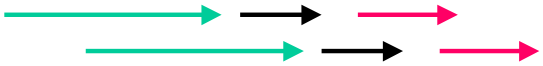
Response Time User Models

Card et.al. The Psychology of Human Computer Interaction (1983)

Response time in HCI task is composed of acquisition, behavior, and evaluation stages.
<think time> <make response time> <system response time>

serial model

parallel model



Serial models can be used to represent parallel processes (speed vs processing capacity)

Think time is composed of system state evaluation (last task) and acquire/plan next task. A cognitive time component.

Make response is the motor behavior response time component.

Response time models are "error free" and useful for asymptotic HCI tasks.

GOMS model developed for text editing tasks -- applicable to other HCI tasks

{Goals}	(goal (subgoal (sg (...))))
{Operators}	cmds, behaviors, available
{Methods}	plans for using operators to achieve goals
{Selectors}	evaluate among possible methods

GOMS text editing example

Goal: edit manuscript

Goal: edit unit task repeat until done

Goals are decomposed into subgoals until a subgoal that is satisfiable is reached. As methods are selected operators sequences (the user's behavior) is determined.

Expanding on edit unit task:

Goal: edit unit task
Goal: acquire unit task
Goal: execute unit task

Each subgoal has methods:

Goal: acquire unit task
if at end of page get next page
get next task

Goal: execute unit task
Goal: locate position
select : use down arrow
: use string search
Goal: modify text
select : use replace text
: use insert text
verify edit

Keystroke model useful for actual response time predictions.

GOMS model describes operator sequence. Keystroke model takes operator sequence and generated fine grain time predictions.

$T_{unit\ task} = T_{acquire} + T_{execute}$

$T_{execute} = T_k + T_p + T_h + T_m + T_r$

T_k keystroke time = $n_k t_k$
n_k = number of keys entered
(t_k hit key avg = .28 sec)
T_p pointing time (avg = 1.3 sec)
$T_p = .8 + .1 \log (D/S + .5)$ sec
D = target distance, S = target size
T_h homing time (avg = .4 sec)
T_m mental prepartion time (avg = 1.35)
T_r system response time

Benefits of RT Models

Both Goms and Keystroke enable system designers and HCI researchers to develop cognitive models of user behavior and predict times (or relative differences in times) for computer related tasks.

Any keyboarding, or pointer based task can be modelled by GOMS. Keystroke models enable actual user input operation sequences to be categorized.

Both provide scalable modeling utility!

RT Models and Error

Response time models have problems with errors. There are many ways to fail...

Average error, and specific errors (from Norman's classification) can be measured and incorporated into keystroke models.

Response Time and Display Rate

Humans perceive flicker when screens are refreshed (animated) below 24 - 30 frames per second.

Higher the refresh rate the greater appearance of depth.

Higher the screen resolution the more there is to refresh.

Real time animation chip sets w/ coprocessors are becoming available for inexpensive personal computers - this will increase animation.

Reading and Display Rate

In an info retrieval task subject performance was not affected by display rate but was affected by display rate variability.

Performance often better w/ lower variability!

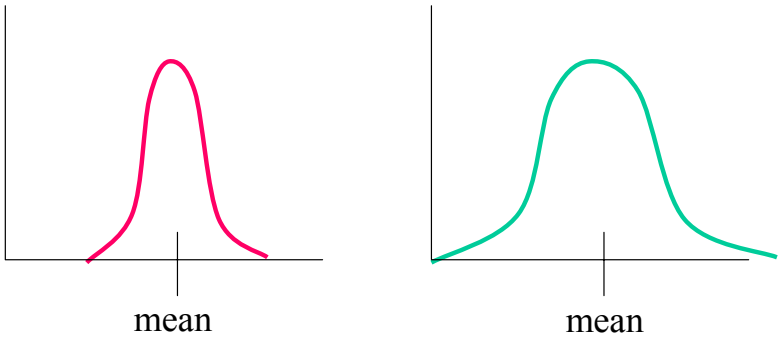
Display Speed & Variability

Speed average interval between user request and system response.
Variability range of interval for response speed.

HCI goal is to reduce response time variability before reducing response speed in reading, retrieval tasks...

Instantaneous display has no variability!

These two distributions have the same mean but different variances.



Response Time and Performance

Users performance is optimal w/ response time under 2 seconds (timeshare session -- telnet).

One study subjective acceptance of response time was positive at 1.8 seconds and unacceptable at 2.5 seconds w/ simple commands.

Response Time and Errors

With fast response time users are less concerned w/ making errors (they can recover fast!).

At slower response time users think and plan their tasks more to reduce delays involved w/ error recovery.

Users are pleased by faster response and frustrated by slower response.

Response Variability & Performance

There is uneven performance data supporting a decreased productivity with increased response variability.

Nevertheless, response variability:

- Reduces user's perceived control of HCI. (fast or slow)
- Reduces user's ability to pace input and plan next events. (slow)

There appears to be a user by task interaction such that each user has their optimal response time for different tasks.

Therefore let user pace the HCI...

User determines display rate with (near) instantaneous refresh rate