Human Computer Interaction

Chapter 07 – Task analysis

Trinh Thanh Trung

Task analysis identifies the actions and cognitive processes required for a user to complete a task or achieve a particular goal.

Upon completion of this lesson, students will be able to:

1. Memorize the concept of task analysis
2. Restate the main characteristics of different task analysis models
3. Distinguish the cognitive models and action-based models

Objectives

1. Introduction
2. GOMS
3. HTA

Content

Introduction

- Definition
- Goals, Tasks & Actions
- Task analysis outputs

Overview

- Task analysis is the process of identifying the information that has to be processed and the steps that have to be carried out in order to achieve the goal of a task using a specific device or method.
  - User's actions (what people do)
  - Objects to be impacted by users (what things they work with)
  - Required knowledge to perform tasks to achieve the ambitious goals (what they must know)

Overview

- Task analysis describes behaviors at three levels:
  - Goals: what you would like to be true, i.e. intention or external task
  - Tasks: how to achieve goals, i.e. activities necessary to achieve goals using an appropriate method, tool, or technique
  - Actions: simple tasks without control structure

Example: "House vacuuming" task analysis

- Purpose: *"House vacuuming"*
- Tasks to do:
  - Get a vacuum cleaner
  - Install the necessary accessories
  - Perform vacuuming
- Some conditions
  - When the trash can is full: remove the trash and reinsert it
  - When done vacuuming: remove the accessories and store the vacuum cleaner
- Knowledge required
  - How to use a vacuum cleaner?
  - How to disassemble the accessories?
  - What is the order of rooms to perform vacuuming?

Task analysis' output

- Detailed description of physical, perceptual, and cognitive activities involved with each task
- Task duration and variability
- Task frequency
- Task sequence
- Task allocation
- Task complexity
- Environmental conditions
- Data and information dependencies
- Tools required for the task
- User skills, education, and training

Task analysis' outcome: address business functions

- Perform a business definition and requirements analysis.
- Determine basic business functions.
- Describe current activities through task analysis.
- Develop a conceptual model of the system.
- Establish design standards or style guides.
- Establish system usability design goals.
- Define training and documentation needs.

Uses of Task Analysis (1)

- Manuals and 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
- Requirements capture and systems design
  - lifts focus from system to use
  - suggests candidates for automation
  - uncovers user's conceptual model

Uses of Task Analysis (2)

- Detailed interface design
  - taxonomies suggest menu layout
  - object/action lists suggest interface objects
  - task frequency guides default choices
  - existing task sequences guide dialogue design

- Attention!!! task analysis is never complete
  - rigid task based design ⇒ inflexible system

Approaches to task analysis

Task decomposition: Splitting task into (ordered) subtasks	Describe the actions people do Structure them within task / subtask hierarchy Describe order of subtasks	Action-based models: HTA
Knowledge based techniques: What the user knows about the task and how it is organized	Focus on: Objects used in task Actions performed Taxonomies represent levels of abstraction	Cognitive models: GOMS
Entity-relation based analysis: Relationships between objects, actions and the people who perform them	Focus on objects, actions and their relationships Emphasize domain understanding not implementation	Object-oriented analysis + non-computer entities
General method	Observe Collect unstructured lists of words and actions Organize using notation or diagrams	Linguistic models: TAG, BNF

GOMS

- Goals – Operators – Methods – Selection Rules

GOMS

- Formal representation of routine cognitive skill.
- GOMS models user's behavior in terms of:
  - Goals: the successful end state for the task
    - What the user wants to do.
  - Operators: action performed on the machine
    - Specific steps a user is able to take and assigned a specific execution time.
  - Methods
    - Well-learned sequences of sub-goals and operators that can accomplish a goal.
  - Selection Rules
    - Guidelines for deciding between multiple methods.

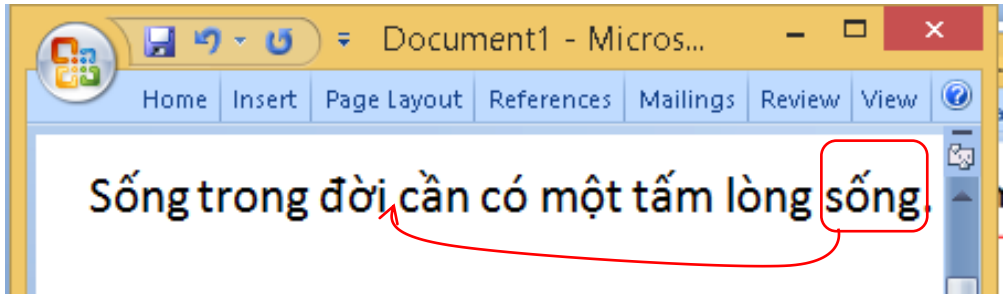
GOMS: KLM

- KLM - Keystroke-Level Model
- Simplest GOMS technique
  - The basis for all other GOMS techniques
  - Predicts execution time
- Requires analyst-supplied methods

GOMS: KLM

- Assumes that routine cognitive skills can be decomposed into a serial sequence of basic cognitive operations and motor activities, which are:
  - K: A keystroke (280 msec)
  - B: A button click (200 msec)
  - M: A single mental operator (1350 msec)
  - P: Pointing to a target on a small display (1100 msec or $0.1 \times \log_2 (D/S + 0.5)$sec)
  - H: Moving hands from the keyboard to a mouse (400 msec)
  - D: drawing (0.9+0.16 × length in cm msec)
  - R: response time of system

KLM Example



Top-level Goal: Edit the text (move "sống" to before "cần")

Subgoal: Highlight word

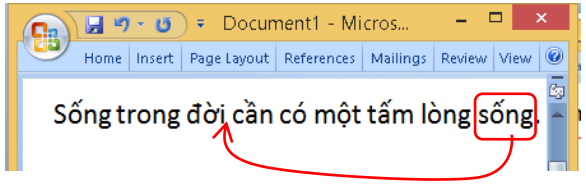
Operators: Move-mouse
Click mouse-button
Type characters (keyboard shortcuts)

Methods:
1. Delete-word-and-retype (retype method)
2. Cut-and-paste-using-keyboard-shortcuts (shortcuts method)
3. Cut-and-paste-using menus (menus method)

Selection Rules: If the word to be moved is one or two characters long, use retype method
Else, if remember shortcuts, use shortcuts method
Else, use the menus method

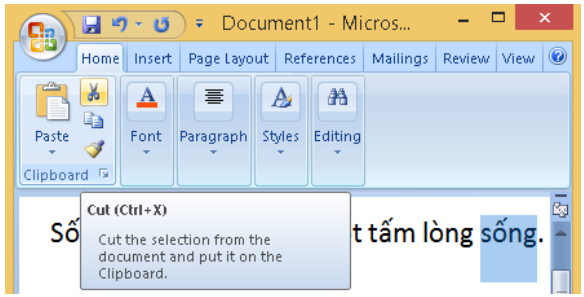
Method Used: Cut-and-paste-using-menus

1



Task: Select a word

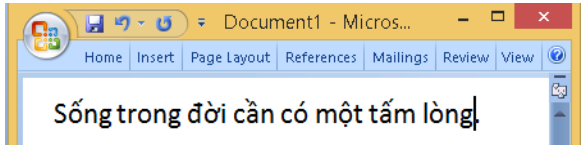
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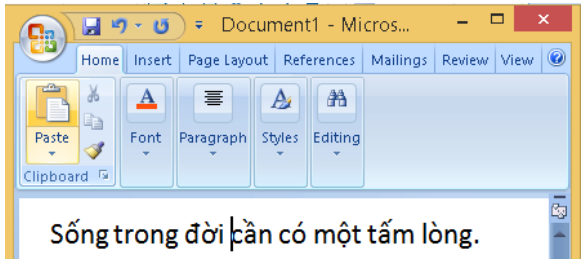
M=1.35
P=1.10
B=0.20

Task: Cut a word

3

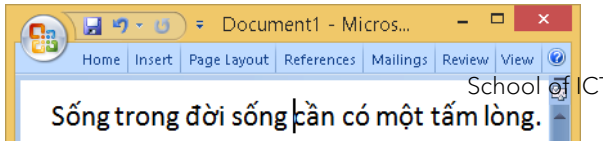


4



Task: Paste a word

5



Description	Operator	Duration (sec)
Mentally Prepare	M	1.35
Move cursor to “sống”	P	1.10
Double-click mouse button	BB	0.40
Mentally Prepare	M	1.35
Move cursor to Home Menu	P	1.10
Click mouse button	B	0.20
Move cursor to Cut menu item	P	1.10
Click mouse button	B	0.20
Mentally Prepare	M	1.35
Move cursor to before “cần”	P	1.10
Click mouse button	B	0.20
Mentally Prepare	M	1.35
Move cursor to Home menu	P	1.10
Click mouse button	B	0.20
Move cursor to Paste menu item	P	1.10
Click mouse button	B	0.20
TOTAL PREDICTED TIME		**13.40**

GOMS: Card, Moran, and Newell (CMN-GOMS)

- Sub-goal invocations and method selection are predicted by the model given the task situation in program form

  → analysis is general and executable

- Predicts operator sequence and execution time based directly on the Model Human Processor

CMN-GOMS

Unit tasks

Keystrokes

Description	Duration (sec)
GOAL: MOVE-WORD	
…….**GOAL: CUT-WORD**	
……**GOAL: HIGHLIGHT-WORD**	
……..MOVE-CURSOR-TO-BEGINNING	1.10
……..CLICK-MOUSE-BUTTON	0.20
……..VERIFY-HIGHLIGHT	1.35
……..**GOAL: ISSUE-CUT-COMMAND**	
……MOVE-CURSOR-TO-HOME-MENU	
……PRESS-MOUSE-BUTTON	0.10
……MOVE-MOUSE-TO-CUT-ITEM	1.10
……VERIFY-HIGHLIGHT	1.35
……RELEASE-MOUSE-BUTTON	0.10
……**GOAL: PASTE-WORD**	
……**GOAL: POSITION-CURSOR-AT-INSERTION-POINT**	
……MOVE-CURSOR-TO-INSERTION-POINT	1.10
……CLICK-MOUSE-BUTTON	0.20
……VERIFY-POSITION	1.35
……**GOAL: ISSUE-PASTE-COMMAND**	
……MOVE-CURSOR-TO-HOME-MENU	
……PRESS-MOUSE-BUTTON	0.10
……MOVE-MOUSE-TO-PASTE-ITEM	
……VERIFY-HIGHLIGHT	1.35
……RELEASE-MOUSE-BUTTON	0.10
TOTAL PREDICTED TIME	**12.88**

HTA

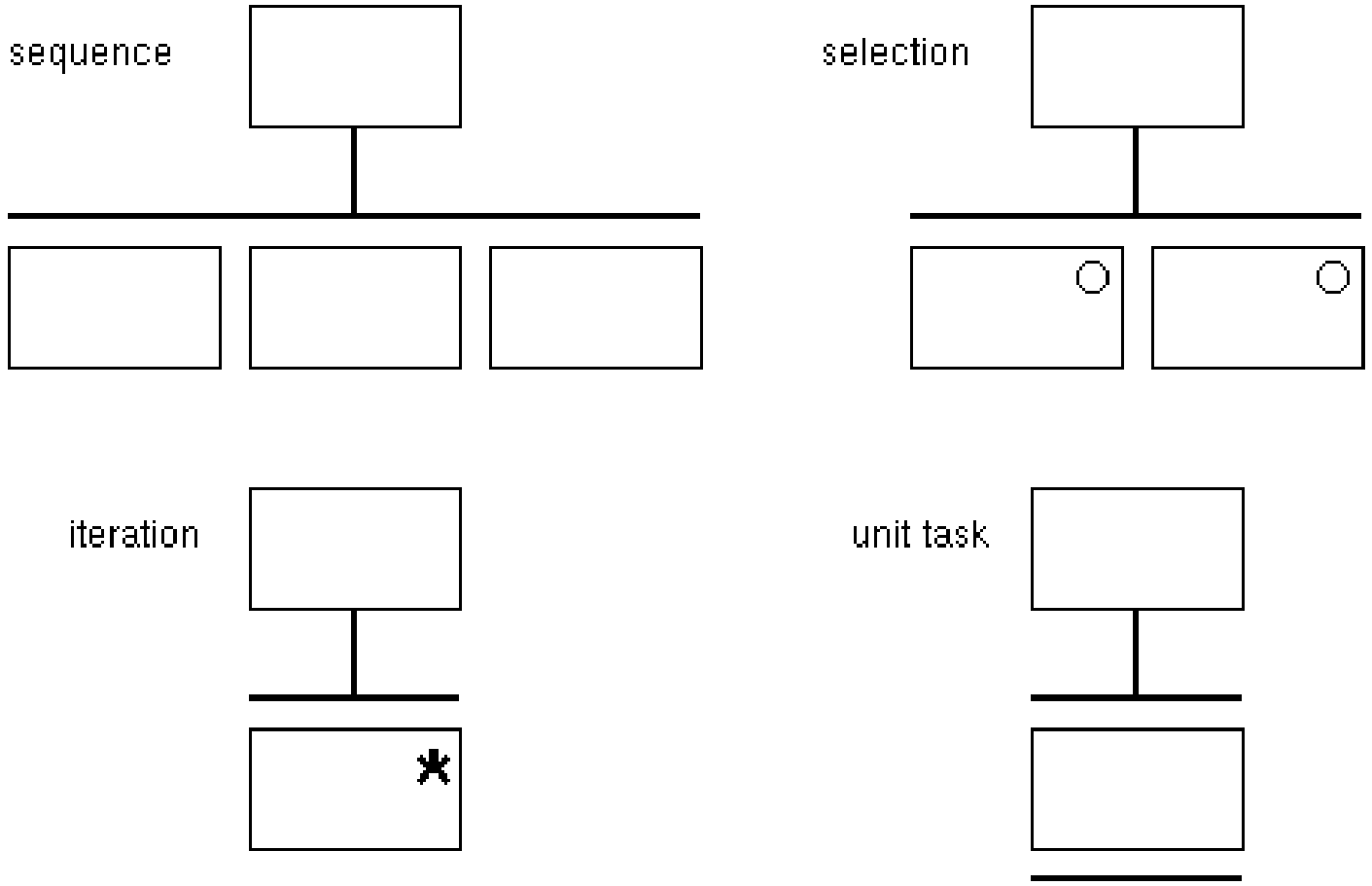
- Task decomposition
- Textual and diagrammatic HTA description
- Types of plan
- Stopping rules
- HTA description refinement

Overview

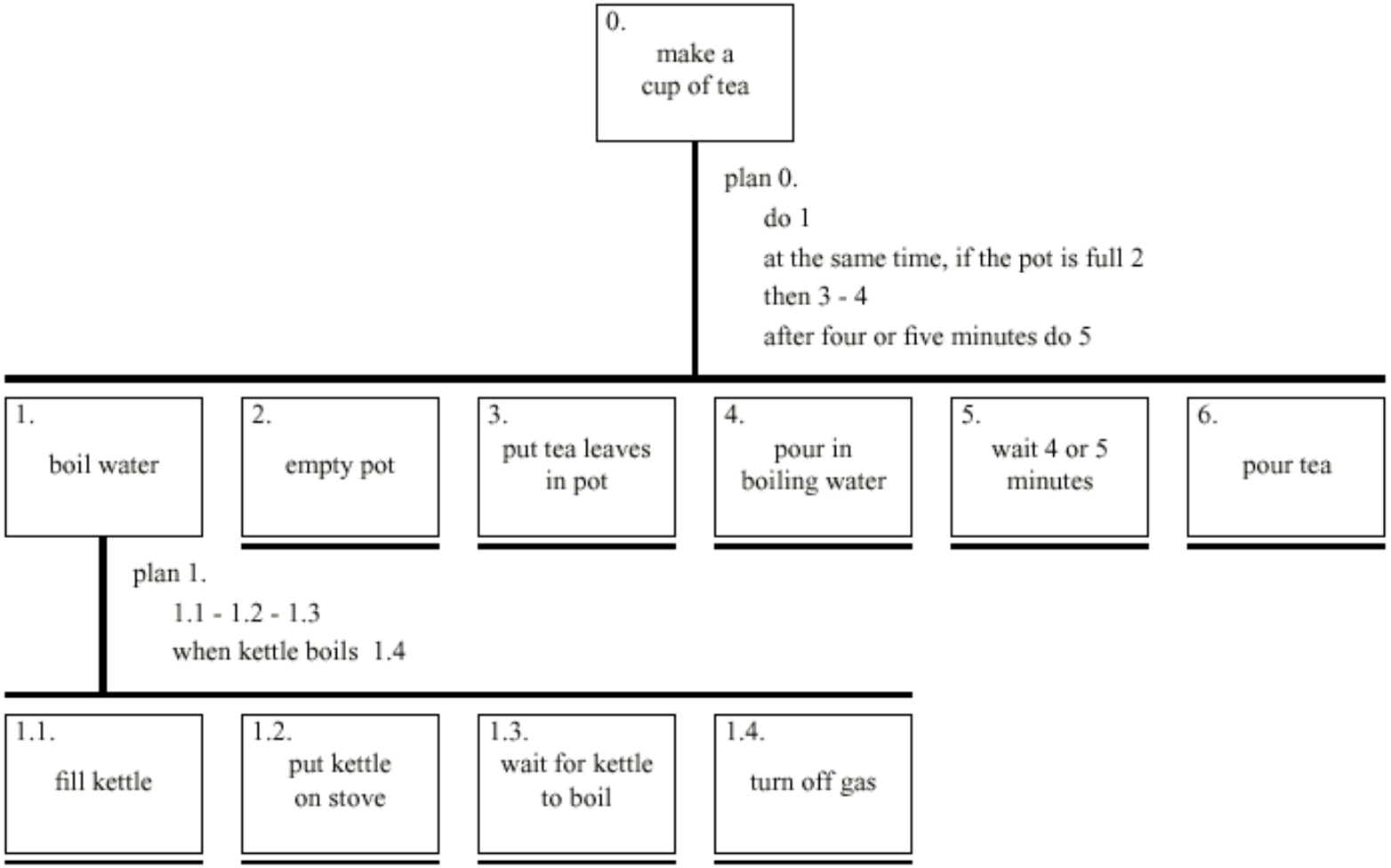
- HTA - Hierarchical Task Analysis is an action-based model based on *task decomposition* approach
  - text and diagrams to show hierarchy
  - plans to describe order

- Aims:
  - describe the actions people do
  - structure them within task / sub-task hierarchy
  - describe order of sub-tasks

HTA Structure Chart Notation



Diagrammatic HTA description



- Line under box means no further expansion.
- Plans shown on diagram or written elsewhere.

Textual HTA description

Generating the hierarchy:

- get list of tasks
- group tasks into higher level tasks
- decompose lowest level tasks further

```
0. Main goal
    1. Task 1
    2. Task 2
    3. Task 3
        3.1. Sub-task
        /Action
        3.2. …
    4. …
```

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

Plan:

- 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

Types of plan

Plan is the conditions which are necessary to undertake the tasks.
Only the plans denote order of tasks

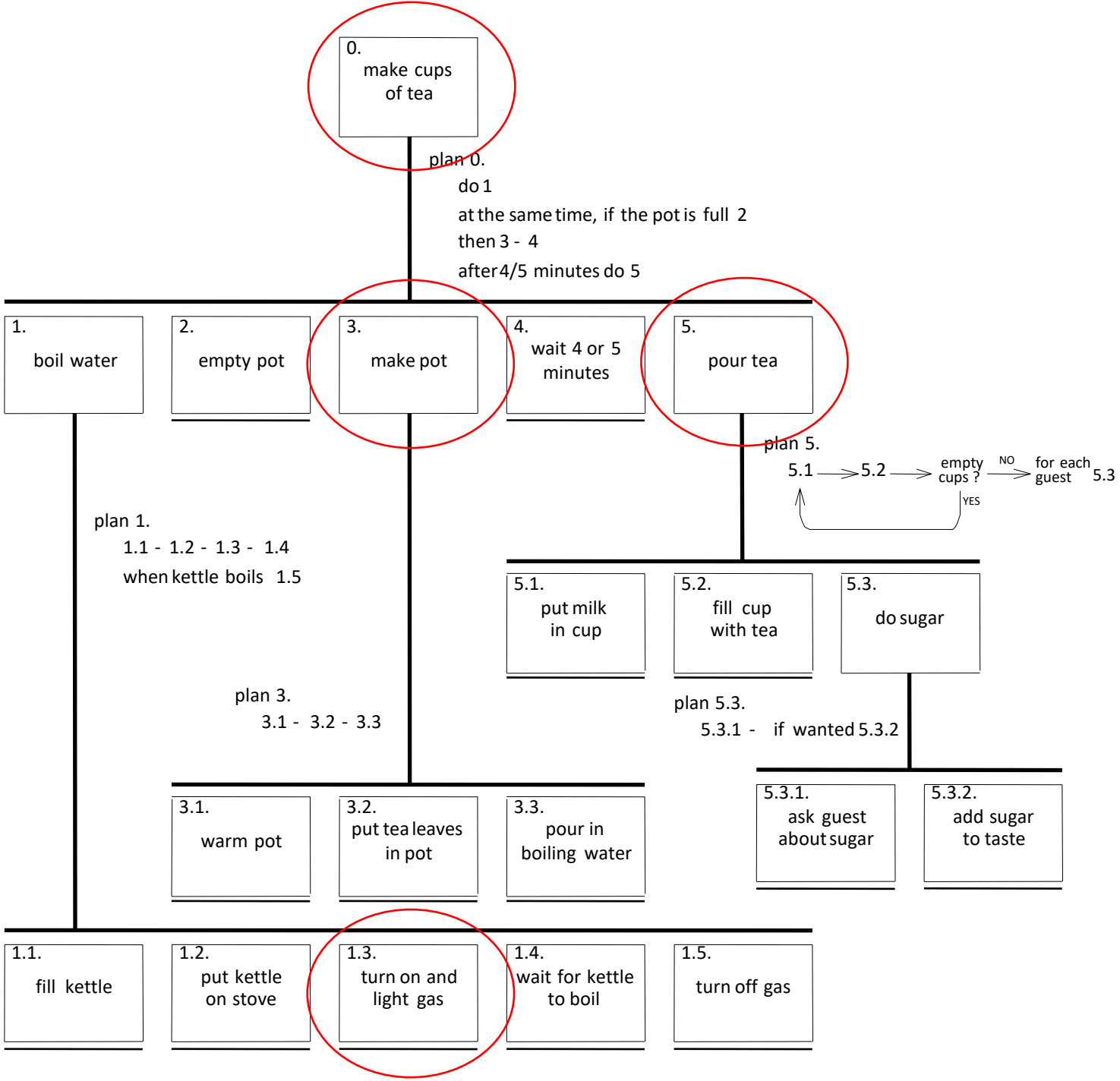
Fixed sequence	• 1.1 then 1.2 then 1.3
Optional tasks	• if the pot is full 2
Waiting for events	• when kettle boils 1.4
Cycles	• do 5.1 5.2 while there are still empty cups
Time-sharing	• do 1; at the same time ...
Discretionary	• do any of 3.1, 3.2 or 3.3 in any order
Mixtures	• most plans involve several of the above

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

Refining the description

- Given initial HTA (textual or diagram)
  - How to check/improve it?
- Some heuristics:
  - Paired actions
  - Restructure
  - Balance
  - Generalize



Redefined HTA For Making Tea

- 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?
- Generalize: e.g., make one cup or two or more

Stages of a HTA

1. Starting the analysis

a) Specify the main task.

b) Break down main task into 4-8 subtask, and specify in terms of objectives. Cover the whole area of interest

c) Draw out as layered plans, logically & technically correct. None should be missing.

2. Progressing the analysis

a) Decide on level of detail and stop decomposition. Should be consistent between tasks. Can range from detailed to high level description.

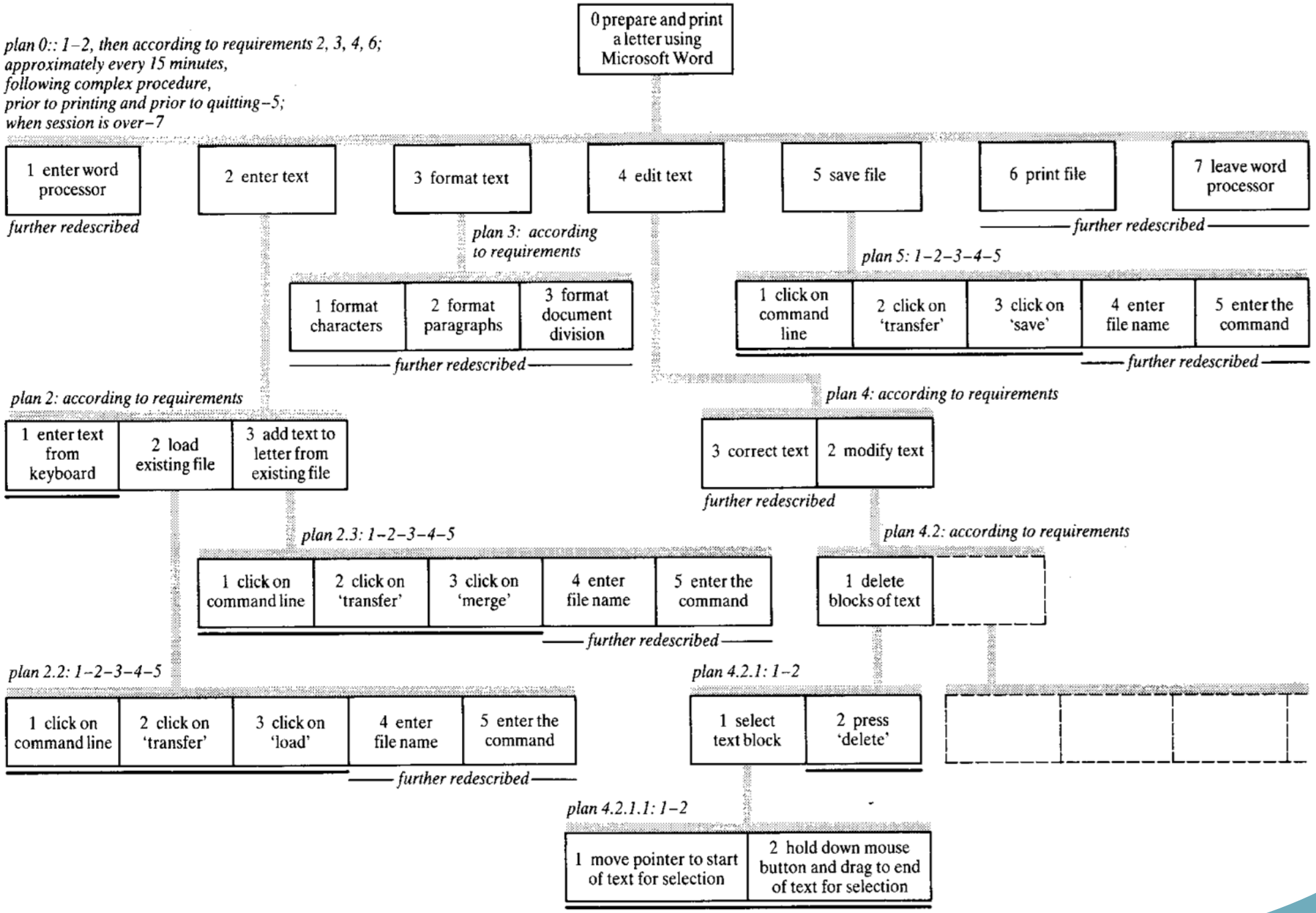
b) Decide if a depth first or breadth first decomposition should be done. Can alternate between the two.

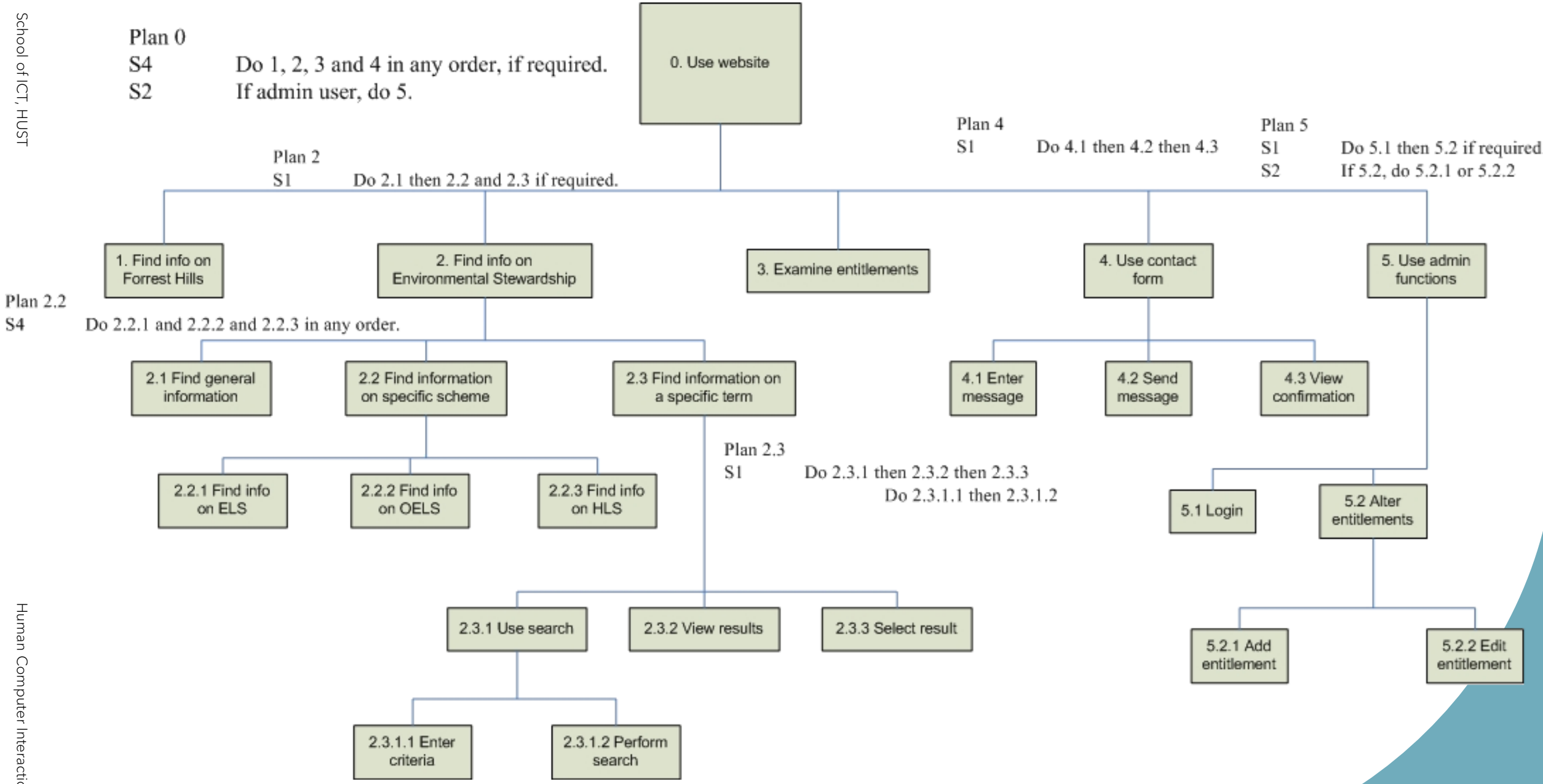
c) Label and number the HTA.

3. Finalizing the analysis.

a) Check that decomposition and numbering is consistent. May produce a written account of the processes.

b) Have a second person look it over. They should know the tasks but not be involved in the analysis.


plan 0:: 1–2, then according to requirements 2, 3, 4, 6;
approximately every 15 minutes,
following complex procedure,
prior to printing and prior to quitting–5;
when session is over–7
0 prepare and print a letter using Microsoft Word
1 enter word processor
2 enter text
3 format text
4 edit text
5 save file
6 print file
7 leave word processor
further redescribed
plan 3: according to requirements
1 format characters
2 format paragraphs
3 format document division
further redescribed
plan 5: 1–2–3–4–5
1 click on command line
2 click on 'transfer'
3 click on 'save'
4 enter file name
5 enter the command
further redescribed
plan 2: according to requirements
1 enter text from keyboard
2 load existing file
3 add text to letter from existing file
plan 4: according to requirements
3 correct text
2 modify text
further redescribed
plan 2.3: 1–2–3–4–5
1 click on command line
2 click on 'transfer'
3 click on 'merge'
4 enter file name
5 enter the command
further redescribed
plan 4.2: according to requirements
1 delete blocks of text
plan 2.2: 1–2–3–4–5
1 click on command line
2 click on 'transfer'
3 click on 'load'
4 enter file name
5 enter the command
further redescribed
plan 4.2.1: 1–2
1 select text block
2 press 'delete'
plan 4.2.1.1: 1–2
1 move pointer to start of text for selection
2 hold down mouse button and drag to end of text for selection


Plan 0
S4 Do 1, 2, 3 and 4 in any order, if required.
S2 If admin user, do 5.
0. Use website
Plan 2
S1 Do 2.1 then 2.2 and 2.3 if required.
Plan 4
S1 Do 4.1 then 4.2 then 4.3
Plan 5
S1 Do 5.1 then 5.2 if required.
S2 If 5.2, do 5.2.1 or 5.2.2
1. Find info on Forrest Hills
2. Find info on Environmental Stewardship
3. Examine entitlements
4. Use contact form
5. Use admin functions
Plan 2.2
S4 Do 2.2.1 and 2.2.2 and 2.2.3 in any order.
2.1 Find general information
2.2 Find information on specific scheme
2.3 Find information on a specific term
4.1 Enter message
4.2 Send message
4.3 View confirmation
2.2.1 Find info on ELS
2.2.2 Find info on OELS
2.2.3 Find info on HLS
Plan 2.3
S1 Do 2.3.1 then 2.3.2 then 2.3.3
Do 2.3.1.1 then 2.3.1.2
5.1 Login
5.2 Alter entitlements
2.3.1 Use search
2.3.2 View results
2.3.3 Select result
5.2.1 Add entitlement
5.2.2 Edit entitlement
2.3.1.1 Enter criteria
2.3.1.2 Perform search

Thank you for your attentions!

Any questions?



References

- References:
  - HCI: Chapter 3
  - ID: Chapter 5, 6
- Textbook
  - HCI: Alan J. Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Janet E. Finley. Human-Computer Interaction, 3rd edition. Prentice Hall, 834 pages, 2004. ISBN: 978-0130461094.
  - ID: Helen Sharp, Yvonne Rogers, Jenn Preece. Interaction Design: Beyond Human-Computer Interaction, 2nd edition. Addison Wesley Publishing Company, 800 pages, 2007. ISBN: 978-0-470-01866-8
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