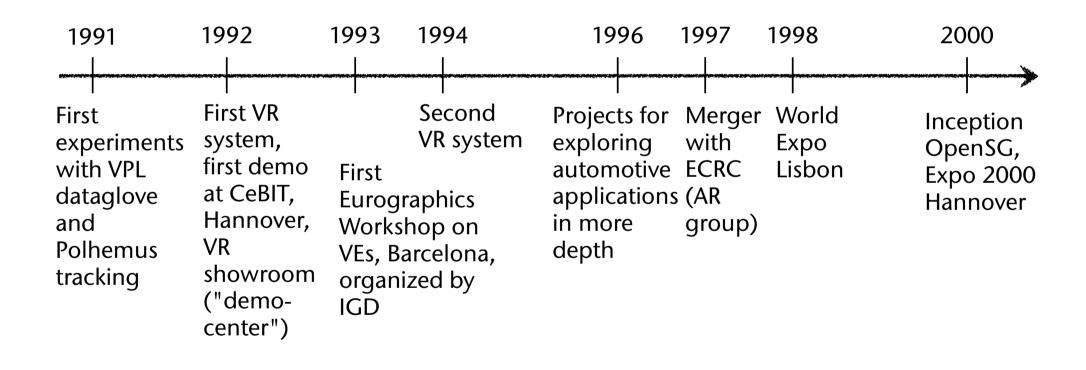# VR Research at Fraunhofer IGD, Department for VR and AR, Darmstadt, Germany
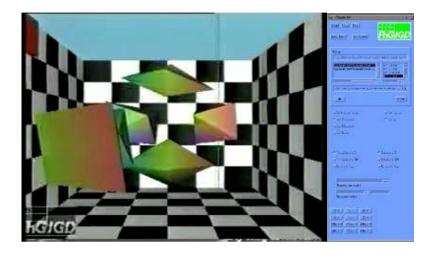
Wolfgang Felger, formerly BMW Information Management, Munich, Germany
Martin Göbel, Hochschule Bonn-Rhein-Sieg, Germany
Dirk Reiners, University of Central Florida, FL, USA
Gabriel Zachmann, University of Bremen, Germany

Timeline *(as far as memory serves me)*

1991
First experiments with VPL dataglove and Polhemus tracking

1992
First VR system, first demo at CeBIT, Hannover, VR showroom ("demo-center")

1993
First Eurographics Workshop on VEs, Barcelona, organized by IGD

1994
Second VR system

1996
Projects for exploring automotive applications in more depth

1997
Merger with ECRC (AR group)

1998
World Expo Lisbon

2000
Inception OpenSG, Expo 2000 Hannover

Early Applications

- 1992: 3D puzzle to investigate efficiency of 6 DOF interactions [SPIE 1992]
  - No HMD, no stereo, but Polhemus tracking and VPL dataglove
- 1993: VR sculpting ("potter")
  - Full-fledged VR application
  - Very simplistic 3D sculpting (virtual clay)

VR Hardware at IGD

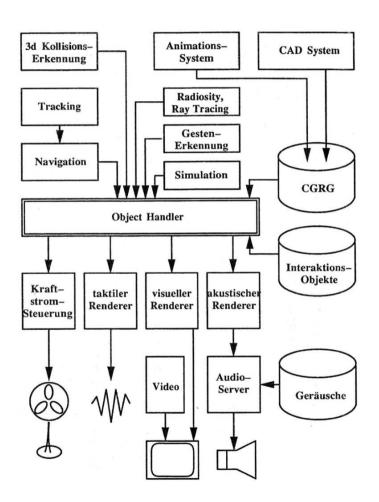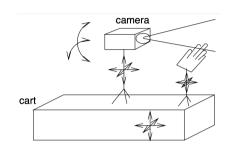With correction of tracking errors of electromagnetic systems using scattered data interpolation
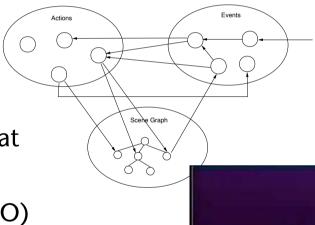
VR Systems: Virtual Design 1

- Grew out of former sci-vis software (Vis-a-Vis) [C&G 1993]
  - Not designed for realtime rendering
- Written in C, single-threaded
- Object handler as central DS
- Output channels: visual (HMD), audio (using HRTF's), tactile, fan

VR Systems: Virtual Design 2

- Started in 1994 during research stay at NCSA, Urbana-Champaign, Illinois

- Flying carpet paradigm as a general framework to describe navigation metaphors

- Proper scene graph

  - Multi-threaded, multi-pipe, pipelined
  - Highly optimized

- "Plugin framework" for loading code on demand at runtime using Unix' shared objects

- Description language and data flow paradigm (AEO) for behavior

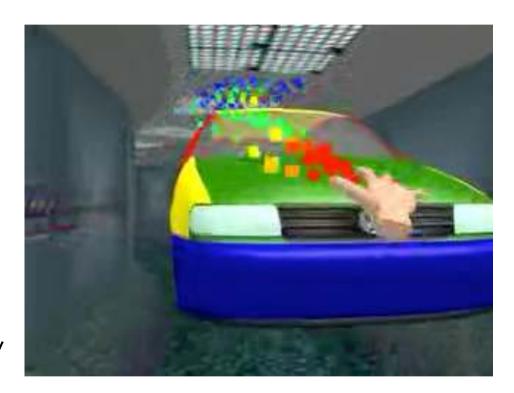- First VR system including exact collision detection natively for polygon soups (to my knowledge)

Demos and Shows

- CeBIT 1993, Hannover, Germany:
    - First full-fledged VR demo
    - Architectural walk-through through the new airport in Abu Dhabi
    - Simple 3D interactions (e.g., grasping using sticky metaphor)
- Siggraph 1994, Orlando, FL:
  demo in the Cave at VROOM
    - Interactions using dataglove and inverse kinematics
    - Pre-computed lighting using IGD's radiosity solver (Genesis)
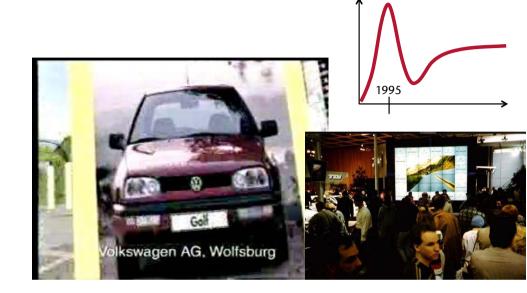   - Updating of lighting in background process

- Hannover Industry Expo 1995:

  - First VR show together with German company, Volkswagen

  - Initiated by Dr. Peter Zimmermann, then head of simulations research

  - Attended by Ferdinand Piëch, then CEO of Volkswagen

  - Goal: establish concept of virtual prototyping with automotive industry

Shows for Marketing

- Detroit Auto Show, January 1996:
  - Big installation on VW's booth accommodating some 50 participants per show
  - Shows every 30 minutes, 8 hours per day, 2 weeks
  - Only one incident when SGI's graphics board broke (replaced within 1 hour)
- Marketing tour through Switzerland for UBS:
  - VR installation on a truck
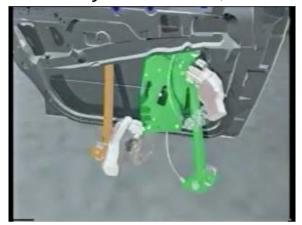 - HMD, SGI Crimson Reality engine, Polhemus tracking

Virtual Prototyping Projects with Automotive Industries (1996+)

Assembly simulation, BMW

Volkswagen (VW)

Ergonomic tests, with BMW

Volkswagen built their own applications, on top of our VR system

BMW AG, München
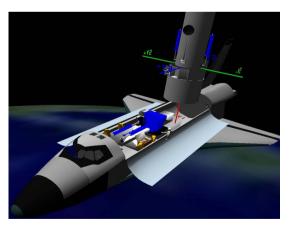IGD

Interior styling with BMW
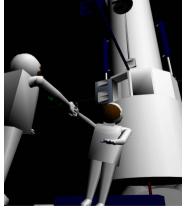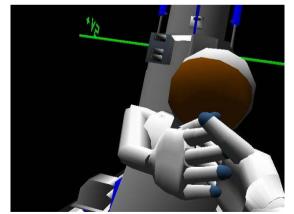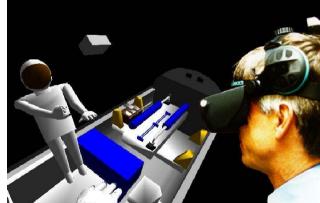
Car body styling, with VW

Volkswagen AG, Wolfsburg

Distributed, Collaborative Training of Astronauts

- Collaboration between NASA, JSC, Bowen Loftin, and IGD, 1995
- Partipitating astronauts in the experiment: Bernard Harris (NASA), Ulf Merbold (ESA)
- VR setup: HMDs, dataglove, joysticks, spacemouse, 2 × 64 kbit/sec bandwidth, update rate 5 Hz, latency 0.1 sec,
- Task: collaborative maintenance of the Hubble space telescope

Cultural Heritage

Caves of Dun Huang
Featuring projected
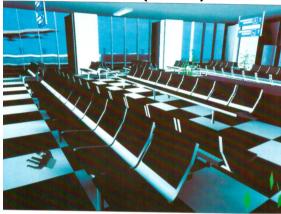light sources (1997)

Temple of Hera, Greece
AR demo

Cathedral of Siena,
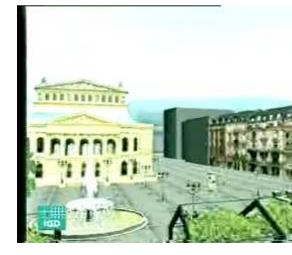Tuscany, Italy
(1999, for Expo
Hannover 2000)

Architecture

Abu Dhabi (1992)

Frankfurt, Germany (1995)
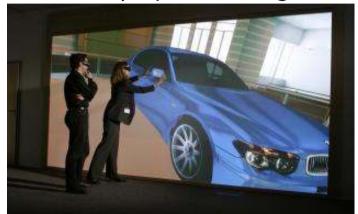

Darmstadt, Germany
Home town of IGD (1993)

Other Activities

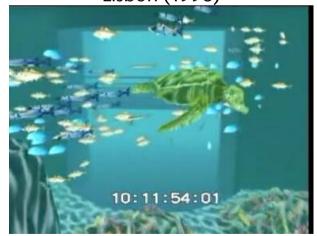IGD's HeyeWall: stereo projection using PC cluster (2002/2003)

Treatment of fear of flying, Lufthansa (1996/1997)
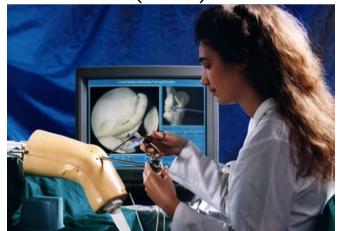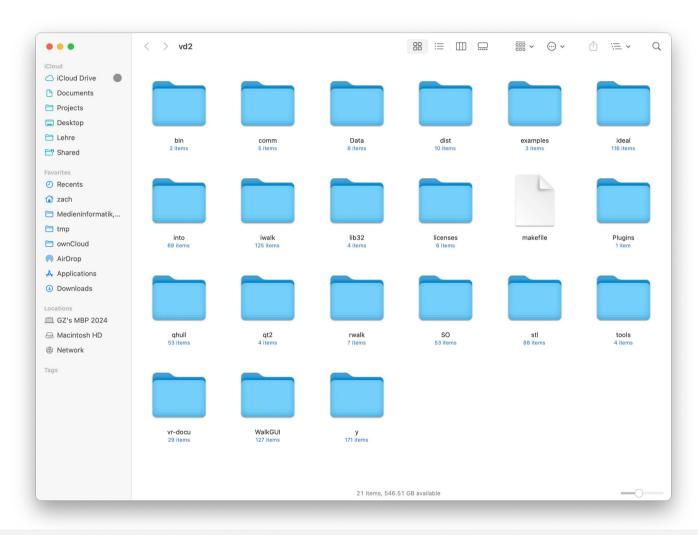
Virtual Oceanarium at World Expo, Lisbon (1998)

Training minimally invasive surgery (1994+)

Archiving the Code

People Involved in VR at IGD

Special Thanks to

- Head of IGD: José Encarnação

- Department Heads: Martin Göbel, Stefan Müller

- Researchers at IGD: Hermin Aftahi, Peter Astheimer, Fan Dai, Wolfgang Felger, Torsten Fröhlich, Thomas Frühauf, Helmut Haase, Elke Hergenröther, Udo Jakob, Kennet Karlsson, Wolfram Kresse, Bernd Lutz, Dirk Reiners, Frank Schöffel, Florian Schröder, Matthias Unbescheiden, Gabriel Zachmann, Rolf Ziegler,

- Students: Jochen Ehnes, Tatjana Neiss, Johannes Strassner, Hanno Wirth, Rolf Kruse,

- NCSA, Urbana-Champaign: Donna Cox, Bill Sherman, George Francis,

- Office of Naval Research: Larry Rosenblum

- NASA & U of Houston: Bowen Loftin