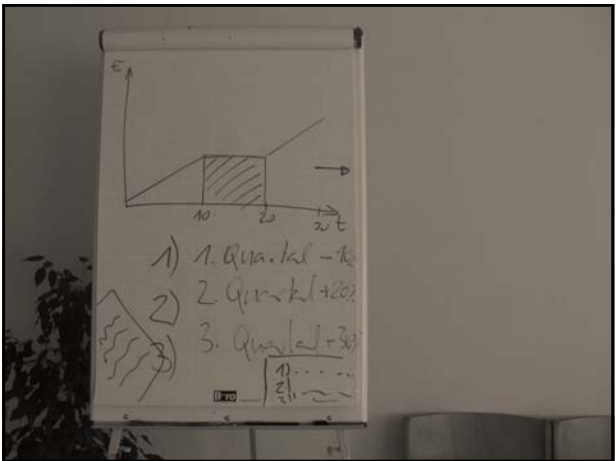
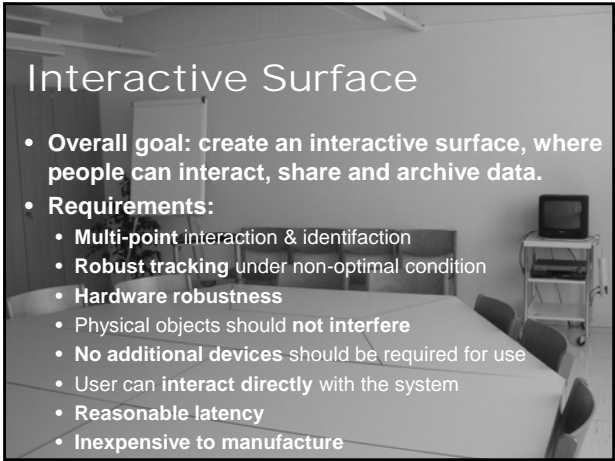


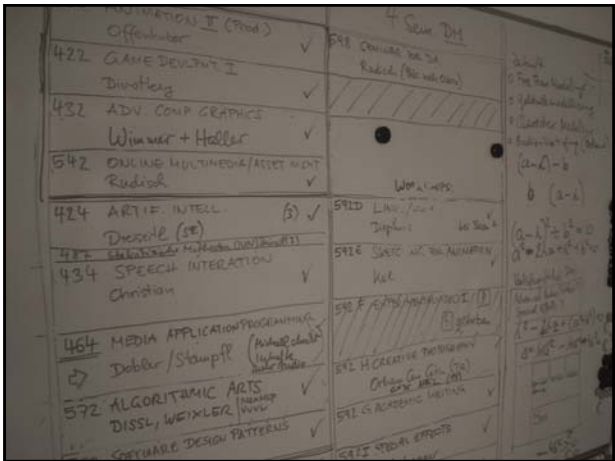
# Novel Interaction Paradigms using digital pens

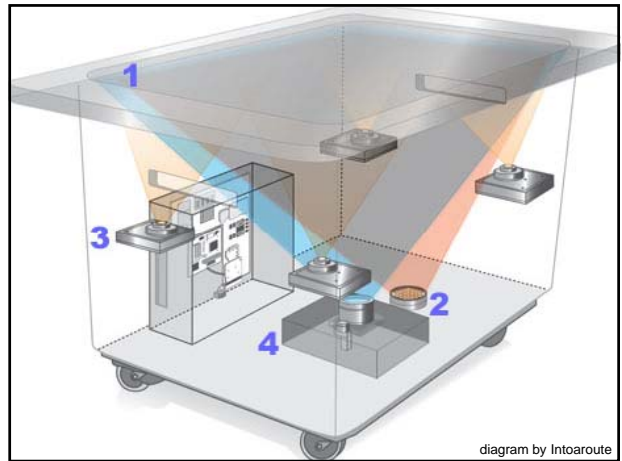
**Michael Haller**  
Upper Austria University of Applied Sciences  
Hagenberg – AUSTRIA

# Interactive Surface

- **Overall goal:** create an interactive surface, where people can interact, share and archive data.
- **Requirements:**
  - **Multi-point** interaction & identification
  - **Robust tracking** under non-optimal condition
  - **Hardware robustness**
  - Physical objects should **not interfere**
  - **No additional devices** should be required for use
  - User can **interact directly** with the system
  - **Reasonable latency**
  - **Inexpensive to manufacture**





### Experimental Results

- Finger-operated touch screen**
  - Best in speed and worst in accuracy (Albert, 1982)
- Stylus(Pen)-operated touch screen**
  - Comparable to a mouse on both speed and accuracy measures (Mack & Lang, 1989)

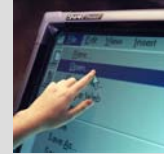
Benko et al. (2006)

## Finger-operated touch screens

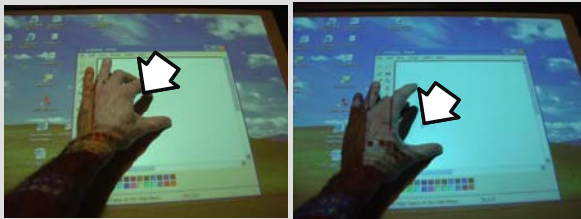
- Pros:
  - No special hardware requirements
  - Really intuitive (especially for novices)
  - Fast & Direct Input
  - Finger is usable, any pen is usable
- Cons:
  - The user's finger may obscure parts of the screen
  - The screen gets dirty from finger prints
  - Less precise without pen

## Pens for large surfaces

- SmartBoard allows both touch and pen interaction (optical-based)
- Ultrasonic-based tracking setups (e.g. MIMIO, eBeam)
- Digital pens?



## Touch-Interaction



(used with permission of MERL)

Esenher, A. and Ryall, K. Fluid DTMouse: Better Mouse Support for Touch Based Interactions. in *Proc. of Advanced Visual Interfaces* (Venezia, Italy, May 23 - 26, 2006), ACM Press, New York, NY, 112-115.

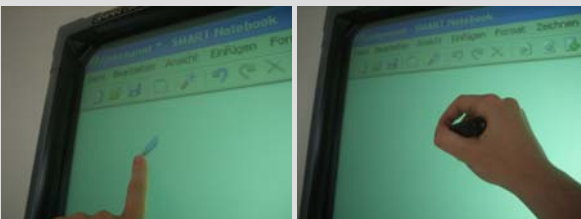
## Digital Pen, Scrivo.1

- Optical navigation & mouse-hover technology, 800 dpi
- No special surface requirements (it does not work on glass surfaces)
- BT-communication



## Touch+Pen != Pen+Touch

- Finger-operated touch screens often support pen input (e.g. SmartBoard)
- Pen-operated touch screens mostly do not support finger touch



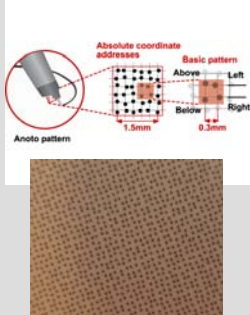
## Digital Pen, ANOTO

- Captures position (x, y) in absolute coordinates, time (t), pressure (p), and status (up, down)



[www.anoto.com](http://www.anoto.com)

## Anoto Digital Pen - 2



- What the pen sees?
- Pen camera use IR light
- Pattern has to be printed using IR absorbing ink
- User content should be printed with IR transparent ink

## Combining Advantages

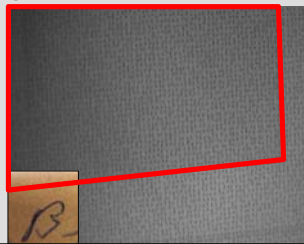
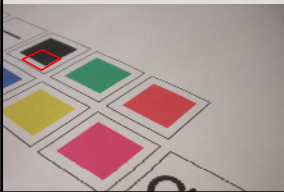
Paper Notebook: Robust, Battery, ...



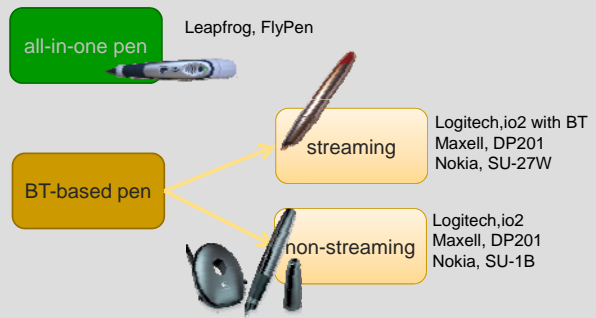
Computers: Search, Storage

## Anoto Digital Pen - 3

- C, M, Y are infrared (IR) transparent
- Black content has to be printed as C+M+Y, not K
- Real ink becomes invisible



## Different types of pen



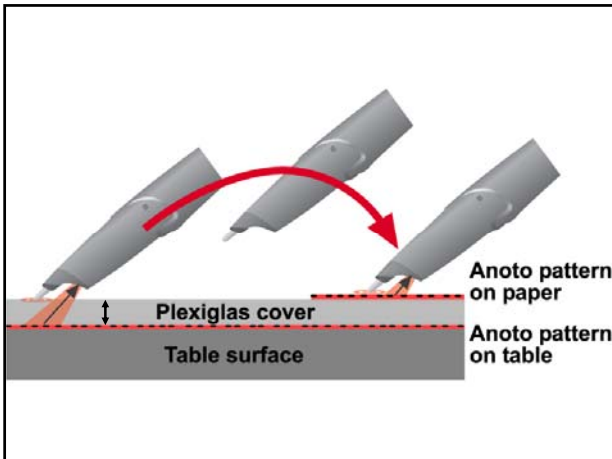
## Anoto Digital Pen - 4

- Transferring data to the computer
  - Manual transfer via dock
  - Automatic transfer via Bluetooth
  - The pen provides both page ID and the pen ID



## Scenario 1: Large table





## Tracking Performance

- 8 pens on a single BT dongle at 50 Hz
- Large table sizes are no problem (accuracy is not depending on the size) – 3 to 4 projectors mounted on the ceiling
- Occlusion & shadow problem
- Hand interaction



## Real vs. Digital Paper

### Real Paper

- Real Ink + Digital Ink
- Tracking of paper
  - ARToolKit (Kato, 2001), ARTag (Fiala, 2005)



### Digital Paper

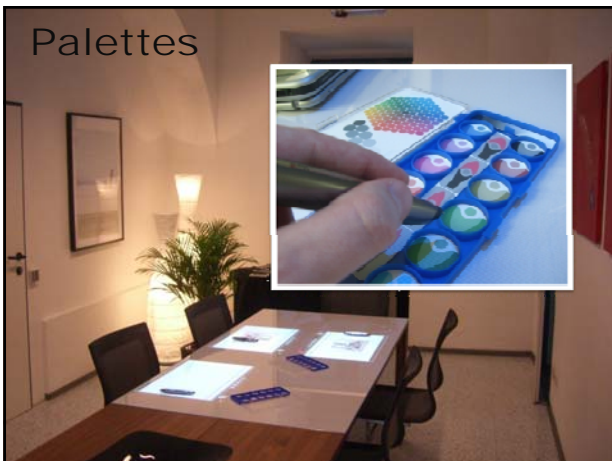
- Stylus tip
- Digital Ink



## Rear-projection table



## Palettes



## Rear-projection setup











- Experiment 1: Transparent foil
  - Good tracking, problems with image
- Experiment 2: Lee filter
  - White diffusion (used for spot-lights)
  - Good tracking, bad image
- Experiment 3: Backlit foil
  - great diffusion of projected imaged
  - Perfect tracking



## Applications

- Interactive Table
- Digital Whiteboard (INTOI)
- Digital & Real ink(going back to real ink)

## Related Work 3

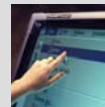
Requirements	Diamond Touch	DVIT	Mimio
Multi-point interaction & identification			
Robust tracking under non-optimal condition			
Hardware robustness			
Physical objects should <b>not</b> interfere			
No additional devices should be required for use			
User can <b>interact directly</b> with the system			
Reasonable latency			
Inexpensive to manufacture			
Multi-point interaction & identification			

 ...does not fulfill

# Interactive Table

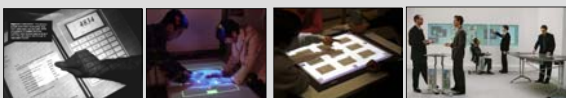
## Related Work 2

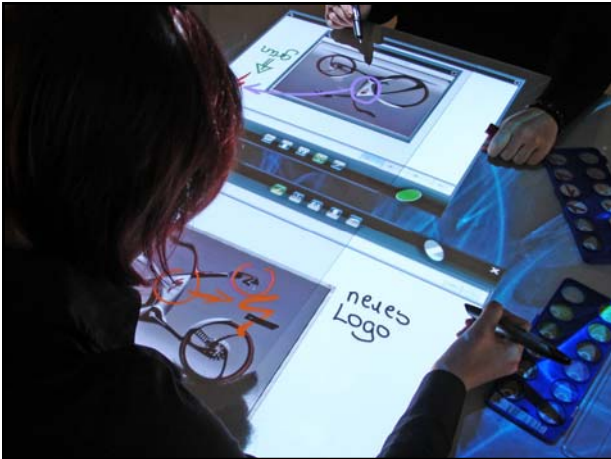
- Measuring the capacitance of users using a mesh-shapes sensor grid
  - DiamondTouch, InteracTable
- Smart (embedded) cameras
  - NextWindow
  - DVIT (Digital Vision Touch)
- Ultrasonic tracking
  - MIMIO, eBeam



## Related Work

- DigitalDesk (Wellner, 1992)
- SmartSkin (Sony CSL, 2002)
- DiamondTouch (MERL, 2003)
- InteracTable(Streitz et al., 2003)





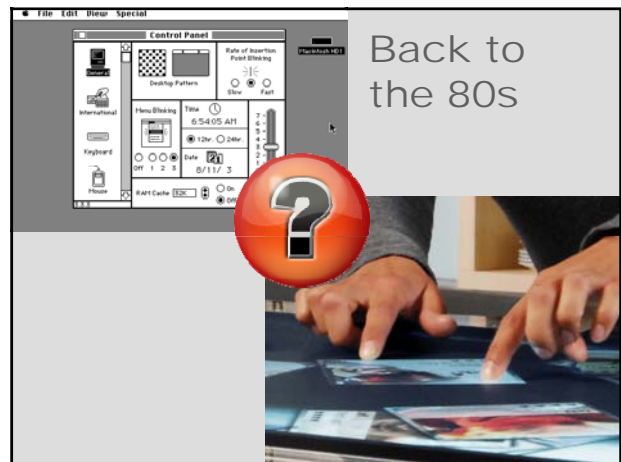
## Notice that

- Most of current tabletop applications are dealing with photo sharing



## Pilot Study

- Pilot study with users from a company
- They want to:
  - transform workspaces through direct touch
  - move digital data with their hand
  - pan/zoom with the hand
  - use a virtual keyboard via direct touch
  - write with a pen
  - sketch with a pen
  - select menu options with the pen
- They don't want to:
  - Write with their fingers
  - Switch between different hardware input devices



Back to the 80s

## Pen & Touch

- Pilot study results reveal that a pen and touch combination would perfectly support workflows
- natural usage of each device has top priority

### Pen

- Handwriting
- Sketching
- Accessing small GUI items
- Select options from a menu

### Touch

- Workspace transformation (move, scale, rotate)
- General menu control

## Traditional tables are never clean



## Pie Menus / Popup Menus

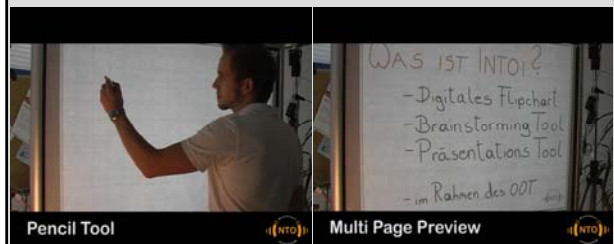


# Digital Whiteboard

## User-Drawn Menus



## INTOI (Interchange of ideas)



Pencil Tool



Multi Page Preview



## Pen & Hand interaction



Hand Feature Tracking



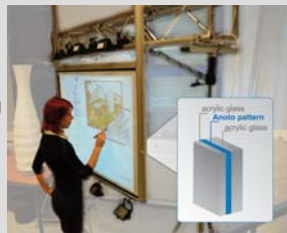
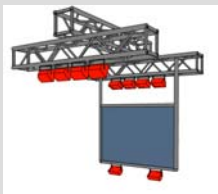
# INTOI - Interchange of ideas



- HP Colorlucet Backlit UV foil
- Protecting acrylic glass (<4mm)
- Features:
  - Multi-User Interaction
  - Simultaneous interaction
  - Scalable
  - Combination of touch and pen-interaction

# Digital & Real ink

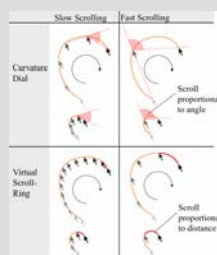
- Hand tracking
  - Shadow-based IR tracking
  - Currently



# Paper affordances [Sellen01]

- Pros:
  - Easy to navigate
    - Two-handed interactions and tactile feedback
    - Reading across more than one document at once
  - Easy to annotate
    - Directly on the document or on a nearby pad
  - Well accepted during meetings
    - Socially accepted conventions
- Cons:
  - No combination with digital world
    - Printed documents are created and edited as digital documents
  - Expensive to distribute and archive

# New interaction paradigm



cf. Smith, G., Schraefel, M., and Baudisch, P. Curve Dial: Eyes-free Parameter Entry for GUIs. In CHI 2005 Extended Abstracts (demo paper), Portland, OR, Apr 2005, pp. 1146-1147.

# Real and digital data



- **Pick-And-Drop**  
Pick data from a printed document and move it to the interactive surface.
- **Paper Device**  
The paper as an alternative control device
- **Sketch-And-Send**  
Draw & store sketches and send it to the table/wall display during a presentation

## Real and digital data



**Sketch-And-Send**  
 Draw & store sketches and send it to the table/wall display presentation

## Real and digital data



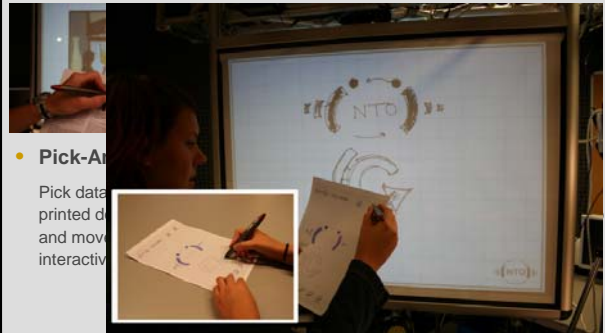
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## Tablet PC?

- Ease of navigation and annotation
  - Paper is easy to navigate
  - Paper is easy to annotate
- Display size
  - high-resolution display
  - Size can be changed
- Practical issues
  - Paper is low cost
  - Paper is resilient
  - Paper does not have batteries (but the pen does!)

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# Thanks

Peter Brandl, Michael Hurnaus, Daniel Leithinger, Jakob Leitner, Verena Lugmayr, Jürgen Oberngruber, Claudia Oster, Christian Schafleitner, Thomas Seifried.



# Questions

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web: <http://www.officeoftomorrow.org>

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