COSC368 Humans and Computers:

Introduction to Human-Computer Interaction (HCI)

Andy Cockburn
University of Canterbury

People

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- Katia De Lu & Stewart Dowding
  - Tutors
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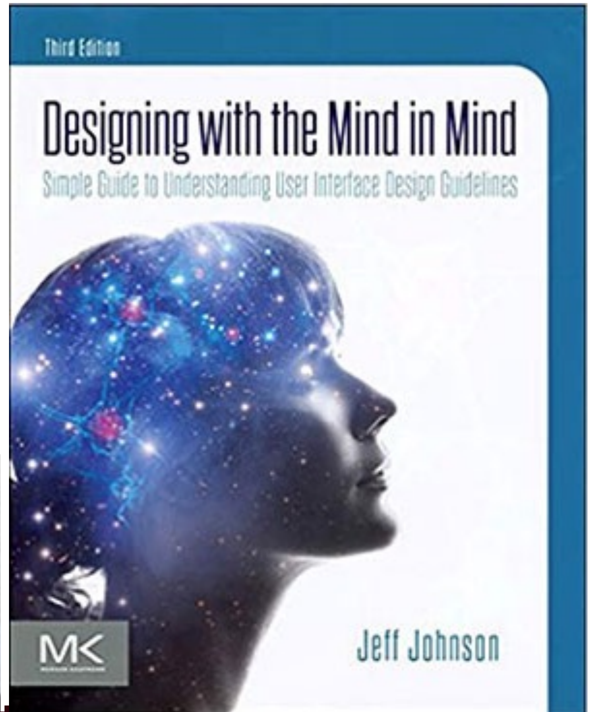
Assessment

- Labs
  - 9% (1% per lab, starting this week)
- Usability Analysis and Storyboard
  - 25%
  - 5pm, Wed 22nd September
- Design Specification and Rationale
  - 15%
  - 5pm, Wed 20th October
- Exam
  - 51%
  - TBA

Recommended Text & Resources

- "Designing with the Mind in Mind", 2nd or 3rd Edition
  Jeff Johnson, Morgan-Kaufmann
- (Based on Jeff teaching COSC368)
- Papers on ACM Digital Library: canterbury.libguides.com/cosc
- Stuff posted on Learn



Schedule (short)

- Introduction
- Models of interaction and interface technology
- The human
- Interface design
- Evaluation
- (UI intellectual property)

Schedule (long)

Week	Beginning	LECTURES	LABS
1	19-July	Introduction to HCI	Lab 1: Python/TkInter refresher
2	26-July	Models of interaction	Lab 2: Python/TkInter: Keyboard GUI
3	2-Aug	The Human – senses	Lab 3: Python/TkInter: Canvas & Fitts law GUI
4	9-Aug	The Human – performance and phenomena	Lab 4: Fitts' law experiment and analysis
5	16-Aug	Interface Design – Iteration	Lab 5: Sketching Designs
6	23-Aug	Interface Design – Task Centred System Design	Assignment help
	30-Aug		
	6-Sept		
7	13-Sept	Interface Design – Heuristics	Lab 6: Visual search, decision, skill development
8	20-Sept	Interface Design – Heuristics II	Lab 7: Performance prediction
9	27-Sept	Interface Design – Graphical design	Lab 8: Heuristic evaluation
10	4-Oct	Interface Evaluation & Empirical Methods	Lab 9: Experimental data analysis
11	11-Oct	Interface Evaluation & Empirical Methods 2	Assignment help
12	18-Oct	Overflow and UI Intellectual Property	

Your Outcomes (my goals)

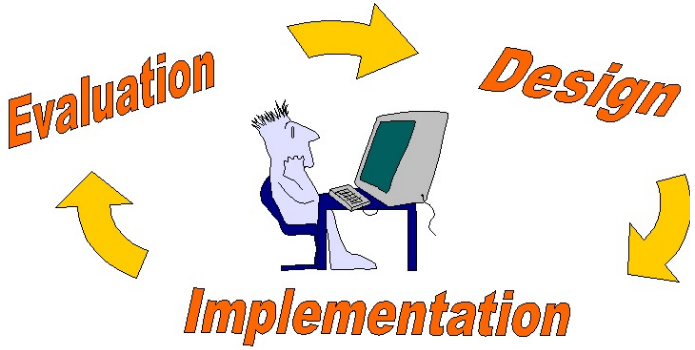
- Understand key human factors influencing human-computer interaction
- Know guidelines, models, and methods that aid interface design, and be able to apply them
- Be able to evaluate user interfaces and designs

- Make the interactive world better
- Stimulate your interest (please speak up!)

Introduction

Human-Computer Interaction (HCI)?

"HCI is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use, and with the study of major phenomena surrounding them."
ACM SIGCHI Curricula, 1992



HCI Jobs

seek.co.nz "UX"

UX Architect

Farrow Jamieson Ltd

More jobs from this company

UX Architect

Trimble are seeking a UX Architect for their new user experience machine control team within the CTCT (Caterpillar Trimble Controls Technologies) Joint Venture. The successful candidate will act as the end user advocate in the design and implementation of machine control solutions that maximise the ease of doing business.

What is CTCT?

The CTCT division (a joint venture between Trimble and Caterpillar) develops positioning and control products for earth-moving and paving machines in the construction and mining industries, using technologies such as GPS, optical total stations, lasers and sonics. The products are used in a range of applications where the operator of the machine benefits from position and location data.

The Position

A successful candidate will assist the CTCT UX team with developing on-site, in-cab and office-based systems for precision control displays of the future for a vast array of construction and mining equipment.

Key Responsibilities

- Application of strategic thinking to deliver end-to-end user experience solutions with a focus on user needs and business goals
- Utilise end user requirements to create compelling representations of the solution's high-level interaction, navigation, and organisation design
- Expertly craft documentation to represent the user experience, including: user scenarios / use cases, design specifications, detailed wire-frames, flow diagrams, and schematics
- Develop meaningful prototypes (high and low fidelity) that communicate design, architecture and UI flow
- Utilise UI prototypes to communicate with software development teams to assure UX quality and vision is maintained
- Build effective, collaborative working relationships with program strategy, product management, marketing, and engineering to deliver best in class solutions
- Shift easily among projects in a variety of size and scope.

Skills & Experience Required

- Bachelor's degree preferred in design related discipline: Information Architecture, Interaction Design or Interface Design, Human Computer Interaction; Design Planning, or Psychology

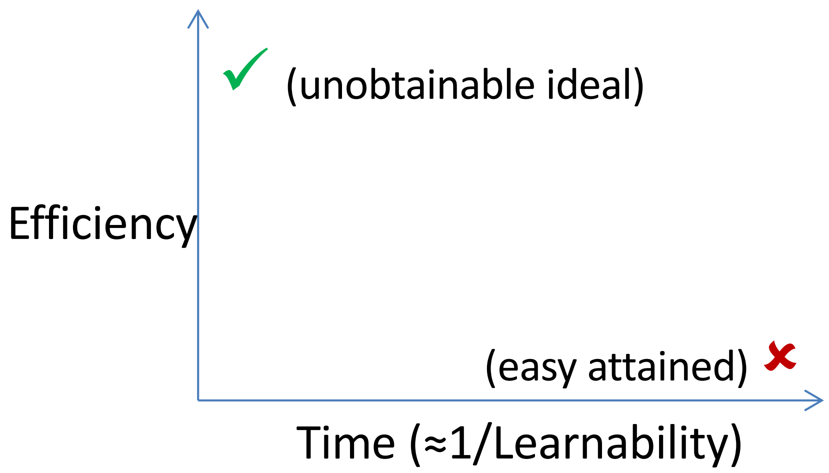
Goals of HCI

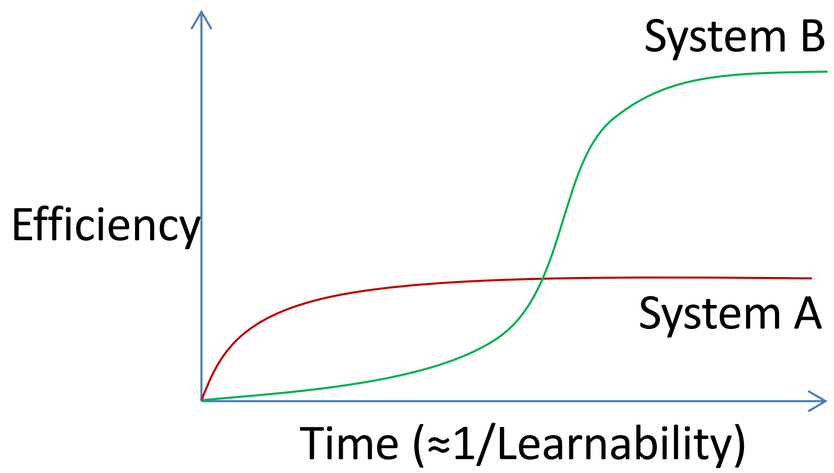
Improved usability:

1. Learnability
2. Efficiency
3. Subjective satisfaction
4. *Memorability*
5. *Errors*

Jakob Nielsen's Alertbox: http://www.useit.com/
"Usability 101"

Alert: Goal tradeoffs abound!





- Design focus depends on user needs
- *Know the user!*

Knowing the User: Preliminary Factors

- Safety considerations
- Need for throughput (efficiency)
- Frequency of use
- Physical space, lighting, noise, pollution
- Social context
- Cognitive factors: age, fatigue, stress, focus

Usability problems

- Everywhere: doors, gadgets, software, …
- "Usability is like oxygen… you only notice it when it's absent"

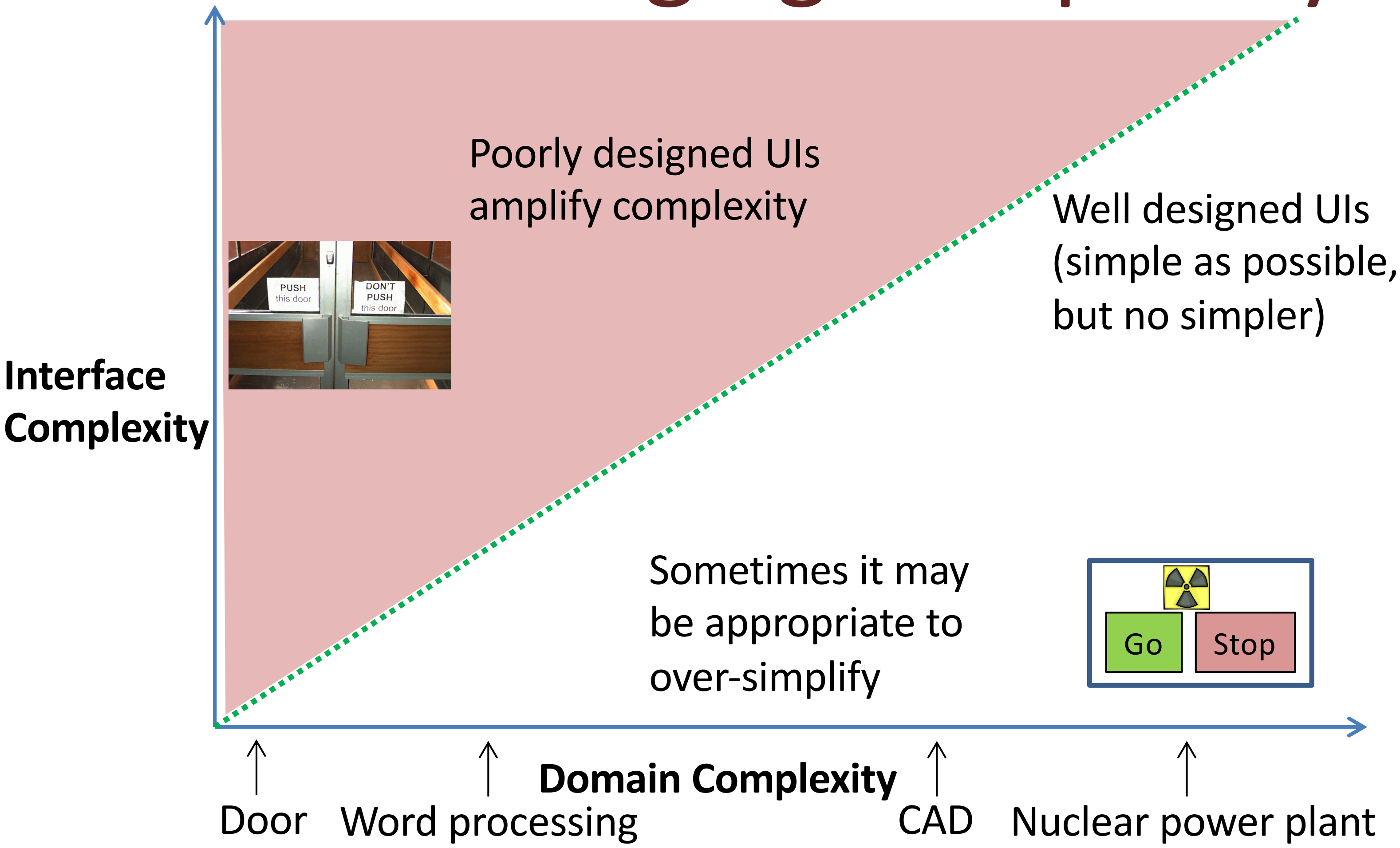

快
乐
PULL
推
PUSH

The Job of HCI: Managing Complexity

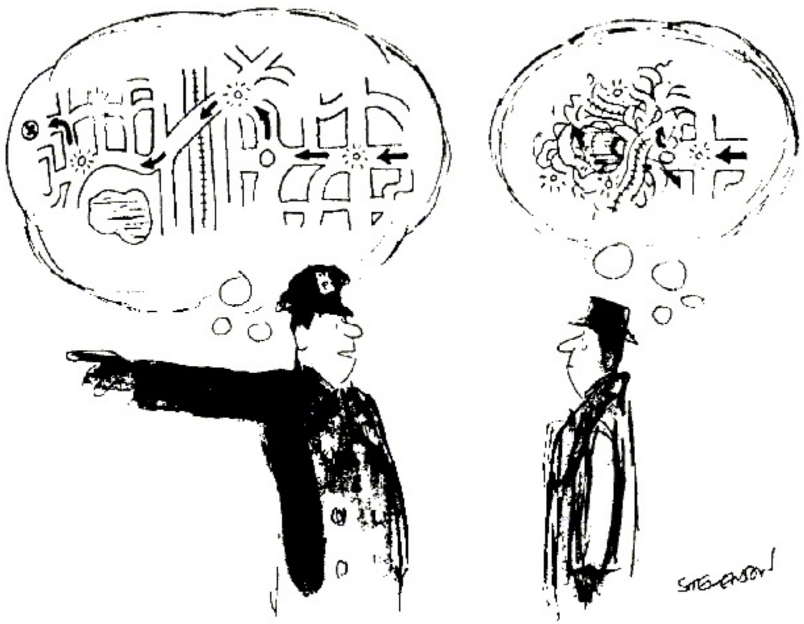
"Designing an object to be simple and clear… requires relentless pursuit of that simplicity even when obstacles appear which would seem to stand in the way" Ted Nelson, 1977

"Everything should be made as simple as possible, but not simpler" A. Einstein (maybe).

Managing Complexity

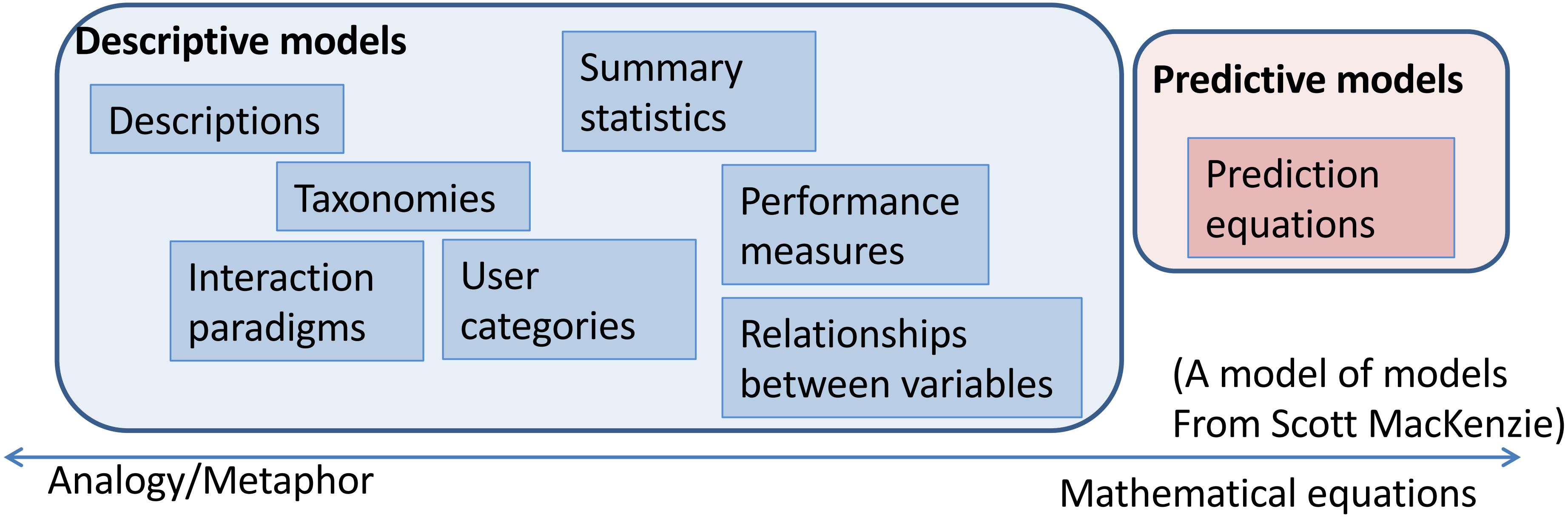


Models of Interaction



What is a model?

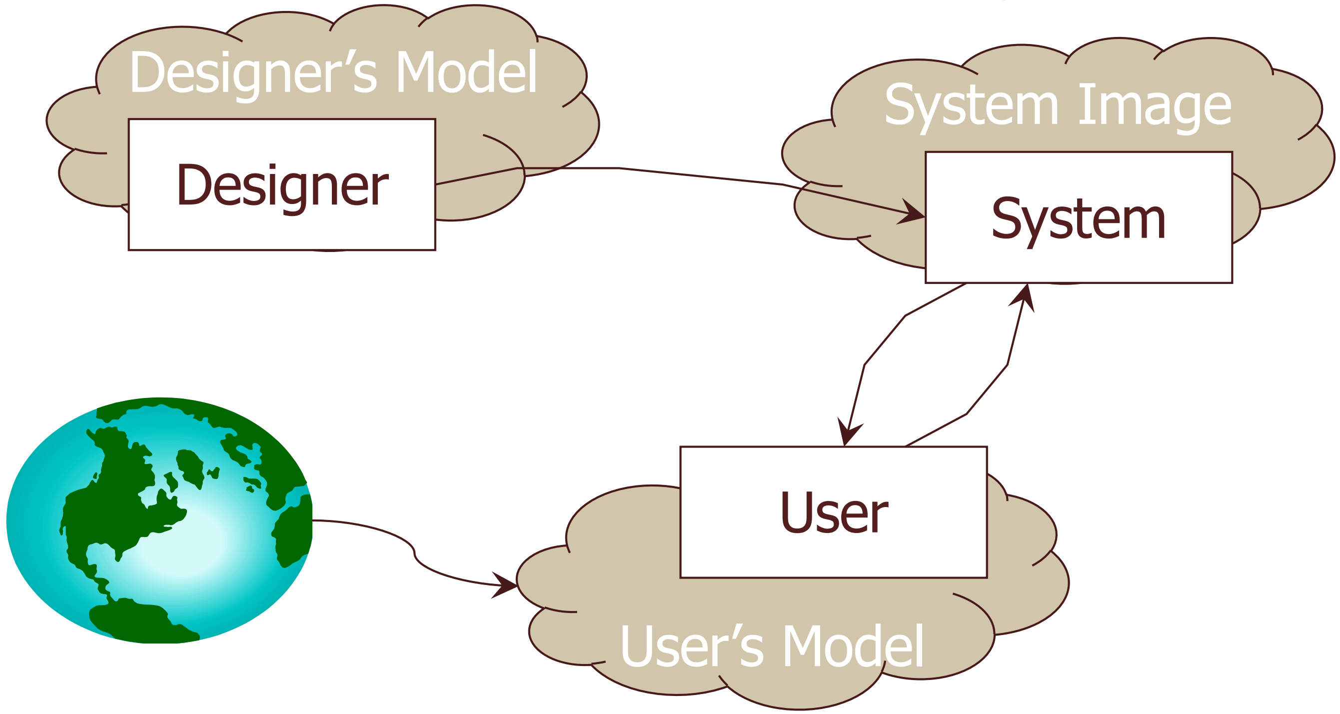
- A model is a simplification of reality
- They are useful when they help understand a complex artifact (e.g., a computer system)



Don Norman’s Model of Interaction

(Norman, ‘The Psychology/Design of Everyday Things’, 1988)

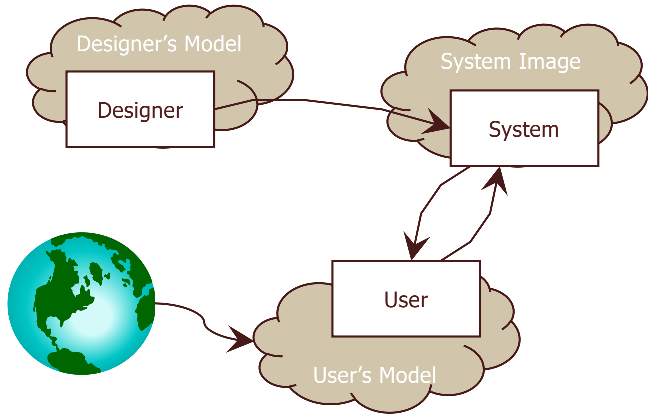
- Helps understand designer’s role in creating a system that is used by a thinking person



Don Norman’s Model of Interaction

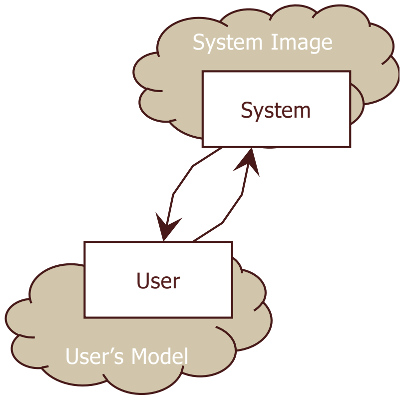
(Norman, ‘The Psychology/Design of Everyday Things’, 1988)

- Designer’s model
  - Designer’s conception of interaction
  - Hopefully intentional!
- System image
  - How the system *appears* to be used
  - Affordance
- User’s model
  - Drawn on to predict behaviour
  - Built and refined from feedback



Don Norman’s Execute-Evaluate Cycle

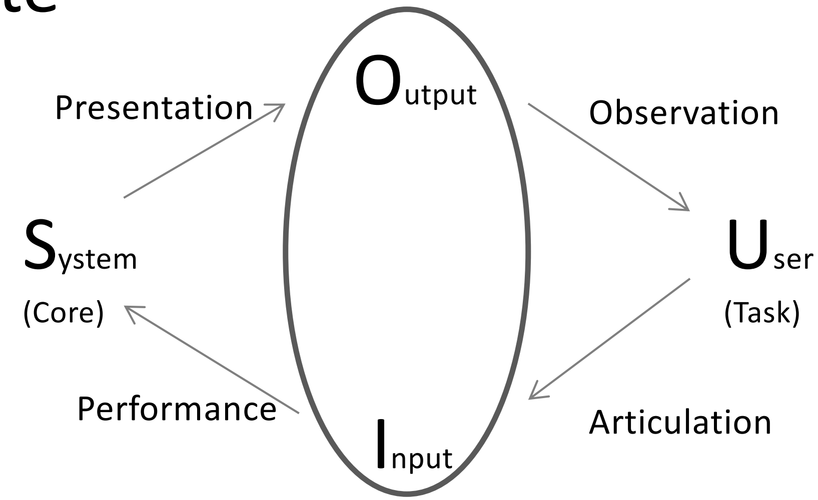
- Execute:
  - Goal > Intention > Actions > Execution
  - ‘Gulf of Execution’: problems executing intention/action
- Evaluate:
  - Perceive > Interpret > Evaluate
  - ‘Gulf of Evaluation’: problems assessing state, determining effect, etc.



UISO Interaction Framework

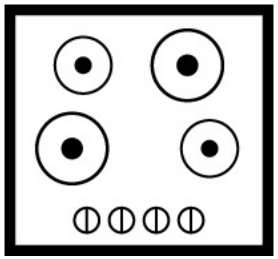
(Abowd and Beale '91)

- Emphasises translations during interaction
  - Articulation: user's task language to input language
  - Performance: callbacks, etc.
  - Presentation: show new state
  - Observation: interpretation

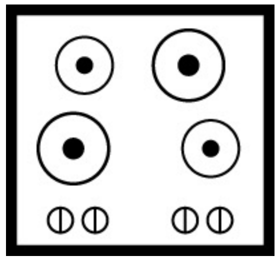


Mappings

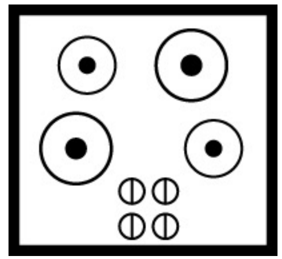
- Good mappings (relationships) between U and I/O increase usability



Arbitrary mapping



Slight disambiguation



Better (and better still?)

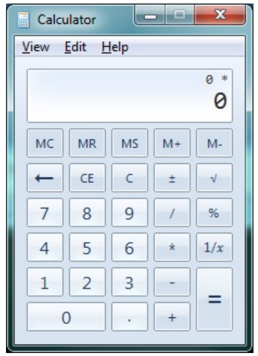
Stove tops

Affordance

(Gibson, 1977; Norman '88)

- Objects afford particular actions to users
  - Buttons afford pushing, chairs sitting, glass smashing, sliders sliding, dials turning, handles pulling
- Poor affordance encourages incorrect actions

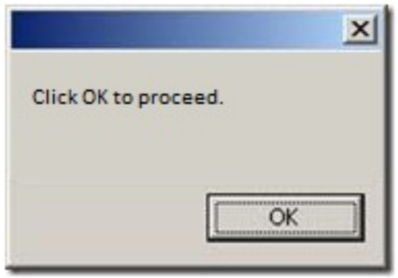
- Strong affordance may stifle efficiency



Over/Under-Determined Dialogues

- Ideally dialogue is ‘well-determined’ – natural translation from task to input language
- Under-determined – user knows what they want to do, but not how to do it

- Over-determined – user forced through unnecessary or unnatural steps



Direct Manipulation

(Shneiderman, 1982)

- Visibility of objects
- Direct, rapid, incremental, reversible actions
- Rapid feedback
- Syntactic correctness
  - disable illegal actions
- Replace language with action

Direct Manipulation

(Shneiderman, 1982)

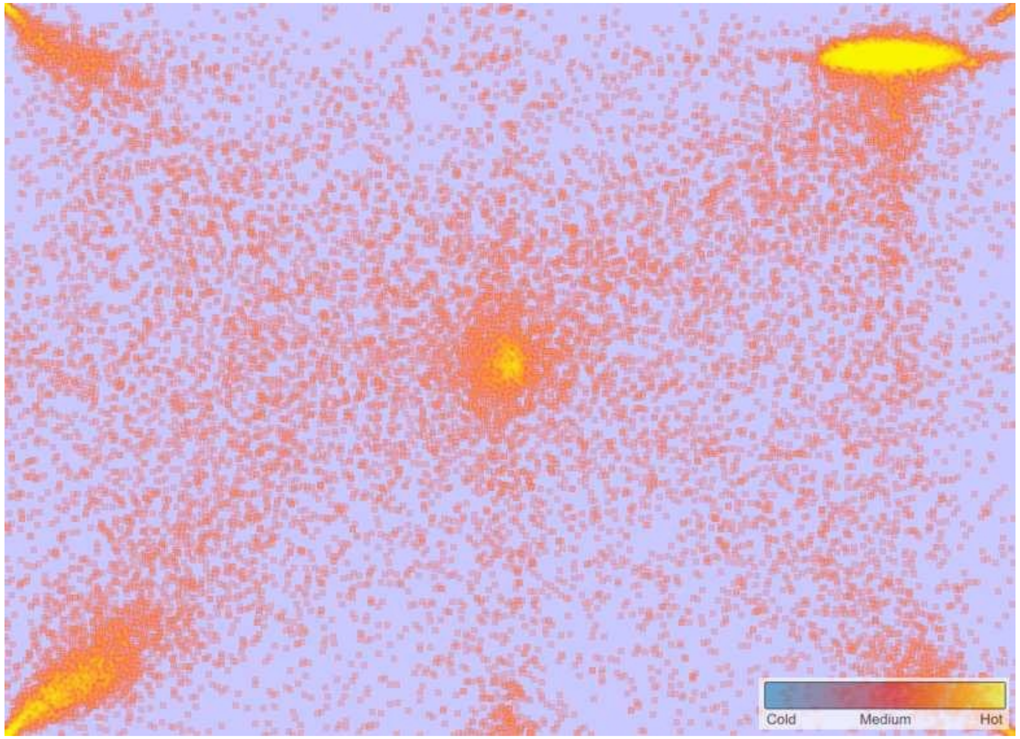
- Advantages:
  - Easy to learn
  - Low memory requirements
  - Easy to undo
  - Immediate feedback to user actions
  - Enables user to use spatial cues

- Disadvantages:
  - Consumes screen real estate
  - High graphical system requirements
  - May trap user in ‘beginner mode’

The Human

Finished files are the result of years of scientific study, combined with the experience of many years.

blogoscoped.com/click2



Human Factors

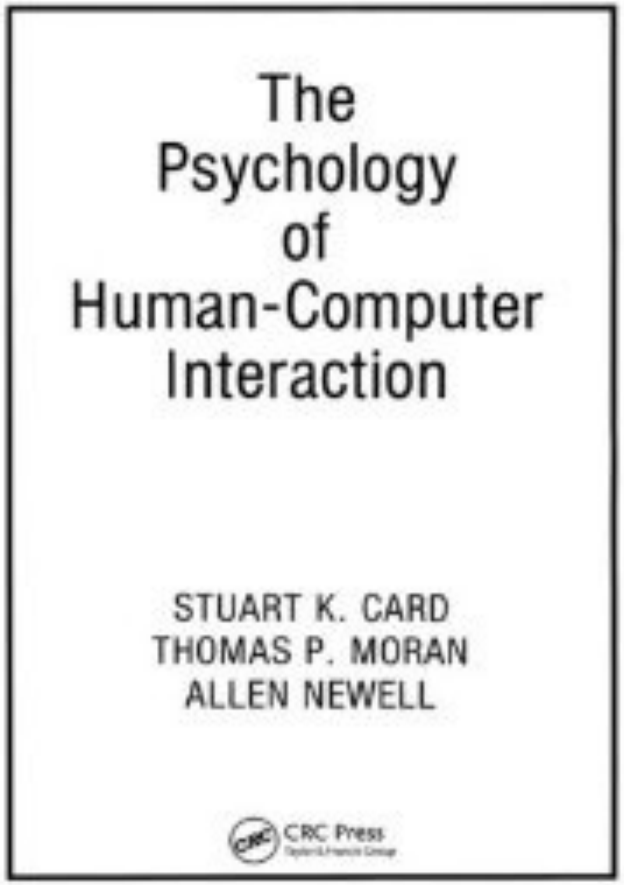
- Psychological and physiological abilities (users and designers) have implications for design
  - Perceptual: how we perceive things (input)
  - Cognitive: how we processes information
  - Motor: how we perform actions (output)
  - Social: how we interact with others
- Understand efficiencies, problems, causes, etc.
- Predict interaction

Also: NASA Man-Systems Integration Standards: https://msis.jsc.nasa.gov/Volume1.htm

The Human Information Processor

Card, Moran, Newell 1983

- Underlying psychology of interaction
- Predictive engineering models (GOMS/KLM)
- Extensive empirical validation
- Core computer science!



The Human Information Processor

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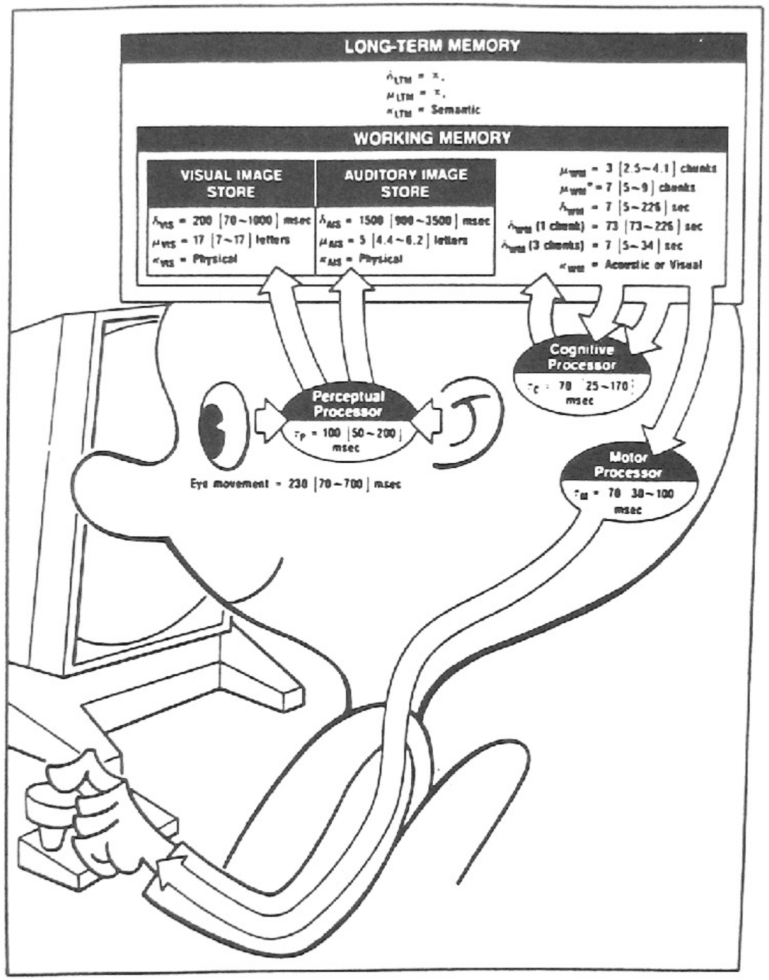
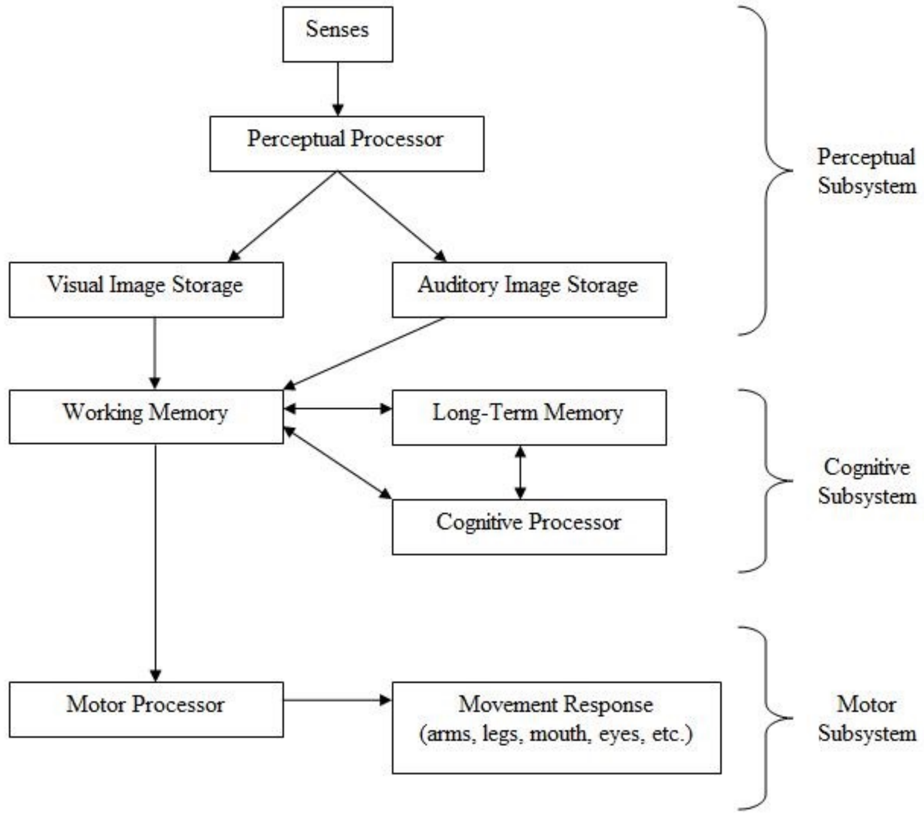




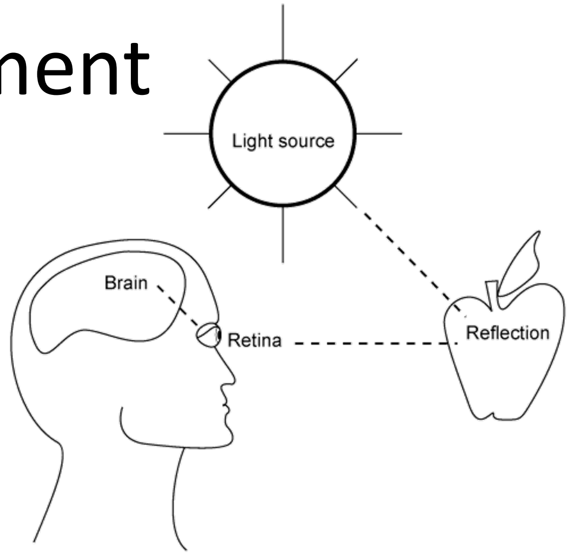
Also: NASA Man-Systems Integration Standards: https://msis.jsc.nasa.gov/Volume1.htm

The Human: Overview

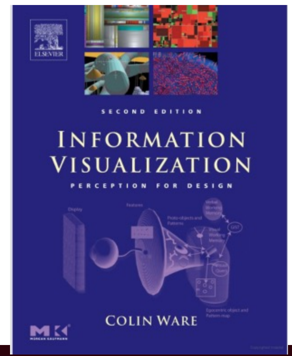
- Human Input
  - Vision, hearing, haptics, olfaction
- Human Output
  - Pointing, steering, speech, typing, …
- Human Processing
  - Visual search, decision times, learning
- Human Memory
- Human Phenomena & Collaboration
- Human Error
- And UI implications of each

Human Input: Vision

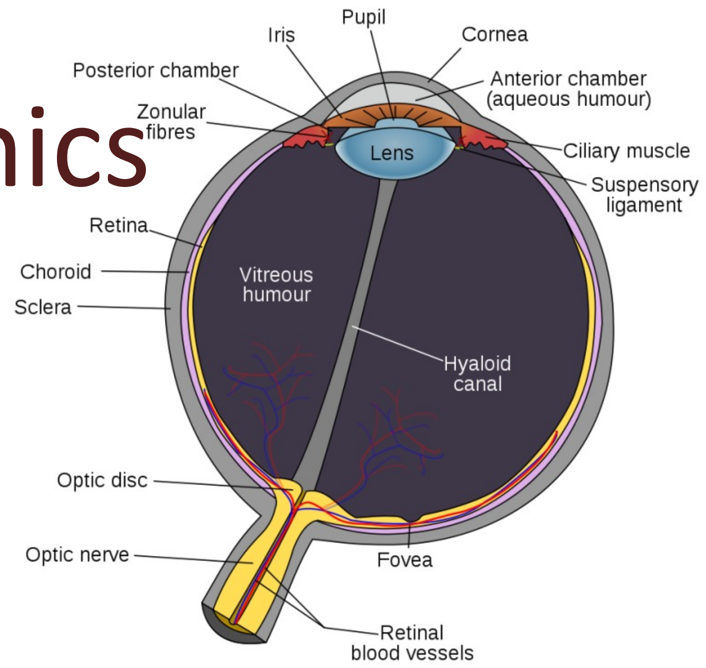
- Mechanics, acuity & movement
- Size and depth
- Colour
- Reading



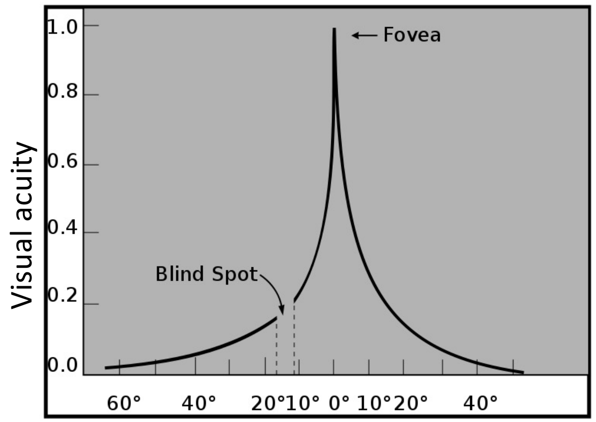
- Colin Ware. Information Visualization: Perception by Design



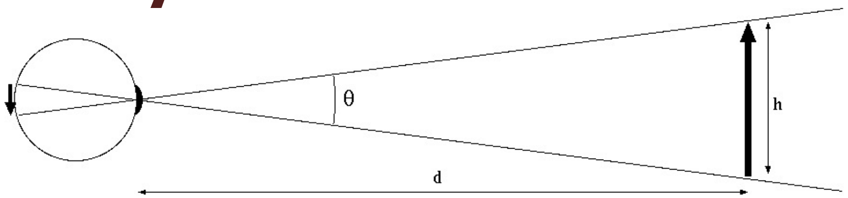
Vision Mechanics



- Photoreceptors cells
  - Rods: low light, monochrome, 100M across retina (not fovea)
  - Cones: normal light, colour, 6M, in fovea
- Fovea: detailed vision of ≈2°
- Retina: non-detailed vision of ≈120°; sensitive to movement



Visual Acuity



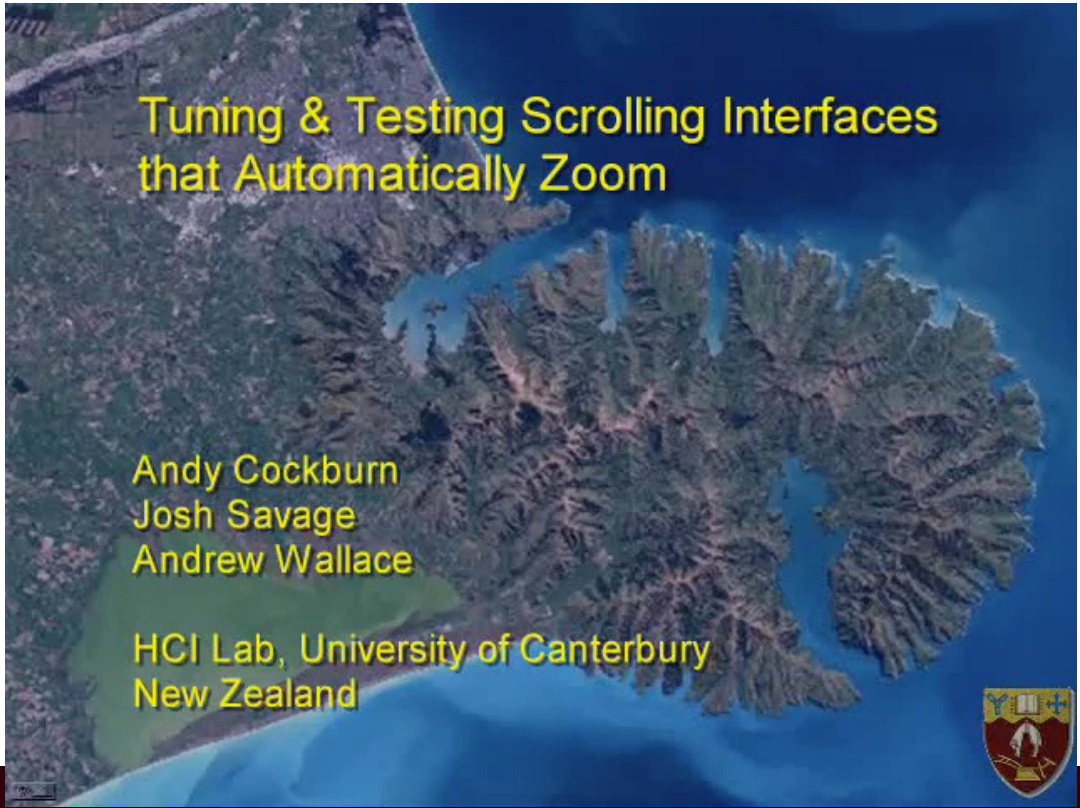
- Point acuity: 
  1 minute of arc
- Grating acuity: 
  1-2 minutes of arc
- Letter acuity: **E**
  5 minutes of arc
- Vernier acuity:
  10 seconds of arc

Eye movement

- Fixations: visual processing occurs when the eye is stationary (nearly)
- Saccades: rapid eye movements (900° sec), blind
- Eye movement used as input via eye-tracker
  - "Midas touch" problem
- Smooth-pursuit: for tracking moving objects; up to 100° sec; cannot be induced voluntarily
  - relevant in scrolling, e.g. SDAZ

Demo: SDAZ

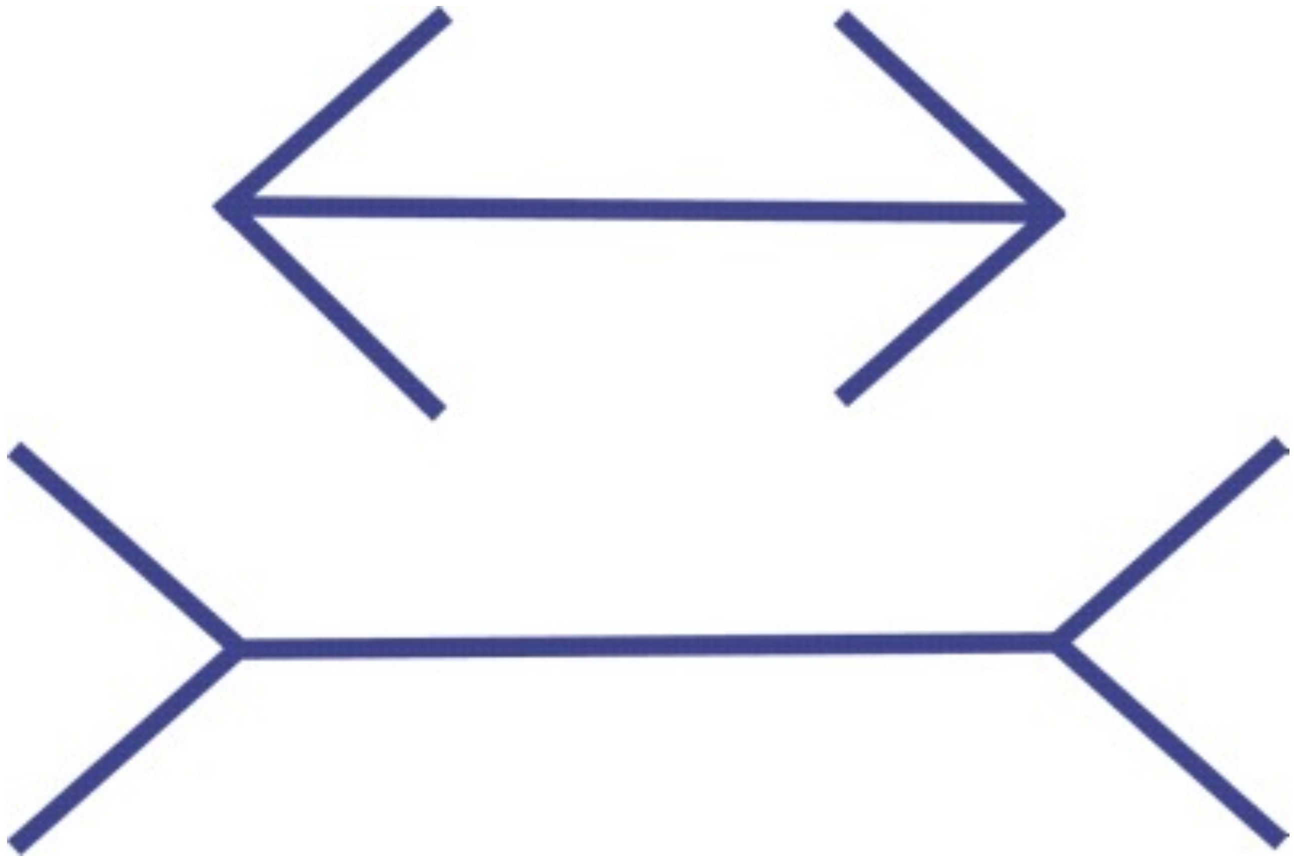
- Speed-dependent automatic zooming: overcome motion blur…



Size/Depth Cues

- Familiarity
- Linear perspective
- Horizon distance
- Size constancy
- Texture gradient
- Occlusion
- Depth of focus
- Aerial perspective
- Shadows/Shading
- Stereoscopy
(ineffective beyond 10m; best within 1m)

Muller-Lyer Illusion



Depth-based UIs: 3D

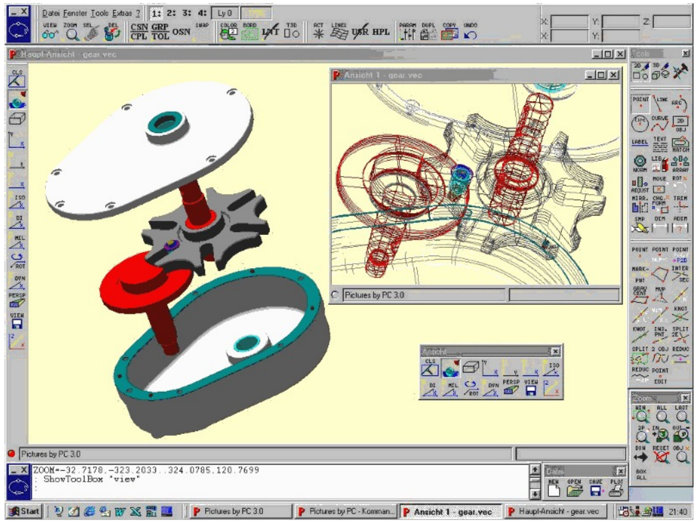
- The real world is 3D
- So all interaction should ideally be 3D, right?

Wrong!

(In my opinion.)

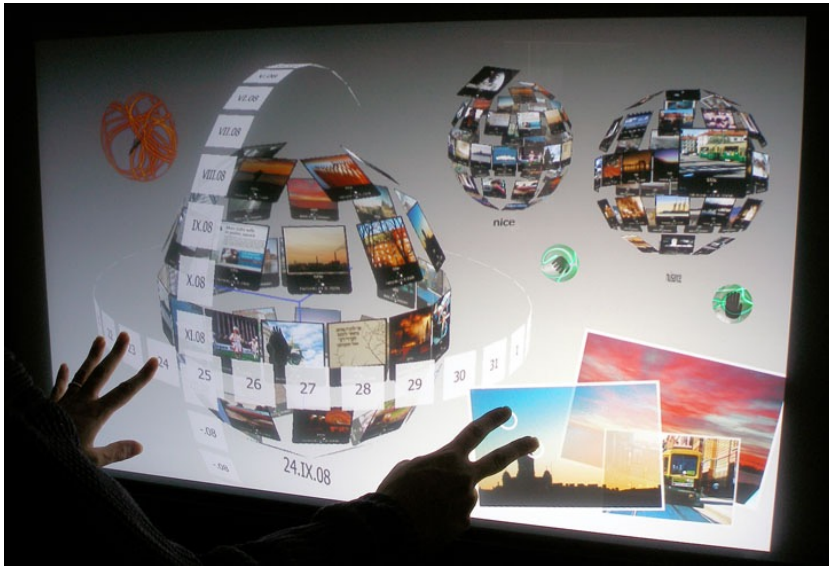
Depth-based UIs: 3D

- 3D can be invaluable for interaction with 3D objects or in 3D environments



Depth-based UIs: 3D

- 3D introduces problems for non 3D interactions:
  - Navigation/orientation
  - Occlusion
  - Layout efficiency
  - Layout complexity
  - Motion sickness

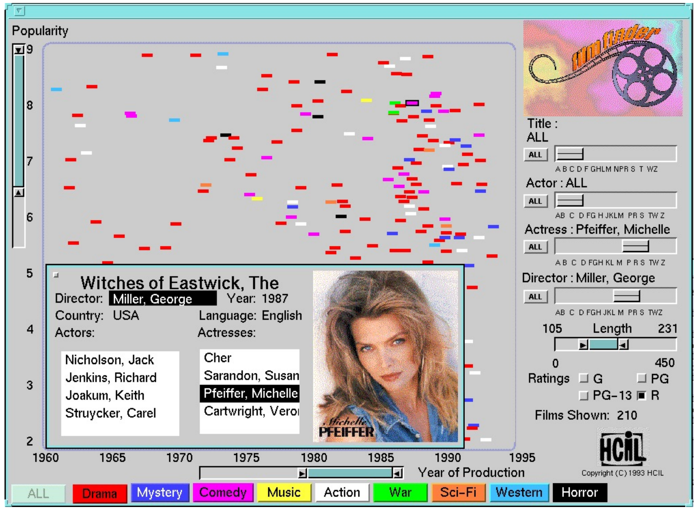


- Use with caution!

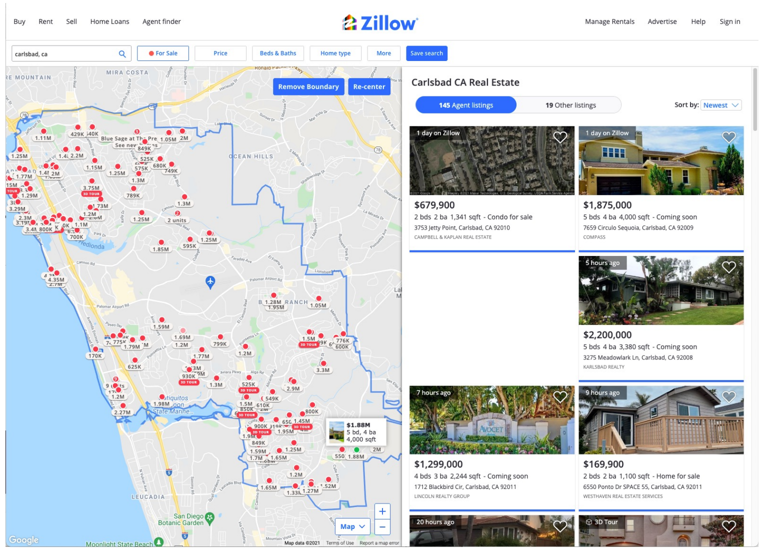
Depth-based UIs: Zooming

- “Visual Information-Seeking Mantra”
  Ben Shneiderman

Overview first, zoom and filter, details on demand



Ahlberg & Shneiderman’s FilmFinder (1994) www.cs.umd.edu/hcil/spotfire/



Zillow’s zooming web interface www.zillow.com/carlsbad-ca

Colour

- Colour can clarify information and enhance subjective experience
- 8% males, 0.4% females have some form of colour deficiency
  - Protanomaly : red; 1% M, 0.01% F
  - Deuteranomaly: green; 6% M, 0.4% F
  - Tritanomaly: blue, 0.01% M, F
- Sensitivity to blue is lowest (2% cones)

Colour

Protanopic color vision.

Normal trichromatic color vision.

Deuteranopic color vision.

Image checker…

http://www.vischeck.com/vischeck/vischeckImage.php

Chesham
Chalfont & Latimer
Amersham
Chorleywood
Rickmansworth
Watford
Croxley
Moor Park
Northwood
Northwood Hills
Pinner
West Ruislip
Hillingdon
Ruislip
Ruislip Manor
Eastcote
Uxbridge
Ickenham
Rayners Lane
Ruislip Gardens
South Ruislip
Northolt
Greenford
Perivale
Hanger Lane
West Harrow
North Harrow
Harrow-on-the-Hill
South Harrow
Sudbury Hill
Sudbury Town
Alperton
Park Royal
North Ealing
Ealing Broadway
West Acton
North Acton
East Acton
White City
Ealing Common
Acton Central
South Acton
Acton Town
South Ealing
Northfields
Boston Manor
Osterley
Hounslow East
Hounslow Central
Hounslow West
Hatton Cross
Heathrow Terminals 1, 2, 3
Heathrow Terminal 4
Heathrow Terminal 5
Chiswick Park
Turnham Green
Stamford Brook
Ravenscourt Park
Gunnersbury
Kew Gardens
Richmond
Watford Junction
Watford High Street
Bushey
Carpenders Park
Hatch End
Headstone Lane
Harrow & Wealdstone
Kenton
Preston Road
Northwick Park
South Kenton
North Wembley
Wembley Central
Stonebridge Park
Harlesden
Willesden Junction
Wembley Park
Stanmore
Canons Park
Queensbury
Kingsbury
Neasden
Dollis Hill
Willesden Green
Kilburn
Brondesbury Park
Kensal Rise
Brondesbury
Kensal Green
Queen's Park
Kilburn High Road
South Hampstead
West Hampstead
Finchley Road
Swiss Cottage
St. John's Wood
Kilburn Park
Maida Vale
Warwick Avenue
Royal Oak
Westbourne Park
Paddington
Edgware Road
Marylebone
Baker Street
Great Portland Street
Euston
Ladbroke Grove
Latimer Road
Wood Lane
Shepherd's Bush
Shepherd's Bush Market
Goldhawk Road
Kensington (Olympia)
Hammersmith
Barons Court
West Kensington
Holland Park
Notting Hill Gate
Bayswater
Lancaster Gate
Queensway
Marble Arch
Bond Street
Oxford Circus
Regent's Park
Warren Street
Euston Square
High Street Kensington
Hyde Park Corner
Knightsbridge
Gloucester Road
South Kensington
Sloane Square
Green Park
Piccadilly Circus
St. James's Park
Victoria
Westminster
Earl's Court
West Brompton
Fulham Broadway
Parsons Green
Putney Bridge
East Putney
Southfields
Wimbledon Park
Wimbledon
Imperial Wharf
Clapham Junction
Edgware
Burnt Oak
Colindale
Hendon Central
Brent Cross
Golders Green
Hampstead
Finchley Road & Frognal
Hampstead Heath
Belsize Park
Chalk Farm
Camden Town
Mornington Crescent
Kentish Town West
Kentish Town
Camden Road
Gospel Oak
High Barnet
Totteridge & Whetstone
Woodside Park
West Finchley
Mill Hill East
Finchley Central
East Finchley
Highgate
Archway
Tufnell Park
Crouch Hill
Upper Holloway
Cockfosters
Oakwood
Southgate
Arnos Grove
Bounds Green
Wood Green
Turnpike Lane
Manor House
Harringay Green Lanes
South Tottenham
Seven Sisters
Tottenham Hale
Blackhorse Road
Walthamstow Central
Walthamstow Queen's Road
Arsenal
Finsbury Park
Holloway Road
Caledonian Road
Highbury & Islington
Caledonian Road & Barnsbury
Canonbury
Dalston Kingsland
Hackney Central
Dalston Junction
Homerton
Hackney Wick
Stratford
King's Cross St. Pancras
Angel
Old Street
Haggerston
Hoxton
Farringdon
Barbican
Moorgate
Russell Square
Goodge Street
Holborn
Chancery Lane
Tottenham Court Road
Covent Garden
Leicester Square
Charing Cross
Embankment
Temple
Blackfriars
St. Paul's
Bank
Mansion House
Cannon Street
Monument
Tower Hill
Fenchurch Street
Tower Gateway
Liverpool Street
Shoreditch High Street
Aldgate East
Aldgate
Whitechapel
Bethnal Green
Mile End
Stepney Green
Shadwell
Wapping
Rotherhithe
Canada Water
Surrey Quays
London Bridge
Bermondsey
Borough
Southwark
Waterloo
Lambeth North
Elephant & Castle
Pimlico
Vauxhall
Kennington
Oval
Stockwell
Brixton
Clapham North
Clapham Common
Clapham South
Balham
Tooting Bec
Tooting Broadway
Colliers Wood
South Wimbledon
Morden
Epping
Theydon Bois
Debden
Loughton
Buckhurst Hill
Roding Valley
Chigwell
Grange Hill
Hainault
Fairlop
Barkingside
Newbury Park
Woodford
South Woodford
Snaresbrook
Redbridge
Wanstead
Gants Hill
Leytonstone
Leytonstone High Road
Leyton Midland Road
Leyton
Wanstead Park
Woodgrange Park
Upminster
Upminster Bridge
Hornchurch
Elm Park
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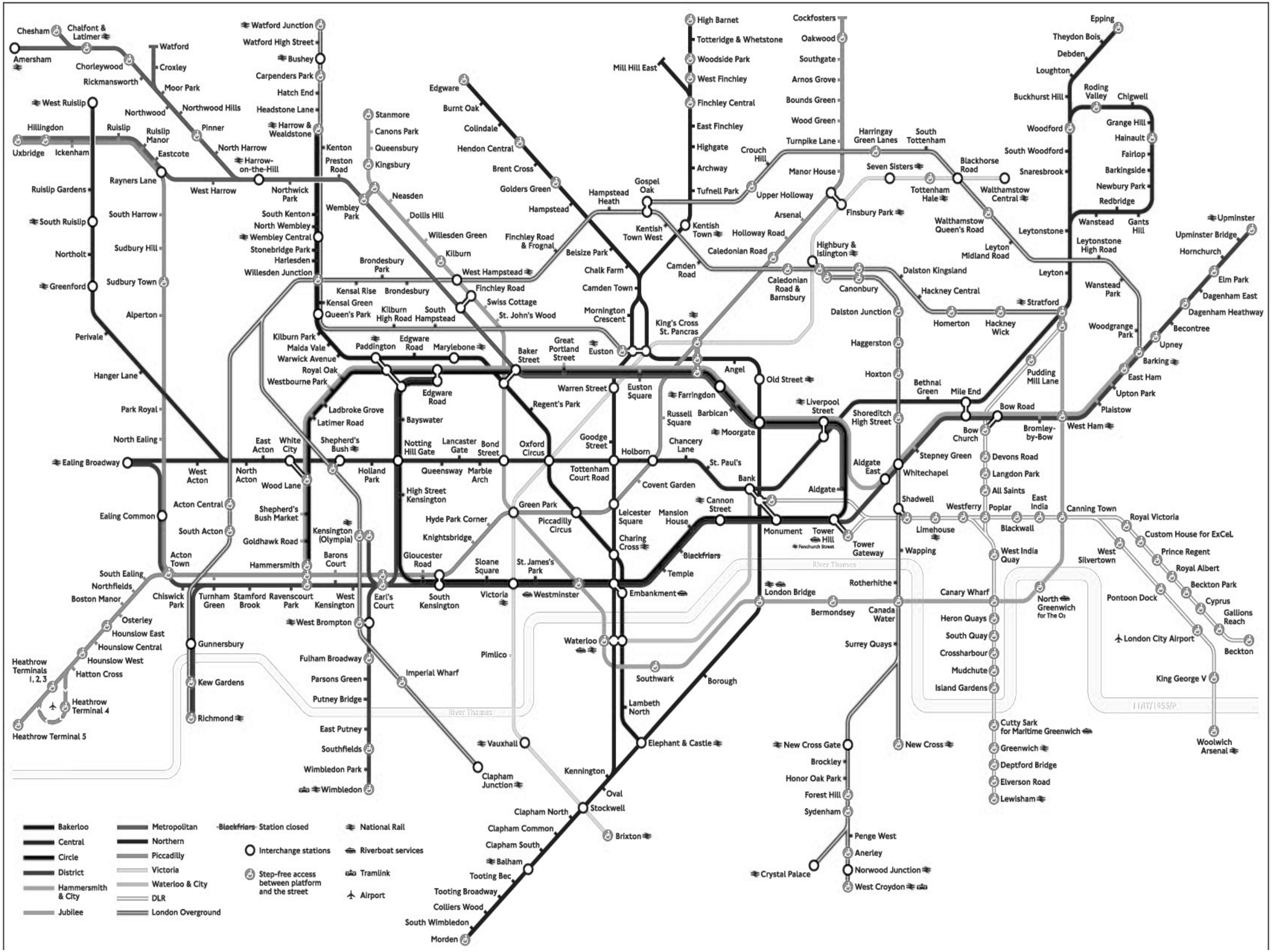

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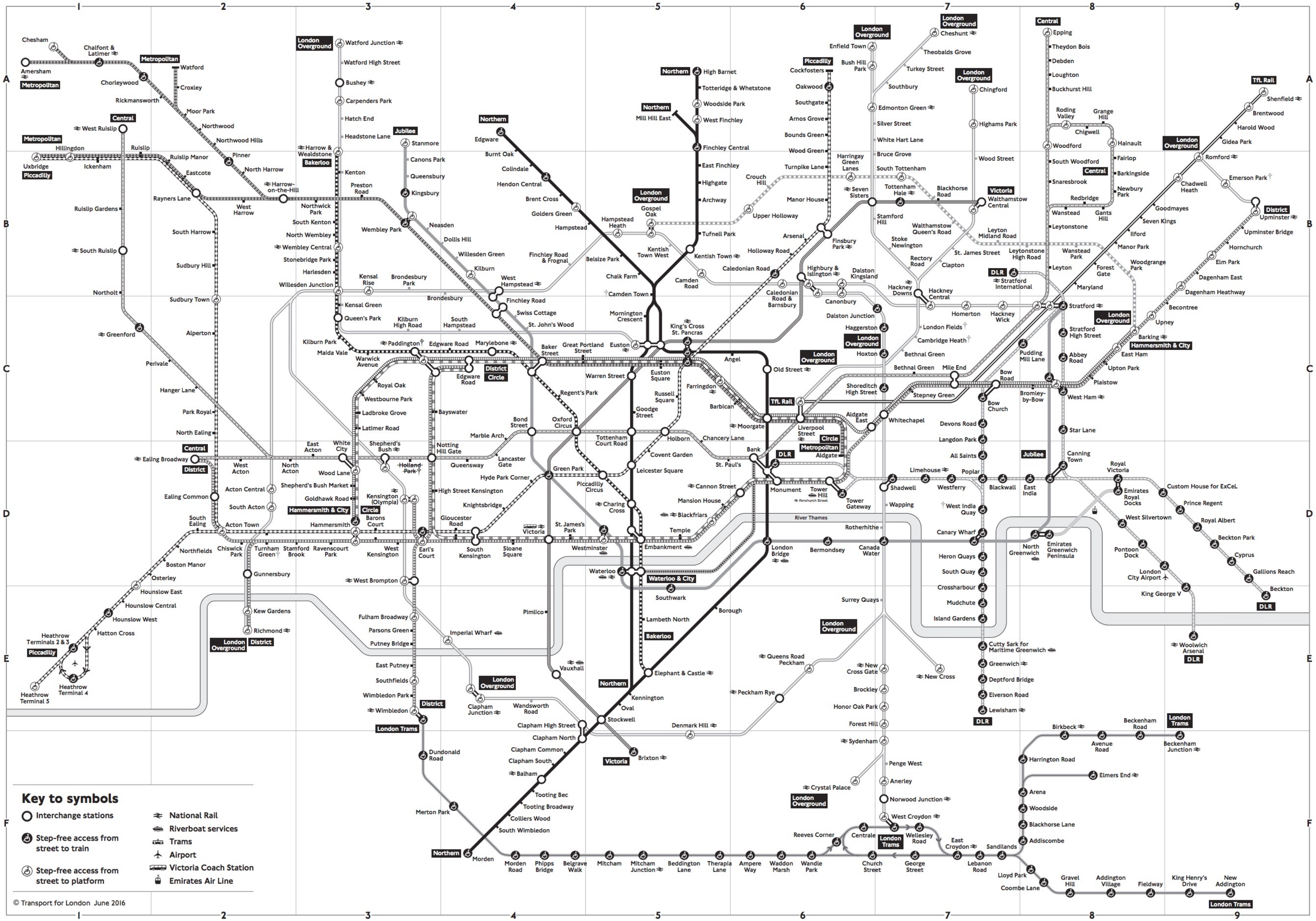

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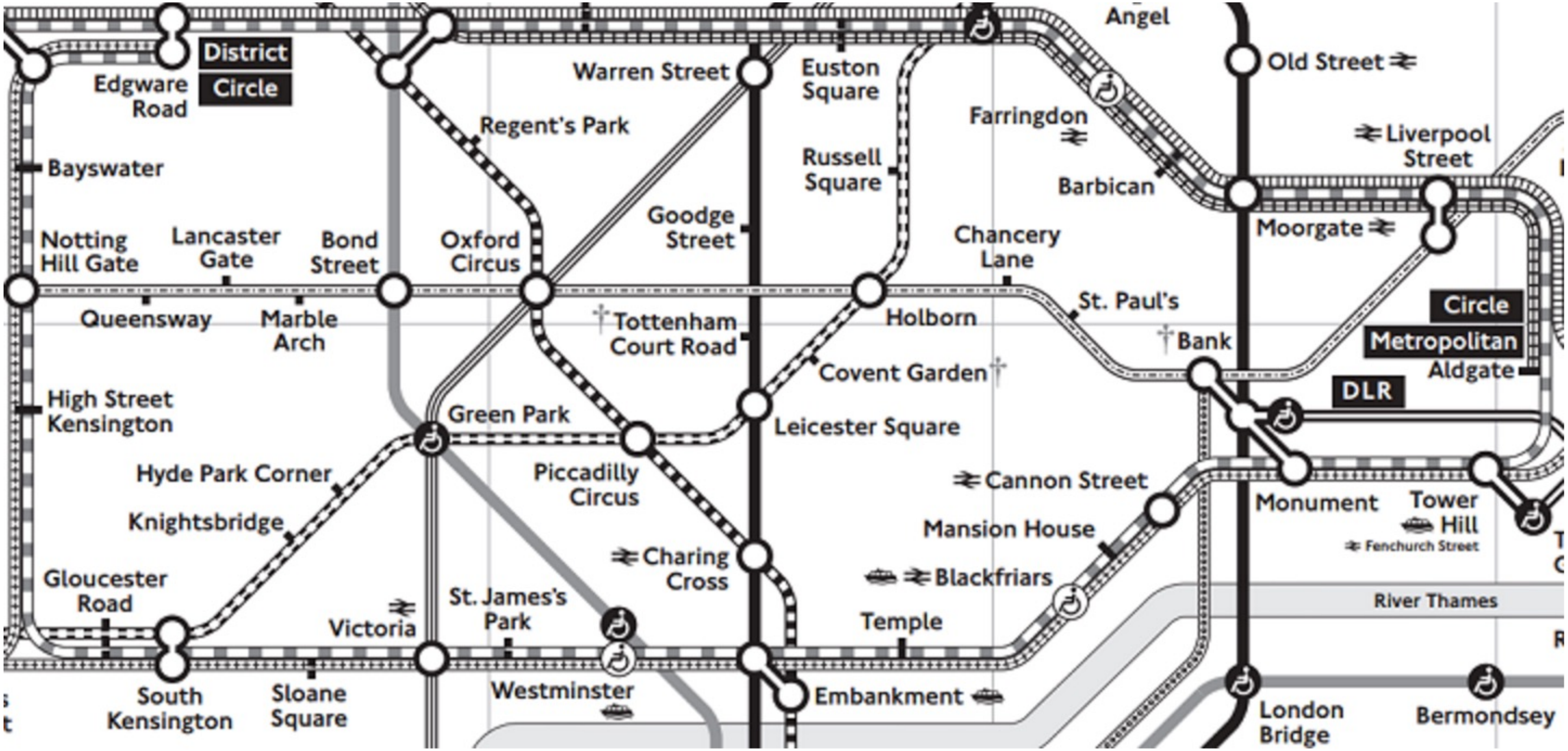

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London Bridge
Bermondsey

Reading

- Saccades, fixations (94% time), regressions
- ≈ 250 words/min (first time)
- Reading speed impaired by ALL CAPS, probably due to reduced character legibility

Human Input: Auditory

- Part of eyes-free interaction
- Pitch: ≈ 20Hz to 15 KHz; good to poor distinction
- Many parameters: amplitude, timbre, direction
- Filtering capabilities (e.g., cocktail party effect)
- Problems with signal interference and noise!

Human Input: Haptic

- Haptics =
  - Proprioception: sense of limb location +
  - Kinaesthesia: particularly limb movement +
  - Tactition: skin sensations
- Potentially powerful: eg Braille

- [redacted]

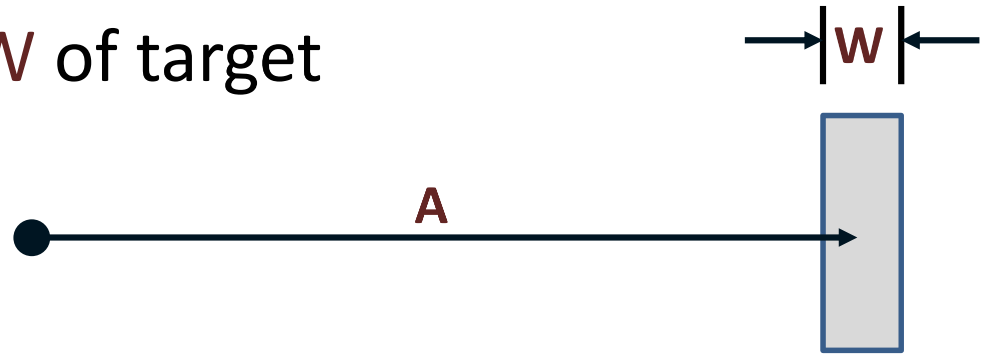
Human Input: Olfactory!

Human Output

- Motor response times depend on stimuli:
  - Visual ≈ 200 ms, audio ≈ 150 ms, haptics ≈ 700 ms
  - Faster for combined signals
- Muscle actions:
  - Isotonic: contraction yields movement (e.g., mouse)
  - Isometric: contraction with no movement

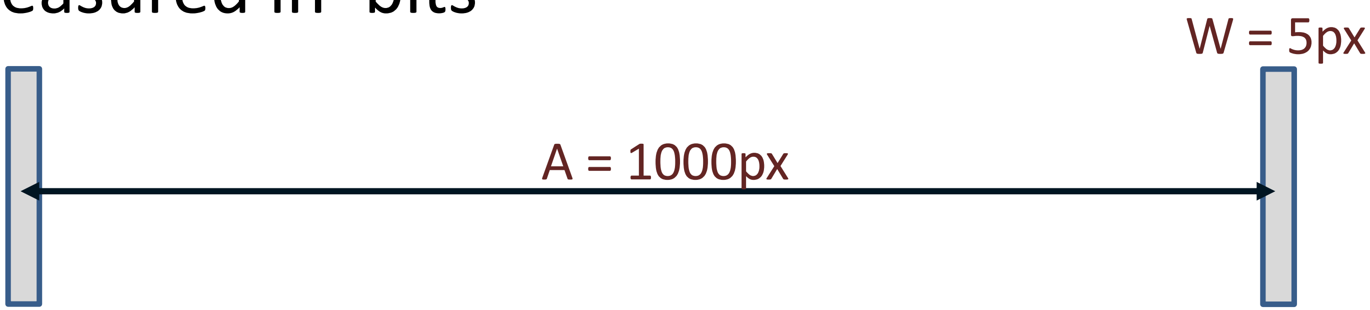
Human Output: Pointing
Fitts' Law

- A model of rapid, aimed human movement:
- Predictive of tasks; descriptive of devices
- Derived from Shannon's theory of capacity of information channels:
  - 'Signal': amplitude A of movement (or D for distance)
  - 'Noise': width W of target



Human Output: Pointing
Fitts' Law

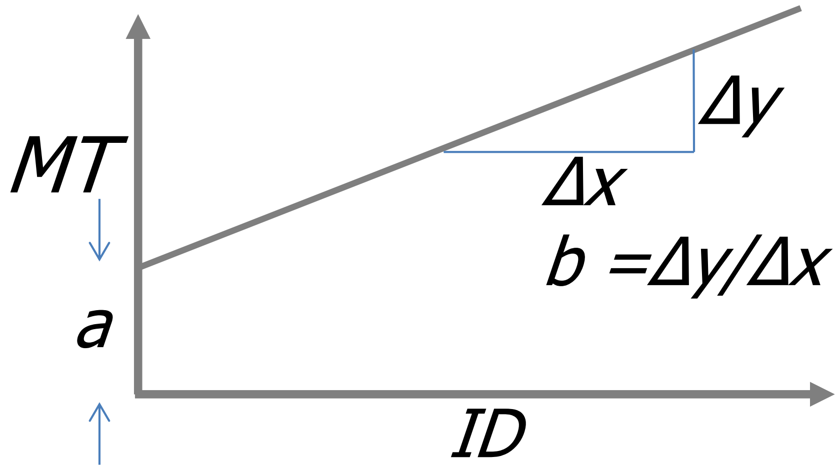
- 'Index of difficulty' (ID) measures difficulty of rapid aimed movement:
  - $ID = log_2 (A/W + 1)$
  - Measured in 'bits'



  - ID = $log_2 (1000/5 + 1) = 7.651$ *bits*

Human Output: Pointing
Fitts' Law

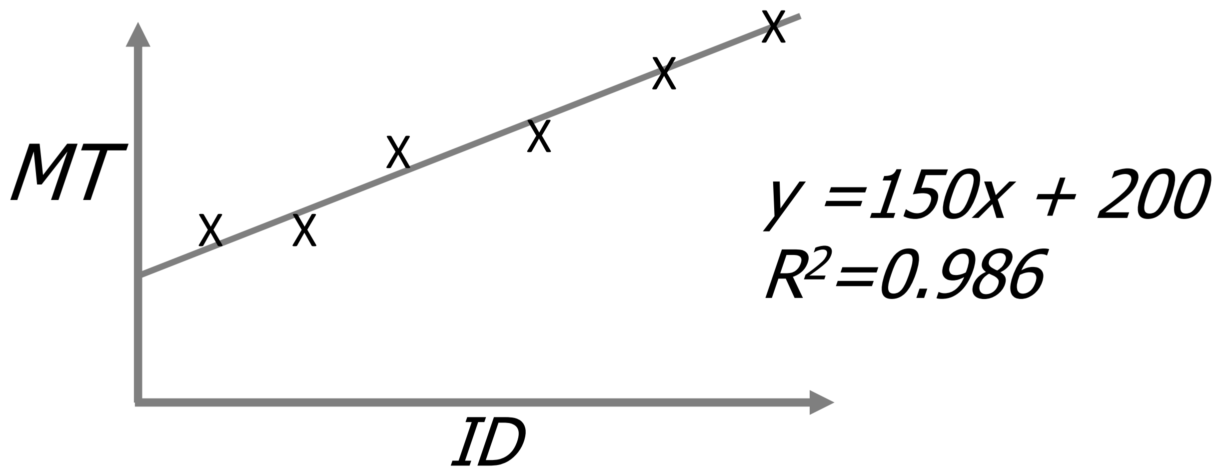
- Fitts' Law: movement time (*MT)* is linear with *ID*
  - $MT = a + b\ ID$ or $MT = a + b \log_2 (A/W + 1)$



  - Reciprocal of slope (*1/b)* also called 'throughput' or 'bandwidth' of device; in bits/second

Human Output: Pointing
Fitts' Law

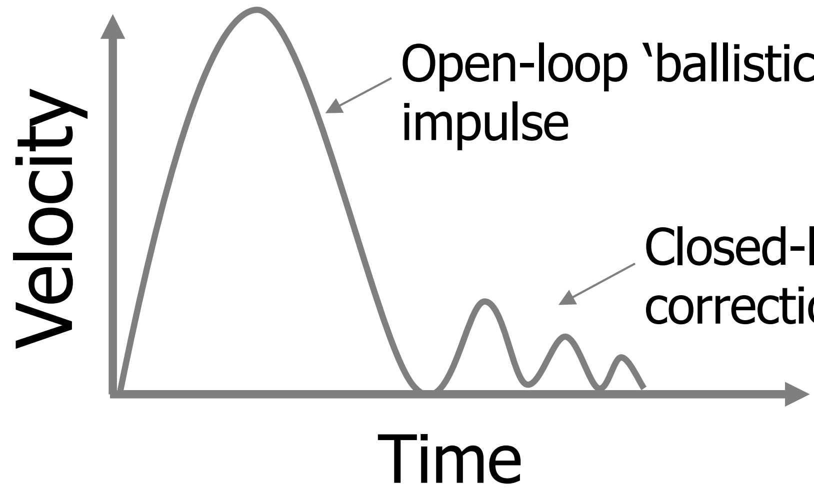
- *a* and *b* empirically determined (regression)



- For a mouse:
  - *a* typically 200-500 ms
  - *b typically* 100-300 ms/bit

Human Output: Pointing
Fitts' Law

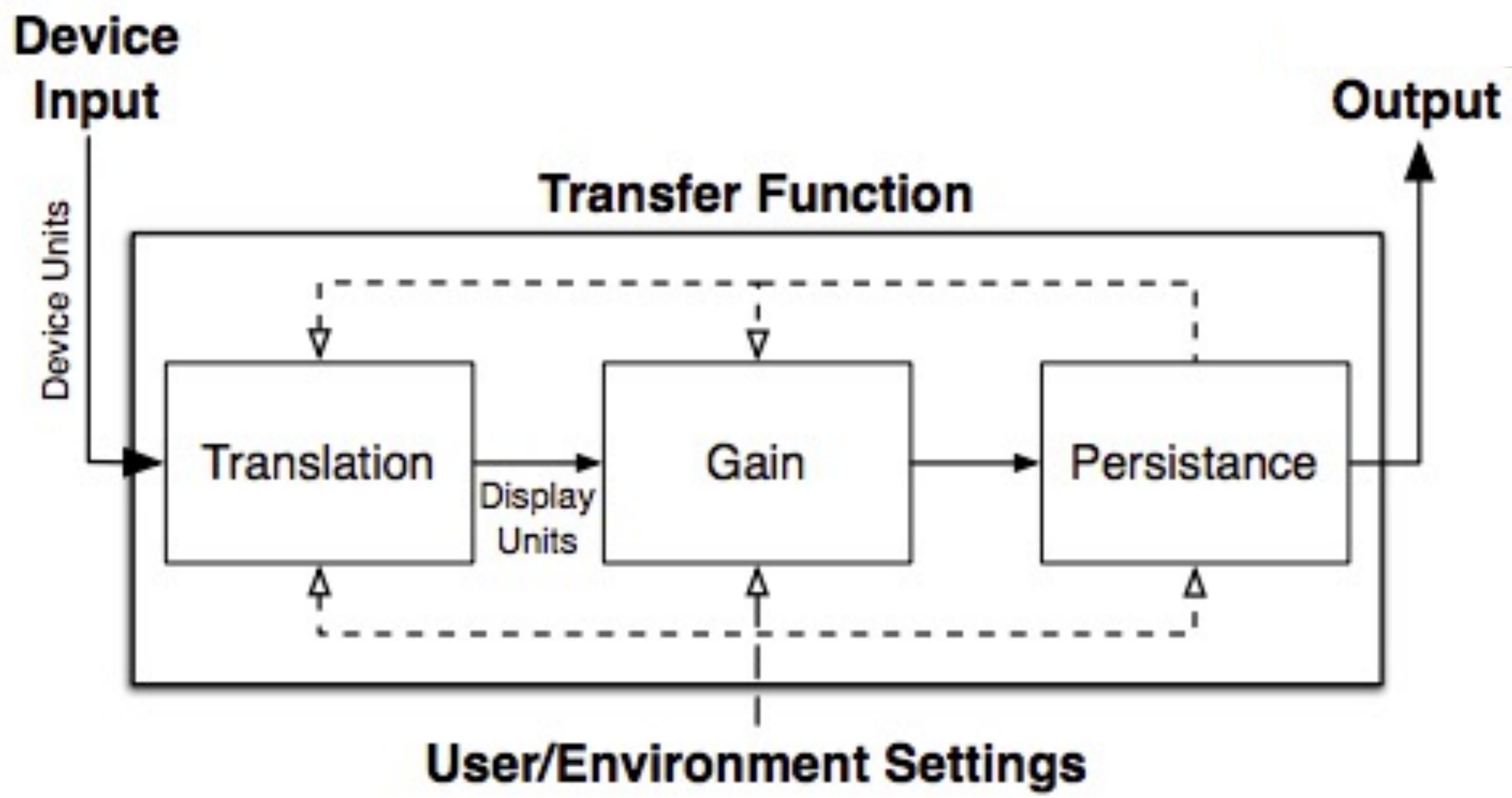
- Accurate and extensively validated for many types of aimed pointing
  - Consider velocity profile



Input Devices: Pointing & Scrolling

- Human Output received as System Input
- Direct vs Indirect
- Absolute vs Relative (Hybrid?)
- Control: position (zero-order), rate (first-order), acceleration (second-order)
- Isotonic (force with movement) vs Isometric (force without movement)
- Control-Display Gain and Transfer Functions

Input Devices: Transfer Functions



Input Devices: Scrolling Gain Example

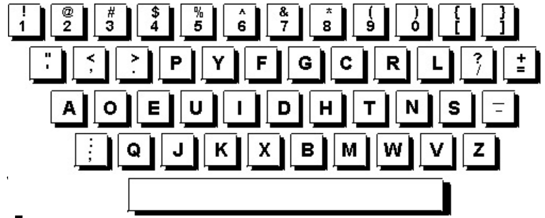
DLD gain. Cockburn et al. 2012

Input Devices: Touch Scrolling Transfer Function

Input Techniques: Bimanual input and ‘magic lenses’

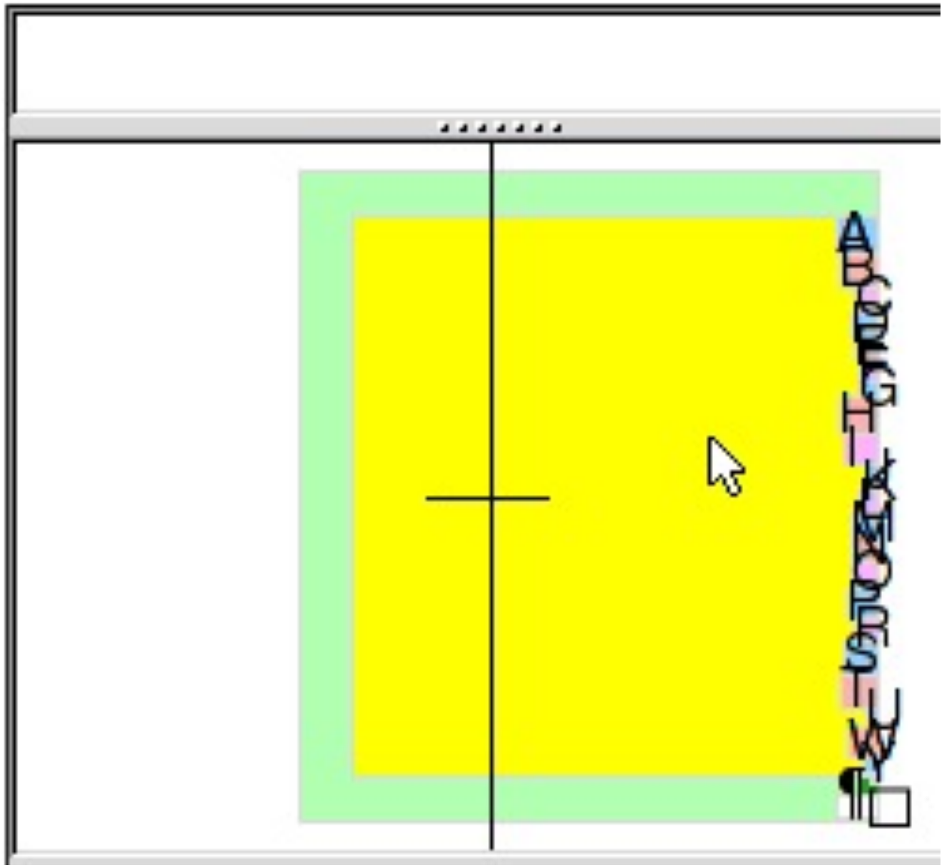
T3 Design.
Kurtenbach et al., 1997!

Text Input



- Alternative keyboards (e.g., Dvorak)
- Chord keys
- Constrained keyboards
- Reactive/predictive systems (e.g., Dasher)
- Gestural input (unistrokes, ShapeWriter/Swipe)
- Hand-writing recognition

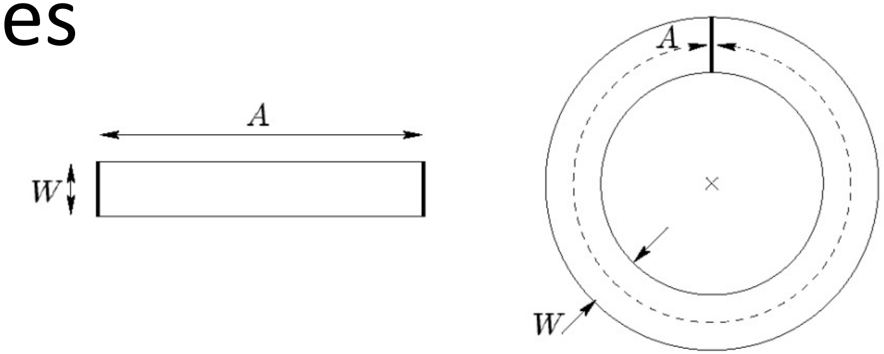
Text Input
Dasher



Text Input
On GoogleGlass?

Human Output: Steering Law

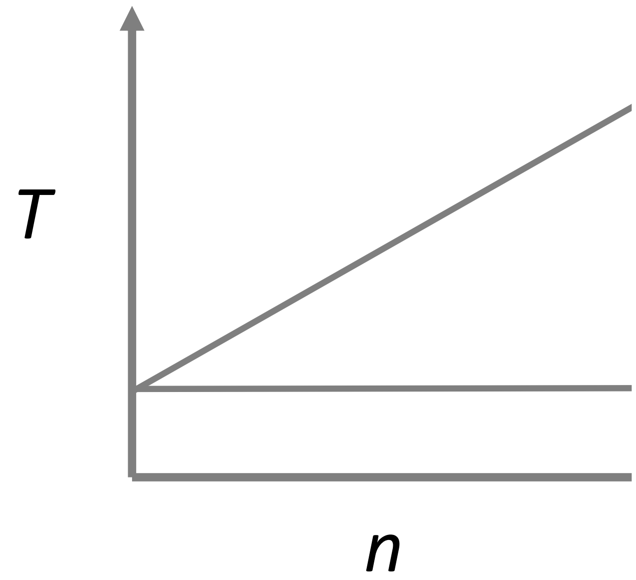
- A model of continuously controlled 'steering'
  - $MT = a + b\ ID$ or $MT = a + b\ (A/W)$
  - *A* is the tunnel length; *W* is tunnel width
  - *(A/W)* still called 'index of difficulty'
- Also works when W varies

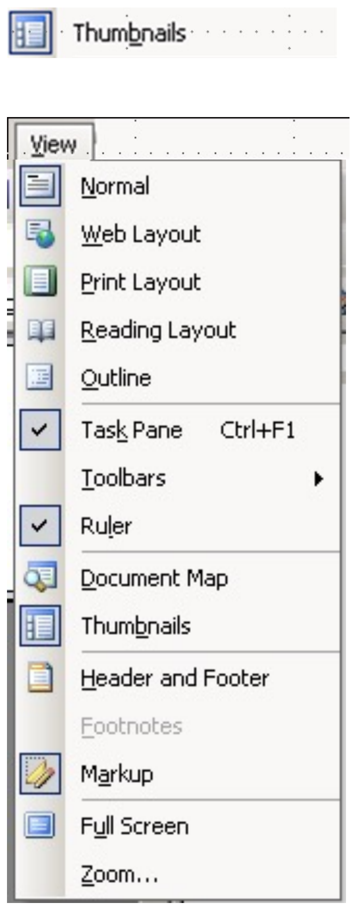


(a) Linear tunnel (b) Circular tunnel

Human Processing: Visual Search Time

- Extensively researched in psychology





Findlater, et al. CHI'09

Human Processing: Visual Search Time

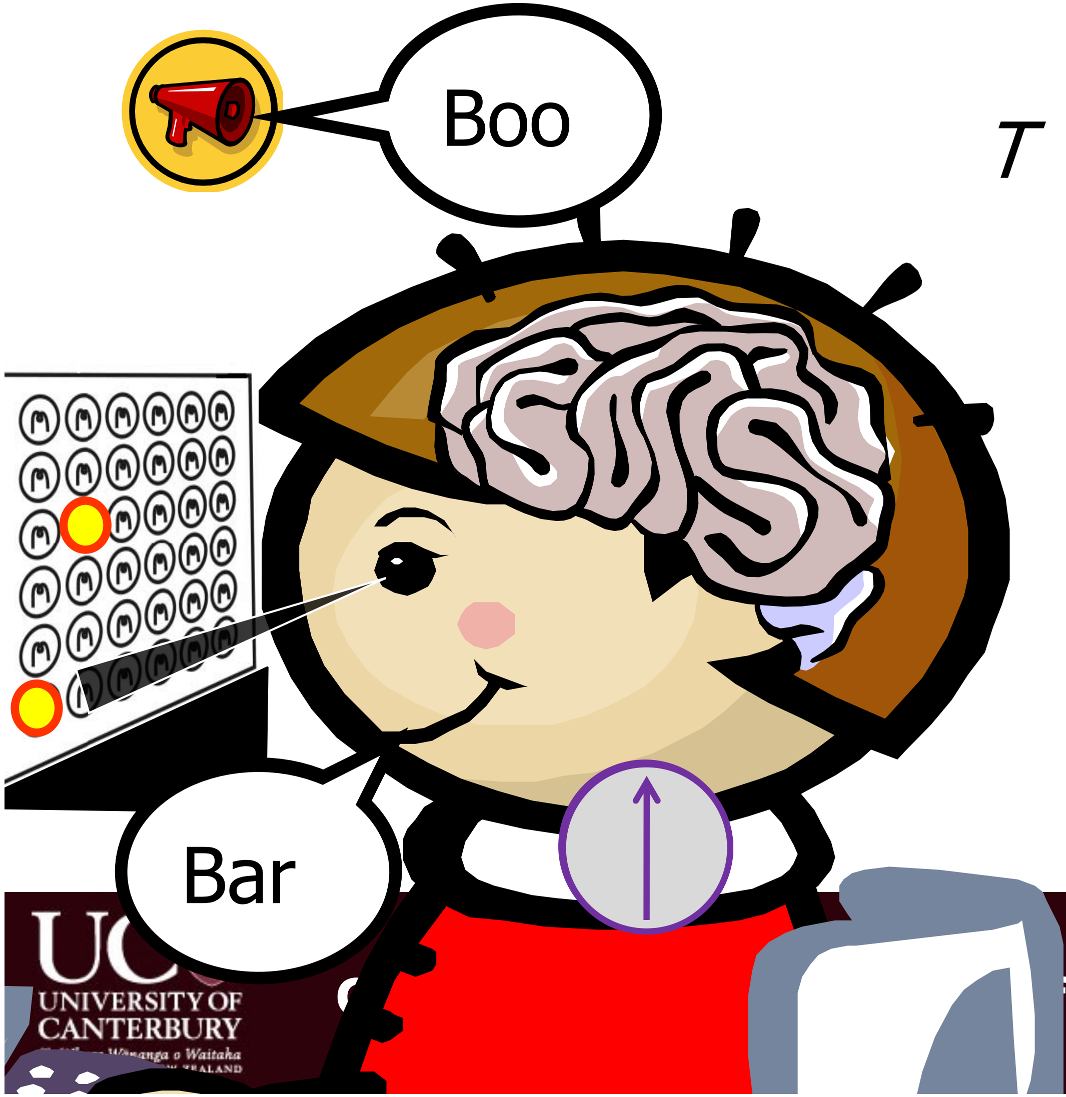
- Extensively researched in psychology
- Visual search time is a linear function of the number of candidate items: O(n) , i.e., $T = a+b\times n$
- BUT, pop-out effects can reduce that to O(1)

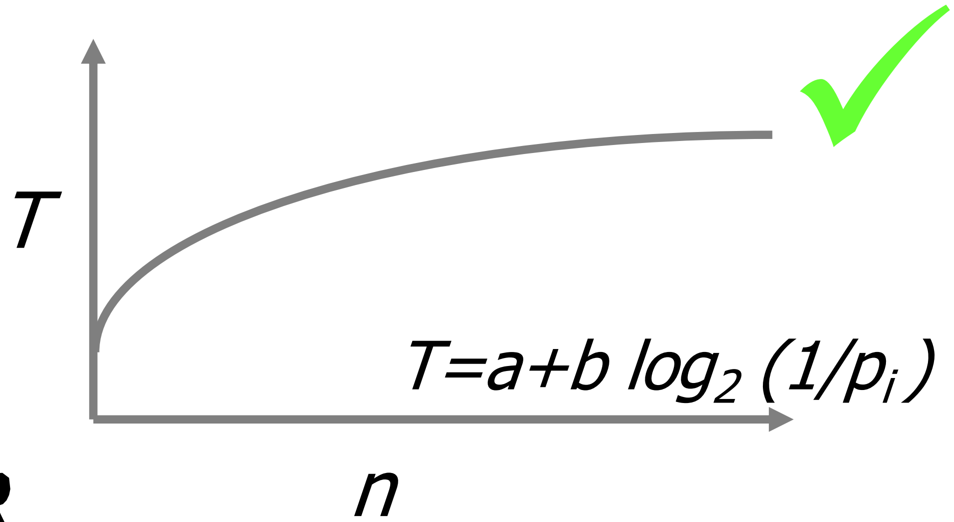
- Visual search is essential when novice, but ideally unnecessary with experience (more soon)

Human Processing: Hick/Hyman Law of Decision Time

- Choice reaction time when optimally prepared
  - $T = a + b \times H$
  - H is 'information entropy'
  - For item *i,* with probability p_i, $H_i = log_2(1/p_i)$
  - For *n* equally probable items, $H = log_2(n)$
- We make frequent decisions quickly!

Human Processing: Hick/Hyman Law of Decision Time





$$T = a + b \log_2 (1/p_i)$$

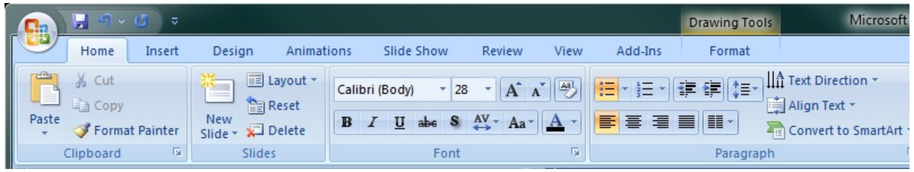
In our menu experiments,
a=240ms, b=80ms/bit

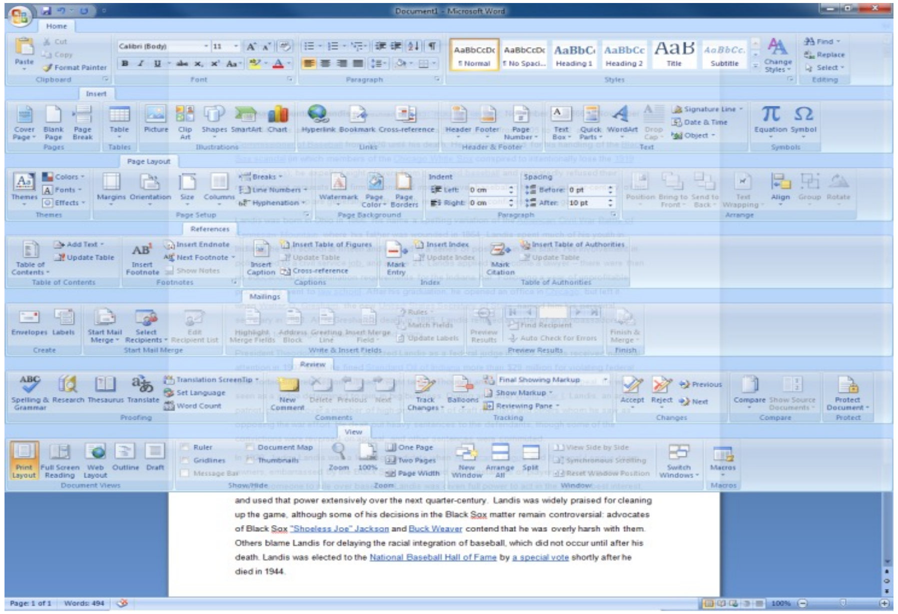
Human Processing: Implications of Hick/Hyman Law

- Decisions are fast: O(log n)
- Applies to name retrieval (commands) and location retrieval
- In GUIs, replace visual search (O(n)) with decision through spatial stability

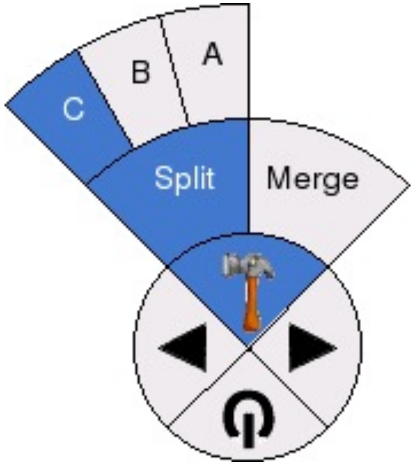
Spatial consistent user interfaces

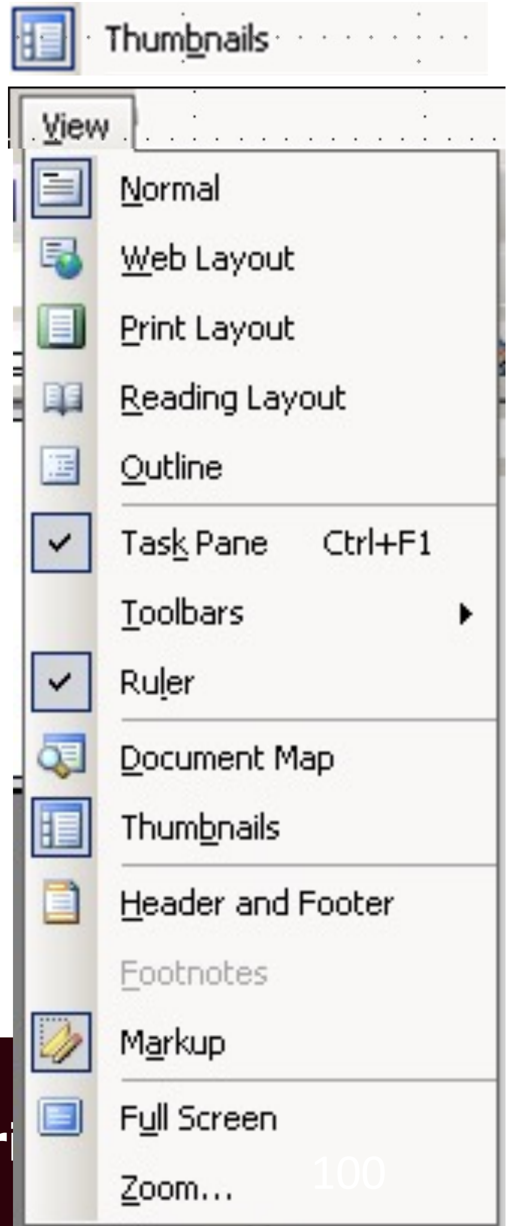
Morphing menus





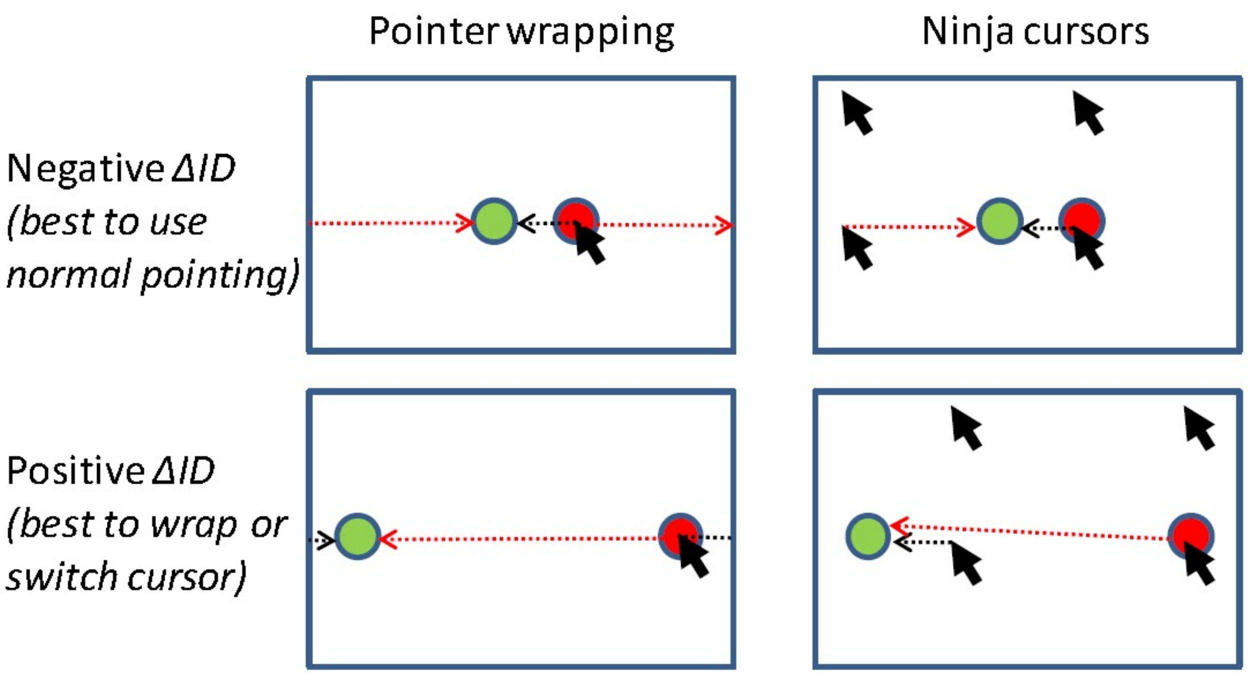
Pie/Marking menus





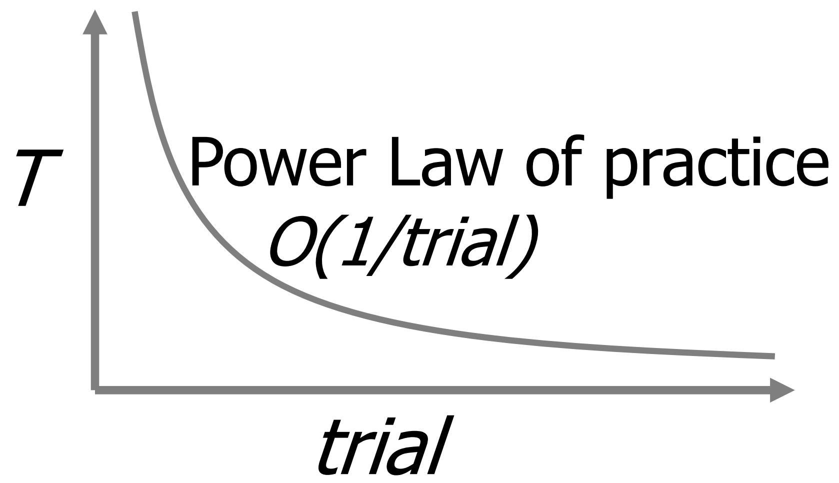
Decision costs in pointing

- Torus pointing and "ninja-cursors"



Human Processing: Power Law of Practice

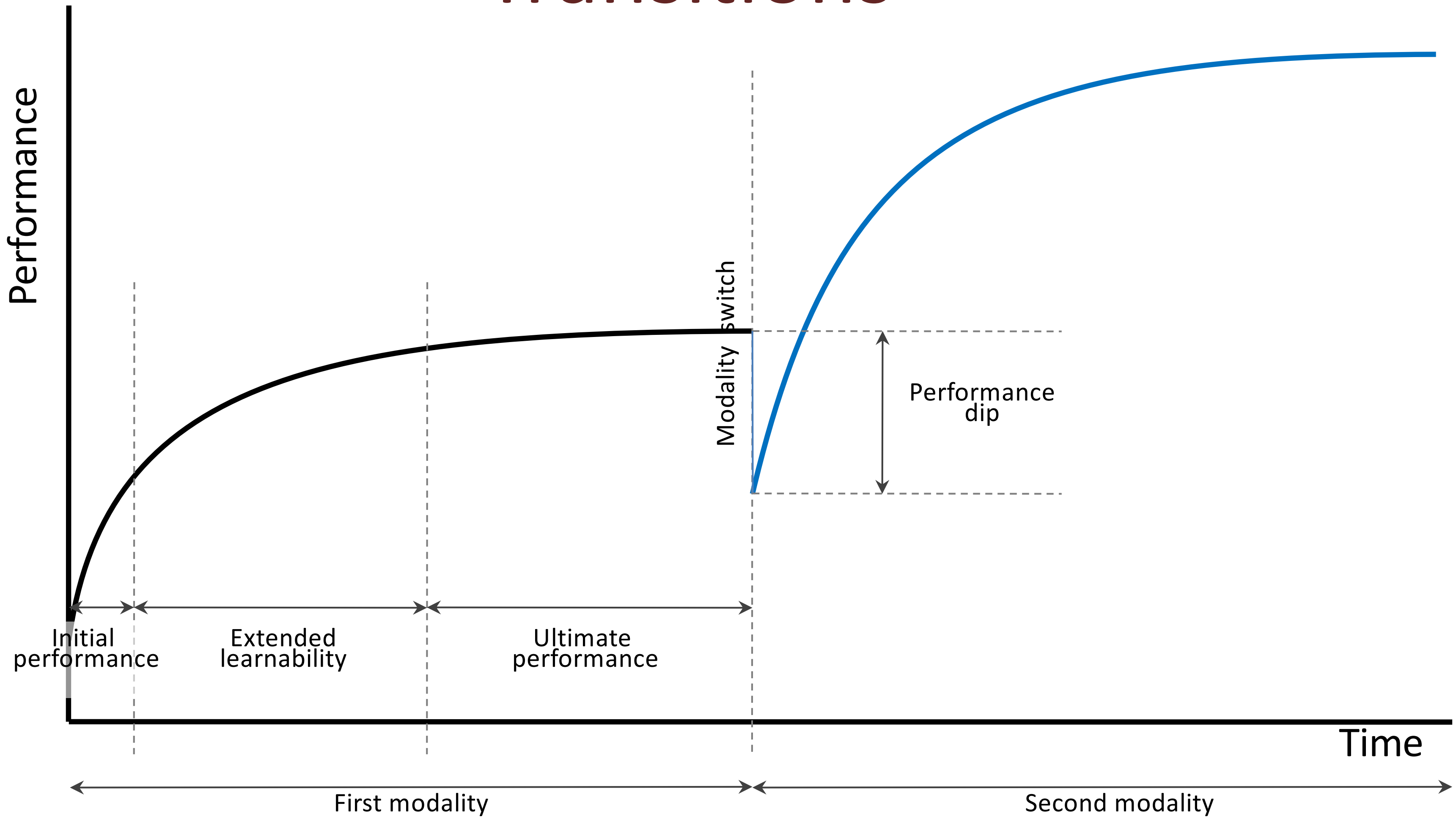
- Performance rapidly speeds up with practice
  - $T_n = Cn^{-\alpha}$ or $\log(T_n) = C - \alpha \log(n)$
  - T_n is time on trial n
  - C is time on trial 1
  - α is learning curve
- Applies to simple and complex tasks



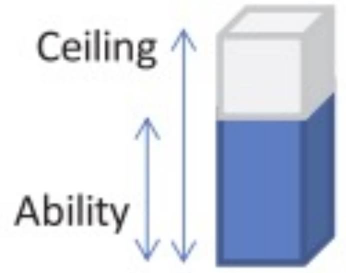
Novice to Expert Transitions

- People use the same tools for years/decades
- Yet shortcut vocabularies are small, and frequency of their use is low
- Many factors:
  - Satisficing (making do rather than optimising)
  - Lack of mnemonics (e.g., Ctrl P for <u>p</u>rint... <u>p</u>aste?)
  - Lack of visibility
- How to support transition to expertise?

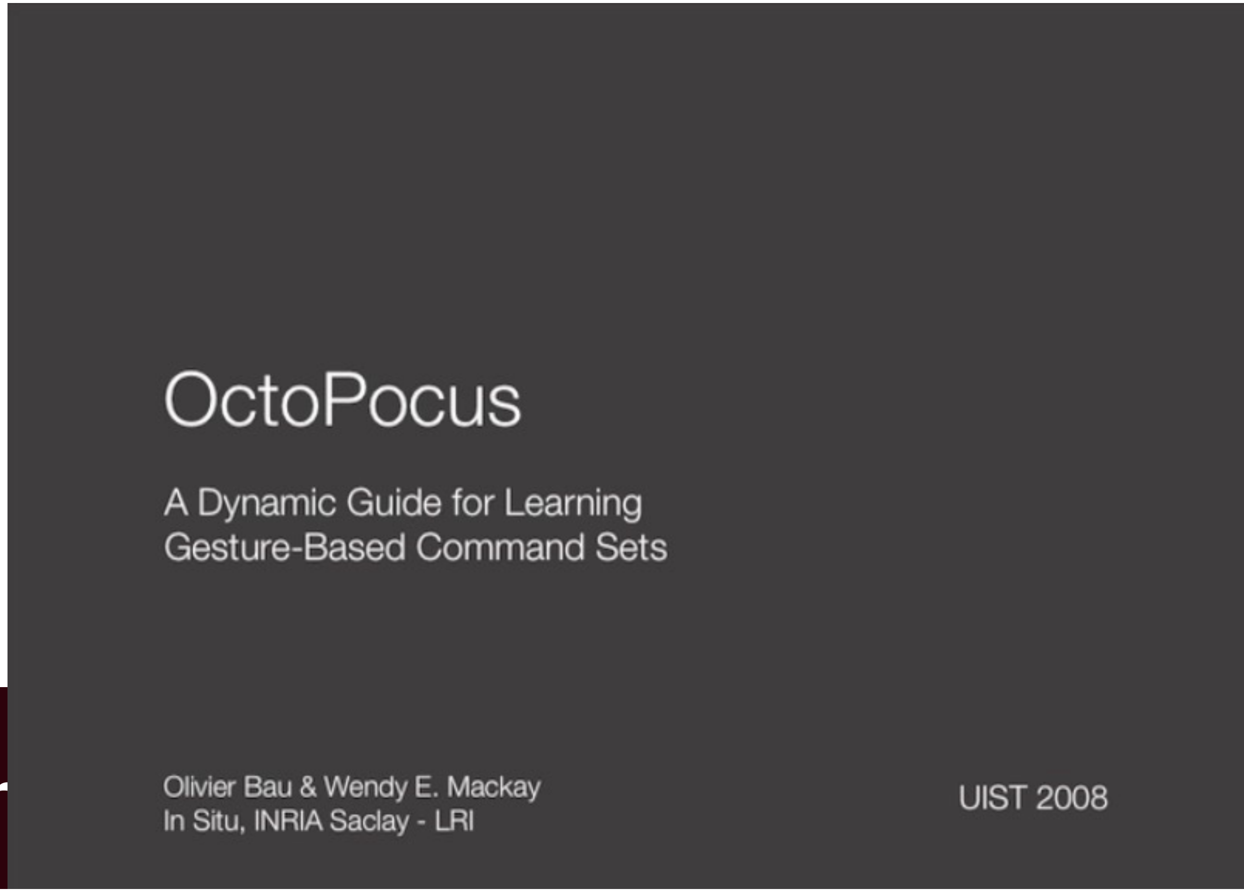
Characterising Novice to Expert Transitions



Domains of Interface Performance Improvement

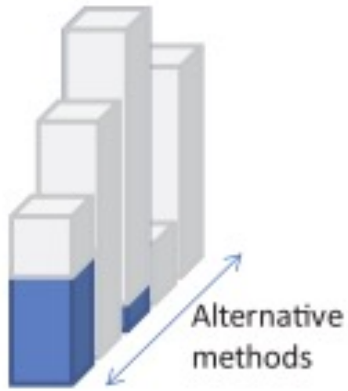


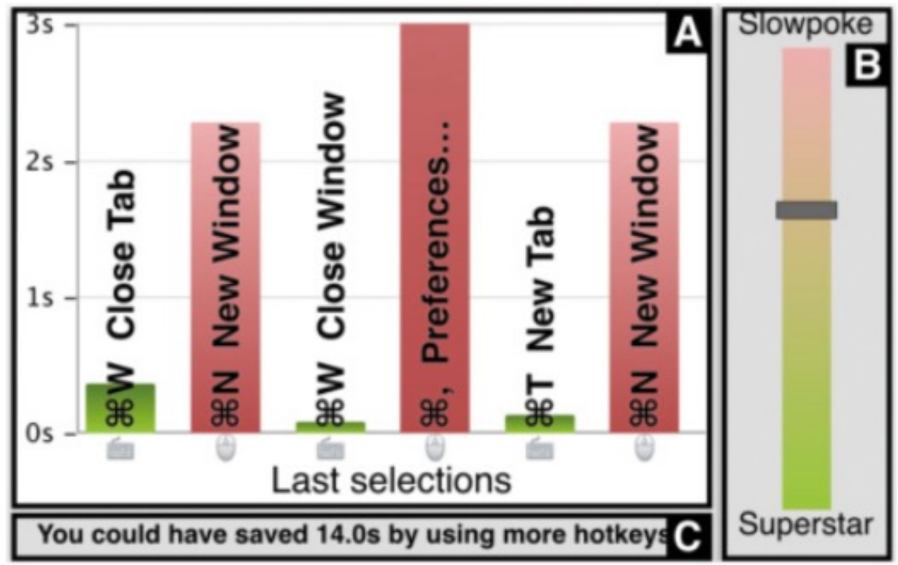
1. Intra-modal improvement
   – E.g. *guidance* techniques



Domains of Interface Performance Improvement

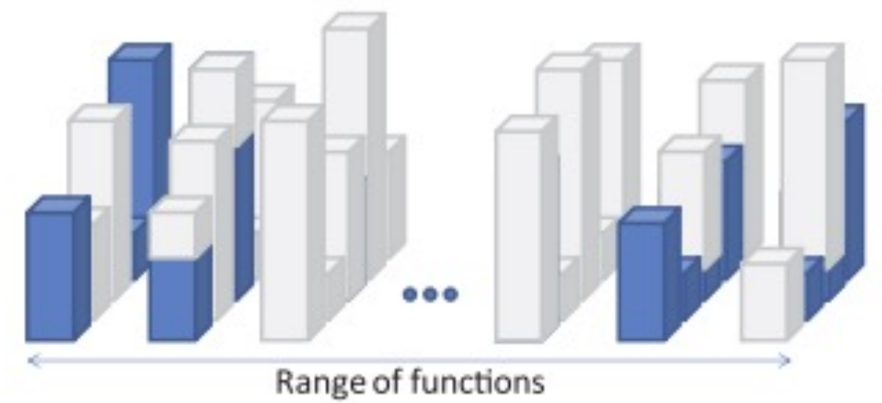
1. Intra-modal improvement
2. Inter-modal improvement
   – E.g., skillometers

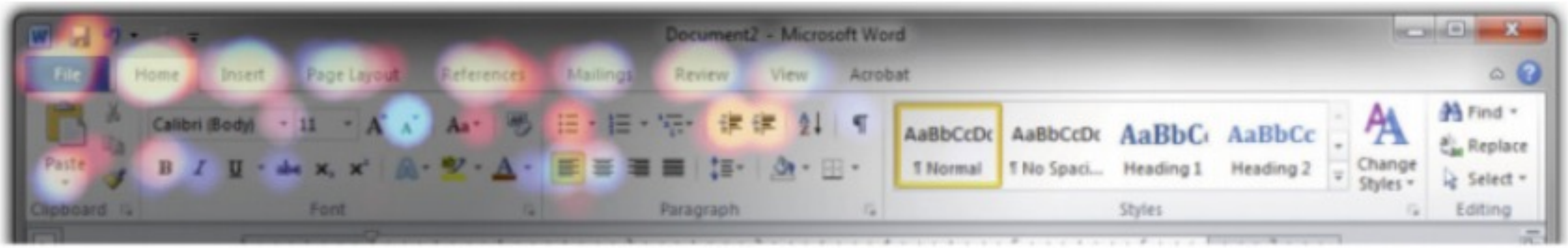




Domains of Interface Performance Improvement

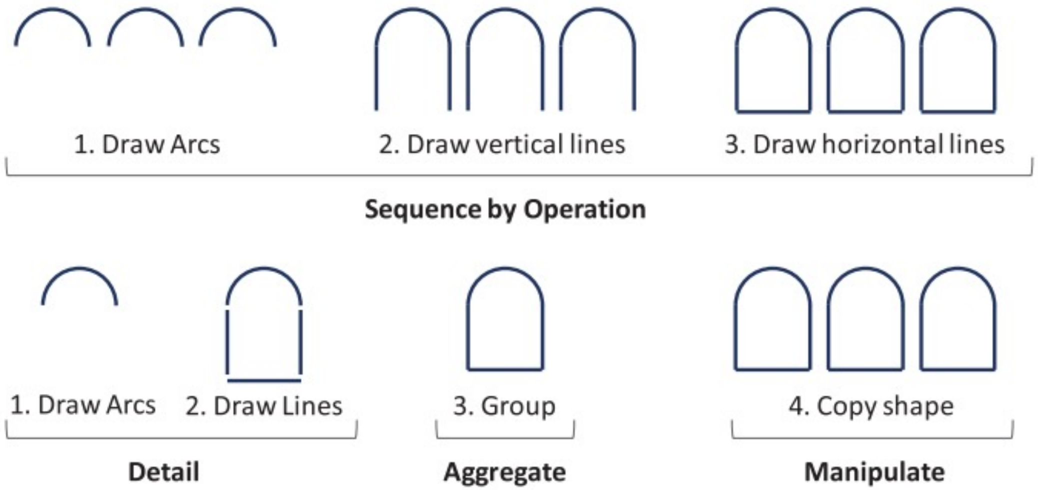
1. Intra-modal improvement
2. Inter-modal improvement
3. Vocabulary extension
   – E.g., community command use



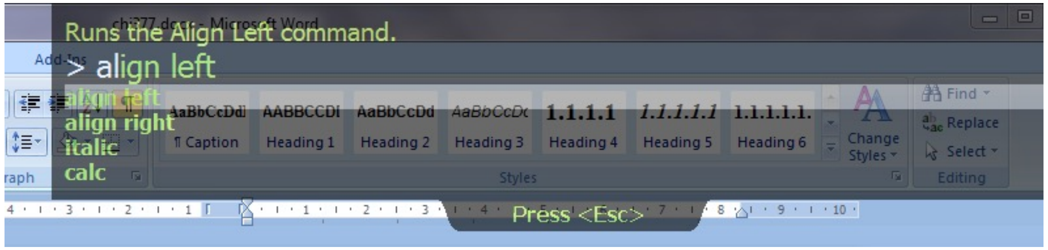


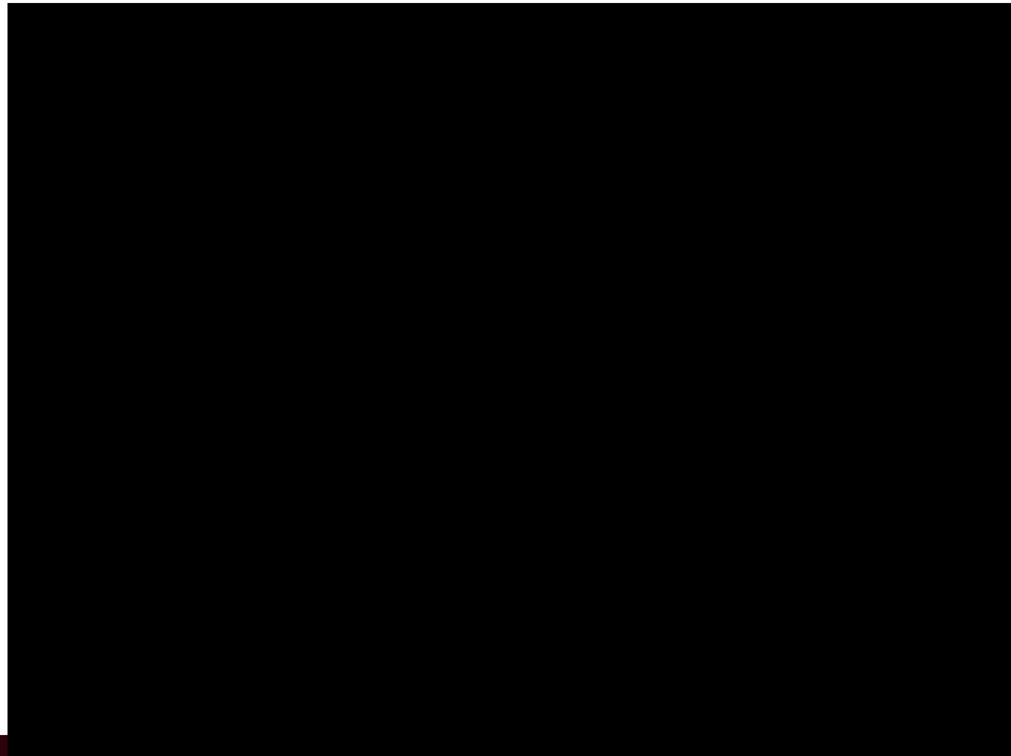
Domains of Interface Performance Improvement

1. Intra-modal improvement
2. Inter-modal improvement
3. Vocabulary extension
4. Task strategy



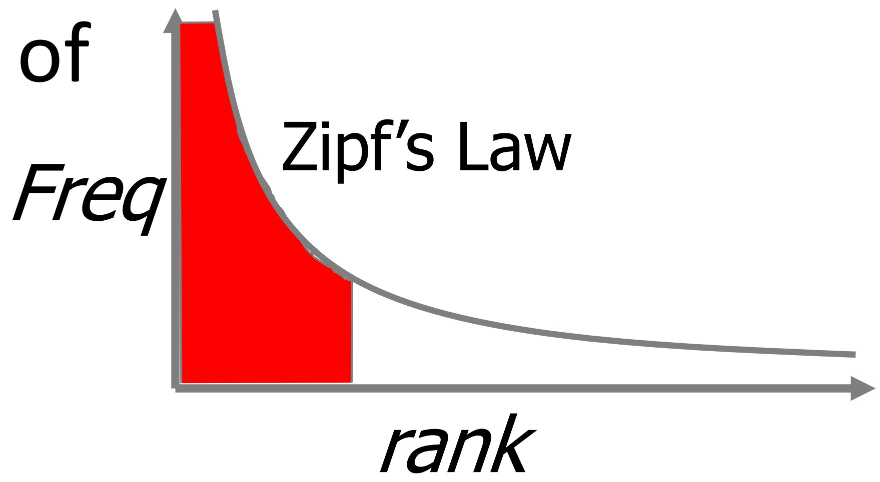
Blur: Supporting Novice to Expert Transitions



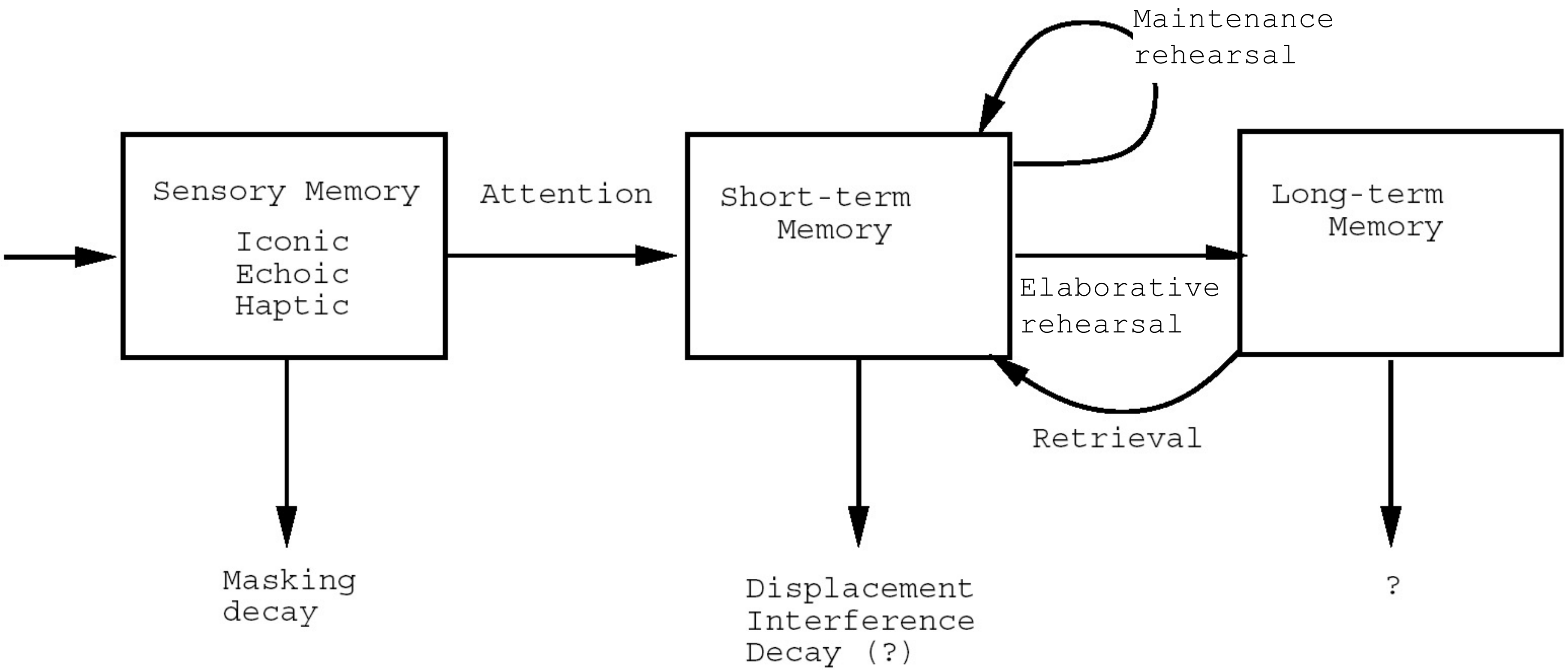


Human Pattern of Behaviour: Zipf's Law, Pareto Principle, 80-20 rule

- Frequency of words (Zipf 1932)
  - $P_n \approx n^{-\alpha}$
  - P_n is scaling factor of frequency of n^{th} ranked word
  - $\alpha \approx 1$
- Also applies to frequency of commands, URLs, apps, windows, ...
- 80% of time using 20%



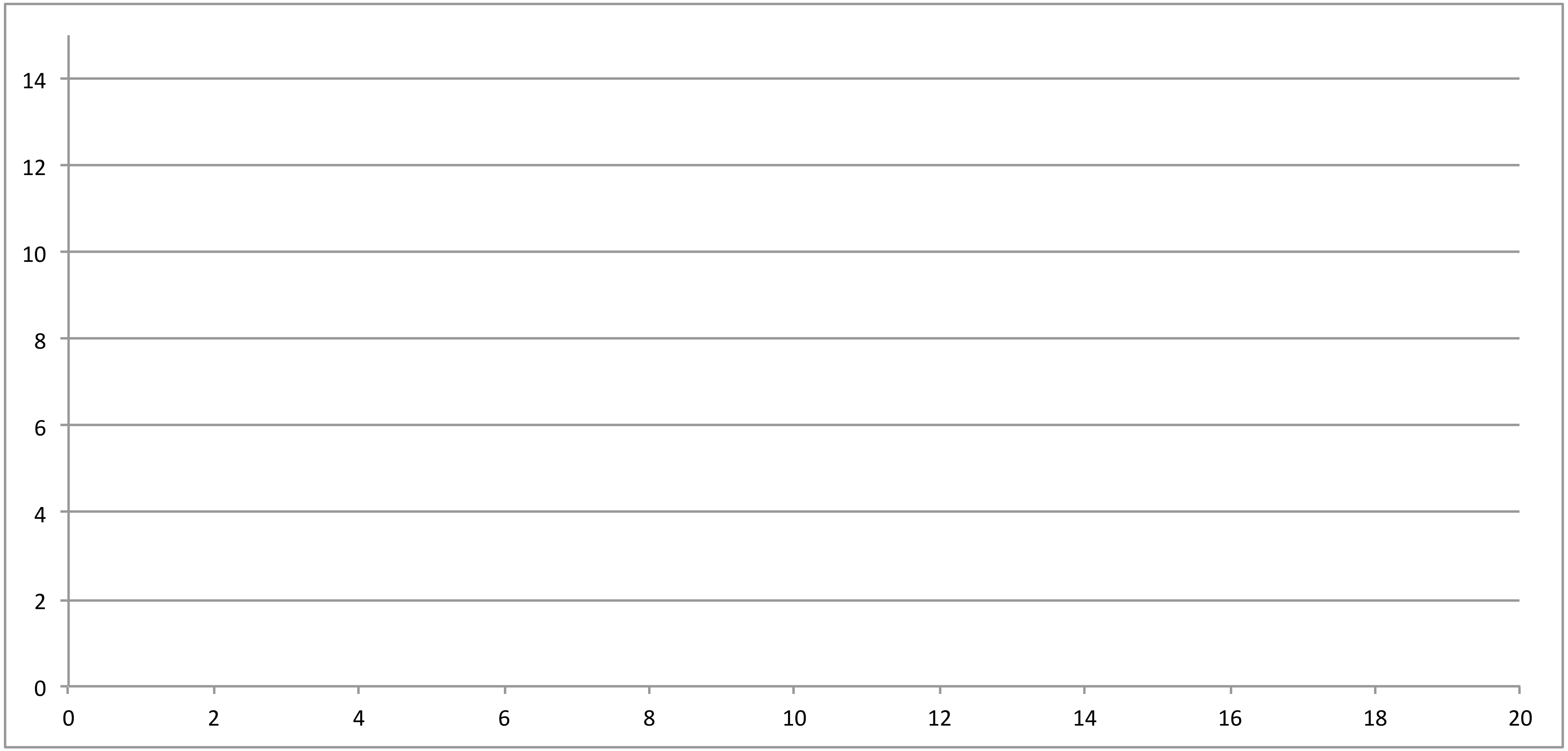
Human Memory: Simplified Model



Short-Term Memory

- Input from sensory or long-term memory
- Capacity up to 7±2 'chunks' (abstractions)
- Chunks used to aid storage and reconstruction
- Fast access (≈70ms); rapid decay (≈200ms)
- Constant update and interference
- Maintenance rehearsal

Test of 7±2



Long-Term Memory

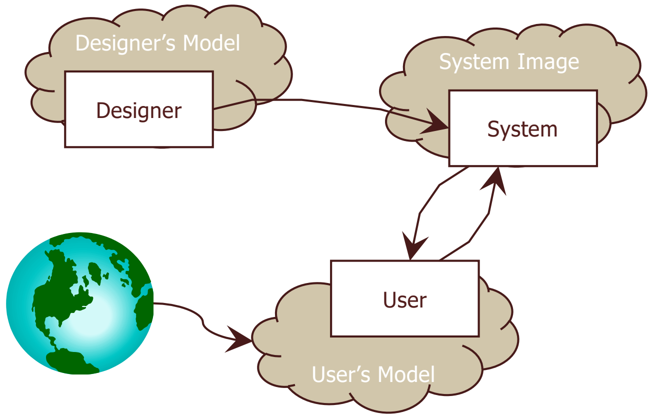
- Input through elaborative rehearsal and extensive repetition
- Slow access (>100ms)
- Decay?

Lessons

- Support recognition; don't demand recall
- Support spatial processing

Human Error: Mistakes

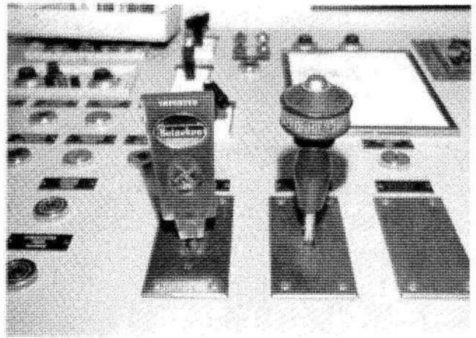
- Errors of conscious decision
- Due to incorrect or incomplete model of system
- Only detected with feedback



Human Error: Slips

Errors of automatic and skilled behaviour

- Capture error
  - Two action sequences with common starting point(s)
  - Captured into wrong path (usually the more frequent one)
- Description error
  - More than one object allowing the same/similar action
  - Execute right action on wrong object
- Data-driven error
  - External data interferes with STM
- Associative activation error



Stroop Effect

(Data-Driven Error)

Red
Blue
Yellow
Green
Orange
Purple
Red
Green
Yellow
Blue
Green

Blue
Red
Green
Orange
Yellow
Red
Green
Purple
Green
Yellow
Blue

Human Error: Slips (continued)

- Loss-of-activation error
  - Goal displaced/decayed from STM completed
- Mode error
  - Right action, wrong system state
- Motor slip
  - Pointing/steering/keying error
- Premature closure error
  - ‘Dangling’ UI actions required after perceived goal completion

Aside: What is a mode?

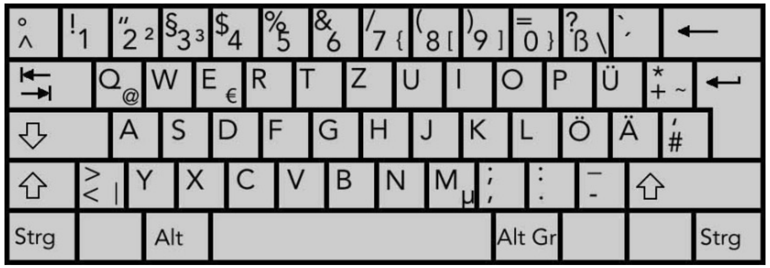
- System **partition**
  - Different set of commands available
  - Different interpretation of same commands/actions
  - Different display method
- Modal dialog
  - Grabs focus for application/desktop and must be dismissed to proceed
- Ensure modes are visible/noticeable

Human Phenomena

But people don't conform to simple models

- International/cultural differences

Source: w3.org



On or off?

Human Phenomena

- Sapir-Whorf Hypothesis
  - Language influences the way we think
  - More generally, "Law of the instrument" or "Maslow's hammer"
  - Our language/tools influence how we think about design/interaction

Human Phenomena

- Cognitive Dissonance
  - Inconsistent cognitions are uncomfortable
  - Therefore rationalise beliefs
  - [Festinger experiments with dull tasks: https://www.youtube.com/watch?v=1kmVy1QPXn0](https://www.youtube.com/watch?v=1kmVy1QPXn0)

  - "I spent 5 years learning to use this software"
    - "This software is slow and really hard to use" (I'm a mug)
    - *"I like this software and I can use it well"* (resolves dissonance)

Human Phenomena

- Homeostasis
  - People maintain equilibrium
  - If a system makes things easier, it'll be used to do more difficult things
  - If a system makes things safer, it'll be used to do more dangerous things

Human Phenomena

- Satisficing
  - People make do rather than optimise
  - E.g., ‘hunt-and-peck’ typing for decades because too busy right now to learn touch typing
  - How many keyboard shortcuts do you know and use?

Human Phenomena

- Hawthorne Effect
  - People like being involved
  - Complicates evaluations

Human Phenomena

- Explaining away errors
  - In hindsight, it's often easiest to blame the user

Human Phenomena

- Fixation
  - Tendency to repeatedly reuse the same solution method rather than think of new/better methods

Human Phenomena

- Perception versus reality
  - People's perception often differs from reality
  - E.g., perceived duration varies for filled versus unfilled time

Human Phenomena

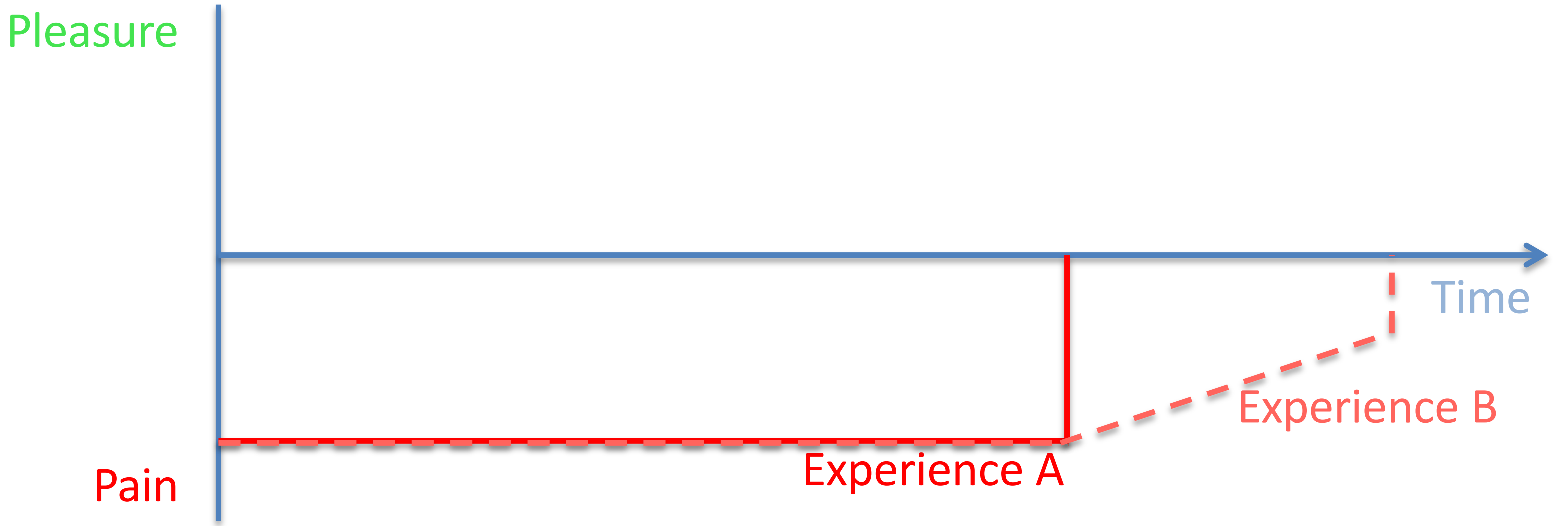
- Peak-End Effects

Human Phenomena

- Peak-End Effects

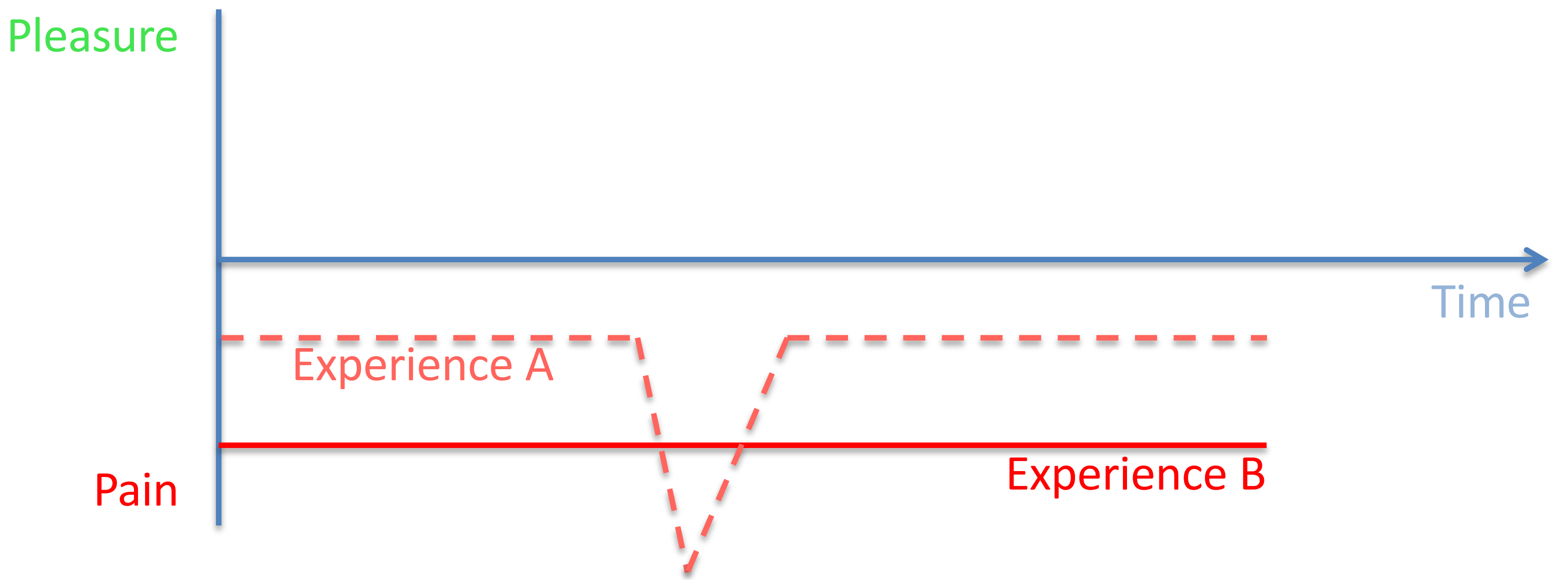
Human Phenomena

- Peak-End Effects



Human Phenomena

- Peak-End Effects



Human Phenomena

- Peak-End Effects
  – People's retrospective assessment of experience is heavily influenced by moments of peak and end intensity
  – (People prefer more pain to less, if it finishes better)

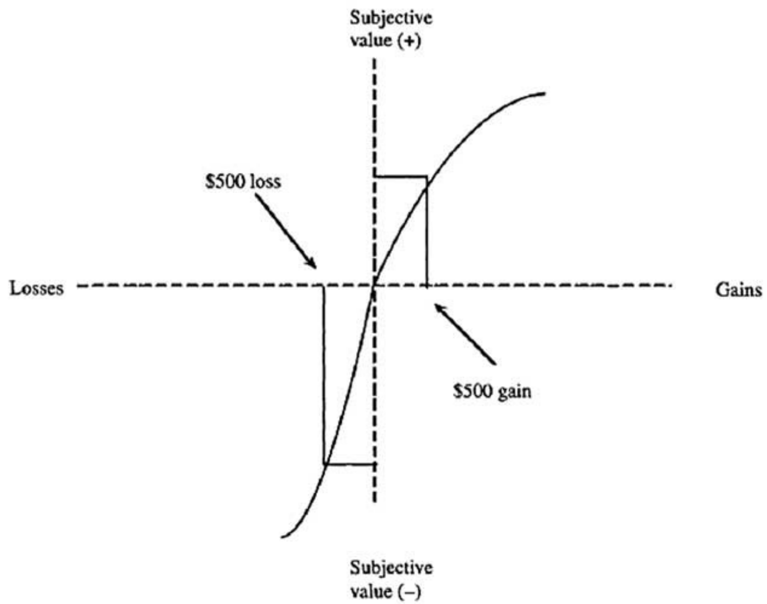
Human Phenomena

- Negativity bias
  - One coin toss: win $110 on heads; lose $100 on tails will you take it?

Human Phenomena

- Negativity bias
  - One coin toss: win $110 on heads; lose $100 on tails will you take it?

- Bad is stronger than good



Human Phenomena

- Communication convergence:
  - Similarity of pace, gestures, phrases aids affinity, pro-social behaviour, & positive communication outcomes
  - Interfaces could (& should?) measure user pace and adapt effects to match
  - E.g., rate of speech, timeouts, speed of animations, etc.

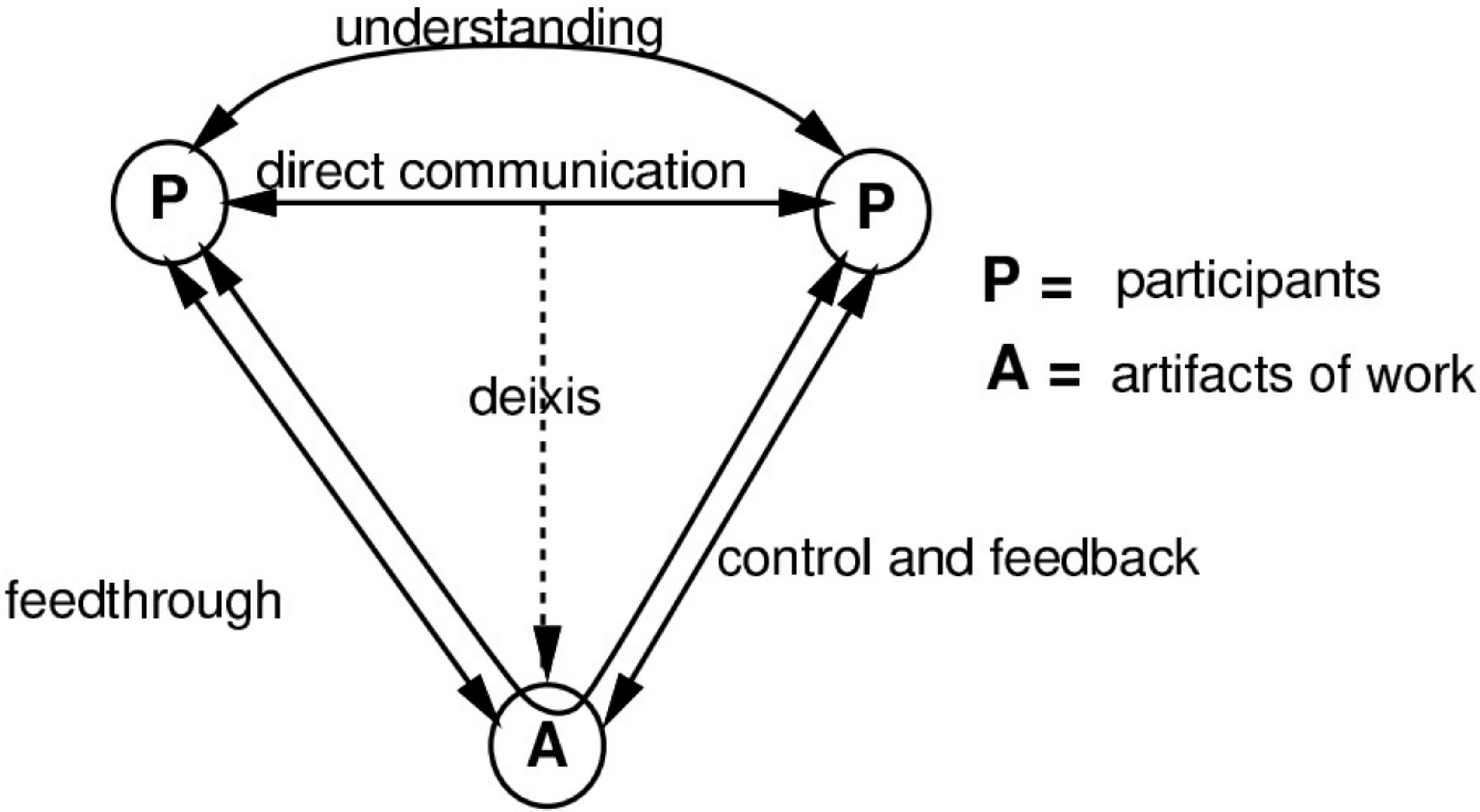
Human Phenomena

- Collaboration
  - Work is inherently collaborative
  - "Computer Supported Cooperative Work: (CSCW) investigates collaboration and how to support it
  - "Groupware" systems support collaborative work
  - Social software (e.g., Facebook) also fits here
  - *Very* difficult to design!

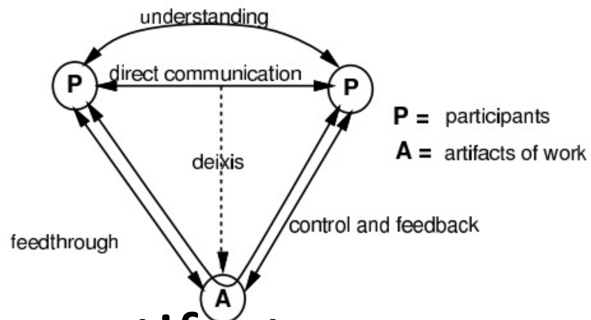
CSCW
Engelbart's "Mother of All Demos" 1968

Video link on "Extra Resources" on Learn

CSCW
Participant-Artifact-Participant Framework



CSCW
Participant-Artifact-Participant Framework



- Classifies:
  - What people do
  - What systems should support
- Feedthrough: communication through an artifact
- Direct communication takes many forms:
  - Obvious: text, speech
  - Subtle “back-channels”: nods, ‘uh-huh’, facial expression, gestures, etc.
- Deixis: communication coupled with contextual reference (e.g., “shift that”)
- WYSIWIS design principle

CSCW: Awareness Framework

- **Focus**: the more an object is within your focus, the more aware you are of it
- **Nimbus**: the more an object is in your nimbus, the more aware it is of you

Tom Rodden, 1996

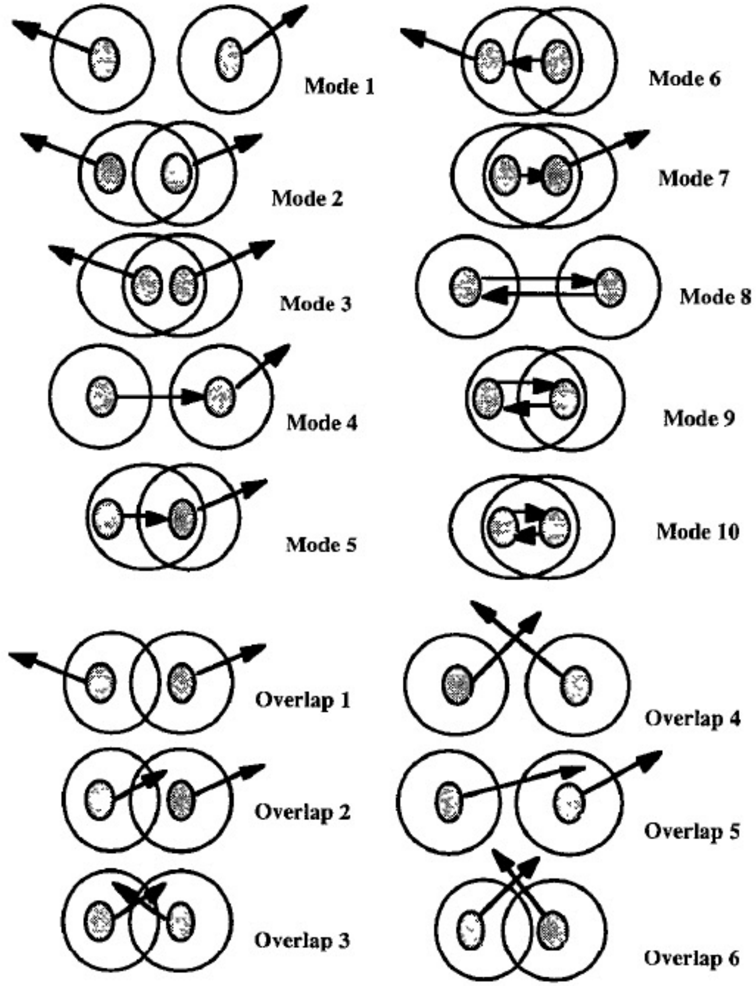


Figure 4 Different Modes of Awareness