

Mixed paper-computer interfaces

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Systems reviewed (1/2)

- Desk Systems
 - DigitalDesk
 - VideoMosaic
 - Ariel
 - InteractiveDesk
 - EnhancedDesk
 - MetaDesk

Systems Reviewed (2/2)

- Others:
 - Audio Notebook
 - PaperLink
 - XAX

Desk Systems

- Approach
Project images and record remotely
- Technology
Video cameras, video projectors, scanners,
bar code readers
- Applications
Office work, Film-making, construction,
architecture

Other systems

- Approach:
Imbed devices within objects
- Technology:
Electronic paper, sensors, tags, augmented electronic devices
- Applications:
Office work, education, offices facilities

Augmented environment

- Independent devices provide and collect information from the surrounding environment, displaying information onto objects and capturing information about the user's interactions with them.
- “Desk systems”.

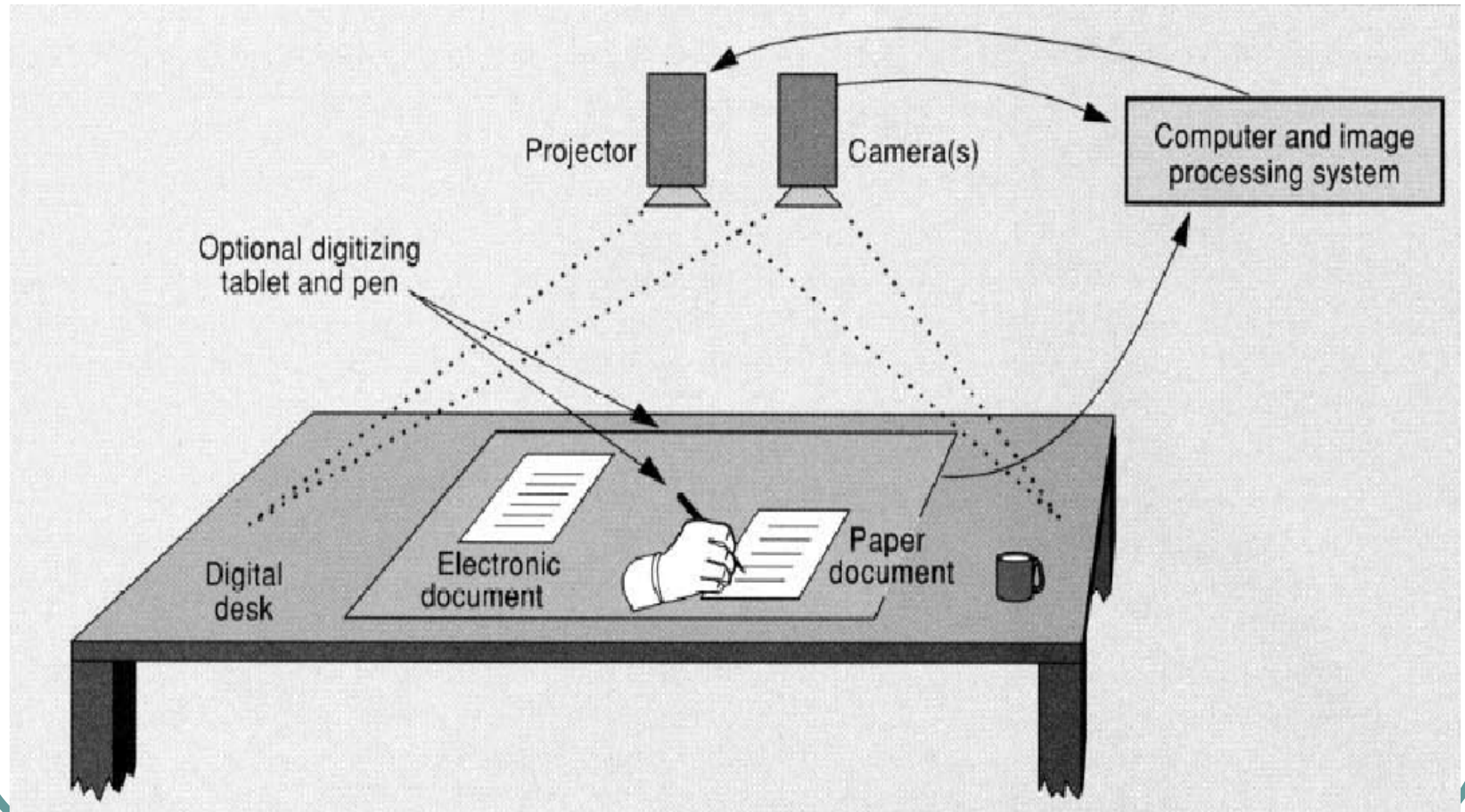
Digital Desk - Goals

- Combination of paper and electronic desks.
- Make the desk more like a workstation (opposite of “desk metaphor”).
- Tactile manipulation
- Electronic objects gain physical properties and physical objects gain electronic properties

XAX ...first attempt?

- Fax-based paper user interface to a storage and retrieval system. Ordinary paper forms are enhanced to control a PC through a fax machine.
- These paper documents gain some properties of electronic documents.
- BUT fax machines are slow compared to computer screens and response time is limited by the delay it takes to scan and print a page, and this limits the range of interaction techniques possible.

Digital Desk (Wellner 1991)



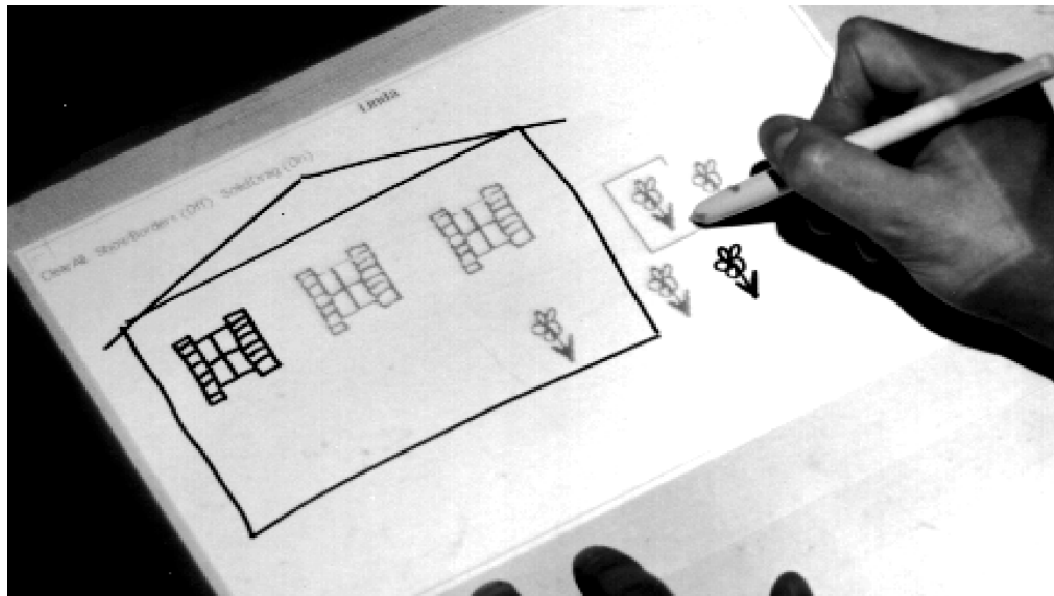
Digital Desk - Applications

- Calculator
(direct computer-based interaction, paper with electronic properties)



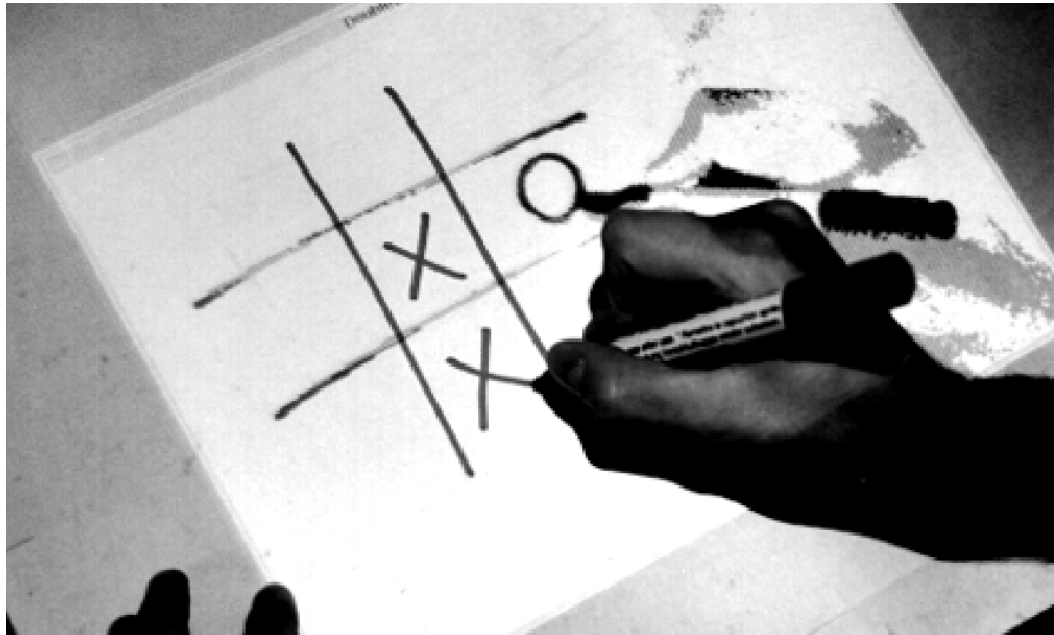
Digital Desk - Applications

- PaperPaint
(construct mixed paper and electronic drawing)



Digital Desk - Applications

- DoubleDigitalDesk
(share interactively real paper documents)



Digital Desk – Advantages

- Interacting with paper and the computer at the same time
- Easier to read
- More space
- More manual

Digital Desk – Disadvantages

- Limitations in the technology (OCR, finger tracking, etc)
- Limited commands
- No portable
- No user testing

Video Mosaic (Mackay et al 1994)



Video Mosaic - Extensions

- Additional input devices pen and barcode reader
- Additional output devices additional screen
- Two versions:
 - Unix version
 - on manual tapping on paper-button
 - Mac version
 - menu interface projected on the desktop and selecting by using the pen
- Multimedia

VideoMosaic

Video Mosaic Storyboard				
Storyboard: Video Mosaic tape for MM94		Date: 19/3/94		 4567
Author: Mackay and Pagani				
S.M.E. Approval:		Design Approval:		
Elements:	New	Delete	Copy	Storyboard: Play Reorder Print 1/page Print 3/page

Figure 6: A storyboard header (Macintosh version)

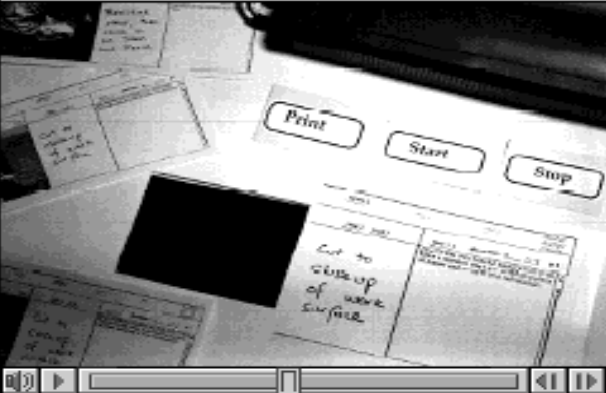
Video Mosaic Element														
File	Camera	Record	In	Out	Best	Save	Show list	Insert	Delete	Save	Scan	Clear	Save	
							Here is Video Mosaic in a normal office setting.				Voice over ... Wide shot of desk, then zoom to each piece of equipment.			
• Video Mosaic provides a means of sh • Here is Video Mosaic in a normal of • Let's look at the equipment • A camera is located above the desk • As is the projector														
							Start 00:00:53 Stop 00:01:12							
Video Mosaic provides a means Here is Video Mos Let's look at the A camera is located above t As is the														

Figure 7: A storyboard element (Macintosh version)

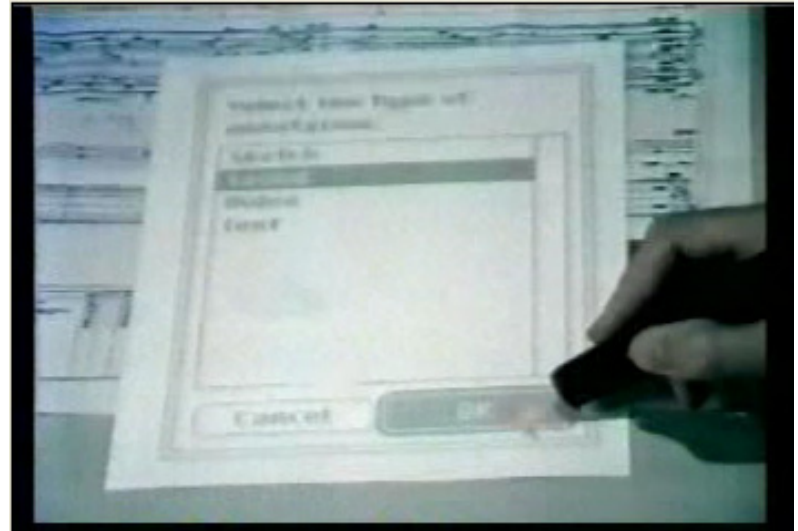
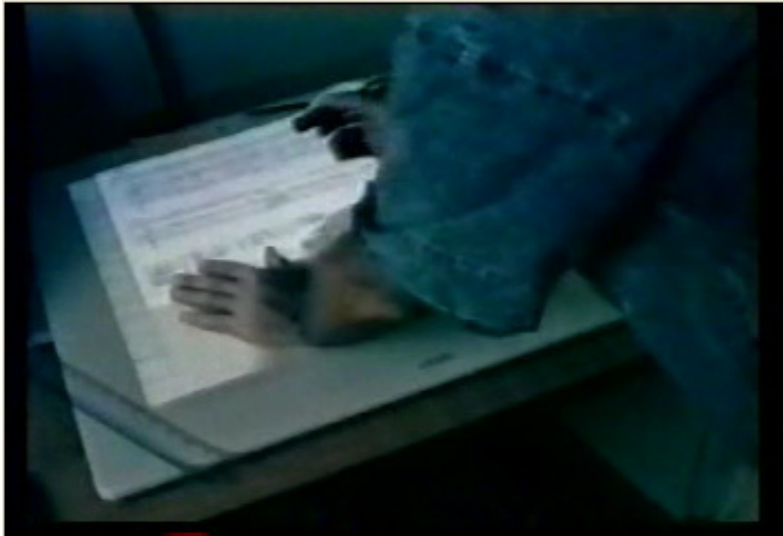
Video Mosaic - Disadvantages

- Display overlapping
- Inconsistency between information on paper and information on the computer

Video Mosaic - Comments

- Scenario based design
- Intended audience: video producers
- No user studies, no results

Ariel (Mackay et al 1995)



Ariel - Goals

- Engineers prefer paper drawings to make annotations
- Annotations are never transferred to the computer
- Cooperative work: share informal notes

Ariel - Features

- Multimedia
- Bar code for commands and drawing identification
- Live video
- Virtual paper window
- Hand-held scanner
- Allows the digitization of annotations

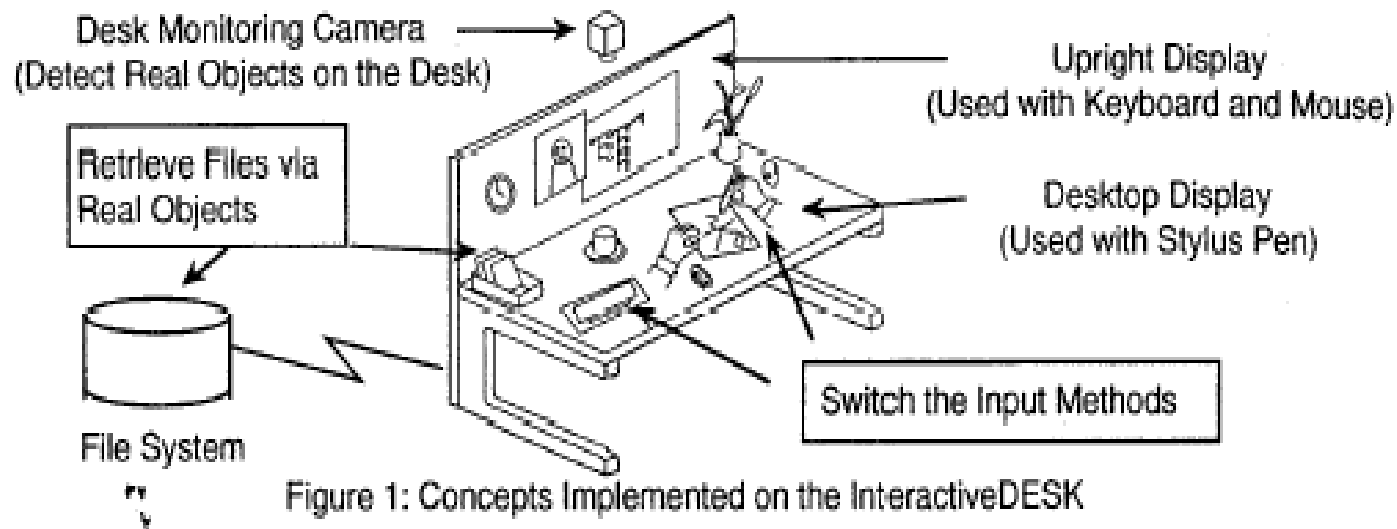
Ariel - Disadvantages

- Annotations directly on the drawing are not transferred (at least not automatically)
- Seeing projected information and differentiating it from information on paper
 - Virtual Paper Windows

Ariel – Comments

- Scenario based design
- Similar to video mosaic
- Intended audience: Engineers

InteractiveDesk (Arai et al. 1995)



InteractiveDesk - Goals

- Integrate pen-based systems with conventional computer devices
- Switching between input mechanism as easily as possible
- Focus on how to retrieve electronic documents

InteractiveDesk - Features

- Two input mechanisms
 - Keyboard and mouse
 - Pen and tablet
- Two output mechanisms
 - Conventional screen
 - Tablet
- One way link from physical objects to electronic document

InteractiveDesk - Disadvantages

- Still has two unsynchronized, probably unorganized versions of the documents (electronic and physical)
- Interaction with real objects limited to retrieving files
- Makes the computer aware of the switching of inputs, but does not eliminate them
- Documents are displayed on traditional computer displays

Enhanced Desk - Goals

- “Smoothly integrates paper and digital information on a desk and provides direct manipulation of the digital information with the hands and fingers of users”.

EnhancedDesk (Kobayashi et al 1997)



EnhancedDesk – Differences

- Bar code reader
- Multimedia
- No OCR
- Better finger tracking technology

EnhancedDesk – Disadvantages

- Same problems as Digital Desk:
 - Limited commands
 - No portable
 - No user testing
- Poor resolution display
- No annotations nor digitizing of handwritten material

EnhancedDesk – Comments

- Try to enhance paper documents by providing multimedia and dynamic content
- Emphasis on tactile manipulation (lot of effort to achieve this)
- Limited interaction (no menus, no buttons)

EnhancedDesk

- An application:
Interactive TextBook
 - Interactive content for text books
 - No simultaneous interaction with paper and computer



MetaDesk (Ullmer & Ishi 1997)



MetaDesk - Goals

- Tangible user interface
- Physical form to GUI devices (phicons)
- Exploit physical affordances
- Not limited to paper

MetaDesk - Comments

- Translates the desktop metaphor back to a real desktop
- Interaction with real objects
- Multiple displays

MetaDesk- Disadvantages

- Limited interaction
- Ambiguity in interpretation of icons
(reuse of phicons on different contexts)
- One way links, real objects only for input
- How to specify more abstract actions over the objects?

Other augmented reality systems

- PaperLink - Norrie & Signer
 - Uses conventional paper for input, conventional (computer) displays for output
 - Creates hyperlinks between existing paper documents and the computer
- Audio Notebook
 - Not really a computer, but a recorder
 - Uses pages on a notepad as bookmarks for voice records
 - Uses paper for main input, electronic devices (buttons, leds, speakers) for output and secondary input
 - Annotations are kept on conventional paper
- Listen Reader

General comments

- The purpose is not to replace computers nor paper, but provide specifics applications which benefit from the combination of both in an interactive way.
- Digitizing existing paper documents not very important

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