VRIJE UNIVERSITEIT BRUSSEL

Next Generation User Interfaces

Pen-based Interaction

Prof. Beat Signer

Department of Computer Science
Vrije Universiteit Brussel

http://www.beatsigner.com

History of Pens and Writing Instruments

stones as writing instruments for cave paintings starting ~40 000 BC

[http://en.wikipedia.org/wiki/Cave_painting]

History of Pens and Writing Instruments ...

stylus
~3200 BC

reed pen
~3000 BC

silver pencil
~1000 BC

ink brush pen
~300 BC

quill pen
~500-1900 AD

History of Pens and Writing Instruments ...

- Clay and wax tablets
  - ~3200 BC
- Papyrus
  - ~3000 BC
- Parchment
  - ~300 BC
  - made from animal skin
- Paper
  - invented in China in 105 AD
    - brought to Europe by Arabs
    - produced in Europe ~1100 AD
    - rags were only replaced by wood pulp ~1850 AD

Papyrus


Paper

History of Pens and Writing Instruments ...

dip pen
~1800

fountain pen
1884

ruling pen

radiograph
1953

pencil

History of Pens and Writing Instruments ...

marker pen
~1910

ballpoint pen
1938

rollerball pen
1963

ceramic tip
pen

?

40 000 Years of Evolution in Writing Tools

- Existing pens and writing tools have evolved over the last 40 000 years
- Pens have been optimised for the corresponding writing surfaces
- It sometimes took a long time before a new writing tool got adopted (e.g. paper)
- There has been a *coevolution of paper and work practices* over a long time period
- *Everybody knows how to use pen and paper* and has some *expectations* when using these artefacts

The Paperless Office

Over the next decade, most corporate offices will still be geared to the movement of information on pieces of paper. Office automation will bring improvements in productivity through the use of automatic typewriters and other stand-alone equipment that crank out paper faster. Some interoffice information will move electronically, but what the manager reads and files will be printed on paper.

But during this period, a relatively small but fast-growing group of companies will have moved into the office-of-the-future environment. The leap forward will be led by the "papermakers"—those companies that are involved primarily in generating, modifying, or moving paper. These pioneers will have hooked together word-processing equipment into office systems to transfer information electronically and to move it into and out of central electronic files. For them, it will be the start of the paperless office.

Productivity gains will rival those of today's factory and accounting departments. But the pacing factor will still be people, because the technology of the office of the future does not fit the structure of how things are traditionally done in the office.

Historically, the key stimulus in the application of any new technology has been the need to solve a current problem. And the "papermakers" now have an overpowering problem, one that is too big to be solved by today's word-

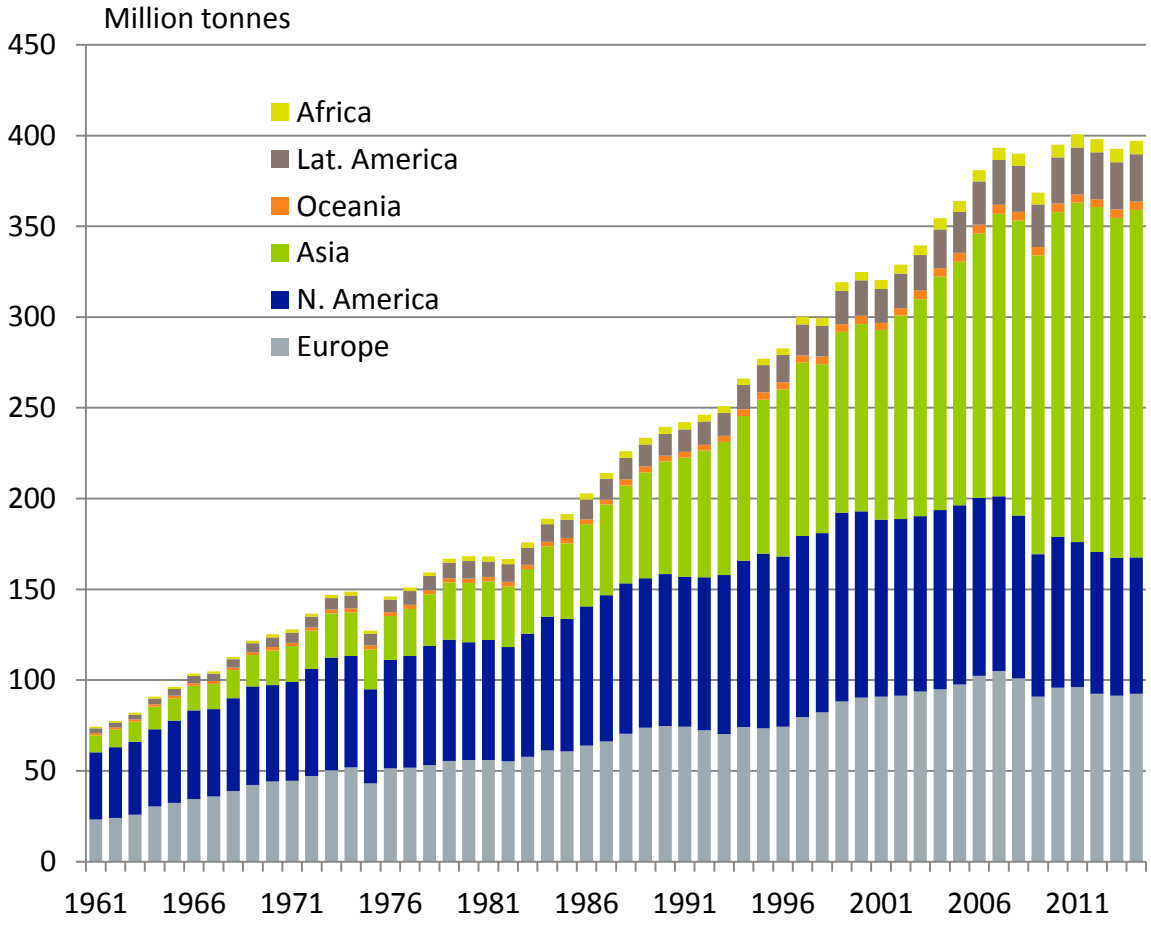
80 BUSINESS WEEK: June 30, 1975

The Myth of the Paperless Office ...

- For decades, people have predicted the office of the future as a paperless office
  - documents generated, published and distributed electronically
  - documents read electronically
- What has happened to this imminent revolution?

The Myth of the Paperless Office

Worldwide Paper and Board Consumption



2014	Mill. Tonnes	%Change
Asia	191	2,2 %
Europe	92	1,2 %
N. America	75	-1,2 %
Oceania	5	-1,7 %
Lat. America	26	0,4 %
Africa	7	0,0 %
Total	**397**	**1,1 %**

*% change from previous year

Source: FAO, http://www.forestindustries.fi/statistics/15-Pulp%20and%20Paper%20Industry

Affordances of Pen and Paper

- The *affordances* of an object are the *physical properties* of an object that *determine how people use* that *object*
- Affordances of paper
  - light, flexible, mobile and cheap
  - robust
  - porous
  - opaque or transparent
  - high resolution
  - ease of navigation
    - flipping through pages or across documents
  - easy to annotate
  - hard to replicate and must be accessed locally
  - ...

Affordances of Pen and Paper ...

- Human interaction with paper
  - grasping
  - folding
  - tearing
  - carrying
  - writing on
  - *juxtaposing paper documents*
  - arranging paper documents in space
  - ...
- *Paper supports some forms of collaboration and interaction that are difficult to mimic in digital space!*

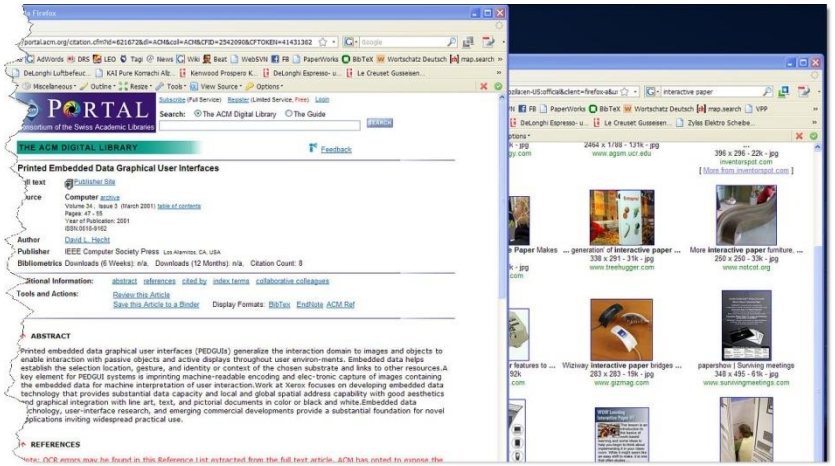
Affordances of Pen and Paper ...

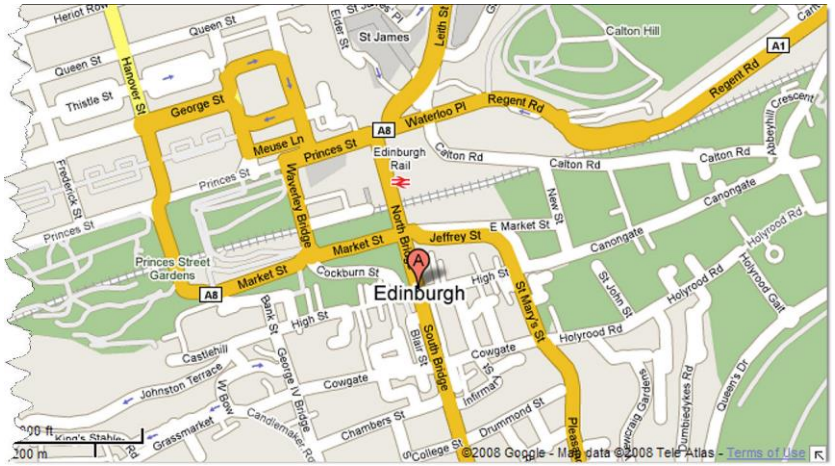
- Affordances of pens
  - robust
  - light
  - mobile
  - colour
  - erasable
  - cheap
  - durable
  - easy to draw on different surfaces
  - ...

Today's Human-Computer Interaction

- How are pen and paper currently integrated in our daily work with computers?
- How to deal with the *paper-digital divide*?

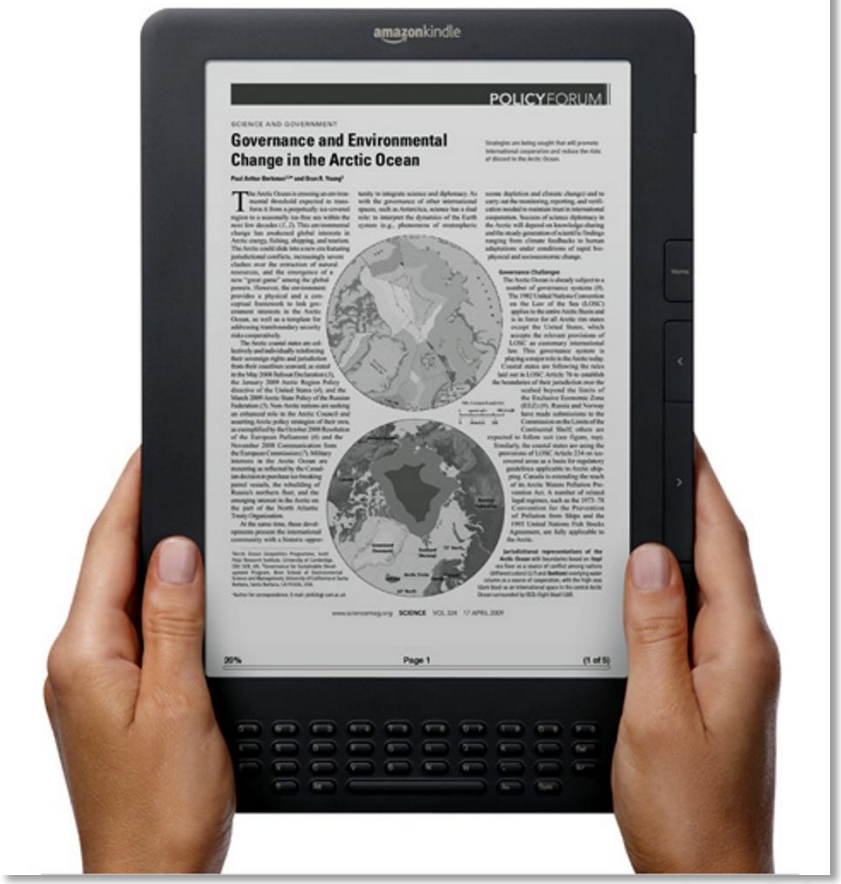
Bridging the Paper-Digital Divide





Paper-Digital Integration

Electronic Paper



Amazon Kindle

Augmented / Interactive Paper

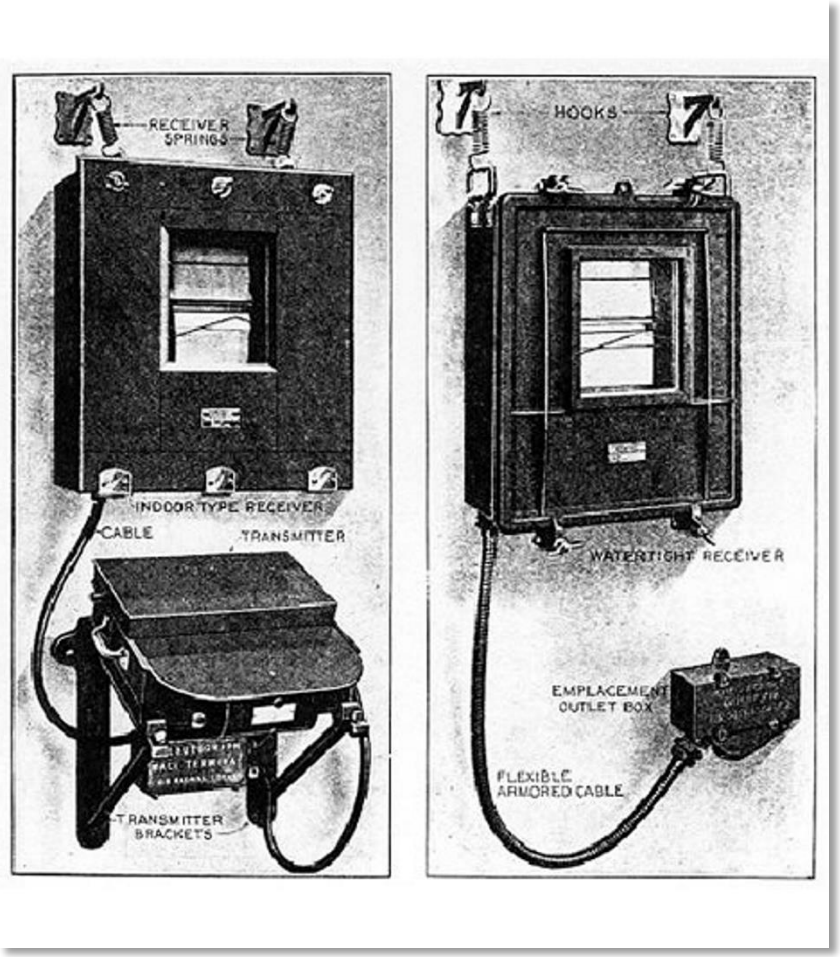
Anoto Digital Pen and Paper Technology

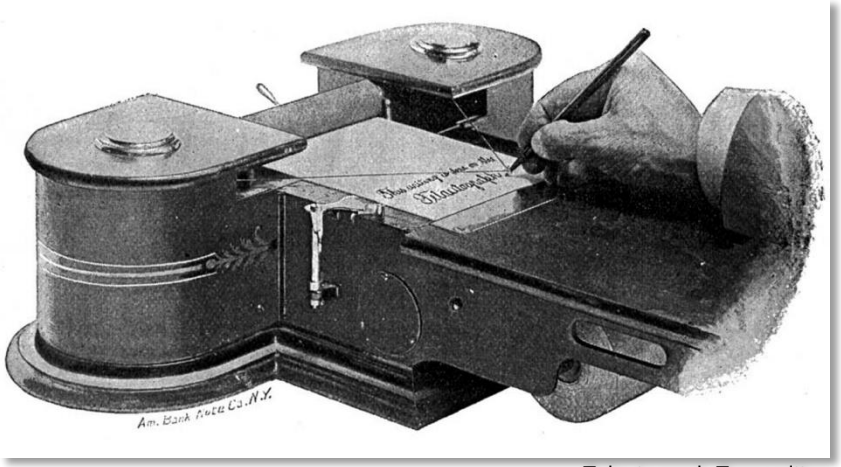
Telautograph

- Telautograph invented in 1888 by Elisha Gray
- Transforms *pen writing* at the sending station into *electrical impules* (via potentiometers)
- Reproduces the drawing at the receiving station via a pen attached to a servomechanism
  - e.g. remote signatures

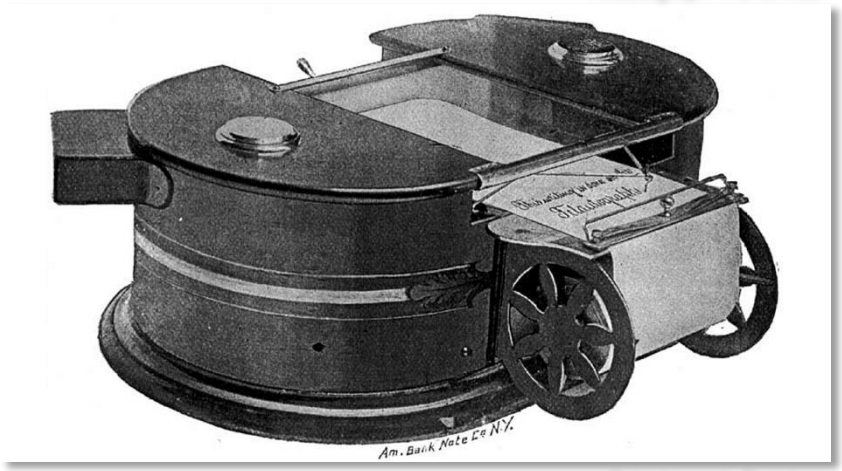
Telautograph [http://www.ndl.go.jp/exposition/e/data/L/399l.html]

Telautograph ...





Telautograph Transmitter

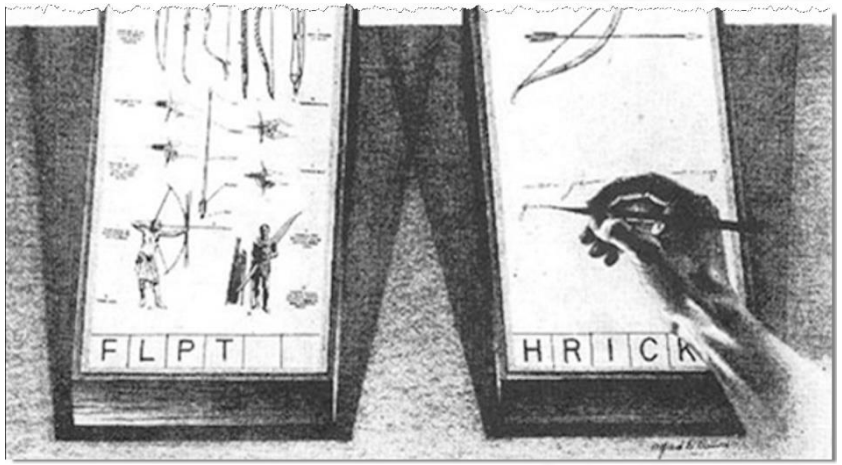


Telautograph Receiver

Memex

- Vannevar Bush's article *'As We May Think'* (1945) introduces the *Memex* (*mem*ory *ex*tender)
- Store and access information on microfilms
  - create and follow cross-references in the form of *associative trails*
  - *pen-based creation* and *annotation* of content

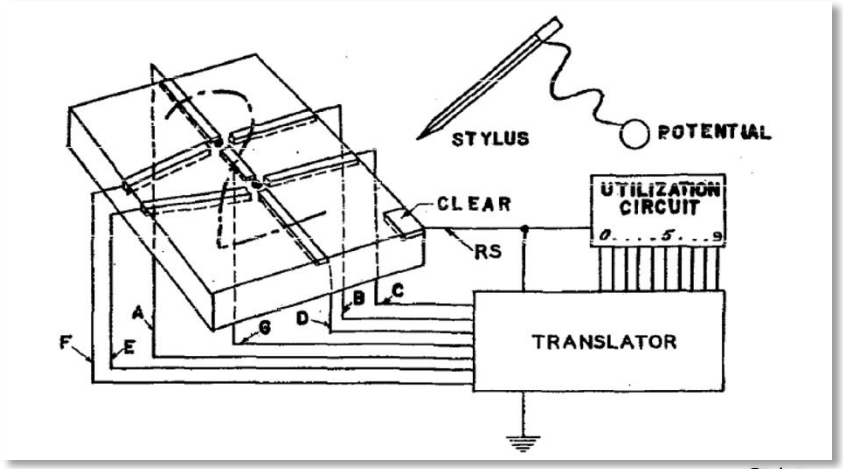
Memex, Vannevar Bush, 1945



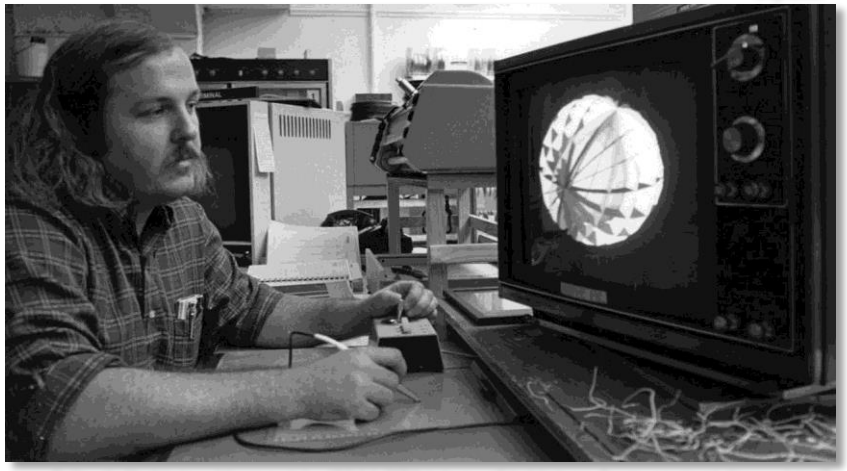
Pen-based Memex interaction

Stylator and RAND Tablet

- Stylator (stylus translater) was the first computer with pen-based input
  - demonstarted by Tom Dimond in 1957
  - *handwriting recognition*
- Another early pen-operated computing device was the RAND Tablet in 1961



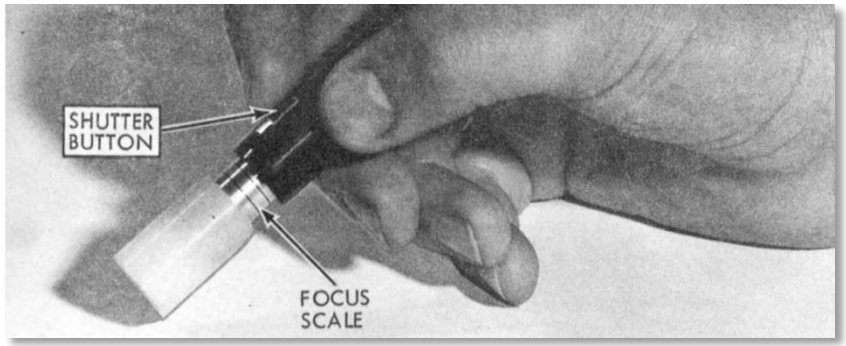
Stylator



[http://alltabletpc.blogspot.be/2011/07/history-of-tablet-pc-from-ancient-times.html]

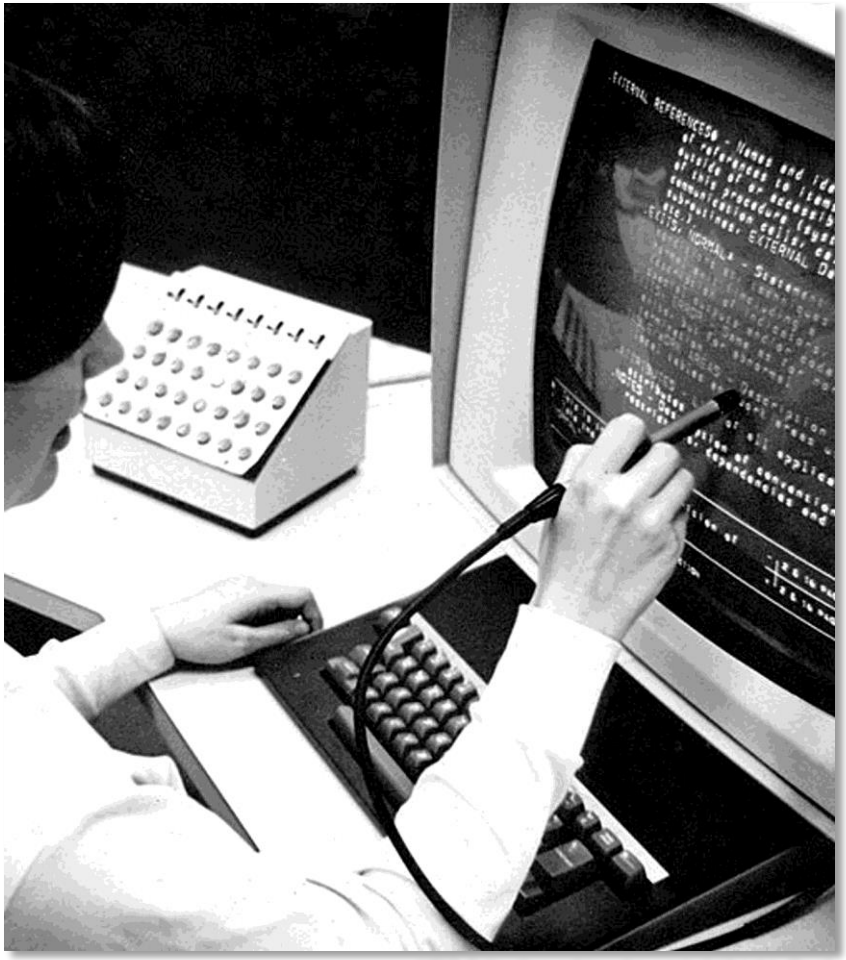
Sketchpad (1963)

- Sketchpad developed as part of Ivan Sutherland's PhD thesis at MIT
  - drawing tool
  - light pen and buttons
  - first graphical user interface
  - direct manipulation of graphical objects
  - basis for many new interface ideas



Light Pen

- Light-sensitive pen input device for cathode ray tube (CRT) screens
  - creates a signal each time the screen's electron beam passes the position of the pen
- Disadvantages
  - not very accurate due to rounding errors and noise
  - entire screen image has to be rather bright



HES [http://en.wikipedia.org/wiki/Light_Pen]

Graphics Tablet

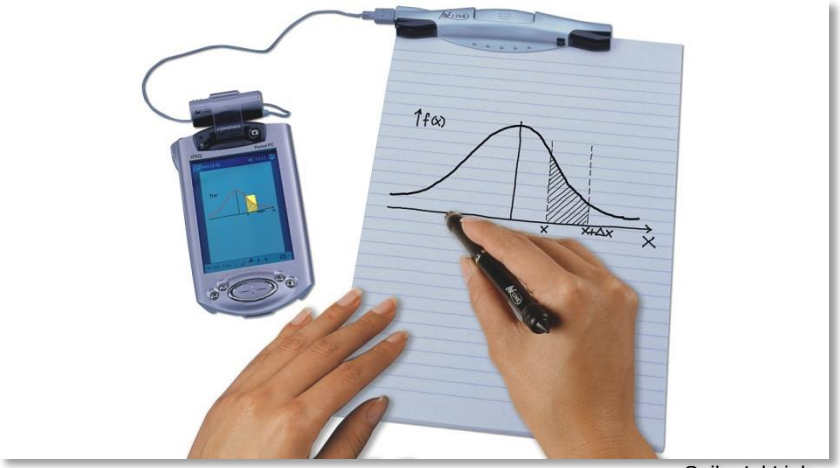
- Digitises hand-drawn sketches
- Passive tablets
  - pen powered by the tablet (electromagnetic induction)
- Active tablets
  - pen has its own battery
- In addition to the *electromagnetic tracking* there exist other solutions
  - accoustic tracking
  - optical tracking

Wacom Bamboo

Wacom Cintiq

Ultrasonic Position Detection Pens

- Paper clip to track hand-writing on paper via ultra-sonic position detection
- Larger versions transform standard whiteboards from a simple writing medium into a powerful collabo-ration and communication tool
- *Calibration* might be an issue

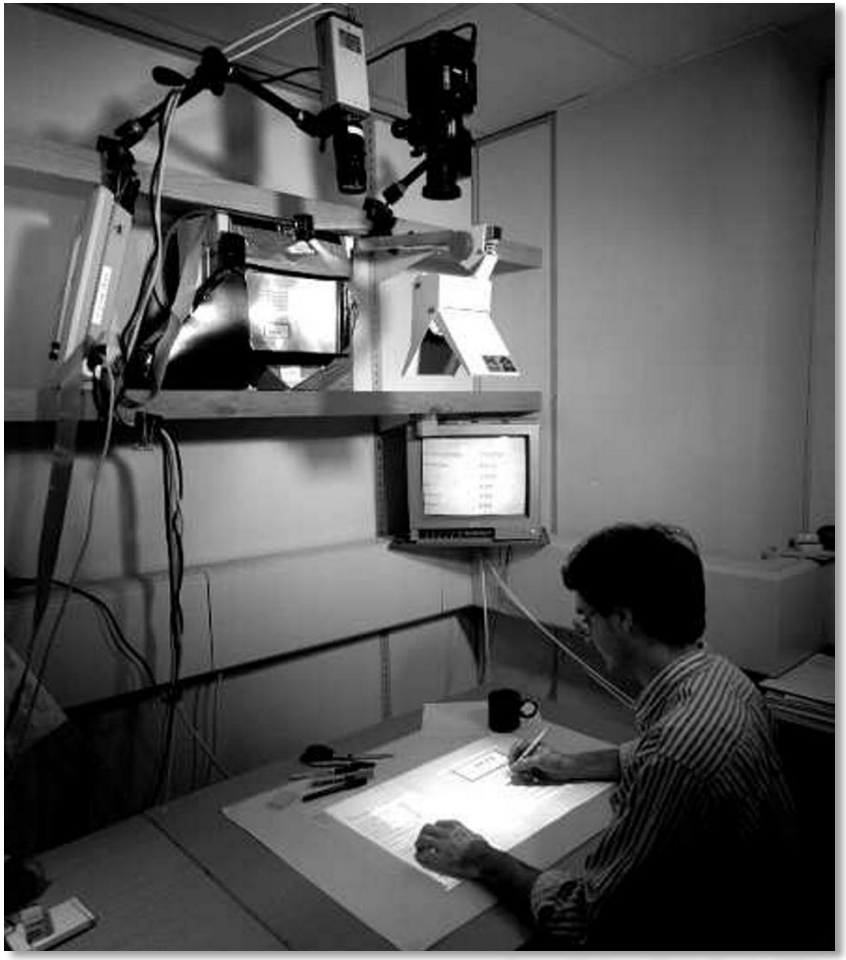


Seiko InkLink

Mimio Xi

DigitalDesk

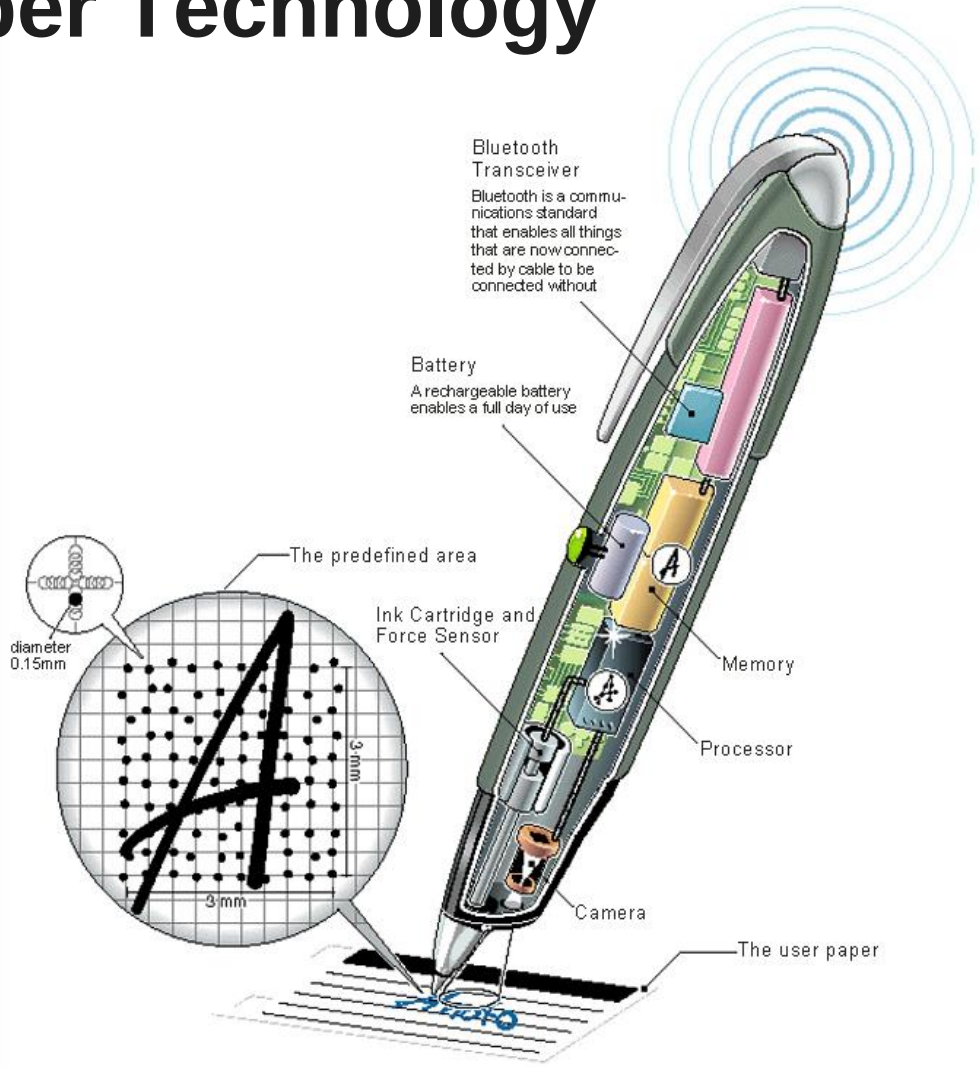
- DigitalDesk developed by Pierre Wellner at Xerox EuroPARC
  - camera-based tracking and projection
- *"Instead of making the workstation more like a desk, make the desk more like a workstation"*
- Many follow-up augmented desk projects
- What about *mobility*?



Pierre Wellner, DigitalDesk, 1991

Digital Pen and Paper Technology

- *Anoto* offers
  - camera technology
  - pattern license (virtual paper space of 60 million km^2)
- Pen manufacturers
  - Nokia
  - Maxell
  - Adapx
  - Livescribe
  - …



Digital Pens

Nokia SU-1B

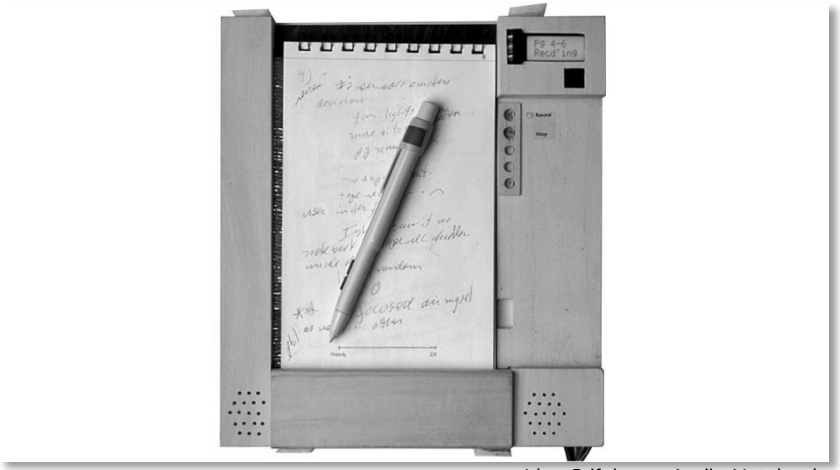
Magicomm G303

FLY Fusion
Pentop Computer

Livescribe Echo
Smartpen

Notetaking

- Audio Notebook by Lisa Stifelman (1996)
  - records audio and synchronises it with the handwriting
  - uses graphics tablet for pen tracking
- Livescribe Echo Pen (2010)
  - records audio on the pen and synchronises it with the handwriting
  - uses Anoto pattern for the pen tracking

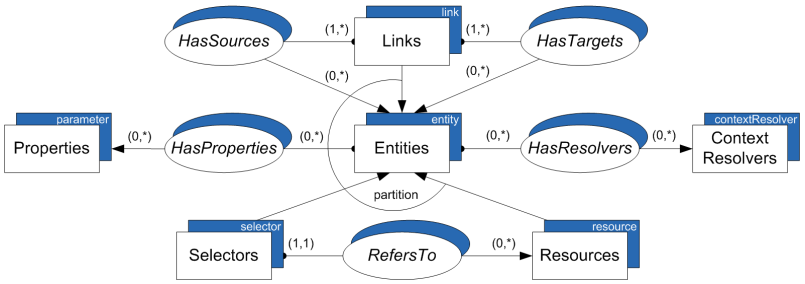


Lisa Stifelman, Audio Notebook

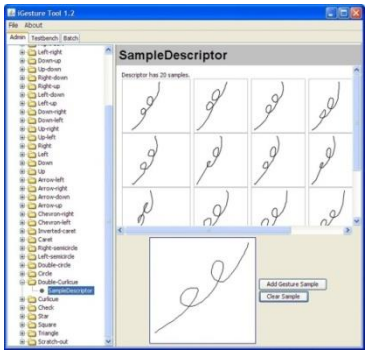
Livescribe Echo Pen

iPaper Research

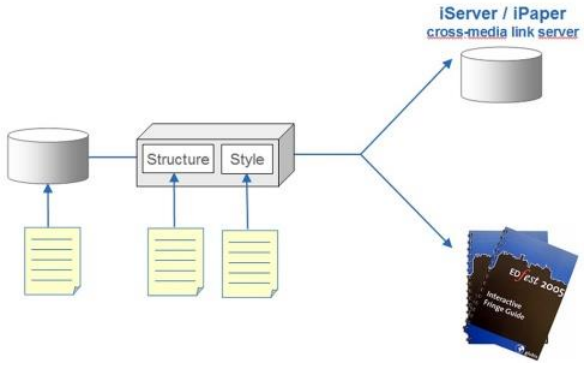
Link Metamodel (RSL)



Tools

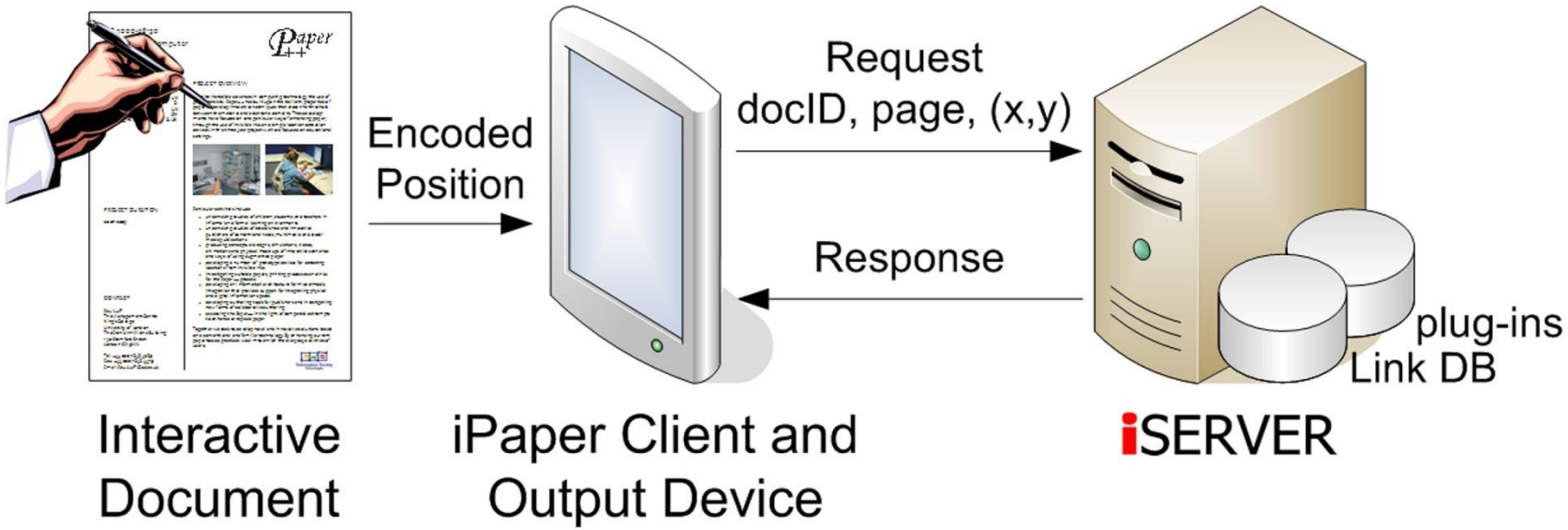


Cross-Media Server / Publishing

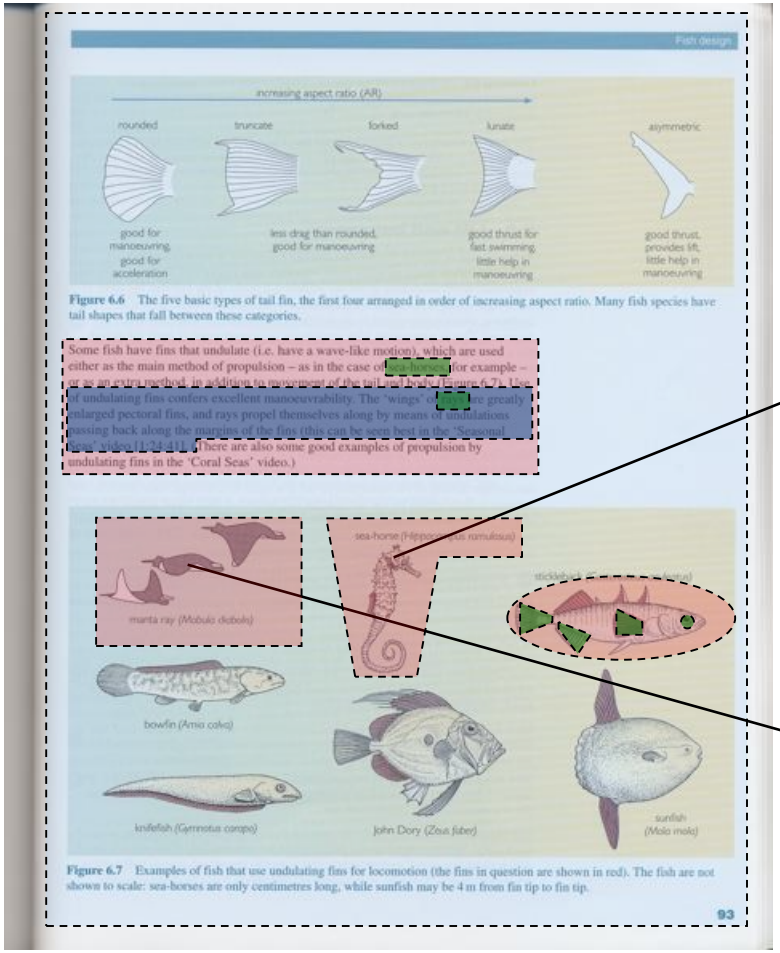


Applications

Cross-Media Server (iServer)



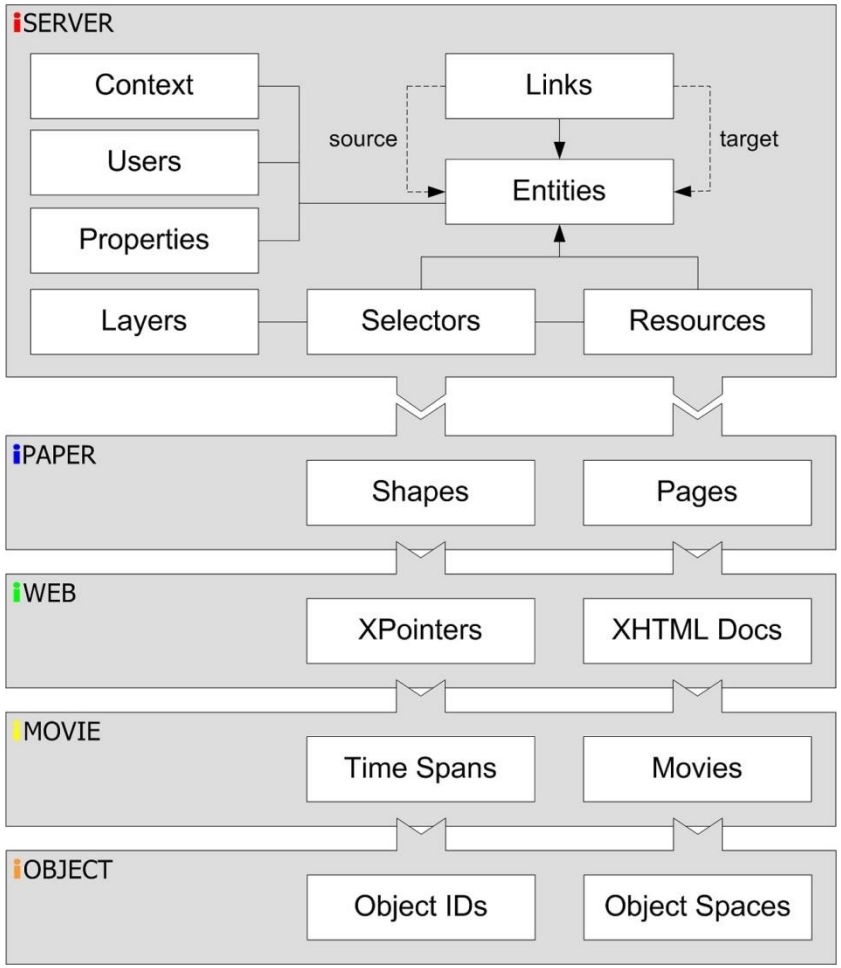
Active Page Areas and Layers

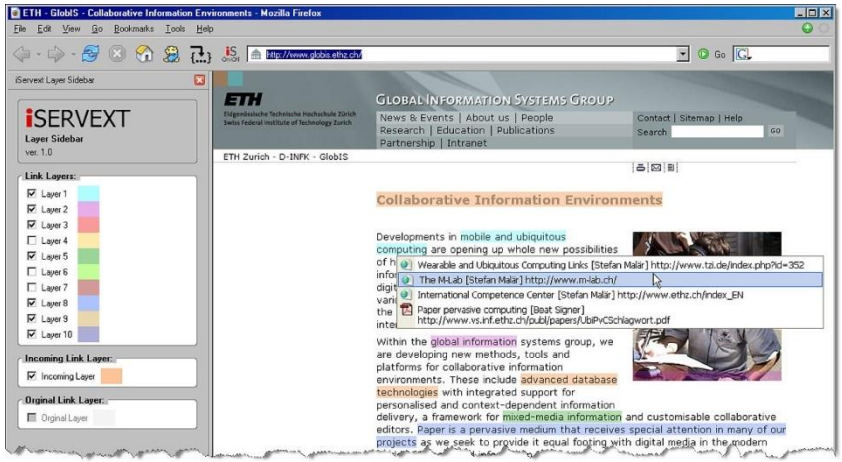


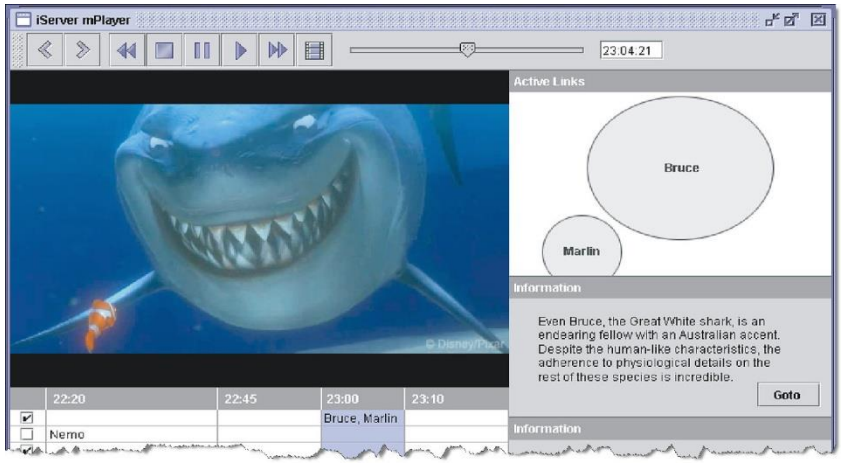
image

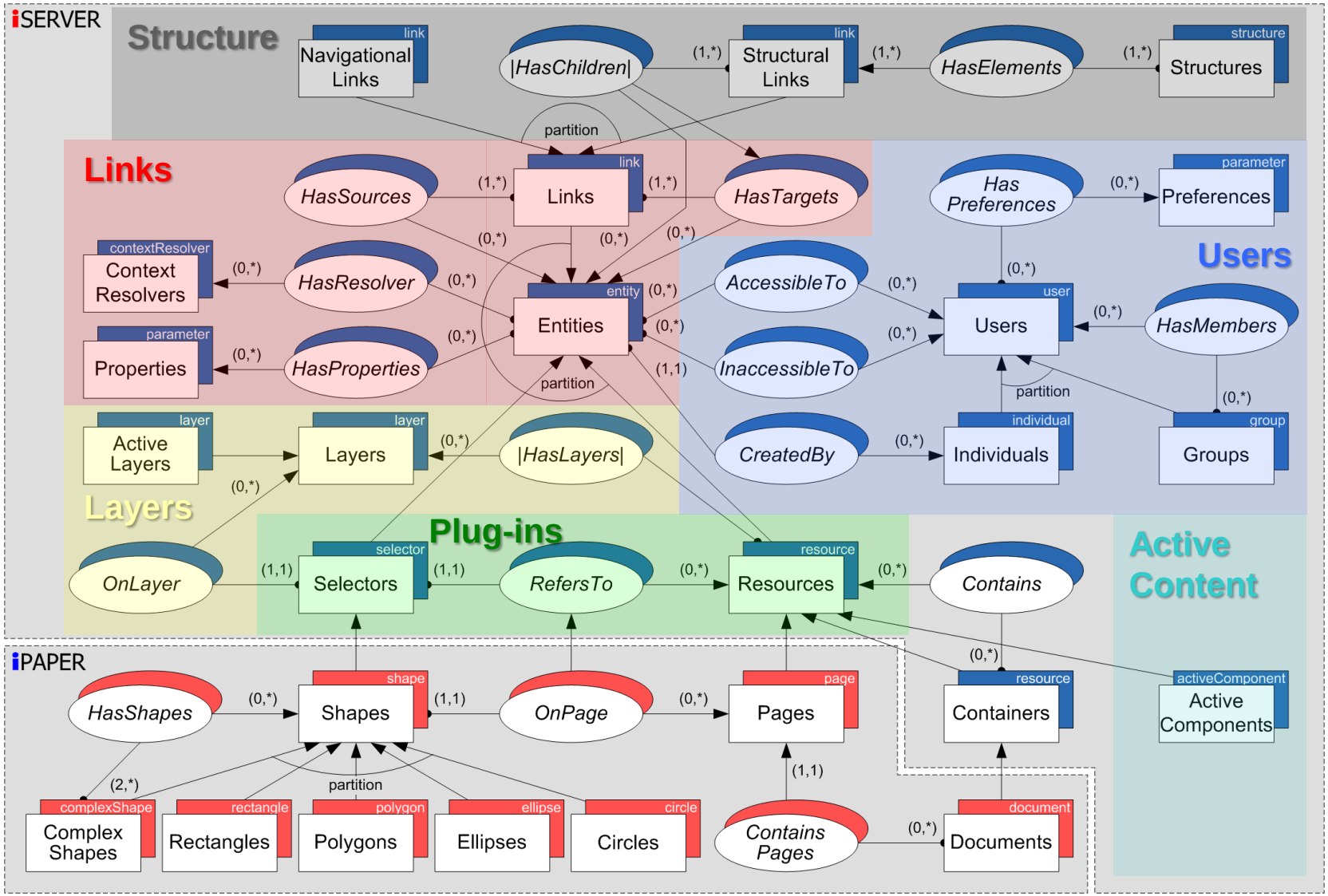
video clip

RSL Metamodel and iServer

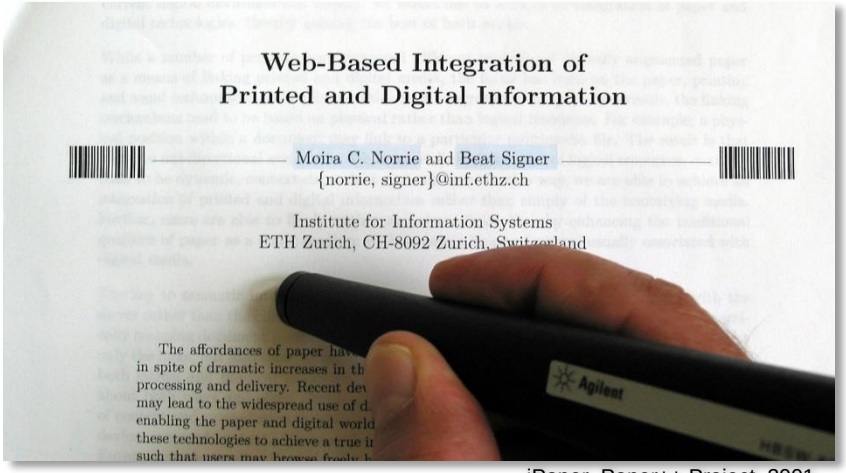




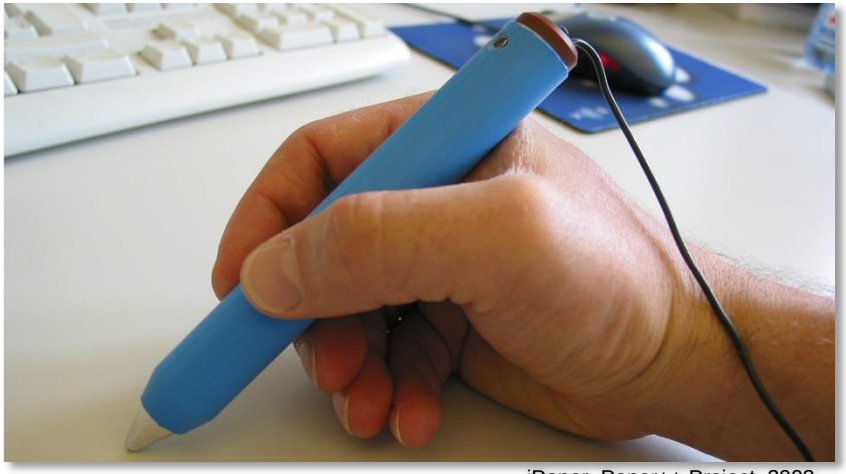



iSERVER
Structure
link
Navigational Links
|HasChildren|
(1,*)
link
Structural Links
(1,*)
HasElements
(1,*)
structure
Structures
partition
Links
link
Links
HasSources
(1,*)
(1,*)
HasTargets
(0,*)
(0,*)
(0,*)
contextResolver
Context Resolvers
(0,*)
HasResolver
(0,*)
entity
Entities
(0,*)
parameter
Properties
(0,*)
HasProperties
(0,*)
(0,*)
partition
(1,1)
Has Preferences
(0,*)
parameter
Preferences
Users
AccessibleTo
(0,*)
user
Users
(0,*)
HasMembers
(0,*)
InaccessibleTo
(0,*)
(0,*)
partition
(0,*)
layer
Active Layers
layer
Layers
(0,*)
|HasLayers|
(0,*)
CreatedBy
(0,*)
individual
Individuals
group
Groups
Layers
Plug-ins
Active Content
OnLayer
(0,*)
(1,1)
selector
Selectors
(1,1)
RefersTo
(0,*)
resource
Resources
(0,*)
Contains
(0,*)
iPAPER
HasShapes
(0,*)
shape
Shapes
(1,1)
OnPage
(0,*)
page
Pages
resource
Containers
activeComponent
Active Components
(2,*)
partition
complexShape
Complex Shapes
rectangle
Rectangles
polygon
Polygons
ellipse
Ellipses
circle
Circles
(1,1)
Contains Pages
(0,*)
document
Documents

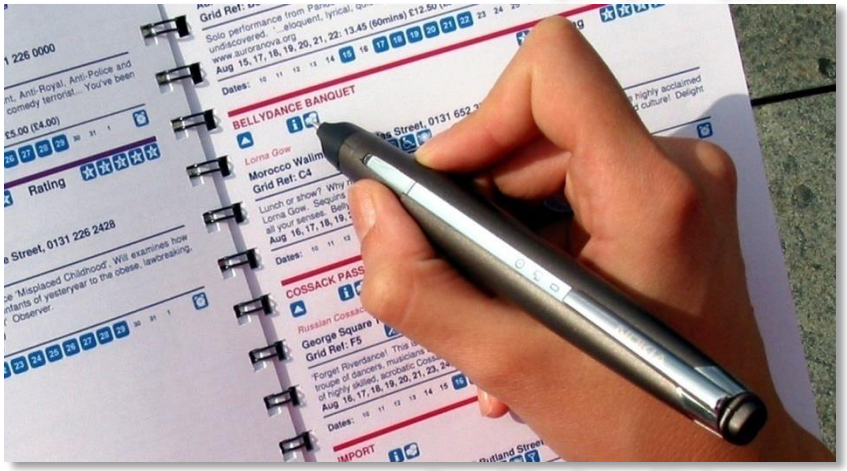
Input Device Independence



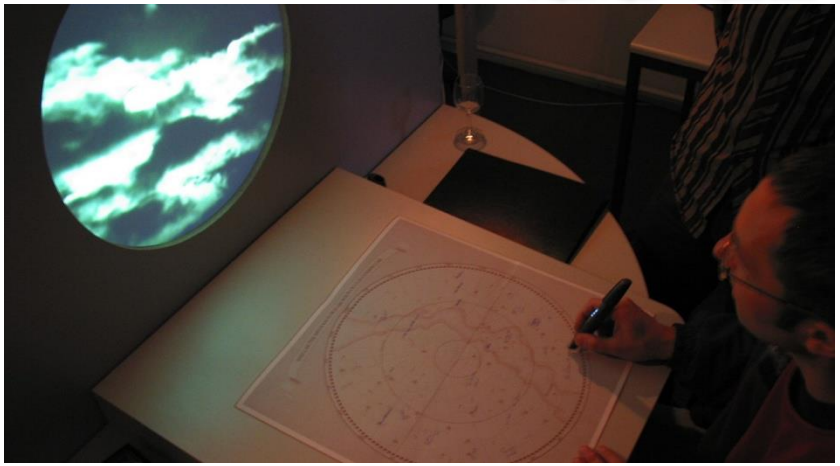
iPaper, Paper++ Project, 2001



iPaper, Paper++ Project, 2003



iPaper, EdFest Project, ETH Zurich, 2005



iPaper, The Lost Cosmonaut Project, ETH Zurich, 2004

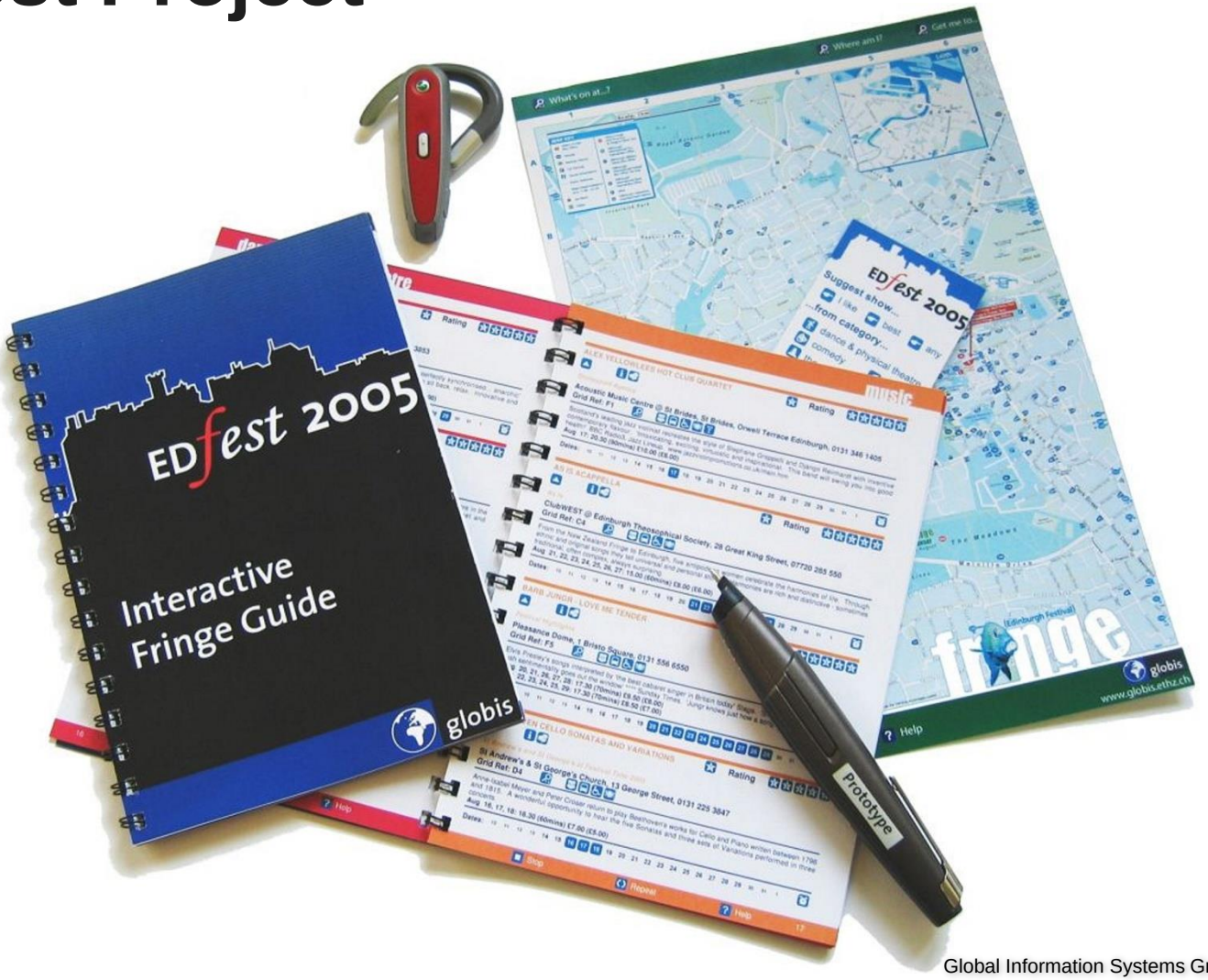
Digital Pen and Paper Applications

- **Enhanced Reading**
  - interactive paper maps
  - interactive festival brochures
  - educational materials
  - auction brochures
  - scientific publications
  - …
- **Paper-based Interfaces**
  - PaperPoint
  - document proof-editing
  - digital libraries
  - video analysis tool
  - educational games
- **Enhanced Writing**
  - photo album
  - researcher's notebook
  - mammography annotation
  - query by sketching
  - …
- **Art Installations**
  - Lost Cosmonaut
  - Generosa Enterprise
- **Interactive Tabletops**
  - photo browser
  - collaborative sketch tool

PaperPoint Presentation Tool

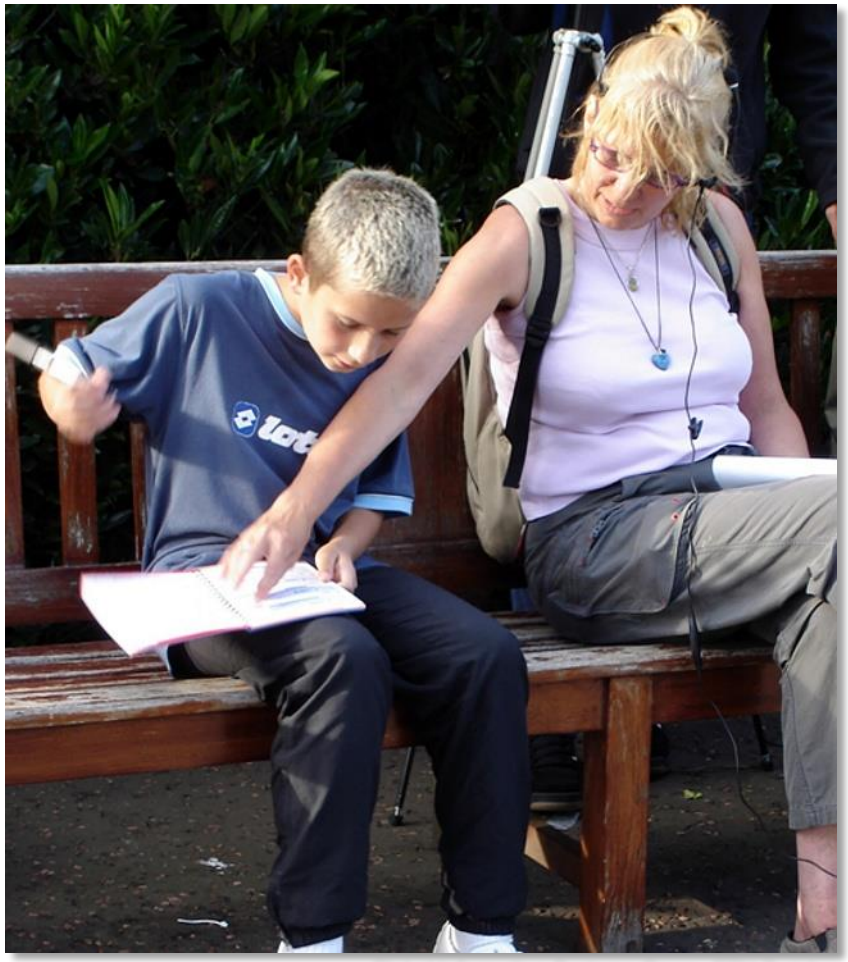
- Mobile PowerPoint presen-tation tool
  - *non-linear* presentations
  - real-time annotations
  - digital whiteboard
  - ...
- Multi-pen support
  - brainstorming

EdFest Project



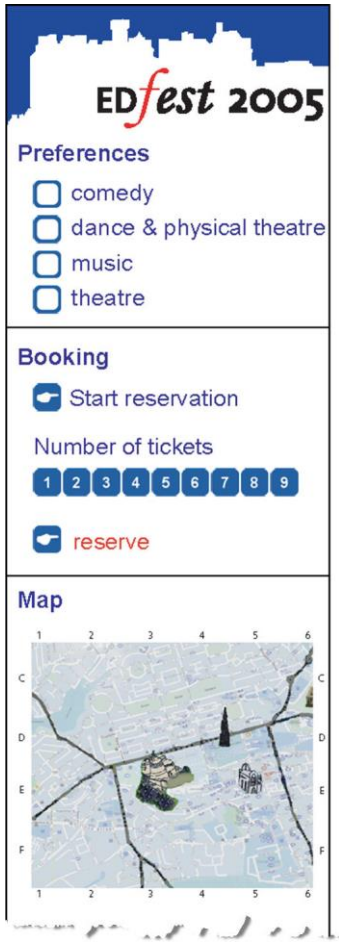
Global Information Systems Group, ETH Zurich

EdFest User Trials



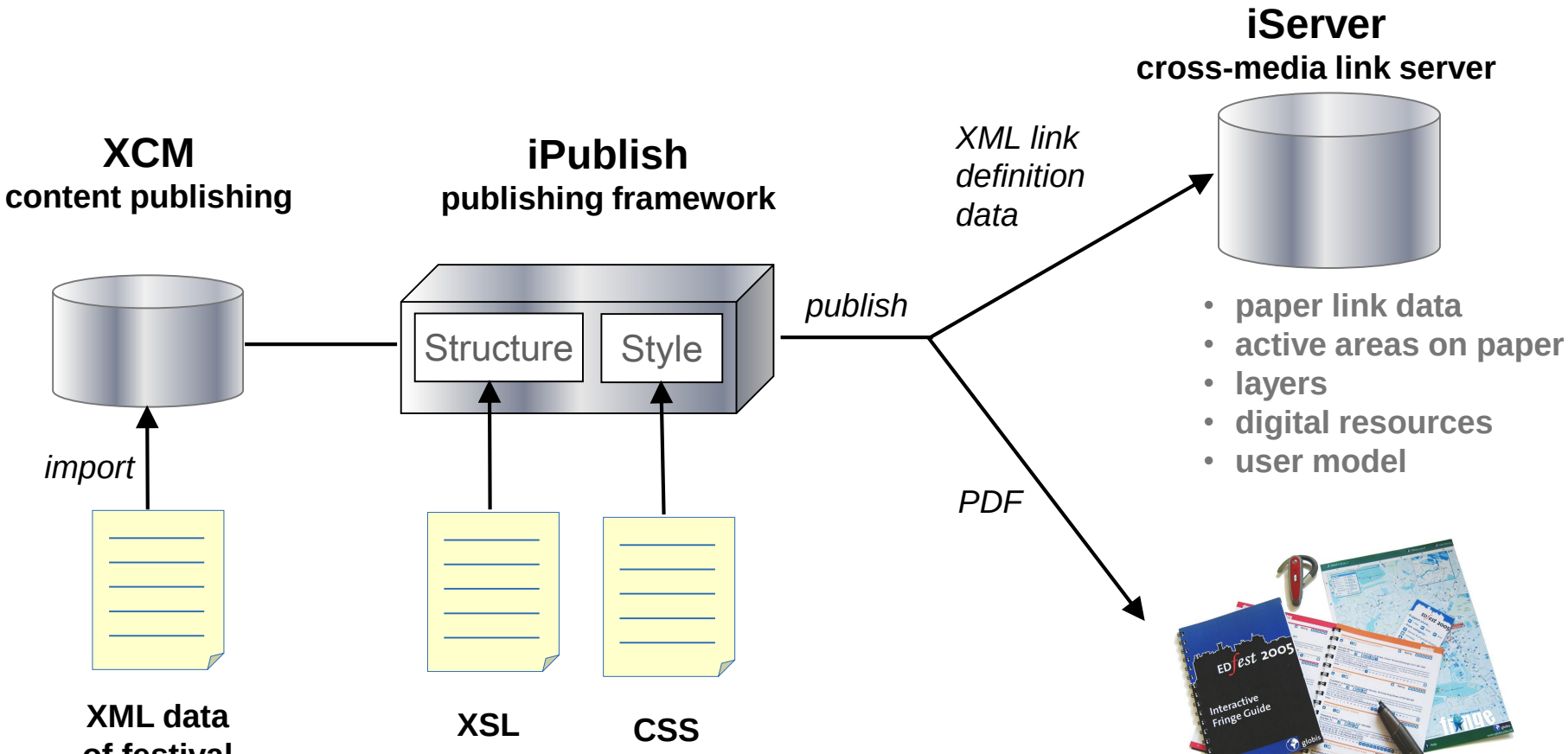
Global Information Systems Group, ETH Zurich

EdFest Documents

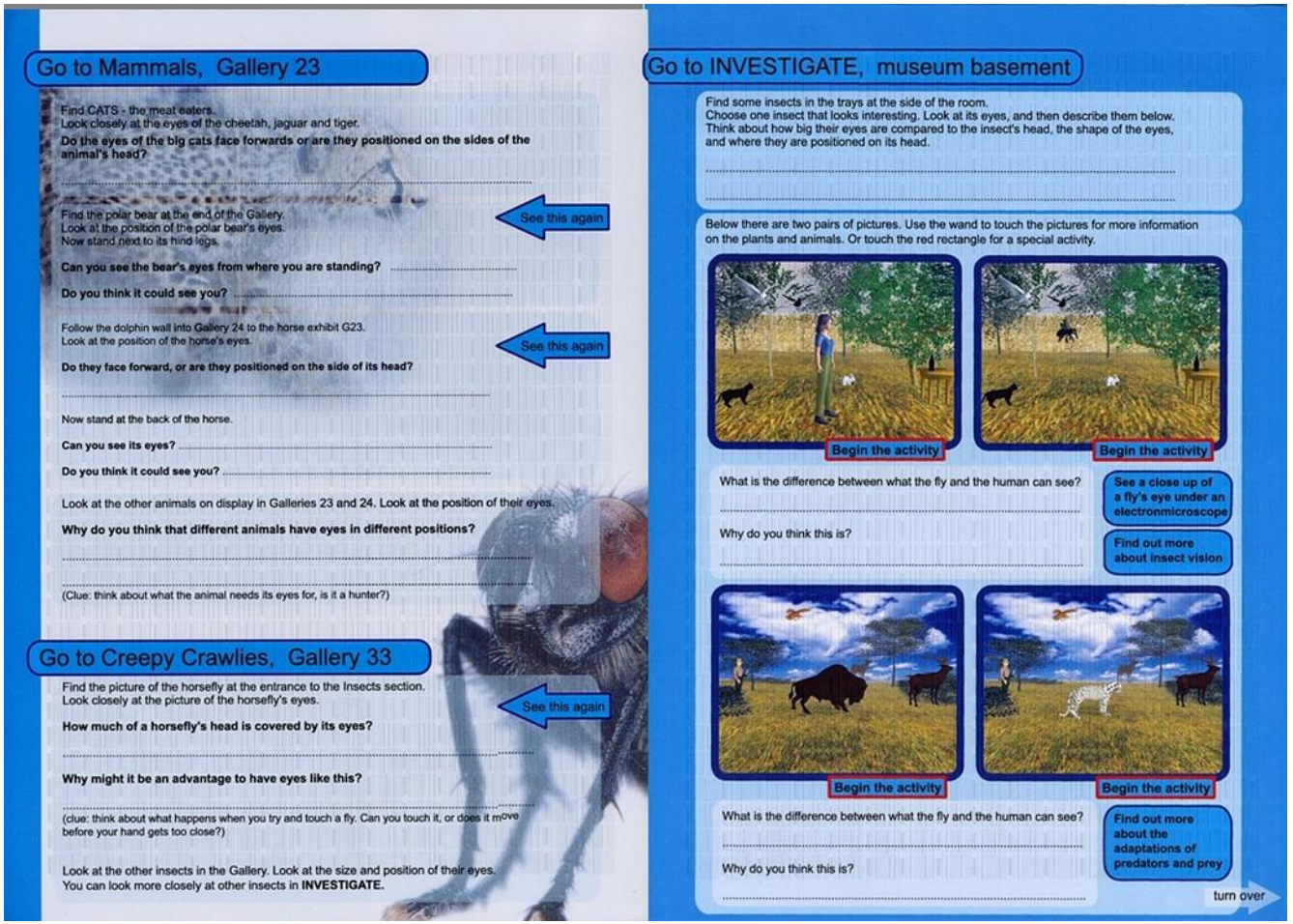


Global Information Systems Group, ETH Zurich

Cross-Media Publishing Framework



Natural History Museum, London



Go to Mammals, Gallery 23

Find CATS - the meat eaters.
Look closely at the eyes of the cheetah, jaguar and tiger.
Do the eyes of the big cats face forwards or are they positioned on the sides of the animal's head?

Find the polar bear at the end of the Gallery.
Look at the position of the polar bear's eyes.
Now stand next to its hind legs.
See this again
Can you see the bear's eyes from where you are standing?
Do you think it could see you?

Follow the dolphin wall into Gallery 24 to the horse exhibit G23.
Look at the position of the horse's eyes.
See this again
Do they face forward, or are they positioned on the side of its head?

Now stand at the back of the horse.
Can you see its eyes?
Do you think it could see you?

Look at the other animals on display in Galleries 23 and 24. Look at the position of their eyes.
Why do you think that different animals have eyes in different positions?
(Clue: think about what the animal needs its eyes for, is it a hunter?)

Go to Creepy Crawlies, Gallery 33

Find the picture of the horsefly at the entrance to the Insects section.
Look closely at the picture of the horsefly's eyes.
See this again
How much of a horsefly's head is covered by its eyes?
Why might it be an advantage to have eyes like this?
(clue: think about what happens when you try and touch a fly. Can you touch it, or does it move before your hand gets too close?)

Look at the other insects in the Gallery. Look at the size and position of their eyes.
You can look more closely at other insects in **INVESTIGATE.**

Go to INVESTIGATE, museum basement

Find some insects in the trays at the side of the room.
Choose one insect that looks interesting. Look at its eyes, and then describe them below.
Think about how big their eyes are compared to the insect's head, the shape of the eyes, and where they are positioned on its head.

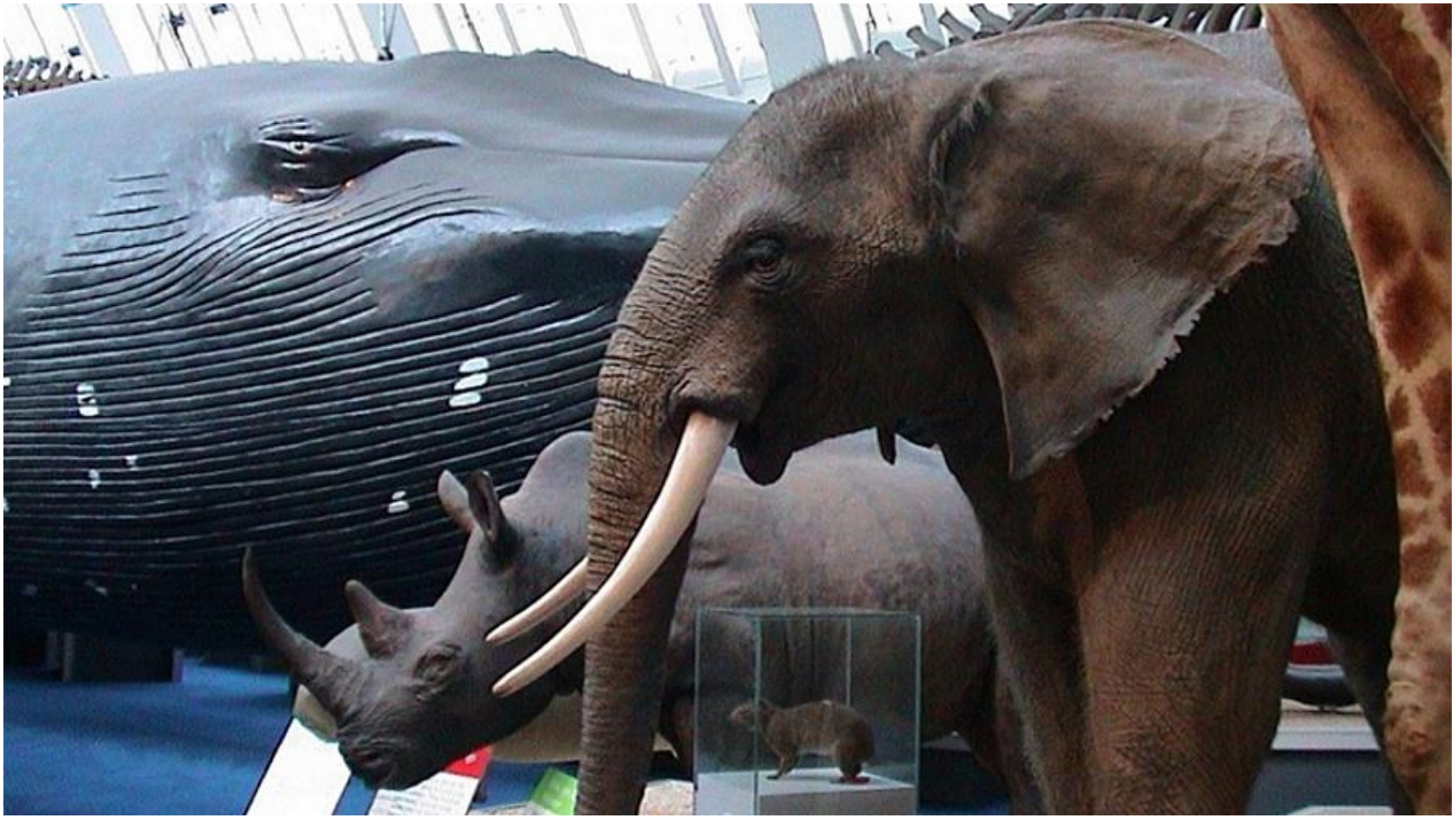
Below there are two pairs of pictures. Use the wand to touch the pictures for more information on the plants and animals. Or touch the red rectangle for a special activity.

Begin the activity
Begin the activity
What is the difference between what the fly and the human can see?
Why do you think this is?
See a close up of a fly's eye under an electronmicroscope
Find out more about insect vision

Begin the activity
Begin the activity
What is the difference between what the fly and the human can see?
Why do you think this is?
Find out more about the adaptations of predators and prey
turn over

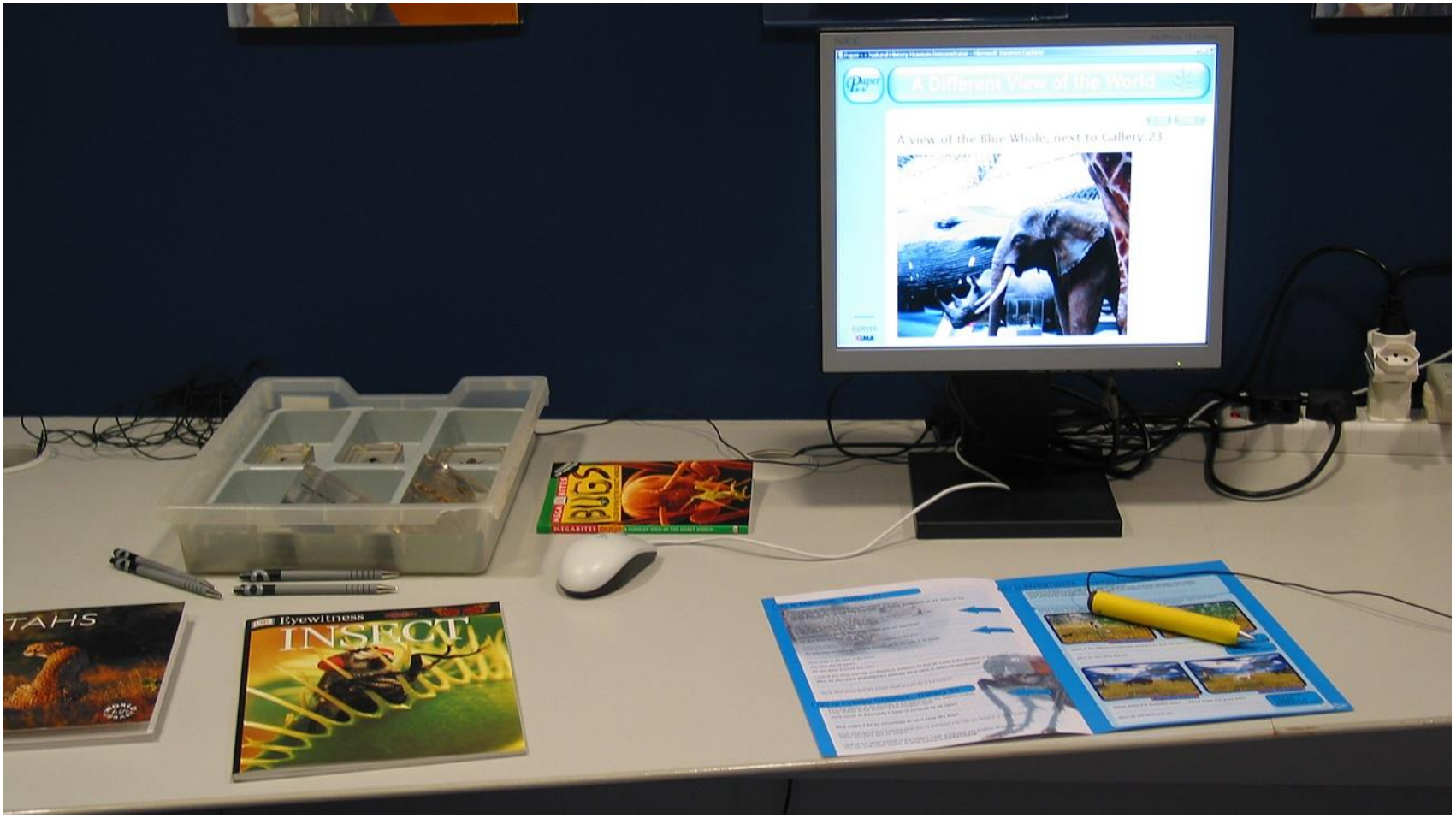
Paper++ Project

Natural History Museum, London ...



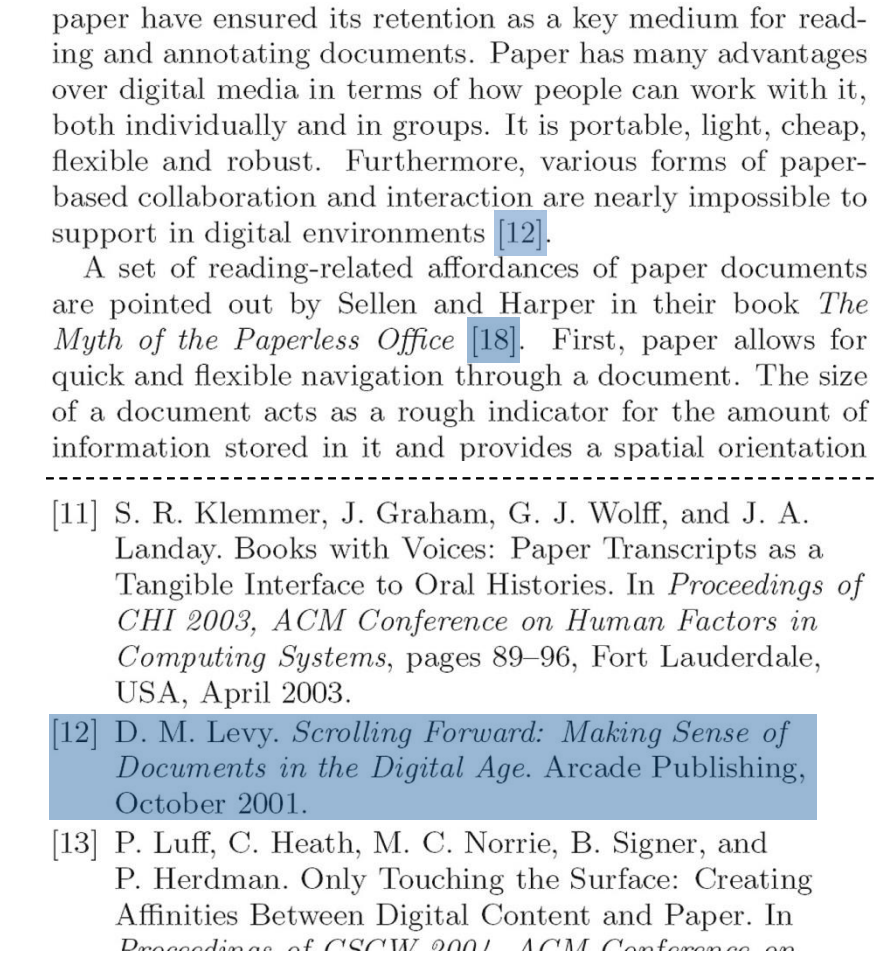
Natural History Museum, London ...

Natural History Museum, London ...



Print-n-Link

- Handle *existing* PDF documents
  - e.g. research papers
- *Automatic* link authoring at print time
  - applicable to other domains



paper have ensured its retention as a key medium for reading and annotating documents. Paper has many advantages over digital media in terms of how people can work with it, both individually and in groups. It is portable, light, cheap, flexible and robust. Furthermore, various forms of paper-based collaboration and interaction are nearly impossible to support in digital environments [12].

A set of reading-related affordances of paper documents are pointed out by Sellen and Harper in their book *The Myth of the Paperless Office* [18]. First, paper allows for quick and flexible navigation through a document. The size of a document acts as a rough indicator for the amount of information stored in it and provides a spatial orientation

---

[11] S. R. Klemmer, J. Graham, G. J. Wolff, and J. A. Landay. Books with Voices: Paper Transcripts as a Tangible Interface to Oral Histories. In *Proceedings of CHI 2003, ACM Conference on Human Factors in Computing Systems*, pages 89–96, Fort Lauderdale, USA, April 2003.

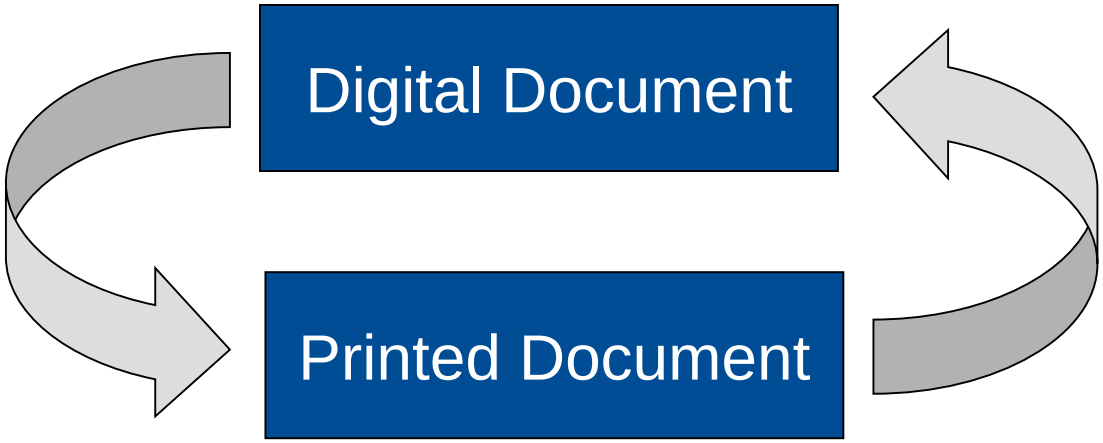
[12] D. M. Levy. *Scrolling Forward: Making Sense of Documents in the Digital Age*. Arcade Publishing, October 2001.

[13] P. Luff, C. Heath, M. C. Norrie, B. Signer, and P. Herdman. Only Touching the Surface: Creating Affinities Between Digital Content and Paper. In *Proceedings of CSCW 2004, ACM Conference on*

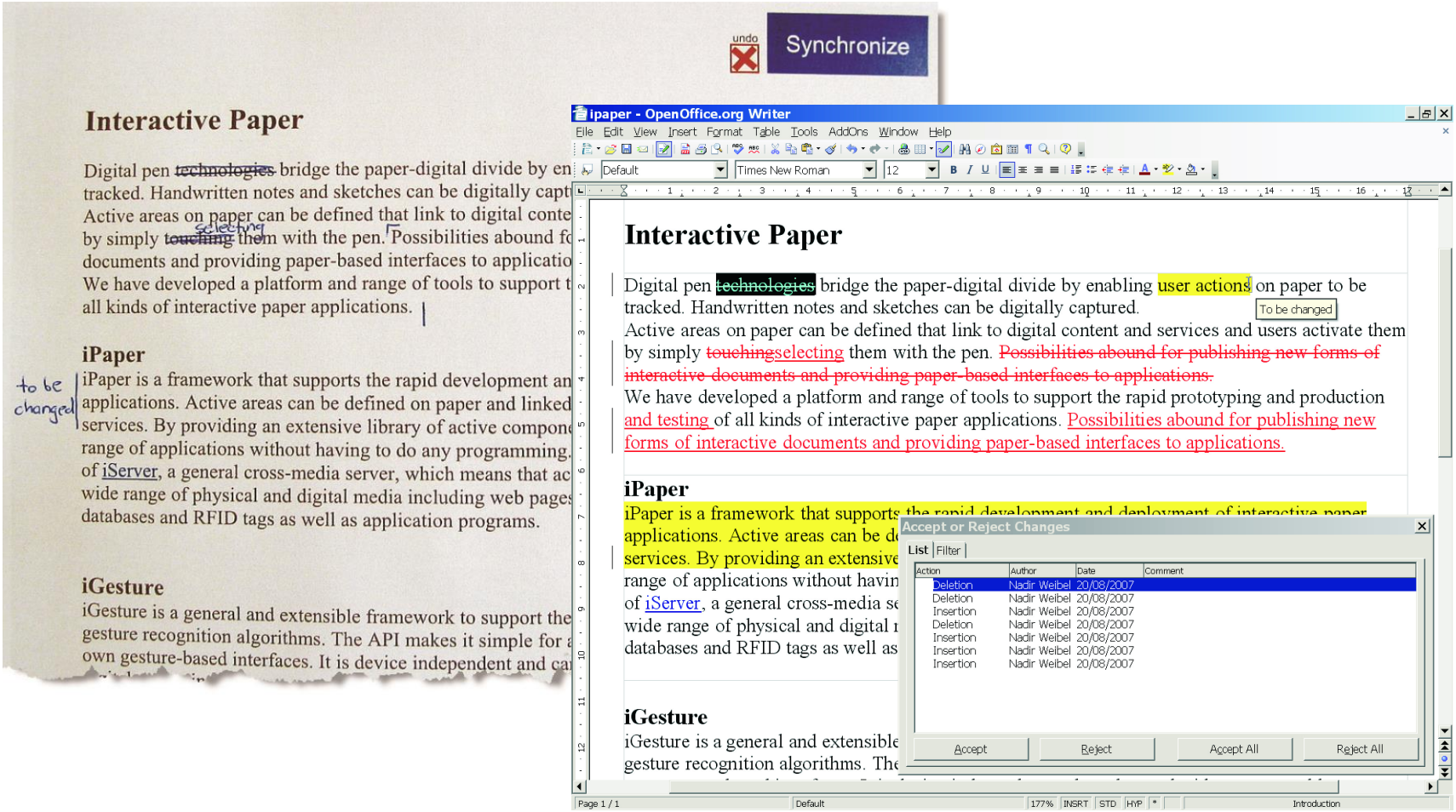
Global Information Systems Group, ETH Zurich

Document Authoring and Editing

- Digital pen and paper-based user interface
- Support for collaborative editing
- *Multiple* digital/physical *editing iteration cycles*
  - *seamless transition* between paper and digital information

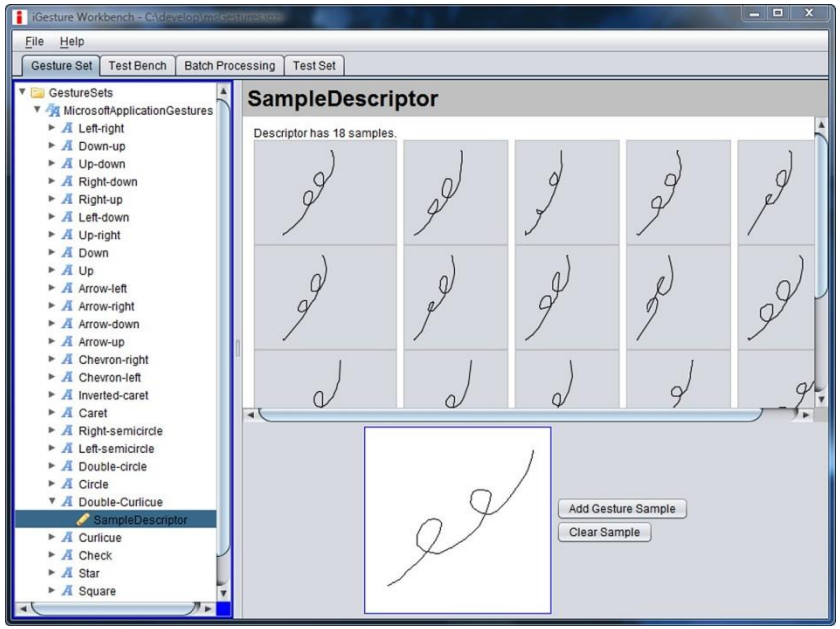


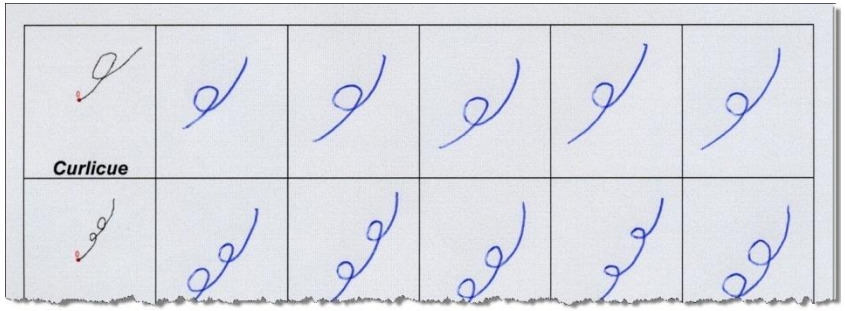
PaperProof: Paper-Digital Proof-Editing



Global Information Systems Group, ETH Zurich

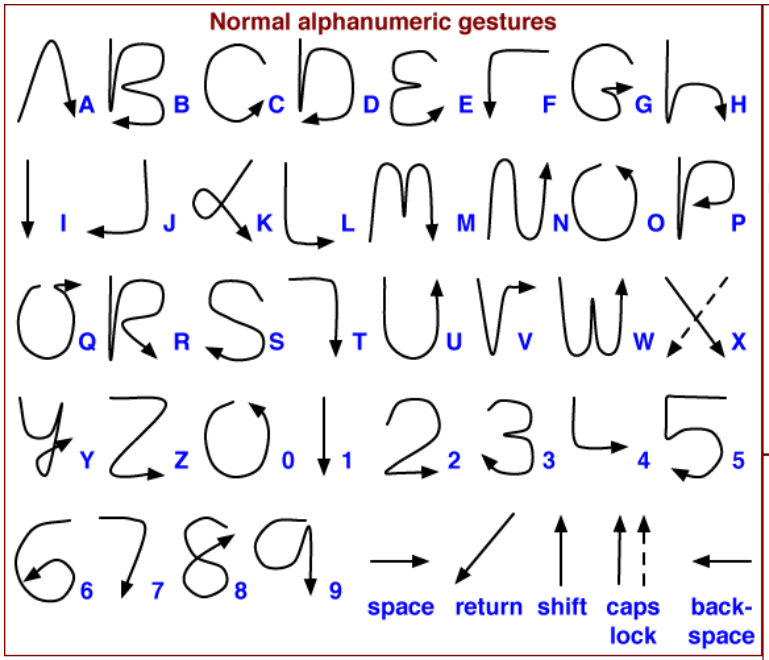
iGesture Framework

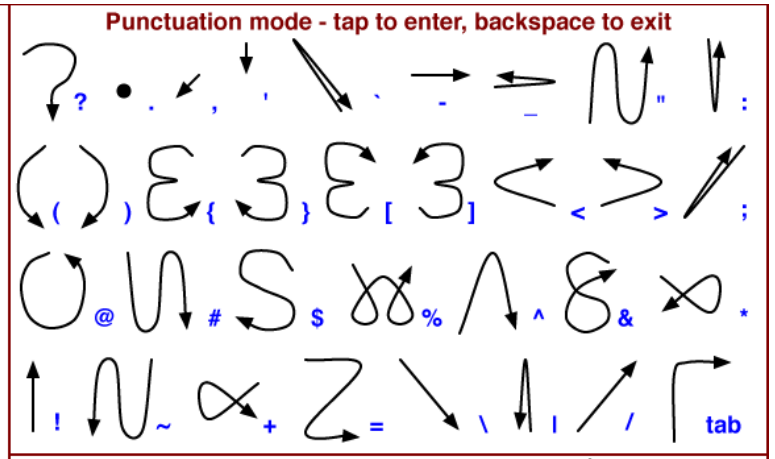


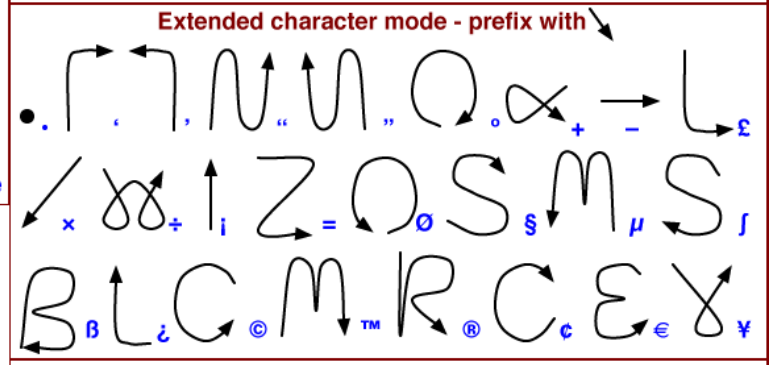


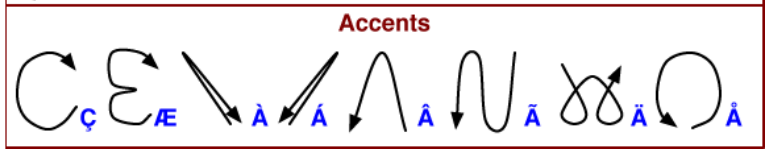
- iGesture Workbench
  - create/test gesture sets and algorithms
- Different modalities
  - digital pen, tablet PC, mouse, Wii remote, …
  - multimodal gestures
- Open Source
  - http://www.igesture.org

Graffiti Gestures (Palm OS)









- Single-stroke gestures
- Have to learn new alphabet

Microsoft Application Gestures

scratch-out	erase content
 triangle	insert
 square	action item
 star	action item
 check	check-off
 curlicue	cut
 double-curlicue	copy
 circle	application-specific

 double-circle	paste
 left-semicircle	undo
 right-semicircle	redo
 caret	past/insert
 inverted-caret	insert
 chevron-left	application-specific
 chevron-right	application-specific
 arrow-up	application-specific

Gesture Design Guidelines

- Different gestures should not look too similar
  - better recognition results
- Gestures should be user friendly
  - intuitivity and usability
- Reasonable size of gesture set
- Reuse of gestures
  - same semantics for different applications
  - application-specific gestures

Digital Ink Processing

- Parse proprietary pen formats
  - position, timestamp, force, tilt, …
- Stroke detection
  - pen up and pen down events
  - time difference between succeeding points
  - distance between succeeding points, …
- Interpolation / Filtering

Ink Markup Language (InkML)

W3C

W3C Recommendation

- XML language for representing digital ink
- Pen movement data
  - <trace> and <traceFormat> elements
  - x,y coordinates, force, angles
- Device-specific information
  - resolution, sample rate, …

Ink Markup Language (InkML) …

W3C Recommendation

```
<ink>
 <trace>10 0, 9 14, 8 28, 7 42, 6 56, 6 70, 8 84, 8 98,
  8 112, 9 126, 10 140, 13 154, 14 168, 17 182, 18 188
 </trace>
 <trace>130 155, 144 159, 158 160, 170 154, 179 143,
  179 129, 166 125, 152 128, 140 136, 131 149, 126 163
 </trace>
 ...
 <inkSource manufacturer="magicomm" model="G303">
  <sampleRate uniform="true" value="70"/>
  <srcProperty name="weight" value="100" units="g"/>
 </inkSource>
 ...
</ink>
```

Rough Guide

9

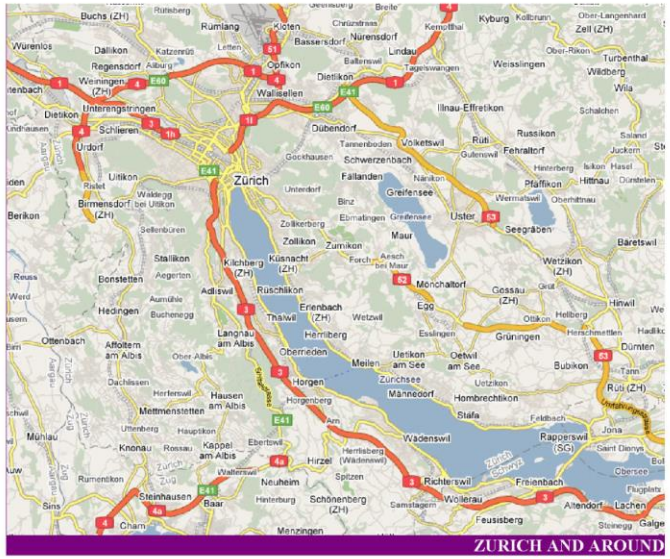
Zürich

Zürich's relationship to the world is not of the spirit, but of commerce.

C.G. Jung

Not so long ago, **ZÜRICH** was famed chiefly for being the cleanest, most icily efficient city in Europe. Apocryphal stories abound from the 1970s of the calm and order of the midweek lunch hour in the financial district, of tourists embarking on efforts to find a cigarette butt or an empty crisp packet discarded on the streets – and drawing a blank every time. Things have changed. If you live in a big city yourself and are tiring of Switzerland's picture-perfect country towns, visiting Zürich will be like coming home: finally you can walk on crowded, multi-ethnic streets, buy a kebab, get a drink after midnight, feel a lived-in urban buzz.

Zürich is still best known for a phrase coined as a response to the city's collective sense of superiority. After World War II, Zürich's foreign exchange speculators had become so powerful and secretive that irritated British ministers, amidst the 1964 sterling crisis, spoke of them as gnomes, scurrying about in the corridors and vaults of the private banks manipulating the outside world and forever counting their gold. Their reference to **"the gnomes of Zürich"** stuck, and journalists reporting on Switzerland's often-murky banking and finance industries still reach for the phrase today. Aptly, Zürich now hosts the world's most important market for trading **gold** and precious metals, and boasts the fourth-largest stock market, after New York, London and Tokyo. Exceptional affluence tends to define the area these days and yet, despite its wealth and status as Switzerland's biggest city (population 360,000), Zürich is not a flashy place at all. The ghost of the bible-thumping Reformer Huldrych Zwingli still stands at the shoulder of the bankers, industrialists and business people who live and breathe the city's ingrained Protestant



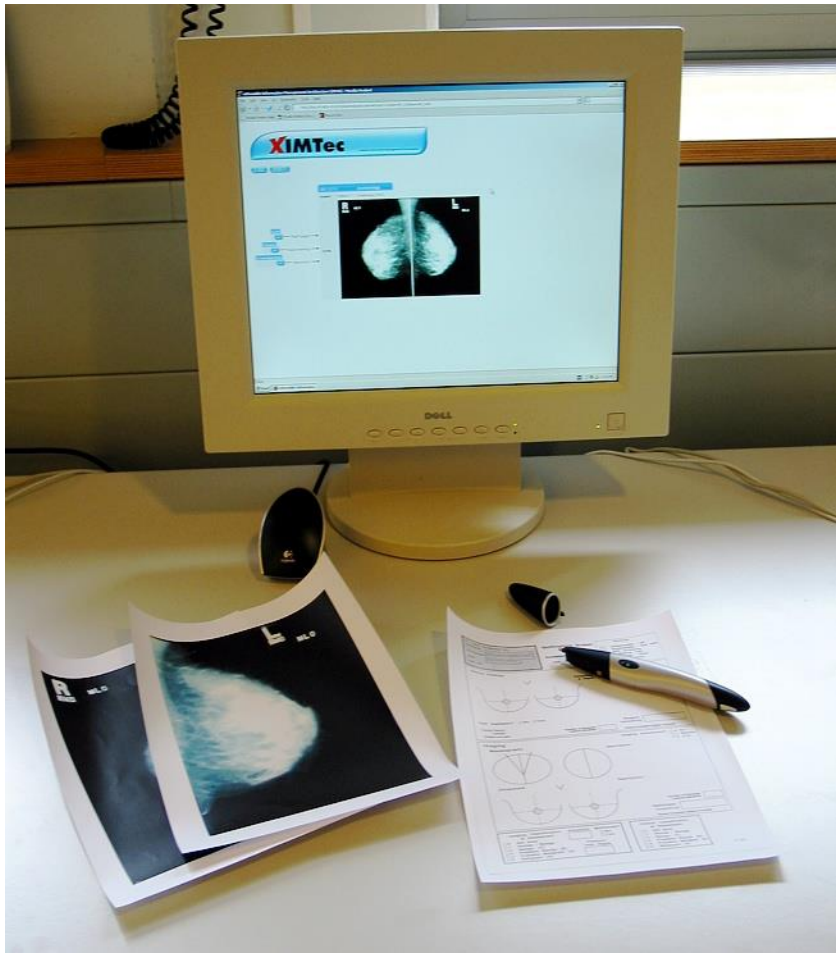
clubs. The medieval **Old Town**, characterized by the steep, cobbled alleys and attractive, small-scale architecture of the **Niederdorf** district, comprises a substantial part of the city centre and is perfect for exploratory wanderings. With a handful of medieval churches to take in, including the mighty **Grossmünster** and graceful **Fraumünster**, the superb **Kunsthaus** art gallery and the most engaging café culture in German-speaking Switzerland, you could easily spend days here.

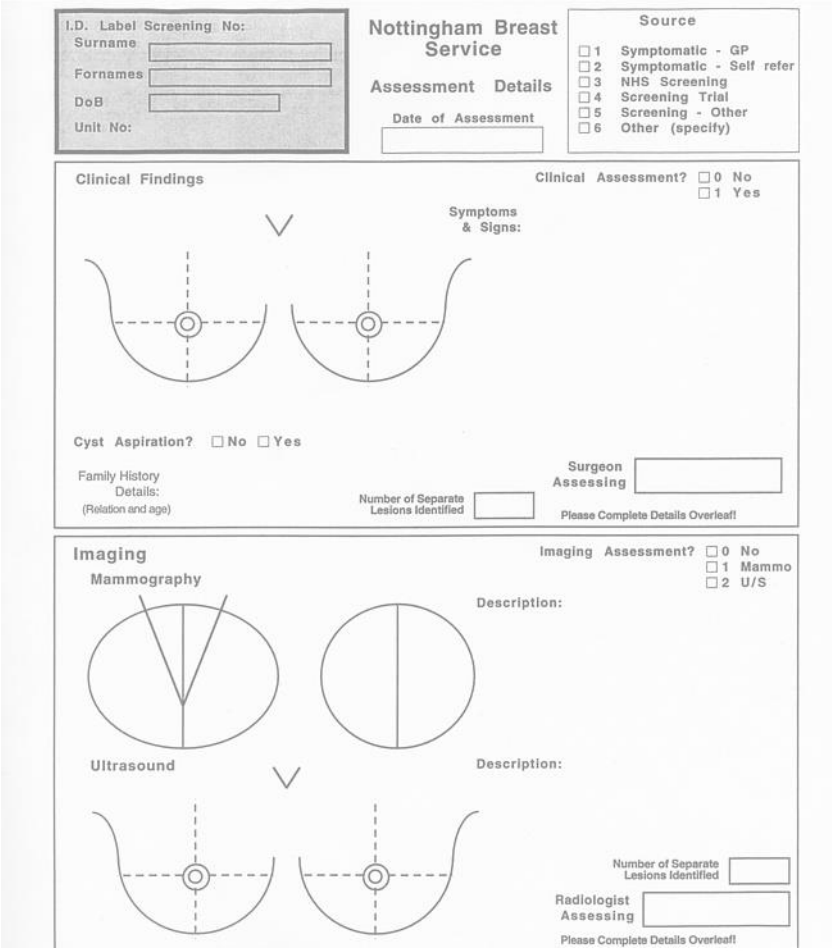
Some history

The **Romans** were the first to fortify the area, creating a customs post on the Lindenhof in the first century BC and naming it *Turicum*. The legend of the city's foundation dates from the martyrdom of **Felix and Regula**, deserters from a Roman legion based in Valais.

Global Information Systems Group, ETH Zurich

Mammography Annotations





Global Information Systems Group, ETH Zurich

DiDA Learning Material

- Diploma in Digital Applications
  - includes *Using ICT*, *Multimedia*, *Graphics* and *ICT in Enterprise*
- *"...designed to stimulate students' creativity and develop real-world, practical skills..."*
- Published by Edexcel (Pearson Education)
- Interactive DiDA book combines printed information with CD-ROM and web content

DiDA ...

5

Why use a database

More and more data is generated all the time. Organisations need to be able to store, search and sort the data to produce valid and useful information.

Case study: The Boots Advantage Card

Many high street stores offer customers some kind of loyalty card and need to store information about cardholders.

For example, Boots customers can use the Advantage Card. Every time the customer makes a purchase, the card is scanned and points are added. These points can be used at any time to buy products in the store. When the card is scanned, the till displays the current value of points on the card.

Boots has over 1400 stores and about 400 of these have an Advantage Point – this is an information point where a customer can insert the card and find out how many points they have to spend.

Activity 5.1

Every time a customer applies for an Advantage Card, a form is completed. Look at the online application form for a Boots Advantage card to find out what data is collected from each customer.

The same details are collected from each Advantage Card holder and the same data is stored for each of them. This data is stored on a computer along with the card number issued and a points total of zero.

The Advantage Card is not a swipe card with a magnetic strip – it is a smart chip card. This means that some data is stored on the card as well as in the database. When a customer makes a purchase, the chip is read to identify the customer and this speeds things up.

TALKING POINT 5.1

Think about different things you and your family do in a typical week and when and where data is being collected. What might it be used for?

66

Making use of databases

5

Designing a database structure

Database software can recognise different types of data. When you design a database you must make sure that each field can accept the correct type of data.

Data types and formats

It is very important to use the correct data types for fields as this helps to reduce errors by restricting what can be entered. You should make sure that you understand exactly what can and cannot be entered in fields with different data types.

For each type, you can also specify the format. This table shows the common data types with examples of formats:

Type	Description	Examples of formats
Alphanumeric (Text)	Text including number	Upper case, lower case
Numeric	Numbers	Decimal places, currency, percentages
Date/Time	Date and time Date only Time only	05/06/87 15:45 Various date formats such as: 05/06/87, 5 June 1987, Various time formats such as: 15:45, 15:45:05, 03:34PM
Currency	Money	Symbol £, e, etc. Decimal places
Yes/No	Where input is li to two valuesmited	

Can I do this?

Using database tools, make sure you can:

- Create a new database table
- Create new fields in a table
- Select field sizes and formats

You can specify how data must be displayed even if it is entered in a different format.

Activity 5.4

Create a database table and enter a field called BIRTHDAY. Select the correct data type and format it to dd/mm/yyyy. Try entering 4/5/05, 4 May 05, 04/05/2005, etc – you should see 04/05/2005 in every row of the table.

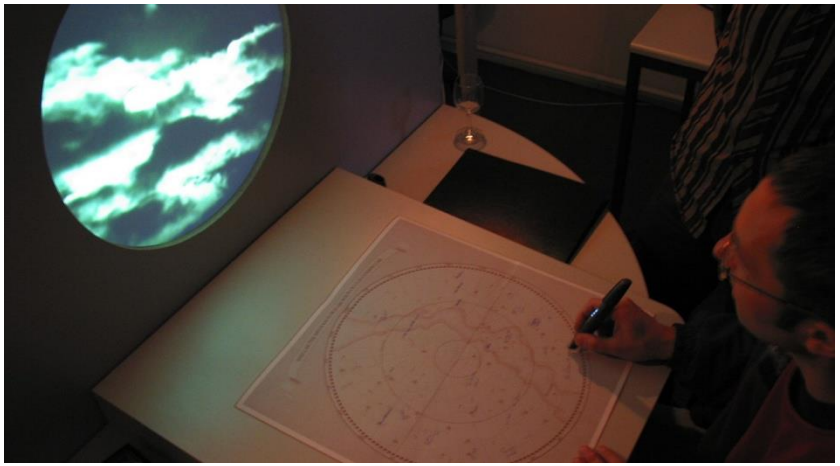
69

Global Information Systems Group, ETH Zurich

The Lost Cosmonaut

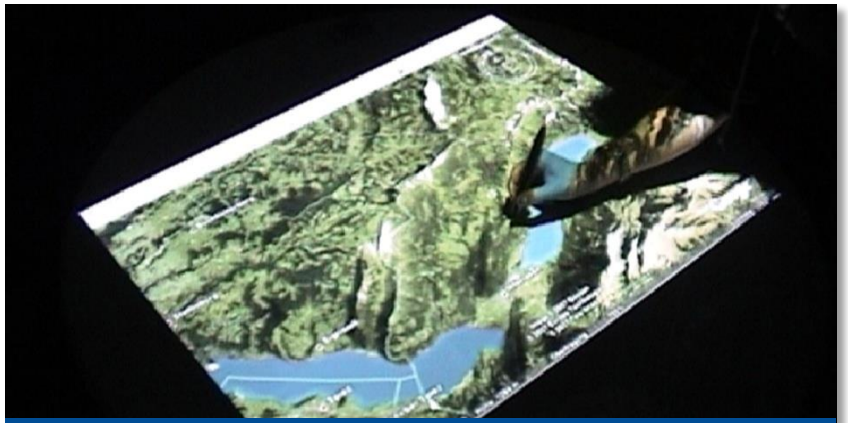
- Writing as a collaborative act of memory and story-telling
- Reading, writing and narrative as an act of making sense
- Handwriting as a tool for human-computer interaction

In collaboration with Axel Vogelsang, Artists in Labs Programme

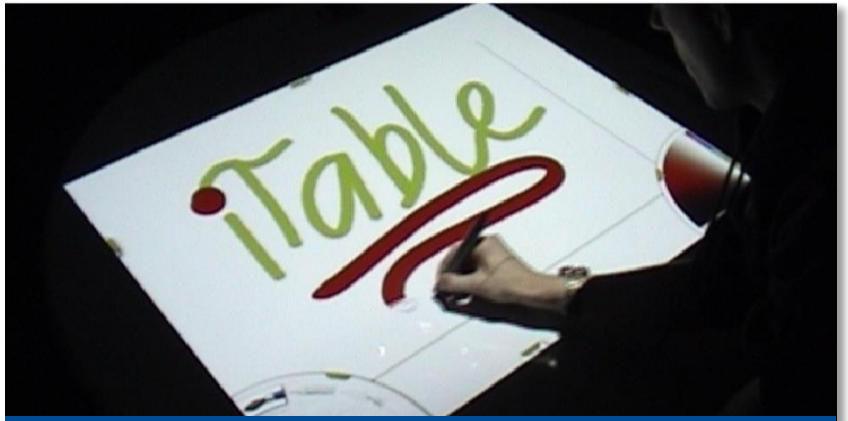


Global Information Systems Group, ETH Zurich

Interactive Table (iTable)



Pen-Based Google Earth Browser



Pen-Based Drawing Tool

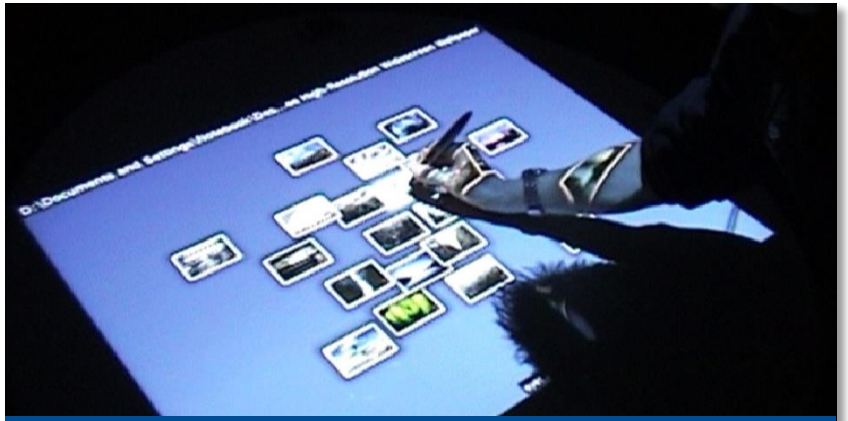


Photo Browser

Photo Browser (Slider)

Global Information Systems Group, ETH Zurich

Interactive Table (iTable) Video

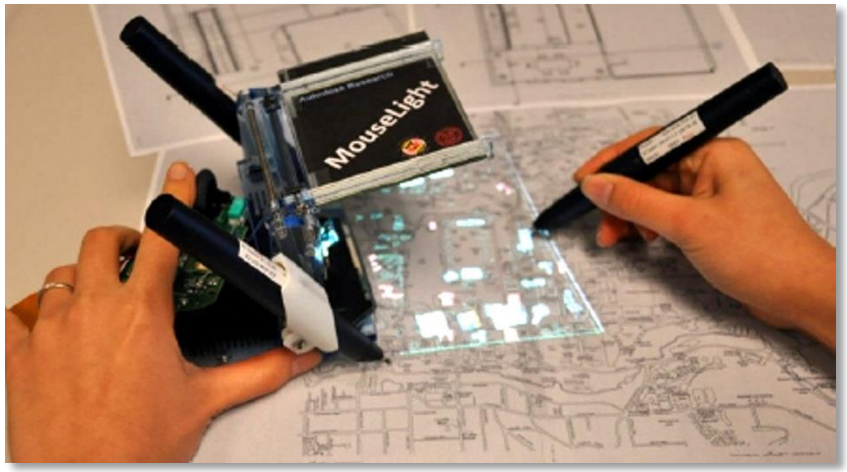
Global Information Systems Group, ETH Zurich

Pen and Paper Design

- *Visualisation* of interactive areas and functionality
  - design patterns
- Interaction design
  - online versus offline input processing
  - lack of modal dialogues
  - *multimodal interaction*
- Findings might be applicable to traditional GUIs
  - e.g. cross-application widget interaction

Innovative Hardware and Materials

- Mobile solutions for feed-back on paper documents
  - spatially aware projection of information
  - digital pen with display
  - voice feedback
  - ...
- Fusion of electronic paper and interactive paper
  - printed electronics



Conclusions

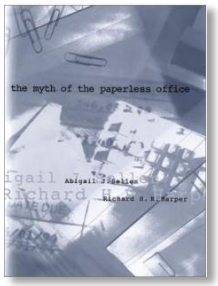
- Pen input is not always the most effective input
  - sometimes it is faster to type on a keyboard rather than to write
- New challenges in terms of interaction design
  - what are the user's expectations (based on known use of pen)?
  - combination with other modalities and lack of control
  - visual encoding and design
  - how to provide feedback if used without a screen?
    - might need modes and timeouts
- Device independence and digital ink abstraction
  - different pens can be used to control an application
- Automatic application deployment and installation
  - easy interaction with arbitrary digital or physical documents

Homework

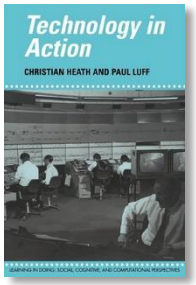
- Read the following paper that is available on PointCarré (papers/Signer 2010)
  - B. Signer and M.C. Norrie, *Interactive Paper: Past, Present and Future*, Proceedings of PaperComp 2010, 1st International Workshop on Paper Computing, Copenhagen Denmark, September 2010

References

Fundamental Concepts for Interactive Paper and Cross-Media Information Spaces, Beat Signer, Books on Demand, May 2008
ISBN-13: 978-3837027136



The Myth of the Paperless Office, Abigail Sellen and Richard Harper, The MIT Press, February 2003
ISBN-13: 978-0262692830



Technology in Action, Christian Heath and Paul Luff, Cambridge University Press, June 2000
ISBN-13: 978-0521560337

References …

- M.R. Davis and T.O. Ellis, *The RAND Tablet: A Man-Machine Graphical Communication Device*, Proceedings of AFIPS 1964
  - http://dx.doi.org/10.1145/1464052.1464080
- I. Sutherland, *Sketchpad: A Man-Machine Graphical Communication System*, PhD Thesis, Massachusetts Institute of Technology, January 1963
  - https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-574.pdf
- *Sketchpad Demo*
  - https://www.youtube.com/watch?v=USyoT_Ha_bA

References …

- P. Wellner, *The DigitalDesk Calculator: Tangible Manipulation on a Desk Top Display*, Proceedings of ACM UIST 1991, Hilton Head, USA, November 1991
  - http://dx.doi.org/10.1145/120782.120785
- L.J. Stifelman, Augmenting Real-World Objects: A Paper-based Audio Notebook, Proceedings of CHI 1996, International Conference on Human Factors in Computing Systems, Vancouver, Canada, April 1996
  - http://dx.doi.org/10.1145/257089.257279

References …

- B. Signer and M.C. Norrie, *Interactive Paper: Past, Present and Future*, Proceedings of PaperComp 2010, 1st International Workshop on Paper Computing, Copenhagen Denmark, September 2010
  - http://beatsigner.com/publications/signer_PaperComp2010.pdf
- B. Signer and M.C. Norrie, *PaperPoint: A Paper-based Presentation and Interactive Paper Prototyping Tool*, Proceedings of TEI 2007, 1st International Conference on Tangible and Embedded Interaction, Baton Rouge, USA, February 2007
  - http://beatsigner.com/publications/signer_TEI2007.pdf

References …

- M.C. Norrie, B. Signer, M. Grossniklaus, R. Belotti, C. Decurtins and N. Weibel, *Context-Aware Platform for Mobile Data Management*, ACM/Baltzer Wireless Networks (WINET), 13(6), December 2007
  - http://beatsigner.com/publications/norrie_WINET2007.pdf
- P. Luff, C. Heath, M.C. Norrie, B. Signer and P. Herdman, *Only Touching the Surface: Creating Affinities Between Digital Content and Paper*, Proceedings of CSCW 2004, ACM Conference on Computer Supported Cooperative Work, Chicago, USA, November 2004
  - http://beatsigner.com/publications/luff_CSCW2014.pdf

References …

- M.C. Norrie, B. Signer and N. Weibel, *Print-n-Link: Weaving the Paper Web*, Proceedings of DocEng 2006, ACM Symposium on Document Engineering, Amsterdam, The Netherlands, October 2006
  - http://beatsigner.com/publications/norrie_DocEng2006.pdf
- N. Weibel, B. Signer, P. Ponti and M.C. Norrie, *PaperProof: A Paper-Digital Proof-Editing System*, CoPADD 2007, 2nd International Workshop on Collaborating over Paper and Digital Documents, London, UK, November 2007
  - http://beatsigner.com/publications/weibel_CHI2008.pdf

References …

- B. Signer, U. Kurmann and M.C. Norrie, *iGesture: A General Gesture Recognition Framework*, Proceedings of ICDAR 2007, 9th International Conference on Document Analysis and Recognition, Curitiba, Brazil, September 2007
  - http://beatsigner.com/publications/signer_ICDAR2007.pdf
- A. Vogelsang and B. Signer, *The Lost Cosmonaut: An Interactive Narrative Environment on Basis of Digitally Enhanced Paper*, Proceedings of the International Conference on Virtual Storytelling 2005, Strasbourg, France, December 2005
  - http://beatsigner.com/publications/vogelsang_ICVS2005.pdf

References …

- *Interactive Paper*
  - http://www.beatsigner.com/interactivePaper.html
- *iGesture Framework*
  - http://www.igesture.org
- *Print-n-Link Video*
  - https://www.youtube.com/watch?v=d-lXzi8mPMY
- *PaperProof Video*
  - https://www.youtube.com/watch?v=8ZW2Msw6HM0
- *The Lost Cosmonaut Video*
  - https://www.youtube.com/watch?v=fu27Cmr1aX4
- *Interactive Table (iTable) Video*
  - https://www.youtube.com/watch?v=rc7I5h6XirY

VRIJE
UNIVERSITEIT
BRUSSEL

Next Lecture

Interactive Tabletops and Surfaces