Physical and device models

- The Keystroke Level Model (KLM)
- Buxton's 3-state model

- Based on empirical knowledge of human motor system
- User's task: acquisition then execution.
  - these only address execution
- Complementary with goal hierarchies

Keystroke Level Model (KLM)

- lowest level of (original) GOMS

- seven execution phase operators
  - Physical motor: K - keystroking
    B – mouse button
    P - pointing
    H - homing
    D - drawing
  - Mental   M - mental preparation
  - System   R - response

- times are empirically determined.
  $$T_{execute} = T_K + T_B + T_P + T_H + T_D + T_M + T_R$$

KLM times (Card, Moran & Newell)

- K   Press key
  - Good typist (90 wpm)   0.12
  - Poor typist (40 wpm)   0.28
  - Non-typist   1.20
- B   Mouse button press
  - Down or up   0.10
  - Click   0.20
- P   Point with mouse
  - Fitts' law $0.1 \log_2(D/S + 0.5)$
  - Average movement   1.10
- H   Hands to/from keyboard   0.40
- D   Drawing   Domain dependent
- M   Mentally prepare   1.35
- R   Response from system   Measure

KLM example

```
GOAL: ICONISE-WINDOW
[select
   GOAL: USE-CLOSE-METHOD
   .     MOVE-MOUSE-TO- FILE-MENU
   .     PULL-DOWN-FILE-MENU
   .     CLICK-OVER-CLOSE-OPTION
   GOAL: USE-CTRL-W-METHOD
         PRESS-CONTROL-W-KEY]
```

- compare alternatives:
  - USE-CTRL-W-METHOD vs.
  - USE-CLOSE-METHOD

- assume hand starts on mouse

USE-CTRL-W-METHOD		USE-CLOSE-METHOD	
H[to kbd]	0.40	P[to menu]	1.1
M	1.35	B[LEFT down]	0.1
K[ctrlW key]	0.28	M	1.35
		P[to option]	1.1
		B[LEFT up]	0.1
Total	2.03 s	Total	3.75 s

KLM exercise

- Delete a file using drag to trash method

- Delete a file using delete key method

Rules for Placing Mental (M) Operators

Use Rule 0 to place candidate M's and then cycle through Rules 1 to 4 for each M to see whether it should be deleted

- **Rule 0** Inset M's in front of all K's and B's that are not part of text or numeric argument strings proper (e.g., text or numbers). Place M's in front of all P's that select commands (not arguments).
- **Rule 1** If an operator following an M is fully anticipated in an operator just previous to M, then delete the M.
  - E.g., point with mouse then click PMB -> PB
- **Rule 2** If a string of MK's belongs to a cognitive unit (e.g., the name of a command) then delete all M's but the first.
- **Rule 3** If a K is a redundant terminator (e.g., the terminator of a command immediately following the terminator of its argument) then delete the M in front of it.
  - E.g., terminate argument and then command MKMK -> MKK
- **Rule 4** If a K terminates a constant string (e.g., a command name) then delete the M in front of it; but if the K terminates a variable string (e.g., an argument string) then keep the M in front of it.

Architectural models

- All of these cognitive models make assumptions about the architecture of the human mind.
- Long-term/Short-term memory
- Problem spaces
- Interacting Cognitive Subsystems
- Connectionist
- ACT

Display-based interaction

- Most cognitive models do not deal with user observation and perception

- Some techniques have been extended to handle system output
  (e.g., BNF with sensing terminals, Display-TAG)
  but problems persist

- Exploratory interaction versus planning