Model-based Design
Keystroke Level Model - I

Objective

- In the previous lecture, we have discussed about the idea of model-based design in HCI
- We have also discussed about the type of models used in HCI
  - We learned about the concepts of prescriptive and predictive models
  - We came across different types of predictive engineering models

Objective

- As we mentioned, the particular type of predictive engineering model that we shall be dealing with in this module are the “simple models of human information processing”
- GOMS family of models is the best known examples of the above type
  - GOMS stands for **G**oals, **O**perators, **M**ethods and **S**election Rules

Objective

- The family consists of FOUR models
  - **K**eystroke **L**evel **M**odel or KLM
  - Original GOMS proposed by **C**ard, **M**oran and **N**ewell, popularly known as (CMN) GOMS
  - **N**atural GOMS **L**anguage or NGOMSL
  - **C**ognitive **P**erceptual **M**otor or (CPM)GOMS [also known as **C**ritical **P**ath **M**ethod GOMS]

Objective

- In this and the next two lecture, we shall learn about two members of the model family, namely the KLM and the (CMN)GOMS
- In particular, we shall learn
  - The idea of the models
  - Application of the model in interface design

Keystroke Level Model (KLM)

- We start with the Keystroke Level Model (KLM)
  - The model was proposed way back in 1980 by Card, Moran and Newell; retains its popularity even today
  - This is the earliest model to be proposed in the GOMS family (and one of the first predictive models in HCI)

KLM - Purpose

- The model provides a quantitative tool (like other predictive engineering models)
  - The model allows a designer to ‘predict’ the time it takes for an average user to execute a task using an interface and interaction method
  - For example, the model can predict how long it takes to close this PPT using the “close” menu option

How KLM Works

- In KLM, it is assumed that any decision-making task is composed of a series of ‘elementary’ cognitive (mental) steps, that are executed in sequence
- These ‘elementary’ steps essentially represent low-level cognitive activities, which can not be decomposed any further

How KLM Works

- The method of breaking down a higher-level cognitive activity into a sequence of elementary steps is simple to understand, provides a good level of accuracy and enough flexibility to apply in practical design situations

The Idea of Operators

- To understand how the model works, we first have to understand this concept of ‘elementary’ cognitive steps

- These elementary cognitive steps are known as ***operators***

  – For example, a key press, mouse button press and release etc.

The Idea of Operators

- Each operator takes a pre-determined amount of time to perform
- The operator times are determined from empirical data (i.e., data collected from several users over a period of time under different experimental conditions)
  - That means, operator times represent average user behavior (not the exact behavior of an individual)

The Idea of Operators

- The empirical nature of operator values indicate that, we can predict the behavior of average user with KLM
  - The model can not predict individual traits
- There are seven operator defined, belonging to three broad groups

The Idea of Operators

- There are seven operator defined, belonging to three broad groups
  - Physical (motor) operators
  - Mental operator
  - System response operator

Physical (Motor) Operators

- There are five operators, that represent five elementary motor actions with respect to an interaction

Operator	Description
K	The motor operator representing a key-press
B	The motor operator representing a mouse-button press or release
P	The task of pointing (moving some pointer to a target)
H	Homing or the task of switching hand between mouse and keyboard
D	Drawing a line using mouse (not used much nowadays)

Mental Operator

- Unlike physical operators, the core thinking process is represented by a single operator **M**, known as the “mental operator”

- Any decision-making (thinking) process is modeled by M

System Response Operator

- KLM originally defined an operator **R**, to model the system response time (e.g., the time between a key press and appearance of the corresponding character on the screen)

System Response Operator

- When the model was first proposed (1980), R was significant
  - However, it is no longer used since we are accustomed to almost instantaneous system response, unless we are dealing with some networked system where network delay may be an issue

Operator Times

- as we mentioned before, each operator in KLM refers to an elementary cognitive activity that takes a pre-determined amount of time to perform
- The times are shown in the next slides (excluding the times for the operators D which is rarely used and R, which is system dependent)

Physical (Motor) Operator Times

Operator	**Description**	**Time (second)**
K **(**The key press operator**)**	Time to perform K for a good (expert) typist	0.12
	Time to perform K by a poor typist	0.28
	Time to perform K by a non-typist	1.20

Physical (Motor) Operator Times

Operator	Description	Time (second)
B (The mouse-button press/release operator)	Time to press or release a mouse-button	0.10
	Time to perform a mouse click (involving one press followed by one release)	$2 \times 0.10 = 0.20$

Physical (Motor) Operator Times

Operator	Description	Time (second)
P **(**The pointing operator**)**	Time to perform a pointing task with mouse	1.10
H (the homing operator)	Time to move hand from/to keyboard to/from mouse	0.40

Mental Operator Time

Operator	**Description**	**Time (second)**
M **(**The mental operator**)**	Time to mentally prepare for a physical action	1.35

How KLM Works

- In KLM, we build a model for task execution in terms of the operators
  - That is why KLM belongs to the cognitive task analysis (CTA) approach to design
- For this, we need to choose one or more representative task scenarios for the proposed design

How KLM Works

- Next, we need to specify the design to the point where keystroke (operator)-level actions can be listed for the specific task scenarios
- Then, we have to figure out the best way to do the task or the way the users will do it

How KLM Works

- Next, we have to list the keystroke-level actions and the corresponding physical operators involved in doing the task
- If necessary, we may have to include operators when the user must wait for the system to respond (as we discussed before, this step may not be ignored most of the times for modern-day computing systems)

How KLM Works

- In the listing, we have to insert mental operator M when user has to stop and think (or when the designer feels that the user has to think before taking next action)

How KLM Works

- Once we list in proper sequence all the operators involved in executing the task, we have to do the following
  - Look up the standard execution time for each operator
  - Add the execution times of the operators in the list

How KLM Works

- The total of the operator times obtained in the previous step is “the time estimated for an average user to complete the task with the proposed design”

How KLM Works

- If there are more than one design, we can estimate the completion time of the same task with the alternative designs
  - The design with least estimated task completion time will be the best

Note

- We shall see an example of task execution time estimation using a KLM in the next lecture