AVR Technologies and the Future of Workforce Training

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Clarifying Terms

AVR = Augmented and Virtual Reality
- Often implicitly includes Mixed Reality

**Augmented Reality** = projecting digital 3D images onto user’s real-world environment
Virtual Reality = Immersing user in a digitally created 3D environment
Clarifying Terms

**Mixed Reality** = projecting digital 3D images onto user’s real-world environment AND having user’s environment change/interact with those 3D images.
The Potential: New Methods of Training, New Heights of Productivity

Prior Limitations on software-based workforce training:

- Training often not nested in trainee's environment—real or simulated—limiting retention
- Experiences were often very conventional; no 'wow' factor
- Difficult to disseminate beyond PC space or web space
- In web space, difficult to go beyond very basic interactions (watch video/presentation or read text, take quiz)

Emerging AVR technologies allow trainers to:

- Increase retention by having trainee interact with their own environment, or simulations of workplace environment
- Increase retention and performance by allowing trainee to repeat process quickly and efficiently
- Increase retention by putting trainee through unique experiences (greater 'wow' factor)
- Utilize smartphone technology to allow for wider dissemination of training applications
- Provide more complex, engaging and visually interesting interactions in the web space that still integrate easily into LMS's
BLENDED WELDING TRAINING

2010 IOWA STATE UNIVERSITY STUDY OVERVIEW

11 PARTICIPANTS TRAINED USING 100% TRADITIONAL WELDING
80 TRAINING HOURS OVER TWO WEEKS

22 TOTAL PARTICIPANTS

PARTICIPANTS TRAINED USING 50% TRADITIONAL & 50% VIRTUAL WELDING

THE VIRTUAL WELDING GROUP EXPERIENCED

- Significantly HIGHER levels of team learning and interaction
- Greatly REDUCED training costs
  - Total savings equate to $2,680 / $243 per student
- Significantly GREATER amount of welds
CERTIFICATION RATE

<table>
<thead>
<tr>
<th>Weld Type</th>
<th># of Participants Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G</td>
<td>9</td>
</tr>
<tr>
<td>1G</td>
<td>6</td>
</tr>
<tr>
<td>3F</td>
<td>5</td>
</tr>
<tr>
<td>3G</td>
<td>5</td>
</tr>
</tbody>
</table>

AN INCREASE OF 41.6% IN OVERALL CERTIFICATION FOR THE VR GROUP

TRAINING TIME

<table>
<thead>
<tr>
<th>Time in Hours</th>
<th>Advantages of Virtual Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Practice welds without spending time in setup and material gathering.</td>
</tr>
<tr>
<td>12.3</td>
<td>Sunscreen without wasting material or losing time in assembly and repositioning.</td>
</tr>
<tr>
<td>14.1</td>
<td>Practice welds without spending time in setup and material gathering.</td>
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<td>Sunscreen without wasting material or losing time in assembly and repositioning.</td>
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<td>Sunscreen without wasting material or losing time in assembly and repositioning.</td>
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<tr>
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<td>Sunscreen without wasting material or losing time in assembly and repositioning.</td>
</tr>
</tbody>
</table>

100% Traditional Welding 50% Traditional & 50% Virtual Welding

FOR PRODUCT INFORMATION AND TO VIEW THE STUDY, VISIT www.vrtex.com

LINCOLN ELECTRIC
THE WELDING EXPERTS®
The Pitfalls: Challenges AVR Must Overcome

- The technology is still maturing--some of its solutions have not gained wide distribution, and have significant barriers to entry in terms of cost and hardware requirements.

- It is still not as familiar as, say, smartphone tech this generation, or PC tech in the last generation; there are signs that this is changing, however.

- Some AVR solutions require new, unfamiliar approaches to UI.

- Technology’s Rate of Change.
The Platforms: the AVR Tech available to businesses and educators

Mobile AVR

- Augmented Reality applications
- Prominent examples: Pokemon Go, QR codes,
- Phone-based VR applications
- Prominent Examples: 360 video, phone-based VR headsets

Web-based Virtual Simulations

- Browser-based Environmental Simulations
- Most Prominent Platform: WebGL
The Platforms: the AVR Tech available to businesses and educators

VR Headsets
- Prominent Examples: Oculus, HTC Vive

Mixed Reality
- First Attempts: Google Glass
- Prominent Examples Still in Use: Hololens, Hololens 2, Windows 10 Mixed Reality Headsets
Mobile Advantages and Drawbacks

Advantages
- Ease of Distribution
- User familiarity with device
- Relatively Low Expenses
- Portability
- Accessibility
- Cost

Disadvantages
- Processing Power Constraints
- App Store Requirements
- Certain UI schemes unfamiliar
EICC and Mobile AVR: Water InTENse

Marker-based beginnings

Markerless transition

Adding platform interoperability
EICC and Mobile AVR: AR Foundation and NSF

- Student-built AR Foundation project

- Mobile AVR Applications as pedagogical tools in the classroom
  - Present same advantages mentioned before to students
  - Way of training future workforce
Web-based Virtual Simulations: Advantages and Drawbacks

Advantages

- Extremely wide, easy Distribution
- Ease of Interaction with LMS's
- Familiarity with UI schemes

Disadvantages

- VERY resource-constrained
- bandwidth dependent
- Diminished 'wow' factor
EICC and Web AVR: Current Projects
Virtual Reality: Advantages and Drawbacks

Advantages

- ‘Wow’ factor
- Total Immersion
- ‘Learn By Doing’
- Can put trainee in unique circumstances

Disadvantages

- Accessibility, ease of use
- Technology still young & expensive
- Requires not only headset but high-powered graphics card

Learning Retention Rates

- Lecture: 5%
- Reading: 10%
- Audio-visual: 20%
- Demonstration: 30%
- Group Discussion: 50%
- Learning by doing (VR Powered Training): 75%
- Learning by teaching others: 90%

Number of VR Headsets, In millions Unit, Global, 2016-2021*

Source: National Training Laboratories, USA

Source: Cisco Systems
Mixed Reality (XR)

-Mixed Reality technology can overlay virtual images onto a user’s immediate environment, AND have these images respond to changes in the user’s environment.

-Similar to augmented reality technologies, but less ‘passive’

Because it is often executed using cloud technology, it can also transmit data about the user’s environment to a third party (databases, LMS’s, web services) and have information possessed by third party influence what the user sees overlay-wise (in addition to influence derived from changes in user’s environment itself).
Mixed Reality: Advantages and Drawbacks

Advantages

- Possibly highest-potential tech
- Two-way interaction with environment
- Big ‘wow’ factor
- Greater capacity for collaboration
- Allows for building validation checks into training procedures
- Allows you to leverage SME expertise without tradeoffs

Disadvantages

- Relatively new technology and VERY expensive at the moment (Hololens 2 average cost $3500)
- Platforms like Hololens 2 only available to business and industry, not consumer
- Currently requires use of cloud, so bandwidth dependent
- UI unfamiliar to most users

<table>
<thead>
<tr>
<th></th>
<th>Hololens 2</th>
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<tbody>
<tr>
<td>Weight</td>
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</tr>
<tr>
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<tr>
<td>Refresh Rate</td>
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<tr>
<td>Price</td>
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EICC and XR

- on-boarding training
- XR platforms allow for creation of instructor-guided training programs that can communicate with EICC's Canvas LMS.
- Presents opportunity for greater standardization and modularization of training new team members.
- XR allows you to capture the 'tribal knowledge' of senior personnel and/or SME's without requiring SME's presence during training process
What’s Next?

Short-run:

- exploring possibilities offered by WebGL platform
- polishing delivery of short, episodic training apps
- polishing ability of apps to work with SCORM-compliant LMS’s
- developing pipelines to major distribution outlets like Google Play Store, Apple Store, Steam, etc.

Long-run:

- incorporating smaller episodic apps into larger, (SCORM compliant) LMS-run courses on broader, more general subjects, to use as the basis for an integrated learning platform.
- develop diverse library of apps that utilizes every type of AVR platform--from mobile AR to headset VR and XR.
Technology improves labor productivity.

Increased output of labor increases investment and R&D in adopted technology.

Technology becomes cheaper, more effective and more widely adopted for training.

Productivity/Development Cycle