COSC368 Humans and Computers:
Introduction to Human-Computer Interaction (HCI)

Andy Cockburn
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People

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- Sarah Kennelly & Nathan Cleaver
  - Tutors
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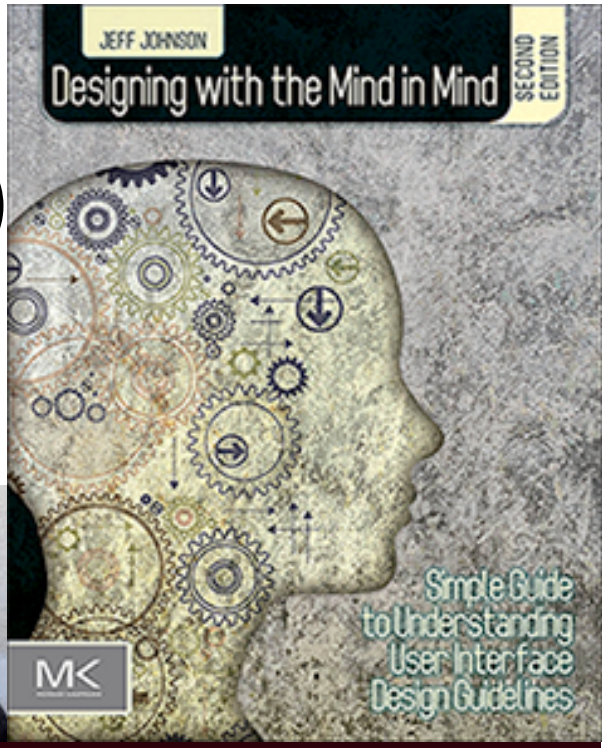
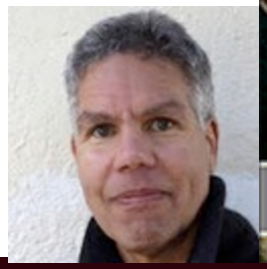
Assessment

- Labs
  - 9% (1% per lab, starting this week)
- Usability Analysis and Storyboard
  - 25%
  - 5pm, Wed 16th September
- Design Specification and Rationale
  - 15%
  - 5pm, Wed 14th October
- Exam
  - 51%
  - TBA

Recommended Text & Resources

- "Designing with the Mind in Mind", 2nd 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)

		LECTURES	LABS
Week	**Beginning**		
1	13-July	Introduction to HCI	Lab 1: Python/TkInter refresher
2	20-July	Models of interaction and technology	Lab 2: Python/TkInter: Keyboard GUI
3	27-July	The Human – senses	Lab 3: Python/TkInter: Canvas & Fitts law GUI
4	3-Aug	The Human – performance and phenomena	Lab 4: Fitts' law experiment and analysis
5	10-Aug	Interface Design – Iteration	Lab 5: Sketching Designs
6	17-Aug	Interface Design – Task Centred System Design	Assignment help
	24-Aug		
	31-Aug		
7	7-Sept	Interface Design – Heuristics	Lab 6: Visual search, decision, skill development
8	14-Sept	Interface Design – Heuristics II	Lab 7: Performance prediction
9	21-Sept	Interface Design – Graphical design	Lab 8: Heuristic evaluation
10	28-Sept	Interface Evaluation & Empirical Methods	Lab 9: Experimental data analysis
11	5-Oct	Interface Evaluation & Empirical Methods 2	Assignment help
12	12-Oct	Overflow and UI Intellectual Property	

Your Outcomes (my goals)

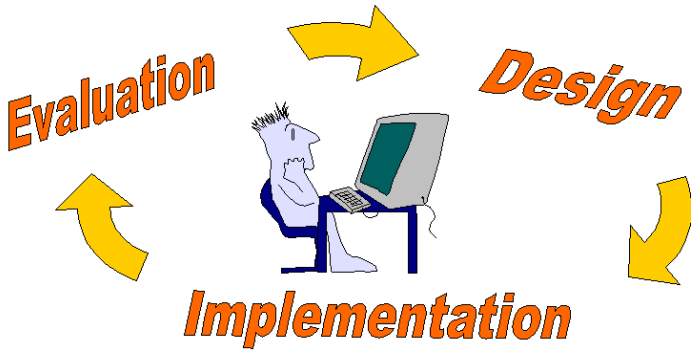
- Understand key human factors influencing human-computer interaction
- Know guidelines, models, and methods that aid interface design, and be able to apply them
- Be able to evaluate user interfaces and designs

- 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

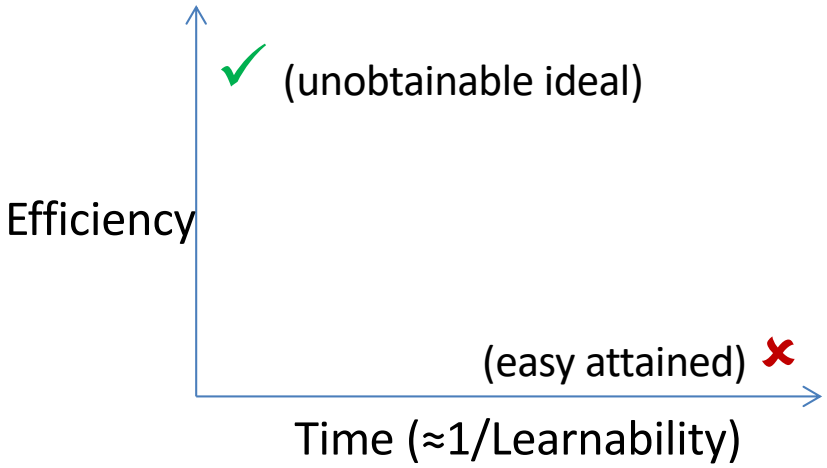
Goals of HCI

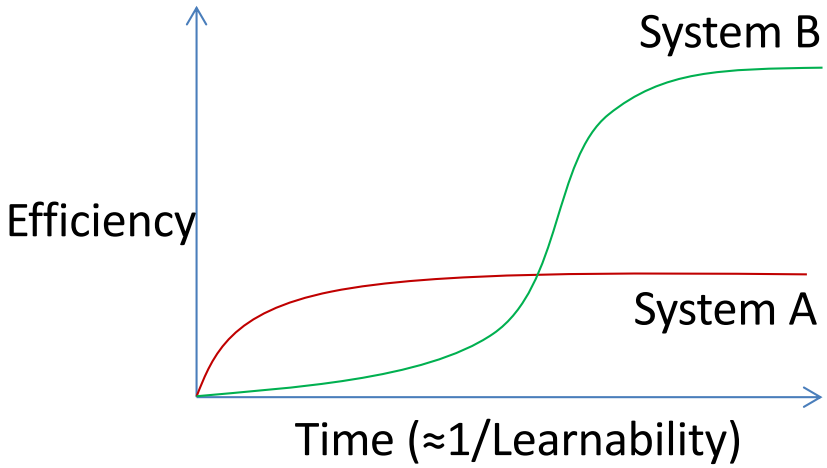
Improved usability:

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”

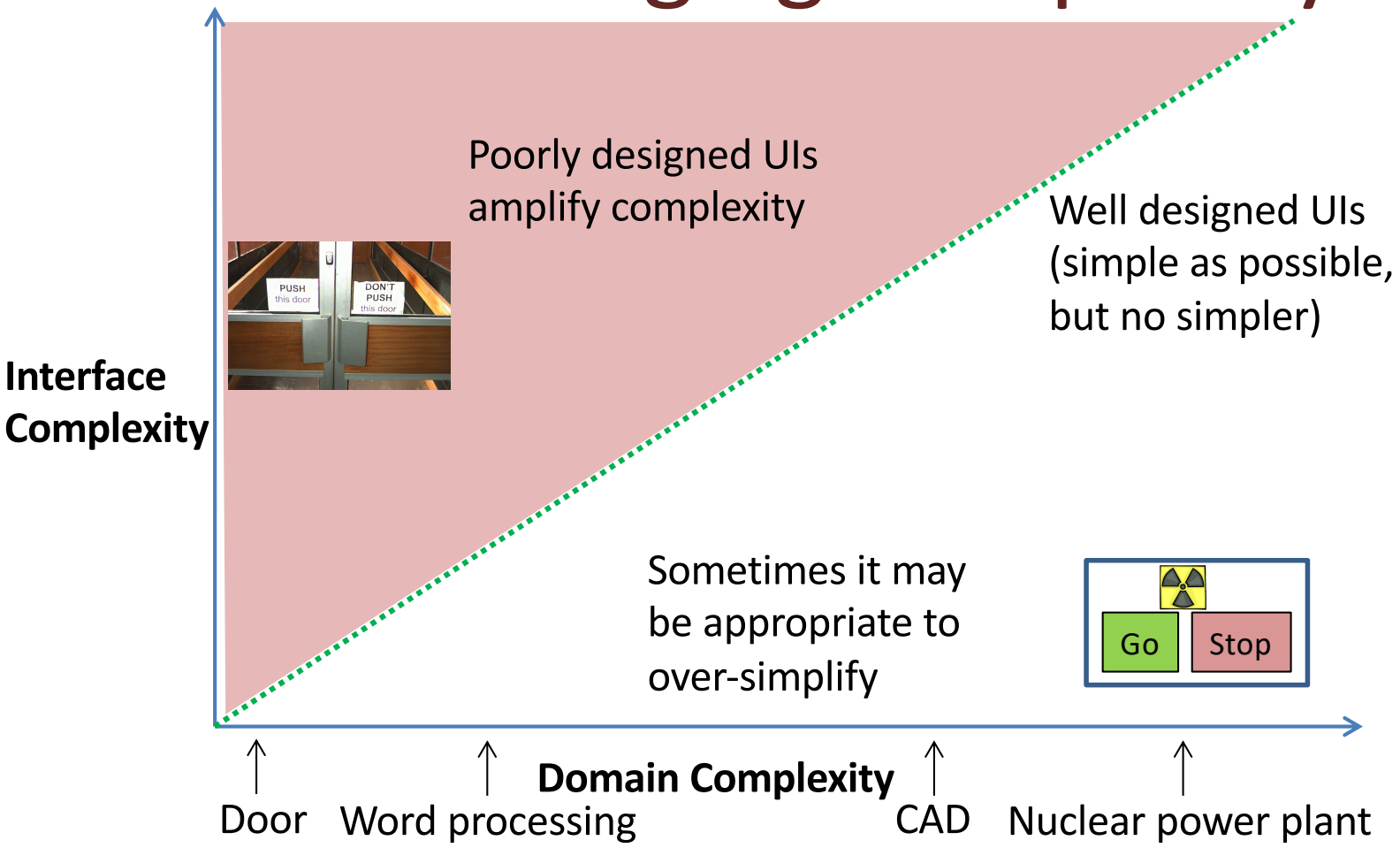

PULL
推
PUSH

The Job of HCI: Managing Complexity

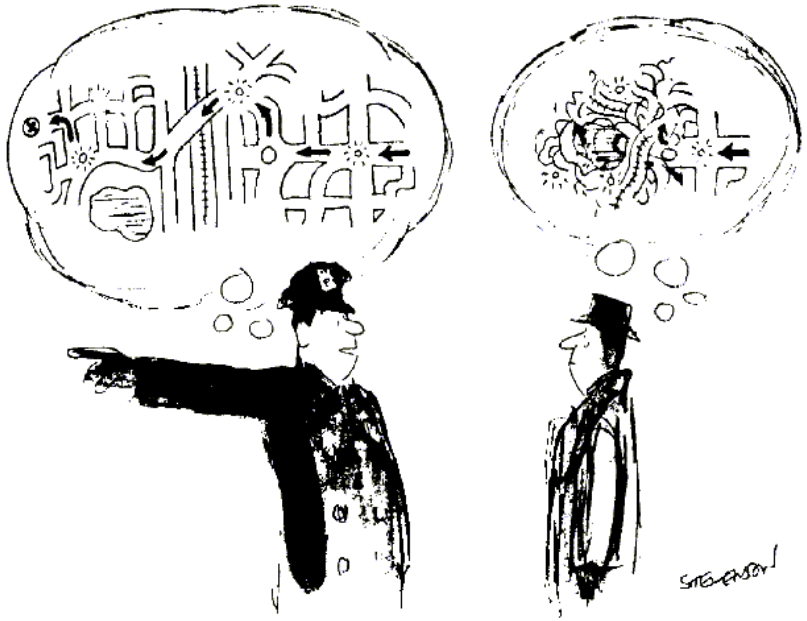
"Designing an object to be simple and clear… requires relentless pursuit of that simplicity even when obstacles appear which would seem to stand in the way" Ted Nelson, 1977

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

Managing Complexity

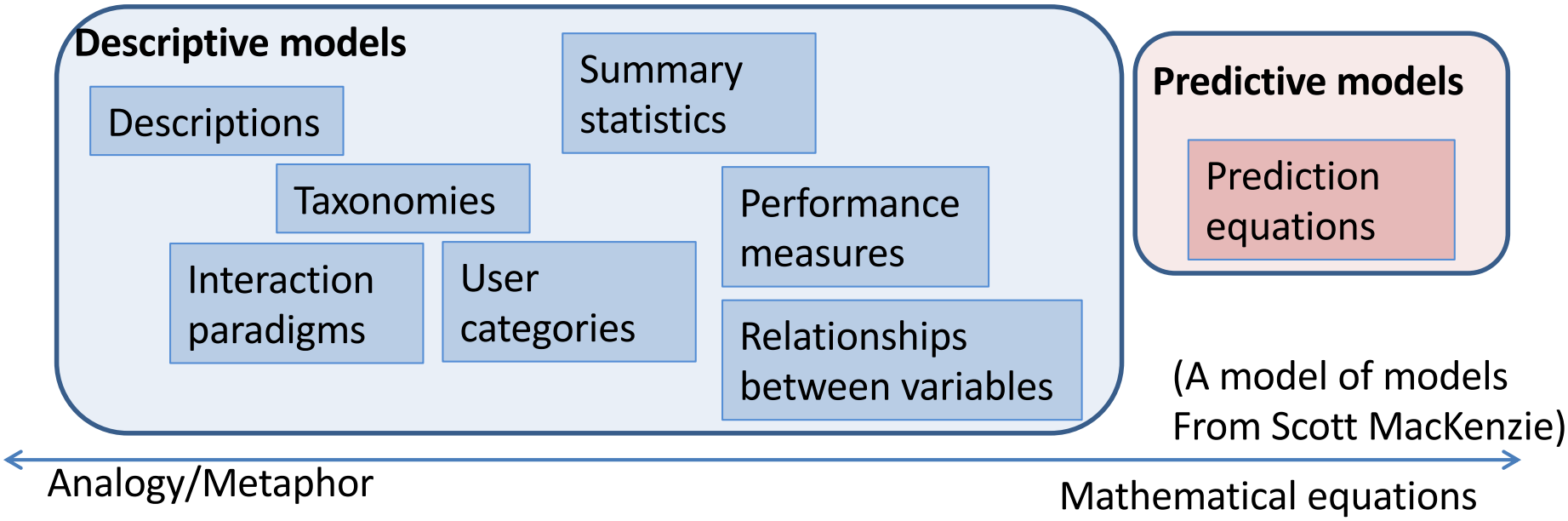


Models of Interaction



What is a model?

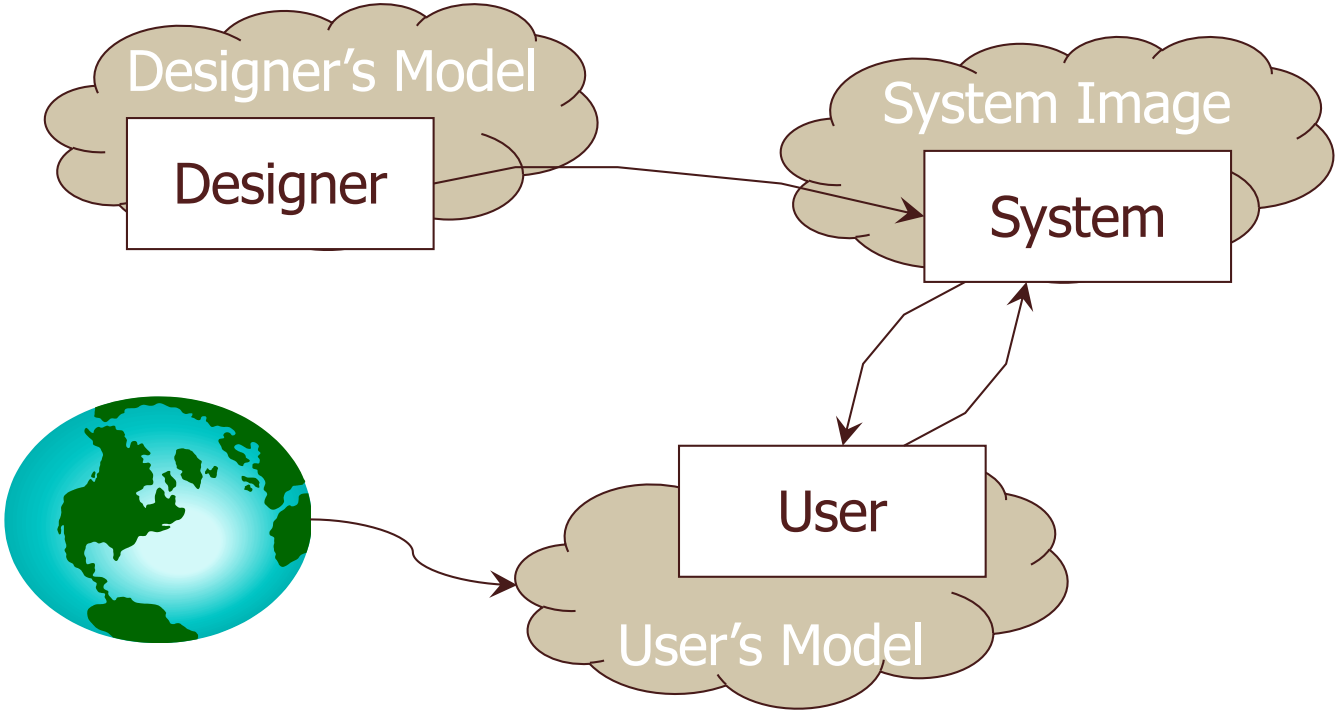
- A model is a simplification of reality
- They are useful when they help understand a complex artifact (e.g., a computer system)



Don Norman's Model of Interaction

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

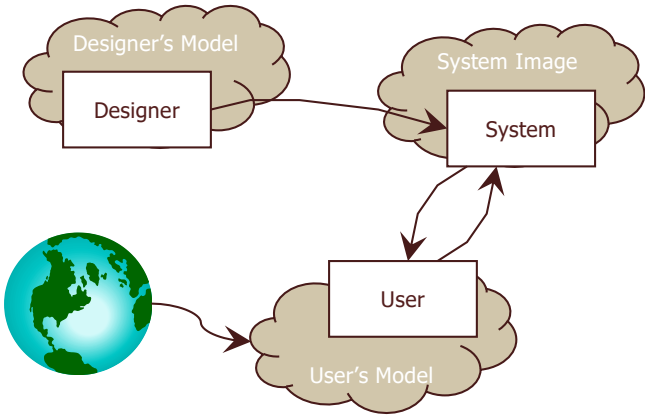
- Helps understand designer's role in creating a system that is used by a thinking person



Don Norman's Model of Interaction

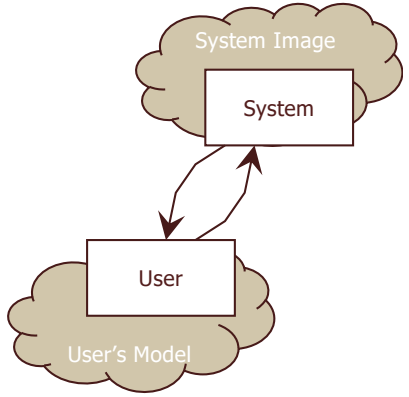
(Norman, 'The Psychology/Design of Everyday Things', 1988)

- 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

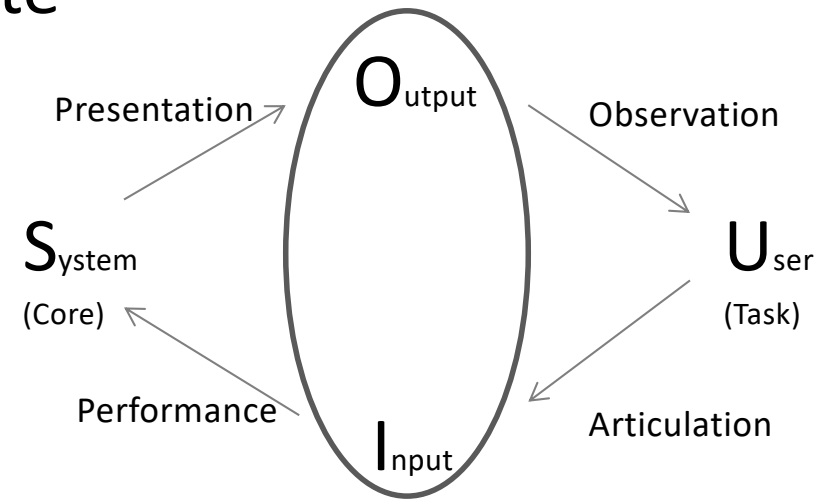
- Execute:
  - Goal > Intention > Actions > Execution
  - 'Gulf of Execution': problems executing intention/action
- Evaluate:
  - Perceive > Interpret > Evaluate
  - 'Gulf of Evaluation': problems assessing state, determining effect, etc.



UISO Interaction Framework

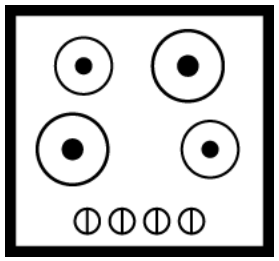
(Abowd and Beale '91)

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

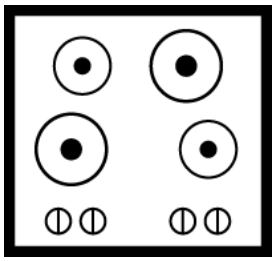


Mappings

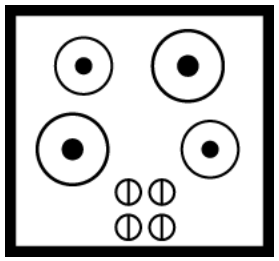
- Good mappings (relationships) between U and I/O increase usability



Arbitrary mapping



Slight disambiguation



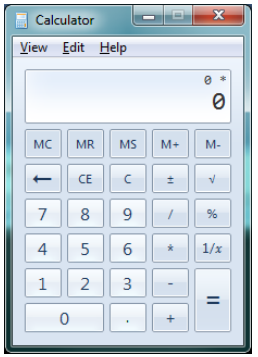
Better (and better still?)

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



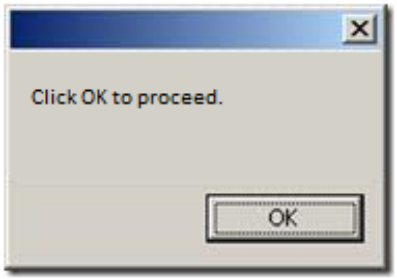
- Strong affordance may stifle efficiency

Interface Technology: Styles

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



The Dominant Interaction Styles

- Command Line
- Menu-Based Interface
- Form Fill-In & Question and Answer ‘Wizards’
- Direct Manipulation
- Web Navigation
- Three-Dimensional Environments (3DUI)
- Zoomable Interface (ZUI)
- Natural User Interface (NUI)
- Agent-based

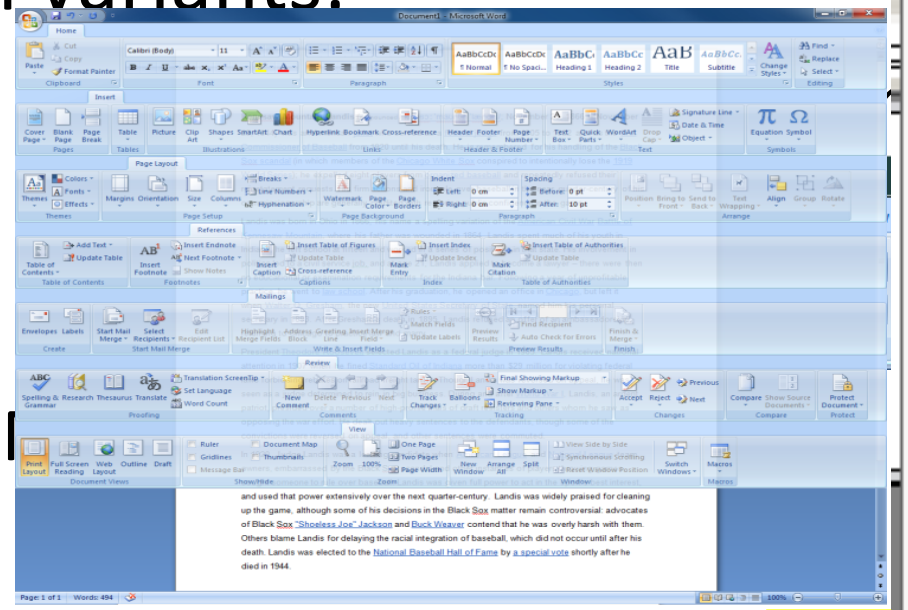
Command Line

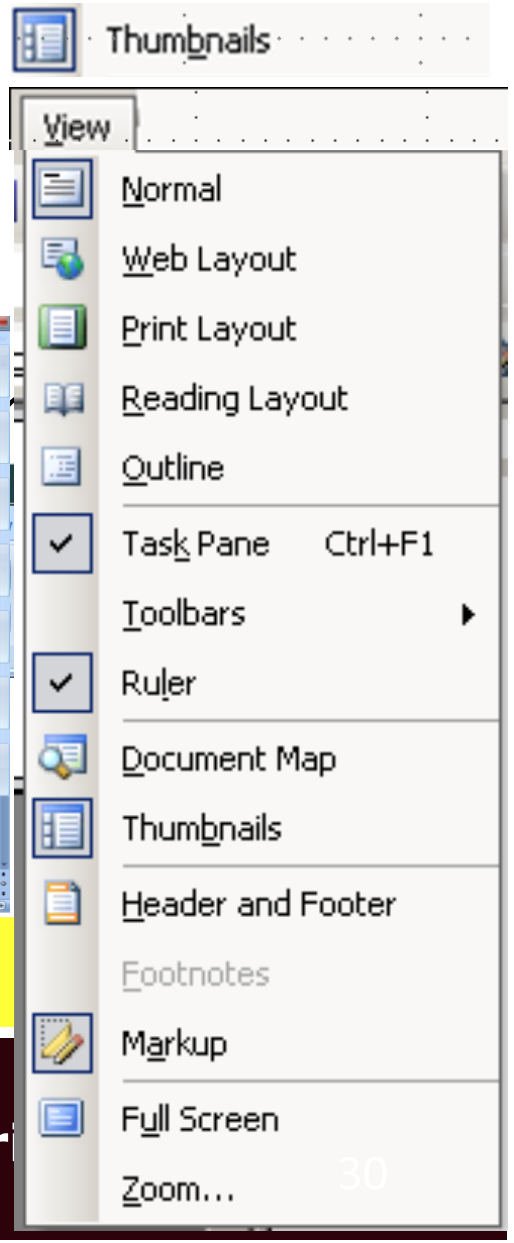
- Fast and powerful
  - Minimal mechanical demands
  - Many shortcuts (e.g. type-ahead, history, wild-cards)
  - Flexible (many parameters)
- Under-determining
  - Hard to learn; problems with synonyms
- High error rates
- Computationally cheap

HUMAN

Menu-Based Interfaces

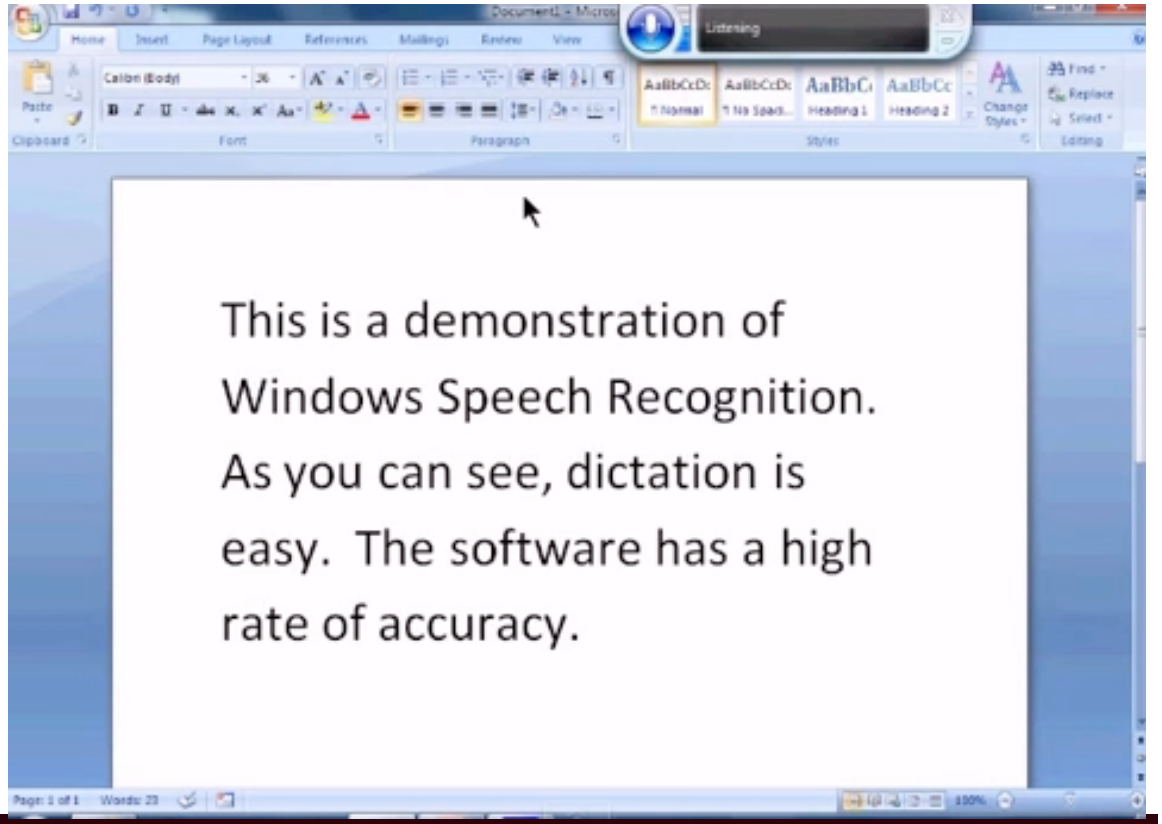
- Selection from a set of alternatives
- Many visual variants:
  - Pull-down
  - Cascading
  - Ribbon
  - CommandI
  - Pie menus
  - Ephemeral adaptation/Morphing





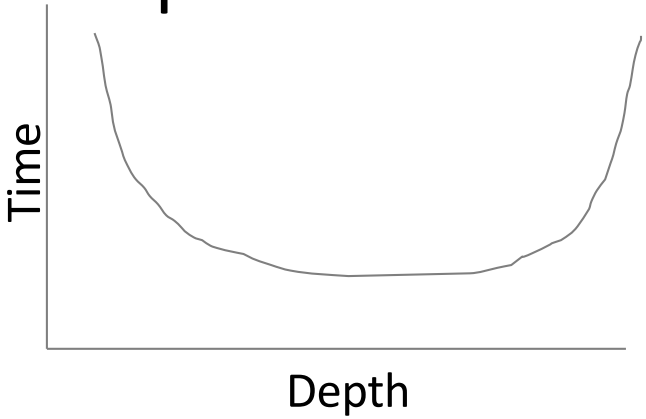
Menu-Based Interfaces

- Several methods for selection:
  - Pointer
  - Keyboard
  - Gesture
  - Number (voice, keyboard)

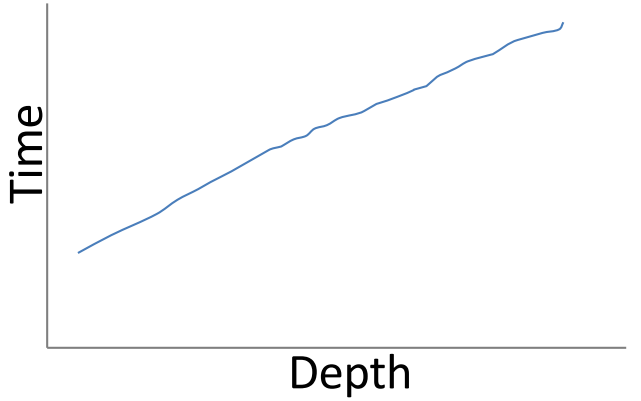


Menu Hierarchy Structure?

- Broad and Shallow, or Narrow and Deep?
- U-Shape with depth for novices
  - Novices search through options
  - (Predictable using O(n) model of visual search + Fitts' Law)



- Slows with depth for experts
  - Experts recall stable locations
  - Predictable using O(log n) Hick/Hyman law + Fitts' Law

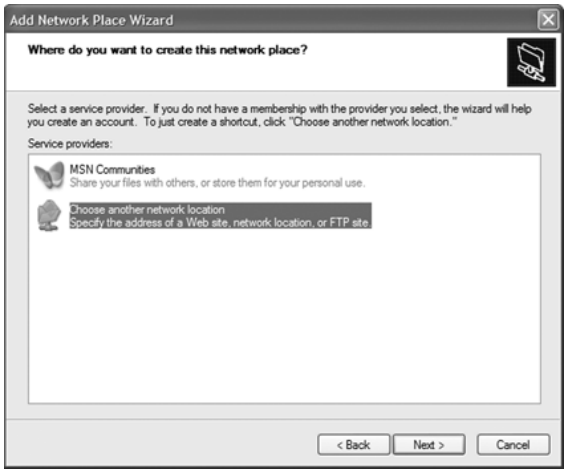


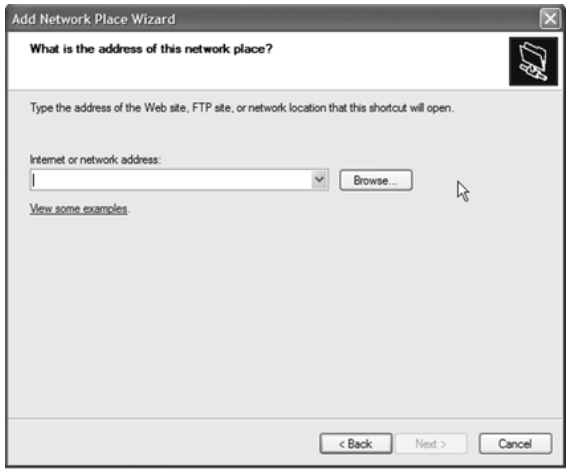
Menu Pros and Cons

- Advantages
  - Easy to learn
  - Small, incremental actions (easy to undo)
- Disadvantages
  - Over-determining for experts
  - Screen real-estate consumption
  - Trap users in ‘beginner mode’ (more later)

Form-Fill, Q&A Wizards

- Modal ‘harvesting’ of information from users
- Heavily over-determining
- Used for one-off critical actions (e.g., installation)
- (Also common from novice UI designers)





Direct Manipulation

(Shneiderman, 1982)

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

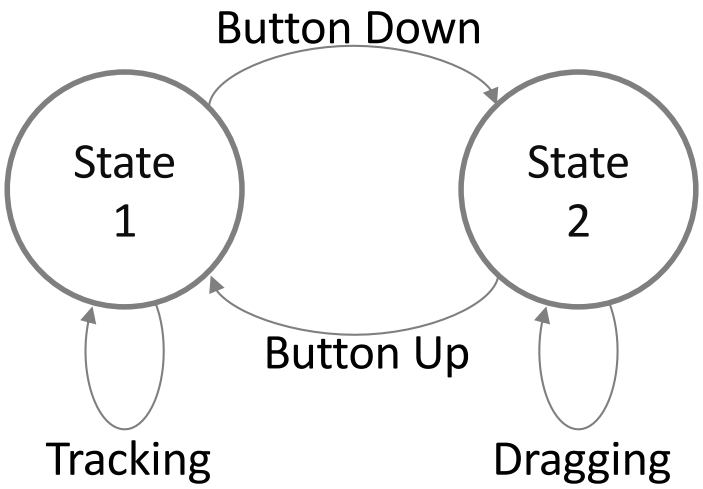
Direct Manipulation

(Shneiderman, 1982)

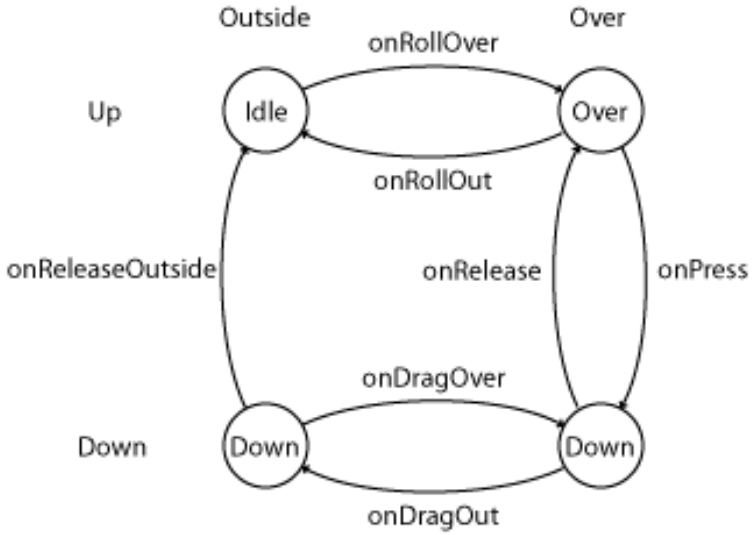
- Advantages:
  - Easy to learn
  - Low memory requirements
  - Easy to undo
  - Immediate feedback to user actions
  - Enables user to use spatial cues

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

Input Device Complications with Direct Manipulation



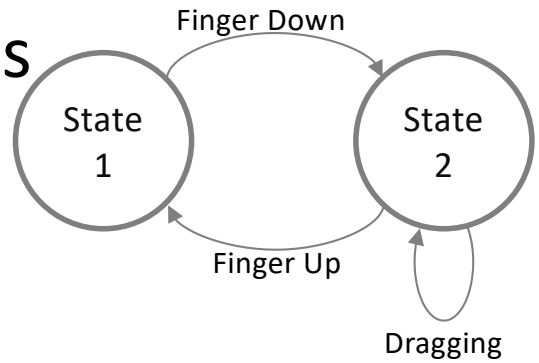
Typical input *device* states (e.g., mouse)

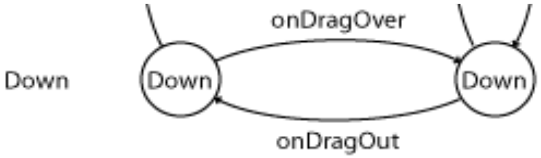


Give a large range of potential bindings when combined with display objects

Input Device Complications with Direct Manipulation

- But most current touch sensitive devices don't support tracking states
- Need to think of other methods to partition & access functionality





- QUESTION: What characteristics of touch might be used to express intention?

Web Navigation

- Main interaction mechanisms:
  - Links (author's job)
  - Search Engines (Google/Bing's job)
  - Windows/Tabs (Browser's job)
  - History mechanisms (Browser's job)
- Users are highly repetitive (more later)
- Short term history (Back/Forward)
- Long term histories
  - Recency, Frequency, Frecency, AwesomeBar
  - Bookmarks

3D UIs

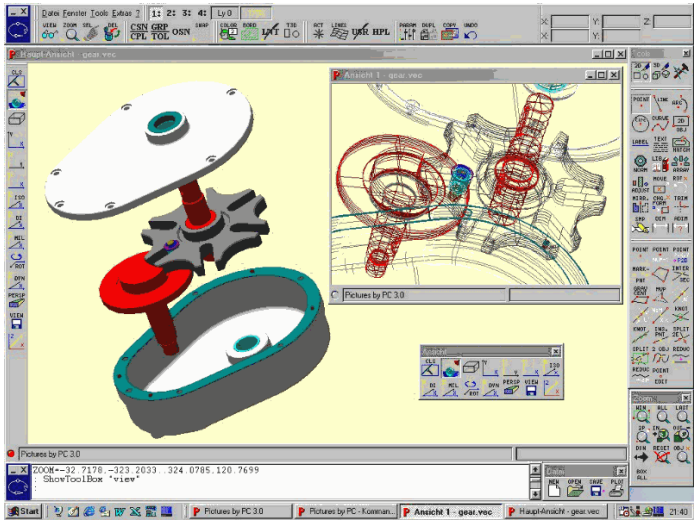
- The real world is 3D
- So all interaction should ideally be 3D, right?

Wrong!

(In my opinion.)

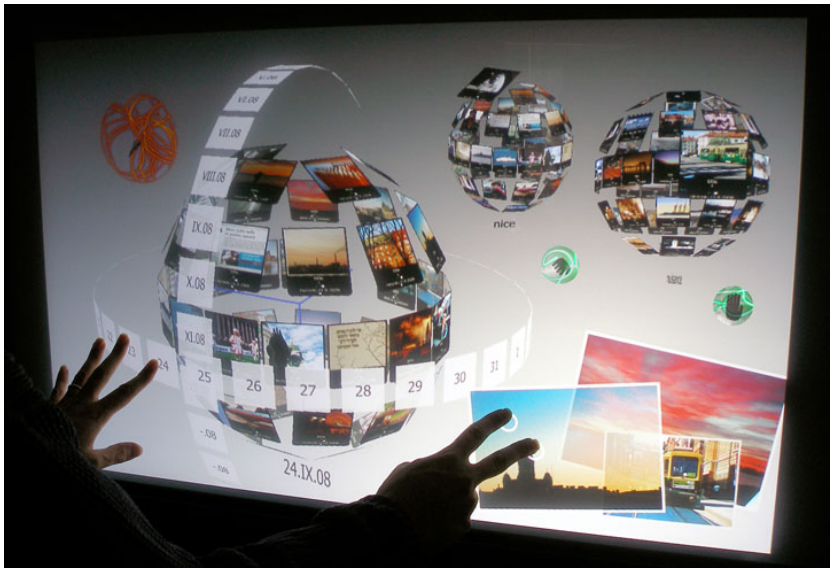
3D UIs

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



3D UIs

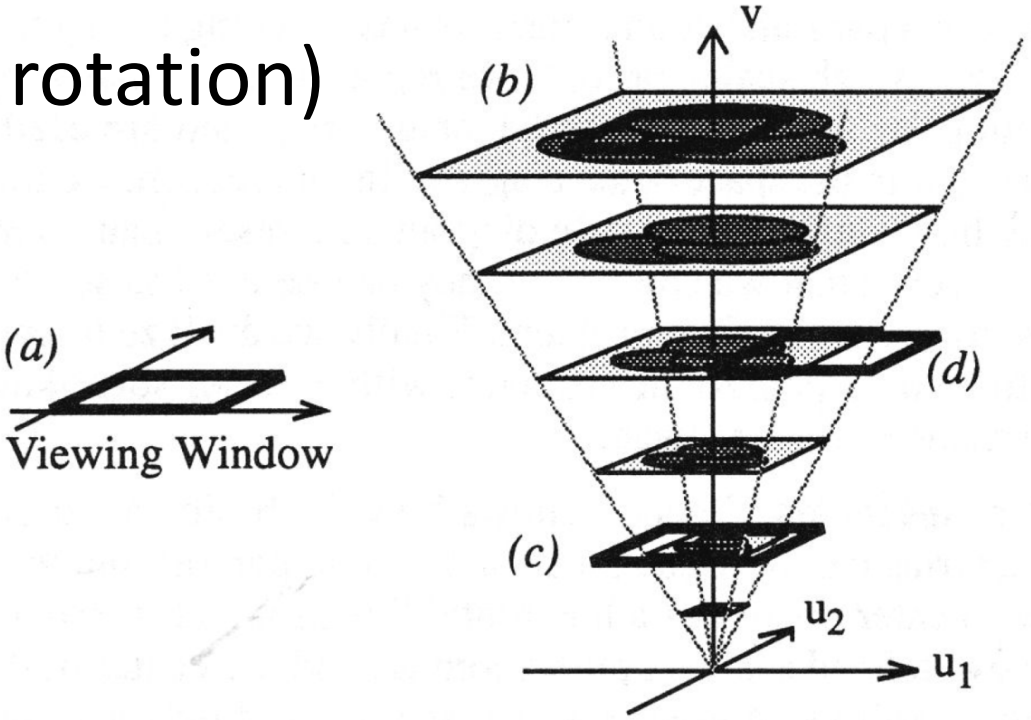
- 3D introduces problems for non 3D interactions:
  - Navigation/orientation
  - Occlusion
  - Layout efficiency
  - Layout complexity
  - Motion sickness
- Use with caution!
- (3D perception soon)



Zoomable UI

- Interaction sometimes best achieved through space-scale navigation: ZUIs
- Space: translation (& rotation)
- Scale: zoom

- Zoom reversal can be a problem
- So can “Desert Fog”



Furnas & Bederson, 1995

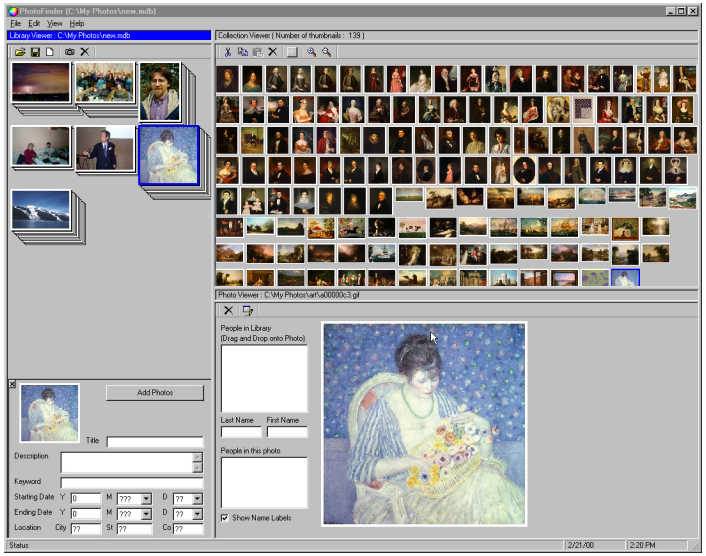
Zoomable UI

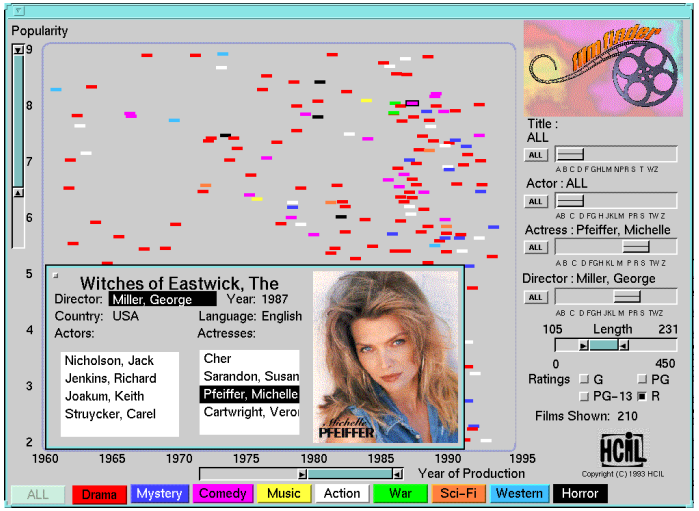
- Many good examples:
  - Google Maps, Google Finance: www.google.com/finance
  - Prezi (includes rotation): prezi.com

Zoomable UI

- "Visual Information-Seeking Mantra"
  Ben Shneiderman

Overview first, zoom and filter, details on demand





Ahlberg & Shneiderman's FilmFinder
www.cs.umd.edu/hcil/spotfire/

Natural UI

- "Natural User Interface" (NUI) is a new buzzword for 'intuitive' UIs employing 'natural' interactions such as gesture/speech

- Many problems:
  - Differences in expectations/familiarity
  - Meaning depends on context: "she said she didn't know"
  - Ambiguities: "put that there"
  - Action often terser/faster than language: "change the fifth word on the ninth line to bold"

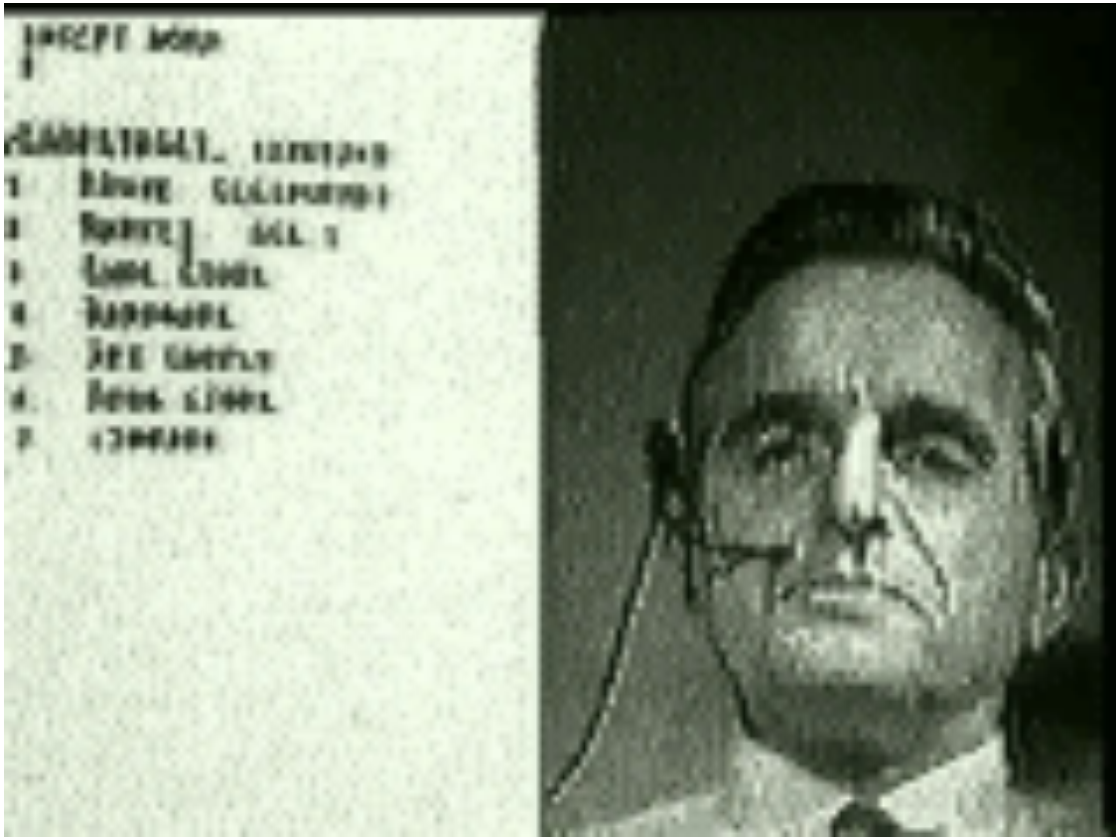
Natural UI

- Speech Input & Output
- Advantages:
  - No display required
  - Hands free
  - Easy to learn (maybe)
- Disadvantages:
  - High error rates
  - Slow
  - Difficult to browse history

CSCW
Computer Supported Cooperative Work

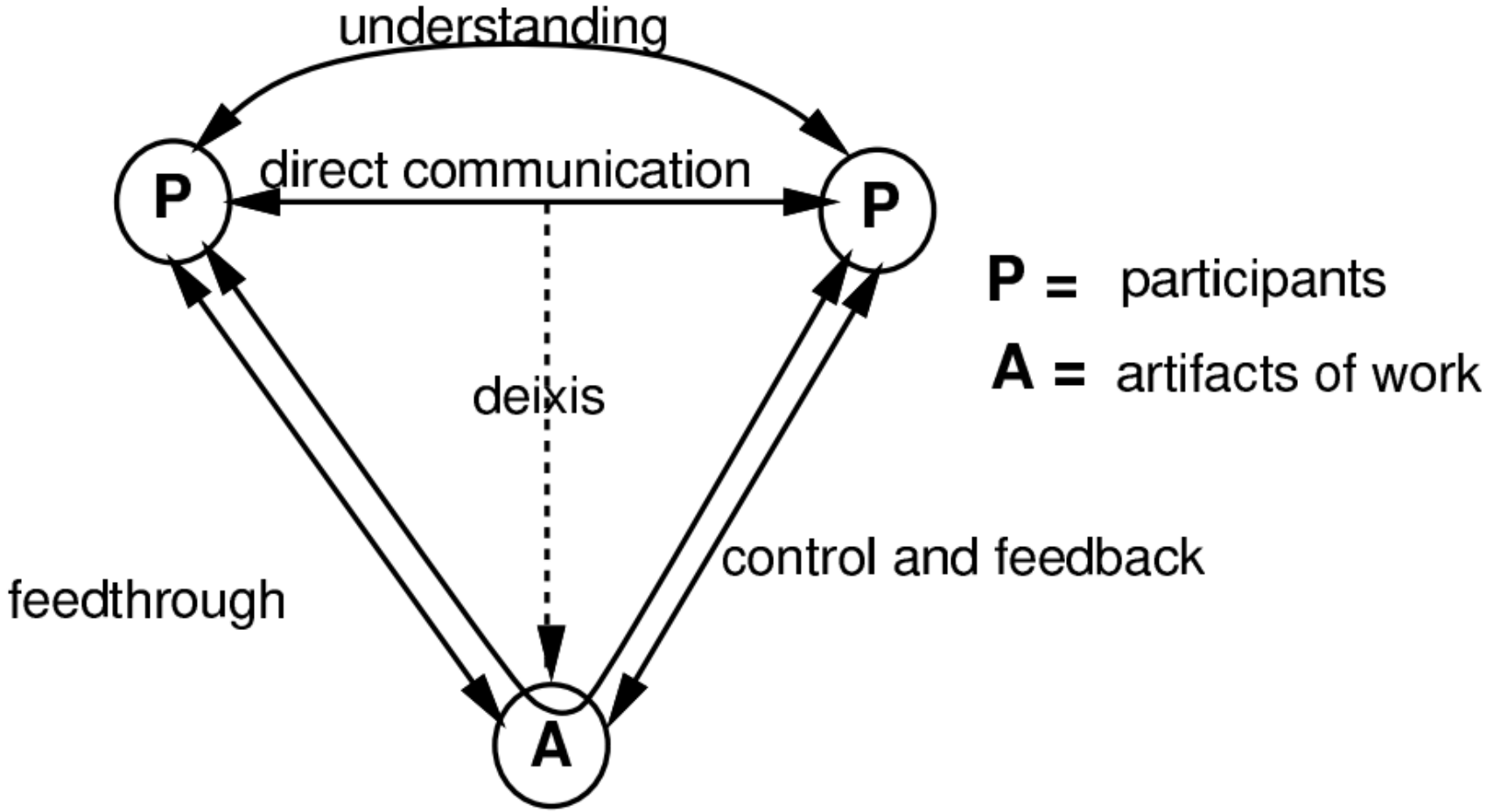
- Work is inherently collaborative
- CSCW investigates how collaborative work is conducted and how to support it
- “Groupware” systems support collaborative work
- Social software (e.g., Facebook) also fits here
- *Very* difficult to design!

CSCW
Engelbart's "Mother of All Demos" 1968

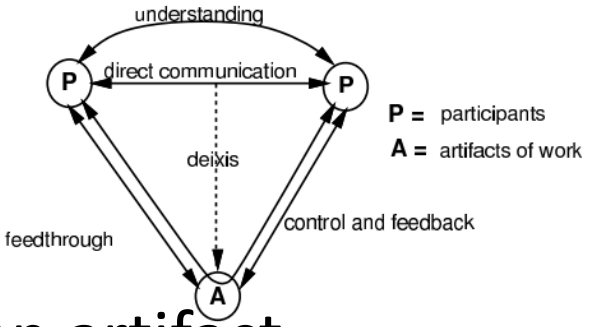


Video link on "Extra Resources" on Learn

CSCW
Participant-Artifact-Participant Framework

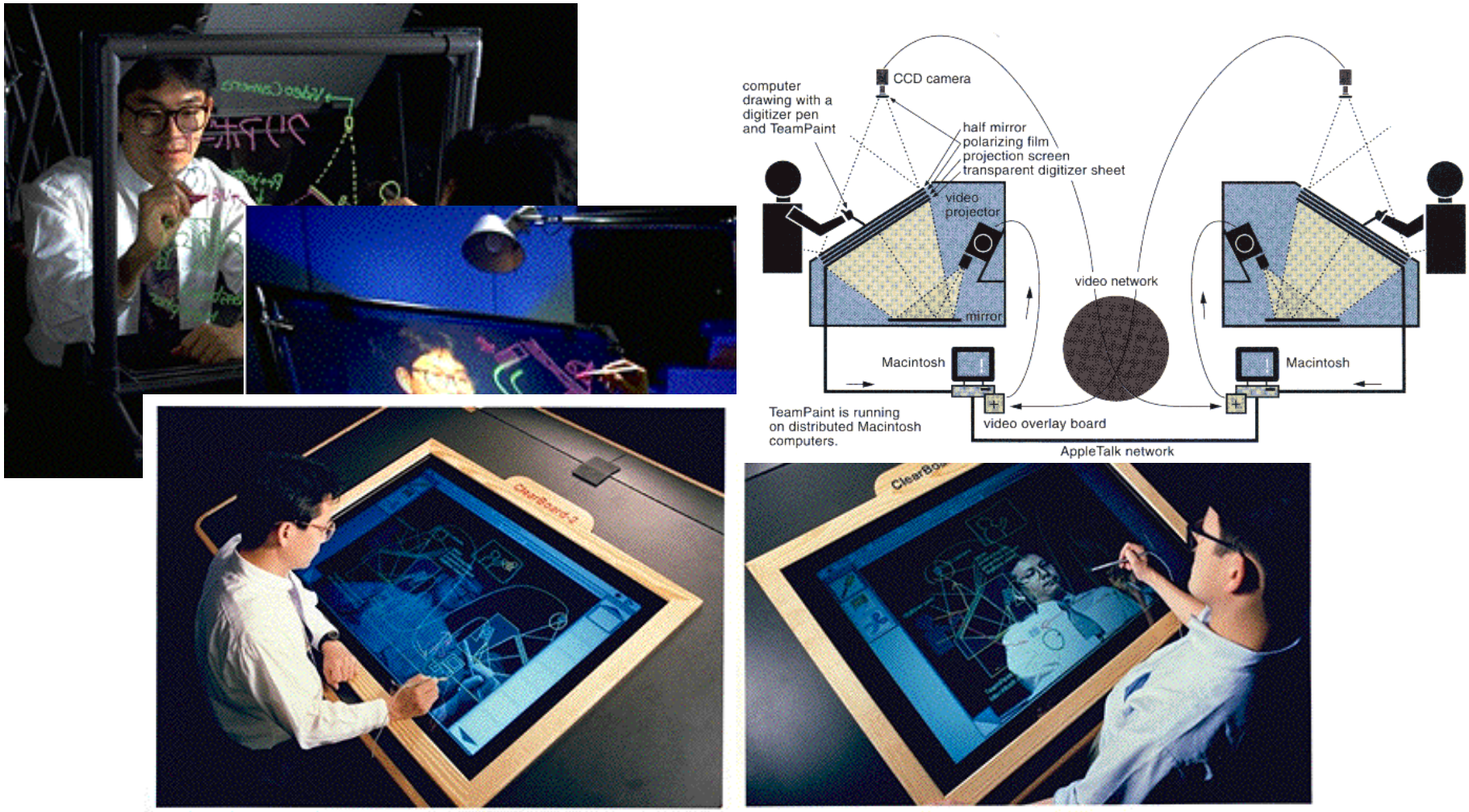


CSCW
Participant-Artifact-Participant Framework

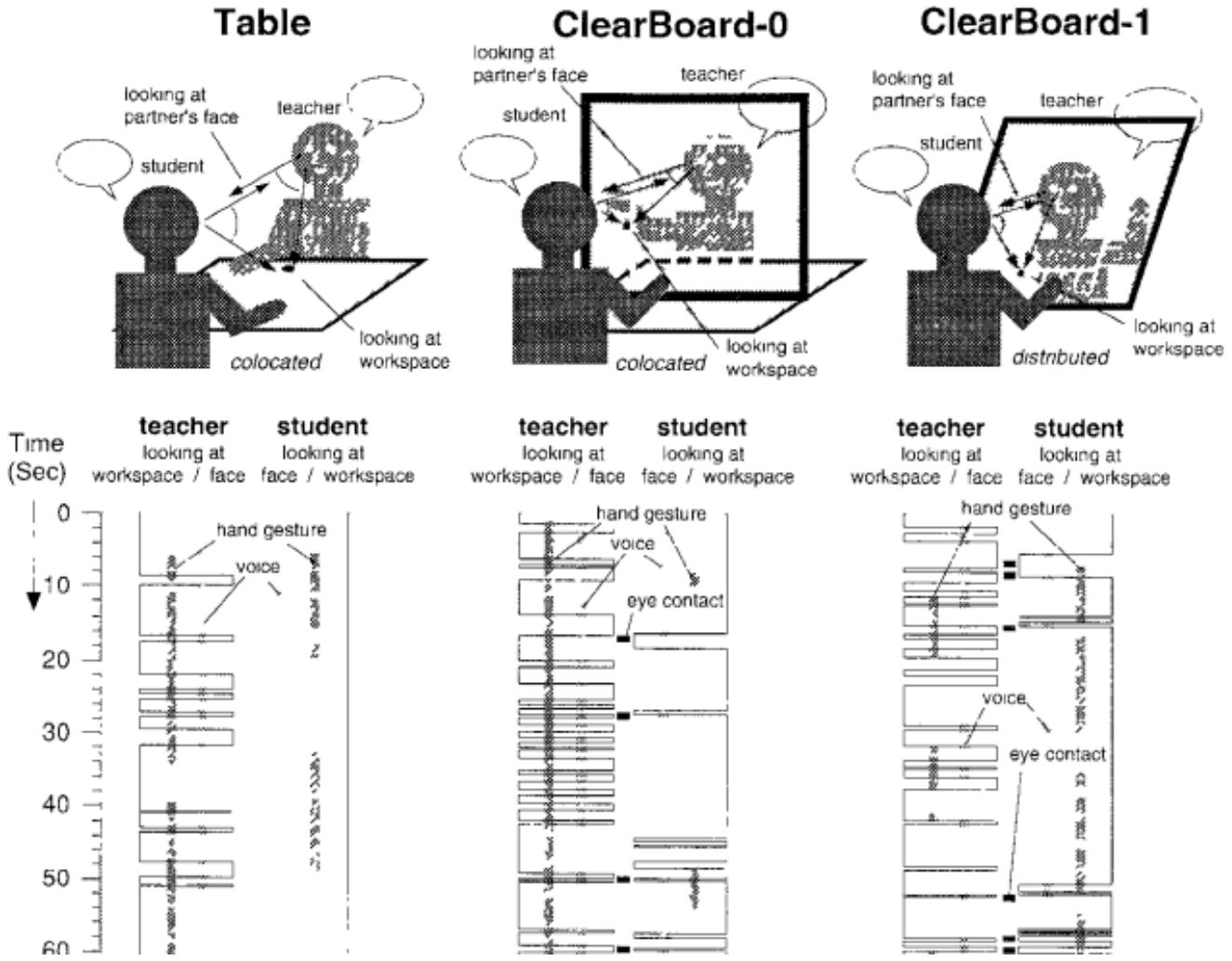


- Classifies:
  - What people do
  - What systems should support
- Feedthrough: communication through an artifact
- Direct communication takes many forms:
  - Obvious: text, speech
  - Subtle “back-channels”: nods, ‘uh-huh’, facial expression, gestures, etc.
- Deixis: communication coupled with contextual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

CSCW: Clearboard System



CSCW: Evaluating Clearboard



CSCW: Awareness Frameworks

- **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

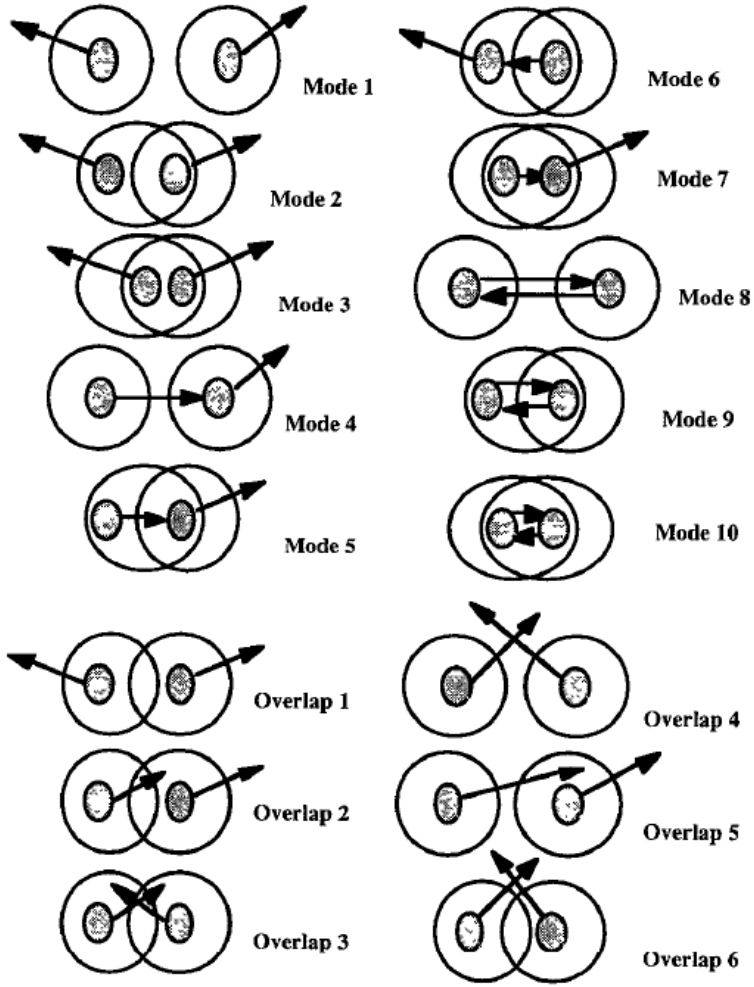


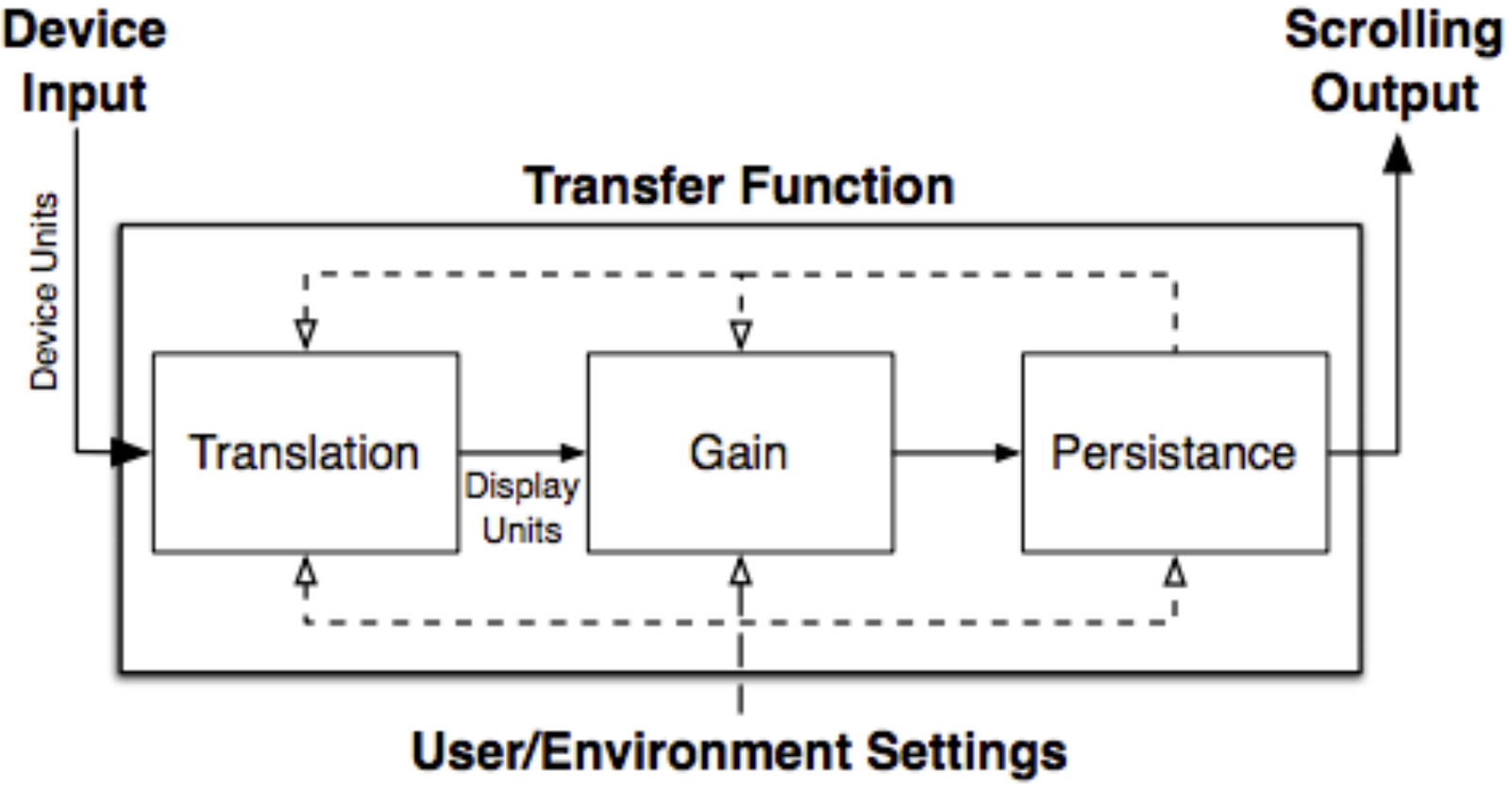
Figure 4 Different Modes of Awareness

Interface Technology: Input, Output, Processing

Input Devices: Pointing & Scrolling

- 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

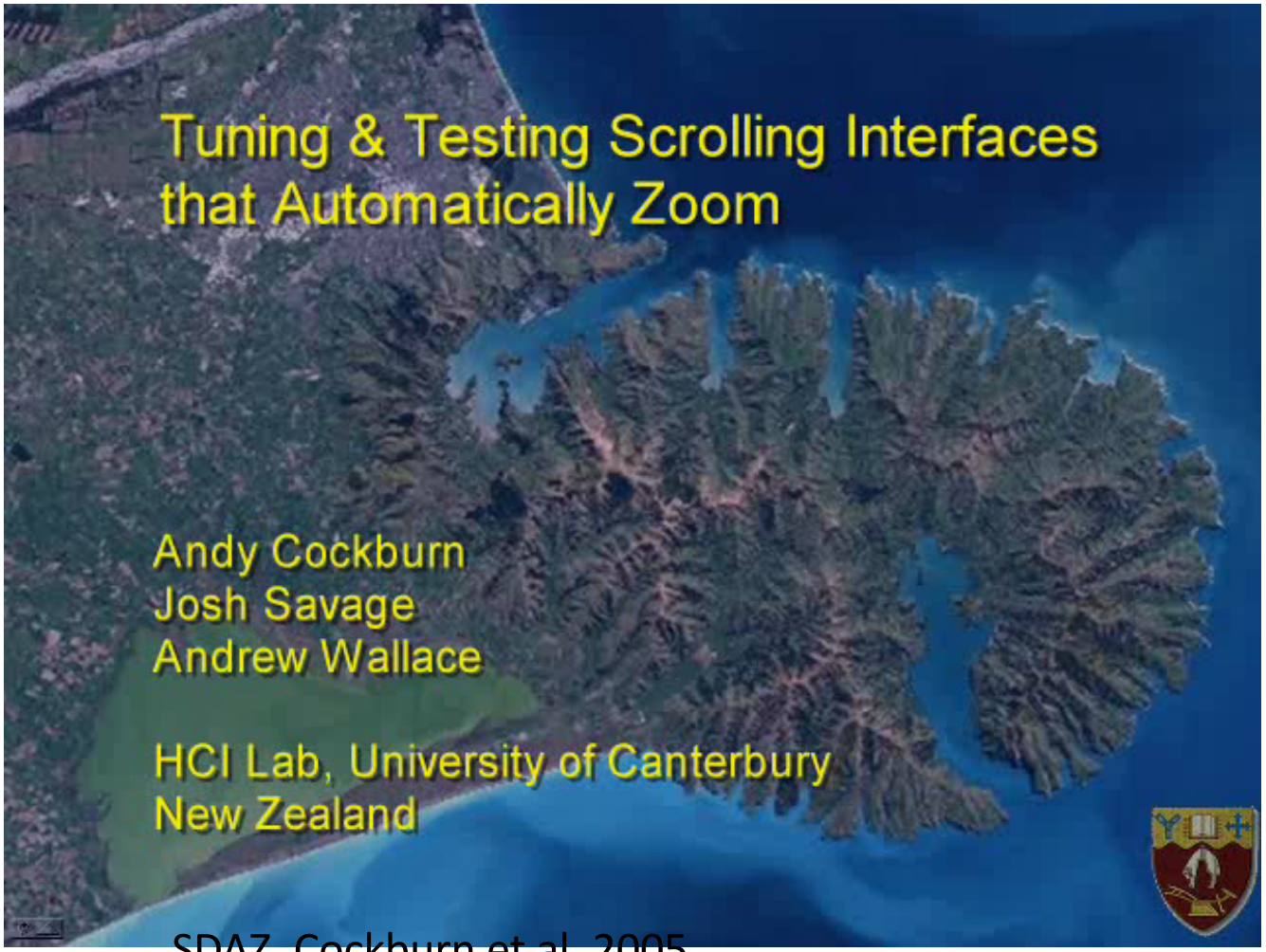


Input Devices: Scrolling Gain Example

DLD gain. Cockburn et al. 2012

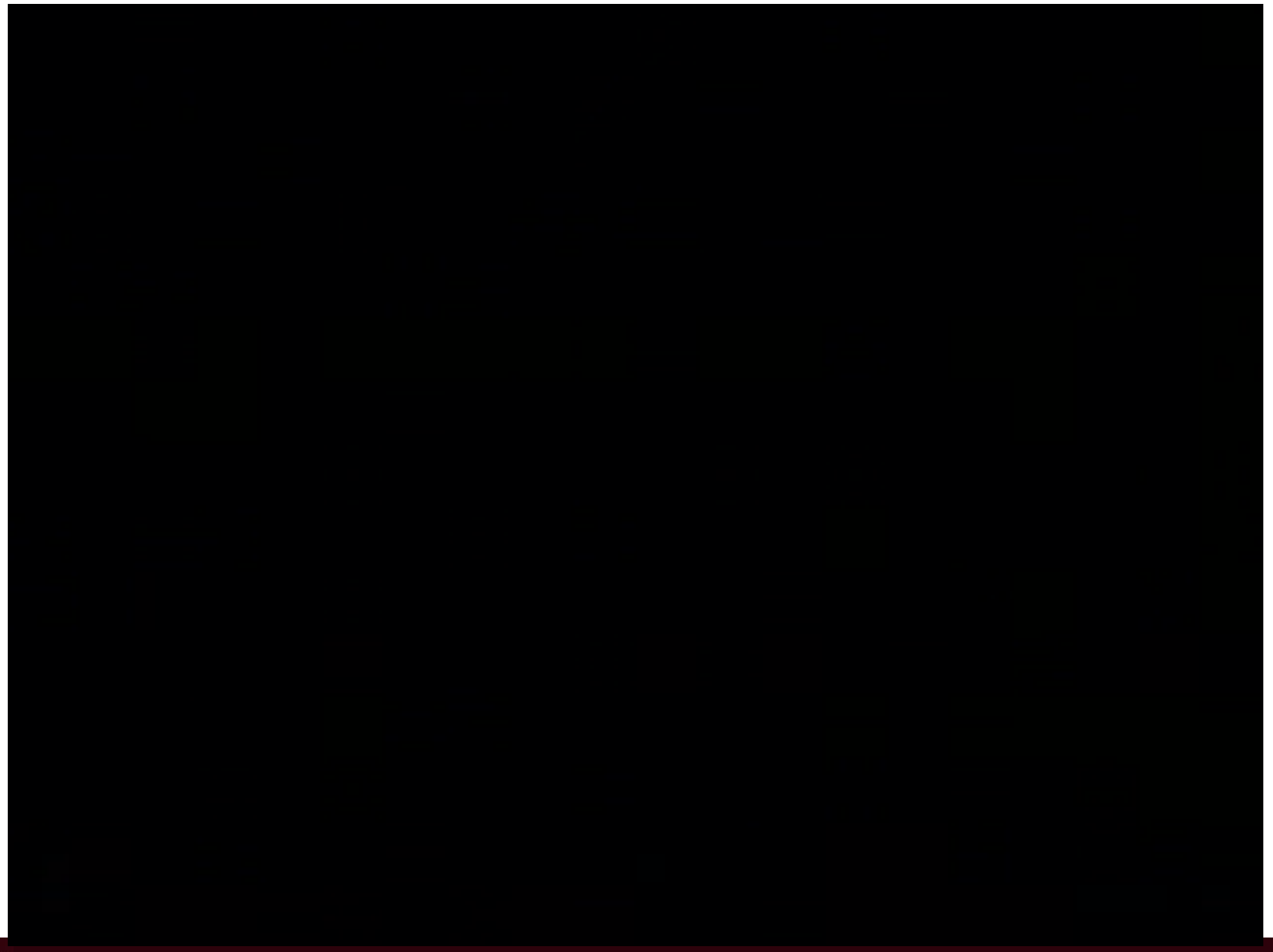
Input Devices:
Touch Scrolling Transfer Function

Input Devices: Pointing & Scrolling



SDAZ. Cockburn et al. 2005

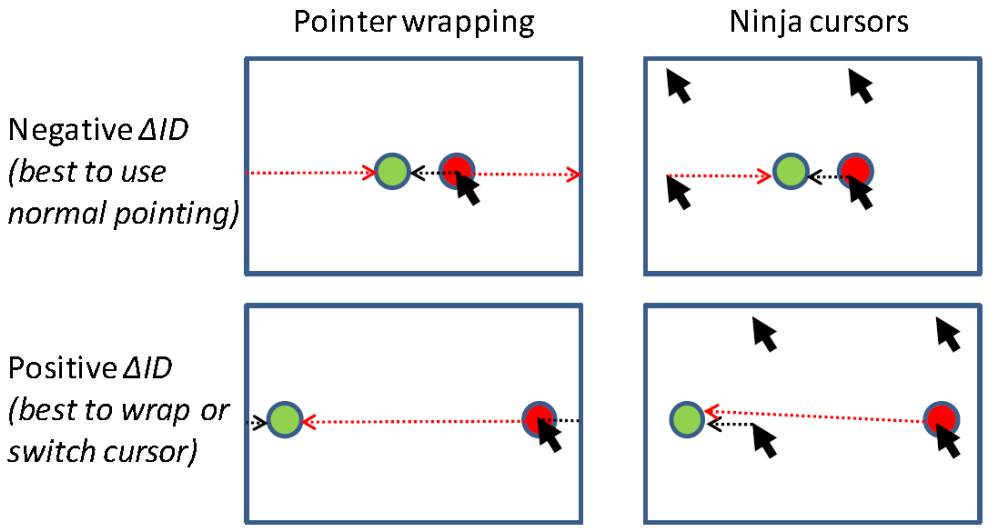
Input Techniques: Bimanual input and ‘magic lenses’



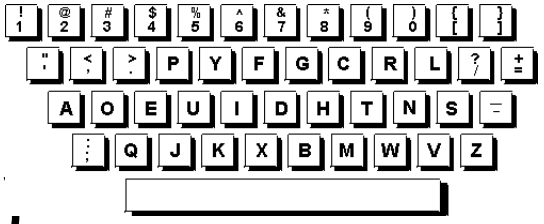
T3 Design.
Kurtenbach et al., 1997!

Input Techniques: Other Pointing

- Multi-touch
- Eyegaze and “midas touch”
- Torus pointing and “ninja-cursors”



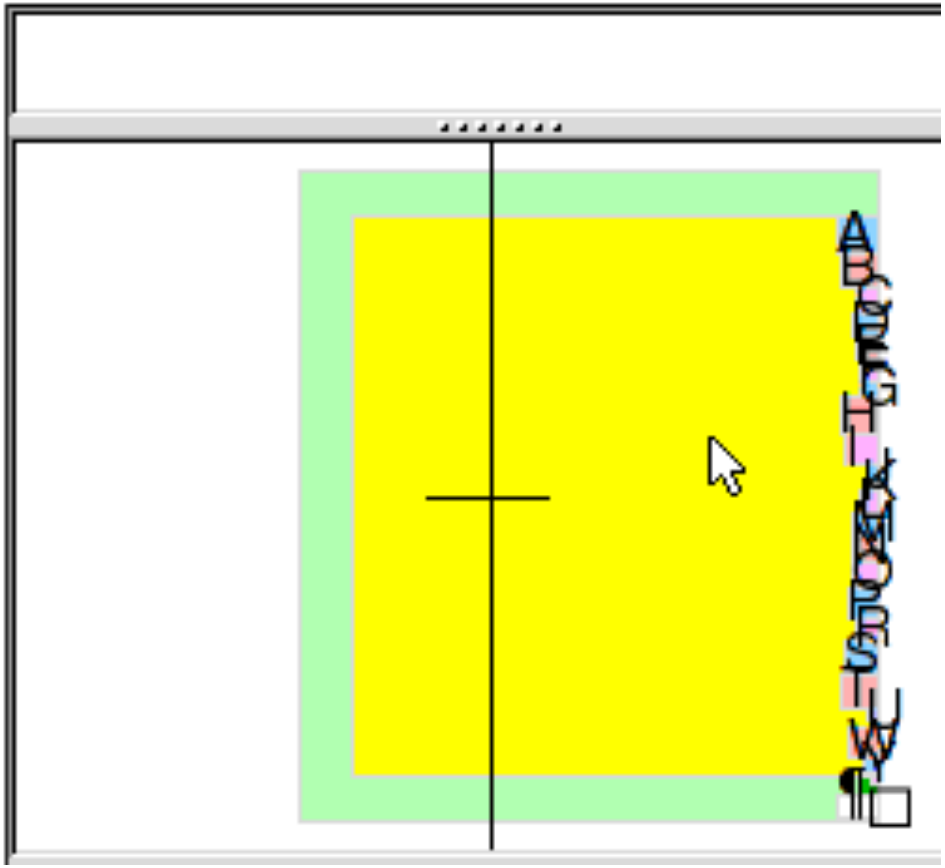
Text Input



- Alternative keyboards (e.g., Dvorak)
- Chord keys

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

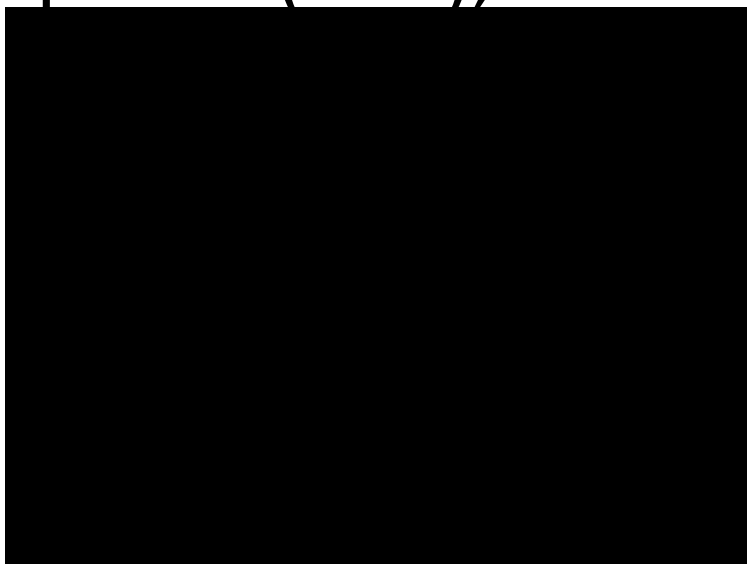
Text Input
Dasher



Text Input
On GoogleGlass?

Other Input Methods

- Speech (good for discrete commands)
- Cameras (e.g., Kinect, AR)
- Biometrics: Galvanic skin response (GSR), pupil dilation, skinput
- Accelerometers, gyros, ...
- BCI



Skinput, Harrison et al. 2010.

Output

- Large table/wall devices
- Tiny mobile devices (e.g., watch)
- Spatial sound
- 3D displays
- Volumetric displays
- Haptics

Processing Speed Concerns

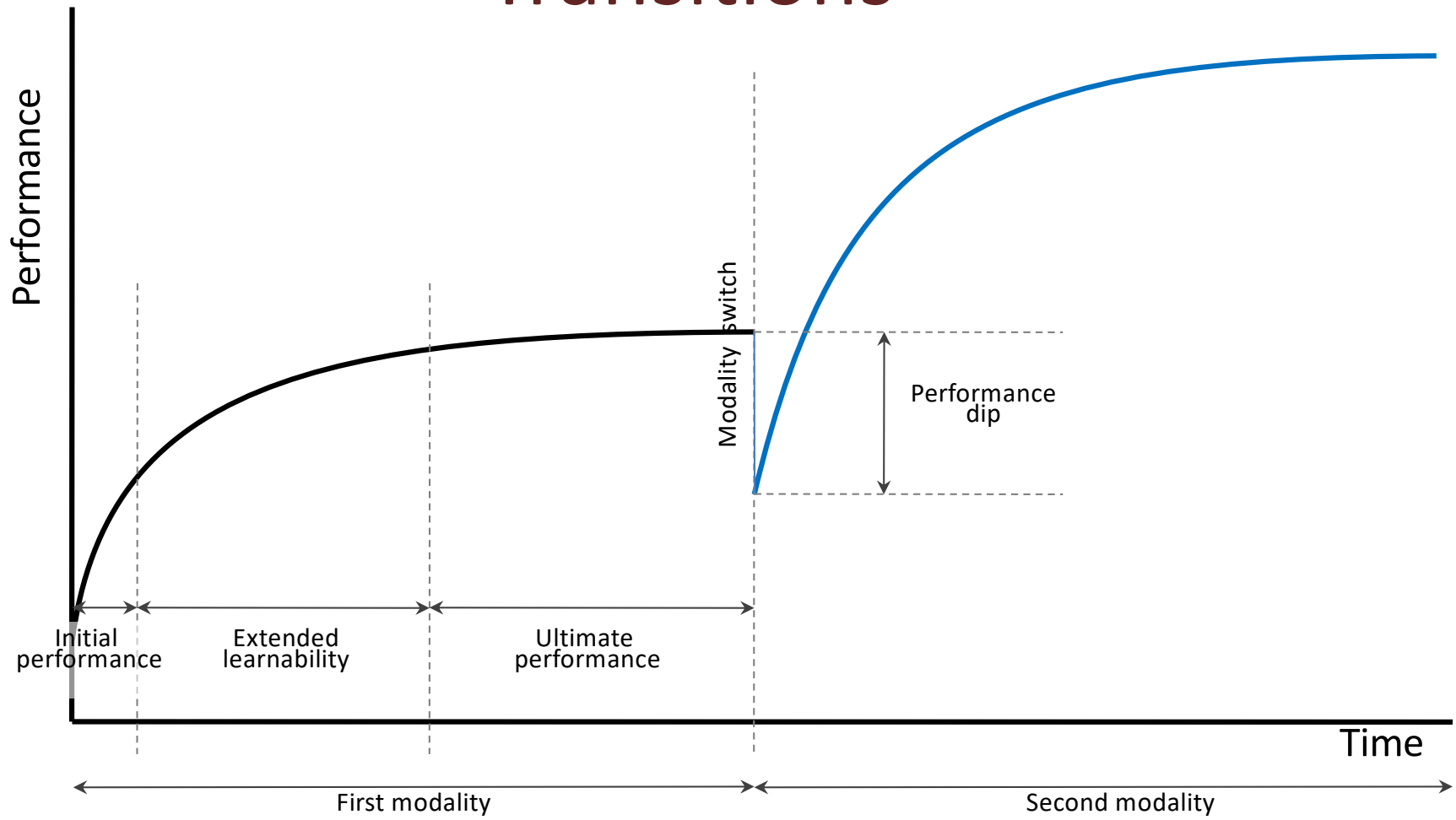
- Designers: Beware of the myth of the infinitely fast machine
- Timing and delay problems are critical for hand-eye coordination and collaboration
  - Latency: duration of predictable delay
  - Jitter: variability of delay
- Processing too slow:
  - "simultaneous" actions may be registered separately
  - users may repeat actions

Novice to Expert Transition

Novice to Expert Transitions

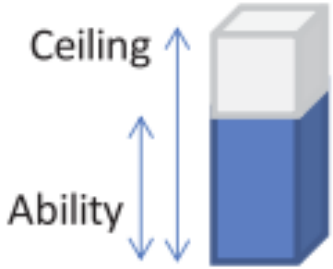
- People use the same tools for years/decades
- Yet shortcut vocabularies are small, and frequency of their use is low
- Many factors:
  - Satisficing (making do rather than optimising)
  - Lack of mnemonics (e.g., Ctrl P for print… paste?)
  - Lack of visibility
- How to support transition to expertise?

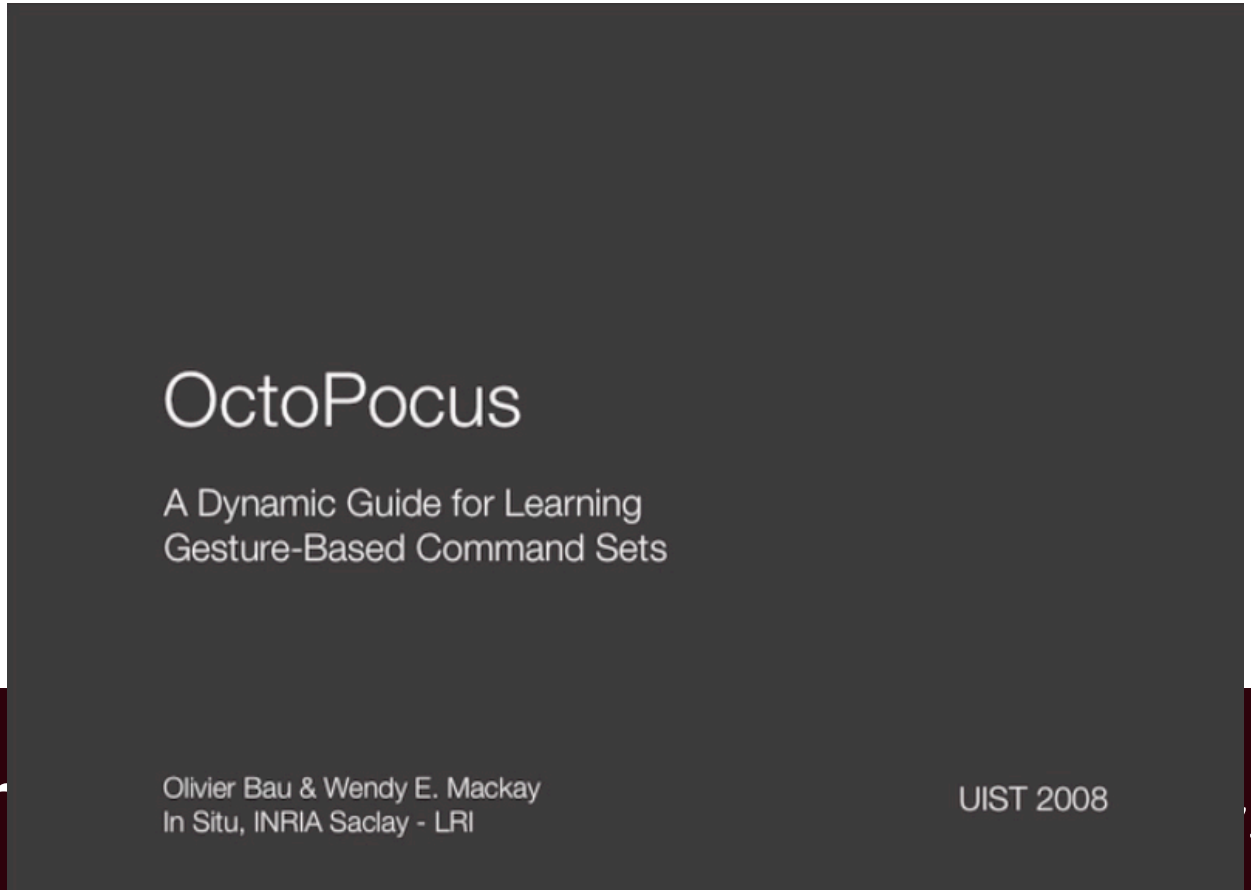
Characterising Novice to Expert Transitions



Domains of Interface Performance Improvement

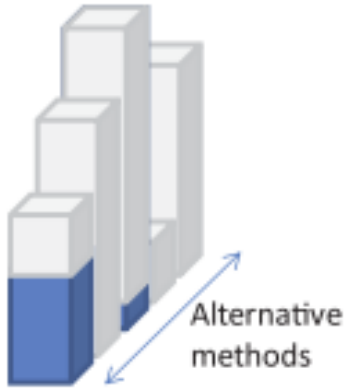
1. Intra-modal improvement
   – E.g. *guidance* techniques

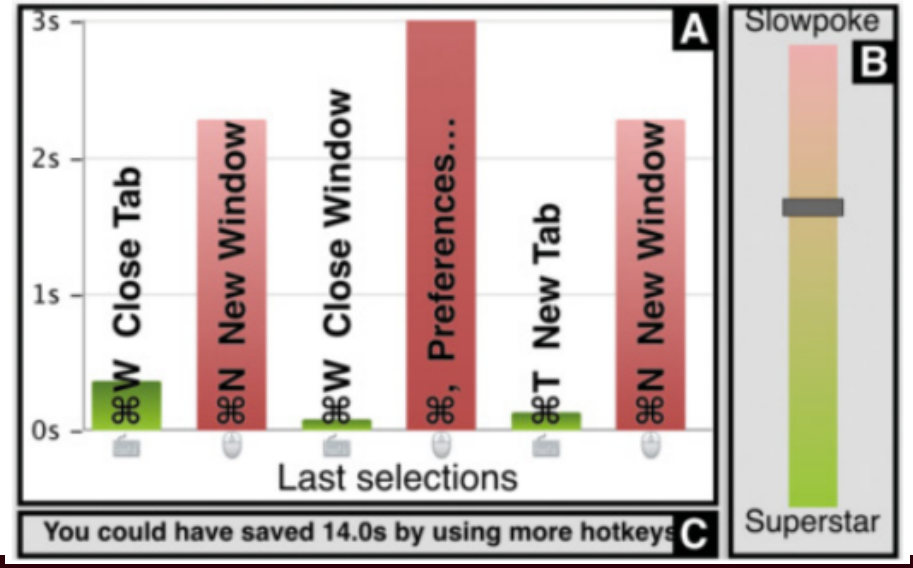




Domains of Interface Performance Improvement

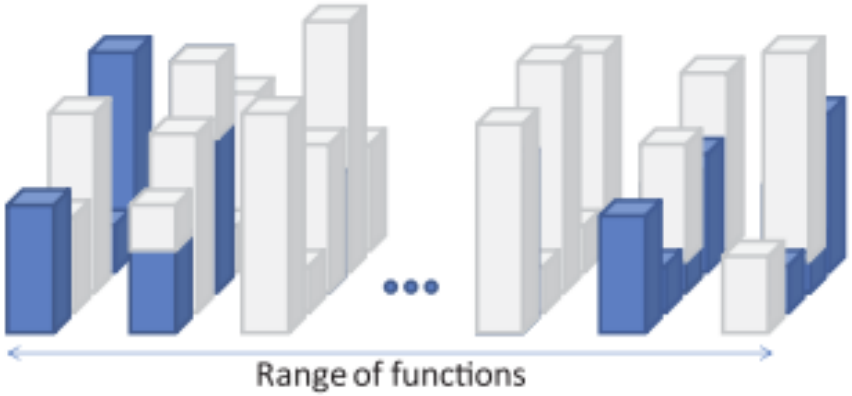
1. Intra-modal improvement
2. Inter-modal improvement
   - E.g., skillometers

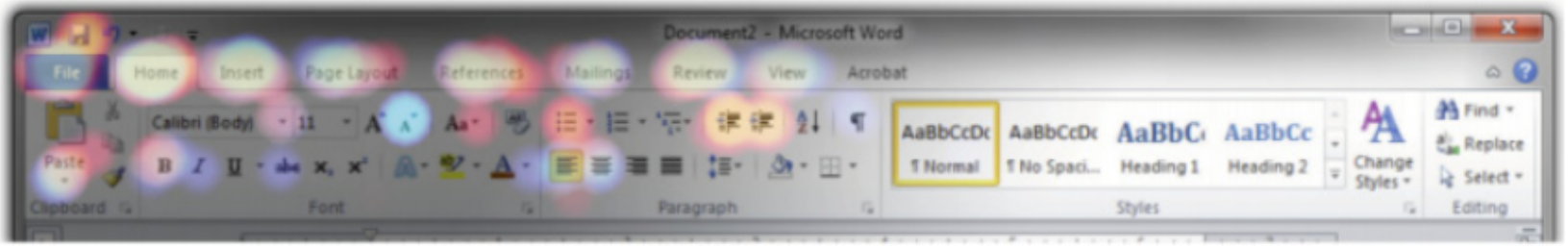




Domains of Interface Performance Improvement

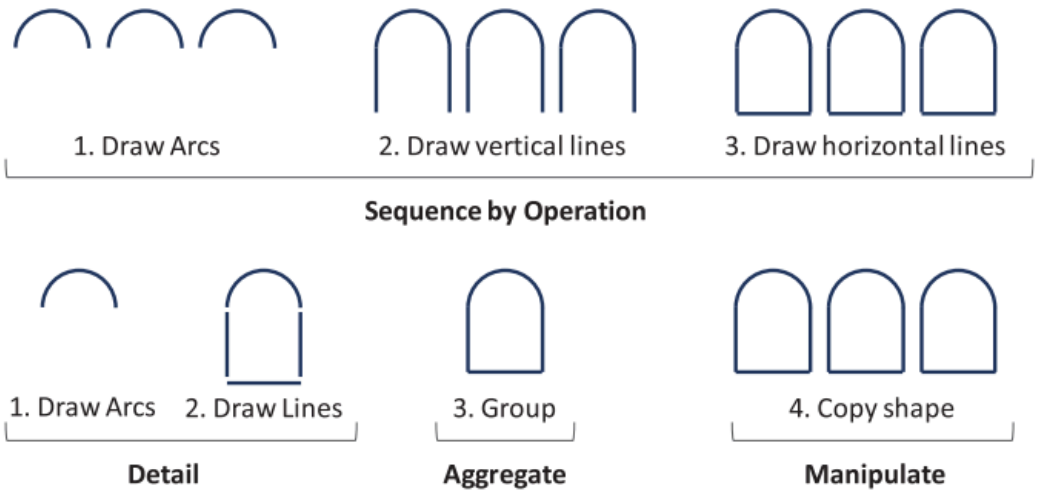
1. Intra-modal improvement
2. Inter-modal improvement
3. Vocabulary extension
   - E.g., community command use





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