

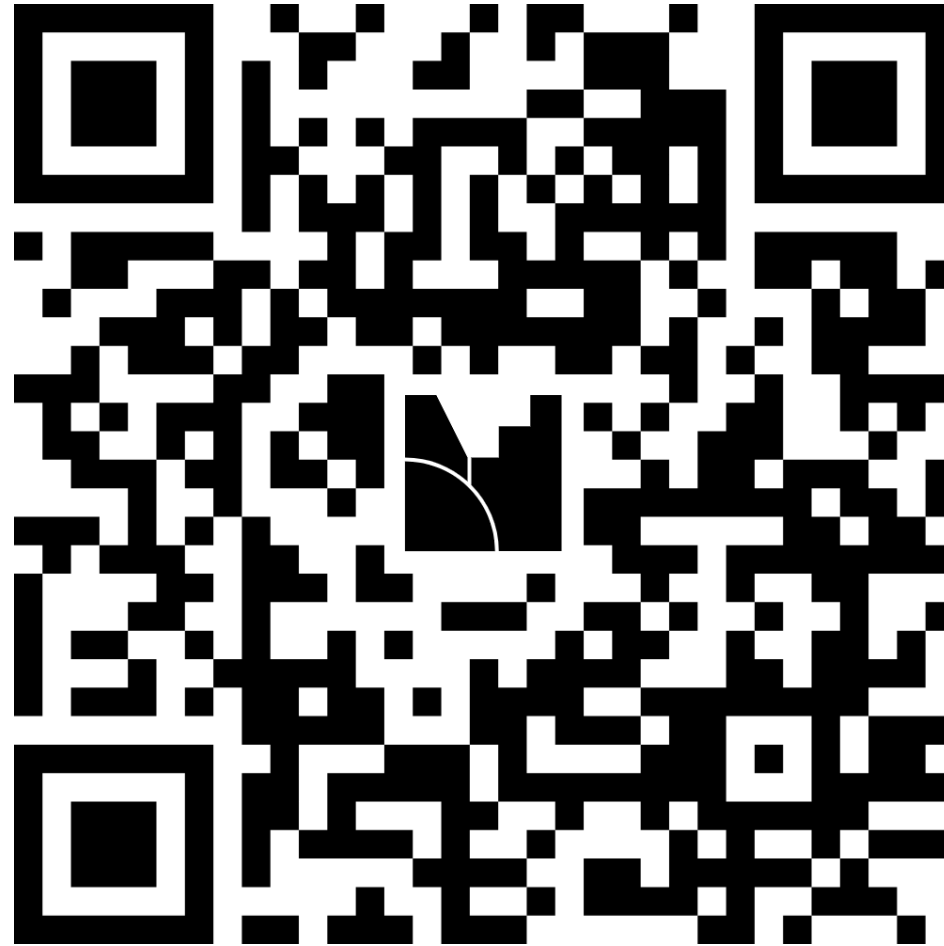
Designing Novel Interactions

Prepared by:
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Topics of Discussion

- WIMP
 - What is WIMP?
 - When does it fail?
- Spatially Immersive Interfaces
 - VR
 - AR
- Tangible User Interfaces
 - Reactable
 - inform & Radical Atoms
 - Lego Tangible Interfaces
- Voice-User Interfaces (VUI)
 - What is it?
 - Differences with WIMP
 - Ward Watch as VUI
 - Evaluation: WoZ
- Prototyping Novel Interfaces
- Adapting Heuristics for Novel Interfaces

Menti Link



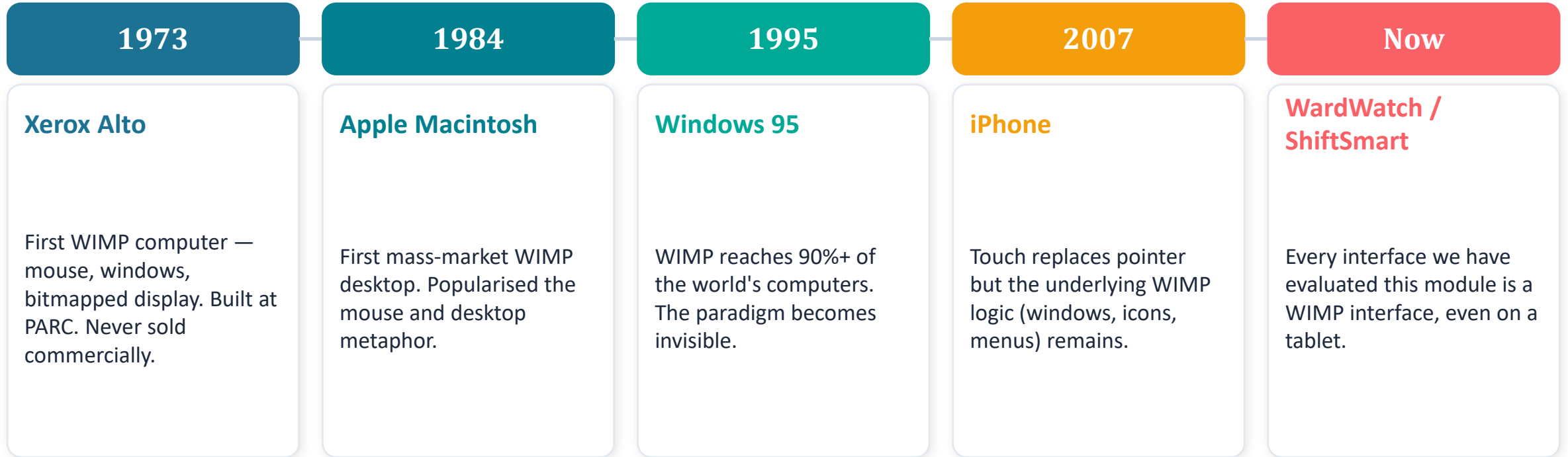
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What is WIMP — and why does it dominate?

Windows · Icons · Menus · Pointer — the paradigm behind almost every interface you have evaluated in this module [1, 2].



What WIMP assumes about every user:

- ✗ Has two free hands
- ✗ Is seated at a stable surface
- ✗ Can look at a screen for extended periods
- ✗ Is not wearing gloves, a helmet, or a surgical mask
- ✗ Has a background noise level low enough to read
- ✗ Is not simultaneously performing another physical task

[1] Hutchins, E., Hollan, J. and Norman, D. (1985). Direct manipulation interfaces. *Human-Computer Interaction*, 1(4), pp.311–338.

[2] Myers, B.A. (1998). A brief history of human-computer interaction technology. *Interactions*, 5(2), pp.44–54.

When does WIMP fail?

WIMP breaks down when its assumptions about the user and environment stop being true [3].



Healthcare

Problem:

Surgeons cannot touch a screen mid-operation. Nurses are gloved and cannot use a mouse. Patients may have motor impairments.

Alternative:

Voice commands, gesture, foot pedals, ambient displays



Mobile / On-the-move

Problem:

Users are walking, driving, carrying things. Attention is split. Glancing at a screen is dangerous or impossible.

Alternative:

Voice interface, wearables, haptic feedback, heads-up display



Immersive / Spatial

Problem:

Inside VR/AR there is no physical keyboard or mouse. The user's body is the controller. WIMP has no concept of 3D space.

Alternative:

Hand tracking, gaze, controller input, spatial UI



Physical environments

Problem:

Factory floors, construction sites, kitchens i.e., dirty hands, loud noise, awkward postures make screen interaction impractical.

Alternative:

Tangible interfaces, projected UI, voice, foot pedals

[3] van Dam, A. (1997). Post-WIMP user interfaces. *Communications of the ACM*, 40(2), pp.63–67.

[4] Weiser, M. (1991). The computer for the 21st century. *Scientific American*, 265(3), pp.94–104.

Spatially Immersive Interfaces

Two spatial paradigms — AR adds to reality, VR replaces it. Both require fundamentally new design thinking [5, 6].

Virtual Reality (VR)

The user is fully immersed in a digital environment. No physical world visible. Meta Quest, PlayStation VR, Valve Index. Used for training, therapy, and entertainment.

Design principles:

- Locomotion design — how users move without physically moving (teleportation vs smooth movement). Smooth = motion sickness
- Diegetic vs non-diegetic UI — does the interface exist inside the world or float in front of the user?
- Frame rate — below 90fps causes simulator sickness in most users. Non-negotiable.
- Presence — the feeling of 'being there'. Broken by inconsistencies in the virtual environment.

Healthcare: Surgical simulation training (Osso VR), phobia treatment (VR exposure therapy), pain management, rehabilitation



<https://www.youtube.com/watch?v=dkYGUMGUu4U>

[5] Azuma, R.T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, 6(4), pp.355–385.

[6] Sherman, W.R. and Craig, A.B. (2018). *Understanding Virtual Reality*. 2nd edn. Cambridge, MA: Morgan Kaufmann.

Spatially Immersive Interfaces

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Augmented Reality (AR)

Digital content is overlaid on the physical world. The user sees both simultaneously. Apple Vision Pro, Microsoft HoloLens, Google Maps Live View, IKEA Place.

Design principles:

- Anchor points — digital content must track to physical surfaces accurately or it feels broken
- Occlusion — digital objects should be occluded by physical objects (otherwise the illusion fails)
- Information density — physical world is already complex; adding too much digital content causes overload
- Lighting and contrast — overlays must be legible in variable real-world lighting conditions



<https://www.youtube.com/watch?v=DWxiiguFLf8>



<https://www.youtube.com/watch?v=9faG8dUHJuk>

Healthcare: Vein-finding AR (AccuVein), surgical overlay guidance, hospital wayfinding, drug interaction overlays on patient records

[5] Azuma, R.T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, 6(4), pp.355–385.

[6] Sherman, W.R. and Craig, A.B. (2018). *Understanding Virtual Reality*. 2nd edn. Cambridge, MA: Morgan Kaufmann.

Tangible User Interfaces (TUIs)

Physical objects in the real world are coupled to digital representations; you manipulate the world to change the computation [7, 8].

Origin: Hiroshi Ishii & Brygg Ullmer, MIT Media Lab (1997). 'Tangible Bits' — the physical world as the interface. Instead of clicking an icon, you pick up a block. The representation and the control are the same physical thing.

Reactable

A tabletop synthesiser where physical blocks represent instruments. Moving and rotating blocks changes the music in real time. Used by Björk on tour.

Design principle:

The interface IS the instrument — no screen, no menu, no pointer.

HCI link: Embodies Dourish's Embodied Interaction — cognition is distributed across the performer's body, the objects, and the table surface.



<https://www.youtube.com/watch?v=hNeCHI4NAzw>

[7] Ishii, H. and Ullmer, B. (1997). *Tangible bits: towards seamless interfaces between people, bits and atoms*. CHI '97. pp.234–241.

[8] Resnick, M. et al. (1998). *Digital manipulatives: new toys to think with*. CHI '98. pp.281–287.

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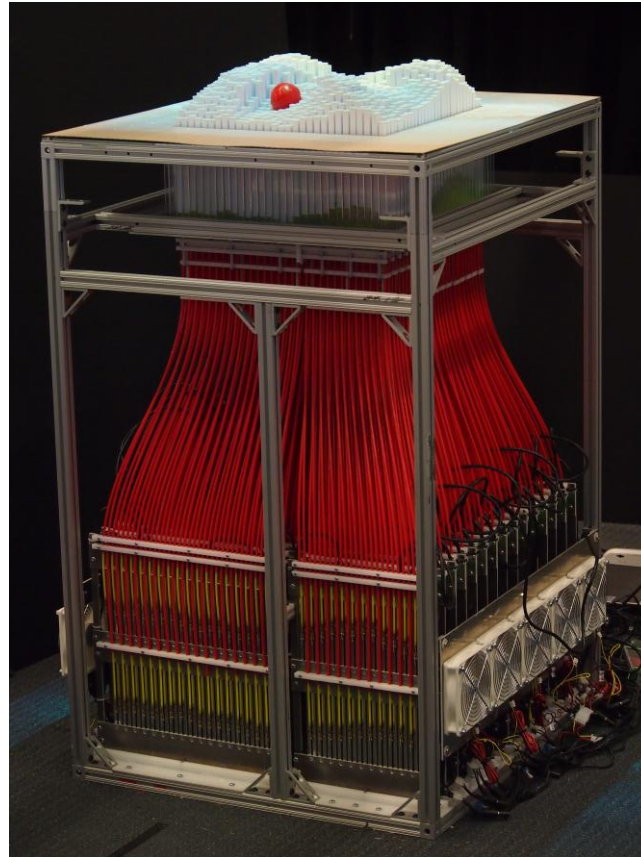
InFORM Table

inFORM is a shape-shifting table that renders 3D data physically developed by MIT Media Lab.

Design principle:

'Atoms and bits' — the physical and digital are the same material.

HCI link: Direct application of Activity Theory — the artefact mediates action so completely that the distinction between tool and output disappears.



<https://www.youtube.com/watch?v=ouP9xNujkNo&t=211s>

[7] Ishii, H. and Ullmer, B. (1997). *Tangible bits: towards seamless interfaces between people, bits and atoms*. CHI '97. pp.234–241.

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LEGO Tangible Interface in Education

Physical LEGO bricks are tracked by a camera; children code by arranging bricks rather than typing developed by MIT Media Lab. Used in primary schools and programming literacy initiatives.

Design principle:

The physical action IS the programming, debugging means rearranging objects.

HCI link: Lower cognitive load for novices — motor memory can substitute for syntactic memory. Removes the blank-screen problem entirely.



https://www.youtube.com/watch?v=C_P3nNl0XQo

[7] Ishii, H. and Ullmer, B. (1997). Tangible bits: towards seamless interfaces between people, bits and atoms. CHI '97. pp.234–241.

[8] Resnick, M. et al. (1998). Digital manipulatives: new toys to think with. CHI '98. pp.281–287.

Voice User Interface (VUI) Design

In a VUI, the interface IS the conversation as there is no screen to scan, no icon to click, no back button [9, 10].

What changes when you move from screen to voice:

Dimension	Screen (WIMP)	Voice (VUI)
Navigation	User scans a menu and picks an option	User must remember or discover what they can say
Affordance	Buttons, labels, and icons signal available actions	Nothing signals what to say — the system must tell you
Errors	Screen message sits until user reads it	Error is a spoken turn — user hears it once and it is gone
Undo	Back button / Ctrl+Z always available	'Cancel' must be explicitly designed into every flow
Feedback	Visual confirmation persists on screen	Confirmation is spoken — user must hold it in working memory
Pace	User sets the pace (read as fast or slow as they like)	System controls pacing — too slow = frustrating, too fast = missed



Design principle: In a VUI, silence IS a system response. Pauses, partial confirmations, and 'Hmm...' sounds are all interface design decisions. You should never design a voice interface by starting from a screen flow.

WardWatch as a Voice Interface

Sample voice interaction for the WardWatch system as a conversation [7, 8].

NURSE: Hey WardWatch.

SYSTEM: WardWatch ready. Which patient?

NURSE: Patient Edwards, Bed 7.

SYSTEM: Found: Marcus Edwards, Bed 7. Current risk status: not flagged. What would you like to do?

NURSE: Flag as high risk.

SYSTEM: Confirm: flag Marcus Edwards, Bed 7 as high risk?

NURSE: Confirm.

SYSTEM: Done. Edwards flagged as high risk. Handover updated.

Error path (patient name not recognised):

NURSE: Flag Edwards.

SYSTEM: I found 2 patients named Edwards. Bed 7 or Bed 12?

Wizard of Oz

The Wizard of Oz method was not originally an evaluation technique; it was how voice interfaces were first researched [11].

1984, IBM Research — John Kelley wanted to study how people would use a natural language interface before the technology existed. A researcher sat hidden behind a partition and typed responses that a voice synthesiser read aloud. Participants believed they were talking to a real AI. This was the first Wizard of Oz study. [11]



Test voice interfaces before NLP is built

The wizard types responses that a synthesiser reads aloud. Participants cannot tell the difference. You get real behavioural data from a system that does not exist yet.

Test AR overlays before building the app

A second screen operator places digital overlays on a video feed in real time. Used to evaluate AR surgical guidance, AR wayfinding, and AR maintenance instructions.

Test gesture interfaces before cameras are calibrated

An operator maps participant gestures to system responses in real time. Evaluates gesture vocabulary and discoverability before any computer vision pipeline exists.

Prototyping Novel Interfaces Without Building Them

You can evaluate a voice interface without NLP, an AR system without cameras, and a TUI without sensors [12, 13].



1. Wizard of Oz

A hidden researcher simulates system responses in real time. Participant believes the system is real.

When: Voice interfaces, AR overlays, gesture recognition, AI systems — any interaction that doesn't exist yet

Ref: Kelley (1984) [11] — used today in the lab activity



2. Bodystorming

Designers act out the interaction in the physical space where it will be used, with no technology at all — bodies as props.

When: Healthcare contexts, physical spaces, TUIs, AR wayfinding, anywhere the body and space are part of the interaction

Ref: Oulasvirta et al. (2003) [12] — 'Interaction in 4-second bursts'



3. Paper scripts + storyboards

Voice flows written as conversation scripts; AR interactions drawn as comic panels showing what the user would see at each step.

When: Early-stage ideation before any prototyping. Cheap, fast, and collaborative.

Ref: Preece, Rogers & Sharp (2019) [13] — Chapter 11: Prototyping



4. Physical stand-ins

Cardboard boxes wired with LEDs for TUIs. Arduino boards for basic sensing. Everyday objects (mugs, blocks) to test grip and manipulation before engineering the real artefact.

When: TUIs, wearables, tangible interfaces — any physical form factor

Ref: Hartmann et al. (2006) [14] — Reflective physical prototyping

[12] Oulasvirta, A. et al. (2003). Understanding contexts by being there. *Personal and Ubiquitous Computing*, 7(2), pp.125–134.

[13] Preece, J., Rogers, Y. and Sharp, H. (2019). *Interaction Design*. 5th edn. Wiley.

[14] Hartmann, Björn, et al. "Reflective physical prototyping through integrated design, test, and analysis." *Proceedings of the 19th annual ACM symposium on User interface software and technology*. 2006.

Adapting Heuristics for Novel Interfaces

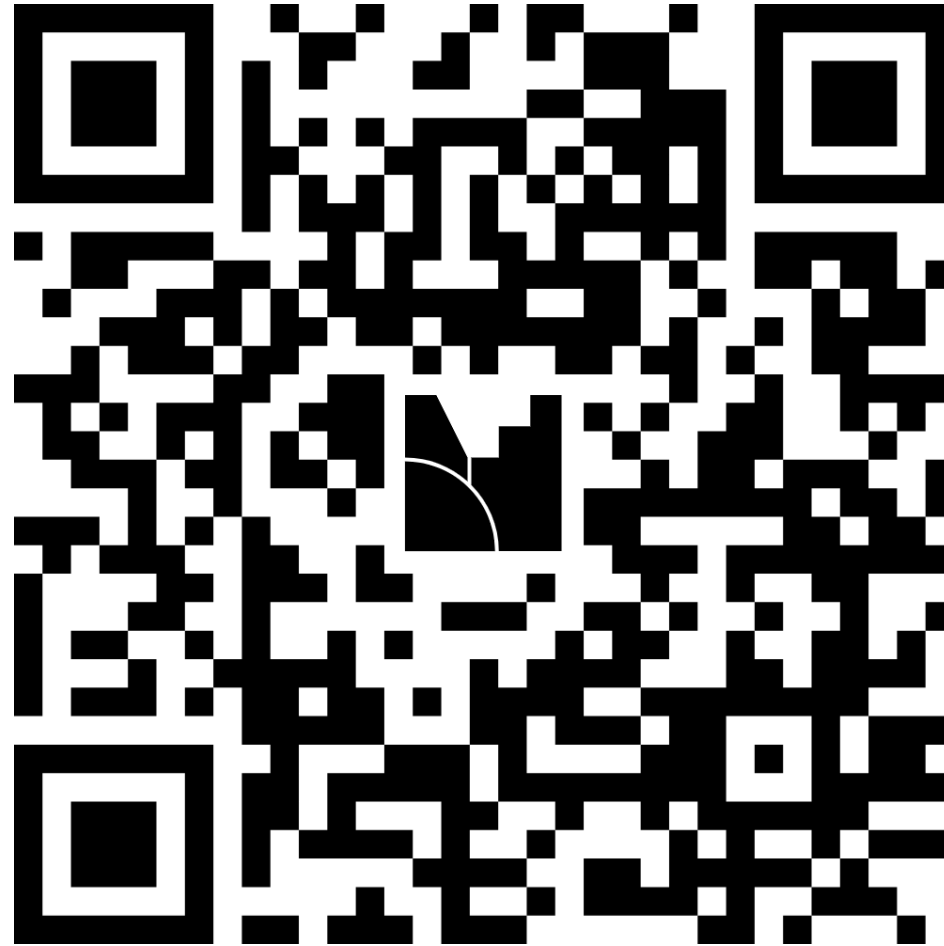
Nielsen's 10 heuristics were written for WIMP. Each paradigm shift requires reinterpretation or replacement [15, 16]. Here are some examples of how they can be adapted (more are provided in the lab exercise).

Nielsen (WIMP)	Voice adaptation	Gesture adaptation	AR adaptation
H1: Visibility of system status	V1: Clarity of purpose — system must announce what it can do in every turn	Immediate visual/haptic feedback after each recognised gesture	Digital overlays update in sync with physical world movement
H2: Match between system and real world	V2: Match to spoken language — natural speech, not system jargon	Gestures should mirror natural physical actions (reach = select, push = dismiss)	Digital labels should match the physical objects they are attached to
H3: User control and freedom	V3 + V4: Error recovery + Confirmation — 'cancel' must always be possible by voice	All gestures must be reversible; no accidental trigger without confirmation	User must be able to dismiss or reposition overlays at any time
H9: Help users recover from errors	Error message must say what went wrong AND give a spoken example of what to try	Unrecognised gesture must show visual example of recognised alternatives	Calibration failure must offer explicit recovery step visible in the user's field of view
H6: Recognition over recall	DOES NOT APPLY — voice is inherently recall-based. Mitigated by prompt design.	Gesture vocabulary must be small enough to memorise. Tutorial on first use.	Labels and callouts reduce recall burden by attaching information to physical objects

Thank you for your attention!

Questions?

Feedback



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