Outline

Overview

Task Decomposition

Knowledge Based Analyses

Conclusion

Exercise

References
Focus on Analysis

- Interaction design driven by what is wanted
- Analysis of tasks and knowledge informs:
  - functionality and objects offered in interface;
  - organisation (layout, grouping, navigation).
Task Analysis

- **Task Analysis** is the study of the way people perform their jobs. Aim is to determine:
  - what they do
  - what things they use
  - what they must know

Task analysis gathers both declarative and procedural knowledge:
- Declarative: objects and relationships
- Procedural: task sequences, goals and subgoals
  - Also dependencies and constraints

Originally a tool for writing training manuals, now used more widely in business process analysis.

Emphasises users' existing tasks, rather than desired system as in systems analysis.

Emphasises observable behaviour and whole job, rather than internal mental state and "unit" tasks as in cognitive models.
Task Analysis

- **Task Analysis** is the study of the way people perform their jobs. Aim is to determine:
  - what they do
  - what things they use
  - what they must know

- Task analysis gathers both *declarative* and *procedural* knowledge
  - Declarative: objects and relationships
  - Procedural: task sequences, goals and subgoals
  - Also dependencies and constraints

Originally a tool for writing training manuals, now used more widely in business process analysis. Emphasises users+existing tasks, rather than desired system as in systems analysis. Emphasises observable behaviour and whole job, rather than internal mental state and “unit” tasks as in cognitive models.
Task Analysis

- **Task Analysis** is the study of the way people perform their jobs. Aim is to determine:
  - what they do
  - what things they use
  - what they must know

- Task analysis gathers both *declarative* and *procedural* knowledge
  - Declarative: objects and relationships
  - Procedural: task sequences, goals and subgoals
  - Also dependencies and constraints

- Originally a tool for writing training manuals, now used more widely in business process analysis.
Task Analysis

- **Task Analysis** is the study of the way people perform their jobs. Aim is to determine:
  - what they do
  - what things they use
  - what they must know

- Task analysis gathers both *declarative* and *procedural* knowledge
  - Declarative: objects and relationships
  - Procedural: task sequences, goals and subgoals
  - Also dependencies and constraints

- Originally a tool for writing training manuals, now used more widely in business process analysis

- Emphasises users+existing tasks, rather than desired system as in *systems analysis*

- Emphasises observable behaviour and whole job, rather than internal mental state and “unit” tasks as in *cognitive models*
Example Task: Cleaning House

To clean the house:

- get the vacuum cleaner out;
- fix the appropriate attachments;
- clean the rooms;
- when the dust bag gets full, empty it;
- put the vacuum cleaner and tools away.
Example Task: Cleaning House

To clean the house:

- get the vacuum cleaner out;
- fix the appropriate attachments;
- clean the rooms;
- when the dust bag gets full, empty it;
- put the vacuum cleaner and tools away.

We must know about:

- vacuum cleaners, their attachments, dust bags, cupboards, rooms.
Example Layout

- Items related by proximity and boundaries
- Layout suggests order, but doesn’t impose it
Approaches

There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
Approaches

There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
  - **gardener digs**
Approaches

There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
  - gardener *digs* soil

.cf database design not covered further here
Approaches

There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
  - gardener *digs soil using*
There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
  - gardener *digs* soil *using* spade

- cf database design
  - not covered further here
Approaches

There are many different approaches, notations and techniques.

- **Task decomposition**
  - splitting task into (ordered) subtasks

- **Knowledge-based techniques**
  - what the user knows about the task
  - and how it is organised

- **Entity/object based analysis**
  - relationships between objects, actions and the people who perform them
    - gardener *digs* soil *using* spade
  - cf database design
  - not covered further here
The general method for Task Analysis is:

- observe
- collect unstructured lists of words and actions
- organize using notation or diagrams
Outline

Overview

Task Decomposition

Knowledge Based Analyses

Conclusion

Exercise

References
Task Decomposition

- **Aims:**
  - describe the actions people do
  - structure them within task subtask hierarchy
  - describe order of subtasks

- **Variants:**
  - **Hierarchical Task Analysis (HTA)**
    – the most common
  - **ConcurTaskTrees (CTT)**, by Paternò (2000)
    – uses LOTOS temporal operators

- **Procedural task knowledge elicitation techniques:**
  - Observation, re-enactment
  - Ask about procedures and triggers (pre-conditions)
  - “What happens if X goes wrong?”
  - Sorting steps into appropriate orders
Hierarchy description

0. clean the house
   1. get the vacuum cleaner out
   2. get the appropriate attachment
   3. clean the rooms
      3.1 clean the hall
      3.2 clean the living rooms
      3.3 clean the bedrooms
   4. empty the dust bag
   5. put vacuum cleaner and attachments away
Textual HTA

Hierarchy description

0. clean the house
   1. get the vacuum cleaner out
   2. get the appropriate attachment
   3. clean the rooms
      3.1 clean the hall
      3.2 clean the living rooms
      3.3 clean the bedrooms
   4. empty the dust bag
   5. put vacuum cleaner and attachments away

Plans

Plan 0: do 1, 2, 3, 5 in order;
       when dust bag full, do 4

Plan 3: do 3.1, 3.2, 3.3 in any order, as needed
Diagrammatic HTA

0. make a cup of tea

plan 0.
do 1
at the same time, if the pot is full 2
then 3 – 4
after four or five minutes do 6

1. boil water
2. empty pot
3. put tea leaves in pot
4. pour in boiling water
5. wait 4 or 5 minutes
6. pour tea

plan 1.
1.1 – 1.2 – 1.3
when kettle boils 1.4

1.1. fill kettle
1.2. put kettle on hob
1.3. wait for kettle to boil
1.4. turn off gas

[Dix et al, p. 515]
How to check or improve the initial HTA? Some heuristics are:

- **paired actions** where is “turn on gas”?
- **restructure** generate task “make pot”
  - **balance** is “pour tea” simpler than “make pot”?
- **generalise** make one cup . . . or more
Refined HTA for making tea

0. Make cups of tea

Plan 0.
do 1 at the same time, if the pot is full 2 then 3 - 4 after four or five minutes do 5

Plan 1.
1.1 - 1.2 - 1.3 - 1.4 when kettle boils 1.5

Plan 3.
3.1 - 3.2 - 3.3

Plan 5.
5.1 - 5.2

5.3. Do sugar

5.3.1. Ask guest about sugar
5.3.2. Add sugar to taste

4. Wait 4 or 5 minutes

5. Pour tea

2. Empty pot

3. Make pot

1. Boil water

1.1. Fill kettle
1.2. Put kettle on hob
1.3. Turn on and light gas
1.4. Wait for kettle to boil
1.5. Turn off gas
Types of plan

- **sequence** 1.1 then 1.2 then 1.3
- **optional** if the pot is full 2
- **wait** when kettle boils, do 1.4
- **cycles** do 5.1 5.2 while there are still empty cups
- **parallel** do 1; at the same time ...
- **discretionary** do any of 1.3.1, 1.3.2 or 1.3.3 in any order

Most plans use several of these.

Waiting can be considered:

- a task — for “busy” waits, e.g. making tea
- part of the plan — end is the event, e.g. email reply received
Outline

Overview

Task Decomposition

Knowledge Based Analyses

Conclusion

Exercise

References
Knowledge Based Analyses

- Aim to understand knowledge required for a task
  - provide training material, how-to manuals;
  - take advantage of common knowledge across tasks.
Knowledge Based Analyses

- Aim to understand knowledge required for a task
  - provide training material, how-to manuals;
  - take advantage of common knowledge across tasks.

- Focus on:
  - objects used in task
  - actions performed
Knowledge Based Analyses

- Aim to understand knowledge required for a task
  - provide training material, how-to manuals;
  - take advantage of common knowledge across tasks.
- Focus on:
  - **objects** used in task
  - **actions** performed
- Use **taxonomies**:
  - represent levels of abstraction
  - organisation (grouping) depends on purpose
Knowledge Based Analyses

- Aim to understand knowledge required for a task
  - provide training material, how-to manuals;
  - take advantage of common knowledge across tasks.

- Focus on:
  - objects used in task
  - actions performed

- Use **taxonomies**:
  - represent levels of abstraction
  - organisation (grouping) depends on purpose

- Declarative knowledge elicitation techniques:
  - established convention, existing documentation
  - asking users to list objects; card sorting
  - structured interviews, listing nouns and verbs
Laddering

1. Start subject off with a seed item: type faces

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

2. Move around task domain knowledge using prompts:
   - To move down: *Can you give examples of type faces?*
   - To move across: *What alternatives are there to type faces for changing the appearance of text?*
   - To move up: *What have Times Roman, Helvetica in common?*
## Car Control Taxonomy

<table>
<thead>
<tr>
<th>Category</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Controls</td>
<td>steering: steering wheel, indicators</td>
</tr>
<tr>
<td></td>
<td>engine: direct ignition, accelerator, foot brake</td>
</tr>
<tr>
<td></td>
<td>gearing: clutch, gear stick</td>
</tr>
<tr>
<td></td>
<td>lights: external headlights, hazard lights</td>
</tr>
<tr>
<td></td>
<td>internal: courtesy light</td>
</tr>
<tr>
<td>Wash/Wipe</td>
<td>wipers: front wipers, rear wipers</td>
</tr>
<tr>
<td></td>
<td>washers: front washers, rear washers</td>
</tr>
<tr>
<td>Heating</td>
<td>temperature control, air direction, fan, rear screen heater</td>
</tr>
<tr>
<td>Parking</td>
<td>hand brake, door lock</td>
</tr>
<tr>
<td>Radio</td>
<td>numerous!</td>
</tr>
</tbody>
</table>
### Car Control Taxonomy

<table>
<thead>
<tr>
<th>Motor Controls</th>
<th>Steering</th>
<th>Engine</th>
<th>Gearing</th>
<th>Lights</th>
<th>Wash/Wipe</th>
<th>Heating</th>
<th>Parking</th>
<th>Radio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>steering</strong></td>
<td>steering wheel, indicators</td>
<td>direct ignition, accelerator, foot brake</td>
<td>clutch, gear stick</td>
<td>external headlights, hazard lights</td>
<td>front front wipers, front washers</td>
<td>temperature control, air direction, fan, rear screen heater</td>
<td>hand brake, door lock</td>
<td>numerous!</td>
</tr>
<tr>
<td><strong>engine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>gearing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>lights</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>wash/wipe</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>heating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>parking</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>radio</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task Descriptive Hierarchy (TDH)

▶ Task Analysis for Knowledge Description (TAKD) uses three types of branches in TDH taxonomies:
  ▶ **XOR** — object in exactly one branch
  ▶ **AND** — object must be in both
  ▶ **OR** — can be in one, many or none

wash/wipe **AND**

<table>
<thead>
<tr>
<th>function</th>
<th>XOR</th>
<th>wipers</th>
<th>washers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>front wipers,</td>
<td>rear wipers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>front washers,</td>
<td>rear washers</td>
</tr>
<tr>
<td>position</td>
<td>XOR</td>
<td>front</td>
<td>rear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>front wipers,</td>
<td>rear wipers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>front washers,</td>
<td>rear washers</td>
</tr>
</tbody>
</table>
Larger TDH example

kitchen item AND
/____shape XOR
/   |____dished mixing bowl, casserole, saucepan,
/   |_______soup bowl, glass
/   |____flat plate, chopping board, frying pan
/____function OR
   {____preparation mixing bowl, plate, chopping board
   {____cooking frying pan, casserole, saucepan
   {____dining XOR
      |___for food plate, soup bowl, casserole
      |___for drink glass

N.B. /   { indicates branch type; operator names AND, XOR, OR not usually used
Examining TDH taxonomies

- The **uniqueness rule**: can the diagram distinguish every object?
  - If not, may consider adding extra classifiers

- Taxonomies for actions are similar, e.g.
  - kitchen job XOR
    - preparation
    - beating
    - mixing
  - cooking
    - frying
    - boiling
    - baking
  - dining
    - pouring
    - eating
    - drinking

- Compare taxonomies to restructure/find omissions

- Objects often more easily observed than tasks!

- Notice: TDH decomposes by similarity, HTA by how-to.
The uniqueness rule: can the diagram distinguish every object?
- If not, may consider adding extra classifiers

Taxonomies for actions are similar, e.g.

- kitchen job XOR
  - preparation, beating, mixing
  - cooking, frying, boiling, baking
  - dining, pouring, eating, drinking

Notice: TDH decomposes by similarity, HTA by how-to.
Examining TDH taxonomies

- The **uniqueness rule**: can the diagram distinguish every object?
  - If not, may consider adding extra classifiers
- Taxonomies for actions are similar, e.g.
  ```plaintext
  kitchen job XOR
  |___ preparation  beating, mixing
  |___ cooking  frying, boiling, baking
  |___ dining  pouring, eating, drinking
  ```
- Compare taxonomies to restructure/find omissions
- Objects often more easily observed than tasks!
- Notice: TDH decomposes by similarity, HTA by how-to.
Abstraction and cuts

- After producing detailed taxonomy, we can cut to yield an abstract view.
- e.g. cutting above shape and below dining, plate becomes:
  - kitchen
  - item/function{preparation,dining}/
- This is a term in the Knowledge Representation Grammar (KRG)
- Composite KRG term: *beating in a mixing bowl* is
  - kitchen job(preparation) using
    - a kitchen item/function{preparation}/
- Terms and sequences in KRG may provide tools for further analysis.
Applying Task Analysis

▶ For documentation: **How To** manual
  ▶ useful for novices
  ▶ assumes all tasks known
▶ Requirements capture and design
  ▶ lifts focus from system to use
  ▶ suggests candidates for automation
  ▶ may uncover user’s conceptual model
▶ Detailed interface design
  ▶ taxonomies suggest menu layout
  ▶ object/action lists suggest interface objects
  ▶ task frequency guides default choices
  ▶ existing task sequences guide dialogue design

Task analysis can be continually iterated to improve and enhance.
Exercise

1. Investigate the use of **cluster analysis** to classify objects into groups.
   - Cluster analysis works by constructing a matrix of object similarities using a distance measure.
   - The distance measure may be a psychological (user-driven) estimate of relatedness determined by experiment or interview.

2. Derive a taxonomy from existing menu and dialogue layouts in a common application (e.g., word processor, image editor)

3. Perform a cluster analysis on the basic tasks and objects, and examine whether it agrees with the application layout.
Outline

Overview

Task Decomposition

Knowledge Based Analyses

Conclusion

Exercise

References
Fabio Paternò. *Model-Based Design and Evaluation of Interactive Applications.*

See also:
- Dix et al, Chapter 15, and further reading recommendations there.
- More about CTT at http://giove.cnuce.cnr.it/ConcurTaskTrees.html