Exercise Slides

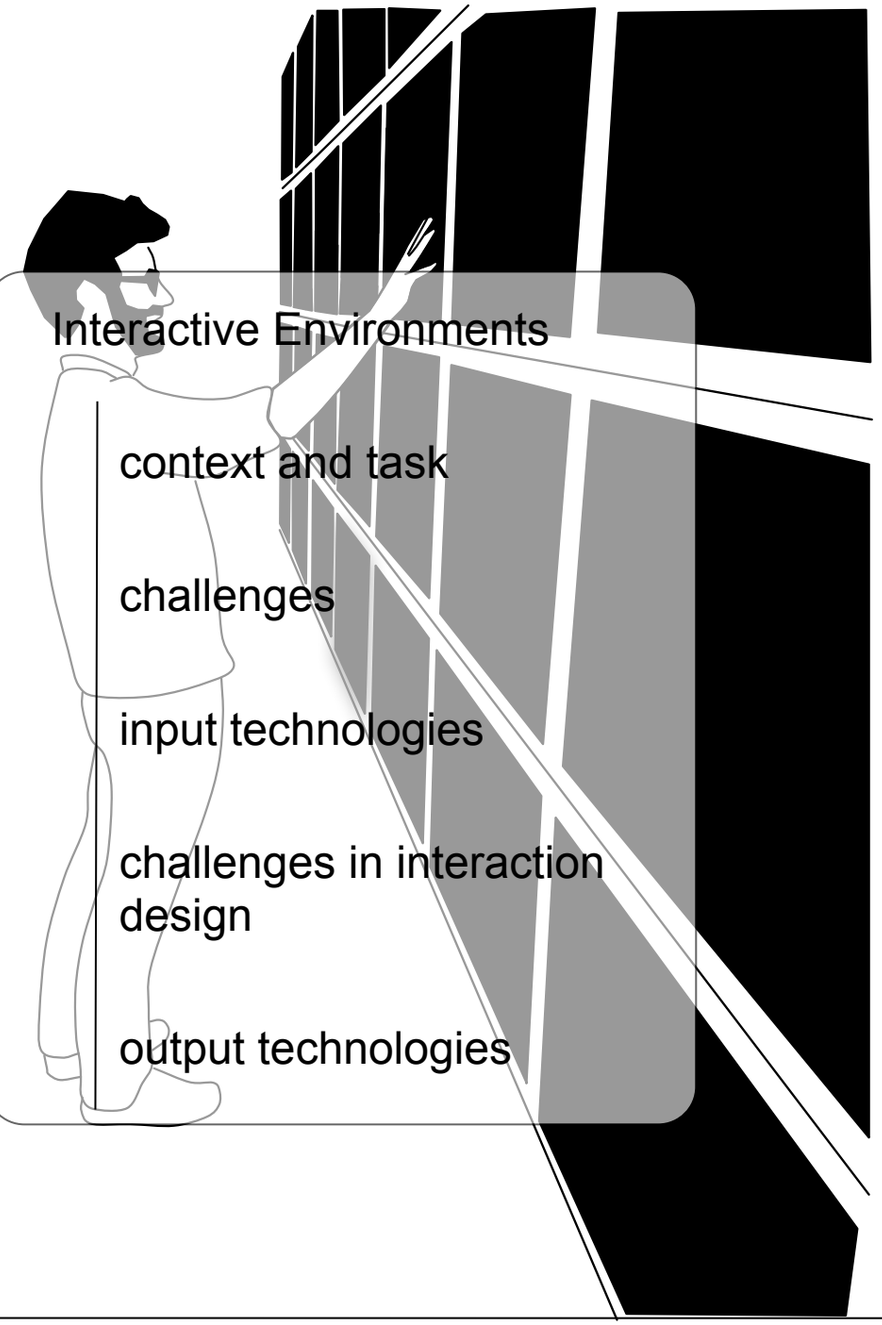
- slides are online
- password will be announced during the sessions
- email in UniWorx

- question for a potential future exercises:
  - could those who have programmable phones please prepare to have access to *eduroam* if not already done?

Mensch-Maschine Interaktion 2

Interactive Environments

Mobile Technologies



Desktop

Desktop Environments

- context and task
- challenges
- input technologies
- challenges in interaction design
- output technologies

Mobile

- context and task
- challenges
- input technologies
- challenges in interaction design
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Interactive Environments

- context and task
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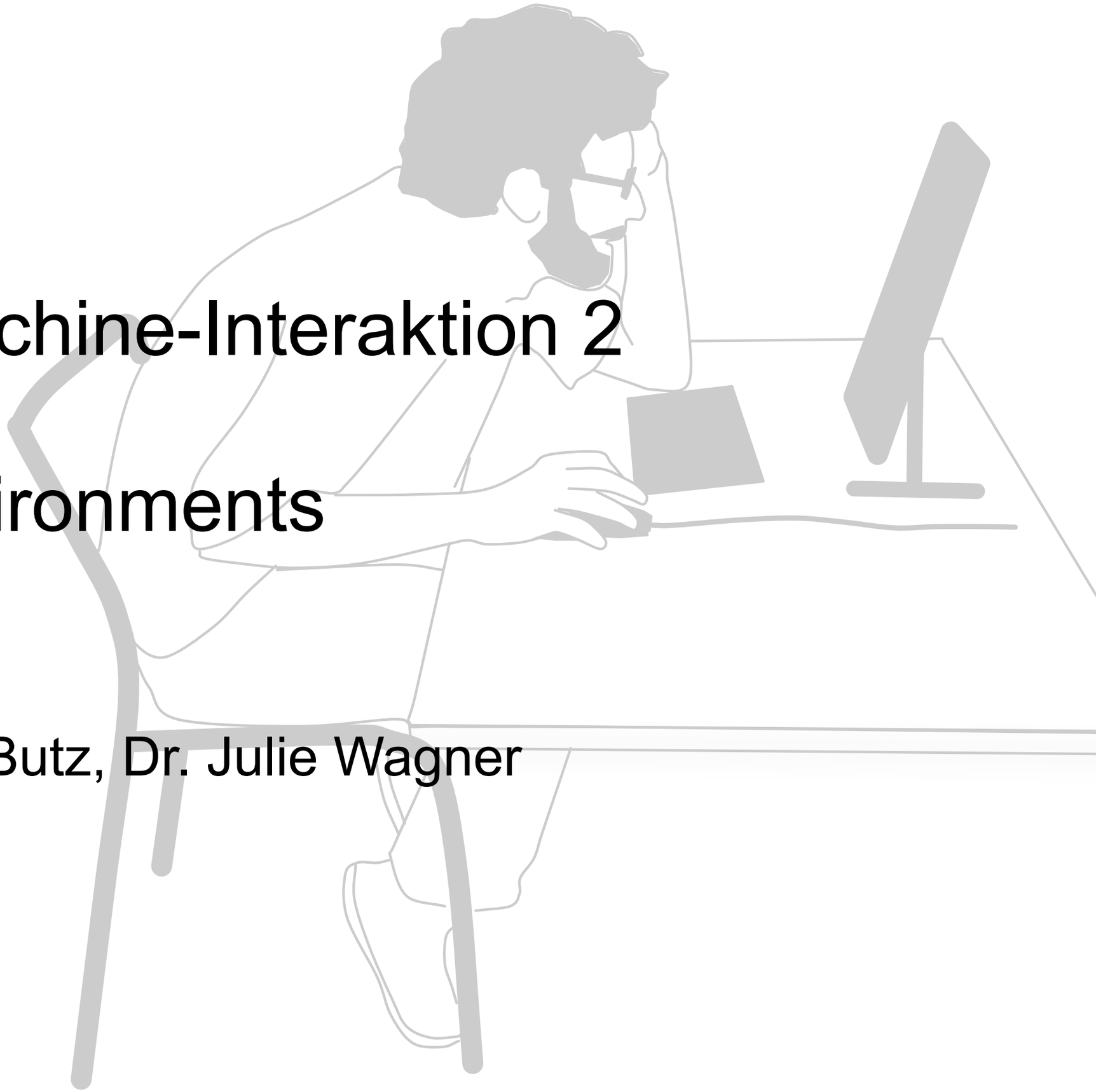
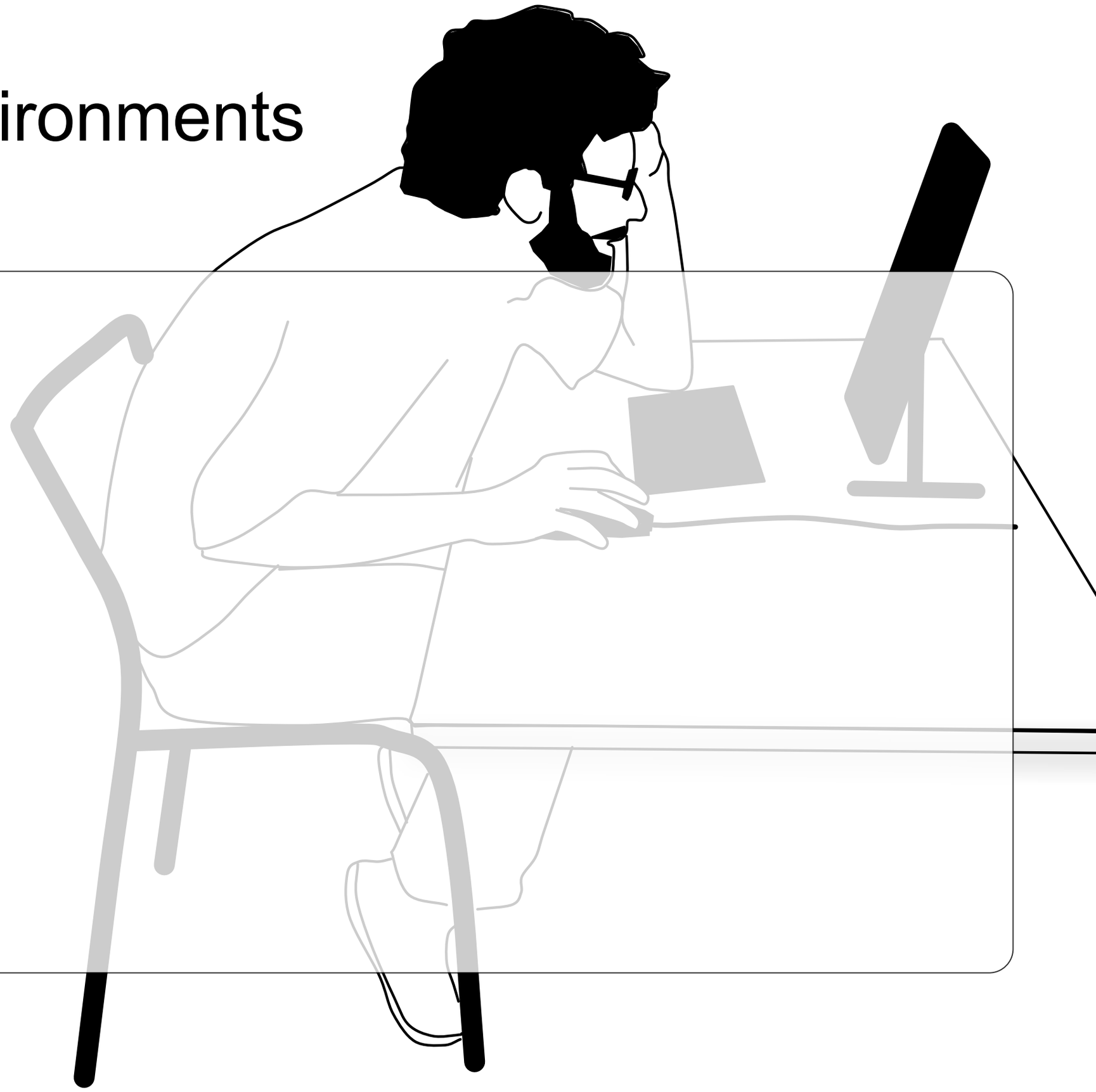
Mensch-Maschine-Interaktion 2

Desktop Environments



Prof. Dr. Andreas Butz, Dr. Julie Wagner

Desktop Environments



context and task

challenges

input technologies

challenges in interaction design

output technologies

- 1973 Xerox PARC's 'Alto'
- hardware:
  - bit-mapped display
  - mouse
  - chord-keyboard (like 5 piano keys)
- single person setup, seated

http://www.catb.org/esr/writings/taouu/html/ch02s05.html

Desktop

- **context and task**
- challenges
- input technologies
- challenges in interaction design
- output technologies

http://www.youtube.com/watch?v=zVw86emu-K0

Xerox star 1981, commercial product of ‘Alto’

- 1973 Xerox PARC's 'Alto'
- hardware:
  - bit-mapped display
  - mouse
  - chord-keyboard (like 5 piano keys)
- single person setup, seated
- GUI features:
  - WYSIWYG
  - sliders, scrollbar
  - windows
  - icons
  - menus
  - pointer

= WIMP

http://www.catb.org/esr/writings/taouu/html/ch02s05.html

Desktop

context and task

challenges

input technologies

challenges in interaction design

output technologies

Design Rationale

- Who was it designed for?

Desktop

- **context and task**
- challenges
- input technologies
- challenges in interaction design
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http://www.youtube.com/watch?v=zVw86emu-K0

- **context and task**
- challenges
- input technologies
- challenges in interaction design
- output technologies

Design Rationale

- Who was it designed for?
- What do they do?
- What is their context?
- Goal:

Design Rationale

- Who was it designed for?
- What do they do?
  - collect information
  - arrange/rearrange information
  - process information
- What is their context?
  - working under pressure, deadlines
  - typing skills
  - no time for learning “complex piece of office equipment”
  - cope with a lot of content
- Goal: optimizing/eliminating time-consuming tasks.

similar questions

new tasks we want to use computers for

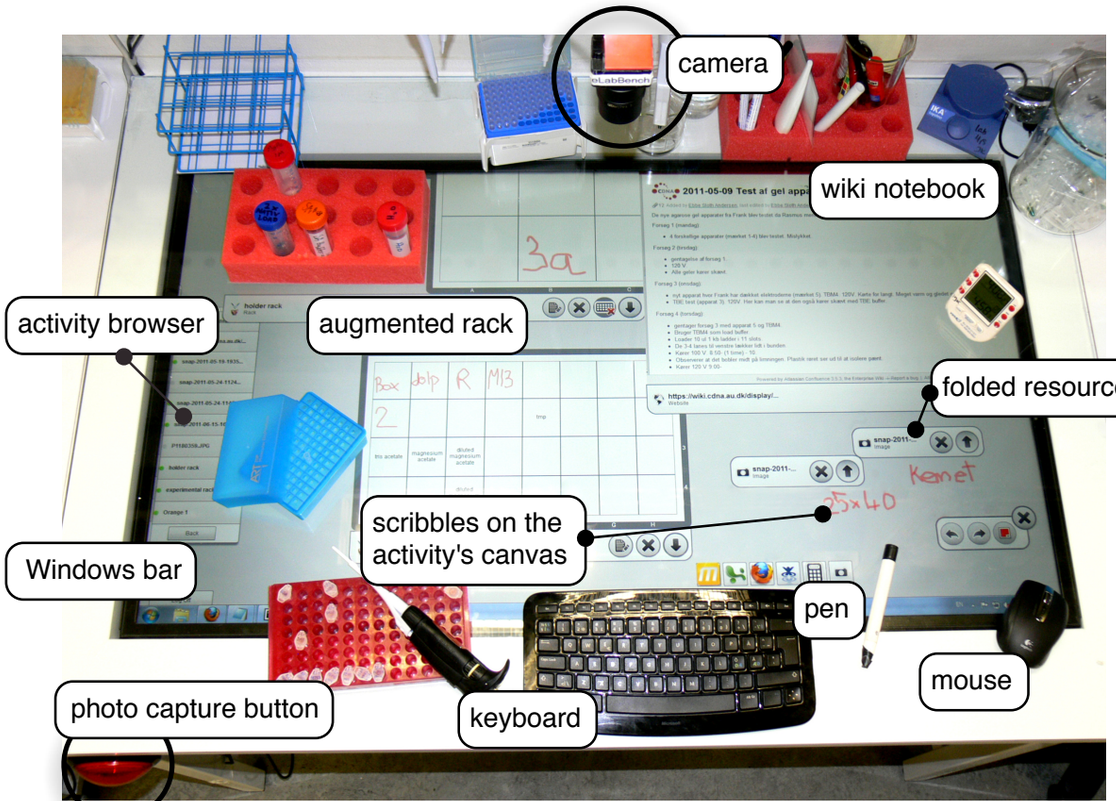
new context we use technology in

Might that be the reason for getting rid of chord keyboard?

Multiple “work places”

- example: biologists
- problem: redundancy in working process

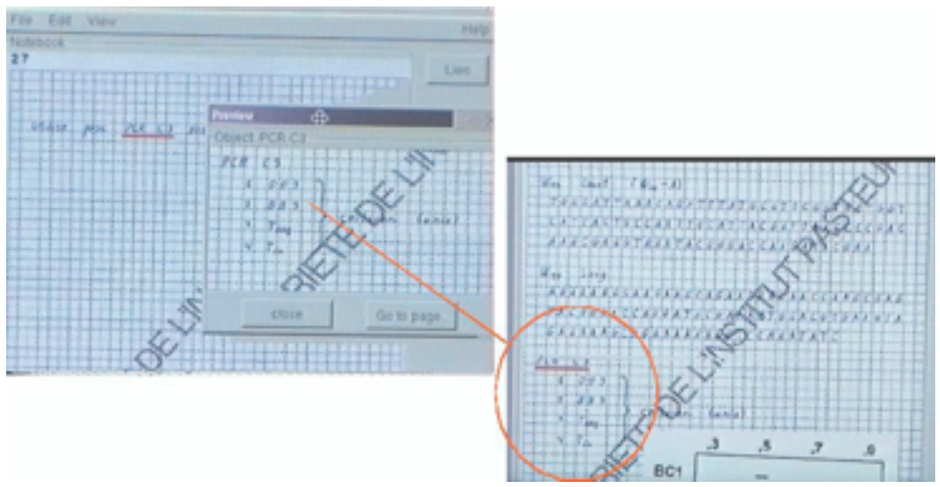
http://www.tabard.fr/publications/elabbench-deployment.pdf



http://www.tabard.fr/publications/elabbench-deployment.pdf

Imposed External Decisions

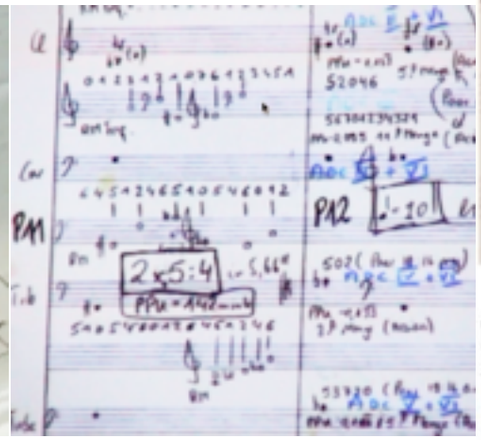
- example: biologists at Institut Pasteur (in Paris)
- problem: multiple media

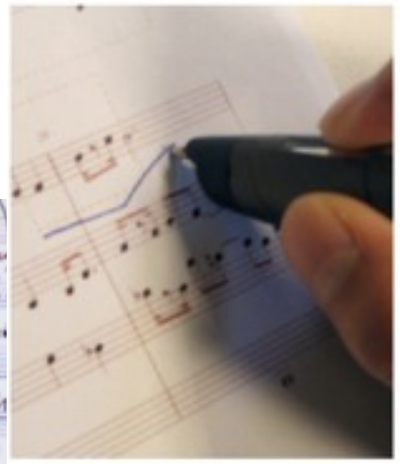


https://www.lri.fr/~mackay/pdffiles/ERCIM.News.pdf

Creative Tasks

- example composers
- problem: express your ideas, support creativity





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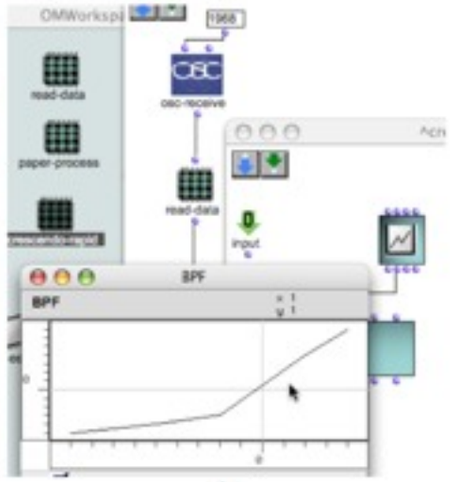
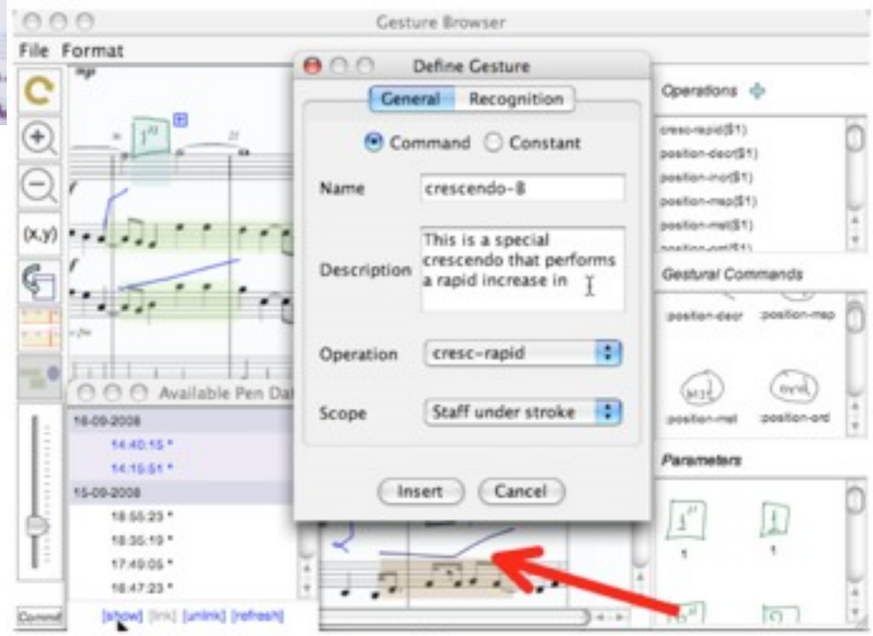


(b)

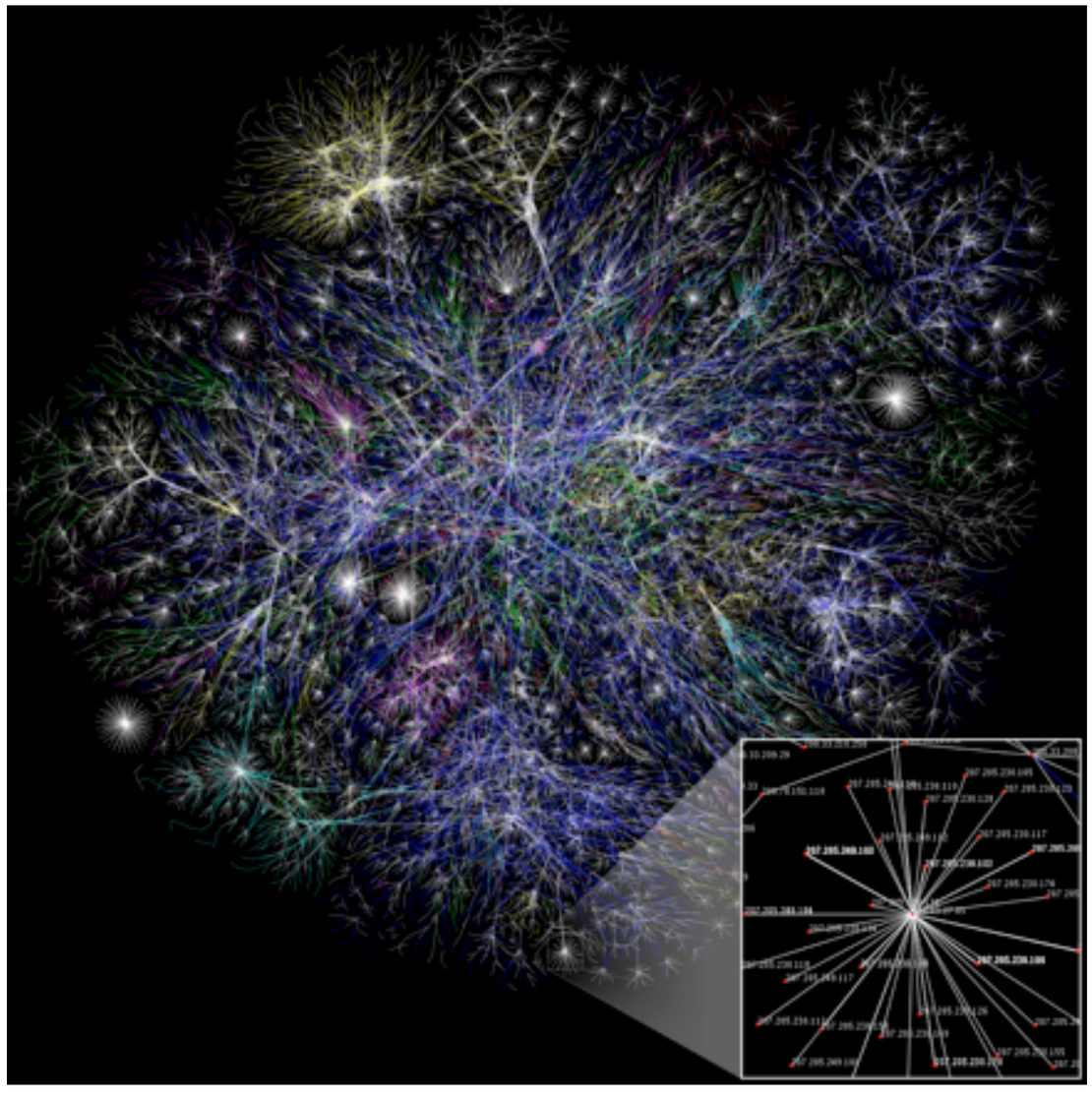


(c)

https://www.lri.fr/~fanis/

Exploration of Large Datasets

- example: researchers
- problem: navigate in large datasets



http://upload.wikimedia.org/wikipedia/commons/d/d2/Internet_map_1024.jpg

Exploration of Large Datasets

- example: collaborative data exploration
- problem: social aspects of interaction

Guest Lecturer: Michel Beaudouin-Lafon

http://insitu.lri.fr/Projects/WILD

Desktop

- **context and task**
- challenges
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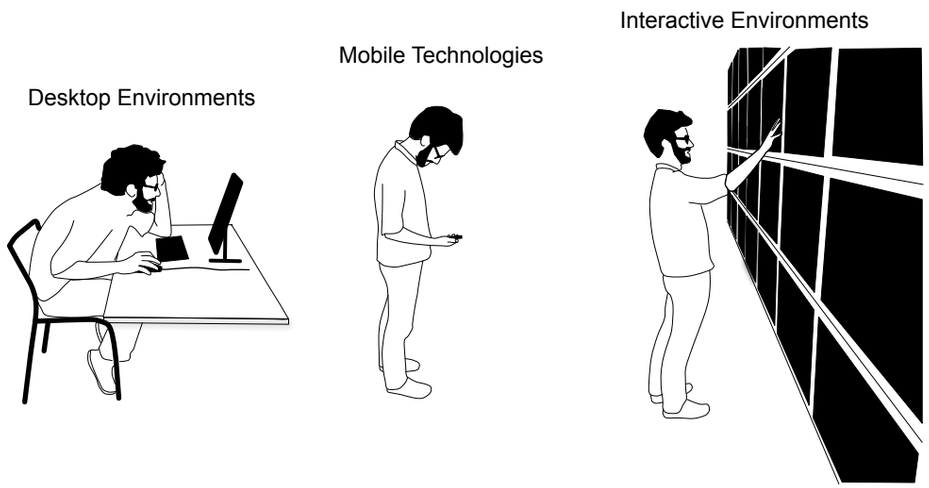
Interactive Cognitive Aids in Medicine

http://www.youtube.com/watch?v=UoMHzX36Gmg

Take-away message

- understand complex way of history to understand how we got where we are!
  - technical and economic constraints
  - changes by living with technology
- there is no single setup that can model all human tasks.
  - Let's push the boundaries in shape, functionality and usage.



Take-away message

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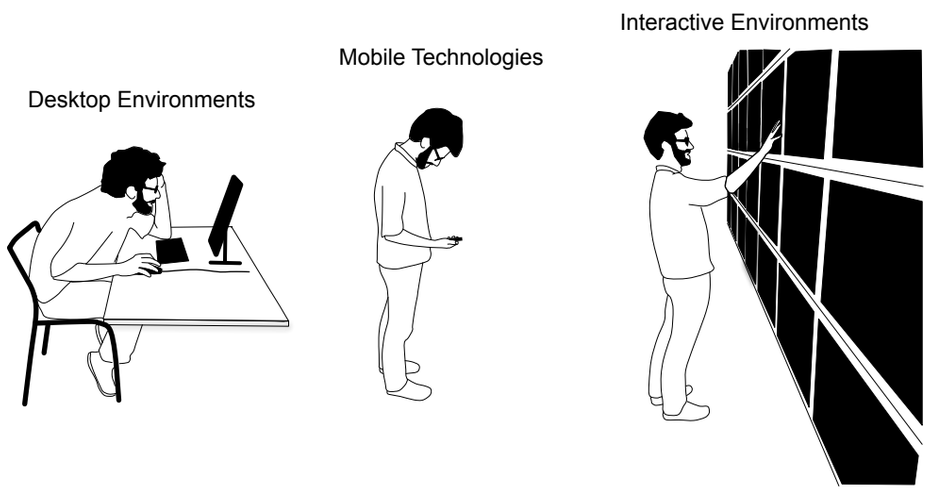
  - changes by living with technology
- there is no single setup that can model all human tasks.
  - Let's push the boundaries in shape, functionality and usage.

5 MINUTE MICRO-TASK

Come up with professions and their task that are not well modeled with a desktop setup and might take advantage of other forms or shapes of technology.



Challenges in HCI

- models discussed in MMI1:
  - Hick's law, Guiard's kinematic chain theory, GOMS, **KLM** etc.
- two particular challenges in HCI:
  - predictive model
    - value and decide between two alternatives.

Predictive Power

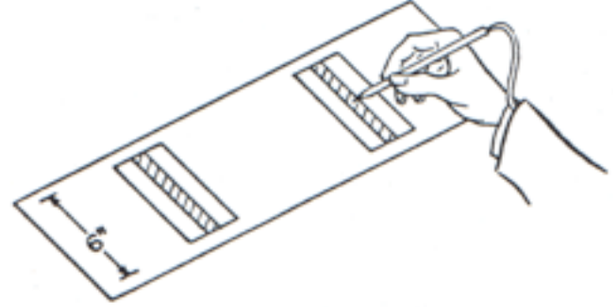
  - systematic exploration of design alternatives
    - are there more than two alternatives? what are the other alternative?

Generative Power

    - why did I choose these two designs? what are their differences?

Descriptive Power

Predictive Model

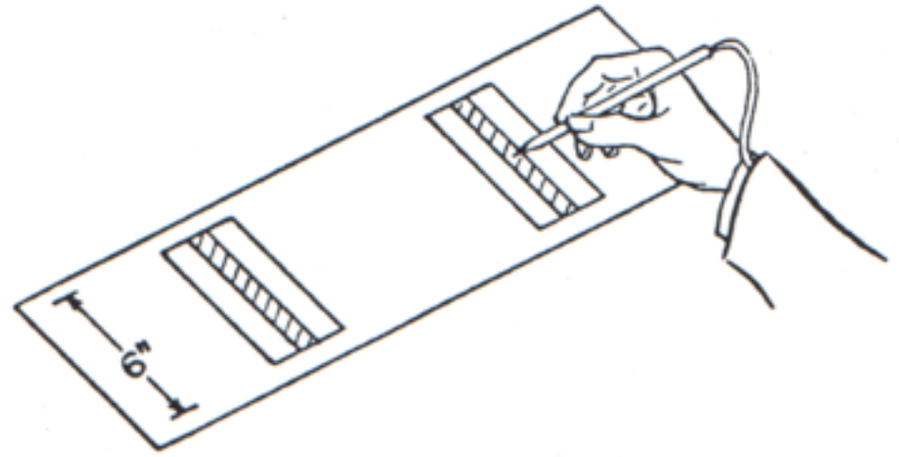


- Fitts' law is a robust model of human psychomotor behavior
- Predicts movement time for rapid, aimed pointing tasks
  - Clicking on buttons, touching icons, etc.
- Developed by Paul Fitts in 1954
- Fitts' discovery "was a major factor leading to the mouse's commercial introduction by Xerox" [Stuart Card]

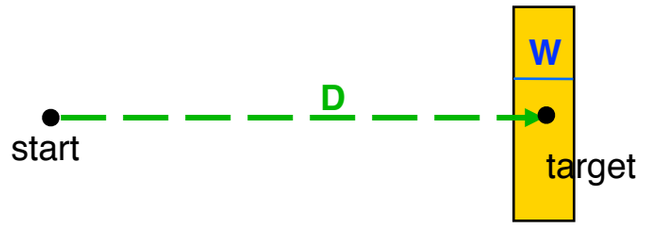
http://plyojump.com/classes/images/computer_history/sage_lightpen.jpg

Literature:
Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. *Journal of Experimental Psychology*, *47*, 381-391.

Predictive Model



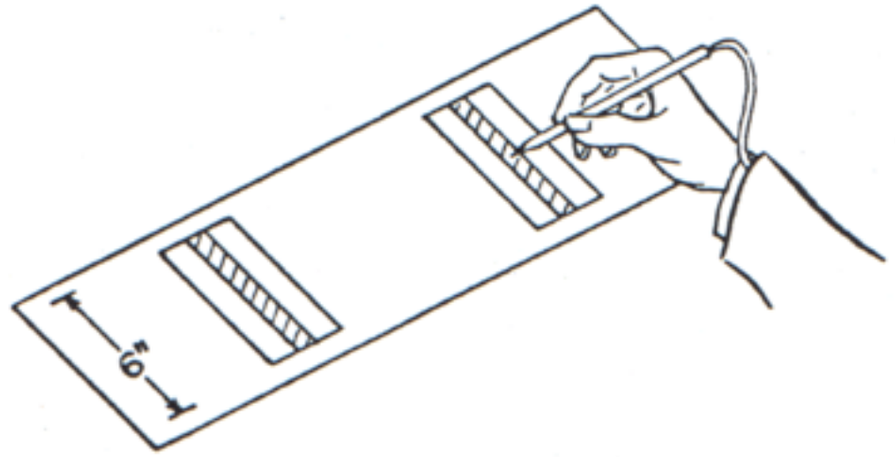
$$MT = a + b \log_2\left(1 + \frac{D}{W}\right)$$



- **MT**: movement time
- **a and b**: constants dependent on the pointing system (user/input device)
- **D**: distance to the target area
- **W**: width of the target

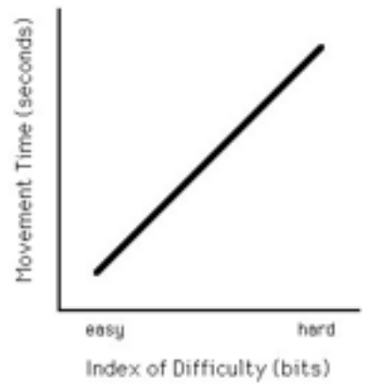
Literature:
Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. *Journal of Experimental Psychology*, *47*, 381-391.

Predictive Model



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

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

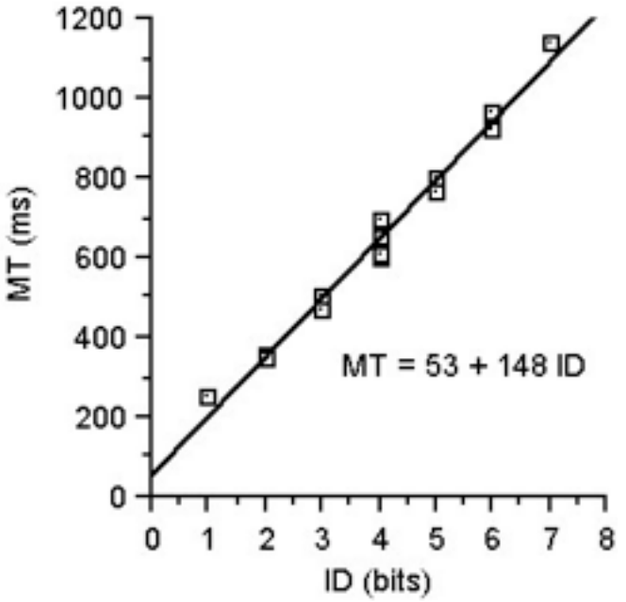


http://www.yorku.ca/mack/GI92.html

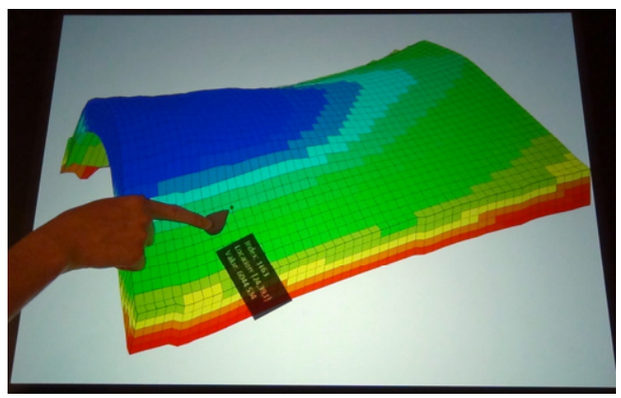
- index of difficulty
  - ID difficulty of task independent of device / method
- units
  - constant a measured in seconds
  - constant b measured in seconds / bit
  - index of difficulty, ID measured in bits

Building a Fitts' Law Model

- interactive computing systems: manipulating a cursor with the mouse, selecting icons in virtual space using a glove, grabbing tangible objects.
- determine slope and intercept coefficients
  - controlled experiment
  - one or more input devices
  - task condition
- cover range of difficulties
- conduct multiple trials in each condition and measure the required time.
- perform tests of correlation and linear regression.



http://www.yorku.ca/mack/GI92.html



http://utouch.cpsc.ucalgary.ca/docs/PointItSplitItPeelItViewIt-ITS2011-NS.pdf

Importance for HCI

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

- inspire interaction techniques for optimizing MT:
  - increase W
  - decrease D
  - do both
  - improve hardware, reduce b
  - reduce a?
- create standards
- give a value to a design solution and justify why design A is better than design B.
- attention: findings can be different between lab studies and field studies.
- model does not capture complete complexity of a situation.

Desktop

context and task

challenges

Predictive models

input technologies

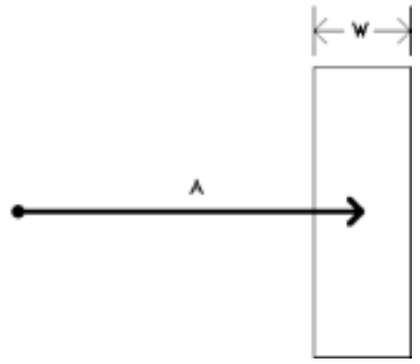
challenges in interaction design

output technologies

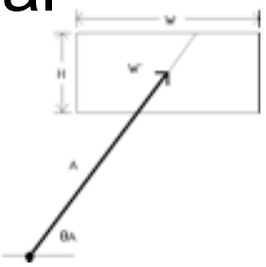
Assumptions

- one-dimensional movement
- straight line movement
- constant velocity
- undivided attention of movement

no one-dimensional task



- two models:
  - W' model: substitutes for W the extend of the target along an approach vector through the center
    - "+" : theoretically attractive, retains one-dimensional model
    - "-" : requires angle of movement
  - SMALLER-OF model: substitutes for W either the width or height of the target, whichever is smaller.
    - "+": easy to apply
    - "-": but limited to rectangular targets.

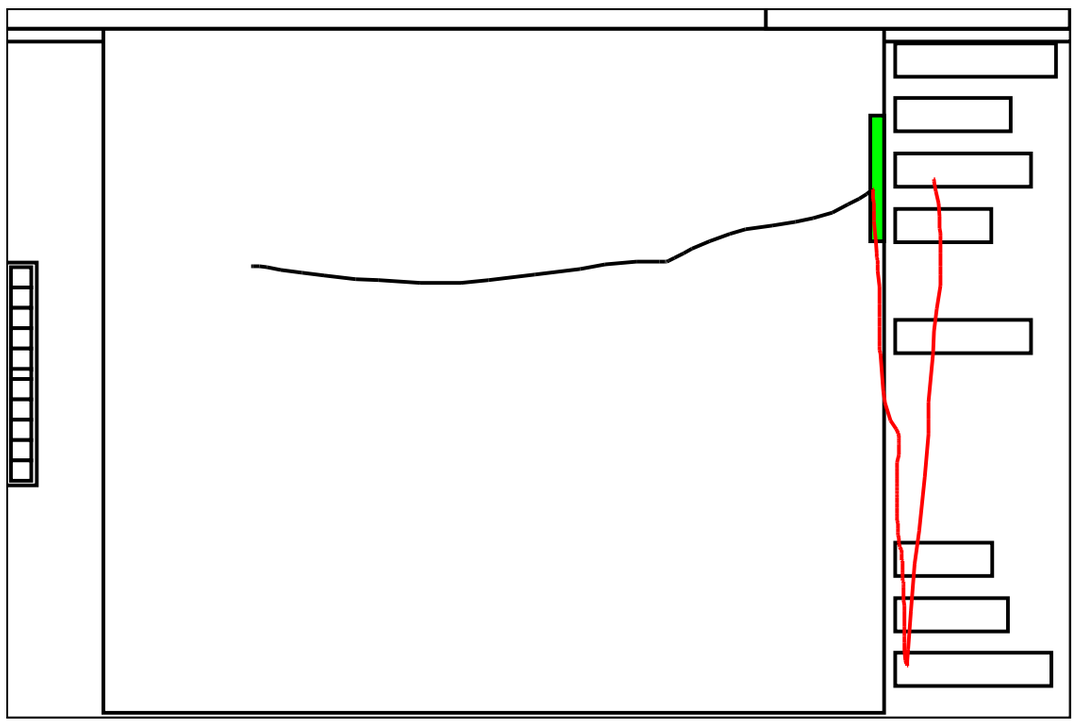


http://www.billbuxton.com/fitts92.html

Literature:
MacKenzie et al. (1992): Extending Fitts' law to two-dimensional tasks. CHI'92

no straight line movement

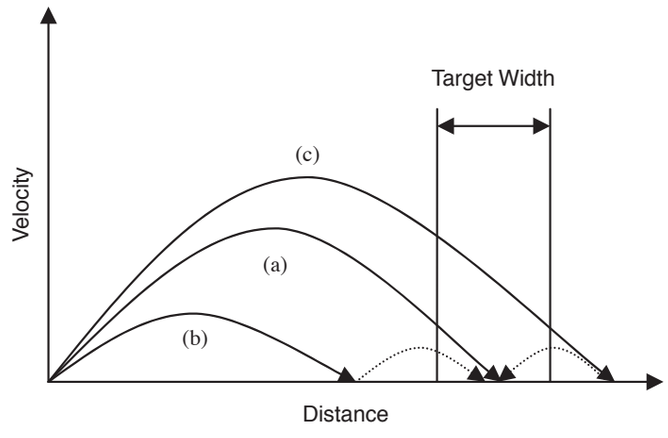
- length-distance ratio
  - Motion is not always straight: spiral or zig-zag
    - to measure this deviation from ideal trajectory use legnth-distance ration (LD)
    - LD = length of movement/actual distance



Literature:
Chapuis, O. et al. (2007). *Fitts' Law in the Wild: A Field Study of Aimed Movements.* Technical Report LRI

no constant velocity

- no single smooth motion
- motion composed of sequence of one or more sub-movements
  - ballistic phase: first movement is large and fast, cover most of distance
  - corrective control phase: small and slower movements
- deterministic iterative-corrections model
  - sub-movements have equal duration, each travel a constant fraction of the remaining distance toward the target and are all executed



Literature:
Meyer et al. *Optimality in human motor performacne: ideal control of rapid aimed movements,* 1988

Desktop

context and task

challenges

Predictive models

input technologies

challenges in interaction design

output technologies

bimanual pointing

- perform a bimanual aiming task
  - one hand reaches for target in 10cm distance
  - other hand reached for target in 30cm distance
- What happened? What is MT in this case?

Literature:
Marteniuk, R.G. et al. (1984). *Bimanual movement control: Information processing and interaction effects.* Quarterly Journal of Experimental Psychology, 36A, 335-336

bimanual pointing

- perform a bimanual aiming task
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- What happened? What is MT in this case?

MICRO-EXPERIMENT

try a bimanual pointing task yourself!

Literature:
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bimanual pointing

- perform a bimanual aiming task
  - one hand reaches for target in 10cm distance
  - other hand reached for target in 30cm distance
- What happened? What is MT in this case?
- Bimanual tasks are not just two simultaneously performed uni-manual tasks.
  - inter-limb coordination has tendency towards symmetry
  - limited degree of independence
- von Holst (1939), "*Beharrungstendenz*" vs. "*Magnetoeffekt*"
- more about bimanual interaction in section "*mobile technologies*".

Literature:

Marteniuk, R.G. et al. (1984). *Bimanual movement control: Information processing and interaction effects.* Quarterly Journal of Experimental Psychology, 36A, 335-336

Importance for HCI

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  - increase W
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  - do both
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  - reduce a?
- create standards
- give a value to a design solution and justify why design A is better than design B.
- attention: findings can be different between lab studies and field studies.
- model does not capture complete complexity of a situation.

adapt and refine models to new situations

contributes to understanding

helps communicating observed phenomena

Systematic Exploration

- variety of input devices: keyboards, mice, headmice, pen+tablet, dialboxes, polhemus sensors, gloves, body suits.
- descriptive power:
  - ‘my design is...’
  - ‘design A and B differ in...’
- predictive power
  - design A is faster than B because...
- generative power
  - the combination of X and Y had not been explored before...

Literature: Card et al., “A Morphological Analysis of the Design Space of Input Devices”. ACM Transactions on Information Systems, Vol.9, No. 2, 1991

Systematic Exploration

- morphological design space analysis.
- input device = point in a parametrically described design space.
  - primitive movement vocabulary
  - set of composition operators
- formal and visual description of input devices.
- testing points in design space
  - expressiveness
  - effectiveness
- limitations: idealized devices (no lag, noise etc.), speech excluded.

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Desktop

- context and task
- challenges
  - Predictive Models
  - **Systematic Exploration**
- input technologies
- challenges in interaction design
- output technologies

Primitive Movement Vocabulary

"an input device is a transducer from the physical properties of the world into logical parameters of an application" (Baeker and Buxton)

⟨M, In, S, R, Out, W⟩,

where

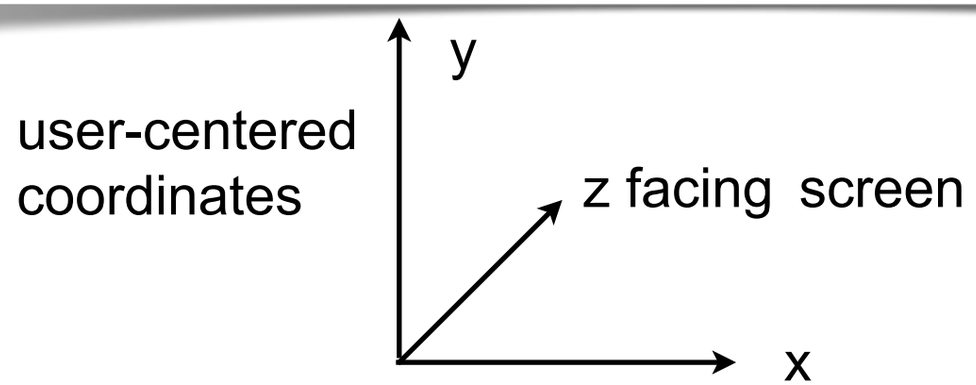
- **M is a manipulation operator,**
- **In is the input domain,**
- **S is the current state of the device,**
- **R is a resolution function mapping from the input domain set to the output domain set,**
- **Out is the output domain set, and**
- **W is a general-purpose set of device properties that describe additional aspects of how a device works (perhaps using production systems).**

Literature: Baecker et al., "Reading in Human-Computer Interaction: A Multidisciplinary Approach". Kaufmann, Los Altos, Calif., 1987

Manipulation operators *M*

Table I. Physical Properties Used by Input Devices

	Linear	Rotary
Position		
Absolute	Position **P**	Rotation **R**
Relative	Movement **dP**	Delta rotation **dR**
Force		
Absolute	Force **F**	Torque **T**
Relative	Delta force **dF**	Delta torque **dT**



- What are the limitations of this approach?
  - what about speech interaction?
  - what else is not modeled?

Literature: Card et al., “A Morphological Analysis of the Design Space of Input Devices”. ACM Transactions on Information Systems, Vol.9, No. 2, 1991

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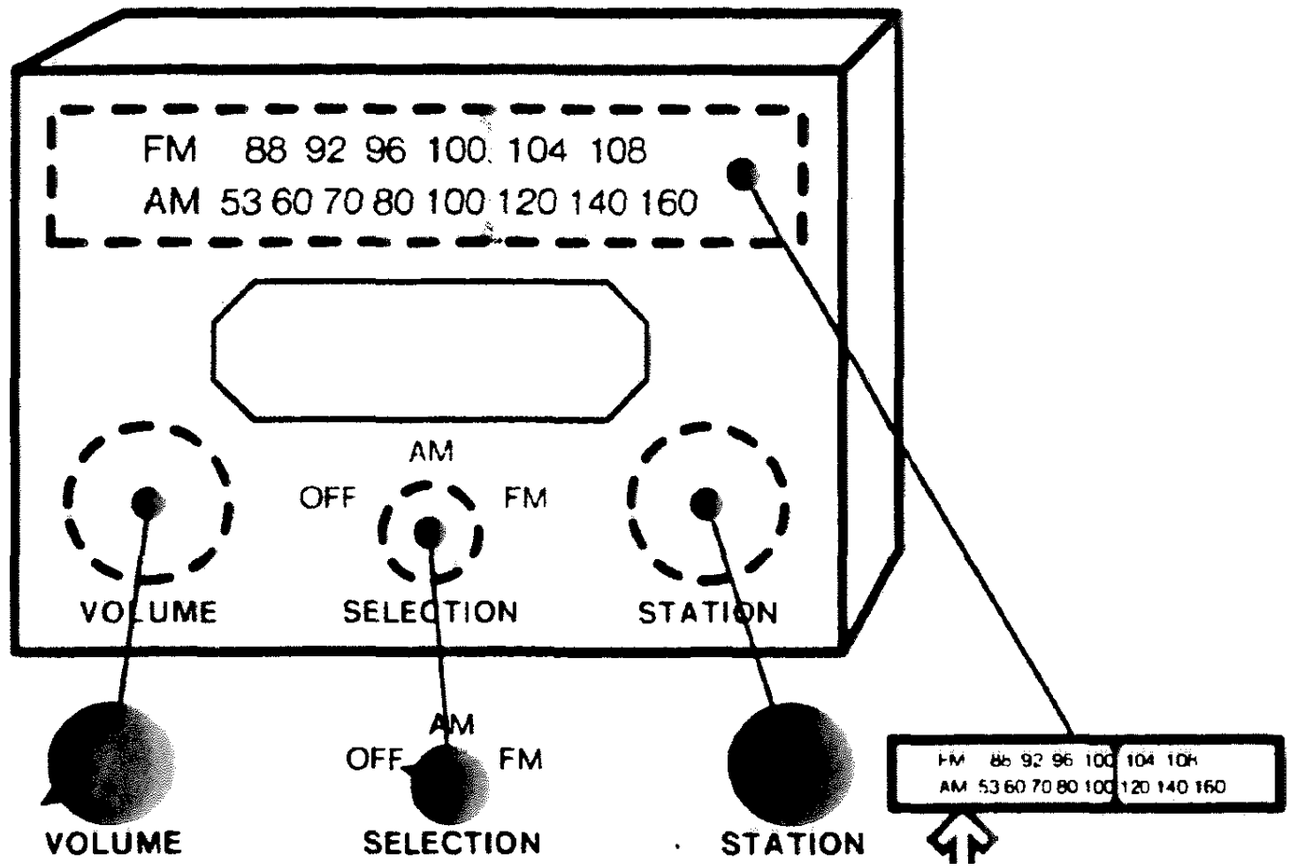

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VolumeKnob =
<Rz, [0°,270°],0°, I, [0°,270°], {}>

Desktop

- context and task
- challenges
  - Predictive Models
  - **Systematic Exploration**
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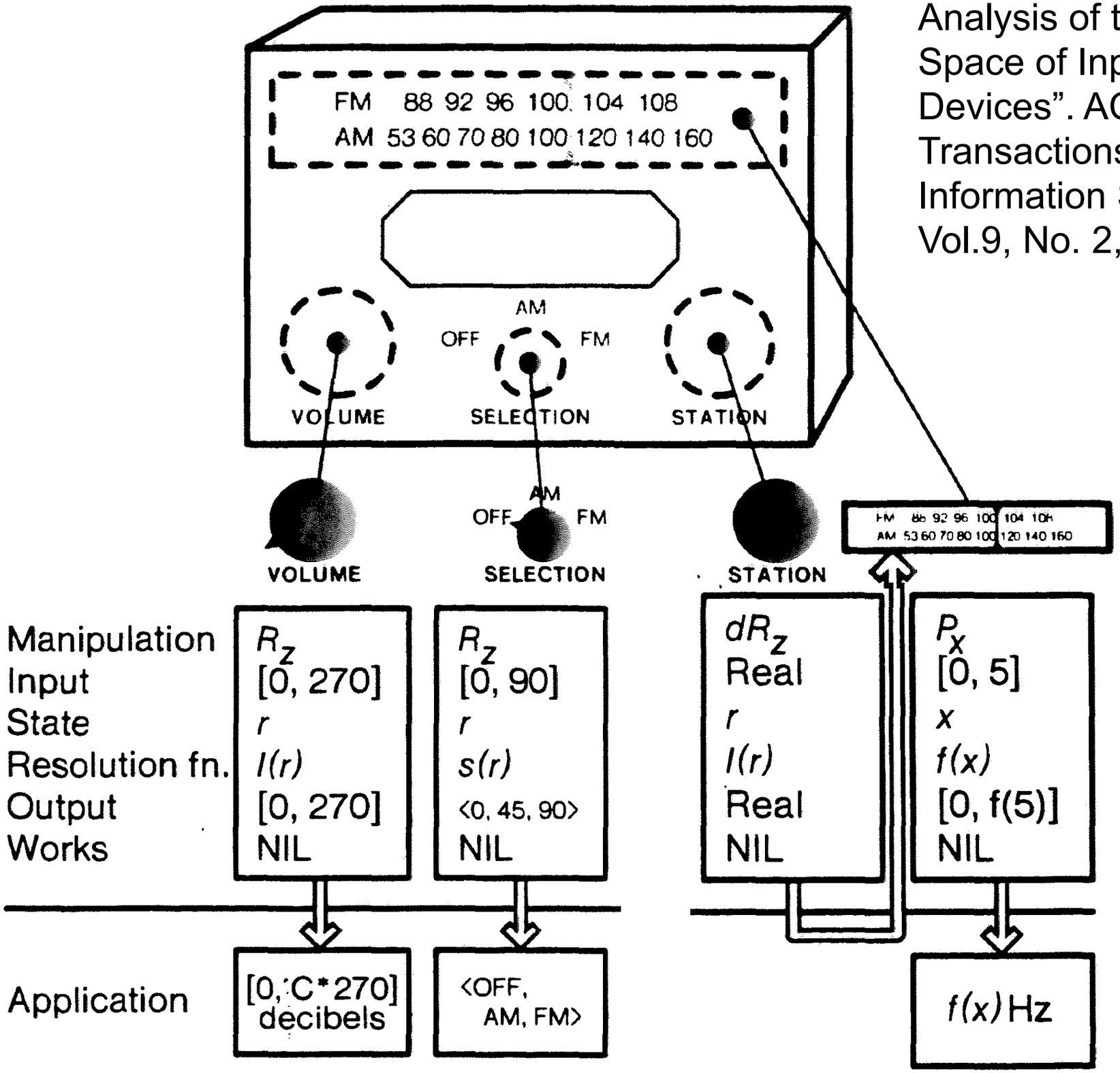
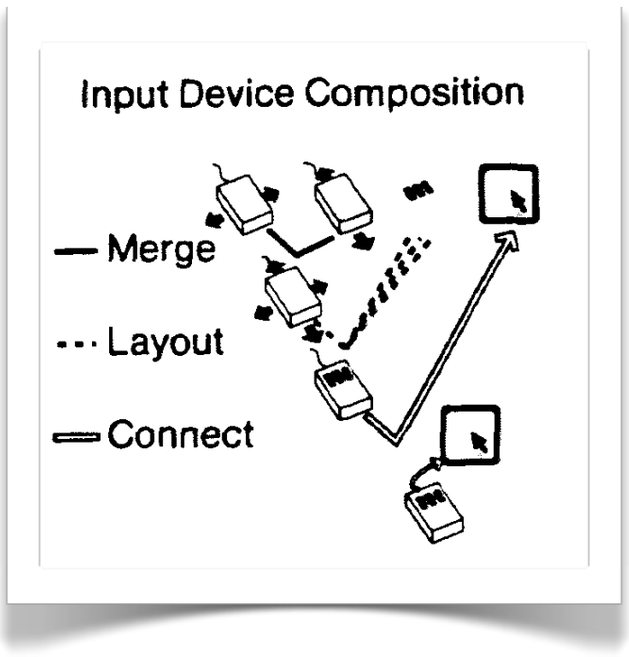
Try it yourself!

Literature: Card et al., “A Morphological Analysis of the Design Space of Input Devices”. ACM Transactions on Information Systems, Vol.9, No. 2, 1991



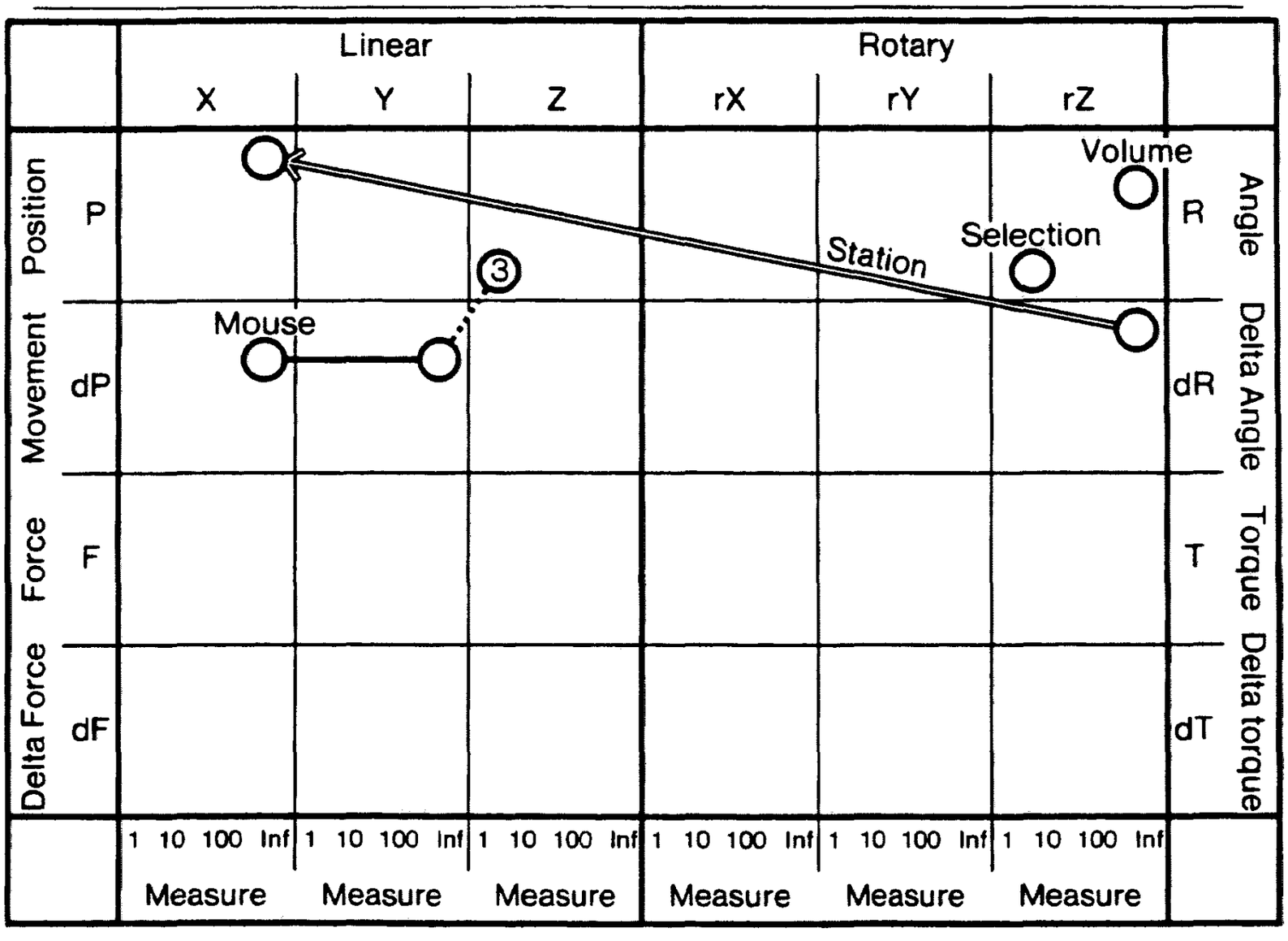
Composition Operators

- merge composition
  - two devices can be composed so that their common sets are merged
- layout composition
  - several devices laid out together in a control panel
- connect composition
  - two devices connected that the output of one is cascaded to the input of the other



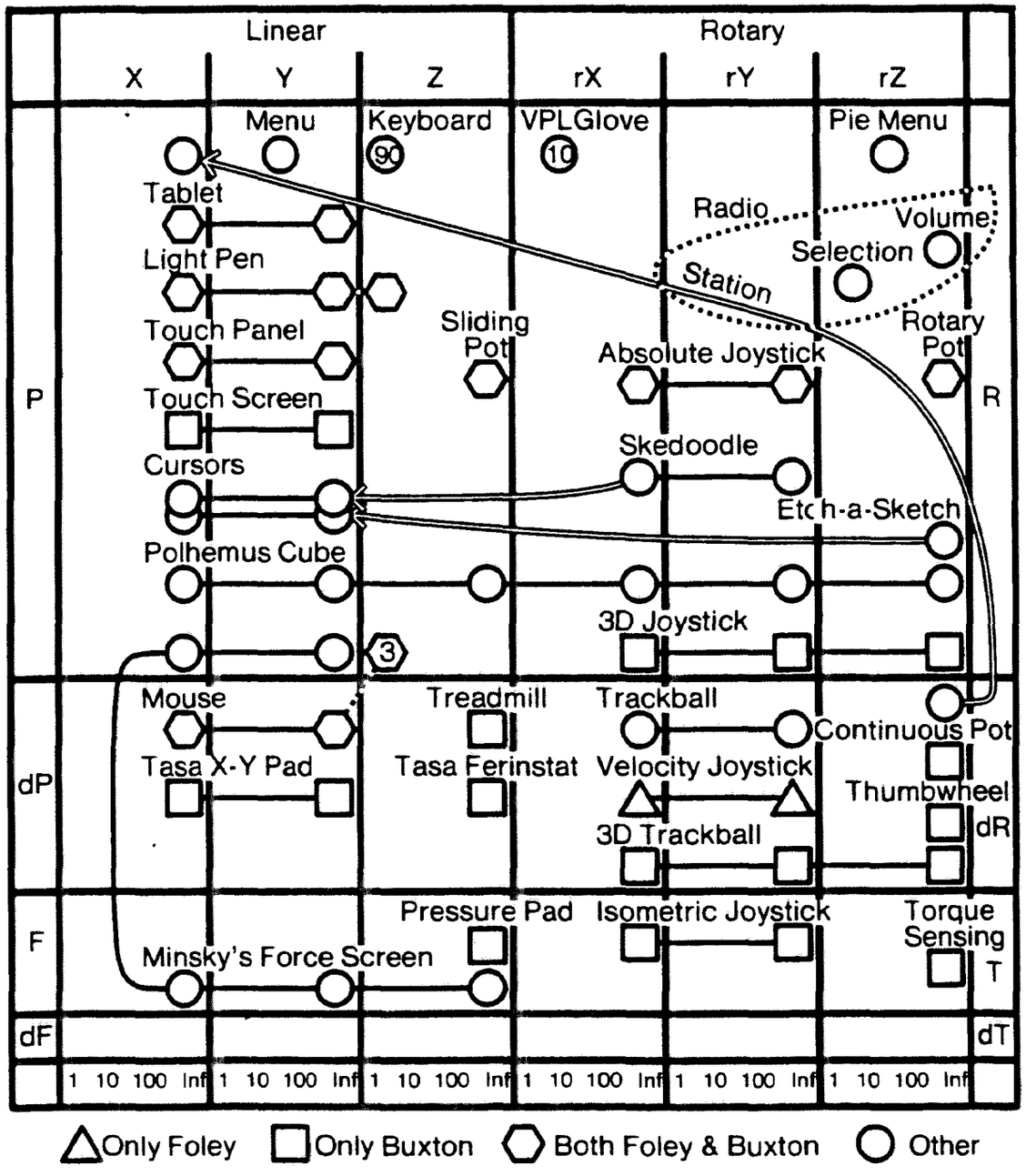
Literature: Card et al., “A Morphological Analysis of the Design Space of Input Devices”. ACM Transactions on Information Systems, Vol.9, No. 2, 1991

Visual Description



Importance for interaction design?

- Morphological Approach
  - cope with complexity, cope with large number of alternatives.
- Descriptive power (how?)
- Generative power (how?)



Take-away Message

- models are important
  - research:
    - communicate interdisciplinary field
    - establish understanding of a phenomena
    - work on systematic ways of exploring designs
  - industry:
    - can reduce costs of testing different designs
    - generate ideas for the next product
- require models that enable
  - description
  - prediction
  - generation of new ideas.
- reality vs. model