Lecture 12:
Interface Design IV:
Functional Analysis

Jon Oberlander

School of informatics

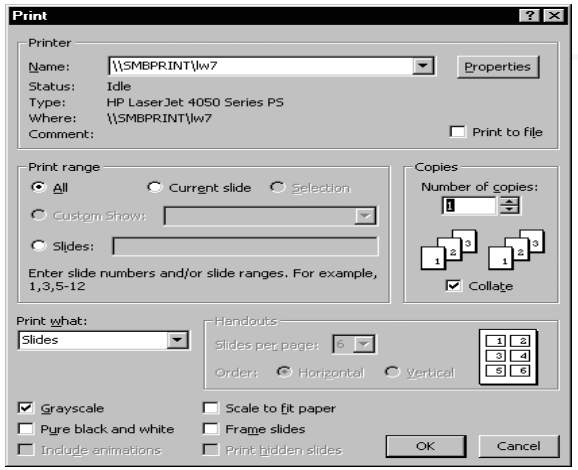
Introduction

- Interface design should be driven by what users want to use the system for
- Functional analysis design focuses on establishing what users want to do and how:
  - Task knowledge and information needs
  - Tasks, including steps and objects involved
  - Semantic and temporal relationships between task steps and objects
- This knowledge is then used to drive subsequent design decisions:
  - The functionality and objects provided in the interface
  - The organisation of the interface:
    - Layout and grouping of interface functions and components to reflect semantic relationships
    - Sequencing of access to interface functions to reflect procedural constraints

Purpose of Task Analysis

- Identify tasks and gather knowledge users employ to perform them
- Analyse to determine interface structure and presentation
- Steps involved in a task suggest functionality required
- Task vocabulary suggests names for operations and objects
- Taxonomies suggest semantic relationships:
  - Layout and group interface components e.g., menus, to reflect them
- Taxonomies suggest importance:
  - Structure access to interface components to reflect frequency of use

Layout Example



Layout groups related items through proximity and sub-area boundaries.

Layout suggests an order, but doesn't impose it.

Task Analysis

- Declarative and procedural knowledge required for the performance of tasks
- Task structure
  - Goals and sub-goals
  - Task procedures, typical sequences of step
  - Dependencies and constraints
- Developed originally as a tool for writing training manuals
  - Establish overall goal
  - Decompose goal into plan consisting of sub-goals
  - Repeat until description is 'adequate'

Task Knowledge Elicitation Techniques

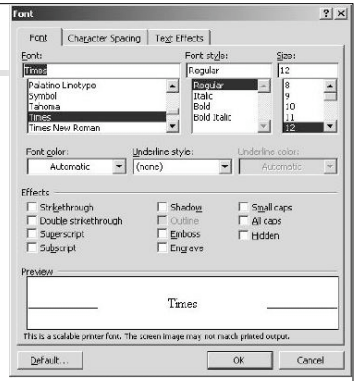
- Techniques for identifying procedural knowledge include:
  - Asking about standard procedures
  - Asking "what happens if X goes wrong?"
  - Ask users what preconditions must be satisfied for each step of a task
  - Listing task steps and asking users to sort them into appropriate orders

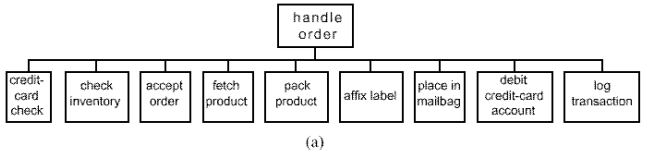
Task Knowledge Elicitation Techniques

- Getting users to list all objects and activities involved in a task
- Structured interviews followed by listing all relevant nouns and verbs
- Observation
- Re-enactment protocols
  - Note objects and actions mentioned
- Collecting examples of artifacts e.g., documents used

Laddering

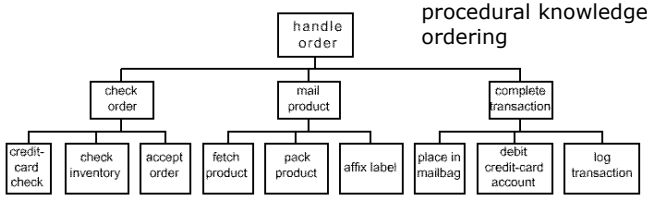
1. Start subject off with a seed item:
   - Type faces
2. Move around task domain knowledge using appropriate prompts:
   1. To move down:
      - Can you give examples of type faces?
   2. To move across:
      - What alternatives are there to type faces for changing the appearance of text?
   3. To move up:
      - What have Times Roman, Helvetica in common?



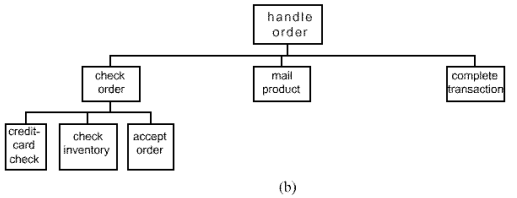


(a)

Task analysis of procedural knowledge of ordering

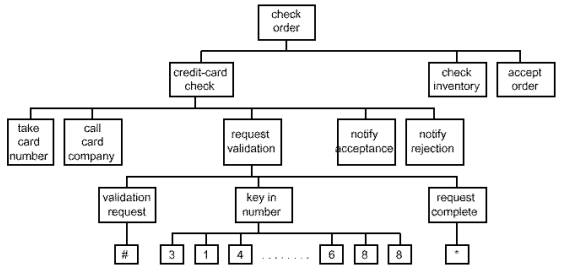


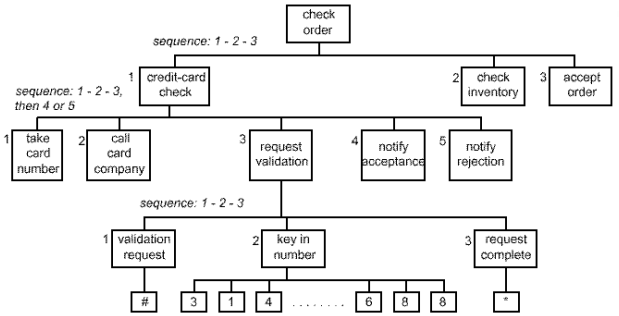
(b)



(b)

More detailed procedural task analysis for Check Order





Hierarchical task analysis (HTA) adds sequencing information

A More Complex Example: Collaborative Authoring Tool

- When people author collaboratively, they will review each other's drafts and make comments in the form of annotations, e.g.:
  - A1: highlight word (circle), a link to a margin and a general comment about all of document
  - A2: link from text to a question
  - A3: highlight phrase (underline)
  - A4: long arrow within page from A3 to A2
  - A5: highlight part of word and a local comment in the margin

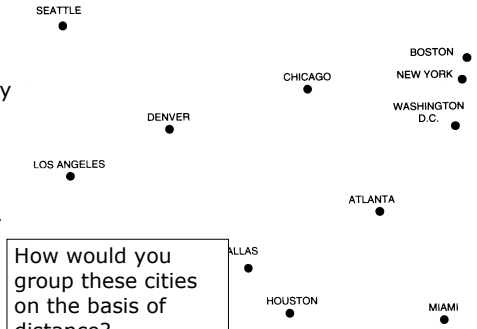
A More Complex Example: Collaborative Authoring Tool

Our analysis follows in outline the method known as Task Analysis for Knowledge Description (TAKD)

- Identify 'specific entities':
  - Circle annotation in document
  - Underline annotation in document
  - Word in document
  - Phrase in document
  - Short arrow link
  - Long arrow link
  - General comment
  - Local comment
- Identify generic entities:
  - Source: section to which annotation refers
  - Link: connecting source to comment
  - Annotation: the comment itself

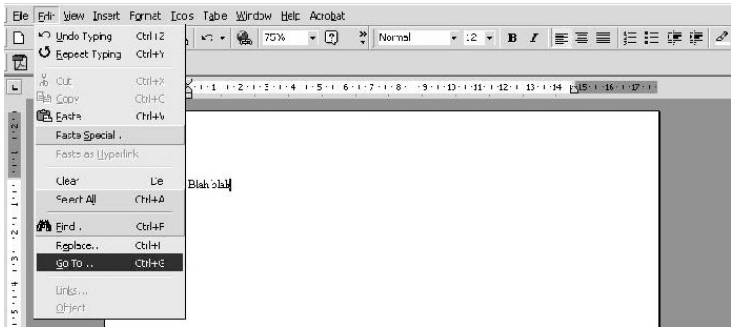
Categorising: Finding Structure

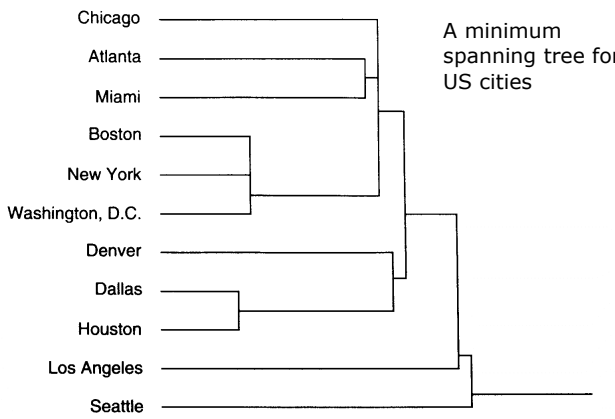
- How would users categorise functions and objects?
- How might users' categories be reflected in the way interface functionality and objects are structured?
- E.g., menu design, spatial layout



How would you group these cities on the basis of distance?

Why Are Word Menus Like This?





A minimum spanning tree for US cities

Categorising by Distance Measures

- Measures of psychological distance
- Individual responses summed to create a distance matrix
- Pair-wise ranking of relatedness performed for all item pairs
- Analyse using cluster analysis:
  - Heuristic search to find optimal partition of n items

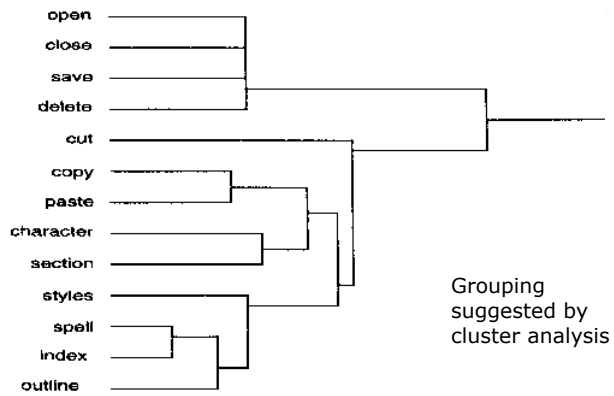
Cluster Analysis

1. Create individual triangular n x n matrix representing n items to be clustered, using 0/1 to signify related/unrelated
2. Add individual distance matrices together
3. Similarity threshold applied to decide if pairs of items are connected
4. Resemblance threshold to decide if each item in group has higher enough family resemblance
5. Clusters extracted until all items accounted for
6. Repeat with different thresholds until 'optimal' clustering found
7. Goodness of clusters can be measured in terms of:
   - Cluster tightness: average similarity of group members
   - Prototypicality: average of each group member's similarity with others

Cluster Analysis Example: WP Commands

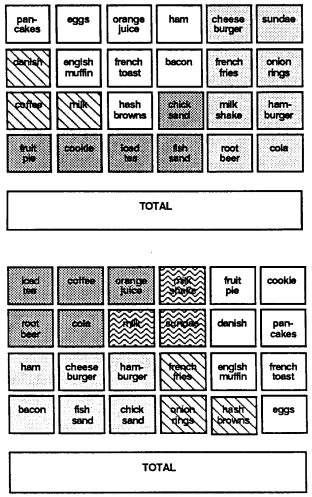
COMMANDS	open	close	save	delete	cut	copy	paste	char.	section	styles	out.	spell	index
open		1	2	3	8	6	6	6	7	7	6	6	7
close	1		1	2	5	6	7	6	6	7	7	7	7
save	2	1		5	6	5	5	4	6	7	5	7	7
delete	3	2	5		2	5	6	7	7	7	6	6	7
cut	6	5	6	2		2	3	5	5	7	7	7	7
copy	6	6	5	5	2		2	4	4	7	7	7	7
paste	6	7	5	6	3	2		4	6	7	7	7	7
character	6	6	4	7	5	4	4		2	4	7	7	7
section	7	6	6	7	5	4	6	2		6	7	7	7
styles	7	7	7	7	7	7	7	4	6		6	7	7
outline	6	7	5	6	7	7	7	7	7	6		1	1
spell	6	7	7	6	7	7	7	7	7	7	1		1
index		7	7	7	7	7	7	7	7	7	7	1	1

Note: in this example, similar items have *low* scores



Grouping suggested by cluster analysis

Cluster Analysis Example: The Fast Food Keyboard



Grouping by co-occurrence in orders

Grouping by similarity of items

Functions with "Adjust" in them
AVG SIM 0.93

Items	Proto
Adjust graticule intensity	0.95
Adjust display intensity	0.95
Adjust readout intensity	0.90

Functions which toggle the display
AVG SIM 0.90

Items	Proto
Toggle menu display	0.90
Toggle readout display	0.90

Manipulation of intensified zone
AVG SIM 0.77

Items	Proto
Change size of inten zone	0.80
Adjust intensified zone inten	0.80

Functions that select waveform
AVG SIM 0.70

Items	Proto
Select target wfm for cursor	0.75
Select wfm for vertical	0.70
Select reference waveform	0.65

Hardcopy
AVG SIM 0.70

Items	Proto
Print waveform	0.70
Set print control params	0.70

Functions with the word "trigger"
AVG SIM 0.65

Items	Proto
Enter trigger word	0.73
Autoset trigger	0.70
Adjust trigger level	0.68
Select trigger	0.67
Choose trigger coupling	0.66

Functions with the word "Set"
AVG SIM 0.57

Items	Proto
Set delay by events	0.65
Set number of env sweeps	0.58
Set delay time	0.58
Set number of sweeps aver	0.55
Set calibration of a channel	0.50

Functions that choose things
AVG SIM 0.53

Items	Proto
Choose input coupling	0.60
Choose numbering scheme	0.58
Choose bandwidth limit	0.56
Choose mode	0.52
Choose magnification factor	0.52
Select TV signal interlaced	0.38

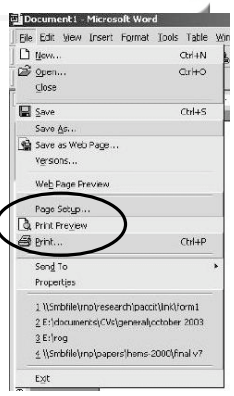
Functions with the word "sweep"
AVG SIM 0.50

Note: high values signify closeness

Cluster Analysis Example: The Oscilloscope Front Panel

Task Analysis Issues

- May be difficult to devise a novel solution using task analysis
- Task descriptions are typically lengthy
- The problem of adequacy: how much detail is required?
- Tasks are situated, i.e., take place under conditions that can never be fully anticipated, nor fully described, but which must still be accommodated
  - Should results of task analysis be rigidly adhered to?
  - Investigate trade offs between structured interaction and flexibility



Further Reading

- Dix et al., (2nd ed) chapter 7; (3rd ed) chapter 15.
- Newman and Lamming, chapter 6, p. 117-24