Measuring Performance

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OUTLINE

- Fitts Law
- HCI Applications
- Fitts Law: Beyond the Desktop

Fitts Law

- Fitts law is a descriptive model of human movement.
- Fitts' Law predicts that the time to point at an object using a device is a function of the distance from the target object & the object's size.

$$MT = a + b \log_2(A / W + 1)$$

Where *MT* is the dependent variable

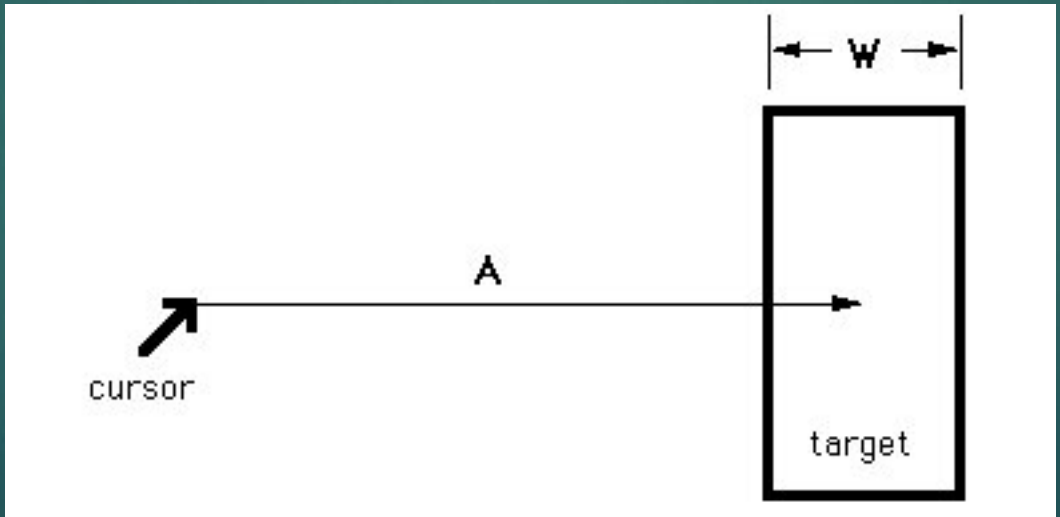
a and *b* are regression coefficients

A is the distance or amplitude to move

W is the width of the region within which the move terminates

- The further away & the smaller the object, the longer the time to locate it & point to it.

- The first use of Fitts' law in HCI research was the work of Card, English, and Burr (1978) who compared four devices for selecting text on a CRT display.
- Subjects were required to move the cursor from a home position to a target position and select it by pushing a button.
- Mouse came out on top compared to the other devices.



MacKenzie, I. S. (1992, September). Movement time prediction in human-computer interfaces. In Proceedings of Graphics Interface (Vol. 92, No. 7, p. 1)

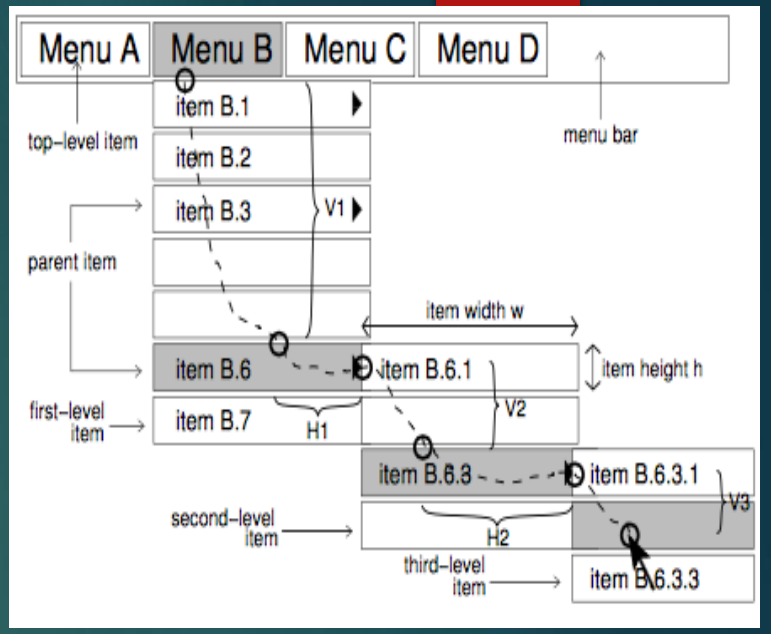
HCI Applications

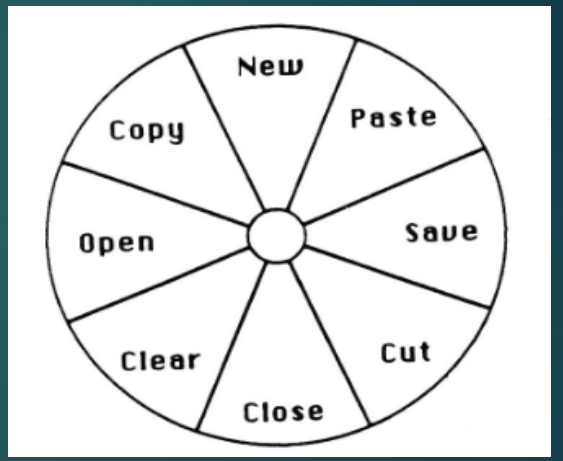
- Research and Design Tool
- Movement Time Prediction
- Pointing
- Semantic Pointing
- Navigation

Research and Design Tool

Pull-Down Menus

- Selecting a menu item in a cascading pull-down menu is a time consuming and complex grapgical user-interface task.
- Many techniques to improve selection:
  - Split menus
  - Vertical enlargement of menu items(Walker et al.)
  - Gesture based selection (Kobayashi and Igarashi)
  - Pie-shaped (circular) menus

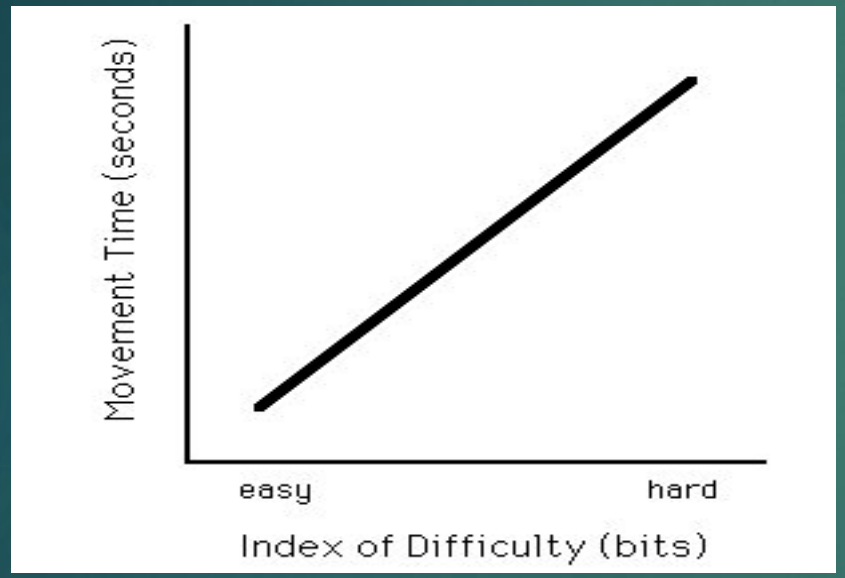


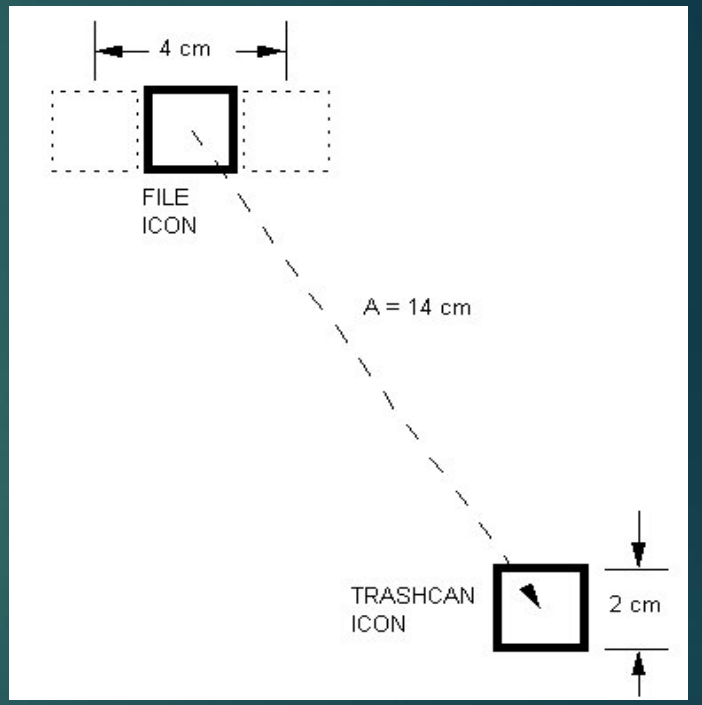


1.Ahlström, D. (2005, April). Modeling and improving selection in cascading pull-down menus using Fitts' law, the steering law and force fields. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 61-70). ACM.
2.Boritz, J., & Cowan, W. B. (1991). Fitts's law studies of directional mouse movement. human performance, 1, 6.

Movement Time Prediction

- A movement model based on Fitts' law is an equation predicting movement time (*MT*) from a task's index of difficulty (*ID*).





- Movement time for hard tasks is longer than for easy tasks

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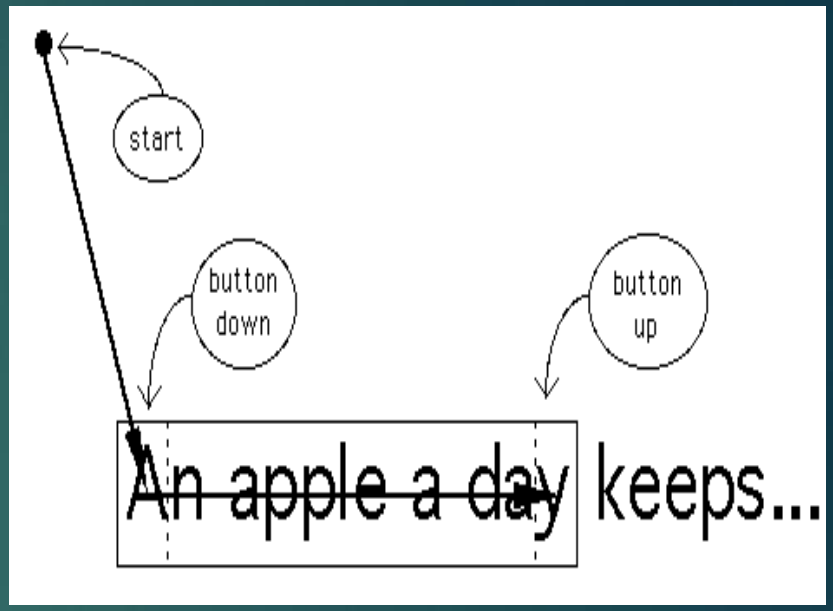
Pointing

- An important task in graphical user interfaces is the point-drag sequence.
- Fitts law is used as a predictive model for pointing tasks but its application to drag sequences is limited to studies by researchers like Gillian, MacKenzie, etc.
- Gillan et al. (1990, 1992) tested Fitts' law in point-select and point-drag-select tasks. They concluded that

1.Point-clicking was relatively faster and under control of the width and the height of the text to be selected and its distance from the starting point.

2.Dragging time was under control the dragging distance and the height of the text object.

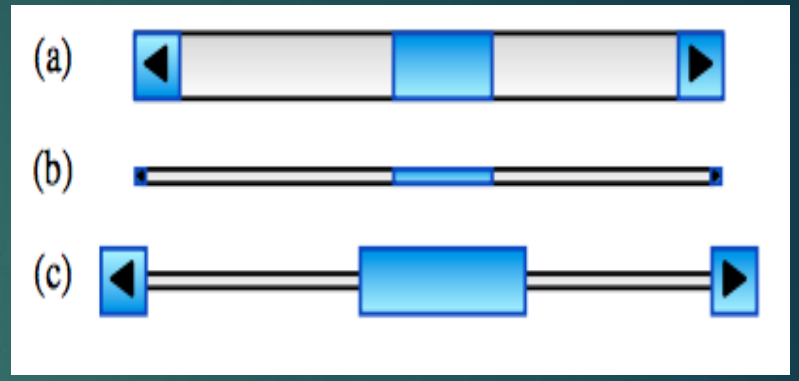
- MacKenzie et al. (1991) tested serial pointing and dragging and found that the rate of information processing during dragging was less efficient than during pointing.



MacKenzie, I. S., & Buxton, W. (1994). Prediction of pointing and dragging times in graphical user interfaces. Interacting with Computers, 6(2), 213-227.

Semantic Pointing

- To improve target acquisition in graphical user inter- faces (GUIs) researchers introduced the concept of semantic pointing .
- The difficulty of pointing task is not directly linked to the onscreen representation of the task but to the actual difficulty of the movement performed in the physical world to accomplish it.
- Semantic pointing uses two independent sizes :
  - Visual size
  - Motor size- gives importance to the object of interaction
- To control the motor size Control Display ratio is adapted.

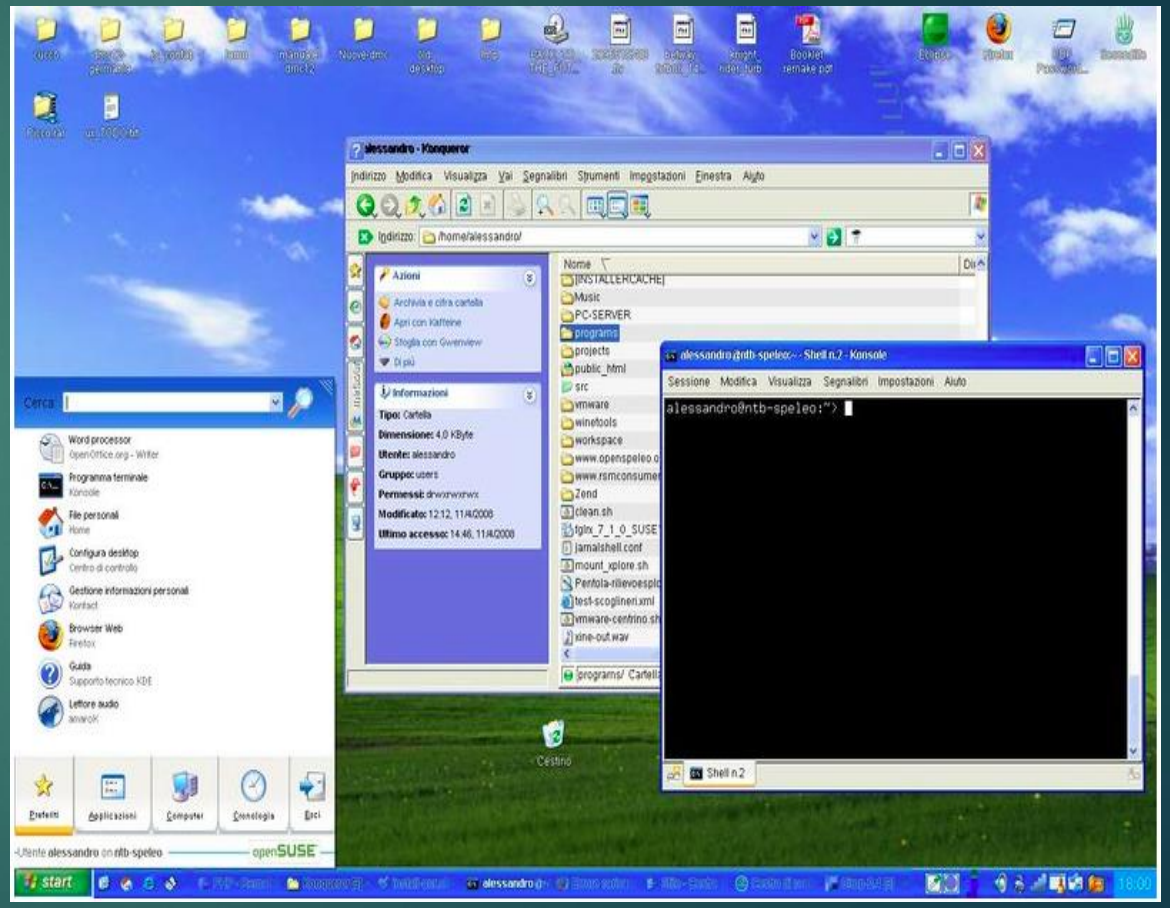




Blanch, R., Guiard, Y., & Beaudouin-Lafon, M. (2004, April). Semantic pointing: improving target acquisition with control-display ratio adaptation. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 519-526). ACM.

Navigation

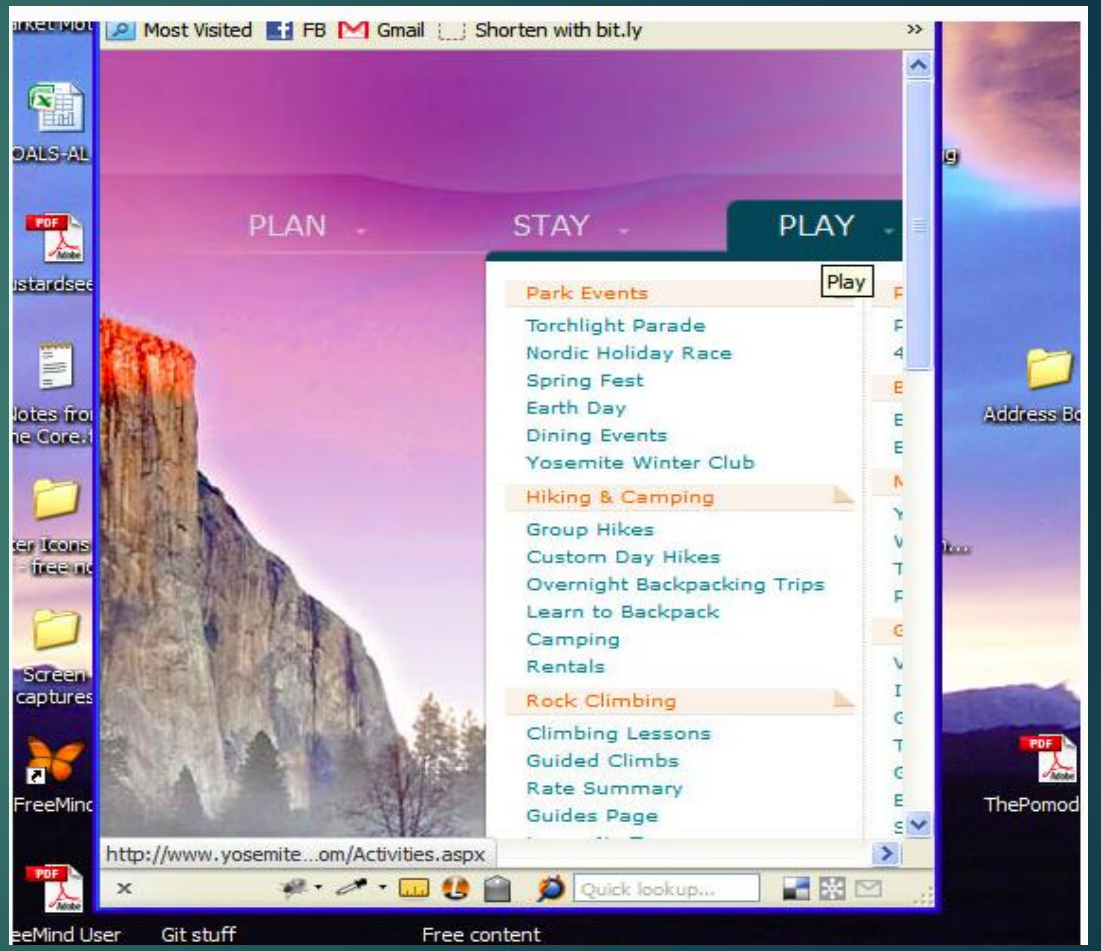
- Navigation amounts to a form of multi-scale pointing.
- Navigation is a metaphor in HCI-that of a living organism moving itself as a whole relative to a complex environment that is only partially accessible to the senses .



File:Ricing at its finest.jpg - InstallGentoo Wiki. (2016). *Wiki.installgentoo.com*. Retrieved 10 March 2016, from https://wiki.installgentoo.com/index.php/File:Ricing_at_its_finest.jpg

Navigation (contd.)

- The time needed to reach a target on a multiscale interface obeys Fitts law.



menu?, I. (2016). *In what situation is it best to use a mega menu?*. *Ux.stackexchange.com*. Retrieved 10 March 2016, from http://ux.stackexchange.com/questions/36164/in-what-situation-is-it-best-to-use-a-mega-menu

Fitts Law : Beyond The Desktop

- Fitts' law has been shown to apply various conditions:
- Hands, feet, head-mounted sights, eye gaze
- Input devices
- Physical environments
- User populations (young, old, mentally retarded, and drugged participants)

Applications of Fitts Law : Beyond The Desktop

- **SMARTPHONES/ TABLETS**
  - Finger Touch
  - Tilt
- **VIRTUAL REALITY**
  - Determining the effect of Frame Rate and Lag
- **HUMANS**
  - Human – Human Interaction
  - Manual Obstacle Avoidance

- **LARGE DISPLAYS**
  - Pointing on Large Stereoscopic Displays

Smartphones/ Tablets

- **Finger Touch**
- The user can interact directly with what is displayed.
- Fat Finger Problem – having difficulty in using the devices for input because of the size of the finger covering the small buttons and fields surrounding the target.
- A dual-distribution hypothesis was implemented to interpret the distribution of endpoints in finger touch input.



$$ID_f = \log_2\left(\frac{A}{\sqrt{2\pi e(\sigma^2-\sigma_a^2)}}+1\right)$$



1. Bi, X., Li, Y., & Zhai, S. (2013, April). FFitts law: modeling finger touch with fitts' law. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1363-1372). Paris, France. ACM.
2. (2016). *Mobilecommunitydesign.com*. Retrieved 10 March 2016, from http://www.mobilecommunitydesign.com/uploaded_images/iphone-776256.png
(2016). *Cdn.inquisitr.com*. Retrieved 10 March 2016, from http://cdn.inquisitr.com/wp-content/uploads/2012/12/Fat-Finger-iPhone-Sales-At-Sprint.png

- **Tilt**
  - Tilt sensor detects the orientation of the object with the reference planes.
  - Tilt was evaluated as an input method for devices with built-in accelerometers
  - Tilt is frequently used in gaming.
  - Target selection types - First entry and dwell
  - Throughput is low

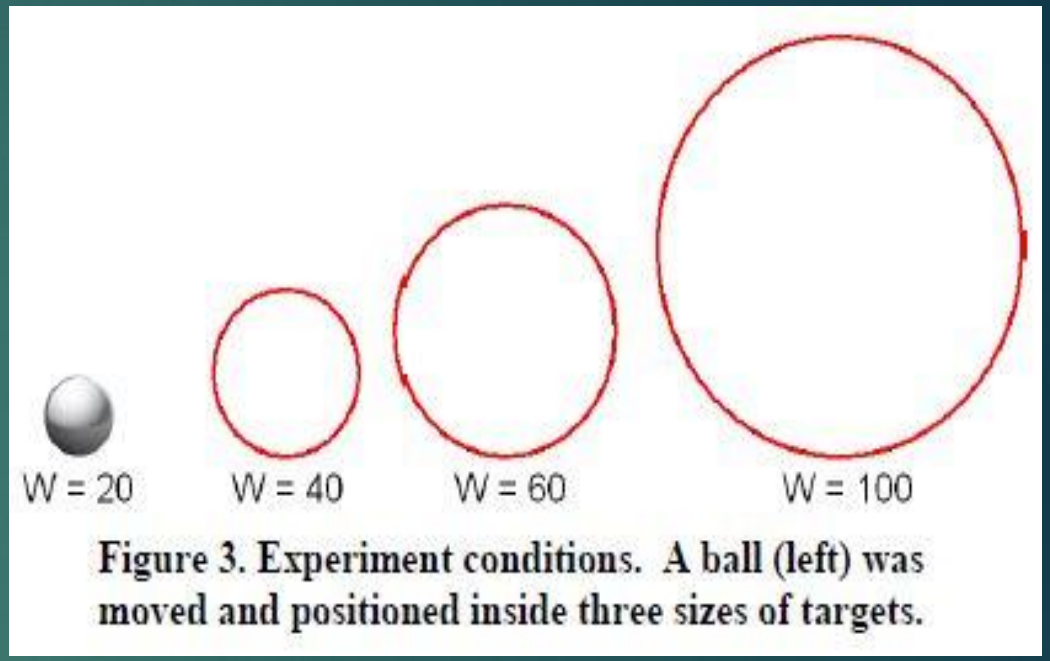
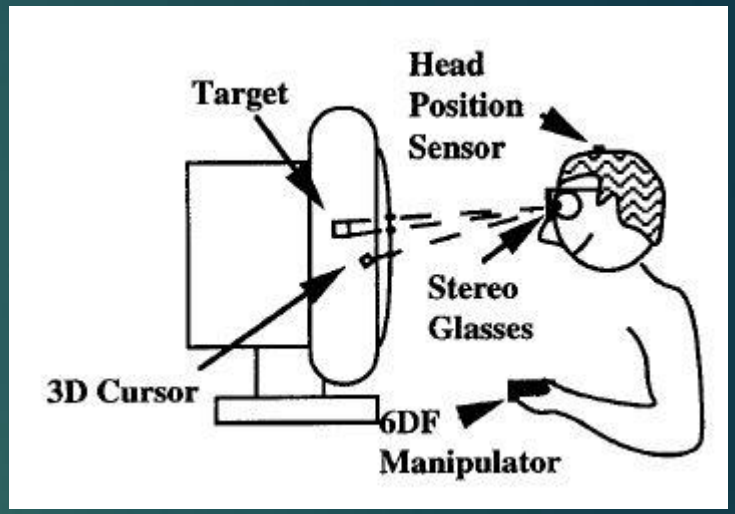


Figure 3. Experiment conditions. A ball (left) was moved and positioned inside three sizes of targets.

MacKenzie, I. S., & Teather, R. J. (2012, October). FittsTilt: the application of Fitts' law to tilt-based interaction. In Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (pp. 568-577). Copenhagen, Denmark. ACM.

Virtual Reality

- **Determining the effect of Frame Rate and Lag**
- A correct perspective view of a 3D object is maintained by coupling user's eye position to the graphical image.
- Using variations in Fitts Law, the effects of frame rate and lag on performance were evaluated.
- The experiment was conducted by using high frame rate, early sampling and late sampling.



Ware, C., & Balakrishnan, R. (1994). Reaching for objects in VR displays: lag and frame rate. ACM Transactions on Computer-Human Interaction (TOCHI), 1(4), 331-356.New York, NY, USA.

Large Displays

- **Pointing on Large Stereoscopic Displays**
- Mid-air pointing is similar to pointing in everyday life: it relies on the human sensorimotor system and it is unconstrained by contact with a surface or object.
- Widely varying levels of control/display gain characterize the interaction with large displays, in order to support both accurate localized input and the ability to interact over large distances.
- It also frequently involves input from a distance, meaning that a user is located out of physical reach of the display

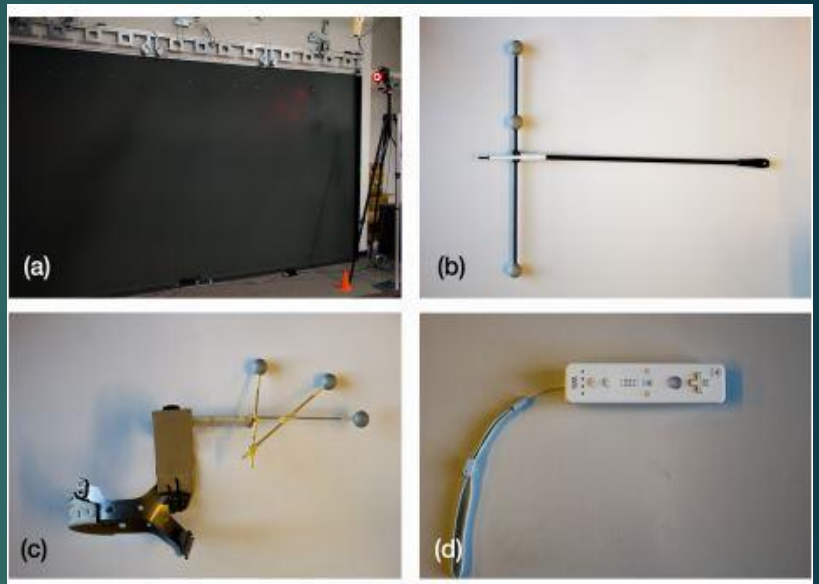


Figure 2.3: Apparatus: (a) Large screen stereoscopic display (b) Hand-held pointer (c) Head gear (d) WiiMote for click events.

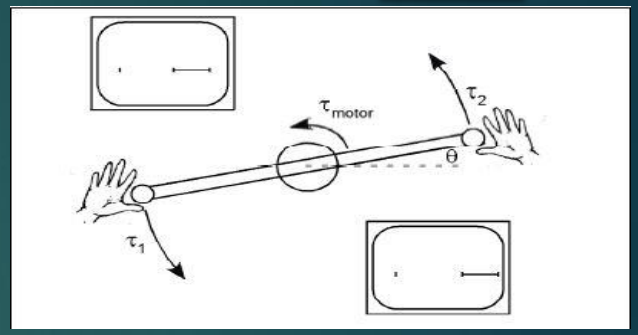
Rajendran, V. (2012). *Interaction with Large Stereoscopic Displays* (Doctoral dissertation, UNIVERSITY OF BRITISH COLUMBIA (Vancouver).

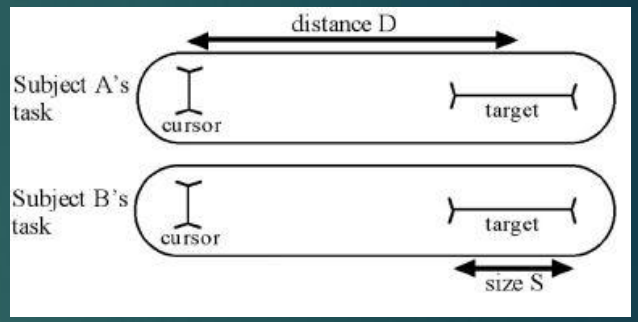
Large Displays

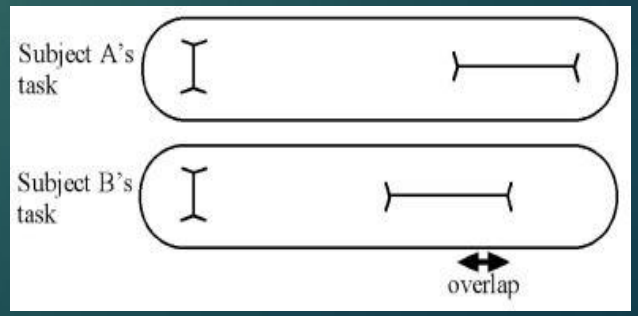
- **Impact of Gain on Pointing Performance**
- Explore the space of pointing models and to describe how independent contributions of movement amplitude and target width to pointing time can be captured.
- Two-part formulations (i.e., Welford and Shannon-Welford) will accurately model pointing performance at each individual gain level.

Humans

- **Human – Human Interaction**
- Many tasks require two people to work together on the same task.
- In such tasks, the person feels the force and motion produced by the other and determines what the other person is trying to do.
- Also, both of them wont be having the same goal and so need to compromise.



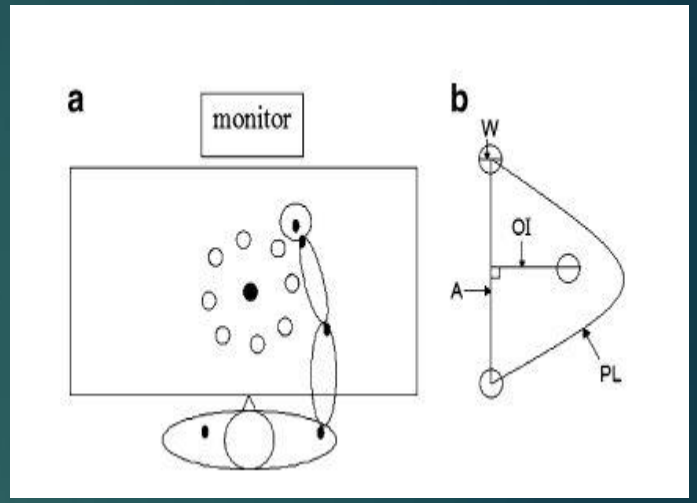




Reed, K., Peshkin, M., Colgate, J. E., & Patton, J. (2004, April). Initial studies in human-robot-human interaction: Fitts' law for two people. In Robotics and Automation, 2004. Proceedings. ICRA'04. 2004 IEEE International Conference on (Vol. 3, pp. 2333-2338).New Orleans, LA, USA. IEEE.

Manual Obstacle Avoidance

- Predicting movement times for obstacle-avoiding movements.
- The presence of an obstacle increases the required movement distance but leaves the distance between targets unchanged.



Jax, S. A., Rosenbaum, D. A., & Vaughan, J. (2007). Extending Fitts' Law to manual obstacle avoidance. Experimental brain research, 180(4), 775-779.

CONCLUSION

- In HCI, Fitts Law plays an important role in designing interfaces.
- It applies only to movement in single dimensions, but its variations can be used for multi-dimensions as well as for obstacle-avoiding movements.

Activity

- Fitts Law Demonstration

QUESTIONS?

THANK YOU

References

1. MacKenzie, I. S., & Buxton, W. (1994). Prediction of pointing and dragging times in graphical user interfaces. *Interacting with Computers*, *6*(2), 213-227.

2. MacKenzie, I. S. (1992). Fitts' law as a research and design tool in human-computer interaction. *Human-computer interaction*, *7*(1), 91-139.

3. Boritz, J., & Cowan, W. B. (1991). Fitts's law studies of directional mouse movement. *human performance*, *1*, 6.

4. Guiard, Y., Beaudouin-Lafon, M., & Mottet, D. (1999, May). Navigation as multiscale pointing: extending Fitts' model to very high precision tasks. In Proceedings of the SIGCHI conference on Human Factors in Computing Systems (pp. 450-457).Pittsburgh, Pennsylvania, USA. ACM.

5. Forlines, C., Wigdor, D., Shen, C., & Balakrishnan, R. (2007, April). Direct-touch vs. mouse input for tabletop displays. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 647-656). ACM.

6. MacKenzie, I. S. (1992, September). Movement time prediction in human-computer interfaces. In *Proceedings of Graphics Interface* (Vol. 92, No. 7, p. 1)

7. Ahlström, D. (2005, April). Modeling and improving selection in cascading pull-down menus using Fitts' law, the steering law and force fields. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 61-70). ACM.

8. Blanch, R., Guiard, Y., & Beaudouin-Lafon, M. (2004, April). Semantic pointing: improving target acquisition with control-display ratio adaptation. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 519-526). ACM.

9. Walker, N., & Smelcer, J. B. (1990, March). A comparison of selection time from walking and pull-down menus. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 221-226). ACM.

10. Kobayashi, M., & Igarashi, T. (2003, November). Considering the direction of cursor movement for efficient traversal of cascading menus. In *Proceedings of the 16th annual ACM symposium on User interface software and technology* (pp. 91-94). ACM.

References (contd.)

11. Bi, X., Li, Y., & Zhai, S. (2013, April). FFitts law: modeling finger touch with fitts' law. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1363-1372). Paris, France. ACM.

12. Shoemaker, G., Tsukitani, T., Kitamura, Y., & Booth, K. S. (2012). Two-part models capture the impact of gain on pointing performance. ACM Transactions on Computer-Human Interaction (TOCHI), 19(4), 28.New York, NY, USA.

13. MacKenzie, I. S., & Teather, R. J. (2012, October). FittsTilt: the application of Fitts' law to tilt-based interaction. In Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (pp. 568-577). Copenhagen, Denmark. ACM.

14. Reed, K., Peshkin, M., Colgate, J. E., & Patton, J. (2004, April). Initial studies in human-robot-human interaction: Fitts' law for two people. In Robotics and Automation, 2004. Proceedings. ICRA'04. 2004 IEEE International Conference on (Vol. 3, pp. 2333-2338).New Orleans, LA, USA. IEEE.

15. Jax, S. A., Rosenbaum, D. A., & Vaughan, J. (2007). Extending Fitts' Law to manual obstacle avoidance. Experimental brain research, 180(4), 775-779.

16. Ware, C., & Balakrishnan, R. (1994). Reaching for objects in VR displays: lag and frame rate. ACM Transactions on Computer-Human Interaction (TOCHI), 1(4), 331-356.New York, NY, USA.

References (contd.)

17. Rajendran, V. (2013). Interaction with large stereoscopic displays : Fitts and multiple object tracking studies for virtual reality. *University Of British Columbia*. http://dx.doi.org/10.14288/1.005221013.

18. Atwood, J. (2006). *Fitts' Law and Infinite Width*. *Blog.codinghorror.com*. Retrieved 10 March 2016, from http://blog.codinghorror.com/fitts-law-and-infinite-width/

19. *Fat finger problem dictionary definition | fat finger problem defined*. (2016). *Yourdictionary.com*. Retrieved 10 March 2016, from http://www.yourdictionary.com/fat-finger-problem

20. *Touchscreen*. (2016). *Wikipedia*. Retrieved 10 March 2016, from https://en.wikipedia.org/wiki/Touchscreen

21. Activity – Fitts Law Demonstration retrieved from http://fww.few.vu.nl/hci/interactive/fitts/

22. Chen, J. (2011). *Hick-Hyman & Fitts Law _Jing*. [online] Slideshare.net. Available at: http://www.slideshare.net/JingChen4/hickhyman-fitts-law-jing [Accessed 10 Mar. 2016].