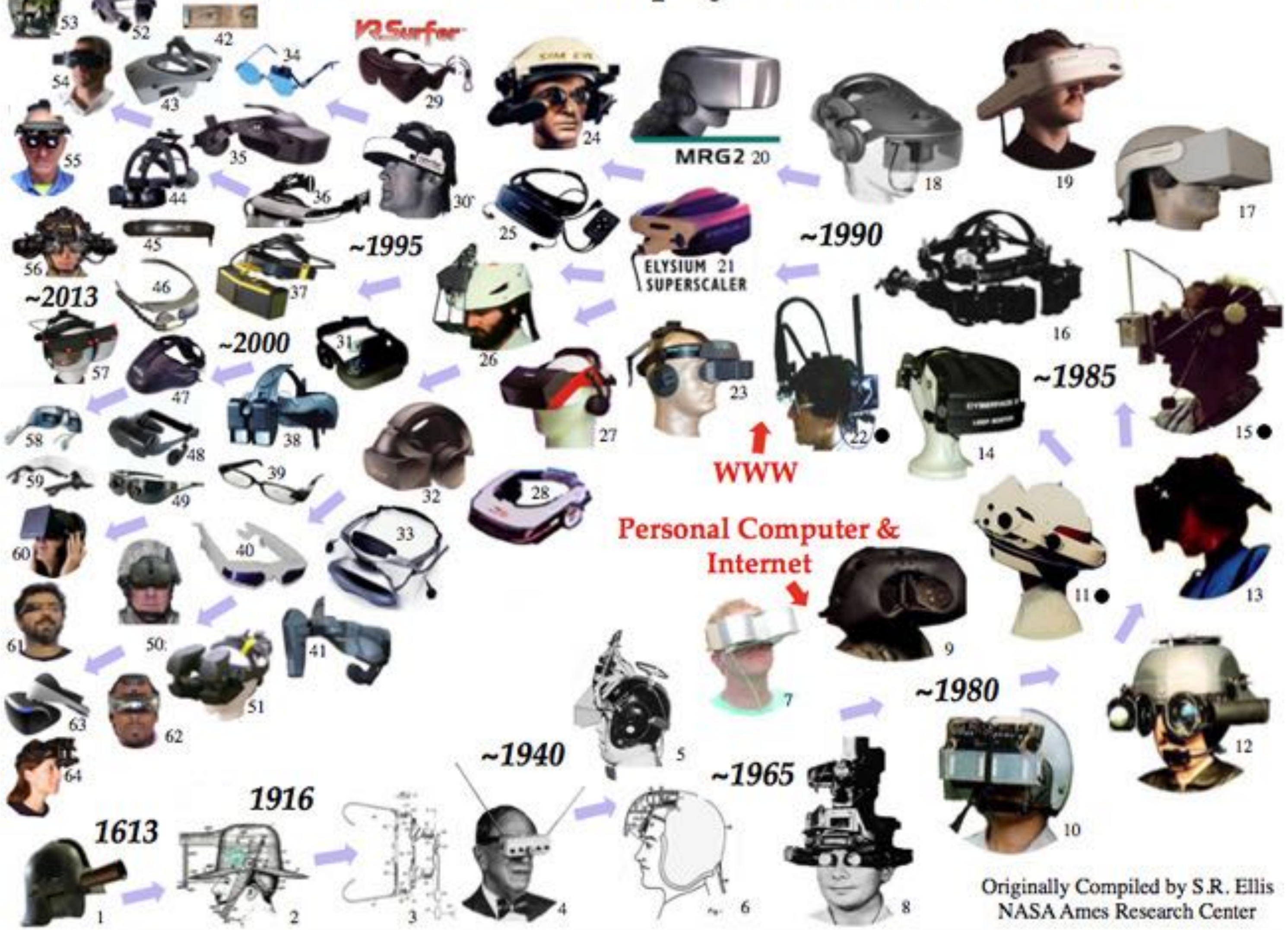
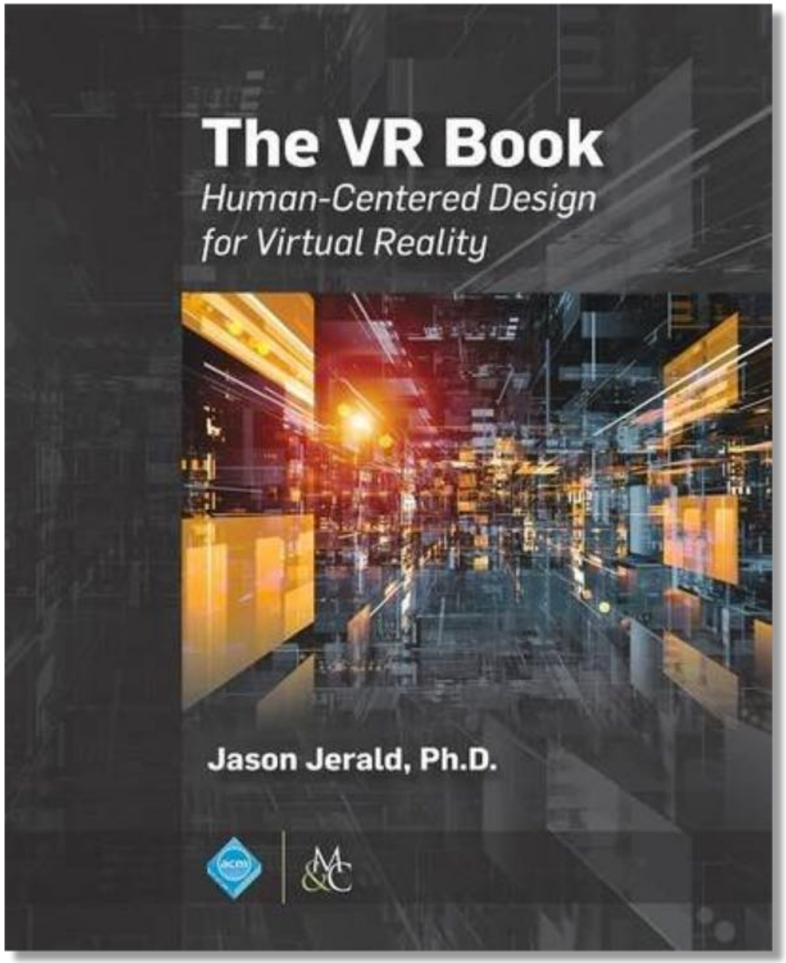
Interaction Design & Virtual Reality (IDVR)

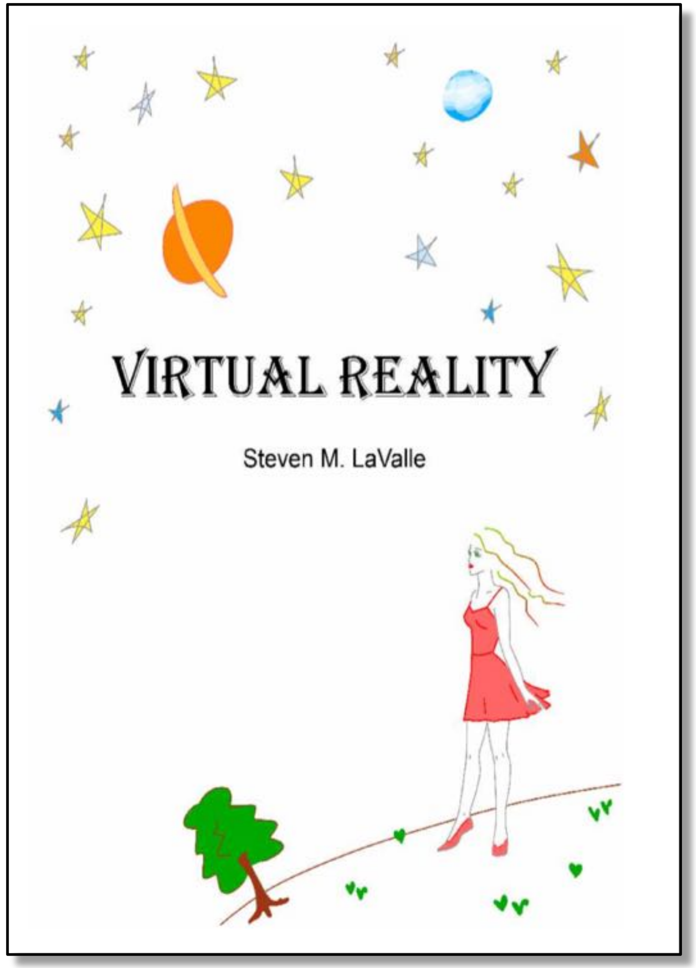
Liwei CHAN 詹力韋

Some Head-Mounted Displays & Viewers Over Time

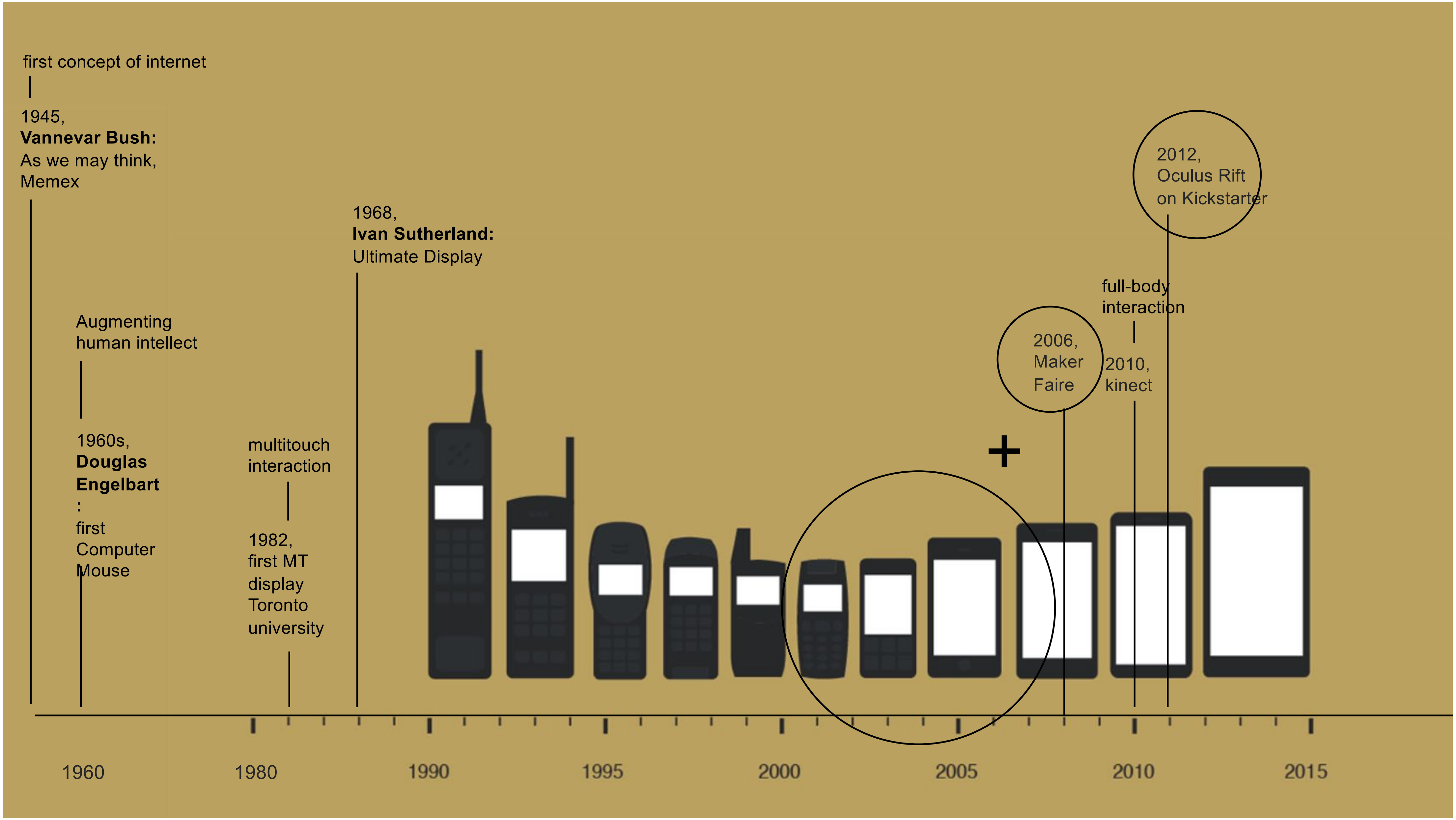



The VR Book
Human-Centered Design for Virtual Reality
Jason Jerald, Ph.D.

2015


VIRTUAL REALITY
Steven M. LaValle

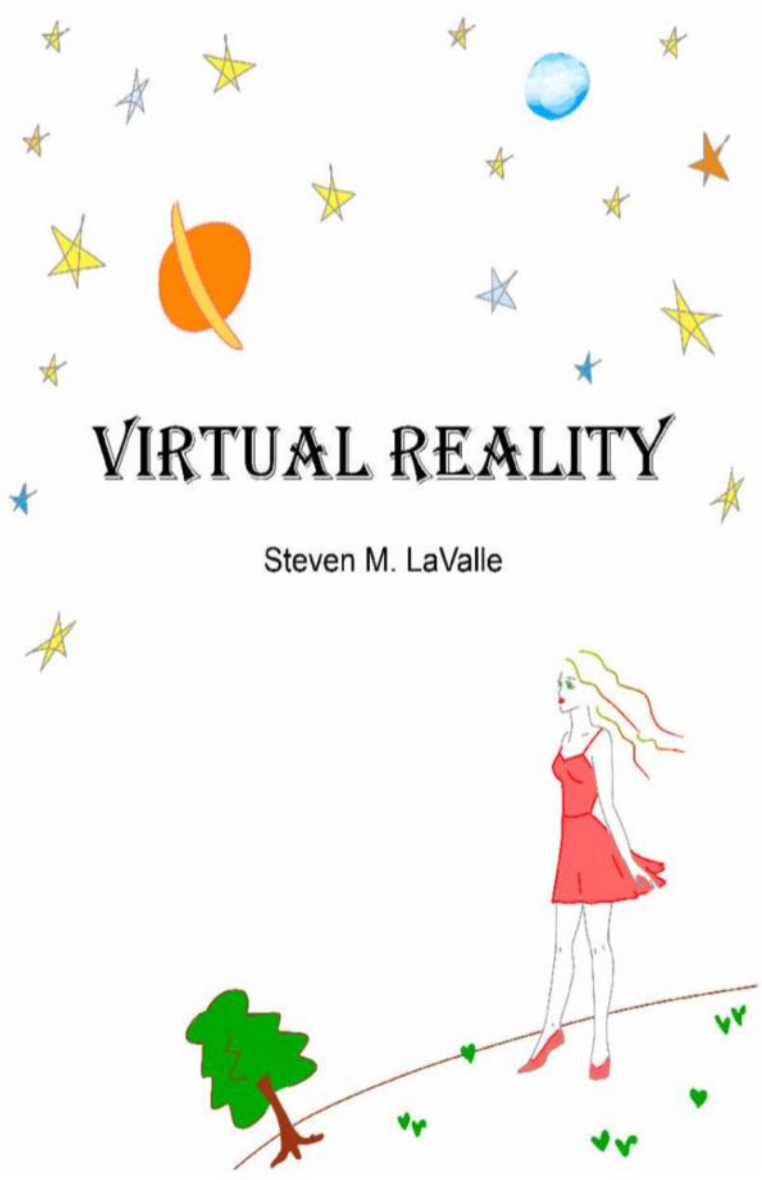
2016

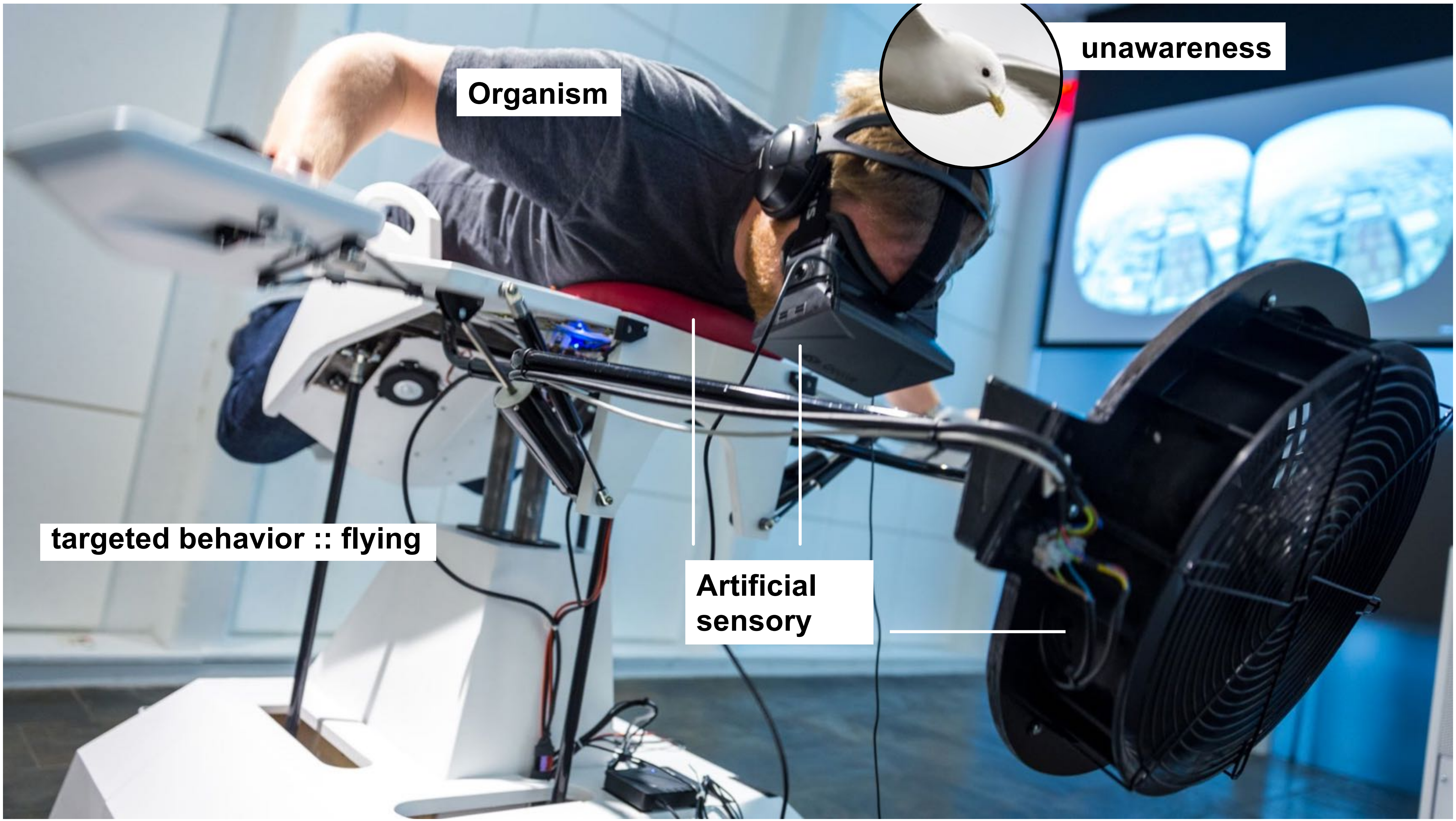

first concept of internet
1945,
Vannevar Bush:
As we may think,
Memex
1968,
Ivan Sutherland:
Ultimate Display
2012,
Oculus Rift
on Kickstarter
full-body
interaction
Augmenting
human intellect
2006,
Maker
Faire
2010,
kinect
1960s,
Douglas
Engelbart
:
first
Computer
Mouse
multitouch
interaction
1982,
first MT
display
Toronto
university
+
1960
1980
1990
1995
2000
2005
2010
2015

Real Virtuality

Definition of VR

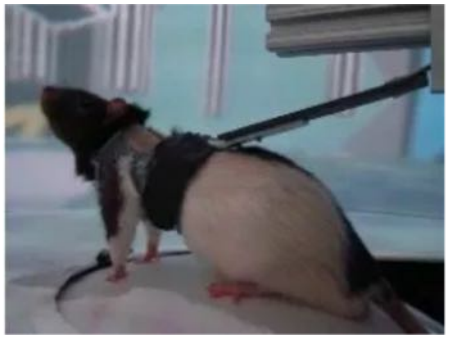
Inducing **targeted behavior** in an **organism** by using **artificial sensory** stimulation, while the organism has little or **no awareness** of the interference.

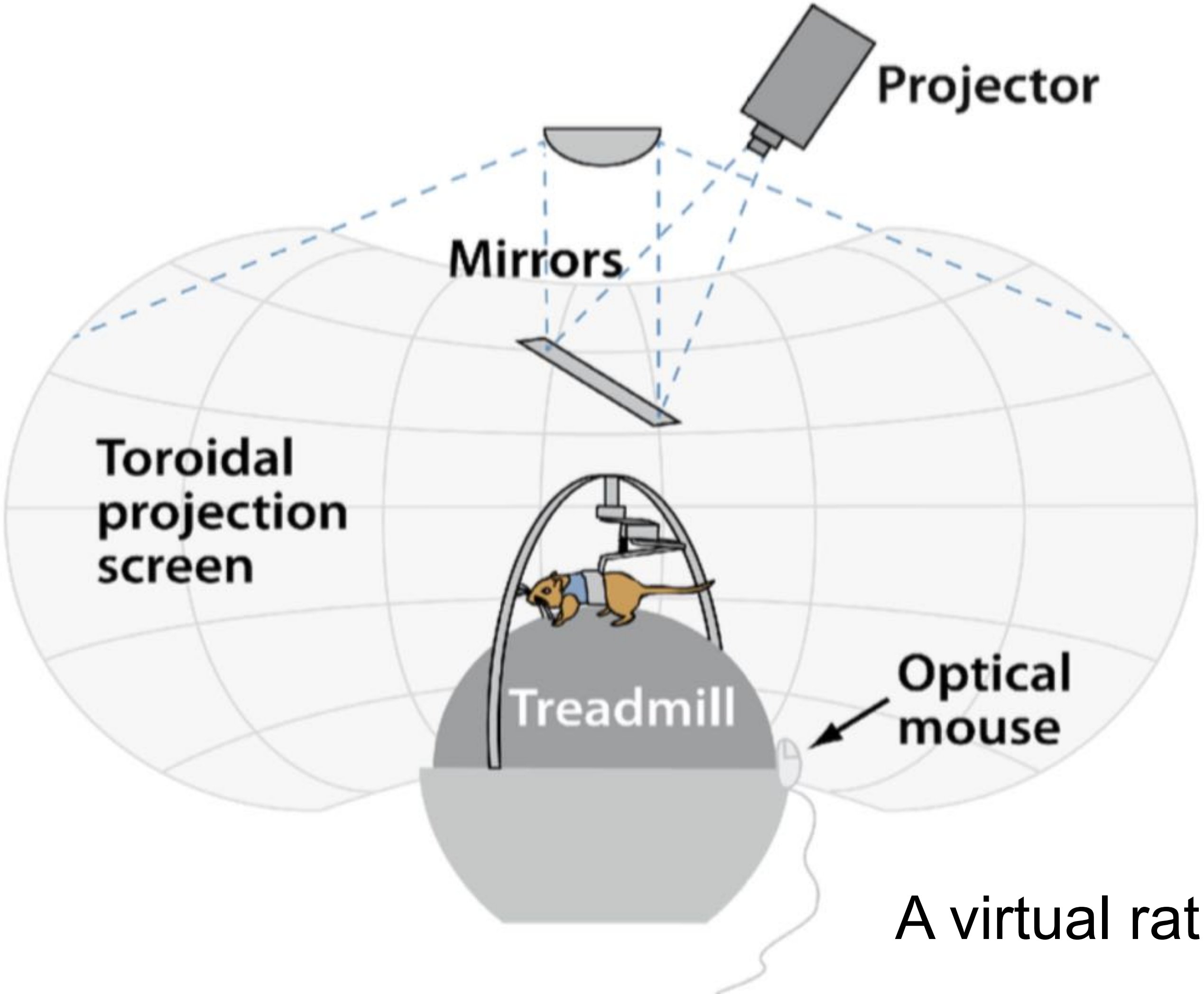



Organism
unawareness
targeted behavior :: flying
Artificial
sensory

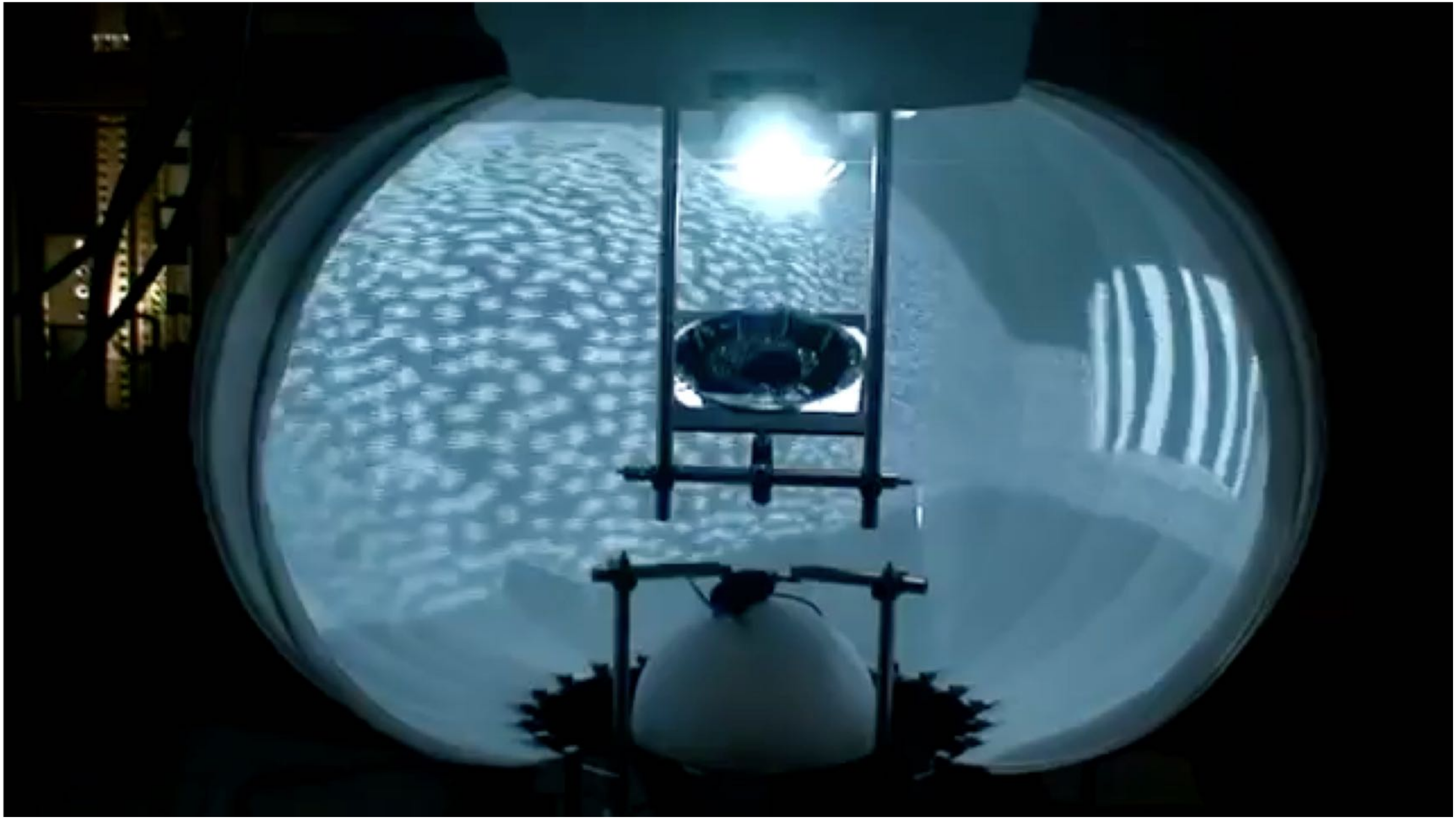
Organism is in most cases **you**, or…

a rat.





A virtual rat reality

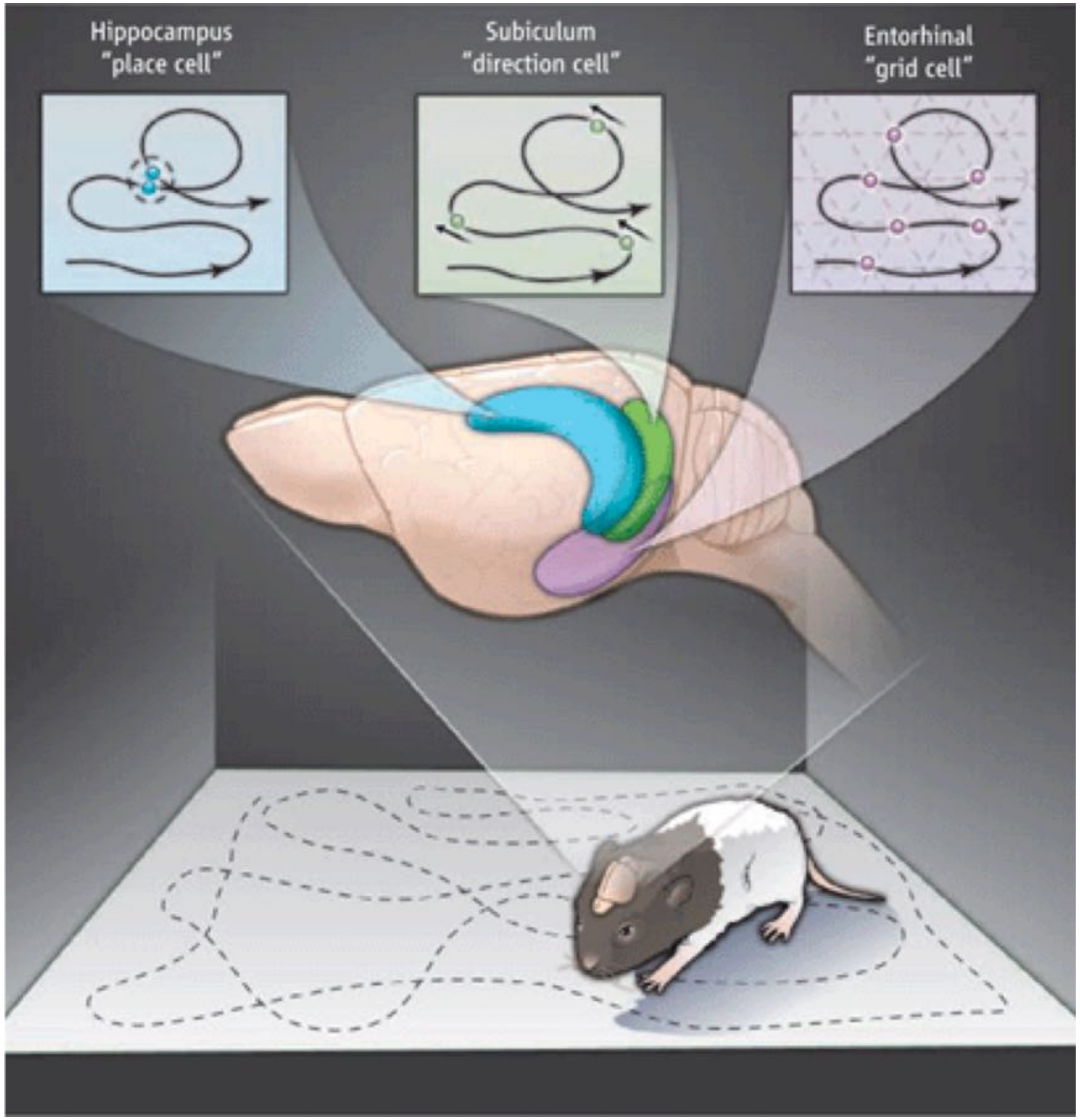


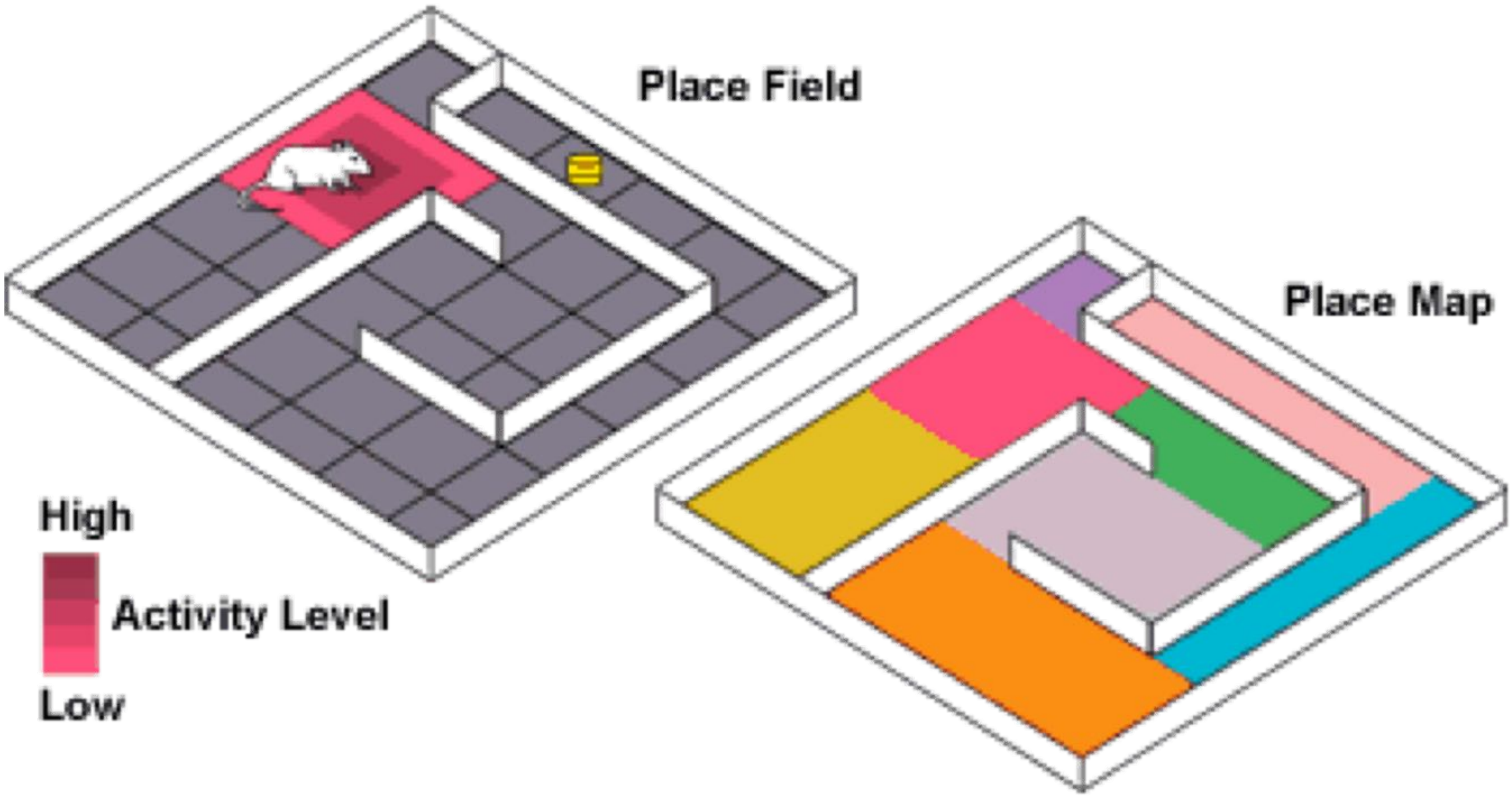
Navigating Space: How Your Brain Knows Where You Are

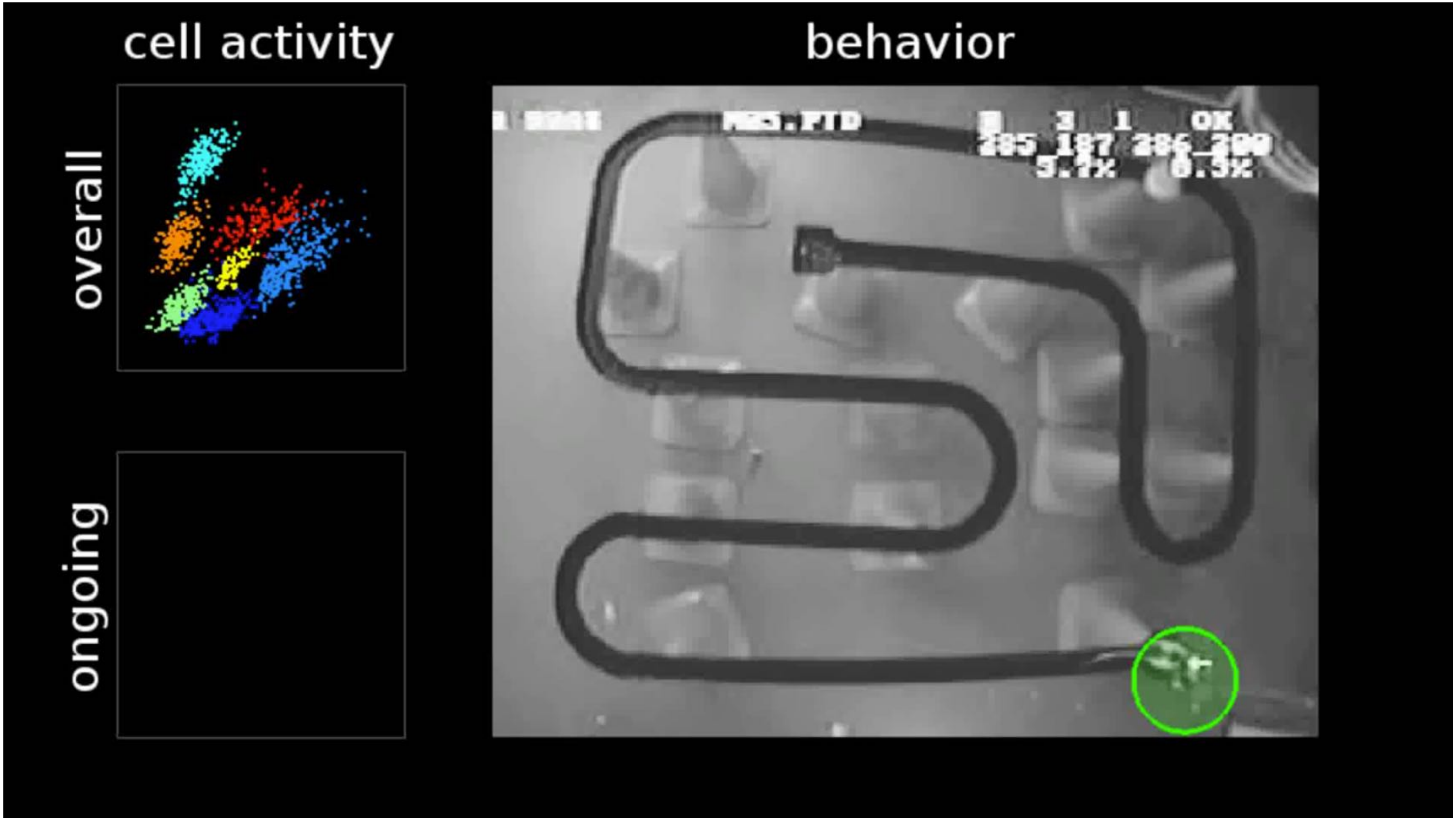
Cognitive map
(1940 Edward Tolman)

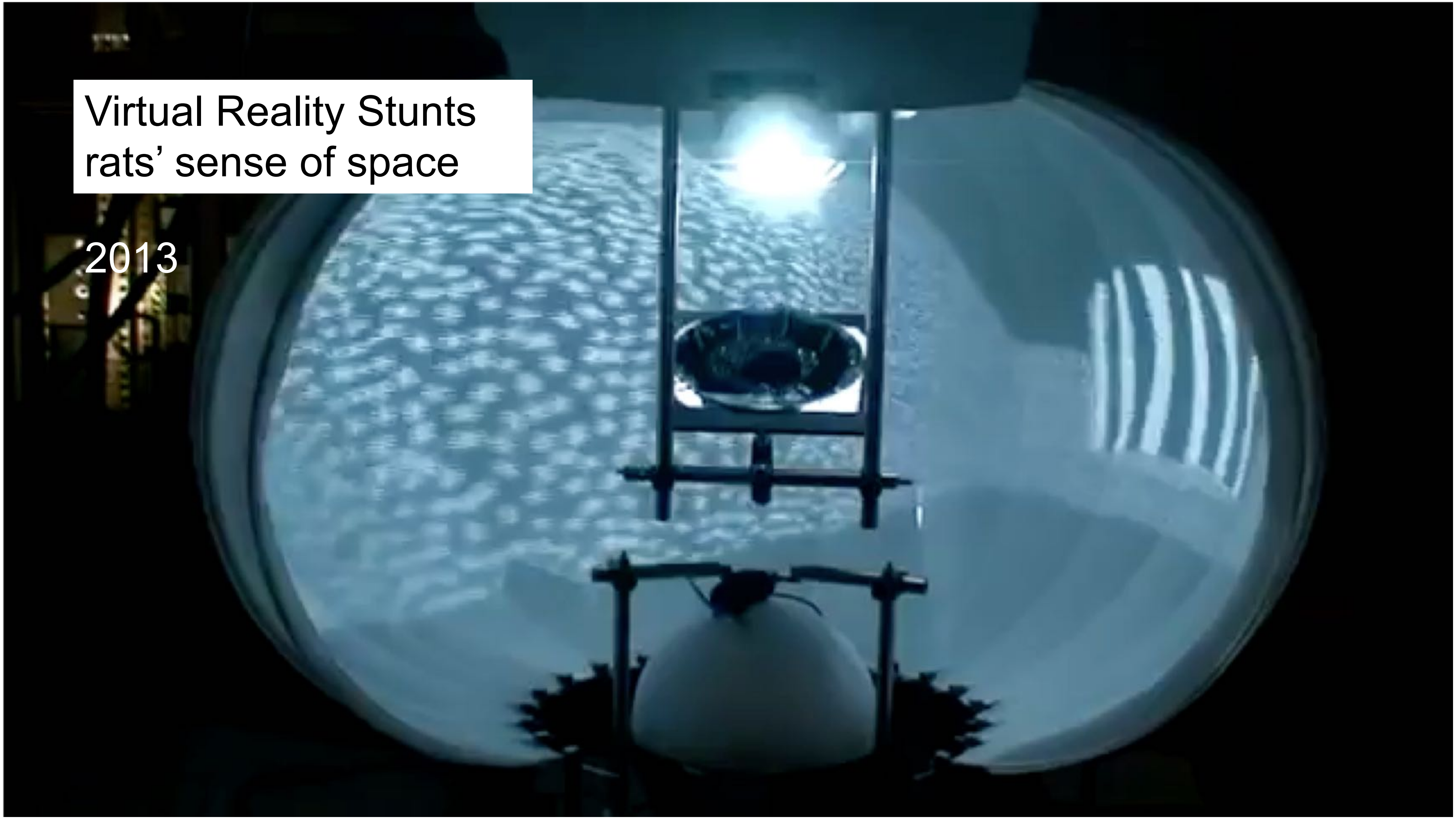
↓

Place cell
(1971)

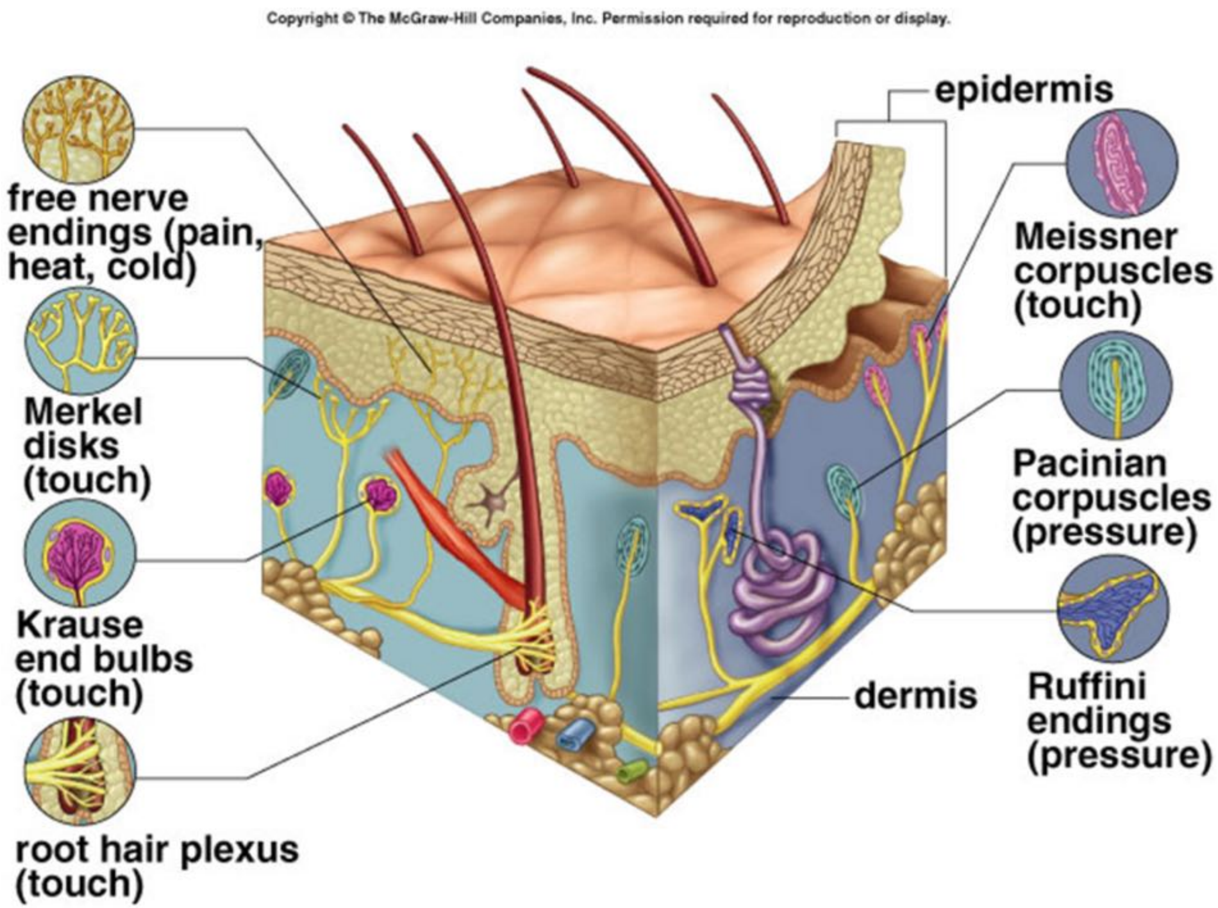



Place Field
Place Map
High
Activity Level
Low


cell activity
behavior
overall
ongoing


Virtual Reality Stunts rats' sense of space
2013

Artificial sensory stimulation is the engineering to fool you



No awareness := unawareness
:= the sense of being there

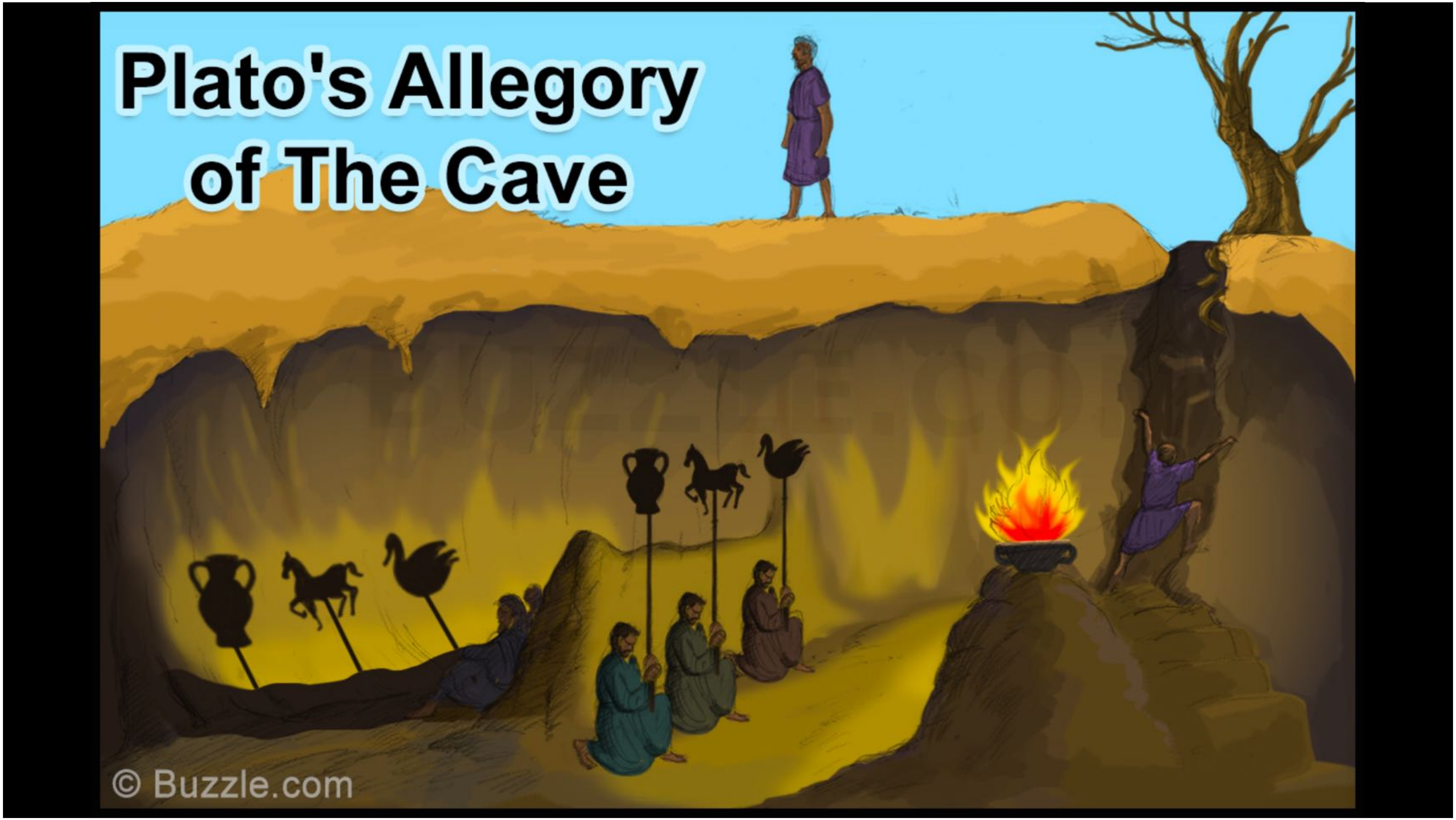
Definition of VR

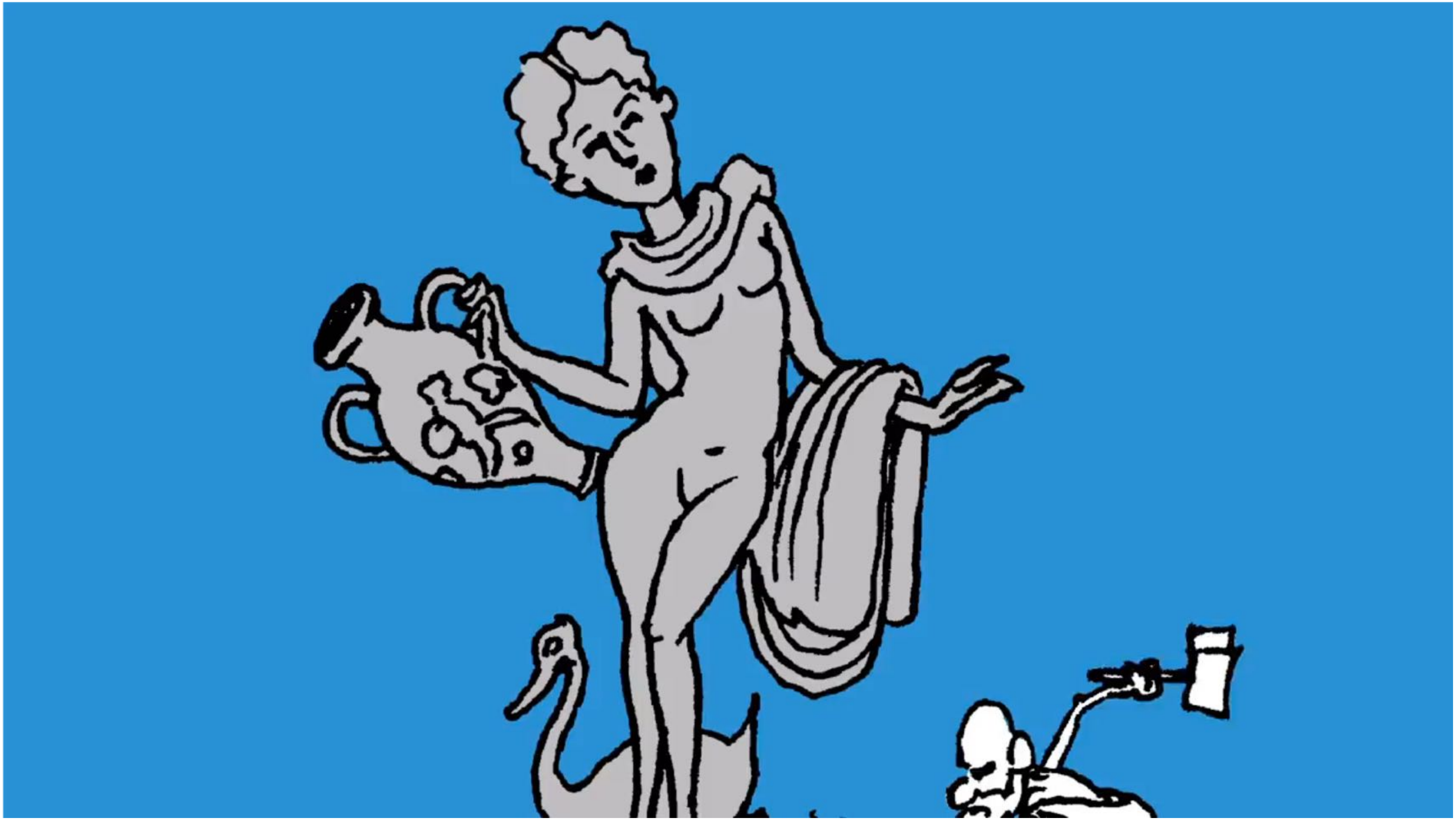
Inducing **targeted behavior** in an **organism** by using **artificial sensory** stimulation, while the organism has little or no **awareness** of the interference.

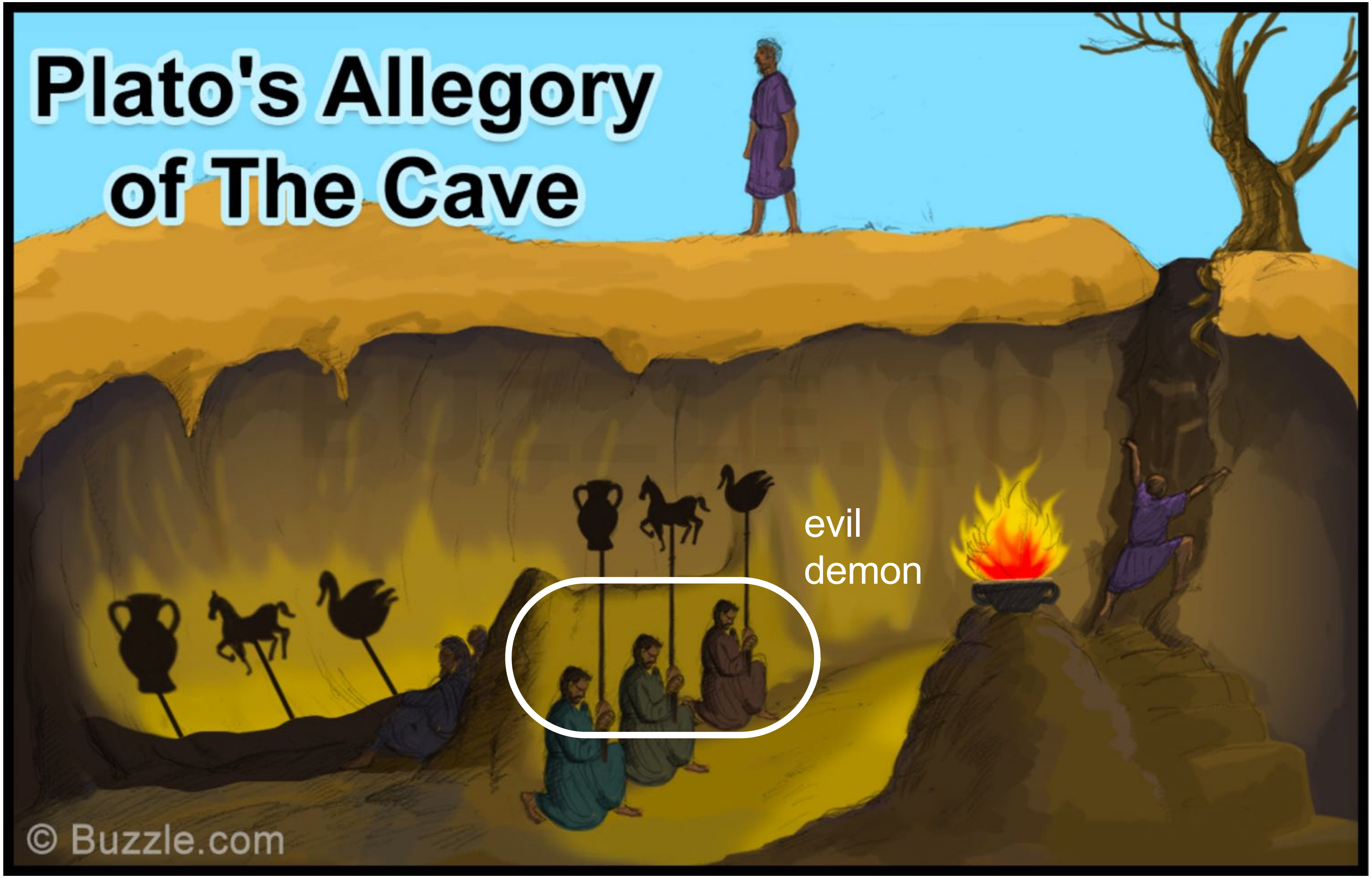
Testing the boundaries

- listening to music through head- phones
- watching a movie at a theater
- a portrait or painting on the wall
- reading a novel

What is the reality?

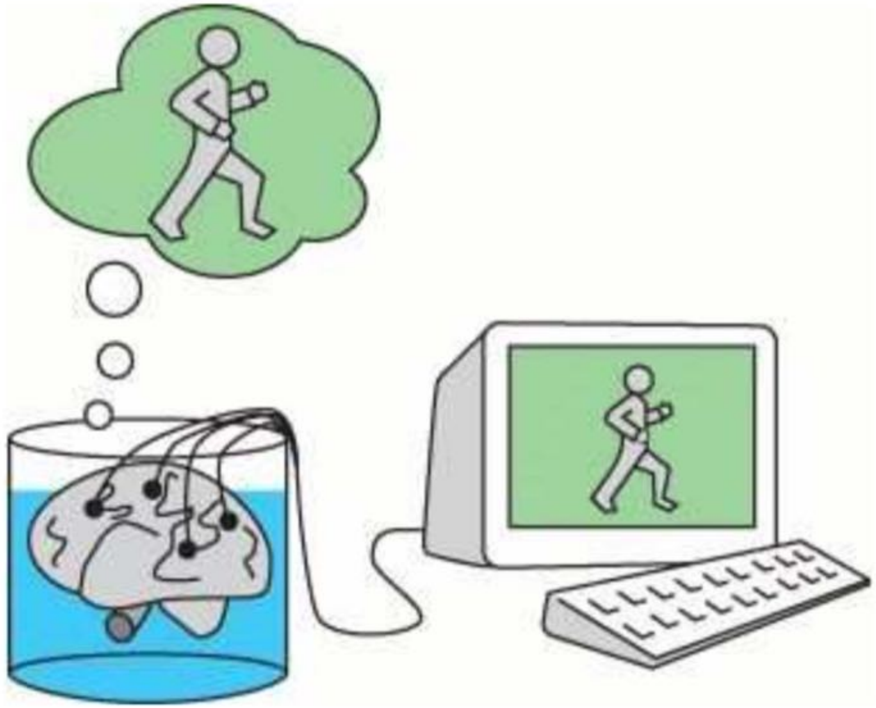

Plato's Allegory of The Cave
© Buzzle.com




Plato's Allegory of The Cave
evil demon
© Buzzle.com

1973

A thought experiment:
The brain in a vat.
By Gilbert Harman.



1999

which became the basis of the 1999 movie "The Matrix".

VR History

- a technological perspective


'VR TROOPERS' - SABAN
SABAN'S
VR
TROOPERS
c|net

- from stationary to mobility
- from simplicity to realism

VR History

- a technological perspective

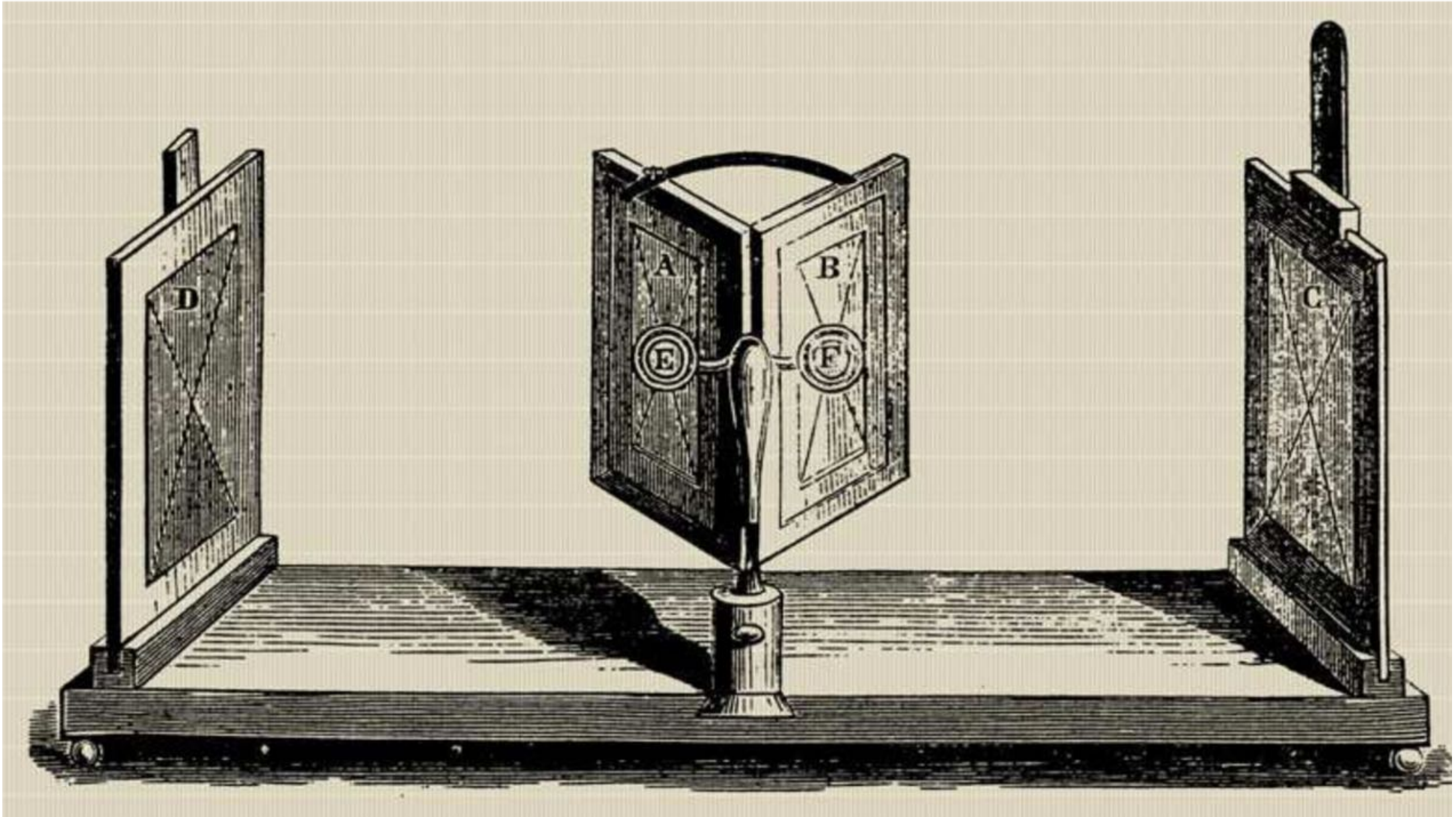
from stationary to mobility

- toward convenience and portability

1) having to go somewhere to watch it, to
2) being able to watch it in your home, to
3) being able to carry it anywhere.

whether pictures, movies, phones, computers, or video games, the same progression continues.

1838 by Charles Wheatstone in a system called the **stereoscope**



1838 by Charles Wheatstone in a system called the **stereoscope**

A portable version.
Brewster stereoscope from 1860.

1930s View-Master

Estimated over a half million stereoscopes has been sold

conceptually same things

1860

1930s

2014

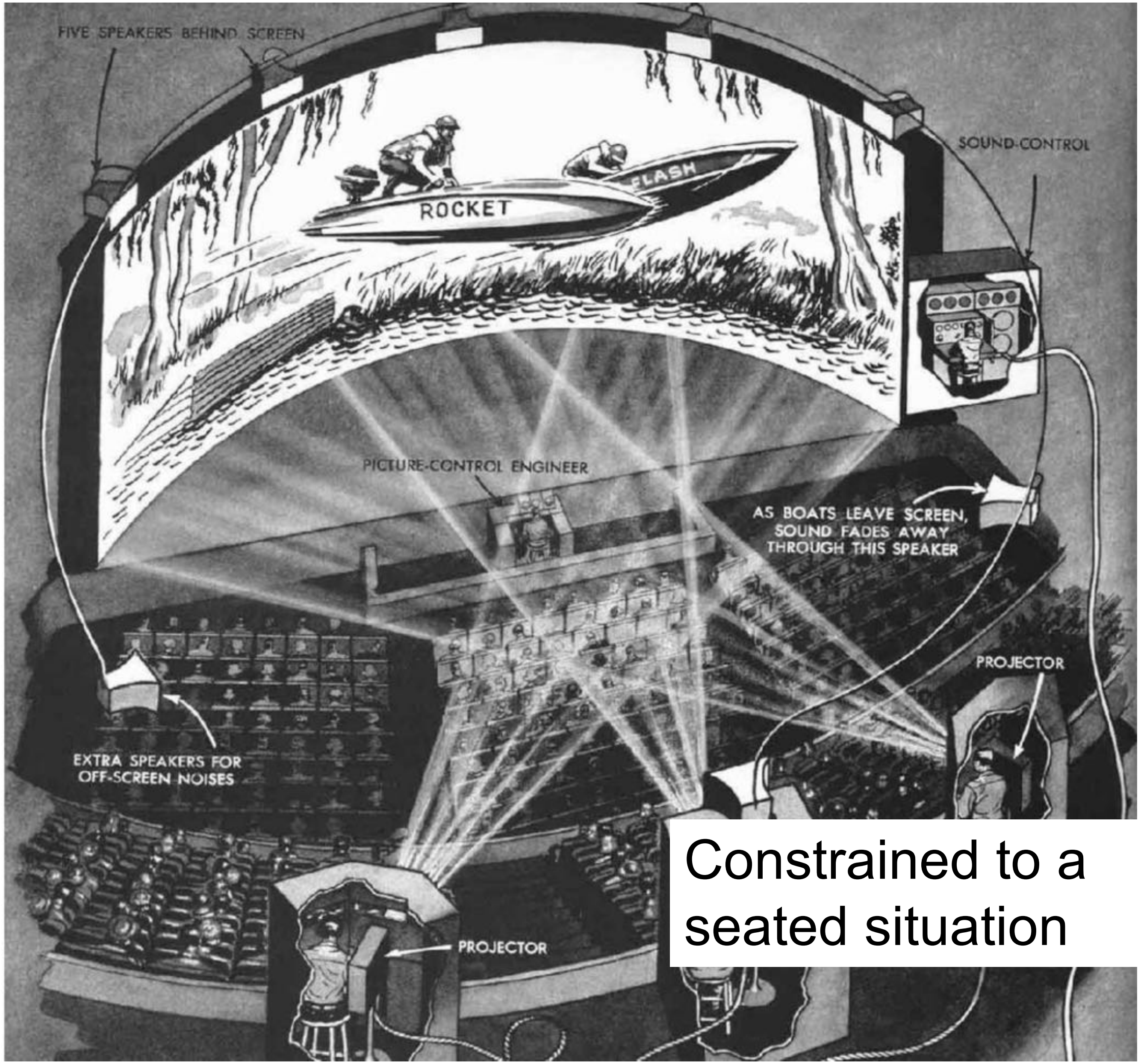
- from simplicity to realism

In 1957, Sensorama adds motion pictures, sound, vibration, and even smells to the experience

1838, stereoscope

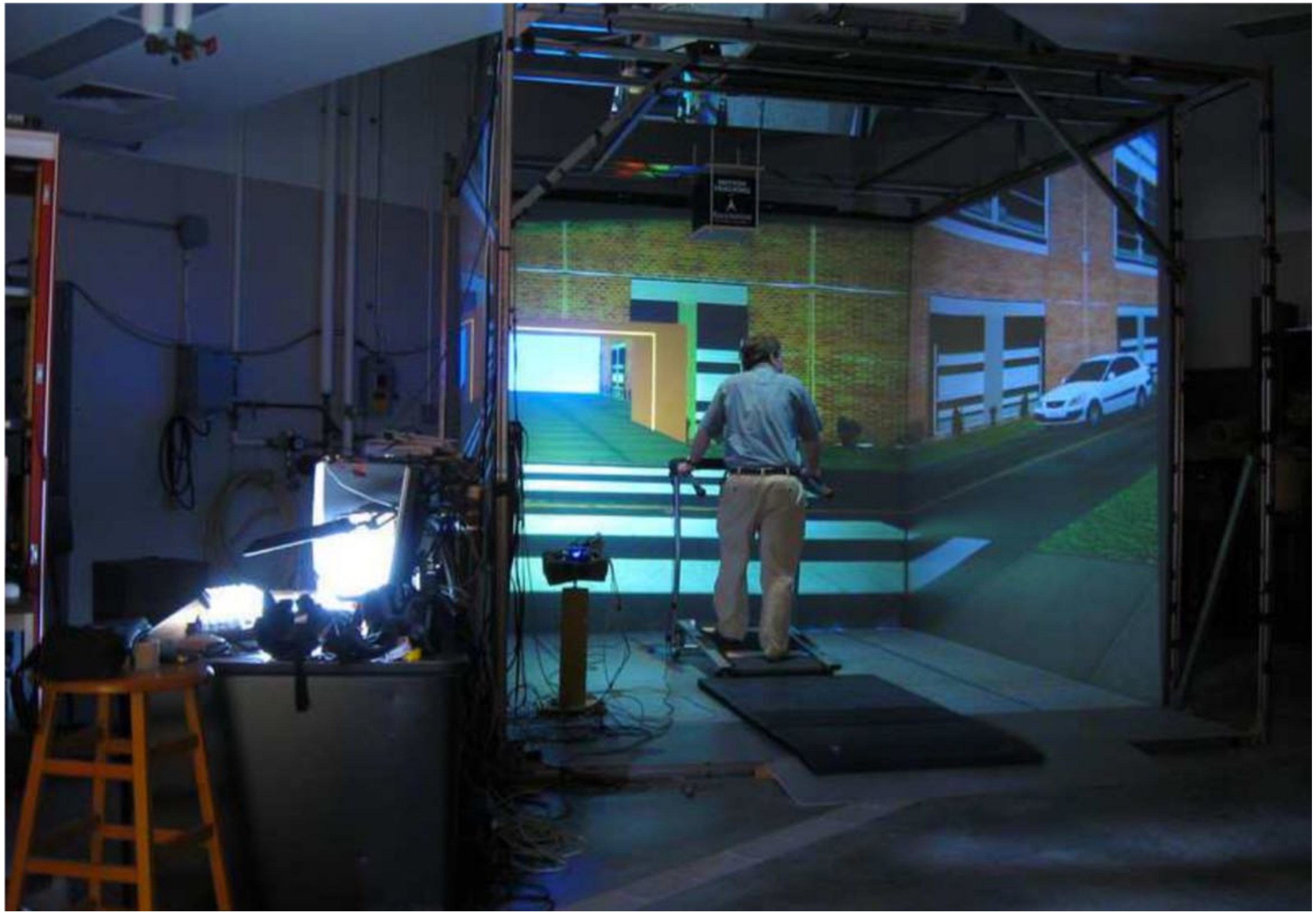
from simple
to realistic

Larger movie screens caused the popularity of 3D movies to wane in the 1950s



Constrained to a seated situation

CAVE, which
was introduced in 1992 at
the University of Illinois

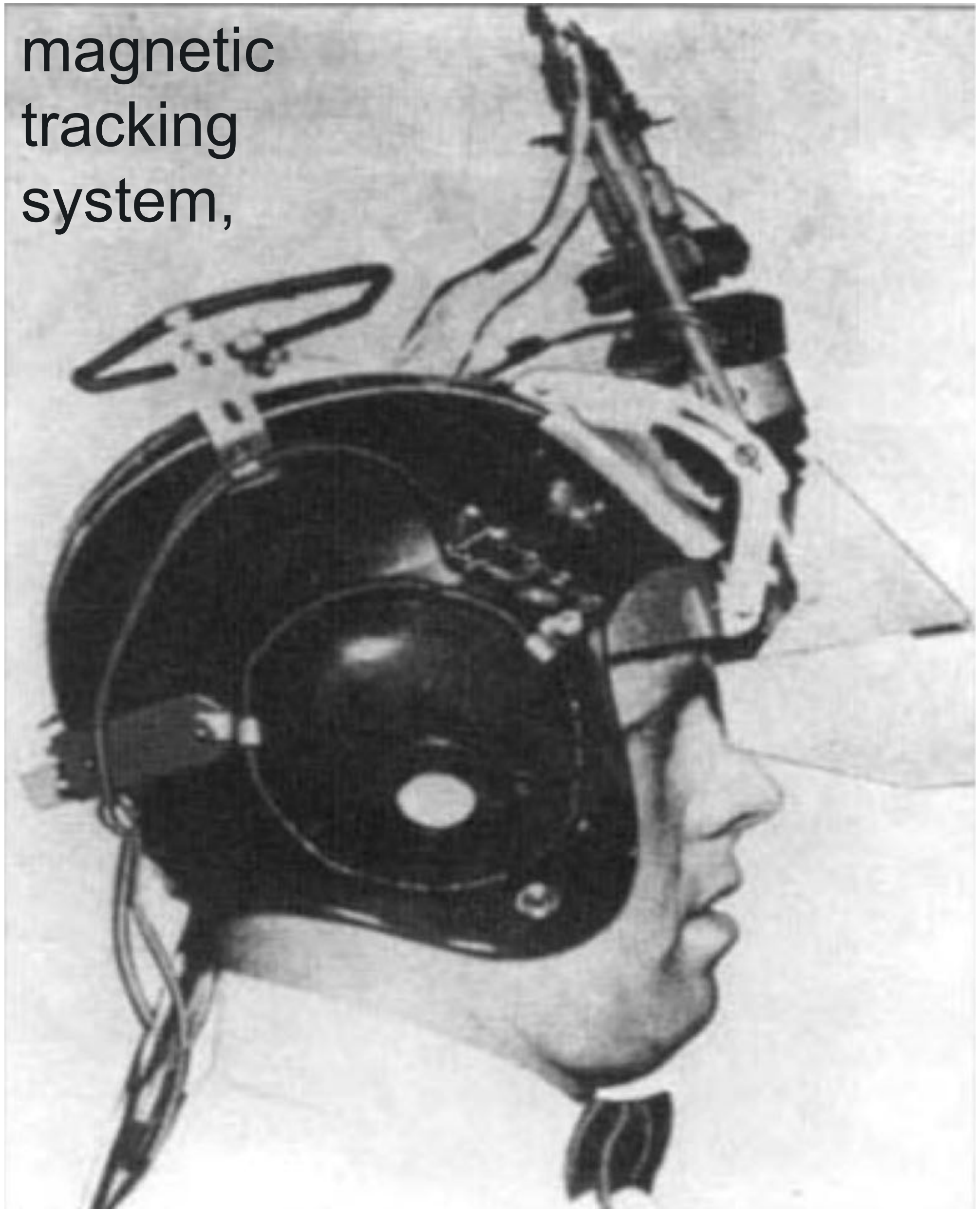


mobiity

In 1962,
Philco Corporation engineers built the first actual working tracked HMD that included head tracking.

as the user moves his head, a camera in a different room moved so the user could see as if he were at the other location.

- First HMD
- First telepresence system.



virtual
world

In 1968, Ivan proposed the first VR
headset that combines
head tracking and **computer graphics**

The perception of stationarity:
To make an object appear to be stationary while you move your sense organ, the device producing the stimulus must change its output to compensate for the motion. This requires sensors and tracking systems to become part of the VR system.

being there!!

the **ultimate display** would, of course, be a room within which the computer can **control the existence of matter**.

1965

The Ultimate Display

Ivan E. Sutherland

Information Processing Techniques
Office, ARPA, OSD

We live in a physical world whose properties we have come to know well through long familiarity. We sense an involvement with this physical world which gives us the ability to predict its properties well. For example, we can predict where objects will fall, how well-known shapes look from other angles, and how much force is required to push objects against friction. We lack corresponding familiarity with the forces on charged particles, forces in non-uniform fields, the effects of nonprojective geometric transformations, and high-inertia, low friction motion. A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland.

Computer displays today cover a variety of capabilities. Some have only the fundamental ability to plot dots. Displays being sold now generally have built in line-drawing capability. An ability to draw simple curves would be useful. Some available displays are able to plot very short line segments in arbitrary directions, to form characters or more complex curves. Each of these abilities has a history and a known utility.

It is equally possible for a computer to construct a picture made up of colored areas. Knowlton's movie language, BEFLIX [1], is an excellent example of how computers can produce area-filling pictures. No display available commercially today has the ability to present such area-filling pictures for direct human use. It is likely that new display equipment will have area-filling capability. We have much to learn about how to make good use of this new ability.

The most common direct computer input today is the typewriter keyboard. Typewriters are inexpensive, reliable, and produce easily transmitted signals. As more and more on-line systems are used, it is likely that many more typewriter consoles will come into use. Tomorrow's computer user will interact with a computer through a typewriter. He ought to know how to touch type.

A variety of other manual-input devices are possible. The light pen or RAND Tablet stylus serve a very useful function in pointing to displayed items and in drawing or printing For input to the computer. The possibilities for very smooth interaction with the computer through these devices is only just beginning to be exploited. RAND Corporation has in operation today a debugging tool which recognizes printed changes of register contents, and simple pointing and moving motions for format relocation. Using RAND's techniques you can change a digit printed on the screen by merely writing what you want on top of it. If you want to move the contents of one displayed register into another, merely point to the first and "drag" it over to the second. The facility with which such an interaction system lets its user interact with the computer is remarkable.

Knobs and joysticks of various kinds serve a useful function in adjusting parameters of some computation going on. For example, adjustment of the viewing angle of a perspective view is conveniently handled through a three-rotation joystick. Push buttons with lights are often useful. Syllable voice input should not be ignored.

In many cases the computer program needs to know which part of a picture the man is pointing at. The two-dimensional nature of pictures makes it impossible to order the parts of a picture by neighborhood. Converting from display coordinates to find the object pointed at is, therefore, a time-consuming process. A light pen can interrupt at the time that the display circuits transfer the item being pointed at, thus automatically indicating its address and coordinates. Special circuits on the RAND Tablet or other position input device can make it serve the same function.

What the program actually needs to know is where in memory is the structure which the man is pointing to. In a display with its own memory, a light pen return tells where in the display file the thing pointed to is, but not necessarily where in main memory. Worse yet, the program really needs to know which sub part of which part the man is pointing to. No existing display equipment computes the depths of recursions that are needed. New displays with analog memories may well lose the pointing ability altogether.

Other Types of Display

If the task of the display is to serve as a looking-glass into the mathematical wonderland constructed in computer memory, it should serve as many senses as possible. So far as I know, no one seriously proposes computer displays of smell, or taste. Excellent audio displays exist, but unfortunately we have little ability to have the computer produce meaningful sounds. I want to describe for you a kinesthetic display.

The force required to move a joystick could be computer controlled, just as the actuation force on the controls of a Link Trainer are changed to give the feel of a real airplane. With such a display, a computer model of particles in an electric field could combine manual control of the position, of a moving charge, replete with the sensation of forces on the charge, with visual presentation of the charge's position. Quite complicated "joysticks" with force feedback capability exist. For example, the controls on the General Electric "handyman" are nothing but joysticks with nearly as many degrees of freedom as the human arm. By use of such an input/output device, we can add a force display to our sight and sound capability.

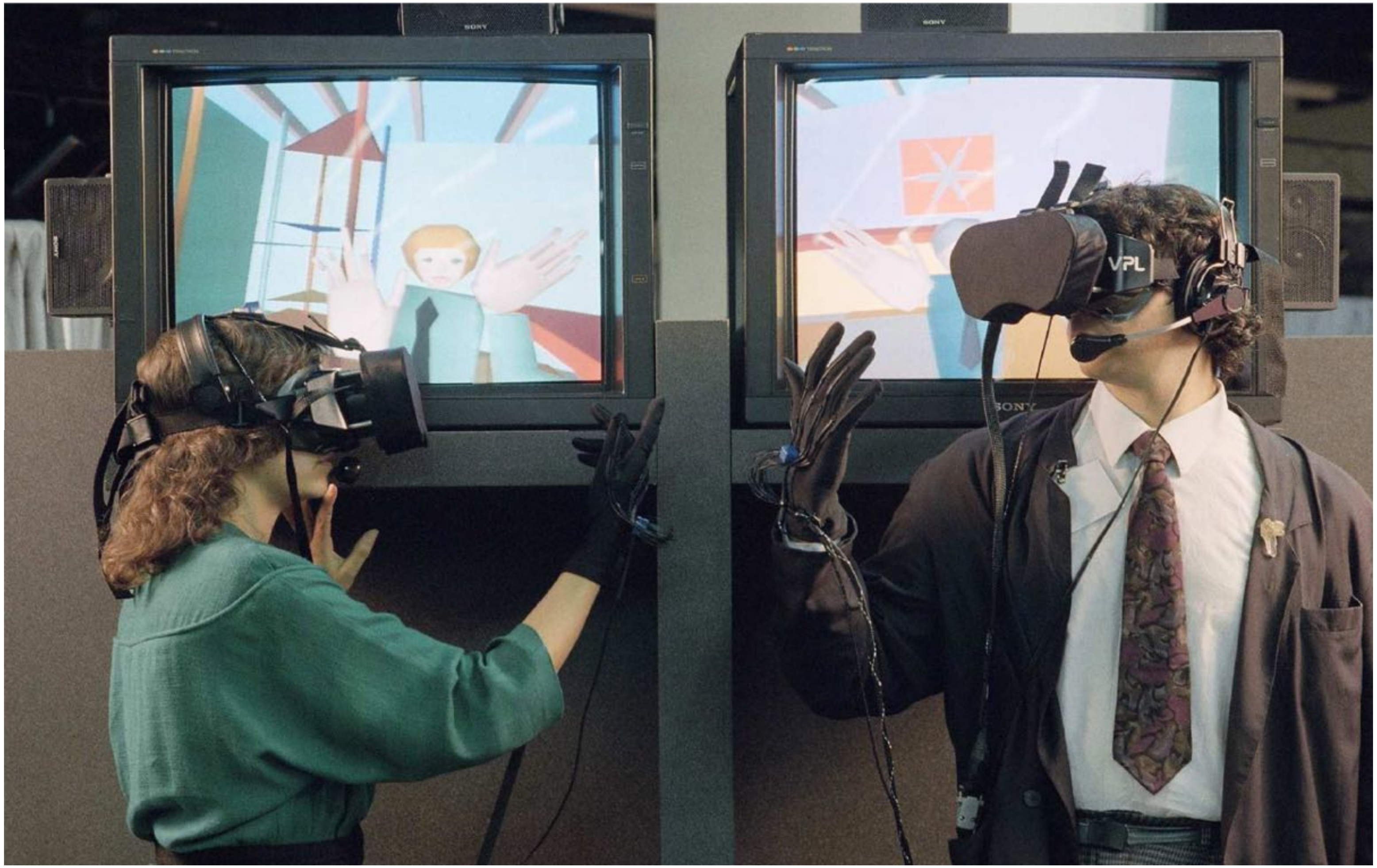
1980s, goggles and gloves

The NASA VIEW system

Virtual interface
Environment
Workstation

Optical flex sensors to measure **finger bending**

Tactile vibrator **feedback**



1990s: VR exploded.

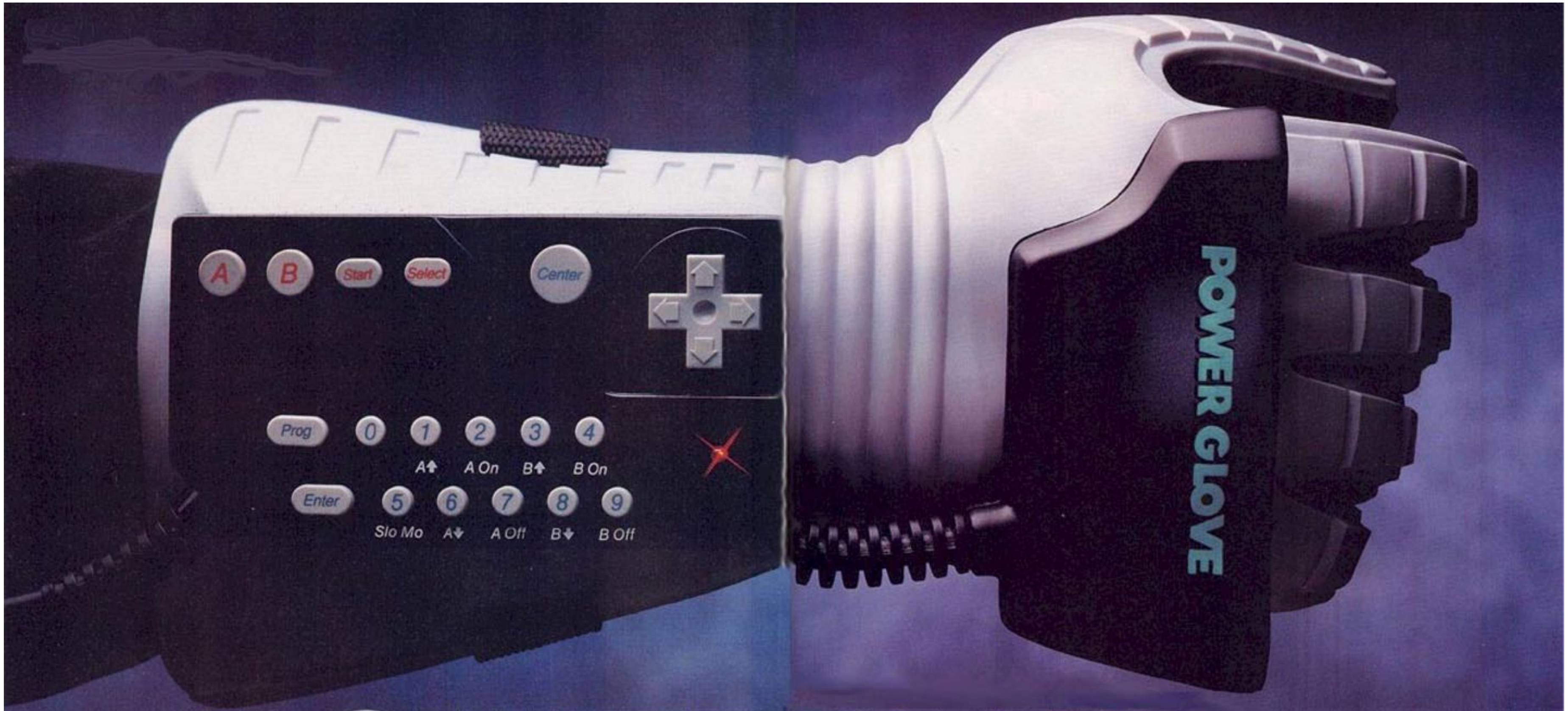
Sega, Disney, General Motors.

1993.
Wired magazine predicted that within five years more than one in ten people would wear HMDs while traveling in buses, trains and planes.

1995.
New York Times reported that VR market to reach 4 billion by 1998.

1990s,

VR-based video games appeared
in arcades games



POWERPLAY.

The Power Glove.™ You plug it in like any joystick. But the similarity stops there. Because now you don't just guide the action. You're in the action.

As soon as you put on the Power Glove, its 3-D sensors track the position of your hand in space. You enter the program code. Calibrate the glove. Center it. And feel the mechanical moves of a joystick give way to free-flowing, instant response. You actually knock out Mike Tyson. Grab the steering wheel of Rad Racer.* Bank and fire your P-38 in 1943™ The Battle of Midway. All simply by moving your hand.

The Power Glove has a unique programmable keypad that gives the best NES™ players moves they've never had before—and never will have with a joystick. Twist your wrist for an immediate head butt in Double Dragon. Bend a finger for "Thrash Mode"—your character turns and shoots in all possible directions. Bend another for "One-Shot Turnaround": you automatically change direction and fire faster than you ever could with a joystick.

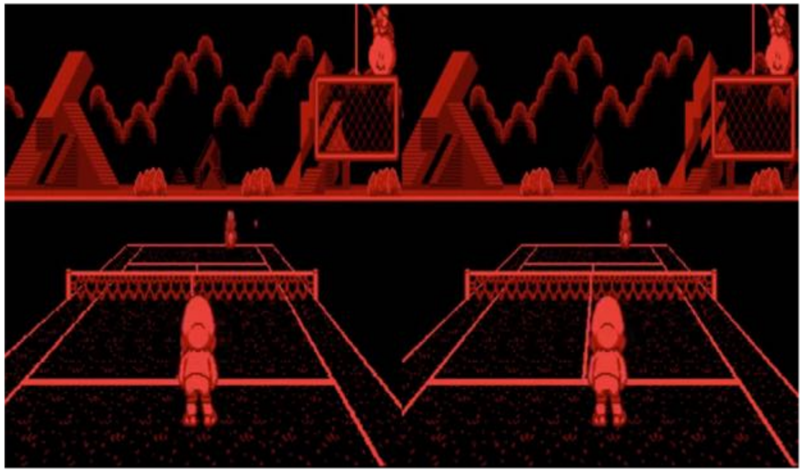
With new moves at your disposal, it makes your joystick games especially vertical scroll games, new. Different. More exciting.

And that's only the beginning.

and at home

1995, Virtual Body
from Nintendo

- the experiences were not compelling or comfortable enough to attract mass interest.




VIRTUAL BOY
Mario 00
Donkey 00

wii

switch

1998. VR bubble burst

Technology could not support the promise of VR.
VR going out of business.

2000s : VR winter.

research continued at corporate, government, academic, and military laboratories.

Not directly for VR,
but very much inspired
by Ivan’s concept of
Ultimate Display

Not directly for VR,
but very much inspired
by Ivan’s concept of
Ultimate Display

switch


Joy-Con
Rotation

MxR Lab’s open source project on low-cost
Field of View To Go (FOV2GO) own

2012. IEEE VR. Best Demo Award.

A member of that lab, **Palmer Luckey**, started sharing his prototype on Meant to be seen.

Shortly, he left the lab and
launched the Oculus Rift on kickstarter.

The new era of VR was born.


AUGUST 17, 2015
TIME
The Surprising Joy of
Virtual Reality
And why it's about to change the world
By Joel Stein

The Story of VR - A Look at the History Behind Virtual Reality

Real Environment
Augmented Reality (AR)
Augmented Virtuality (AV)
Virtual Reality (VR)
Spatial Real World
Mixed Reality
Immersive Virtual World
Google Glass
Oculus Rift DK1

Extended Reality (XR)

- a superset which includes the entire spectrum from "the complete real" to "the complete virtual”
- an umbrella term for virtual, mixed, and augmented reality
- all real-and-virtual combined environments

- Wikipedia

VR sickness

perceptual psychology

problems in the VR hardware and low-level software

a careless VR developer who misunderstands or disregards
the side effects of the experience on the user.

VR has the power to overwhelm the senses and the brain, leading to fatigue or sickness.

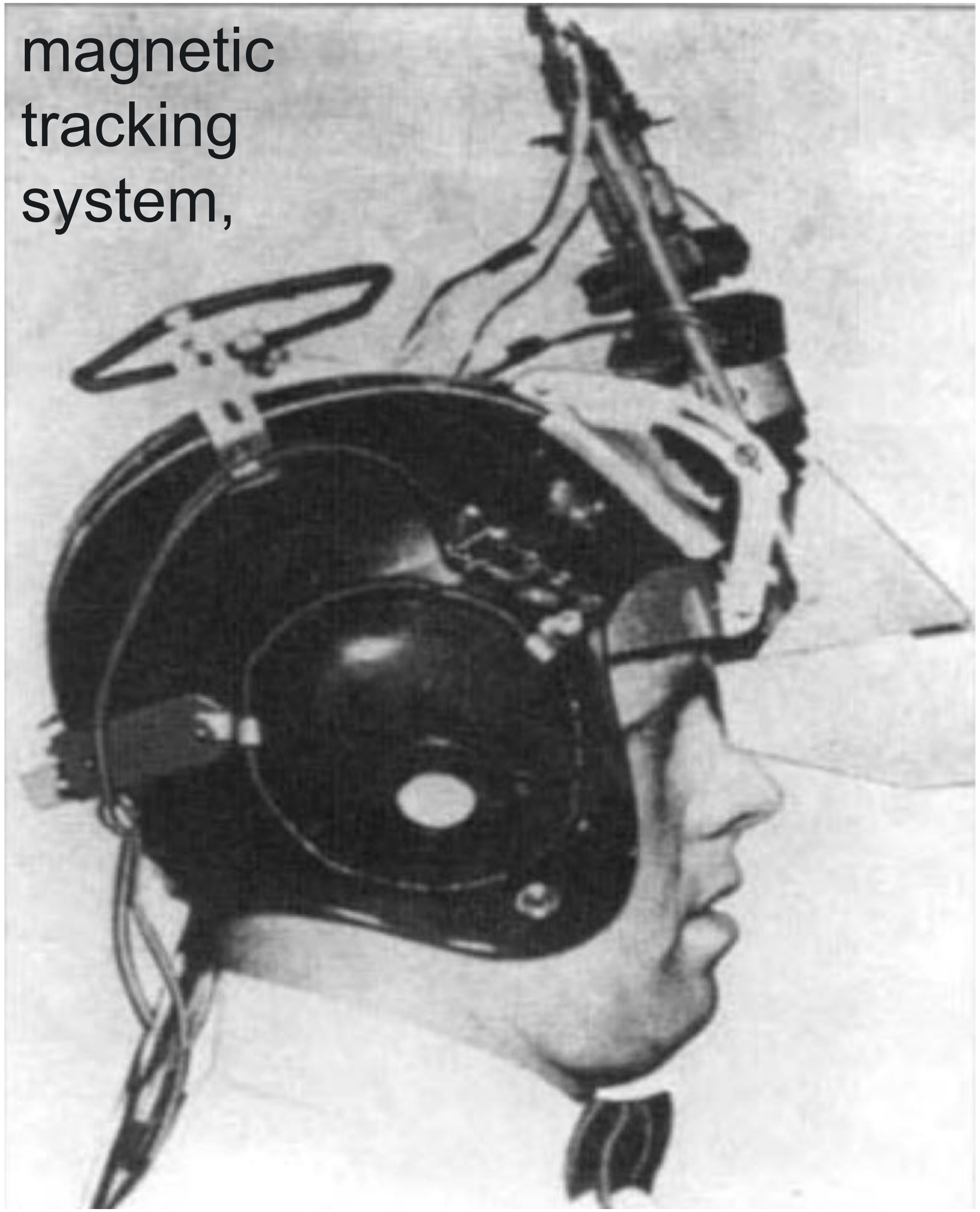
Gorilla arms syndrome

Various “realities”

The most important idea of VR is that the user’s perception of reality has been **altered** through engineering, rather than whether the environment they believe they are in seems more “real” or “virtual”.

Telepresence

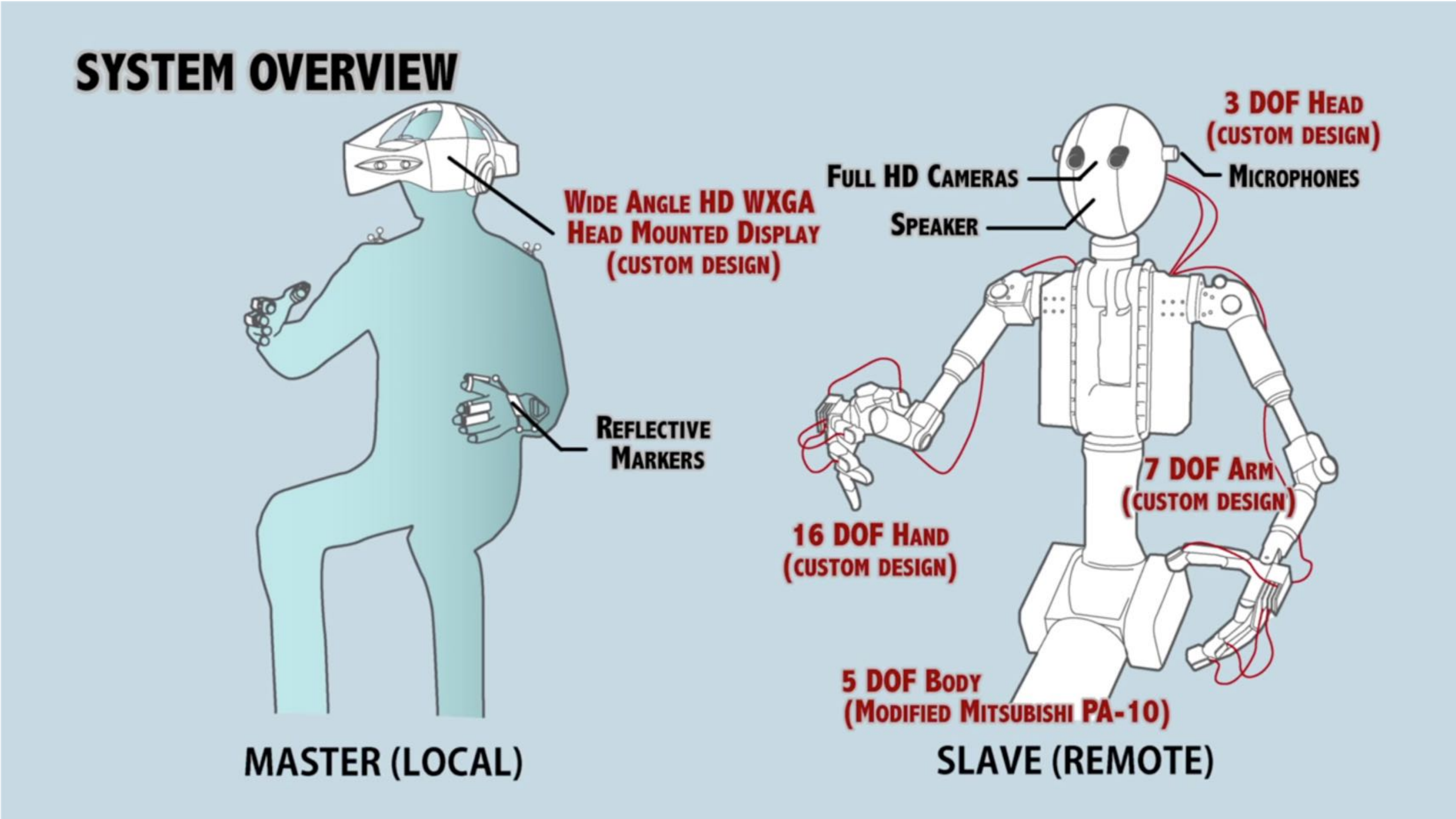
1962

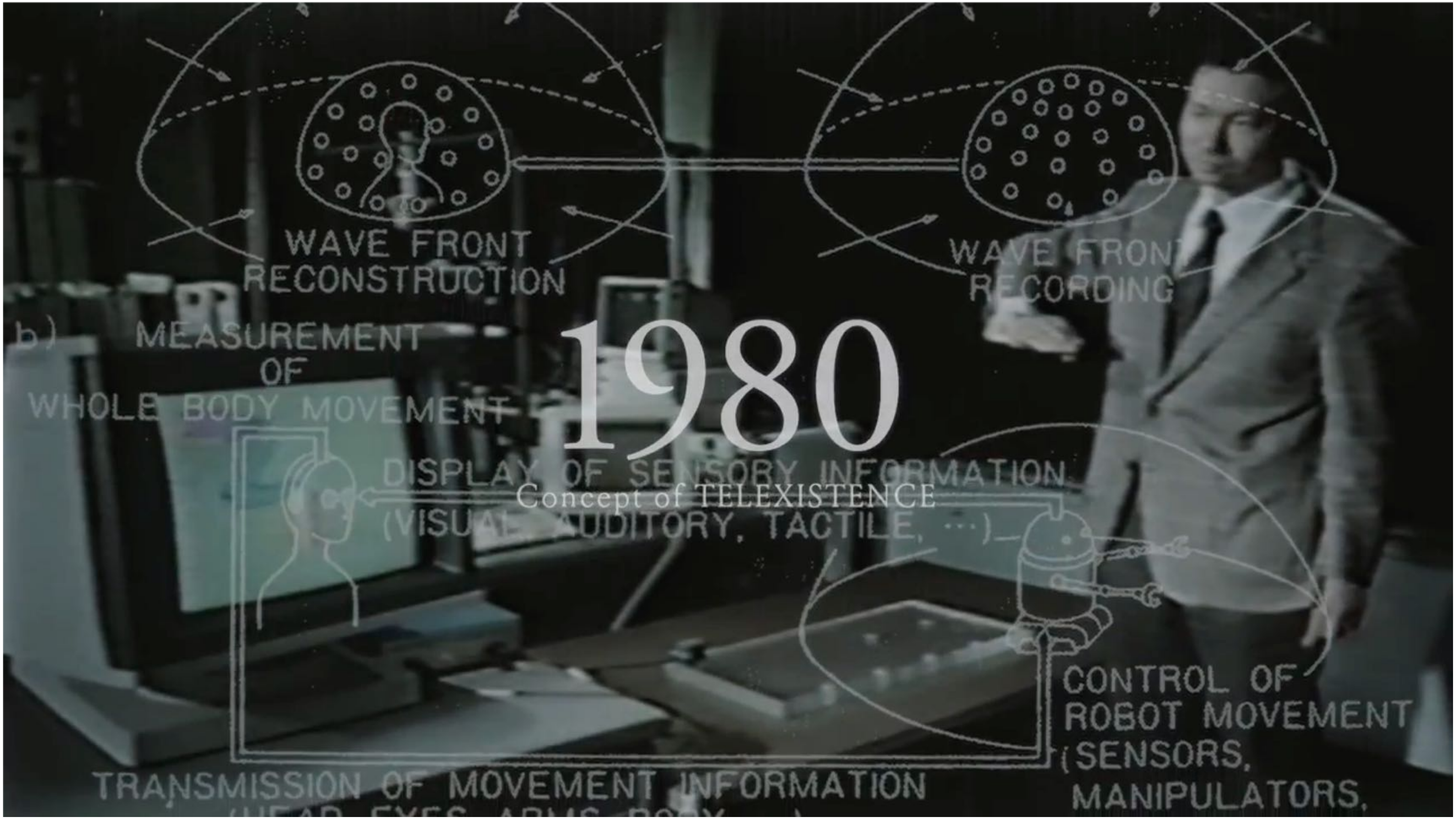


Telexistence

1981, Susumu Tachi

Telesar V


SYSTEM OVERVIEW
WIDE ANGLE HD WXGA
HEAD MOUNTED DISPLAY
(CUSTOM DESIGN)
REFLECTIVE
MARKERS
MASTER (LOCAL)
3 DOF HEAD
(CUSTOM DESIGN)
FULL HD CAMERAS
MICROPHONES
SPEAKER
7 DOF ARM
(CUSTOM DESIGN)
16 DOF HAND
(CUSTOM DESIGN)
5 DOF BODY
(MODIFIED MITSUBISHI PA-10)
SLAVE (REMOTE)


1980
Concept of TELEXISTENCE
WAVE FRONT RECONSTRUCTION
WAVE FRONT RECORDING
b) MEASUREMENT OF WHOLE BODY MOVEMENT
DISPLAY OF SENSORY INFORMATION
(VISUAL, AUDITORY, TACTILE, ...)
CONTROL OF ROBOT MOVEMENT
(SENSORS, MANIPULATORS,
TRANSMISSION OF MOVEMENT INFORMATION

Virtual Reality

1968

being there!!

- Virtual Reality
- Augmented Realty
- Mixed Reality
- Extended Reality
- Telepresence
- Telexistence

Dennou Coil

a Japanese science fiction anime television series`

- The children access the virtual world through Internet-connected visors called dennō eyeglasses. This allows them to see virtual reality superimposed on objective reality.

- To visually confirm something as virtual, the children often lift their glasses from their eyes. The visors also work in conjunction with futuristic ear monitors placed behind the ear, which allow the wearer to hear sounds from the virtual environment.