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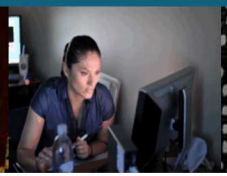
Three Critical Considerations for Adopting Immersive Technology



PRESENTED BY

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Overview of Immersive Technology (XR)

Augmented Reality (AR)

- Least immersive
- Phone, tablet, or head-mounted device with transparent lenses
- Data is overlaid on the physical environment, on screen or in a heads-up display
- Applications run on device

Mixed Reality (MR)

- Somewhat immersive
- Head-mounted device with transparent lenses or camera
- 3D data is placed within the physical environment
- Applications may run on device or PC

Virtual Reality (VR)

- Fully immersive
- Head-mounted device with opaque display or room with special screen and glasses
- The user is placed inside a virtual environment
- Applications run on PC

Use Cases and Motivation

Training and Simulation

- Gain experience in isolation: one can comfortably make and correct mistakes
- Try, learn, and repeat processes in a safe environment to refine skills
- Learn in an environment that mimics the real work environment—feels more "hands on"
- Receive "just-in-time" training that doesn't require other staff members to supervise or teach

Data Visualization

- Interact with physical or virtual object with additional information displayed
- Walk around or even inside 3D models

Collaboration

- Converse with others in real time while viewing and interacting with the same virtual object
- Immersive, virtual meetings with team members

Image Source: https://pixabay.com/photos/thought-idea-innovation-imagination-2123970/

How We're Using Immersive Technology at Sandia

Training
- Process
- Safety
- Security
- Exercise Simulation

Data Visualization
- Computed Tomography
- Satellite Orbital Display
- Experiment Results
- Facilities Data

By Feature
(Current and Future Work)
- Multi-User Applications
- Object Recognition
- Real-Time Data
- Analytics

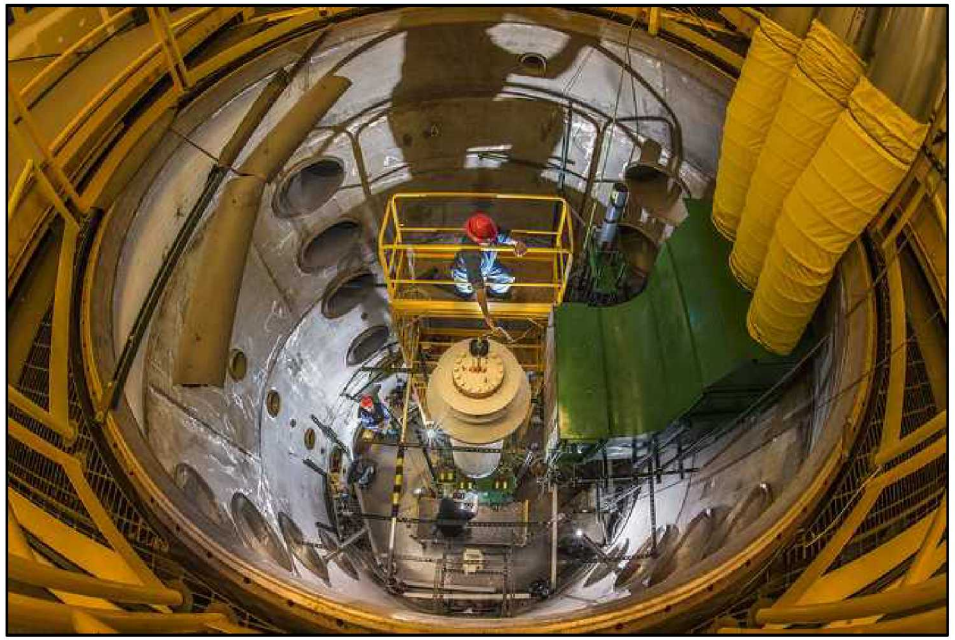


Image Source: https://www.flickr.com/photos/sandialabs/31980542167/

In-Depth Look: Process Safety Training Application

Safety-Focused Training for Engineers

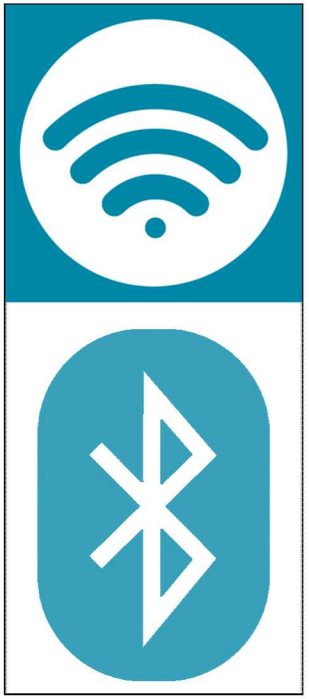
- New hires can learn what they didn't learn in school
  - The learner can see animations of operations
  - An avatar is present to help them, encouraging teamwork
  - Questions are asked to help them learn
- Training is streamlined
  - People can learn outside of a formal, scheduled class
  - Reduces time to competency, knowledge can be immediately applied
- Cost effective solution
  - No trainer presence required for the experience
  - No travel required to experience the process

Consideration #1: Security

What features are common in XR devices?

Wi-Fi and Bluetooth

- Most XR devices are capable of transmitting Bluetooth
- Many XR devices can also transmit Wi-Fi
- For some devices, this functionality cannot be disabled
- For some applications, the use of Wi-Fi or Bluetooth is desired



Camera and Microphone

- Many XR devices have built-in microphones for voice commands and dictation, as well as for collaborative experiences
- Many XR devices have the ability to capture images and some can even capture room geometry

Operating Systems and Drivers

- Standalone devices run their own on-board operating system
- Tethered and wireless devices require drivers to be installed

Image Source (top): https://pixabay.com/vectors/wireless-connection-wifi-signal-3717309/
Image Source (bottom): https://pixabay.com/vectors/bluetooth-icon-bluetooth-logo-670069/

What are the concerns around specific features?

Wi-Fi and Bluetooth

- Some cyber attacks take advantage of Wi-Fi and Bluetooth technology
- XR development teams and end users need to understand that policies extend to these devices

Camera and Microphone

- Is the data being sent out? If so, where?
- How can we avoid "hot mic" incidents?

Operating Systems and Drivers

- Standalone devices may require Wi-Fi for OS updates
- Driver software may be blocked

Image Source: https://pixabay.com/photos/ransomware-cybersecurity-cyber-3998798/

What can we do to mitigate security risks?

Know the device
When purchasing, look at technical specifications to ensure that most security concerns are identified up front and test the device to learn more

Work with security personnel
Ask questions, get necessary approvals, and be specific when discussing intended use

Disable functionality that is not being used
More often than not, device features like microphone and camera can be controlled

Take appropriate action if some functionality cannot be disabled
Know how the device uses data and make sure that the device is operated within organizational policy parameters

Use Security Features
Many on-board operating systems have built-in security features (e.g. BitLocker)

When in doubt, reach out to vendors
Many are willing to answer questions and offer suggestions to help XR development teams understand how to improve the security of the device

Image Source: https://pixabay.com/illustrations/business-search-seo-engine-2082639/

Consideration #2: Human Factors

What general concerns are there for human factors?

Comfort

- Do the devices cause physical discomfort?
- Is there motion or animation in the application that causes physical discomfort?
- Are there any interactions with the application that cause physical discomfort?

Distractions

- Is the method of interaction with the device or application intuitive enough to keep the user from becoming frustrated?
- Are there design issues with the user interface that monopolize the user's attention?
- Is the application designed in a way that allows users with disabilities to appreciate the experience?

Trust

- Can the users believe what they're seeing?
- Can the technology live up to its purpose?

Image Source: https://pxhere.com/en/photo/1447399

What are some concerns for specific use cases?

Training

- Are the appropriate stimuli introduced in training?
- How can the application be designed so that skills can be transferred to the job?
- Is the application designed such that negative experiences can be avoided?

Data Visualization

- Is the purpose of the visualization to provide some level of cognitive offload in performing a task? If so, is the application fulfilling that purpose?
- Is the immersive device the appropriate platform for the type of visualization?

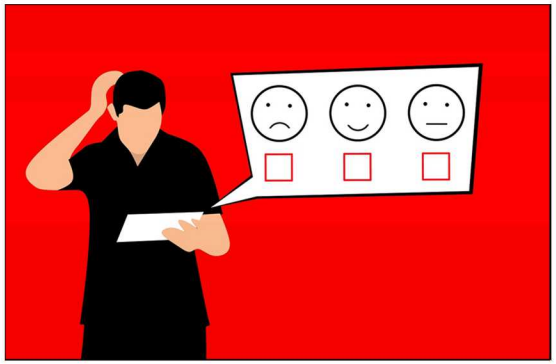


Image Source: https://www.maxpixel.net/Feedback-Online-Survey-User-Customer-Experience-3239623

What can we do?

Be Helpful

- When giving demonstrations, work with users to ensure that they are wearing the device properly
- When designing and developing the application, follow general user experience and accessibility conventions

Consult With Experts

- Engage with human factors and usability experts early in the project lifecycle
- Consistently elicit feedback from these experts, especially when design changes are made

Conduct User Studies

- Work with usability experts to test the application with users and gauge how intuitive the interactions are with the application interface
- Work with human factors experts to perform formal user studies and evaluate the effectiveness of the application

Image Source: https://pxhere.com/en/photo/1570335

Consideration #3: Device Limitations

What constraints are inherent in XR devices?

Standalone Devices

- Limited memory and graphics processing
- Limited storage
- Some are sensitive to light

Tethered Devices

- Dependent on PC capabilities
- Limited physical movement

Any Device

- Input options
- Field of view

Image Source: https://pixabay.com/illustrations/question-question-mark-response-1015308/

How do constraints affect application performance?

Performance and Storage

- Graphics tradeoffs:
  - High resolution models can cause an application to jitter and update slowly
  - Low resolution models may have fewer performance implications but may also have poor aesthetics
- Depending on the size of data to be used for an application, it may not all fit on a device

Mobility and Environment

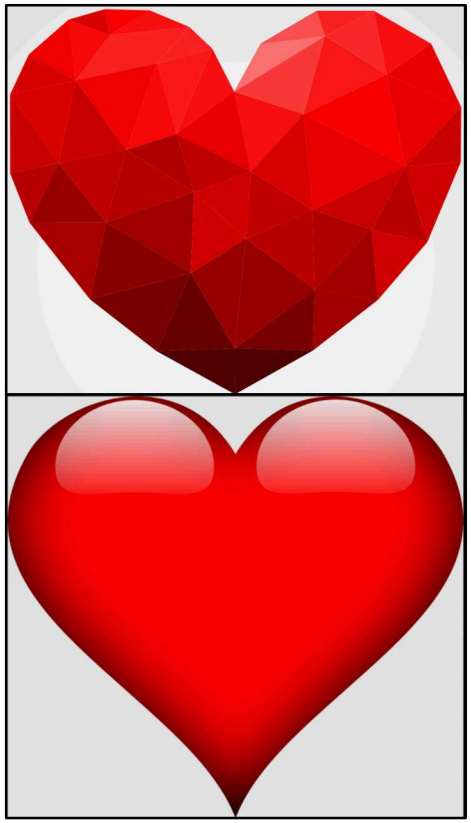
- It may be difficult or even unsafe to physically walk around a scene in an immersive application
- Tethered devices limit movement even further
- For some devices, applications can be difficult to see in an environment with bright light

Input and Field of View

- Bluetooth controllers are sometimes not an option
- Some users have a lot of trouble with gestures
- Some users are uncomfortable with voice commands
- Some devices have a small field of view, limiting what can be displayed to the user at a given time

Image Source: https://pixabay.com/illustrations/questions-answers-question-mark-1014060/

What options do I have?



Performance and Storage

- Have an effective graphics pipeline
  - Find a good balance between 3D model quality and polygon count
  - Normal maps can be used to make a low resolution model look like a high resolution model
- When possible:
  - Offload heavy processing to a more powerful machine or a cloud environment
  - Store data elsewhere and access it at runtime

Mobility and Environment

- Include functionality, like teleporting, that allows the user to navigate the scene virtually
- Use a film "shield" to block bright light from devices that are sensitive to light

Input and Field of View

- Use built-in functionality that provides input alternatives
- Consider custom approaches for input
- Experiment with different design approaches for limited real estate
- Ensure that the appropriate device is being used

Image Source (top): https://pixabay.com/vectors/love-heart-low-poly-valentine-2519688/
Image Source (bottom): https://pixabay.com/vectors/heart-love-red-valentine-romantic-157895/

Building an Organizational Capability

Overcome Additional Challenges

XR Projects are Heavily Creative

- The most effective teams are interdisciplinary
- Be ready for design changes
  - Establish a feedback loop with the customer by demonstrating often
  - Design and develop for modifiability

Many Moving Pieces

- Establish an agile process but keep overhead low
- Build quality control into the process to minimize technical debt
- Save time by avoiding duplicate effort
- Communicate consistently

Keeping the Lights On

- Market applications and the technology itself
- Secure consistent funding or organizational buy-in
- Budget effectively
  - Ensure critical team members are covered
  - Stay up to date on device releases and decide when to procure and when to pass

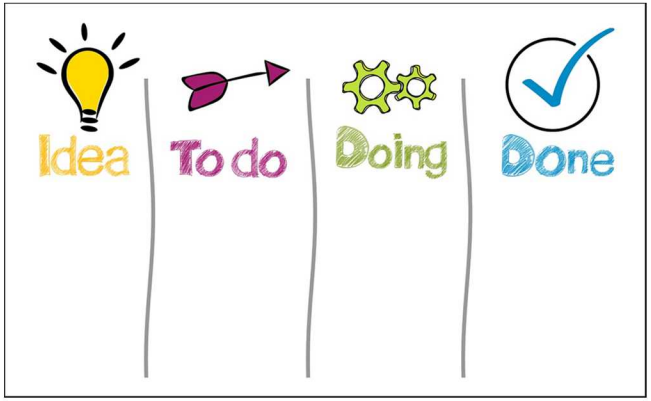


Image Source: https://pixabay.com/photos/work-work-process-organize-business-4051777/

Build a Team

Have a Good Range of Skills

- Software Architecture and Development
- 3D Modeling and Graphic Design
- Machine Learning and Data Analytics
- Business and Marketing
- Security and Networking
- UX Design and Research
- Human Factors Research

Keep the Team Together

- Have a team for the capability, not the project, and evolve as a unit
- Be mindful when making personnel changes
- Not everyone has to be full time, some can even simply consult

Image Source: https://pixabay.com/illustrations/business-tree-growth-success-team-1137366/

Final Thoughts

Address Key Considerations Early

- Avoid security incidents
- Design for user experience
- Identify solutions for device limitations
- Engage appropriate experts

Work With Other Teams

- Share knowledge and educate newcomers
- When possible and practical, avoid duplicating effort

Mature Your Team

- Find your niche—applies to devices and application types
- Market your capability
- Be creative and innovative

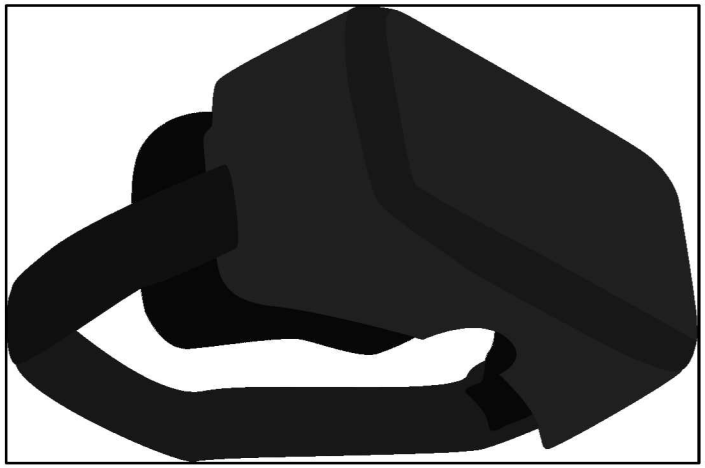


Image Source: https://pixabay.com/illustrations/vr-ar-reality-virtual-reality-1911451/

Thank you!