Mixed Reality

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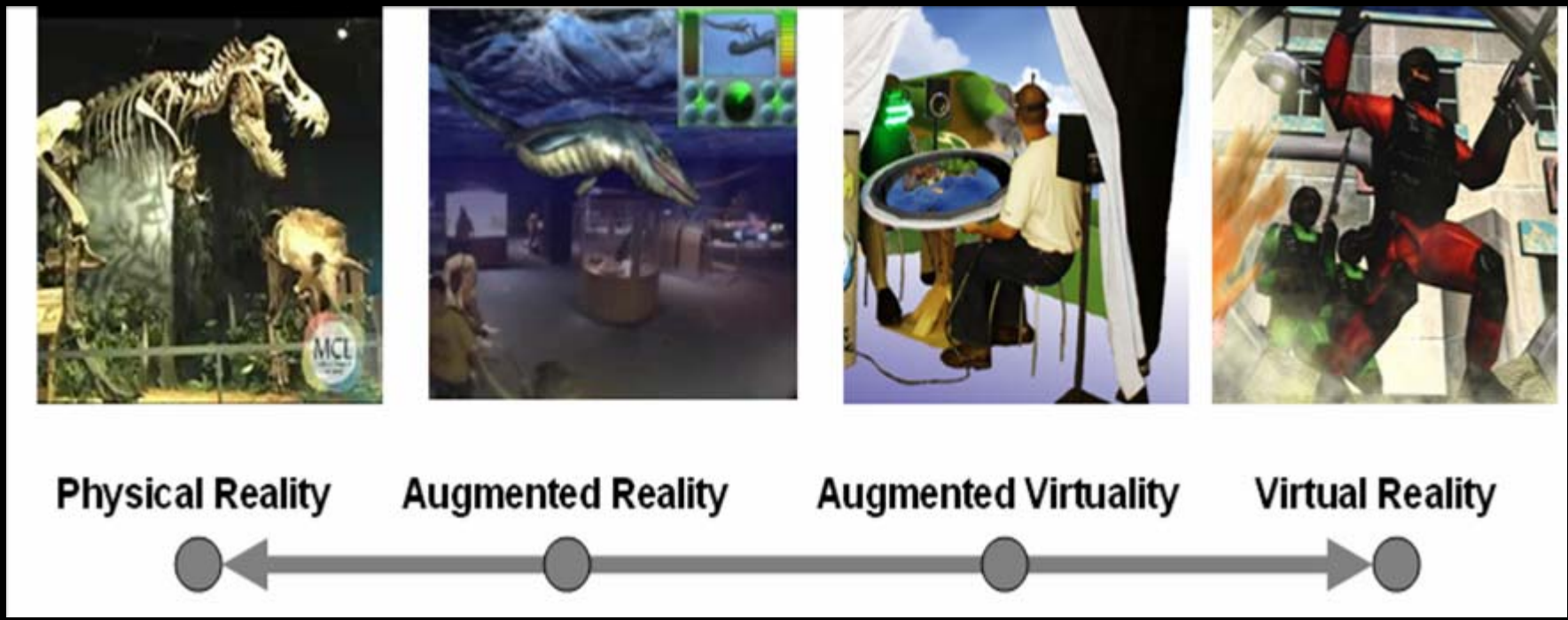
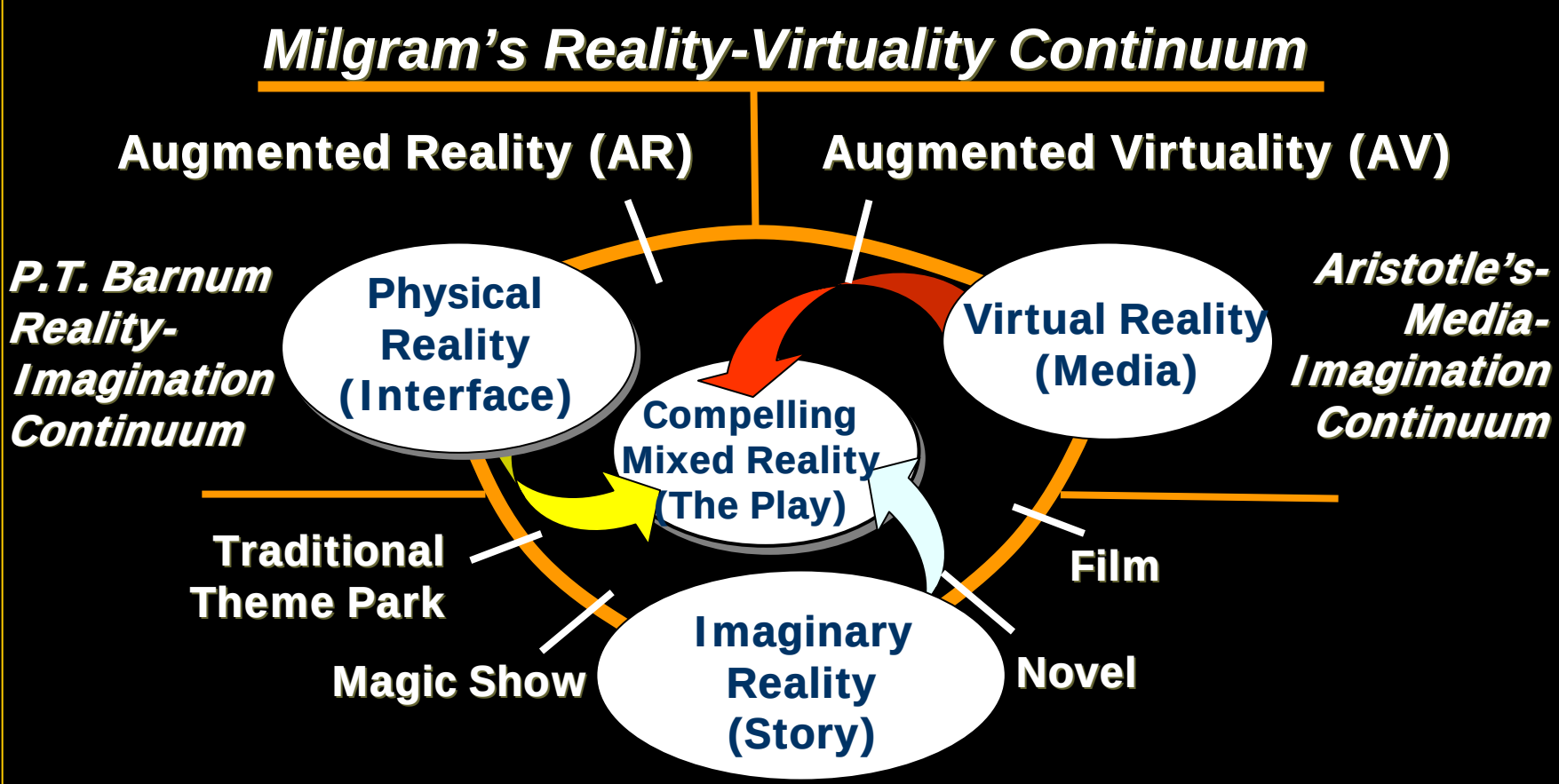
MR Contexts

- Physical Reality (PR) – real world
- Virtual Reality (VR) – purely synthetic
- Augmented Reality (AR) – virtual assets registered in real world
- Augmented Virtuality (AV) – real (people, props) layered in virtual space

Mixed Reality Continuum



Milgram + Imagination



Mixed Reality Properties

- Blends the real and the synthetic into a single landscape & experience
- Addresses multiple senses
- Requires proper registration of real and virtual, relative to each other
- Typically requires complex behaviors of virtual characters
- Enables buy-in through imagination

Content is king

- Create experiences that last a lifetime
  - Experiential movie trailers
  - Situational awareness training
  - Free-choice learning
  - Cognitive and physical rehabilitation
  - Creative collaboration
  - Teacher screening and training
  - …
- Imagination is the important dimension

Siggraph'03:experiential trailer

Situational awareness

Virtual Camera View

Real World Stage

Immersive Action

User view of trainer

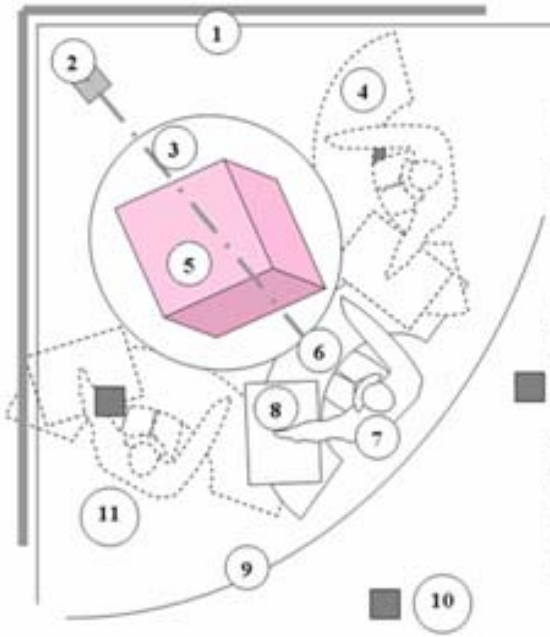
Free-choice learning

Water's journey

- Coming to a science center near you
- Initial focus is on the Everglades
- But, water is central to all ecologies
- Move clock backwards or forwards
  - Real blends to virtual
  - User-chosen policies affect what is experienced

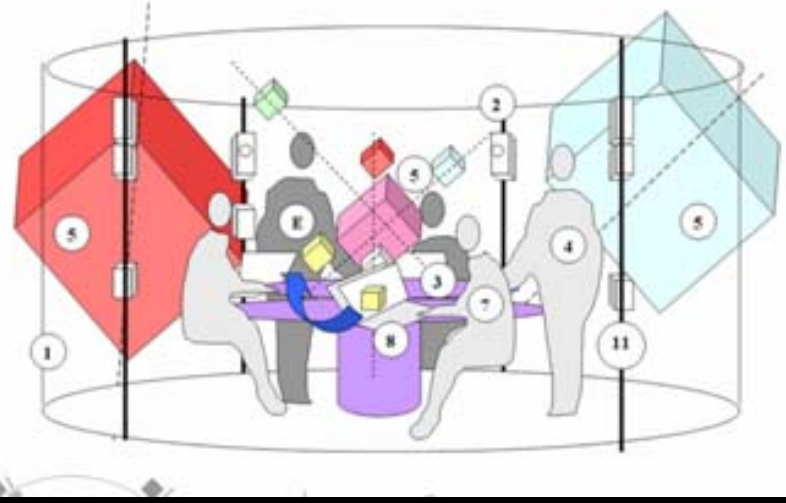
Cognitive rehabilitation

Human experience modeler



Individual Video See-Through Mixed Reality Station

1. Omni-Directional Retro-Reflective Backing
2. Camera Capture of Participant.
3. Rotational table used as rotational dial with retro-reflective material (individual selection and orientation of data).
4. Live or Perceived Participant
5. Representation of data
6. Individual work space
7. Participant with Video See-through Head Mounted Display.
8. Personal data source.
9. Retro-reflective curtain
10. Two Tiered Surround Sound Capture and Display.
11. Live or Perceived Participant

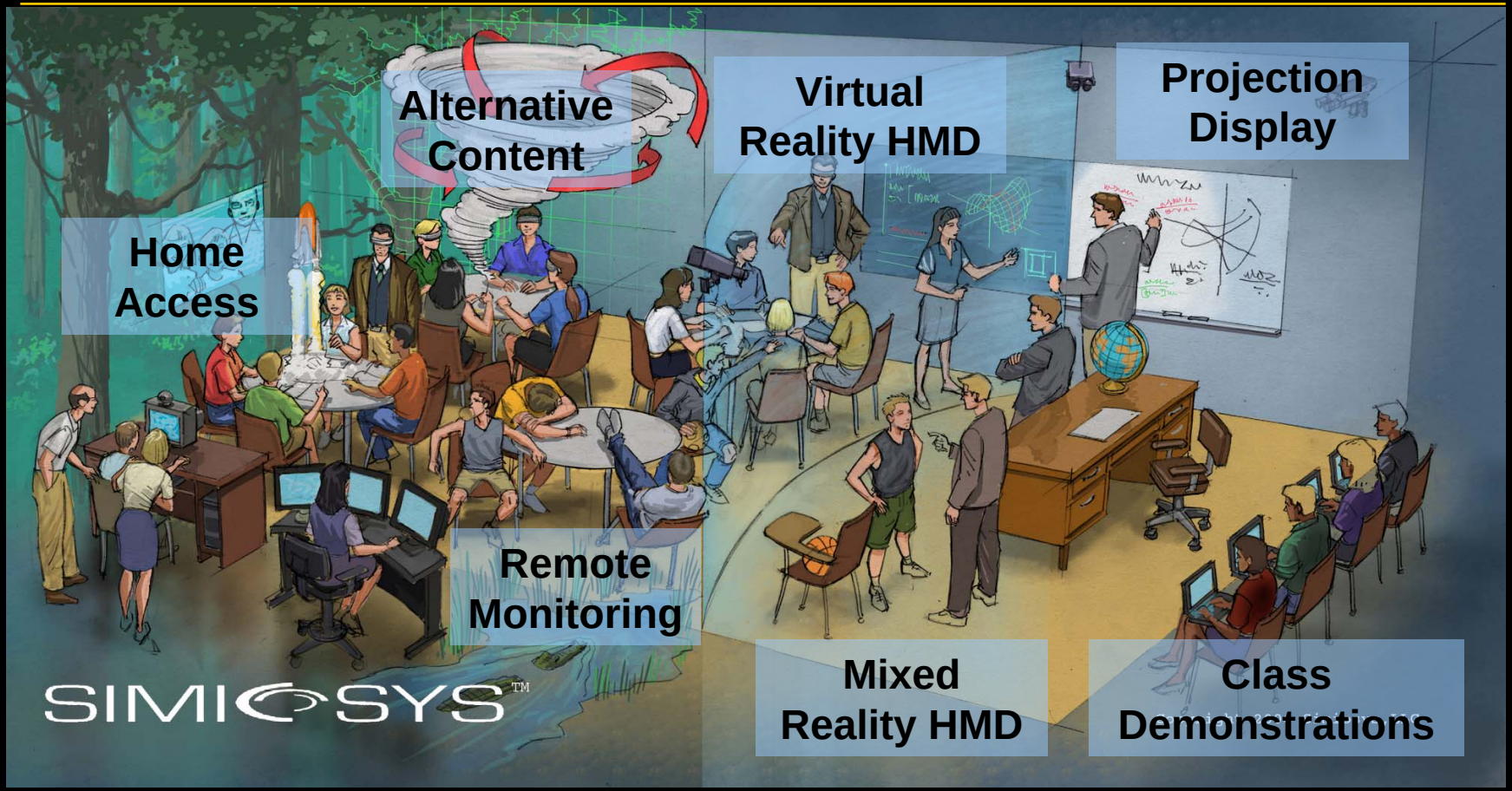


COLLABORATION

Teacher screening and training

- Cost to hire a teacher is $15,000
- Cost to remove can be much higher
- Turnover in inner city is 50% in 3 years
- Many last less than a year
- Children are unintended guinea pigs
- Want to select those who can succeed
- Want to help those who want to succeed

STAR Simulator



Creating the virtual setting

Virtual Classroom

Virtual Students

Environmental Scan

Virtual Puppeteer

Motion Capture

Front room – early prototype

Back room -- puppeteers

Three views of class

In front of class

At desk of student

Personal contact

Educating the educator

Tools of the trade

- Tracking & registration
- Visual capture / delivery
- Audio capture / delivery
- Special effects
- Software infrastructure
- Artist tools

Technical infrastructure

Tracking

- Technologies
  - Magnetic
  - Optical
  - Vision (often with markers/features)
  - Acoustical
  - Inertial
- Hybrid (hardware and soft/hardware)
- Calibration

Registration / Illumination

- Virtual and real must be properly placed relative to each other
- Inter-occlusion must be properly managed
- Mutual shadowing must occur, including shadows from real caused by virtual light
- The effects of ambient light (real and virtual) must be rendered

Visual Capture / Rendering

MR HMDs

Optical

Light capture

Video

Dome Screens

Demo Dome

Flat World

MR Windows

Rendering in MR

- Shadows and Shading
  - GPU-based real-time algorithms
  - Virtual effects real and vice versa
    - Shadow casting
    - Lights, even virtual lights affect real objects
- Ambient Lighting
  - Capture changes in real world palette
  - Use tone mapping to alter palettes of virtual objects

Real-Time Shadows

Blending Real & Virtual

- Next slide shows a real-time technique for inducing lighting changes in real world on virtual objects.
- Technique just analyzes colors of real and induces changes in these on those of virtual objects.

Fake illumination

More visual stuff

- Artist tools
  - Artist uses paint brush for highlights
  - Each paint stroke adds a gene
  - Material “evolves” constrained by artist’s vision
- Synthetic natural environments
  - Millions of blades of grass
  - Visualization of forests on fire

Neuroevolved material design

Shadows from individual blades

Forest fire visualizations

Pipeline: Audio for VR/MR

- Planning & Prescripting
- Capturing
- Synthesizing, Mixing, and Mastering
- Designing Sound & Integrating
- Delivering

Audio for Simulation. Why Care?

- 360 degrees
- Hear through walls, around corners
- Communication
- Environmental recognition
- Increased sense of presence & immersion
- False/negative training

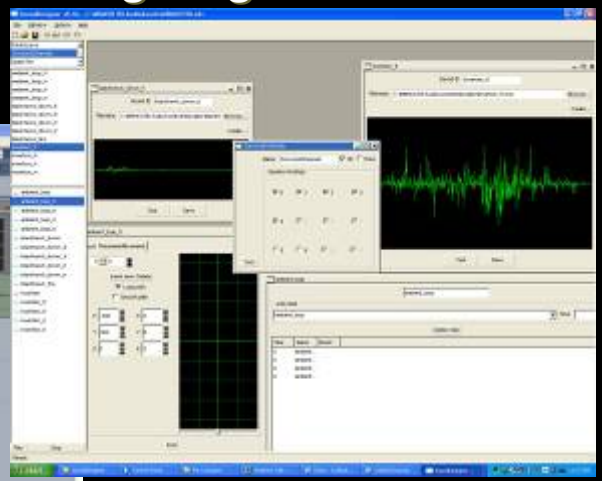
Audio Capture / Rendering

Surround Hydrophones

Holophone

Mixing

Designing



Delivery in constrained settings

Special Effects Delivery

- Dimmer Packs
- Pneumatic / Smoke System
- Sound Transducers (”Bass Shakers”)
- Etc.

Funded projects

- Visualization for decision making (NSF)
- Impact of MR on performance (Army)
- Cognitive & physical rehab (NSF)
- MR in museums (NSF)
- Joint forces training (Navy)

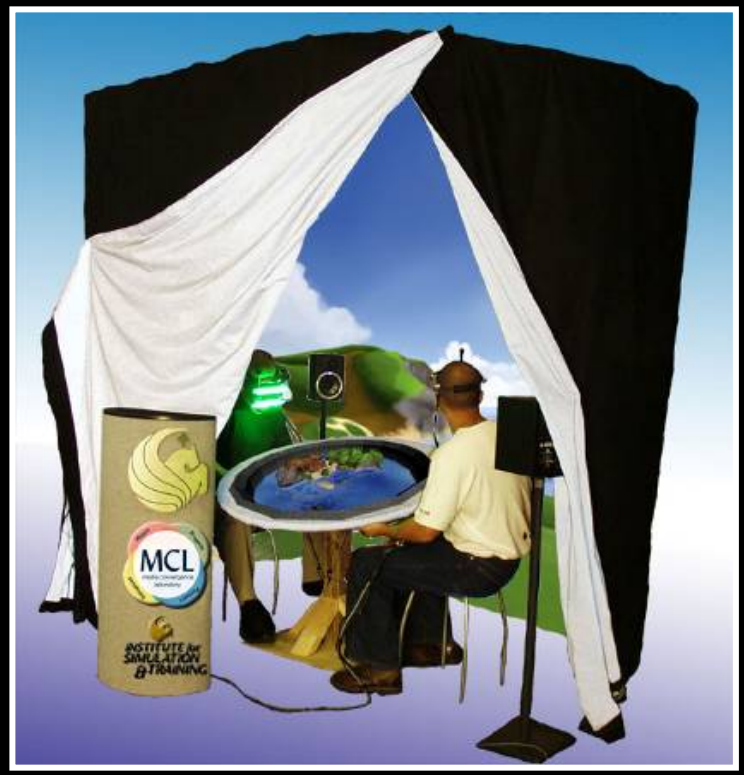
Underlying research

- Neuroevolved behaviors
- Automatic chroma key calibration
- New story engine
- Network protocols
- New audio engine

Creative Process in MR

- PR is constrained by physical space
- VR limits person-to-person expression and context of PR
- AR often limits escape from real world
- AV limits context to artificial
- In general, we want to move smoothly along the MR continuum

MS Demo Dome

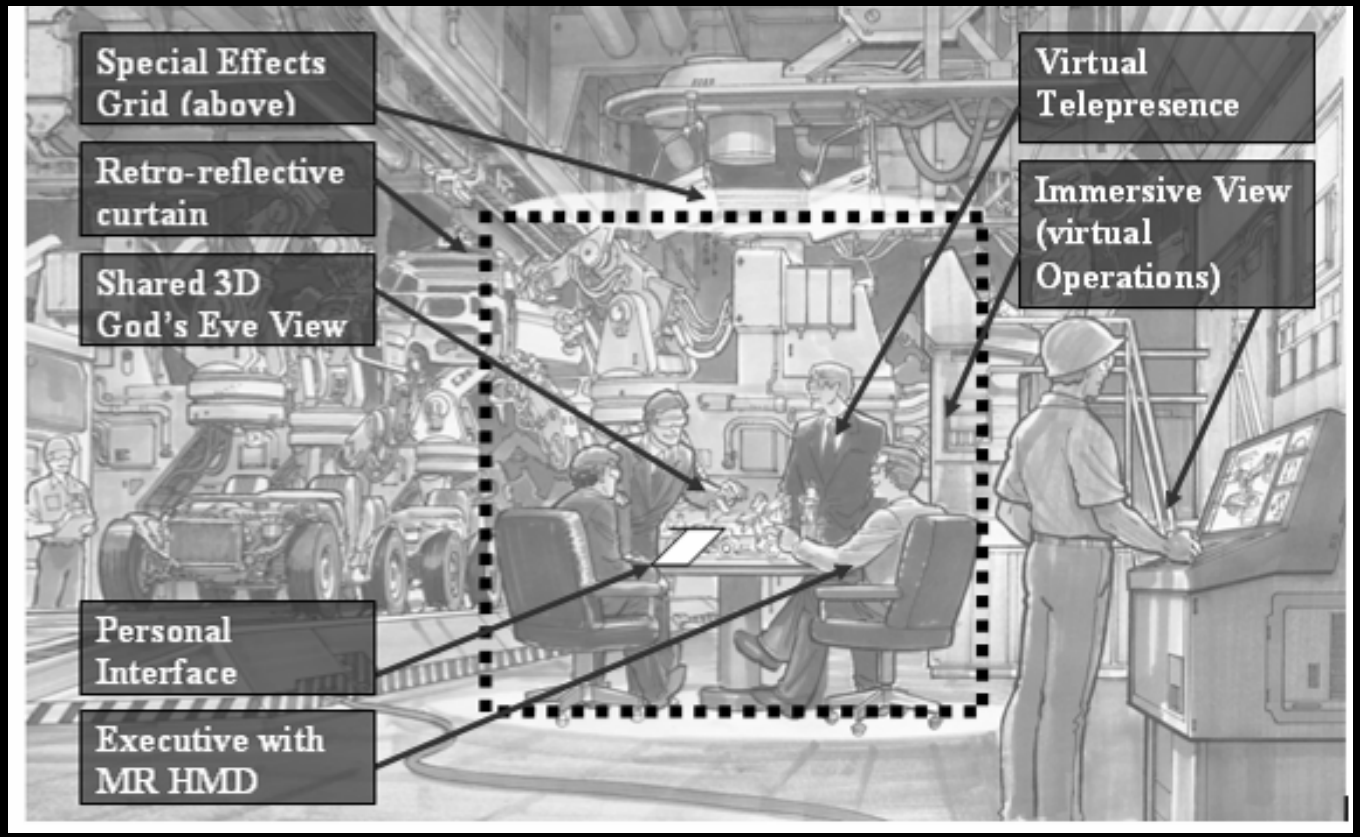


Placing Real Entities into Virtual Environments

Demo Dome Characteristics

- Lightweight
- Relatively Inexpensive
- Distinct POVs
  - E.g., consider a city planner and an architect
  - But both need to have a common context (the cityscape)
  - Each wants specialized information (codes vs physical characteristics)

Continuum in co-design



Along the Continuum

- Start in PR (look at current plant)
- Move to AR (add new equipment and new windows)
- Individual jumps out to VR to privately review designs
- Move to AV as all are surrounded by new design, but still see each other

Contact info

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