Human in the Loop and Ubiquitous Computing: Technologies for the Virtuality Continuum and Intelligent Environments

- State of the Art, Technology Trends, Roadmaps -

Prof. Dr.-Ing. José L. Encarnação
Fraunhofer IGD
Fraunhoferstrasse 5
64283 Darmstadt
Germany

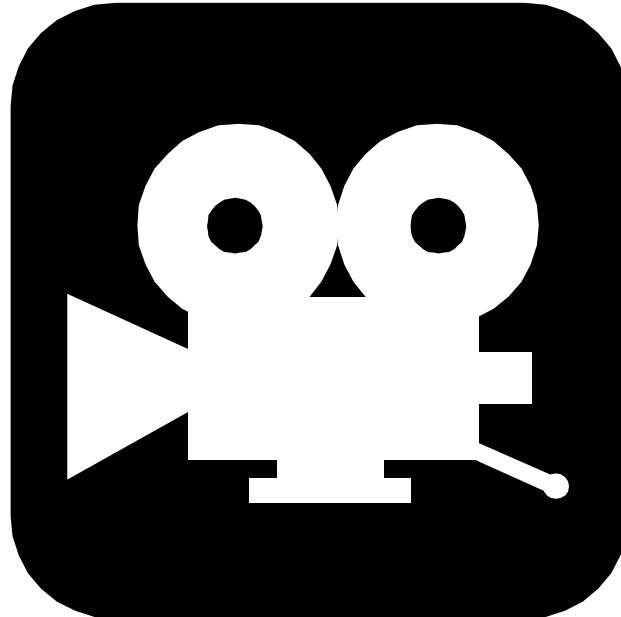Tel.: +49 (6151) 155 – 130; Fax.: +49 (6151) 155 - 430
Email: jle@igd.fhg.de; http://www.igd.fhg.de

Plzen, 7th February 2002

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Outline

➢ Actual Observations

➢ Development, Trends, Topics

➢ Roadmaps

    ↳ Technology

    ↳ Faculties

➢ Conclusion

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of
INI-GraphicsNet

Wieviel können wir
BEWEGEN?

Actual Observations

Video – Virtual Oceanarium

Fraunhofer Institut Graphische Datenverarbeitung

Member of INI-GraphicsNet

Observation 1:
Standard User Interface: hardly changed in 20 Years

What hasn't / has hardly changed:

➢ WIMP

    ↳ Windows

    ↳ Icons

    ↳ Menus

    ↳ Pointer

➢ Resolution
(today: 1280 x 1024)

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet

Standard User Interface...

... is a technology for a human with

⇨one eye

⇨one ear

⇨without mouth

⇨without body

⇨one hand

⇨one finger

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

The Complexity is Increasing ...

➢ Amount of available data

➢ Information worlds

➢ Networked systems

➢ Simulations

➢ Presentation methods

➢ ...

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Moore´s Law ...
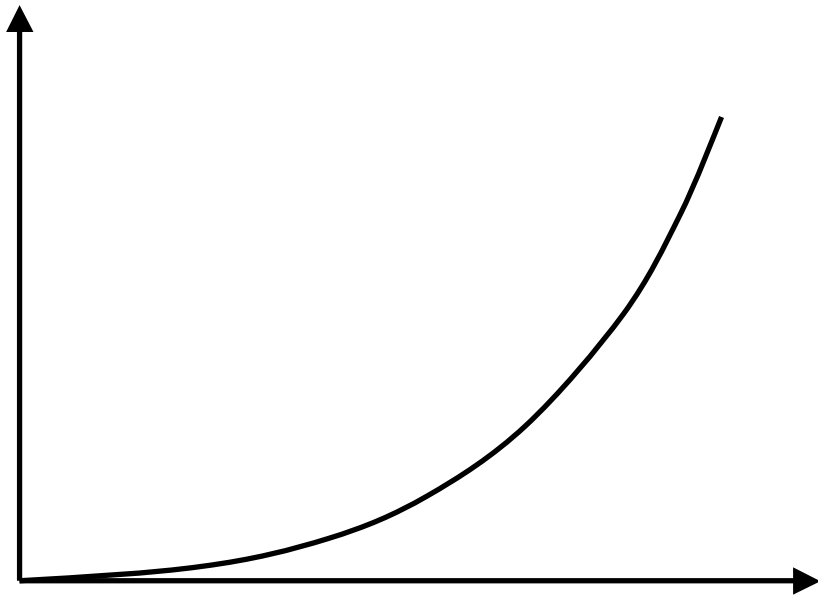
Twice the Performance every 18 Month

What does that really mean:

➢ **Computers in the future are**

    ↳ **faster**

    ↳ **more powerful**

    ↳ **cheaper**

as in the past

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

But ...
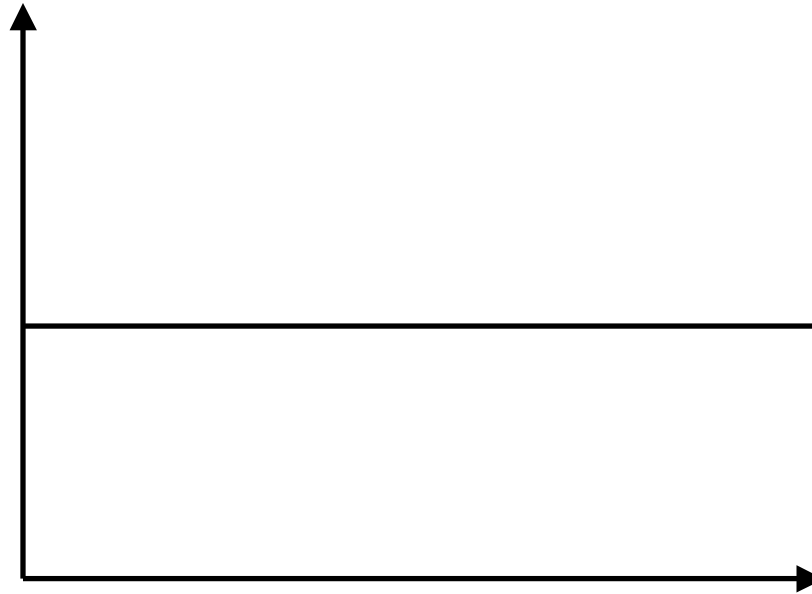
... the Capacity of the Human Brain is Constant!

Fraunhofer Institut Graphische Datenverarbeitung

Member of INI-GraphicsNet

Key Elements for further Development

Mobility

Ubiquity

Multimodality

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet
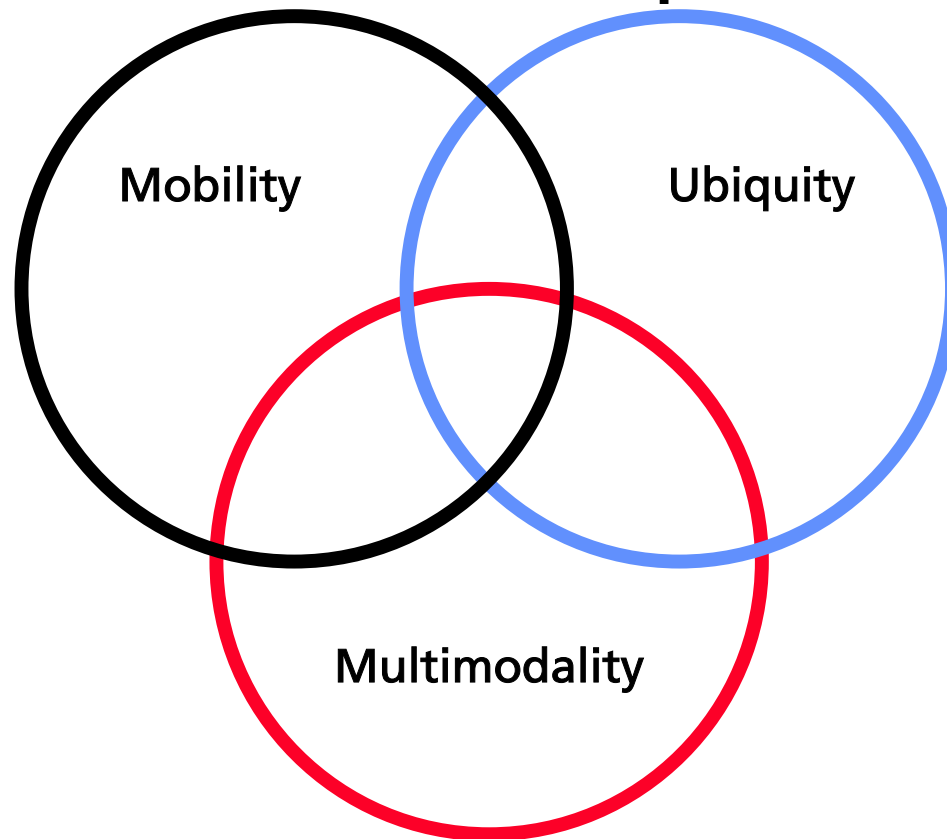
Mobility

User Support

➢ Everywhere

➢ Anytime

➢ For every task!

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
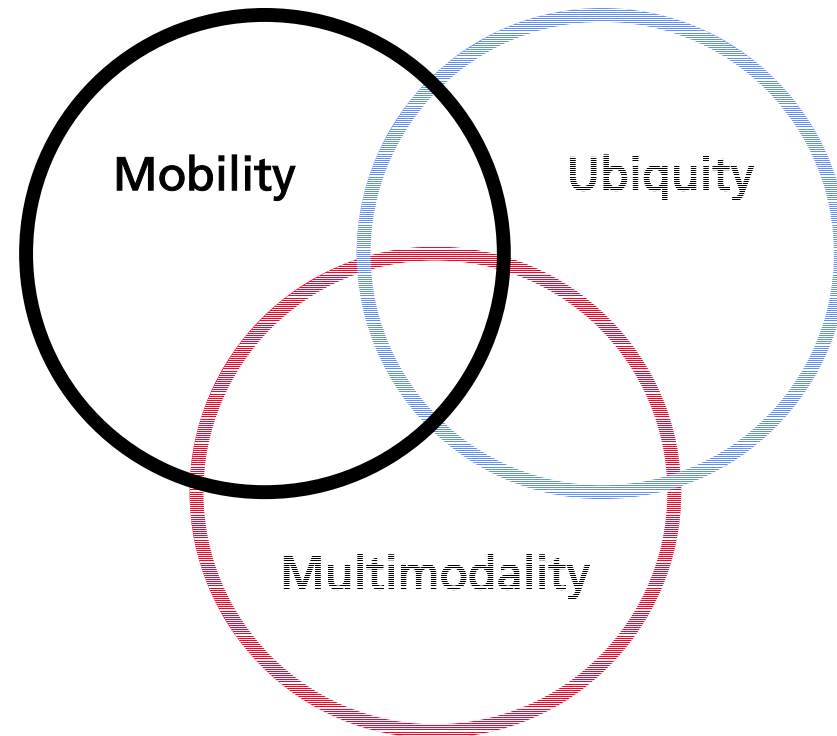
Ubiquity

Computer

- ➢ Everywhere

- ➢ Anytime

- ➢ For everyone!

Mobility

Ubiquity

Multimodality

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet
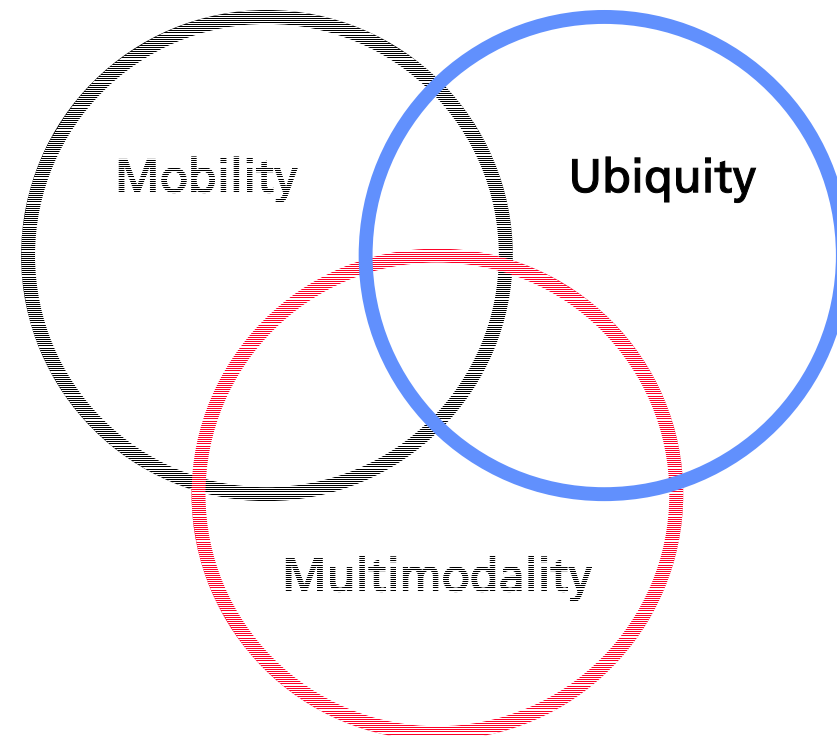
Multimodality

We remember

➢ **10% of what we read**

➢ **20% of what we hear**

➢ **30% of what we see**

➢ **50% of what we hear and see**

➢ **70% of what we say**

➢ **90% of what we do**

Mobility   Ubiquity

Multimodality

Fraunhofer Institut
Graphische
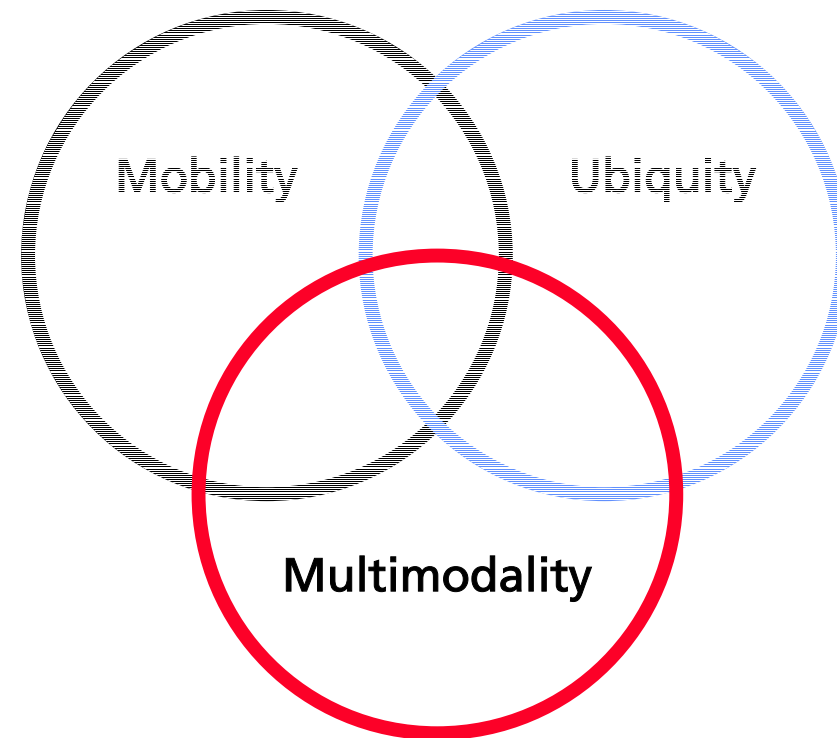Datenverarbeitung

Member of

INI-GraphicsNet
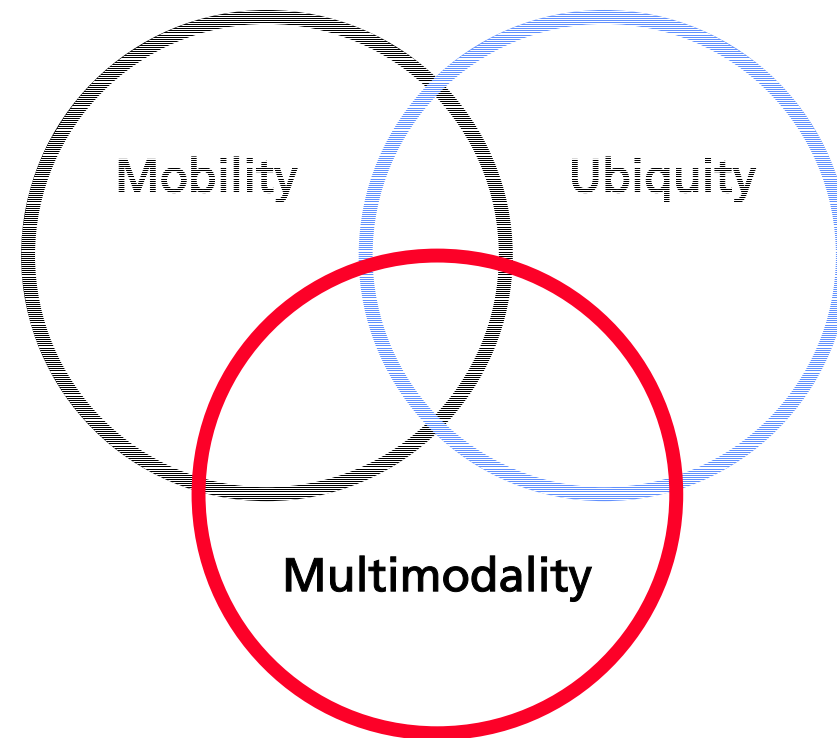
Multimodality

Data types

➢ Text

➢ Image (static, dynamic)

➢ Video

➢ Music

Requirement

➢ Multimodal navigation and/or
to experiment in computer
generated worlds

Mobility

Ubiquity

Multimodality

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Development, Trends, Topics

Today

Computer graphics is today

➢ Visualization

➢ Interaction with visual information

➢ Visual communication over networks

**... where is the expected quantum leap?**

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of
INI-GraphicsNet

The Evolution

➢ Leave the „desktop"

➢ Millions of users

➢ Web-based „visual" services

➢ 2D und 3D „for all"

➢ Interactive video technology

➢ Interactive broadcasting

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet

The **Revolution** needs a **quantum leap**

➢ **„Rendering" for other senses** has to be developed and consistently integrated into the „Rendering-Pipeline"

➢ **Integration** of our **biological system** with **computers** and other communication systems

➢ The man-machine interface becomes „fuzzy"

➢ **Paradigm shift**

   ⬥ Virtuality-Continuum

   ⬥ Human-Centered Computing and Interaction

   ⬥ Mobility and Ubiquity

Fraunhofer Institut
Graphische
Datenverarbeitung
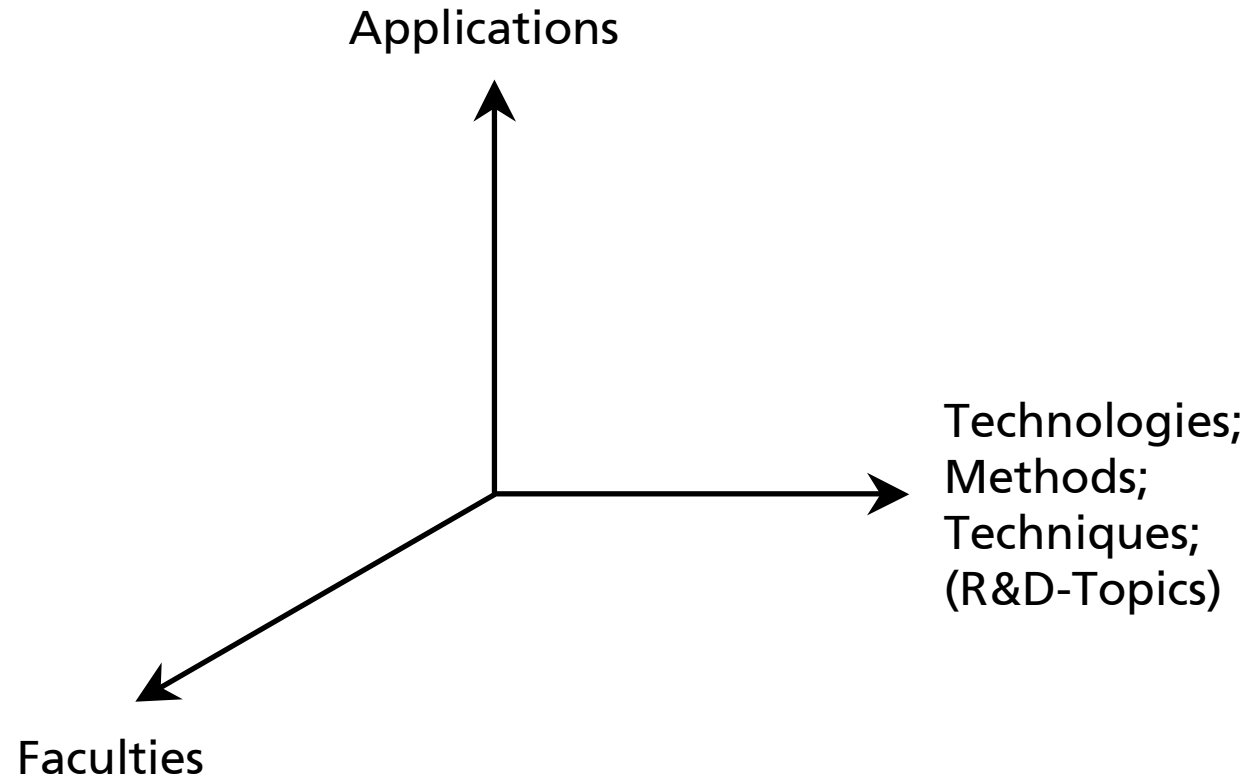
Member of

INI-GraphicsNet
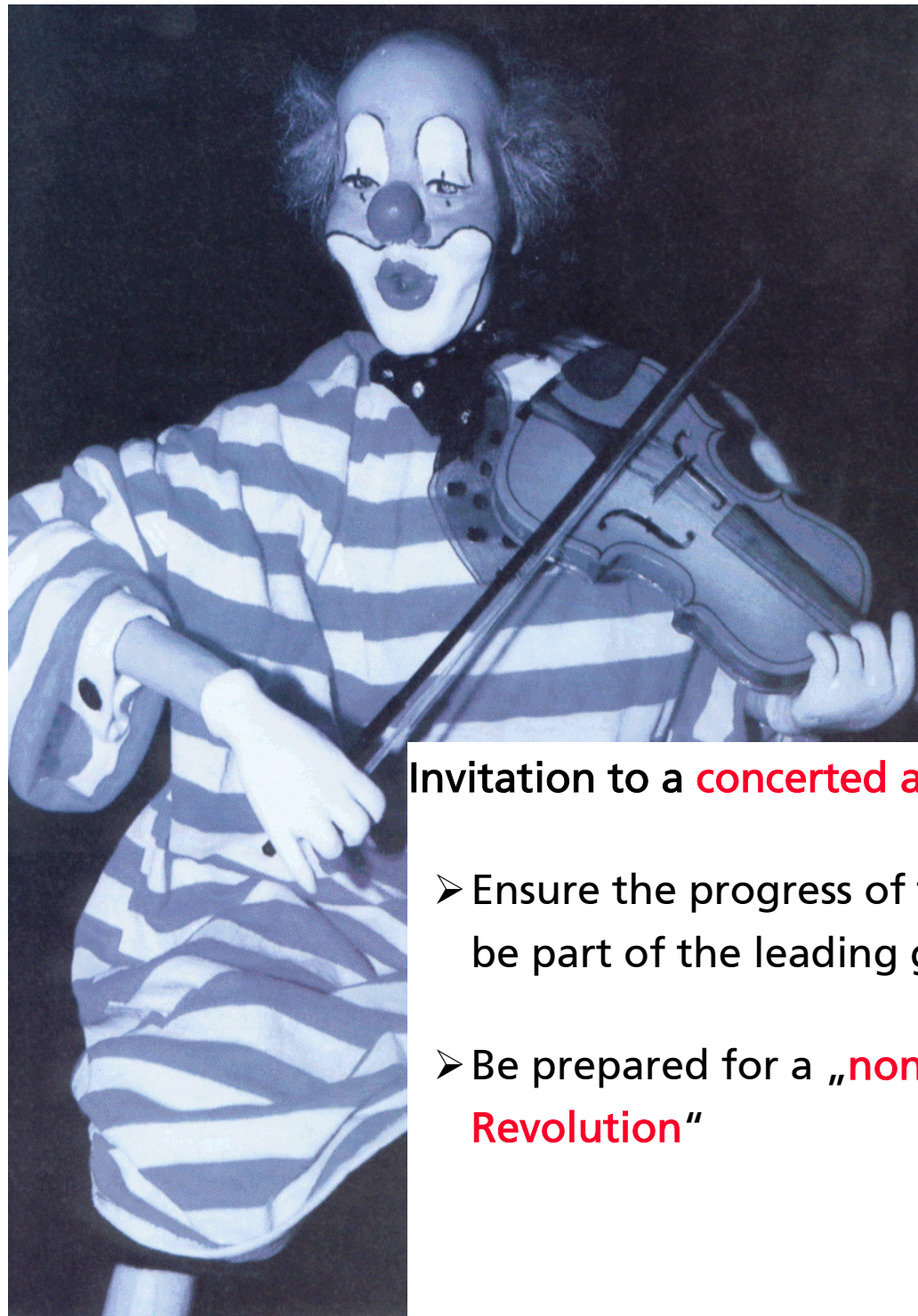
Invitation to a concerted action:

➢ Ensure the progress of the evolution and be part of the leading groups

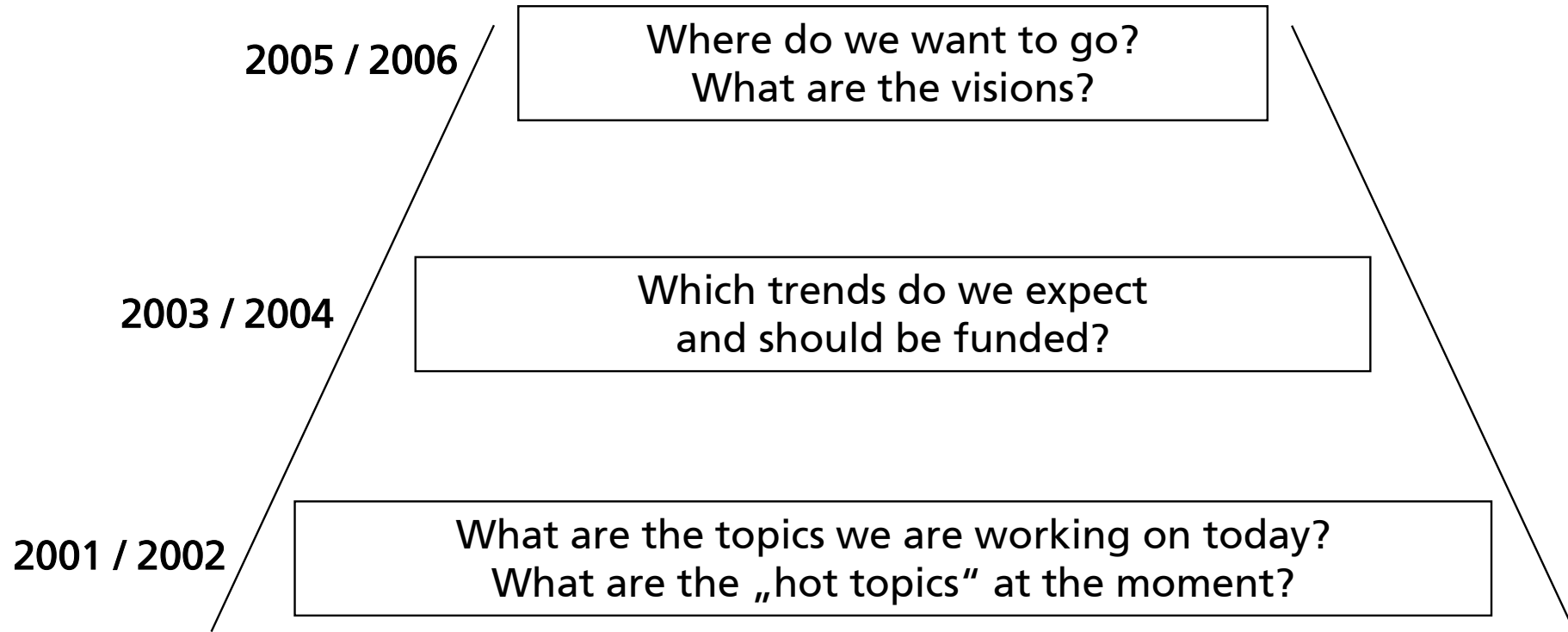➢ Be prepared for a „non predictable Revolution"

Stimmt
die Richtung?

Roadmaps

Roadmaps

Applications

Technologies;
Methods;
Techniques;
(R&D-Topics)

Faculties

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet

Technology Roadmap

2005 / 2006

> **Where do we want to go?**
> **What are the visions?**

2003 / 2004

> **Which trends do we expect**
> **and should be funded?**

2001 / 2002

> **What are the topics we are working on today?**
> **What are the „hot topics" at the moment?**

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Technology Roadmap

(2001 – 2002)

Technology Roadmap (2001 – 2002)

R&D-Topics

2005 / 2006

2003 / 2004

2001 / 2002

Tracking	VR / AR	Mobility	Knowledge-"Mining" and -Visualization
Interactive Broadcasting	Multimodal Interaction	Agents	Avatars

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
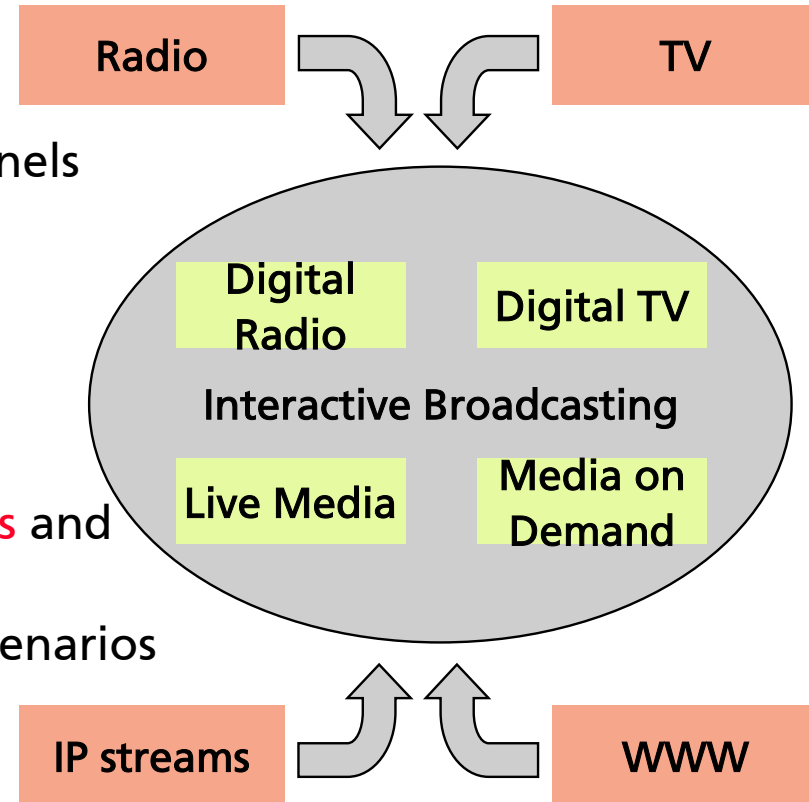
INI-GraphicsNet

25
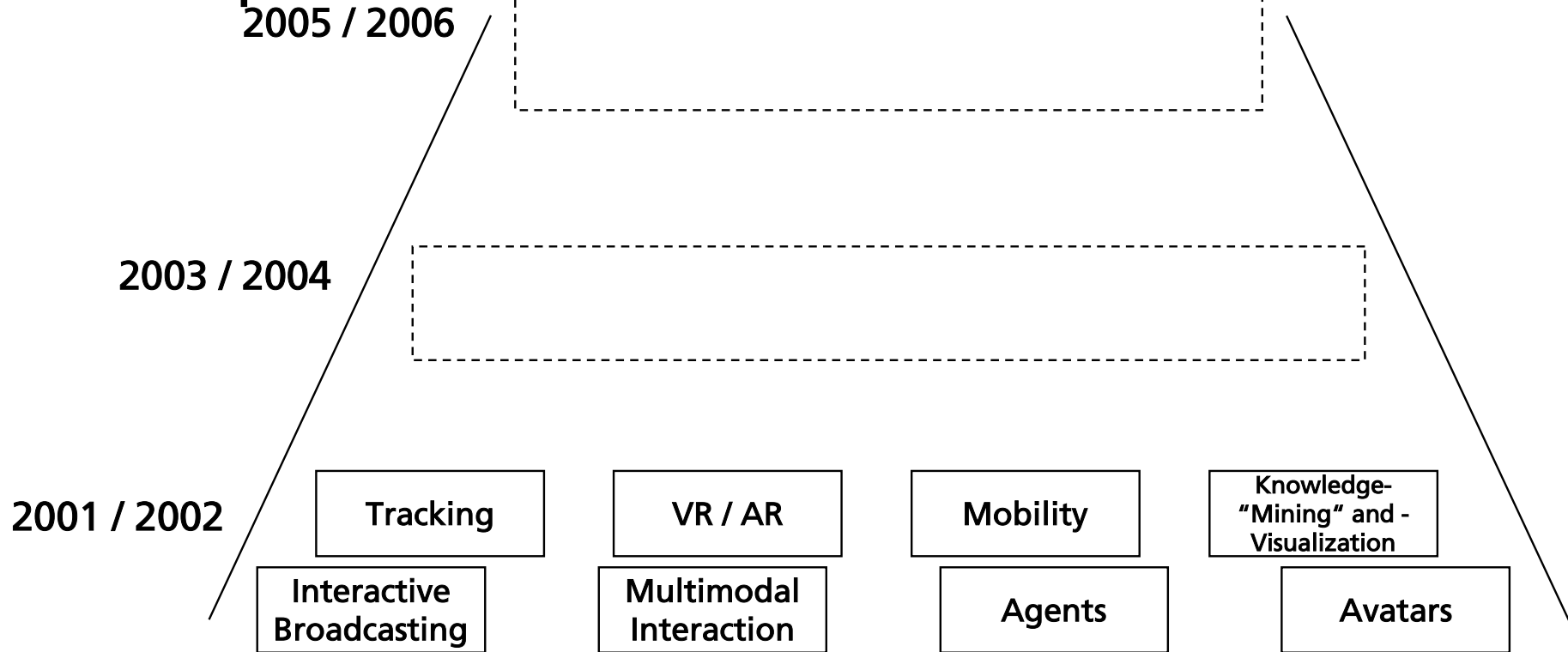
What is Interactive Broadcasting?

It is more than

➢ Video Streaming and transmission channels

➢ Interactive television

It combines

➢ Contents, services, transmission channels and

➢ Applications for different application scenarios

and supports the activity of the user.

| Radio | TV |

Digital Radio
Digital TV
Interactive Broadcasting
Live Media
Media on Demand

| IP streams | WWW |

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet

Research- and Development Topics

Integration of broadcast content into online services

➤ Which content types – besides TV – are suitable?

Presentation of the content on different output devices

➤ A TV set is not a computer monitor!

➤ Mobile vs. stationary output devices

Which applications can be used in different context?

➤ When will the user be about to use the offered services (at home, in the office, during travel, ...)

Fraunhofer Institut
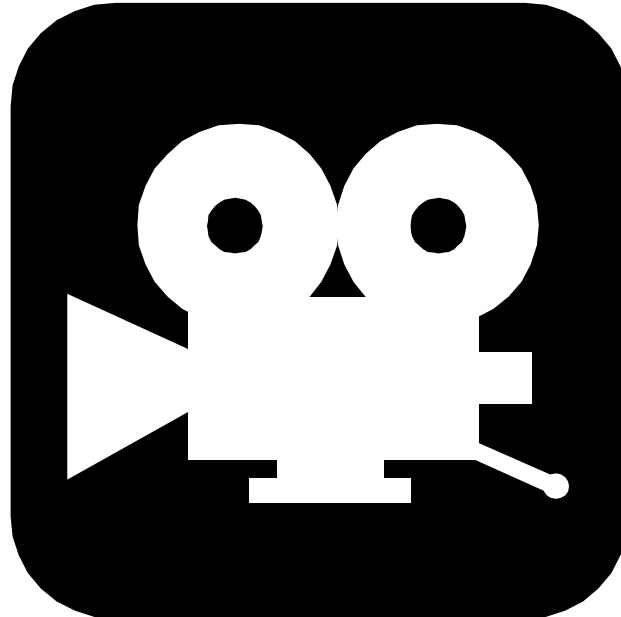Graphische
Datenverarbeitung

INI-GraphicsNet

Multimodal Interaction

Multimodal Interaction

➢ Gesture- and speech recognition

➢ Haptic Displays

New interaction metaphors

➢ Digital Assistants

➢ Avatar

Fraunhofer Institut Graphische Datenverarbeitung
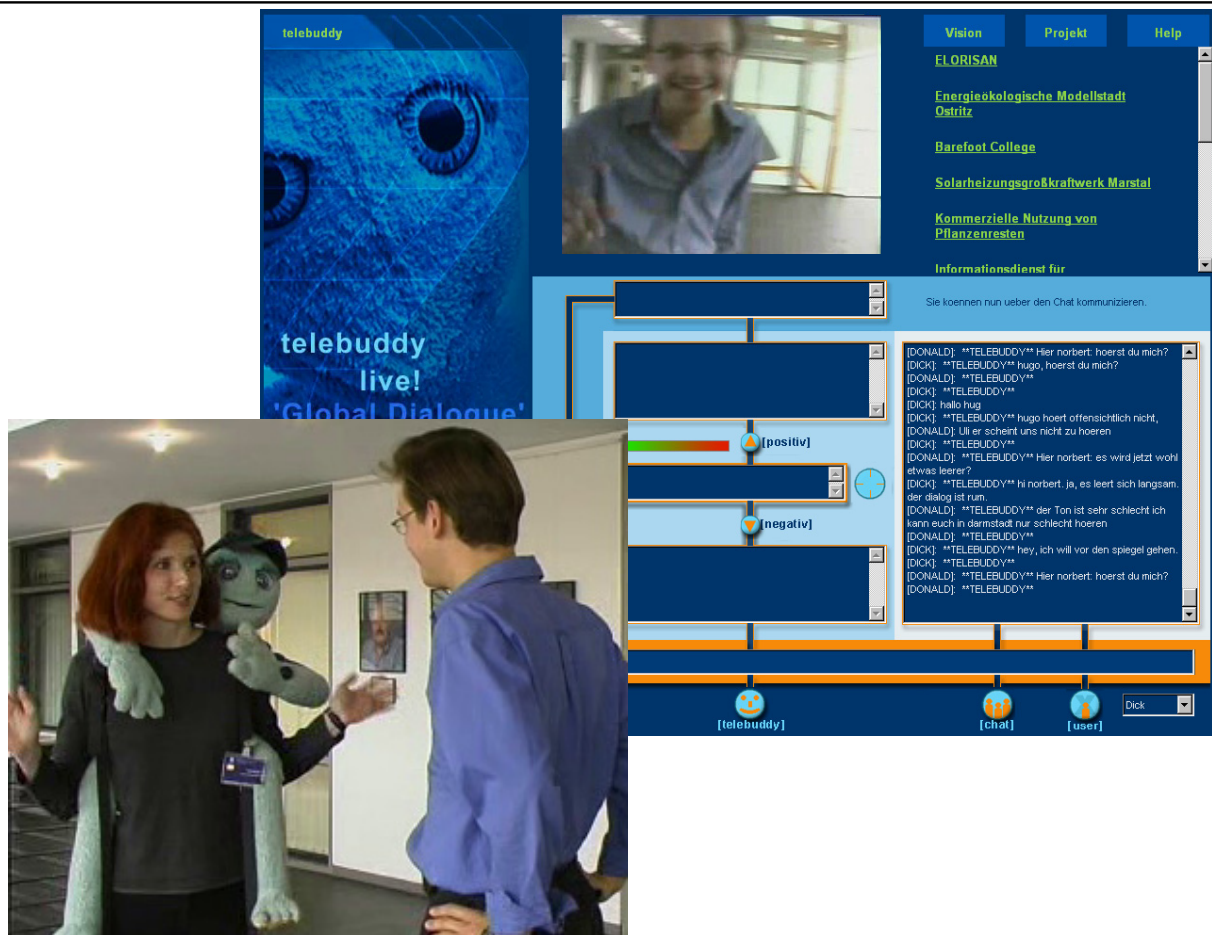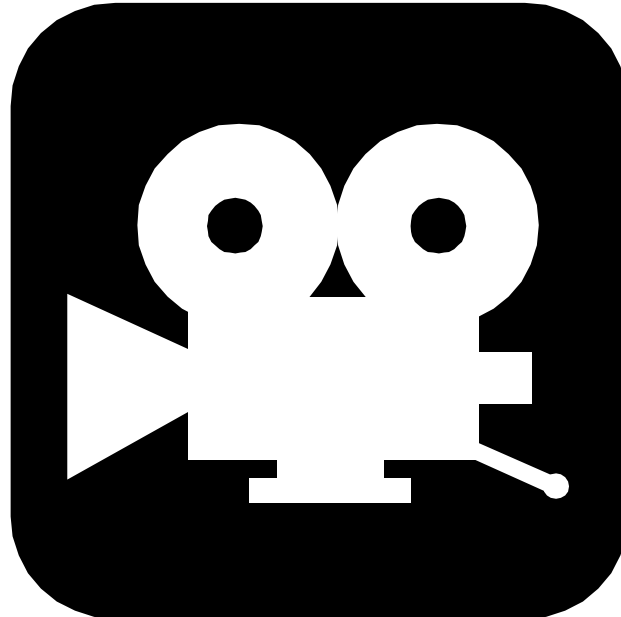
Member of
INI-GraphicsNet
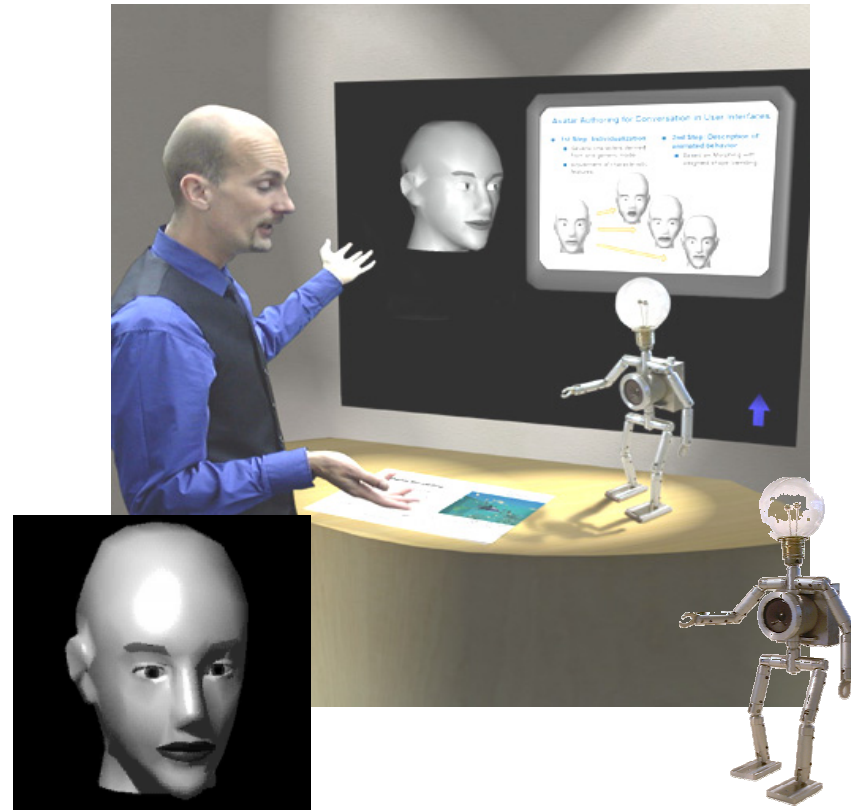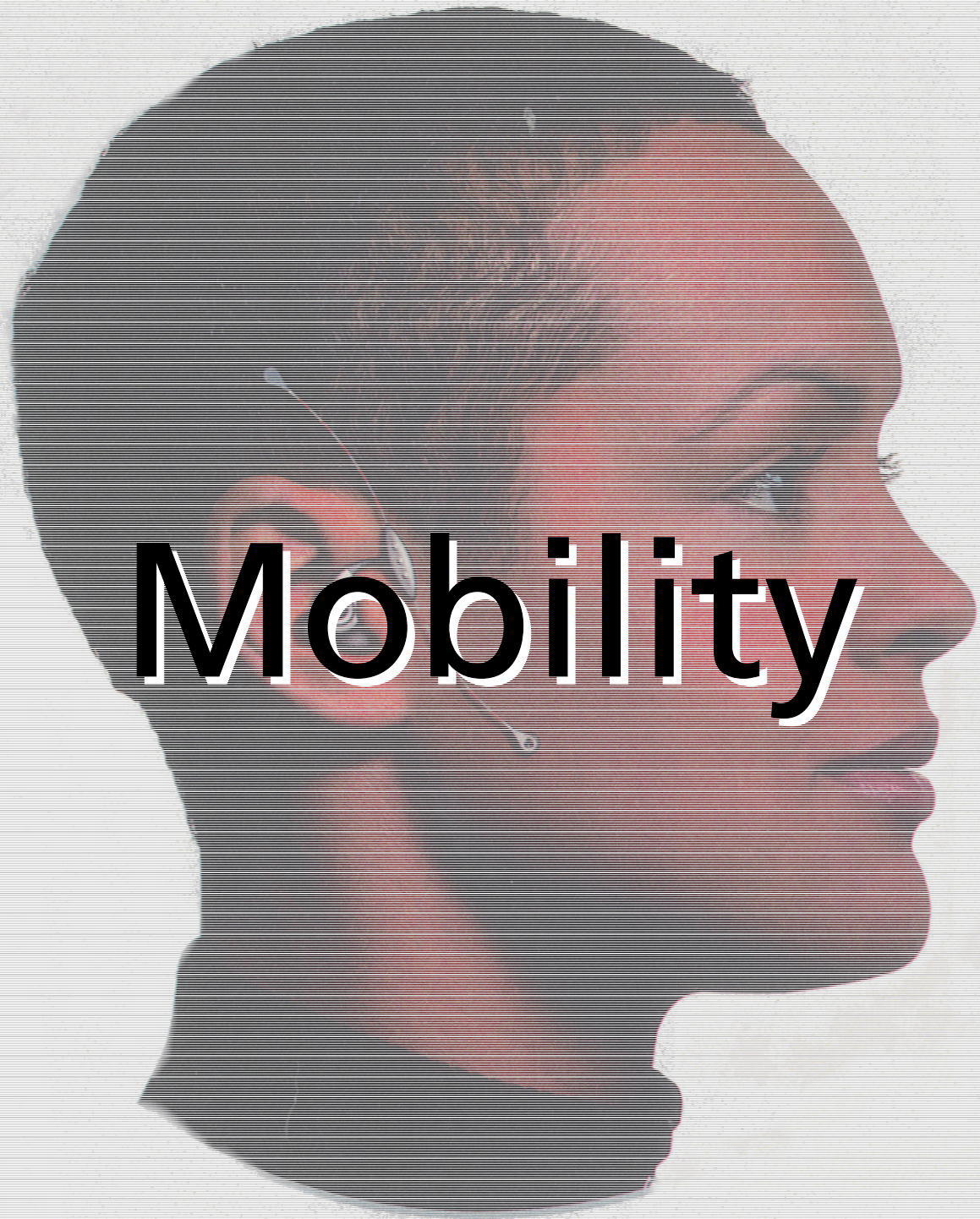
Video – Avatar Programming

Avatar

Physical Avatar-Interface

> Fun / Attention

> Avatar will be controlled by internet users and visitors

> New forms of communication

> Design and usability

Fraunhofer Institut Graphische Datenverarbeitung

INI-GraphicsNet

Video – Telebuddy

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet

Mobility

Mobility

Wearable Computer

- ➢ **Features**
  - ⇨ Wearable during the work
  - ⇨ Hands remain free
- ➢ **May include sensors**
  - ⇨ Registration of the physical environment
- ➢ **Autonomous actions**
  - ⇨ e.g. may inform the user about incoming informations
- ➢ **Operational all the time (24/7)**

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Tracking

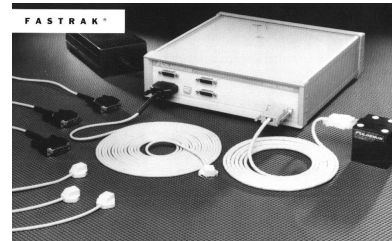**Coarse tracking:**

➢ Active badges, GPS

Precise tracking:

➢ Magnetic

➢ Ultrasound

➢ Mechanic

➢ Inertial

➢ Optic

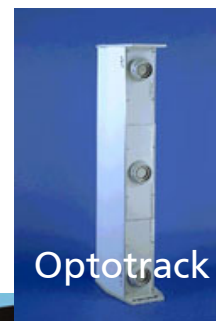➢ Laser

Trend: Combination

➢ Hybrid Tracking

Flashpoint
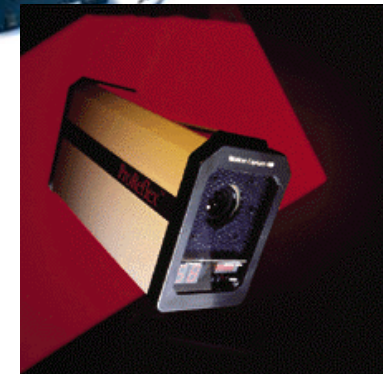
Fastrak

Intersense

Optotrack

Ascention

Qualisys

Fraunhofer Institut Graphische Datenverarbeitung

INI-GraphicsNet
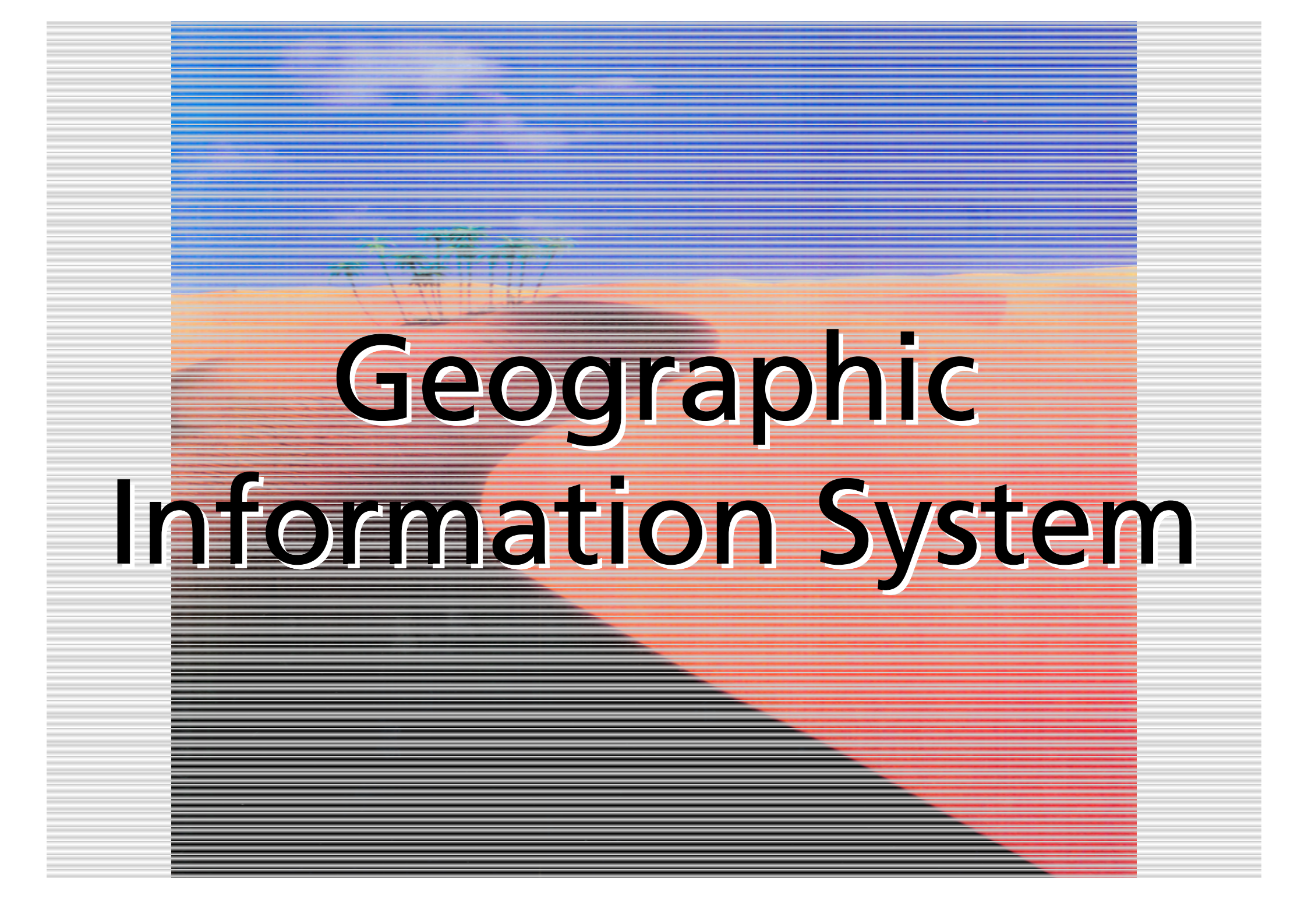
Geographic Information System

Presentation of Traffic Routes – „Yesterday"

Imhof 1923, Picture of Klausenpass-Street

Presentation of Traffic Routes – „Today" - Monomodal
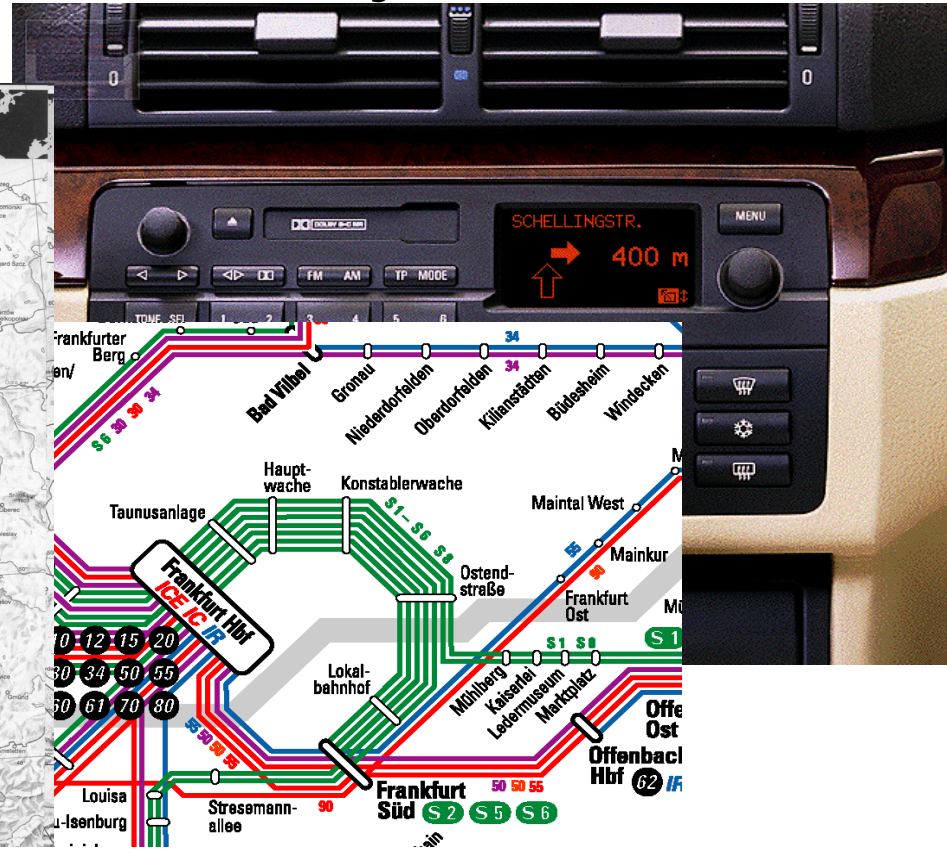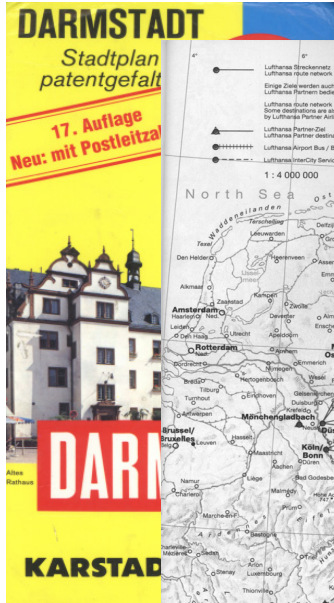
Intermodal Personal Mobility Assistant

➢ „Knows" (spatial) goals

➢ Usable in different locations

    ↳car, public transport, plane, ...

➢ Offers informative description of directions

➢ „Knows" attractions in the area

➢ Is able to make online reservations in nearby hotels

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Knowledge-"Mining" and -Visualization

Business Needs Knowledge

Knowledge-"Mining" and -Visualization

➢ Visualization of data and structures

   ↳ Show correlations (Infospaces)

   ↳ New media (e.g. 3D-Models)

➢ Analysis techniques

   ↳ Text correlations, image analysis

   ↳ Topic-Map

   ↳ (Automatic) metadata creation

Fraunhofer Institut Graphische Datenverarbeitung

INI-GraphicsNet
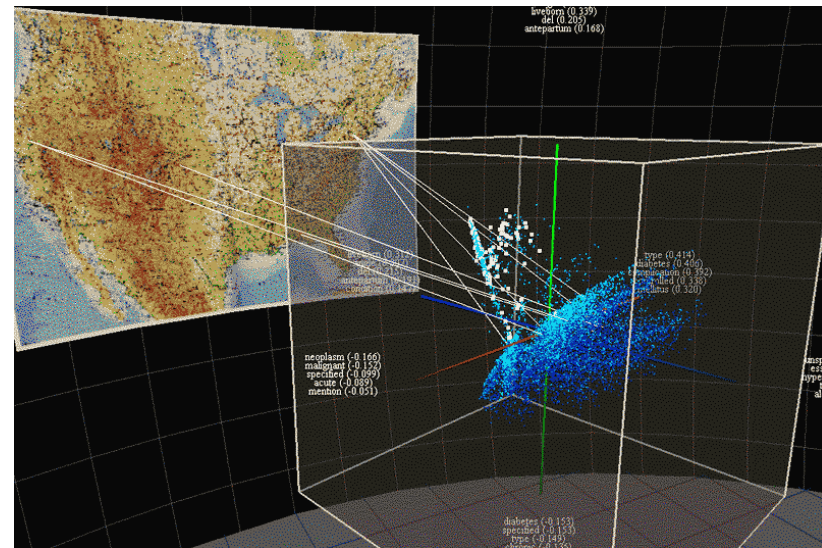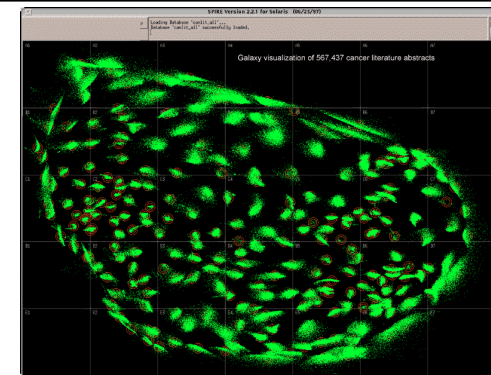
Virtual Reality (VR)

Third Generation is in sight

- 3D graphic systems in PCs (also at home)

- Vivid attractive, virtual worlds

- Interactive knowledge imparting (history, nature, science, ...)

- Distributed virtual worlds (VR videoconferencing)

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of
INI-GraphicsNet
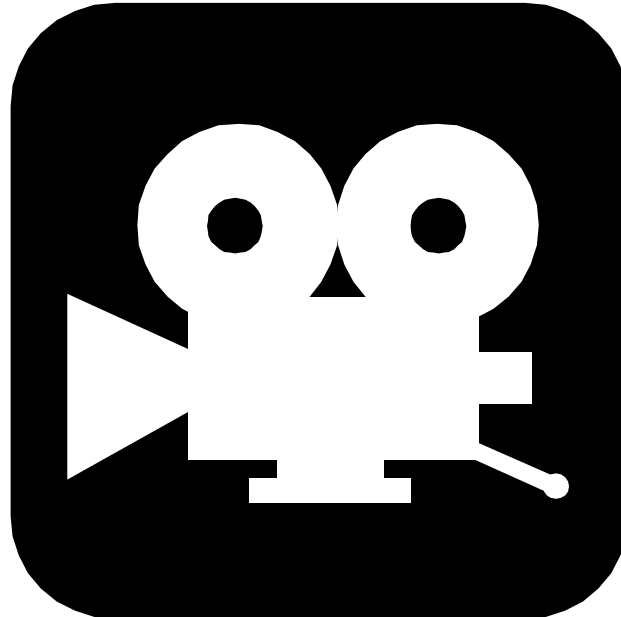
Video – Cathedral of Siena

Fraunhofer **Institut
Graphische
Datenverarbeitung**

IGD

Member of

INI-GraphicsNet

Augmented Reality (AR)

➢ First real world applications available (ARVIKA)

➢ Registration of on-line data (especially for medical applications)

➢ Concepts for interaction with real and virtual objects

➢ „Breakthrough" relies on the next hardware generation (mobile computers and cell phones), which will be equipped with cameras

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet
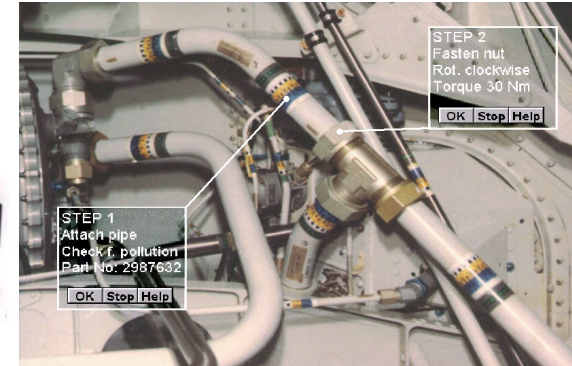
Technology Roadmap

(2003 – 2004)

Explore

Technology Roadmap (2003 – 2004)
R&D-Topics

2005 / 2006

2003 / 2004

| Sensors; Feedback | Scalable Tracking | „Tangible" Information | Digital Story Telling |

Knowledge management in broadcasting applications

Mixed Reality (MR)

Task Modeling

2001 / 2002

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of

INI-GraphicsNet
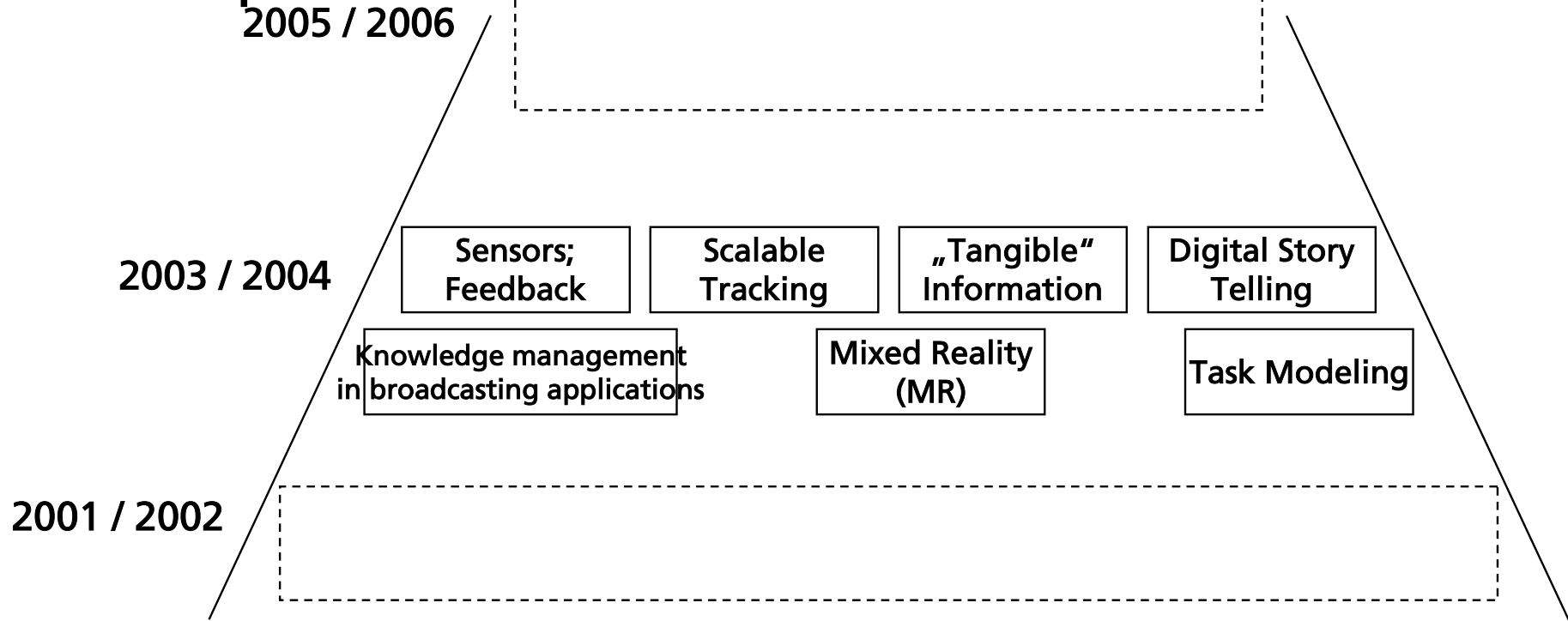
Knowledge management in broadcasting applications

➢ Automatic video hyperlinks

➢ New forms of interaction

    ↳ „Off-Screen Hyperlinking"

Broadcasting Applications

Presentation of Product Information

X,Y-coordinates, frame,
profileID, movie name

Additional information,
web page

Server

Client

Product Information

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet
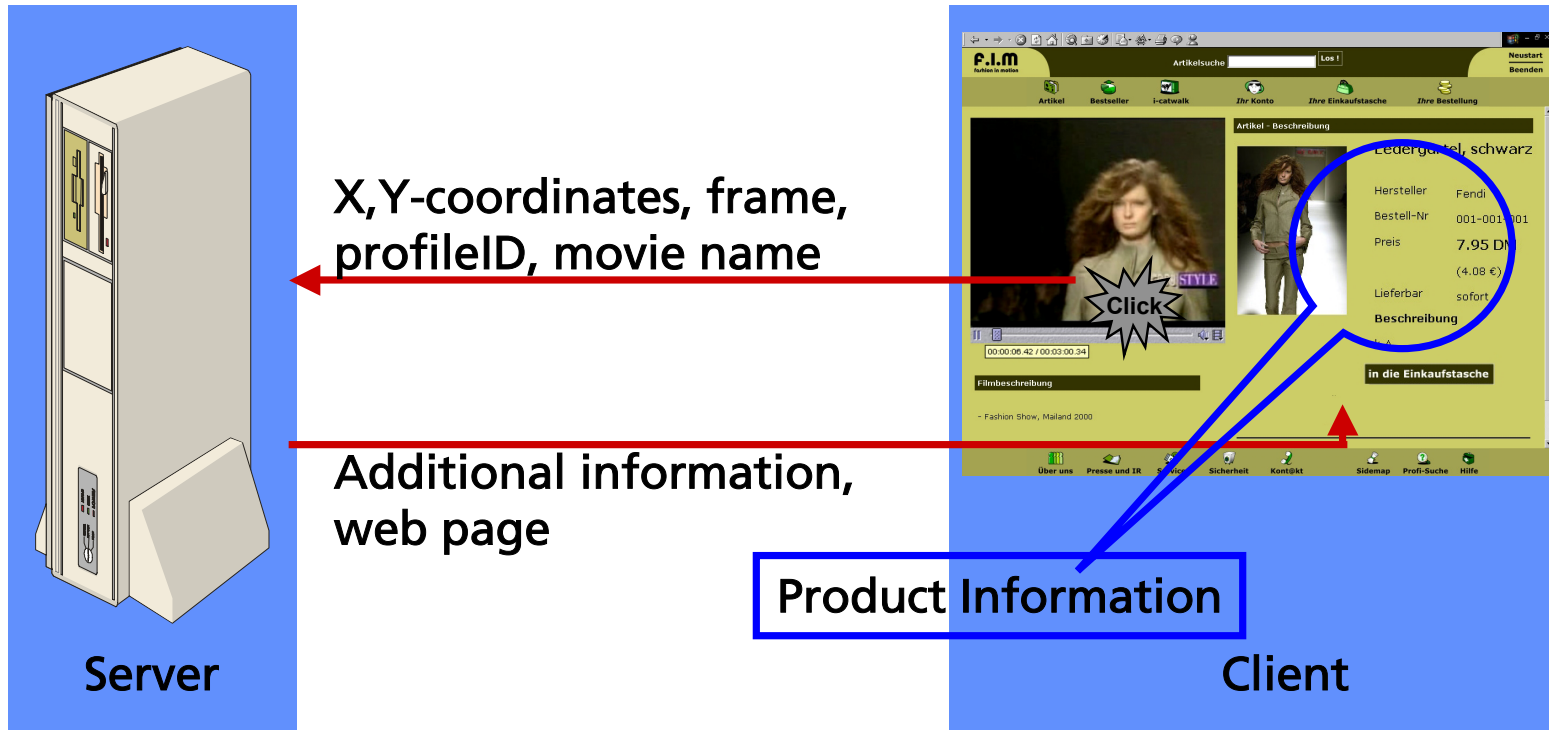
Broadcasting Applications

Authoring tools

➢ Object definition

➢ Automatc tracking using key-frames

Video – Interactive Broadcasting

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
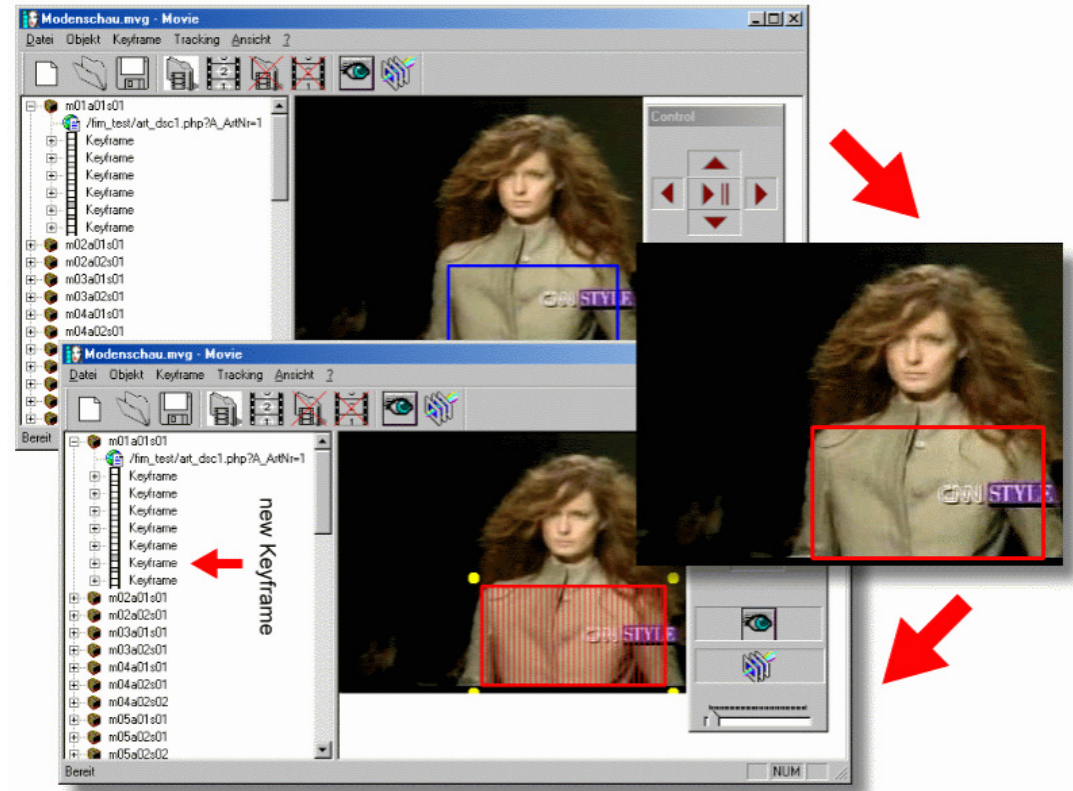
Definition Mixed Reality (MR)

Virtuality continuum *(Paul Milgram)*

Several classes of existing hybrid display environments can be found, which could reasonably be considered to constitute MR interfaces according to the 'virtuality continuum'

Fraunhofer Institut Graphische Datenverarbeitung

INI-GraphicsNet

Mixed Reality (MR)

Different aspects for the distinction between Reality and Virtuality:

- ➢ Real vs. virtual objects

- ➢ Direct vs. Indirect viewing

- ➢ Real vs. virtual images

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet
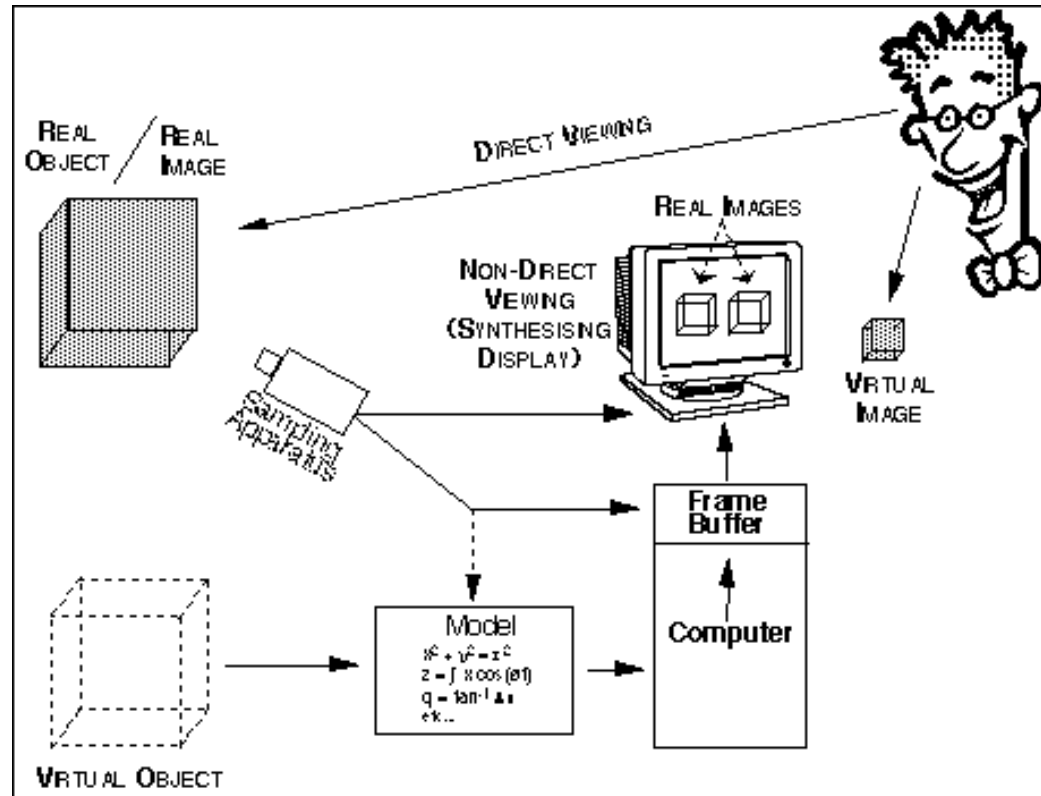
Mixed Reality Applications: Production, maintenance, ...

Supporting

➢ Development

➢ Production

➢ Training

➢ Service

by superposition of 3D instructions
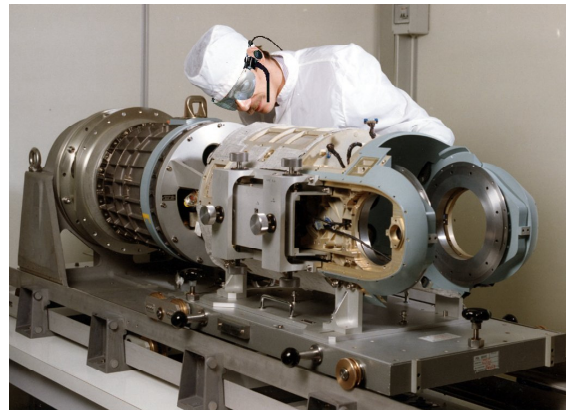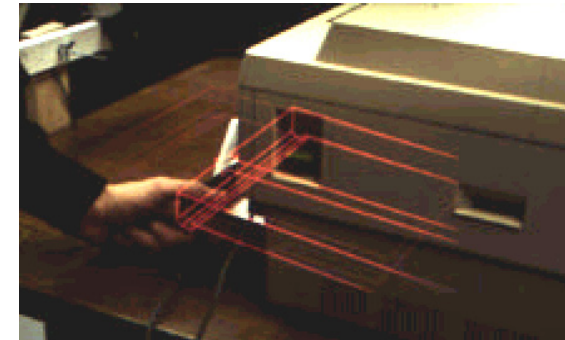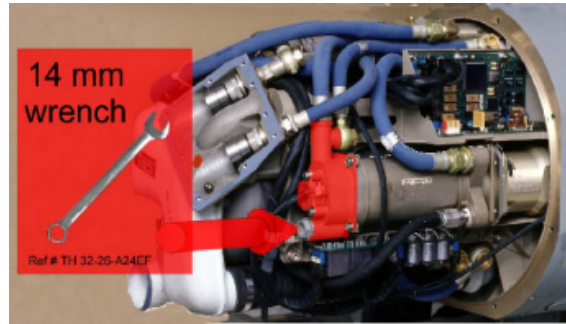
Mixed Reality Applications: Medicine

➢ Education and training

➢ Support for minmal invasive surgery

➢ Operation scheduling

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of
INI-GraphicsNet
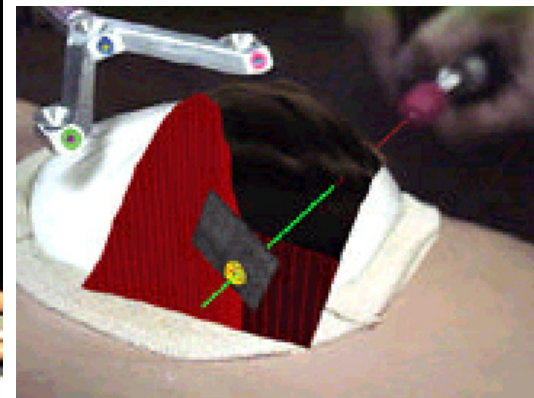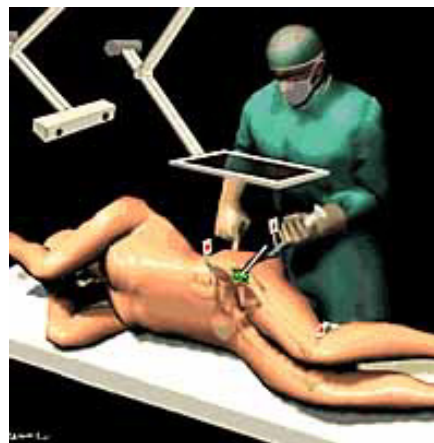
Mixed Reality Applications: Guidance and Information Systems

Main Tasks

➢ Navigation

➢ Information imparting
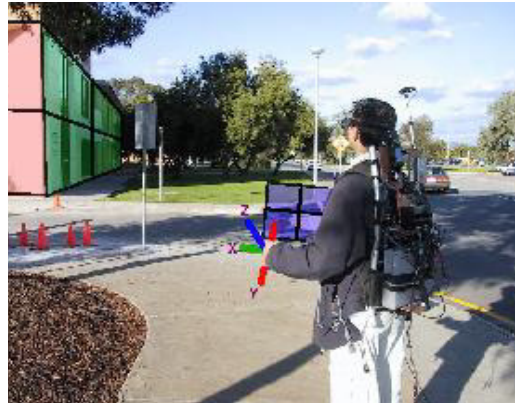
Mixed Reality Applications: Entertainment

➢ **Multiplayer Entertainment** in Mixed Reality Environments

➢ **Users interact "directly"** with the avatar
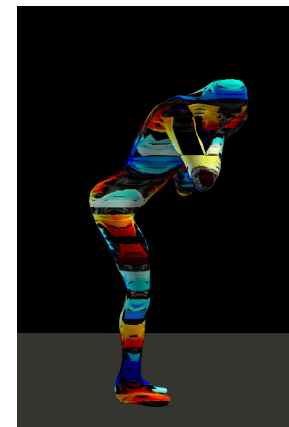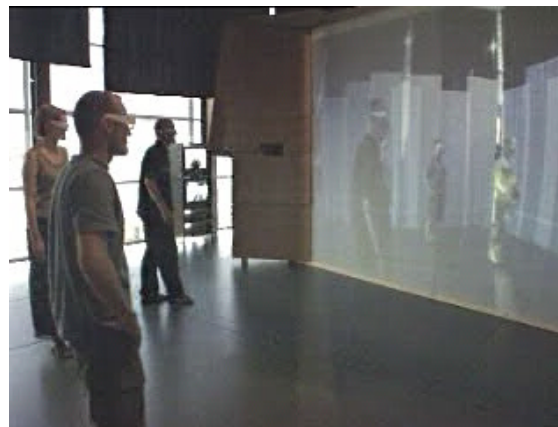
Personal Ubiquitous Assistance

Task Modeling

➢ For personal ubiquitous assistance

Sensors

➢ Registration of the physical environment

➢ Feedback in „online" mode

IGD

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Personal Ubiquitous Assistance

Facts about everyday life:

➢ Complex spatial and temporally widespread tasks/activities (e.g. maintenance)

➢ Diverse parallel activities

➢ Frequent context switches from one task to another

What is the right way to support the user here?

14 mm wrench

Ref # TH 32-26-A24CF

IGD

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet
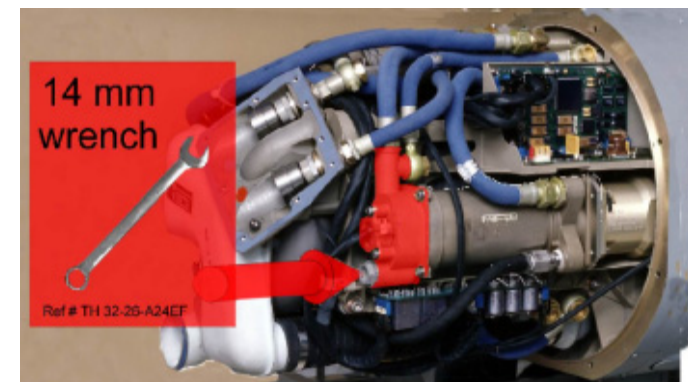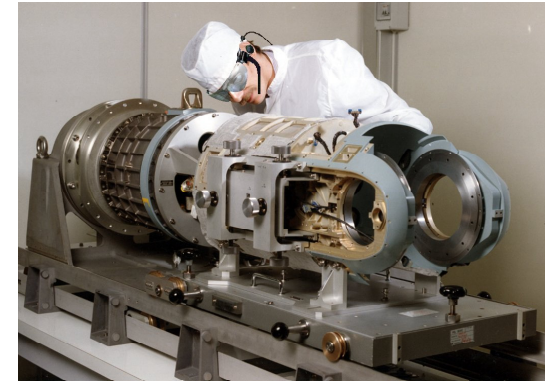
Personal Ubiquitous Assistance

Necessary Technologies

➢ Situation and event tracing (sensor technology)

➢ Task models (description of tasks)

➢ Prediction methods (determination of action alternatives)

➢ Presentation and interaction mechanisms for „synchronisation"

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Task Modeling
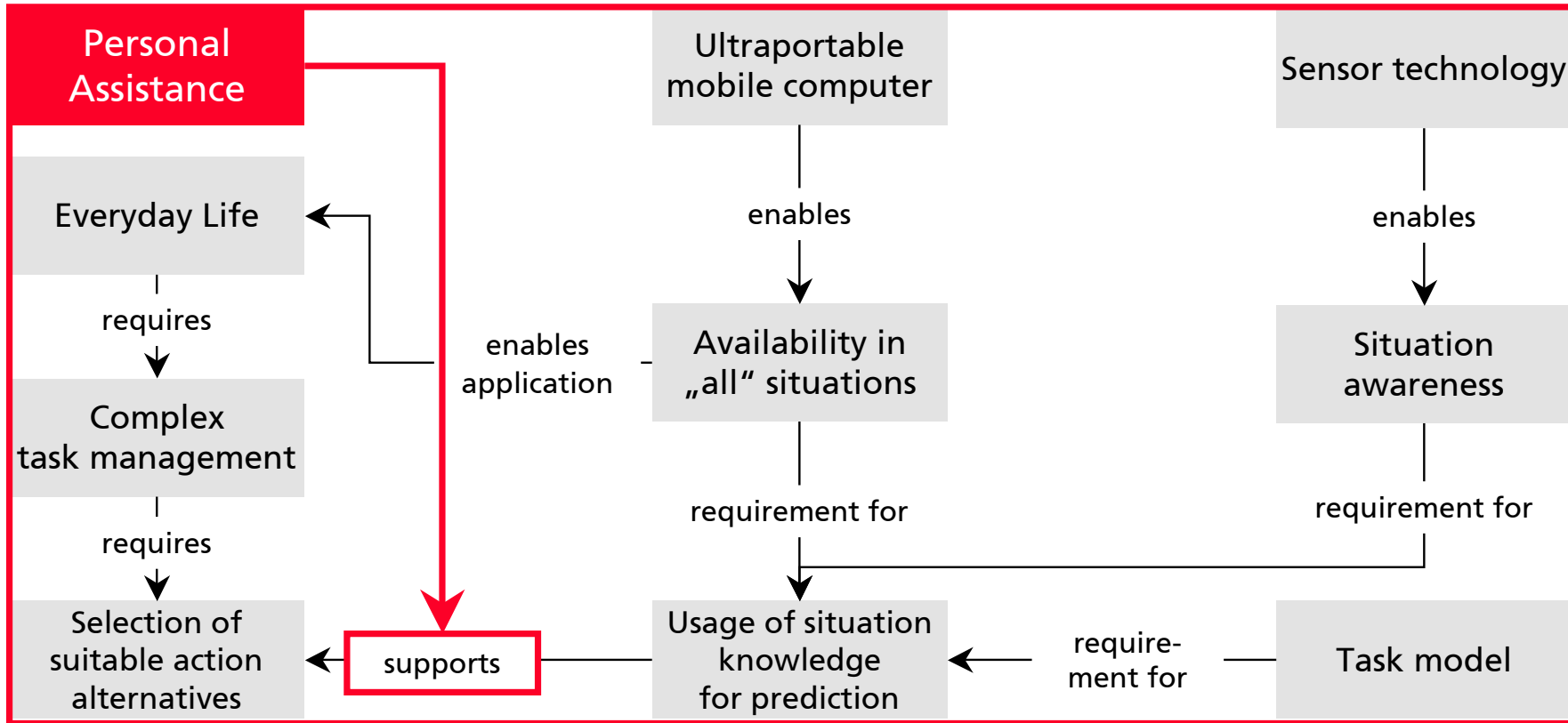
Digital Storytelling (1)

Integration of multimedia „fragments"

➢ Computer graphics: images, animations, 3D worlds

➢ Real recording: photo, video

➢ Syntheses and recording of: music, spoken text, noise

➢ Multimodal user centered interaction

➢ Immersive or mobile environment

➢ Network based presentation and cooperation

to a comprehensive experience

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Digital Storytelling (2)

Interdisciplinary teamwork

➢ Writing as programming

➢ High-Level-API for
   „**Non-Programmers**"

Digital Storytelling API

Graphics API

4 GL Languages

3 GL Languages

Assembler Coding

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet

Video – Gari's Game

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
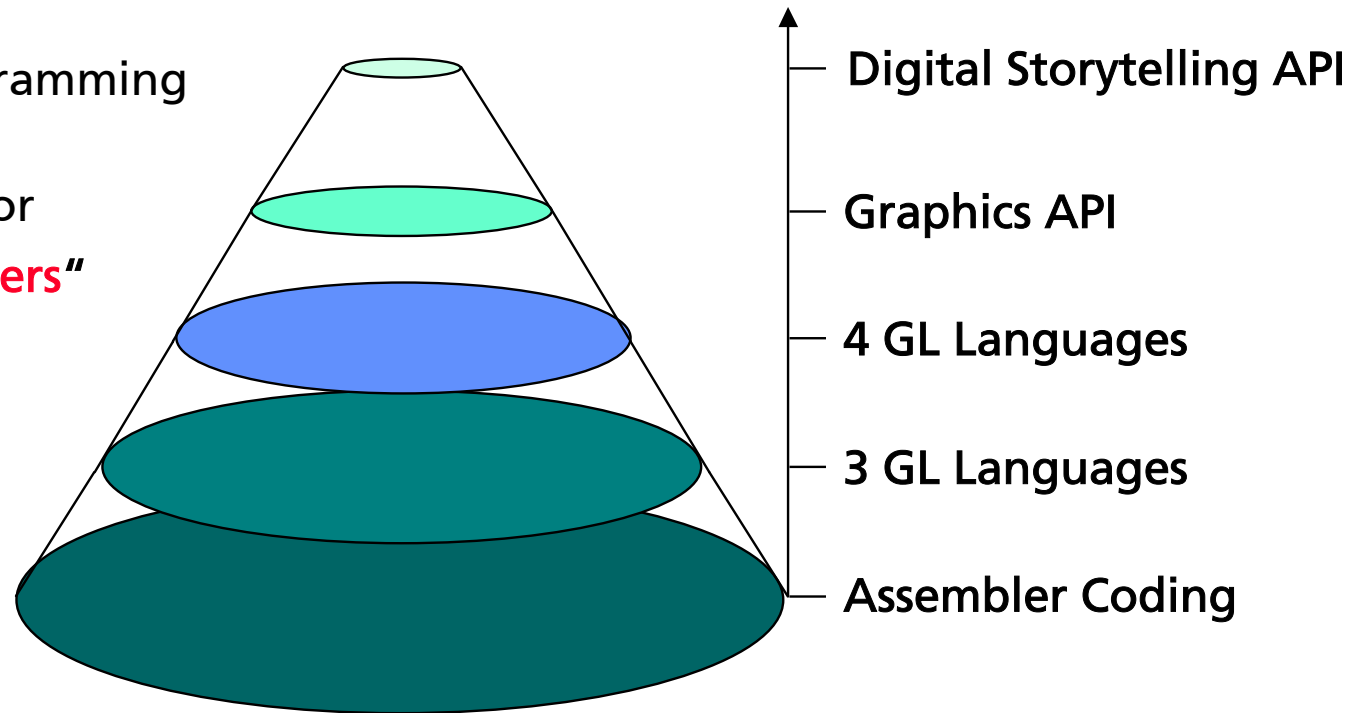
Digital Storytelling

System view

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet
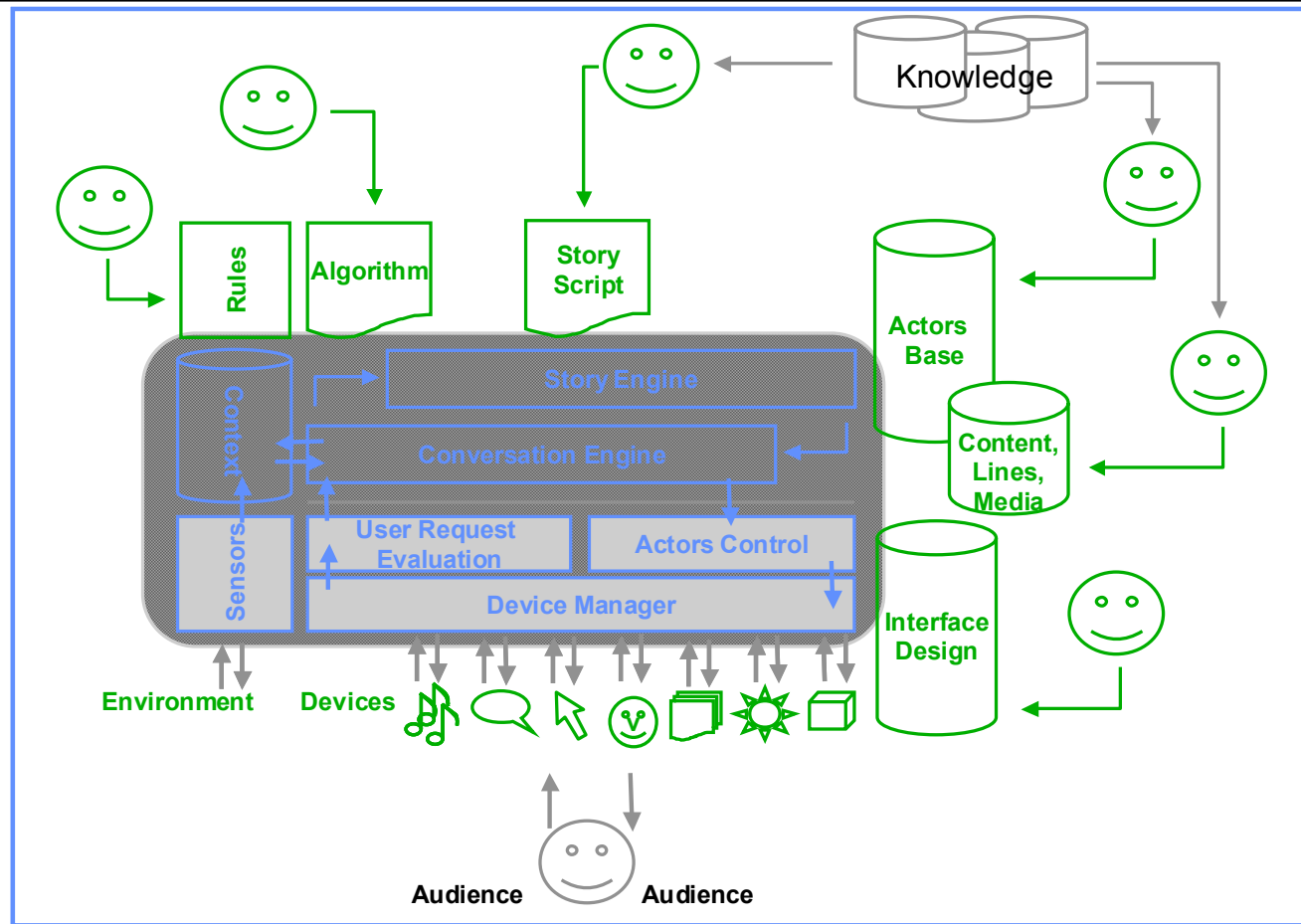
GEIST

Experience a historic context in an urban environment by using a mobile AR information system and digital storytelling

Mobile Augmented Reality

➢ Historic information for pedestrians

➢ Application for Tourism and Training

Research topics

➢ Video based, mobile tracking system using wearable computers

➢ Historic knowledge database

➢ Automatic, animated presentation through interactive story engine

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet

Interactive Storytelling within the GEIST Project

Magic Equipment:

➢ Interface is part of the story!

➢ Seemless integration with AR sensors: ghosts „show up"

➢ User is protagonist of the story

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Innovative Perspektiven

Technology Roadmap

(2005 – 2006)

Technology Roadmap (2005 – 2006)

R&D-Topics

2005 / 2006

„Intelligent" Environments	„Perceptual" Computing

Human in the Loop	Virtuality Continuum	UMTS

2003 / 2004

2001 / 2002

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet

Human in the Loop

Alternative platforms (embedded processors, smart cards, etc.)	Interactive Appliances	Multimedia Workspace

DTV

(Inter-)
Net

DTV

Inter-
active

Digital

Human

Media

Tech-

nology

Story

Net-
Work-
ing

Augmented
Reality

Telling

**Interactive Internet
Broadcasting and Networking**

New Interactionparadigms

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Virtuality Continuum (VC)

Applications | App-1 | | App-2 | ... | App-n |

Application Programming Interface (new API's)

VR   VK   AR

| Product definition | Design | Analyses | Production planning | Production | Operation | Maintenance | Recycling |

Mixed Reality Driver

I ↑   O ↓   I/O ↕

New I/O-Devices (incl. Sensors, Tracking, etc.)

75

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet

UMTS (Universal Mobile Telecommunications System)

➢ Users are „24 hours" online

➢ Using UMTS we will use only one universal device for several applications

    ✎ Video over the internet

    ✎ Download of software, video and music

    ✎ Infotainment

    ✎ etc.

➢ **Research topic**

    ✎ „ WAP (Wireless Application Protocol) for graphical objects"

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

WAP for Graphical Objects

➢ Platform independent transmission of complex, dynamic 3D graphics

➢ Availability on „arbitrary" output devices

➢ Dynamic adaptation of the data based on the available network capacity will make the distinction between stationary and mobile devices obsolete

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
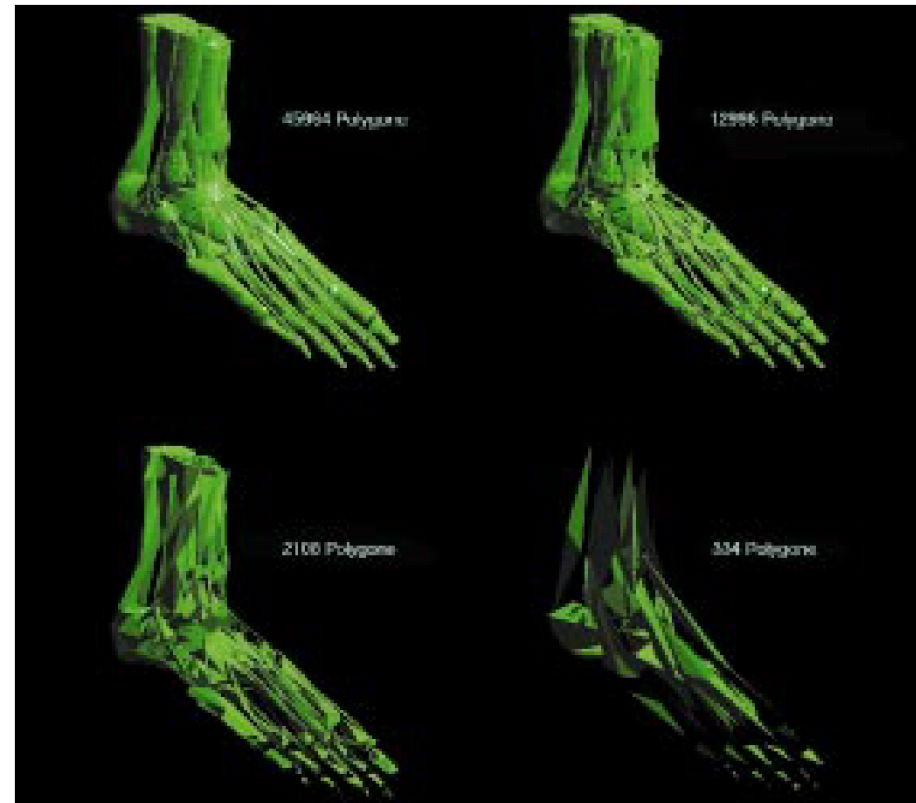
WAP for Graphical Objects

➢ **Progressive transmission of 3D data between different devices**

➢ **Integration of mobile devices through WAP**

➢ **Animation and interaction on distributed systems**

Server

Handy

Workstation

Laptop

79
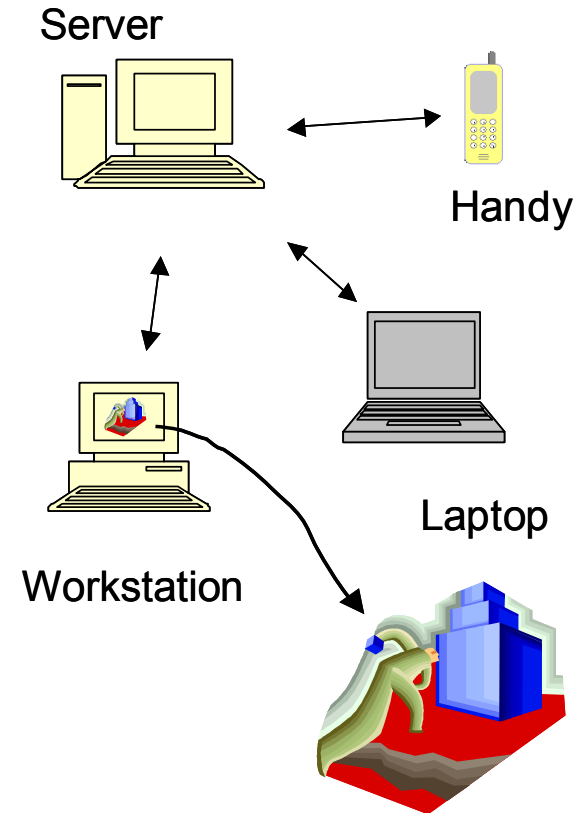
„Intelligent" Environment

Goal Oriented Interaction

➢ User will define goals and will no longer use commands to control the computer

➢ Challenge

↳ The system has to organize the collaboration of the available devices by itself

↳ The system has to „understand" the goals of the user within the multimodal interaction of the user

↳ The user has to spot the potential of the environment

➢ No general problem solver possible

↳ The system needs „location und situation awareness", in order to reduce the users target area

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

Perceptual Computing

➢ Recognition and consideration of the user emotions

➢ Recognition and consideration of physical reactions

➢ Context-"Awareness"

➢ Address new users (elderly and handicapped persons) through „ability-awareness"

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

INI-GraphicsNet

Video – Baby

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet
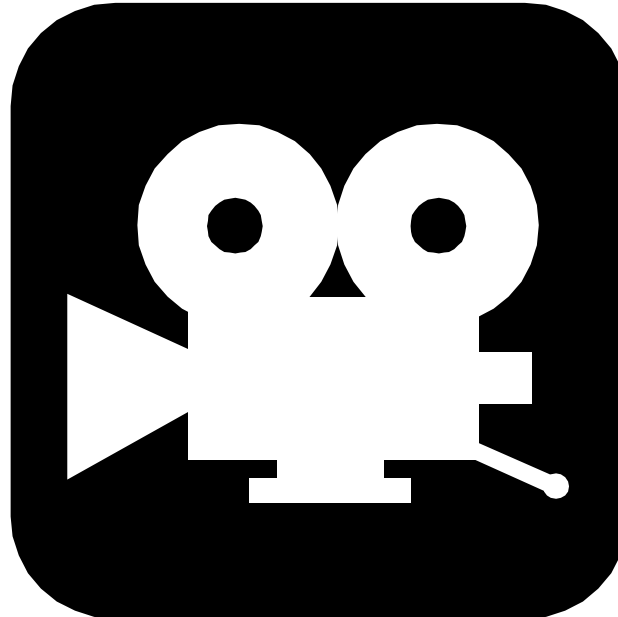
erst Maß nehmen, dann empfehlen.

Roadmap
Faculties

Roadmap Faculties (1)

2007 / 2009

2004 / 2006

2001 / 2003

Faculties - Today

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet

Roadmap Faculties (2)

2007 / 2009

2004 / 2006

Human-Centered Multimodal Interfaces

Knowledge Engineering, Mining and Visualization

Video Technology and Interactive Broadcasting

2001 / 2003

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet

Roadmap Faculties (3)

2007 / 2009

Usability Engineering

Perceptual Computing

Situation and Task Awareness Computing

2004 / 2006

2001 / 2003

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet
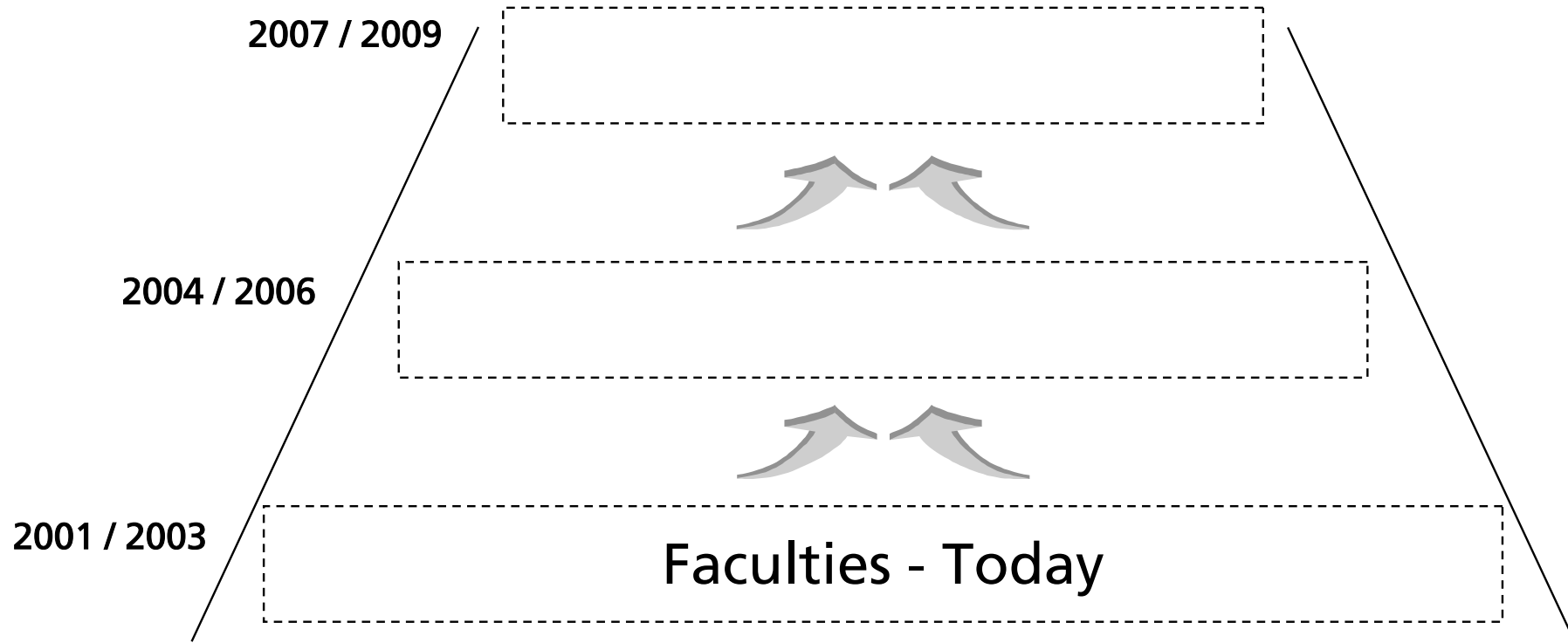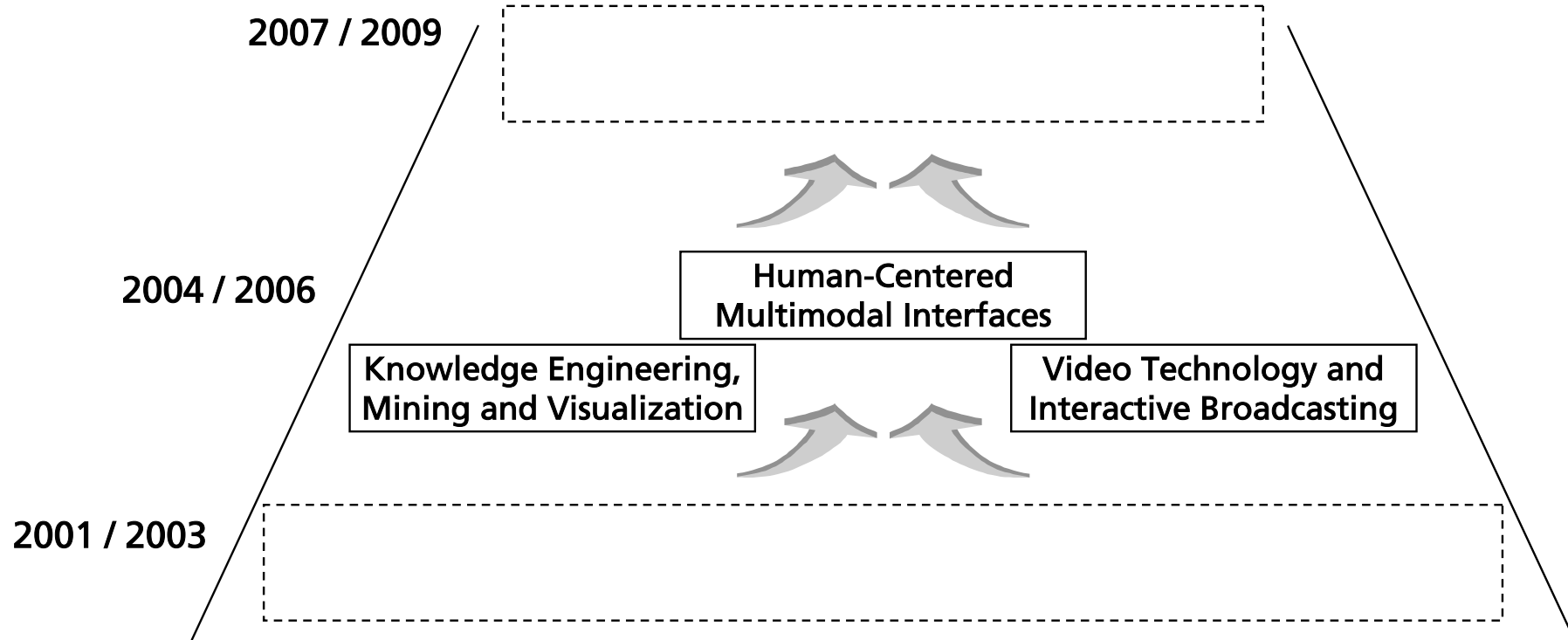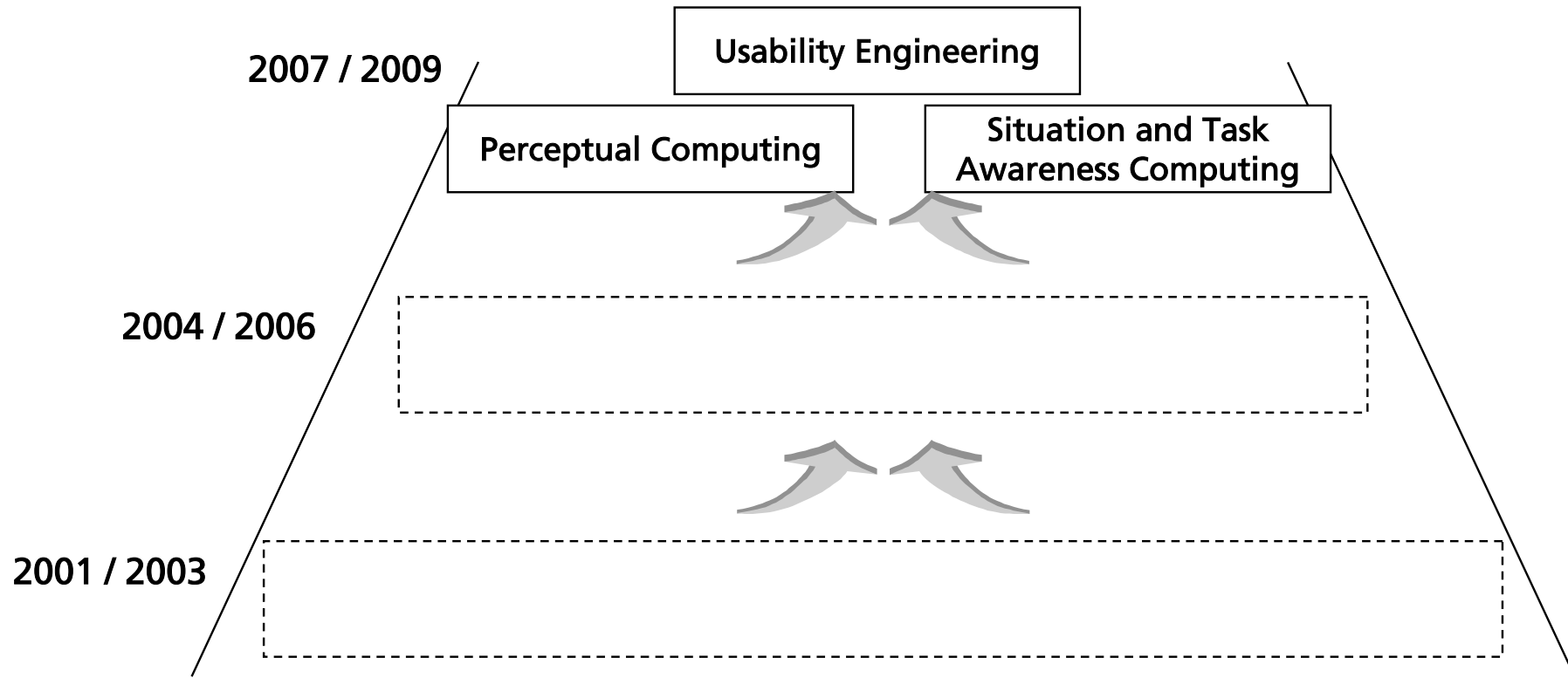
Ein Konzept im ganzen
ist stets nur so
erfolgreich wie seine
Ideen im Detail

Roadmaps of
New Faculties
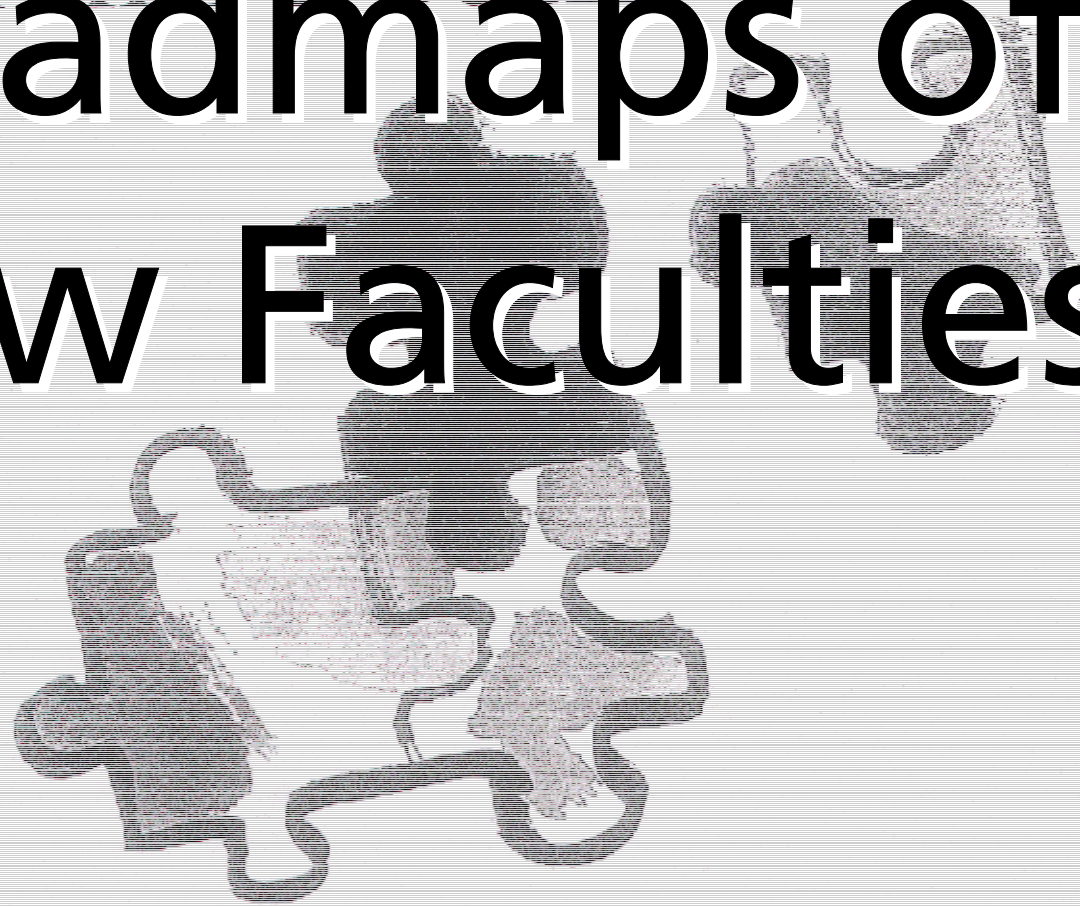
Roadmap: Perceptual Computing

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet
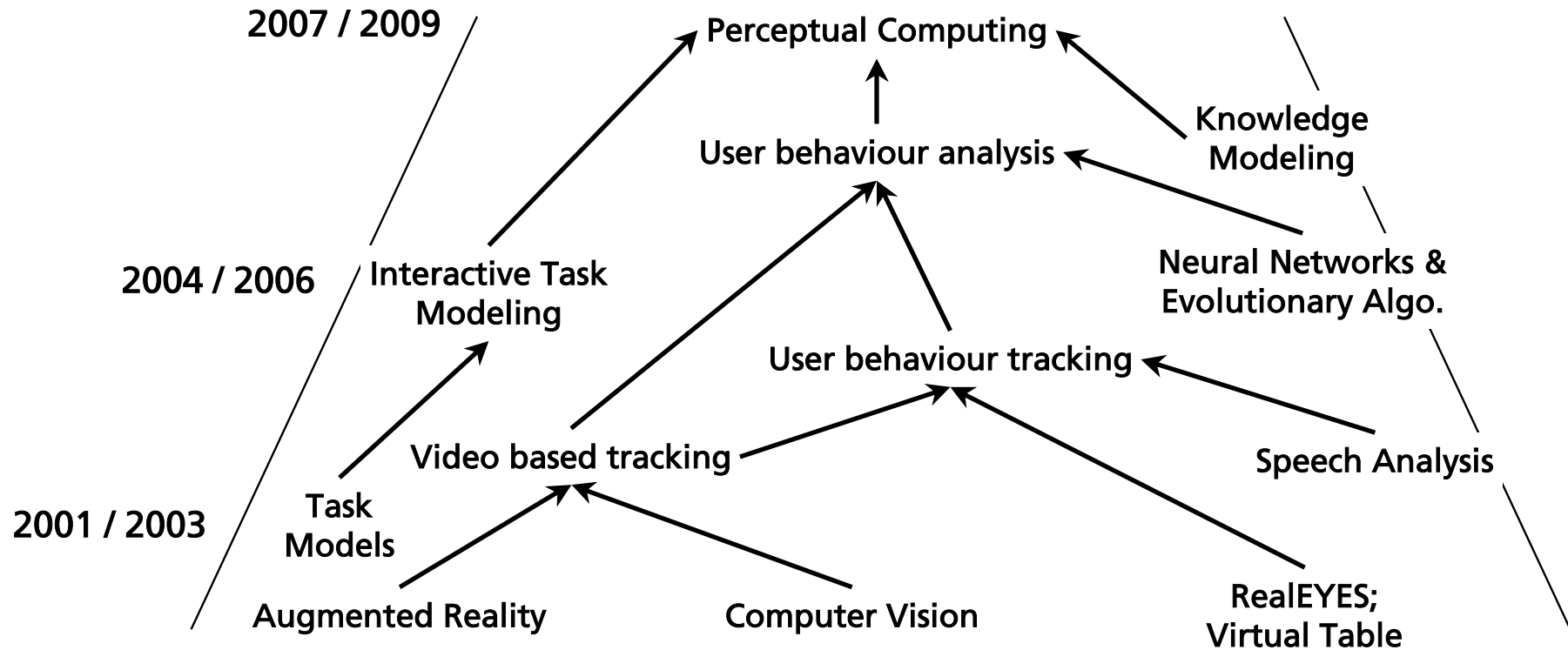
Roadmap: Usability Engineering

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet
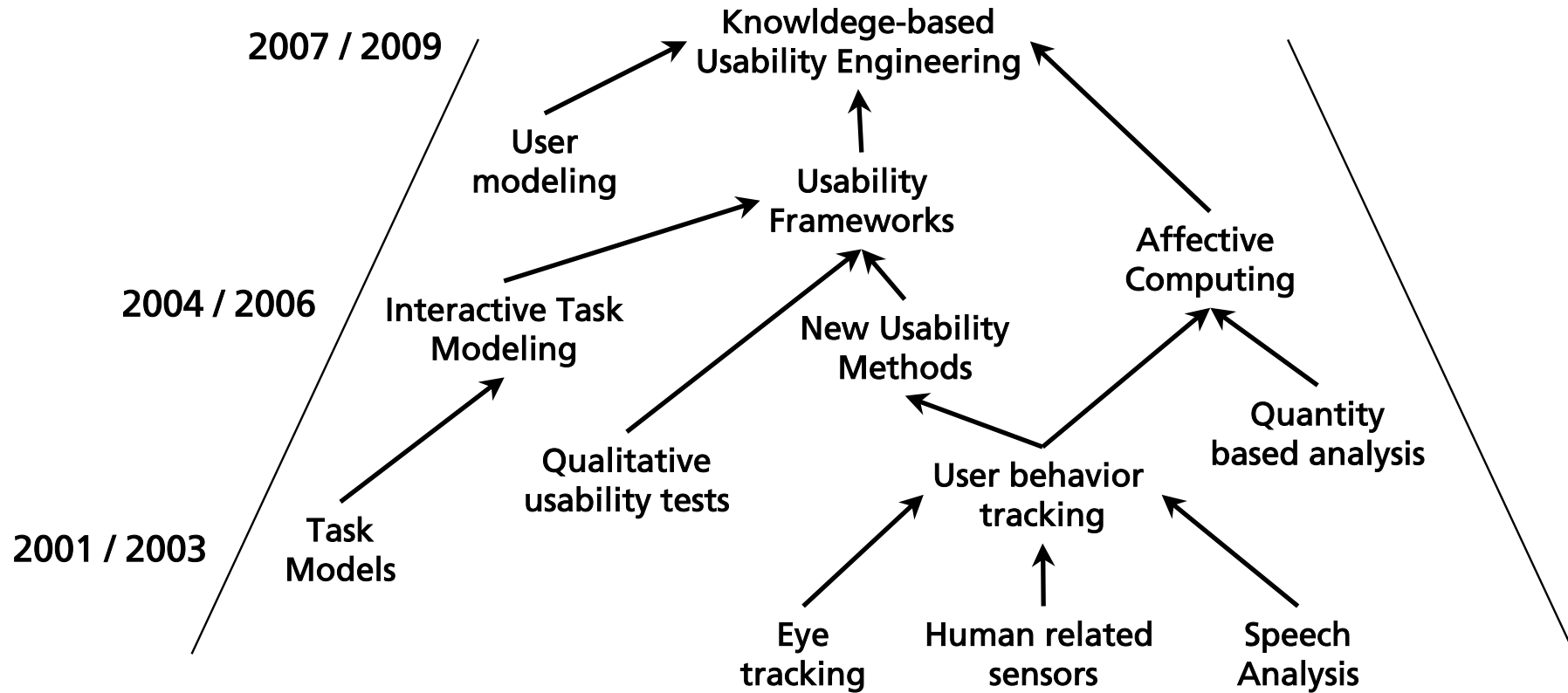
Roadmap: Situation and Task Awareness Computing
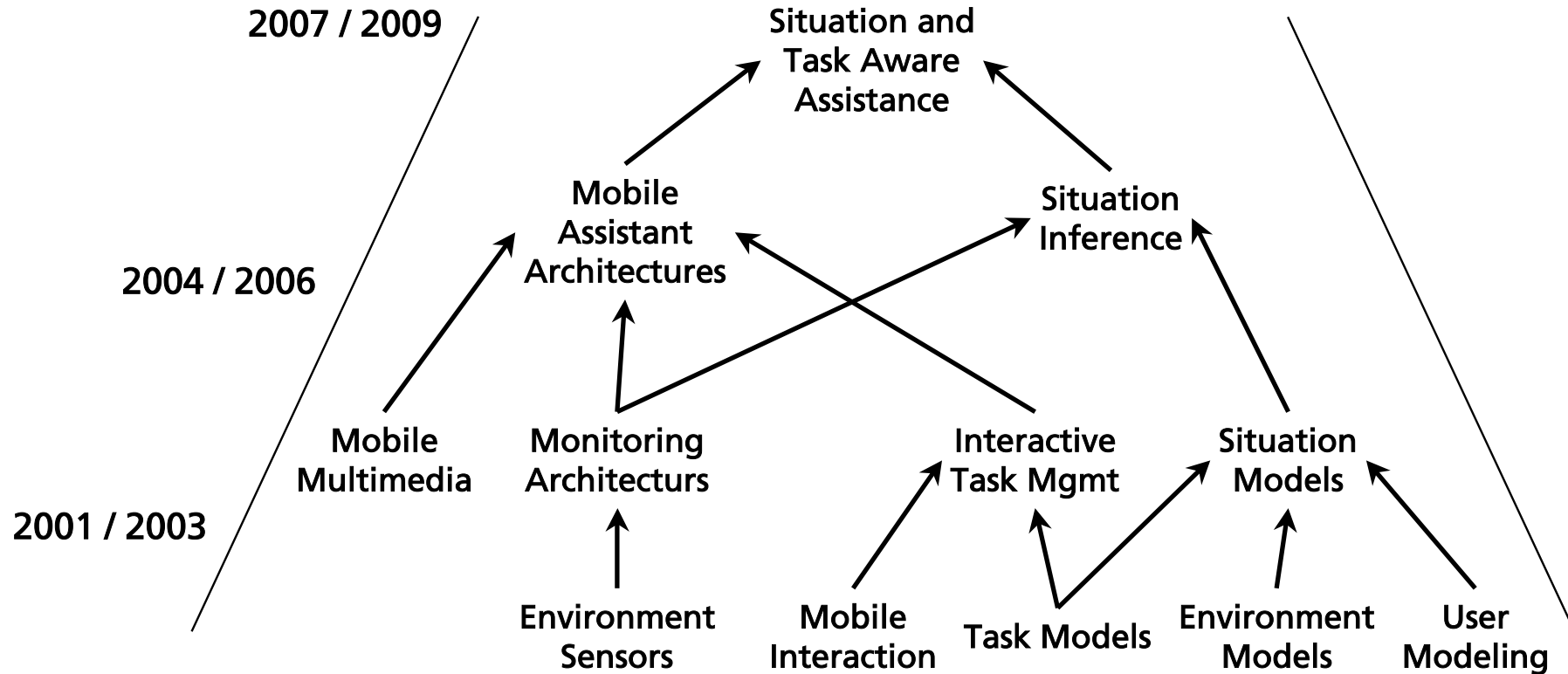
92

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Conclusion

Conclusion

➢ Ensure the progress of the evolution

➢ Be prepared for a „non predictable revolution"

➢ Personal view from José L. Encarnação

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Technology Roadmap

2005 / 2006

„Intelligent" Environments   „Perceptual" Computing

Human in the Loop   Virtuality Continuum   UMTS

2003 / 2004

Sensors; Feedback   Scalable Tracking   „Tangible" Information   Digital Story Telling

Knowledge-management in Broadcast Applications   Mixed Realities (MR)   Task Modeling

2001 / 2002

Tracking   VR / AR   Mobility   Knowledge-"Mining" u. -Visualization

Interactive Broadcasting   Multimodal Interaction   Agents   Avatars

Fraunhofer Institut Graphische Datenverarbeitung

Member of

INI-GraphicsNet

Applications (Markets)

New Application Areas

➢ Multimodal, multimedia networked Service Engineering and
   Providing (MM-ASP)

➢ Appliance Techniques; Mobility Computing

➢ eLearning; Life-long Learning

➢ Visualization, Simulation und Modeling in den Life-Sciences

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Roadmap Applications

2007 / 2009

| Multimodal, multimedia networked Service Engineering and Providing (MM-ASP) | Appliance Techniques; Mobility Computing |

| eLearning; Life-long Learning | Visualization, Simulation and Modelling in the Life-Sciences |

2004 / 2006

| Art and Cultural Heritage | Edutainment |

| New Media Online and Broadcasting Services | IT-Security; Engineering and Systems |

2001 / 2003

| eBusiness | Computer Aided Engineering |

| Telecommunication, Networking and Services | Mobile Information Systems | Education & Training |

IGD

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of

INI-GraphicsNet

97

Roadmap Faculties

2007 / 2009

| Usability Engineering |

| Perceptual Computing | | Situation and Task Awareness Computing |

2004 / 2006

| Human-Centered Multimodal Interfaces |

| Knowledge Engineering, Mining and Visualization | | Video Technology and Interactive Broadcasting |

2001 / 2003

| Faculties - Today |

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet

Key Technologies for the Future of the Information and Communication Technology

➢ Digital representations and the real environment are growing together
(virtuality continuum)

➢ Levels of abstraction are becoming more flexible (ubiquity; mobility)

➢ Perception and interaction with digital representations lead to new
requirements (human in the Loop)

Fraunhofer Institut
Graphische
Datenverarbeitung

IGD

Member of

INI-GraphicsNet

Vision (1)

Visualization in the future stands for:

➢ Eliminate existing weak spots

   ↳ High quality visualization for everyone, anytime, everywhere

   ↳ Provide more than a tool

➢ Innovative human-computer-interface

   ↳ Leave the „desktop metaphor"

➢ Human centered

Fraunhofer Institut
Graphische
Datenverarbeitung

Member of
INI-GraphicsNet

Vision (2)

➢ "Rendering" for other senses has to be developed and consistently integrated into the "Rendering-Pipeline"

➢ Integration of our "biological system" with computers and other communication systems

➢ Self-controlled visualization

➢ Establish standards

Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
Member of

Goals and Objectives

„When setting goals, it's important to be realistic. But we have to ge beyond that if we want to accomplish anything. We have to aim at advanced and achievable goals and objectives that result from an evolutionary approach, but opens opportunites to follow an unexpected revolution"
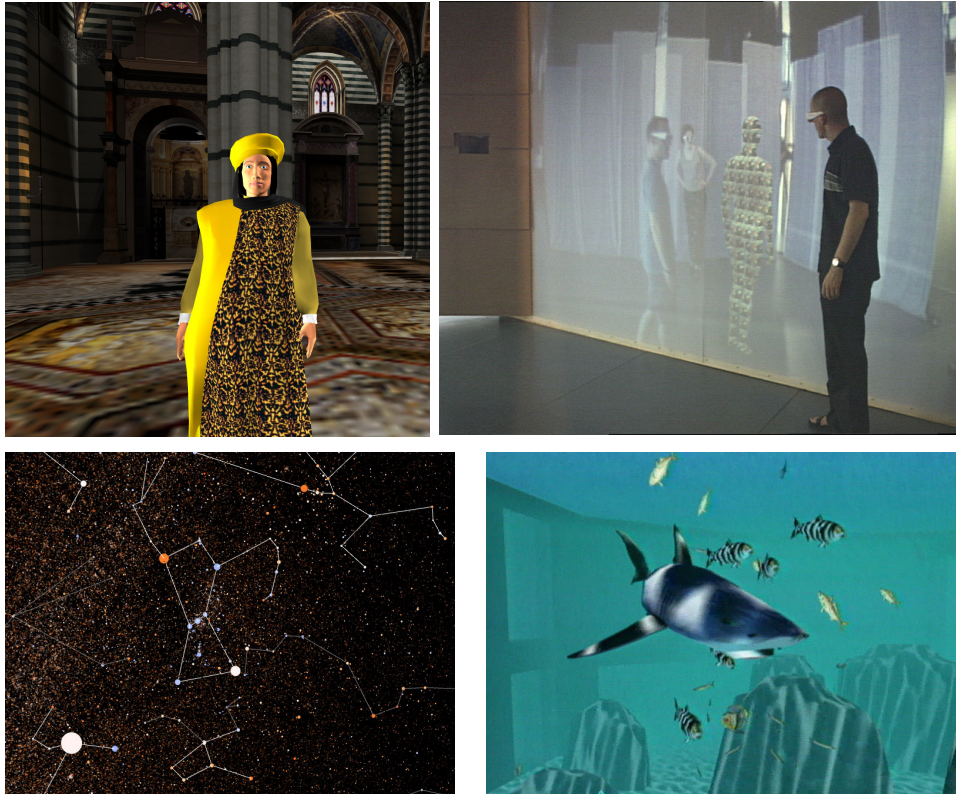
Fraunhofer Institut
Graphische
Datenverarbeitung

INI-GraphicsNet
Member of
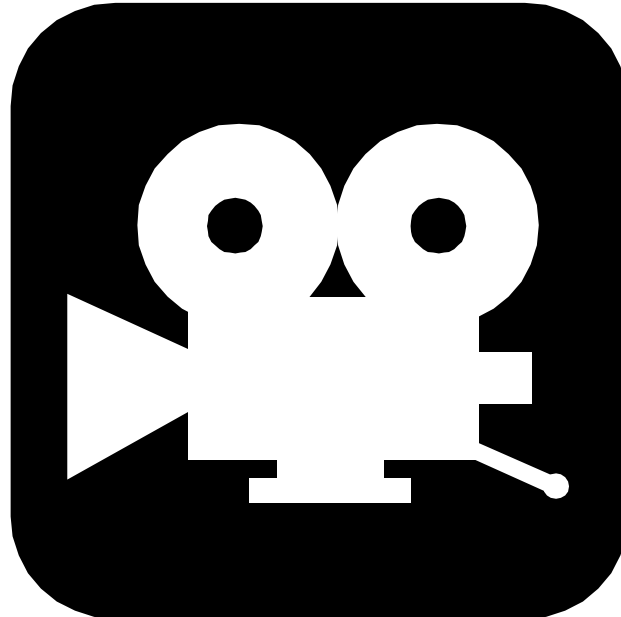
Video – ACM SIGGRAPH

... and finally my personal vision:

Cybernarium

Cybernarium: the Idea ...

Using VR and AR we have a technology

- ➢ With an enormous didactic potential
- ➢ That makes a new experience possible
- ➢ Transfer know-how in a new and attractive way
- ➢ That has to be presented to a broad audience
- ➢ That allows the user to be immersed in virtual worlds
- ➢ That offers fun, attraction and learning

cybernarium

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of INI-GraphicsNet

Cybernarium: a VR technology park

www.cybernarium.de

Cybernarium:

➢ "not another" multimedia oder science park

➢ "Exploratorium" for VR and AR technologies

➢ Accessible for the public

➢ Will transfer contents about culture, history, space, biology etc. through attractive and often changing exhibits and the opportunity to "experience" the information

Cybernarium: the Concept ...

- ➢ Museum part: simulators (e.g. flight simulator) and technology
- ➢ Experience part with high-end installations (CAVE, projections)
- ➢ "Cyberdome" with changing presentations
- ➢ VR service company
- ➢ Budget for several extraordinary new exhibits per year

cybernarium

Fraunhofer Institut Graphische Datenverarbeitung

IGD

Member of
INI-GraphicsNet

Cybernarium Days 2002

➢ First public presentation of the idea in Darmstadt

    ✑ 15 exhibits; 6 days opened

    ✑ We hoped for 6000 visitors

➢ The Reality

    ✑ 10.000(!) visitors

    ✑ Waiting time up to 3 hours

    ✑ Overall positive feedback

Fraunhofer Institut Graphische Datenverarbeitung

Member of
INI-GraphicsNet
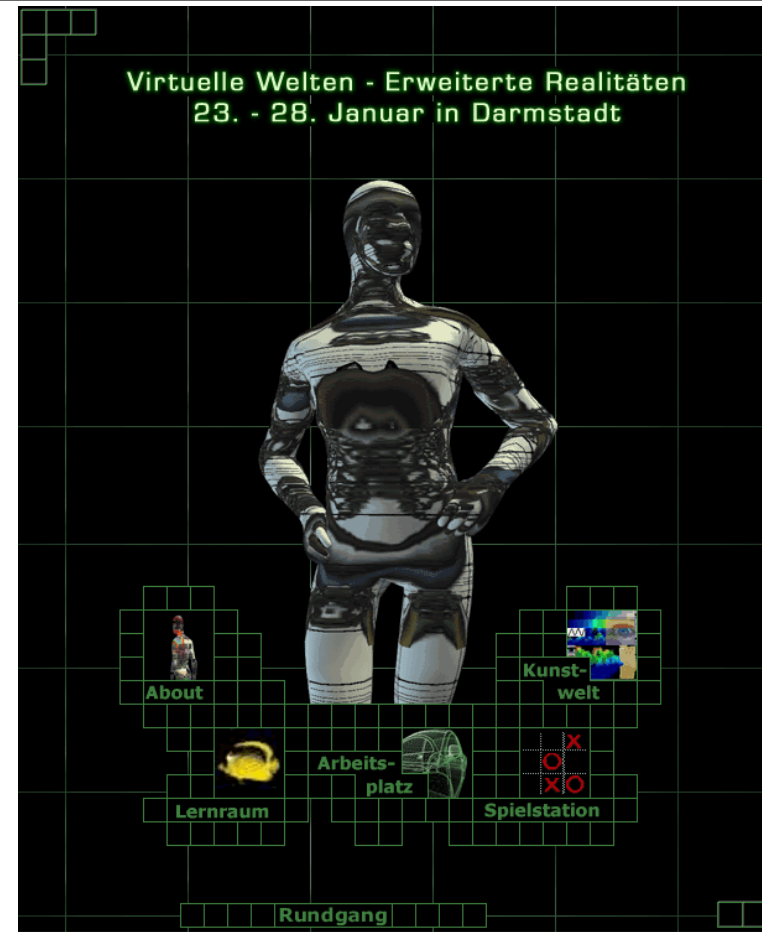
Our Goal

Official Opening in Summer 2004!

Thank you for your attention !