

# New Technologies

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# Stroke Capturing Technologies

## ◆ *Digital Notepads:*

- **IBM Electric Ink**
- **Dynomite**
- Pegasus
- NotePals

## ◆ *Digital Whiteboards:*

- **DUMMBO**
- **Mimio**
- Tivoli
- DynaWall

## ◆ *Digital Sketches:*

- **Drawing-Prism**
- **SATIN**
- PerSketch

## ◆ *Miscellaneous:*

- **UniStrokes, Scribbler**



# Digital Notepads

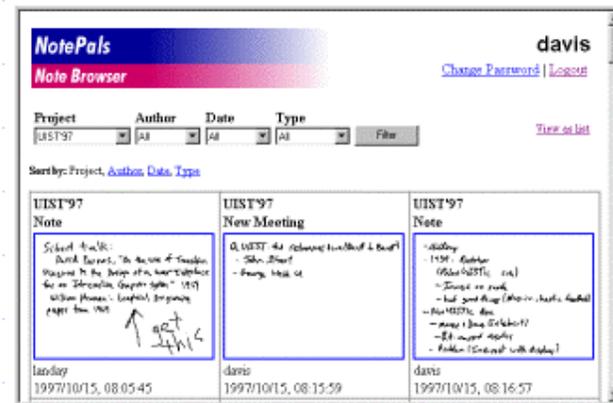


Figure 2. The Note Browser displaying notes from UIST '97.



# IBM Electric Ink

## ◆ Real-time Handwriting Recognition

### ◆ Process:

- Resize and sanction handwriting to obtain standardized shapes
- Breakdown into manageable strokes
- Recognize with HMM (Hidden Markov Models) and NN (Neural Nets), using clustering heuristics, word-dictionary and empirical data

### ◆ Reliability Factors:

- Dictionary-size
- Writing Style
- Trainability

# IBM Electric Ink

## ◆ Types of Handwriting Recognition:

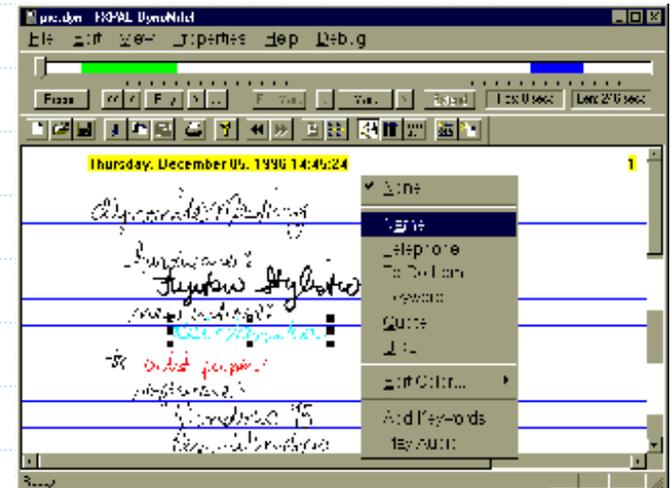
- Word/sentence recognition
- Drawings
- Non alpha-numeric (special actions)

## ◆ Word Recognition Process:

- Pre-processing (Noise reduction, normalization, segmentation)
- Feature extraction
- Recognition and Linguistic processing (Rules, NN, HMM, Dictionaries)

# Dynomite (Palo Alto & MIT Labs)

- ◆ Free-form pen-based input (accepts strokes/gestures)
- ◆ Dynamically alterable 'digital notes'
- ◆ Support for Marking (assigning properties such as To-do, Name, URL etc)
- ◆ Review and Retrieval based on time-stamps, properties, keywords
- ◆ Audio Note-taking Support:
  - Synchronization with digital strokes
  - Audio Highlighting
  - Bandwidth conservation



# Digital Whiteboards



# DUMMBO (Georgia Tech, 1999)

- ◆ Dynamic Ubiquitous Mobile Meeting Board
- ◆ Mirrors traditional whiteboard functionality
  - Look-and-feel (board, colored pens, eraser, hand-gestures)
  - Real-time multiple-user input
  - Transparent interaction
- ◆ Digital Features
  - Capture and timestamp of significant events
    - Audio notes
    - Strokes (normal ink, erase, hover)
    - Arrival and departure of people
    - Beginning and ending of sessions
    - Location of whiteboard from room-to-room
  - Playback of session (temporal/content-based filters)

# DUMMBO

The screenshot displays the DUMMBO application window titled "DummbaAccess". The main area is a whiteboard with handwritten notes and diagrams:

- CW**: A diagram showing a box labeled "W" with an arrow pointing to it from the word "Sensor".
- GUI**: A simple rectangular box with a smaller rectangle inside.
- CA**: A box containing the text "- data" and "- ID".
- Location**: A list of terms: "location", "size", "Speech/Audio".
- Entity**: A list of terms: "Entity", "People plus Things System".
- Diagram**: A flow diagram with boxes labeled "AT", "S", and "O", connected by arrows.
- Text**: "location = Person widget" and "(1.-)".

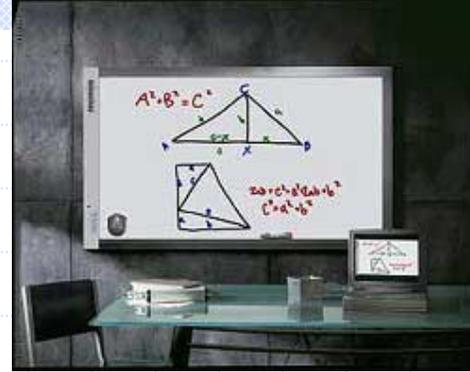
At the bottom, there are playback controls and filters:

- Playback controls**: Includes "Play" and "Stop" buttons and a progress bar.
- Filters**: Includes a calendar grid, a "When:" dropdown (set to "Aug", 1998), a "Who:" dropdown (set to "Jason Brotherton"), and a "Where:" dropdown (set to "Mobile SMART Board #1").

Annotations on the right side of the image point to specific features:

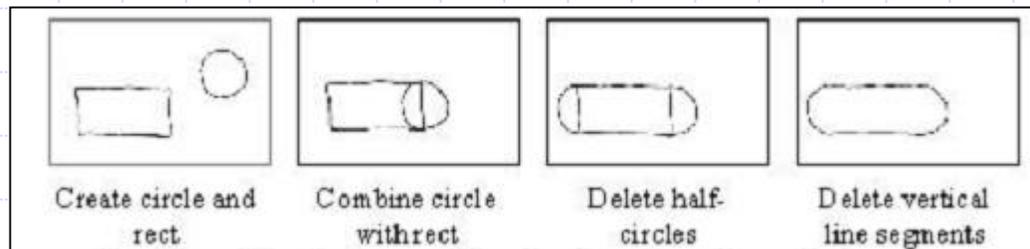
- "Ink written before current time is in original color" points to the "Sensor" and "W" diagram.
- "Ink written after current time is displayed in gray" points to the "AT", "S", and "O" diagram.
- "Current time within session" points to the current position on the playback bar.
- "Selected session" points to the "Who:" dropdown.
- "Selected day" points to the highlighted day "4" in the calendar.
- "Day containing whiteboard activity" points to the highlighted days "24", "25", "26", "27", and "28" in the calendar.

# Mimio



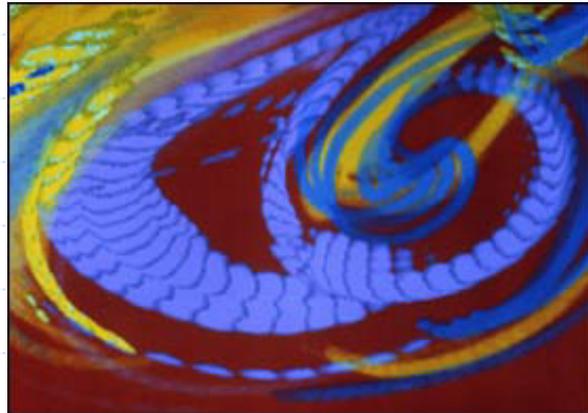
- ◆ A combination of portable hardware and easy to use software that allows you to record, play back, print, and share whiteboard information (text, images, audio)
- ◆ Contains various plug-ins that support:
  - Automatic Handwriting Recognition
  - Broadcast over the Web using Microsoft Net-Meeting
  - Class-room interaction between teachers and students
- ◆ Uses a high-resolution ultrasonic position capture system consisting of a capture bar, color-coded marker sleeves and an electronic eraser
- ◆ Compatible with whiteboards or flip-charts, PCs or Macs and can fit any flat-surface from 2' X 3' to 4' X 8' in size

# Digital Sketches



# Drawing-Prism (1985)

- ◆ Tool to record paint-brush strokes digitally
- ◆ Mechanism:
  - Transparent table-top with an underlying camera
  - Transparent liquid cover
  - Brush-strokes in liquid are captured by the camera
- ◆ Advantages:
  - Incorporate 'real' brush-strokes into computer graphics
  - Allows new visual effects



# SATIN (Berkeley)

- ◆ Java-toolkit to support effective informal pen-based applications
- ◆ Provides utilities and interpreters for manipulating strokes
  - Straighten, split, merge sub-strokes
  - Simplify granularity
  - Interpret gestures, commands
- ◆ API used to build various commercial applications
  - DENIM (Web-design tool)
  - SketchySPICE (CAD tool)

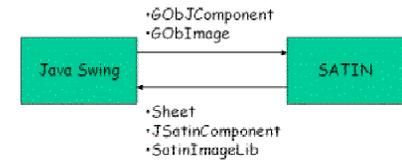


Figure 3 – Classes bridging the gap between SATIN and Java Swing. Swing widgets can be displayed in SATIN, and SATIN graphical objects can be embedded in Swing applications.

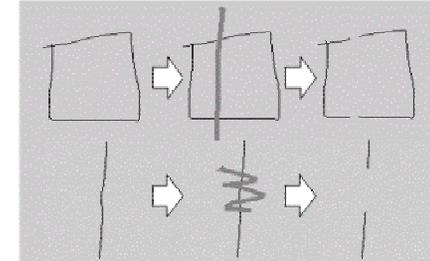


Figure 4 – Two example policies of splitting strokes. The thicker line is a gesture created by pressing the right button.

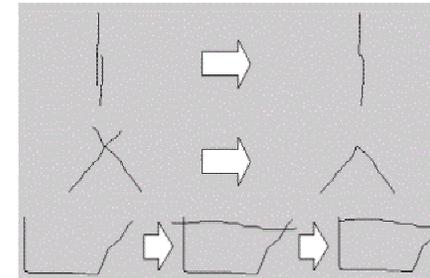


Figure 5 – At the top, two separate strokes near each other are combined into a single stroke. In the middle, two separate strokes that intersect near their endpoints are merged into a single stroke. At the bottom, two separate strokes that intersected near both of their endpoints are merged into a closed shape.

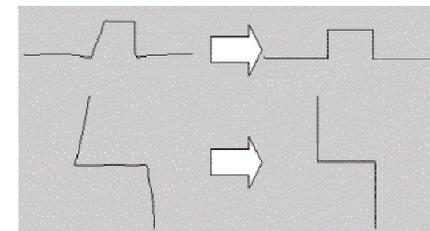


Figure 6 – Two examples of straightening strokes.



# Miscellaneous

# Unistrokes (Xerox 1993)

## ◆ Motivation:

- Pen-based Keyboard
- Replacement for 'hunt-and-peck' touch typing with 'heads-up' typing
- Small input-device size

## ◆ Design:

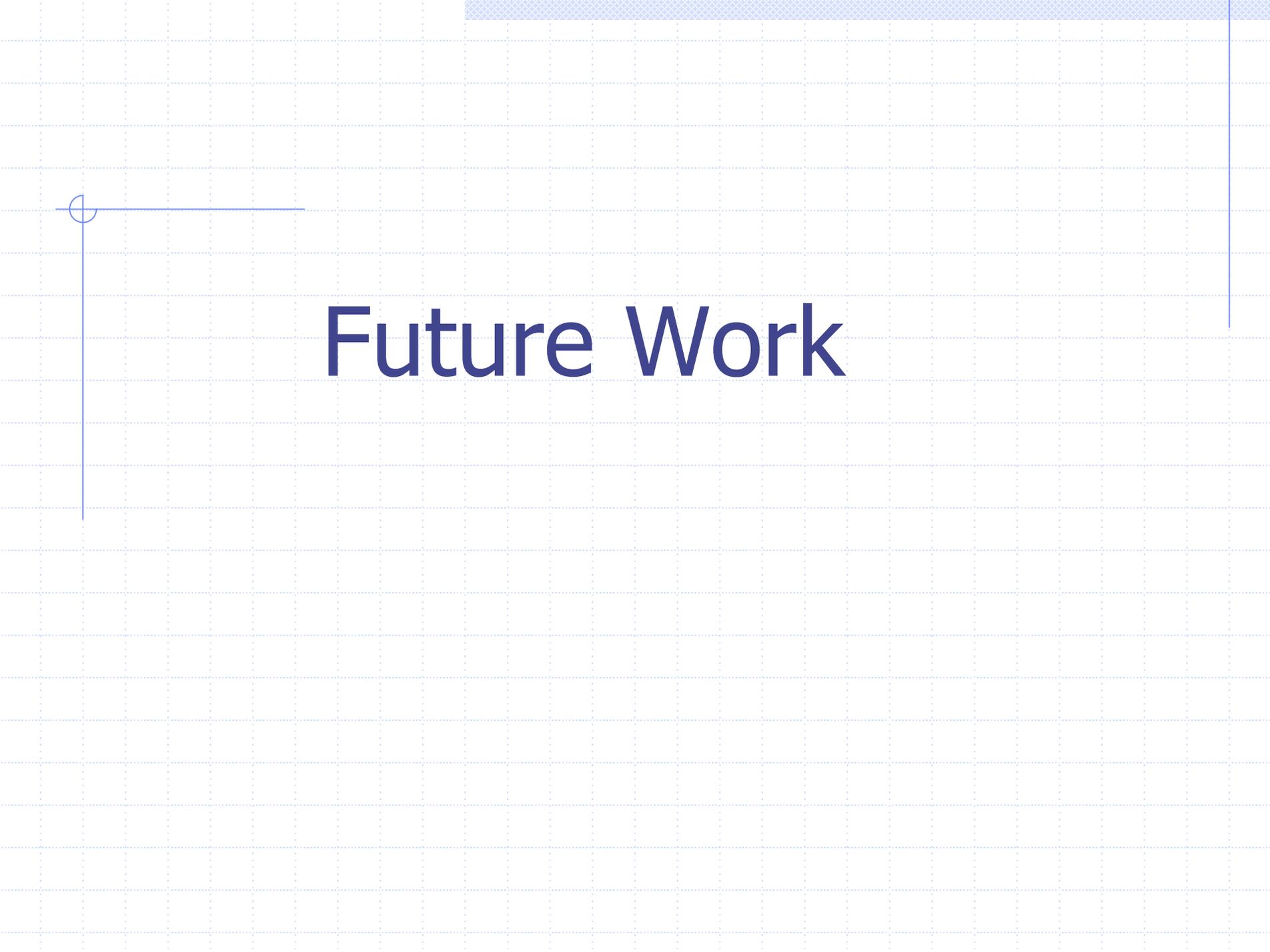
- Unique alphabet based on 5 strokes
- Major Criteria - easy to learn, unambiguous and fast to write
- One-to-one mapping between letters and strokes
- Various tricks employed to increase efficiency

## ◆ Applications:

- Graffiti in Palm-Pilots

# Scribbler (Xerox 1995)

- ◆ Tool to Search through Personal Digital Ink notes
- ◆ Technique:
  - Represents ink as sequence of strokes
  - Pre-process strokes to discard velocity data
  - Break down document into stroke-groups (words)
  - Compare target word to each stroke group
  - Dynamic user-defined threshold for matching
- ◆ Key Disadvantages:
  - Personalized
  - Sub-optimal thresholds affect accuracy



# Future Work

# Innovative Ideas

- ◆ Digital Desk: Video-image processing in an office-environment
- ◆ Paper Link: Augmenting paper with electronic features (Dataglyphs)
- ◆ Intelligent Paper: Invisible printed marks
- ◆ Palette: Cards for electronic slide shows
- ◆ Video-mosaic: Using paper video storyboards
- ◆ Insight Lab: Using bar-codes to link different media

# Appendix A: Related to Digital Notepads

Publication: Jayashree Subrahmonia, Thomas Zimmerman , *'Pen-Computing Challenges', 2000* ([Link-1](#), [Link-2](#))

## ◆ Notebook Case Study:

- Common Note-taking practices:
  - ◆ Organization of notes (subject-wise, chronological)
  - ◆ Structure (into logical segments)
  - ◆ Marking (aid in review and retrieval)
- Advantages of Standard Notebooks:
  - ◆ Ability to input free-form notes on paper (edit/arrange ink)
  - ◆ Ability to create arbitrary structure
  - ◆ Material can be reviewed easily by visual scanning (e.g. To-do items)
- Disadvantages of Standard Notebooks:
  - ◆ Input-speed limited
  - ◆ Finding specific information is difficult
  - ◆ Reuse (transferring from paper->digital media) is arduous but necessary

## ◆ Digital Interface Design: Types of Pen-input Hardware

- Magnetic tracking (+high spatial resolution, +modest cost)
- Electric tracking (-unreliable pen-trajectory analysis)
- Ultrasonic tracking (+high temporal resolution, +low weight, -low spatial resolution)
- Optical tracking (+low power, +easy to integrate)

## Appendix B: Related to Digital Whiteboards

Publication: Brotherton et al, '*Supporting Capture and Access Interfaces for Informal and Opportunistic Meetings*' ([Link](#))

### ◆ Barriers to Informal Capture and Access:

- Start-up cost (cheap, mobile, easy to setup)
- Transparent interaction (unobtrusive digital interface)
- Lack of structure (flexibility to handle 'open' meetings)
- Effective retrieval (capture and playback experiences)

### ◆ Survey of Existing Tools:

- DynaWall - hand gestures for throwing (moving) objects and suck-and-spill (cut-and-paste)
- Tivoli - combines stroke-based gestures with spatial layout to determine semantic content
- Mimio - 'Electronic' whiteboard with real-time handwriting recognition and recording

# Appendix C: Related to Digital Sketches

Publication: Hong et al, '*Sketch Recognizers from the End-user's, Designer's and Programmer's Perspective*' ([Link](#))

## ◆ The Three Viewpoints:

- End-User's - need for a user-friendly and useful sketch-based application to perform some task
- Designer's - need to design and evaluate interfaces, specifying structure and functionality (SILK, Quill, DENIM)
- Programmer's - need to use API and toolkits (SATIN, OOPS) to develop applications for end-users

## ◆ Research Problems:

- Immediate / Delayed Recognition?
  - ◆ SILK - strokes processed and recognized in real-time, hindering flow
  - ◆ Burlap - recognition only when required (through mediation)
  - ◆ DENIM - almost no recognition (still widely used)
- Amount of Recognition? (sketches and gestures)
  - ◆ SILK - uses only Rubine Recognizer - rigid approach, low robustness
  - ◆ Quill - lets designers create and test pen-gestures
- General Issues:
  - ◆ 'Invisible' interface (no visual action-list, improper feedback - DENIM)
  - ◆ Variation in strokes (need for ambiguity, mediators such as repetition - OOPS)