair.

The display output file only works on the Oculus Go headset platform. It will not work in phones. If the Iowa DOT desires a version of the display that could be downloaded for use as a phone app, ISU would have to be contracted to do this through an amendment or other means that includes additional funds.

Phones to which Oculus Go headsets are paired do not need to be present for the headsets to work, but may be needed for specific kinds of troubleshooting. An Oculus account will need to be established, so that the Iowa DOT can pair the headsets with one of the previously purchased phones.

ISU brought a paper questionnaire that could be used in future deployments where more time with each user is available. It was suggested that this questionnaire (or a revised version) could be employed at the Farm Progress Show to avoid potential issues with using tablet computers in that environment. More discussion to follow on this topic, after the Fair is over. A single Yes or No question (devised by Strategic Communications staff) with jars to receive tokens will be used at the Fair.

The ending message for the display needs to be determined. ISU suggested that a current fatality count (e.g. "As of June 30th, there have been XXX fatalities on Iowa roadways") may be a powerful reminder of driver safety. Strategic Communications staff will decide on an ending message and provide to ISU.

ISU suggested that they could load both their own and U of I's VR displays to the headsets once the new units have arrived, and when U of I completes their display. In order to simplify the menus in the headsets and aid navigation to the VR project files, ISU will look into removal or hiding of other preloaded and advertised/downloadable content.

Some discussion occurred regarding setting up another VR display at TRB. Vanessa suggested this topic could fulfill a Training/Workforce Development goal. More investigation would be needed to pursue this idea.

Micah asked whether a video of the State Fair booth installation could be made for FHWA use.

- **ISU will write a user manual to aid Fair booth attendants in hardware/software issues.**
- **Iowa DOT (Strategic Communications) will provide ISU the preferred ending message for the display.**
- **Iowa DOT will provide additional headsets to ISU for loading of both ISU and UI displays (UI to transfer files to ISU for this, once their display is complete).**
- **Annette will make a request for an account to be set up with Oculus.**
- **Iowa DOT will purchase one (or 2) pair of noise-canceling headphones with easily cleanable surfaces, as well as other necessary supplies for the State Fair (KMO to investigate).**
- **Training of Fair booth staff will commence in a couple of weeks; ISU is requested to help train booth attendants, help with headset setup, etc.**
- **ISU will capture a video of the complete display (once the ending message has been added), and some high-resolution still images from points within the animation as chosen by Iowa DOT (Strategic Communications).**

Next Meeting: TBD - roughly 2 weeks - will be centered around Fair booth attendant training. Iowa DOT/OBS/KMO/kmo/05 July 2018

(END OF REPORT)