VR display systems

- Morton Heilig began designing the first multisensory virtual experiences in 1956 (patented in 1961): Sensorama
- Projected film, audio, vibration, wind, and odors.
- The five "experiences" included
  - a motorcycle ride through New York
  - a bicycle ride
  - a ride on a dune buggy
  - a helicopter ride over Century city in 1960
  - a dance by a belly dancer.

- Heilig also patented an idea for a device that some consider the first Head-Mounted Display (HMD) (proposed 1960 and applied for patent in 1962).
  - Wide field of view optics to view 3D photographic slides.
  - Stereo sound.
  - Odor generator.
VR visual display systems

- “A head-mounted three-dimensional display” (Sutherland, 1968) by Iven. E. Sutherland:
  - Hidden-line graphics
  - Mechanical tracking
  - See through HMD
  - Quint Foster wearing the Head-Mounted Display (circa 1967)

VR visual display systems

- Head-mounted display (HMD)
  - Scene completely surrounds user
  - Graphics are sharp and bright
    - FOV is narrow
    - Devices are heavy, cumbersome
    - Can’t see other people (nowadays see-through with some devices)

- Boom (Binocular Omni Orientation Monitor)
  - High resolution (>1280x1024)
  - Wide Field of View
  - User must not carry heavy weight
  - Electromechanical tracking with minimal lag
    - Limited user movement
    - Requires the user to hold onto the BOOM for control
VR visual display systems

- Projection Walls
  - Active or passive stereo
  - Multi-projector systems require overlap

VR visual display systems

- Cylindrical Screen Configurations, e.g., Cone
  - Common in industry
  - Projection difficult, curved screen requires distortion correction in hardware or software
VR visual display systems

- (Responsive) Workbench
  - Table-top metaphor
  - Change display orientation
  - Integrates real & virtual
  - Less immersion
  - Occlusion/cancellation
  - Expensive

Baron workbench (courtesy of BARCO Co.)

- Two-Sided Workbench, holoscreen
  - Enlarged view volume (w.r.t. workbench)
  - Enhanced immersion
  - High resolution possible
  - Telepresence

Wall (door/window metaphor)
  - Allows 1:1 real object sizes
  - High resolution possible
  - Relative cheap
  - Screen size limit
  - Immersion breaks at the display borders

GMD/TAN 1997/98
VR visual display systems

- CAVE\textsuperscript{1} (Cave Automatic Virtual Environment)
  - Multi-wall (usually 4) provides wide FOV
  - Can see other people
  - Higher deg. of immersion
  - High resolution possible
  - Less bright with CRT, Wall-wall reflection with DLP etc.
  - Visible edge(s)
  - Calibration expensive
  - Expensive

\textsuperscript{1}registered trademark of Fakespace Systems

picture courtesy of Fakespace Systems
VR display systems

- Several more specialized visual display systems exist (see images on bottom/right).
- The term display system is not restricted to visual display system.
- Each sense for which stimuli has to be simulated requires its own display.
- Many VR systems (including the introduced ones) already include more than one display type, e.g., many visual displays include an auditory display (CAVEs, HMDs with earphones, etc.).