Firefighter Immersive Learning Environment (FILE) Summit: Developing a Roadmap for Fire Service Training

Final Proceedings by:

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May 2023

Held: February 7 & 8, at Illinois Fire Service Institute, Champaign, IL, USA.

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Acknowledgements

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Foreword

Training is a critical part of the fire service. As new technological innovation applications (e.g., virtual reality, augmented reality, artificial intelligence, machine learning, robotics, etc.) emerge and are proven in other arenas, fire service training academies must investigate these to see their impact on the skills, safety, and wellness of firefighter trainees. This project seeks to leverage the immersive learning technologies that have proven to be beneficial in other high-risk occupations, such as military, law enforcement, health care, and identify the value of application of immersive learning for firefighter training.

The overall goal of this project is to identify, assess, and summarize the available and emerging technological tools, techniques, and innovations, to support the application of immersive learning environments in fire service training and address its impact on firefighter skills, health, and safety during training. The project objectives are:

- Describe the value of immersive learning on firefighter skills, and competency-based testing and evaluation,
- Establish baseline knowledge of Immersive Learning Environment that could be adapted to fire service training,
- Identify, prioritize the future needs and barriers of fire training academies to implement immersive learning,
- Communicate the needs of fire academies recognized and understood by others, especially technology innovators, and
- Create a firefighter immersive learning environment roadmap to provide guidance to fire training academies and others in support of implementing immersive learning.

The project is funded by a DHS FEMA Assistance to Firefighters Grant (AFG) FP&S Program to the Fire Protection Research Foundation (FPRF) and North American Fire Training Directors (NAFTD) as the principal project partners.

This two-year project consists of three primary components: (1) Literature review to develop baseline content and material that summarize the current landscape of immersive learning in fire service training and education; (2) Targeted focus group meetings with key types of NAFTD representative fire academies (e.g., large, small, community college based, etc.) to gain insight about the distinct training delivery systems of fire training academies; and (3) Stakeholder Summit to present, review, and evaluate the overall state of immersive learning technology in fire service training and develop a firefighter immersive learning environment (FILE) roadmap to provide guidance to fire training academies and others in support of future implementation of immersive learning.

This Summit proceedings is addressing the third deliverable of the three primary components of this project, i.e., stakeholder summit to review baseline information, support networked dialogue, and support discussions on adopting and adapting immersive learning approaches in fire service training. The subsequent additional deliverables from this overall project effort include a literature review report and a targeted focus group meeting summary report.

This Proceedings has been prepared by Ken Willette, Executive Director at NAFTD, and Casey Grant, Executive Director at DSRAE, LLC. The Focus Groups were hosted by the NAFTD at Illinois Fire Service Institute, with assistance from FPRF and DSRAE LLC. The Research Foundation appreciates the guidance provided by the Project Technical Panelists, the funding provided by the FEMA Assistance to Firefighters
Grant Program, and the Illinois Fire Service Institute who generously hosted the summit and all others that contributed to this project and summit.

The information contained herein is based on the input of a range of professionals and subject-matter-experts. While considerable effort has been taken to accurately document this input, the final interpretation of the information contained herein resides with the report authors. The content, opinions and conclusions contained in this report are solely those of the authors and do not necessarily represent the views of the Fire Protection Research Foundation, NFPA®, Project Technical Panel or Sponsors. The Foundation makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

About the Fire Protection Research Foundation

The Fire Protection Research Foundation plans, manages, and communicates research on a broad range of fire safety issues in collaboration with scientists and laboratories around the world. The Foundation is an affiliate of NFPA.

About the National Fire Protection Association (NFPA)

Founded in 1896, NFPA is a global, nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. The association delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering the NFPA mission.

All NFPA codes and standards can be viewed online for free.

Keywords: training, immersive learning, education, professional qualifications, firefighting, fire service training, augmented reality, virtual reality, mixed reality, simulation, SWOT analysis.

Report number: FPRF-2023-06

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<thead>
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<th>Institution</th>
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<td>UIUC National Center for Supercomputing Applications (NCSA)</td>
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<td>Farzaneh Masoud</td>
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<td>Sreenivasan Ranganathan</td>
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<td>Kenneth Willette</td>
<td>North American Fire Training Directors (NAFTD)</td>
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Executive Summary

This report represents the Proceedings of the “Firefighter Immersive Learning Environment (FILE) Summit”, conducted on February 7 & 8 of 2023, hosted at Illinois Fire Service Institute, Champaign, IL. The stakeholder summit is a key component of two-year research project is funded by a DHS/FEMA Assistance to Firefighters Grant (AFG) Fire Prevention & Safety Program. This summit reviewed baseline information, supported networked dialogue, and supported discussions on adopting and adapting immersive learning approaches in fire service training.

The primary summary observations from the FILE Summit are addressed in chapter 7 of this report and in this executive summary section. These include general overarching observations, as well as several specific observations.

1) Applications
   a) Applications: Immersive learning has great promise for application to all levels of fire fighter and fire officer training. While it is currently used for pump operations, live fire attack skills enhancement and increasing situational awareness, it should be leveraged for hazmat, tech rescue, EMS training, and firefighter recruitment and retention.
   b) High-Risk Incidents: Address low-frequency high-risk events (e.g., confined space, extrication, tanker rollover, drug lab, swift water, under ice, etc.)
   c) Live Fire Training: The use of immersive learning should serve as a complement to in-person live fire training and not replace it.
   d) Parallel Professions: Learn from immersive learning applications in other safety critical professions, including commercial aviation, aircraft maintenance technology, construction, healthcare, military, maritime, nuclear power, oil & gas, manufacturing, mining, etc.
   e) Introducing Skills & Maintaining Proficiency: Immersive learning technologies can be effectively used to introduce skills and maintain proficiencies of the 1 million plus firefighters in the US. Emerging issues (e.g., replacement firefighting foams, battery energy storage systems (BESS), etc.) require retraining across the entire fire service.

2) Key Features
   a) Immersive Learning Technologies: These emerging technologies are tools that must be: (i) aligned with validated curriculum and learning objectives (the JPR’s); (ii) able to deliver high quality training outcomes that support fire and emergency services; (iii) founded on a continued dialogue between developers, integrators, curriculum designers, instructors, fire academies, researchers, funders, and governmental agencies; and (iv) based on uniform evaluation methods that measure the ability of the technologies to achieve learning.
   b) Multi-Users: Support cross discipline usage and promote team learning environments.
   c) Common Documentation Platforms: Provide common standardized dashboards to facilitate documentation that is needed from different organizations (e.g., national, state, local, etc.).
   d) Adaptable to hybrid/blended training: Immersive learning environments are recommended as a very important part of hybrid/blended learning and should, as technology continues to develop, evolve into a more important role.
e) **Minimize Risk:** Minimize risk during training by creating a safe environment for learning; and enhancing skills to prepare firefighters for operations in IDLH and similar environments.

3) **Learning Experience**
   a) **Learning Environments:** Provide immersive learning environments customizable to local conditions and response needs, that are experiential, safe, engaging, memorable, and provide a sense of presence.
   b) **Layered Content:** Supports development of wholistic curriculums that utilize training content in a layered manner resulting in achieving desired training outcomes.
   c) **Job Performance Requirements:** Integrate use of JPRs as performance metrics and produce documentation that can be used for skills, validation, and certification.
   d) **Inclusion and Equity:** Provide equitable training opportunities to the broad fire service population inclusive of all generations, genders, and races; adaptable to help influence firefighters to address acceptance of immersive learning.
   e) **Muscle Memory Development:** Provide opportunity for repeatable skills performance at varied locations maintaining alignment with established curriculums and learning objectives.

4) **Policy**
   a) **Single Voice:** Facilitate a unified, single voice of the fire service on immersive learning and the associated supporting technologies.
   b) **Standardization:** Generate language in applicable NFPA standards to address immersive learning environments (& update NFPA 1451 Annex C). Consider a separate standard for immersive learning technology.
   c) **Direct & Indirect Costs:** Identify all direct and indirect costs as part of a full cost benefit analysis, including value propositions. Address specific approaches, such as leases, regional-shared programs, and public/private partnerships. Quantify intangible costs, such as health & safety benefits, infrastructure support costs, etc.
   d) **Managing the Evolution:** This is an evolutionary process that needs to be well-managed, and it is not a revolution. Immersive learning technologies are being implemented in numerous safety-critical professions, and the fire service should embrace this technology and maximize the advantages it provides.
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1) Summit Overview

These Proceedings provide the documentation for a stakeholder summit that reviewed baseline information, supported networked dialogue, and supported discussions on adopting and adapting immersive learning approaches in fire service training. The summit was a two-day in-person meeting hosted at the Illinois Fire Service Institute located on the campus of the University of Illinois Urbana-Champaign, held on Tuesday and Wednesday, 7 & 8, February 2023.

Specifically, the Summit has sought to stimulate a cross-dialogue on quantifying the needs of fire training academies and the solutions offered by the technological innovations identified in the baseline knowledge activity. This has involved a project contractor that has presented baseline content and materials. This summit is a key part of this overall research project and addressed the following objectives:

- Understanding the current landscape of immersive learning training for fire service training:
  - To share the results of project research and stakeholder feedback to create a shared vision;
  - Clarify the value proposition and benefits of adapting immersive learning;
  - Comparing, illustrating, and citing parallel professions as examples.
- Identify and address the barriers in implementing immersive learning in fire service training;
- Introduce the immersive learning knowledge base;
- To develop recommendations for future direction (i.e., roadmap) to advance the use of immersive learning.

![Figure 1: Summit Venue - IFSI State Fire Academy](image-url)
The program used during the Summit is addressed in Figure 2, Summit Program. This started with a welcome and overview of the research project and Summit objectives, and a keynote presentation by the US Fire Administrator Dr. Lori Moore-Merrell. Multiple presentations followed that established key concepts and issues that formed the basis of the baseline information on this topic. Two Breakout Group discussions were held on the remainder of Day 1 and the morning of Day 2, with each group reporting their results in full session. During the evening of Day 1, IFSI hosted a networking reception that included multiple exhibits and live demonstrations of their current activities utilizing immersive learning (e.g., driving simulator demonstrations).

<table>
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<tr>
<td><strong>DAY ONE: Tuesday, February 7, 2023, 8 AM – 5 PM US CT</strong></td>
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<td><strong>Theme:</strong> Firefighter Immersive Learning Environment: Current Landscape &amp; Applications</td>
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The registered attendees are illustrated in Table 1. The Summit was well attended and had a diverse and balanced mix of attendees with different stakeholder interests, as had been identified in the earlier Focus Group part of this Project. The individuals participating in each Breakout Group are identified later in this these Proceedings addressing the Breakout Groups.

**Table 1: Summary of Summit Attendees**

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Affiliation</th>
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<td>Rod</td>
<td>Ammon</td>
<td>Stonehouse Media &amp; NFFF Learning</td>
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2) FILE Project Overview

The Summit and these Proceedings are a specific task of the research project Firefighter Immersive Learning Environment (FILE), a.k.a., Application of Immersive Learning on Firefighter Skills, Health, and Safety During Training. Throughout this report the overall research effort will be referred to as the FILE project.

The goal of the FILE project is to identify, assess, and summarize the available and emerging technological tools, techniques, and innovations, to support the application of immersive learning environments in fire service training and address its impact on firefighter skills, health, and safety during training. The objectives in support of this goal are:

- Describe the value of immersive learning on firefighter skills, and competency-based testing and evaluation;
- Establish baseline knowledge of Immersive Learning Environment that could be adapted to fire service training;
- Identify, prioritize the future needs and barriers of fire training academies to implement immersive learning;
- Communicate the needs of fire academies recognized and understood by others, especially technology innovators; and
- Create a firefighter immersive learning environment roadmap to provide guidance to fire training academies and others in support of implementing immersive learning.

The key tasks of the FILE project are (1) Baseline Content Development, (2) Targeted Focus Group Meetings; and (3) a Stakeholder Summit. Each are separate deliverables from this project and each have their own report. Elements that will be addressed by this collection of information are:

- Description of the current landscape;
- Identification of future needs;
- Identification of barriers;
- Analysis of gaps; and
- Establishment of an Immersive Learning Knowledgebase

The immersive learning environment used for fire service training involves an active marketplace with various commercial interests. On this basis, any mention of commercial technology and/or training products, from content providers, technology providers or any other entities, is solely for informational reference and is not intended as an endorsement in any way.

The FILE project is scheduled to be completed by third quarter of 2023 and is funded by an Assistance to Firefighters Grant (AFG) from the Federal Emergency Management Agency (US DHS/FEMA). This project is led by the Fire Protection Research Foundation (FPRF) in partnership with the North American Fire Training Directors (NAFTD) with assistance from others on specific project tasks (e.g., DSRAE LLC).
3) Baseline Information - Summit Presentations

The baseline information for the FILE project was reviewed during the first part of the Summit. This included multiple presentations and review of the reports already published in support of the FILE project. The slides used in the Summit presentations are included in Annex A.

As background, training is a critical part of the fire service. As new technological innovation applications emerge and are proven in other arenas, fire service training academies must investigate (e.g., virtual reality, augmented reality, artificial intelligence, machine learning, robotics, etc.) these to see their impact on the safety and wellness of firefighter trainees.

This project leverages the immersive learning technologies that have proven to be beneficial in other high-risk occupations, such as military, law enforcement, health care, aviation, and identify the value of immersive learning in firefighter training. The FILE project is a 2-year effort that seeks to evaluate the application of immersive learning in firefighter training as a tool to reduce risk during training and enhance firefighter safety. The various technologies are rapidly being implemented throughout all aspects of society, and it is important for the fire service to control their own destiny and properly manage the evolution of new immersive learning approaches.

Day One started with a Call to Order and Welcome presentation by NAFTD Executive Director Ken Willette, with special thanks to Illinois Fire Service Institute for providing the host venue for the Summit. Ken provided a brief presentation that highlighting the purpose and intent of the Summit and the overarching FILE project, and clarified all the key program and logistical details.

This included a review of the upcoming Breakout Group discussion. All feedback is important, and we want to hear from everyone. A primary focus will be Fire fighter health and safety, and critically, we need to reduce FF injuries and fatalities. The Breakout Group discussions need to clarify the next steps, and a roadmap, and help solidify the vision of where we go next.

The Summit Keynote Presentation was provided by Dr. Lori Moore-Merrell, US Fire Administrator. Her presentation was titled United States Fire Administration: A Prepared and Resilient Fire and Emergency Medical Service. Notably, the topic area addressed by the Summit is one that Lori knows well, as exemplified by some of her earlier works being directly referenced by this project (e.g., past presentations on the generational learning dynamics of today’s fire service). Since being appointed as the US Fire Administrator by President Biden, she has been working to re-align the USFA priorities and fire service training is now receiving a new, renewed focus.

Dr. Moore-Merrell reflected on aspects of her earlier work that clarifies the unique learning and interactions of the various generations, including, for example, the difference in learning between the Boomers versus Xers versus Millennials versus Zoomers. Examples of immersive learning and experiential learning were used for illustration purposes. Further detail was also provided on the use of technology, linear versus non-linear thinking capacity, benefits of immersive learning, measurable retention, and the importance of good data.
A review of the first project deliverable, i.e., the **FILE Project Literature Review**, was directly addressed via a presentation by Dr. Alan Craig, Brendan McGinty, and David Bock from UIUC. This was the first of the three FILE project deliverables and is now posted on the FILE project website. They outlined effective immersive learning programs in multiple parallel arenas, such as military, aviation, surgery, sports, etc. Because of the emerging nature of immersive learning approaches, standardized universal definitions are still evolving. A central theme of their presentation is the importance to focus on realistic and manageable sub-pieces of the learning experience. They underscored this central theme with a vivid example from another project involving the University of Illinois Football Team, that effectively taught players how to line up before the snap (aptly called the **Formation Recognition System**). Using virtual reality, they transformed the learning process and made it much more effective and efficient for the players.

Dr. Katelynn Kapalo with Indiana University provided a presentation on **Immersive Learning in Other Safety-Critical Domains: Insights for the Fire Service**. This focused on the core question of “what can the fire service learn from other professions?” Immersive learning environments need to be experiential, safe, engaging, and provide a sense of presence. Specific, vivid examples were provided of immersive learning applications in other professions, including commercial aviation, aircraft maintenance technology, construction, healthcare (with movement to improve soft skills), military, maritime, nuclear power, oil & gas, manufacturing, and mining. Elements of successful learning should include: retention & focus; meaningful representation; multiple mappings of information; and reflective learning. Practical takeaways for the fire service are (1) the need to evolve tools at different levels of skill development; (2) focus on clear objectives for learning; and (3) triangulation of sources for measuring training. Next steps for the fire service should consider the following: singular tasks or combination of tasks; target user groups; measurement metrics; and the evaluation process.

NFPA’s Bartholomew Jae (B.J.) provided an **Update on NFPA Training**. This training seeks to address and stay current with NFPA codes & standards, as well as emerging issues. Examples include
programs on hot works, NFPA 1700, wildfire, and arc-flash. Going forward, it needs to be clear that no instructional jobs are being replaced with immersive learning. Disruption happens on the fringe and pulls on the middle, and thus start on the fringe. As a clear demonstration of the evolution of new technology that is changing today’s world, B.J. outlined key concepts used at the Summit (e.g., immersive learning) as described by the latest artificial intelligence tool, Chat GPT (available free and on-line).

A case study example of immersive learning at a state training academy was reviewed by P.J. Norwood, Director of Training at the Connecticut Fire Academy. His presentation, titled *Connecticut Fire Training Academy Experience with Immersive Learning*, outlined their specific program and indicated that immersive learning approaches are not now and already in widespread use. They have been less focused on testing and evaluation, and more on training and implementation. Further, this has been less on foundational knowledge, and more on implementation. Over the last three years they have been effectively overhauling and updating their programs, and have successfully created new blended learning models. The key to their efforts has been instructor buy-in. Going forward this is seen as an essential element, i.e., instructor buy-in, and technology providers and others must address this further.

Christina Francis with Tesla provided a presentation on *Using Immersive Learning to Improve Firefighter Safety for Critical Infrastructure*. This addressed the efforts of Tesla to use virtual reality and augmented reality for specific fire service training on their equipment and installations. Their immersive learning programs symbolize the efforts of industry to provide widespread training for critical fixed infrastructure (e.g., power generating facilities) on a periodic basis in the most effective and efficient manner possible. They are faced with training and re-training all firefighters (not just new recruits) on their facilities in the applicable jurisdictions. Importantly, especially for fire service training academies, organizations like Tesla are continually looking to establish private/public partnerships to train as many firefighters as possible.

Dr. Farzaneh Masoud with Illinois Fire Services Institute and David Bock with UIUC NCSA presented on the *IESI Situational Awareness Simulator*. This built upon the earlier presentation addressing the FILE Project Literature Review by the UIUC research team, also located on the campus of the University of Illinois. Farzaneh emphasized the earlier important theme to focus on realistic and manageable sub-pieces of the learning experience, as symbolized by their successful other project involving the University of Illinois Football Team teaching the players how to line up before the snap (i.e., the Formation Recognition System). They are working to adapt this same approach to a situational awareness simulator, to maximize the learning experience for firefighters on the fire ground.

A presentation titled *The Tech is Ready. Are We? Exploring Immersive Learning Technologies for the Fire Service*, was provided by Dr. Jason Moats, Director of the TEEX Testing & Innovation Center at the Texas A&M Engineering Extension Service. With several examples he clarified that immersive learning is not new for the fire service, and we broaden our understanding and the definition of immersive learning to include what we already do. Going forward we need to manage the evolutionary process and address the critical characteristics (e.g., safer training, realism and fidelity, scalability, etc.) as well as concerns (e.g., ineffective learning, VR sickness, technological unemployment, etc.).
Importantly, the fire service needs a process to assess technology, including possibly 3rd party testing, that looks at analysis, design, evaluation, advances, and so on. TEEX is looking at such an approach. This is needed by fire service training providers as well as those providing technology and are seeking to address fire service training needs.

A final presentation was made by Casey Grant of DSRAE LLC that provided a recap of the FILE Project Focus Group Report, which was the second of the three FILE project deliverables. This is available on the FILE project webpage, along with the previously mentioned Literature Review Report (first of the three FILE project deliverables). Multiple targeted focus group meetings with key representative fire academies (e.g., large, small, community college based, etc.) provided important insights about the distinct training delivery systems of fire training academies. A key output from the Focus Group discussions was the SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis, that evolved organically from the Focus Groups. The next section of these Proceedings explains the SWOT table in detail, which served as a central discussion item for the Breakout Groups at the Summit.

A Panel Discussion was a central part of the review of this topic, titled The Future Training Landscape Roundtable. The Panel was composed of the following (shown alphabetically by last name):

- Eric Hagman (NFF, National Fallen Firefighters Foundation)
- Gary Ludwig, Champaign Fire Dept. (representing IAFC, International Association of Fire Chiefs).
- Dr. Lori Moore-Merrell (USFA, United States Fire Administration);
- P. J. Norwood, Connecticut Fire Academy (representing NAFTD, North America Fire Training Directors)
- Kevin Quinn (NVFC, National Volunteer Fire Council)
- Dr. Joshua Smith (IAFF, International Association of Fire Fighters)
- Kevin Sofen, Darley & Smart Firefighting (Panel Moderator)

The Panel discussion was led by moderator Kevin Sofen who posed multiple questions and discussion points to all the Panel members. Sweeping comments were provided by all Panel members, and the audience asked numerous questions and provided additional comments. Key issues that received significant focus and discussion included the following:

- Cost is a critical issue, both direct costs (e.g., purchasing technology) and indirect costs (e.g., infrastructure support), and this needs to be compared to savings and cost-benefits (e.g., cost of traditional approaches, reduction of training injuries, etc.).
- This is an evolutionary process that needs to be well-managed, and it is not a revolution.
- Immersive learning technologies are being implemented all throughout society, and the fire service needs to adapt and control their destiny on this topic area.
- We need to focus moving beyond one-on-one learning with these technologies and implement them for multiple users at once (a.k.a. the so-called scalability issue).
- We should not be getting stuck on the issue of immersive learning being a substitute for live fire training, because it is not, it is a supplement.
• Repetitions and building muscle memory is important, and we need to focus on realistic sub-tasks like the earlier football team analogy described by the UIUC presenters.

• There needs to be meaningful programs established that maximize efficiencies, like regional programs or funding arrangements with private/public partnerships (as mentioned with the aforementioned Tesla presentation).

• All are seeking to address this into daily operations and to normalize the concepts, with several clear examples mentioned like the NFFF programs and the IAFF activities that have more than a dozen immersive learning platforms in place.

• There is a clear need to consider using immersive learning technologies for other than the traditional fireground like a building fire, and use it for hazmat training, tech rescue training, EMS, and recruitment of new fire fighters which is presently a critical issue with the volunteer fire service.

Figure 4: Panel Discussion - The Future Training Landscape Roundtable
There are three deliverables from this overall FILE project, and these are:
   (1) Baseline Content Development,
   (2) Targeted Focus Group Meetings; and
   (3) a Stakeholder Summit.

Each are separate deliverables from this project, and each have their own report. These Proceedings address the third of these three deliverables and builds upon the first and second project deliverables. This section provides a recap of these earlier reports, since the Summit utilized much of the baseline information established by these earlier FILE project activities.

The first project deliverable from the FILE project is the "Firefighter Immersive Learning Environment (FILE): Literature Review". This literature review report summarizes the current landscape of immersive learning in fire service training and education; Definitions of major terms, including where disagreements exist; SWOT analysis of Virtual Reality (VR) in firefighter training, including barriers to adoption; Future needs analysis, indicating the process of identifying and integrating needs and solutions; Gap analysis, suggesting what is most needed to fully address identified needs.

The Literature Review project deliverable was directly addressed by the aforementioned presentation by the UIUC research team. They clarified that immersive learning for the fire service is not new and has existed for decades on parallel arenas. Standardized definitions are elusive in this area, and it is continually changing. A critical detail is to focus on realistic and manageable sub-pieces of the learning and skill-building experience.

They provided a vivid example of this with a separate earlier project where they provided an immersive learning approach for the University of Illinois Football Team. This only addressed lining up before the snap and was called the Formation Recognition System. It appropriately dissected the learning experience to address a manageable key sub-issue. This replaced a crude approach using x's and o's on blackboards that was very challenging to learn, and the virtual reality approach radically improved the team's learning experience.

They additionally pointed out the importance for a Future Needs Analysis, and that the mapping of JPRs (Job Performance Requirements) is a key starting point and baseline. Successful learning requires side-by-side development, and not one way. This has to be an exchange and requires an ongoing dialogue to be effective. Finally, for all approaches there should be clear testing and evaluation, with the appropriate refinement.

The second project deliverable from the FILE project is the "Firefighter Immersive Learning Environment (FILE): Focus Group Summary". This Focus Group summary is addressing the second deliverable of the three primary components of this project, i.e., Targeted focus group meetings with key types of North American Fire Training Directors (NAFTD) representative fire academies (e.g.,
large, small, community college based, etc.) to gain insight about the distinct training delivery systems of fire training academies.

A key output from the Focus Group Discussions was the SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis shown in Table 2. This SWOT table would serve as a central discussion item for the Breakout Group at the Summit.

The SWOT analysis developed organically, during earlier discussions with the multiple Focus Groups. The pros and cons continually revolved around certain specific subject areas (e.g., cost). These are indicated as “Issues or Attributes” in column D of the SWOT Analysis. Arguably this Column D is the core of the SWOT table, shown with a double border and reflective of the remainder of the table to the left and to the right. After comparing all these specific subject areas, they eventually were distilled and consolidated into 16 specific issues or attributes. These represent the row as seen in Columns D, as well as Columns E, F, G and H.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users, Training Academies</td>
<td></td>
<td></td>
<td></td>
<td>Present (Today)</td>
<td>Strengths</td>
<td>Weaknesses</td>
<td>Opportunities</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>A1 Admin (Training Academies)</td>
<td>A2 Admin (Fire Departments)</td>
<td>B1 Admin (Fire Departments)</td>
<td>Providers, Private Support (e.g., ESS providers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2) Instructors</td>
<td>A3) Curriculum Developers/Program &amp; Testing Managers</td>
<td>A4) learners</td>
<td>A1 Admin (Training Academies)</td>
<td>A3) Curriculum Developers/Program &amp; Testing Managers</td>
<td>A4) learners</td>
<td>A1 Admin (Training Academies)</td>
<td>A3) Curriculum Developers/Program &amp; Testing Managers</td>
</tr>
<tr>
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<td>14</td>
<td>15</td>
<td>16</td>
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</tr>
</tbody>
</table>

Table 2: Focus Group SWOT Analysis on Immersive Learning

There were multiple consistent themes that were heard repeatedly. Among these consistencies was the expression of the pros and cons as seen for both (1) today and (2) tomorrow. These in turn provided the base elements for the SWOT Analysis, with the strengths and weaknesses expressed for the present landscape (i.e., today), as well as the opportunities and threats for the future (i.e., tomorrow). These SWOT characteristics are summarized in columns E, F, G, and H in the SWOT table. This is shown as the lightly shaded gray area of the SWOT table, serving as the elements within Columns E, F, G and H.

Another feature that soon became apparent was who specifically was providing the feedback, and this ultimately led to Columns A, B and C that illustrate the perspective of the participants. For example,
different groups had a natural tendency to focus on areas directly impacting them, such as recruit fire fighters on learning retention, instructors on teaching potential, and academy administrators on cost benefit. This led to the brackets represented in Columns A, B and C, and summarized in Table 3: Primary Focus Group Perspectives.

<table>
<thead>
<tr>
<th>Users - Training Academies</th>
<th>Users - Fire Departments</th>
<th>Providers &amp; Supporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1) Admin</td>
<td>B1) Admin</td>
<td>C1) Content</td>
</tr>
<tr>
<td>A2) Instructors</td>
<td>B2) Recruits</td>
<td>C2) Technology</td>
</tr>
<tr>
<td>A3) Curriculum Developers / Program &amp; Testing Managers</td>
<td>B3) In Service</td>
<td>C3) Certification / Accreditation Orgs</td>
</tr>
<tr>
<td>A4) Learners</td>
<td></td>
<td>C4) Others</td>
</tr>
</tbody>
</table>

The Focus Group participants repeatedly addressed the 16 core issues/attributes (shown in Column D of the SWOT table), depending on which Focus Group perspective they represented (in Table 3). These repeated expressions from the participants of the 16 core issues/attributes (Column D) ultimately coalesced into three broad groupings, represented by the shading in the table of green (rows 1-7), red (rows 8-11), and yellow (rows 12-16). Column C for the Providers & Supporters is not shaded since these participants consistently discussed every issue/attribute. Similarly, all participants discussed the yellow shaded section (rows 12-16).

Certain discussion themes were noteworthy. This included a gravitation of participants to a baseline fixation on live fire training, as if this was the sole application. Cost was a regular discussion point, which sometimes started as a weakness though upon further discussion would become characterized as a strength. Other regular discussion points were health & safety, as well as scalability. All participants indicated they are looking forward to scalability to go beyond 1-to-1 learning, stating that firefighting is a team sport, and they are seeking applications shared collectively, similar to military applications, the gaming industry and others. Also, of interest the use of immersive learning for applications whose goal was beyond simply training fire fighters, such as public service (to respect responding fire apparatus) or recruitment of new fire fighters for volunteer fire departments.

Detailed presentations on these two project reports and additional topics were provided on the first half of Summit Day One. The Summit presentation slides are included in Annex A. These two earlier project reports are available for download on the project website at [www.nfpa.org/ffimmersivelearning](http://www.nfpa.org/ffimmersivelearning).
5) Discussion of Recommended Next Steps

The Breakout Groups met twice, first at the end of Day One and again at the beginning of Day Two. They reported back to the full attendance following each of their two sessions. The attendees were each assigned to one of four Breakout Groups as shown in Table 4, with the intent to balance each group with a diversity of representatives and stakeholders.

Table 4: Summary of Breakout Group Attendees

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Affiliation</th>
<th>Breakout Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrick</td>
<td>Farrow</td>
<td>Hampden Fire</td>
<td>Yellow</td>
</tr>
<tr>
<td>Alex</td>
<td>Gorush</td>
<td>Ascent Integrated Tech</td>
<td>Yellow</td>
</tr>
<tr>
<td>Corbo</td>
<td>Jackman</td>
<td>FEMA - Assistance to Firefighters Grant Program</td>
<td>Yellow</td>
</tr>
<tr>
<td>Bartholomew</td>
<td>Jay</td>
<td>National Fire Protection Association (NFPA)</td>
<td>Yellow</td>
</tr>
<tr>
<td>Kate</td>
<td>Kapalo</td>
<td>University of Central Florida</td>
<td>Yellow</td>
</tr>
<tr>
<td>Rick</td>
<td>Lane</td>
<td>KFT Fire Trainer, LLC</td>
<td>Yellow</td>
</tr>
<tr>
<td>Gary</td>
<td>Ludwig</td>
<td>Champaign Fire Dept. &amp; IAFC</td>
<td>Yellow</td>
</tr>
<tr>
<td>William</td>
<td>Perez</td>
<td>University of Connecticut Fire Department</td>
<td>Yellow</td>
</tr>
<tr>
<td>Bob</td>
<td>Rand</td>
<td>The Pro Board</td>
<td>Yellow</td>
</tr>
<tr>
<td>Sreeni</td>
<td>Rampanathan</td>
<td>FPRF</td>
<td>Yellow</td>
</tr>
<tr>
<td>Michelle</td>
<td>Royal</td>
<td>FirstLink Research &amp; Analytics</td>
<td>Yellow</td>
</tr>
<tr>
<td>Philip</td>
<td>Stittleburg</td>
<td>La Farge Fire Dept.</td>
<td>Yellow</td>
</tr>
<tr>
<td>Douglas</td>
<td>Cline</td>
<td>IFISI &amp; Horry County Fire Rescue</td>
<td>Green</td>
</tr>
<tr>
<td>Jeff</td>
<td>Godfriedon</td>
<td>FLAIM Systems</td>
<td>Green</td>
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<tr>
<td>Eric</td>
<td>Hagman</td>
<td>National Fallen Firefighters Foundation (NFFF)</td>
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<tr>
<td>Amanda</td>
<td>Kimball</td>
<td>FPRF</td>
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<tr>
<td>David</td>
<td>Krome</td>
<td>IFSTF Fire Protection Publications</td>
<td>Green</td>
</tr>
<tr>
<td>Trace</td>
<td>Lawless</td>
<td>International Association of Arson Investigators (IAI)</td>
<td>Green</td>
</tr>
<tr>
<td>Brendan</td>
<td>McGinley</td>
<td>UIUC NCSA</td>
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<td>Jason</td>
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<td>Michael</td>
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<td>Alan</td>
<td>Craig</td>
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<td>Robert</td>
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<tr>
<td>Christina</td>
<td>Francis</td>
<td>Tesla</td>
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<tr>
<td>Casey</td>
<td>Grant</td>
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<td>Cindy J.</td>
<td>Huse</td>
<td>Media Defined Inc / NetExam</td>
<td>Orange</td>
</tr>
<tr>
<td>Charlie</td>
<td>Kludt</td>
<td>NFVC &amp; South Dakota Firefighters Association</td>
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<tr>
<td>Tom</td>
<td>Neville</td>
<td>Auerbach Pollock Friedlander</td>
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<tr>
<td>P.J.</td>
<td>Norwood</td>
<td>Connecticut Fire Academy</td>
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<td>Dennis</td>
<td>Orendal</td>
<td>Professional</td>
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<tr>
<td>Caroline</td>
<td>Reed</td>
<td>Oklahoma State University Fire Service Training</td>
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<tr>
<td>Joshua</td>
<td>Smith</td>
<td>International Association of Fire Fighters (IAFF)</td>
<td>Orange</td>
</tr>
<tr>
<td>Grant</td>
<td>Tinker</td>
<td>Colorado Springs Fire Dept. &amp; Commission on Professional Credentialing</td>
<td>Orange</td>
</tr>
<tr>
<td>David</td>
<td>Bock</td>
<td>UIUC NCSA</td>
<td>Blue</td>
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<tr>
<td>Brian</td>
<td>Brauer</td>
<td>The Pro Board</td>
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</tr>
<tr>
<td>Jamie</td>
<td>Burgess</td>
<td>International Association of Fire Fighters (IAFF)</td>
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<tr>
<td>Paul</td>
<td>Coustion</td>
<td>Ascent Integrated Tech</td>
<td>Blue</td>
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<tr>
<td>Brian</td>
<td>Hendrickson</td>
<td>Jones &amp; Bartlett Learning/Publisher</td>
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<tr>
<td>Garrett</td>
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<tr>
<td>Farzaneh</td>
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<td>Ike</td>
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<tr>
<td>William</td>
<td>Peterson</td>
<td>NFPA Professional Qualifications CC</td>
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<tr>
<td>Kevin D.</td>
<td>Quinn</td>
<td>National Volunteer Fire Council (NVFC)</td>
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</tr>
<tr>
<td>Kevin</td>
<td>Sofen</td>
<td>Darley &amp; Smart Firefighting</td>
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<tr>
<td>Kenneth</td>
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<td>North American Fire Training Directors (NAFTD)</td>
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<tr>
<td>Evan</td>
<td>Wing</td>
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</table>

The Day One Breakout Groups each worked on separate distinct topics (as shown in Figure 5), and they each reported the results of their discussions back separately to the full session. The results of each Breakout Group are summarized in Figures 6, 7, 8, and 9. The theme of the Day One discussions
was to clarify recommended next steps on certain distinct topics that were addressed earlier in the day by the presenters. These distinct topics were:

- Other Critical Safety Domains
- Implications of Immersive Learning Technologies
- Fire Academy Case Study
- Situational Awareness Simulator

![Breakout Discussion Overview – Day 1](image)

**1.1. Other Critical Safety Domains (YELLOW Breakout Group)**

1.1.1. **Leverage Applications in Parallel Professions.** Look at existing repository of resources applicable to fire service and public safety. Build off from / leverage existing resources

1.1.2. **Gamification.** Gamification vs Reality: We should motivate training; “fun” = motivation. Reality can be built into training, and it can still be fun.

1.1.2.1. Concern about these terminologies are “funding”. Portray the "Needs" as priority.

1.1.2.2. Tech driven terminology vs Need driven terminology

1.1.2.3. Technology should fulfill the Need.

1.1.2.4. “Gamification & Fun” should aide with “Engagement” of learner/student.

1.1.2.5. Training is IMPORTANT. Methods needed to motivate, stimulate and engage student in learning environment.

1.1.3. **Identify Targeted Fire Service Applications.** May not be applicable for FF I, II. But there are opportunities with other programs such as inspectors...

1.1.4. **Skills Focused Training.** Breakdown/define “training” further while considering the applicability of Immersive learning. Is it skills training?

1.1.5. **Identify Critical Safety Domains.** Catalog other critical safety domains; what immersive learning exists in other domains

1.1.5.1. Examples include construction, medical, aviation, military.

1.1.5.2. International Use Cases: and learning from them.

1.1.5.3. Group of other professions who have used immersive learning to share the experiences, learnings etc.

1.1.6. **Clarify Funding Models.** Funding aspect:

1.1.6.1. Consider Military Fire Service

1.1.6.2. Leverage Industry collaborations/investments

1.1.7. **Business Models.** Develop a business-model: - Have a proof-of-concept model and then test it and scale it up.

1.1.7.1. Understand “cost of ownership”, best practices for implementation.

1.1.7.2. Leverage mandatory requirements for “funding”.

1.1.8. **Standardization.** Create universal open-source standards; use cases, technical and operational requirements. – Creating a library.

1.1.9. **Regional Coordination.** Reduce redundancy between States; approach regionally....

![Figure 6: Other Critical Safety Domains (YELLOW Breakout Group)](image)
<table>
<thead>
<tr>
<th>1.2.</th>
<th><strong>Implications of Immersive Learning Technologies (GREEN Breakout Group)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.1.</td>
<td><strong>Immersive Learning Definition.</strong> Need to clarify understanding of immersive learning.</td>
</tr>
<tr>
<td>1.2.1.1.</td>
<td>Lots of folks have a false sense of what it is</td>
</tr>
<tr>
<td>1.2.1.2.</td>
<td>Need to show people the opportunities and understand where the tech is</td>
</tr>
<tr>
<td>1.2.1.3.</td>
<td>Can use Immersive Learning tech for advocacy–show policymakers</td>
</tr>
<tr>
<td>1.2.1.4.</td>
<td>Applies to all types of immersive tech</td>
</tr>
<tr>
<td>1.2.1.5.</td>
<td>In a temporary bubble where the kids coming out of high school had challenges with the learning environment due to Covid – need to navigate through that</td>
</tr>
<tr>
<td>1.2.1.6.</td>
<td>It is difficult to describe the potential for immersive learning technologies to folks that have not experienced it</td>
</tr>
<tr>
<td>1.2.1.7.</td>
<td>There is buy in from various stakeholders on immersive learning – build on this</td>
</tr>
<tr>
<td>1.2.1.8.</td>
<td>Are technologies keeping up with what training centers want to do?</td>
</tr>
<tr>
<td>1.2.1.9.</td>
<td>Challenge: Cannot keep qualified staff to develop/maintain training because of the job market for these types of skills. Is tech keeping up with what training centers want to do?</td>
</tr>
<tr>
<td>1.2.1.10.</td>
<td>How do we know when the tech, content, activities, people are all matched up to what the training should look like?</td>
</tr>
<tr>
<td>1.2.2.</td>
<td><strong>Research Agenda Clearinghouse.</strong> Need to create a clearing house of the activities and to lay out the research agenda</td>
</tr>
<tr>
<td>1.2.2.1.</td>
<td>Who is in the space, what are the needs, case studies, use cases – helps justify expense, learn from peers and find collaboration opportunities</td>
</tr>
<tr>
<td>1.2.2.2.</td>
<td>Need incentive to bring the information together for everyone’s benefit</td>
</tr>
<tr>
<td>1.2.2.3.</td>
<td>Connect the vendor and the academic community</td>
</tr>
<tr>
<td>1.2.3.</td>
<td><strong>Technology Pathways.</strong> Clarify the pathways for the technology.</td>
</tr>
<tr>
<td>1.2.3.1.</td>
<td>Where are we?</td>
</tr>
<tr>
<td>1.2.3.2.</td>
<td>What is desired?</td>
</tr>
<tr>
<td>1.2.3.3.</td>
<td>Then prioritize</td>
</tr>
<tr>
<td>1.2.3.4.</td>
<td>Consider sustainability, continued process for implementation for new tech</td>
</tr>
<tr>
<td>1.2.4.</td>
<td><strong>Technology Implementation.</strong> How do we get technology from a tool (e.g., a shovel) to the task? – Steps to standardization</td>
</tr>
<tr>
<td>1.2.5.</td>
<td><strong>ROI Metrics.</strong> What are the metrics for ROI?</td>
</tr>
<tr>
<td>1.2.5.1.</td>
<td>Cost of virtual training vs in person training</td>
</tr>
<tr>
<td>1.2.5.2.</td>
<td>Costs of injuries due to training</td>
</tr>
<tr>
<td>1.2.6.</td>
<td><strong>Educational Campaign.</strong> We need an educational campaign addressing Immersive Learning Technologies</td>
</tr>
<tr>
<td>1.2.6.1.</td>
<td>Congressional down to local jurisdictions</td>
</tr>
<tr>
<td>1.2.6.2.</td>
<td>Need to educate instructors (they are a key stakeholder)</td>
</tr>
<tr>
<td>1.2.6.3.</td>
<td>Communicate the benefits of immersive learning vs live training vs not training</td>
</tr>
<tr>
<td>1.2.6.4.</td>
<td>Reduced injuries/deaths from training</td>
</tr>
<tr>
<td>1.2.6.5.</td>
<td>Reduced occupational exposure (health care costs)</td>
</tr>
<tr>
<td>1.2.6.6.</td>
<td>Can help with retention and increase the pipeline to those that do not typically come to the profession</td>
</tr>
<tr>
<td>1.2.6.7.</td>
<td>Need to convince the naysayers so can get buy in from decision makers</td>
</tr>
<tr>
<td>1.2.6.8.</td>
<td>There are tools. What do FDs want/need? Fire service need to speak with one voice.</td>
</tr>
<tr>
<td>1.2.6.9.</td>
<td>Develop some talking points, examples</td>
</tr>
<tr>
<td>1.2.7.</td>
<td><strong>Demonstrate Value-Added.</strong> Show the value of immersive learning to multiple audiences and stakeholders.</td>
</tr>
<tr>
<td>1.2.7.1.</td>
<td>Those that are doing CRR, public education</td>
</tr>
<tr>
<td>1.2.7.2.</td>
<td>Weave throughout the standards – not just rely on one aspect</td>
</tr>
<tr>
<td>1.2.7.3.</td>
<td>Expand the annex that exists in NFPA 1451 and weave throughout</td>
</tr>
<tr>
<td>1.2.7.4.</td>
<td>This hinges on the instructors – They need to be comfortable before they use it – They need to be advocates</td>
</tr>
</tbody>
</table>

**Figure 7: Implications of Immersive Learning Technologies (GREEN Breakout Group)**
1.3. Fire Academy Case Study (ORANGE Breakout Group)

1.3.1. **Goal & Objectives.** Need a grand vision. Be clear on the overall goal and objectives.

1.3.2. **Fire Service Performance Environment.** Need to identify, clarify, confirm, and work with the required fire service performance environment.

1.3.3. **Targeted Applications.** Focus on targeted success.
   1.3.3.1. Need technology providers to address specific needs (similar to Alignment Formation).
   1.3.3.2. Address high profile events that people can relate to, that are universal.

1.3.4. **Partnerships.** Shared Journey. Need to provide clear direction to the tech-providers on the fire service needs.

1.3.5. **Blended Learning.** Support blended learning to manage the evolution.

1.3.6. **Prototype Programs.** Clarify good enough. In doesn’t need to be perfect for the evolutionary journey. “Don’t let perfection be the enemy of good enough”. Learn by moving forward.

1.3.7. **Data Sets.** Leverage other existing data sets in support of fire service training (e.g., google maps, Zillow, etc.)

1.3.8. **Customizable Scenarios.** Need templates to provide unique customized Scenarios, with flexibility to adapt to what is needed.
   1.3.8.1. Be clear on student views and instructor’s views.
   1.3.8.2. Tech providers should NOT develop the final scenarios, except with clear guidance.

1.3.9. **Job Performance Requirements.** Work with the JPRs as a baseline. Coordinate with the ProQual Standards & JPRs.

1.3.10. **Exploitation & Manipulation.** Need to address systematic exploitation and manipulation (i.e., gaming the system)

1.3.11. **Instructors.** We need embracement and engagement with/from Instructors.

1.3.12. **Instructional Confidence.** Trust factor with instructors is important (in your lifetime, who was your all-time favorite teacher?)

1.3.13. **Student Needs.** Address the final consumers real needs and what they want. Keep it simple and meet the student where they are.

1.3.14. **Critical Elements.** The critical elements that are needed for immersive learning are:
   1.3.14.1. Must provide an experience that is virtually not dangerous (short & long term).
   1.3.14.2. Must be cost effective.
   1.3.14.3. Must address multi-users.
   1.3.14.4. Must address recruitment, retention, and public outreach.
   1.3.14.5. Make it local (i.e., real).

*Figure 8: Fire Academy Case Study (ORANGE Breakout Group)*
1.4. **Situational Awareness Simulator (BLUE Breakout Group)**

1.4.1. **Standardization.** Engage the NFPA standards process and Technical Committees.

1.4.1.1. Standards already address this as a process not an outcome.

1.4.1.2. Focus on verbs. Clarify what can and cannot be simulated. Standardize vocabulary.

1.4.1.3. Address certification using specific immersive learning techniques.

1.4.1.4. Respect complexity of standards, such that no single approach will address all needs.

1.4.1.5. Promote the ability to work in teams. For example, provide simulation at multiple levels, multiple users/departments in one simulation, i.e. mutual aid companies.

1.4.1.6. Establish and promote a unified voice of the fire service on immersive learning.

1.4.2. **Learning Experience.** Focus on learning and training, and not only enjoyment.

1.4.2.1. Learning experience should demonstrate the importance of teamwork.

1.4.2.2. Provide flexible and customizable programs, with multiple variables.

1.4.2.3. Allow for subscriptions that allow programs to be built in layers.

1.4.2.4. Use as a tool to get an overview of what is happening on the fire ground.

1.4.2.5. Compile diverse situations with VR experts. Address different perspectives on each scenario, e.g., IC vs. engine crew vs. truck crew.

1.4.2.6. Consider broad simulations to allow more abilities and scenarios.

1.4.3. **Training Programs Scheduling.** Fit new learning approaches into present curriculum time limits.

1.4.3.1. Address time constraints and impact on both volunteer and career departments.

1.4.3.2. If adding new content, cut something out of curriculum.

1.4.3.3. Program managers should be aware of hours of training.

1.4.4. **Situational Awareness.** Situational awareness develops when scenario changes and put user in a new environment (taxpayer vs residential).

1.4.4.1. Replicate what the student will be doing.

1.4.4.2. Do not provide extraneous information unless it supports the learning process.

1.4.4.3. Aim for putting the user in situations as realistic as possible.

1.4.5. **Instructors.** Instructor support is essential for success.

1.4.5.1. Automatically track what the user sees and does, and keep logs.

1.4.5.2. Automatically generate final paperwork and records.

1.4.5.3. Allow Instructor to change variables, e.g., wind, time of day, other challenges. Provide the ability to customize.

1.4.5.4. Applicable playbooks for instructors are critical components.

1.4.5.5. Provide realistic and relevant user manuals.

1.4.5.6. Train instructors and other users on correct use of platform.

1.4.6. **Funding.** Establish realistic business models.

1.4.6.1. Be aware that average lifespan of technology companies is brief compared to FDs.

1.4.6.2. Utilize product development from other professions.

1.4.6.3. Coordinate implementation programs with law enforcement using common scenarios.

1.4.6.4. Product development in academic settings generally makes it open source.

1.4.6.5. Coordinate with private industry to address critical infrastructure that requires periodic training (e.g., electric generating plant).

1.4.6.6. Identify Return on Investment (ROI).

1.4.7. **Other Applications.** Use for public education, e.g., wildfire simulation.

1.4.7.1. Use technology to cultivate funding support from public. Use for recruitment.

1.4.7.2. Consider EMS, technical rescue and other applications.

1.4.7.3. Address low frequency/high risk scenarios.

1.4.8. **Maintaining Proficiencies.** Address periodic (e.g., annual) recertification and the maintenance of proficiencies and competency.

1.4.8.1. Address measurable tasks as the foundation for using technology.

1.4.8.2. Develop a matrix with measurable outcomes to gauge proficiency.

1.4.8.3. Stay rooted in realistic science.

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*Figure 9: Situational Awareness Simulator (BLUE Breakout Group)*
6) Discussion of Fundamental Questions

The Day Two Breakout Groups each worked on the same topics (as shown in Figure 10), and they each reported the results of their discussions back to the full session on these common topics. The results of each Breakout Group were consolidated following the Summit, and are summarized in Figures 11, 12, 13, 14, 15, 16, and 17. Note that the consolidated summary of the Breakout Group results all have a unique number to facilitate additional discussion post-Summit. The theme of the Day Two discussions was to address certain fundamental questions and issues. These were:

- 2.1. Vision: Consider a Utopian Environment. With a blank check, what should it include? What is the vision?
- 2.2. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute A: Cost and Benefits
- 2.3. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute B: Health and Safety
- 2.4. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute C: Emerging Hazards and Issues
- 2.5. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute D: Scalability
- 2.6. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute E: Documentation
- 2.7. Case Study: Consider NFPA 1451, Annex C. Does this address the Attributes adequately. If not, what is missing? Identify and prioritize the gaps.

Breakout Discussion Overview – Day 2

- Four Break out groups (with same questions)
- Each group will have an assigned facilitator, scribe, and timer
- One hour plus discussion (8:15 to 9:30 am) followed by 5 min report outs by each group (9:45 to 10:30 am).
- Focus of day 2 is on three “Fundamental questions”
  1. **Vision:** Consider a Utopian Environment. With a blank check, what should it include? What is the vision?
  2. **Attributes:** Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits
  3. **Case Study:** Consider NFPA 1451, Annex C. Does this address the Attributes adequately. If not, what is missing? Identify and prioritize the gaps. (top 3)

Figure 10: Overview of Day 2 Breakout Discussions
2.1. Vision: Consider a Utopian Environment. With a blank check, what should it include? What is the vision?

2.1.1. Features.
   2.1.1.1. Checklist. Provide up front questions that the purchaser needs to know in the form of a new technology checklist.
   2.1.1.2. Interfaces. Provide intuitive interfaces.
   2.1.1.3. Job Performance Requirements. Support technology that utilizes the JPRs.
   2.1.1.4. Layered Content. Promote training content and program that is layered and will build toward the final training outcomes.
   2.1.1.5. Measurable. All features have to be measurable.
   2.1.1.6. Portability. Deployable anywhere its convenient (especially in stations).
   2.1.1.7. Risk Reduction. Indicate the reduction in risk with every scenario and application.
   2.1.1.8. Scope & Purpose. Clarify scope and purpose of all simulations (e.g., introduction, skill sharpening, evaluation, maintaining proficiencies, etc.)
   2.1.1.9. Skill-Based. Develop training programs based on skills.
   2.1.1.10. Validation. Provide for third party validation.

2.1.2. Functionality.
   2.1.2.1. Hardware Operability. Need guaranteed connectivity.
   2.1.2.2. Software Interoperability. Integrate all available data feeds; data-driven analysis for learning. Utilize digital information for all structures in a community; develop ubiquitous digital twins; develop imagery/photogrammetry. Utilize standardized APIs.

2.1.3. Standardization.
   2.1.3.1. Immersive Learning. Generate language in applicable NFPA standards to address immersive learning environments. Consider a separate standard for immersive learning technology.
   2.1.3.2. Job Performance Requirements. Standardize JPRs with NFPA alignment, including documentation.
   2.1.3.3. Pro-Qual Instructor. Develop a pro-qual instructor standard.
   2.1.3.4. Stakeholders. Include all applicable groups and stakeholders. For example, ISO with insurance, and OSHA and other government entities.
   2.1.3.5. Tools. Standardization of how we utilize and master the tools/systems.
   2.1.3.6. User Interface. Promote standardized user interface design and functionality.

2.1.4. Policy Issues.
   2.1.4.1. Customization. Manage customization, and expectations of aftermarket activity.
   2.1.4.2. Evolutionary Transition. Manage the evolution: one single technology is not able to meet all needs.
   2.1.4.3. Prototype Training Approaches. Be willing to implement prototype training programs. Do not let perfection be the enemy of good enough.
   2.1.4.4. Single Voice. Establish and promote a unified, single voice of the fire service on immersive learning and the associated supporting technologies.

2.1.5. Program Features.
   2.1.5.1. Content Design. Work back from what the end result needs to be (standard minimums, secure, customizable by role, feedback.
   2.1.5.2. Developing Best Practices. Enable the sharing of vetted content in support of establishing consensus on best practices.
   2.1.5.3. Instructor Development. Address path for instructor development for technologies.
   2.1.5.4. Productivity. Use productivity as a measure. Is this resource going to save time, make my operation more efficient and productive?
   2.1.5.5. Record Management. Automation of the documentation and integration with record management systems.
   2.1.5.6. Training Integrity. Provide verifiable results and goals that will maintain training integrity.

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Figure 11: The Vision for a Utopian Environment
2.2. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and
benefits --- Attribute A: Cost and Benefits

2.2.1. Business Models.
2.2.1.1. Leases. Consider purchase as a lease, which allows for keeping pace with technology.
2.2.1.2. Funding Mechanisms. Identify, clarify and support alternative funding mechanisms (e.g.,
public/private partnerships).
2.2.1.3. Multi-Stakeholder Cost Analysis. Indicate the costs when shared among multiple end-users.
2.2.1.4. Subscriptions. Consider service and maintenance as a subscription, which allows for keeping pace with
technology.

2.2.2. Cost/Benefit Elements.
2.2.2.1. Cost Baseline. Need to know what the true cost is for what is being replaced/complemented. This is
cost vs. how much am I going to save?
2.2.2.2. Cost Effectiveness. Addressing all aspects of cost. Examples are operations, maintenance, station
downtime, instructor training, etc.
2.2.2.3. Ownership. Clarify cost of acquisition vs cost of ownership.
2.2.2.4. Reuse. Address the reuse and afterlife of all investments and assets.
2.2.2.5. ROI. Address Return on Investment from an accounting standpoint.
2.2.2.6. Support Infrastructure. Clarify all support requirements. Examples include connectivity, hardware
support, software support, technician skills, etc.
2.2.2.7. Technology Depreciation. Address technology lifespans and backwards compatibility.
2.2.2.8. Training Outreach. Address the ability to bring training to stations and other locations, thus reaching
more.

2.2.3. Key Features.
2.2.3.1. Direct & Indirect Costs. Address all direct and indirect costs as part of a full cost benefit analysis –
need value propositions.
2.2.3.2. Templates. Reduce costs by developing templates and checklists to assist with meeting learning
objectives.
2.2.3.3. Previous Cost/Benefit Analysis. Clarify what already exists for cost/benefit for the proposed
applications.

2.2.4. Program Issues.
2.2.4.1. Community Accreditation. Enhancing the fire departments external reputation. For example,
enhanced ISO score, CPSE accreditation, etc.
2.2.4.2. Comparative Costs. Generate a clear cost comparison, with and without immersive learning
approaches. For example, clarify cost of burn tower maintenance and life cycle cost, showing how
having an immersive tool can complement and supplement a program.
2.2.4.3. Clarify Needs. Educate developers/industry on cost models (i.e., both ways).
2.2.4.4. Health & Safety Benefits. Minimizing long term health & safety impacts that generate long-term costs
(e.g., reducing training injuries).
2.2.4.5. Health & Safety Detriment. Address adverse impacts such as simulation sick and quantify the
cost.
2.2.4.6. Learning Efficiency. Amount that can be completed. For example, with multiple repetitions, or saving
downtime in stations.
2.2.4.7. Needs Analysis. Provide needs analysis to support the effective use of end-user resources.
2.2.4.8. Value Proposition. Establish realistic value propositions, and effectively communicate them with the
proper messaging.

Figure12: Attributes from SWOT Analysis - Cost & Benefits
2.3. **Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute B: Health and Safety**

<table>
<thead>
<tr>
<th>2.3.1. Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1.1. Building Confidence. Increased confidence through repetition and increased self-efficacy.</td>
</tr>
<tr>
<td>2.3.1.2. Death and Injury. Reduce deaths and injury caused by physical training. Train on dangerous tasks without potential for harm.</td>
</tr>
<tr>
<td>2.3.1.3. Exposure. Reduce exposure to harmful contaminants that impact long-term health.</td>
</tr>
<tr>
<td>2.3.1.4. Instructor Exposure. Reduce exposure for instructors.</td>
</tr>
<tr>
<td>2.3.1.5. Mental Health. Support mental wellness by reducing anxiety, providing exposure therapy and promoting stress inoculation.</td>
</tr>
<tr>
<td>2.3.1.6. Scalability. Support wide-scale health &amp; safety-oriented training through multi-agency/discipline coordination (e.g., EMS, administrative issues, ethics, etc.)</td>
</tr>
<tr>
<td>2.3.1.7. Situational Awareness. Developing better awareness for a wide range of situations.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>2.3.2. Program Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.2.1. Comparative Analysis. Provide studies on the comparison of results from training with and without immersive learning approaches, for all factors (e.g., health &amp; safety, costs, learning, etc.).</td>
</tr>
<tr>
<td>2.3.2.2. Long Term Effects. Establish consistent reporting on longitudinal studies, i.e., address unintended risks.</td>
</tr>
<tr>
<td>2.3.2.3. New Health Impacts. Address new and different health impacts, such as simulator sickness.</td>
</tr>
<tr>
<td>2.3.2.4. Quantify Costs. Provide better data on actual costs for health and safety, both short term and long term</td>
</tr>
<tr>
<td>2.3.2.5. Stress Simulation. Address stress inoculation to enhance situational awareness.</td>
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<thead>
<tr>
<th>2.3.3. Learning Environment Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.3.1. Biometrics. Incorporate use of wearable technology to get baseline to support fact-based learning.</td>
</tr>
<tr>
<td>2.3.3.2. Efficient learning. Maximize the efficiencies of the learning experience, with minimal downtime.</td>
</tr>
<tr>
<td>2.3.3.3. Extreme Scenarios. Utilize to address low-frequency high-severity events, for purposes such as supporting CRR efforts.</td>
</tr>
</tbody>
</table>

*Figure 13: Attributes from SWOT Analysis - Health & Safety*
2.4. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute C: Emerging Hazards and Issues

2.4.1. Emerging Scenarios.

2.4.1.1. Emerging Hazards. Address new and unusual hazards, such as mutagen environments, energy storage systems, high-volume warehouses, new replacement foams, etc.

2.4.1.2. High-Risk Incidents. Address uncommon severe high-risk events (e.g., confined space, extrication, tanker rollover, drug lab, swift water, under ice, etc.)

2.4.1.3. Pre-Planning Drills. Provide immersive pre-planning for situations difficult to replicate (e.g., structurally unsafe vacant buildings, hoarders, hazardous materials, etc.)

2.4.1.4. Transportation. Address vehicles powered by electric, CNG, LNG, etc, not only in the open (e.g., on a highway) but also where offensive fire attack is required (e.g., tunnels, parking garages, maritime, etc.)

2.4.2. Immersive Learning Challenges.

2.4.2.1. Confidentiality. Respect for personal and private information (e.g., HIPA, biometric data, etc.).

2.4.2.2. Content Misuse. Using unvetted content and putting training materials in the wrong hands. Misuse of digital twins and electronic information for nefarious reasons (e.g., schools)

2.4.2.3. Cultural Acceptance. Overcoming those who aren’t willing to accept technology/progress.

2.4.2.4. Cybersecurity. Address cyber-attack and software failure protection. Provide secure protection of all digital and computer systems.

2.4.2.5. Data Sharing. Resistance to sharing data (e.g., intellectual property, competition, etc.).

2.4.2.6. Surveillance. Unnecessary and inappropriate government Surveillance.

2.4.3. Key Features.

2.4.3.1. Demographics. Address community and fire department changing demographics, such as shifting cultures, increased elderly populations, etc.

2.4.3.2. Feedback. Data from real life should be utilized in training programs.

2.4.3.3. Flexibility. Stay nimble on changing content/data

2.4.3.4. End-User Variability. Consider accessibility & equity across different types of departments.

2.4.3.5. Multi-Users. Support cross discipline usage, and promote team environments.

2.4.3.6. Soft Skills. Address training for soft skills, such as EMS, equipment maintenance, organization protocols, etc.

2.4.3.7. Technological Development. Address fast paced technology development, methods and materials, and the need to keep-up with the development.

2.4.4. Program Issues.

2.4.4.1. Applications. Address all fire service topics (e.g., CRR, inspections, investigations, recruitment, etc.)

2.4.4.2. Digital Platforms. Support access to available digital platforms pushed out to stakeholders and users.

2.4.4.3. Education. Opportunity to quickly raise awareness of emerging hazards and myth bust – address emerging issues faster.

2.4.4.4. Existing Training Infrastructure. Acknowledge and work with the existing training continuum.

2.4.4.5. Partnerships. Ability to harness private industry (e.g., periodic training for fixed, critical infrastructure like power plants)

Figure 14: Attributes from SWOT Analysis - Emerging Hazards & Issues
2.5. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute D: Scalability

2.5.1. Efficiencies,
2.5.1.1. Cost Effectiveness. Support broad-scale use that leads to lower price point for technology.
2.5.1.2. Documentation Efficiencies. Streamlining documentation for mandated training.
2.5.1.3. Equipment Efficiencies. Using cloud-based systems for internet accessibility, redundancy, interoperability, etc.
2.5.1.4. Mutual Aid Effectiveness. Support familiarization for mutual aid in other jurisdictions.

2.5.2. Key Features,
2.5.2.1. Content Consensus. Support the development of a centralized body of knowledge via consensus on the content. For example, from conducting large scale drills.
2.5.2.2. Cost. Address multiple purchase points with the ability to expand. Clarify shared costs, which provide value-added when more than one organization will benefit.
2.5.2.3. Documentation. Automate and streamline documentation for all participants (e.g., video).
2.5.2.4. Instructors. Make sure that instructor cadres are comfortable with technology.
2.5.2.5. Large Scale Drills. Support large-scale training simulations/drills, with numerous agencies and participants. Ability to train with other fire departments and other safety agencies.
2.5.2.6. Layered Approach. Start small and grow (Layered approach and content)
2.5.2.7. Multi-User. Promote multi-user platforms. Firefighting is a team sport.
2.5.2.8. Performance Objectives. Establish clear performance objectives for the learner.
2.5.2.9. Uniformity. Must be uniformly attractive to all types of departments that would be involved in broad drills.

2.5.3. Program Issues,
2.5.3.1. Interoperability. Promote common digital platforms that lead to interoperable systems.
2.5.3.2. Scenario Enhancement. Using variables to extend common training scenarios in uncommon directions (e.g., driver training during bad weather, civil unrest, apparatus malfunction, etc.).
2.5.3.3. Scenario Replication. Providing more scenarios via recordings and replications.
2.5.3.4. Stakeholder Engagement. Simultaneously involve all critical stakeholders in a single scenario through all phases of a fireground event.
2.5.3.5. Training Programs. Standardize the training programs and approaches.
2.5.3.6. Team Building. Support individual development in a teamwork environment.

Figure 15: Attributes from SWOT Analysis - Scalability

2.6. Attributes: Focus on “Attributes” from SWOT Analysis, and provide a summary of direct and indirect costs and benefits --- Attribute E: Documentation

2.6.1. Key Features,
2.6.1.2. Efficiency. Simplify – automate paperwork.
2.6.1.3. Delivery. Customizable delivery mechanisms that meet the objectives of the JPR’s, with documentation.
2.6.1.4. Learning. Real-life vs. JPR’s (i.e., capture failures and reinforce behaviors).

2.6.2. Program Issues,
2.6.2.2. Insurance. Save time on insurance claims and promote quality control (e.g., write better EMS reports).
2.6.2.3. Record Management. Automation of the documentation and integration with record management systems.

2.6.3. Standardization,
2.6.3.1. Common Documentation Platforms. Provide common standardized dashboards to facilitate documentation that is needed from different organizations (e.g., national, state, local, etc.).
2.6.3.2. Cost/Benefit Models. Provide cost/benefit models that generate documentation that is universally recognized.

Figure 16: Attributes from SWOT Analysis - Documentation
2.7. **Case Study: Consider NFPA 1451, Annex C. Does this address the Attributes adequately. If not, what is missing? Identify and prioritize the gaps.**

2.7.1. **Infrastructure Support.**
- 2.7.1.2. Data Administration. Address the collection, maintenance and disposal of sensitive, confidential or proprietary data.
- 2.7.1.3. Real-Life Environments. Provide fidelity to real life environments (e.g., local streets). Import data from local jurisdiction to create realistic scenarios.
- 2.7.1.4. Technology Support. Address training technology support issues, such as maintenance; backwards compatibility, calibration, commissioning, etc.

2.7.2. **Key Features**
- 2.7.2.1. Dynamic Training. Include the introduction of variables in scenarios to support dynamic training.
- 2.7.2.2. JPRs. Coordinate with JPRs.
- 2.7.2.3. Outcomes. Address intended training outcomes. Clearly state what the student is expected to learn and perform when completed (e.g., safe driving under all expected conditions).
- 2.7.2.4. Scenario Independence. Address how data is collected so that it is not specific to one scenario.
- 2.7.2.5. Shared Knowledge. Support the distribution of information & knowledge (e.g., not just the Chief).
- 2.7.2.6. Validation. Establish third party validation, including to standardized requirements.

2.7.3. **Program Issues.**
- 2.7.3.1. Commissioning. Address all aspects of commissioning, including prototype development, factory acceptance testing, final application compliance testing, etc.
- 2.7.3.2. Customizable Scenarios. Address the features that allow for environments that are customizable (e.g., using local maps, local real estate, etc.).
- 2.7.3.3. Health & Safety Features. Address health and safety features that should always be emphasized (e.g., seat belt use, familiarity with fire extinguishers, safety equipment indicators).
- 2.7.3.4. Instructor Attributes. Address attributes required for Instructors.
- 2.7.3.5. Instruction-Based. Address instructional issues (in addition to design parameters already stated). For example, include learning objectives, skills to be evaluated, etc.
- 2.7.3.6. Maintenance. Address all maintenance issues and time frames required, including inspection, testing, service support, warranties, etc.
- 2.7.3.7. Multi-Users. Address multi-user interfaces, i.e. driver simulation scenario with multiple apparatus responding to a high-rise building in a dense urban environment).
- 2.7.3.9. Technology Metrics. Promote the use of relevant metrics for key parameters that will aid the ultimate end-users, like cost, safety, and health (e.g. SL Levels).

Figure 17: Driver Simulator Standardization - Case Study

Figure 18: Fire Apparatus Driver Training Simulator, Pic Courtsey: IFSI.
7) Summary Observations

The primary summary observations from the FILE Summit are addressed in this section. These include general overarching observations, as well as several specific observations. These are individually numbered/lettered for identification and discussion purposes.

7.1) Applications
a) **Applications:** Immersive learning has great promise for application to all levels of fire fighter and fire officer training. While it is currently used for pump operations, live fire attack skills enhancement and increasing situational awareness, it should be leveraged for hazmat, tech rescue, EMS training, and firefighter recruitment and retention.
b) **High-Risk Incidents:** Address low-frequency high-risk events (e.g., confined space, extrication, tanker rollover, drug lab, swift water, under ice, etc.)
c) **Live Fire Training:** The use of immersive learning should serve as a complement to in-person live fire training and not replace it.
d) **Parallel Professions:** Learn from immersive learning applications in other safety critical professions, including commercial aviation, aircraft maintenance technology, construction, healthcare, military, maritime, nuclear power, oil & gas, manufacturing, mining, etc.
e) **Introducing Skills & Maintaining Proficiency:** Immersive learning technologies can be effectively used to introduce skills and maintain proficiencies of the 1 million plus firefighters in the US. Emerging issues (e.g., replacement firefighting foams, battery energy storage systems (BESS), etc.) require retraining across the entire fire service.

7.2) Key Features
a) **Immersive Learning Technologies.** These emerging technologies are tools that must be: (i) aligned with validated curriculum and learning objectives (the JPR’s); (ii) able to deliver high quality training outcomes that support fire and emergency services; (iii) founded on a continued dialogue between developers, integrators, curriculum designers, instructors, fire academies, researchers, funders, and governmental agencies; and (iv) based on uniform evaluation methods that measure the ability of the technologies to achieve learning.
b) **Multi-Users:** Support cross discipline usage and promote team learning environments.
c) **Common Documentation Platforms:** Provide common standardized dashboards to facilitate documentation that is needed from different organizations (e.g., national, state, local, etc.).
d) **Adaptable to hybrid/blended training:** Immersive learning environments are recommended as a very important part of hybrid/blended learning and should, as technology continues to develop, evolve into a more important role.
e) **Minimize Risk:** Minimize risk during training by creating a safe environment for learning; and enhancing skills to prepare firefighters for operations in IDLH and similar environments.

7.3) Learning Experience
a) **Learning Environments:** Provide immersive learning environments customizable to local conditions and response needs, that are experiential, safe, engaging, memorable, and provide a sense of presence.
b) **Layered Content**: Supports development of wholistic curriculums that utilize training content in a layered manner resulting in achieving desired training outcomes.

c) **Job Performance Requirements**: Integrate use of JPRs as performance metrics and produce documentation that can be used for skills, validation, and certification.

d) **Inclusion and Equity**: Provide equitable training opportunities to the broad fire service population inclusive of all generations, genders, and races; adaptable to help influence firefighters to address acceptance of immersive learning.

e) **Muscle Memory Development**: Provide opportunity for repeatable skills performance at varied locations maintaining alignment with established curriculums and learning objectives.

### 7.4) Policy

a) **Single Voice**: Facilitate a unified, single voice of the fire service on immersive learning and the associated supporting technologies.

b) **Standardization**: Generate language in applicable NFPA standards to address immersive learning environments (& update NFPA 1451 Annex C). Consider a separate standard for immersive learning technology.

c) **Direct & Indirect Costs**: Identify all direct and indirect costs as part of a full cost benefit analysis, including value propositions. Address specific approaches, such as leases, regional-shared programs, and public/private partnerships. Quantify intangible costs, such as health & safety benefits, infrastructure support costs, etc.

d) **Managing the Evolution**: This is an evolutionary process that needs to be well-managed, and it is not a revolution. Immersive learning technologies are being implemented in numerous safety-critical professions, and the fire service should embrace this technology and maximize the advantages it provides.
Annex A: Summit Presentation Slides

Project Team
- DHS FEMA Assistance to Fire Fighters Grant (FP&S)
- Award#: FEMA-2020-PF-20365
- Principal Project Partners:
  - Fire Protection Research Foundation (FPPF)
  - North American Fire Training Directors (NAFTD)
  - DSRE, LLC
- Project Research Contractors: UICU, NCSA & IFSI
- Project point of Contacts:
  - Ken Willett, NAFTD
  - David Bird, UICU, NCSA
  - Susan Rapinchuk, FPPF
  - Farzam Masoum, IFSI

Project Goal
This 2-year effort seeks to evaluate the application of immersive learning in firefighter training as a tool to reduce risk during training and enhance firefighter safety.
- To identify, assess, and summarize the available and emerging technological tools, techniques, and innovations, to support the application of immersive learning environments in fire service training and address its impact on firefighter skills, health, and safety during training.

Project Objectives
- Describe the value of immersive learning on firefighter skills, and competency-based testing and evaluation
- Establish baseline knowledge of Immersive Learning Environment that could be adapted to fire service training
- Identify, prioritize the future needs and barriers of fire training academies to implement immersive learning
- Communicate the needs of fire academies recognized and understood by others, especially technology innovators
- Create a firefighter immersive learning environment roadmap to provide guidance to fire training academies and others in support of implementing immersive learning

Project Tasks
1. Baseline Content Development
   - Comprehensive review of available information from literature, ongoing research studies, current fire service practices that has implemented immersive learning techniques and generate applicable background supporting information
   a. Current Landscape (including parallel professions)
   b. Barriers
   c. Future Needs
   d. Gap Analysis
   e. Immersive learning knowledgebase
   f. Final report

2. Focus Groups
   Conducted three geographically diverse focus group meetings with representatives of fire service agencies e.g., state, local, community college consortia, etc. In part insight into the doctrine training delivery systems of the training academies and gathered participants' thoughts and experiences in support of generating content on the current and future needs of immersive learning in the fire service training.

3. Stakeholder Summit, Feb 7-8, 2023
   This summit is a key part of this overall project and seeks to address the following objectives:
   - Understanding the current landscape of immersive learning for fire service training
     o To share the results of project research and stakeholder feedback to create a shared vision
     o Clarify the value proposition and benefits of adopting immersive learning
     o Comparing, illustrating, and citing parallel professions as examples
   - Identify and address the barriers in implementing immersive learning in the fire service training
   - To develop recommendations for future (i.e., roadmap) to advance the use of immersive learning

Figure 19: Slide Presentation 1 by Ken Willette - Slides 1 - 8
Anti Trust Compliance

- It is the policy of the TRA Research Foundation to strictly comply with state and federal antitrust laws.
- To support compliance with these laws at all times, the discussions and activities shall be limited to the stated objective of the project, which is to enhance the educational learning environment.
- Meeting members and other participants must remember that their respective firms are or may be competitors in the marketplace. Each member or participant therefore shall conduct themselves in full compliance with the letter and spirit of all state and federal antitrust laws.
- Those participating in meetings must exercise care that there is no discussion or agreement, formal or informal, expressed or implied, as to any matters which might give rise to an obligation of antitrust unlawful nature.
- Confidentiality must be maintained by no discussions, exchange of information, personal action or agreements concerning individual prices, rates, coversages, margins or any other cost data, market practices, claims settlement practices, or any other competitive aspect of a company's operation, market coverage, customer segments, or sales territories.
- Antitrust concerns are serious matters. All members or other participants in meetings and other activities are obliged to speak up immediately for the purpose of preventing any discussion from going beyond the bounds indicated by this statement.

Disclaimer

- Identifying and referring to commercial technology and training products from technology providers during the Summit are informational references only and are not an endorsement.
Presentation 3: Dr. Alan Craig, David Bock and Brendan McGinty, UIUC NCSA

Definition of Major Terms

- No consensus on definitions, despite decades of attempts
- Immersive Learning
  - "...an experiential training methodology that uses Virtual Reality (VR) to simulate real-world scenarios" (STURVR, 2012)
- Virtual Reality
  - "A synthetic, computer-generated reproduction of a real-world environment or situation that is presented to the user in such a way that the user feels that they are present in the virtual world" (Sherman & Craig, 2018, p. 207)

Current Landscape

- The landscape is changing:
  - Companies are coming and going
  - New research on simulator sickness and immersive learning
  - New hardware development
  - New applications
  - Game industry
  - etc.
- Work being done in the adjacent fields provides useful guidance but is not necessarily directly applicable

Fire Service Training & Education

- Academic efforts
  - NIST, NH, Universities around the world, etc
- Others:
  - FLAIM
  - RVR
  - Capt. Kirk McKenzie, Cosumnes Fire Department

Parallel Professions

- Medicine
- Manufacturing
- Construction
- Athletics
- Military
- Etc.

Case Studies

- Aviation
- American Football
- Archeology

Figure 21: Slide Presentation 3 by Alan Craig, David Bock & Brendan McGinty - Slides 1-8
Strengths/Opportunities

- Cost-effectiveness
- Safety
- All-hazards training, tailored to needs of specific jurisdictions
- Data recording
- Adaptable fidelity to guide focus and attention
- Integration with familiar helmets, use of realistic props
- Technological / scientific progress
- Redirected walking to enable movement in small spaces
- Fun

Weaknesses/Threats

- Current technological shortcomings
- Resistance to change
- Potential to instill false confidence
- Adverse health effects, especially simulator sickness
- Possibility that learning may not be (sufficiently) improved
- Over-gamification
- Cost of maintenance/support/expertise
- Unclear how VR can be used in evaluating NFPA testing standards

Future Needs Analysis

1. Use the MHPs as Performance Requirements (PPs) as starting points for a detailed needs analysis including the skills and competencies that firefighters need to know, along with performance metrics.
2. Identify skills/techniques that are easily translated and practiced using VR or AR.
3. Identify specific areas where VR or AR can enhance training for the software to be developed or purchased to support that element of the training.
4. Determine the instructor's role and the software's role in teaching and practicing each skill, including the pacing delivery system and training authoring system.
5. Identify what level of supervision is required for the underlying simulation for each task: low, moderate, full 3D model with high-fidelity simulation...
6. Integrate cost into the analysis to determine which needs may be more cost-effectively addressed with VR vs. non-VR methods.

Gap Analysis

- Task/marking needs analysis
- VR / AR training expertise
- General-purpose software
- Training deployment expertise
- Underlying simulations
- 3D models
- Special-purpose hardware
- Performance metric analysis tools

Conclusion and Recommendations

Where immersive learning can occupy that optimal space on the training continuum, immersive learning environments are recommended as one of the most important parts of a blended learning environment.

Knowledgebase Document

Provides additional information, references, and examples.

Project Team NCSA/UIUC

- Dr. Alan B. Craig, Research Scientist and Sr. Assoc. Dir., HC3, UIUC
- David Bock, Lead Visualization Programmer, co-PI
- Brendan McGinty, Industry Director, PI
- Katherine Kendall, Program Manager
- Nouni Jedford, Project Manager
- Pam Looper, Office Administrator

Thank you

industry@ncsa.illinois.edu

Figure 22: Slide Presentation 3 by Alan Craig, David Bock & Brendan McGinty - Slides 9 - 16
Overview

- Introduction
- Human Factors VIT
  - Information Transfer Learning
  - Attentional Control Learning
  - Important Constraints
- Consequences of interest
- Recommendations from the extant literature
- Discussion

Things that lead up to accidents happen slowly - the accidents happen fast.

-Chief Bruno

Factors that contribute to error:

- Job dissatisfaction
- Lack of time
- Inadequate procedures
- Poor lighting
- Exposure of temperature
- Human factors
  - Physical ability
  - Competence
  - Fatigue
  - Stress or drugs
- Organizational
  - Work pressure
  - Long hours
  - Inefficient supervision
- Environment
  - Poor equipment design or layout

Naturalistic Decision Making

- Defined as decision making by people with expertise in a specific domain working in a naturalistic environment (e.g., medical, military, aviation).
- Decision-making process
  - Goal identification
  - Information gathering
  - Decision-making
  - Control and evaluation

- Most decision errors in aviation are not due to human error, but due to mitigated situation (Norman, 1981)
**State of Science: Human Error**

- Most serious workplace accidents are typically attributed to human error (Woold et al., 2010)
- Domains like aviation, software engineering, and the military have all identified how costly it is to design poor systems or ineffective training
- Enduring perspectives on human error


**Immersive Learning in the Fire Service**

- What can the fire service learn from other disciplines that have adopted immersive learning?
- What are some of the key recommendations for approaching immersive learning with the fire service?

**Immersive Learning**

- Information-Based
- Practice-Based

**What is important about immersive environments?**

- Experiential
- Sense of Presence
- Safe
- Engaging

**Transfer of Training**

Skills and knowledge learned in training are applied to a day-to-day or job

**Domains of Interest**

- Commercial Aviation
- Education
- Healthcare/Medicine
- Military

**Commercial Aviation**

- FAA
  - USC
  - NTSB
Our Gold Standard: Kirkpatrick’s Four Level Model of Training Evaluation

- Level 4: Results
- Level 3: Behavior
- Level 2: Learning
- Level 1: Reaction

Kirkpatrick’s Criticisms
- Propensity to use lower levels
- Causal chains not well-defined or studied

New World Kirkpatrick Model

Kirkpatrick’s Model Example

Practical Takeaways

01 Evolving tools at different levels of skill development
02 Focusing on clear objectives for learning
03 Triangulation of sources for measuring training

Some questions to think about...

- Are we measuring the “right” things (e.g., training effectiveness)?
- Singulat tasks or combinations of skills? (Basic vs. Capstone)
- How can we measure training effectiveness over time?
- Is there a target user group to start with?

Figure 26: Slide Presentation 4 by Katelynn Kapalo - Slides 25 - 32
Singular tasks or capstone approach?

Targeting the right group of learners at the right time

Balance between testing and training?

How will we measure and track both learning AND performance?

Discussion

Other domains have highlighted areas of interest to help focus efforts

It is important to consider the target learner segments and to determine what is needed for each of their roles

Intrinsic learning can help us capture metrics, but we have to be sure we are considering the right ones at the right time

Implications

Theoretical

Methodological

Practical

Acknowledgments

Thanks to Dr. Joe Bonnell, co-collaborator

Interactive Computing Experiences Cluster @ UCF
Learning to protect the world
NFPA Training
January 2023

William, President for Persona Innovation in the world

“Every professional trained on NFPA codes and standards is another skilled worker helping to make the world safer.”
Jim Pauley, NFPA President and CEO

NFPA Training teaches our students to critically think about how to use our codes and standards to help them solve safety problems at work

BUILDING AND LIFE SAFETY, FIRE PROTECTION SYSTEMS, ELECTRICAL SAFETY, INDUSTRIAL CHEMICAL HAZARDS, EMERGENCY RESPONSE.

NFPA Training adds value to individuals and organizations

Professionals benefit from improving performance, safety, and careers
Companies benefit by achieving operational excellence with higher performing teams

NFPA Training’s Immersive Learning Strategy

NFPA Training is delivering scenario-based learning now and building XR immersive learning capabilities to be ready for future demand.

NFPA funded a proof-of-concept VR AR flash experience, and delivered grant funded immersive learning experiences for structural fires (3D) and wildfires (AR). NFPA is currently developing a distributed energy system emergency response serious game.

Metaverse learning

Learning in the metaverse is expected to be a highly immersive and interactive experience, where students can engage with digital content and teachers. It is a multi-sensory and collaborative virtual environment. This could include virtual classroom, interactive simulations and games, virtual field trips, and more. The goal is to provide a new way of learning that is more engaging and accessible, allowing students to learn at their own pace and in a way that is relevant to their lives and interests. Additionally, the metaverse offers the potential for new forms of collaboration and social interaction, making learning more social and connected experience.

Figure 29: Slide Presentation 5 by Bartholomew Jae - Slides 1 - 8

----- Page 46 of 61 -----
Presentation 6: P. J. Norwood, CT Fire Training Academy

What Type of Learner Are You?
- Visual learners - primarily with their eyes
- Auditory learners - with their ears
- Kinesthetic or tactile learners - learn by experience and can be "hands-on" plants
- Group - some people learn better when they work with others, while others prefer to learn on their own.

Do You Know Your Students?
- Generational Group:
  - Early Baby Boomers
    - 1940 - 1959
  - Late Baby Boomers
    - 1960 - 1964
  - Generation X
    - 1965 - 1982
  - Generation Y/Millennials
    - 1983 - 2002
  - Generation Z/Gen Z's
    - 1996 - 2010

Motivating
How Do You Motivate Your Students and Recruits?

Preferred Learning Styles

<table>
<thead>
<tr>
<th>Generation</th>
<th>Learning Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation X</td>
<td>E-Learning</td>
</tr>
<tr>
<td>Generation Y</td>
<td>E-Learning using blogs, podcasts</td>
</tr>
<tr>
<td>Generation Z</td>
<td>Blended models that combine online discussions and in-class collaboration</td>
</tr>
</tbody>
</table>

If they were born after 1965 the research indicates, they prefer some type of electronic integration into their learning.

--- Page 47 of 61 ---
Three Gen-Z Learning Traits

- Expect to be able to do most things right away.
- Include Experiential Learning.
- Ensure your knowledge base includes searchable video.

- They want quick, easy access to information, and they prefer to watch short videos rather than read pages after page of text.
- Every generation has its differences.
- It’s our responsibility as educators to understand them.

Even if it does not make sense to us!

The Connecticut Fire Academy Recruiting Firefighter Program

CFA Recruit Program

- 15 Week Live-In program
- Municipal Departments hire the firefighter(s) and then send them to the CFA
- Hero-to-Hero program
- Self Pay
- Two classes per year (Aug & Feb)
- 600 Hour program
- FFI, FFR, Haz-Mat Awareness & Ops, Rescue
- CORE, Confined Space, Trench Awareness

CFA Recruit Program Scheduling

- Class 968 Fall 2021
  - Sept 12
  - 29 Evening Classes
- Class 969 Spring 2022
  - Jan 30
  - No Evenings
  - Consisted of 3 Stations per day
- Class 970 Fall 2022
  - Sept 12
  - 30 Days
  - No Evenings
  - Curriculum Changes
  - Content Delivery Changes

Recruit Class 70

70 recruits from 21 different departments
- 2 from the hero-to-hero Program
- Average Class Age – 26 years old

Preferred learning methods: Blended educational models that combines online and in-class collaboration.

Downloads

Figure 31: Slide Presentation 6 by P.J. Norwood - Slides 9 - 16
What’s Next?
How Do We Increase Technology Integration?

Leaders don’t force people to follow, they invite them on a journey.

 Instructor “Buy-In”
Engage, invest & involve them

What’s Next?
Increase Technology Integration

FAAC
FLAAM TRAINER

Simulation training can help students achieve 90% learning retention.

Goals of using Simulations – Harness Technology

- Virtual Reality = skill mastery & recruitment
- Pump Simulators = skill mastery
  - safe and consistent

This is how “they” learn!

WHY NOT US?

Figure 33: Slide Presentation 6 by P.J. Norwood - Slides 25 - 32
When We Make It Fun Amazing Things Happen!

Five Rules
- Understand How They Learn
- Motivate Them
- Engage Them
- Make It Enjoyable
- Teach Them How They Learn

CT Fire Academy
Social Media
@CTFIREACADEMY

CT Fire Academy
P.J. Norwood
Director of Training
CT Fire Academy

Figure 34: Slide Presentation 6 by P.J. Norwood - Slides 33 - 36
Presentation 7: Christina Francis, Tesla

The Journey:
- the thought
- the "[o]ne word"
- the conundrum (Captain Kirk)
- the timing
- the "one" of lesser things

Project "Maya" – review of Project Responder & report
- The top need/issue was "the ability to incorporate real-time incident data into decision-making". In other words: transforming data into actionable information that is valuable for making strategic and tactical decisions
- Primary data:
  - Provide better, more accurate real-time telemetry of what is happening during the incident
  - Continuously that telemetry into actions for first responders

Conducted interviews....
Back to this. How can we address the #1 need of the PRB to provide real-time incident data? More importantly, is this the most important issue that needs to be addressed for Megapack users?

Consideration (for Megapacks):
- The issue isn’t "real-time incident data"... It’s "real-time incident knowledge"
- Need to convey "safety by design" to First Responders
- Megapacks were designed to sell form:
- First Responders should not do anything (this is a very limiting)
- KISS

Figure 35: Slide Presentation 7 by Christina Francis - Slides 1 - 8
Tesla is committed to helping fire departments and first responders safely handle emergency situations involving all Tesla products.

Guided available at www.tesla.com/fireresponders

Figure 36: Slide Presentation 7 by Christina Francis - Slides 9 - 11
Presentation 9: Dr. Jason Moats, TEEX

**Introduction**
- Training in fire service
  - Traditional & Remote
  - Blended
  - Drills & Exercises
  - The concept of immersive learning
     - Stimulates multiple senses
     - Presents a toylike
     - Creates an environment where learning is possible

**Types of Immersive Learning Technologies**
- Augmented Reality (AR)
- Mixed Reality (MR)
- Virtual Reality (VR)
- Physical Props

**Augmented Reality**
- Uses
  - Task-based skills development
  - Decision-making skill development
  - Team building
  - Equipment familiarization
  - Environment familiarization / inspection
  - Command, Control, & Coordination
  - Remote applications
  - Examples

**Mixed Reality**
- Uses
  - Skills development & reinforcement
  - Strategy development
  - Decision-making skill development
  - Impossibly or impractical scenarios
  - Examples

**Virtual Reality**
- Uses
  - Skills development & reinforcement
  - Decision-making skill development
  - Working through the impossible or impractical
  - Examples

**Physical Props**
- Uses
  - Task-based skills development
  - Tactics & strategy development
  - Decision-making skill development
  - Team building
  - Realistic experiences
  - Examples

Current Conditions
- The magnitude and complexity of incidents are significantly different & continue to increase
- The work is stressful & dangerous
- Developing the fire service is more complex than five years ago
- Recruitment & retention are more challenging than ever before
- Health & wellness of the public safety workforce is a top priority

Figure 38: Slide Presentation 9 by Jason Moats - Slides 1 - 8

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Advantages of Immersive Learning Technologies

- Increased engagement & retention of training material
- Higher level of realism
- Safer training environment
- Cost-effectiveness
- Flexibility
- Safer training

Challenges & Limitations

- Higher initial investment
- Limited accessibility for some users
- VR sickness / physical accessibility
- Technical and logistical challenges
- User acceptance
- Technology for technology’s sake
- Incorporating the immersive experiences into training

Making Immersive Learning Technologies Work

- Improving acceptance
- Standards
  - Technology – How is the technology assessed?
  - Training – How should the curriculum be structured?

Conclusion

- Great potential for enhancing learning
- Reduces risk
- Larger up-front costs
- More than the technology
- Requires thought & structure
- Not for everyone

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Figure 39: Slide Presentation 9 by Jason Moats - Slides 9 - 13
Annex B: Immersive Learning Standards Example

This annex provides a 4-page example of existing Immersive Learning standardization, addressing Fire Apparatus Driver Simulators (used with permission herein for one-time Summit use).

NFPA 1451, Standard for a Fire and Emergency Service Vehicle Operations Training Program

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Figure 40: Example of Immersive Learning Standardization - page 1 of 4
**NFPA 1451, Standard for a Fire and Emergency Service Vehicle Operations Training Program**

2018 edition, **Annex C: Driver Simulation Guide**

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### C.1.1.2 Out-the-Window Environment

A visual display unit should be provided to represent an out-the-window environment that is in scale to that viewed from the vehicle being replicated. This device would be self-supporting, or secured to the cab, and should be aligned with the cab to provide a geometrically correct out-the-window view.

The out-the-window image should be computer-generated imagery (CGI) and should not be based on “free” video. The virtual world can be representative of a geo-specific or geotopical environment but should be scaled and geometrically representative of a real-world environment.

#### C.1.1.3.1 Image Geometry

The out-the-window image should be representative of the view from the cab and should be geometrically correct and continuous with respect to the operator's viewpoint. The image can be intermixed across the scene to accommodate such things as mirror screen images, but the scene cannot be manipulated to misrepresent the out-the-window scene. Manipulation of the scene would include slowing, bending, stretching, and panning in a way that would be inconsistent with the real-world image and unnatural to the operator, except when injected by the instructor for instructional/training purposes.

#### C.1.1.3.2 Image Generation

The image should be computer-generated imagery. The imagery must be computed and software-updated and reflected or a rate that does not create anomalies or artifacts, such as image doubling and aliasing, that are likely to be distracting to the user.

#### C.1.1.3.3 Image Switching

Image switching can be provided, but it should be limited to instructional purposes only. It cannot be used to misrepresent the view that the operator would see in the real vehicle to overcome limitations in the visual display unit (VDU).

#### C.1.1.3.4 Image

The display should provide proper and smooth motion of an image pattern that does not create adverse effects on the participant. Artifacts can include, but are not limited to, effects such as the following:

1. Distortion
2. Flashing
3. Aliasing

#### C.1.1.4 Aural Cuing (Sound System)

An aural cueing system should be provided to replicate the sounds and noises that would be heard by the operator of the real vehicle. These sounds can be provided through an external sound system or through headphones. Such cues can be volume controlled so as not to be overpowering or disruptive to training. However, control of the volume should be under instructor control.

#### C.1.1.5 Vibration Cuing

A low-frequency effect unit should be provided for vibration cueing, such as road vibrations, engine vibrations, and special effects.

#### C.1.1.6 Motion Cuing

A motion cueing system should be considered. If provided, this unit should produce actual motion displacement effects, such as pitch, roll, and heave.

#### C.1.1.7 Instructor Operator Station

An instructor operator station (IOS) or control station should be provided to allow control of the simulation/ simulator. This unit can be integrated into or separate from the simulator student unit. Operation of the IOS must not be distracting to the student during training, unless for instructional purposes.

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**Figure 41: Example of Immersive Learning Standardization - page 2 of 4
C.2 Simulation Environment.

The simulation should provide the artificial environment that allows the cab hardware to operate as the “real” vehicle and the world environment that the vehicle would operate in. This includes such aspects as vehicle driven, virtual world, weather effects, vehicle faults, and special effects.

C.2.1 Driver Vehicle(s) Representation.

A driver vehicle model(s) should be provided that represents the type of vehicle(s) that is being replicated. The vehicle will be represented by a vehicle dynamics model and a virtual world visual model.

C.2.1.1 Vehicle Dynamics Model.

The simulator can be representative of a single vehicle or several vehicle dynamics models. The vehicle dynamics model should provide a handling model of the vehicle being “driven” but not necessarily that being represented by the physical cab. The vehicle dynamics model should be based on the following factors:

1. Vehicle dimensions (scaled appropriately)
2. Center of gravity (CG)/weight/force
3. Wheelbase and track (turning radius)
4. Suspension type
5. Acceleration
6. Braking/deceleration and road/terrain effects (camber/friction/skidmarks)
7. Object interference (collisions)

C.2.1.2 Vehicle Visual Model.

A corresponding virtual world vehicle model should accompany the vehicle dynamics model. This model should be visually and pictorially representative of the vehicle being represented in the simulated environment, not necessarily that being represented by the physical cab. The visual model should also include, at a minimum, the following components, scaled, placed, and representative of the component as seen from the viewpoint being represented:

1. Vehicle interior (excluding that represented by the cab hardware)
2. Mirrors (internal and external)

C.2.1.3 Vehicle Faults.

Vehicle faults should be provided and should have the appropriate effect on the vehicle that is consistent with the real-world effects. Such faults should include, but not be limited to, the following:

1. Tire blowout
2. Loss of air pressure
3. Loss of brakes
4. Loss of oil pressure
5. Check engine

C.2.2 Virtual World Environment.

The virtual world environment can be geo typical or geo-specific but should be representative of environments that are typical of the real world. All objects and entities should be scaled in proportion to the real-world objects.

C.2.2.1 Virtual World.

The virtual world should be created by computer-generated imagery (CGI) and should be representative of environments found in the real world. Roads should represent a cross-section of roads typically found in the United States, and roadway elements, such as width, signage, traffic lights, markings, and intersections, should meet minimum federal and state DOT guidelines.

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Figure 42: Example of Immersive Learning Standardization - page 3 of 4
### C.2.2.2 Weather Effects

Weather effects should be representative of the real-world effects, should be appropriately represented in the out-the-window scene, and should be consistent with those in the real world on the vehicle dynamics model. Weather effects should include, but not be limited to, the following:

1. Rain
2. Snow
3. Wind direction and speed
4. Fog
5. Dust
6. Time of day (night, day, dusk, dawn)

### C.2.3 Instructor-Based Training

Training should be instructor-based, and training objectives should be met by preset scripted scenarios.

#### C.2.3.1 Scripted Scenario Development

Tools should be made available to allow for the development and adjustment of scripted scenarios.

#### C.2.3.2 Scripted scenarios should provide specific driving skills and teaching elements, such as outlined in Chapter 7, Emergency Response. Scripted scenarios should be repeatable and provide a consistent skill level of training. Training objectives should include, but not be limited to, the following:

1. Acceleration exercises
2. Skill-building exercises
3. General driving
4. Defensive driving
5. Emergency response
6. Vehicle positioning on scene