Title of Innovation: 
Immersive Virtual Learning Environment Training

Nominee(s) 
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Category:
Other—Training/Technology

Dates of Innovation Development:
from December, 2011 to Present

Web site:
www.irtc-hq.com/www.uab.edu
https://amcomcorrosion.army.mil

Summary Description:
Corrosion prevention and control (CPC) training takes place in a low-cost, scalable, and portable virtual reality (VR) training system containing purposely designed and developed corrosion-based immersive virtual learning environments (VLE). The VR system provides a medium that increases users’ interaction, engagement, and immersion through 6 degrees of freedom tracking (i.e. positional and orientation). The VLEs are designed with passive (i.e. video watching, image viewing, audio listening, etc.) and active (user controlled simulations/game play) media and an embedded intelligent agent to provide basic declarative knowledge of CPC principles and theories. The VR system is utilized to train U.S. Army soldiers and to empirically compare routine classroom instructor-led training (i.e. lecture-based multimedia instruction) and immersive VLE training (i.e. VR-based multimedia instruction) in terms of learning and long-term retention.
**Full Description:**

**How does the innovation work?**

The innovation is comprised of output and input devices and software which allow users to interactively train. Vizard™ VR toolkit software by WorldViz®, which is the scripting environment, creates and controls the VLE content and allows for the integration of the various hardware pieces. The hardware consists of a Sony® HMZ-T1™ head mounted display (HMD) (see Figure 2), Microsoft® Kinect® for Windows® (see Figure 2), Zeemote® JS1 controller (see Figure 3), and Inertial Labs™ OS3D sensor (see Figure 4). The HMD provides immersive stereoscopic 3D viewing in an egocentric style (i.e. first-person) while the Kinect, through FAAST™ skeleton tracking software and the OS3D sensor provide real-time tracking of the users’ position and orientation (e.g. navigation and viewing). The JS1 controller allows for system control, selection, and manipulation within the VLEs.

Three custom VLEs (i.e. training modules) were scripted with each covering different learning objectives and CPC topics: importance of CPC, corrosion basics, corrosion influences, corrosion types, basic corrosion prevention (see Figure 5). The embedded intelligent agent guides the user through a combination of passive and active training media while in the virtual environment (VE) (see Figure 6). Each module takes approximately 15 minutes and portions of each allow the user to control the delivery pace of the content (i.e. self-paced learning).

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**Figure 2:** HMD/Kinect

**Figure 3:** Zeemote

**Figure 4:** OS3D sensor

**Figure 5:** VLE sequence. *Note.* Exam topic(s), learning objective(s), and active media bulleted

**Figure 6:** Virtual Environment (i.e. world/scene)

**Figure 7:** Action shooter trivia game
When and how was the innovation developed?
The innovation was conceptualized circa December 2011. From circa June 2012-August 2012 the various components of the VR system were researched, purchased, and developed. From circa June 2013-August 2013 the VLEs were conceptualized, story boarded, and programmed. From circa June 2013-present the innovation is being empirically studied.

The VR system was designed by researching past and present VR technologies (hardware and software). It was developed by integrating a Sony HMZ-T1 head mounted display (HMD) (see Figure 2), Microsoft Kinect for Windows (see Figure 2), Zeemote JS1 controller (see Figure 3), Inertial Labs OS3D sensor (see Figure 4), and WorldViz Vizard VR toolkit.

The VLEs were designed by researching and partaking in various available forms of corrosion training currently available, such as, NACE International® basic corrosion training course, DAU CLM 038 course, Corrconnect.com courses, and U.S. Army Aviation and Missile Life Cycle Management Command (AMCOM) Corrosion Program Office (CPO) CPC training courses. Resources (i.e. images, videos, etc.) needed for the VLEs were either created or gathered from various locations, such as CorrDefense.com. The VLEs were developed by utilizing Vizard VR toolkit software, which allowed for custom programming (i.e. creation and control) of the VLEs.

How or why is the innovation unique?
From June 2013 to August 2013 a through literature review was conducted, which resulted in no findings of an immersive VLE for corrosion training/education. The inventors have taken the stance that typical desktop PC training systems are categorized as non-immersive or semi-immersive. The invention also provides an unique learning experience that motivates and engages a generation of soldiers who have become more accustomed to interactive digital technology and media for not only personal entertainment but educational training as well. Finally, the VR system and VLEs have never been used for corrosion training before now.

What type of corrosion problem does the innovation address?
In 2009, total corrosion costs for the Department of Defense alone were estimated at over 20 billion dollars a year. The ability to just discard and replace corroded assets with new ones has diminished as government continues to pass budget reductions. Now, the importance of educating the soldiers on basic CPC principles and theories has never been greater. Currently, the form of multimedia instruction that is most commonly used is a PowerPoint® presentation accompanied by an instructor’s lecture (i.e. lecture-based multimedia). Using only this form of instruction could potential lead to a loss of trainee engagement as well as suboptimal learning and long-term retention. There is a concern that not augmenting the existing corrosion training with interactive immersive technology, such as VR could be decreasing military readiness and safety.
What is the need that sparked the development of the innovation?
“Passive, lecture-based instruction does not engage learners or capitalize on prior experience.”

The first motivational factor for developing this innovation is the general belief that existing corrosion educational training can be improved by complementing it with immersive virtual reality. The past has shown that applications for VR are vast, and many have not shown the promises as originally proclaimed. However, education/training continues to be viewed as the possible killer market/application for VR.

The second motivational factor was to investigate if augmenting existing corrosion training with immersive VR would help engage, entertain, and/or provoke emotion in the students while fostering increased learning and long-term retention.

Are there technological challenges or limitations that the innovation overcomes?

From the perspective of potential adopters throughout many commercial sectors (including defense and medicine), VR delivered a roller coaster ride of achievement and failure throughout the 1990s. Factors such as commercial naivety on the part of VR companies, significant failures to deliver meaningful and usable intellectual property on the part of so-called academic “centers of excellence”, expensive and unreliable hardware, an absence of case studies with cost-benefit analyses and a widespread absence of attention to the requirements and limitations of the end users, all took their toll by the end of the 1990s.

Today, VR researchers and developers continue to have major challenges to address. Low cost, user friendly, readily available, low latency, high resolution, lightweight, wide field of view consumer grade HMDs still do not fully exist. The HMD used in this invention is a significant step in the right direction. When paired with the low cost Kinect and OS3D the user now has an affordable, scalable, and portable commercial immersive VR system.

Software to create (i.e. script) and control the simulations in the past has also required significant cost and time investments. Vizard enables Python® 2.4 scripting language, which provides a novice programmer a user-friendly scripting environment.

What are the potential applications of the innovation?

- CPC education and/or training
  - Declarative and/or procedural knowledge
  - Motor skills, procedures, strategy, and/or decision making
• Entertainment
  o Engages, motivates, and entices people to learn/study about corrosion

How does the innovation provide an improvement over existing methods, techniques, and technologies?

Much of the current corrosion educational training involves classroom instructor-led education using a traditional educational method consisting of 2D multimedia, print documentation, and lectures. Almost everyone at some point in their life has had to sit in a setting as described above. I ask you this: did you give your full attention, did the instructor keep your attention, did your mind wander, where you distracted by your neighbor or cell phone, or did you even stay awake the full time? The integration of this innovation will help alleviate some of these problems.

![Figure 8: Affordances and positive improvements over traditional pedagogy](image)

What type of impact does the innovation have on the industry/industries it serves?

It helps with a significant problem that the military has when concerned with training and that is death by PowerPoint. The enormous advances in technology can now provide new learning opportunities. TRADOC Pam 525-8-2, The U.S. Army Learning Concept for 2015, is a strategic document that discusses some of these opportunities and lays the groundwork for where the Army’s learning model needs to be at in the coming years.11

Dramatically reduce or eliminate instructor-led slide
presentation lectures and begin using a blended learning approach that incorporates virtual and constructive simulations, gaming technology, or other technology-delivered instruction.\textsuperscript{11,9}

This innovation also makes an impact by allowing corrosion training to follow the trend that technology, media, and screens have become an integral part of almost everyone’s lives, including service members. A study by Google in 2012 revealed that 90\% of all media interactions were screened based.\textsuperscript{14} Much of the Armed Forces are aged 18–24 and a study by Google in 2012 also revealed that video is the #1 most influential source in changing perceptions and gaming has become extremely popular across all generations.\textsuperscript{15}

**Does the innovation fill a technology gap? If so, please explain the technological need and how it was addressed prior to the development of the innovation.**

Immersive VR technology is not new. It can be found as far back at the Sensorama, which received U.S. Patent #3,050,870 in 1962.\textsuperscript{2} It was an immersive 3D experience that had motion, color, stereo sound, aromas, wind effects, and a vibrating seat.\textsuperscript{16} Heilig also received U.S. Patent #2,955,156 for a HMD that supported stereo sound and an odor generator.\textsuperscript{3} Heilig’s HMD is often viewed as one of the first HMDs created, however the first probably goes to the Philco Corporation in 1961.\textsuperscript{17} The Sensorama never became a commercially available product and if it had the cost would have been too steep for the masses. The first consumer grade VR equipment, such as the DataGlove and EyePhone by VPL Research, Inc. did not hit selves until the late 80s. The following decades were tough for consumer VR as prices were high, graphics poor, screen resolution low, field of views small, latency high, ergonomics bad, computing power weak, weights high, and tracking difficult. I believe that the Nintendo\textsuperscript{®} release of the Wii and the advancements in sensor and screen technology by the mobile phone industry sparked this new revolution in affordable consumer VR.

The literature review also produced only three other empirical research studies directly comparing lecture-based and VR-based multimedia instruction.\textsuperscript{18–20}
Has the innovation been tested in the laboratory or in the field? If so, please describe any tests or field demonstrations and the results that support the capability and feasibility of the innovation.

Yes, the innovation is the outcome of Rustin D. Webster’s research for his PhD in Interdisciplinary Engineering from the University of Alabama at Birmingham. The purpose of his study is to compare the routine classroom instructor-led training (i.e. lecture-based multimedia instruction) and immersive VLE training (i.e. VR-based multimedia instruction) in terms of learning and long-term retention of basic CPC theories and principles in U.S. Army soldiers after taking an AMCOM CPO’s CPC training course. Additionally, specific subjective features of the immersive VLE, such as ease of use, ease of learning, user comfort, likability, acceptability, and satisfaction, will be evaluated.

The research study is taking place in two phases. Phase one was a focus group (two parts) to provide face and content validity for research instruments (e.g. questionnaires, interview script, and pre-, post-, and long-term retention exams). Phase two is consisting of a formal research study, which is a group (i.e. control and investigational) comparison experiment (i.e. 2 x 3 mixed between-within subject design).

As of 20 September 2013, the following is the list of completed research sites (first to last):

1. 14 March 2013, Redstone Arsenal, AL (focus group – part two)
2. 23 April 2013, Redstone Arsenal, AL (focus group – part one)
3. 18 June 2013, AMCOM Corrosion Program Office Corrosion Monitors Course, Redstone Arsenal, AL
4. 2 August 2013, Rhode Island Army National Guard, D (Delta) Company, 1st Battalion, 126th Aviation Regiment, North Kingston, RH
5. 20 August 2013, AMCOM Corrosion Program Office Corrosion Monitors Course, Redstone Arsenal, AL
6. 6 September 2013, Army National Guard, Army Aviation Support Facility #3, Jackson, TN
7. 7 September 2013 (morning), Army National Guard, Army Aviation Support Facility #3, Jackson, TN
8. 7 September 2013 (afternoon), Army National Guard, Army Aviation Support Facility #3, Jackson, TN

Scheduled:

1. 1-3 October 2013, U.S. Army, 4th Battalion, 160th Special Operations Aviation Regiment, Joint Base Lewis-McChord, WA
2. 22-24 October 2013, 1st/2nd Battalion, 160th Special Operations Aviation Regiment, Fort Campbell, KY
3. 1-2 November 2013, Army National Guard, Fort Worth, TX
Current investigational group sample size ($N = 10$) is not large enough to perform valid inferential statistical analysis. Data collections will take place as needed until investigational group size reaches 20-30 participants. Current trend is two-three data collections per month, which results in the completion of data collection by years end.

**Is the innovation commercially available? If yes, how long has it been utilized? If not, what is the next step in making the innovation commercially available?**

No, the next step is to finish the formal research study that utilizes the VR system and immersive VLEs. It will then be added to augment or complement existing AMCOM corrosion Program Office CPC training curriculum. The VR system may also be refined with the new Kinect being released Q4 2013 and commercial Oculus Rift®, which is scheduled for 2014.

**Are you aware of other organizations that have introduced similar innovations? If so, how is this innovation different?**

Other low-cost (<$2000) commercial HMD w/ at least 3DoF tracking similar to HMZ-T1 w/OS3D:
- Oculus Rift by Oculus®
- Cinemizer OLED w/ optional head tracking by Zeiss®
- Z800 3DVisor by eMagin®
- Wrap™ 1200VR by Vuzix®

Other low-cost commercial tracking systems similar to Kinect:
- PrimeSense™
- ASUS® Axtion™

Other low-cost commercial input devices like the JS1 controller:
- Presentation control remotes
- Video game controllers
- Gesture/motion control devices

Other VR toolkit software packages similar to Vizard:
- Various others but most our in-house developed or not fully supported by a staffed company

I am not aware of any other organization that has a turn-key 6DoF tracking, low-cost, readily available, and immersive VR system, which also has corrosion based virtual learning environments incorporated.
Are there any patents related to this work? If yes, please provide the patent title, number, and inventor.

No
REFERENCES