JSTO in the News

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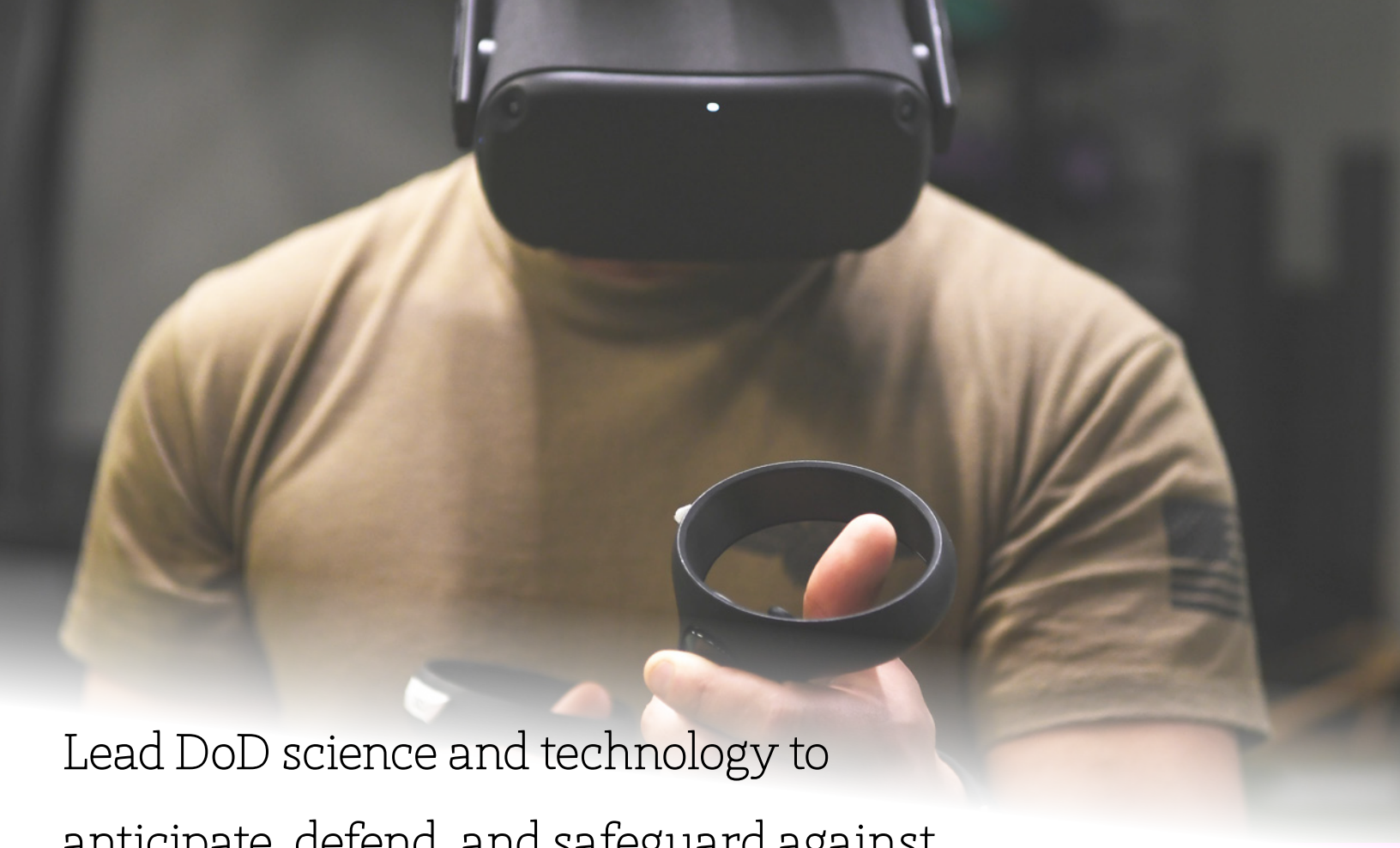
Under the Big Virtual Tent

Virtual Reality Helps Train Warfighters in Chem-Bio Environments



Lead DoD science and technology to anticipate, defend, and safeguard against chemical and biological threats for the warfighter and the nation.

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Front cover: An 82nd Airborne Division Soldier uses the Integrated Visual Augmentation System (IVAS) during a training exercise in October. IVAS is being developed by the Soldier Lethality Cross Functional Team, PEO Soldier, and Microsoft. (U.S. Army photo by Bridgett Siter)

Inside cover: U.S. Air Force Staff Sgt. Marcus Ramirez, 57th Rescue Squadron pararescueman, trains in a virtual reality simulation at Aviano Air Base, Italy, Feb. 18, 2021. This simulation allows pararescuemen the ability to train anywhere. The system is capable of running many different medical training scenarios for the members to accomplish. (U.S. Air Force photo by Airman 1st Class Thomas Keisler)

Back cover: Photo by KJH Studios (www.kristijanhoover.com).

UNDER THE BIG [VIRTUAL] TENT

THE CONVERSATION BETWEEN SCIENTISTS AND WARFIGHTERS IS INDISPENSABLE FOR DEVELOPING TECHNOLOGIES; NOW, VIRTUAL CONCEPT TENTS ARE FACILITATING CONTINUING ADVANCEMENTS DURING THE LOCKDOWN.

Despite the COVID-19 restrictions of 2020, the Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) found a way to garner valuable feedback from warfighters who observed online demonstrations of fledgling technologies as part of DTRA-JSTO's Chemical Biological Operational Analysis (CBOA) annual event rather than be there in person.

Warfighters from U.S. Army's 101st Airborne Division, U.S. Army's 20th CBRNE, and U.S. Marine Corps' 14th Marine Air Group put CBRN technology through its paces in the field during a simulated mission at CBOA 2019. (DTRA CB photo)

At the latest in-person CBOA event in 2019, DTRA-JSTO incorporated a new tool called the User Feedback Tent for Technology Concepts, or Concept Tent, that hosted demonstrations of an assortment of sensors, detectors, mapping software, and other technologies not yet mature enough for the CBOA operational scenarios which could benefit from warfighter feedback. The objectives of the Concept Tent were to:

I. Provide early feedback to explore joint force utility and validate requirements and technology approaches.

II. Identify notional mission or operational parameters.

III. Scope out future user engagements.

The emerging technologies displayed in the Concept Tent related to the medical, assess, protect, and mitigate tasks that warfighters execute when faced with a chemical, biological, radiological, or nuclear (CBRN) threat. Two of the technologies were the Pocket Detection Pouch—a small detection kit that identifies and stores samples, and the Biological Automated Collector/Detector for Expeditionary Reconnaissance (BioACER)—a fully automated biological collection and identification device releasable from an unmanned aerial vehicle over a plume that provides remote analysis in less than 20 minutes.

In the Concept Tent format, the science and technology manager (STM) or a subject matter expert gives a short presentation followed by a Q&A session between the presenter and warfighters. The warfighters then complete a short questionnaire to provide feedback mainly on form, fit, function, and potential employment concepts or considerations in various mission spaces. Warfighter feedback has highlighted mission uses, capability, and placement with a specific focus on ideal size and weight, power supply choices, portability, and integration with wearable technology already in use. The Concept Tent technology developers are then encouraged to participate in future CBOA operational scenario demonstrations when their products mature.

THE EMERGING TECHNOLOGIES DISPLAYED IN THE CONCEPT TENT RELATED TO THE MEDICAL, ASSESS, PROTECT, OR MITIGATE TASKS THAT SERVICE MEMBERS EXECUTE WHEN FACED WITH A CHEMICAL, BIOLOGICAL, RADIOLOGICAL, OR NUCLEAR THREAT.

Even though the in-person CBOA 20 demonstration was canceled, DTRA-JSTO still wanted to respond to the technology developers who rely on CBOA data to guide their development and to make timely investment decisions. Considering state mandates on indoor and outdoor crowd sizes, the virtual Concept Tent leveraged telework by using videoconferencing to present the demonstrations and an online questionnaire to collect feedback. Warfighters previously tasked for the in-person CBOA 20 participated in the virtual event to provide similar feedback they would have made in person.

As the event schedule was circulated and updated with the new virtual format, other interested parties submitted requests to participate, including government agencies and multiple services such as the Joint Program Executive Office, Office of the Surgeon General/Army Medical Command Public Affairs, and other medical divisions. This new audience provided extra exposure to the STMs' technologies in addition to the originally invited CBOA 20 attendees. The virtual option also showcased additional technologies not previously planned for the event.

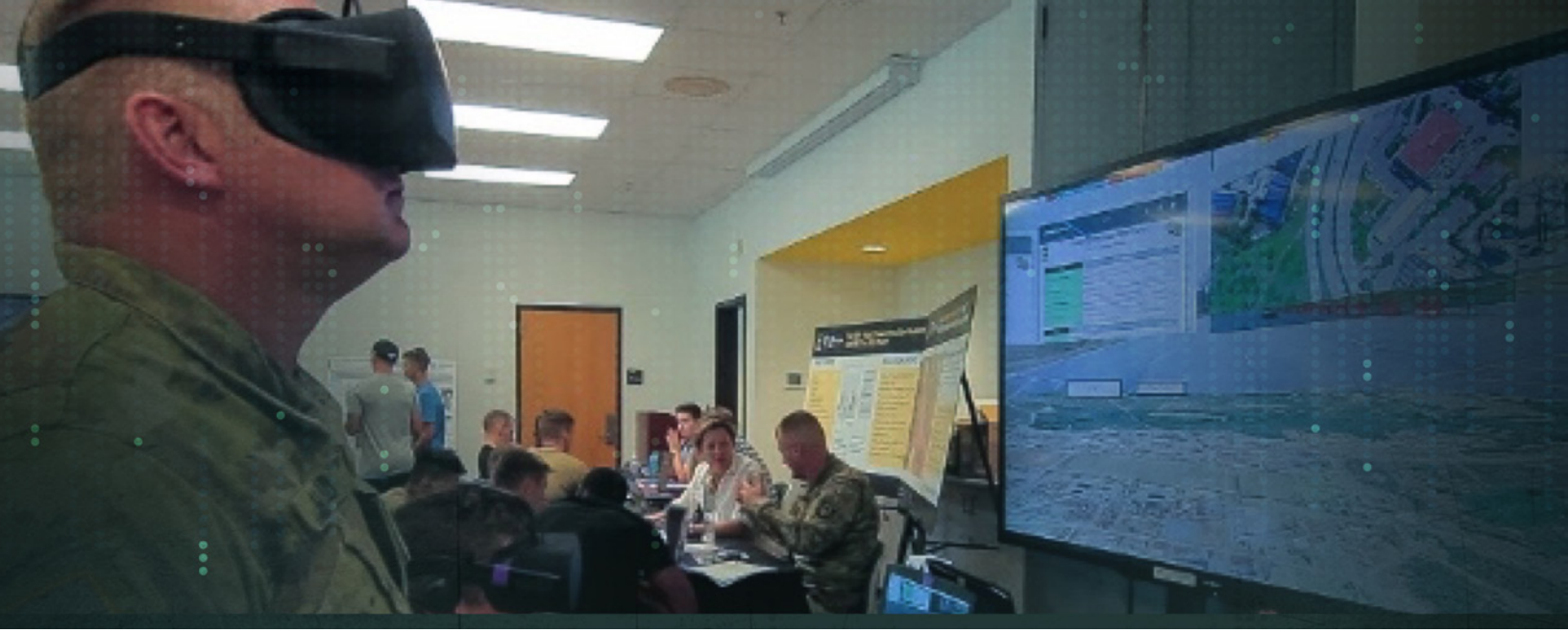
The virtual Concept Tent has several benefits for the warfighter:

I. Warfighters have on-the-spot interactions with the STMs developing the technologies.

II. Warfighters can give the STMs insight into their missions.

III. Warfighters learn of technologies they may use in the future.

Warfighters from U.S. Army's 101st Airborne Division, U.S. Army's 20th CBRNE, and U.S. Marine Corps' 14th Marine Air Group put CBRN technology through its paces in the field during a simulated mission at CBOA 2019. (DTRA CB photo)



Geospacial collaborative environment – User Feedback Concept Tent at CBOA 2019. (DTRA CB photo)

This important early communication between scientist and warfighter could result in ideas for new uses or a simple change to make the technology easier to use prior to building a prototype. These interactions allow warfighters to expand their daily duties beyond the battlefield and provide invaluable insight from their first-hand experiences. The interactions with the technologies challenge warfighters to think outside of their current constraints and imagine new concepts to increase effectiveness and better fit their mission needs.

Some of the 18 virtual CBOA 20 demonstrations included these new technologies:

I. **Rapid Canine Decontamination Kit—** for handlers to use when military working dogs are contaminated in a remote location not near a water supply where they can be thoroughly washed.

II. **Colorimetric Fiber Optic Sensor (CFOS)—** a chemical warfare agent (CWA) and toxic industrial chemical (TIC) detector that can be used in places of interest that require long-distance sensing.

III. **Fast Antimicrobial Sensitivity Test Scan—** an integrated system capable of detecting a broad range of CWA, TIC, and confined-space hazards.

The STMs for BioACER and CFOS are applying to be a part of the full demonstrations scenarios at the next CBOA, further highlighting the importance of CBOA feedback in developing these technologies to more advanced stages.

The success of the first virtual Concept Tent created a template on how to successfully execute virtual events that provide opportunities to increase the number and scope of interactions between government agencies and the joint force. By conducting several virtual events a year, DTRA-JSTO can increase user feedback and expedite technology development while minimizing participants' time away from duty, travel, and logistical footprint.

DTRA-JSTO is proposing three virtual Concept Tents per year in addition to the physical Concept Tent featured at the annual CBOA event and is confirming a greater number of warfighter participants for the next virtual Concept Tent event. ●

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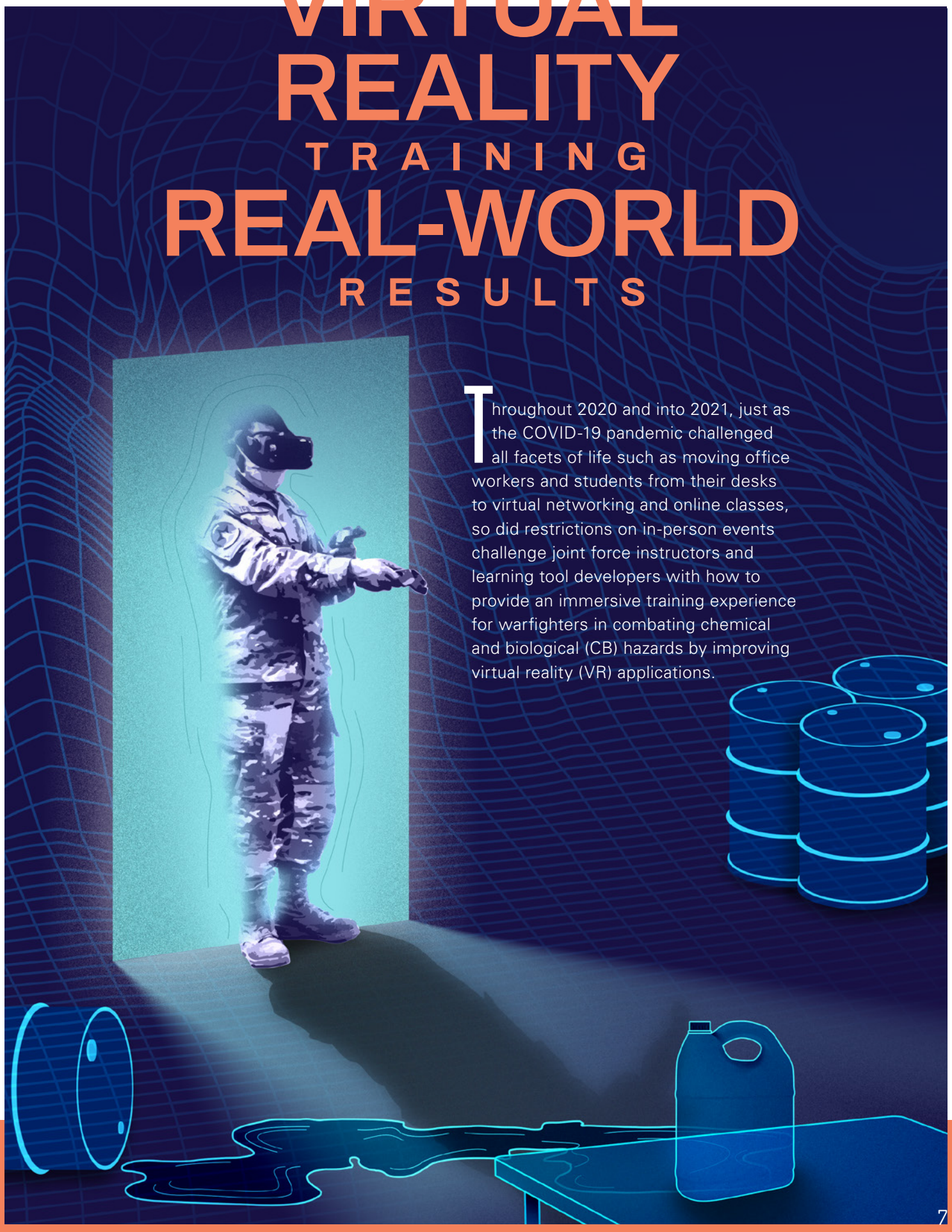
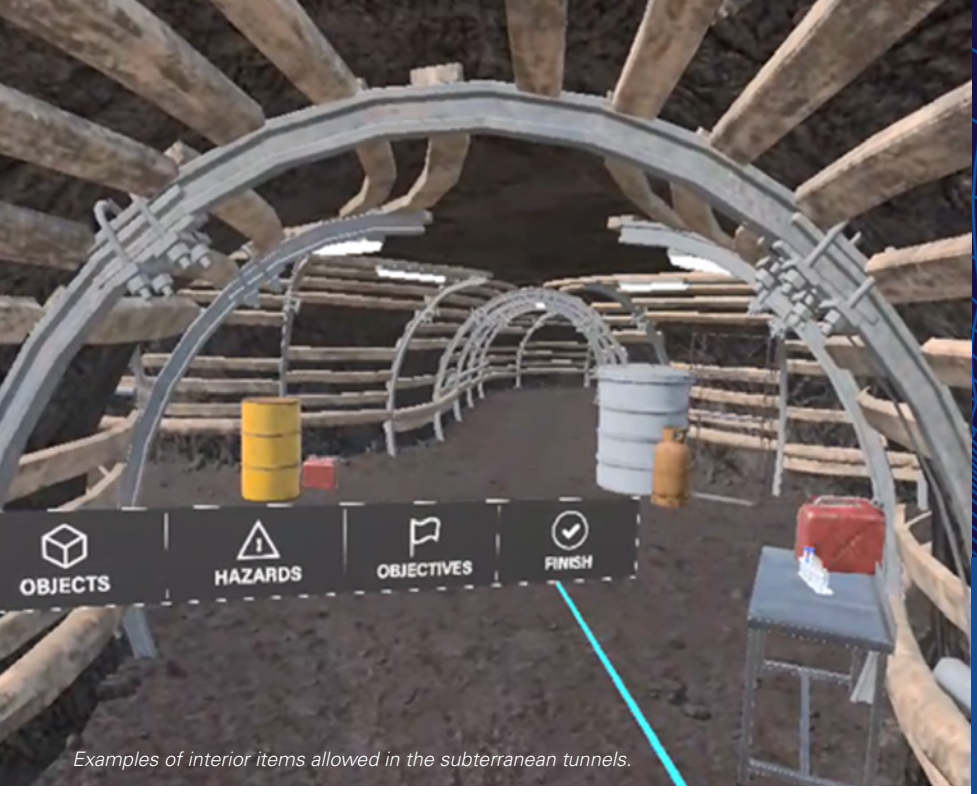
VIRTUAL REALITY TRAINING REAL-WORLD RESULTS



Throughout 2020 and into 2021, just as the COVID-19 pandemic challenged all facets of life such as moving office workers and students from their desks to virtual networking and online classes, so did restrictions on in-person events challenge joint force instructors and learning tool developers with how to provide an immersive training experience for warfighters in combating chemical and biological (CB) hazards by improving virtual reality (VR) applications.



Examples of interior items allowed in the subterranean tunnels.

To help fulfill its mission enabling warfighters to combat and win against CB threats, the Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) worked with the Pacific Northwest National Laboratory (PNNL) and its annual summer Intern Contest to develop a VR capability to enhance CB mission readiness. DTRA-JSTO challenged the PNNL subject matter experts (SMEs) and three groups of interns to deliver their most innovative VR solutions to a specific CB problem and create a subset of the objectives that is a bit beyond what they could realistically achieve within six weeks. Throughout the contest, DTRA-JSTO Science and Technology Managers (STMs) compared the interns' different approaches to the same challenge parameters and evaluated each group on technical and presentation metrics.

An advantage of VR training environments is they can be used anywhere at any time as a convenient and less expensive option when in-person training is limited. But the challenge for the interns was to create a new kind of VR environment with a reconfigurable subterranean setting, allowing projection of a CB incident and immersive consequence-realization training. The interns were to focus their application development to go beyond knowledge training and into enhancing warfighter readiness to assist in mission preparation and planning. The trainers would be able to modify and reconfigure scenario details in a flexible VR training module that:

- Adds replay values
- Suits different training objectives
- Helps prepare the warfighters for various missions

OBJECTIVES FOR SUMMER PROJECT DEVELOPMENT:

Environment

- Produce a single-player, VR-based training tool
- Focus on a subterranean tunnel environment
- Allow a trainer view for scenario setup
- Allow a first-person view for the trainee
- Create After Action Review functions

CB Scenario

- Capable of recognizing the Hazard Prediction and Assessment Capability tool that provides atmospheric transport and dispersion predictions
- Support missions such as site exploitation, rescue, or passing through
- Material options: sarin (nerve agent, military designation GB), chlorine (type of choking agent, designated Cl), and VX nerve agent

CB Effects

- Incorporate agent and concentration-dependent health and human effects
- Depict Joint Chemical Agent Detector (JCAD) sensor with concentration-dependent response

The first step toward creating this VR environment was to integrate the atmospheric transport and dispersion (T&D) models along with health and human effects (H&HE) models that DTRA-JSTO has already developed. DTRA-JSTO executed projects to validate and verify the models, which are valuable assets that trainers can further leverage beyond common applications in hazard situational awareness. With the T&D models, the VR environment can render CB hazards more realistically rather than just animated. The hazard plume's virtual effects on trainee avatars require the H&HE models to put hazard concentration into context with close-to-reality effects that allow the trainees to realize the consequences of CB hazard exposure and their own actions.

DTRA-JSTO wanted trainer-versus-trainee views so that the trainers can adjust the virtual environment and CB scenario depending on mission objectives. After the trainer sets up the scenario, the trainee's avatar walks through the environment in their own view and experiences health effects from exposure to the CB threat materials.

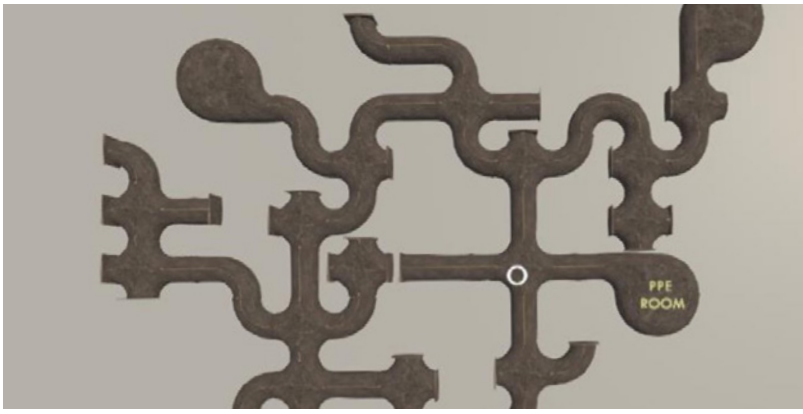
The VR applications provide both prebuilt tunnels and tunnel pieces so the trainer can reconfigure the area. There are also items such as laboratory equipment, barrels, and gas tanks. When setting up a CB scenario, the trainers can select where and when to release three different chemical threats:

- Sarin, a nerve agent with military designation GB
- Chlorine, a type of choking agent designated Cl
- VX nerve agent

The release of the hazardous material is based on simulations using Indoor Building Hazard, which is an Incident Source Module that uses CONTAM—a multizone, indoor air-quality and ventilation analysis computer program—as a submodel of the Hazard Prediction and Assessment Capability tool that provides atmospheric T&D predictions in the event of hazardous atmospheric releases.

The trainers give the trainees mission types such as site exploitation, recon, rescue, or pass through and place various pieces of protective equipment in the scenario for the trainees to select from. When trainee avatars encounter a hazard plume without adequate protection, their health effects are based on Acute Exposure Guideline Levels. The trainee receives

Example of visual effects when exposed to chemical hazard.



Prebuilt tunnel demonstrating the possibility of complex subterranean geometry.

feedback such as blurred vision that mimics smoke screening. There are also panting and coughing sound effects that help create the immersive experience.

Within six weeks, the interns demonstrated the possibility of creating a CB scenario based on validated T&D models and presented concentration-dependent health effects. The competition was close and there was a winner, but DTRA-JSTO directed PNNL SMEs to combine the interns' three applications into a proof-of-concept tool for the portfolio area of Virtual Reality-Based CBD Readiness Preparation for end users to identify capabilities of interest.

DTRA-JSTO is also starting a full-scope project to integrate Joint Outdoor-indoor Urban Large Eddy Simulation for hazard T&D and Chemical-Biological Operational Degradation Analysis Human Effects into the Virtual Tactical Assault Kit. Recreating hazards and effects in the virtual world for immersive and realistic experiences provides an opportunity for modelers to identify capability gaps. ●

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Within the Defense Threat Reduction Agency's Research and Development Directorate resides the Chemical and Biological Technologies Department. This publication highlights the department's advancements in protecting warfighters and citizens from chemical and biological threats through the innovative application of science and technology. DTRA.mil