Human-Computer Interaction

History of HCI – Post-WIMP

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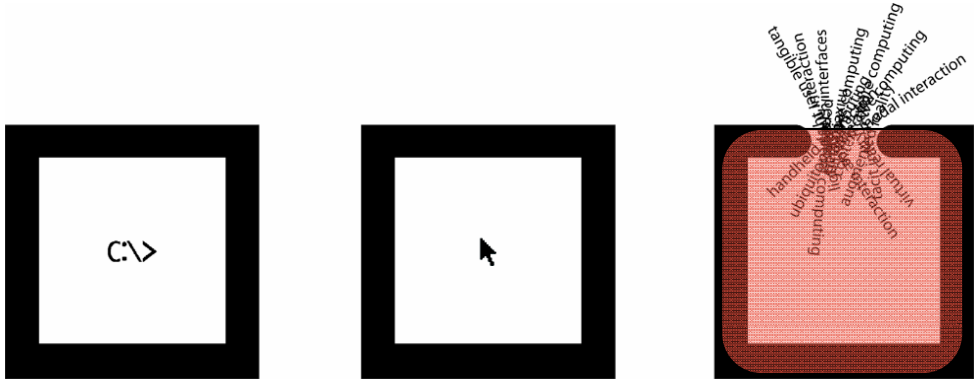
Review - History of HCI



Command User Interfaces WIMP Post-WIMP

Robert J.K. Jacob, Audrey Girouard, Leanne M. Hirshfield, Michael S. Horn, Orit Shaer, Erin Treacy Solovey, and Jamie Zigelbaum. 2008. Reality-based interaction: a framework for post-WIMP interfaces. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems* (CHI '08). ACM, New York, NY, USA, 201-210. DOI=10.1145/1357054.1357089 http://doi.acm.org/10.1145/1357054.1357089

Post-WIMP

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- Definition Post-WIMP
  - According to van Dam: Interfaces “containing at least one interaction technique, not dependent on classical 2D widgets such as menus and icons”

Why going post-WIMP?

A Human Sense Perspective

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- Buxton: WIMP GUIs based on the keyboard and the mouse are the perfect interface only for creatures with a single eye, one or more single-jointed fingers and no other sensory organs

- WIMP reduces interaction the the visual channel

A Groupwork Perspective - Time/Space Matrix

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	same time **synchronous**	**different times** **asynchronous**
same place **colocated**	Face-to-face Interaction •Wall display	Asynchronous Interaction •Public display •Bulletin board
different places **non-colocated**	Synchronous distributed interaction •Video conferencing •Chats •Multi-user editor	Asynchronous distributed Interaction •Group calendar •Email •Wiki

A Ubicomp Perspective

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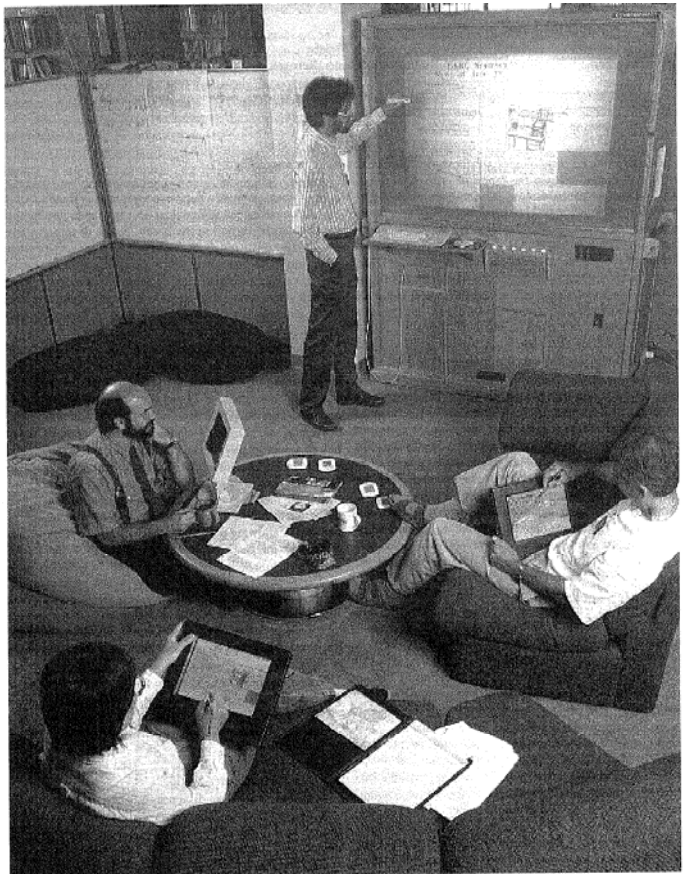
PHASE I:
The Mainframe Era

PHASE II:
The Personal Computing Era

PHASE III:
The Ubiquitous Computing Era



- Mark Weiser's most frequently cited statement: *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."*
- New requirements for interactions

Source: Mark Weiser. 1999. The computer for the 21st century. *SIGMOBILE Mob. Comput. Commun. Rev.* 3, 3 (July 1999), 3-11. DOI=10.1145/329124.329126 http://doi.acm.org/10.1145/329124.329126

Aspects of post-WIMP Interfaces

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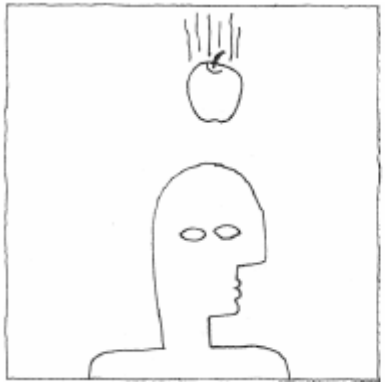
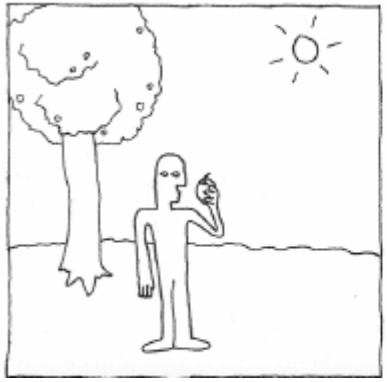


Naive physics

Body awareness and skills



Environment awareness and skills

Social awareness and skills

Source: Robert J.K. Jacob, Audrey Girouard, Leanne M. Hirshfield, Michael S. Horn, Orit Shaer, Erin Treacy Solovey, and Jamie Zigelbaum. 2008. Reality-based interaction: a framework for post-WIMP interfaces. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems* (CHI '08). ACM, New York, NY, USA, 201-210. DOI=10.1145/1357054.1357089 http://doi.acm.org/10.1145/1357054.1357089

Case Study: Apple iPhone

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- Naive physics
  - Illusion of a rubber surface when zooming into an image
  - We know from the phyiscal world that stretching increases a rubber surface
- Environment awareness and skills
  - Spatial metapher for browsing photos
- Body awareness and skills
  - Putting the iPhone next to the user‘s ear shuts off the screen

Source: http://digitaldaily.allthingsd.com/files/2007/06/iphone_coverflow_beck.jpg

Source: Robert J.K. Jacob, Audrey Girouard, Leanne M. Hirshfield, Michael S. Horn, Orit Shaer, Erin Treacy Solovey, and Jamie Zigelbaum. 2008. Reality-based interaction: a framework for post-WIMP interfaces. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems* (CHI '08). ACM, New York, NY, USA, 201-210. DOI=10.1145/1357054.1357089 http://doi.acm.org/10.1145/1357054.1357089

Tradeoffs

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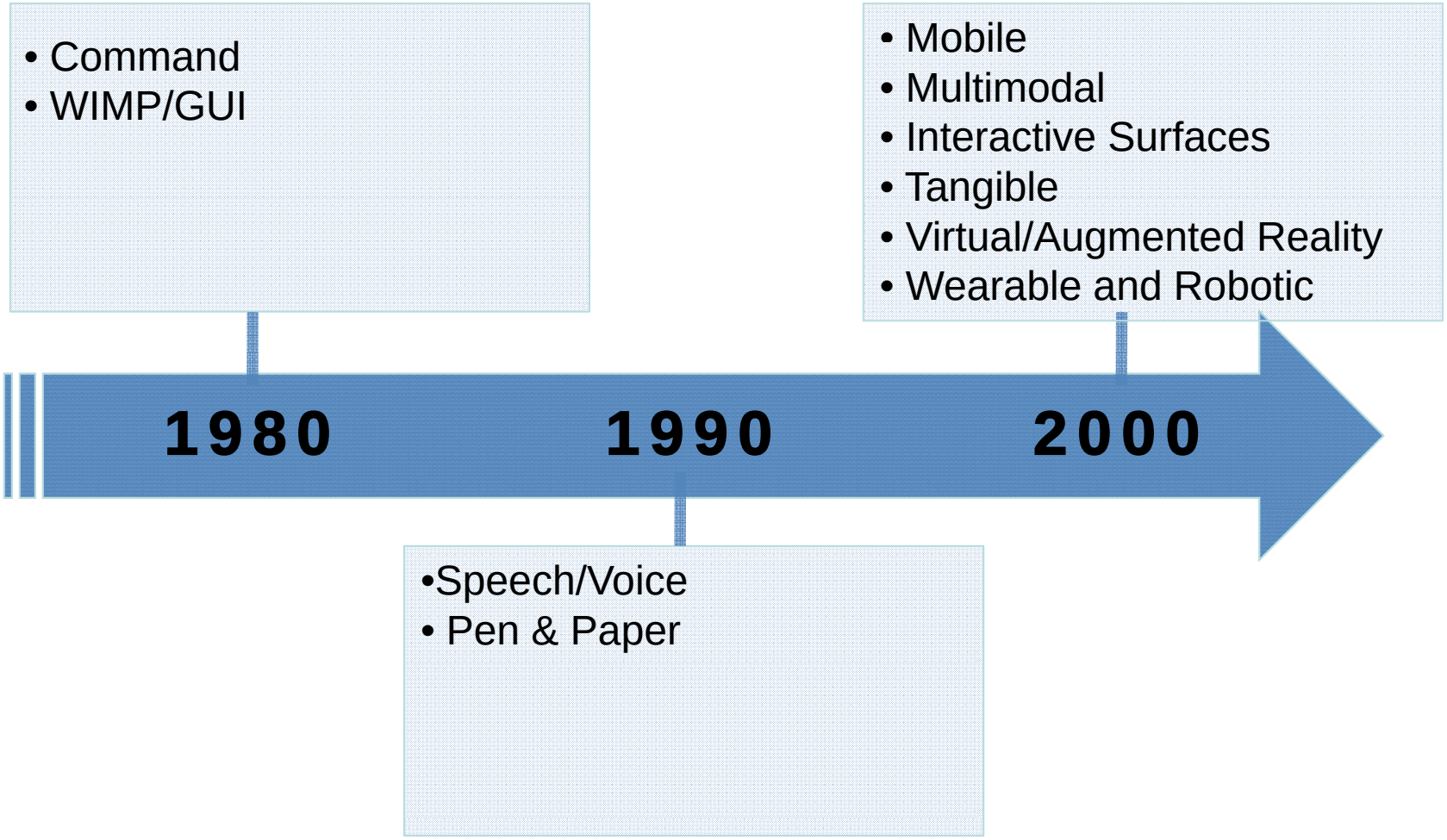
- Versatility over reality
  - Remove physical keyboard in order to gain screen size
  - Gain versatility, remove reality
- Reality over accessibility
  - Web pates are displayed similar to those on traditional desktops
  - Ensure reality, decrease accessibility.

Figure 4. Superman walks normally, but uses additional non real-world commands to provide extra functionality.

Source: Robert J.K. Jacob, Audrey Girouard, Leanne M. Hirshfield, Michael S. Horn, Orit Shaer, Erin Treacy Solovey, and Jamie Zigelbaum. 2008. Reality-based interaction: a framework for post-WIMP interfaces. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems* (CHI '08). ACM, New York, NY, USA, 201-210. DOI=10.1145/1357054.1357089 http://doi.acm.org/10.1145/1357054.1357089

Interface Types



Advanced GUIs

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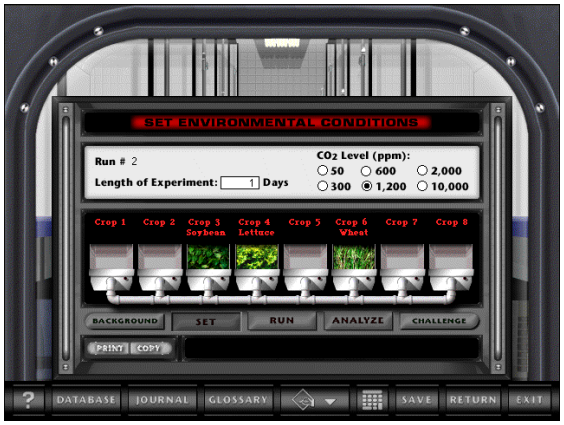
- Extends how users can access, explore and visualize Info.
  - e.g. interactive animations, multimedia, virtual environments and visualization

- Multimedia: (e.g. BioBlast MM learning environment)
  - Combines different media within a single interface with various forms of interactivity
  - Rapid access to multiple rep. of information
  - Provide better way of presenting information
  - Enable easier learning, better understanding and more engagement

- What is the connection to Norman's design principles?



Web Interfaces

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- 1.0 Early websites were largely text-based + Hyperlinks (cp. *hypertext*)
- 2.0 Now getting closer to desktop-like fluid interactivity with AJAX, Web, etc.
- Usability vs. Attractiveness debate:
  - Vanilla or multi-flavour design?

    - Ease of finding something versus aesthetic and enjoyable experience
  - Web designers are:

    - “thinking great literature”
  - Users read the web like a:

    - “billboard going by at 60 miles an hour”
  - Need to determine how to brand a web page to catch and keep “eyeballs”

Usability vs. Attractiveness

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Web Interfaces

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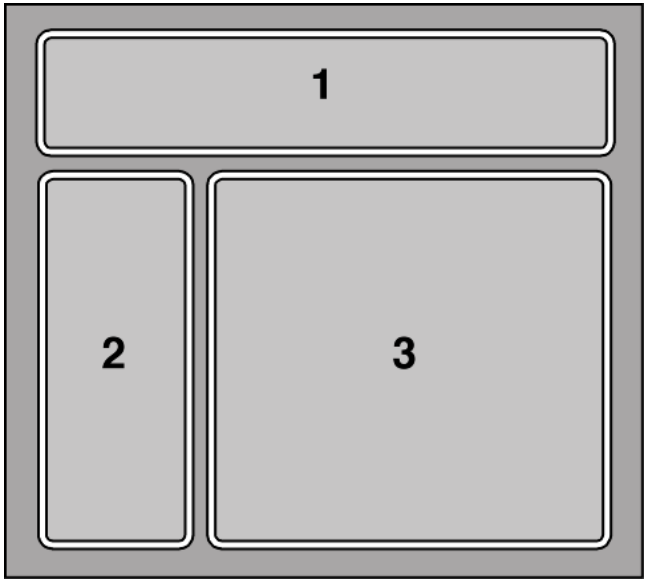
- Web interfaces are getting more like GUIs
- Need to consider how best to design, present, and structure information and system behavior
- But also content and navigation are central

- Veen's design principles
  - Where am I?
  - Where can I go?
  - What's here?

- Lots of other design principles, e.g.
  - http://designinginterfaces.com/
  - http://www.welie.com/



Web Interfaces (Frameworks)

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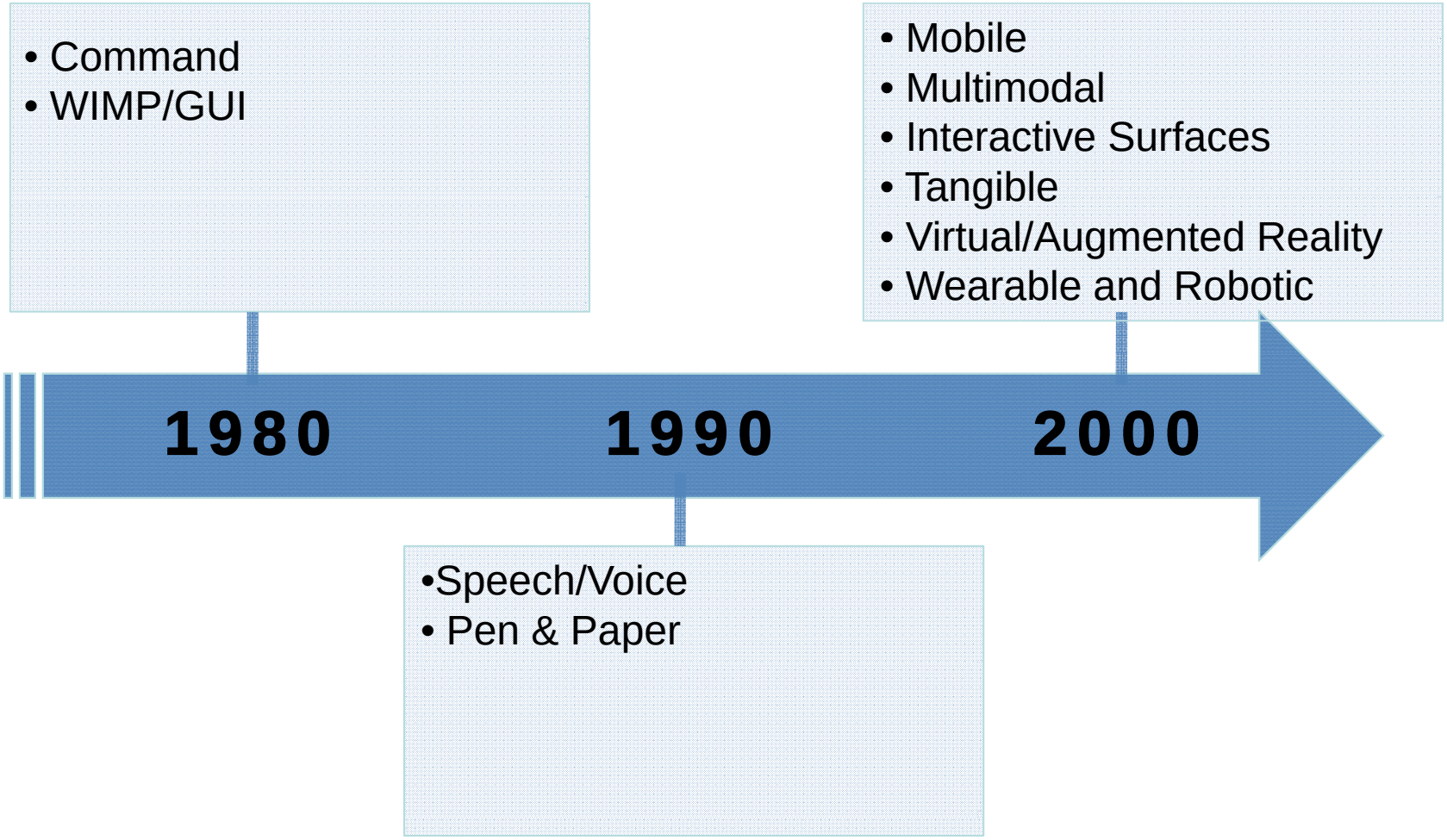
- Lots of frameworks exist which support a convergence of web user interfaces towards well known desktop user interfaces
  - http://cappuccino.org/
  - Google Web Toolkit: http://code.google.com/intl/de-DE/webtoolkit/

- Examples for Desktop like Web applications
  - MS Office Live
  - Google docs
  - Mozilla Prism

Interface Types



Speech Interfaces

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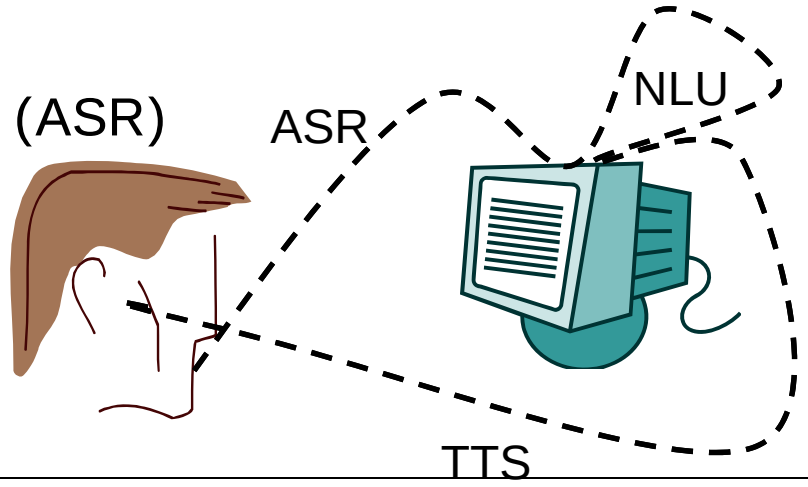
- Special kind of natural language interaction, based on the interaction type of *Conversing*
- Used most for
  - inquiring about very specific information, e.g. flight times
  - to perform a transaction, e.g. buy a ticket
  - Form filling in general
- Several areas involved, e.g.
  - Automatic speech recognition (ASR)
  - Natural language understanding (NLU)
  - Text-to-speech (TTS)



Demo

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Interface Types

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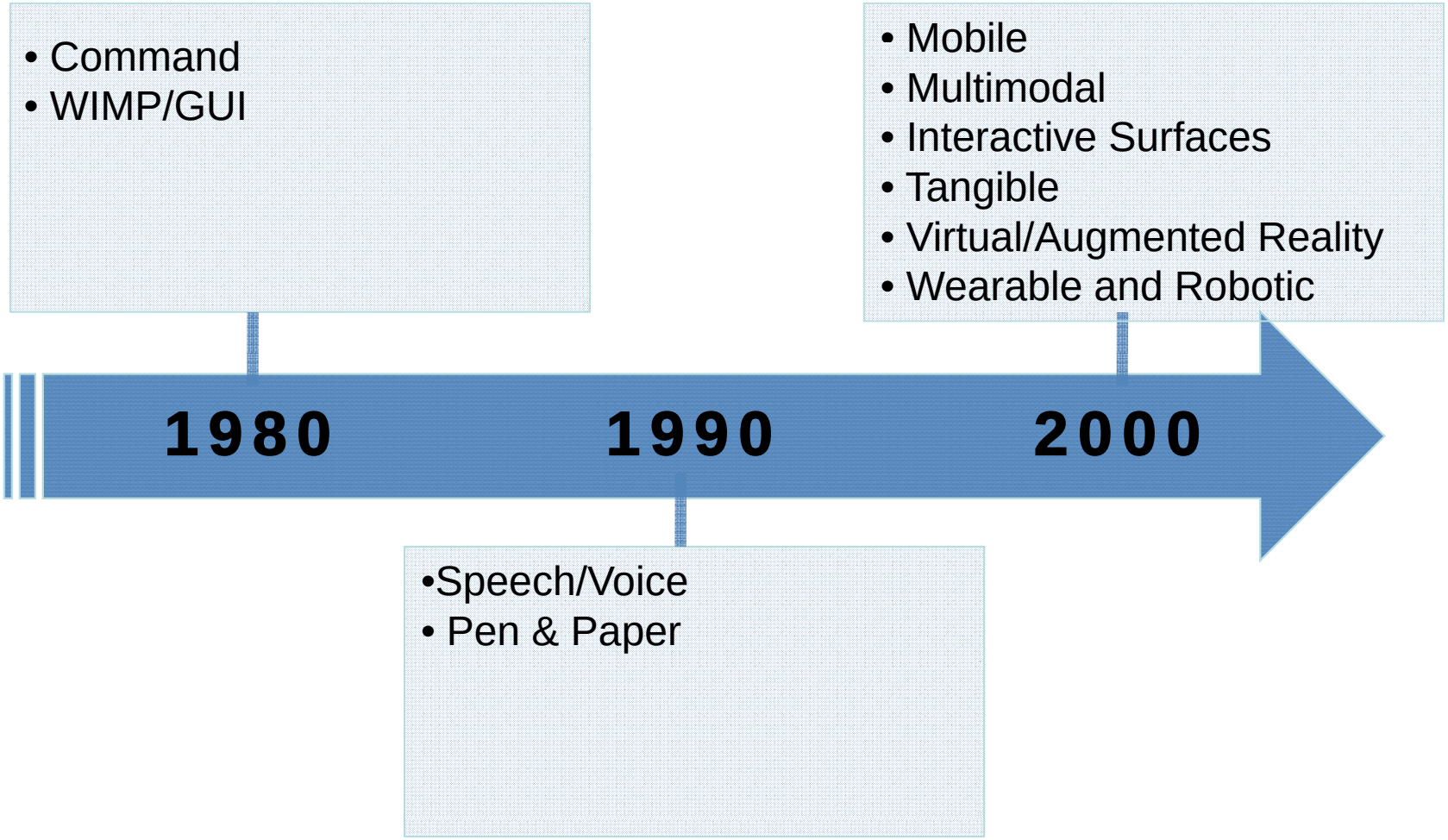

Pen-Based Interface

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- TabletPCs
  - Allow to use the pen as additional input device for WIMP GUI‘s
- Since 1990

Source: Wikipedia

Pen & Paper Interfaces

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- Combining pen & paper has many advantages
  - Ease of navigation
  - Intuitive annotation
  - Flexible spatial organisation
  - Mobility
  - Collaboration mutual awareness
  - Easily accessible

Pen & Paper Interfaces (II)

- Relative Position
  - Ultrasonic
    - Relies on ultrasonic triangulation
    - Digital pen emits constantly ultrasonic waves which are received by an external device
    - Nice side effect: tracking is independent of the material
  - Magnetic induction
    - Surface generates a magnetic field
    - Position of pen is recognized by using induction
    - High resolution 1000 to 5000 dpi

Source: pegatech.com

Source: Wacom.com

Pen & Paper Interfaces (III)

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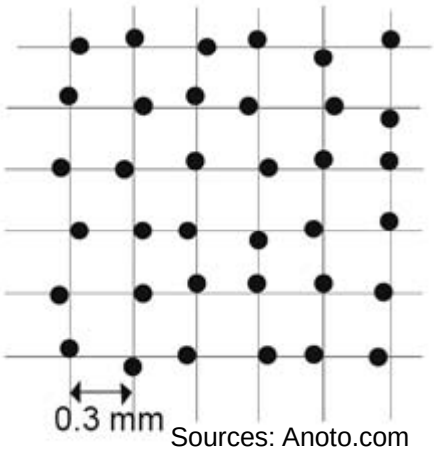
- Absolute Position – Anoto Technology
  - Each 6x6 matrix of dots encodes a unique position which can be read by the build-in infrared camera of the pen
  - Pattern can be printed with traditional printers
- Form factors of digital pens are evolving:
  - E.g. Whiteboard marker



Sources: Anoto.com

Example

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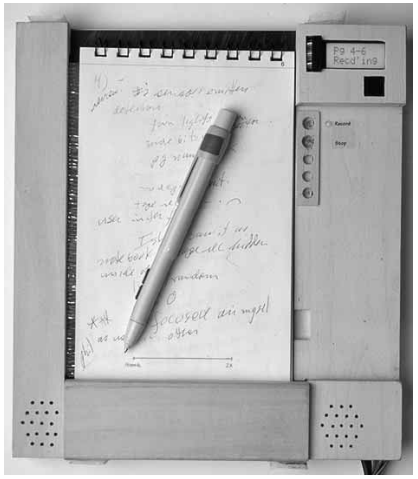
- 2001
  - The Audio notebook by Lisa Stifelman



- Since 2007
  - Livescribe SmartPen

© Livescribe Ltd.

Source: Lisa Stifelman, Barry Arons, and Chris Schmandt. 2001. The audio notebook: paper and pen interaction with structured speech. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (CHI '01). ACM, New York, NY, USA, 182-189. DOI=10.1145/365024.365096 http://doi.acm.org/10.1145/365024.365096

Example

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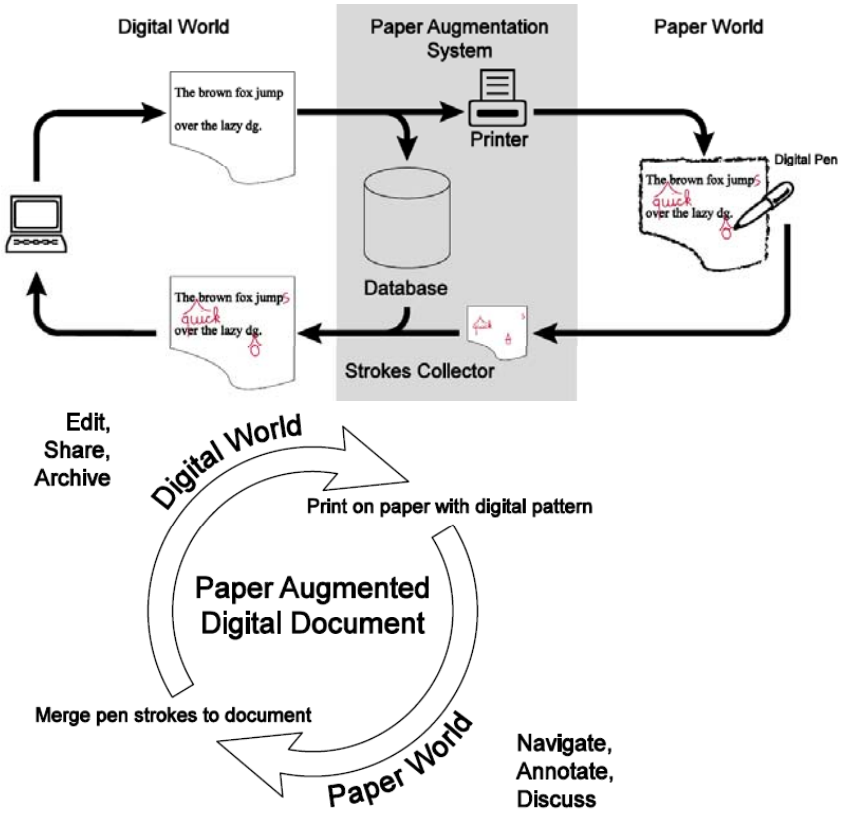
- Idea: Provide a paper and a digital representation of the same document
- Tasks such as proof reading can be performed on paper, whereas archiving takes place on the computer
- PADD allows to manipulate a document either with the computer or with pen&paper



Source: Fran\&\#231;ois Guimbreti\&\#232;re. 2003. Paper augmented digital documents. In *Proceedings of the 16th annual ACM symposium on User interface software and technology* (UIST '03). ACM, New York, NY, USA, 51-60. DOI=10.1145/964696.964702 http://doi.acm.org/10.1145/964696.964702

Future of Paper

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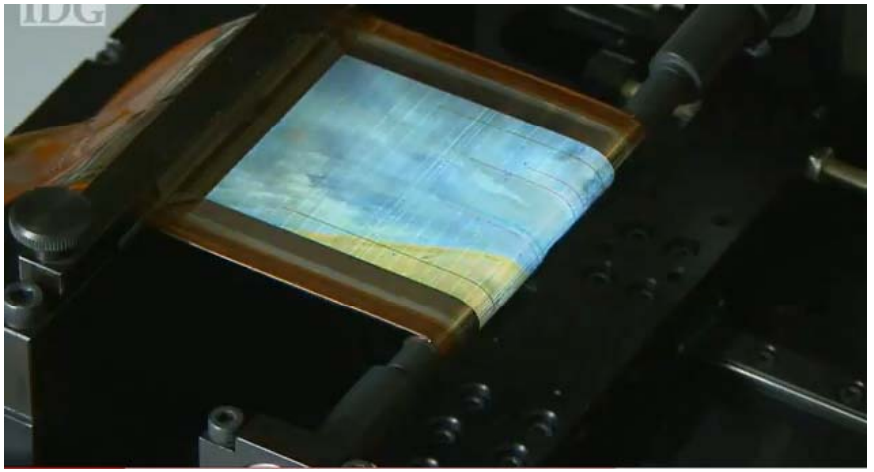
- Displays will become similar to paper
  - Flexible
  - Thin
  - Various Form Factors
  - High readability
  - Cheap



Rollable display developed by Sony

Interface Types

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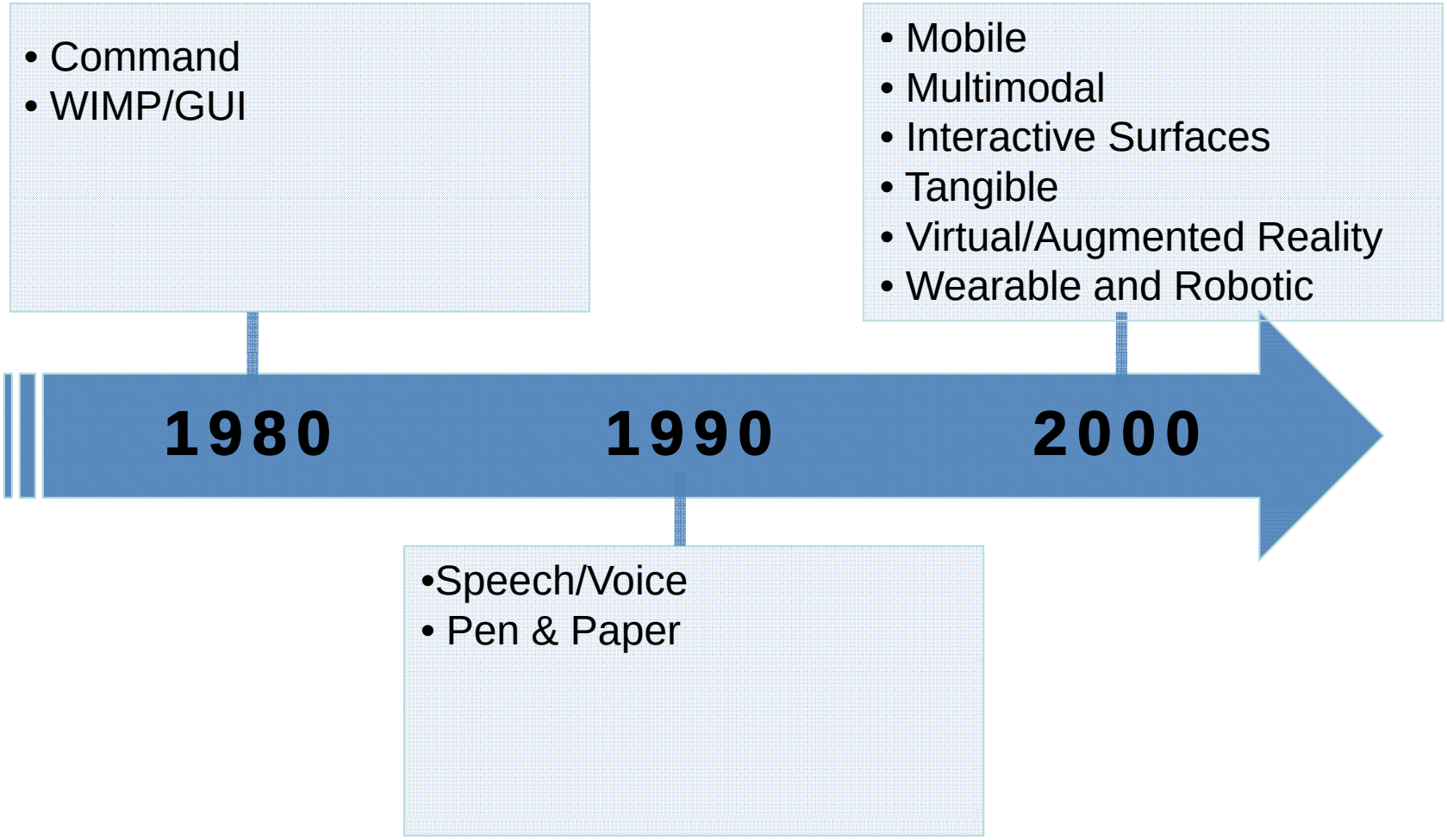

Mobile Interfaces

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Mobile devices for special use

Braille phone

Simple phone

Pager

Guitar amplifier

General purpose devices

Apple iPhone

Android-based phone

Mobile Interfaces

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- Handheld devices intended to be used while on the move.
  - e.g., PDAs, cell phones
- Small screens and restricted number of keys and controls
- Mobile interfaces introduced novel input techniques not known from the desktop:
  - roller wheels, rocker dials, up/down ‘lips’ on the face of phones, 2-way and 4-way directional keypads, softkeys, silk-screened buttons
- Usability and preference for these control devices varies, it depends on the dexterity and commitment of the user

Example Back Device Interaction

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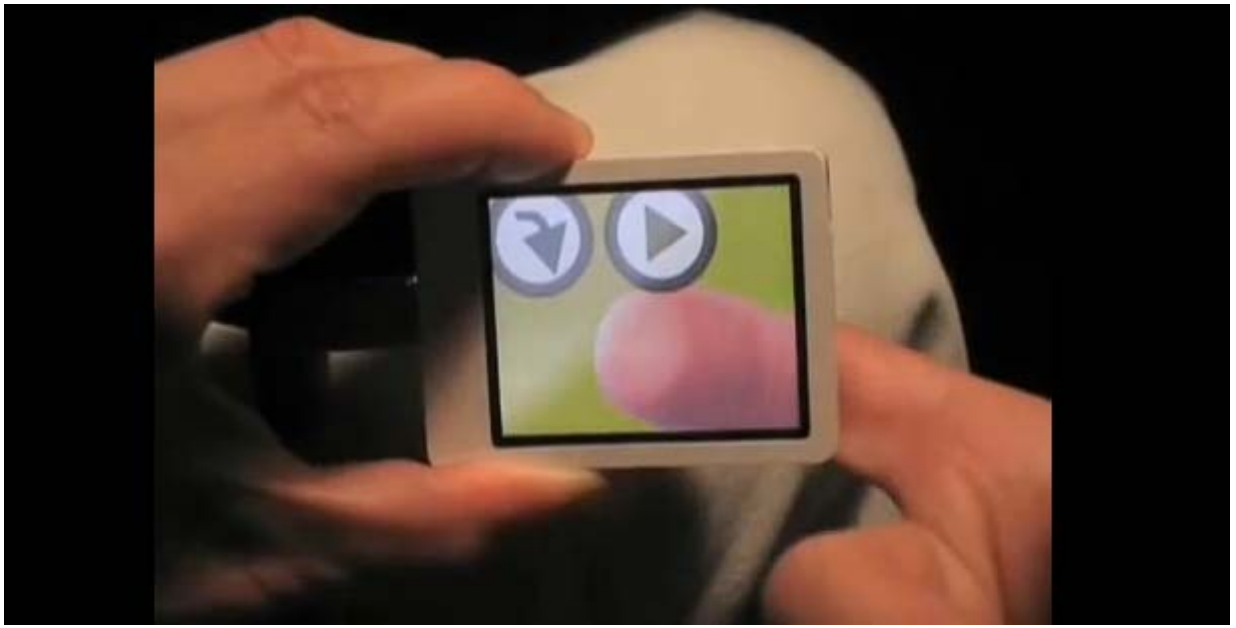

Publication: Patrick Baudisch and Gerry Chu. 2009. Back-of-device interaction allows creating very small touch devices. In *Proceedings of the 27th international conference on Human factors in computing systems* (CHI '09). ACM, New York, NY, USA, 1923-1932. DOI=10.1145/1518701.1518995 http://doi.acm.org/10.1145/1518701.1518995

Example Imaginary Interfaces

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Publication source: Sean Gustafson, Daniel Bierwirth, and Patrick Baudisch. 2010. Imaginary interfaces: spatial interaction with empty hands and without visual feedback. In *Proceedings of the 23nd annual ACM symposium on User interface software and technology* (UIST '10). ACM, New York, NY, USA, 3-12. DOI=10.1145/1866029.1866033 http://doi.acm.org/10.1145/1866029.1866033

Input/Output modalities

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- Mobile phones offer various kind of input and output modalities

Input
- Multitouch
- Camera
- 3-axis accelerometer
- Gyroscope (Rotation)
- Proximity
- GPS + Wi-Fi triangulation
- Compass

Output
- Display
- Sound
- Vibration

Input/Output modalities (II)

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- Mobile phones offer standard sensor, satisfying a wide range of applications
- Special hardware boards for accessing further modalities
  - Arduino
  - Phidgets
- Easy to program
- Cheap

```
int ledPin =  13;    // LED connected to digital pin 13

void setup()   {
 // initialize the digital pin as an output:
 pinMode(ledPin, OUTPUT);
 Serial.begin(9600);
}

void loop()
{
 blinkLed();
}

void blinkLed()
{
 digitalWrite(ledPin, HIGH);
 delay(50);
 digitalWrite(ledPin, LOW);
 delay(500);
}
```

Demo Phidgets

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Interface Types

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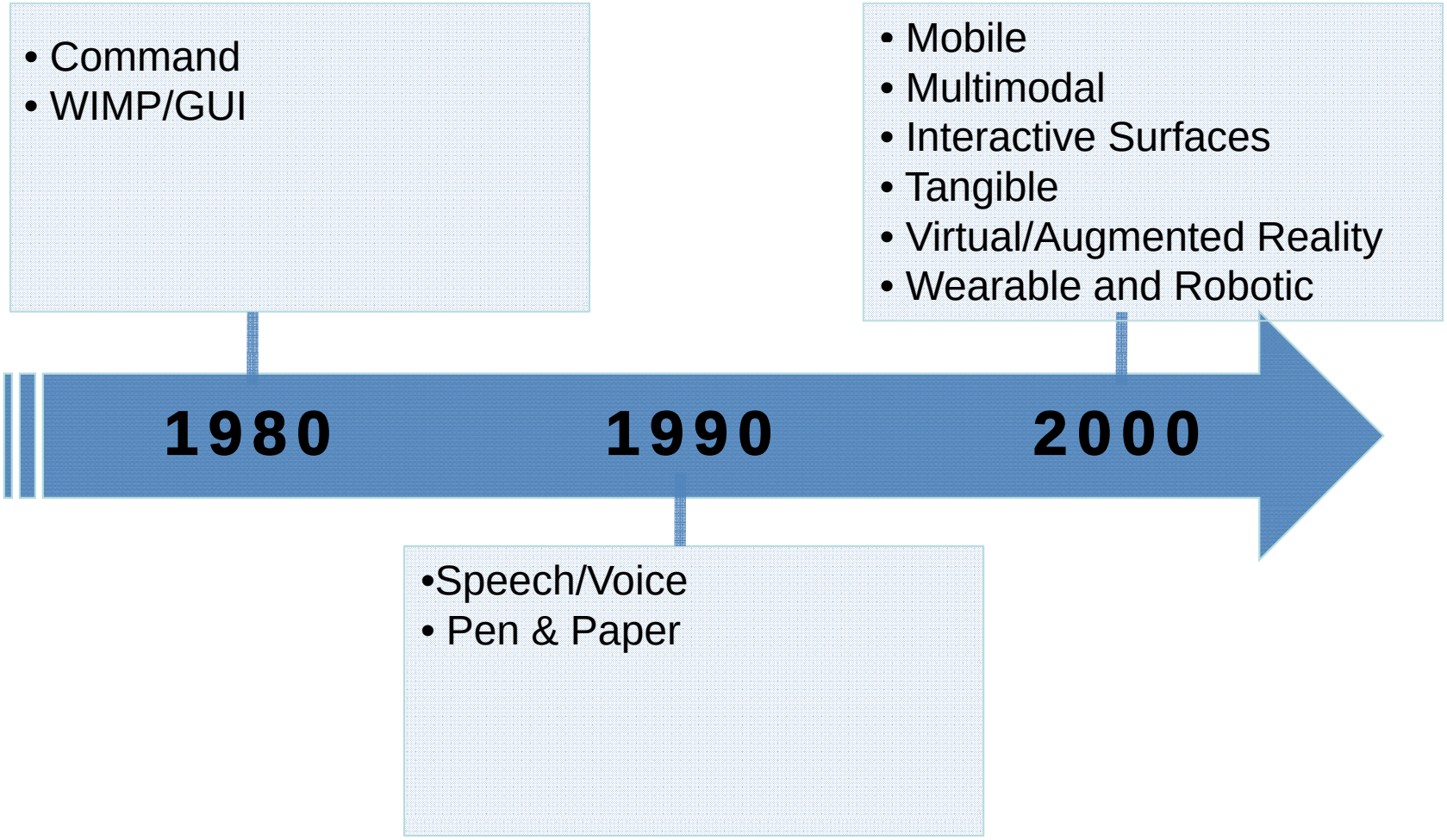

Multimodal Interfaces

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- Combining different interface techniques
  - Touch
  - Sight
  - Sound

- Assumption that multimodal interfaces are more akin to the multimodal experience in the phyiscal world.
  - But it‘s still unclear what is acutally gained from combining different input and outputs

Examples

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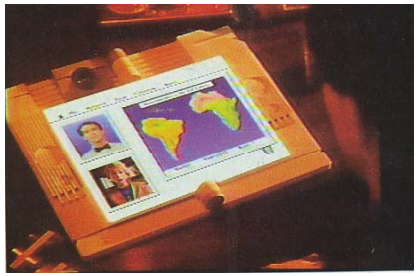
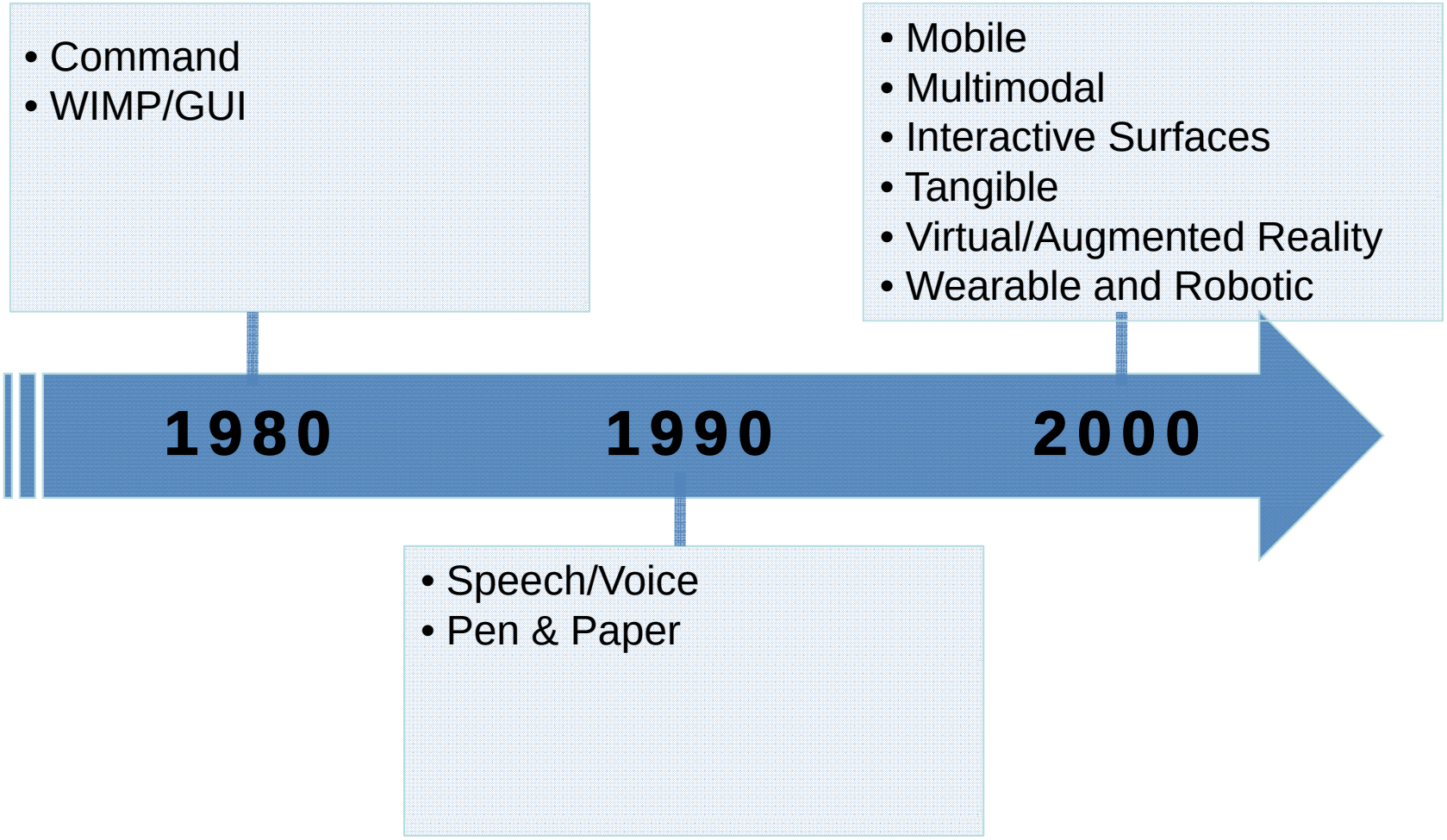
- Put That There (MIT, 1980)
  - Key advances
    - Recognizing human gestures
    - Combining voice with other input modes

- Apple Knowledge Navigator (1988)
  - Vision video mockup (not implemented)
  - Key advances
    - Got people enticed with ideas of user agents and multimedia



Interface Types



Interactive Surfaces

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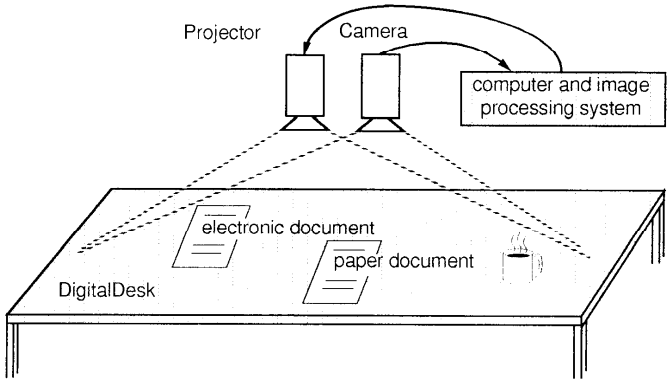
- Interactive wall is placed vertically whereas the tabletop is placed horizontally
- Large display
- Pioneering project: Digital Desk 1991 by Pierre Wellner



Digital Desk, 1991

MS Surface 2007

Collaboration on Tabletops

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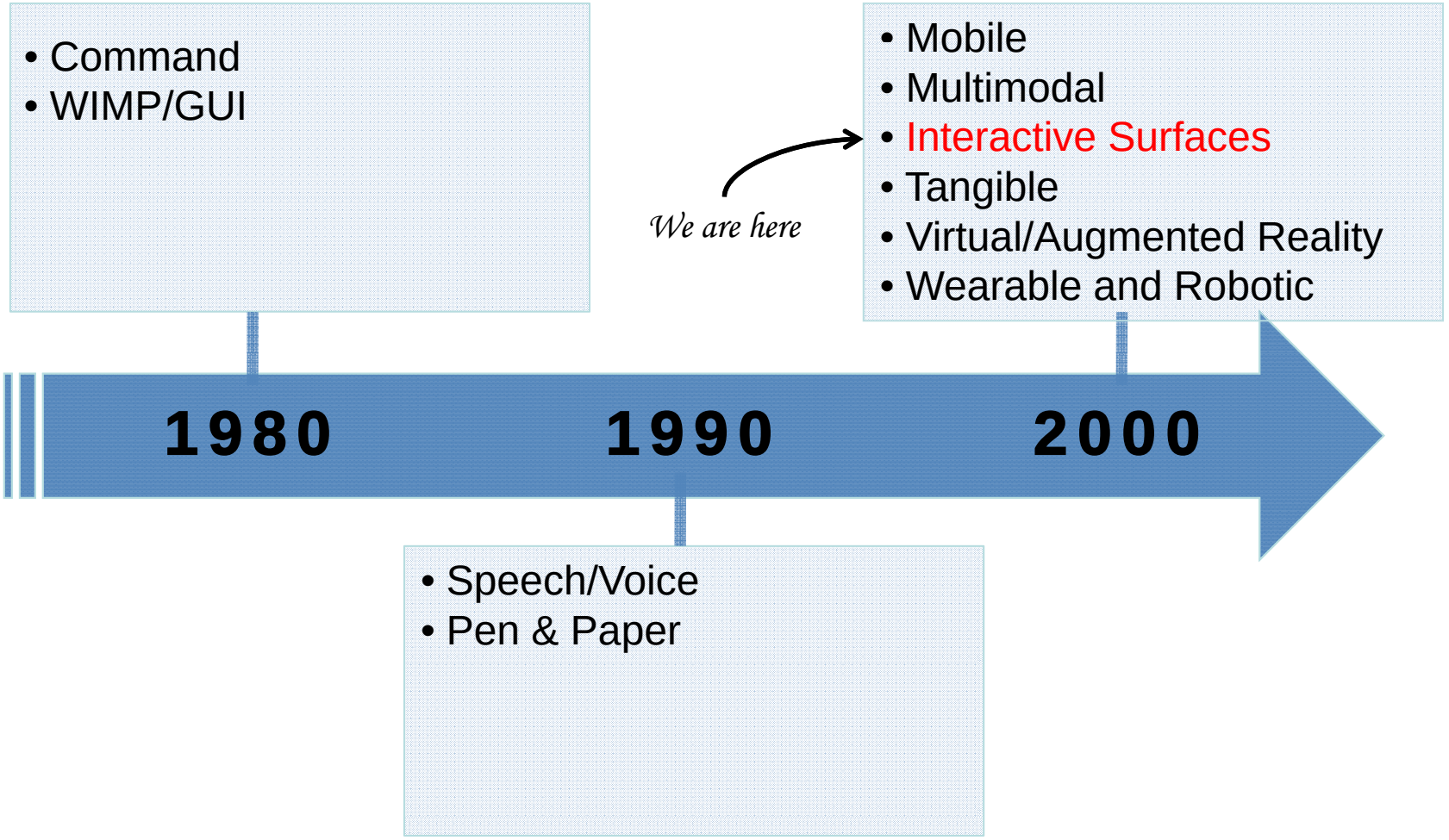
- Designed for collaborative works (more than one person)
- Provide a large interactional space that can support flexible group working
- Can be used by multiple users
  - Can point to and touch information being displayed
  - Simultaneously view the interactions and have same shared point of reference as others
- Can support more equitable participation compared with groups using single PC

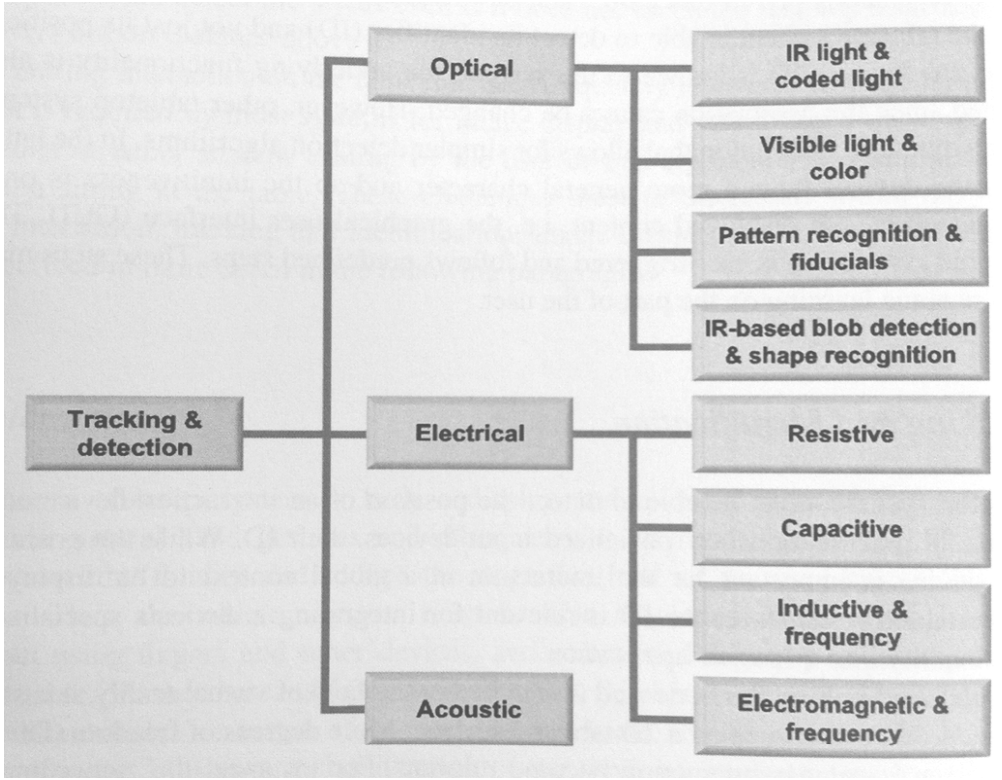
Review


• Command
• WIMP/GUI
We are here
• Mobile
• Multimodal
• Interactive Surfaces
• Tangible
• Virtual/Augmented Reality
• Wearable and Robotic
1980
1990
2000
• Speech/Voice
• Pen & Paper

Tabletop – Under the surface

- Goal: Detection of the position and the ID of the input device (such as stylus, touch, graspable object)

- Challenges
  - Allowing more than 2 degrees of freedom
    - Instead of using only the x and y-coordinate, the z-coordinate is additionally included for tracking objects above the surface
  - Distinguishing between intended and non-intended interaction



Source: Tabletops – Horizontal Interactive Displays by Christian Müller-Tomfelde (Springer)

Frustrated Total Internal Reflection (FTIR)

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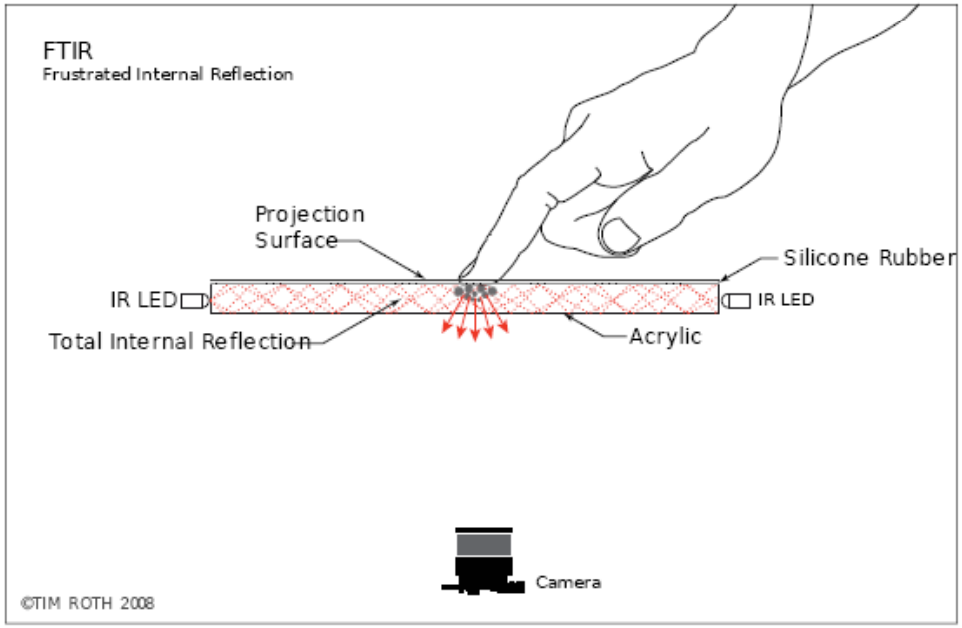
- Discovered by Jeff Han 2005
- Allows very robust tracking of fingers
- Setup:
  - The acrylic plate is surrounded by LEDs which inject IR-light into the plate
- Touching the surface let the light escape the plate
- Camera detects IR light
- Standard computer vision techniques are use to recognize touches (e.g. blob detection)



Source: nuigroup.com/go/

Diffuse Illumination (DI)

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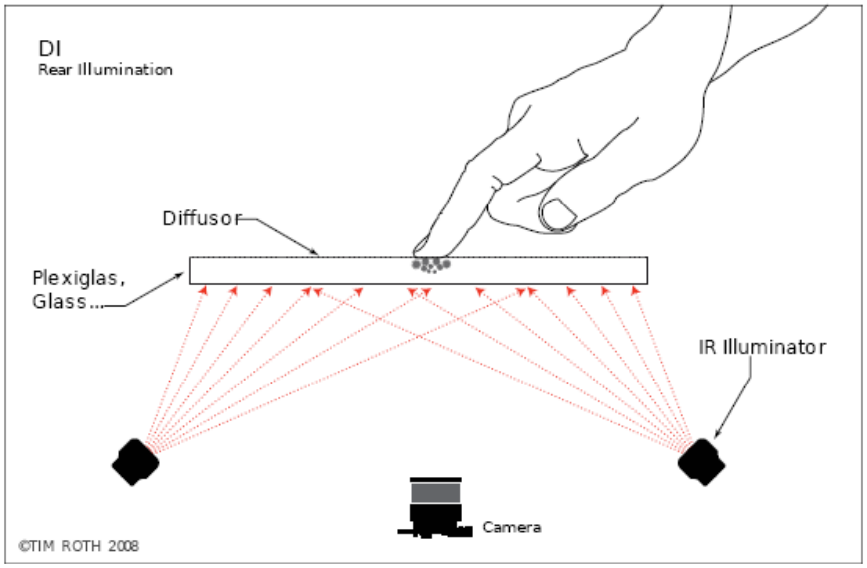
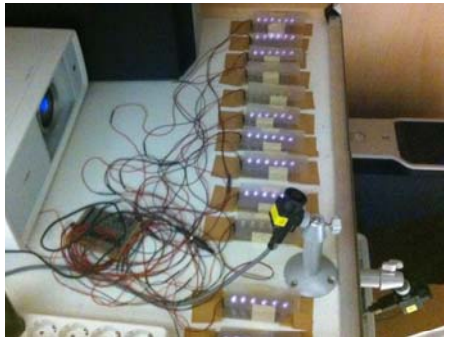
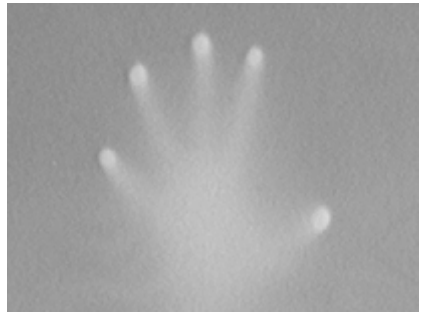
- Setup
  - IR illuminators emit light on the projection surface
  - An object (e.g. a finger) diffuses the IR light, which can then be detected by a camera
  - Basic computer vision techniques are applied (e.g. blob detection)
- Advantages
  - Tracking and identification of objects (e.g. via fiducial markers) including objects above the table
  - Any transparent surface material will do







Source: http://nuigroup.com/go/

Demo – $1 Tabletop

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- Got infected and want to build your own Tabletop?
  - Good starting points:
    - http://wiki.nuigroup.com/Hardware
    - http://www.youtube.com/watch?v=dcN53tgeyhA&feature=player_embedded

Discussion

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- Computer vision methods still provide coarse and sometimes ambiguous results
- Resolution of projectors is low compared to the resolution of LCD monitors
- Tabletops are quite bulky

Electrical Touch Technologies

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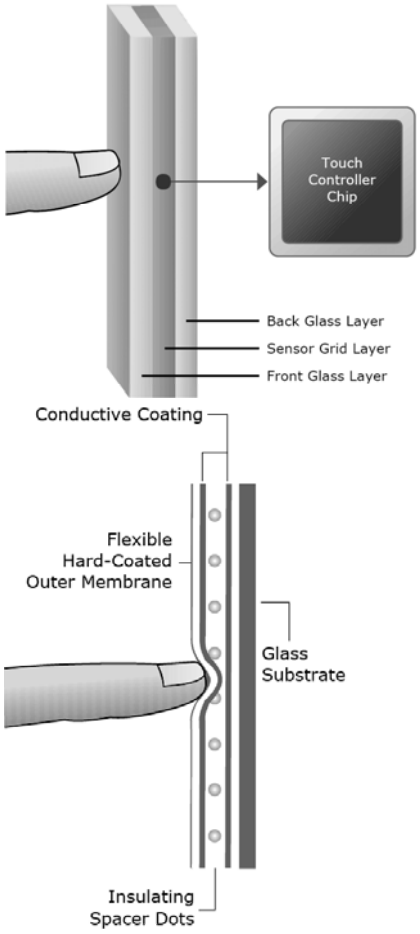
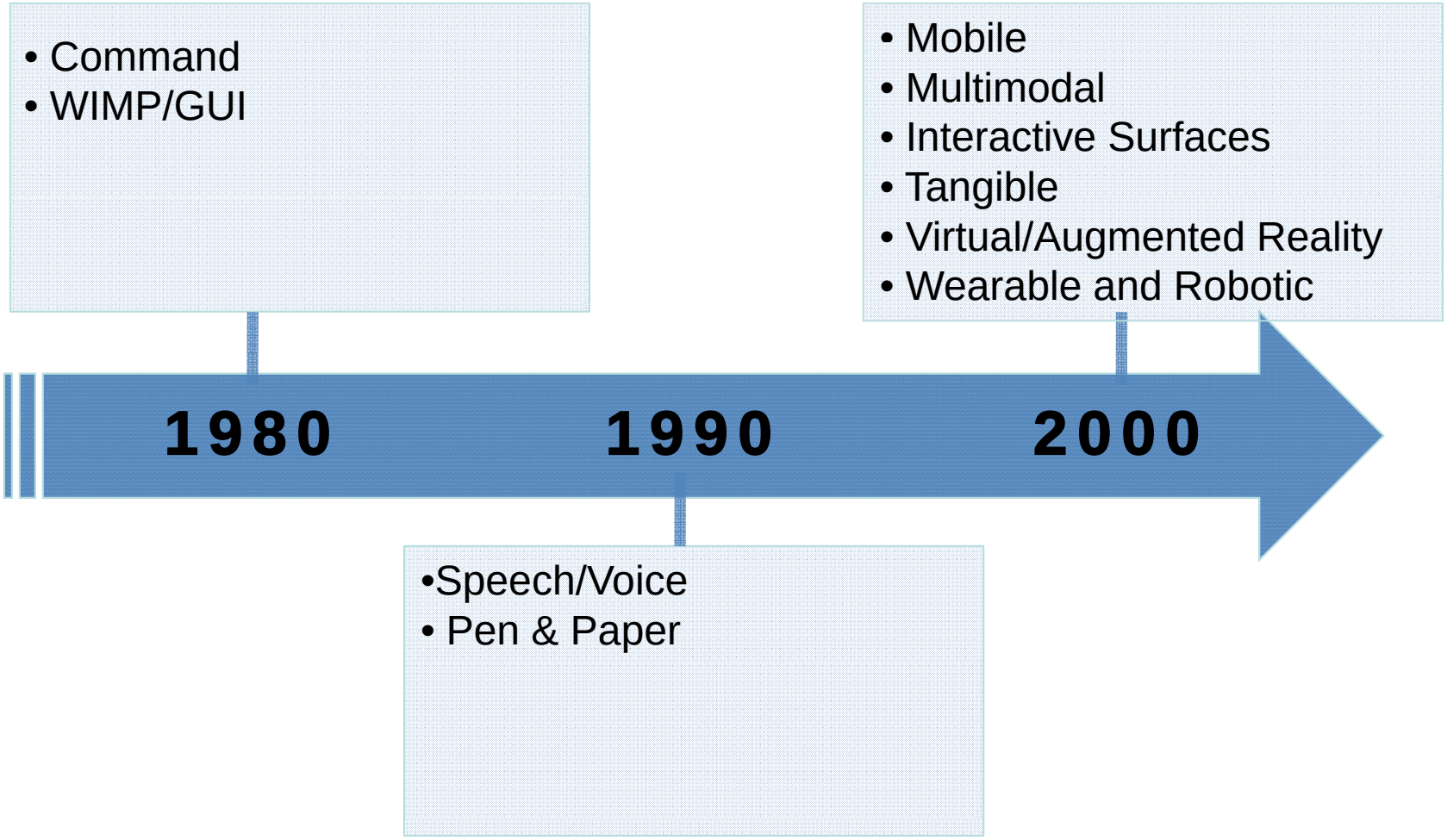
- Capacitive Touch
  - Active technology
  - Need conductive device (e.g. finger)
  - High clarity
  - expensive
- Resistive Touch
  - Passive technology
  - Works with various objects
  - Low clarity (75-80%)
  - Cheap
- Both technologies require industrial quality fabrication facilities



Interface Types



Tangible User Interfaces

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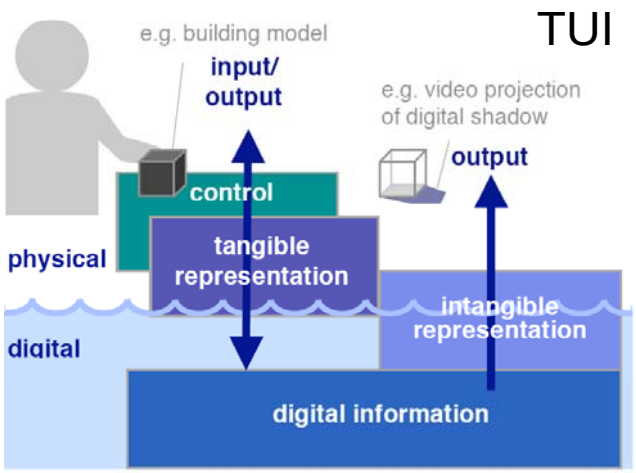
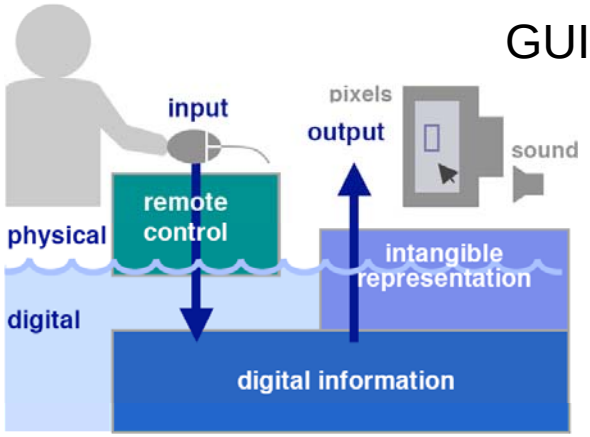
- TUI
  - Tangible objects (e.g. a physical cube) are used to control AND represent digital information
  - Intangible representation (e.g. a video projection) can help to synchronize digital information with the tangible representation



- GUI
  - Generic input devices (e.g. mouse) are used to control digital information
  - Digital Information are represented in intangible form (e.g. on a display)



Tangible User Interfaces

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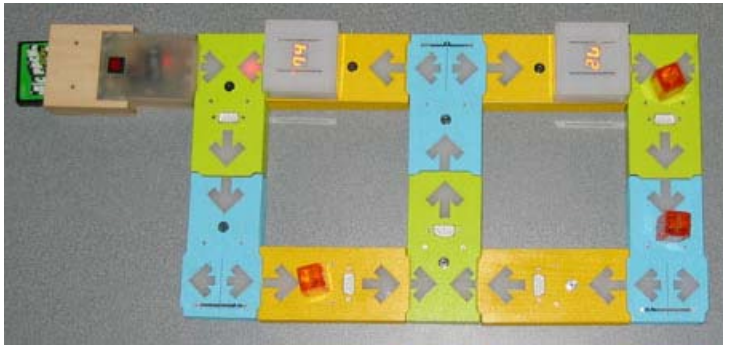
- Key Idea: Give physical form to digital information

- Memory hook
  - --- land of atoms, sea of bits ---

- TUIs are specials purpose interface whereas GUIs serve as general purpose interface
  - Space-multiplexing vs. Time-multiplexing
    - TUI - Space MP: Each function has a dedicated transducer
    - GUI – Time MP: One device to control different functions at different points in time

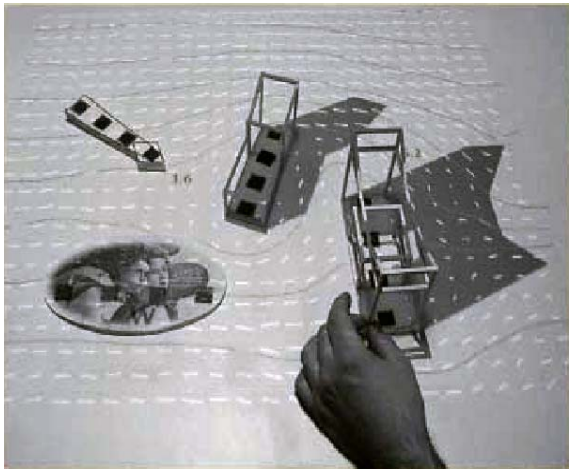
Examples

- *Flow Blocks*
  - Should enable kids to model and analyze dynamic behaviour
  - System consists of tangible bricks (green, blue and orange) that transport light pulses and control blocks which e.g. display the overall number of light pulses.



Source: Oren Zuckerman, Saeed Arida, and Mitchel Resnick. 2005. Extending tangible interfaces for education: digital montessori-inspired manipulatives. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (CHI '05). ACM, New York, NY, USA, 859-868. DOI=10.1145/1054972.1055093 http://doi.acm.org/10.1145/1054972.1055093

- *Urp*
  - Tangible interface for urban planning
  - If a building is placed on the surface, shadows are projected onto the surface as well as the changed wind conditions (small white arrows)



Source: John Underkoffler and Hiroshi Ishii. 1999. Urp: a luminous-tangible workbench for urban planning and design. In *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit* (CHI '99). ACM, New York, NY, USA, 386-393. DOI=10.1145/302979.303114 http://doi.acm.org/10.1145/302979.303114

TUI Discussion

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- Advantages (acc. to Fitzmaurice, Rogers)
  - Users receive passive haptic feedback from the physical object
  - Encourages two handed interactions
  - More parallel input specification by the user, increasing the communication bandwidth
  - affords multi-person, collaborative use
  - Externalizes traditionally internal computer representations
  - Making the interaction more direct due to the use of physical artefacts
  - Takes advantage of our keen spatial reasoning skills
  - encourages different ways of representing and exploring a problem space
  - People are able to see and understand situations differently
    - can lead to greater insight, learning, and problem-solving than with other kinds of interfaces
    - can facilitate creativity and reflection

TUI Discussion

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- Disadvantages
  - Restricted to special purpose applications due to the tight coupling of the physical object and the digital information
  - Output capabilities of physical objects are still limited, e.g. How to computationally change the shape of an physical object.

Example Reactable

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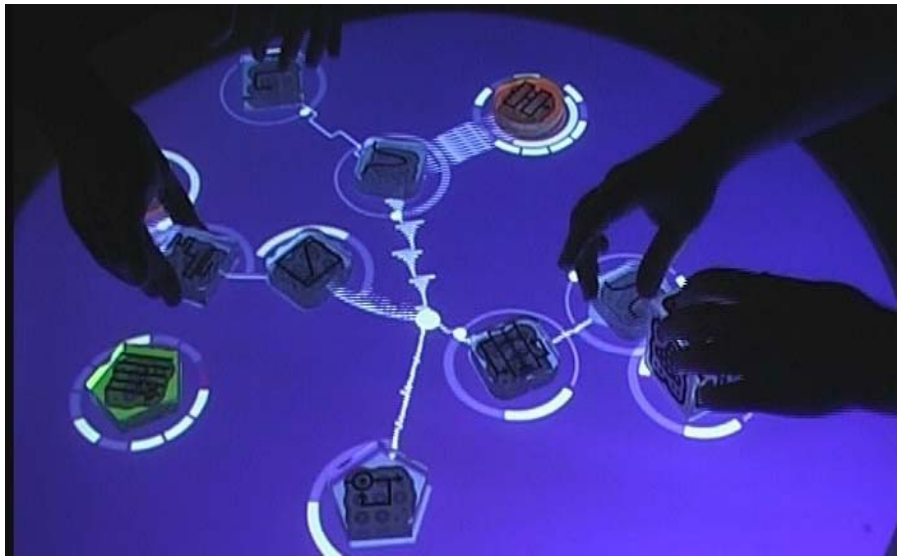
- Tangible Synthesizer

- Started as a research project, now commercially available



Source: Sergi Jord\&\#224;, G\&\#252;nter Geiger, Marcos Alonso, and Martin Kaltenbrunner. 2007. The reacTable: exploring the synergy between live music performance and tabletop tangible interfaces. In *Proceedings of the 1st international conference on Tangible and embedded interaction* (TEI '07). ACM, New York, NY, USA, 139-146. DOI=10.1145/1226969.1226998 http://doi.acm.org/10.1145/1226969.1226998

Combining TUI and Tabletop

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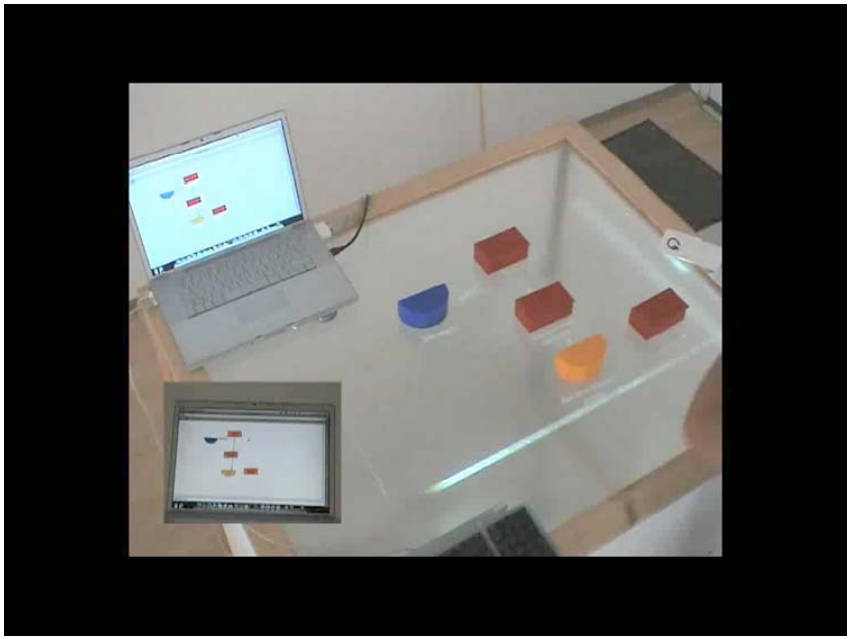
- Comprehand
  - Tangible user interface (interactive surface + tangibles)
  - Stefan Oppl, Johannes Kepler Universität Linz, Austria



Paper: : Stefan Oppl and Christian Stary. 2009. Tabletop concept mapping. In *Proceedings of the 3rd International Conference on Tangible and Embedded Interaction* (TEI '09). ACM, New York, NY, USA, 275-282. DOI=10.1145/1517664.1517721 http://doi.acm.org/10.1145/1517664.1517721

Pattern Recognition

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- Augment a tangible with a machine readable label in order to detect and locate it
- Characteristics:
  - Is the ID embedded in the marker?
  - How is the form factor (flat or non-flat)?
  - What is the minimum size of the marker for a given distance to the camera?
  - How is the partial occlusion behavior?
  - How many degrees of freedom does the tracking system offer? (max 6 DOF: x, y, z, yaw, pitch, roll)
  - What light conditions are necessary in order to detect the marker?

- Available frameworks:
  - ARToolKit (http://www.hitl.washington.edu/artoolkit/download/)
  - reacTIVision (http://reactivision.sourceforge.net/)

Excursion: Ambient Interfaces

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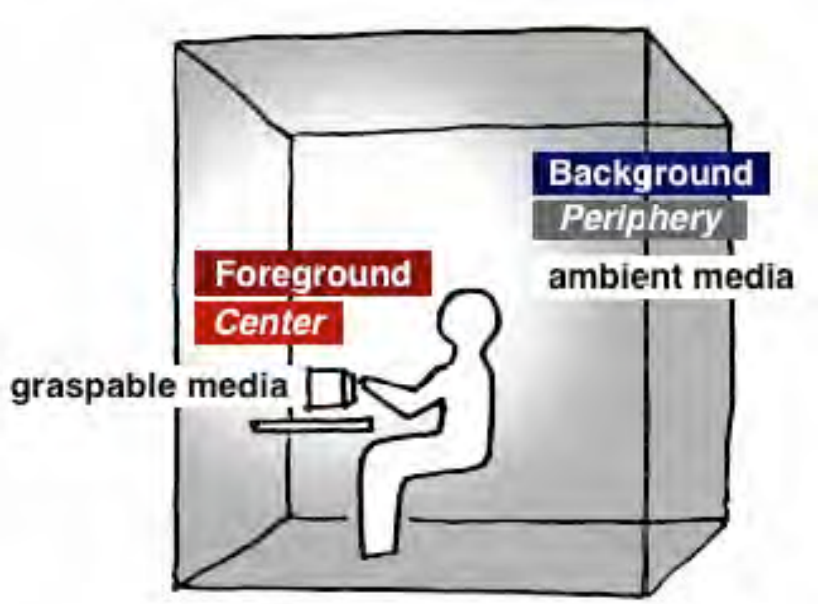
- Ishii: “Smooth the transition of the users’ focus of attention between background and foreground”
- Use the users’ peripheral senses
  - E.g. changing the lightening conditions or the temperature



Example

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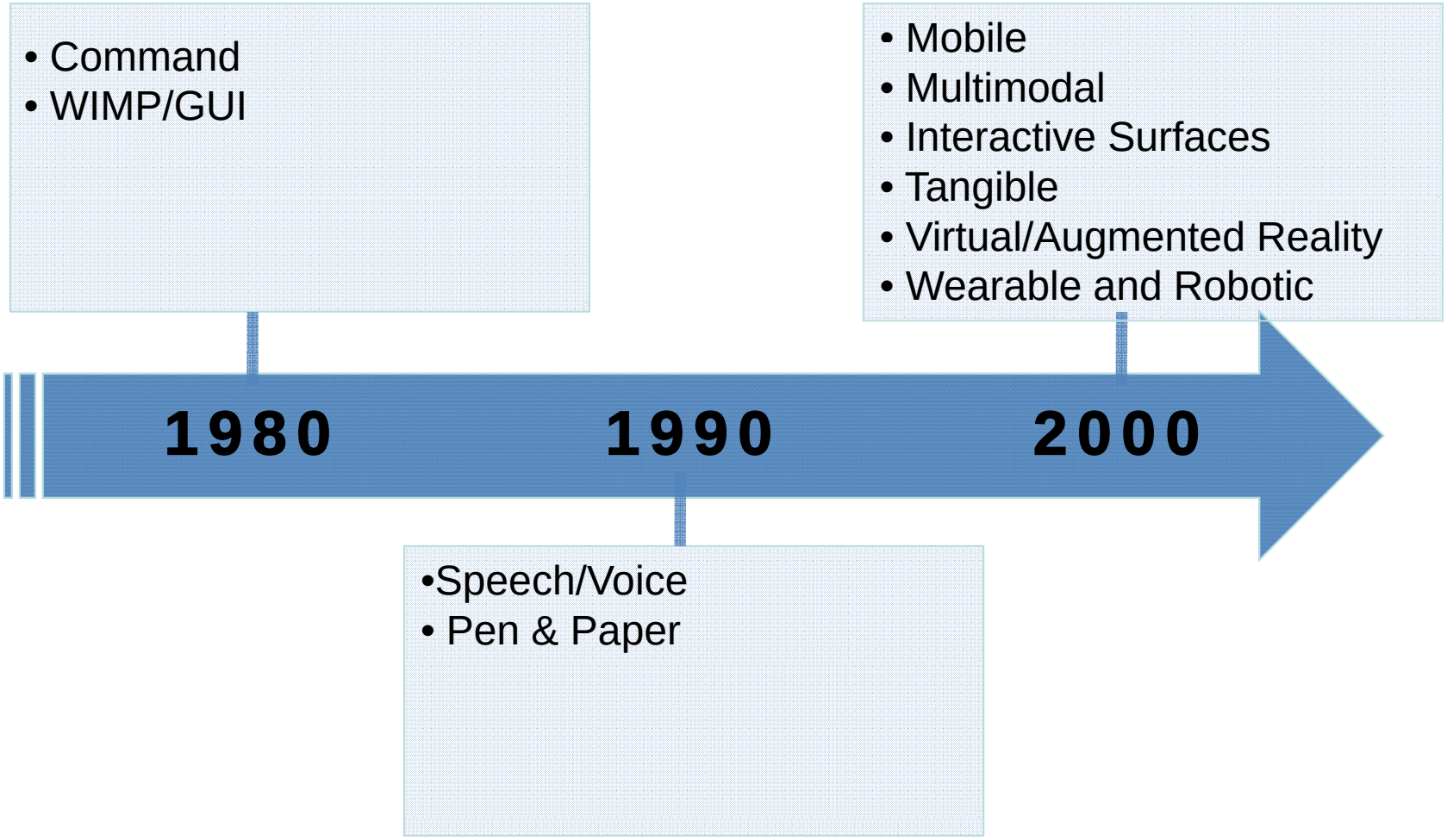
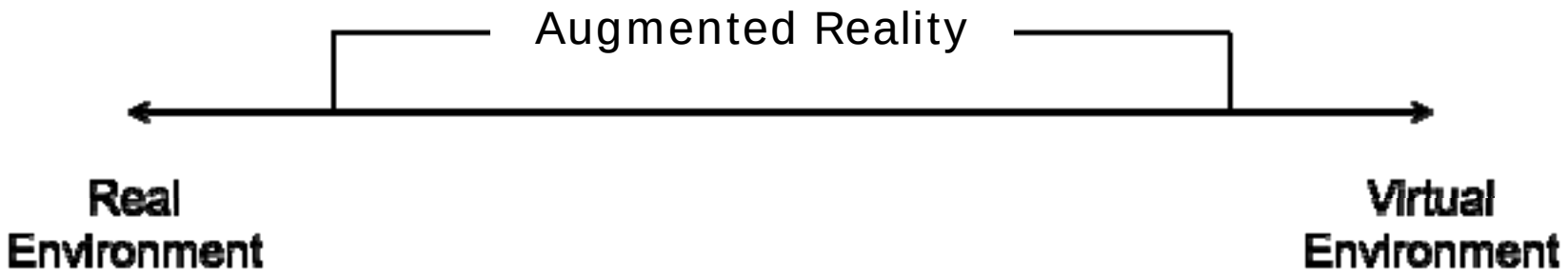
- Can ambient media help people to decide?
- Height of the orange balls is connected to the usage of the elevator
- Height of the grey ball reflects the usage of the stairs

Source: Yvonne Rogers, William R. Hazlewood, Paul Marshall, Nick Dalton, and Susanna Hertrich. 2010. Ambient influence: can twinkly lights lure and abstract representations trigger behavioral change?. In *Proceedings of the 12th ACM international conference on Ubiquitous computing* (Ubicomp '10). ACM, New York, NY, USA, 261-270. DOI=10.1145/1864349.1864372 http://doi.acm.org/10.1145/1864349.1864372

Interface Types



Augmented and Virtual Reality



Virtual Reality

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- Virtual Reality Environments
  - Started in 1990
  - Computer-generated graphical simulations providing:
    “the illusion of participation in a synthetic environment”
  - New kinds of experience, users interact with objects
  - Navigation in 3D space.
  - Can have a higher level of fidelity with the objects they represent,
    c.f. multimedia
  - Uncomfortable to wear.
  - Realism vs. Abstraction

Virtual Reality

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- CAVE = “Cave Automatic Virtual Environment”
- Defined as “*an immersive virtual reality facility designed for the exploration of and interaction with spatially engaging environments”* (NCSA)
- Closed environment, usually a cube
- Passive stereo projection
  - Hence, 2 projectors per plane
  - Goggles required, per person simulation
- Tracking e.g. realized using infrared

Augmented Reality

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- Registration/Tracking technologies
  - Sensor-based tracking
  - Vision-based tracking
- Display
  - See-through HMDs
  - Projection-based displays
  - Handheld displays
- Interaction
  - Tangible and collaborative AR

Studierstube.org

vuzix.com

Parallel Tracking and Mapping for Small AR Workspaces

Extra video results made for ISMAR 2007 conference

Georg Klein and David Murray
Active Vision Laboratory
University of Oxford

AR: Model Tracking

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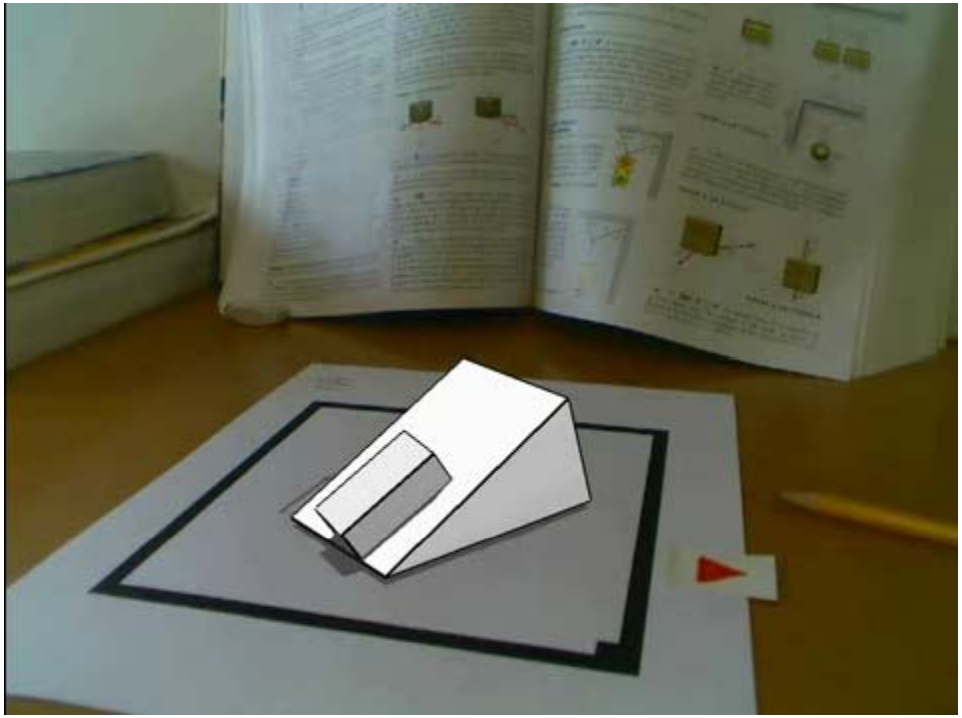
PROFORMA

Probabilistic
Feature-based
On-line
Rapid
Model
Acquisition

Qi Pan

UNIVERSITY OF CAMBRIDGE

AR: In-Place 3D Sketching



AR: EyePet

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Mobile Augmented Reality

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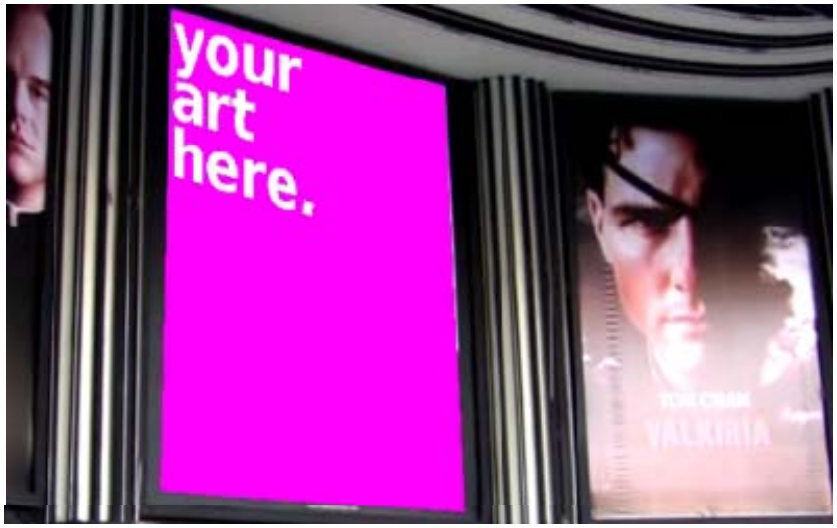
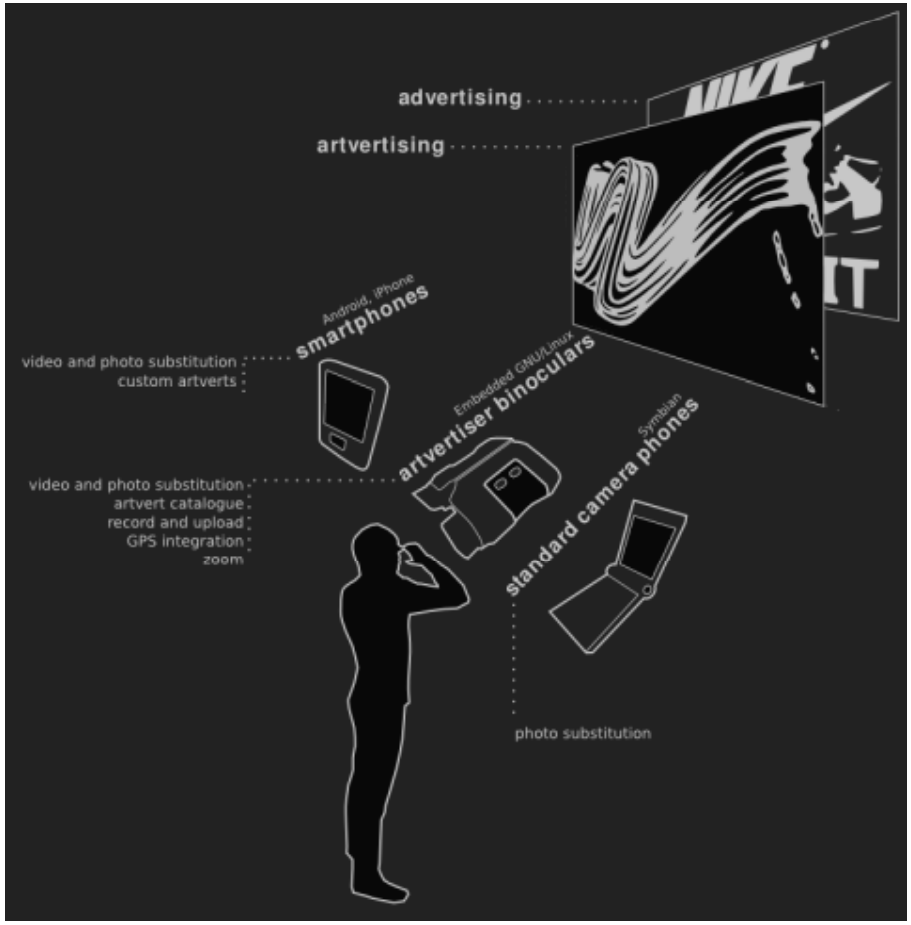
- Artvertiser.com: urban, hand-held AR project by Julian Oliver, Clara Boj and Diego Diaz
- Real-world ad filter
- Hybrid mapping, tangible interaction
- Uses “artvertiser binoculars” for display



Augmented Reality



Tangible MagicLens Interaction

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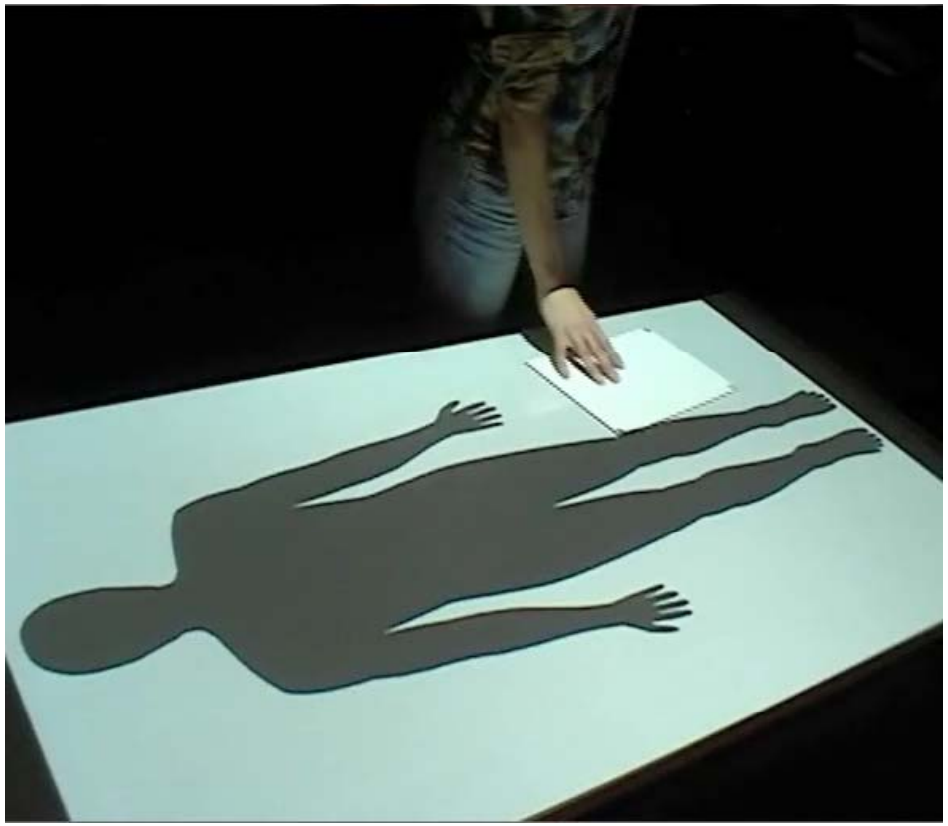
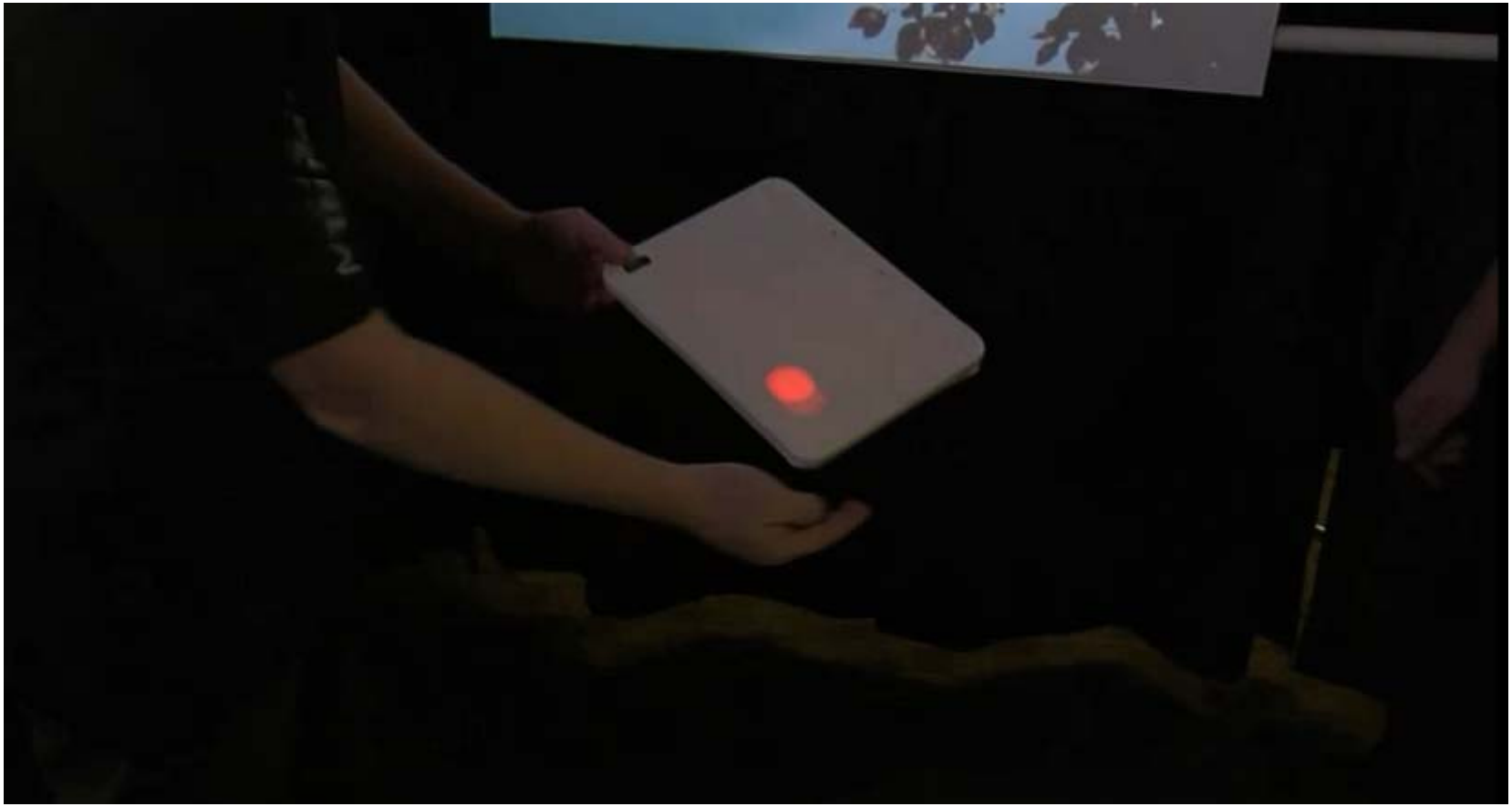
- SpaceLens
  - Interactive surface (table)
  - Infrared scanner
  - Anoto technology
- Application scenarios
  - Volumetric and layered information spaces
  - Temporal and zoomable information spaces
- Raimund Dachselt et al.
  User Interface & Engineering Group, Uni Magdeburg

SpaceLens



Microsoft LightSpace



Depth Camera

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- Present a topographic view of a scene
- Provide depth information to the closest object for every pixel in an image
- Technologies
  - Time of flight:
    - A light source sends an infrared light pulse which is reflects by objects in the environment. According to the time of flight of the wavelengths, a special camera is able to extract the depth information
  - Light coding:
    - An infrared dot pattern is projected on the objects in the environment. A camera extracts the depth information by analyzing the deformation of the pattern

Source: vislab.usyd.edu.au

Source: Wikipedia

Source: Wikipedia

Demo Kinect

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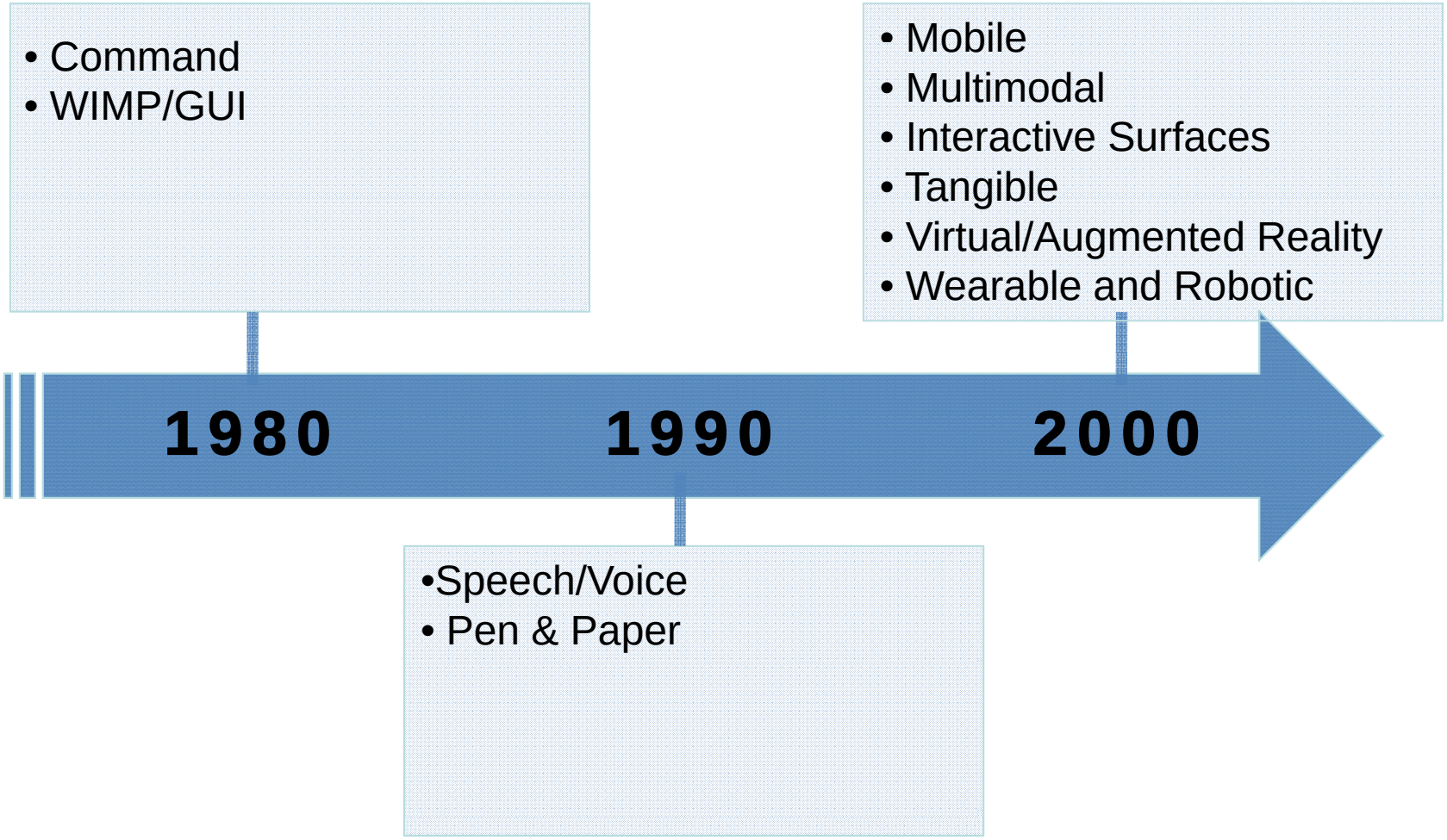
Interface Types



Wearable Interfaces

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- Provide the user with a means of interacting with digital information while on the move

- Steve Mann, “pioneer of wearables”

- Design Issues:
  - Comfort
  - Hygiene
  - Ease of wear
  - Usability

Steve Mann's "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.

Wearable Interfaces – 6th Sense

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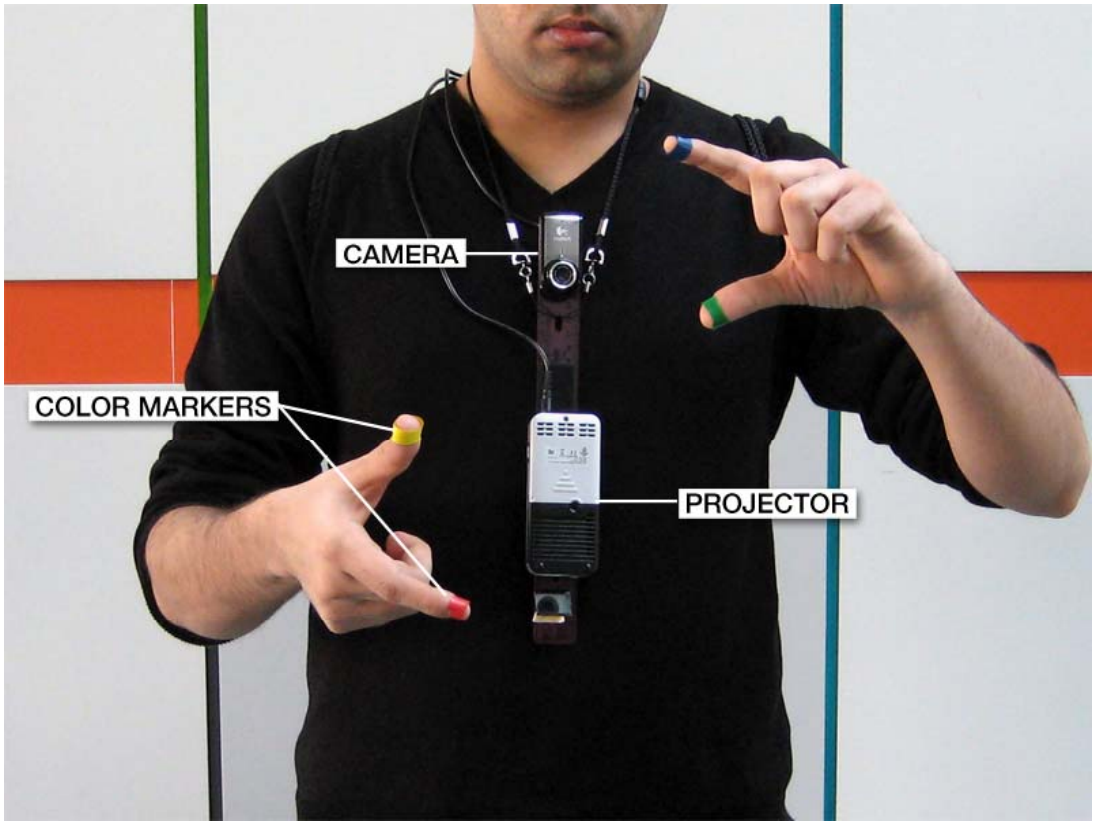
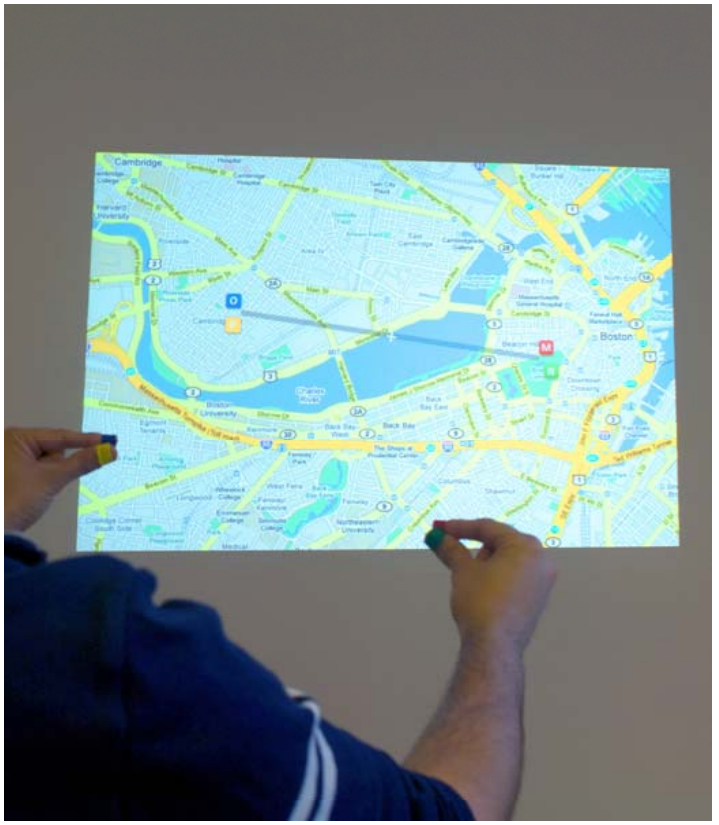
- Paetti Maes et al., MIT Media Lab, 2009





Wearable Interfaces – 6th Sense

Wearable Interfaces - QBIC

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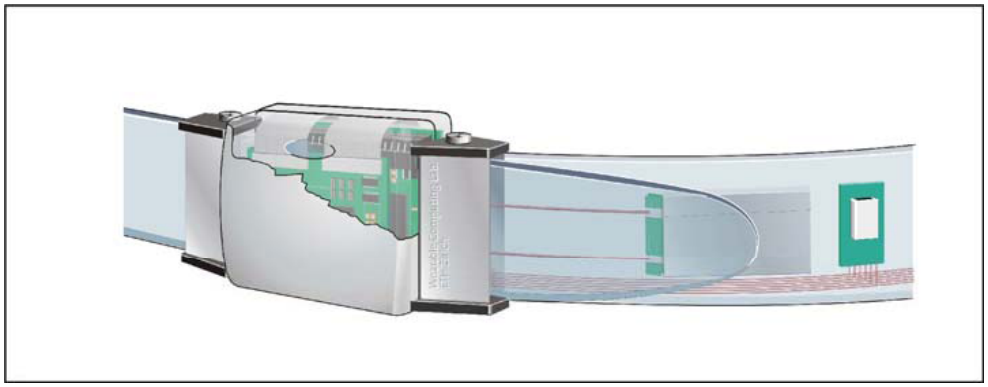
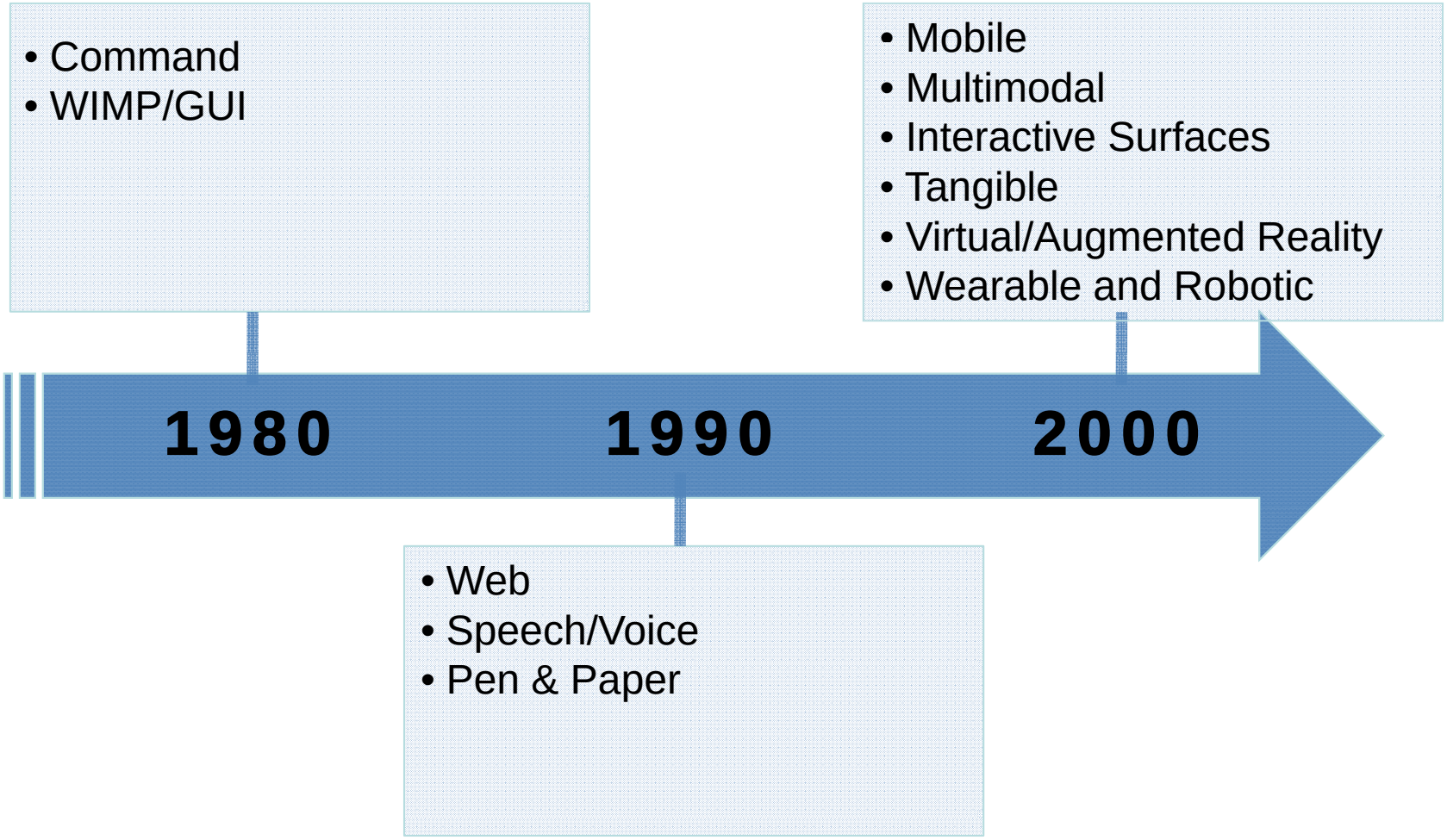
- QBIC = Q-Belt-IntegratedComputer

- Design objectives
  - Comfort
  - Flexibility
  - Reliability



Source: Oliver Amft, Michael Lauffer, Stijn Ossevoort, Fabrizio Macaluso, Paul Lukowicz, and Gerhard Troster. 2004. Design of the OBIC Wearable Computing Platform. In *Proceedings of the Application-Specific Systems, Architectures and Processors, 15th IEEE International Conference* (ASAP '04). IEEE Computer Society, Washington, DC, USA, 398-410. DOI=10.1109/ASAP.2004.20 http://dx.doi.org/10.1109/ASAP.2004.20

Interface Types



Robotic Interfaces

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- Four types:
  - remote robots used in hazardous settings
  - domestic robots helping around the house
  - pet robots as human companions
  - sociable robots that work collaboratively with humans, and communicate and socialize with them – as if they were our peers

Honda.com

Fujitsu.com

Robotic Interfaces

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Which Interface?

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- Is speech as effective as a command-based interface?
- Is a multimodal interface more effective than a monomodal interface?
- Will wearable interfaces be better than mobile interfaces for helping people find information in foreign cities?