Interaction Modelling

Physical and Device models

Physical and Device models seek to model interactions at the level of motor actions.

Unlike cognition, the human motor system is well understood and relatively easy to model.

In this way, Physical and Device models avoid some of the problems associated with other types of cognitive model.

Modelling interactions at such a low level produces very verbose descriptions.

Because of this, physical and device models are unsuitable for describing complete interfaces/systems.

They are typically used in conjunction with other, higher-level models:

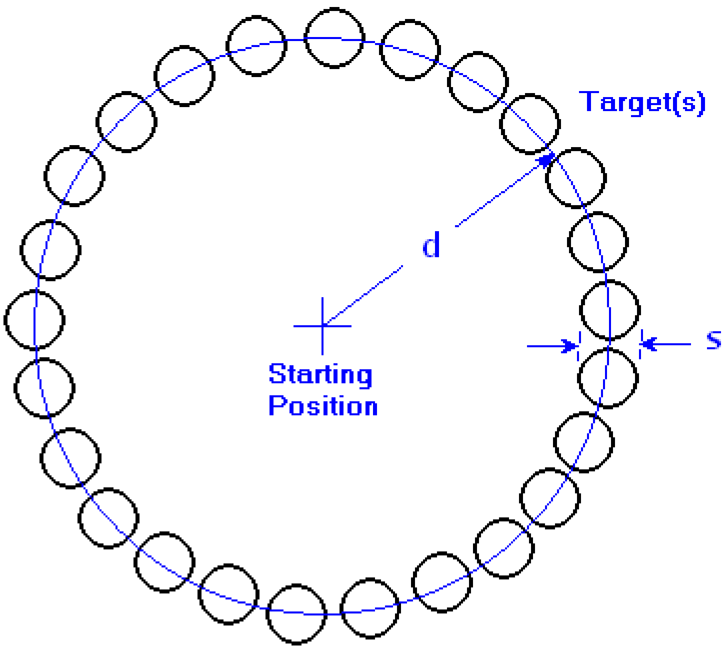
- The overall interaction is specified in a high-level model
- Some of the **unit-tasks** are modelled in a physical or device model.

Physical and device models can yield reliable predictions concerning operations.

Fitts' Law

Fitts' Law states that, for a given system, the time taken to move a pointer onto a target varies as a function of:

- the distance the pointer has to be moved
- the size of the target.



Fitts' Law is normally stated as follows:

$$t_m = a + b \log_2 \left(\frac{d}{s} + 1 \right)$$

Where:

t_m	=	movement time
a	=	start/stop time
b	=	device tracking speed
d	=	distance moved
s	=	target size (relative to the direction of movement)

a and *b* must be empirically determined for different operations, pointing devices, etc..

For example, Mackenzie, Sellen and Buxton compared the use of a mouse and a trackball in pointing and dragging operations, and derived the following values for *a* and *b*:

Operation	***a***	***b***
Pointing with Mouse	-107	223
Pointing with Trackball	75	300
Dragging with Mouse	135	249
Dragging with Trackball	-349	688

From these figures, it can be seen that moving a mouse-driven pointer onto a target when the distance/target-size ratio is 10:1 will take:

$$-107 + 223\ log_2\ (11) = 664\text{ms}$$

However, dragging rather than pointing under the same conditions will take:

$$135 + 249\ log_2\ (11) = 996\text{ms}$$

Some implications of Fitts' Law:

- Interaction times can be reduced by making targets large and distances small wherever possible, e.g.:
  - Pop-up menus are generally faster to use than fixed menus.
  - Menus arranged like pie-charts, with all options equidistant from the starting point, are very efficient.
  - The efficiency of fixed, linear menus can be improved by:
    - placing frequently-used options near the start-point
    - placing the menu at (or near) the screen edge so that it becomes *infinitely large* in the direction of movement.
- Point-and-click operations are usually faster than dragging operations.
  - Dragging takes longer because holding the mouse-button down results in a reduction in speed and accuracy.

- The distance/size *ratio* determines acquisition time.
    - Thus slightly increasing the size of a small target will make selection significantly faster, while making a similar change to a large icon will have less effect

Card, English, and Burr (1978) used Fitts' Law to show that the mouse was the most efficient pointing device then available.

This work led to the choice of a mouse by Xerox for the Star 8010 Information System, the first commercial system to use a GUI.

Fitts' Law has proved extremely accurate when compared with measured figures.

It can be used, in modified form, to derive an *index of difficulty* (ID) for a pointing device.

It has also been modified/extended to model many types of pointing/navigation/target-acquisition tasks

For example, the Accot-Zhai Steering Law (or Accot's law) models the task of navigating along a path or tunnel of specified (variable) width.