

# Instrumented Environments

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Mon, 10-12 Uhr, Theresienstr. 39, Room E 46



# Topics Today

- Tangible User Interfaces
  - Specialized TUIs
  - TUIs in everyday objects
  - Communicative TUIs
- Ambient User Interfaces

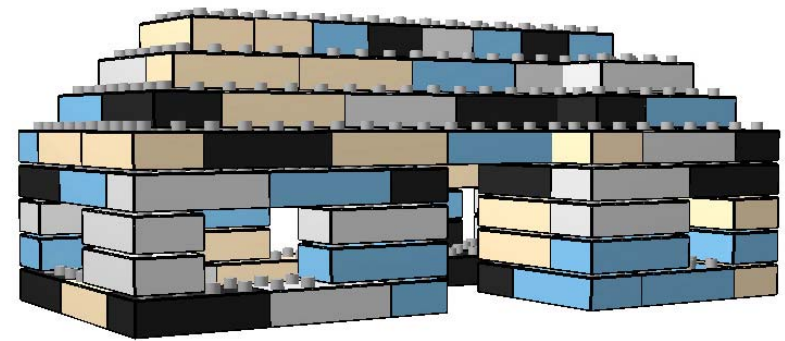
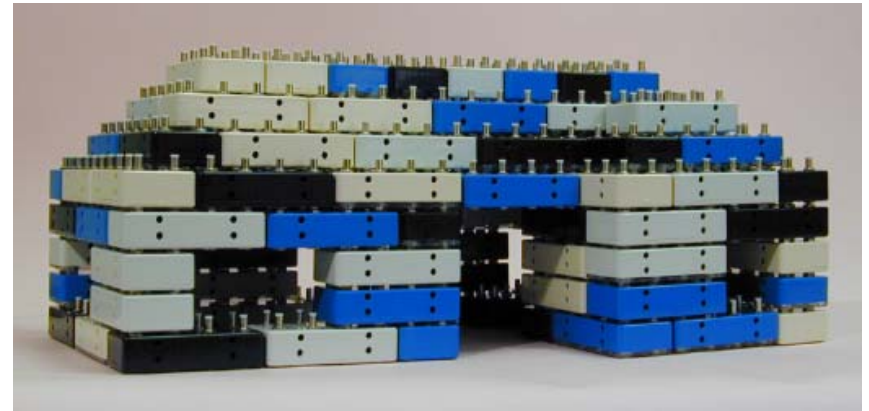
# Tangible User Interfaces

## Specialized TUIs

# 3D modeling with LEGO

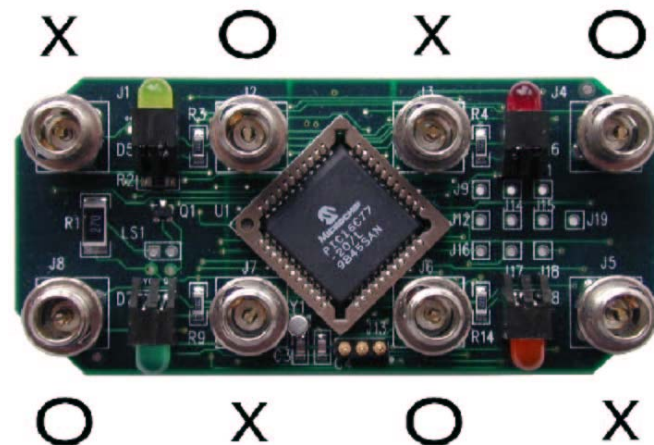
[\(Anderson et al., SIGGRAPH 00\)](#)

- LEGO blocks with connectors and CPU
  - Keep track of their spatial configuration
  - Describe a voxel („volume pixel“) model
- Reconstruction in the host computer
- Interpretation acc. to prototypes



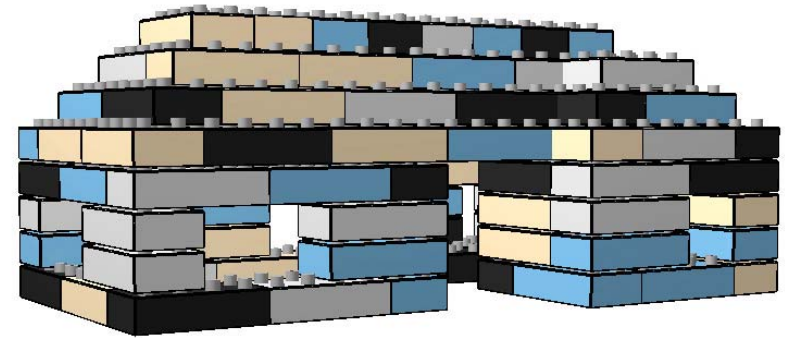
# 3D modeling with LEGO

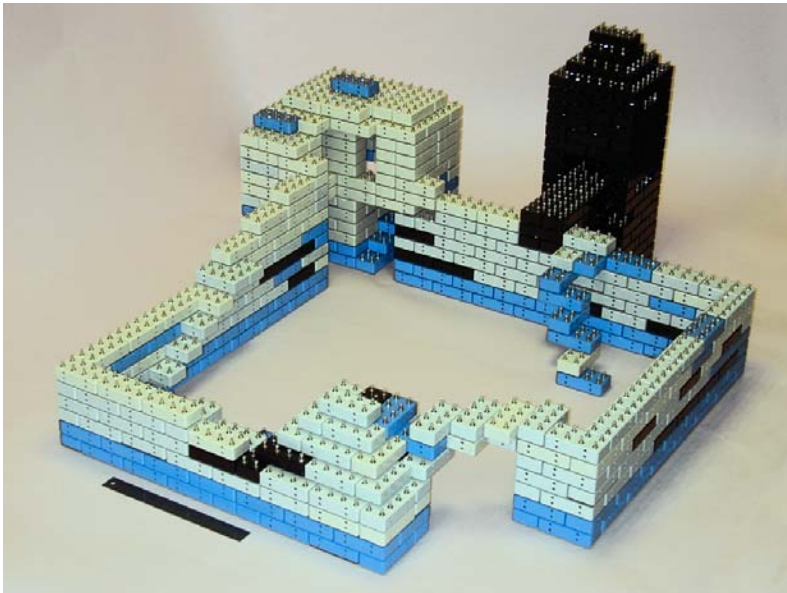
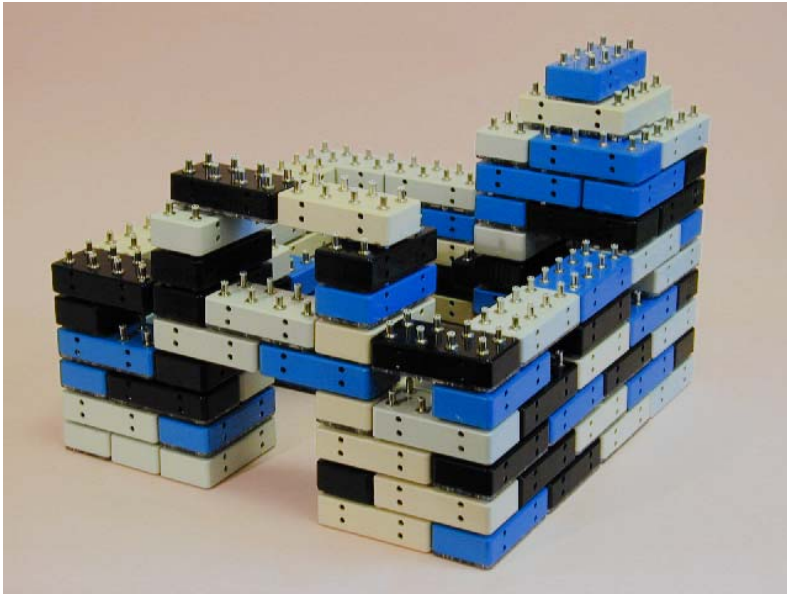
- Each block has 8 plugs on top and 8 jacks on the bottom
  - Inner contact: communication
  - Outer contact: power
  - Use alternating layout and rectifier to power circuit
- When a new block is added, it triggers recognition process



# 3D modeling with LEGO

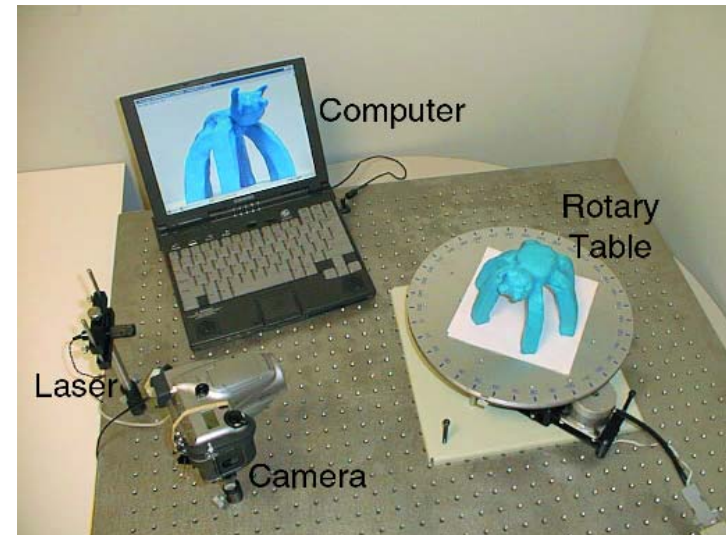
- Interpretation of structure:
  - Transform structure into a set of logical propositions
  - Define rules what is a wall, roof, window...
  - Determine from structure and rules, what block has which function
  - Construct 3D model accordingly





# 3D modeling with clay

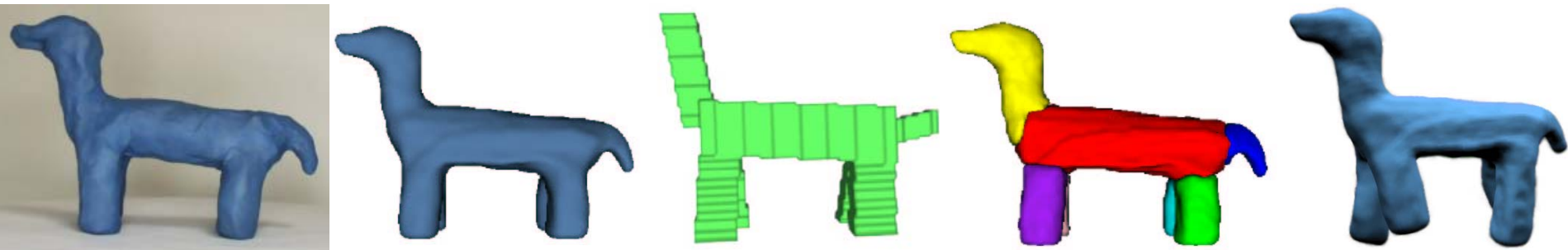
- Model an object in clay
- Scan in its 3D shape
  - Laser striping
  - Camera recording silhouettes
- Try to recognize the structure by matching it to templates
- Interpret the structure according to template and animate it





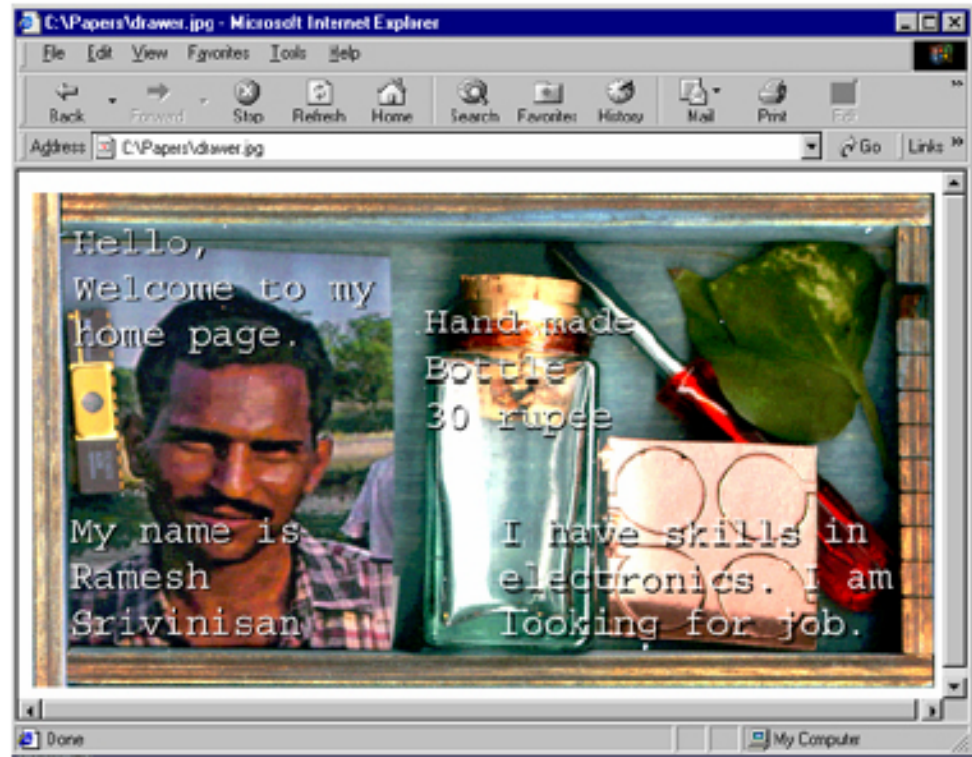
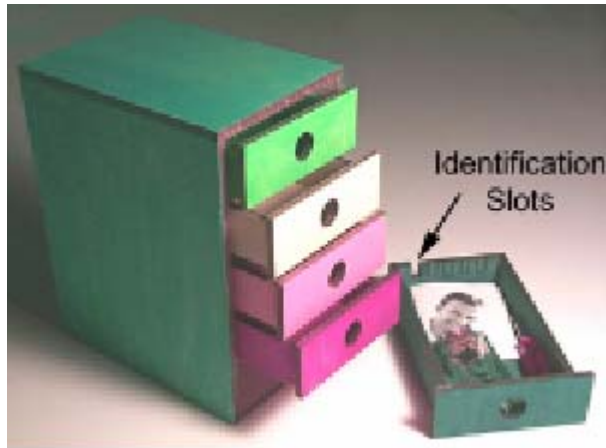
# 3D modeling with clay

- Direction is known, size is normalized
- Compare for each voxel, whether it is filled in the template and the scan → find best match
- Templates have meaningful segments
- Cut scan into the same segments
- Use skeleton animation with the scan



# HomeBox

(Piper, Hwang, Chi 00)

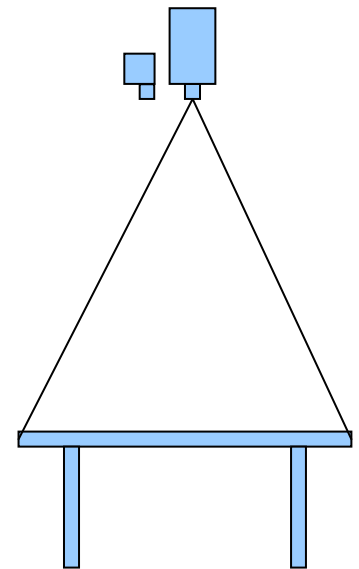
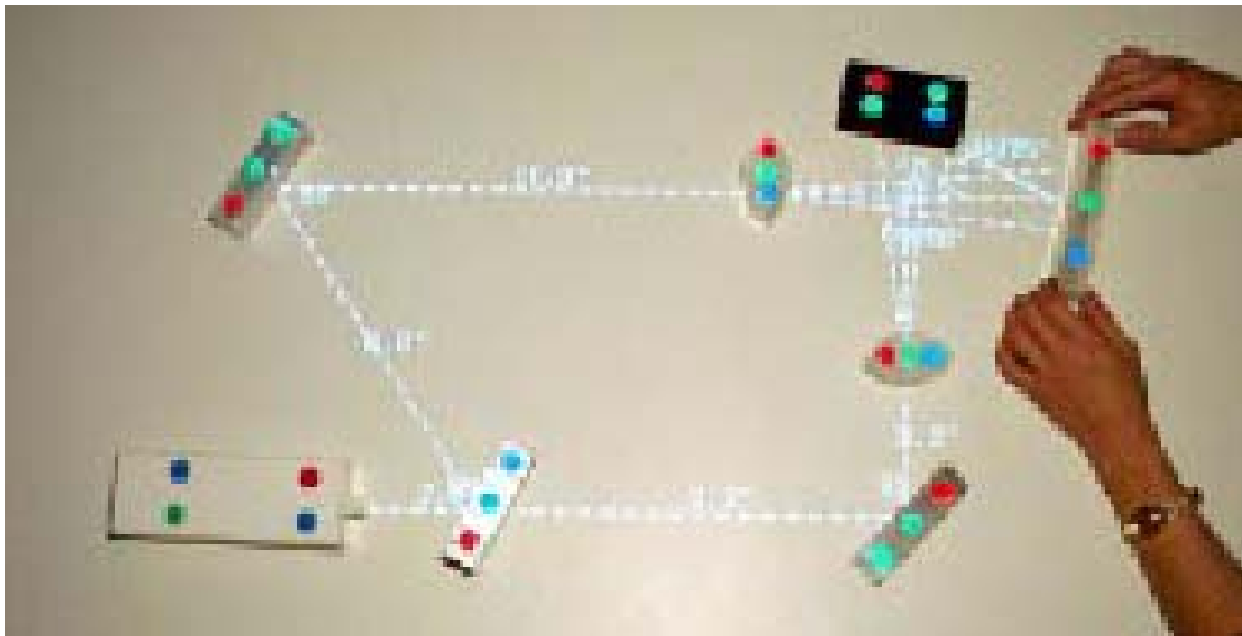


- Drawer represents page
- Physical content is put into drawers
- Insert drawer into scanner
- Annotate with additional text

# Luminous room: Illuminating Light

[\(John Underkoffler and Hiroshi Ishii, CHI 98\)](#)

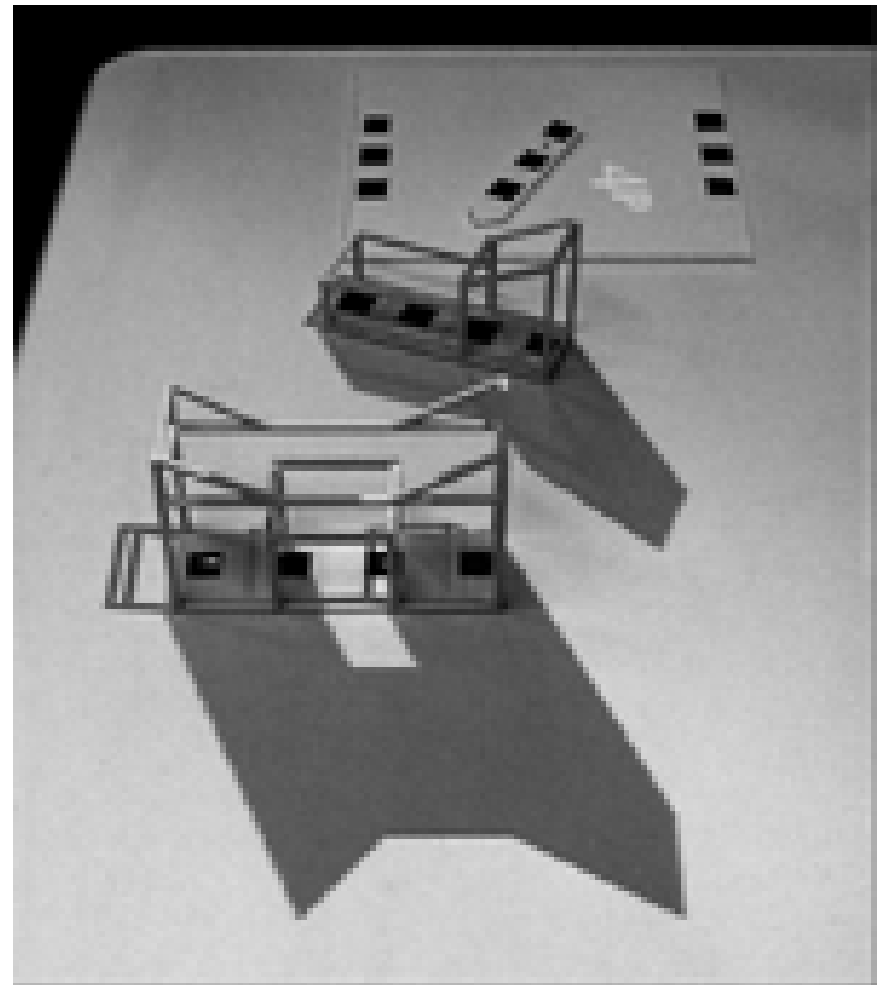
- Simulation of optical/holographic setups
- Phys. objects represent optical elements
- Top projection of resulting laser beam



# Luminous room: Urban Planning (URP)

[\(John Underkoffler and Hiroshi Ishii, CHI 99\)](#)

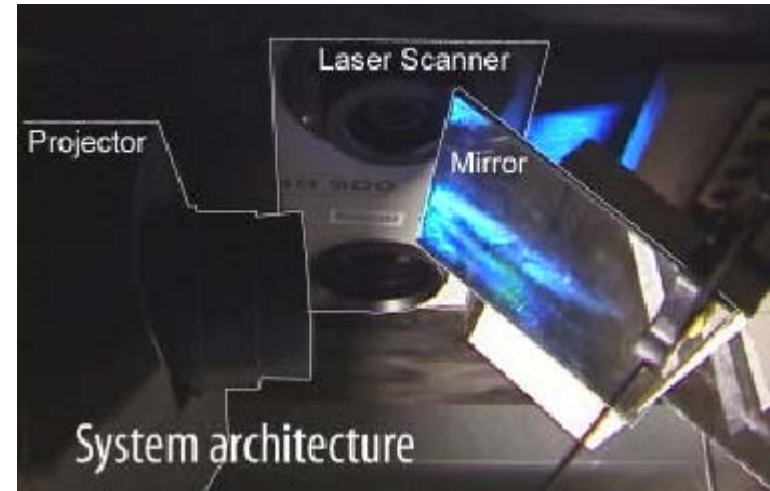
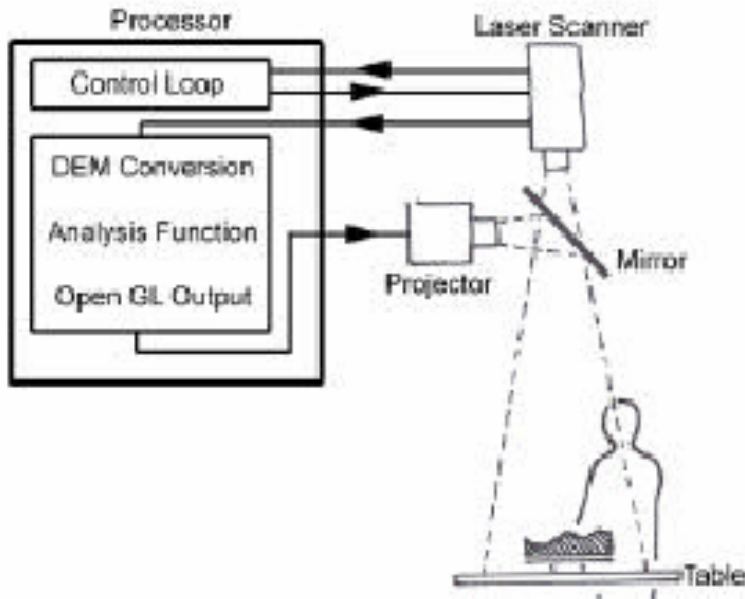
- Move physical models of houses on a desk surface
- Simulate in the computer :
  - Shadows
  - Window reflections
  - Air flow and wind



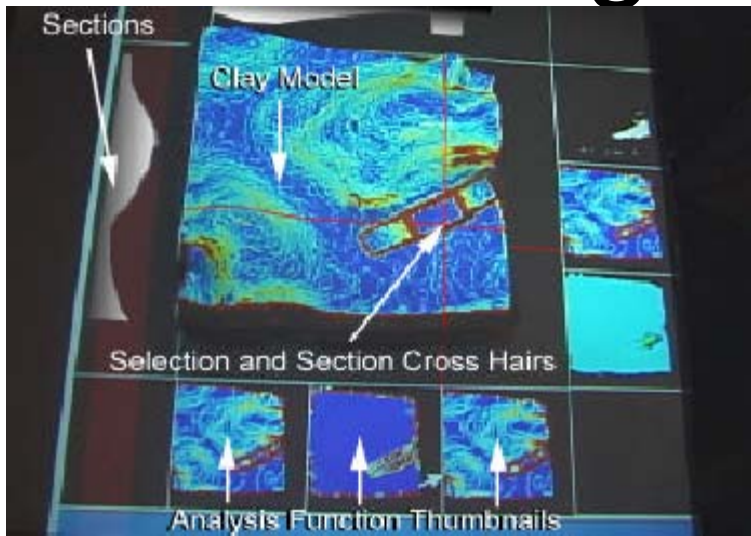
# Illuminating Clay

(Piper, Ratti, Ishii, Chi 02)

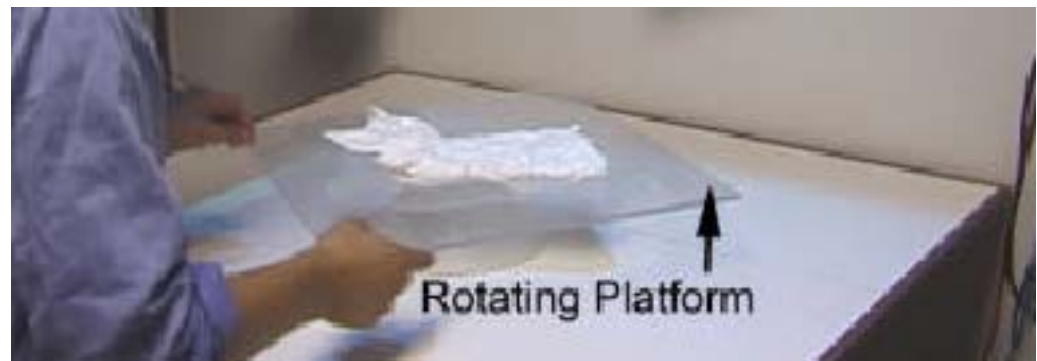
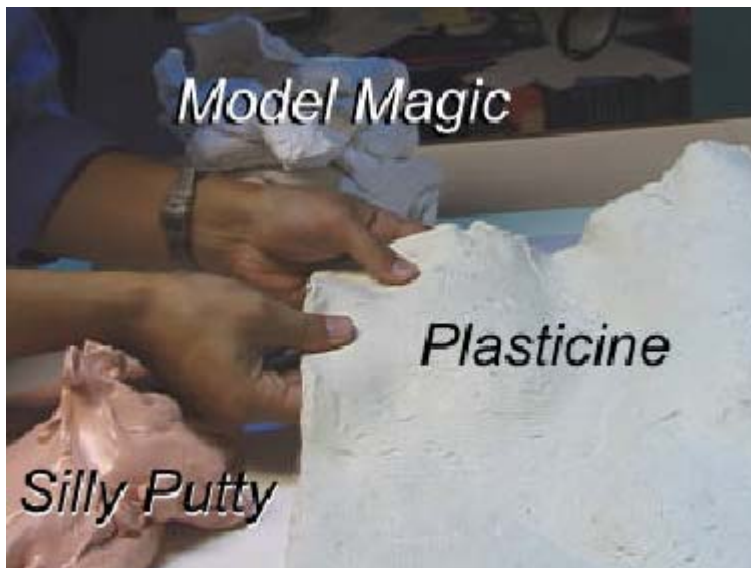
- Clay model on desk surface
- Top projection = output
- 3D laser scanner = input
- Used for landscape design



# Illuminating Clay UI elements

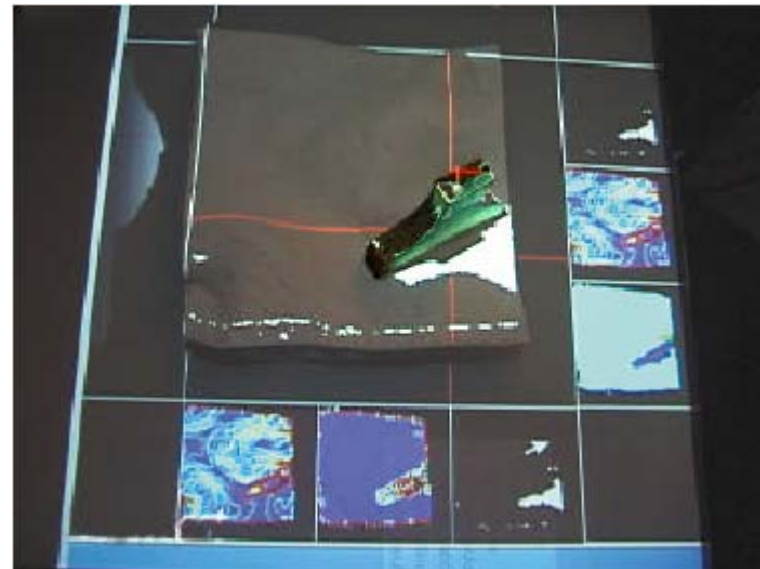
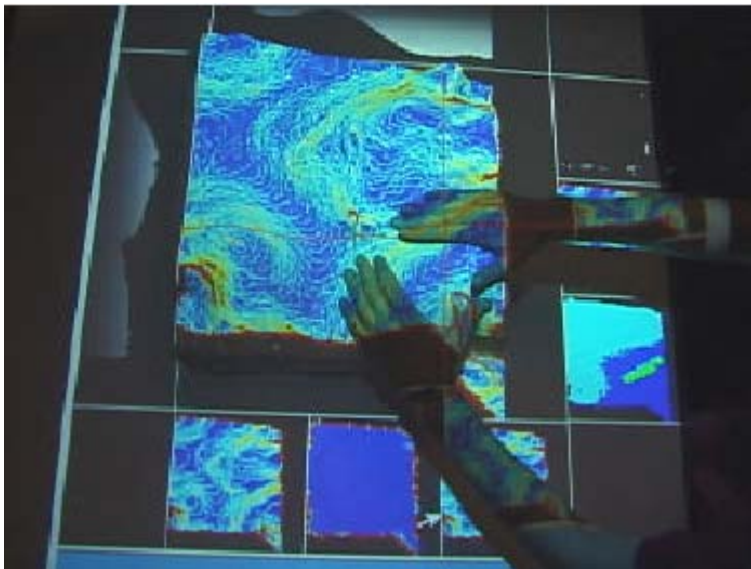


- Deformable clay model
- UI elements for section and analysis functions
- Interaction with terrain

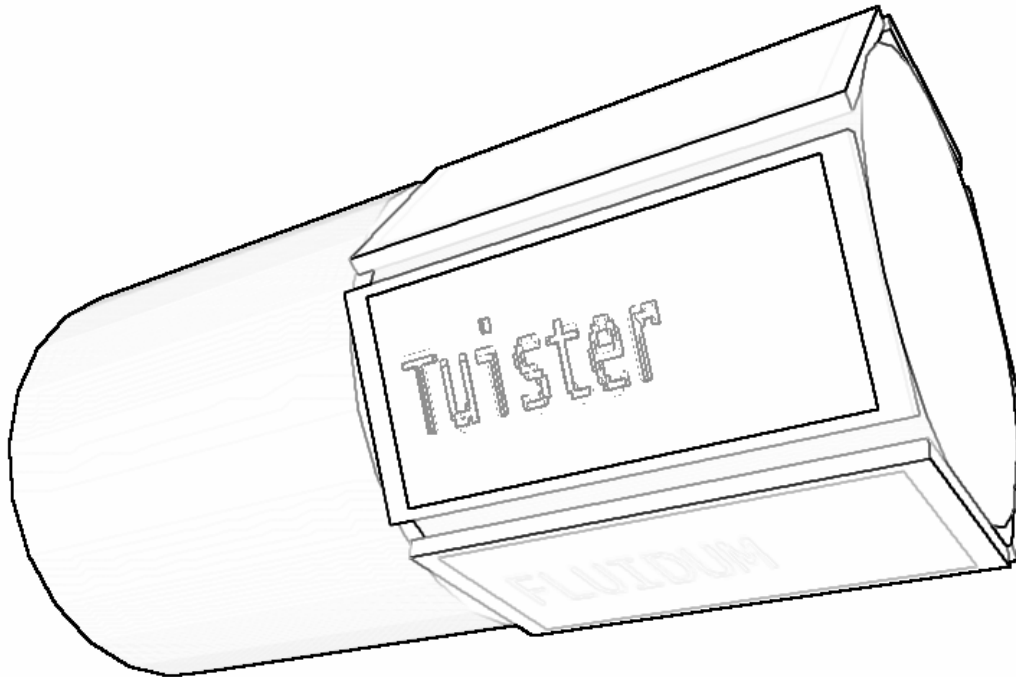


# Illuminating Clay applications

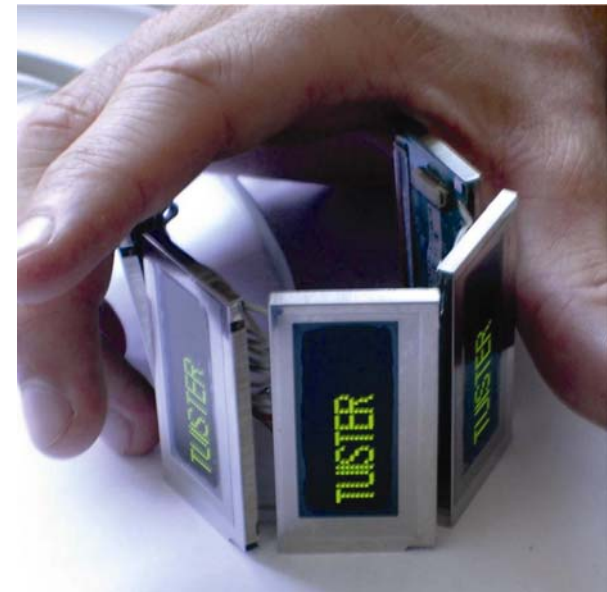
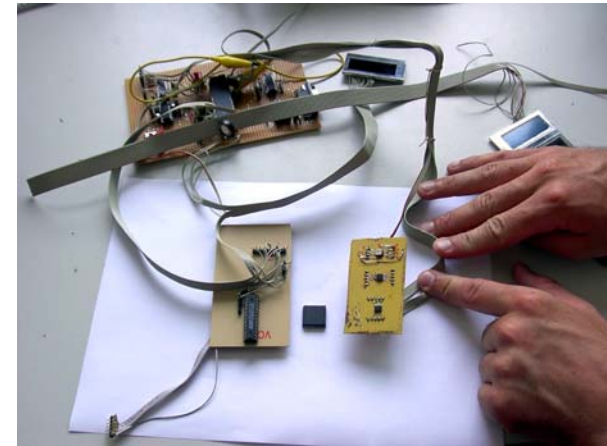
- Slope variation with color feedback
- Solar radiation, shadows



# TUISTER

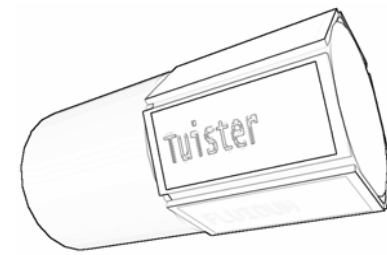


- Interaction object, two-handed, 1DOF each
- Gravitation, magnetic and rotation sensors
- 6 organic Displays
- Serial/BT connection to the environment

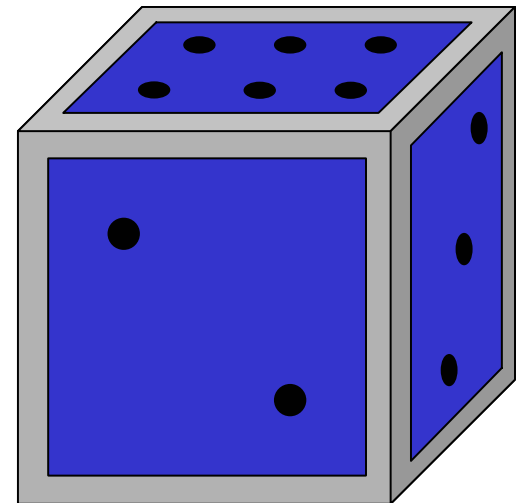




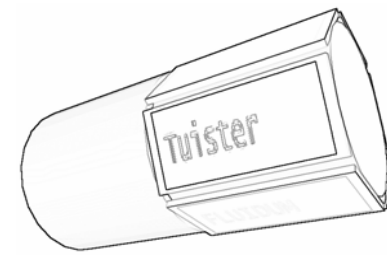
# Initial Idea



- Build a TUI with built-in display
  - Orientation sensitive
  - Direct feedback
  - Standalone operation
- Technical problems
  - No square organic (OLED) displays
- Cognitive issues
  - Different ways to any side
  - Action history?
  - Display orientation?



# Conceptual Design

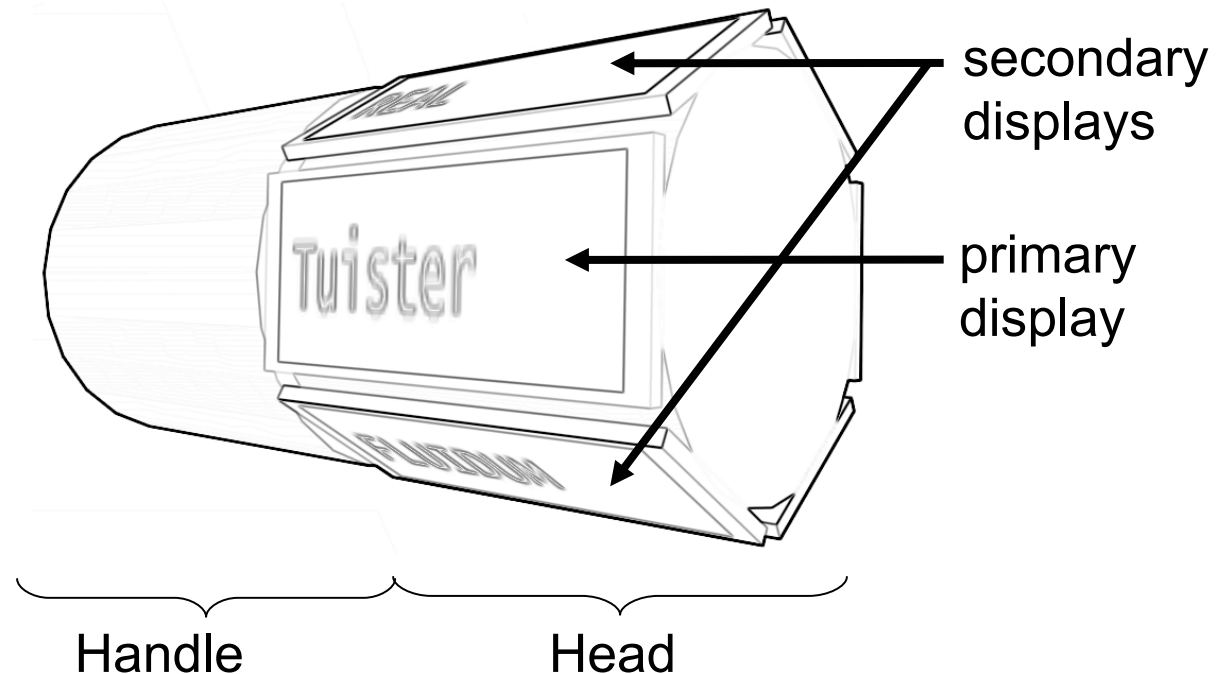
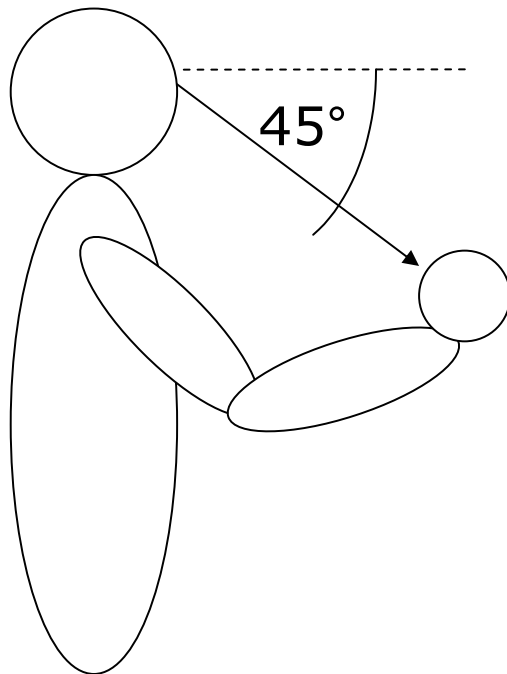


Determination of the primary display by two assumptions:

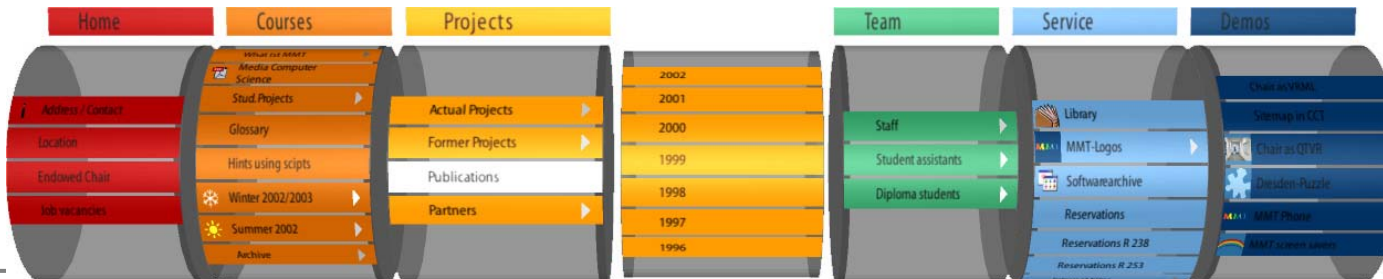
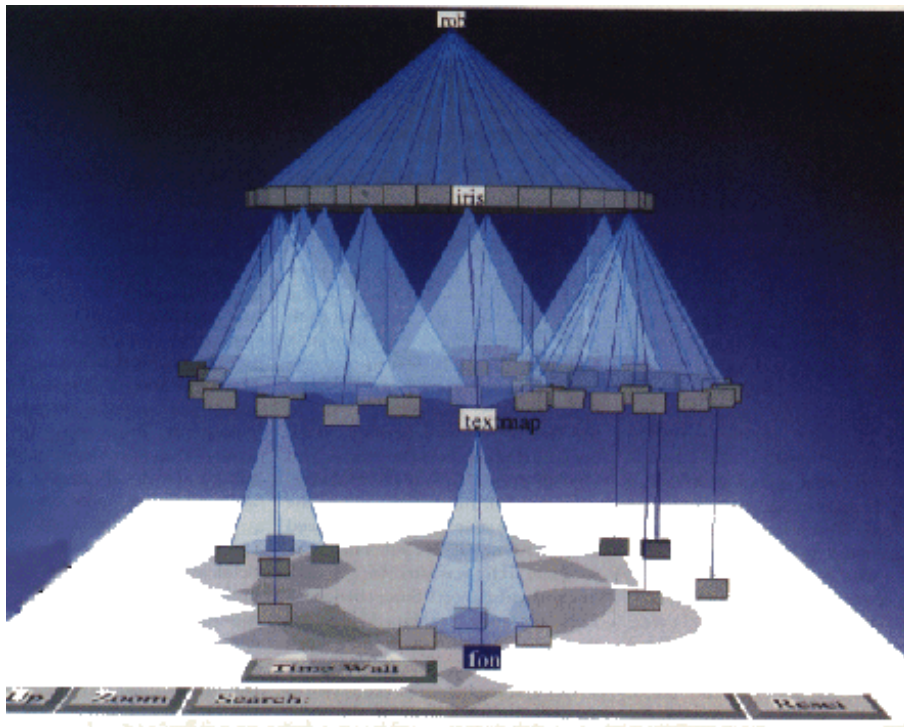
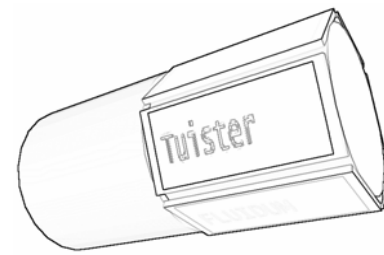
- Text must be upright
- User looks down about  $45^\circ$

Sensors for orientation:

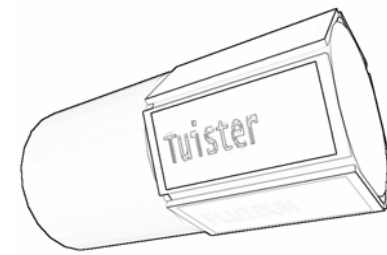
- 2x 2D acceleration
- 3x 1D magnetic
- 1x relative rotation



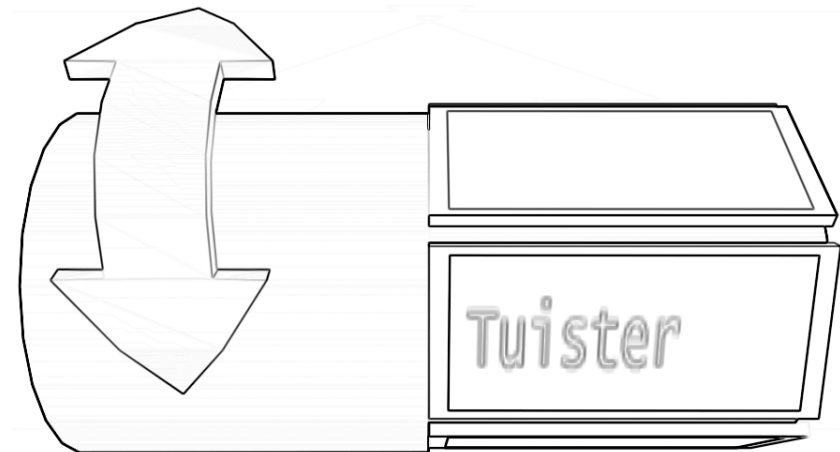
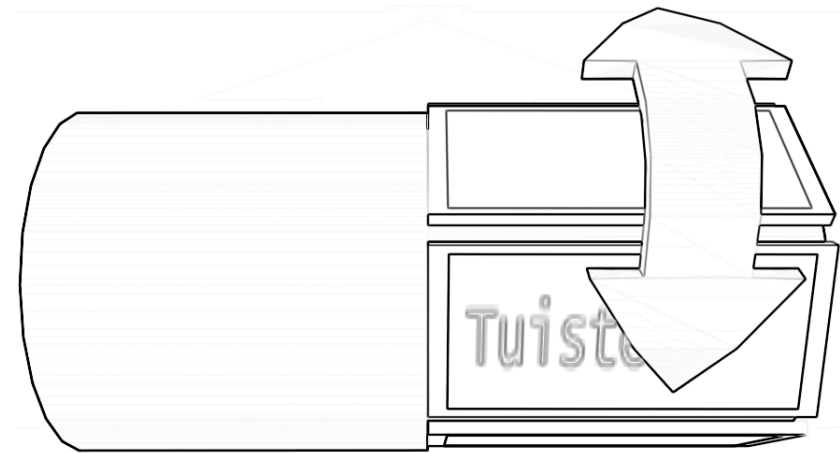
# Intuition: Cone/Lyber trees



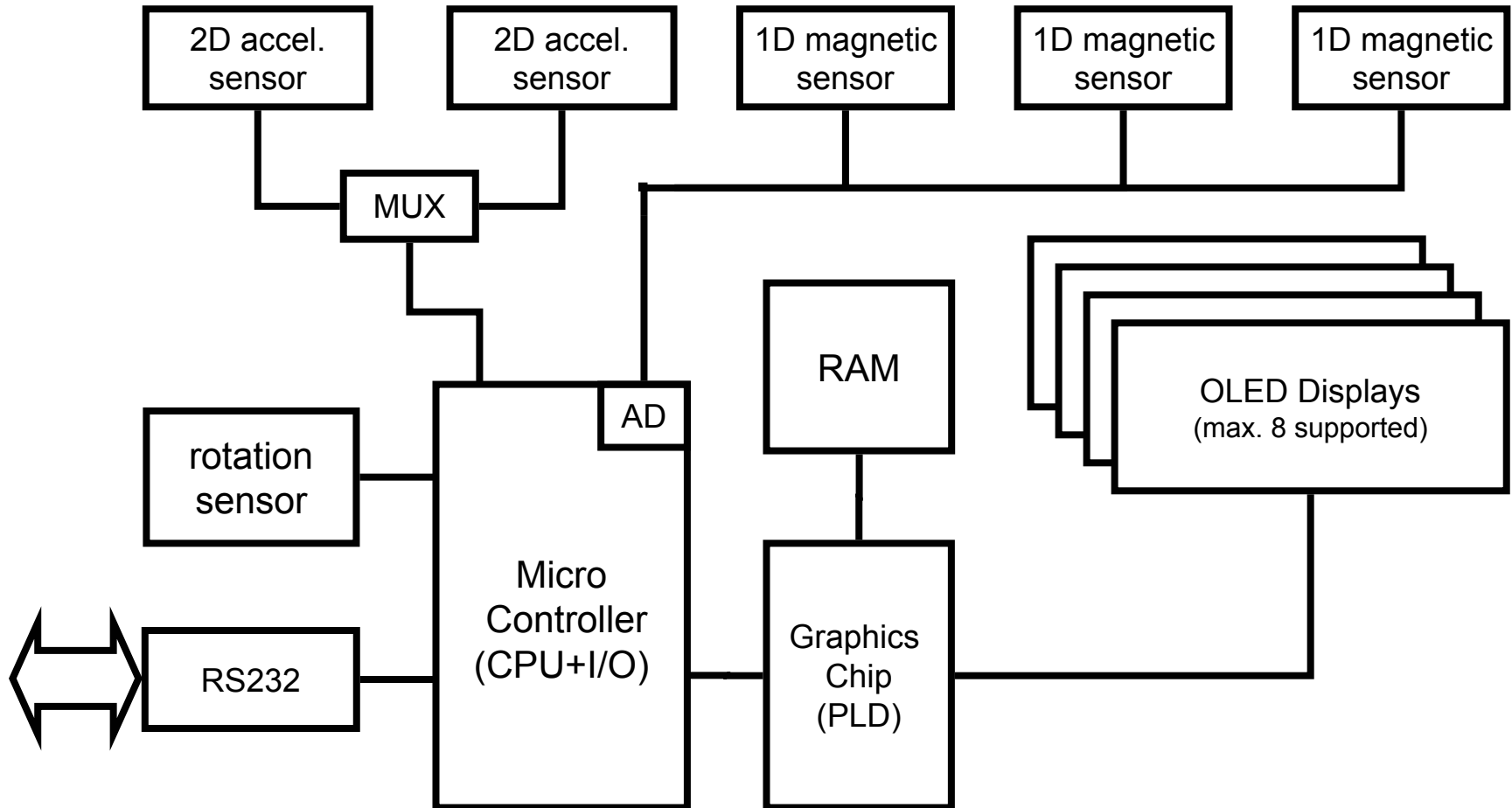
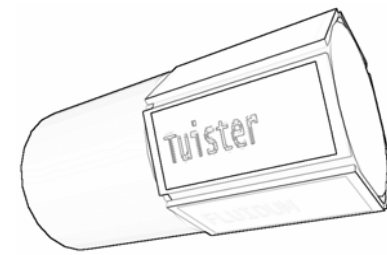
# Two types of rotation



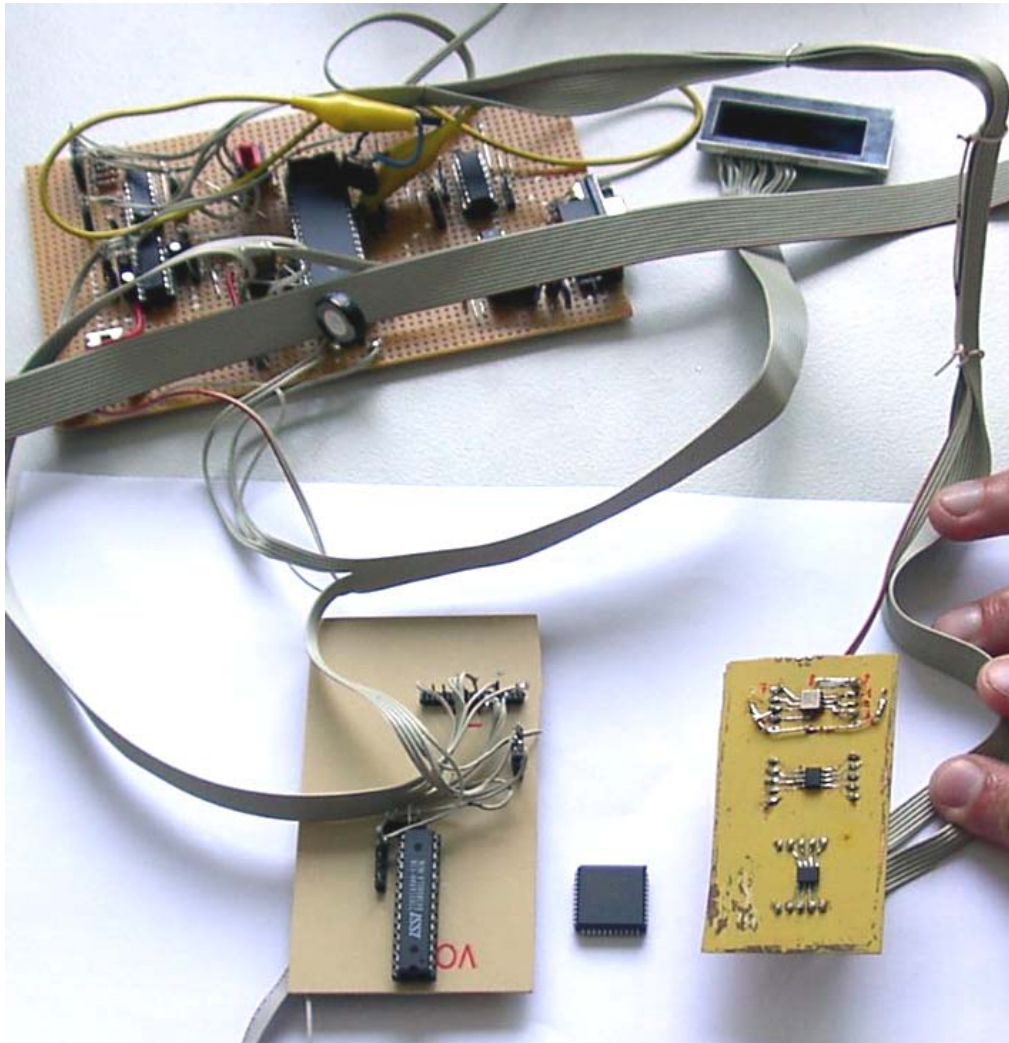
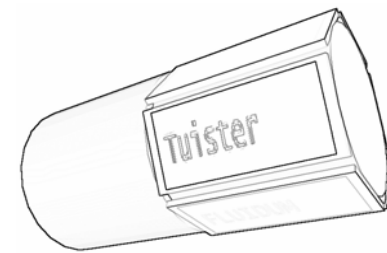
- Rotating the head
  - Direct physical manipulation
  - Choice within one menu level
  - Context via secondary displays
- Rotating the handle
  - Metaphor: (un-)fastening a screw
  - Clockwise = fastening = down
  - Counterclockwise = up
  - Choice of the menu level
- Rotation by hand: few entries
- Free spin: for long menus



# Funktionsdiagramm

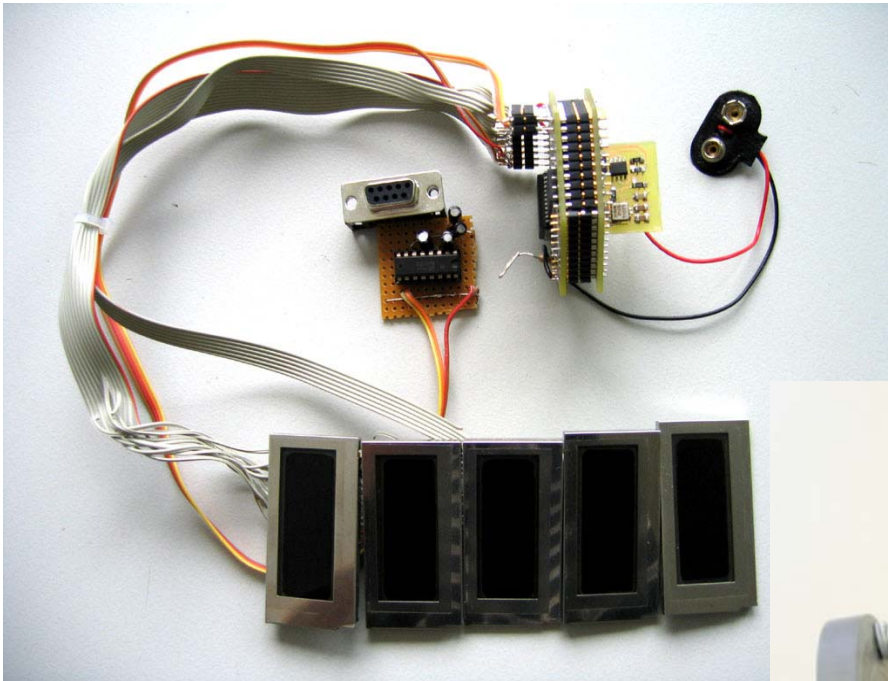
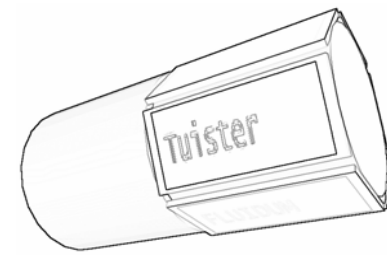


# First Prototype

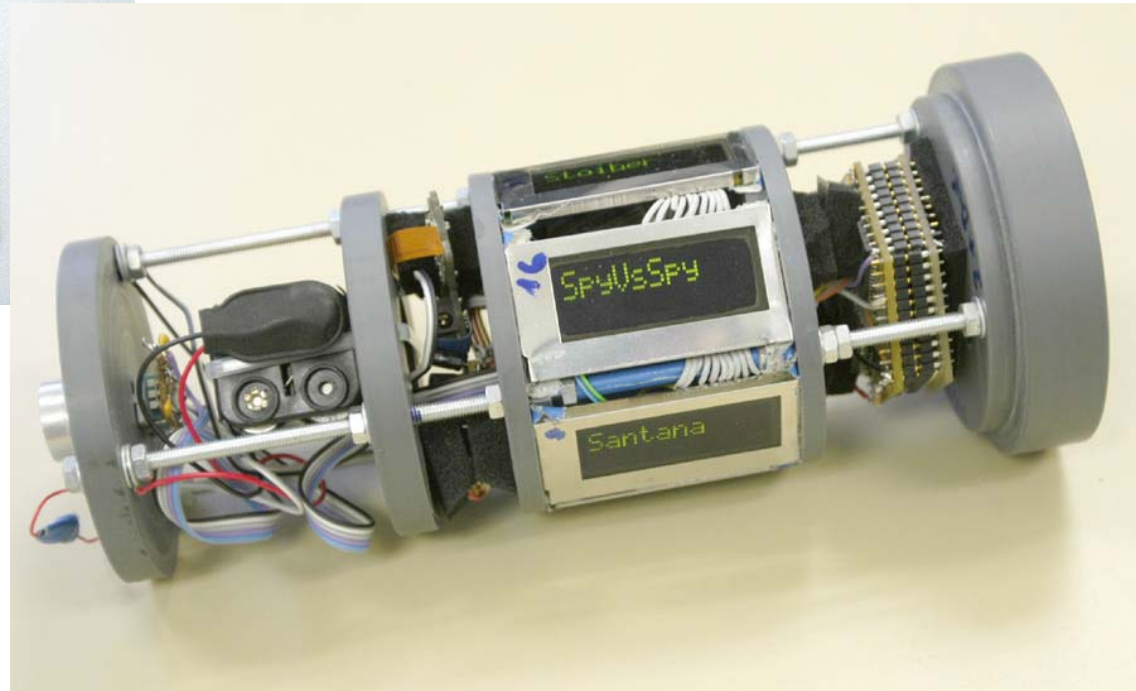


experimental circuit boards  
electronics fully functional  
PLD programming finished  
Serial cable connection

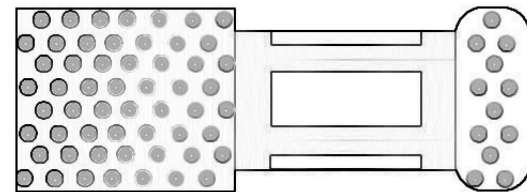
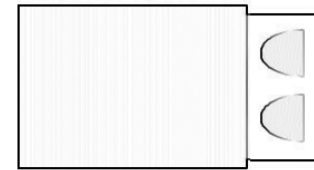
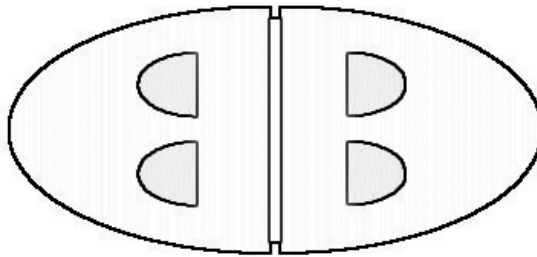
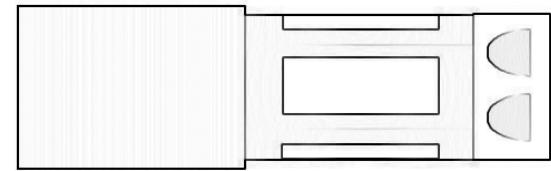
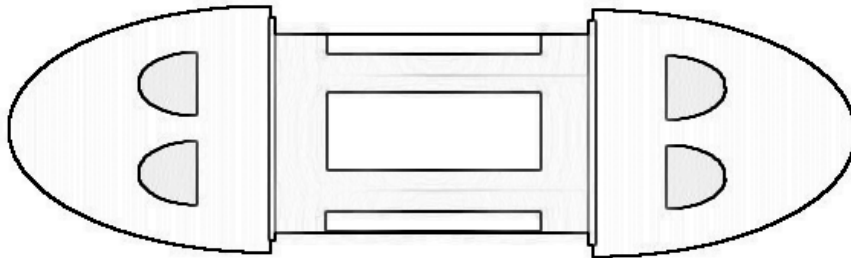
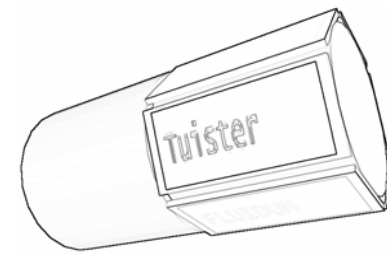
# Second Prototype



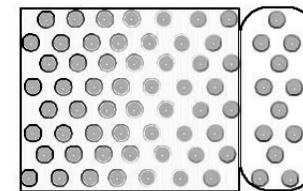
printed circuit boards  
bluetooth connection  
XML hierarchy descriptions  
mechanics working



# Alternative physical designs

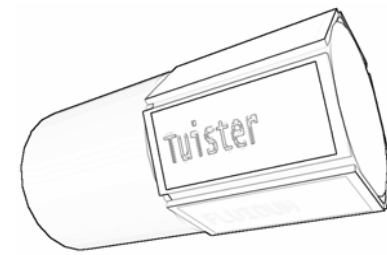


Courtesy of: Fa. Altmayer Design





# Generalization of the Concept

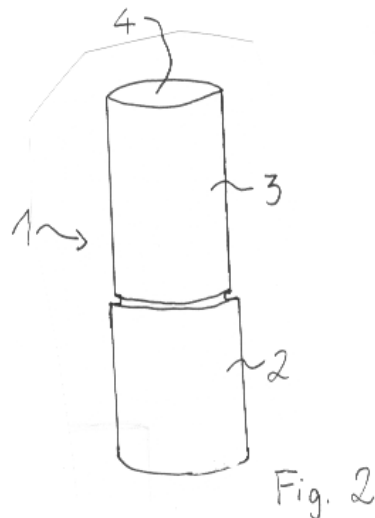
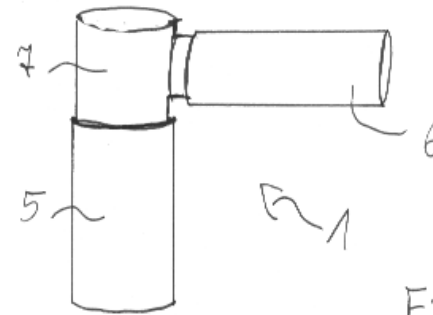
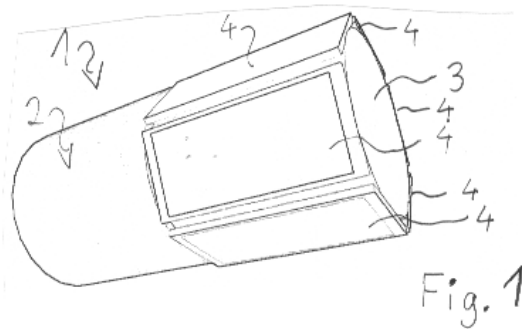


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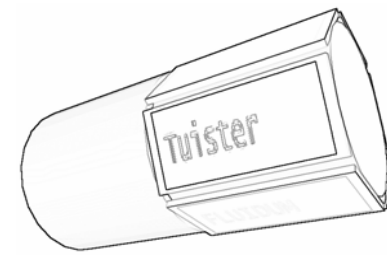
2/2



Abstraction of conceptual design  
Also includes display on front side  
Also includes non-coaxial designs

Patent currently pending

# Commercial Applications



Integration of DAB Radio with MP3 player as a TUISTER  
Head displays for choice of senders/songs  
Handle rotation for volume  
Whole device orientation for (control) on/off

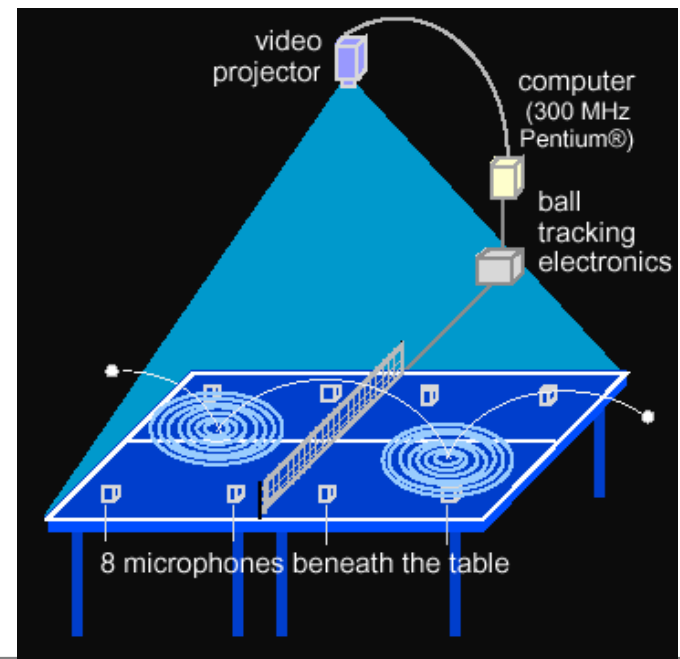
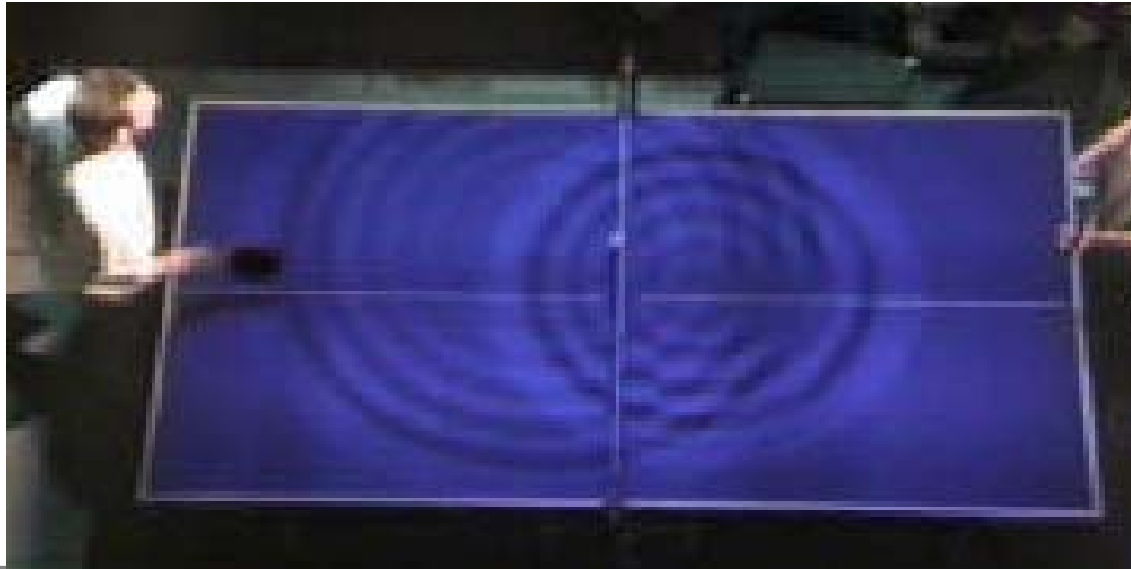
# Tangible User Interfaces

TUIs in everyday objects

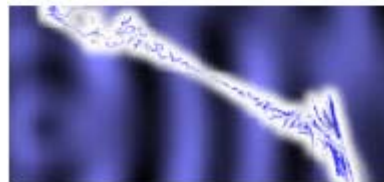
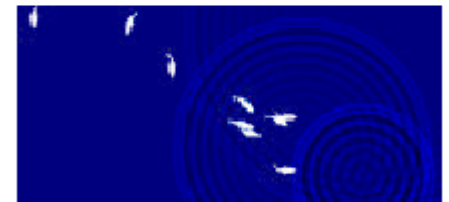
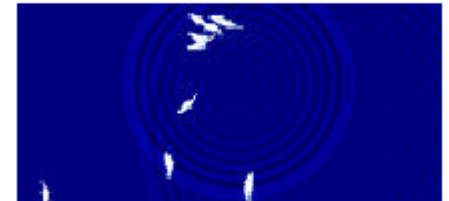
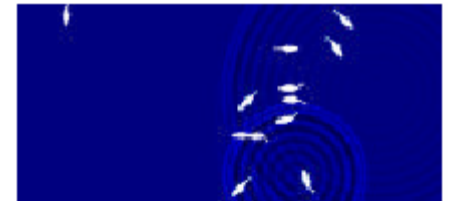
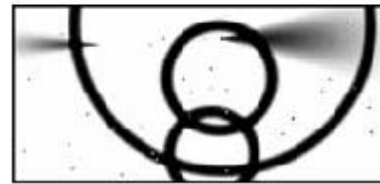
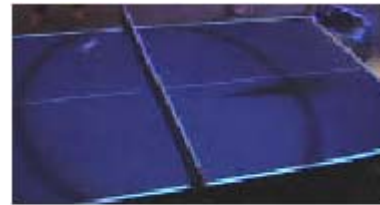
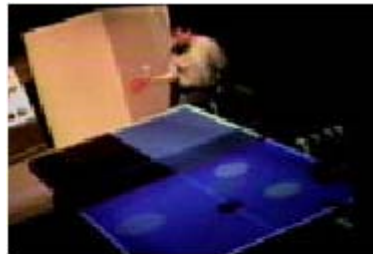
# PingPongPlus

(Ishii et al. SIGGRAPH 98)

- Physical PingPong
- Virtually augmented
- Additional game functionality



# PingPongPlus variations



# MusicBottles

(Ishii, Mazalek, Lee, CHI 01)



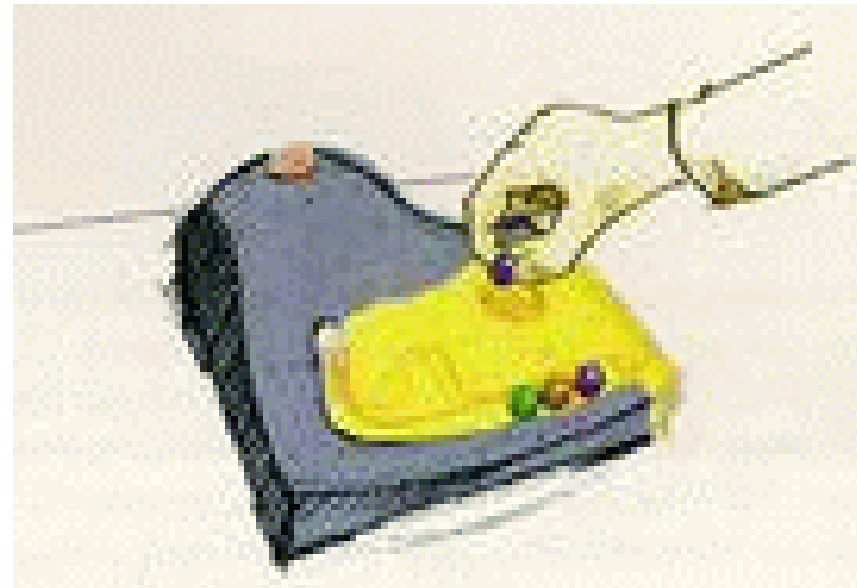
- Bottles contain music (classical, jazz, techno)
- When placed on the desk, light appears around them
- When opened, music can be heard
- Metaphor: bottles contain something, can be released when bottle is opened



# Marble Answering Machine

(concept study by Gary Bishop, RCA)

- Design study and some prototypes
- Each message represented by a marble
- Placing the marble on tray plays back the message
- Placing the marble on the phone calls back



# Tangible User Interfaces

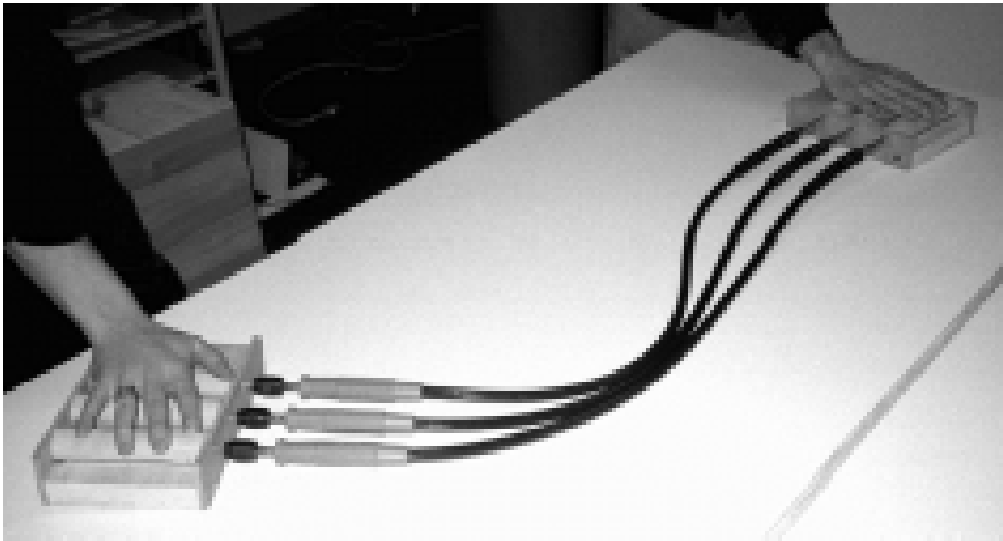
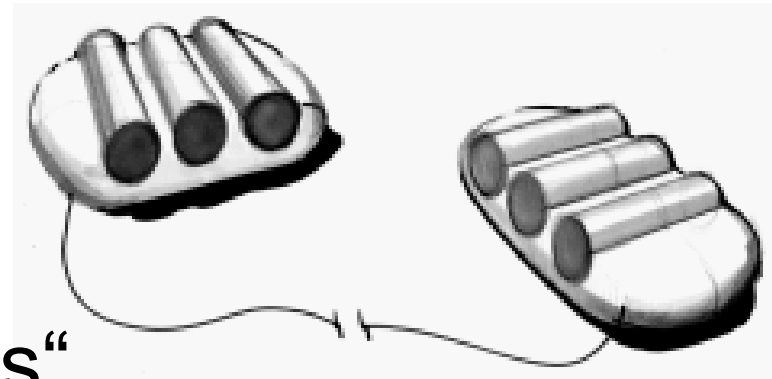
## Communicative TUIs



# InTouch

(Brave, Ishii, Dahley, CSCW 98)

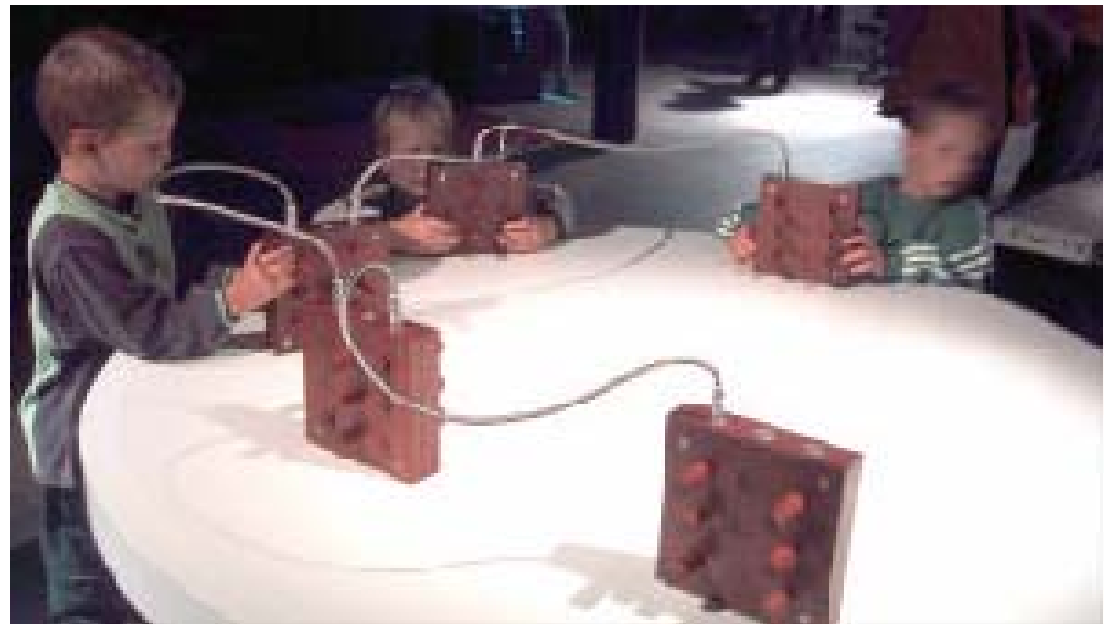
- UI for remote „awareness“
- Enhance the feeling of physical presence



# PegBlocks

(Piper, Ishii, CHI 02)

- Networked blocks with turnable pegs
- Used to teach kindergarten children about basic physical concepts



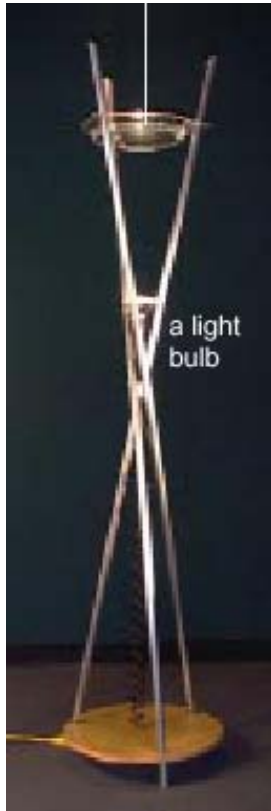
# Ambient User Interfaces

Integrated in everyday  
environment,

Peripheral perception

# Waterlamp

(Dahley, Wisneski, Ishii, CHI 98)



- Lamp shining from below
- Water surface by 3 actuators
- Changing information creates ripples on water surface
- Result: patterns projected on the ceiling



# Pinwheels

(Dahley, Wisneski, Ishii, CHI 98)



- Actual pinwheels, mounted on small DC electrical motors
- Rotation speed changes according to information flows
- Metaphor: flow of air ↔ flow of information

# The window as the interface

(Rodenstein, 99)

- Projection on „privacy film“ (by 3M)
- Can be made transparent or opaque by applying electricity



Figure 2: It will freeze tonight, better wear gloves.



Figure 1. It will get stormy in the next few hours.

# LumiTouch

(Chang et al. CHI 01)

- Connected picture frames
  - show when other frame is squeezed
  - Create a feeling of mutual awareness



Feedback area- Isolated area displays the light being sent.

Three touch sensors indicate pressure on different regions embedded in the frame. Each sensor maps squeeze force to the intensity of three output light colors- red, green or blue.

Color LEDs embedded throughout each frame display the translation from squeeze to light. The active inputs of squeeze are displayed over an Internet connection on the remote frame.

One infrared sensor detects motion near the frame. This is not a positive identification.

Information on passive motion is displayed by ambient light. This allows people to be aware of each other's abstracted remote presence.

# Digital Family Portrait

(Mynatt et al. CHI 01)

- In the “Aware home”
- Lets people “keep an eye” on others
- Balance betw. privacy and contact
  
- Icons around the frame indicate health, activity or relationships
- 28 icons on 4 sides = 4 weeks
- Position and size carry a meaning

