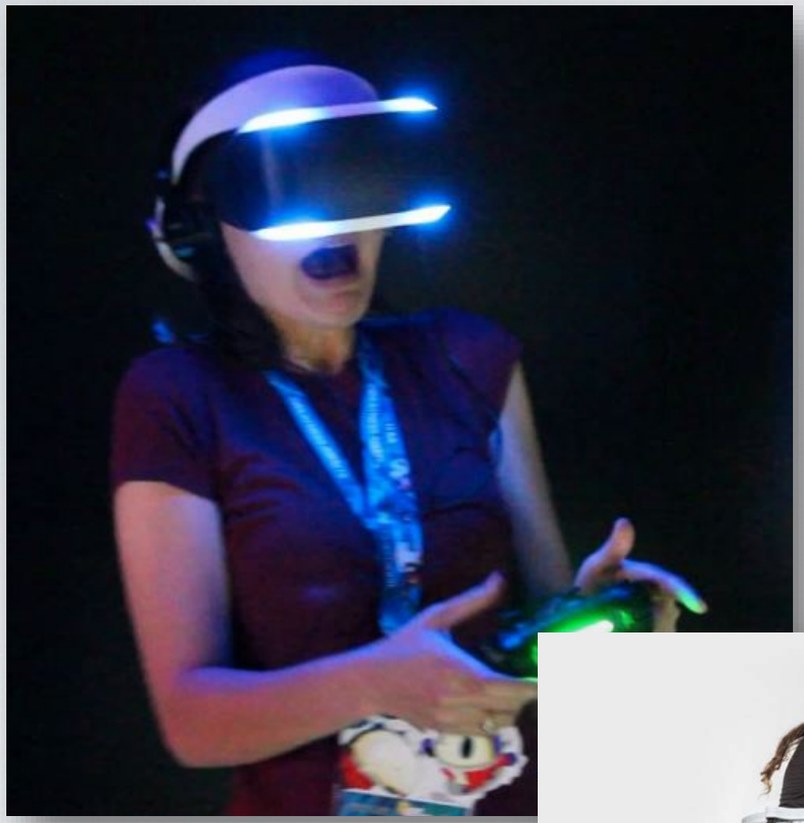
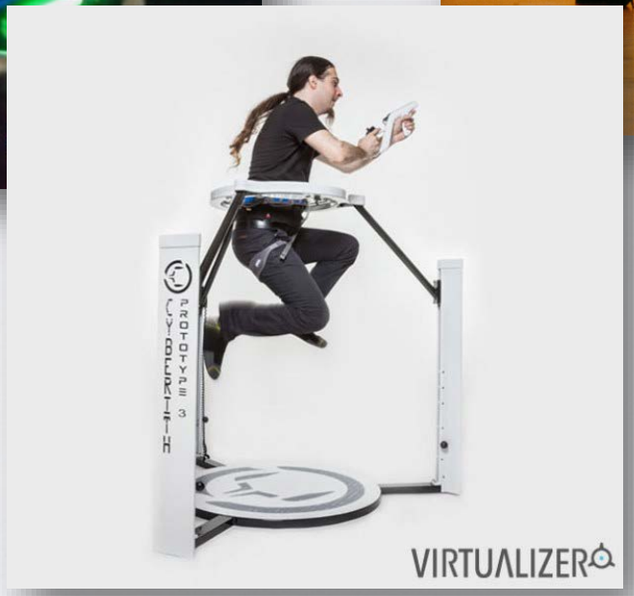
Virtual Reality

Hype or a Technology that can do “real work”?

Dr. Judy M. Vance
Virtual Reality Applications Center (VRAC)
Mechanical Engineering Department
Iowa State University
Ames, IA

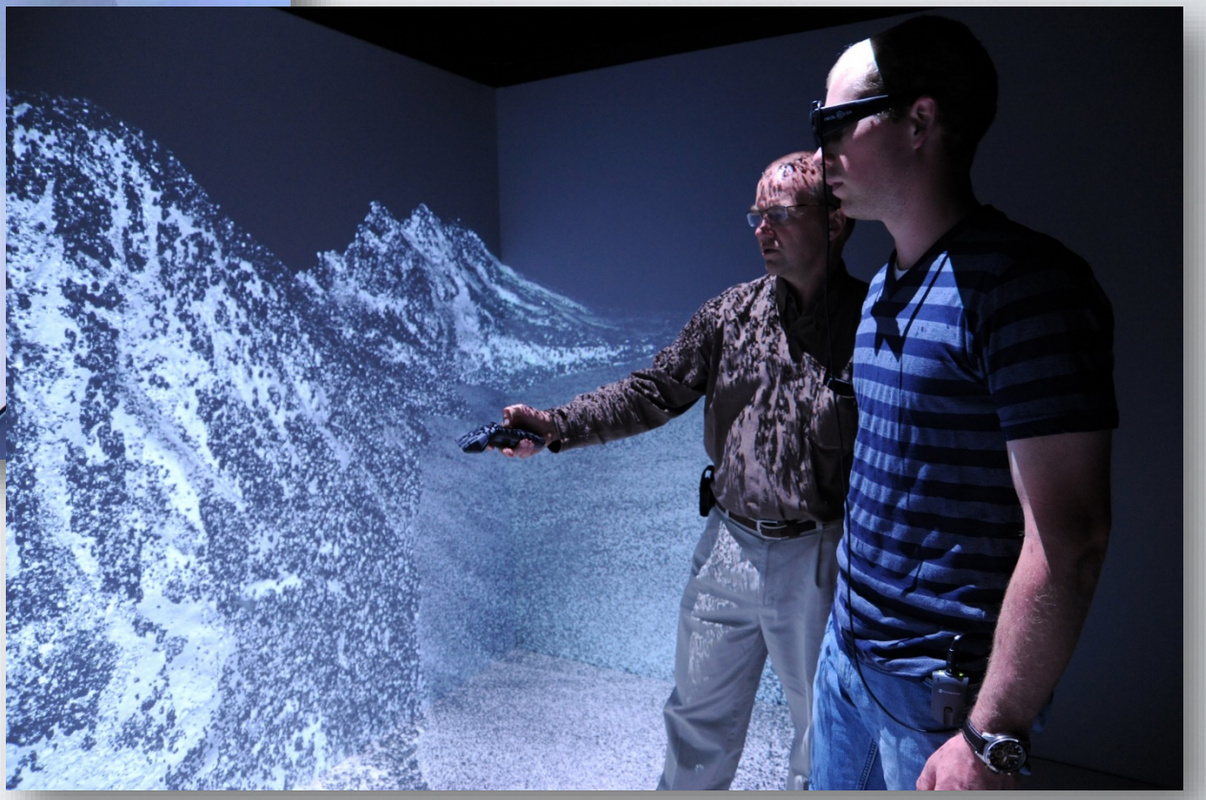
Virtual Reality





Virtual Reality

Virtual Reality



Images courtesy of Idaho National Labs

Virtual Reality

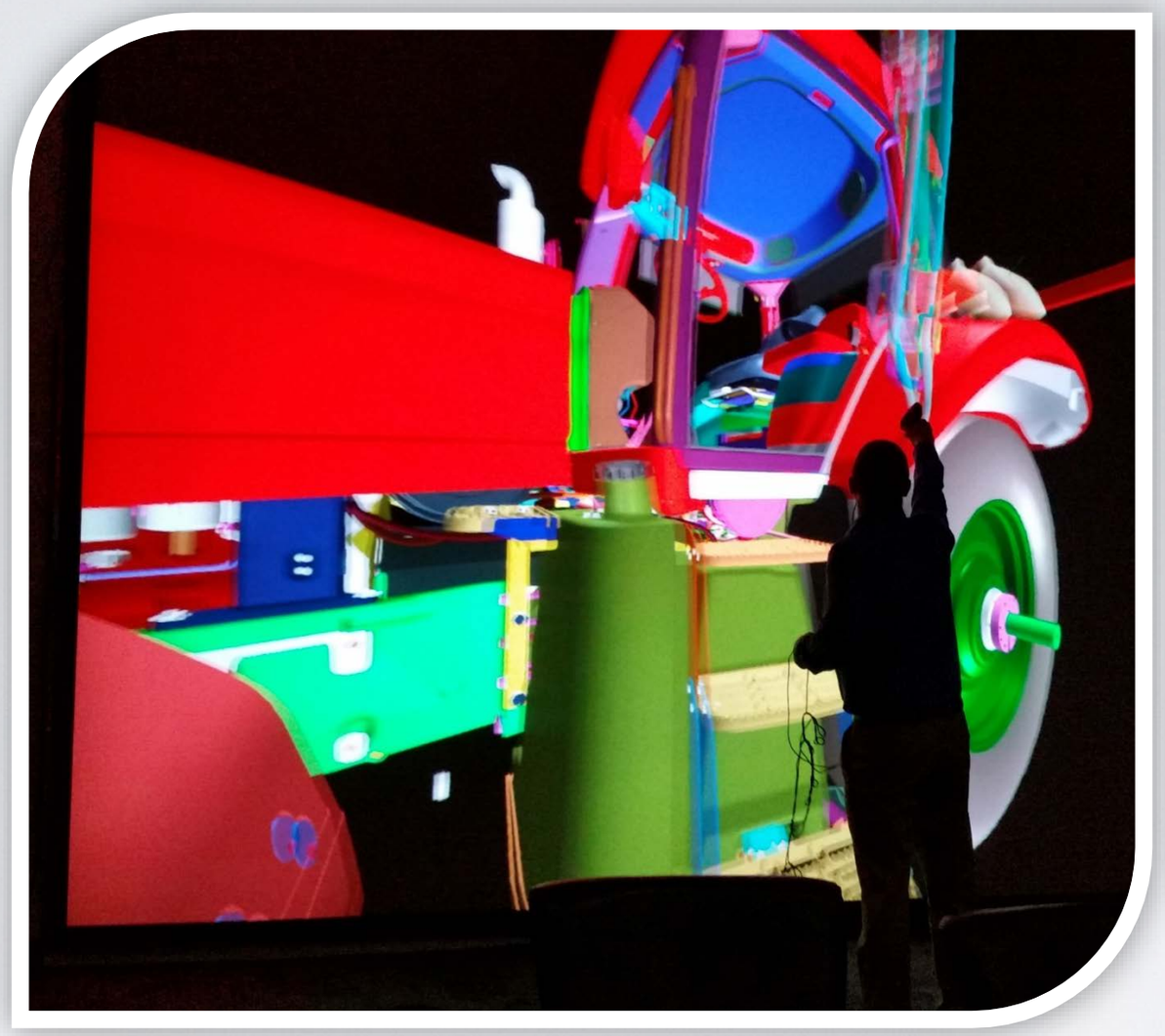
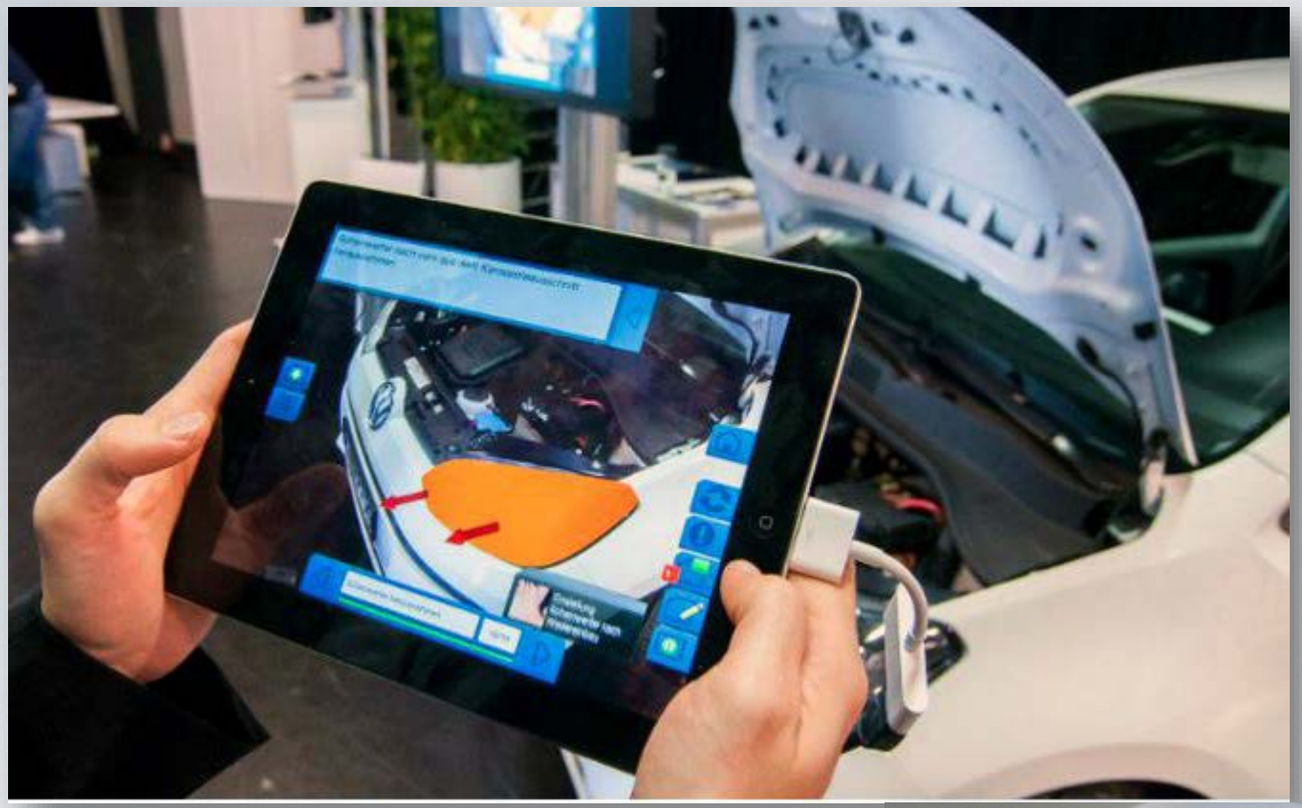


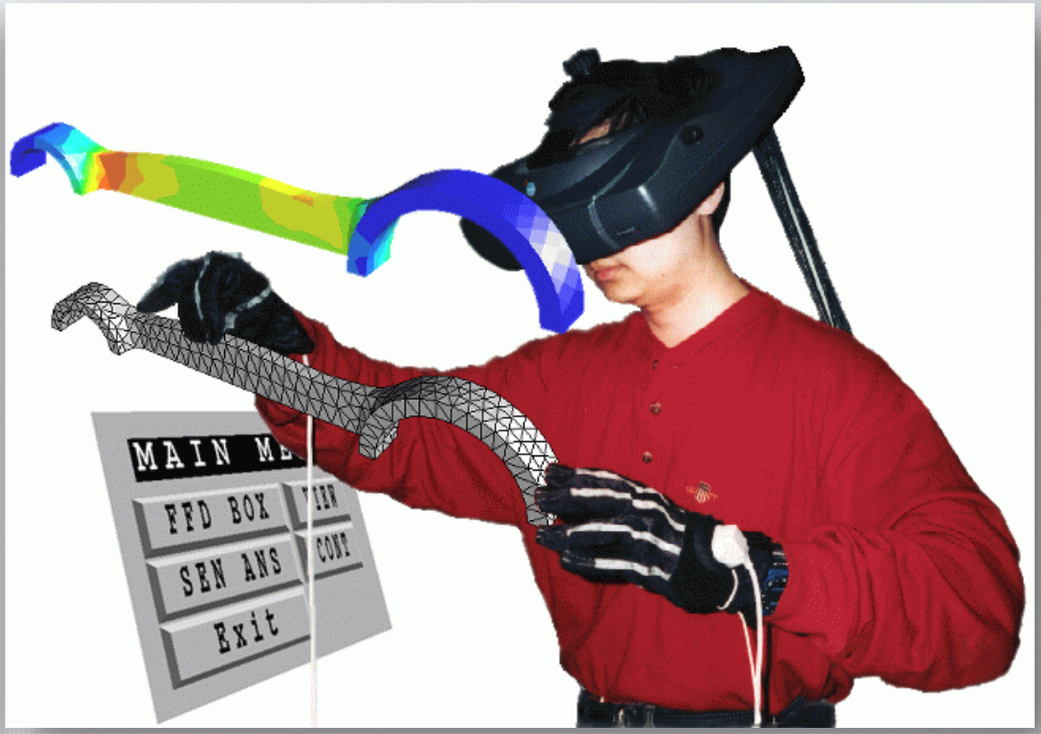
Image courtesy of Case New Holland

Augmented Reality

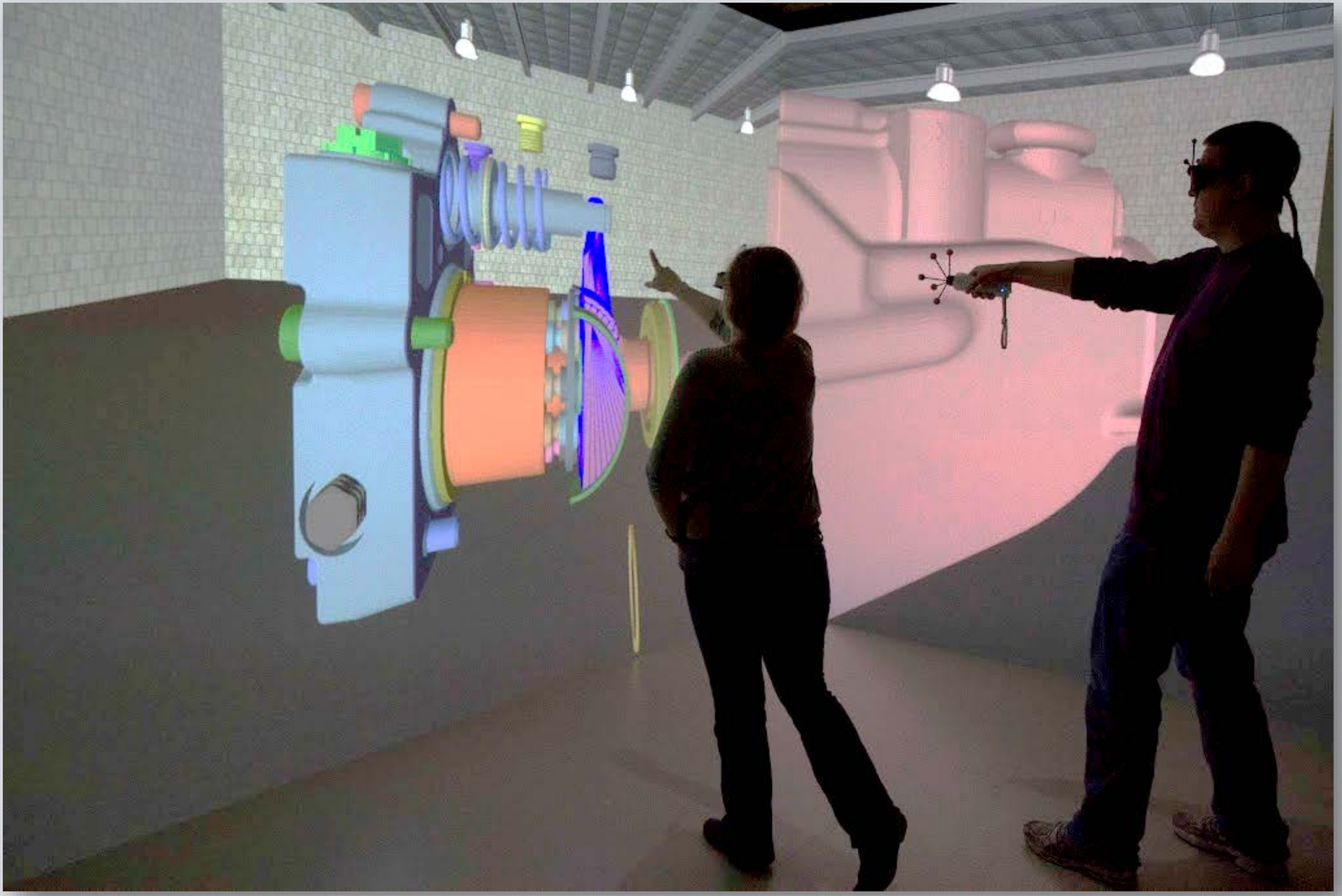


Augmented Reality

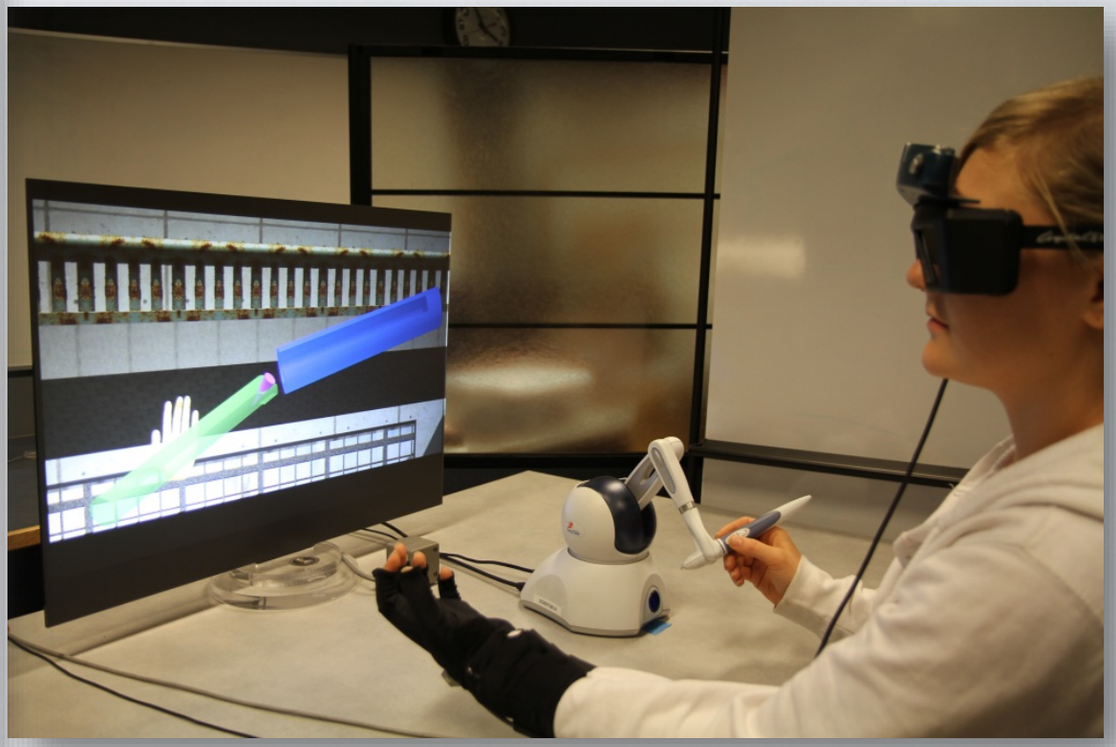
Virtual Reality Applications Center



Virtual Reality Applications Center



Virtual Reality Applications Center



Terminology

- Virtual Reality (VR)
- Virtual Environments (VE)
- Augmented Reality (AR)
- Immersive Technology
- Immersive Computing Technology (ICT)

Virtual Reality

A medium composed of

interactive computer simulations

Virtual Reality

A medium composed of interactive computer simulations that

sense the participant's position and actions

Virtual Reality

A medium composed of interactive computer simulations that sense the participant's position and actions and

replace or augment the feedback to one or more senses

Virtual Reality

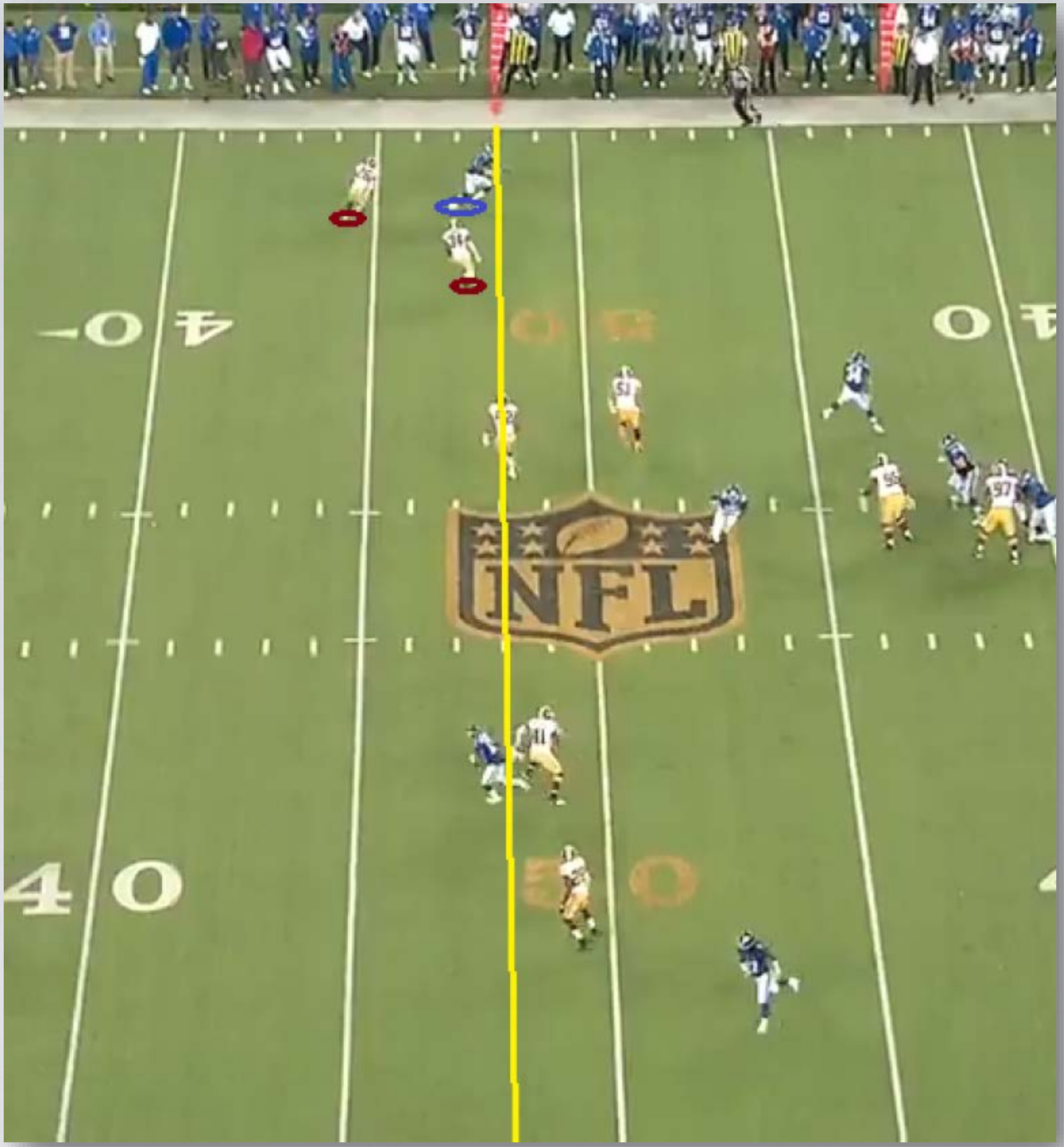
A medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses,

giving the feeling of being mentally immersed or present in the simulation.

Sherman, W. R., Craig, A. B. 2003. Understanding Virtual Reality: Interface, Application, and Design, Morgan Kaufmann Publishing.

Augmented Reality

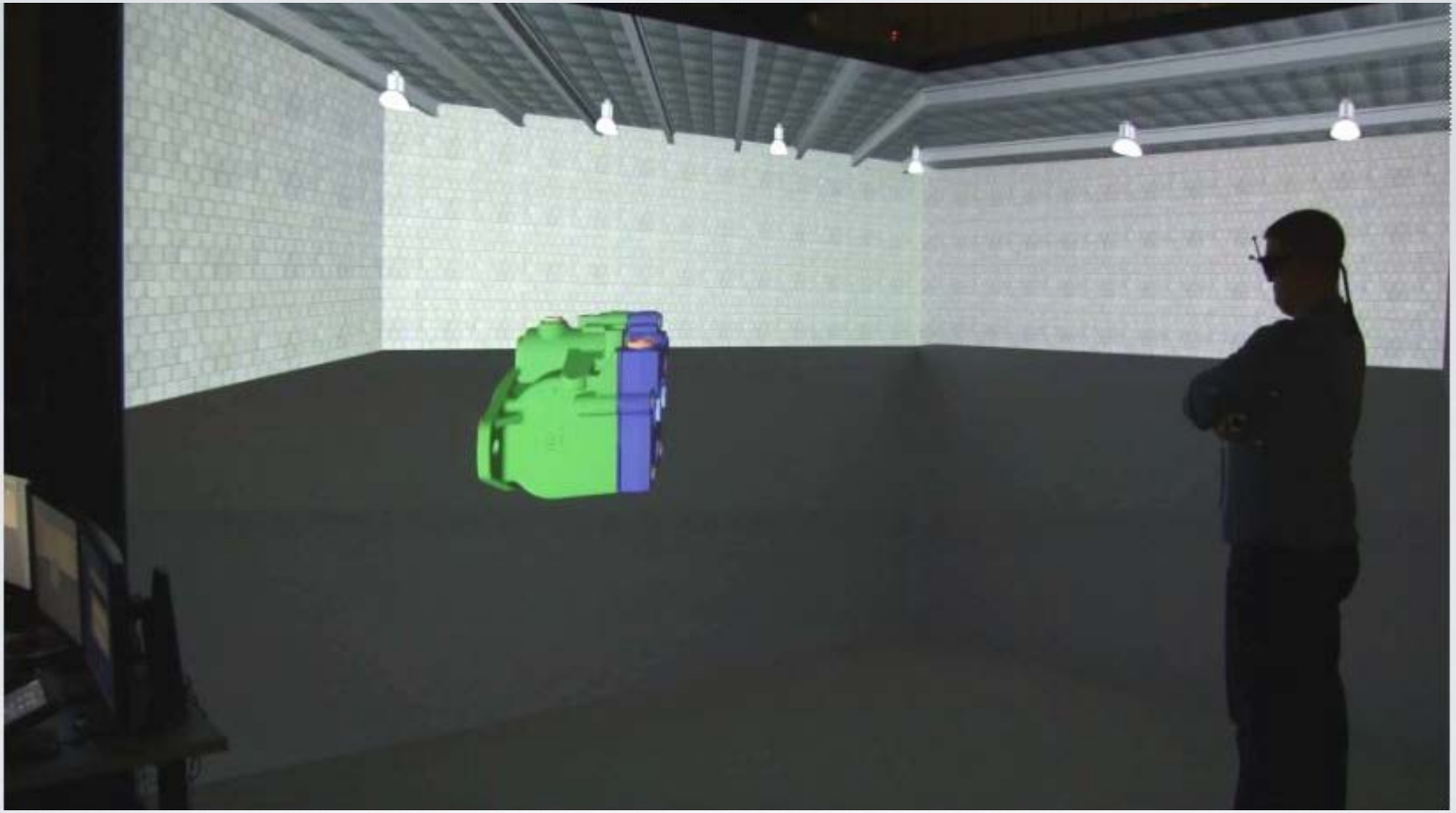
A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.


NFL

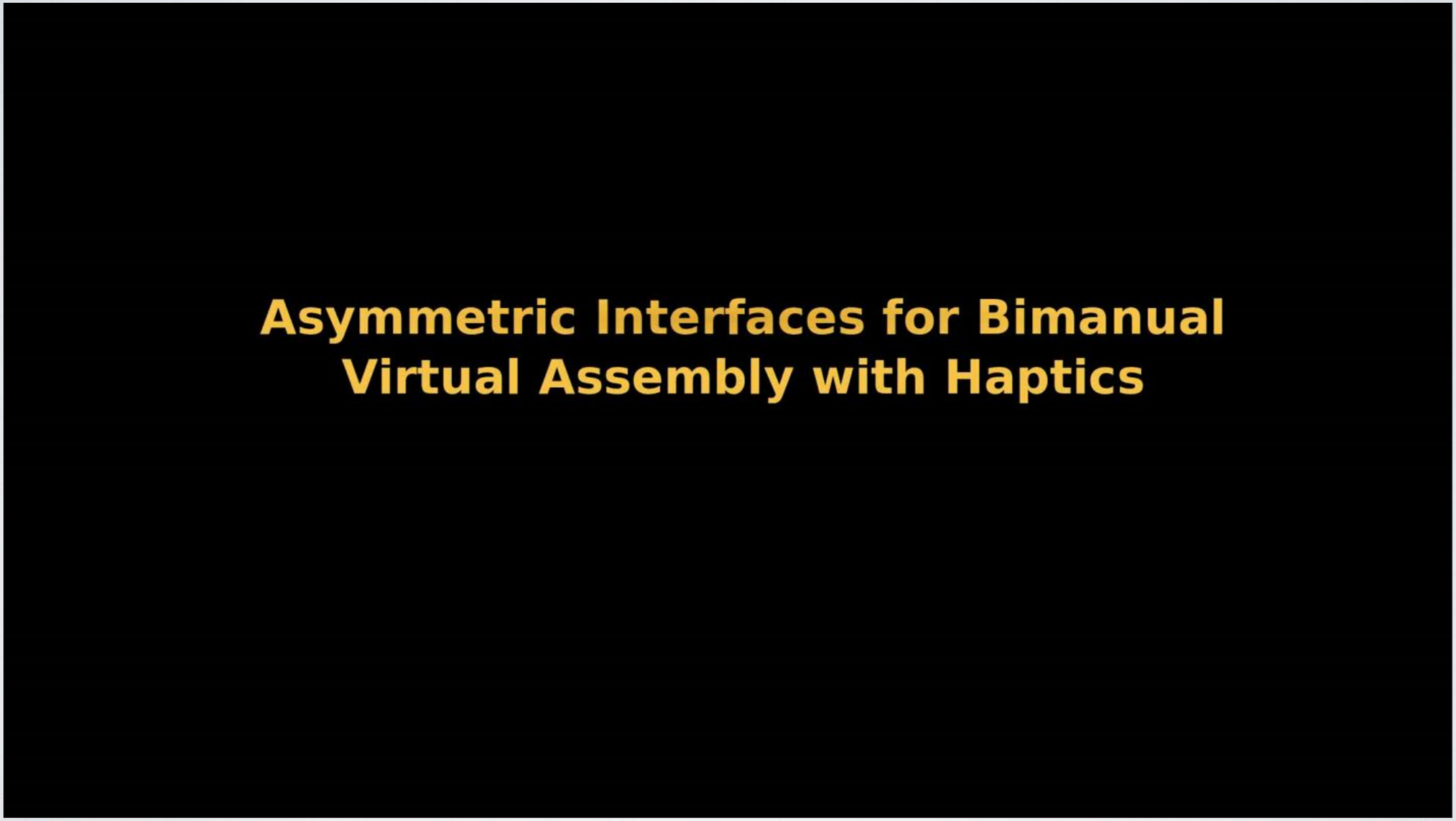
What makes VR unique?

- Human control of the view
- Ability to naturally interact with the computer images

Access this video here:
https://www.youtube.com/watch?v=BrvwaplZXIw



Access this video here:
https://www.youtube.com/watch?v=lL2Ha2Ymht4



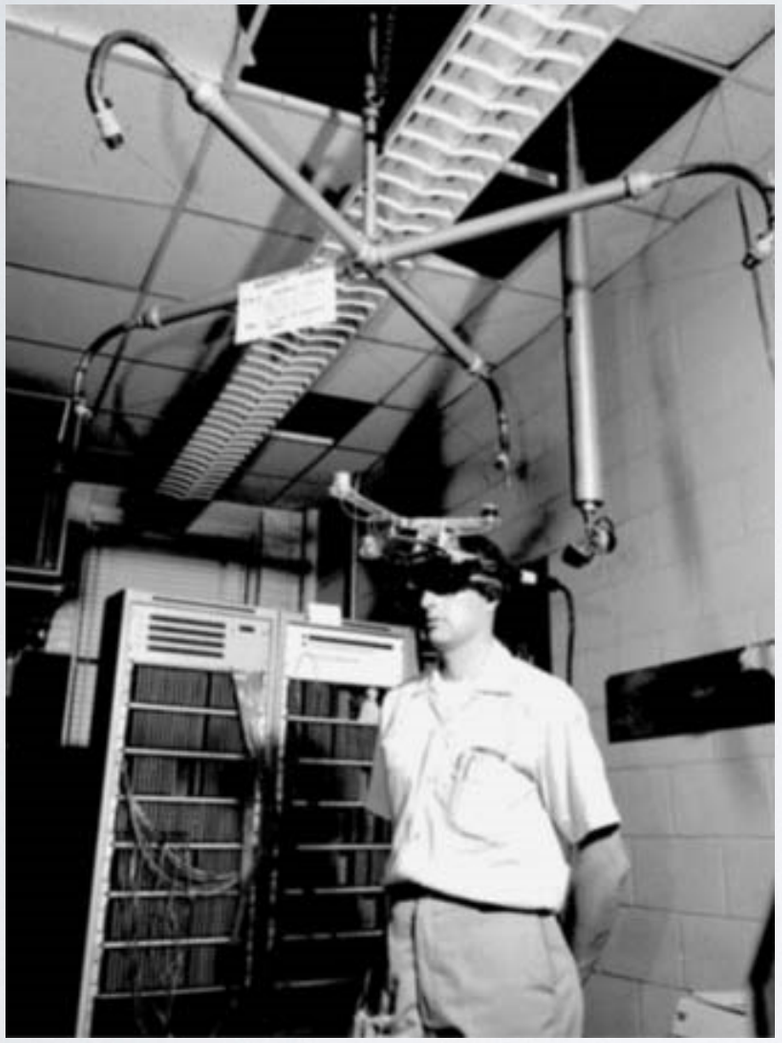
To Make it Work

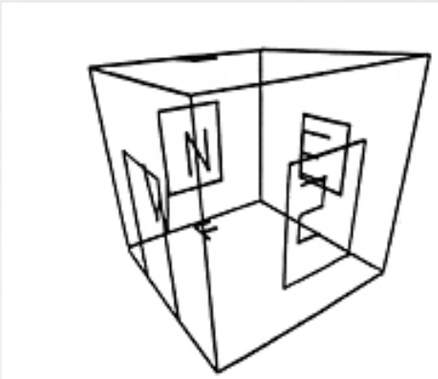
- Position Tracking Technology
- Display Technology
- Sensory Feedback

To Make it Work

- Position Tracking Technology
- Display Technology
- Sensory Feedback

A Head-mounted Three Dimensional Display 1968

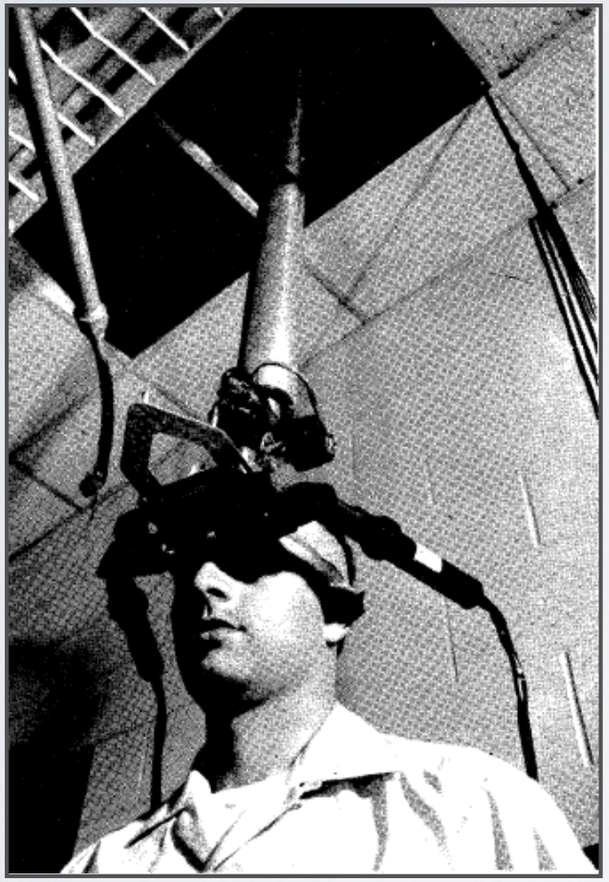


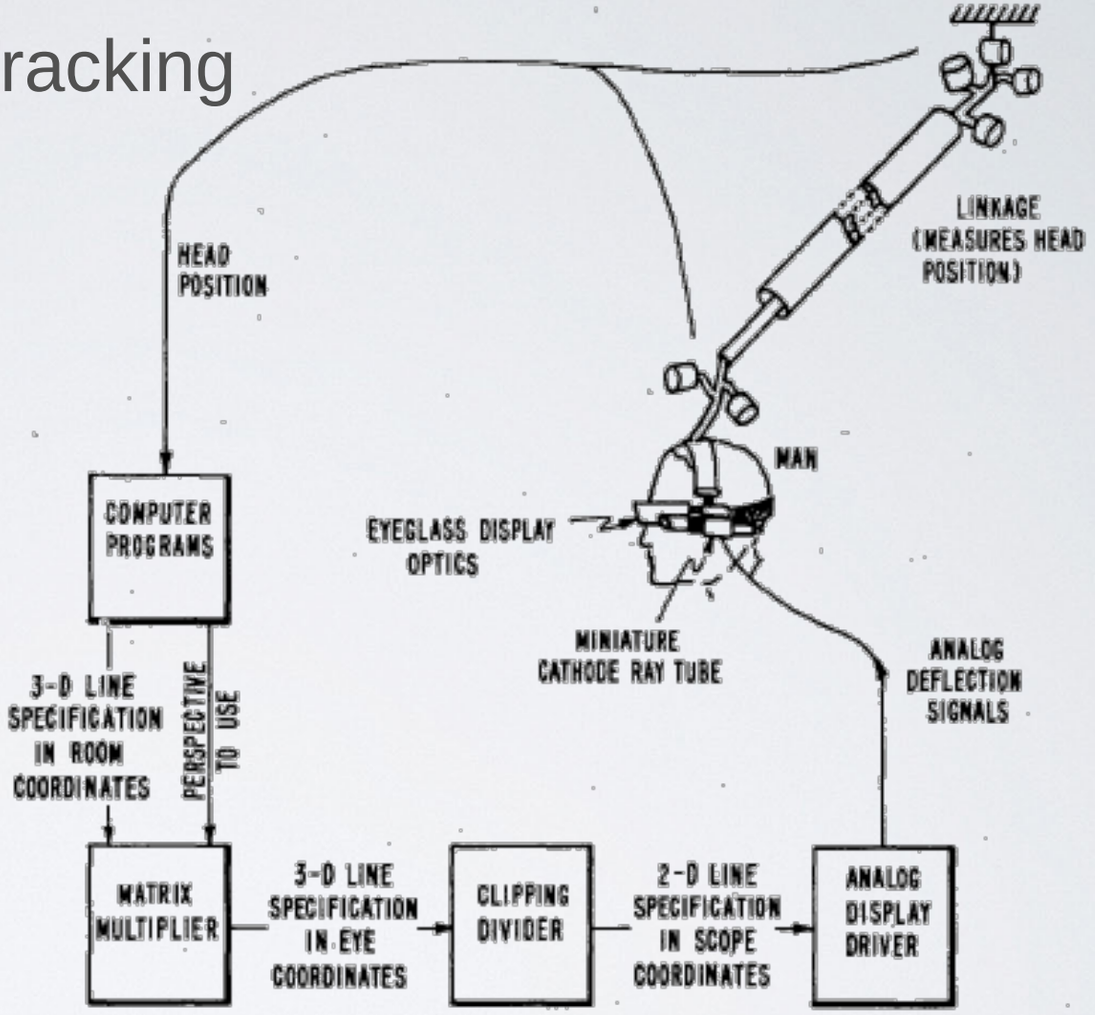


Sutherland, Ivan E., *A Head-mounted Three-dimensional Display*, Proceedings AFIPS '68, December 9-11, 1968 Fall Joint Computer Conference (Fall, part I), pp. 757-764.

Sutherland's HMD

Mechanical Tracking

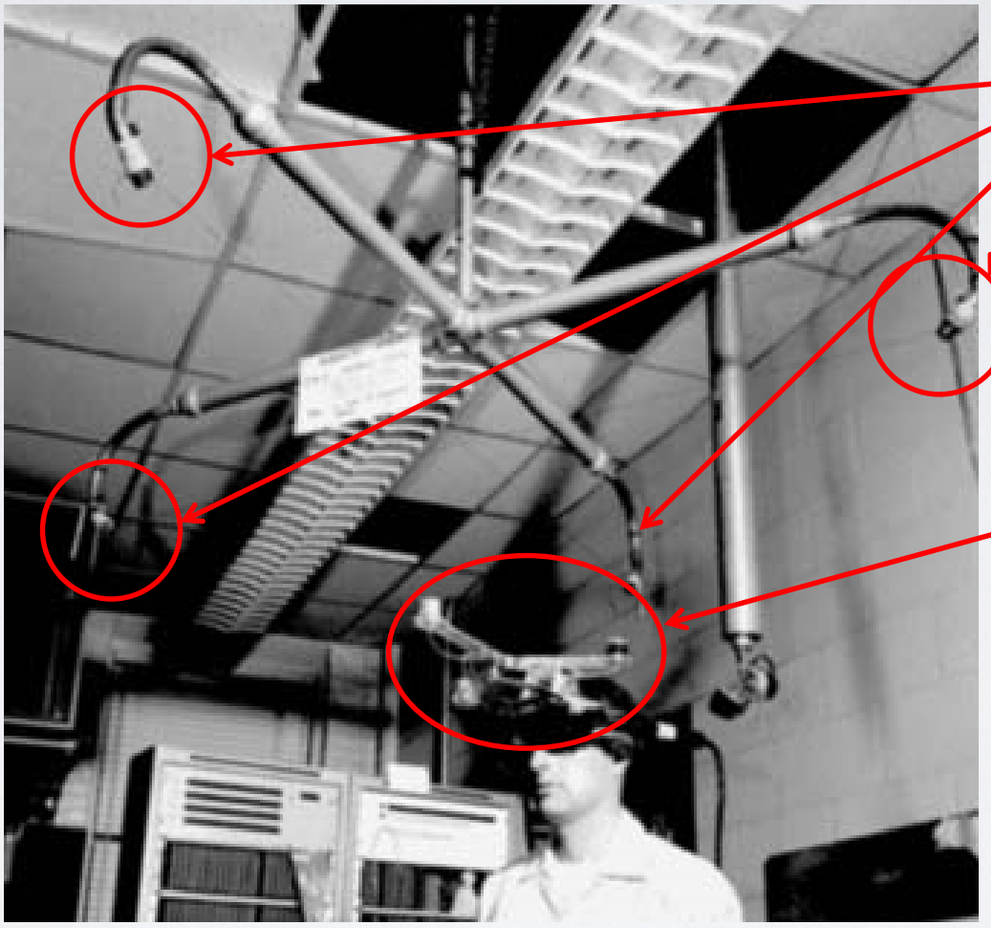




Sutherland, I. E. (1968) A Head-Mounted Three Dimensional Display. American Federation of Information Processing Societies (AFIPS) Fall Joint Computer Conference (FJCC) 33 (pt. 1), pp. 757-764.

Sutherland's HMD

Ultrasonic Tracking



Sutherland, I. E. (1968) A Head-Mounted Three Dimensional Display. American Federation of Information Processing Societies (AFIPS) Fall Joint Computer Conference (FJCC) 33 (pt. 1), pp. 757-764.

Consumer Position Trackers

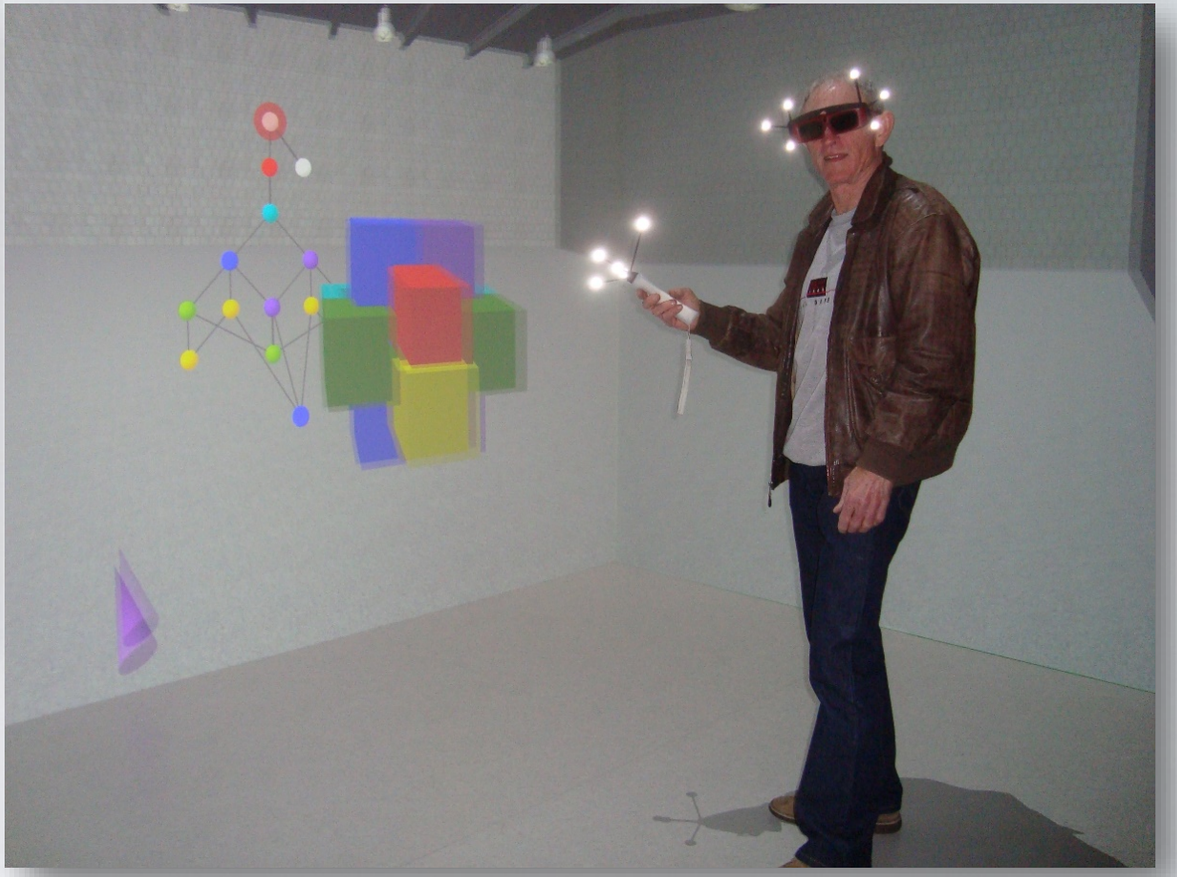
Wii

Consumer Position Trackers

Kinect

Optical Tracking

retroreflective balls



Inertial Tracking

MagneticTracking

Acoustic Tracking

Brain Computer Interface

Mechanical Tracking

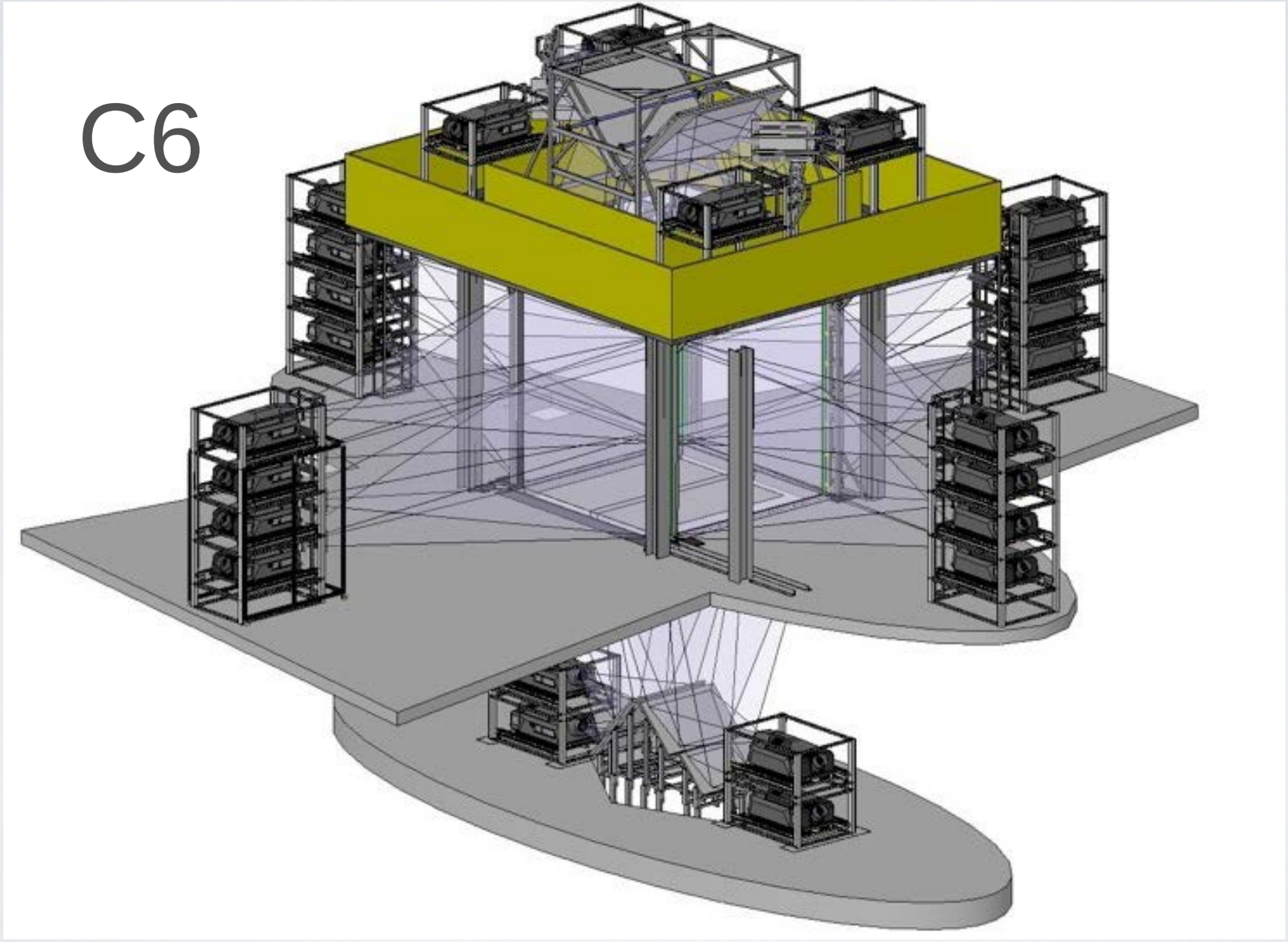
To Make it Work

- Position Tracking Technology
- Display Technology
- Sensory Feedback

Multiple Projection Surfaces

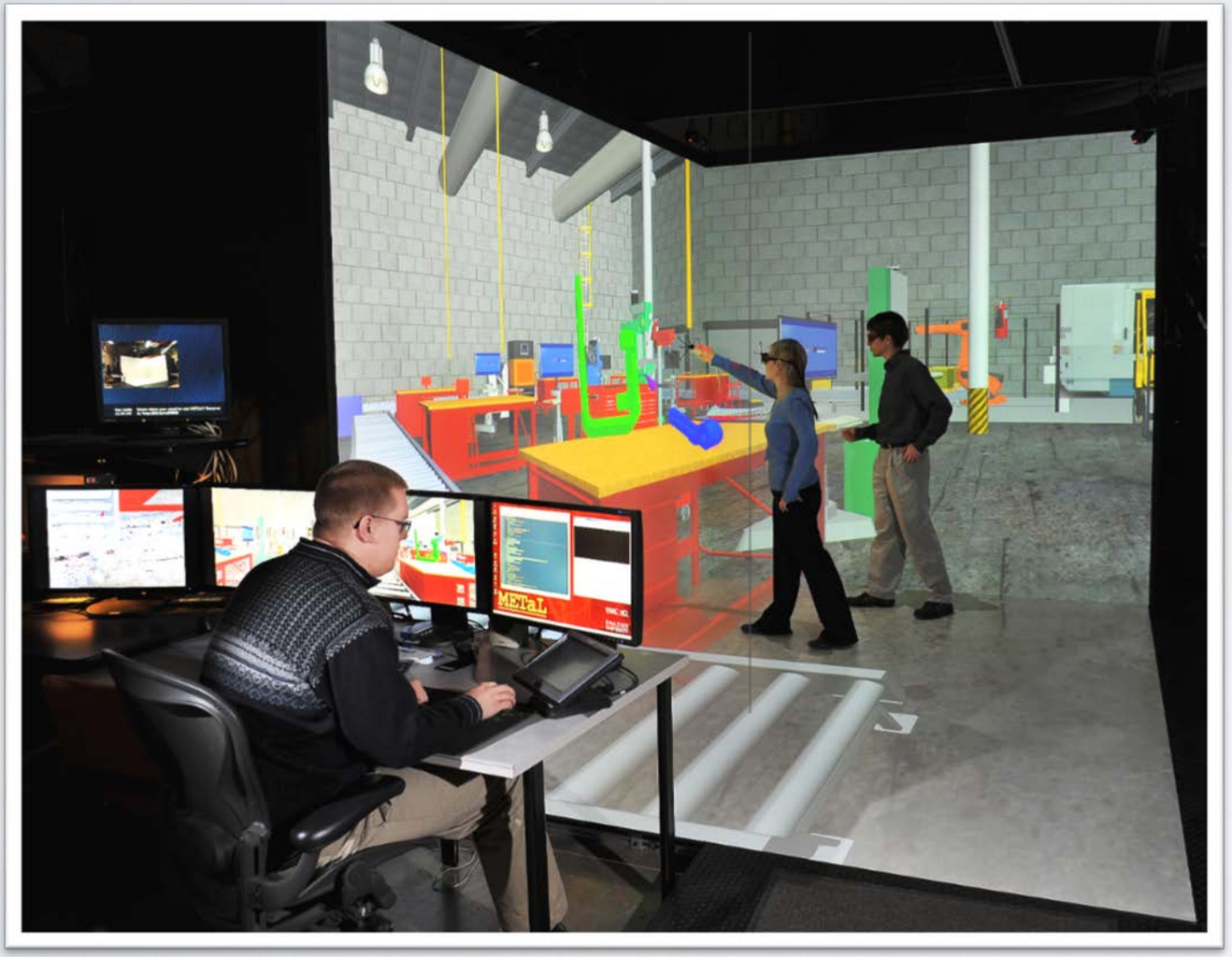
C6

Multiple Projection Surfaces



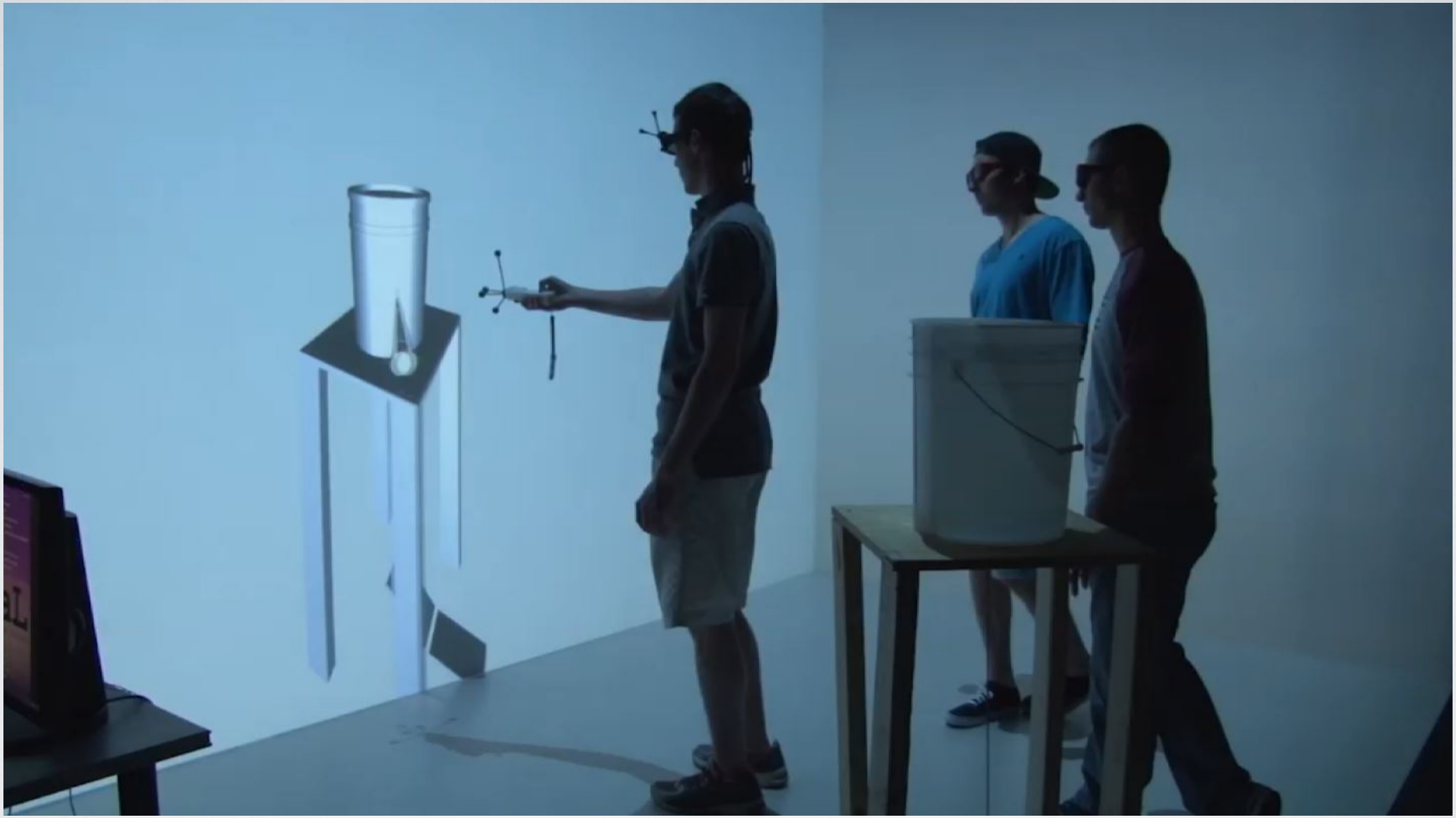
Multiple Projection Surfaces

METaL
MULTIMODAL EXPERIENCE TESTBED AND LABORATORY



- 2 walls, 1 floor
- 3 stereo projectors
- Optical tracking
- Wii remote wand

CAVE

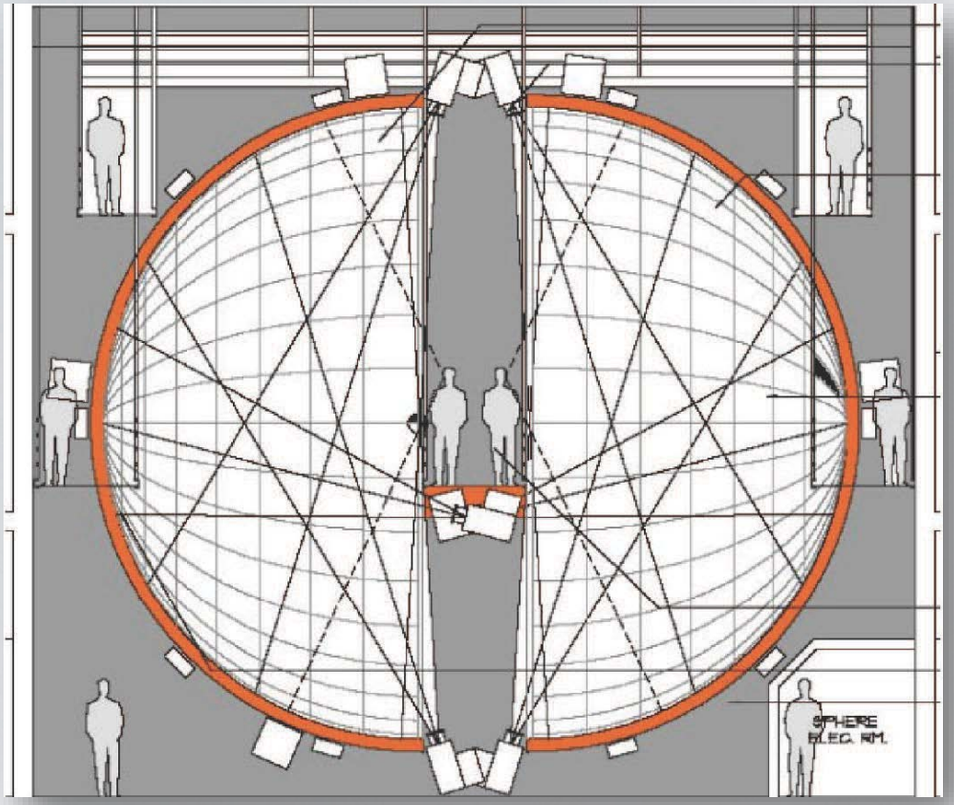


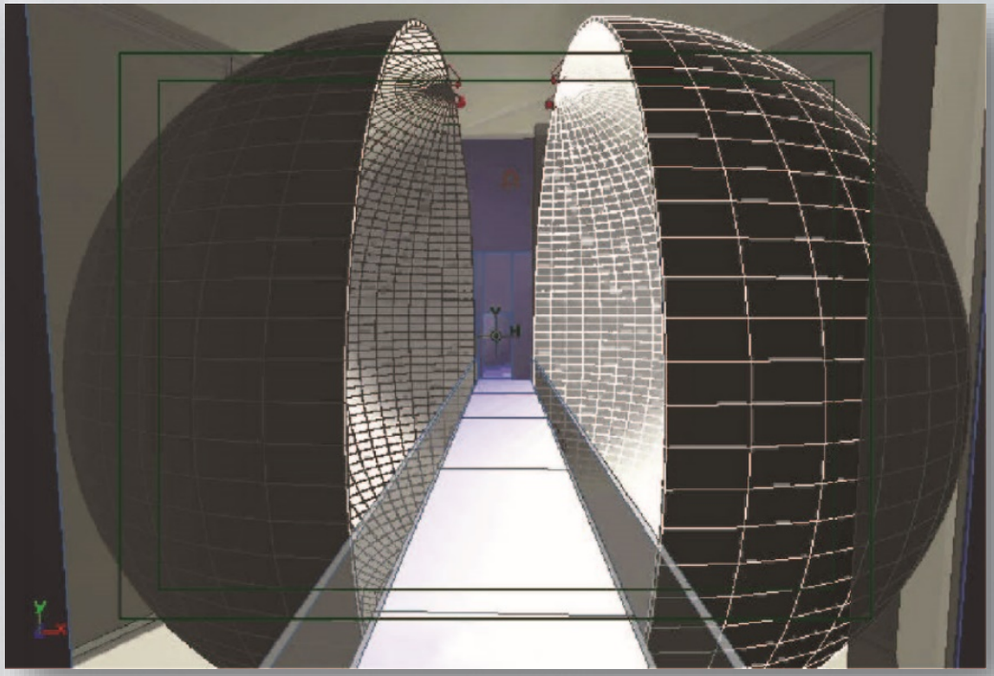
Access this video here:
https://www.youtube.com/watch?v=LyLuOuKM0Wc

Projection Systems

Reality Deck
Stony Brook University
417 LCD displays

Projection Systems





AlloSphere
University of Santa Barbara
14 projectors

Head Mounted Display (HMD)

Image courtesy of Lockheed Martin

See Through HMD

Cell Phone and Tablet AR

Cell Phone and Tablet AR

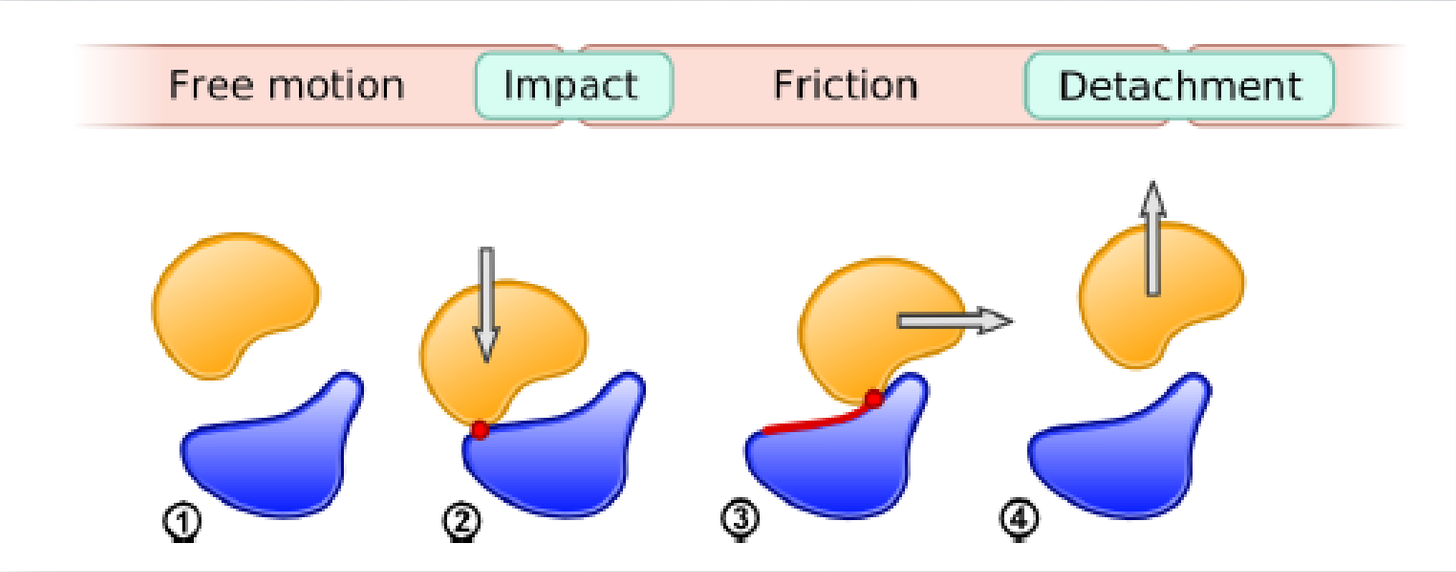
To Make it Work

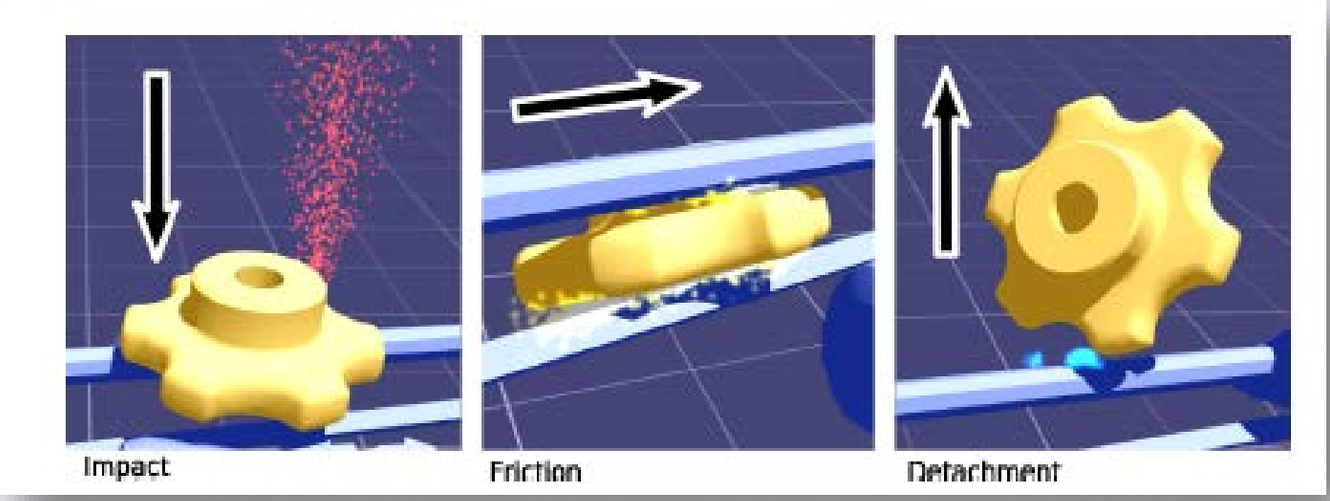
- Position Tracking Technology
- Display Technology
- Sensory Feedback

Sound

- Increase awareness of surroundings
- Cue visual attention
- Convey a variety of complex information without taxing the visual system
- Enhances the visual experience

Object contact





http://people.rennes.inria.fr/Anatole.Lecuyer/vrst_sreng.avi

Haptics

To touch ….

Combination of Real and Virtual

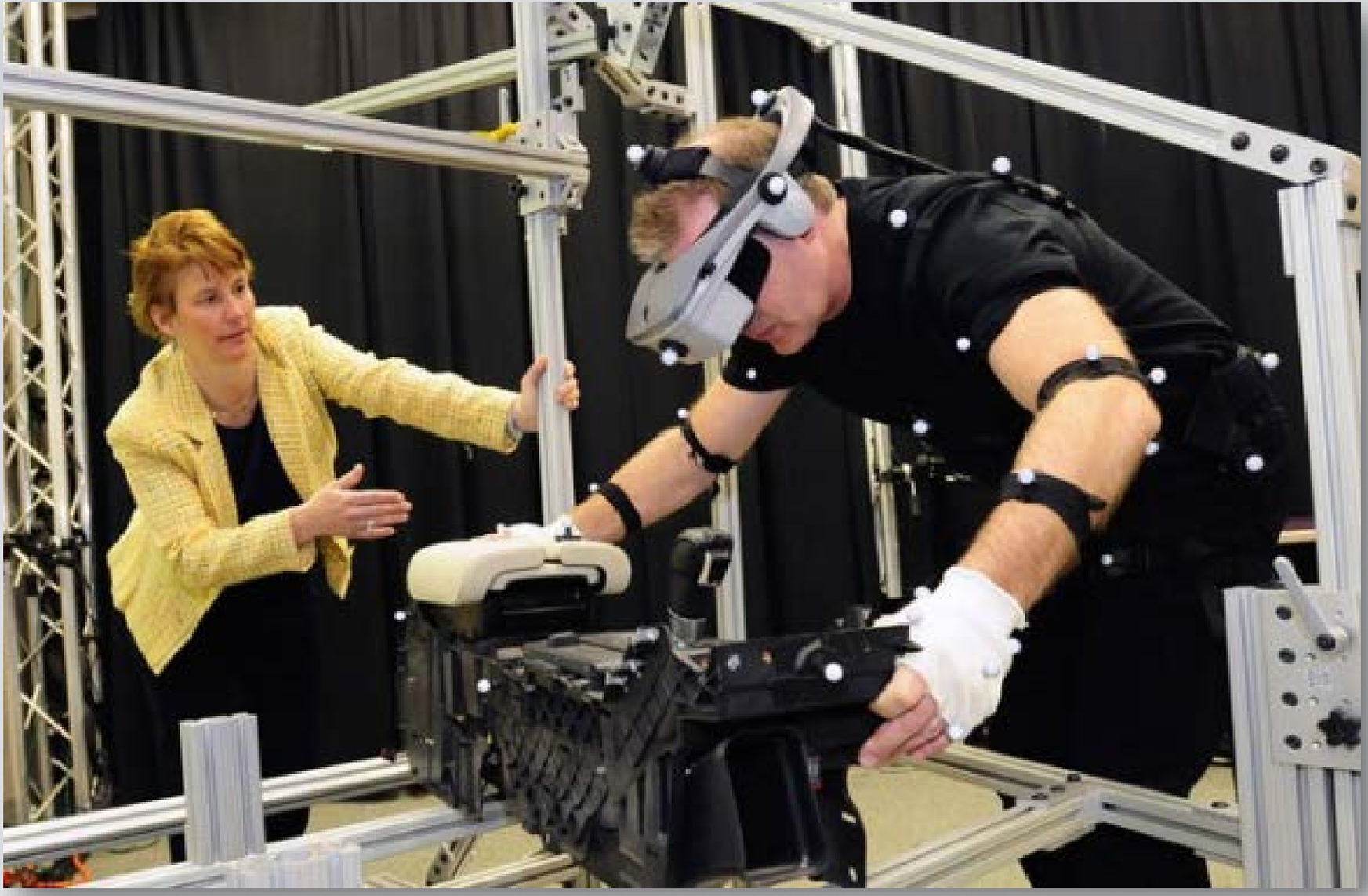


Image courtesy of Ford Motor Co.

Haptics

Access this video here:
https://youtu.be/xQxNT1DAoT4

The Time cover of virtual reality shows Oculus Rift creator floating above a beach.

theguardian

US world opinion sports soccer tech arts lifestyle fashion business travel environment science all

Facebook closes its $2bn Oculus Rift acquisition. What next?

Social network completes deal announced in March, so what does the future hold for its virtual reality division?

Facebook boss Mark Zuckerberg thinks Oculus Rift is 'one of the next most important computing platforms'.

Oculus Rift

Cell Phone HMD

Click to open expanded view

Zeiss Vr ONE Samsung Galaxy S5 Virtual Reality Headset

from Zeiss

4 customer reviews | 12 answered questions

Price: $159.99 & **FREE Shipping**

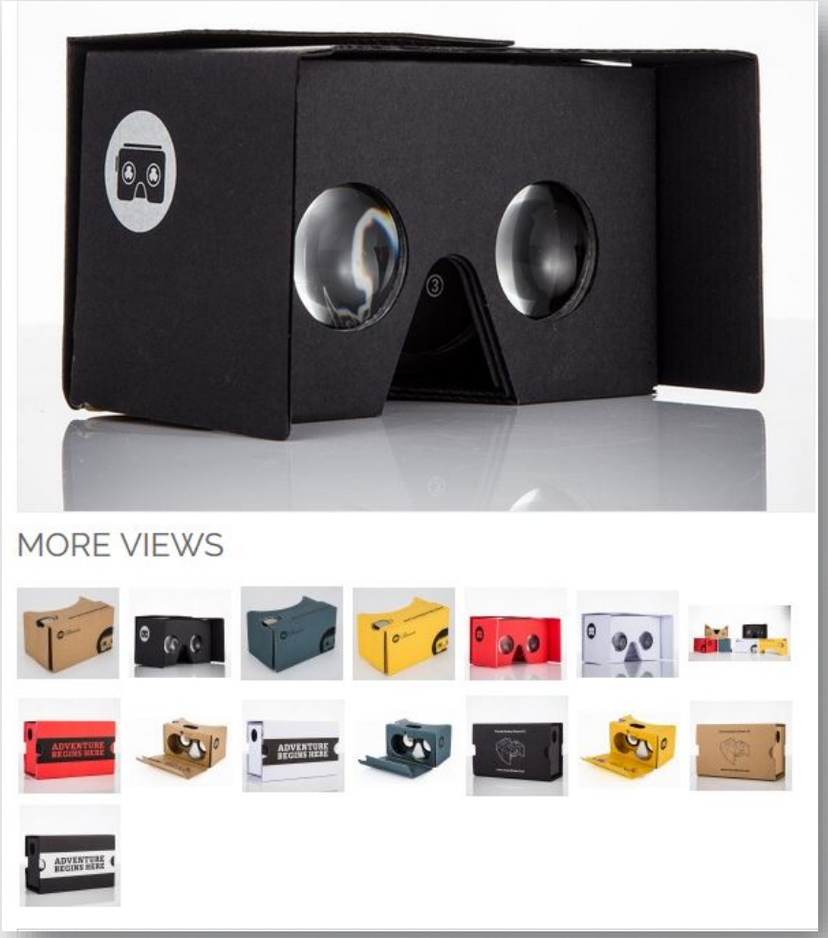
Only 19 left in stock.

Ships from and sold by Wired Gadgets.

- With Limitless Possibilities With the VR ONE, the smartphone you carry in your pocket can take you to worlds of virtual and augmented reality. With already hundreds of apps available on Google Play and AppleApp Store made for mobile VR devices you can simply download and launch the app, lock your smartphone in the VR ONE precision tray and slide it in the VR ONE. Experience VR games, videos, and amazing experiences that were never before possible.
- The Zeiss VR ONE delivers an unrivalled viewing experience with Zeiss precision lenses and the 5.2 inch display of the Galaxy S5 providing stunning and engaging visuals at a mobile-leading resolution. With the VR ONE, the effect is the equivalent of sitting in the best seat of a theatre, being on-stage at a performance with full 360 degree 3D video, and being able to enjoy

Google Cardboard

Buy your new Cardboard 2.0 viewer from I Am Cardboard for $19.99. Black, Blue, Red, Yellow, White and Brown.

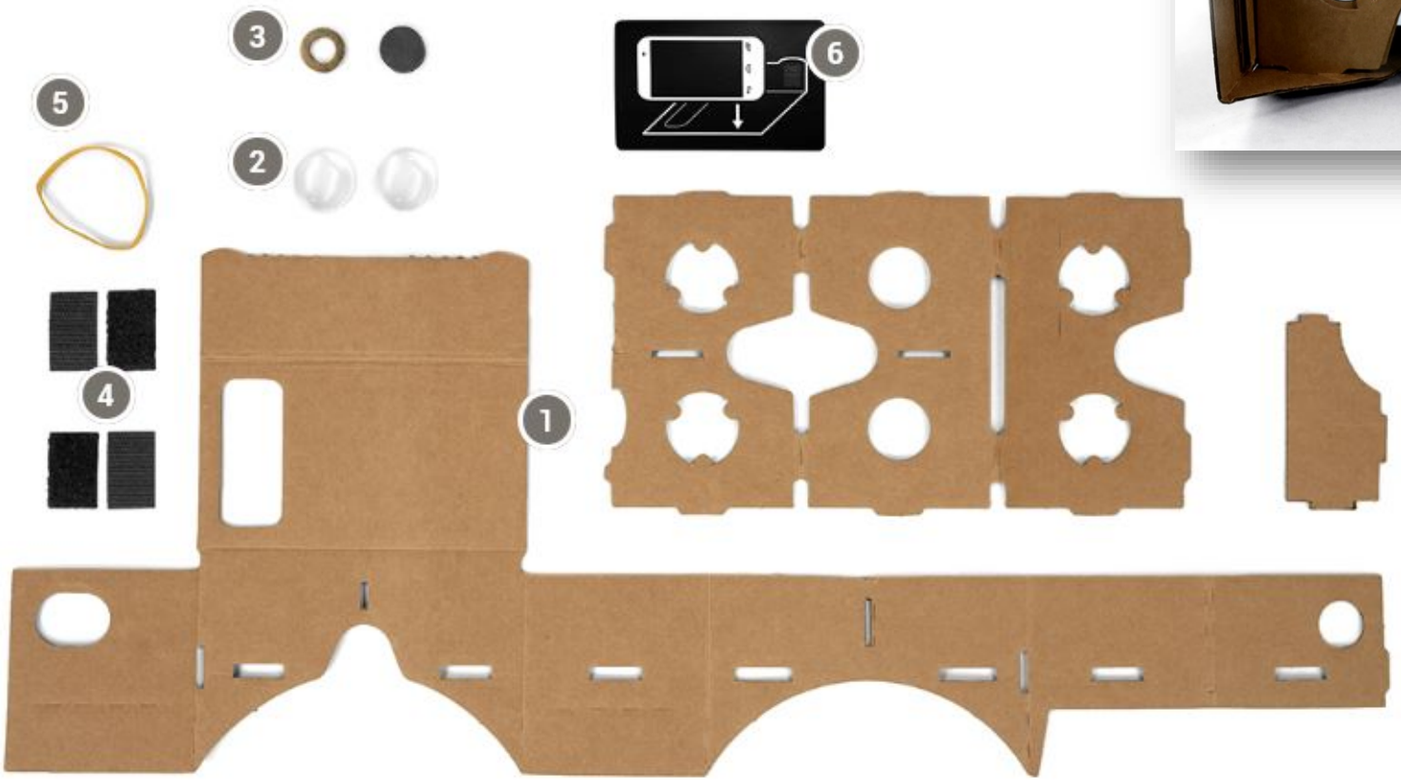


Build your own HMD

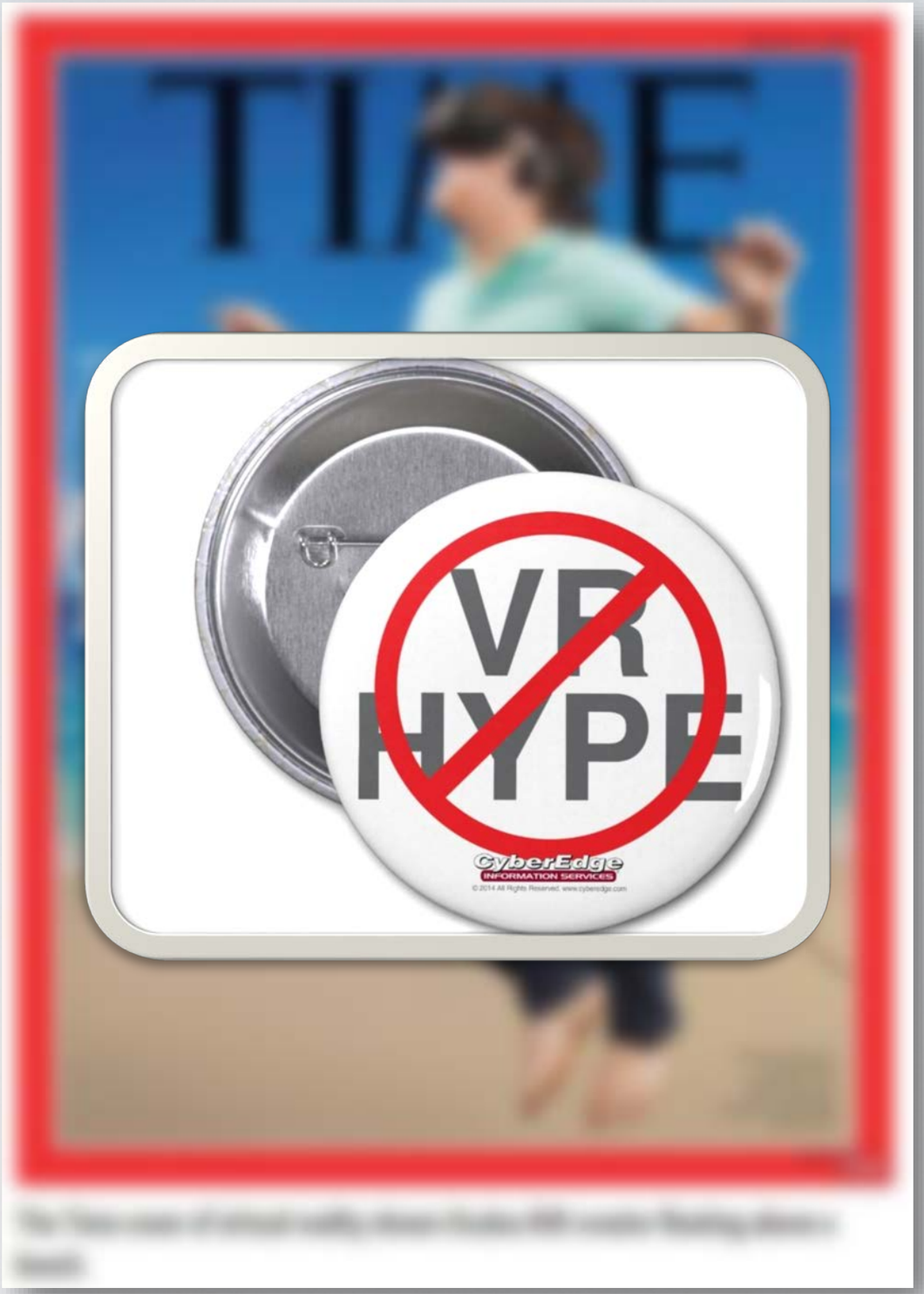
https://developers.google.com/cardboard/

Construct a VR viewer from everyday items you can find in your garage, online or at your local hardware store.

Here's what you need to get started:




3D VIEW · MASTER


TIME
VR
HYPE
CyberEdge
INFORMATION SERVICES

An Industry Case Study: Investigating Early Design Decision Making in Virtual Reality

Leif P. Berg

Observations, interviews, and focus groups were conducted to evaluate the effect of using immersive technology on decision making in early product design

Danfoss ENGINEERING TOMORROW

Power Solutions

HOME PRODUCTS SOLUTIONS PARTS AND SERVICE LITERATURE ABOUT US CONTACT US LOGIN

Search here

- Electronic components
- PLUS+1® GUIDE Software
- Orbital motors
- Piston pumps and motors
  - Closed circuit axial piston motors
  - Closed circuit axial piston pumps
  - Open circuit axial piston motors
  - Open circuit axial piston pumps
- PVG proportional valves
- Steering

Piston pumps and motors

We'll drive your vehicle transmission to a new level of performance with our piston pumps and motors. Designed for intelligent vehicle management systems, our range brings you closer to your goals for reduced fuel consumption and high operator comfort.

Trust our compact piston pumps and motors to give your transmission the power it needs with the low emissions that satisfy today's global regulations.

We deliver components and systems for low, medium and high-power applications, including single and dual path propulsion drives and closed loop auxiliary transmissions. Our range is PLUS+1® Compliant for smooth, seamless integration in intelligent control systems.

- H1 family product brochure
- H1 piston pumps and motors technical information
- Series 45 open circuit axial piston pumps brochure

PLUS+1® Compliance

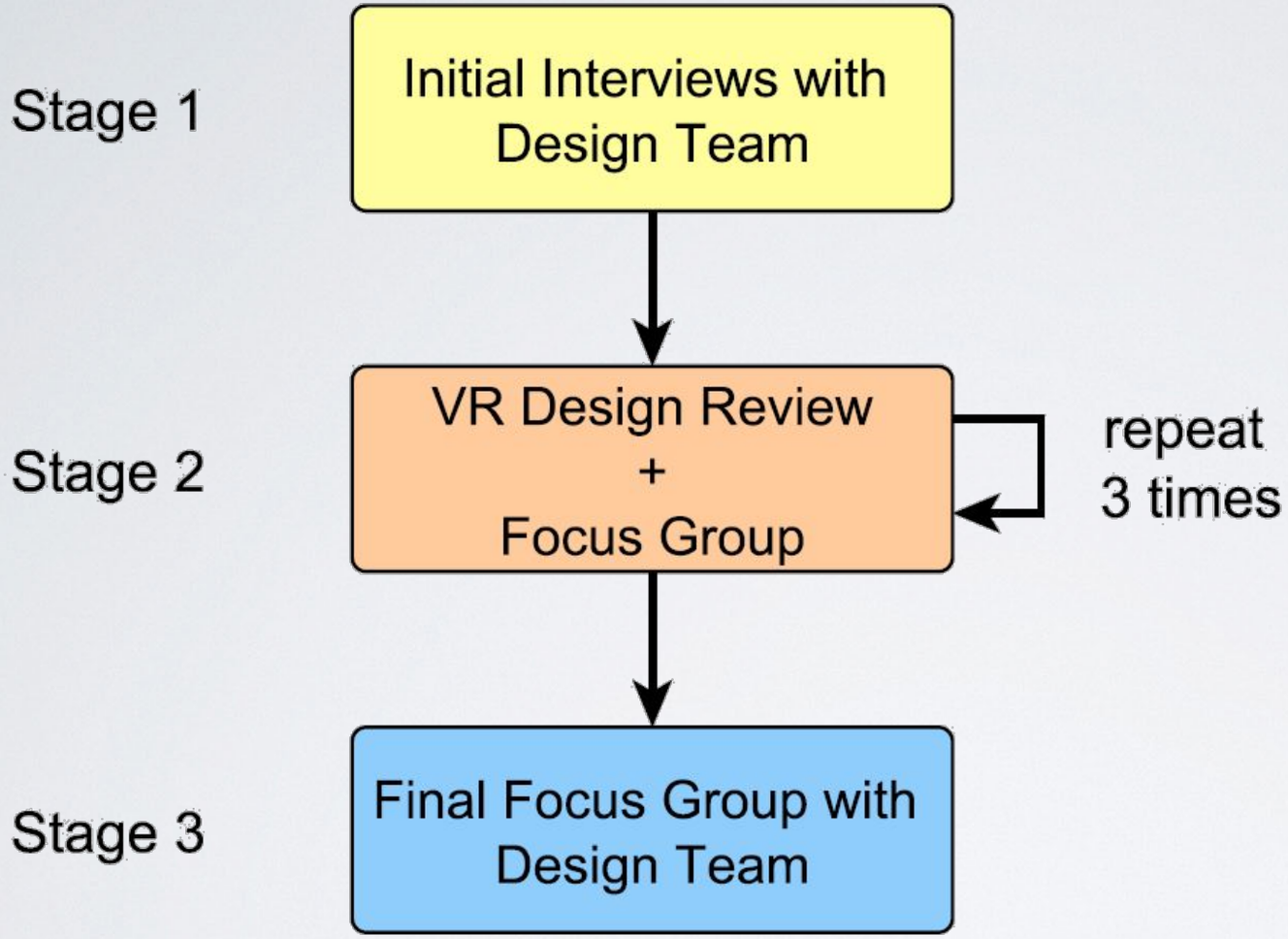
Emissions solutions

Our team can help make your machines efficient and productive while meeting new emissions standards.

- Emissions solutions

Your strongest partner

Our proven competencies continue to provide industry-leading products to



Design team

- 5 engineers
- Ages 31-42

Siemens Teamcenter PLM Visualization

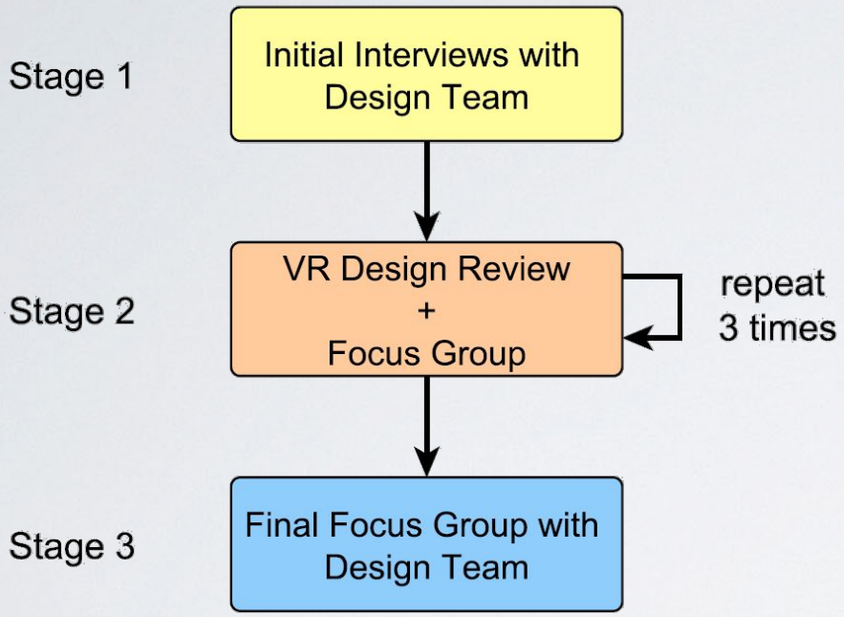


Table 1. Initial Interview Questions (sample)

Have you ever heard of virtual reality? If so, what do you know about it?
Have you ever used a virtual reality system before? If so, when? What was it like?
Do you see virtual reality being helpful in making decisions? How so?
What do you think you would be able to do with a virtual reality system?

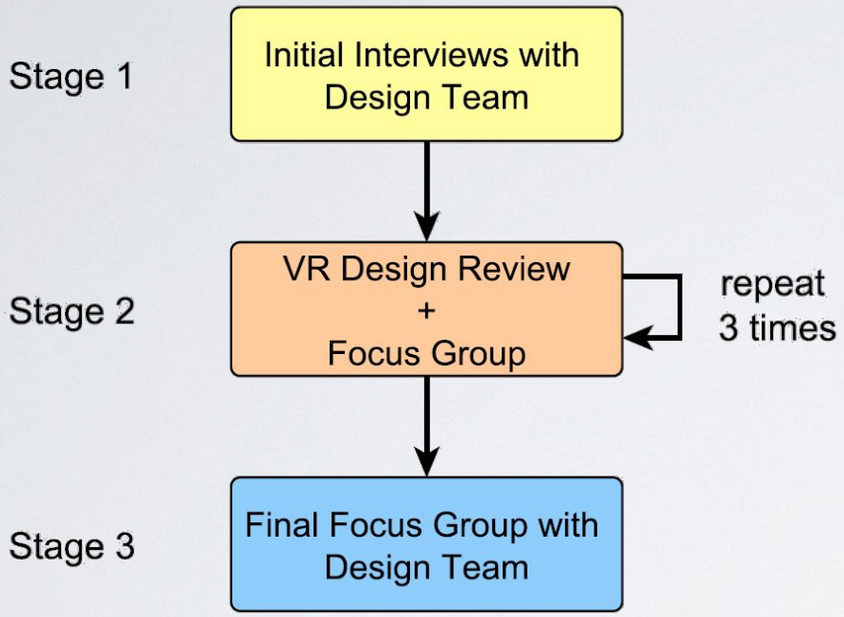
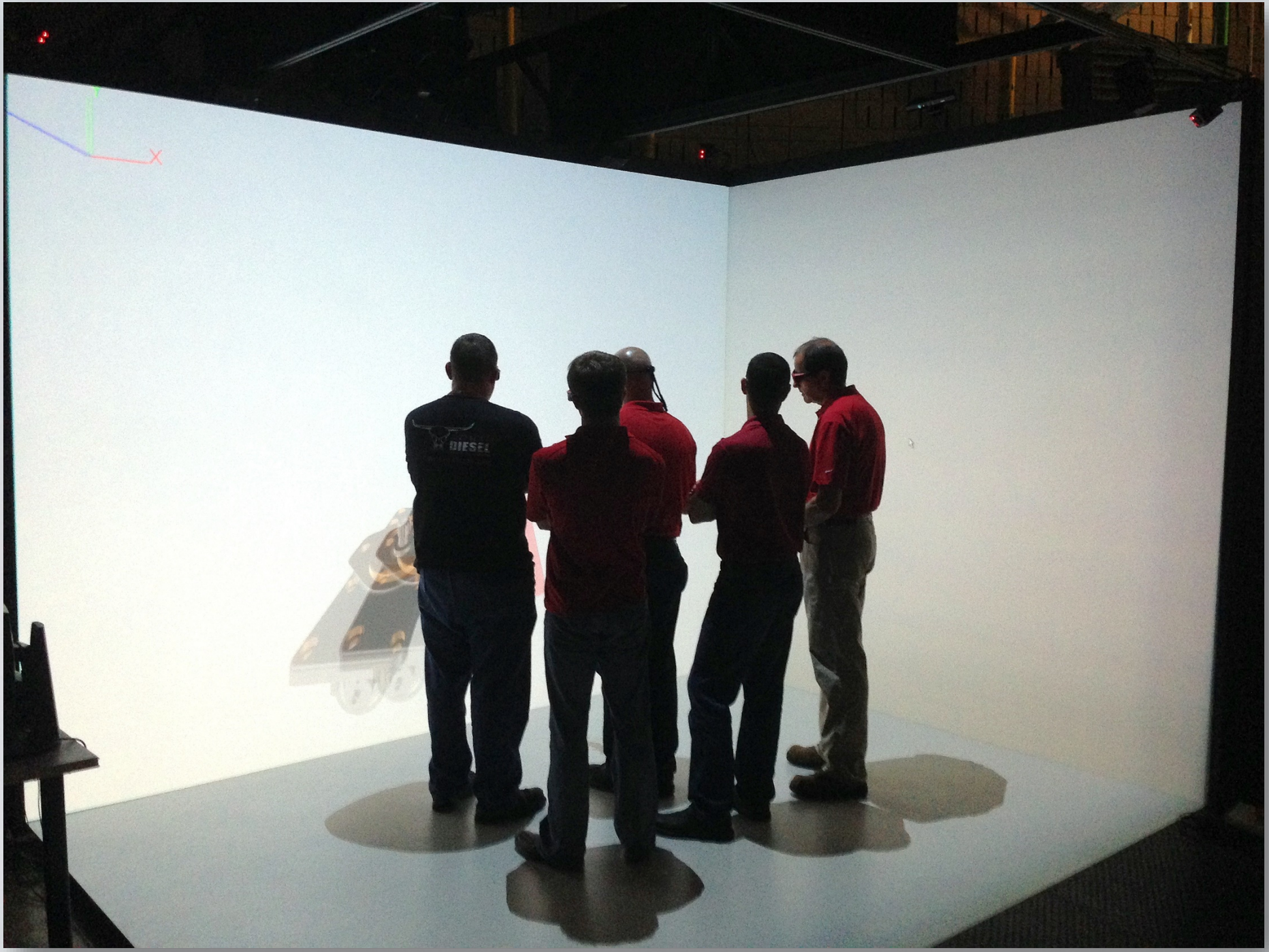


Table 2. Focus Group Questions (sample)

How did your design review go?
What types of questions did you explore?
Was there anything that was particularly challenging about your session today?
Did you make any decisions regarding the design?

Design Review 1

Goal: better understand the spatial relationships between components during the engagement of two critical subassemblies


DIESEL

Design Review 1 Focus Group

"Looking at certain components [in CAD] they look one size, but they are actually another size."

"It gave you a perspective of how far to kneel down to see that engagement."

"Especially the view that you were bringing up while thinking about the clearances and the space within the unit. I didn't have that same perspective, but when you mentioned that and then I got a chance to look at it I thought – Oh yeah, now I can see it."

Design Review 2

Goals

1. Examine the working clearances of some internal components
2. Prototype a proposed method of inserting one subassembly into another

Design Review 2 Focus Group

"[this exercise] reinforced the complex movement required to get that [subassembly] installed."

"If I had a glove instead of a wand [Wii Remote], I may be able to grab the part better."

"I think we passed the glasses around a little bit more. Or someone would notice something and say – hey what do you think?"

"The wow factor was gone, I felt like it was all business, jumped in [and] looked at what we needed to and got that done."

Design Review 3

Goals

1. Examine how the layout of an assembly line would impact interactions between the operator, product, and assembly station
2. Evaluate the tooling at the assembly station

Design Review 3 Focus Group

"How far [away] are the bins?" – "about twelve to fourteen inches"

"Those bench tools aren't going to clog up the workspace as much as I thought."

"Experiencing it in VR is definitely going to put me ahead of the game. When it comes to going to the supplier, I'm not going to be surprised in what I saw. I have clear expectations of it now."

Design Review 3 Focus Group

"I thought it was funny that we went through the same meeting yesterday, with everybody's laptops open, doing other work on the side and not fully engaged, and [got] completely different results."

"It's interactive. You're there. You're in it. Versus you're sitting in a conference room around a table [where] it's too easy to have your laptop open and do some other things. You're standing up, there's no surface for your laptop, you've got glasses on. It's just visual and immersive."

Design Review Summary

- DR1: Introduced the team to VR
- DR2: Design changes were made based on what was learned during the VR experience
- DR3: Design changes were made based on what was learned during the VR experience

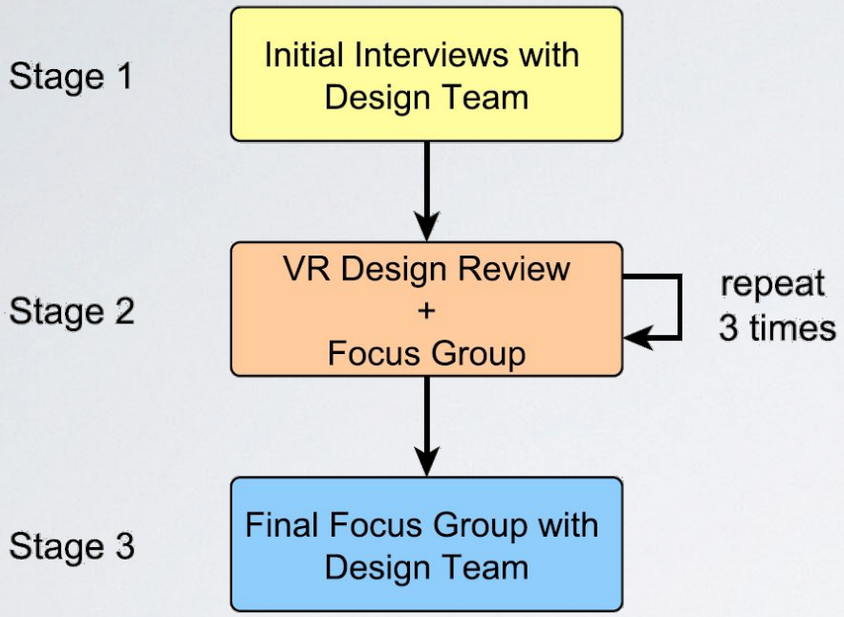


Table 3. Final Focus Group Questions (sample)

Over the course of the visits, do you think your experiences in VR influenced your decision making? If so, how?
Is this something you could see yourself using for future designs? If so, how?
Looking back, if you could change one thing about your experiences, what would it be?
Overall, how was your experience using the virtual reality system?

Final Focus Group

"I think we've done a good job explaining the value. . . , but it's very difficult explaining the experience itself."

- Interacting with the Wii mote was helpful – but awkward and unnatural. The collision detection was not robust enough to be useful.
- Having familiarity with the software in the desktop version supported a smooth transition between CAD and VR.
- Using VR provided an increased sense of team engagement.

Immersive Technology as a Decision Making Tool for Product Design

Leif P. Berg

Industry survey of the use of immersive technology to explore these questions:

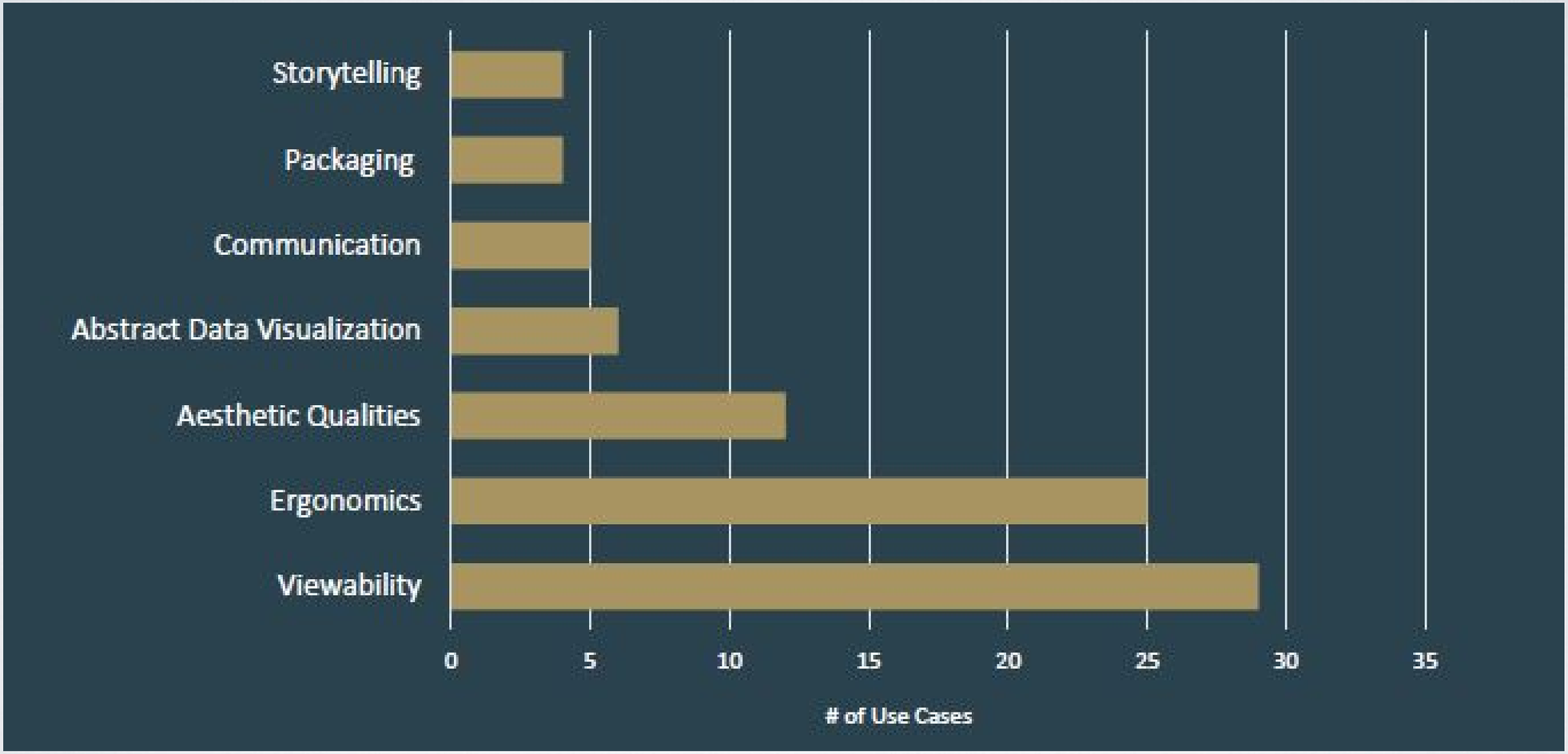
1. How is VR being used to support innovation in industry?
2. How is VR being used to make decisions?
3. What specific benefits do industry VR practitioners experience?
4. What challenges remain for future research?

Procedure

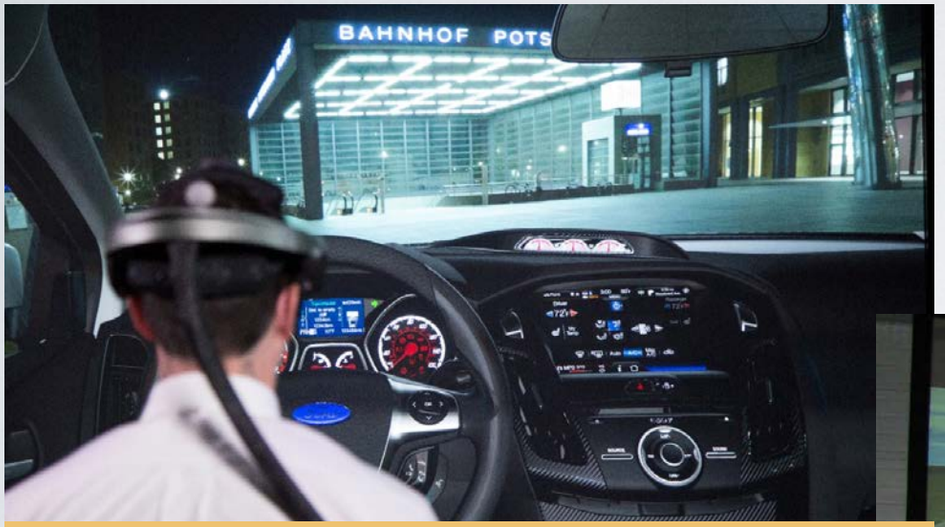
Conducted on-site visits

- Tours
- Interviews

Use Cases


Storytelling
Packaging
Communication
Abstract Data Visualization
Aesthetic Qualities
Ergonomics
Viewability
0
5
10
15
20
25
30
35
# of Use Cases

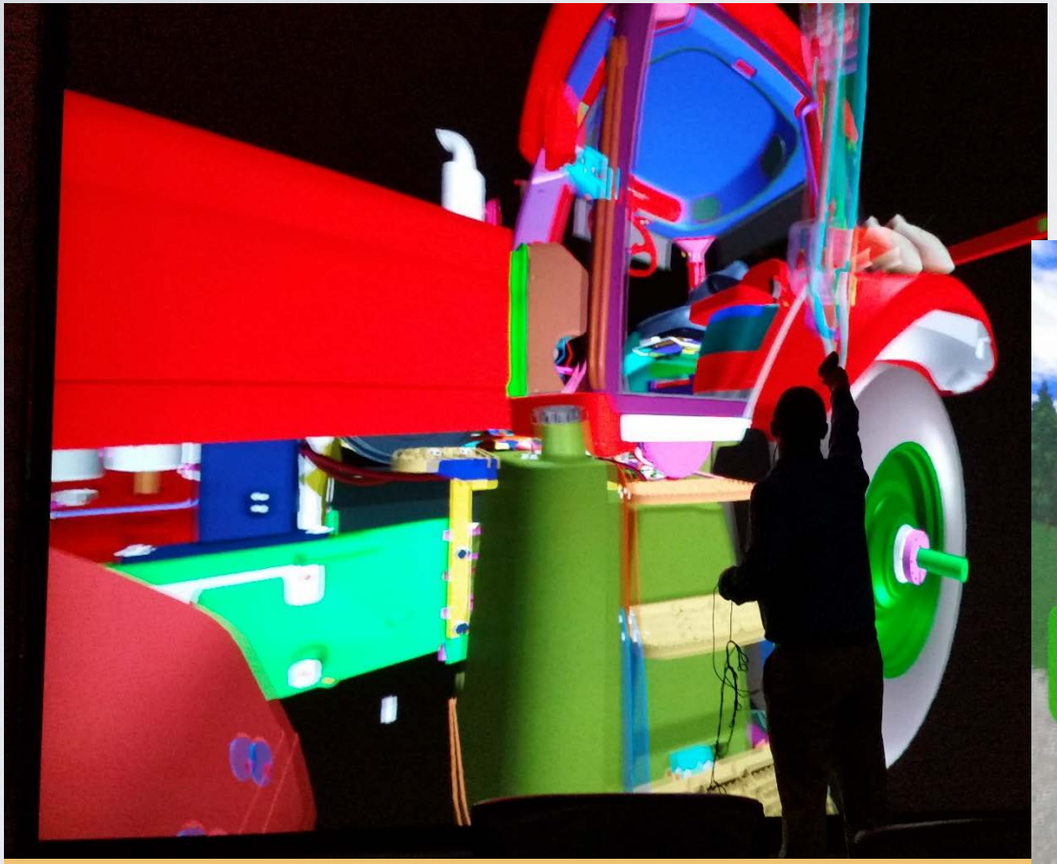
Viewability



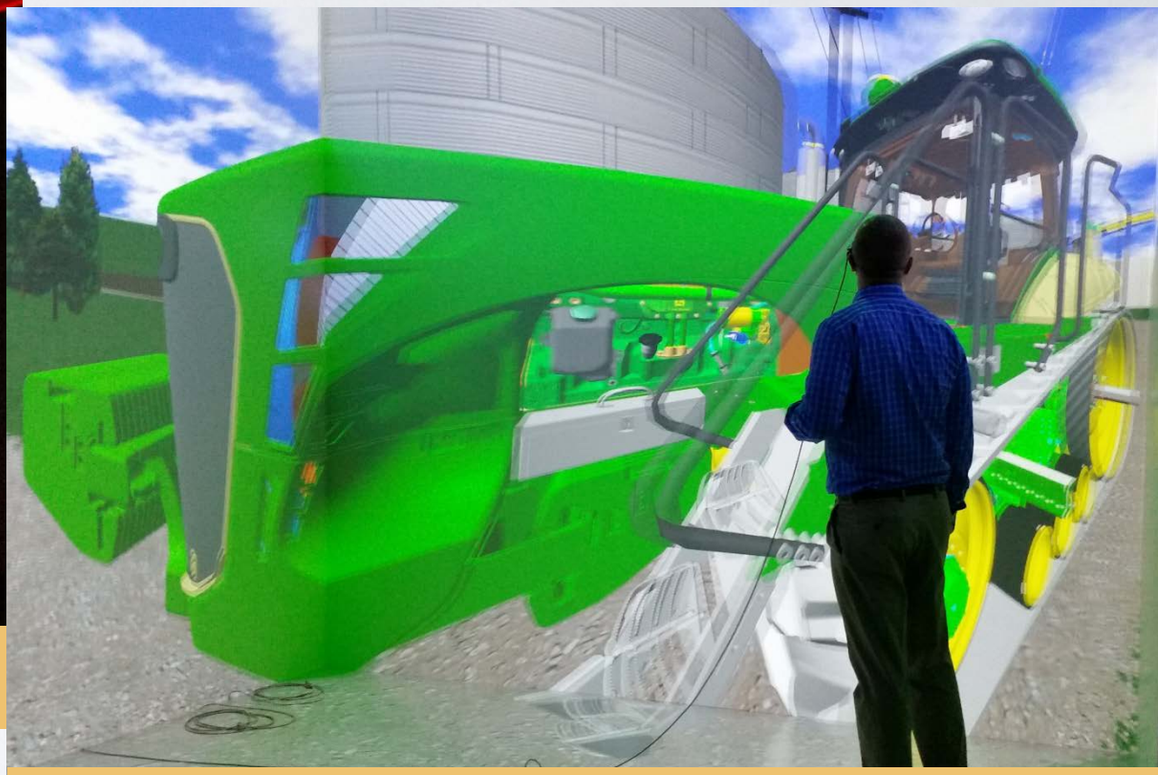
Ford Five Lab

John Deere

Ergonomics



Case New Holland



John Deere

Aesthetic Quality

Ford Five Lab

Communication

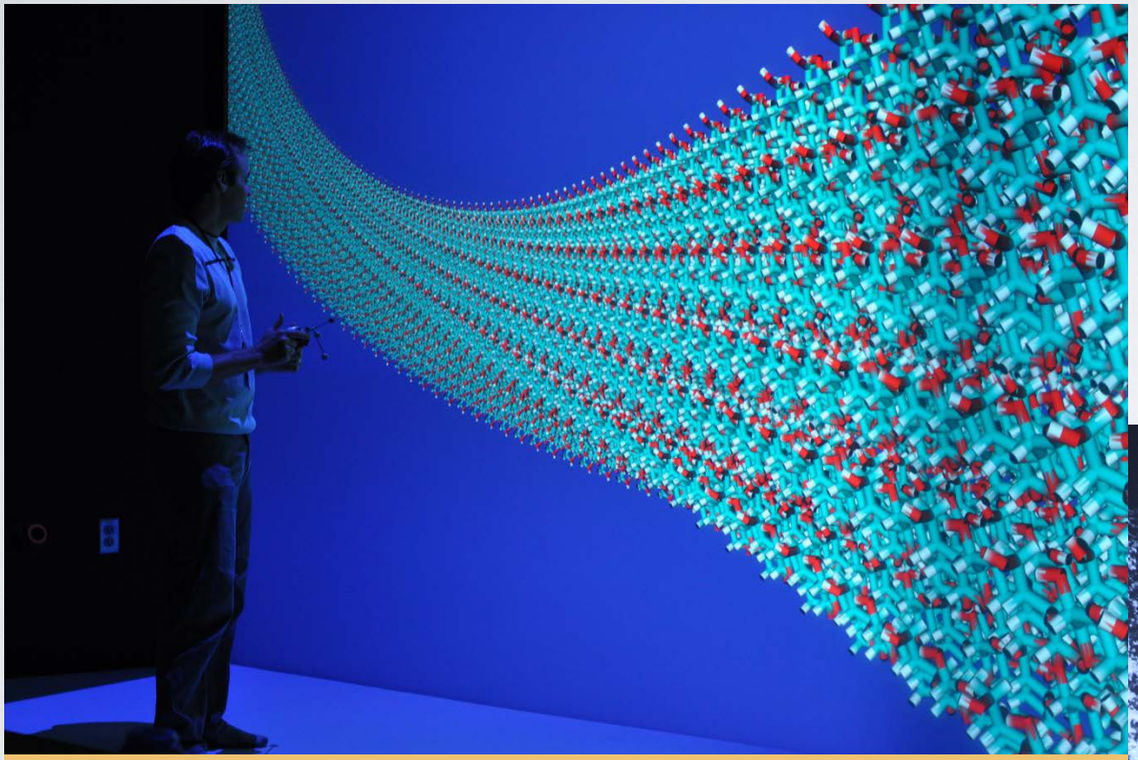
Case New Holland

Miele

Packaging

Tacom

Data Vis



National Renewable Energy Lab

Idaho National Lab

Storytelling

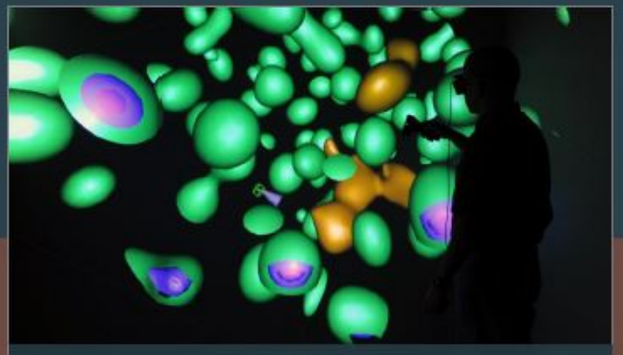
Lockheed Martin

Tacom

What did we learn?

VR is "just another tool in the toolbox."


Miele


NREL


Case New Holland


TACOM


John Deere

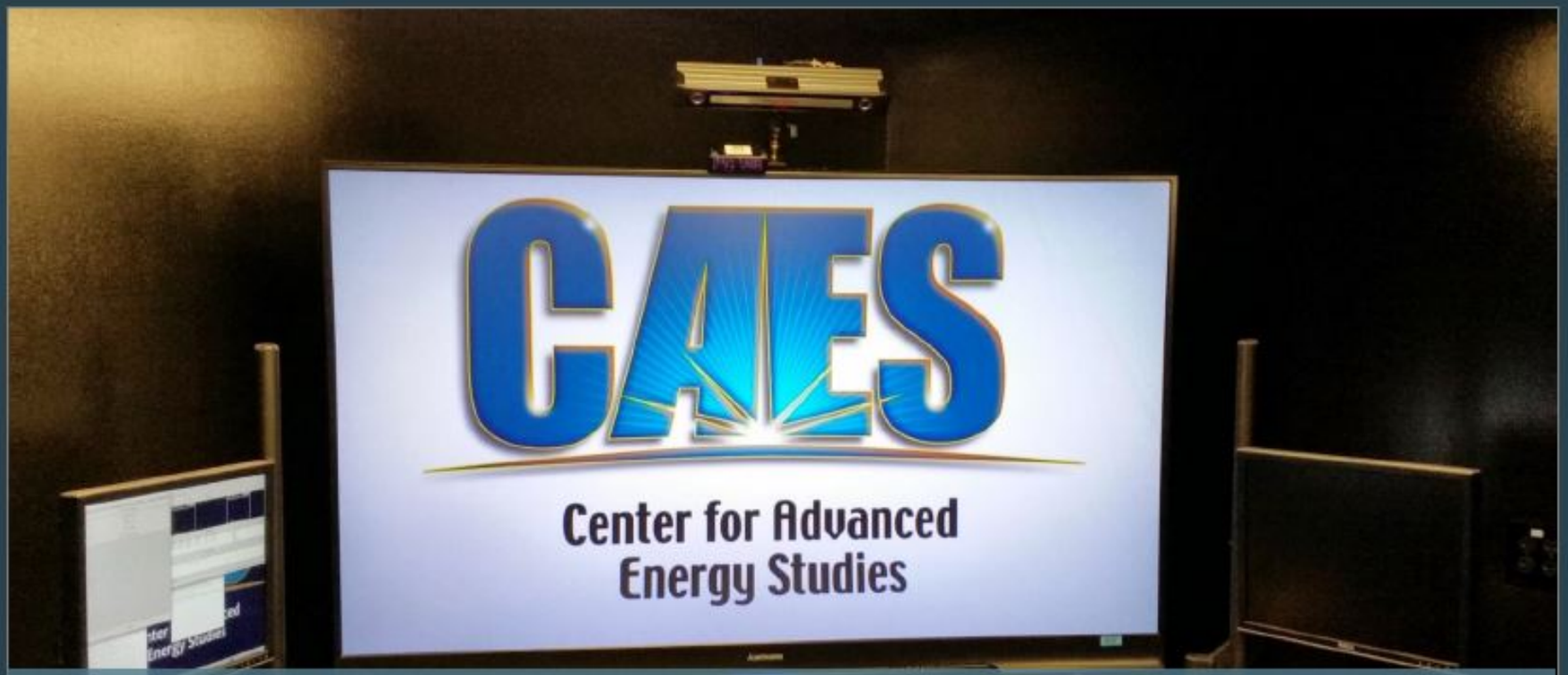
Ford FiVE Lab

Portable systems are on the rise.

"This is a true, two-wire system and that makes it easy."

Idaho National Labs

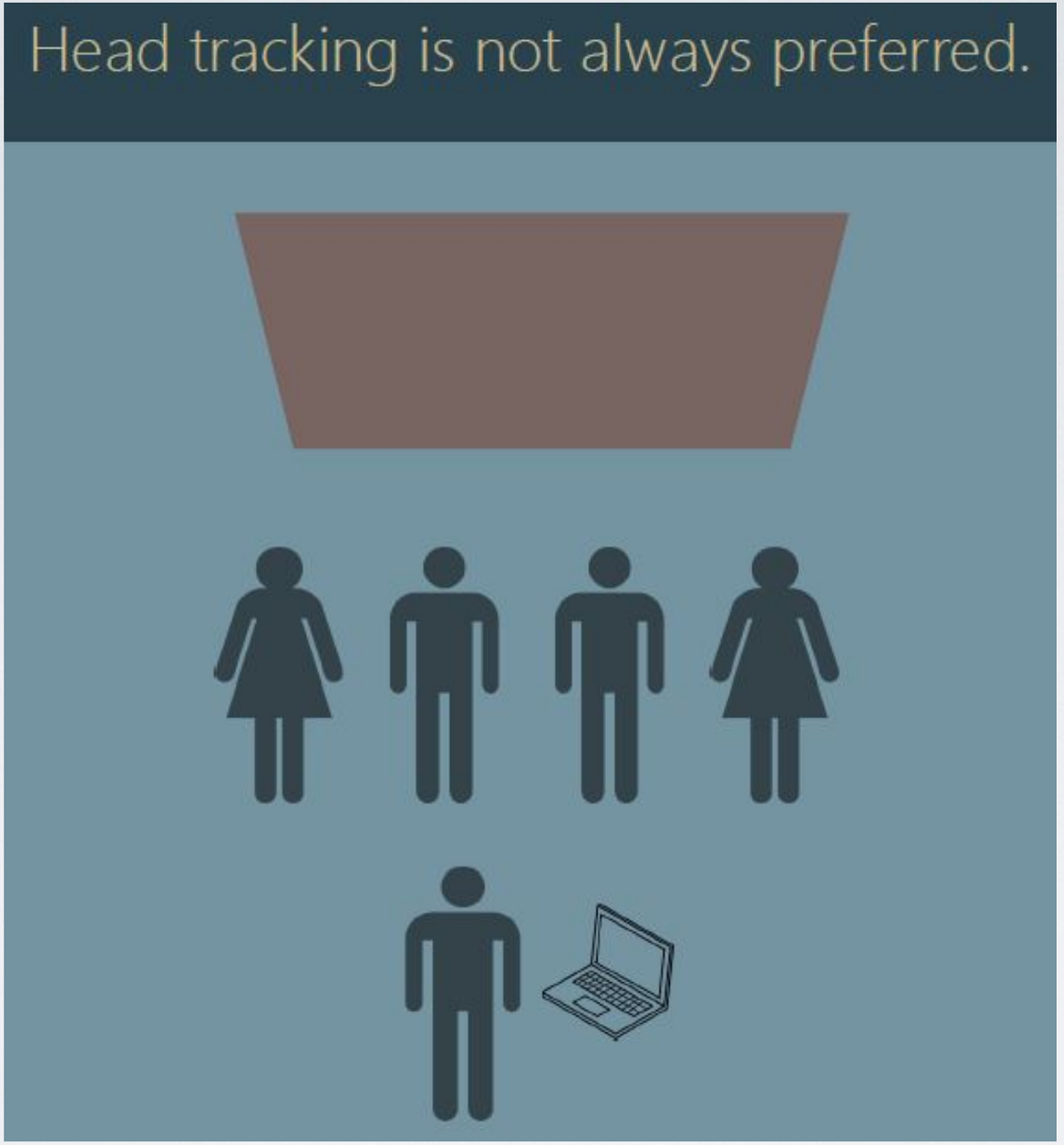
Proximity is important, low cost VR helps.



"Put it near the research. Put it near the data instead of having to drag data over here to a CAVE"

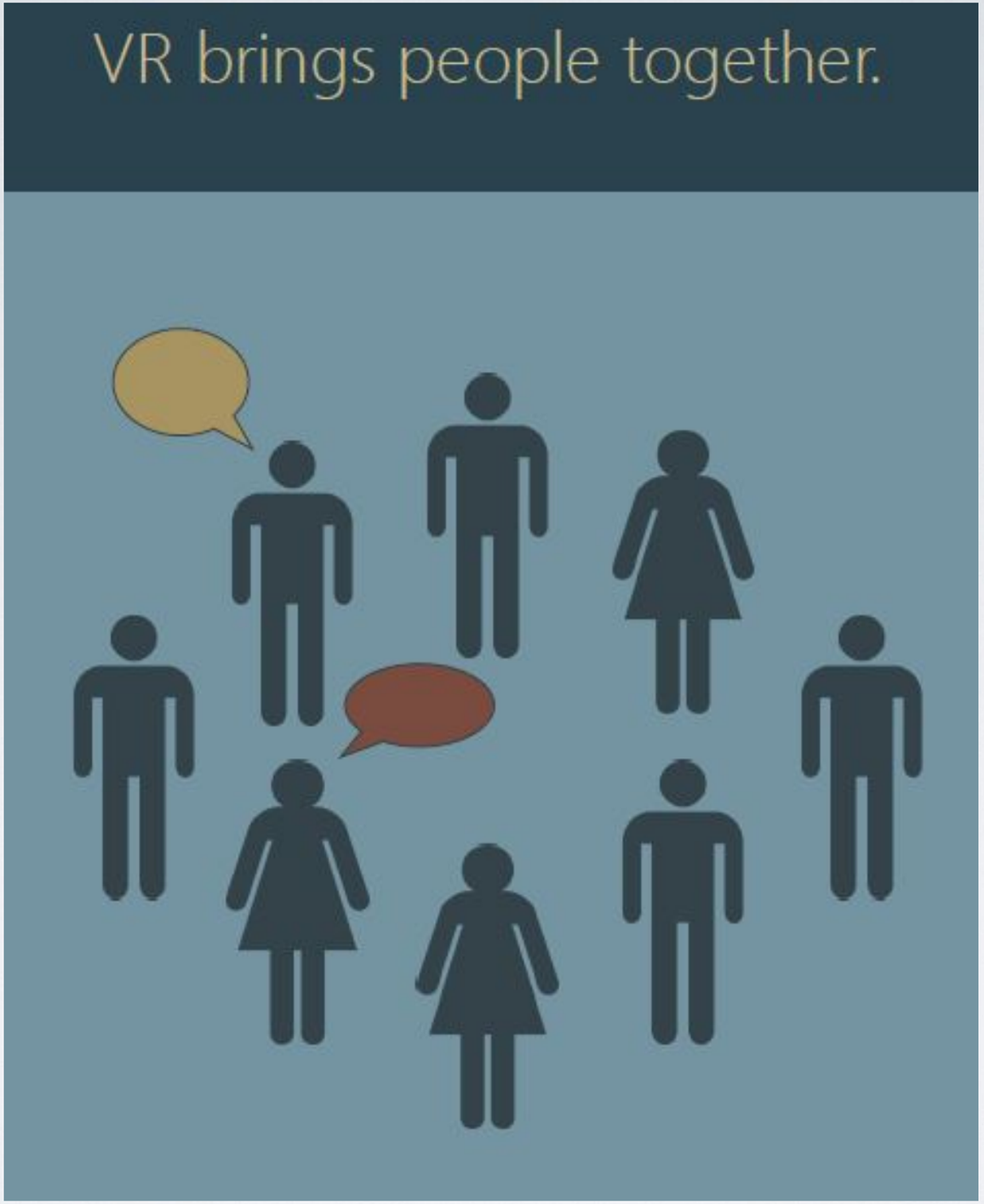
Idaho National Labs

Head tracking is not always preferred.



Novel configurations enable interactive design spaces.

John Deere


VR brings people together.

Starting a VR lab is difficult.

BEFORE

"The first time is when the arm twisting comes."

AFTER

"We don't have to do much selling."

And finally …

The experience of VR is difficult to communicate.

It must be experienced firsthand.

Research Challenges

- Better graphics and brighter displays
- Better model conversion process
- Automated model preparation
- Wider field of view (HMDs)
- Better collision detection and haptics
- More portable solutions

Virtual Reality isn't science fiction any more …

It’s for real!

Image courtesy of Lockheed Martin

Thank you!

Dr. Judy M. Vance
Virtual Reality Applications Center
(VRAC)
Mechanical Engineering Department
Iowa State University
Ames, IA

jmvance@iastate.edu
www.vrac.iastate.edu/~jmvance

The research presented here was performed by Leif Berg, Meisha Berg, Patrick Carlson and Ryan Pavlik with support from the National Science Foundation and the Joseph C. and Elizabeth A. Anderlik Professorship