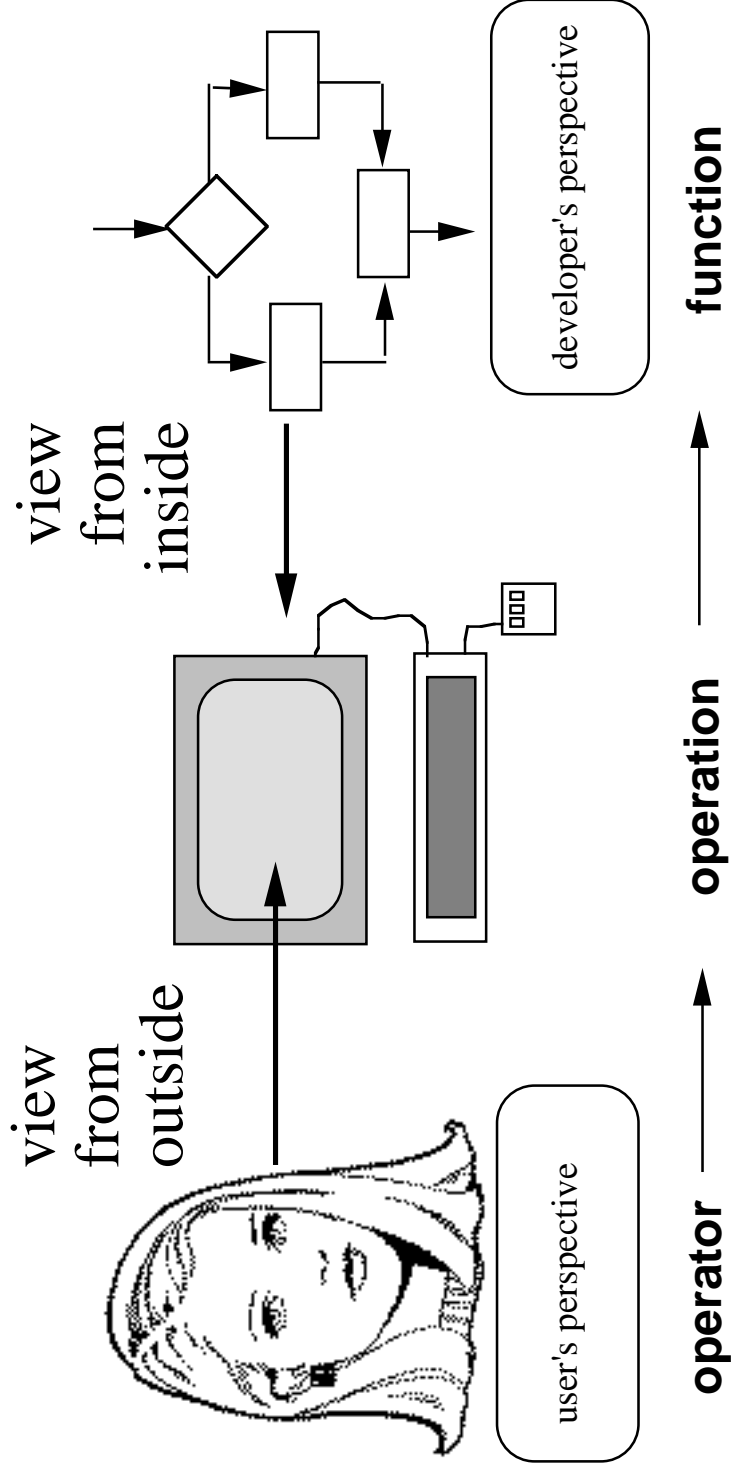


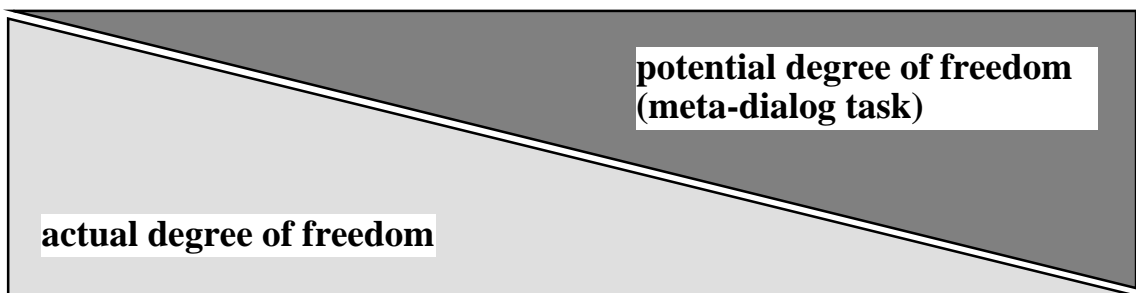
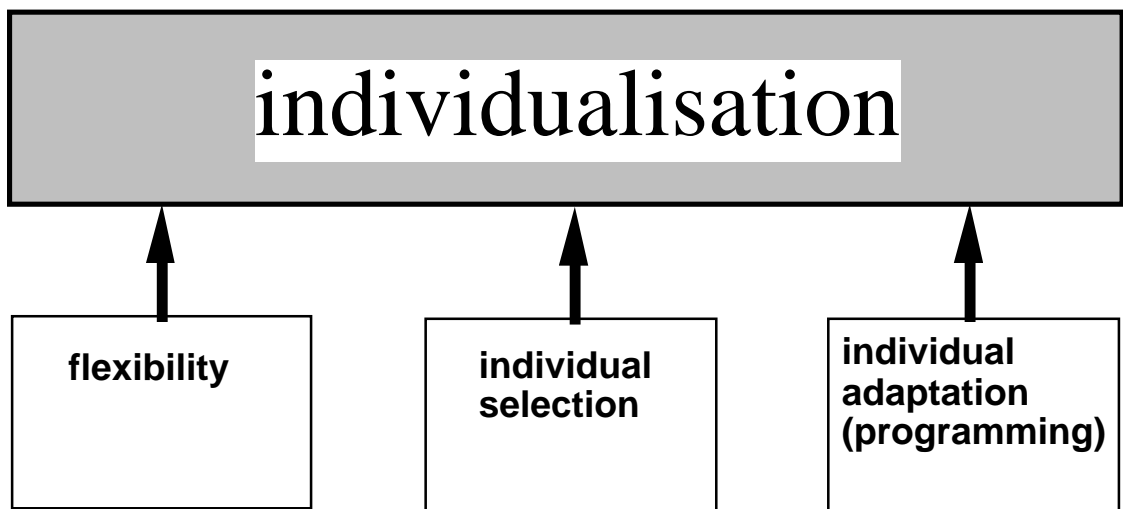
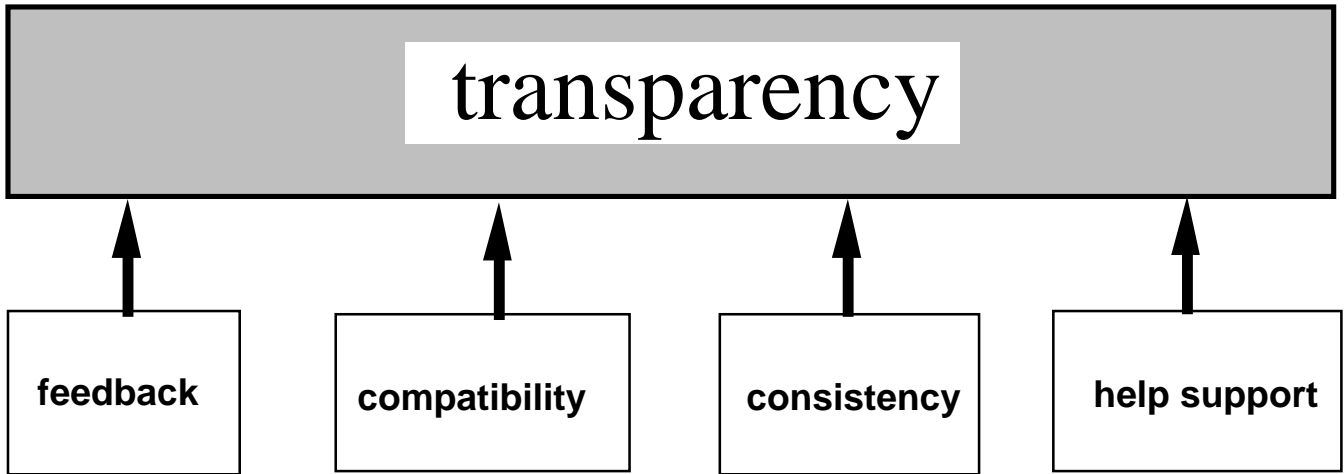
Introduction into Human- Computer Interaction

Matthias Rauterberg

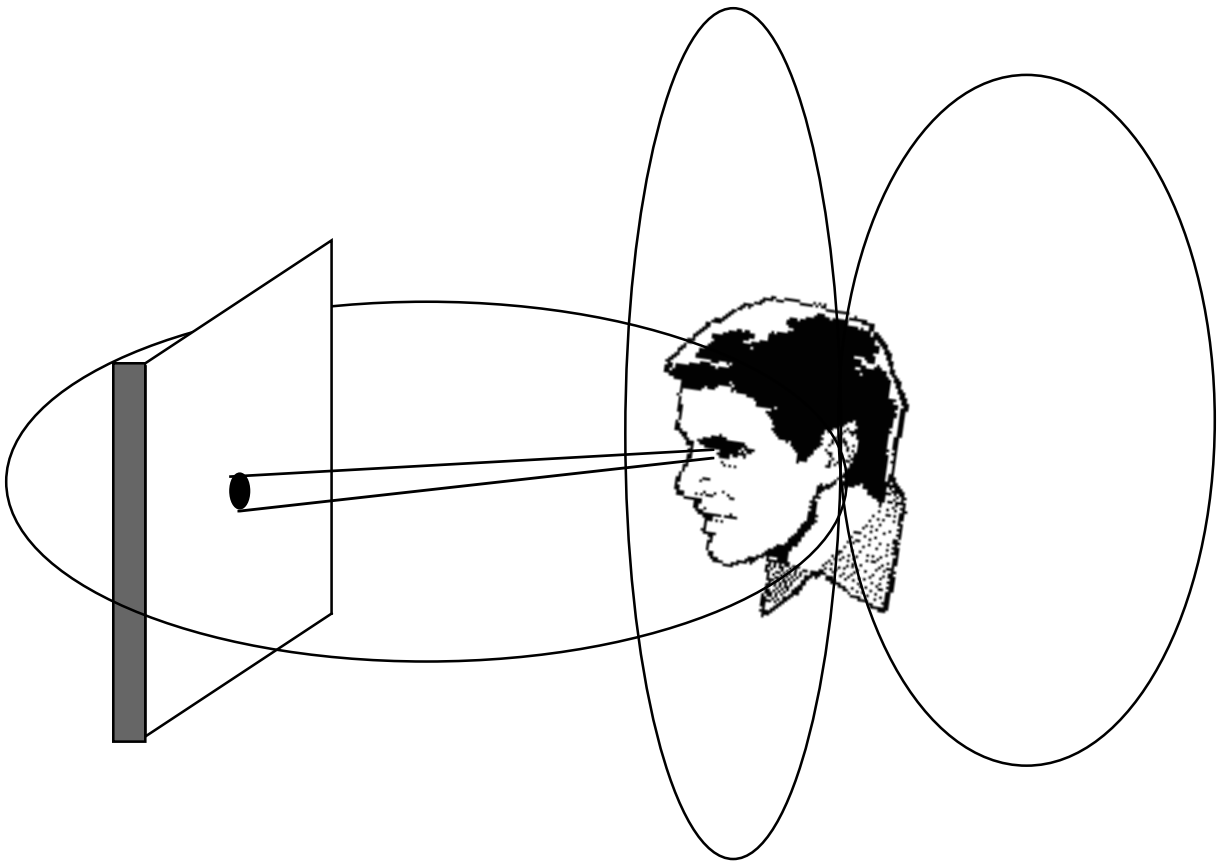
1998



| 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

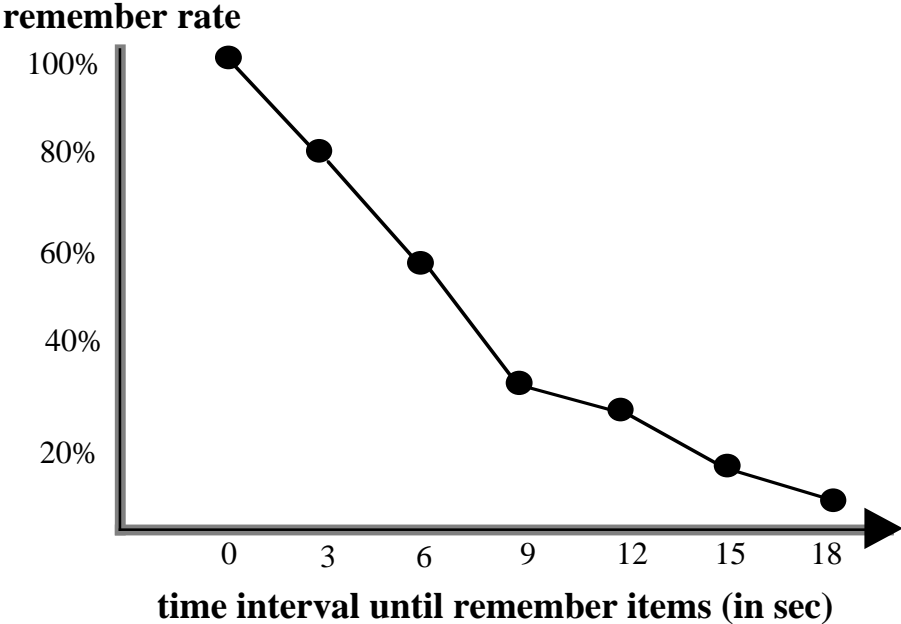
force perception
object recognition
textur and surface perception

linear in time

contact with objects

necessary

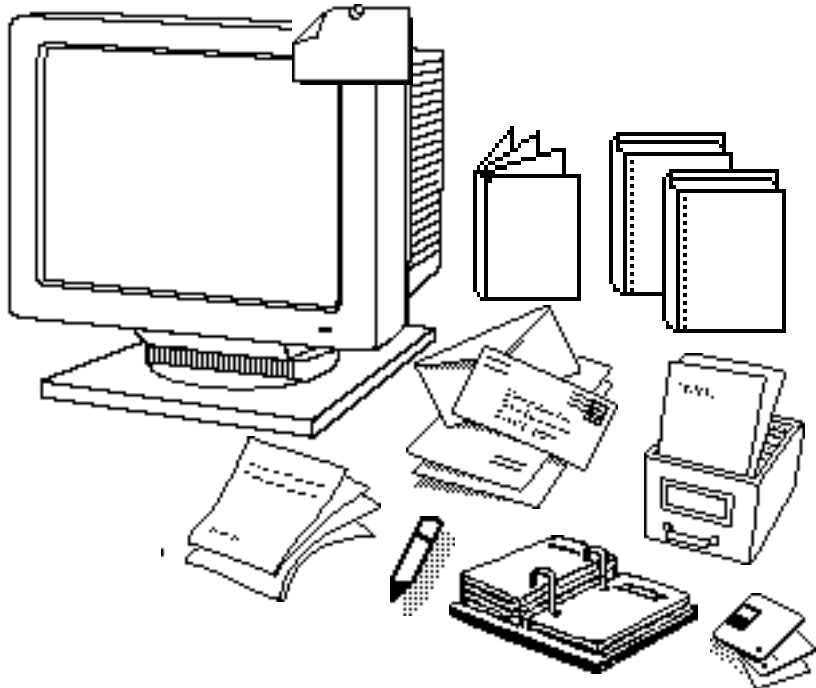
human memory

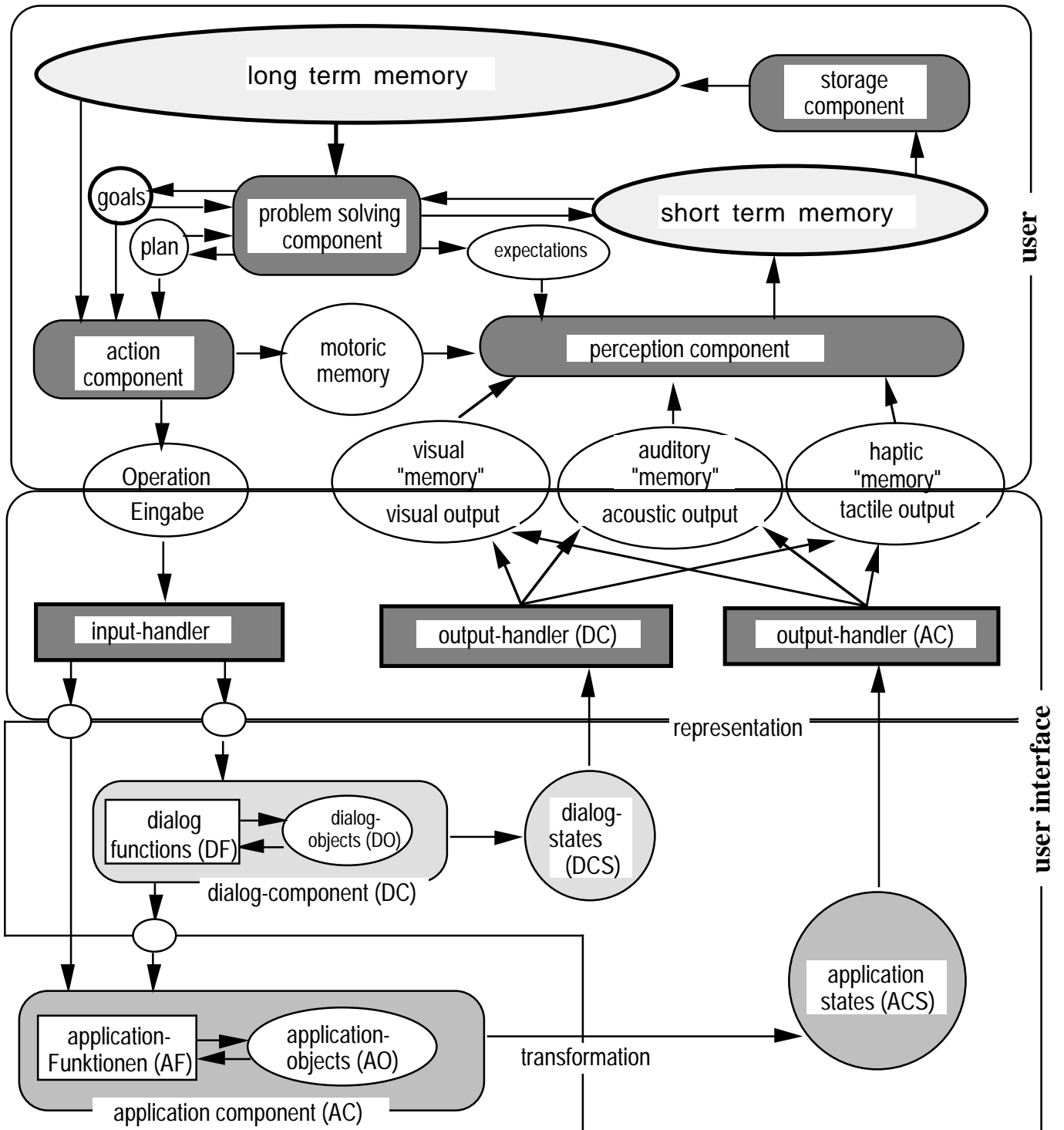


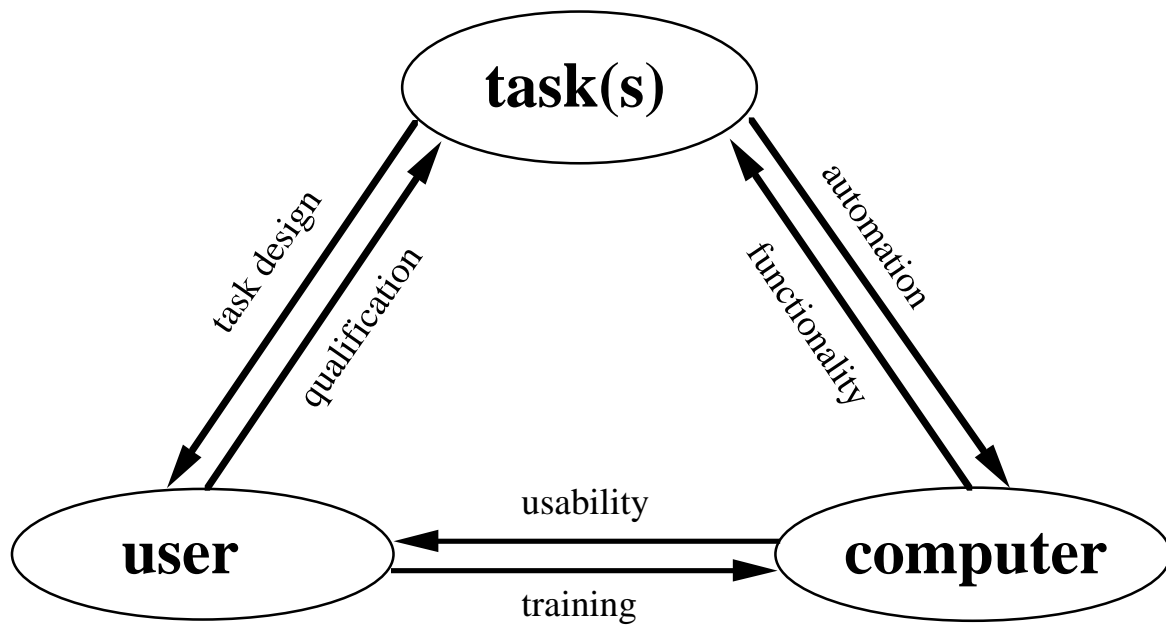
internal memory



external memory



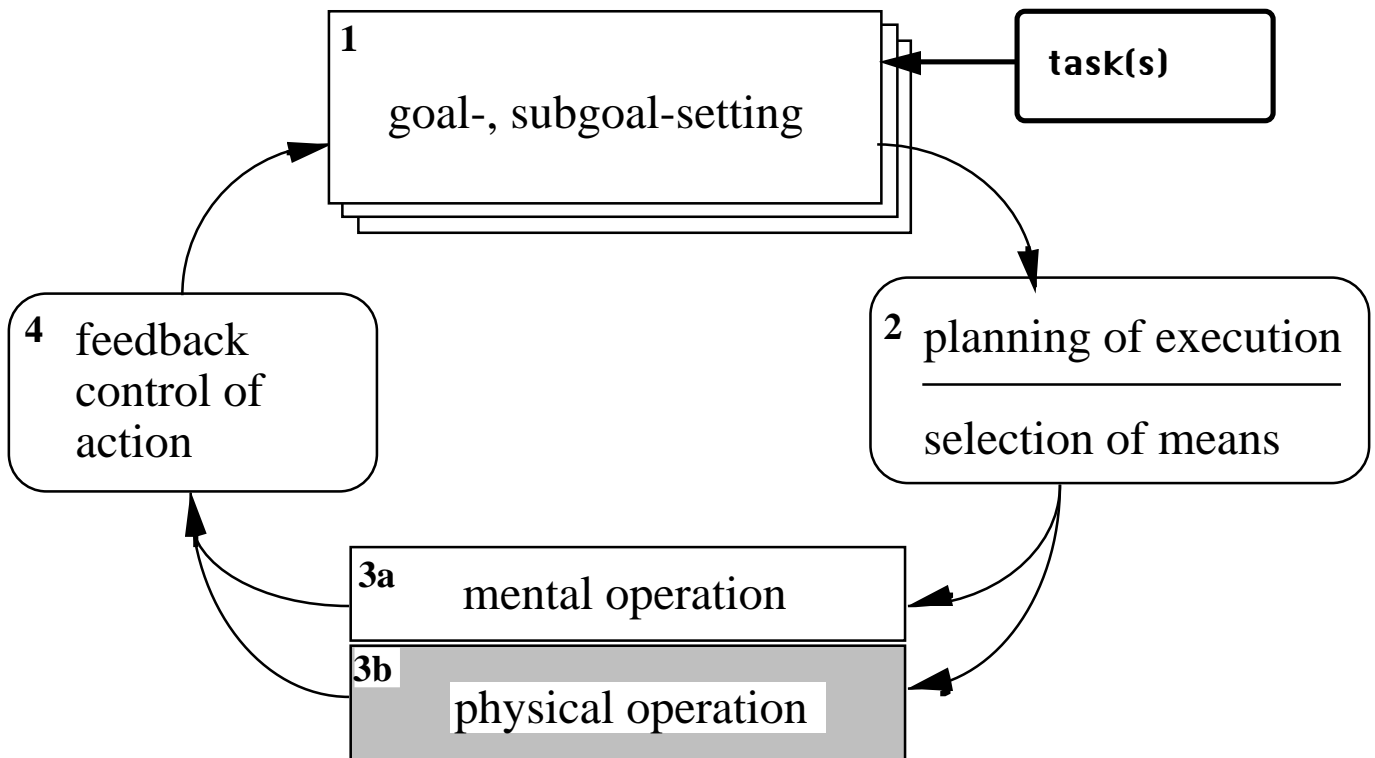




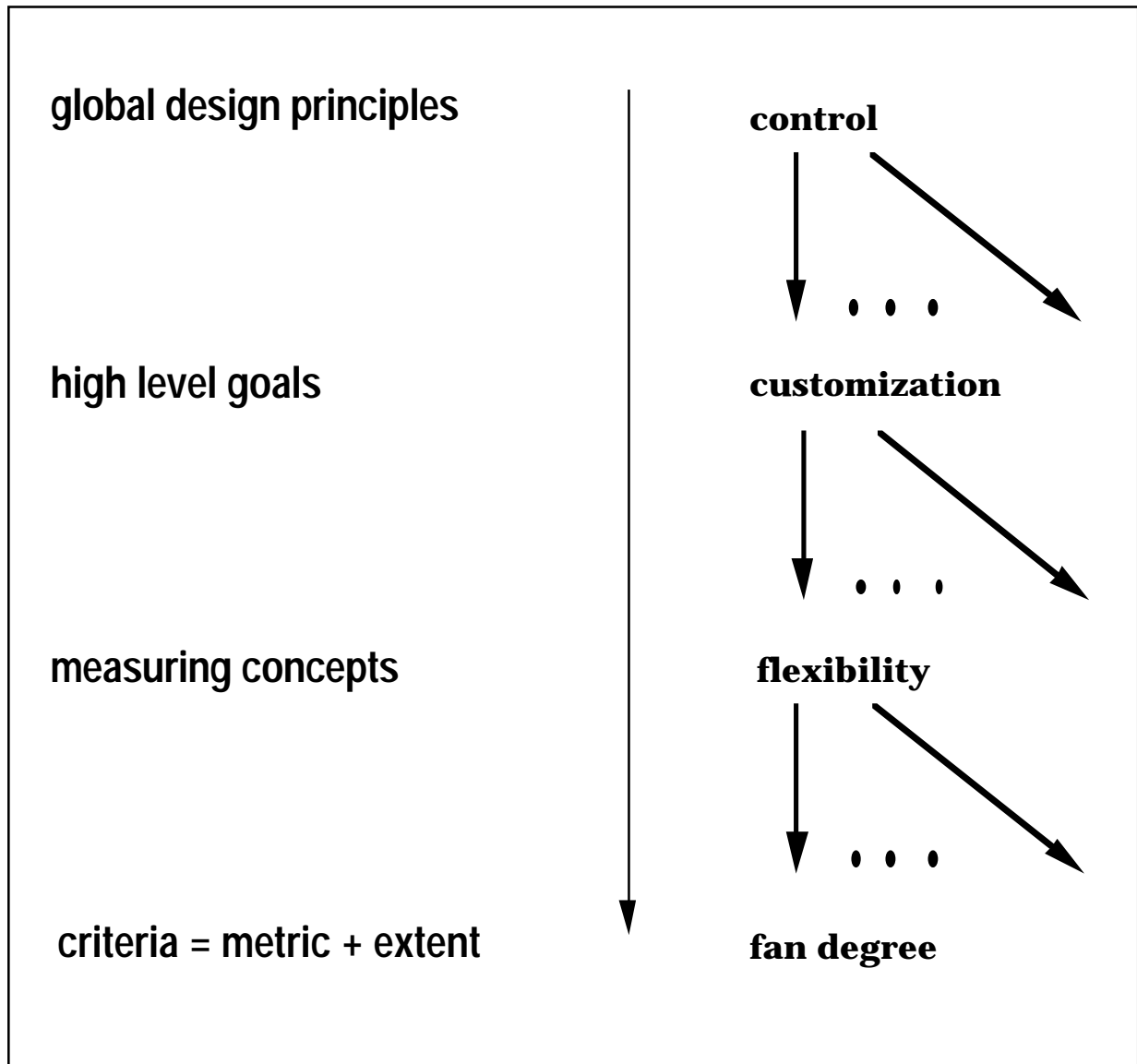
user-oriented requirement analysis

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

the complete action cycle

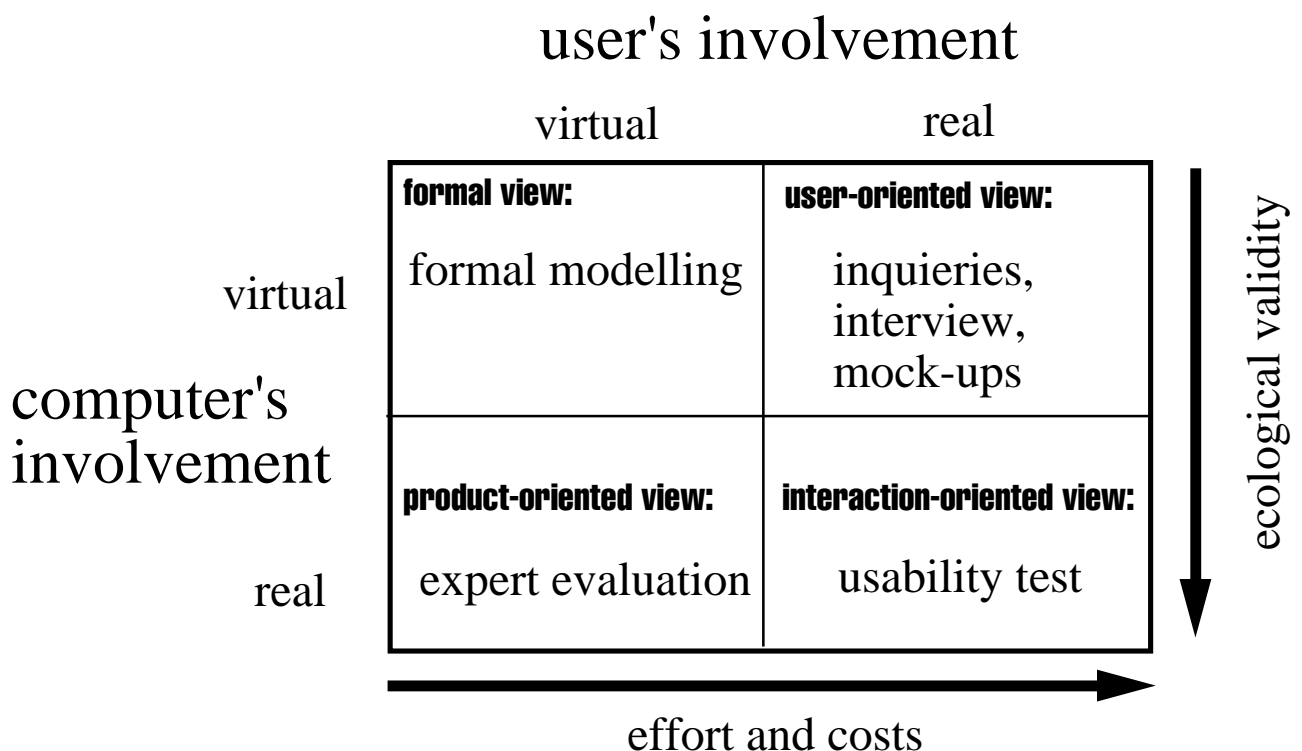


usability specification map (USM)

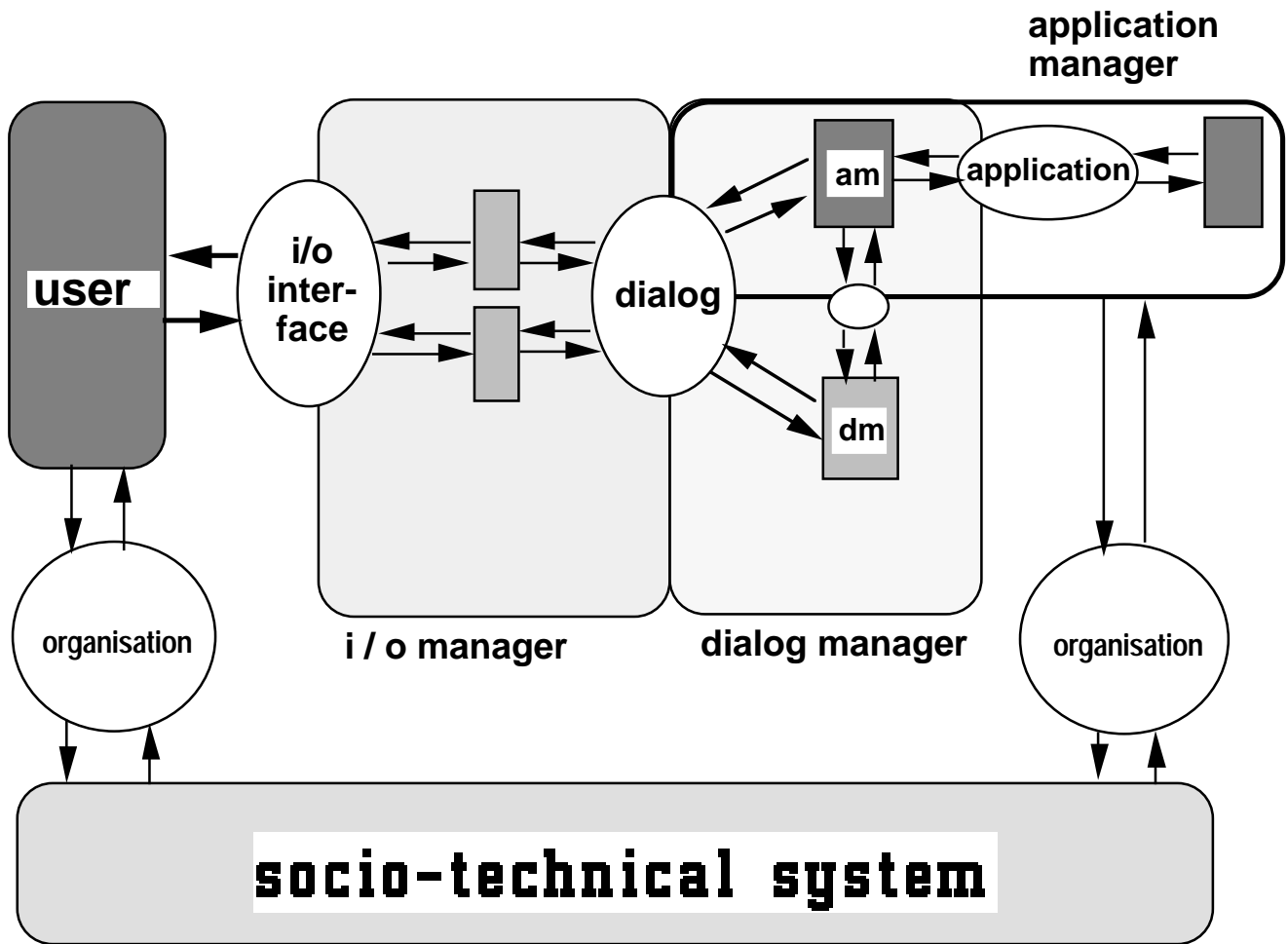


| scale type | examples in the context of HCI |
|------------|--|
| nominal | classification of interfaces (e.g. command, menu, desktop etc.) |
| ordinal | summative evaluation studies (e.g. CUI versus GUI) |
| interval | checklist evaluation (e.g. expert's opinion) |
| rational | quantitative metrics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

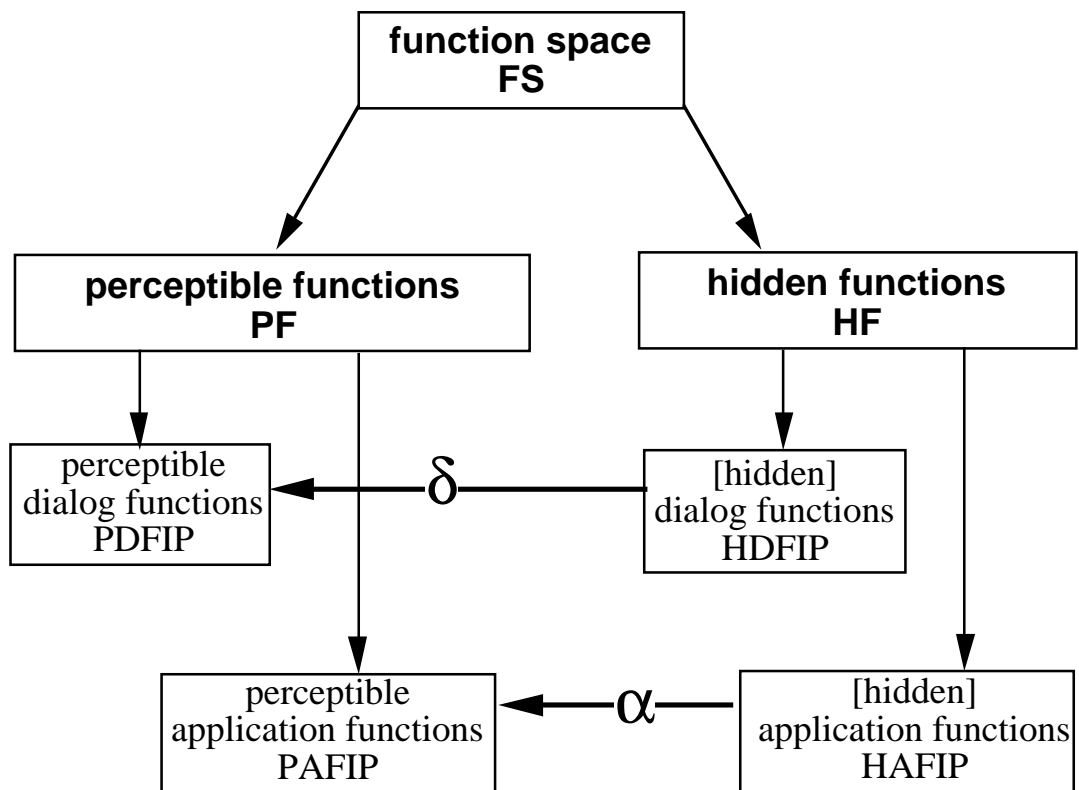
Methods to Measure Usability Quality



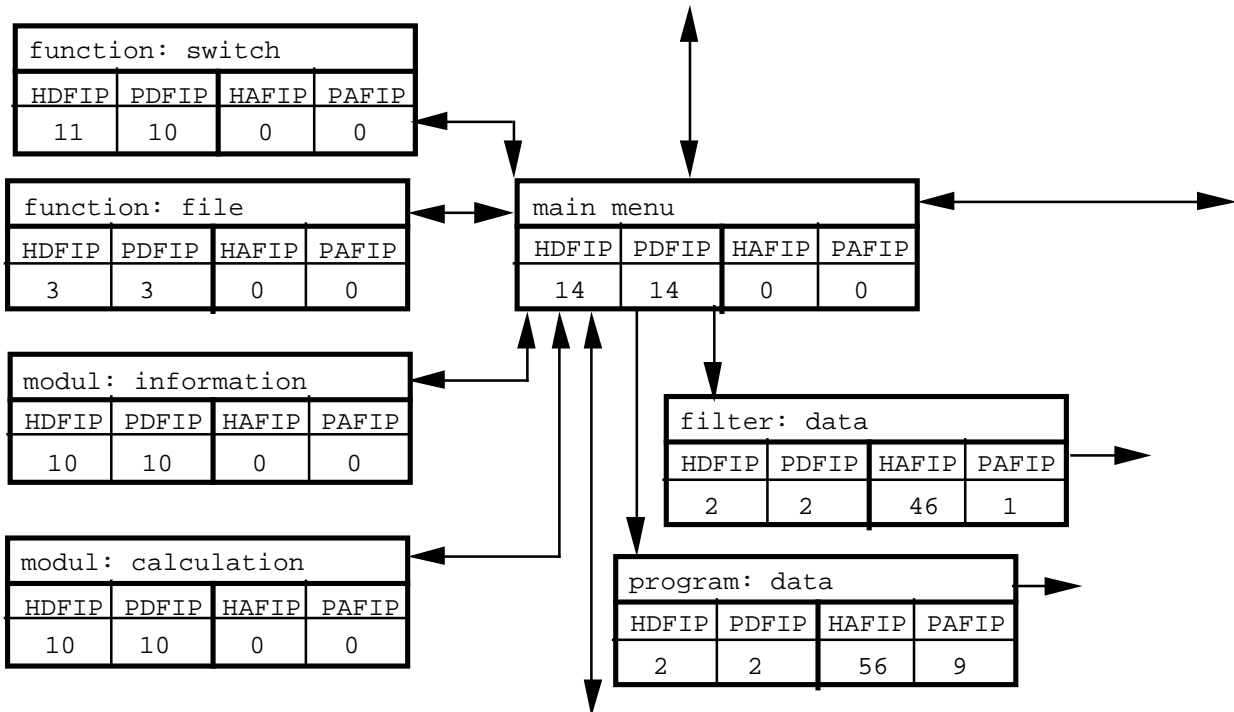
the advanced Seeheim-model:



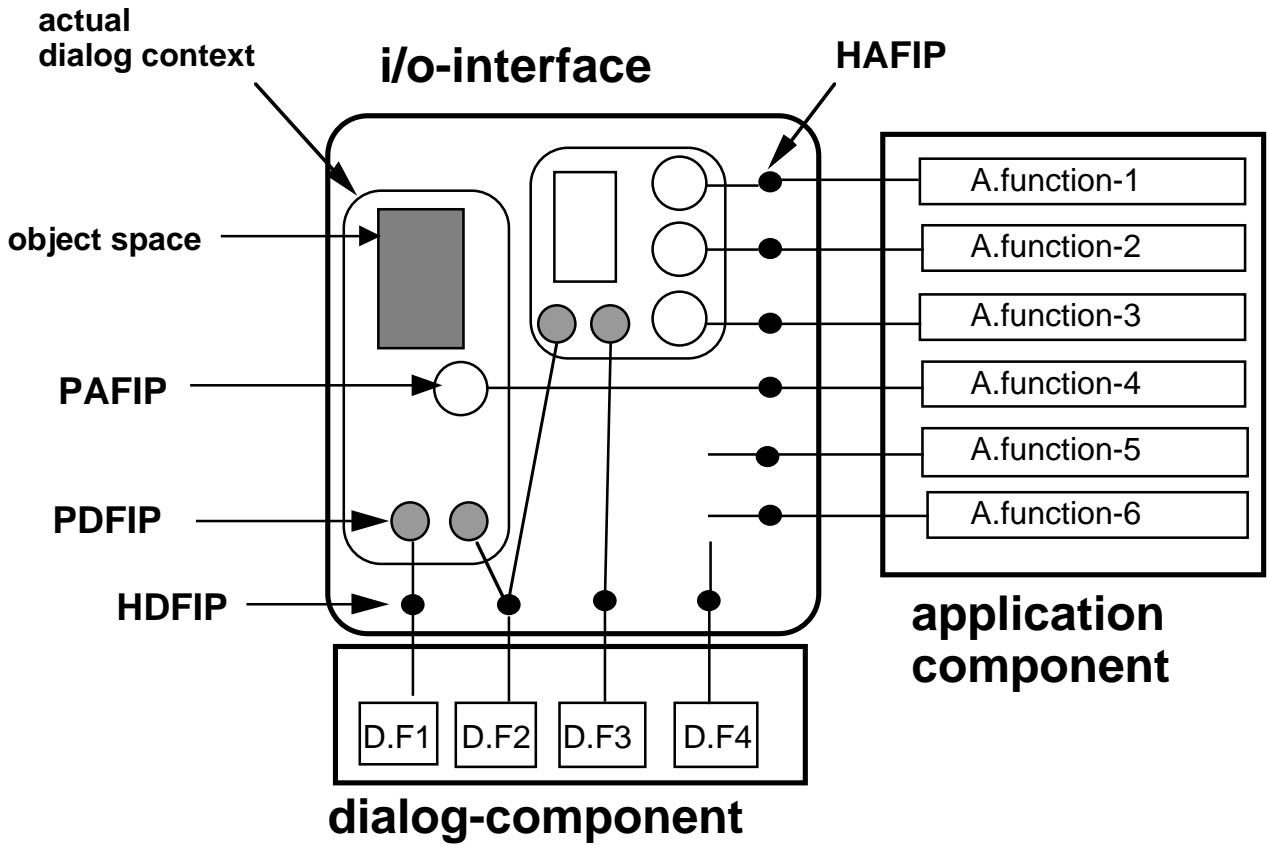
An abstract concept to describe usability aspects



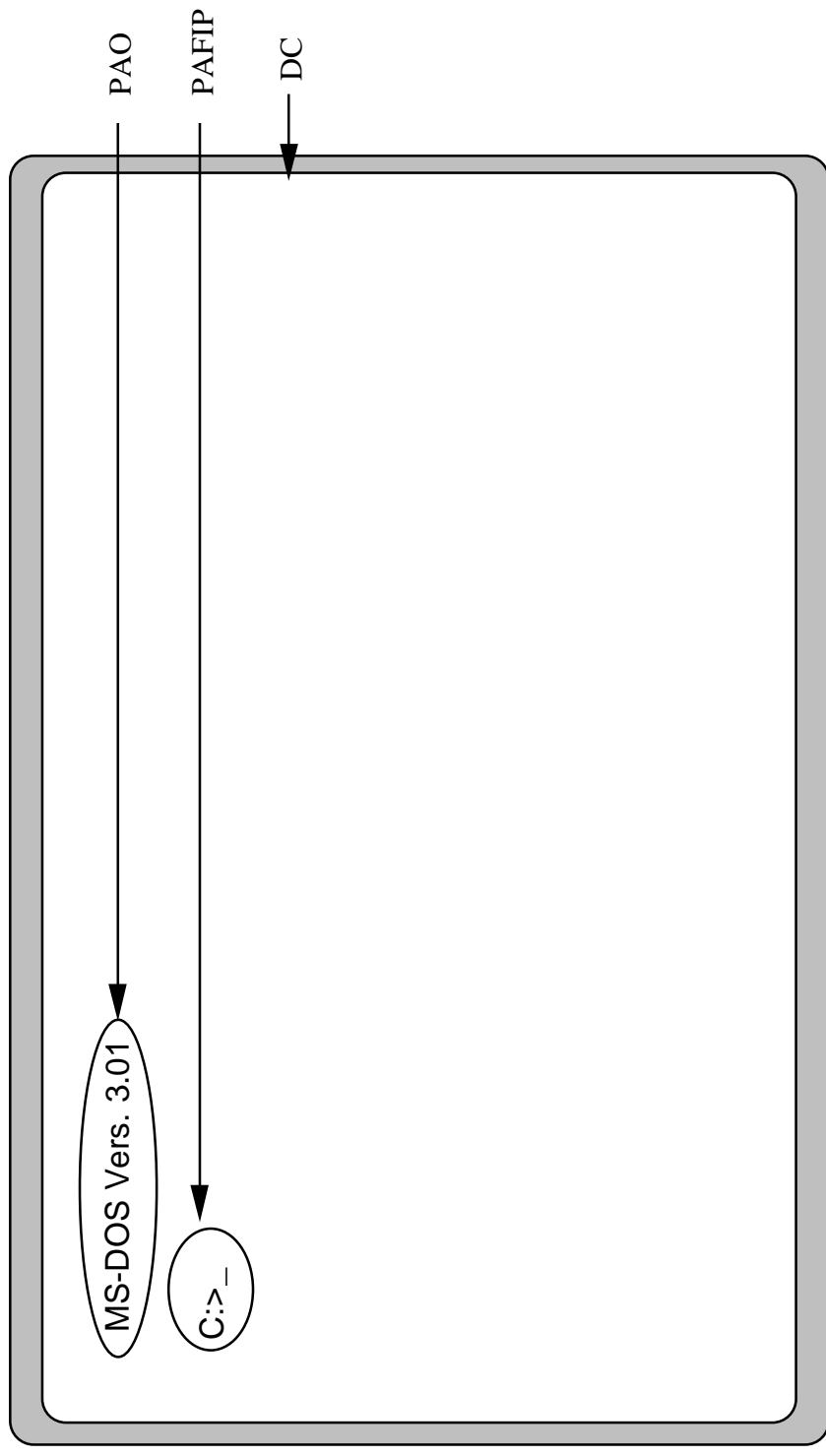
schema of the dialog structure



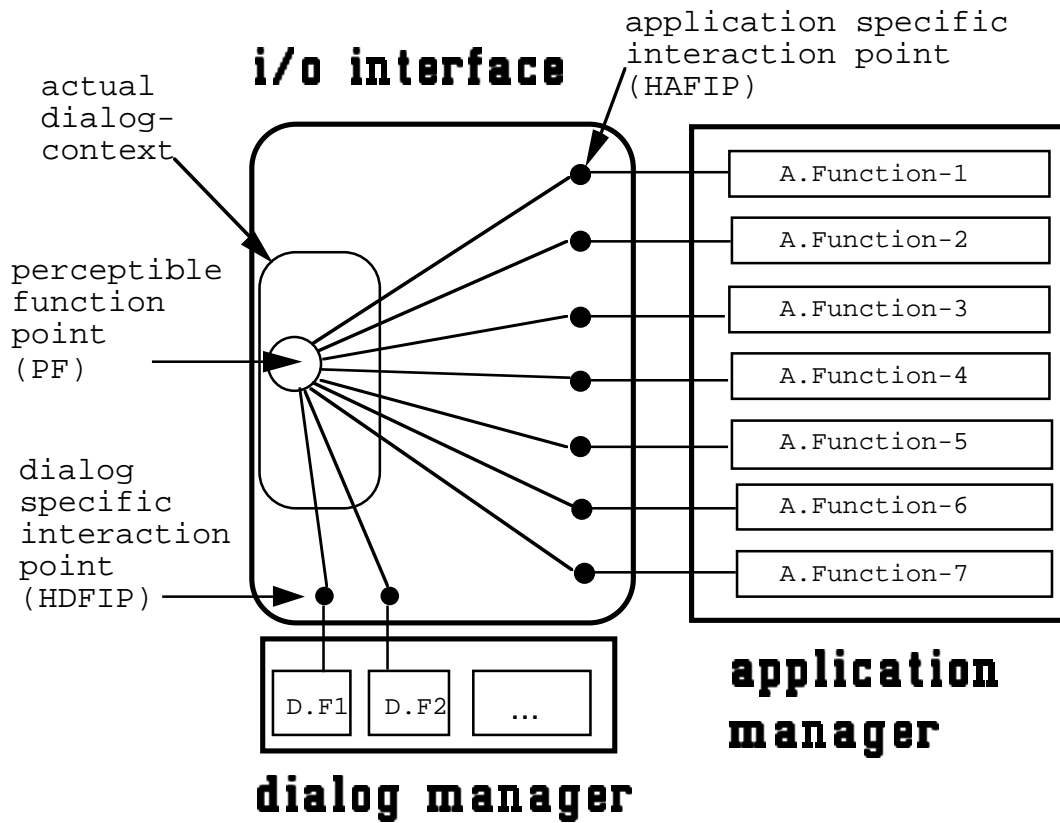
schematic diagram



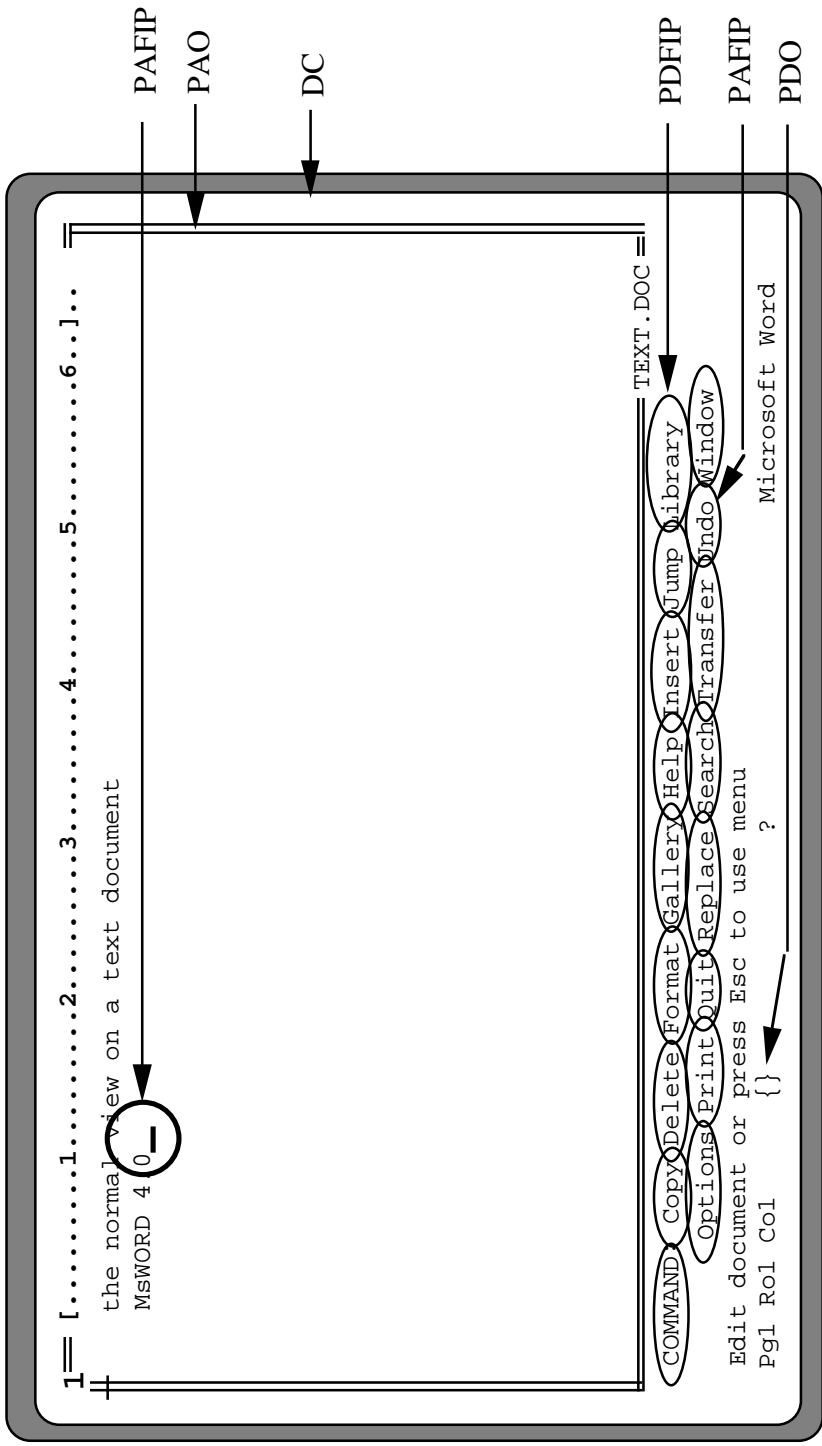
a command language interface



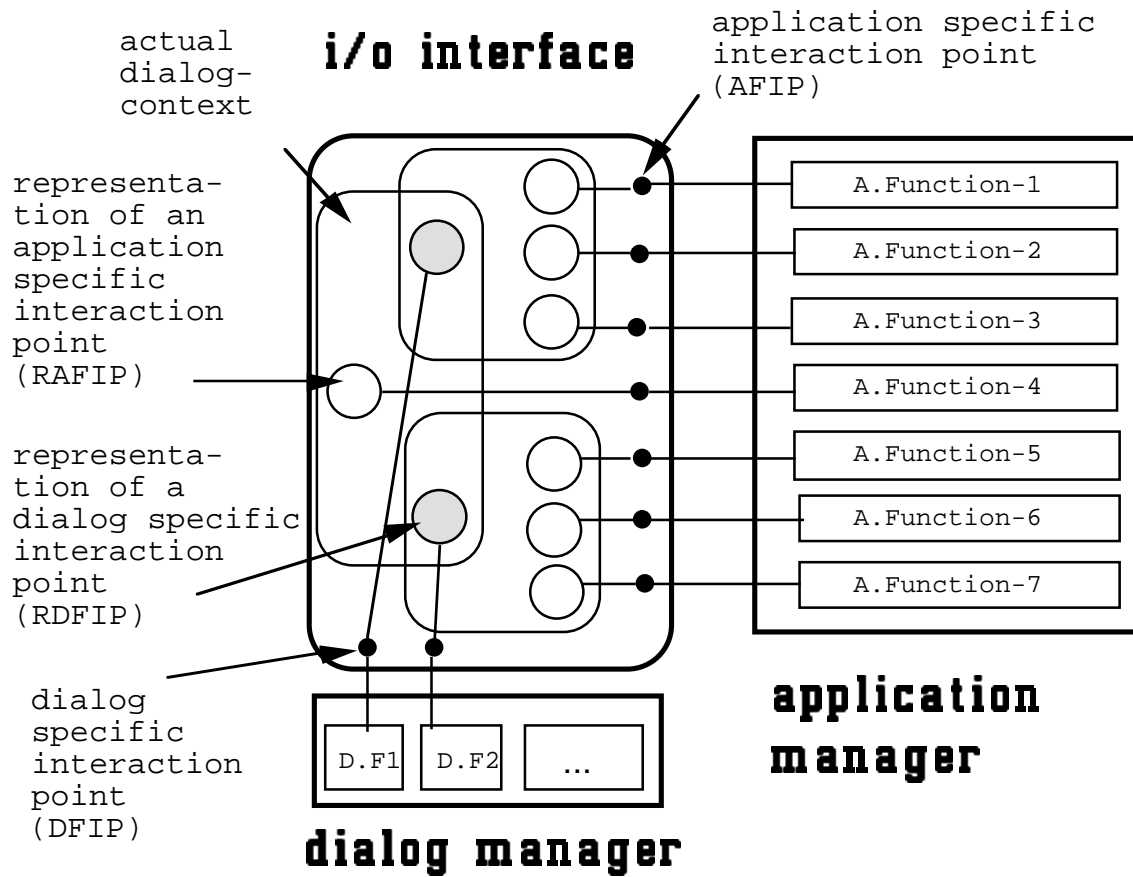
command language interface (CUI)



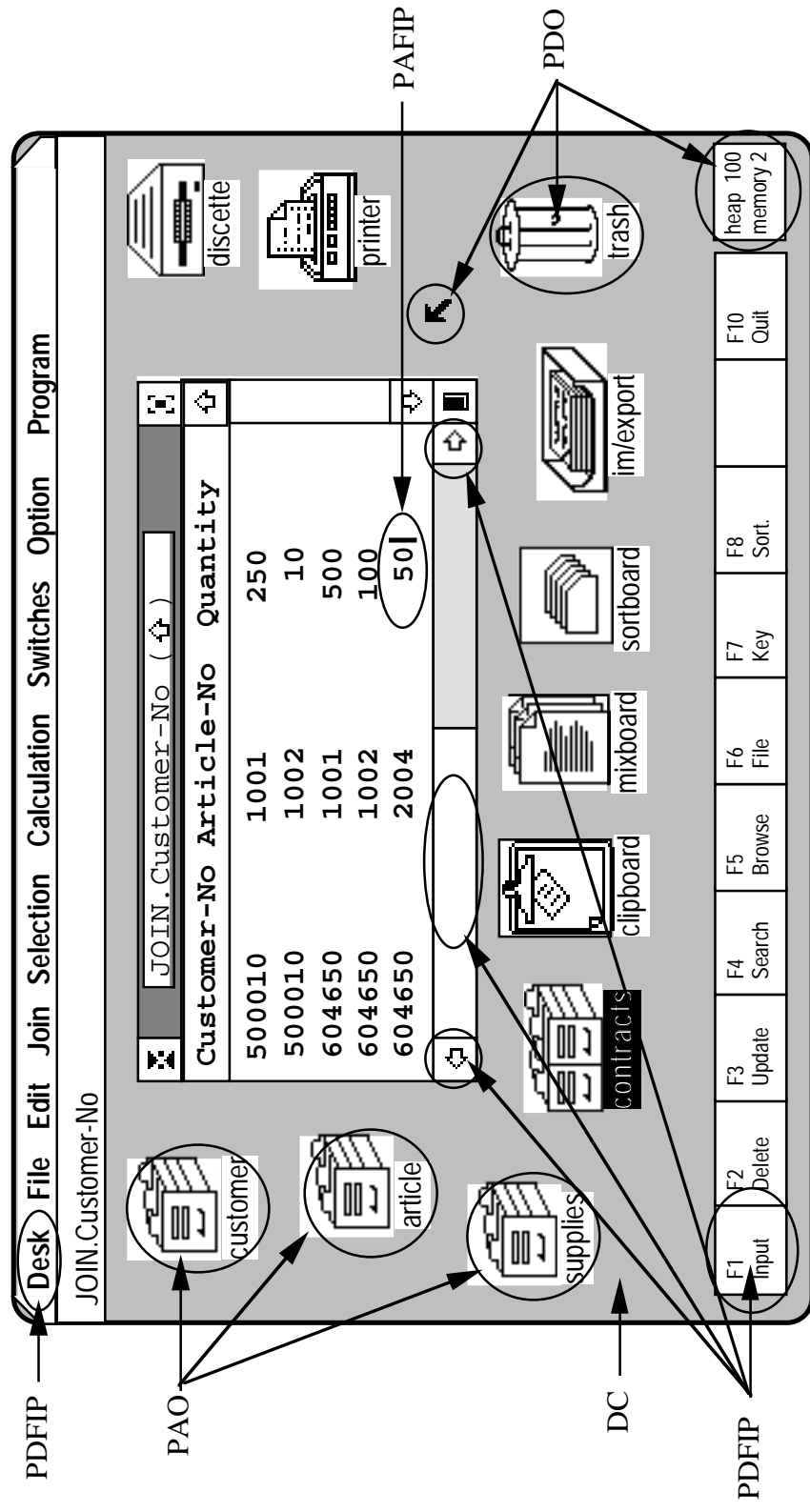
a menu-driven interface (CUI)



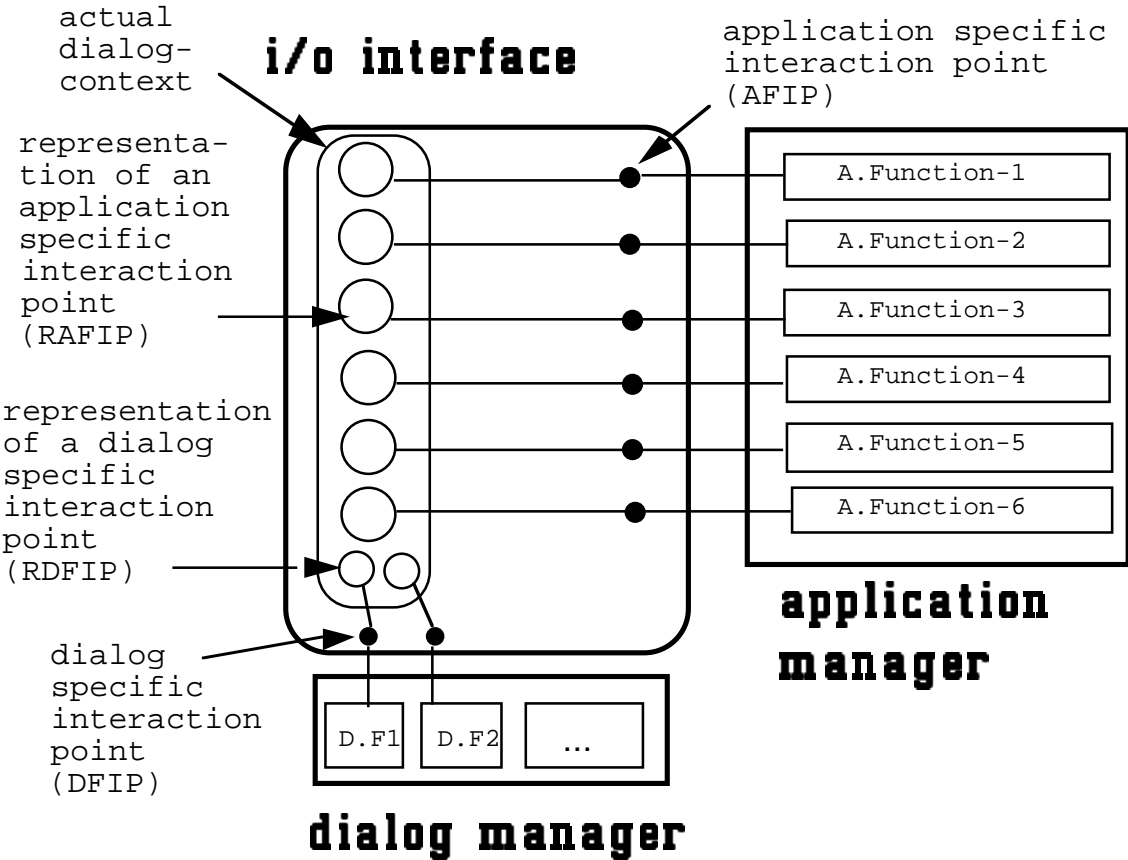
menu driven interface (CUI)



GUI: a desktop interface



direct manipulative interface (GUI)



quantitative measure of "functional feedback":

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

quantitative measure of "fan degree":

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

quantitative measure of "dialog flexibility":

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

quantitative measure of "application flexibility":

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

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 MI |
| | high | command language CI | desktop style direct manipulation DI |

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

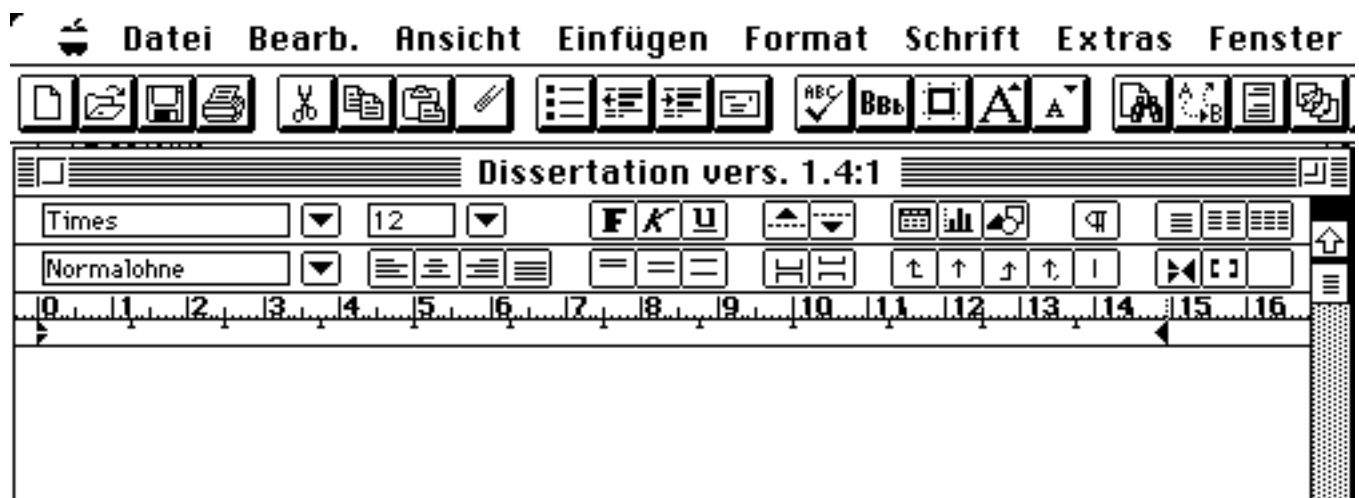
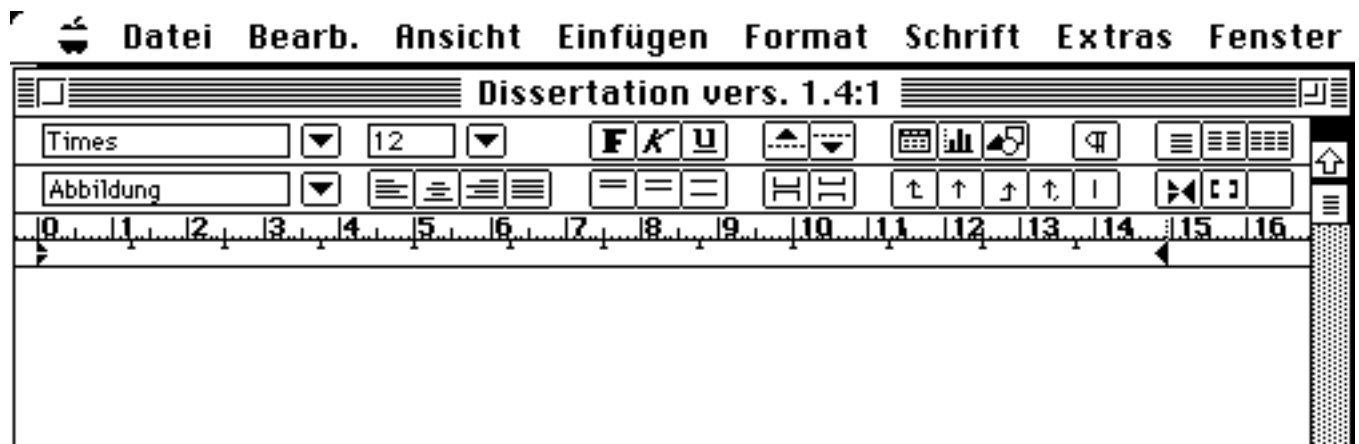
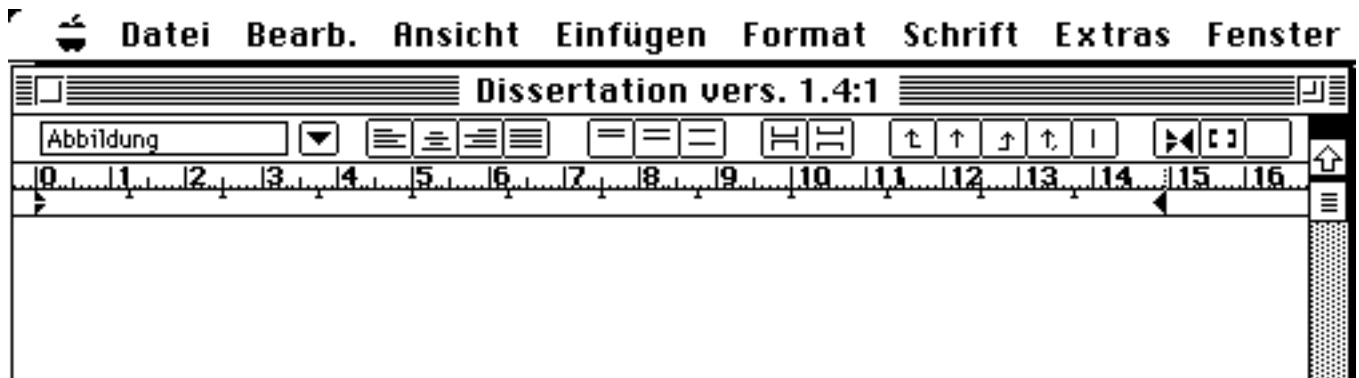
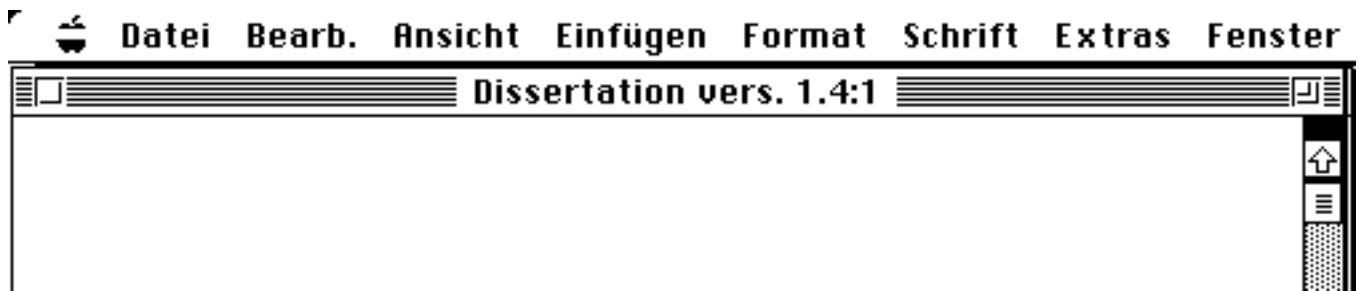
"CI < MI" means that the average usage/preference with/for MI is better than with/for CI;
 "CI = MI" means that there are no published data to decide;
 "CI > MI" means that the average usage/preference with/for CI is better than with/for MI;
 "sig." means that $p \leq 0.05$; "not sig." means that $p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

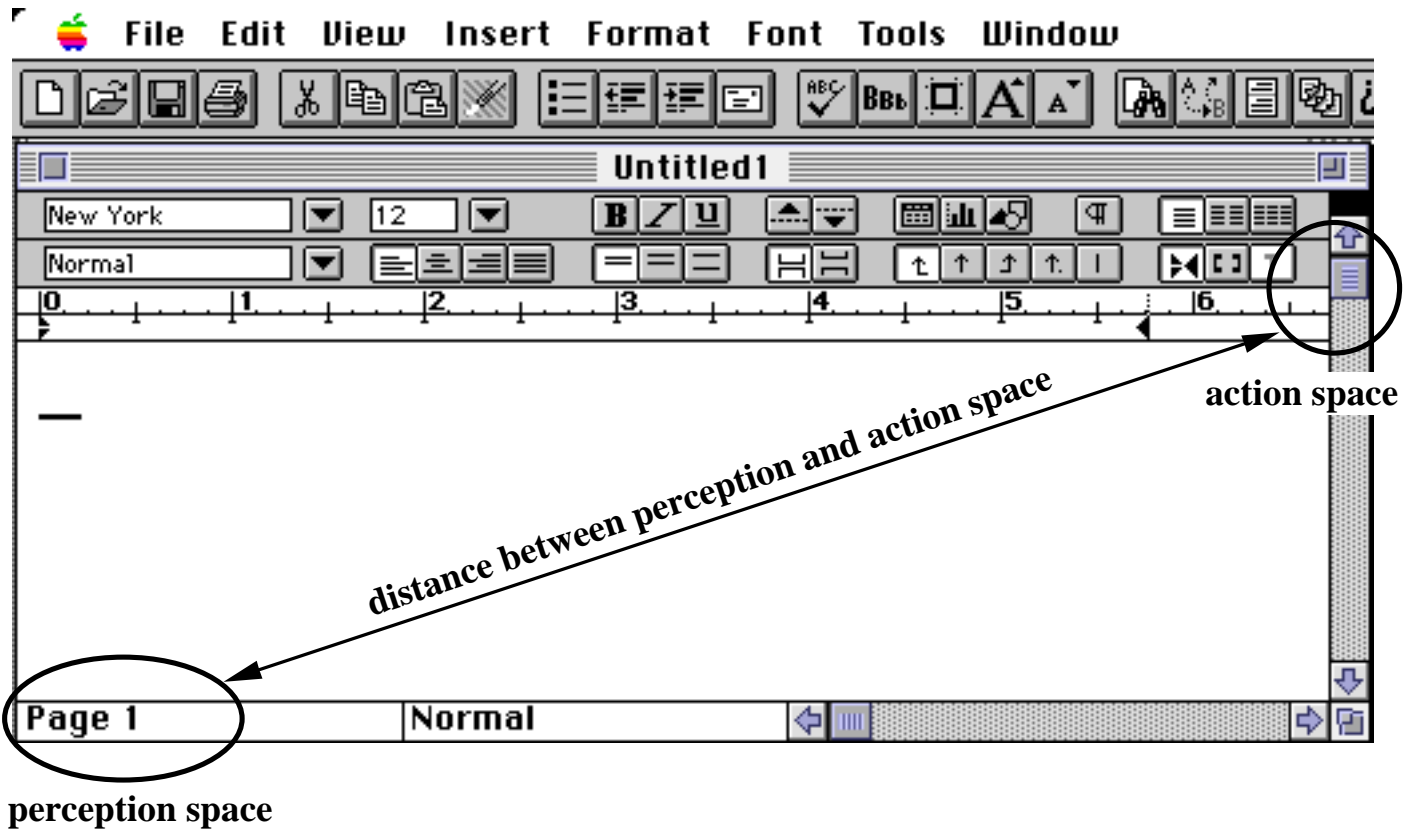
| Reference | interface | skill level | usability metric | outcome | result |
|--------------------------|-------------|-------------|----------------------|---------|----------|
| Streitz et al. (1987) | CI, MI | beginner | task solving time | CI < MI | sig. |
| Chin et al. (1988) | CI, MI | beginner | 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. |

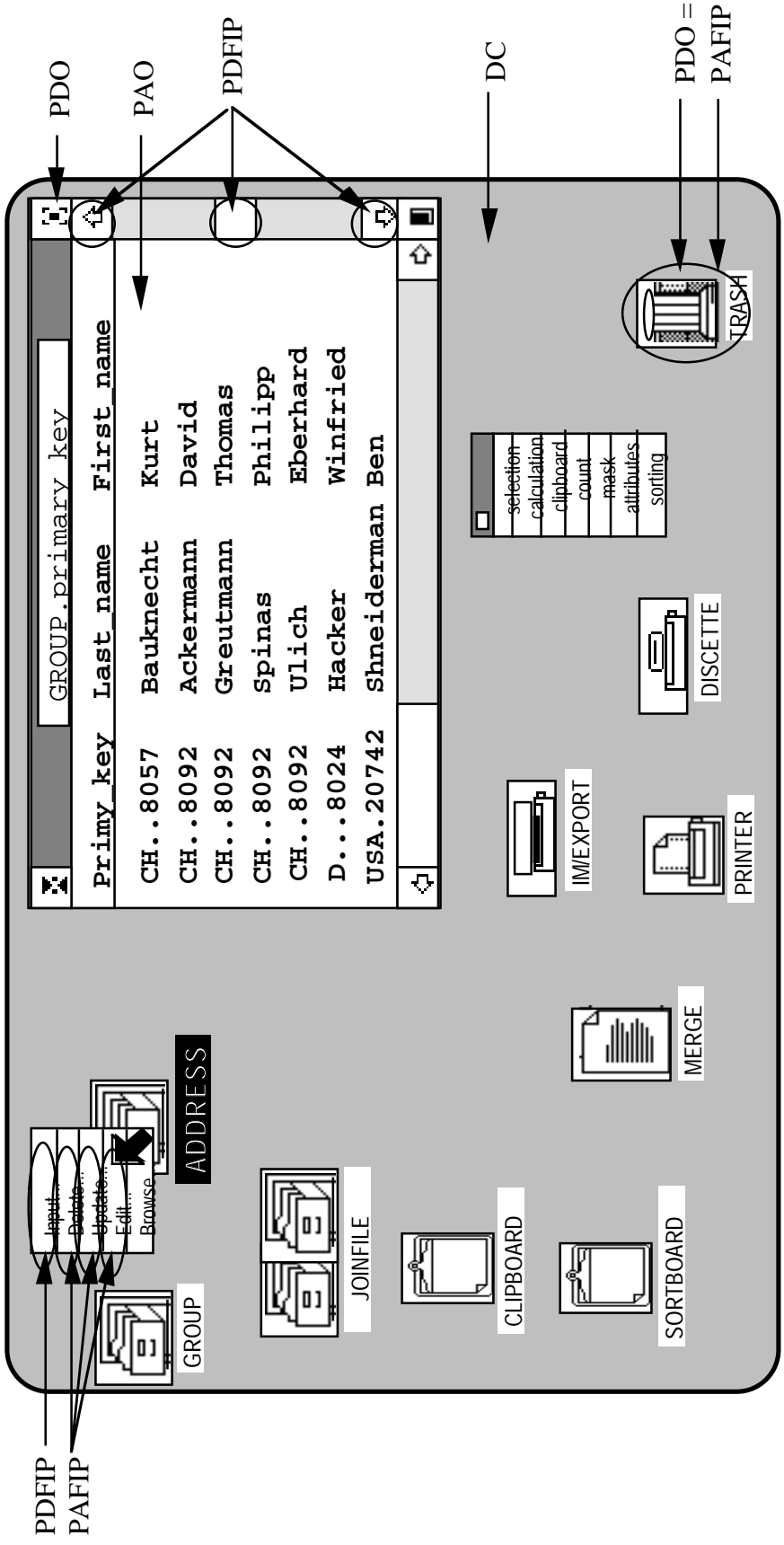
The outcomes of twelve (12) different comparison studies between command (CI) and direct manipulative (DI) interfaces.

"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 $p > 0.05$

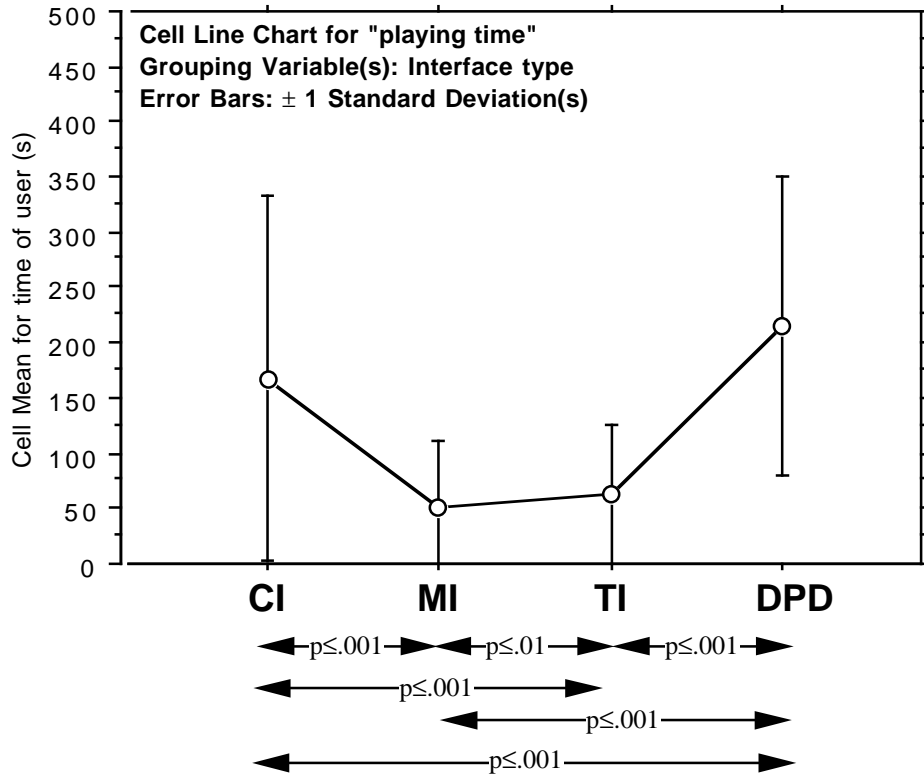
| Reference | interface | skill level | usability metric | outcome | result |
|-----------------------------|------------|-------------|-----------------------|---------|----------|
| Altmann (1987) | CI, DI | beginner | task solving time | CI < DI | sig. |
| Karat et al. (1987) | CI, DI | beginner | 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. |



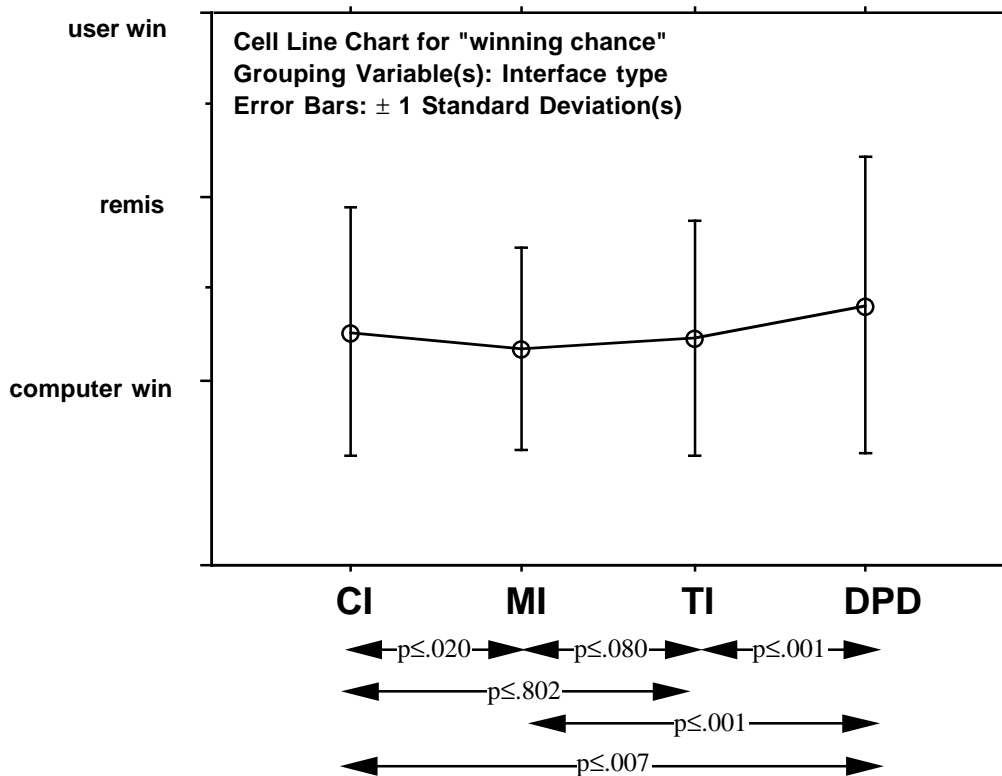




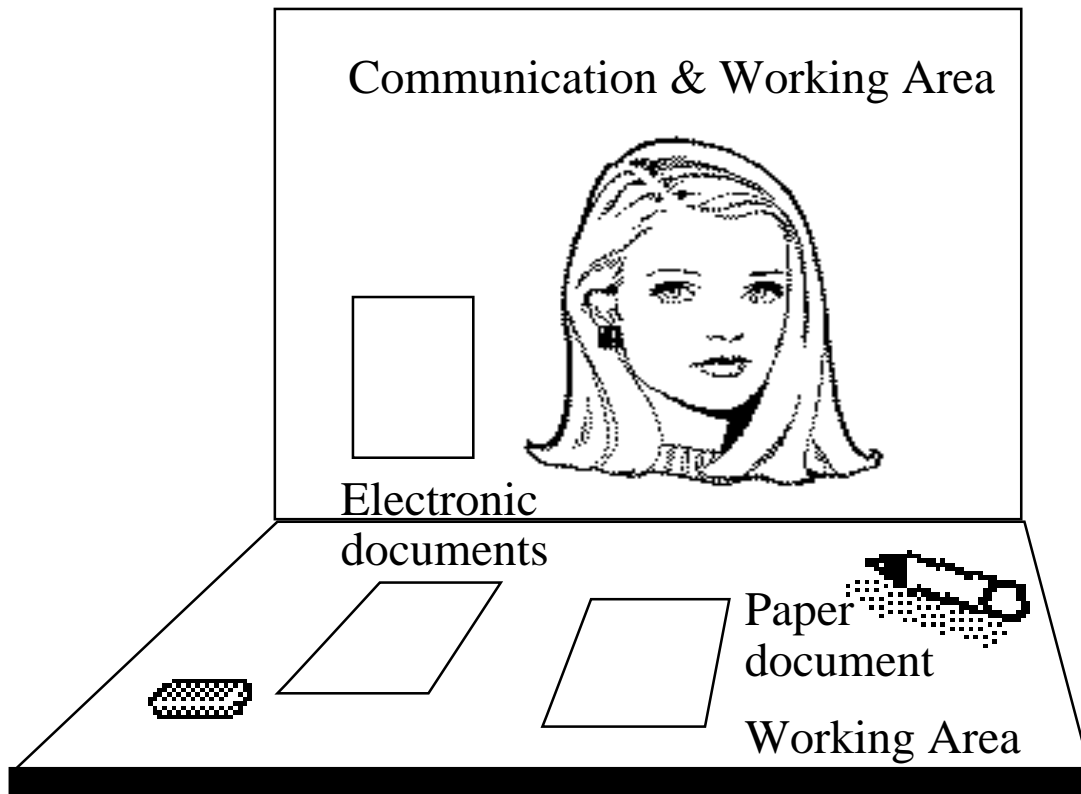
Playing time per game



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.