Performance evaluation of input devices in trajectory-based tasks

- An application of the steering law

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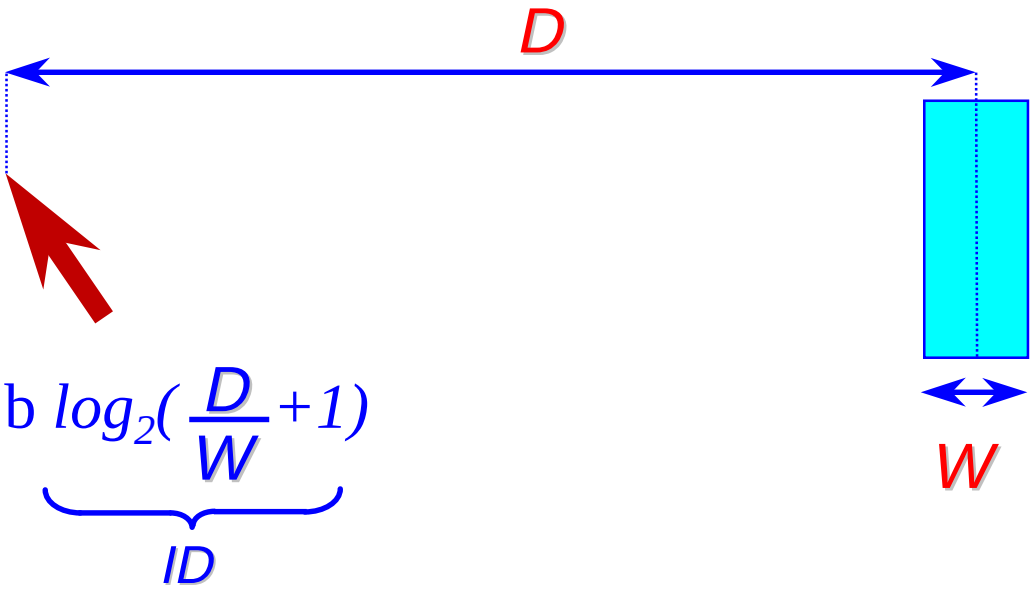
Modeling HCI

- *Hardening HCI* [Newell & Card, 1985]
- *Few models actually available*

Fitts' law and input devices

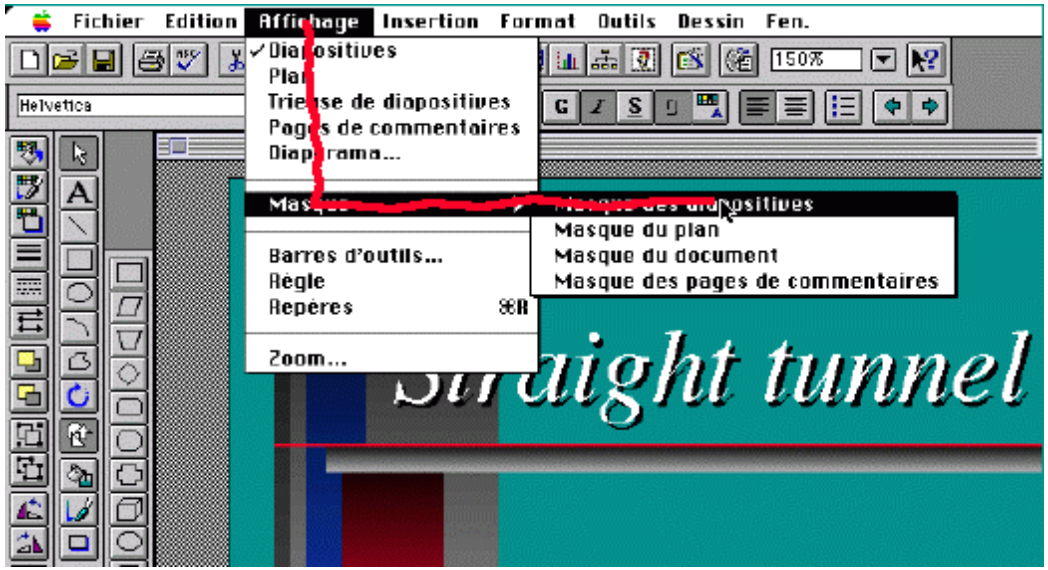


$$MT = a + b \underbrace{\log_2\left(\frac{D}{W} + 1\right)}_{ID}$$

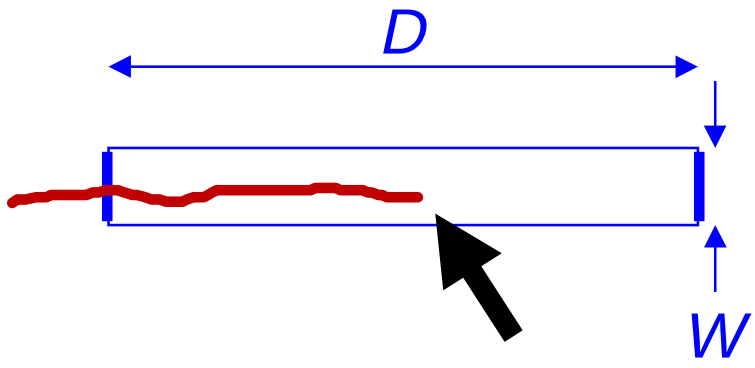
- *Fitts, 1954*
- *Card, English & Burr (1978)*
- *MacKenzie (1992)*

Trajectory-based tasks: examples

- *Menu, drawing, writing, navigation ...*



Steering



- *Long suggested as a testing paradigm*
  - *Buxton 1987*
- *Is there also a law?*

A new law? (Accot and Zhai 1997)

- *2 goals passing*

$$ID = \log_2 \left(\frac{D}{W} + 1 \right)$$

- *3 goals passing*

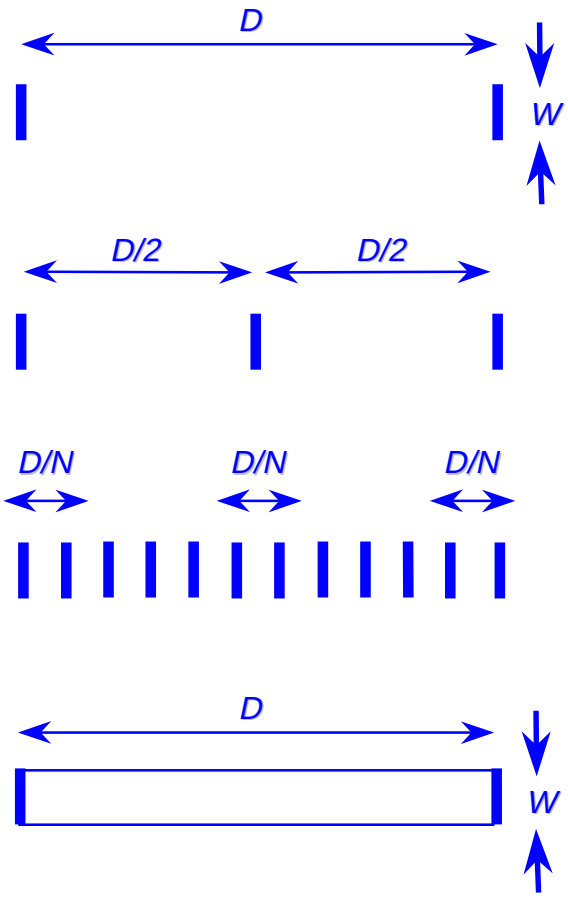
$$ID = 2 \log_2 \left(\frac{D}{2W} + 1 \right)$$

- *N+1 goals passing*

$$ID = N \log_2 \left(\frac{D}{NW} + 1 \right)$$

- *∞ goals passing*

$$ID = \frac{D}{W} ?$$



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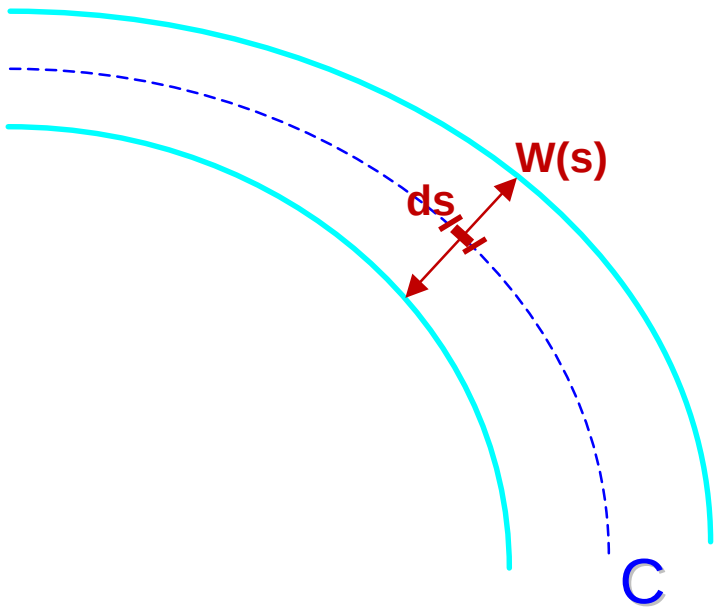
Steering law - General form



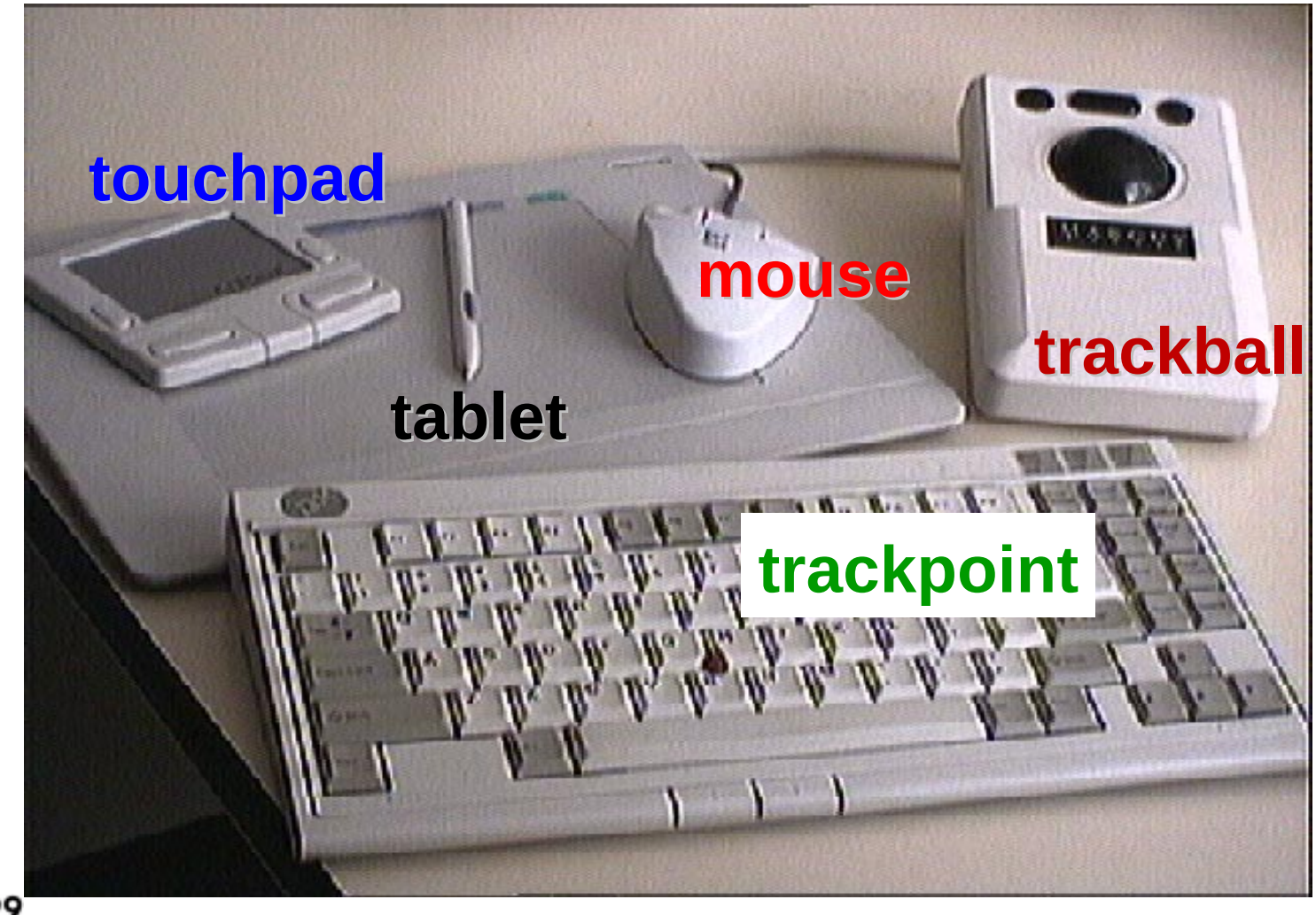
$$T_C = a + b\, ID_C$$

$$ID_C = \int_C \frac{ds}{W(s)}$$

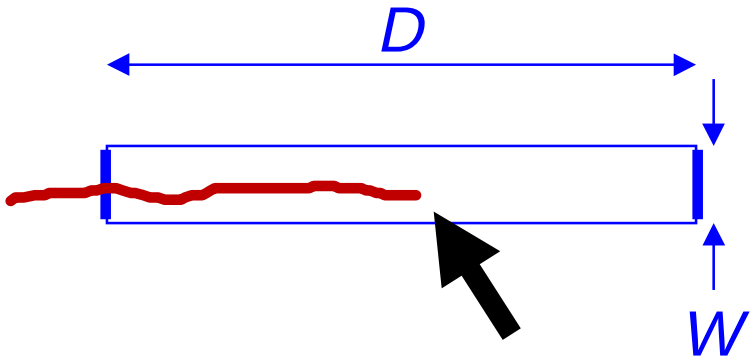
Goals of this study

- *Does steering law hold for other input devices?*
- *How to use steering law for device evaluation?*
- *Characteristics of 5 devices*

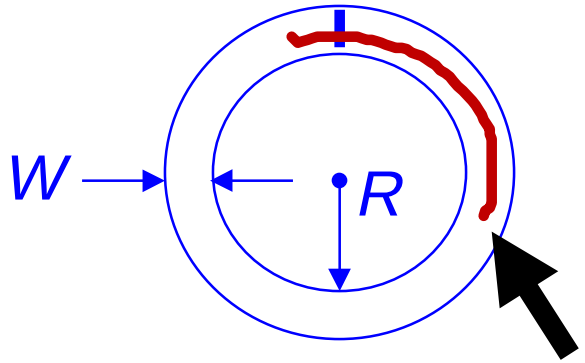
5 Devices studied



Experiment tasks - two categories



$$T = a + b \frac{D}{W}$$

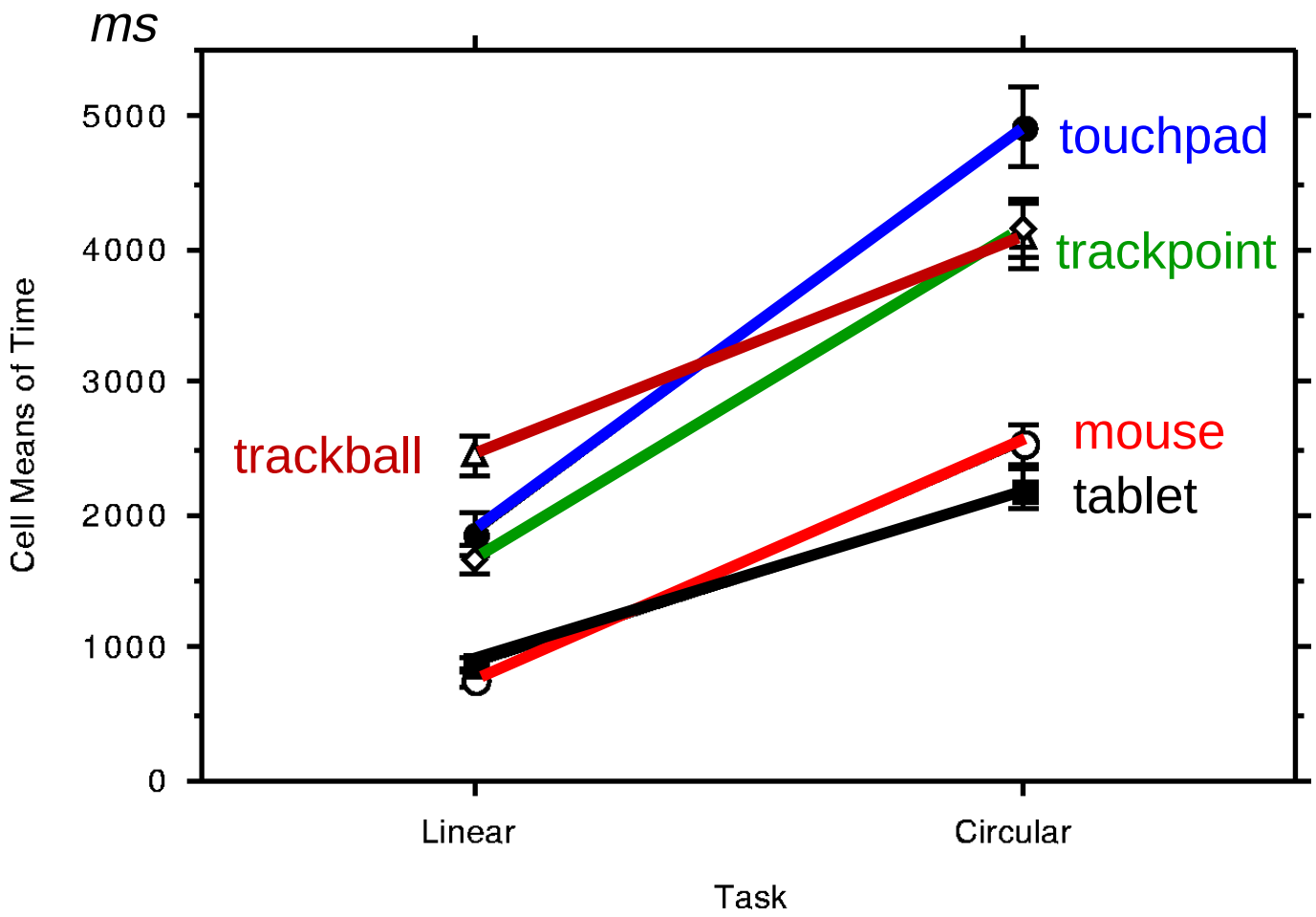


$$T = a + b \frac{2\pi R}{W}$$

Experimental setup

- *2 tasks (linear and circular steering)*
- *5 devices*
- *2 distances (D)*
  - *500, 1000 pixels*
- *3 width (W)*
  - *35, 45, 70 pixels*
- *15 subjects (mouse users, novice to other devices)*

Mean completion time



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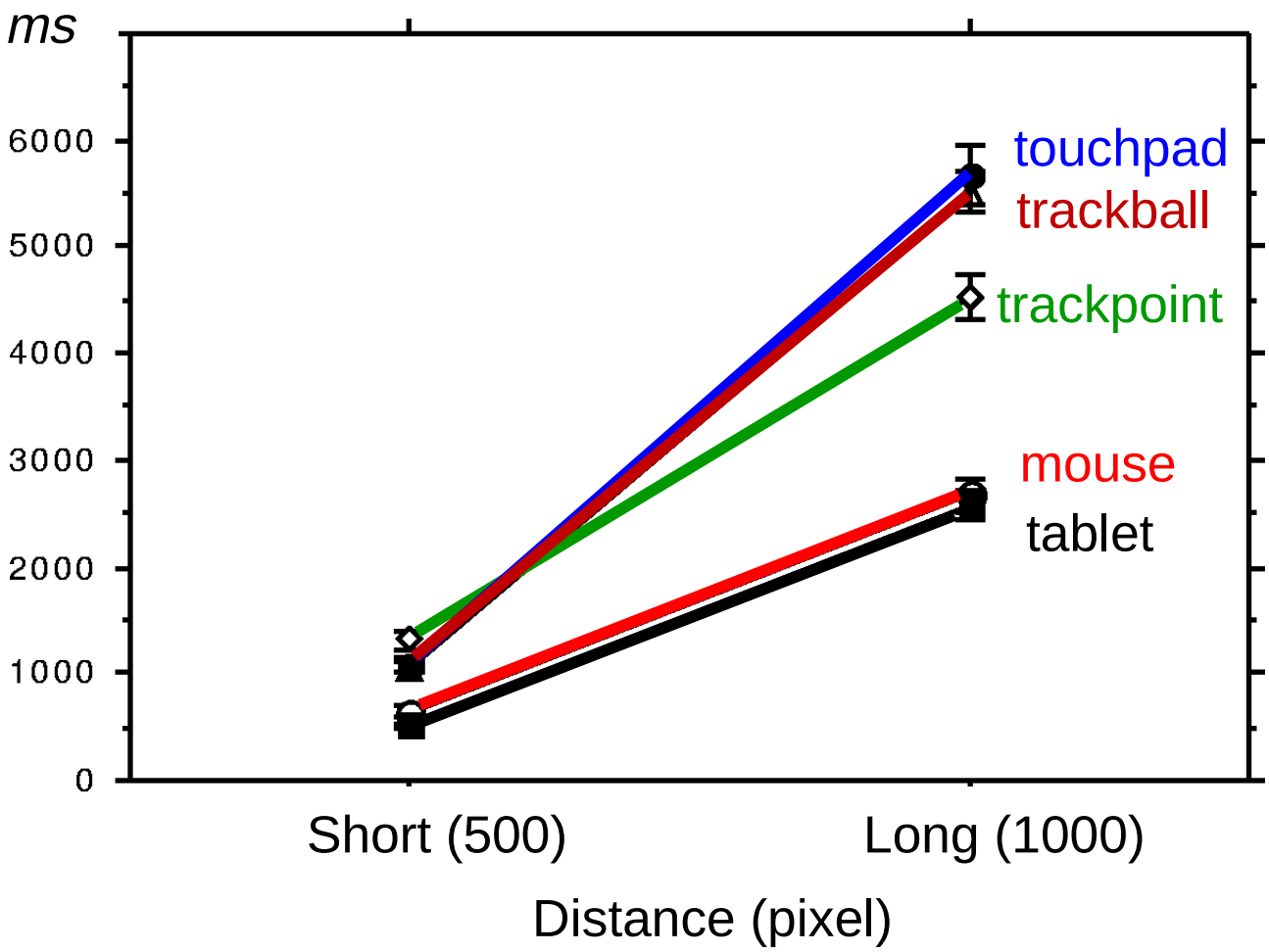
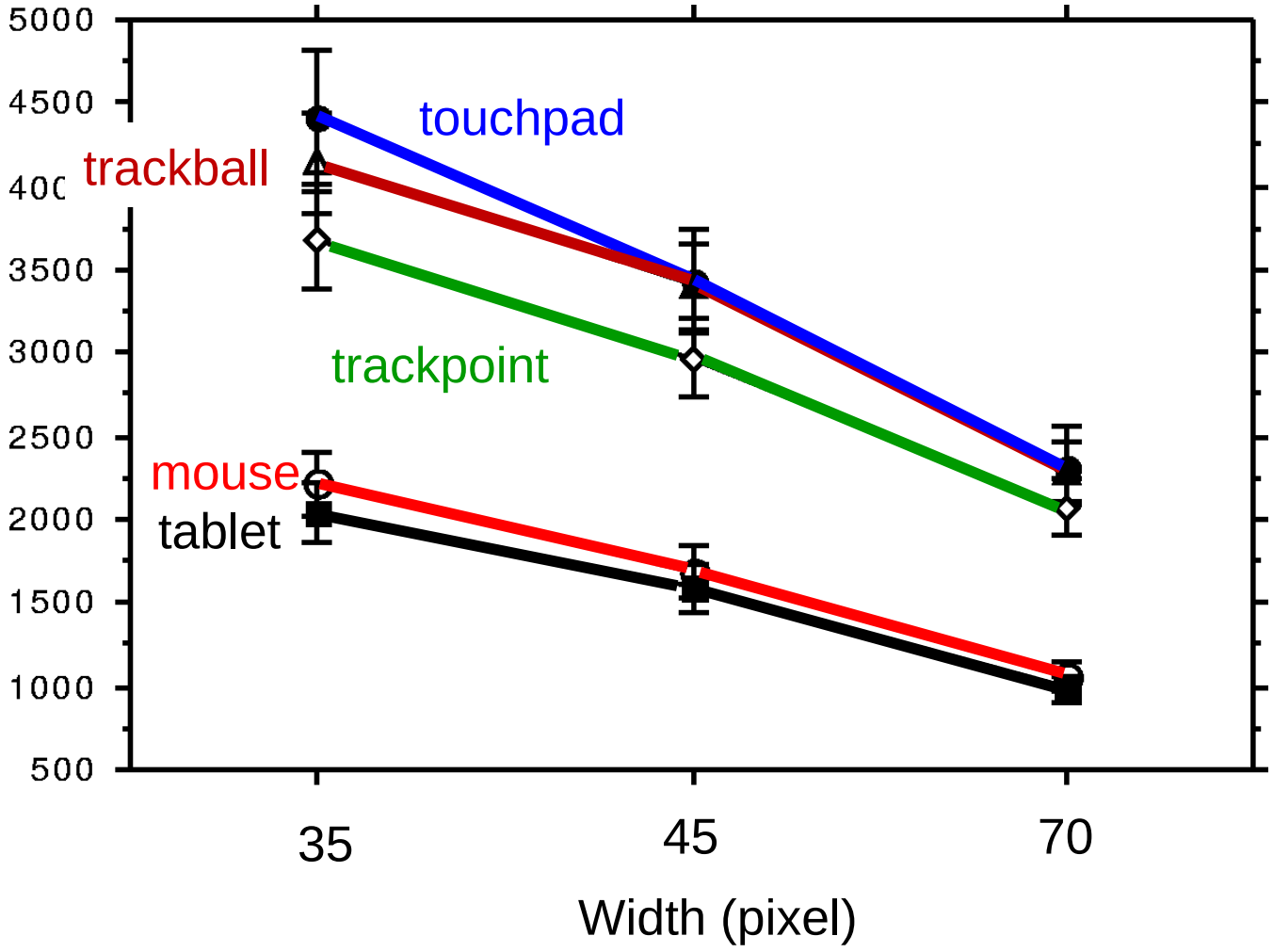
Device x Distance



Device x Width



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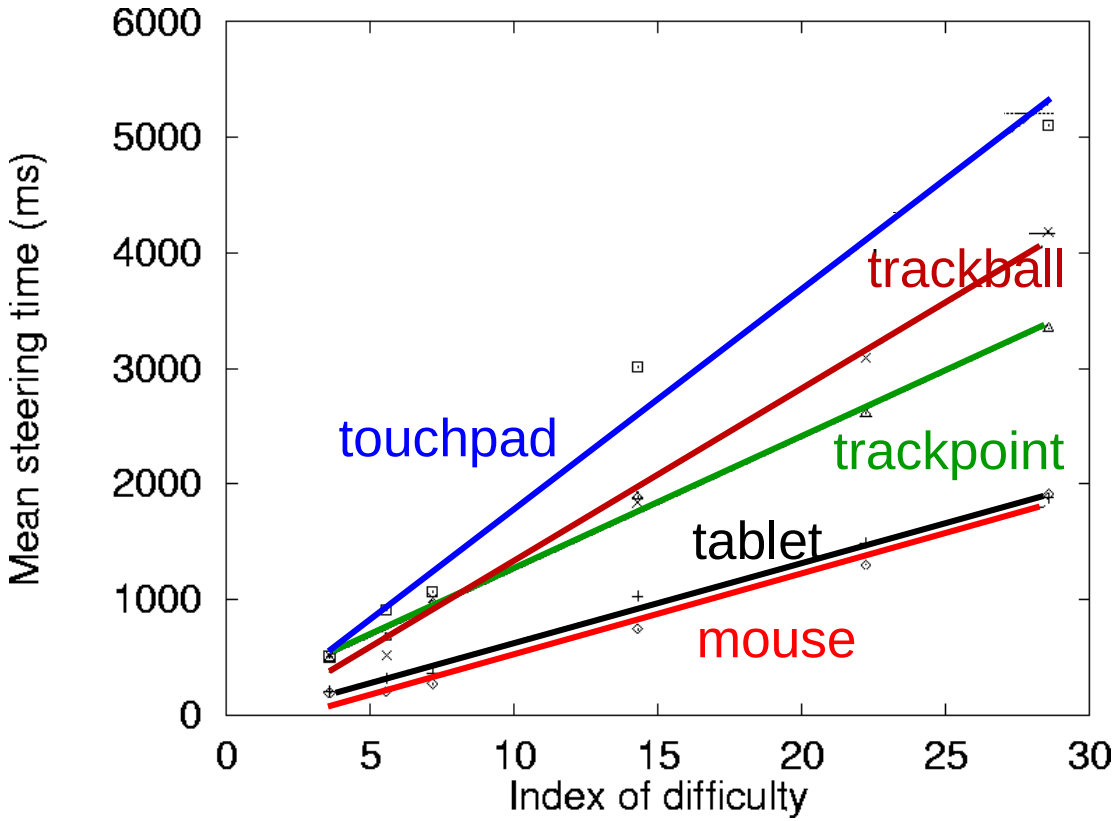
Fit of the model: linear steering

$$T = a + b\,ID$$

$$ID = \frac{D}{W}$$

r^2

- *mouse:* 0.985
- *tablet:* 0.993
- *trackball:* 0.986
- *touchpad:* 0.993
- *trackpoint:* 0.995



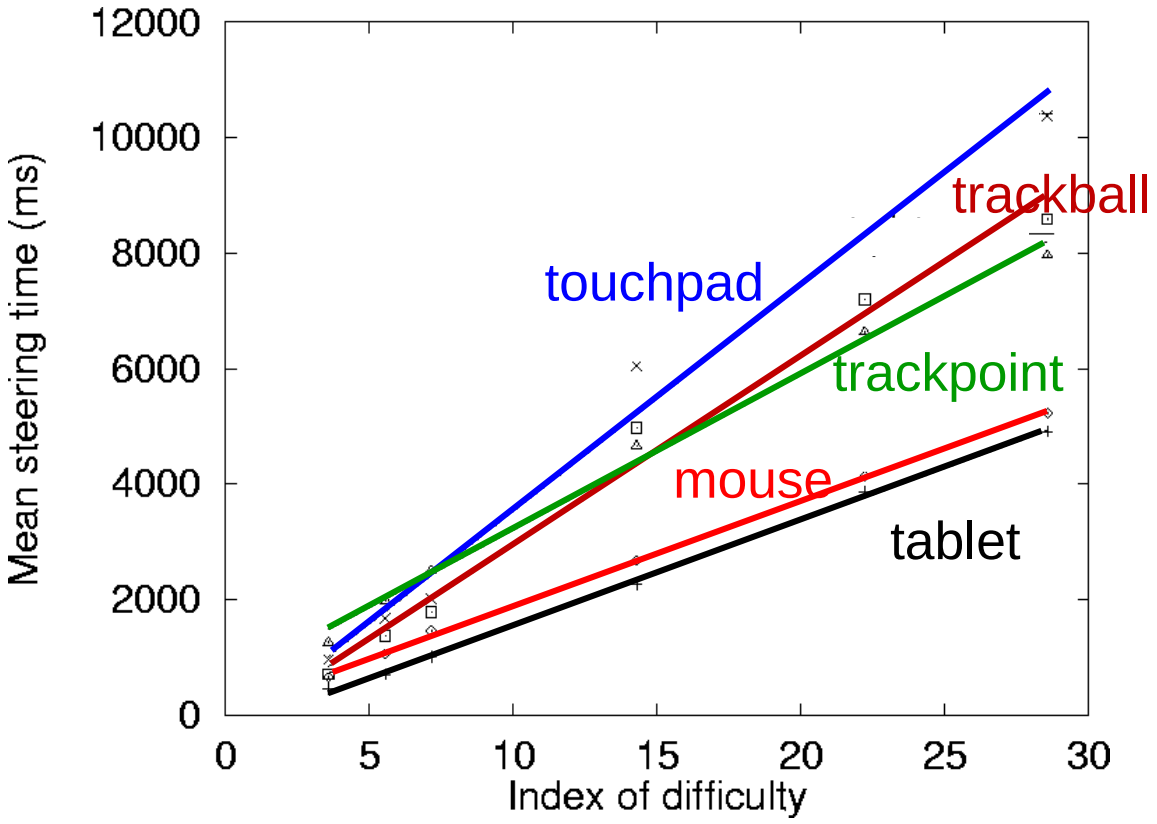
Fit of the model: circular steering

$$T = a + b\,ID$$

$$ID = \frac{2\pi R}{W}$$

r^2

- *mouse:* 0.999
- *tablet:* 0.999
- *trackball:* 0.987
- *touchpad:* 0.986
- *trackpoint:* 0.994



Index of performance

$T_C = a + b\ ID_C$ $\qquad$ $IP = 1/b$

IP	*Linear*	*Circular*
tablet	*14.4*	*5.4*
mouse	*14.3*	*5.5*
trackpoint	*8.7*	*3.7*
touchpad	*6.7*	*2.5*
trackball	*5.3*	*3.0*

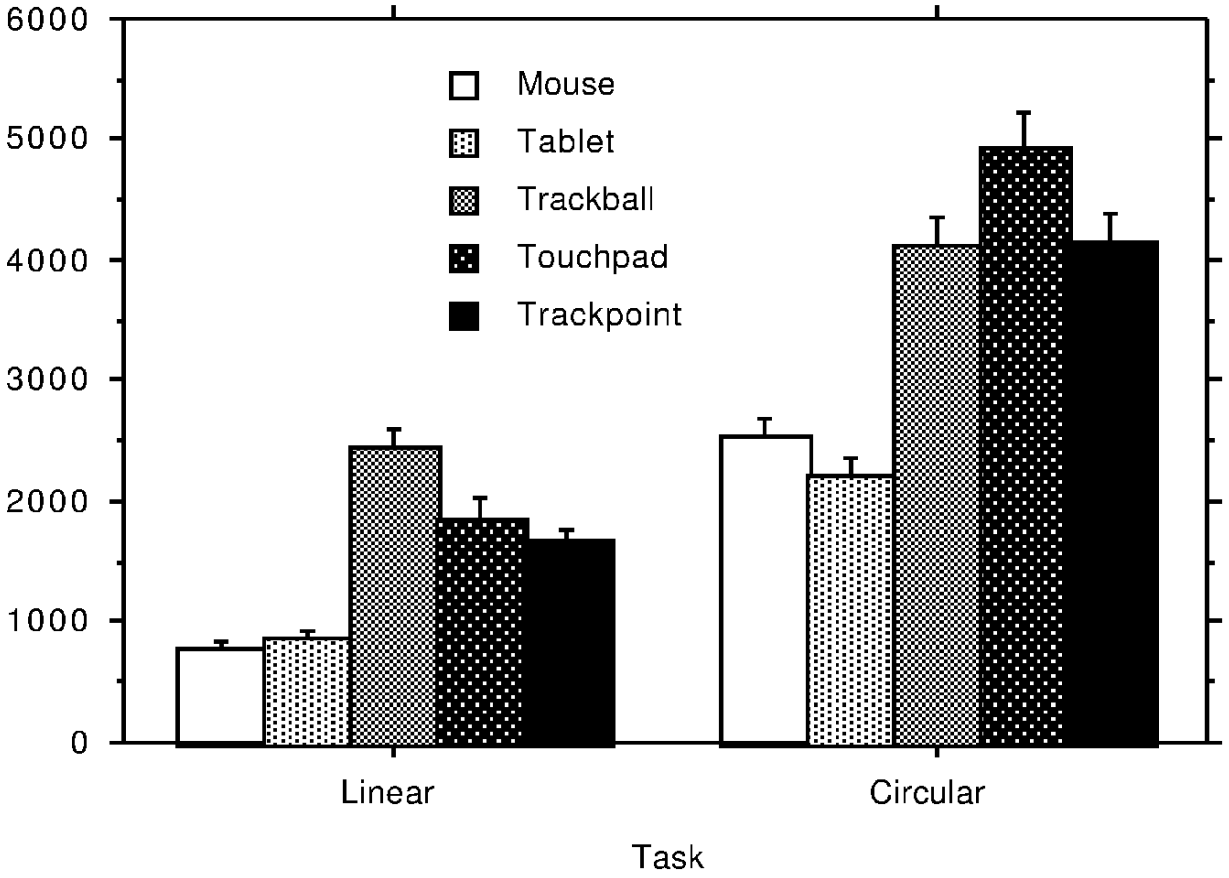
Conclusions

- *Steering law holds for all devices tested*
- *Steering law application illustrated*
- *Devices*
  - *Mouse and Tablet*
  - *Trackpoint*
  - *Touchpad and Trackball*
  - ***Limitations**: expert mouse users, elemental task, no device acquisition*

Acknowledgement

- *Stephane Chatty, CENA*
- *Thomas Baudel, Alias/Wavefront*

Mean completion times (ms)



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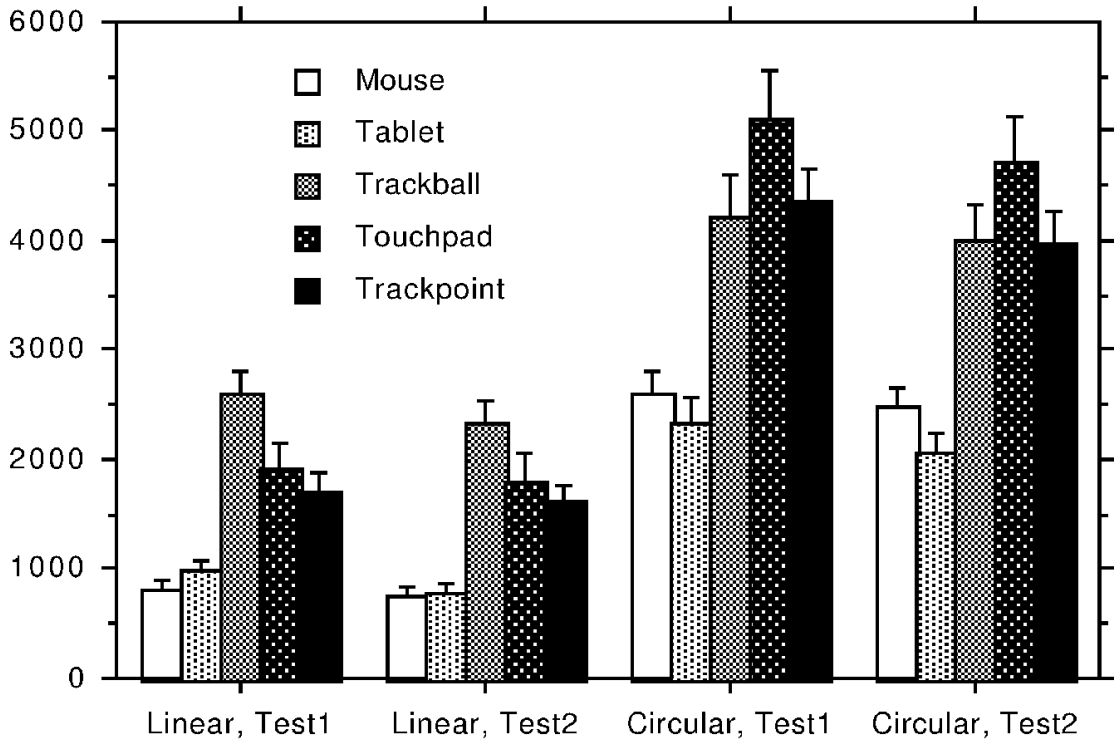
Learning effect



- *learning significant, but did not change device difference*

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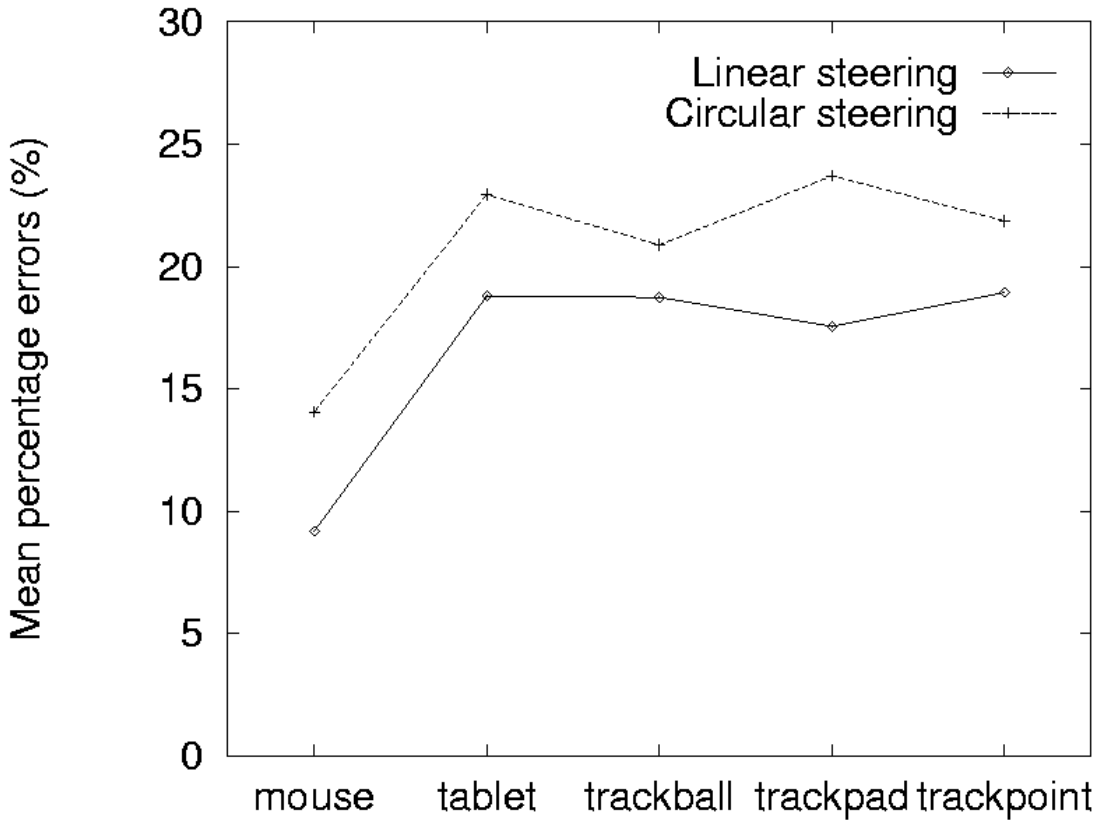
Errors



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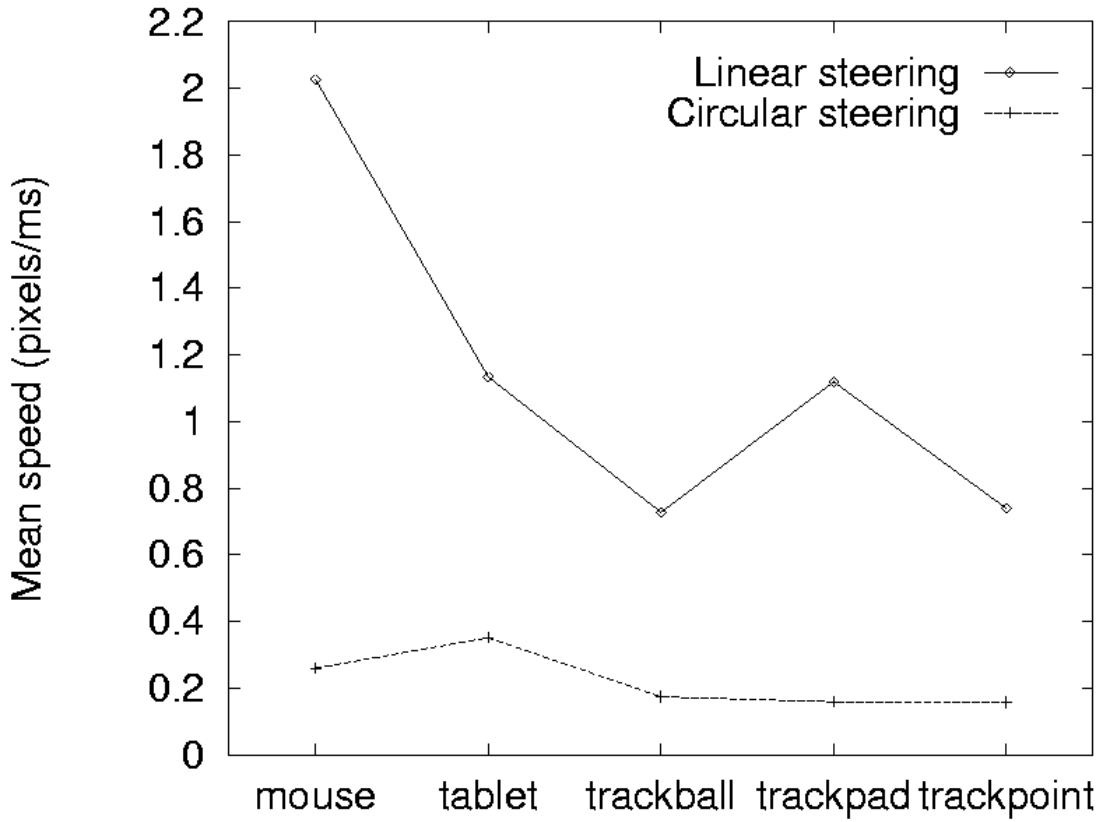
Speeds


Mean speed (pixels/ms)
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Linear steering
Circular steering
mouse
tablet
trackball
trackpad
trackpoint