

## Introduction into human-computer interaction

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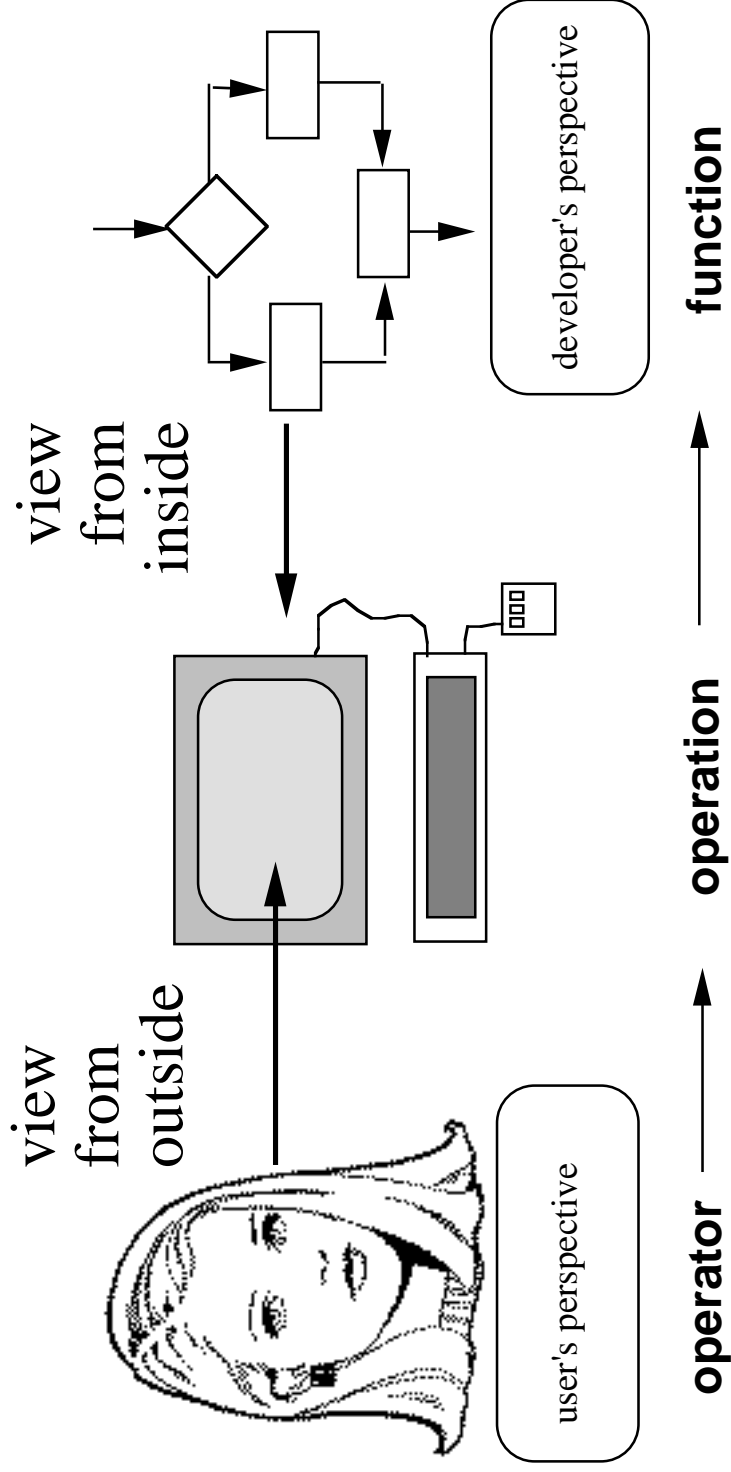
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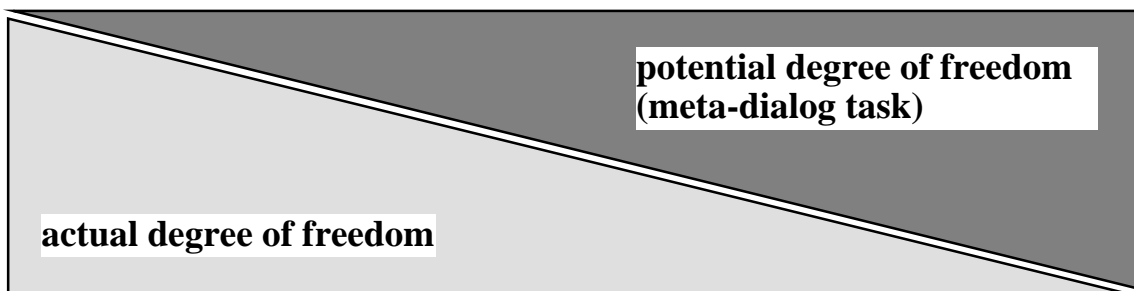
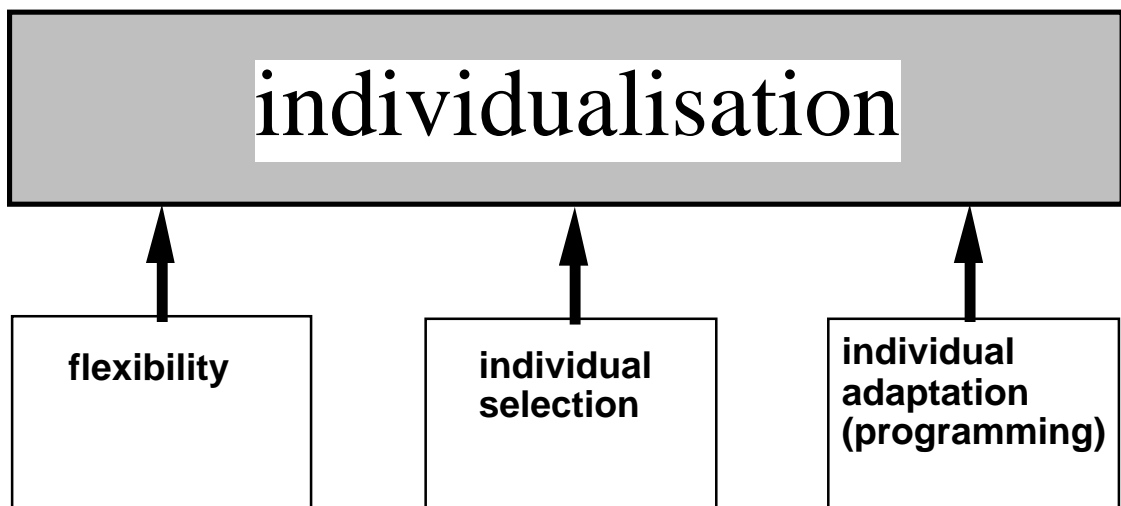
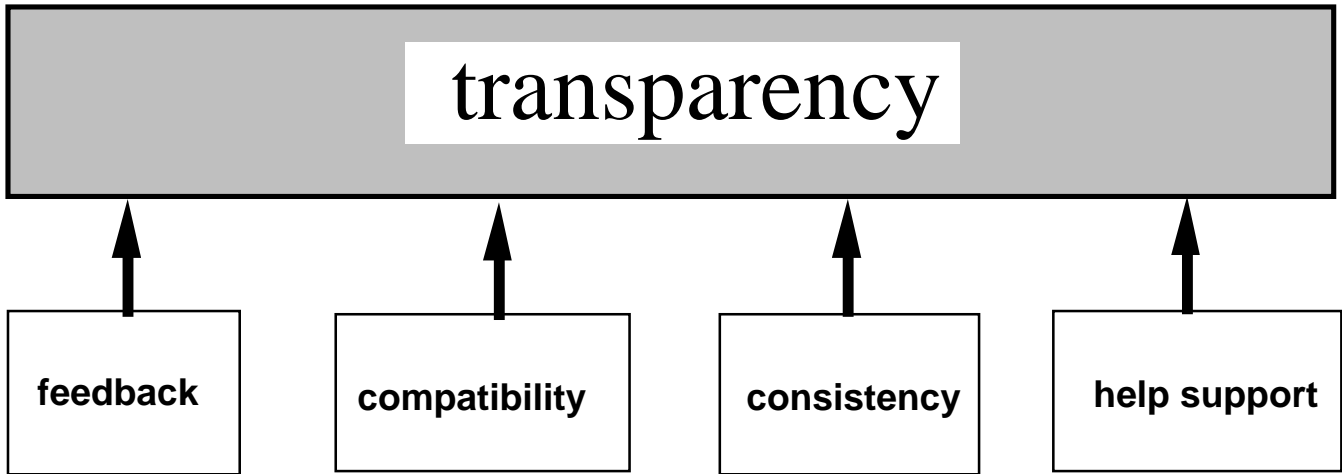
# Introduction into Human- Computer Interaction

**Matthias Rauterberg**

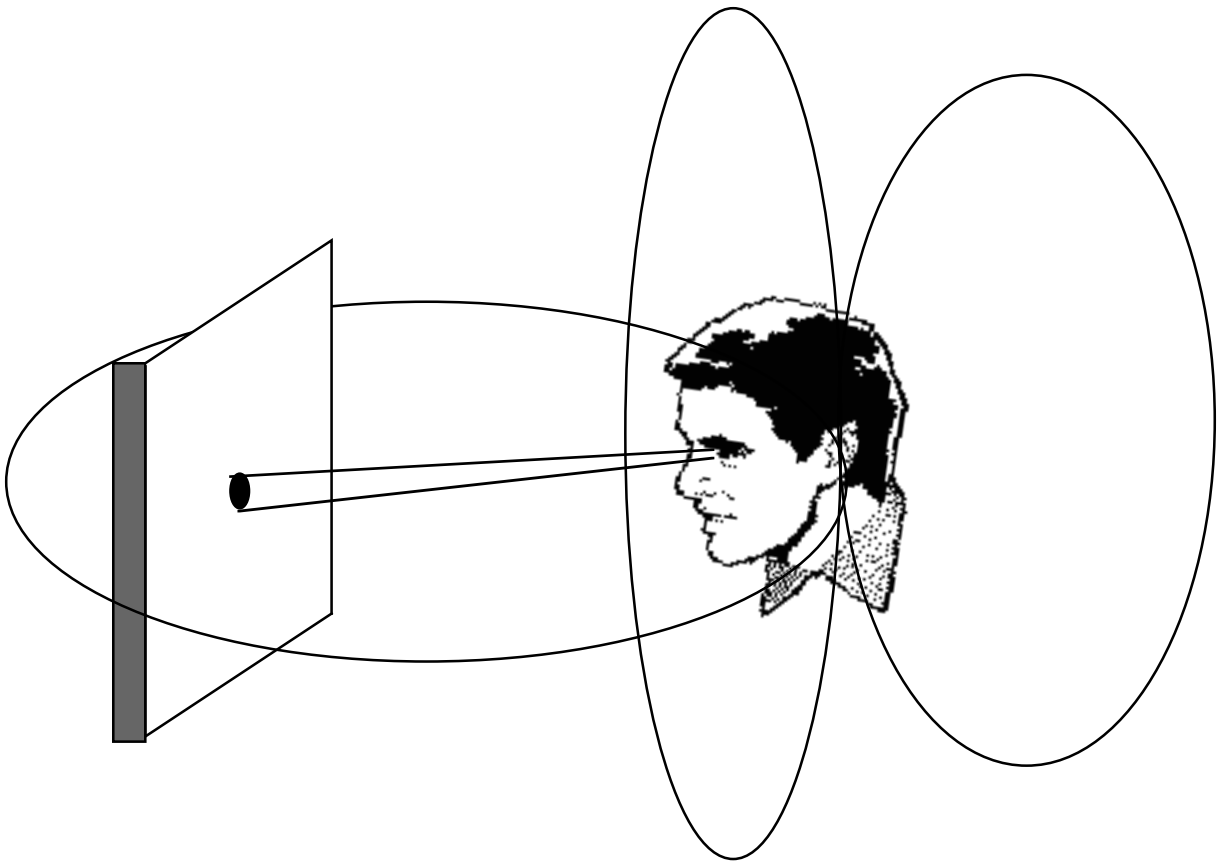
**1998**



DIN 66 234 part 8 (1988)	EC directive 90/270/EEC (1990)	ISO 9241 part 10 (1996)	Ulich (1991)
<p>suitability for the task</p> <p>self-descriptiveness</p>	<p>suitability (activity adapted)</p> <p>feedback about system states</p> <p>appropriate format and pace of information presentation</p>	<p>suitability for the task</p> <p>self-descriptiveness</p>	<p>task orientation</p> <p>transparency</p> <p>feedback</p>
<p>conformity with user expectations</p>	<p>information and instruction of user</p> <p>ease of use applicable to skill level</p> <p>hearing and participation of users</p>	<p>conformity with user expectations</p>	<p>compatibility</p> <p>consistency</p> <p>support</p>
<p>controllability</p> <p>error robustness</p>		<p>suitability for learning</p> <p>suitability for individualization</p> <p>controllability</p> <p>error tolerance</p>	<p>selection possibilities</p> <p>user definability</p> <p>participation</p> <p>flexibility</p>



# Differences between the visual and the auditory sense



## The two most important constraints in interface design

- the control of user's attention
- the physical size of the screen

# feedback modalities

## pros

## cons

visual

parallel in space  
large information transfer

active eye contact necessary

acoustic

enforces attention allocation  
enables the perception of background activities  
important for visually impaired people

noise through environment

linear in time

exists only for a short time span

haptic

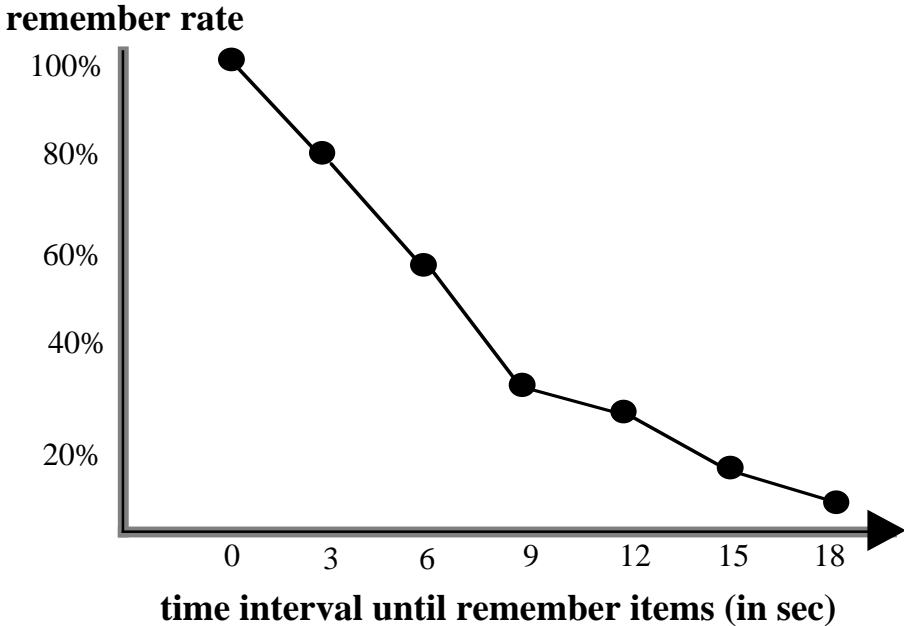
force perception  
object recognition  
textur and surface perception

linear in time

contact with objects

necessary

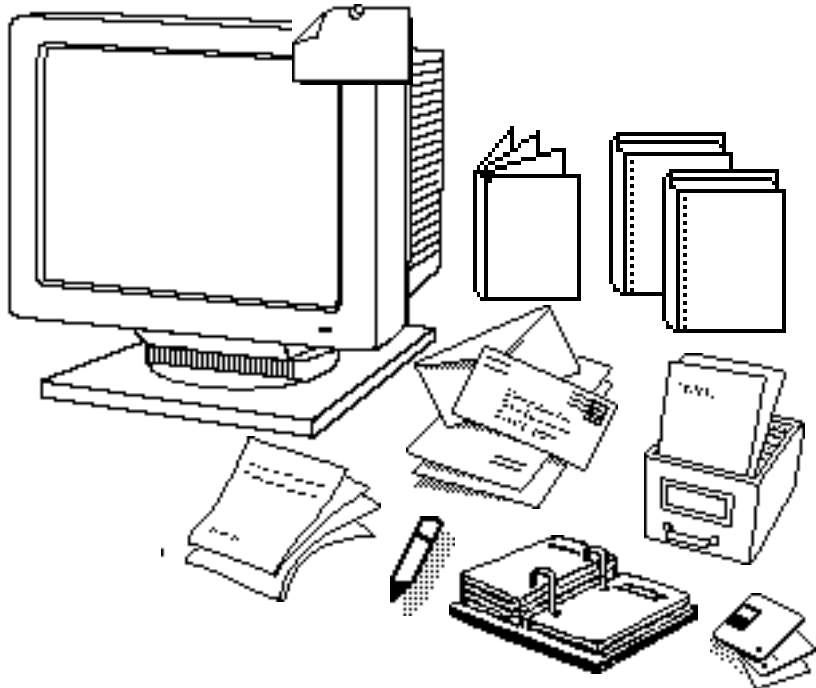
# human memory



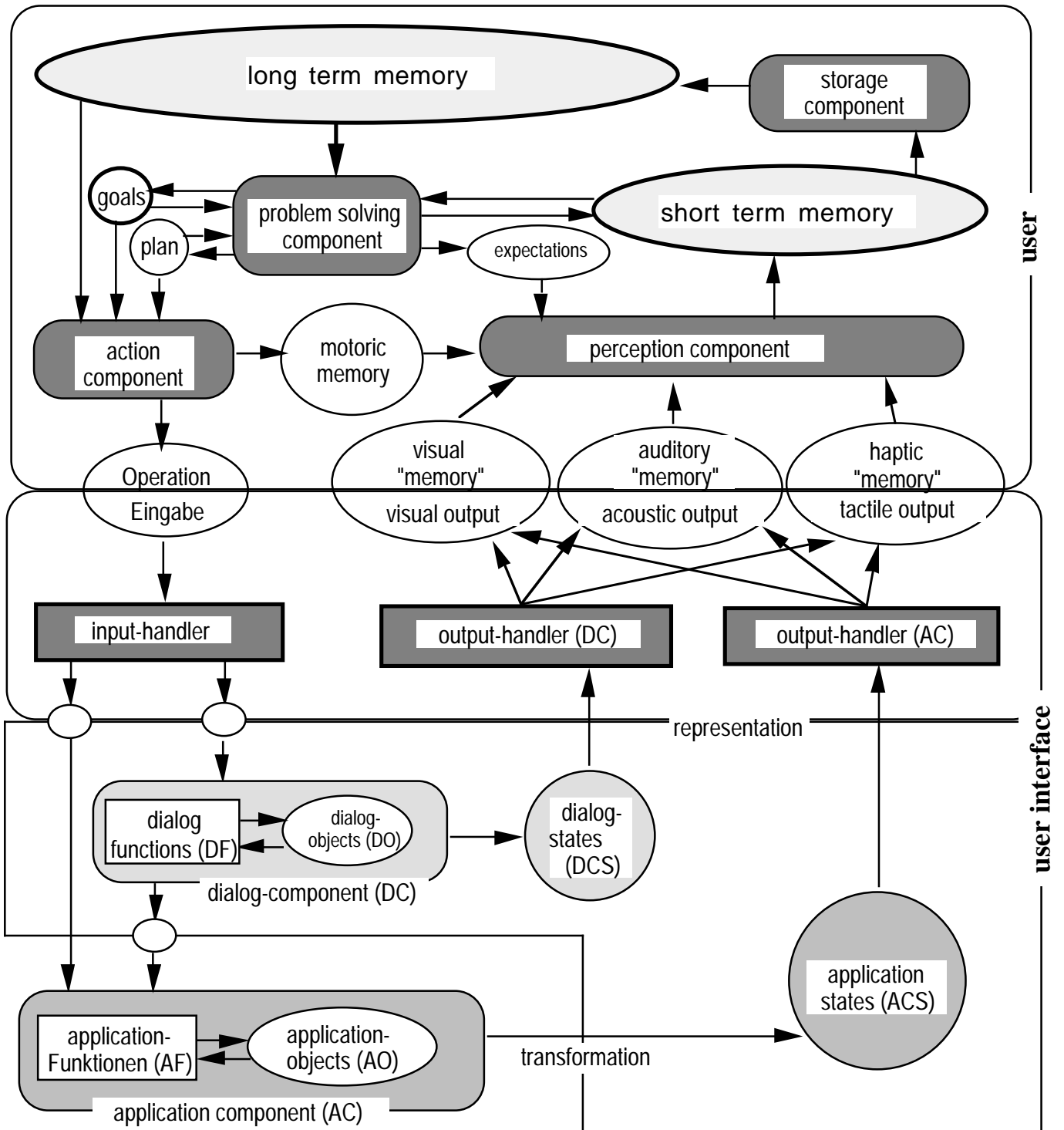
**internal memory**

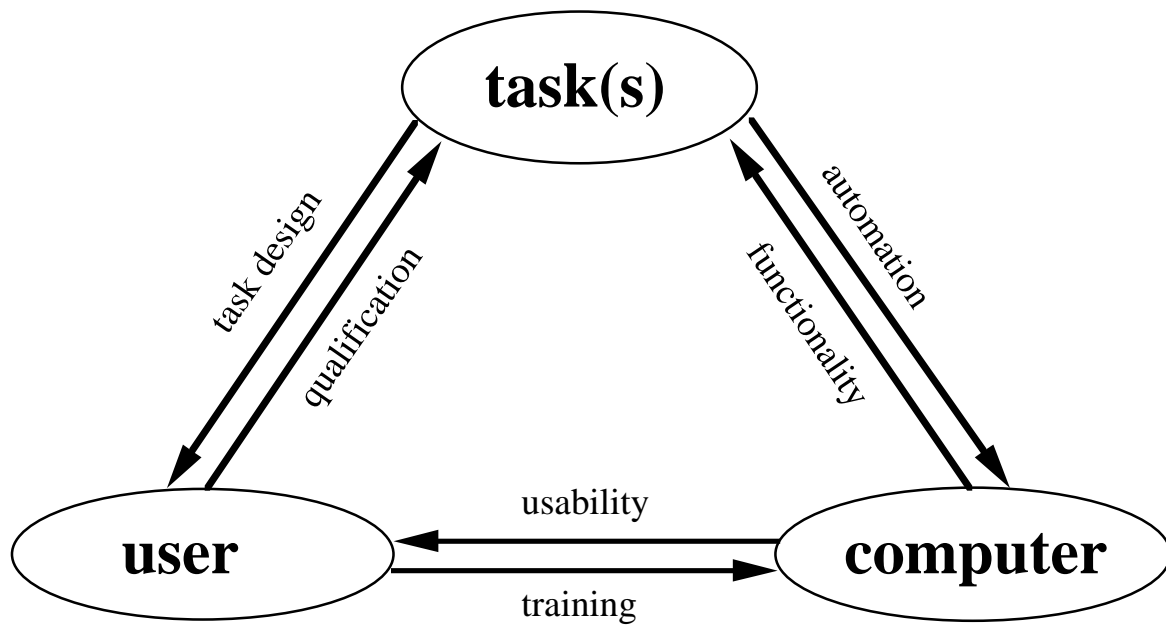


**external memory**





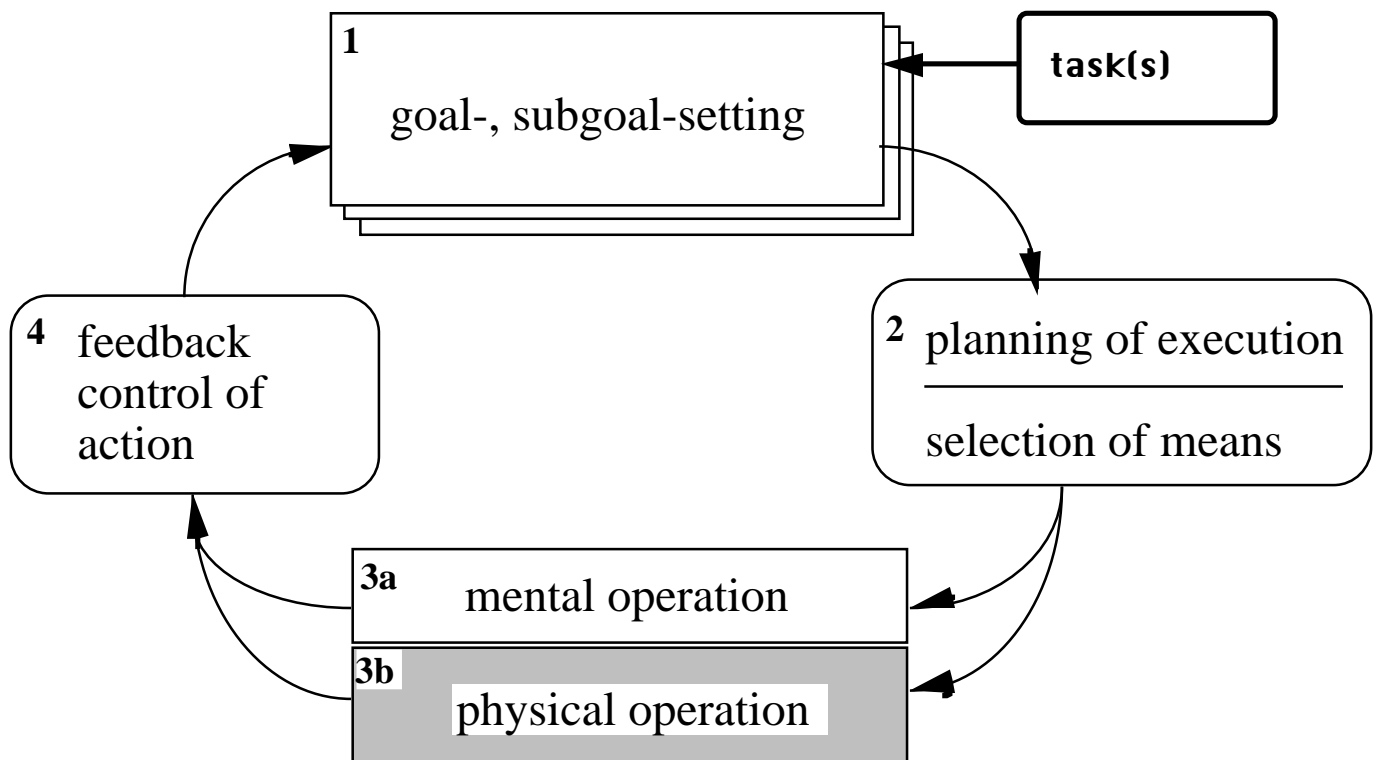




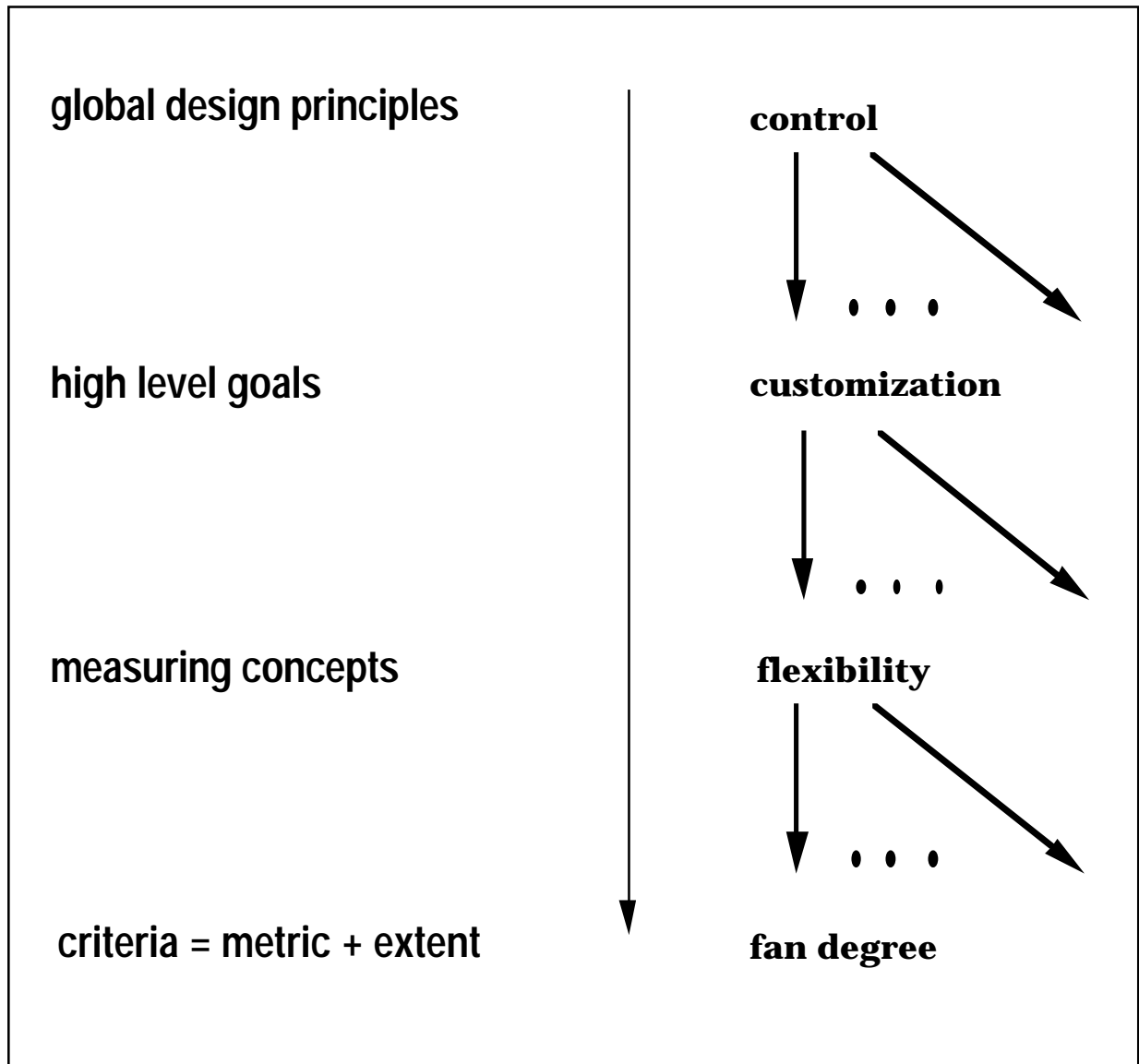
## **user-oriented requirement analysis**

- **know the user**
- **describe the context of use**
- **analyse the user's tasks**
- **decide for man-machine function allocation**

# the complete action cycle

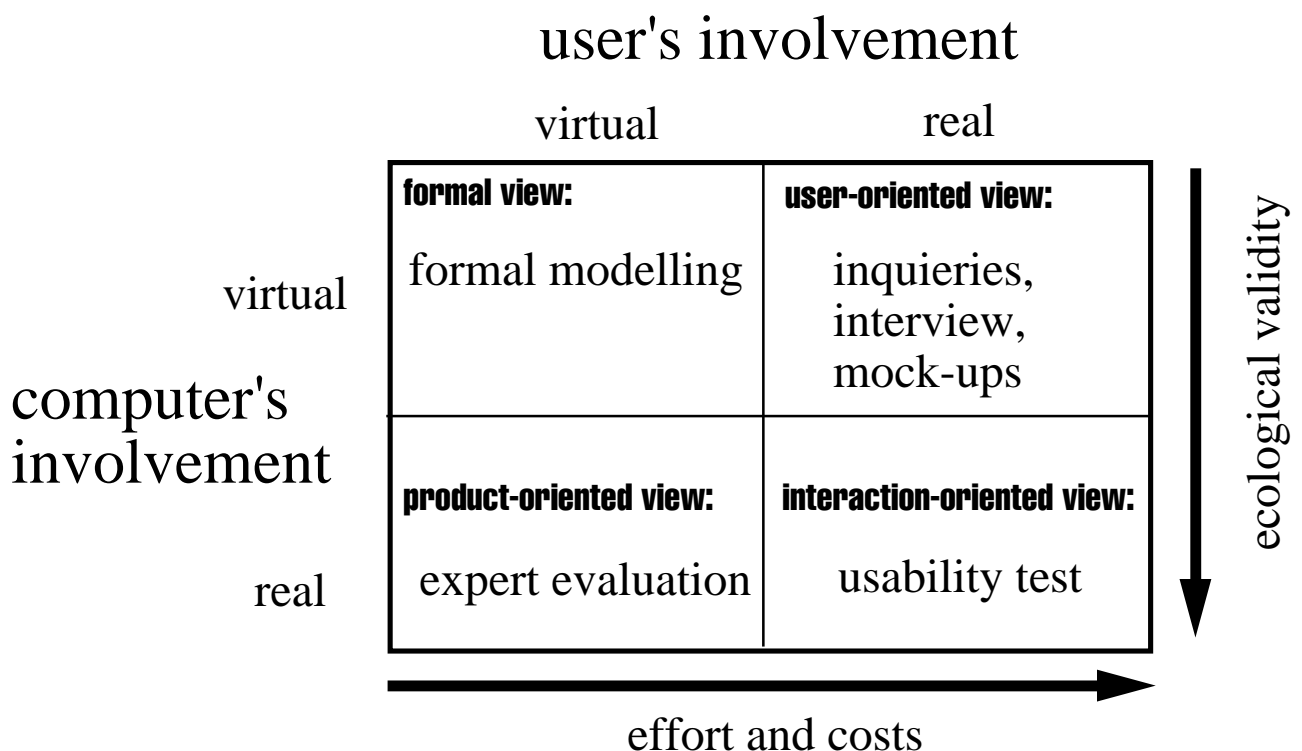


# usability specification map (USM)

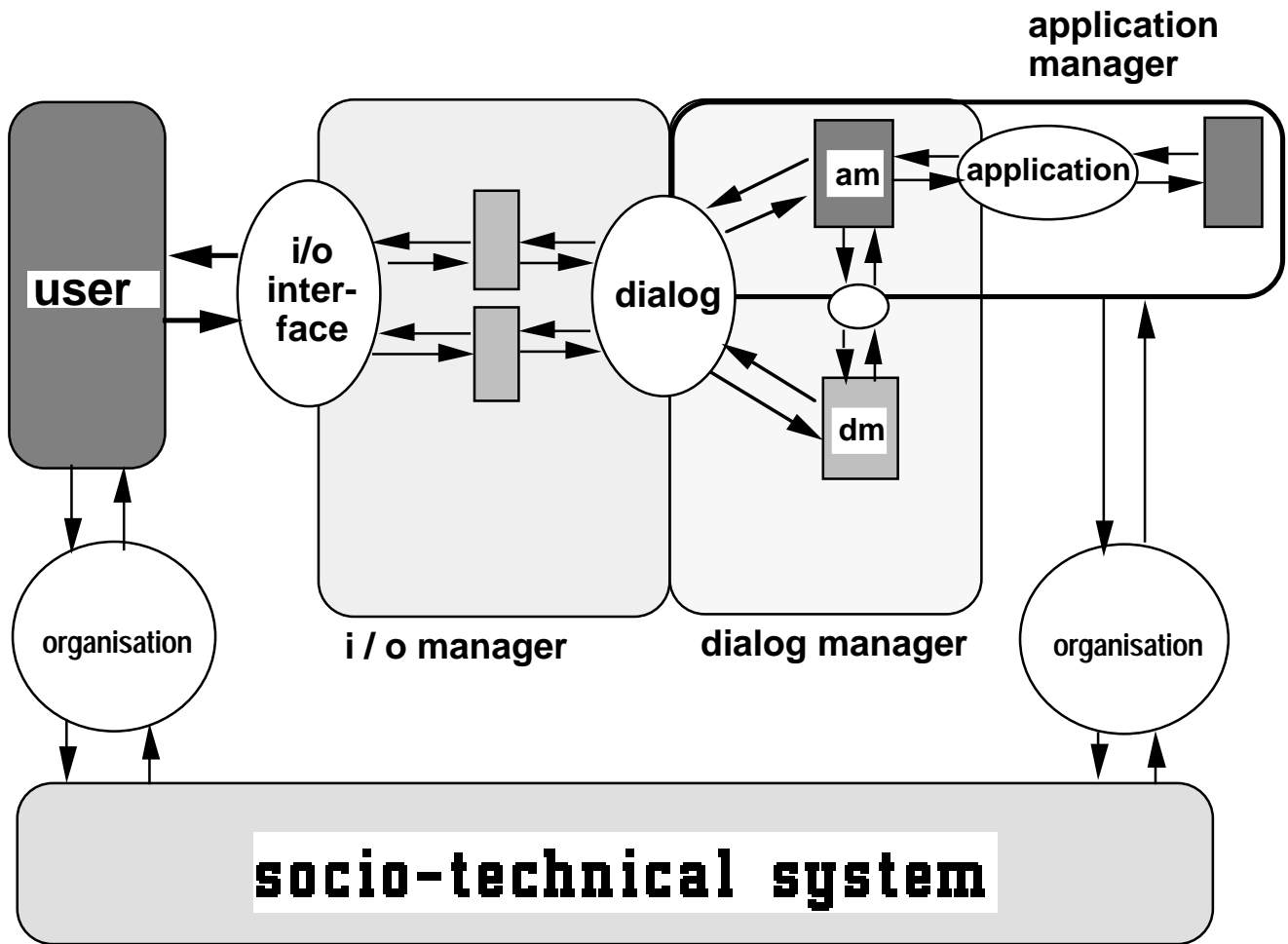


scale type	examples in the context of HCI
nominal	classification of interfaces (e.g. command, menu, desktop etc.)
ordinal	summative evaluation studies (e.g. CUI versus GUI)
interval	checklist evaluation (e.g. expert's opinion)
rational	quantitative metrics

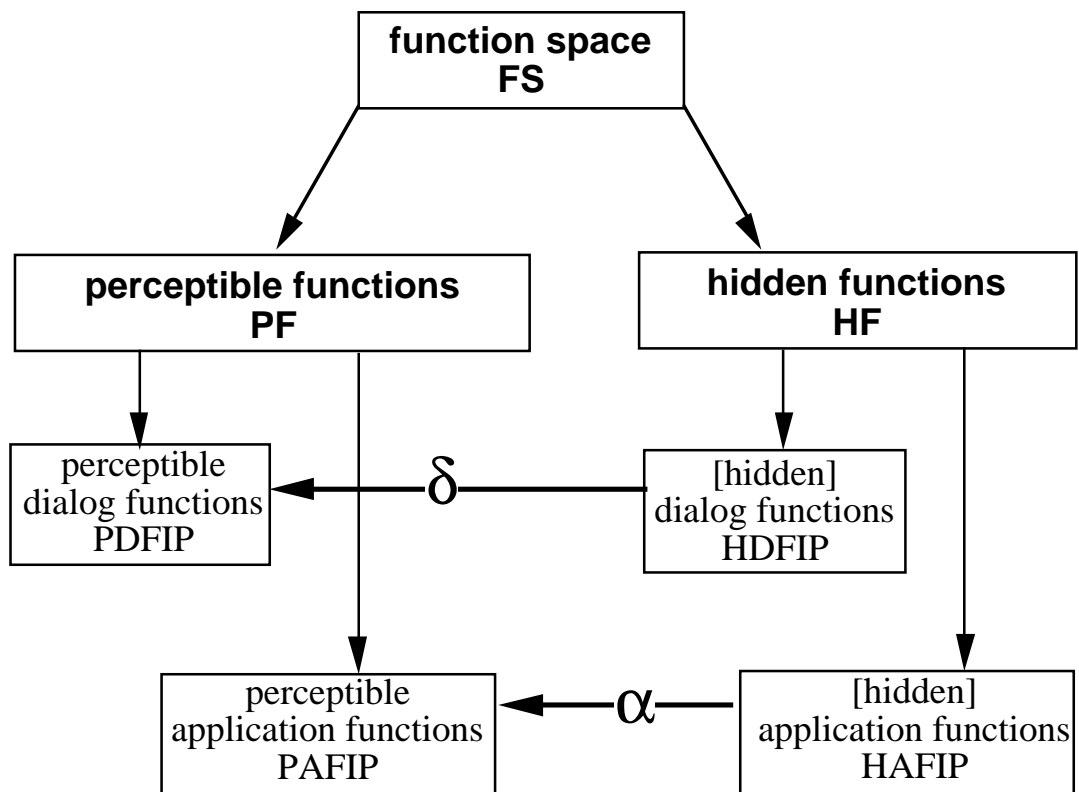
## Methods to Measure Usability Quality



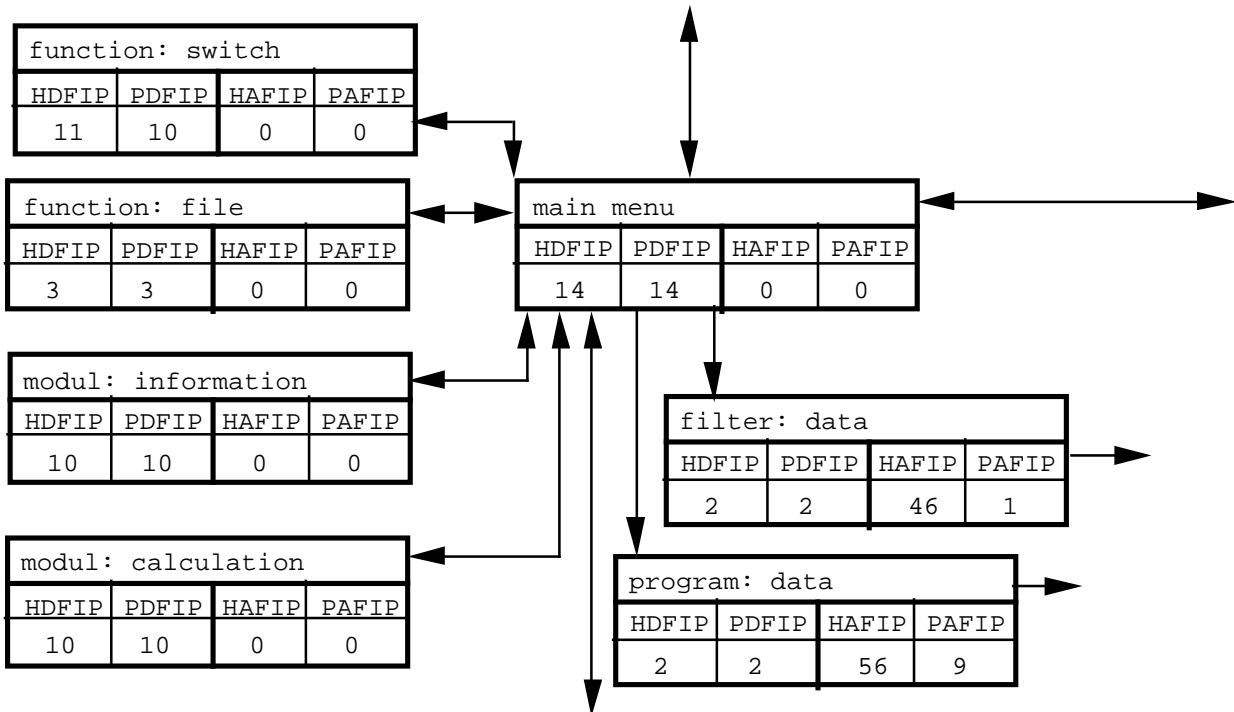
# the advanced Seeheim-model:



# An abstract concept to describe usability aspects

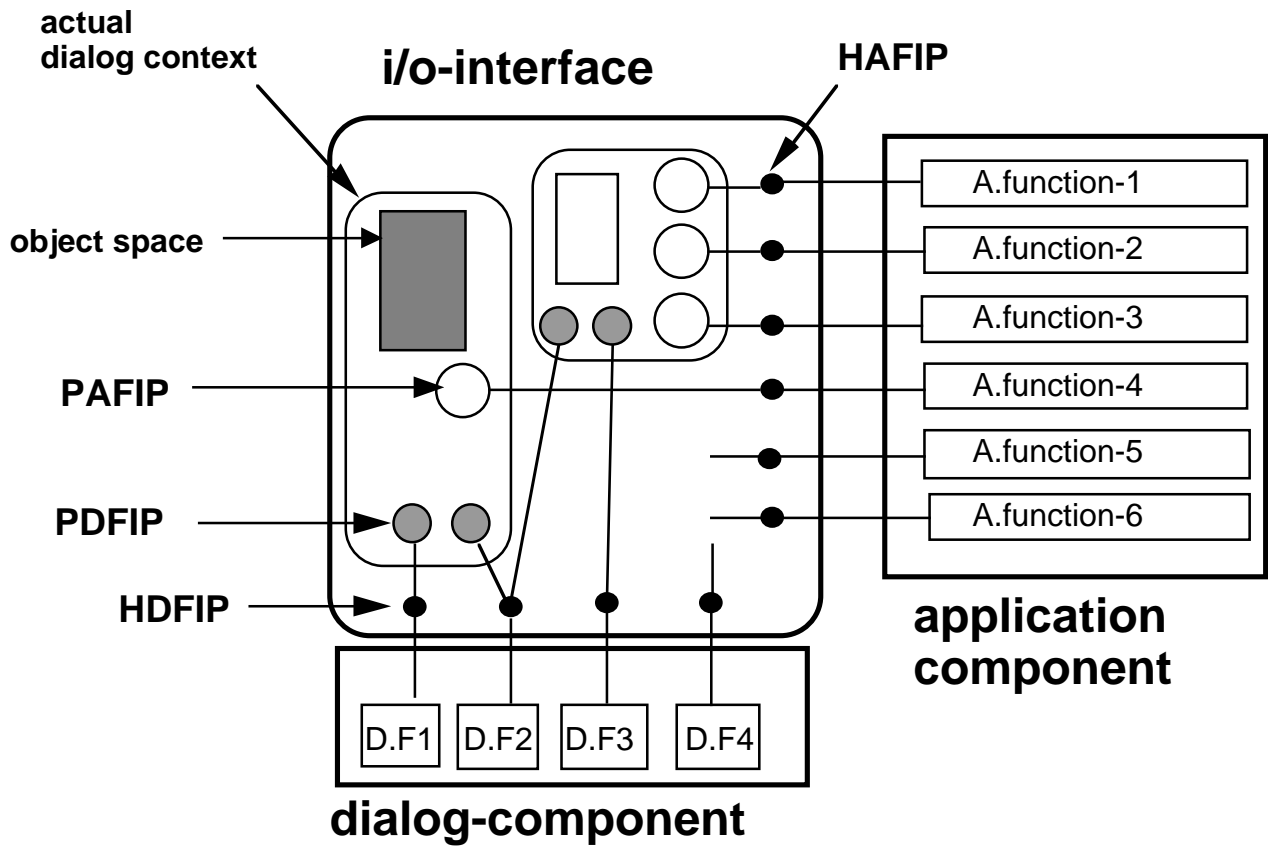


# schema of the dialog structure

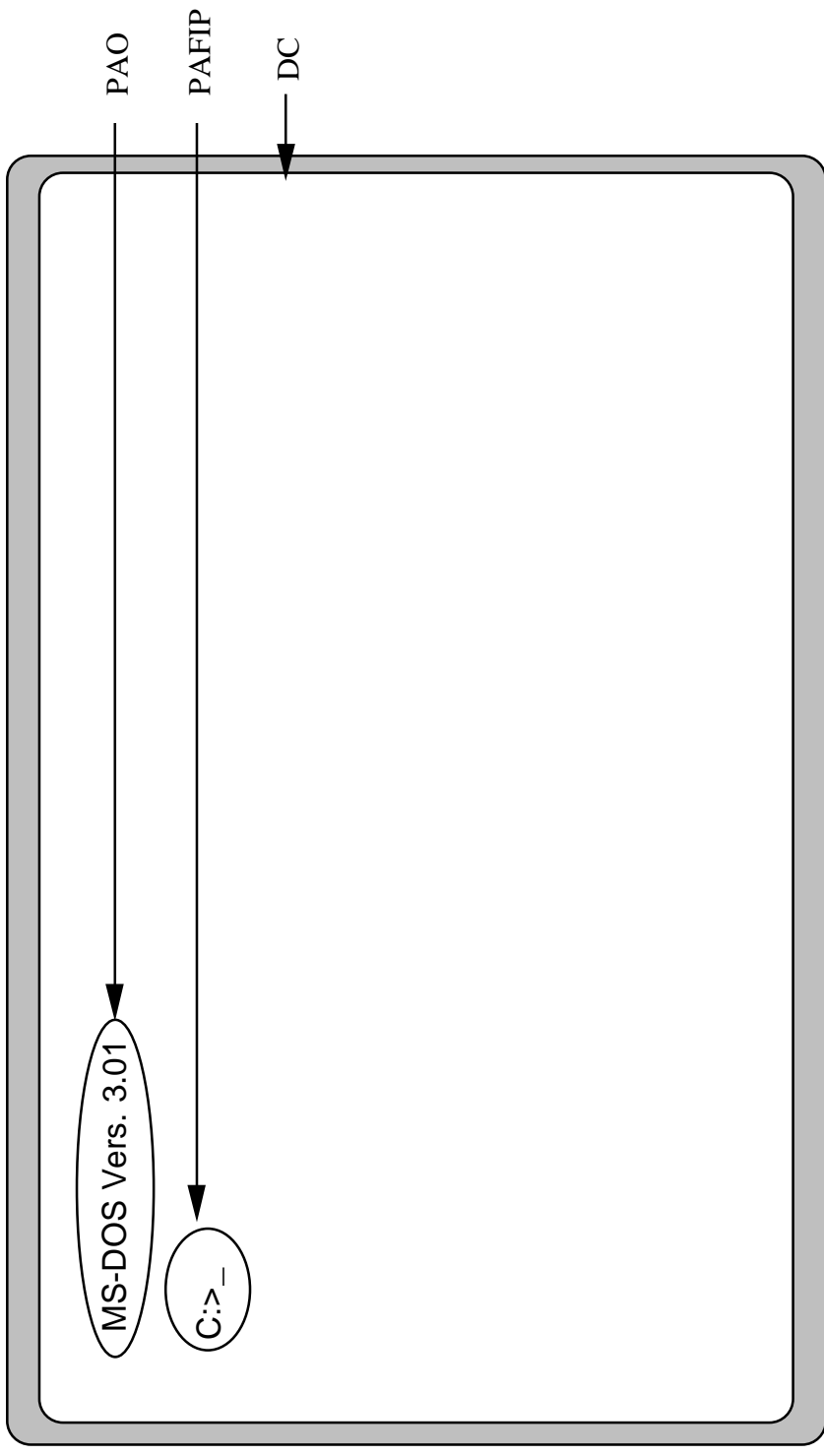




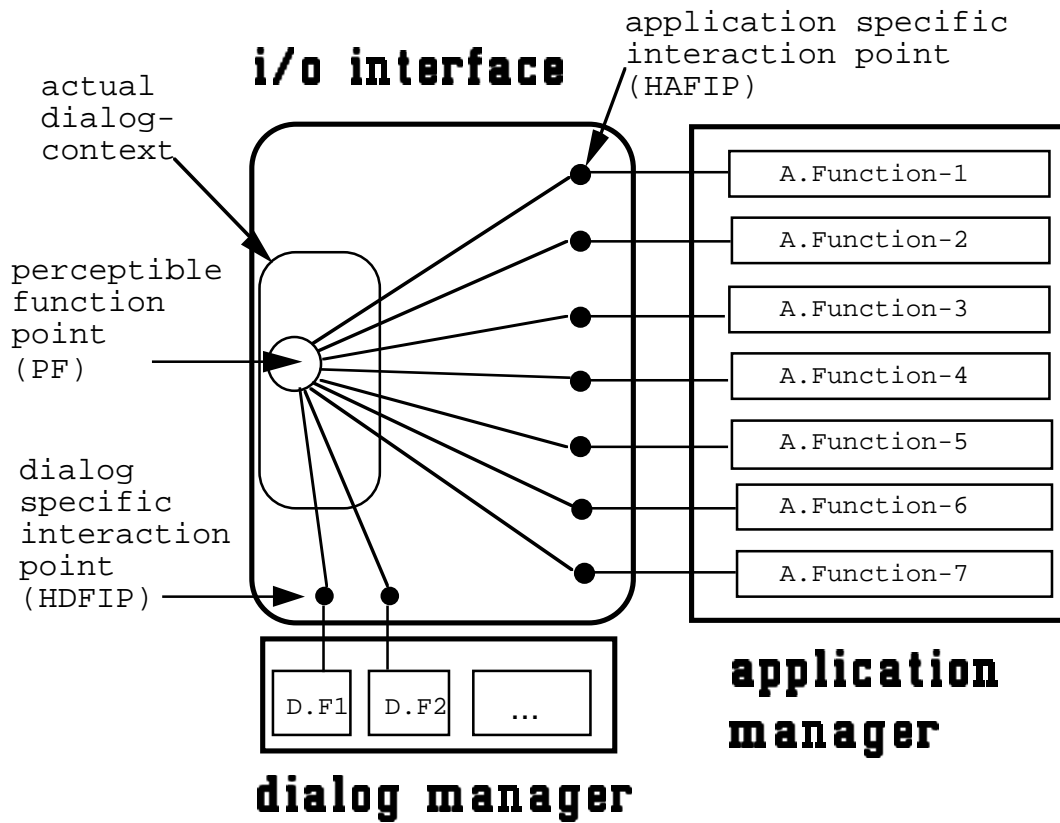
# schematic diagram



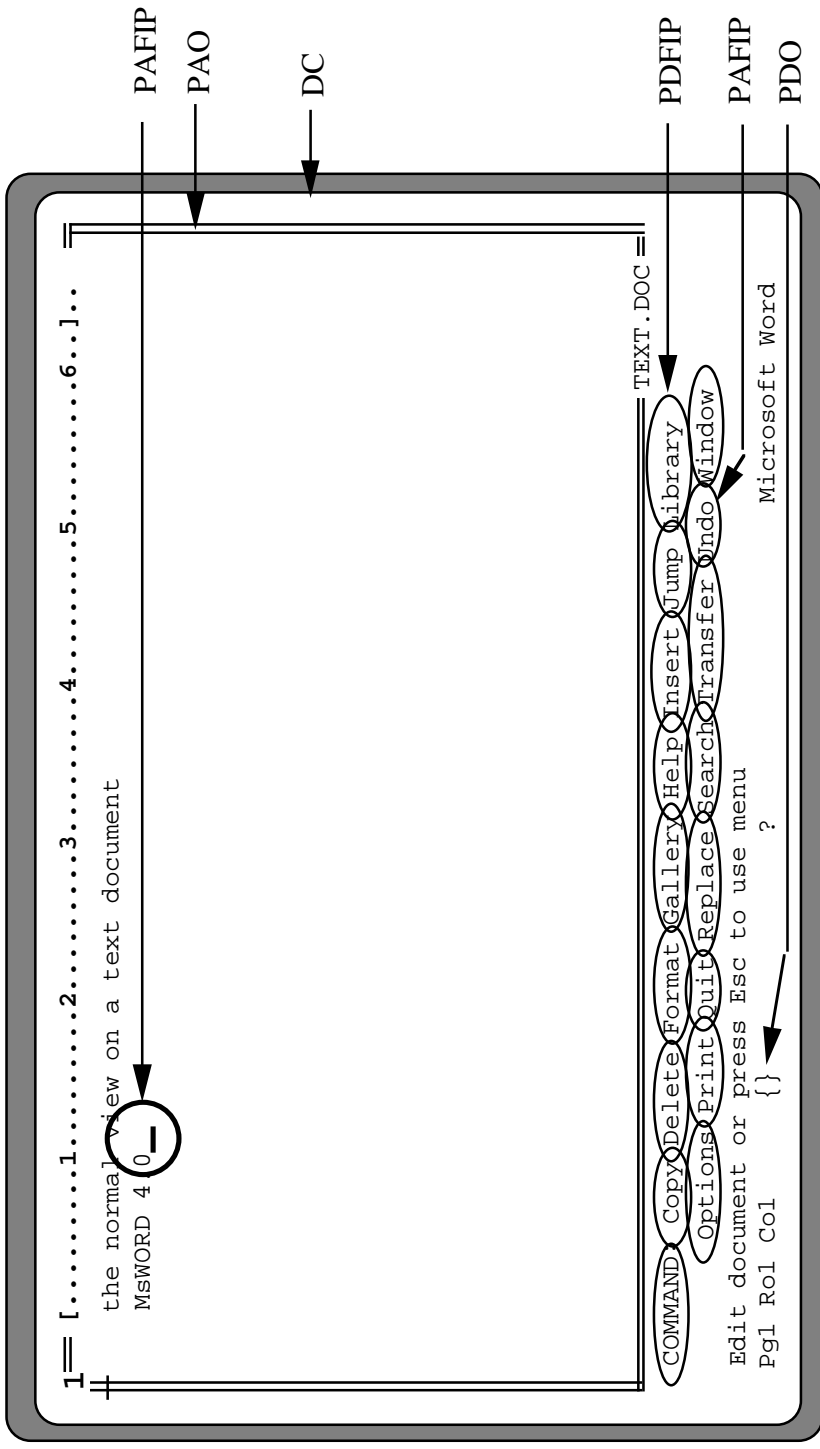
# a command language interface



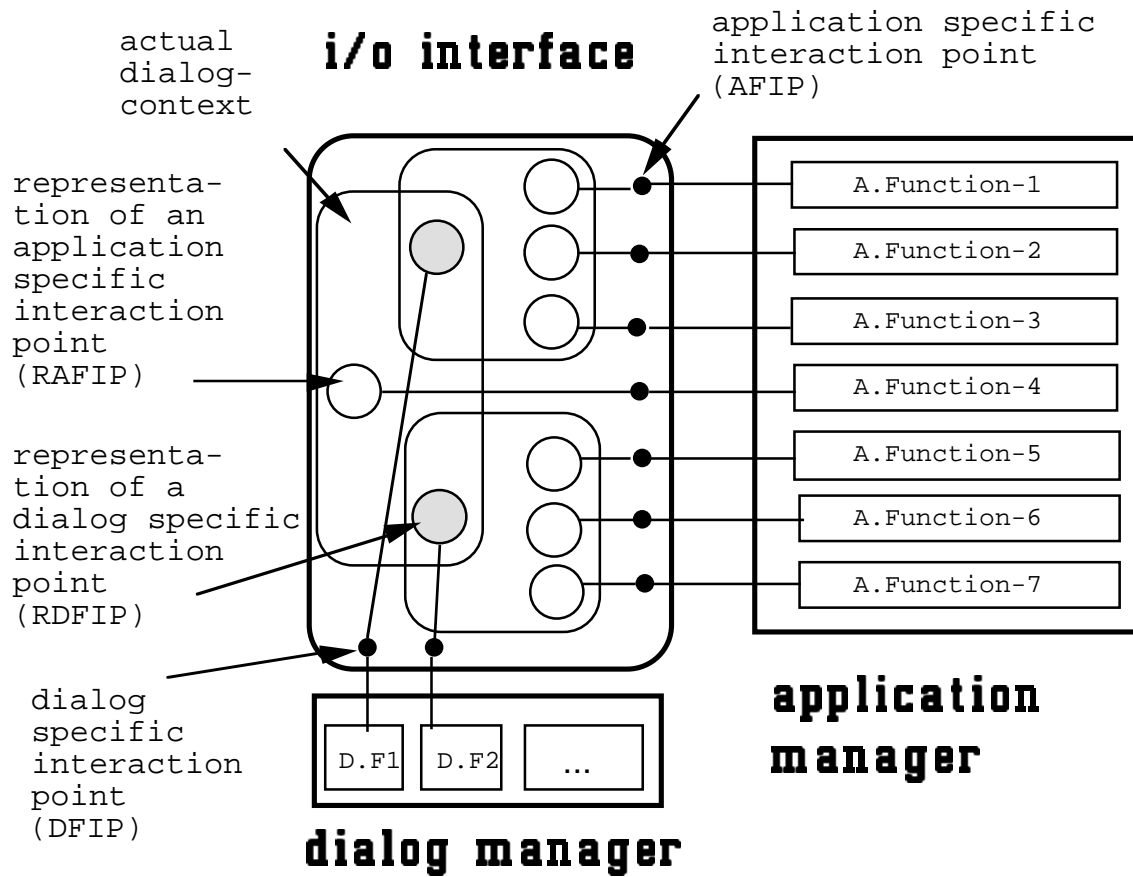
# command language interface (CUI)



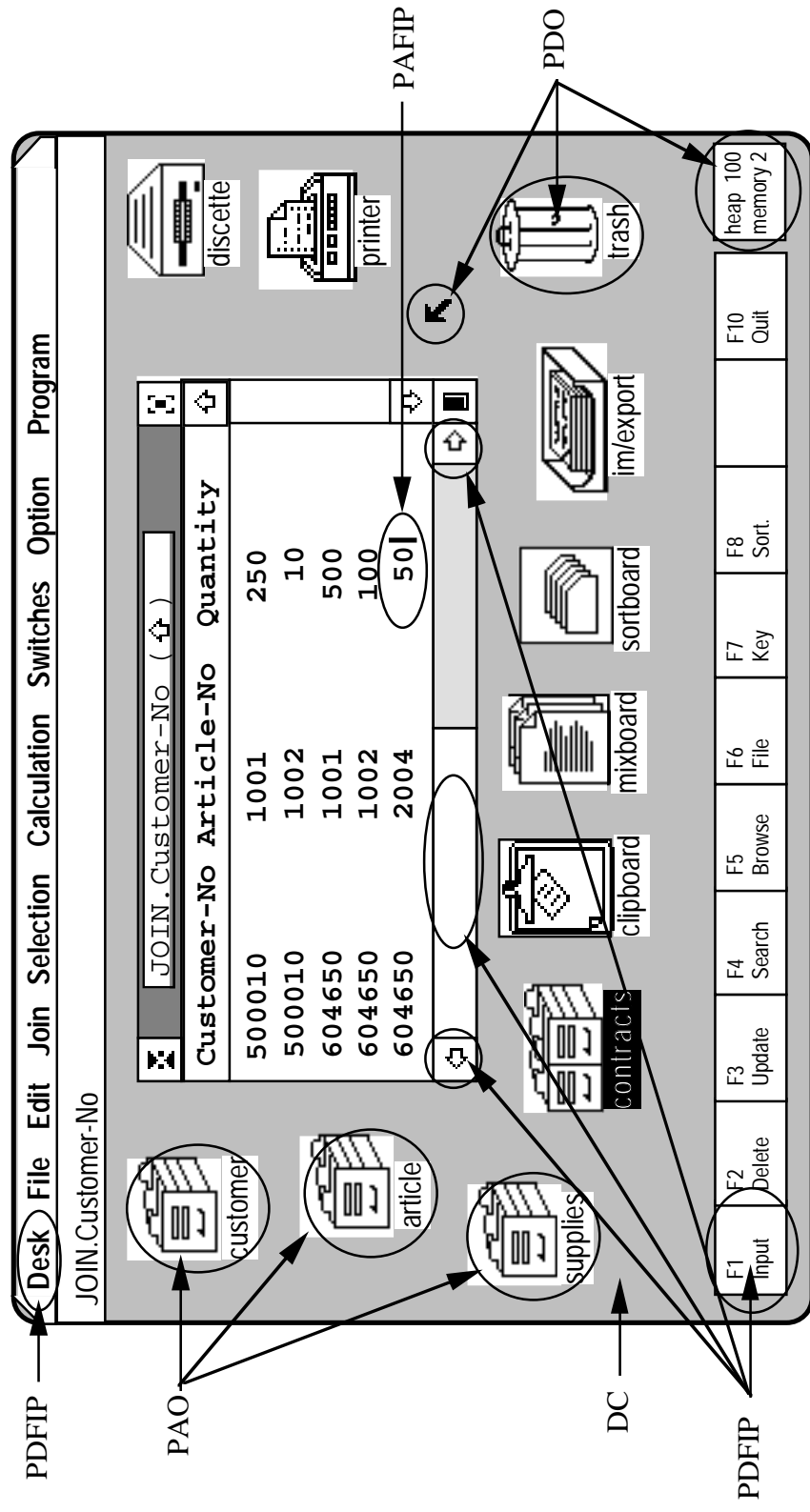
# a menu-driven interface (CUI)



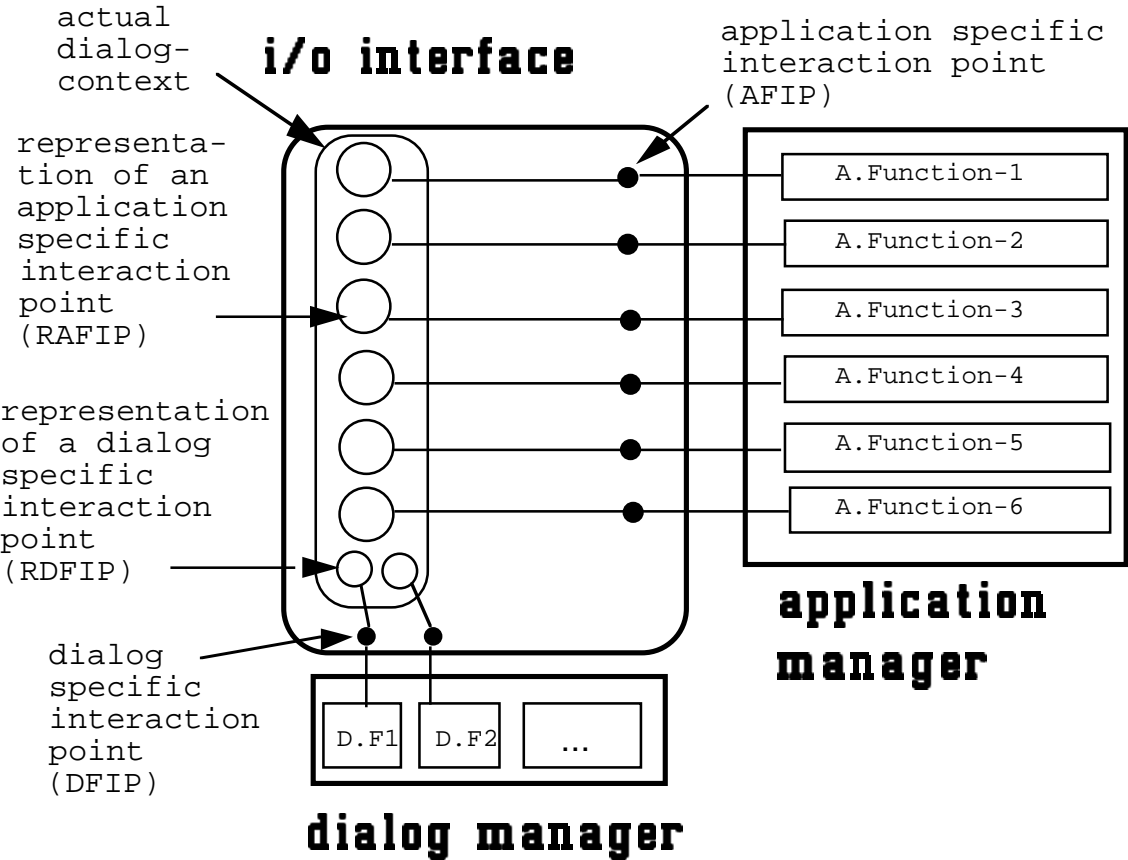
# menu driven interface (CUI)



# GUI: a desktop interface



# direct manipulative interface (GUI)



quantitative measure of "functional feedback":

$$FB = 1/D \sum_{d=1}^D (\#PF_d / \#HF_d) * 100\%$$

quantitative measure of "fan degree":

$$FD = 1/D \sum_{d=1}^D \sum_{f \in HAFIP} Post(D_d, f)$$

quantitative measure of "dialog flexibility":

$$DF1 = 1/D \sum_{d=1}^D \#HDFIP_d$$

quantitative measure of "application flexibility":

$$AF1 = 1/D \sum_{d=1}^D \#HAFIP_d$$



quantitative measure of "feedback":

$$FB = 1/D \sum_{d=1}^D (\#PF_d / \#HF_d) * 100\%$$

quantitative measure of "interactive directness":

$$ID = \{1/P \sum_{p=1}^P \min[\ln_g(PATH_p)]\}^{-1} * 100\%$$

[visual] feedback (FB)

		low	high
interactive directness (ID)	low	batch	menu interface <b>MI</b>
	high	command language <b>CI</b>	desktop style direct manipulation <b>DI</b>

## The outcomes of nine (9) different comparison studies between command (CI) and menu (MI) interfaces.

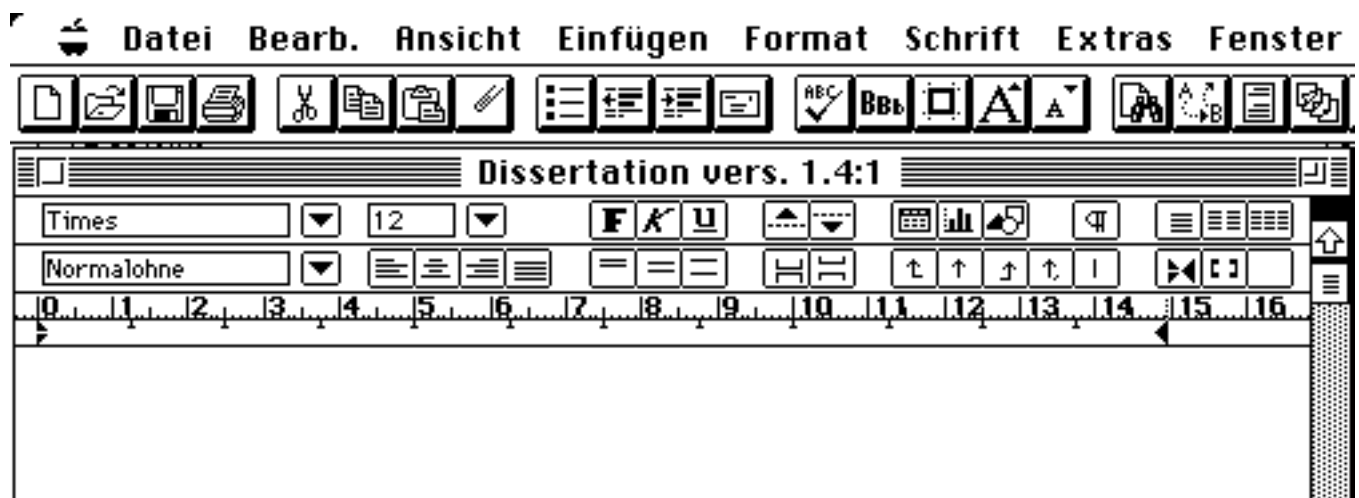
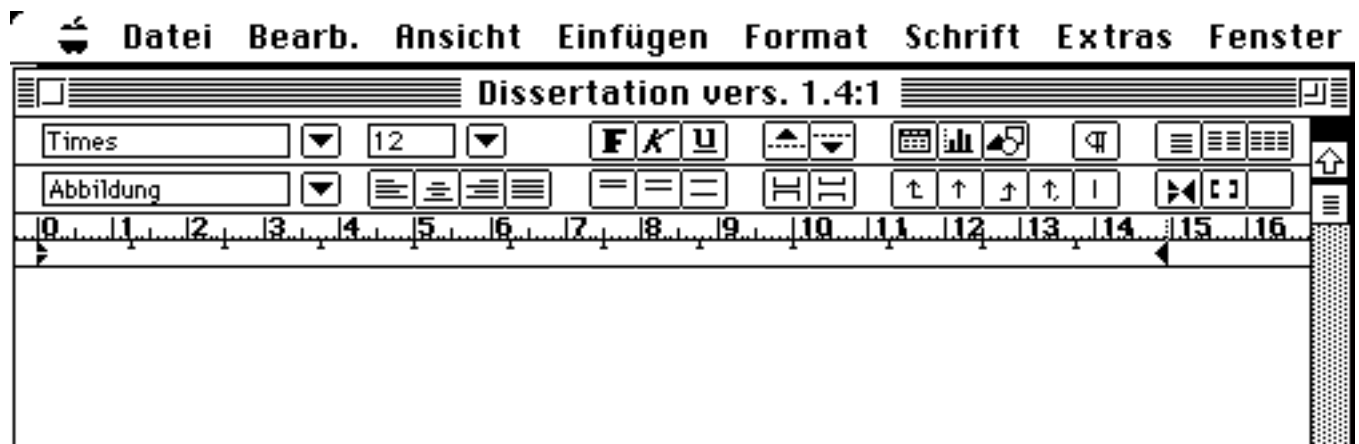
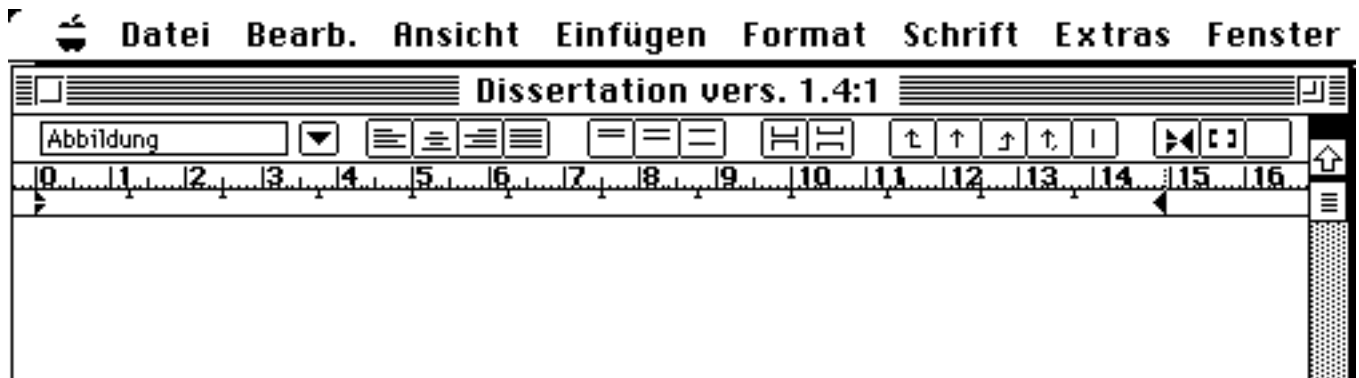
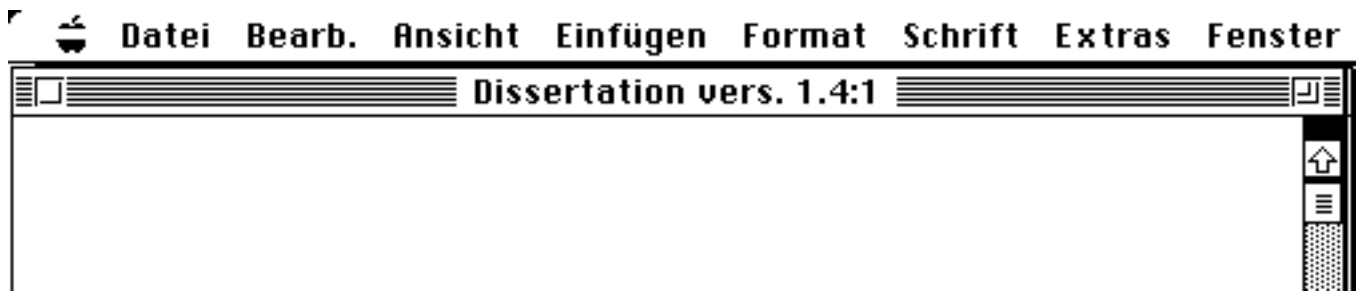
"CI < MI" means that the average usage/preference with/for MI is better than with/for CI;  
 "CI = MI" means that there are no published data to decide;  
 "CI > MI" means that the average usage/preference with/for CI is better than with/for MI;  
 "sig." means that  $p \leq 0.05$ ; "not sig." means that  $p > 0.05$

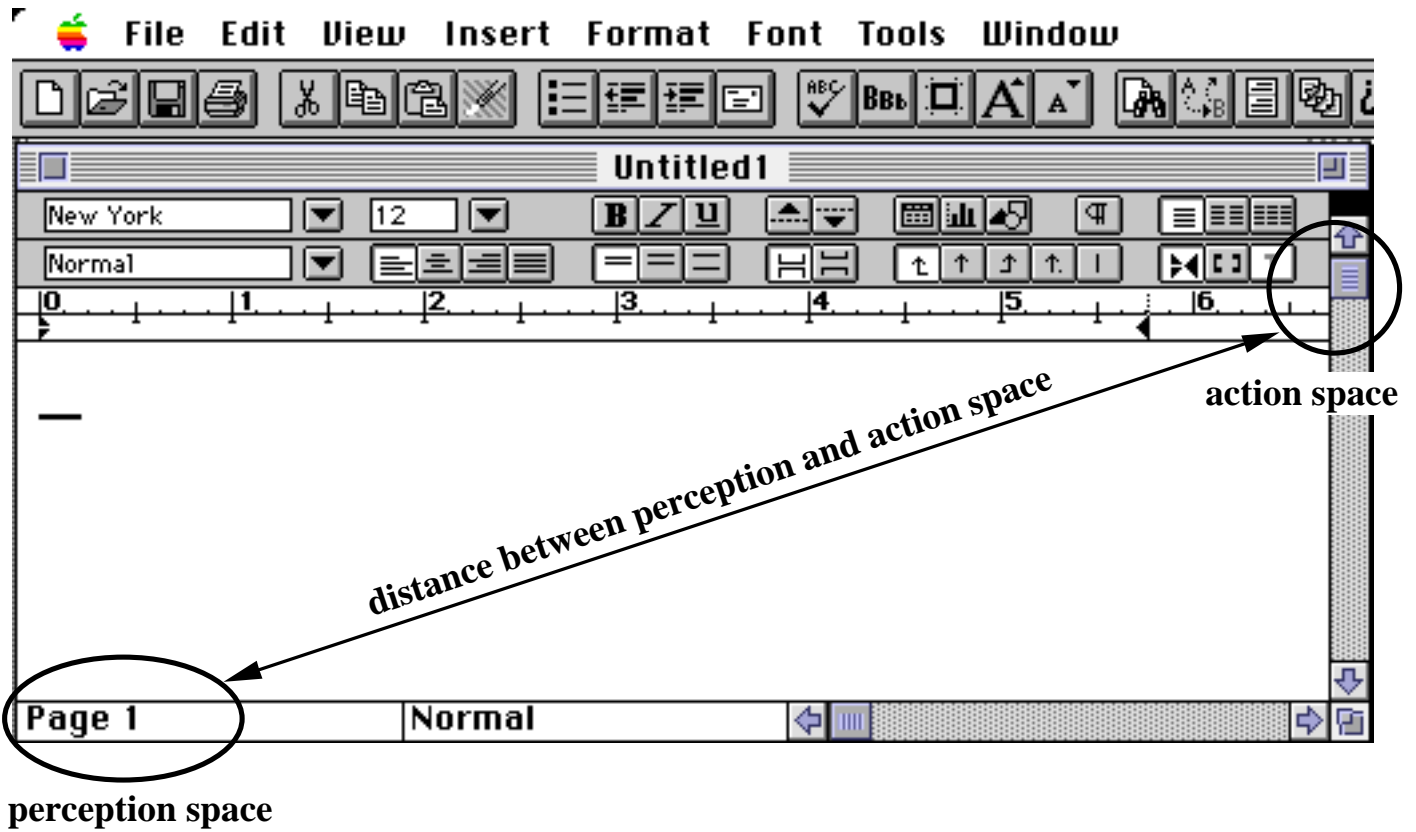
Reference	interface	skill level	usability metric	outcome	result
Streitz et al. (1987)	CI, MI	beginner	task solving time	CI < MI	sig.
Chin et al. (1988)	CI, MI	beginner	subjective rating	CI < MI	sig.
Ogden & Boyle (1982)	CI, MI, HY	beginner	preferences	CI < MI	sig.
Roy (1992)	CI, MI	advanced	error rate	CI < MI	sig.
Roberts & Moran (1983)	CI, MI, DI	experts	task solving time	CI < MI	sig.
Chin et al. (1988)	CI, MI	experts	subjective rating	CI < MI	sig.
Peters et al. (1990)	CI, MI, DI	experts	slips	CI < MI	sig.
Peters et al. (1990)	CI, MI, DI	experts	recognition errors	CI < MI	sig.
Peters et al. (1990)	CI, MI, DI	experts	efficiency	CI < MI	sig.
Ogden & Boyle (1982)	CI, MI, HY	beginner	task time	CI < MI	not sig.
Roy (1992)	CI, MI	advanced	task solving time	CI < MI	not sig.
Antin (1988)	CI, MI, KMI	advanced	subjective rating	CI < MI	not sig.
Hauptmann & Green (1983)	CI, MI, NO	beginner	task solving time	CI = MI	not sig.
Hauptmann & Green (1983)	CI, MI, NO	beginner	number of errors	CI = MI	not sig.
Hauptmann & Green (1983)	CI, MI, NO	beginner	subjective rating	CI = MI	not sig.
Whiteside et al. (1985)	CI, MI, IO	beginner	task completion rate	CI > MI	not sig.
Antin (1988)	CI, MI, KMI	advanced	preferences	CI > MI	not sig.
Roberts & Moran (1983)	CI, MI, DI	experts	error-free task time	CI > MI	not sig.
Whiteside et al. (1985)	CI, MI, IO	advanced	task completion rate	CI > MI	sig.
Streitz et al. (1987)	CI, MI	advanced	task solving time	CI > MI	sig.
Antin (1988)	CI, MI, KMI	advanced	task completion rate	CI > MI	sig.
Whiteside et al. (1985)	CI, MI, IO	experts	task completion rate	CI > MI	sig.

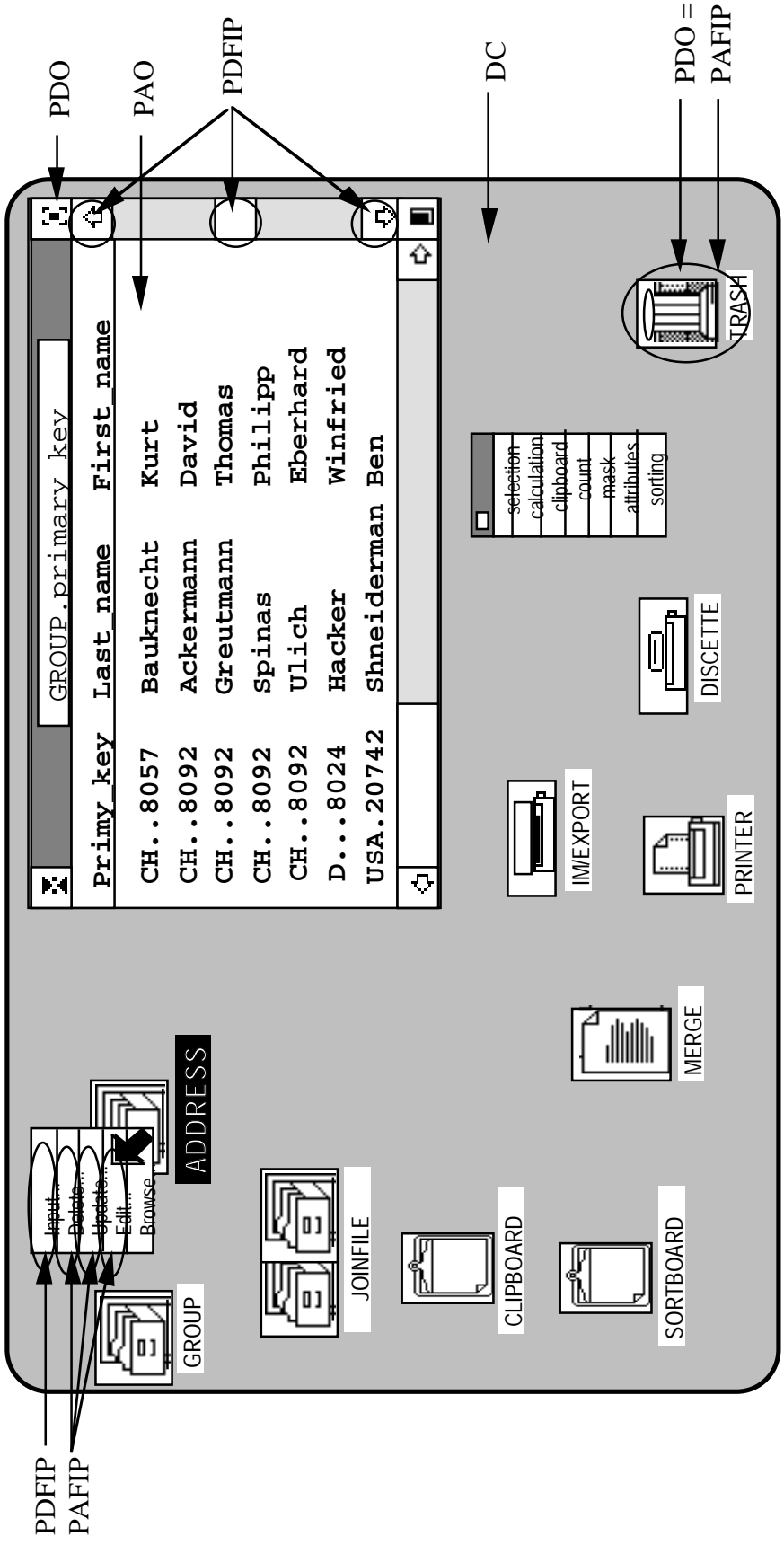
## The outcomes of twelve (12) different comparison studies between command (CI) and direct manipulative (DI) interfaces.

"CI < DI" means that the average usage/preference with/for DI is better than with/for CI;  
 "CI = DI" means that there are no published data to decide;  
 "CI > DI" means that the average usage/preference with/for CI is better than with/for DI;  
 "sig." means that  $p \leq 0.05$ ; "not sig." means that  $p > 0.05$

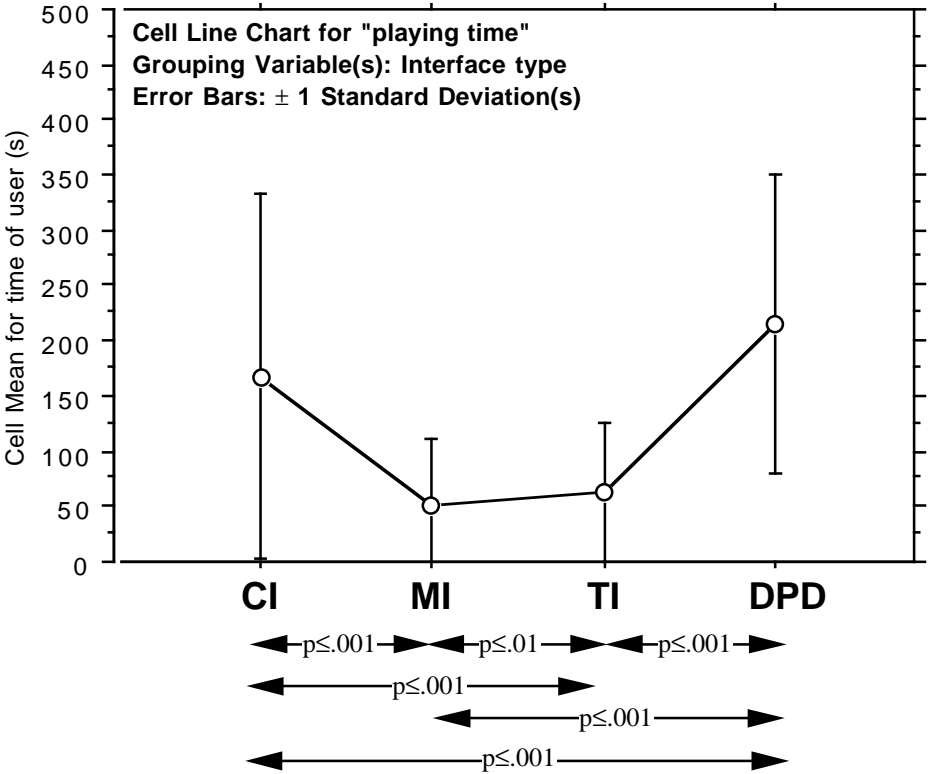
Reference	interface	skill level	usability metric	outcome	result
Altmann (1987)	CI, DI	beginner	task solving time	CI < DI	sig.
Karat et al. (1987)	CI, DI	beginner	task solving time	CI < DI	sig.
Streitz et al. (1989)	CI, DI	beginner	task solving time	CI < DI	sig.
Sengupta & Te'eni (1991)	CI, DI	beginner	task solving time	CI < DI	sig.
Margono et al. (1987)	CI, DI	beginner	number of errors	CI < DI	sig.
Morgan et al. (1991)	CI, DI	beginner	number of errors	CI < DI	sig.
Morgan et al. (1991)	CI, DI	beginner	time between errors	CI < DI	sig.
Karat et al. (1987)	CI, DI	beginner	error correction time	CI < DI	sig.
Morgan et al. (1991)	CI, DI	beginner	error-free time	CI < DI	sig.
Margono et al. (1987)	CI, DI	beginner	subjective rating	CI < DI	sig.
Morgan et al. (1991)	CI, DI	beginner	subjective rating	CI < DI	sig.
Torres-Chazaro et al.(1992)	CI, DI	beginner	subjective rating	CI < DI	sig.
Sengupta & Te'eni (1991)	CI, DI	beginner	efficient usage	CI < DI	sig.
Tombaugh et al. (1989)	CI, DI	advanced	subjective rating	CI < DI	sig.
Torres-Chazaro et al.(1992)	CI, DI	advanced	subjective rating	CI < DI	sig.
Roberts & Moran (1983)	CI, MI, DI	experts	task solving time	CI < DI	sig.
Peters et al. (1990)	CI, MI, DI	experts	oblivion's errors	CI < DI	sig.
Peters et al. (1990)	CI, MI, DI	experts	recognition error	CI < DI	sig.
Peters et al. (1990)	CI, MI, DI	experts	efficiency	CI < DI	sig.
Margono et al. (1987)	CI, DI	beginner	task solving time	CI < DI	not sig.
Morgan et al. (1991)	CI, DI	beginner	task solving time	CI < DI	not sig.
Tombaugh et al. (1989)	CI, DI	advanced	task solving time	CI < DI	not sig.
Roberts & Moran (1983)	CI, MI, DI	experts	error correction time	CI < DI	not sig.
Altmann (1987)	CI, DI	beginner	subjective rating	CI > DI	not sig.
Masson et al. (1988)	CI, DI	advanced	task solving time	CI > DI	sig.



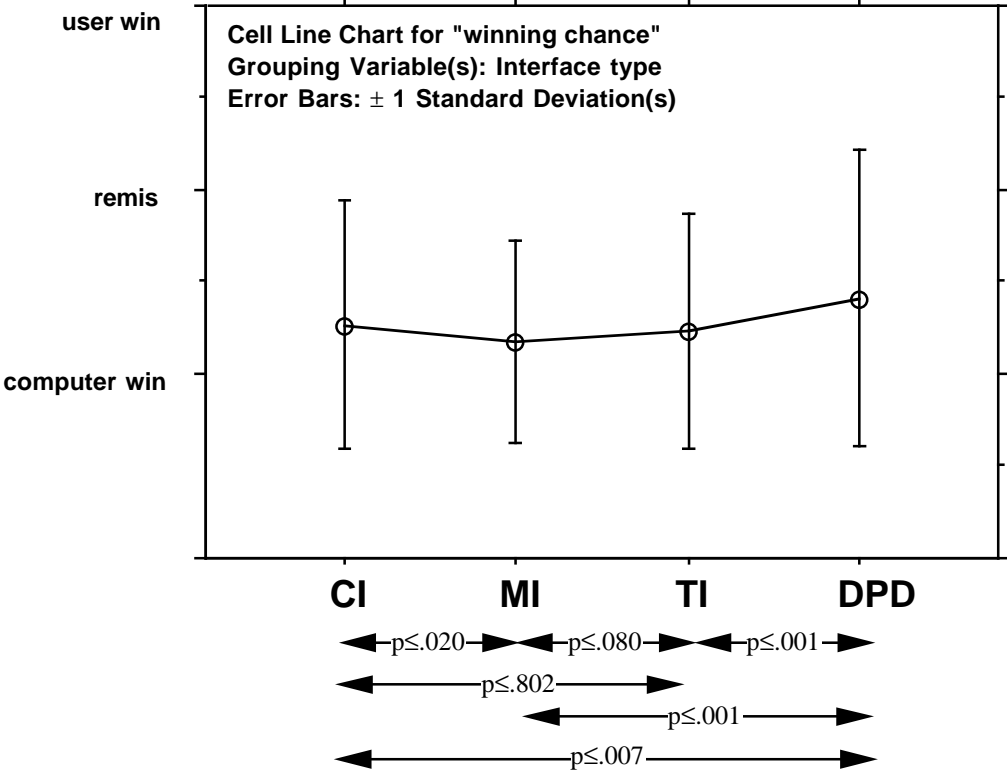




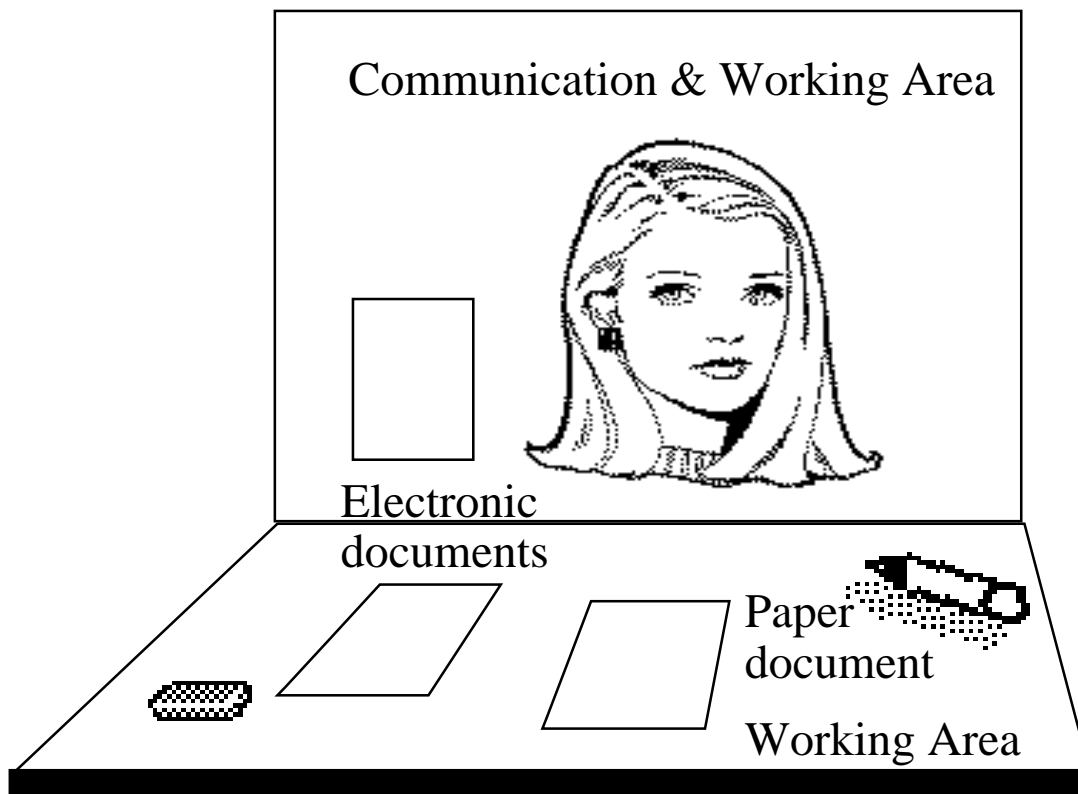
# Playing time per game



# Winning chance per dialog technique



# Architecture of a Natural User Interface (NUI)



Wellner P, Mackay W, Gold R:  
Computer-Augmented Environments: Back to the Real World. (1993)

Fitzmaurice G, Ishii H, Buxton W:  
Bricks: Laying the Foundations for Graspable User Interfaces. (1995)

Tognazzini B:  
Tog on Software Design. (1996).



## **List of relevant books:**

### *About HCI in general:*

- L. Barfield: The user interface - concepts & design. Addison Wesley, 1993.
- P. Booth: An introduction to Human-Computer Interaction. Lawrence Erlbaum, 1990.
- A. Dix, J. Finlay, G. Abowd, R. Beale: Human-Computer Interaction. Prentice, 1993.
- L. Macaulay: Human-Computer Interaction for Software Designers. Thomson, 1995.
- D. Norman, S. Draper: User centered system design. Lawrence Erlbaum, 1986.
- J. Preece, Y. Rogers, H. Sharp, D. Benyon, S. Holland, T. Carey: Human-Computer Interaction. Addison Wesley, 1994.
- B. Shneiderman: Designing the user interface. Addison Wesley, 1997, 3rd edition.

### *About design principles:*

- C. Brown: Human-Computer Interface design guidelines. Ablex, 1989.
- W. Galitz: Handbook of screen format design. QED, 1989.
- C. Gram, G. Cockton (eds.): Design principles for interactive software. Capman & Hall, 1996.
- D. Hix, R. Hartson: Developing user interfaces. Wiley, 1993.
- ISO 9241 (Part 10: Dialogue principles, Part 12: Presentation of information, Part 14: Menu dialogues, Part 15: Command dialogues, Part 16: Direct manipulation dialogues, Part 17: Form fill-in dialogues)
- D. Mayhew: Principles and guidelines in software user interface design. Prentice, 1992.

### *About usability evaluation methods:*

- J. Dumas, J. Redish: A practical guide to usability testing. Ablex, 1993.
- D. Freedman, G. Weinberg: Walkthroughs, Inspections, and technical reviews. Dorset, 1990.
- ISO 9241 (Part 11: Guidance on usability, Part 13: User guidance)
- A. Monk, P. Wright, J. Haber, L. Davenport: Improving your Human-Computer Interface: a practical technique. Prentice Hall, 1993.
- J. Nielsen, R. Mack (ed.): Usability inspection methods. Wiley, 1994.

### *About Design:*

- D. Norman: The psychology of everyday things. Basic Books, 1988.