DESIGN AS HIERARCHICAL DECOMPOSITION ACTIVITY

PROBLEM STATEMENT: SWAPING FAST, FASTER, FASTEST...

Consider an instructor's goal of assigning students to project groups, subject to two conditions: 1) Each group must have a balance of skills; and 2) All groups are about equal in size. This *task environment* (Simon, 1996, p. 12) might be represented in Microsoft Word, the *system*, as follows:

Group-1	*Group-2*	*Group-3*	…
Jill	John	Jude	
Tess	Bill	Mary	
Jack	Fred	Bob	

When forming and adjusting the groups, the instructor will often need to *swap* person-1 with person-2. This need to interchange items arises from the constraints of this particular task environment but swapping is surely a common task for many planning problems.

Microsoft Word provides various methods for completing the swap task. How should these methods be described? How should we assess these methods? What tools can we use to analyze this task in detail?

DESIGN APPROACH: TASK ANALYSIS AND GOMS

Step 1: Exploration with task analysis. Assuming that a person is using Microsoft Word, identify three different editing methods for swapping 'green Tortoise' and 'brown Hare' so that sentence (1) is transformed into (2):

1. One night the green Tortoise, happy as a clam, approached the brown Hare to talk …
2. One night the brown Hare, happy as a clam, approached the green Tortoise to talk …

For each method, describe the steps that must be performed. Your description should outline the general approach – a sketch of the interface for Word may help. Document your work on a transparency. We shall review these in class and select two methods for detailed analysis (see step 2).

Step 2: Modeling performance with the Keystroke-Level Model. For the TWO METHODS SELECTED IN CLASS, propose a sequence of operators for completing the tasks and compute time estimates. For this analysis, please use the following four operators, which are taken from Card, Moran & Newell (1983, p. 264).

Operator	**Time (sec)**	**Notes**
K – Press key or mouse button	0.2	A parameter determined by level of expertise, ranging from 0.08 – 1.2 for best to worst typist.
P – Point with a mouse	1.10	Varies with distance and size of target according to Fitts's law
H – Home hands on keyboard or mouse	0.4	Time to move hands to either the keyboard or mouse.
M – Mentally prepare	1.35	Thinking needed prior to starting a physical operation.

While deciding when to include Hs, Ks, and Ps is relatively straightforward, deciding where to put the Ms is not (see, for example, Lane, Napier, Batsell & Naman, 1993). For this analysis, please use these two heuristics, which are taken from five heuristics proposed by Card, Moran & Newell (1983, p. 265):

Rule 0: Insert Ms in front of all Ks that are not part of a string sequence (e.g., a word being typed).

Insert Ms in front of all Ps that select commands (e.g., select the Edit menu).

Rule 1: If an operator following an M is fully anticipated in an operator just previous to M, then delete M (e.g., pointing and clicking the mouse, P + M + K becomes P+K).

Here are two example analyses:

Task: Select the Save command in Word

Description	**Operator**	**Heuristic**	**Time (Seconds)**
Put hand on mouse	H		0.4
Mental preparation	M	Rule 0	1.35
Move cursor to Edit menu	P		1.10
Mental preparation	~~M~~	Rule 1	0.0
Click mouse	K		0.2
Move cursor to Save item	P		1.10
Mental preparation	~~M~~	Rule 1	0.0
Click mouse	K		0.2
	TOTAL		**1H + 1M + 2P + 2K**
			4.35

Task: Type the word 'Tortoise'

Description	**Operator**	**Heuristic**	**Time (Seconds)**
Put hand on mouse	H		0.4
Mental preparation	M	Rule 0	1.35
Move cursor to insertion point	P		1.10
Mental preparation	~~M~~	Rule 1	0.0
Click mouse	K		0.2
Put hand on keyboard	H		0.4
Mental preparation	~~M~~	Rule 0	0.0
Type shift key + 't'	2K		0.4
Type 'ortoise'	7K		1.4
	TOTAL		**2H + 1M + 1P + 10K**
			5.25

Step 3: Invention. Now, reflect upon the keystroke-level analysis of the two methods for swapping items. Does this analysis suggest a more efficient method for swapping items? Describe the method and compute a time estimate for it. What considerations other than time are important for assessing the new method?

Step 4: Validation. In this step we will conduct a simple experiment and collect performance data for the two methods in an attempt to validate the above keystroke-level analysis. A 'response sheet', contained in a Word document, will be e-mailed to the class shortly after class on Tuesday. Using the response sheet, you should follow this general procedure:

Set-up

1. Set the screen resolution of your computer to 1024 X 768 pixels.
2. Set the mouse properties to default values (e.g., double click speed, pointer speed, etc.).
3. Close all applications except Word and Internet Explorer.
4. Set the view resolution in Word to 100% and remove all unnecessary tool bars.

Practice

1. Explain Method-A and demonstrate it to the participant. (Note: It is important that the participant complete the task *exactly* as specified in the response sheet.)
2. Once the participant understands Method-A, scroll to Practice #1 on the response sheet and position the cursor and mouse pointer before the heading "Practice #1".
3. Ask the participant to place both hands on the keyboard.
4. Prompt the participant to begin and start timing.
5. Stop timing when you see that the participant has finished the task.
6. Note the time to the NEAREST TENTH OF A SECOND, whether the edit was correctly performed or not, and whether the participant made an error during the completion of the task.
7. If Method-A was not followed correctly, explain the deviation and demonstrate the method again.
8. Ask your participant to browse some online news for at least one minute.
9. Repeat the practice until the participant completes three practice tasks correctly.

Trials – Method-A

1. Scroll to Trial #1 on the response sheet and position the cursor and mouse pointer before the heading "Trial #1".
2. Ask the participant to place both hands on the keyboard.
3. Prompt the participant to begin and start timing.
4. Stop timing when you see that the participant has finished the task.
5. Note the time to the NEAREST TENTH OF A SECOND, whether the edit was correctly performed (the correct outcome using the correct method), and whether the participant made an error during the completion of the task.
6. Ask your participant to browse some online news for at least one minute.
7. Repeat until all five trials are completed.

Trials – Method-B

1. Follow the practice procedure as outlined above.
2. Then, collect data in the identical fashion as Method-A.

Note: We will counterbalance the conditions so that half the class will collect data for Method-A then Method-B and half the class will collect data for Method-B then Method-A.

You should e-mail your data in the following format:

Subject	Order	Method	Trial	Time	Correct	# Errors
Your-initials	AB or BA	A or B	1-5	xx.xx	Y or N	#

Your file should contain 11 records with tabs between each column

```
Subject     Order Method      Trial Time  Correct     #Errors
DGH1        AB    A           1     12.3  Y           0
…
DGH1        AB    A           5     9.8   Y           1
DGH1        BA    B           1     15.8  Y           3
…
DGH1        BA    B           5     8.1   Y           0
```

Notes:

1. Please format the data in a text file, named <your_intitials>.txt
2. Please include the column headings on the first row only.
3. Please insert SINGLE TABs between each data field on all rows.
4. Your file should include 11 rows: 1 header row and 5 rows for method-A and five rows for method-B (or 5 rows for method-B and then 5 rows for method-A) Please do not include the practice data.
5. Please note if the final result is correct (Y or N) and how many 'errors' the participant made while completing the task (an integer #).

We will combine the individual data files, producing one aggregate data set which will then be e-mailed to the class.

Explain Method A

drag-n-drop

Please use the following procedure for drag-n-drop:

1. Position the cursor in front of ‘Practice #1’ and place hands on the keyboard;

2. Move the cursor to the beginning of ‘green’;
3. Select ‘green Tortoise’ by clicking and dragging the mouse until ‘green Tortoise’ has been selected;
4. Drag the selection to the appropriate place, just before ‘brown Hare’;
5. Release the mouse;

6. Repeat step 1 to 4 for ‘brown Hare’.

Use **Method A**
Swap the phrases ‘green Tortoise’ and ‘brown Hare’

<<NOTE to Experimenter: At the top of separate pages in Word, please repeat this practice template for X=1..3 – remove this note>>

Practice #X

One night the green Tortoise, happy as a clam, approached the brown Hare to talk …

(Please read some news for at least 1 minute http://news.google.com/)

Use **Method A**
Swap the phrases ‘green Tortoise’ and ‘brown Hare’

<<NOTE to Experimenter: At the top of separate pages in Word, please repeat this trial template for X=1..5– remove this note>>

Trial #X

One night the green Tortoise, happy as a clam, approached the brown Hare to talk …

(Please read some news for at least 1 minute http://news.google.com/)

Explain Method B

keyboard-only

Please use the following procedure for keyboard-only:

1. Position the curse in front of 'Practice #1' and place hands on the keyboard;

2. Use the 'arrow' keys move the cursor to 'green Tortoise';
3. Use the 'Delete' key to delete the phrase 'green Tortoise';
4. Type the phrase 'brown Hare';

5. Use the 'arrow' keys to move the cursor to 'brown Hare';
6. Use the 'Delete' key to delete the phrase 'brown Hare';
7. Type the phrase 'green Tortoise'.

Use **Method B**
Swap the phrases 'green Tortoise' and 'brown Hare'

<<NOTE to Experimenter: At the top of separate pages in Word, please repeat this practice template for X=1..3– remove this note>>

Practice #x

One night the green Tortoise, happy as a clam, approached the brown Hare to talk …

(Please read some news for at least 1 minute http://news.google.com/)

Use **Method B**
Swap the phrases 'green Tortoise' and 'brown Hare'

<<NOTE to Experimenter: At the top of separate pages in Word, please repeat this trial template for X=1..5– remove this note>>

Trial #1

One night the green Tortoise, happy as a clam, approached the brown Hare to talk …

(Please read some news for at least 1 minute http://news.google.com/)