HUMAN-COMPUTER INTERACTION

THIRD EDITION

DIX
FINLAY
ABOWD
BEALE

chapter 15

task models

What is Task Analysis?

Methods to analyse people's jobs:

- what people do
- what things they work with
- what they must know

An Example

- in order 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

- must know about:
  - vacuum cleaners, their attachments, dust bags, cupboards, rooms etc.

Approaches to task analysis

- 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
- lots of different notations/techniques

general method

- observe

- collect unstructured lists of words and actions

- organize using notation or diagrams

Differences from other techniques

Systems analysis		**vs.**		**Task analysis**
system design	-	focus	-	the user
Cognitive models		**vs.**		**Task analysis**
internal mental state	-	focus	-	external actions
practiced \`unit' task	-	focus	-	whole job

Task Decomposition

Aims:

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

Variants:

- Hierarchical Task Analysis (HTA)
  - most common
- CTT (CNUCE, Pisa)
  - uses LOTOS temporal operators

Textual HTA description

Hierarchy description ...

0. in order to 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

... and plans

Plan 0: do 1 - 2 - 3 - 5 in that order. when the dust bag gets full do 4

Plan 3: do any of 3.1, 3.2 or 3.3 in any order depending
on which rooms need cleaning

N.B. only the plans denote order

Generating the hierarchy

1 get list of tasks

2 group tasks into higher level tasks

3 decompose lowest level tasks further

Stopping rules

How do we know when to stop?

Is “empty the dust bag” simple enough?

Purpose: expand only relevant tasks

Motor actions: lowest sensible level

Tasks as explanation

- imagine asking the user the question:

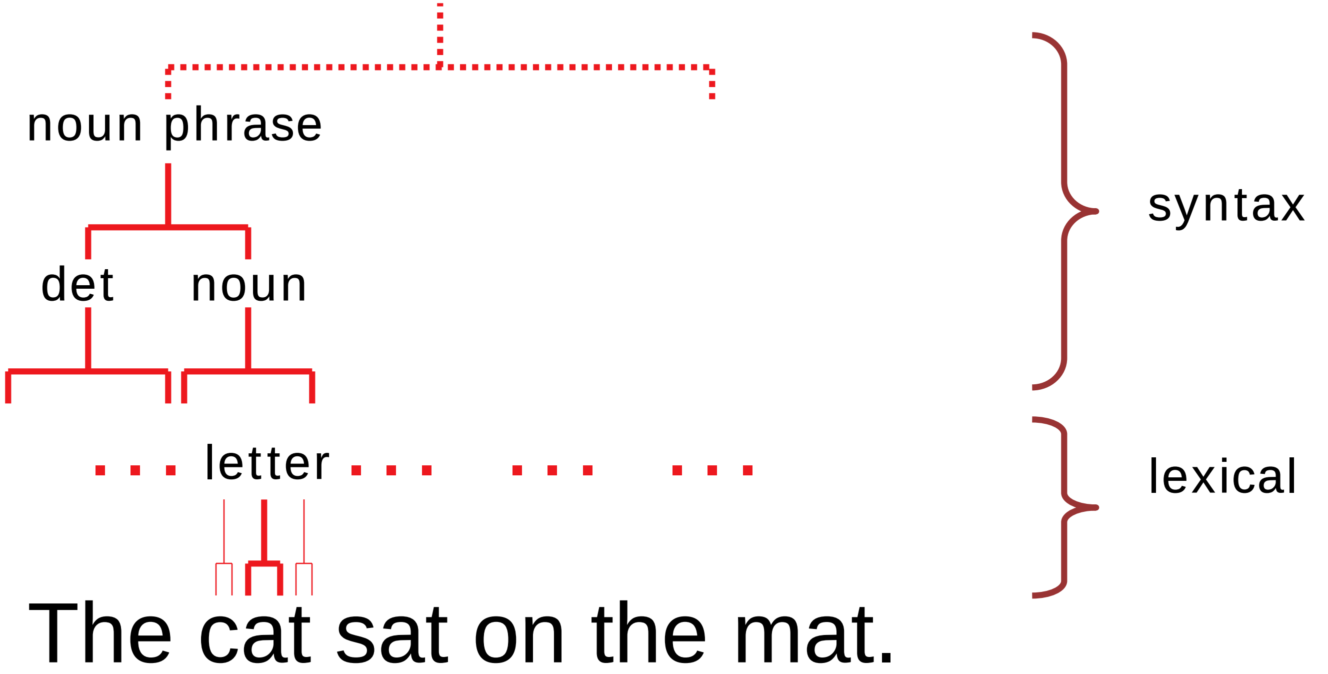
  what are you doing now?

- for the same action the answer may be:

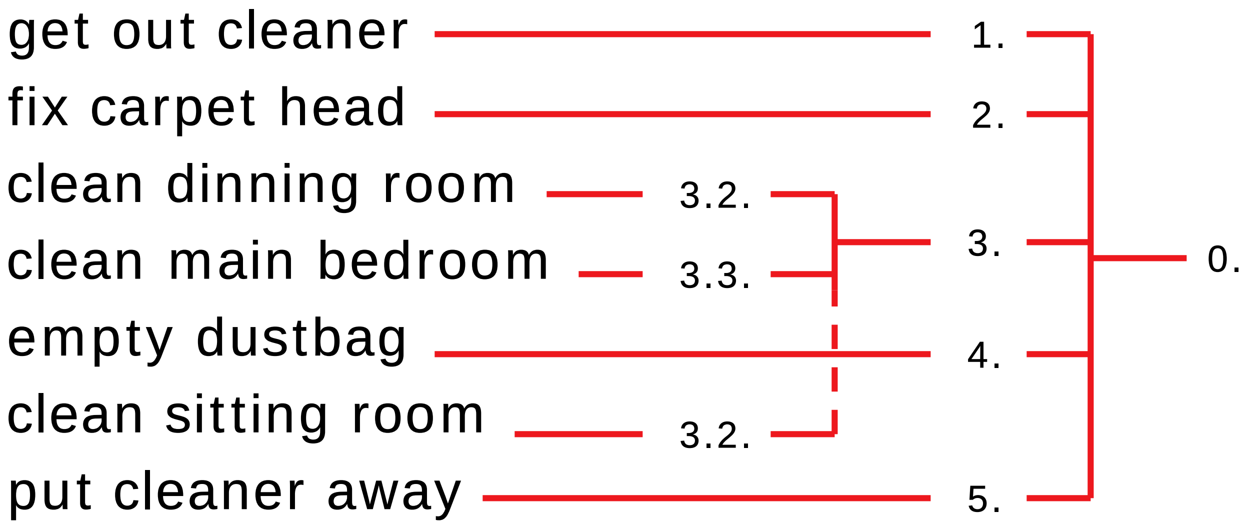
  typing ctrl-B
  making a word bold
  emphasising a word
  editing a document
  writing a letter
  preparing a legal case

HTA as grammar

- can parse sentence into letters, nouns, noun phrase, etc.

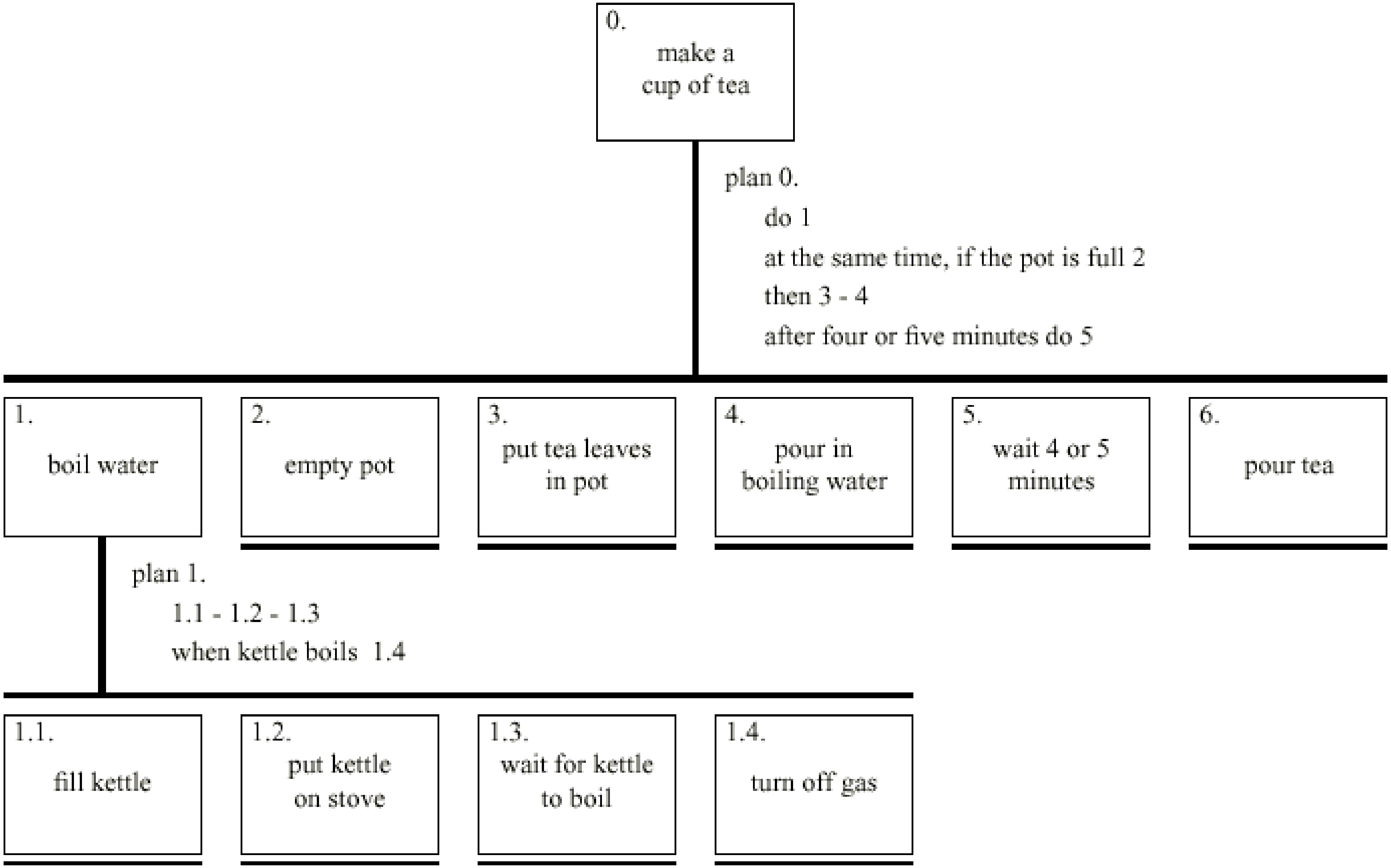


parse scenario using HTA



0. in order to 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

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 5

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 stove

1.3.
wait for kettle to boil

1.4.
turn off gas

Refining the description

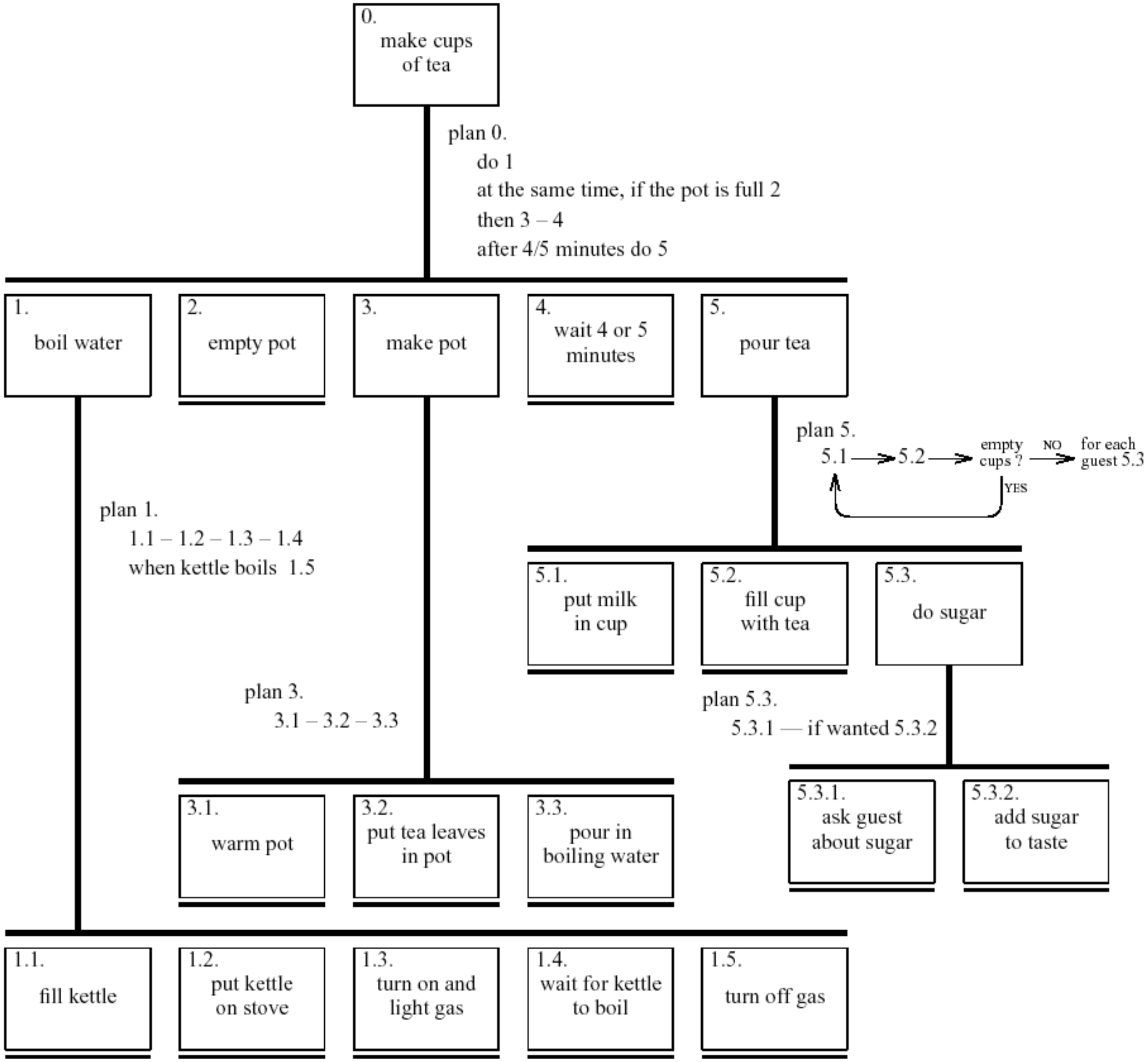
Given initial HTA (textual or diagram)

How to check / improve it?

Some heuristics:

paired actions	e.g., where is `turn on gas'
restructure	e.g., generate task `make pot'
balance	e.g., is `pour tea' simpler than making pot?
generalise	e.g., 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 4/5 minutes do 5

1. boil water

2. empty pot

3. make pot

4. wait 4 or 5 minutes

5. pour tea

plan 1.
1.1 – 1.2 – 1.3 – 1.4
when kettle boils 1.5

1.1. fill kettle

1.2. put kettle on stove

1.3. turn on and light gas

1.4. wait for kettle to boil

1.5. turn off gas

plan 3.
3.1 – 3.2 – 3.3

3.1. warm pot

3.2. put tea leaves in pot

3.3. pour in boiling water

plan 5.
5.1 → 5.2 → empty cups ? NO → for each guest 5.3
YES → 5.1

5.1. put milk in cup

5.2. fill cup with tea

5.3. do sugar

plan 5.3.
5.3.1 — if wanted 5.3.2

5.3.1. ask guest about sugar

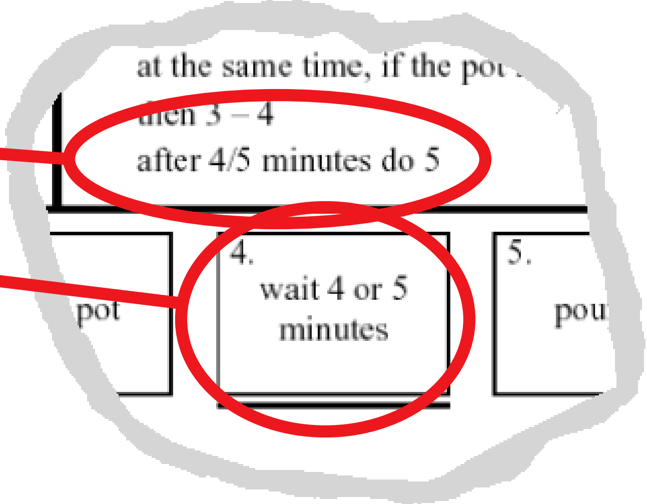
5.3.2. add sugar to taste

Types of plan

fixed sequence	-	1.1 then 1.2 then 1.3
optional tasks	-	if the pot is full 2
wait for events	-	when kettle boils 1.4
cycles	-	do 5.1 5.2 while there are still empty cups
time-sharing	-	do 1; at the same time ...
discretionary	-	do any of 3.1, 3.2 or 3.3 in any order
mixtures	-	most plans involve several of the above

waiting …

- is waiting part of a plan?
  …   or a task?
- generally
  - task – if ‘busy’ wait
    - you are actively waiting
  - plan – if end of delay is the event
    - e.g. “when alarm rings”, “when reply arrives”
- in this example …
  - perhaps a little redundant …
  - TA not an exact science



see chapter 19 for more on delays!

Knowledge Based Analyses

Focus on:

Objects – used in task

Actions – performed

+ Taxonomies –
represent levels of abstraction

Knowledge-Based Example …

- motor controls
  - steering *steering wheel, indicators*
  - engine/speed
    - direct *ignition, accelerator, foot brake*
    - gearing *clutch, gear stick*
  - lights
    - external *headlights, hazard lights*
    - internal *courtesy light*
  - wash/wipe
    - wipers *front wipers, rear wipers*
    - washers *front washers, rear washers*
  - heating *temperature control, air direction, fan, rear screen heater*
  - parking *hand brake, door lock*
  - radio *numerous!*

Task Description Hierarchy

Three types of branch point in taxonomy:

XOR – normal taxonomy
object in one and only one branch

AND – object must be in both
multiple classifications

OR – weakest case
can be in one, many or none

```
wash/wipe AND
     function XOR
             wipe    front wipers, rear wipers
             wash    front washers, rear washers
     position XOR
             front    front wipers, front washers
             rear     rear wipers, rear washers
```

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. ‘/|{’ used for branch types.

More on TDH

Uniqueness rule:

- can the diagram distinguish all objects?

e.g., plate is:

```
kitchen item/shape(flat)/function{preparation,dining(for food)}/
```

nothing else fits this description

Actions have taxonomy too:

```
kitchen job OR
|____ preparation  beating, mixing
|____ cooking frying, boiling, baking
|____ dining  pouring, eating, drinking
```

Abstraction and cuts

After producing detailed taxonomy
'cut' to yield abstract view

That is, ignore lower level nodes

e.g. cutting above shape and below dining, plate becomes:

```
kitchen item/function{preparation,dining}/
```

This is a term in Knowledge Representation Grammar (KRG)

These can be more complex:

e.g. 'beating in a mixing bowl' becomes:

```
kitchen job(preparation) using a
                kitchen item/function{preparation}/
```

Entity-Relationship Techniques

Focus on objects, actions and their relationships

Similar to OO analysis, but ...

- includes non-computer entities
- emphasises domain understanding not implementation

Running example

‘Vera's Veggies’ – a market gardening firm

owner/manager: Vera Bradshaw
employees: Sam Gummage and Tony Peagreen
various tools including a tractor `Fergie‘
two fields and a glasshouse
new computer controlled irrigation system

Objects

Start with list of objects and classify them:

Concrete objects:

- simple things: spade, plough, glasshouse

Actors:

- *human actors*: Vera, Sam, Tony, the customers
- what about the irrigation controller?

Composite objects:

- *sets*: the team = Vera, Sam, Tony
- *tuples*: tractor may be < Fergie, plough >

Attributes

To the objects add attributes:

Object Pump3 **simple** – irrigation pump
- **Attributes**:
  - status: on/off/faulty
  - capacity: 100 litres/minute

N.B. need not be computationally complete

Actions

List actions and associate with each:

- agent – who performs the actions
- patient – which is changed by the action
- instrument – used to perform action

examples:

- Sam (*agent*) planted (*action*) the leeks (*patient*)
- Tony dug the field *with* the spade (*instrument*)

Actions (ctd)

implicit agents – read behind the words

`the field was ploughed' – *by whom?*

indirect agency – the real agent?

`*Vera* programmed the *controller* to irrigate the field'

messages – a special sort of action

`Vera *told* Sam to … '

rôles – an agent acts in several rôles

Vera as *worker* or as *manager*

example – objects and actions

Object Sam **human actor**
Actions:
S1: drive tractor
S2: dig the carrots

Object Vera **human actor**
– the proprietor
Actions: as worker
V1: plant marrow seed
V2: program irrigation controller
Actions: as manager
V3: tell Sam to dig the carrots

Object the men **composite**
Comprises: Sam, Tony

Object glasshouse **simple**
Attribute:
humidity: 0-100%

Object Irrigation Controller
non-human actor
Actions:
IC1: turn on Pump1
IC2: turn on Pump2
IC3: turn on Pump3

Object Marrow **simple**
Actions:
M1: germinate
M2: grow

Events

… when something happens

- performance of action

  ‘Sam dug the carrots’

- spontaneous events

  ‘the marrow seed germinated’

  ‘the humidity drops below 25%’

- timed events

  ‘at midnight the controller turns on’

Relationships

- object-object

  social - Sam is subordinate to Vera

  spatial - pump 3 is in the glasshouse

- action-object

  agent (listed with object)

  patient and instrument

- actions and events

  temporal and causal

  ‘Sam digs the carrots because Vera told him’

- temporal relations

  use HTA or dialogue notations.

  show task sequence (normal HTA)

  show object lifecycle

example – events and relations

Events:

Ev1: humidity drops below 25%

Ev2: midnight

Relations: object-object

location (Pump3, glasshouse)

location (Pump1, Parker’s Patch)

Relations: action-object

patient (V3, Sam)

- Vera tells *Sam* to dig

patient (S2, the carrots)

- Sam digs the *carrots* ...

instrument (S2, spade)

- ... *with* the spade

Relations: action-event

before (V1, M1)

- the marrow must be sown *before* it can germinate

triggers (Ev1, IC3)

- *when* humidity drops below 25%, the controller turns on pump 3

causes (V2, IC1)

□– the controller turns on the pump *because* Vera programmed it

Sources of Information

Documentation

- N.B. manuals say what is *supposed* to happen
  but, good for key words and prompting interviews

Observation

- formal/informal, laboratory/field (see Chapter 9)

Interviews

- the expert: manager or worker? (ask both!)

Early analysis

Extraction from transcripts

- list nouns (objects) and verbs (actions)
- beware technical language and context:
  `the rain poured' vs. `I poured the tea'

Sorting and classifying

- grouping or arranging words on cards
- ranking objects/actions for task relevance (see ch. 9)
- use commercial outliner

Iterative process:

data sources ⌦ analysis

... but costly, so use cheap sources where available

Uses – manuals & documentation

Conceptual Manual

- from knowledge or entity–relations based analysis
- good for open ended tasks

Procedural ‘How to do it’ Manual

- from HTA description
- good for novices
- assumes all tasks known

To make cups of tea

boil water — see page 2
empty pot
make pot — see page 3
wait 4 or 5 minutes
pour tea — see page 4

— page 1 —

Make pot of tea
once water has boiled

warm pot
put tea leaves in pot
pour in boiling water

— page 3 —

Uses – requirements & design

Requirements capture and systems design

- lifts focus from system to use
- suggests candidates for automation
- uncovers 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

NOTE. task analysis is never complete

- rigid task based design ⇒ inflexible system