

# Vorlesung

# Mensch-Maschine-Interaktion

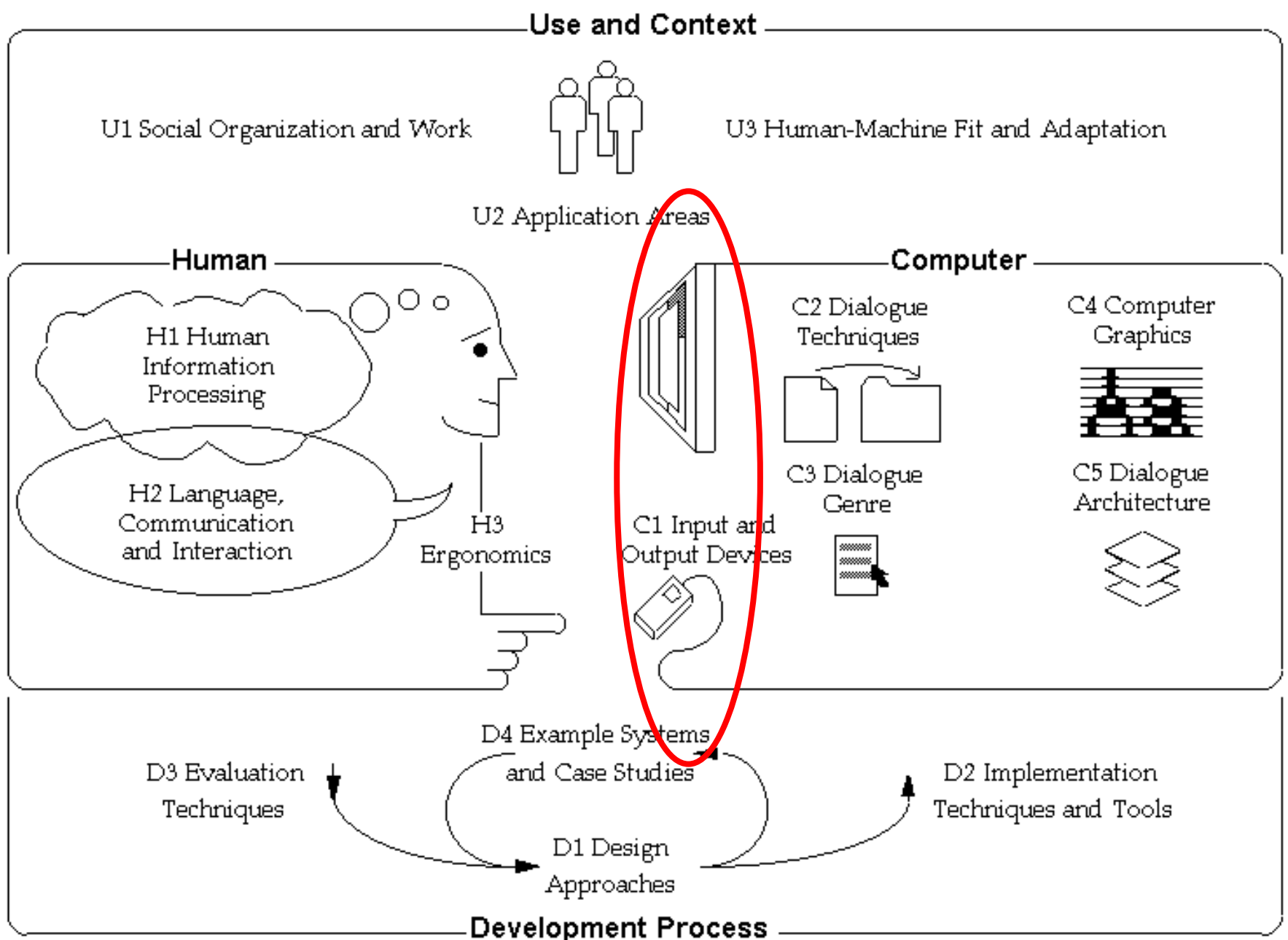
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LFE Medieninformatik

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WS2004/2005

<http://www.medien.ifi.lmu.de/>



from ACM SIGCHI Curricula for HCI


# Human Computer Interaction with Paper?

- Paperless office has not yet happened!
- Advances in technology makes it easier to use paper as interaction media
  - Printing as output mechanism
  - Scanning as input mechanism
- Paper as a temporary interface
  - Multi-step process, e.g.
    - print out a check list on paper
    - user interacts with the checklist on paper
    - scan & recognize interaction and create a database entry
  - for specific scenarios this can be a state of the art solution
- Research (e.g. Xerox) and products (e.g. HP printers)

# Paper interface for photo printing

- E.g. HP PSC 2210 all-in-one
- Steps
  - Insert memory card
  - print proof sheet (index)
  - Select on paper
  - Scan selection
  - Get your selection printed


























**photo proof sheet**

3 simple steps to print photos from camera card





**hp psc 2210**  
all-in-one

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**step 1:** to select photo(s), fill in bubble(s) underneath with a dark pen, 

				
<input type="radio"/> 1 Sep 8 2001 DSCF0072.JPG	<input type="radio"/> 2 Sep 8 2001 DSCF0073.JPG	<input type="radio"/> 3 Sep 8 2001 DSCF0074.JPG	<input type="radio"/> 4 Sep 8 2001 DSCF0075.JPG	<input type="radio"/> 5 Sep 8 2001 DSCF0077.JPG
				
<input type="radio"/> 6 Sep 8 2001 DSCF0078.JPG	<input type="radio"/> 7 Sep 8 2001 DSCF0079.JPG	<input type="radio"/> 8 Sep 8 2001 DSCF0080.JPG	<input type="radio"/> 9 Sep 8 2001 DSCF0084.JPG	<input type="radio"/> 10 Sep 22 2001 DSCF0173.JPG
				
<input type="radio"/> 11 Sep 22 2001 DSCF0174.JPG	<input type="radio"/> 12 Sep 22 2001 DSCF0175.JPG	<input type="radio"/> 13 Sep 22 2001 DSCF0176.JPG	<input type="radio"/> 14 Sep 22 2001 DSCF0177.JPG	<input type="radio"/> 15 Sep 23 2001 DSCF0178.JPG
				
<input type="radio"/> 16 Sep 28 2001 DSCF0200.JPG	<input type="radio"/> 17 Sep 28 2001 DSCF0202.JPG	<input type="radio"/> 18 Sep 28 2001 DSCF0203.JPG	<input type="radio"/> 19 Sep 28 2001 DSCF0204.JPG	<input type="radio"/> 20 Sep 28 2001 DSCF0205.JPG

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<p><b>step 2:</b></p> <p>select print options select only one choice per section</p>	<p>number of prints:</p> <p><input type="radio"/> single</p> <p><input type="radio"/> double</p>	<p>image size (in.):</p> <p><input type="radio"/> 2 x 3</p> <p><input type="radio"/> 3 x 5</p> <p><input type="radio"/> 4 x 6</p> <p><input type="radio"/> 5 x 7</p> <p><input type="radio"/> 8 x 10</p>	<p>paper size:</p> <p><input type="radio"/> 4 x 6</p> <p><input type="radio"/> 8 x 10</p>	<p>borders &amp; frames:</p> <p><input type="radio"/> none</p> <p><input type="radio"/> </p> <p><input type="radio"/> </p> <p><input type="radio"/> </p> <p><input type="radio"/> </p>
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**step 3:** place sheet on scanner glass at front right corner. Press **proof sheet**, then **2**.

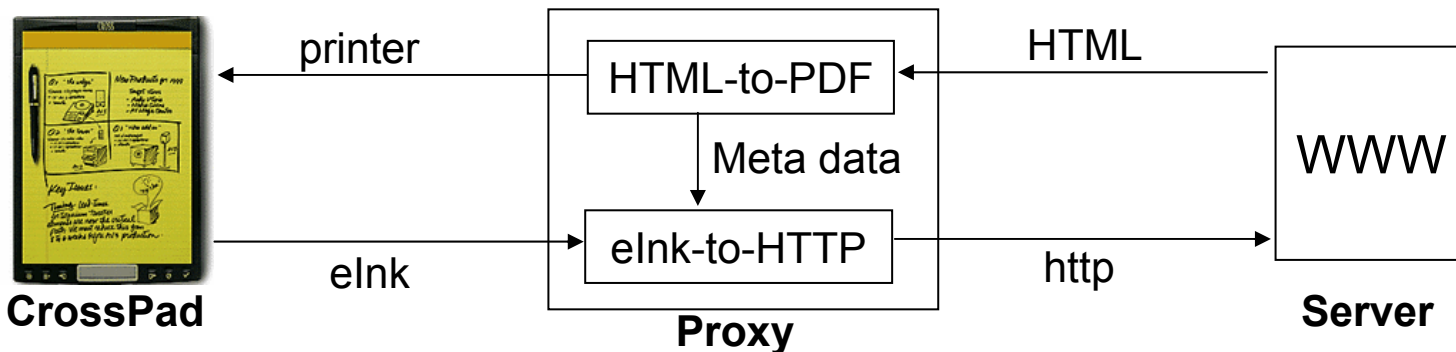
# Paper as input medium

(University of Karlsruhe & SAP cooperate research, 2000)

[http://www.comp.lancs.ac.uk/~albrecht/pubs/pdf/gellersen\\_mc2001\\_paper2webl.pdf](http://www.comp.lancs.ac.uk/~albrecht/pubs/pdf/gellersen_mc2001_paper2webl.pdf)

## Paper-to-Web

- **Using the CrossPad as Client for paper based input**
- **Transparent proxy between CrossPad and Web Server**
  - Conversion of web forms (HTML) into print documents
  - Recognition of handwriting and marks in the paper forms and conversion



## Application, Results

- **Test in different domains (interviews, inventory)**
- **Usability: unobtrusive, transparent, custom interface (additional: paper copy)**

# Capture

# Media Capture Text

- Legacy content (documents, books)
- Technologies for capture
  - Scanner
  - Digital photo camera
  - Results in a bitmap of the text
- Technology for recognition / transformation into text
  - OCR (optical character recognition)
  - Recognize text and format
  - less storage required (if only textual content is of value)
  - Allow search in archived documents

# Media Capture

## Still images, graphics

- Drawing (e.g. cartoon, caricature)
  - Artistic interpretation
  - Digital input (pen, tablet, mouse?)
  - Analog creation and digitizing
- Photo capture (chemical) and digitizing
  - High resolution (e.g. photo for a 4m x 8m poster or A1 Poster with 100dpi)
- Legacy content (e.g. slides, photos, book pages)
- Technologies for still image digital capture
  - Scanner
  - Digital photo camera



# Scanner, examples

- Xerox DigiPath Network Scanner
  - Up to 65 pages per minute
  - Automatic duplex
  - document handler with a 100-sheet capacity
- Polaroid SprintScan 120
  - optical resolution 4000 dpi
  - medium-format film scanner
  - E.g. theoretical 6cm x 9cm ~  
9400 pixel x 14000 pixel = 126 Mega Pixel
  - 6cm x 6cm scan about 1 minute



# Media Capture Video

- Record on photographic film and subsequent digitizing
- Digital capture, examples
  - DV (e.g. Canon XL1 DV)
  - Betacam digital (Sony Betacam SX Camcorder)
  - D1 (8-bit uncompressed digital)
- Capture analog video signal
  - Digitizing legacy content

<http://videoexpert.home.att.net/artic3/256atab.htm>

<http://www.belle-nuit.com/dv/dvddix.html>

<http://www.jamesarnett.com/2-1-6-4.html>





# Incense Clocks

- [...One is a 19th-century Chinese fire clock (a slow fuse lights successive compartments, one at a time) the other an incense clock. Each new smell (another incense) marks a passage of time.]

(<http://www.thisislimitededition.co.uk/printversion.asp?ID=142>)



<http://www.nawcc.org/museum/nwcm/galleries/asian/incense.htm>

# Aromatic Output for HCI

- From: Joseph "Jofish" Kaye, Making scents: aromatic output for HCI, Interactions, Volume 10, Number 1 (2004), Pages 48-61
- Humans use their sense of smell
  - Is food safe to eat?
  - Is there danger due to a fire?
  - Relationships
- An almost entirely unexplored medium in HCI
  - There are reasons for this: technical difficulties in emitting scent on demand,
  - chemical difficulties in creating accurate and pleasant scents

# Physiology and Chemistry of Smell

- A thousand different kinds of olfactory receptors in our nose, and it is thought that each can sense a single kind of chemical bond in a molecule
- No abstract classification
  - Examples: how does mint taste? It tastes like ...mint
  - Compared to colors: green vs. spinach colored
- Rapidly acclimatized
  - Less than 1 minute
- Human Olfactory Bandwidth
  - ... hard to tell
  - Perfumers and florist can distinguish many different smells - potentially thousands

# Technology

- Explored in movie theaters and VR... but not really successful
- Different technologies

[www.scentury5d.com/](http://www.scentury5d.com/)



See for examples: <http://www.aromajet.com/game.htm>  
and J. Kaye, Making scents: aromatic output for HCI

# Ideas in Smell Output, Open Questions

- Olfactory Icons
  - Smell a shot fired each time you press the trigger in Quake
- Ambient Notification
  - Smell of rose to notify you of a date

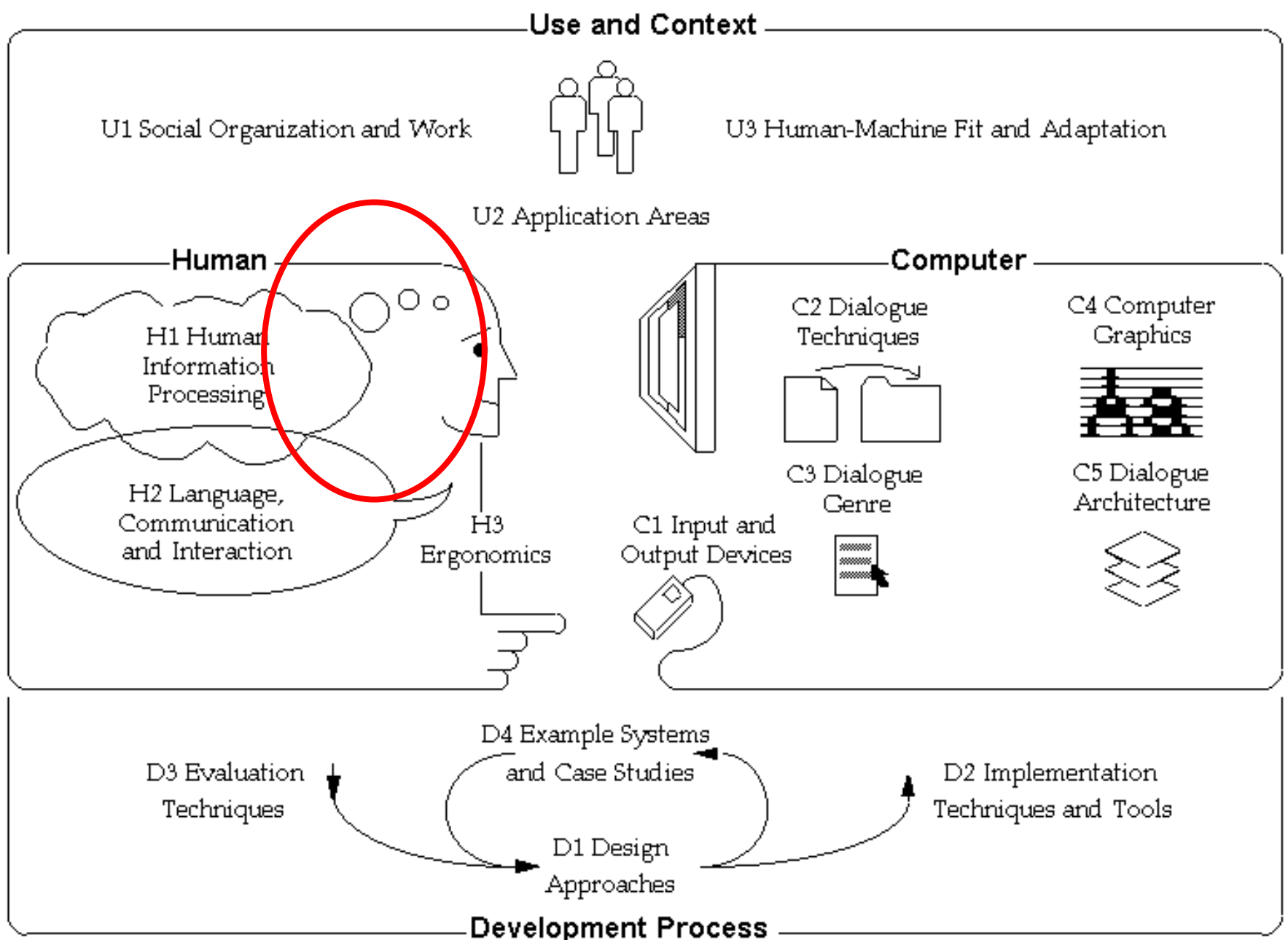
The question of what information should be displayed is fundamental. Olfactory display is useful for slowly-moving, medium-duration information or information for which an aggregate representation is slowly changing.



# Further UIs...

- Bio sensors for
    - Stress level
    - Excitement
    - Tiredness
  - Other sensors
    - Acceleration
    - Proximity
    - Force
    - Weight
- see instrumented environments





from ACM SIGCHI Curricula for HCI

# Perception and Recognition

- How information is acquired from the world and transformed into experiences
- Obvious implication is to design representations which are readily perceivable, e.g.
  - Text should be legible
  - Icons should be easy to distinguish and read

# Color contrasts according to Itten (1)

Johannes Itten: „Die Kunst der Farbe“

**Farbe-an-sich-Kontrast**

**Hell-Dunkel-Kontrast**

Kalt-Warm-Kontrast

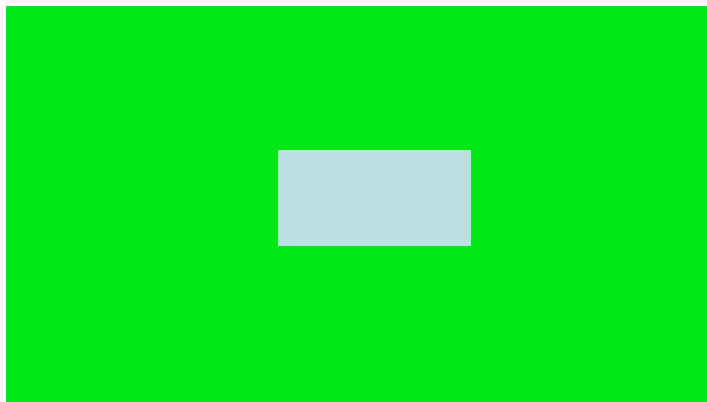
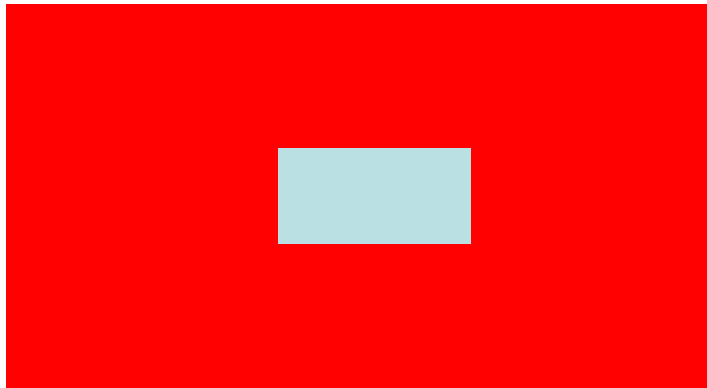


**Komplementärkontrast**

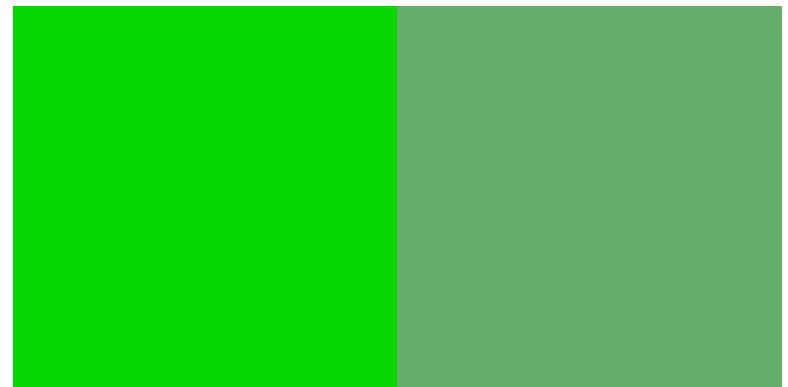
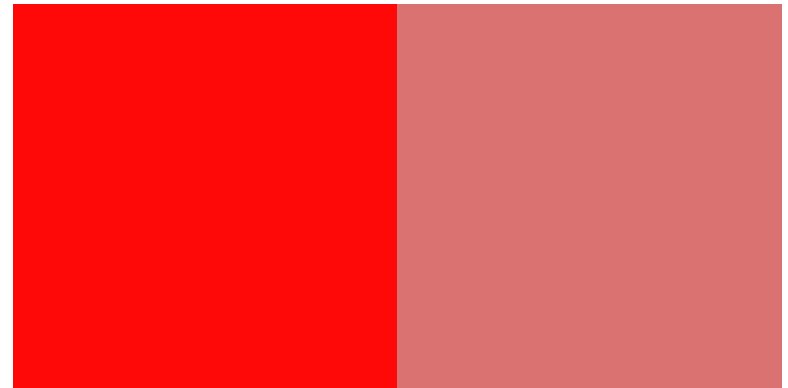
**Komplementärkontrast**

# Color contrasts according to Itten (2)

Simultankontrast



Qualitätskontrast



# Which is easiest to read and why?

What is the time?

What is the time?

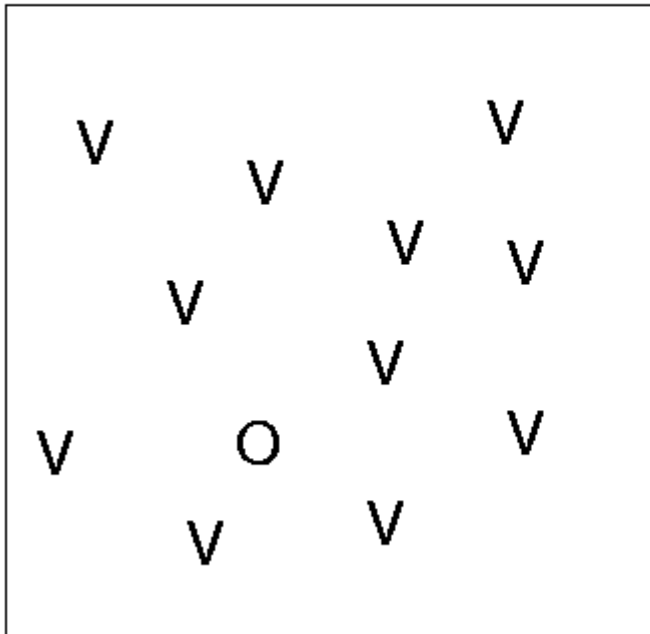
What is the time?

What is the time?

What is the time?

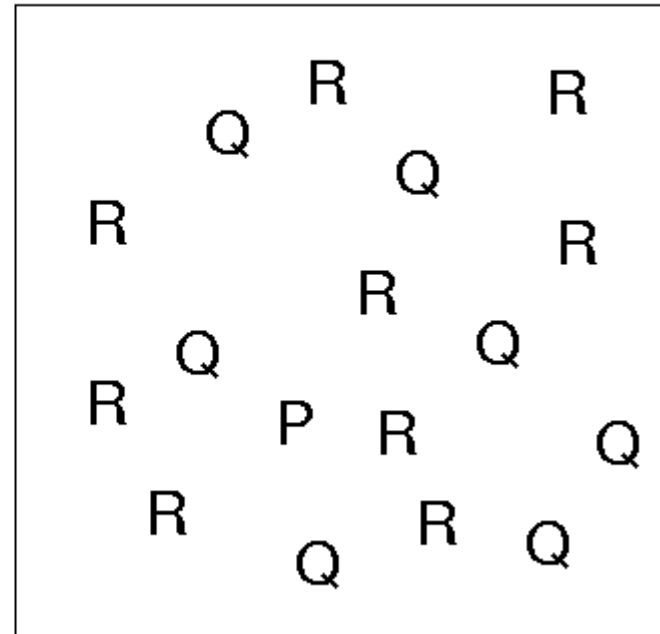
# Visual Search

A)



Preattentive Search

B)



Attentive Search

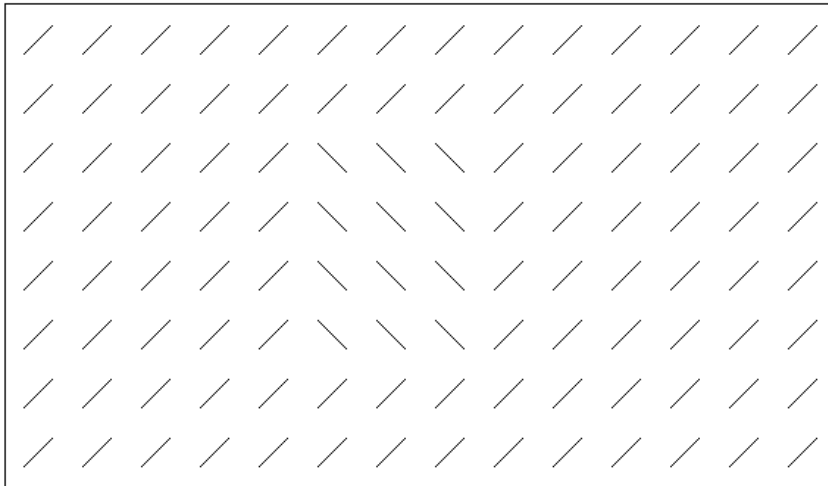
# Attentative Processing

- Aggregation of several attributes
- Goal-oriented comparison of attributes
- Takes longer, but leads to better memorization of images

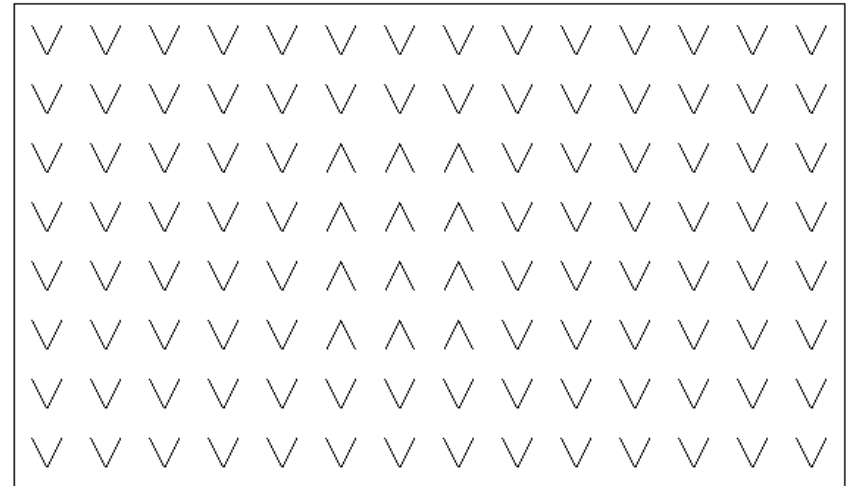


# Visual Search 2

A)



B)

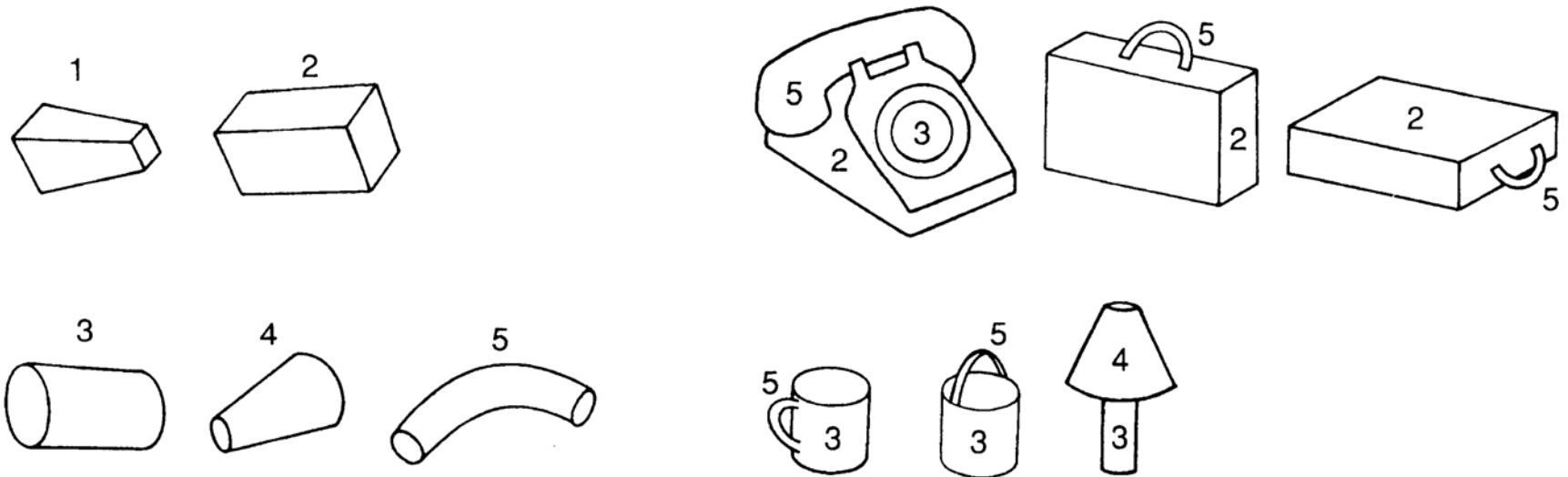


Textones

# Basic Elements (Julesz75 & Triesman80)

- Lines and bows
- slopes
- End points of lines
- color
- movement
- Textones, orientation of textones

# Geons (Biederman87)

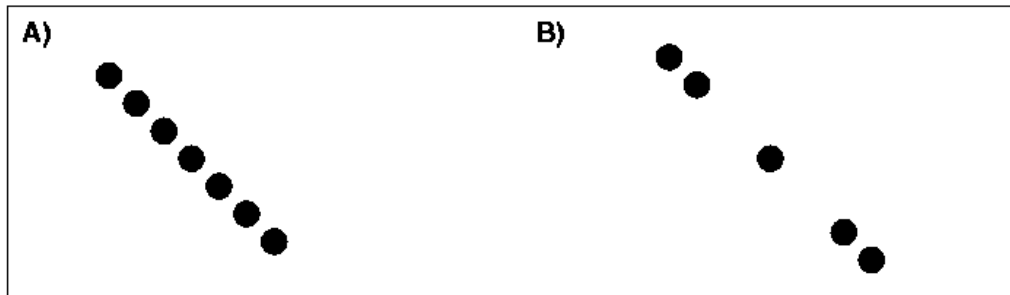


Object recognition by breaking objects down into elementary parts: geons (geometric ions)

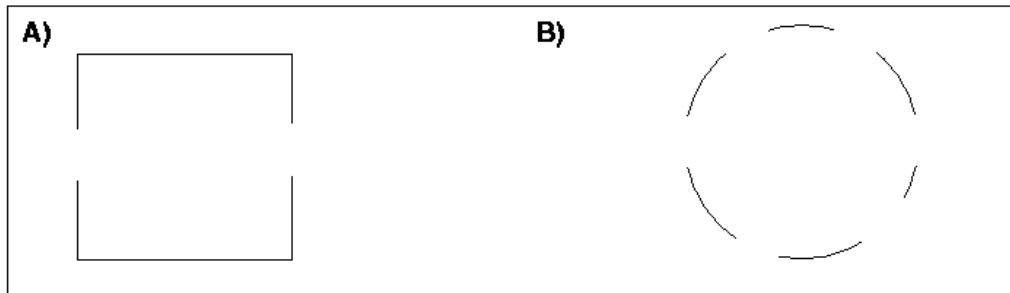
# Gestalt Laws

- The perception of the whole is more than the sum of its elements
- The laws are not strictly defined and describe different classes of observations
- Not just valid for visual but more general for all cognitive processes

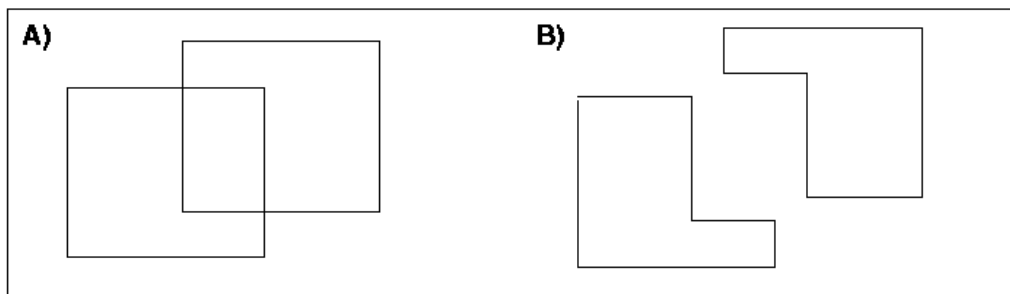
# Gestalt Laws (some of them)



Gesetz der Nähe



Gesetz der Kontinuität

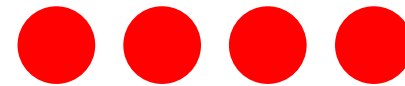


Prägnanzgesetz

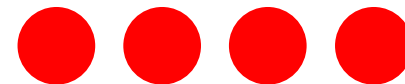
# Gestalt Perception

- Grouping items into group based on

- Proximity



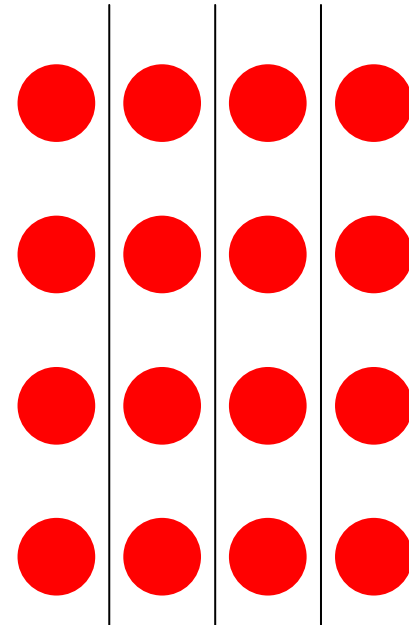
- Similarity



# Gestalt Perception

- Grouping items into group based on

- Proximity

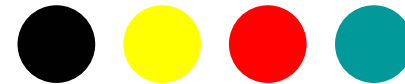
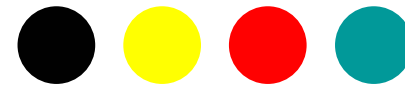


- Similarity

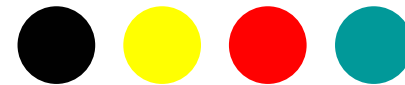
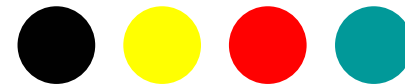
# Gestalt Perception

- Grouping items into group based on

- Proximity



- Similarity





# Gestalt Perception Example

- Keep  
red
- Off  
line
- ???



# Gestalt Perception Example

- Keep  
off  
red  
lines
- !!!







# Change Blindness

- phenomenon in visual perception
- large changes in a scene are not noticed
- Happens when there is a short distraction, e.g.
  - “mud splashes”
  - “brief flicker”
  - “cover box”

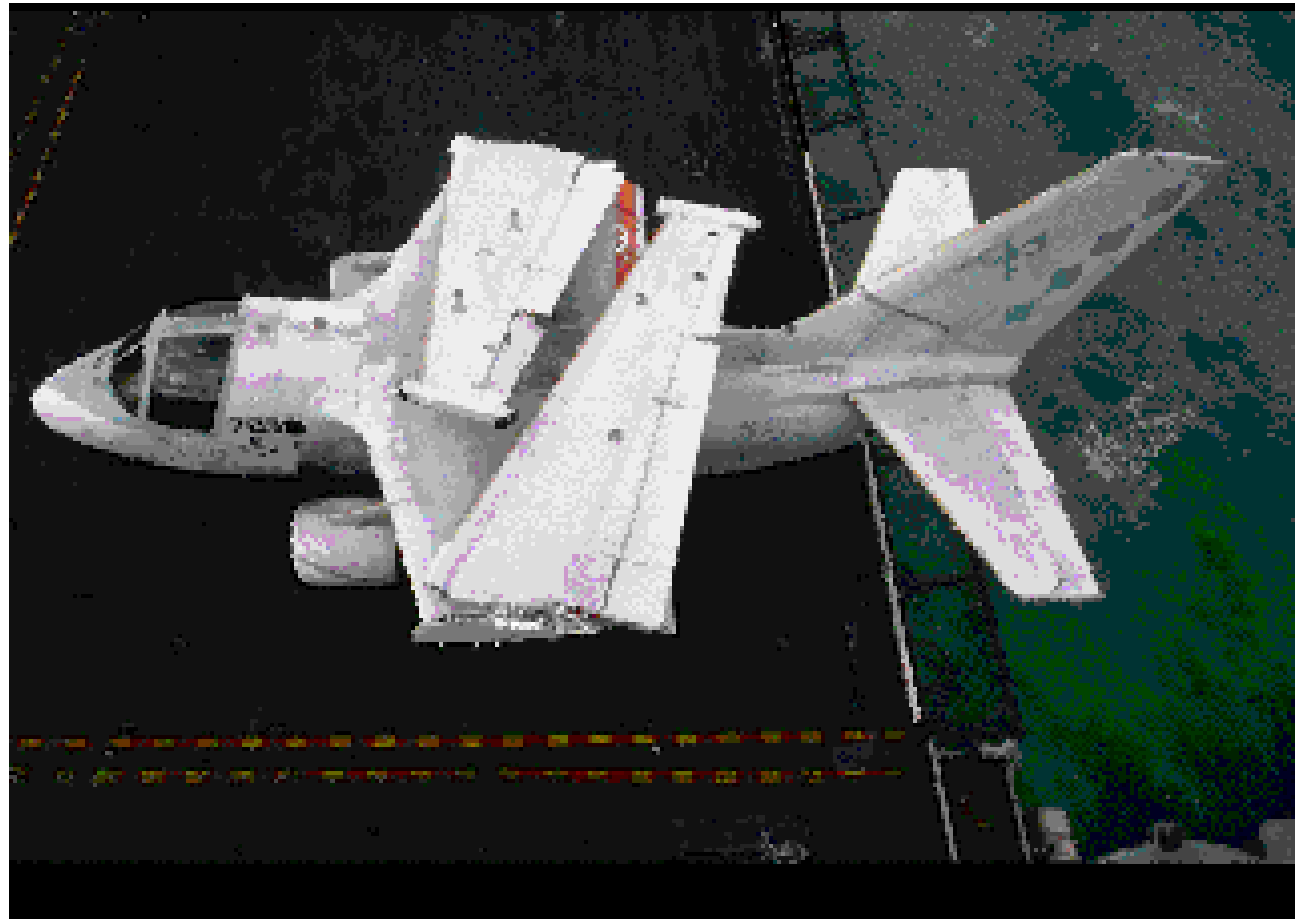
<http://nivea.psycho.univ-paris5.fr/ECS/ECS-CB.html>

# Change blindness

## example: mud splashes



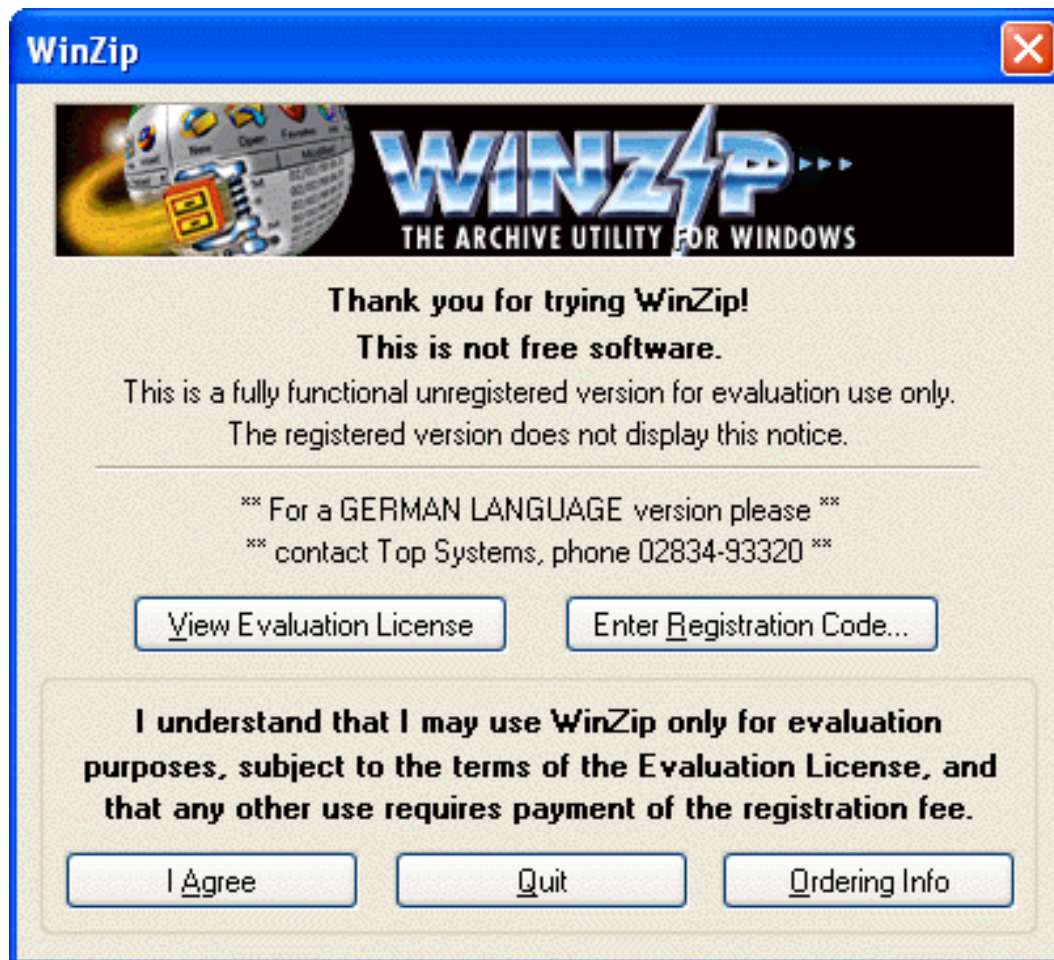
# Change blindness example: flicker



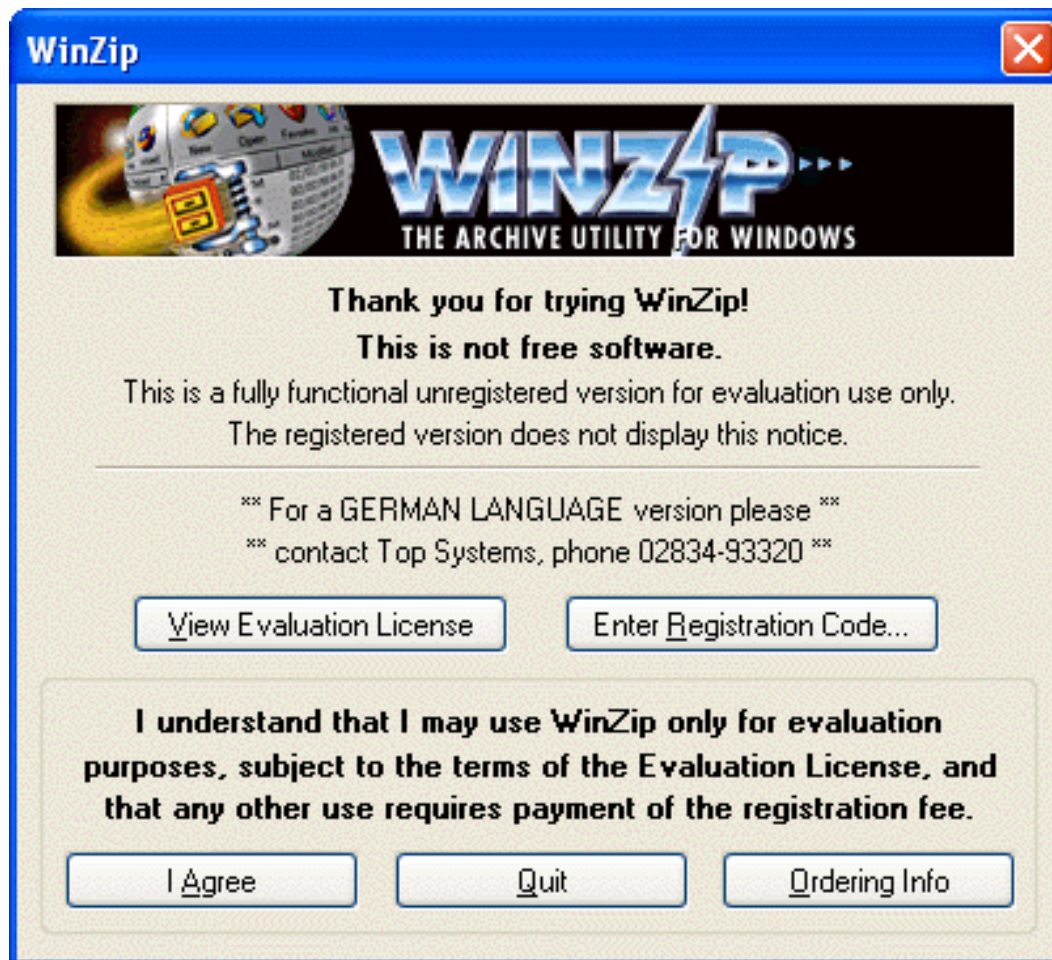
# Change blindness example: box











# References

- Change blindness demo applet  
<http://www.usd.edu/psyc301/Rensink.htm>
- Encyclopedia of Cognitive Science:  
Change blindness  
<http://nivea.psychu.univ-paris5.fr/ECS/ECS-CB.html>

# Use and Context

U1 Social Organization and Work



U3 Human-Machine Fit and Adaptation

U2 Application Areas

## Human

H1 Human Information Processing

H2 Language, Communication and Interaction

H3 Ergonomics

## Computer

C2 Dialogue Techniques



C3 Dialogue Genre



C4 Computer Graphics



C5 Dialogue Architecture



C1 Input and Output Devices



D3 Evaluation Techniques

D4 Example Systems and Case Studies

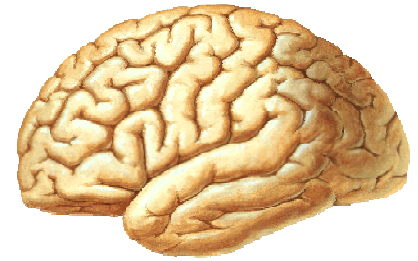
D2 Implementation Techniques and Tools

D1 Design Approaches

## Development Process

from ACM SIGCHI Curricula for HCI

# Memory



- Involves encoding and recalling knowledge and acting appropriately
- We don't remember everything - involves filtering and processing
- Context is important in affecting our memory
- We recognize things much better than being able to recall things
  - The rise of the GUI over command-based interfaces
- Better at remembering images than words
  - The use of icons rather than names

# The problem with the classic '7±2'

- George Miller's theory of how much information people can remember
- <http://www.well.com/user/smalin/miller.html>  
(The Psychological Review, 1956, vol. 63, pp. 81-97)
- People's immediate memory capacity is very limited
- Many designers have been led to believe that this is a useful finding for interaction design

# What some designers get up to...

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page
- **But this is wrong! Why?**



# Why?

- Inappropriate application of the theory
- People can scan lists of bullets, tabs, menu items till they see the one they want
- They don't have to recall them from memory having only briefly heard or seen them
  
- Sometimes a small number of items really is good design
- But it depends on the task and the available screen estate

# More appropriate application of memory research

- File management and retrieval is a real problem to most users
- Research on information retrieval can be usefully applied
- Memory involves 2 processes
  - recall-directed and recognition-based scanning
- File management systems should be designed to optimize both kinds of memory processes



# File management

- Facilitate existing memory strategies and try to assist users when they get stuck
- Help users encode files in richer ways
  - Provide them with ways of saving files using colour, flagging, image, flexible text, time stamping, etc

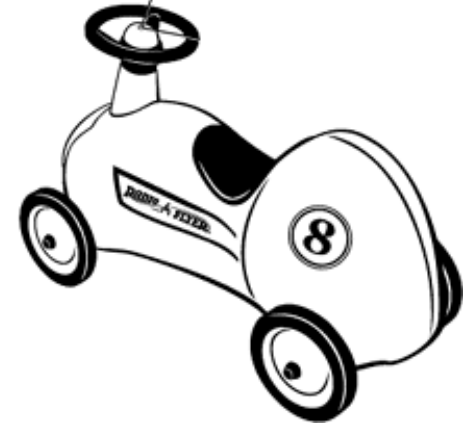


# Mental models

- Users develop an understanding of a system through learning & using it
- Knowledge is often described as a mental model
  - How to use the system (what to do next)
  - What to do with unfamiliar systems or unexpected situations (how the system works)
- People make inferences using mental models of how to carry out tasks

# Mental models

- Craik (1943) described mental models as internal constructions of some aspect of the external world enabling predictions to be made
- Involves unconscious and conscious processes, where images and analogies are activated
- Deep versus shallow models (e.g. how to drive a car and how it works)



# Everyday reasoning & mental models

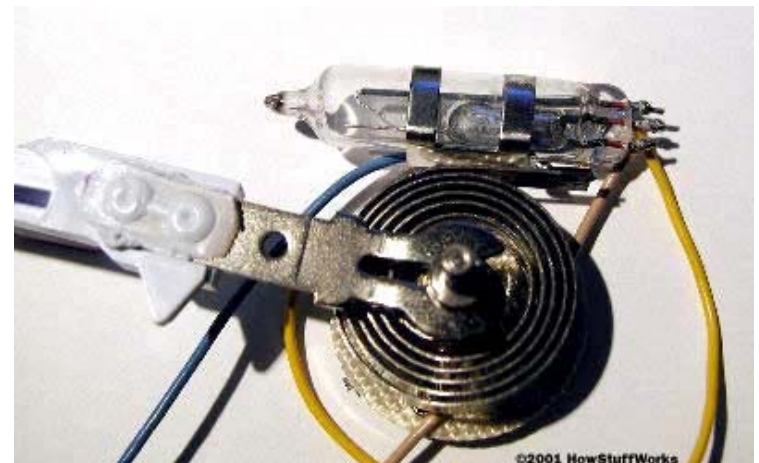
- You arrive home on a cold winter's night to a cold house. How do you get the house to warm up as quickly as possible? Set the thermostat to be at its highest or to the desired temperature?
- You arrive home starving hungry. You look in the fridge and find all that is left is an uncooked pizza. You have an electric oven. Do you warm it up to 375 degrees first and then put it in (as specified by the instructions) or turn the oven up higher to try to warm it up quicker?

# Heating up a room or oven that is thermostat-controlled

- Many people have erroneous mental models (Kempton, '96)
- General valve theory, where 'more is more' principle is generalised to different settings (e.g. gas pedal, gas cooker, tap, radio volume)
- Thermostats are based on the model of an on-off switch



©2001 HowStuffWorks



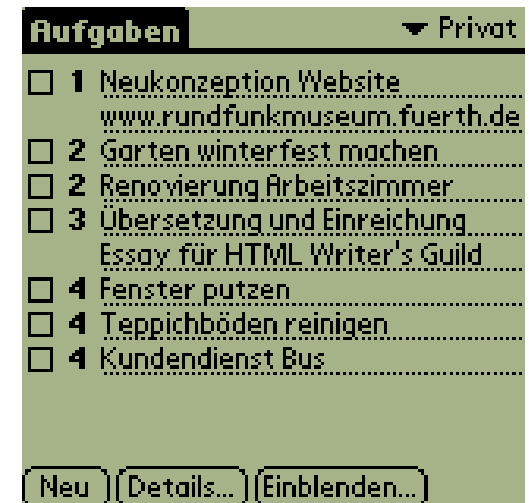
©2001 HowStuffWorks

# Heating up a room or oven that is thermostat-controlled

- Same is often true for understanding how interactive devices and computers work:
  - Poor, often incomplete, easily confusable, based on inappropriate analogies and superstition (Norman, 1983)
  - e.g. frozen cursor/screen - most people will bash all manner of keys

# External cognition

- Concerned with explaining how we interact with external representations (e.g. maps, notes, diagrams)
- What are the cognitive benefits and what processes involved
- How do they extend our cognition?
- What computer-based representations can we develop to help even more?



# Externalizing to reduce memory load

- Diaries, reminders, calendars, notes, shopping lists, to-do lists - written to remind us of what to do
- Post-its, piles, marked emails - where placed indicates priority of what to do
- External representations should:
  - Remind us of the fact that we need to do something (e.g. to buy something for mother's day)
  - Remind us of what to do (e.g. buy a card)
  - Remind us when to do it (e.g. send a card by a certain date)



# Computational offloading

- When a tool is used in conjunction with an external representation to carry out a computation (e.g. pen and paper)
- Try doing the two sums below (a) in your head, (b) on a piece of paper and c) with a calculator.
  - $234 \times 456 = ??$
  - $CCXXXIV \times CDVI = ???$
- Which is easiest and why? Both are identical sums

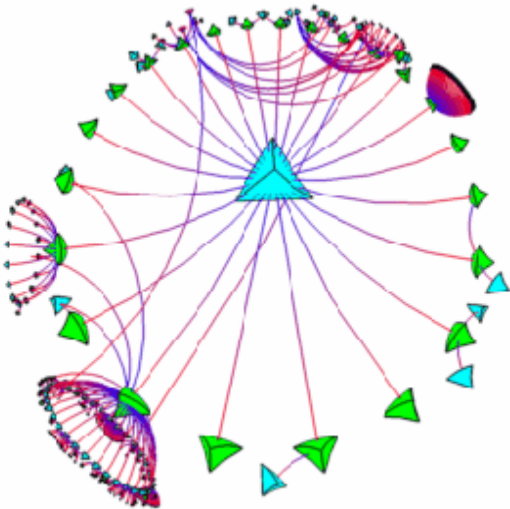
# Annotation and cognitive tracing

- Annotation involves modifying existing representations through making marks
  - e.g. crossing off, ticking, underlining, dog-ears
- Cognitive tracing involves externally manipulating items into different orders or structures
  - e.g. playing scrabble, playing cards

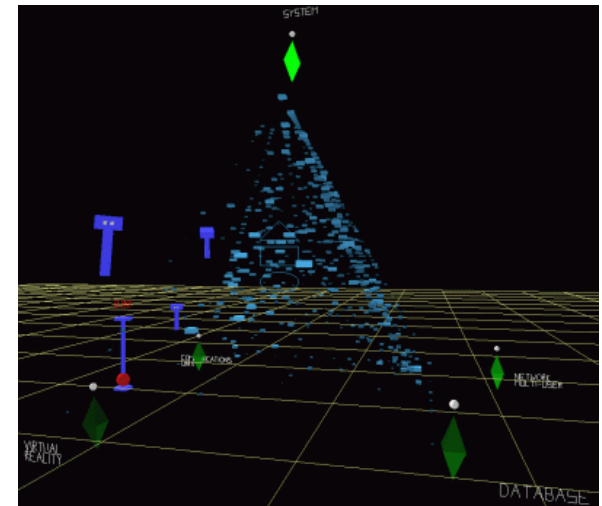


# Design implication

- Provide external representations at the interface that reduce memory load and facilitate computational offloading



e.g. Information visualizations have been designed to allow people to make sense and rapid decisions about masses of data



# Informing design based on our understanding of users

- How can we use knowledge about users to inform system design?
- Provide guidance and tools
  - Design principles and concepts
  - Design rules
- Provide analytic tools
  - Methods for evaluating usability

# Mental models & system design

- Notion of **mental models** has been used as a basis for **conceptual models**
- Assumption is that if you can understand how people develop mental models then can help them develop more appropriate mental models of system functionality
- For example, a design principle is to try to make systems transparent so people can understand them better and know what to do

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U3 Human-Machine Fit and Adaptation

U2 Application Areas

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C5 Dialogue Architecture



D3 Evaluation Techniques

D4 Example Systems and Case Studies

D2 Implementation Techniques and Tools

D1 Design Approaches

## Development Process

from ACM SIGCHI Curricula for HCI

# The design principle of transparency

Goal: the **mental model** of the user should match the **conceptual model** developed by the designer



- NOT to be understood as literal
- useful feedback
- easy to understand
- intuitive to use
- clear & easy to follow instructions
- appropriate online help
- context sensitive guidance of how to proceed when stuck

# Summary

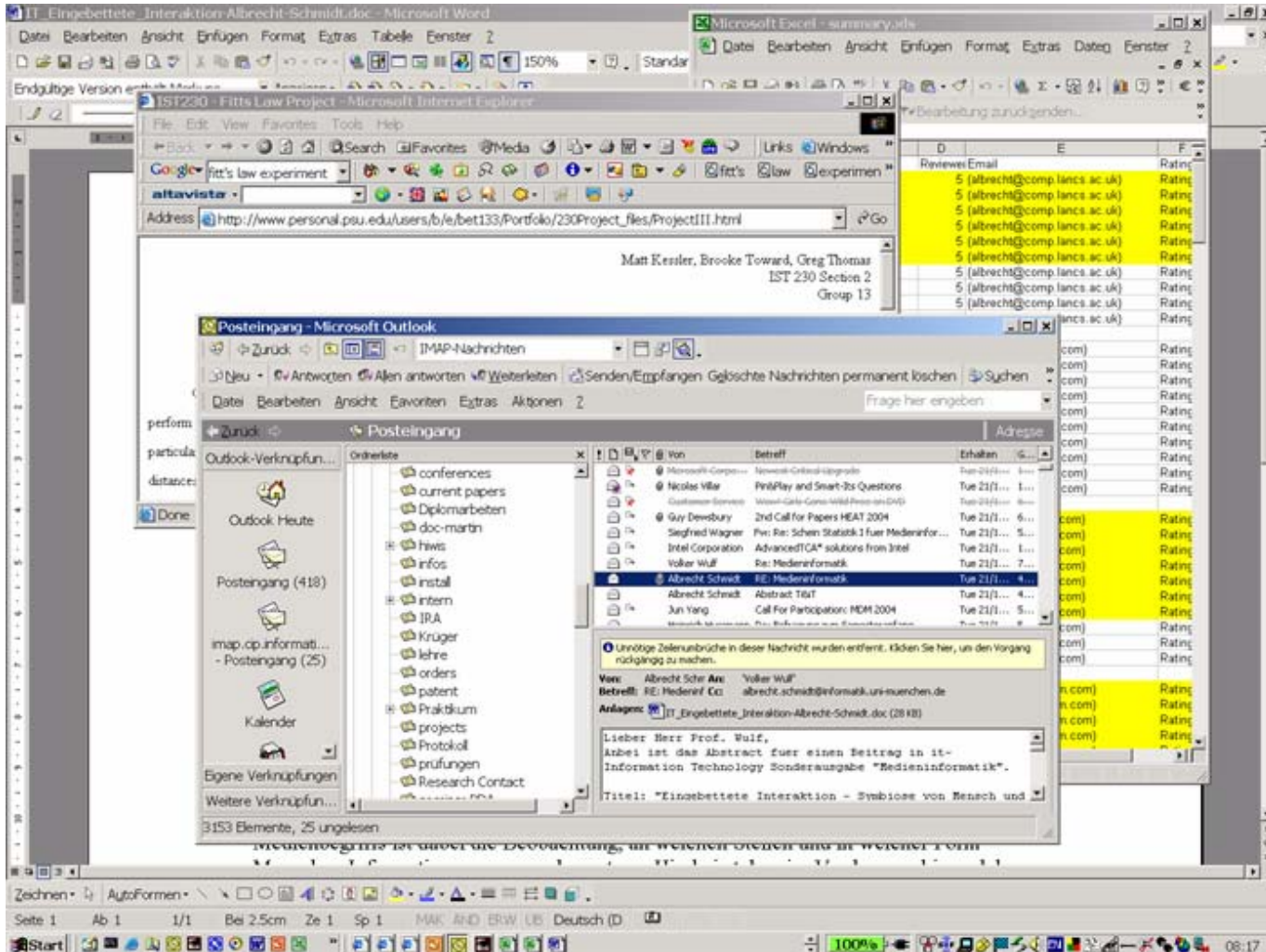
- Cognition involves many processes including attention, memory, perception and learning
- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks
- The conceptual framework of ‘mental models’ and ‘external cognition’ provide ways of understanding how and why people interact with products, which can lead to thinking about how to design better products



# Models and Users

- Why models
- Psychology of everyday things
- Psychology of everyday action
- Seven stages of action
- Models – human and computer

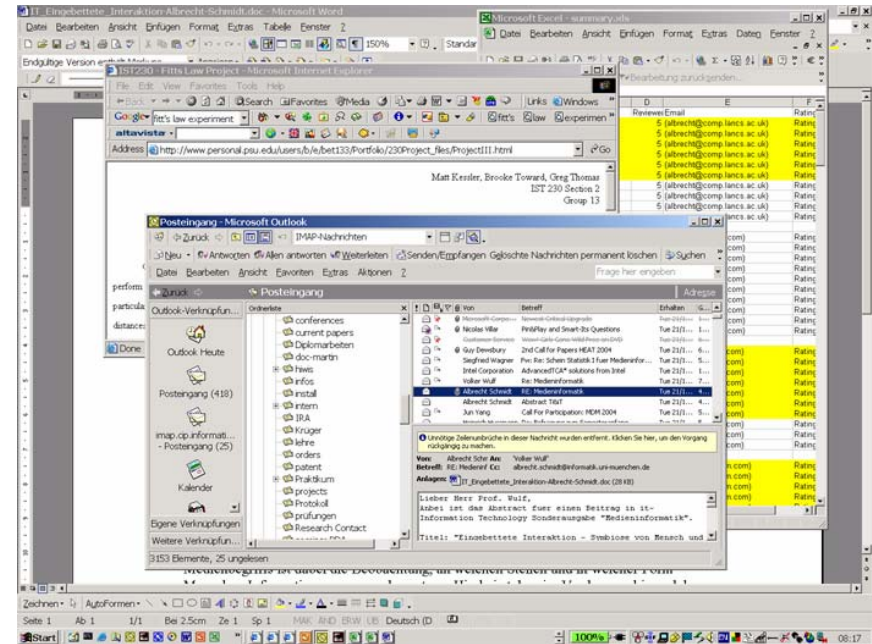
# Practical Motivation



- What do we see?
- What is shown?
- What is the meaning?

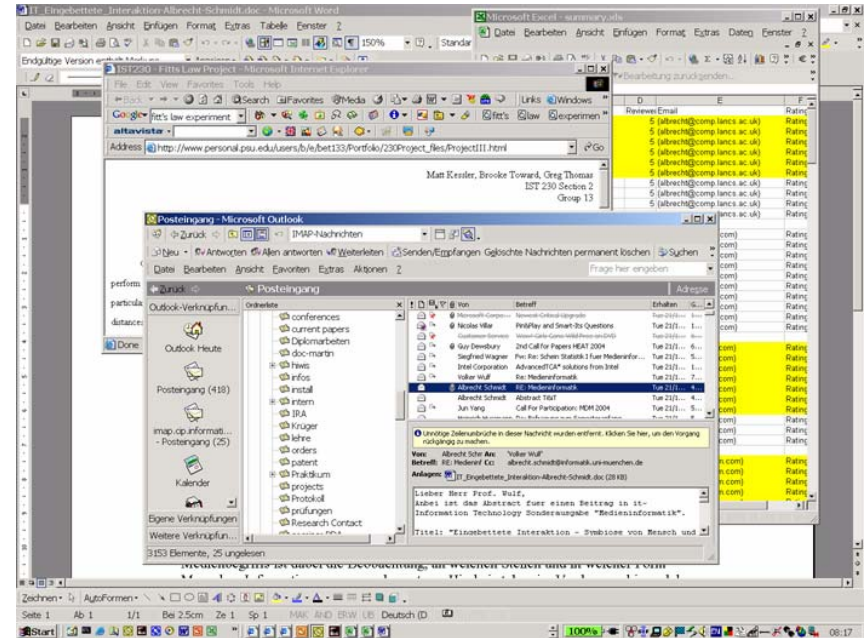
# Skilled Computer Users Answers

- Win2000 desktop
- Text and figures
- Icons and toolbars
- Overlapping windows
- Scroll bars and Menus
- Task bar and status information
- Handles and a pointer
- Representations of documents



# Basic (Naive) Technical Answers

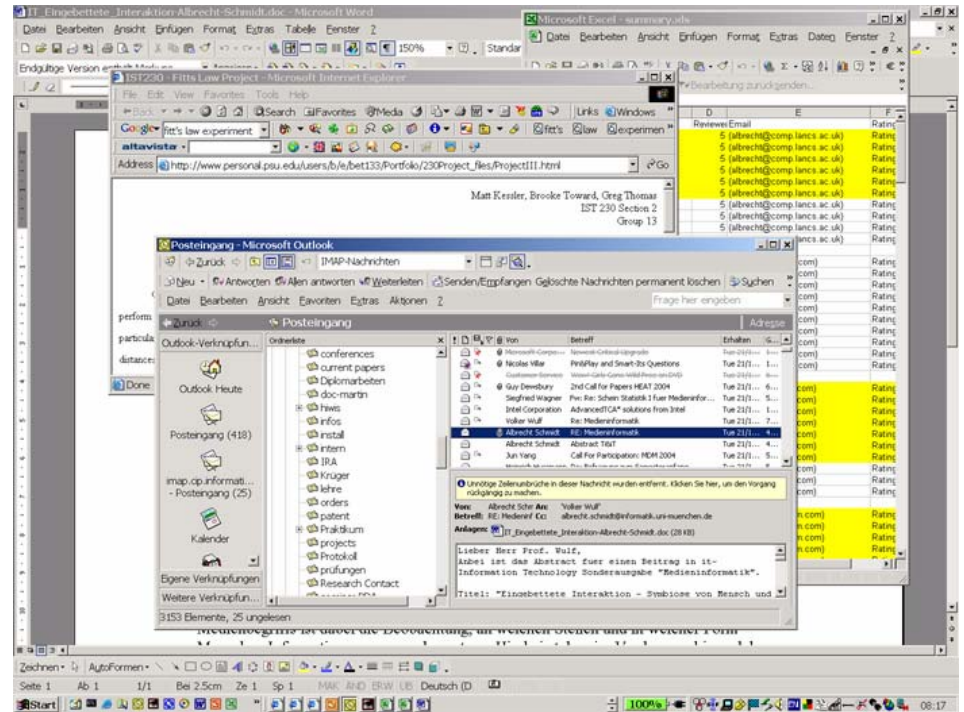
- 2-D surface
- Controllable pixels



- Image with a resolution of 1400x1050 pixels
- For each pixel the colour can be set
- The change of colour can be controlled rapidly

# Perfect User's Answers

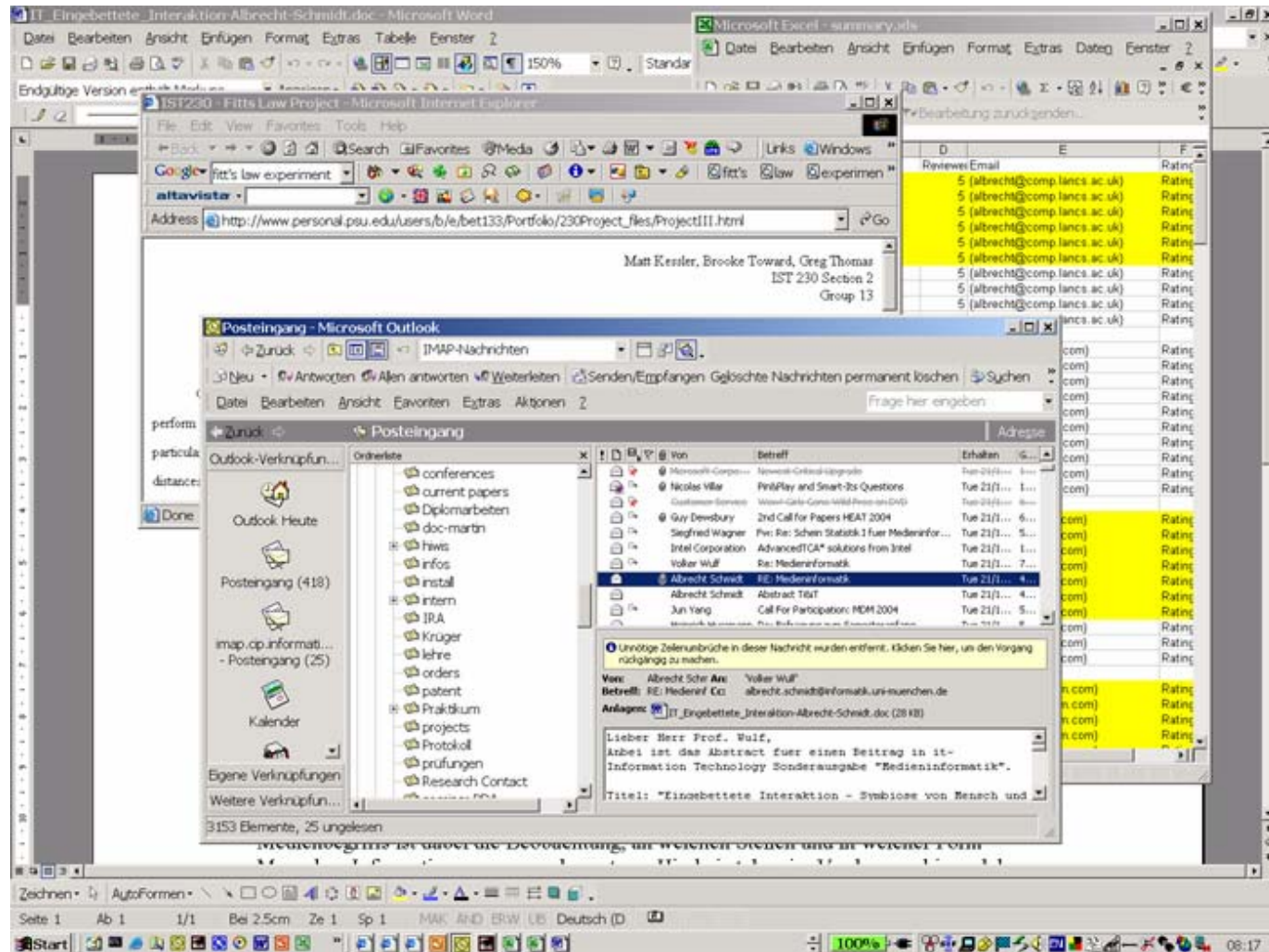
- My work environment
- Meeting notes
- Budget for next year
- Request to write a technical article
- Background information on a psychological phenomenon





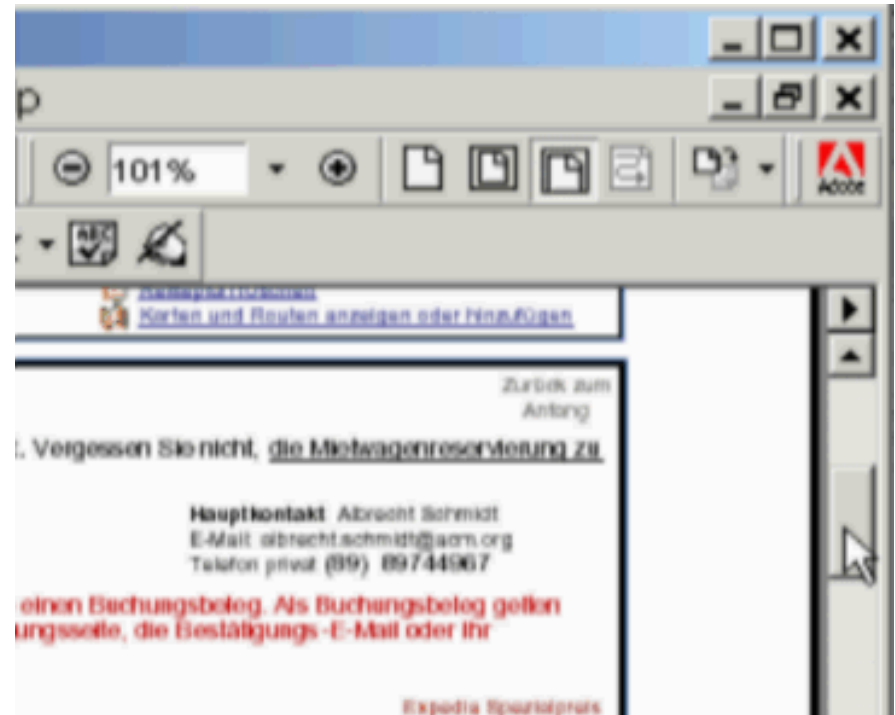
# Example I – Overlaying Windows

- What is the meaning that a window is behind another window?
- What is real?  
What is illusion?
- What does iconizing do?
- Models?  
Conceptually  
Implementation  
Represented



# Example II – Scrolling vs. Hand

- moving up the scroll bar moves down the document
- What happens really?  
What do we imagine?  
What is the metaphor?



# Example II – Scrolling vs. Hand

- moving up the hand moves up the document
- What happens really?  
What do we imagine?  
What is the metaphor?

