



# Virtual Reality

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## Introduction

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1



# Background

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- About me:
  - Anders Backman, C93
  - Been working at HPC2N, VRlab since 1998 doing Visualization and VR, development, courses, project leader.
- About the course
  - 3:rd year
  - Constantly evolving, fast moving target.
  - Several lecturers – Multidisciplinary area
    - Kenneth Holmlund, VRlab
    - Torbjörn Wiberg, CS
    - Lars-Erik Janlert, CS
    - Steven Nordin, Psychology

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## Future

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- Plans on establishing Master Degree in Game Development.
  - Graphics
  - AI
  - Network
  - Story-writing
  - Modeling
  - ...



## Material

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- WWW
  - <http://www.cs.umu.se/kurser/TDBD12>
  - Note!
    - WTK tips: lab/wtk/wtk-tips.html
    - FAQ lab/faq.html
- Book
  - Vince, John, *Virtual Reality Systems*
- Additional readings
  - Lecture notes (will be on the web).
- Articles
  - Will be on the web (some is also distributed on lectures)



## Labs

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- 2 individual
- 1 larger project (3-4 students)
- Software (installed in MA316 and exjobbslab)
  - WorldToolKit
  - World 2 World
  - MathEngine
  - AC3D
- Hardware
  - Polhemus Insidetrak (3)
  - Spaceball (3)
  - Sony HMD (3)

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## What is Virtual Reality?

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- Virtual Reality (VR) [Virtuell Verklighet]
- From the definition of the Swedish National Encyclopedia:
  - *"En datorgenererad skenvärld i vilken användaren upplever sig vara och agera"* (Lars-Erik Janlert)
- *"a computer-synthesized, three-dimensional environment in which a plurality of human participants, appropriately interfaced, may engage and manipulate simulated physical elements in the environment and in some forms, may engage and interact with representations of other humans, past, present, or fictional, or with invented creatures."* (Nugent 1991)
- *"a way to visualize, manipulate, and interact with computers, and extremely complex data."* (Isdale, 1998)
- *"it's a cartoon world you can get into."* Larijani (1993)

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6



## VE, VR

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- Virtual Environment (VE) [Virtuell Miljö]
  - A computer generated and maintained world that a user can be placed "in".
    - Surrounds user
    - Using "all" modalities
      - Vision, ears, balance, touch, smell, taste
    - The world behaves as expected, or as needed by the application
- VR == VE
  - Used synonymously with virtual environment in most cases.
- Characteristics
  - 3D/Stereo
  - Real time
  - Direct interaction (grabbing, pushing, pointing, ...)
  - First person view
  - Presence

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## Presence

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- Virtual presence... Is experienced by a person when sensory information generated only by and within a computer compels a feeling of being present in an environment other than the one the person is actually in" (Sheridan, 1992, pg.6)
- *Presence* – The feeling of being present somewhere
- *Virtual Presence* – the feeling of being present in a simulated environment
- Why is it important?
  - It is easier to understand and interact with a 3D world if you are there.
  - Example: navigating a car.
- Sense of presence improves with realism
  - Some aspects of realism weigh more heavily than others (ex. motion vs. Gravity, texture vs. Shadows)
- Amount of realism necessary is dependent on the application.
  - Need to identify the necessary stimuli.

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8



# Immersion

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- Also called presence
- Produced by:
  - Enveloping environment
  - Natural interaction
  - Realism
  - Responsiveness
    - Flight simulators, pilots grounded when crashing.

<u>Example</u>	<u>VE?</u>	<u>Immersive?</u>
Presentation	No	No
IMAX Movie	N	Yes
VRML world	Yes	No
CAVE	Yes	No

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9



# Categories of VR

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- Desktop VR
  - 3D world shown on monitor, mouse and keyboard input to interact.
  - Low cost, standard PC.
  - VRML, Games
- Augmented Reality
  - A seamless mix between real world and Computer Graphics (CG) as well as sound.
- Telepresence
  - The use of various technologies to produce the effect of placing the user in another location.
- Immersive VR
  - Using other display technologies (helmets, walls, ...)
  - User tracked in some sense

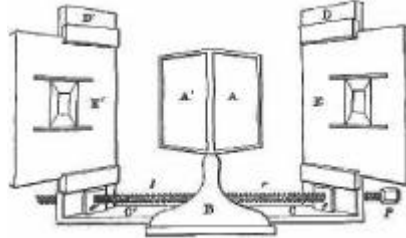
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10

# History of VR

- 1838 – Wheatstone Stereoscope



- Getting inside the picture
  - Early 1950s – Cinerama (Fred Waller)
    - Movie screen big enough to give a 180° horizontal view.
    - Viewers feel like they're in the scene
    - Required 3 cameras and 3 projectors (very much like modern Powerwalls!!)

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11

# History

- 1956 – Sensorama (Morton Heilig)
  - Binocular-like viewing device
  - Vibrating seat
  - Air blowers
  - Stereophonic speakers
  - Odor generator



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12

## History

- Being in a Computer Controlled world
  - 1965 – The Ultimate display vision of Ivan Sutherland
    - Data Visualization: *"A display connected to a digital computer...is like a looking glass into a mathematical Wonderland."*
    - Realism: *"A chair display in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal."*
    - Beyond reality: *"There is no reason why the objects displayed by a computer have to follow ordinary rules of physical reality with which we are familiar."*
  - First Head-Mounted Display VE
    - 1968 – Ivan Sutherland
      - CRT based
      - Hidden-line geometry
      - Mechanical head tracking
      - Binocular, not stereo
      - 40 degree of view.



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## History

- 1984 – NASA Ames Virtual Visual Environment (ViVED)
  - Dr. Michael McGreevy
  - For use for future astronauts
  - tactile input and feedback
  - Voice recognition.
- 1985 – NASA Ames Virtual Interface Environment Workstation (VIEW)



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14

## History

- First VR Company
  - 1985 – VPL Founded
    - Jaron Lanier and Thomas Zimmerman
      - DataGlove – First fully articulated hand
      - DataSuit
      - Jaron Lanier coined the term **Virtual Reality**.
- 1990 VR hit the Mainstream: Entertainment
  - 1991 Virtuality (UK)
    - Based on the Amiga 3000
    - 1-4 players, shoot 'em up
    - At Location Based Entertainment Centers
  - 1998 – DisneyQuest (Orlando)



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15

## Today

- US ARMY – spend close to \$1000 million 1998 in VR research.
- 1993 VR almost worked – 1999 it just works!
- Successful areas
  - Vehicle simulators
  - Entertainment
  - Vehicle design (VW, Volvo, BMW, ...)
  - Architecture
  - Training
  - Medicine
  - Geology

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## Problems

- Mismatching Sensory information
  - For example: Vision and acceleration is not matched in a flight-simulator. (Unless an advanced motion-platform is used).
  - Nausea could be the result
- Latency
  - Due to simulation, graphic rendering of scene, device updates, etc. a latency is introduced.
  - The time it takes for the system to react onto a users action
  - Could cause nausea
- Update frequency
  - Due to simulation, scene complexity, ...
  - The system can only generate a new image every  $n$  second (where  $n=1/x$  and  $x > 1$ ).
  - Frame rate
- Cyber sickness could be the result
- Using an HMD
  - Eye convergence

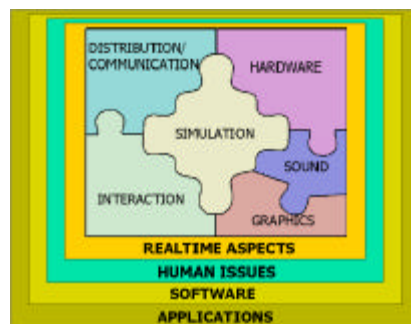
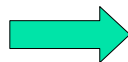
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17

## Developing a VE

- Lots of hardware
- Simulations
- Networking
- Graphics
- Real-time
- Interaction...



A Big puzzle

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18



## Contents of a VE

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- A VE consists of:
  - Objects, entities (cars, buildings, sky, ...)
    - Shape, color, texture – Geometry
    - Physical attributes – Weight, speed, position, etc...
  - User
    - Interacts with the environment
    - Sees through a virtual camera
    - Has a body (avatar)
    - speaks (Voice recognition)
    - Moves (gesture recognition)
  - Multiple users
    - Network connection
  - Simulation
    - What drives the application
      - Behavior
        - Event driven (if collide with that then do that).
        - Physical simulation driven (act according the objects physical attributes)
  - World
    - Connects all the different parts into an environment in which the user(s) can be.

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19



## Contents of this course

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- So how do we go on and create a VE?
- What should you demand from VR software?
- How do we obtain Real Time?
  - Optimize (cheat) but in a way so that the user doesn't notice it.
  
- This is the contents of this course.
  
- This is NOT a modelers course, although modeling is a very important aspect of VR

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20