


Tangible UI

Anderson/Fishkin
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Physical Computing

- In the next set of lectures, we're going to sample a set of HCI areas:
 - Tangible UI
 - Augmented Reality
 - Wearables
 - Ubicomp
- They all try to widen the arena of discourse for computing, to use more of the physical world, via *sensors*.


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Trend

- Exponential growth in computer speed; Moore's Law, but
- Linear, stairstep growth in *bandwidth* and *naturalness* of our interaction with the computer


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Arena of Discourse

- Over time, we've seen an evolution in the use of computers along many dimensions. Let's look at 3:
 - Where are the computers located?
 - How do users provide input?
 - How is output provided?


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Where are the computers located?

- 50s – huge computer room
- 60s – small computer room
- 70s-90s – desktop/laptop
- Things seem to have stalled...

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How do users provide input?

- 50s – flipping switches, typing to cards
- 60s – typing
- 70s-90s – typing, mousing
- Things seem to have stalled...

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How is output provided?

- 50s – blinking lights, tape, printers
- 60s – tape, printers, CRTs
- 70s-90s – printers, CRTs. Some sound, haptic
- Things seem to have stalled...

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In Sum

- There is very little in a 2002 interface that would seem alien to a user of a PARC 1972 interface.
 - “Windows 95 = Mac 84” too generous!
- Why?
 - Have we run out of new ideas?
 - Do we declare victory and move on?
 - Is it MSFT’s fault?

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Breaking on through...

- These new techniques try to break this logjam, in overlapping and complimentary ways.

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Ubicomp

- Ubicomp – computers can be *anywhere*, and look like *anything*. They are *ubiquitous*
- Upcoming lecture



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Digression

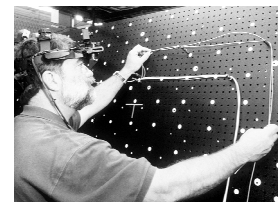
- Ubicomp and Virtual Reality are philosophical opposites
 - Virtual Reality – you are integrated into the computer’s world
 - Ubicomp – the computer is integrated into *your* world
- More on this later

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Augmented Reality

- Enhancing what you see/hear as you move about
- Upcoming lecture




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Tangible Interfaces

- Enhancing physical objects, and your manipulations of them
- This lecture!



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Where are the computers located?

- 70s-90s – desktop/laptop
- 00s
 - On your body (Wearable)
 - In the environment (UbiComp)

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How do users provide input?

- 70s-90s – typing, mousing
- 00s
 - Audio, VR, etc.
 - By manipulating physical objects (Tangible)

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How is output provided?

- 70s-90s – printers, CRTs. Some sound
- 00s
 - By enhancing what you see/hear as you move about (Augmented Reality)
 - By altering physical objects (Tangible)

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Tangible Interfaces

- So, on to Tangible interfaces
- Basic idea, again: to let users interact with physical objects. Three “traditional” ways:
 - “Magic Desks” (Ishii)
 - Augmented/reified objects (Want)
 - Calm computing (Jerimijenko)

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But Why?

- Why is tangibility good?
 - “The interactions with those GUIs are separated from the ordinary physical environment in which we live and interact”
 - “The World is the interface”
 - subset of UbiComp
- People already have physical objects, with learned connotations, affordances, metaphors
- People can do many more gestures than typing and mousing
- Lowers cognitive barriers.

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More on Tangibility

- Tends to use specialized, not "generic" widgets (keyboard, mouse).
- Although can *supplement*, not *replace*, previous generic widgets.
- Generic --- specialized tradeoff debate has been going on for decades.
- Big need for user testing to help resolve this issue!

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Proof is in the citing...

- Ishii paper has been cited 158 times! (<http://citeseer.nj.nec.com/ishii97tangibile.html>)
- Flood of follow-on work
 - (BTW, some done at UW – DMG)

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Parade of Examples

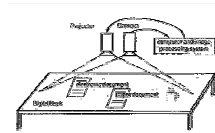
- Many "fellow systems", plus three of theirs. Demonstrate some of the possibilities for Tangible UI (TUI).

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Digital Desk

- Wellner, P., Mackay, W., and Gold, R. "Computer Augmented Environments: Back to the Real World". CACM 36(7), July 1993.
- "Magic Desk". Use cameras to see where hands are, what documents are on top, etc.
- Give feedback by projection system
- Integrate with hands
 - E.g. "where'd I put document X?"
 - E.g. "print this"
- A.R., not TUI



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Task: specifying a planar slice

- The task: specify a plane in 3-space
- That plane then slices through an MRI and displays the results.
- How would you design this UI?

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Hinckley Doll's Head

- Hinckley, K., Pausch, R., Gobbie, J., Kassel, N., Passive real-world interface props for neurosurgical visualization. Proceedings of CHI'94. 1994. ACM. pp. 452-458
- Early and great example of power of metaphor.
- "So advanced, it's simple"
- Had actual users!
- Tangible but not Ubicomp – system totally "tethered" to PC.



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Bricks

- Fitzmaurice, G., Ishii, H., and Buxton, W. "Bricks: Laying the Foundations for Graspable User Interfaces", CHI '95, p. 442-449.
- TUI without any metaphor – closer to the "generic" side of the tradeoff


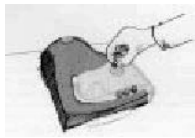


Figure 1. A graspable object.

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Marble Machine


- Bishop, 1995. In Crampton Smith, G. "The Hand That Rocks the Cradle", I.D., May/June 1995.
- Reifies messages into marbles
- Any relation to "Minority Report" purely intentional
- Why is this cool? What have you gained?



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Live Wire

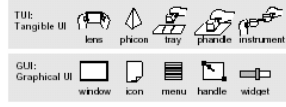
- Example of what has come to be called "calm computing"
- Computer mediates/manages the appearance of some background physical object in a non-intrusive way



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metaDesk


- Merge GUI with "Digital Desk"
- Make physical analogs of GUI instruments
- Term "phicon" has come to refer to *any* such enhanced object



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metaDesk: phicon

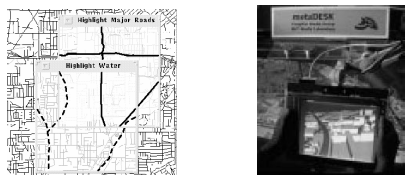
- Take virtual icon and make it physical
- Where icon means "I represent an object (noun) or action (verb)"
- E.g. "show me where this building is"
- Also used then as bricks-like widget



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metaDesk: lens

- Previous GUI work on "Magic Lenses"
 - E.g. Stone, Fishkin, Bier, "The Movable Filter as a User Interface Tool", CHI '94.
- Take virtual lens and make it physical



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metaDesk: ambientRoom

- Examples of “calm computing”
- web activity levels mapped to rain sounds
- web activity levels mapped to water ripples
- Many, many more done in later years

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metaDesk: transBoard

- Think back to “answering machine marbles”
- By reifying virtual objects, we can *carry* and *move* them. Translating back and forth between physical and virtual.
- tends to be called “pick and drop”, after Rekimoto (UIST '97)

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Want paper

- Similar emphasis to Ishii paper, on tangible objects and their manipulations
- Differs:
 - Emphasis on tagging *existing everyday* objects, which already have connotations
 - Explores compound sequences, and context (gesture “language”).
 - Emphasis on lightweight, portable systems
 - Not vision-based

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Let's see a video!

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Overlaps

- Wearable/A.R.
 - smart eyeglasses
- Wearable without A.R.
 - Pager, twiddler, touchType
- A.R. without Wearable
 - soundscapes

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Overlaps

- Ubicomp/Tangible
 - tagged objects
- Ubicomp without Tangible
 - Context sensing
 - Star trek doors
- Tangible without UbiComp
 - Doll's head

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Overlaps

- Tangible/A.R.
 - calm computing
 - (whole 'nother lecture)
- Tangible without A.R.
 - "Smart Photo Cube"
- A.R. without Tangible
 - smart eyeglasses, "smart poster", digital desk

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Overlaps

- I won't fill out the full set of (4 choose 2) + (4 choose 3), (4 choose 4). You get the idea.
- Which is: these are similar techniques "at heart", with different emphases
 - Ubicomp – the computers are scattered about
 - Wearable – you are wearing the computer
 - A.R. – computer is enhancing your journey
 - Tangible – computer is enhancing objects

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Since then....

- Many, many papers exploring this space
 - Also emphasis on expanding vocabulary of *gestures*, not just of objects
- But few user studies or deeper exploration

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Project

- The TUI emphasis on physicality emphasizes touch and gesture. This seems like it might be a good match for UI for the blind, as discussed in a previous lecture. Investigate a TUI interface tailored for the blind.

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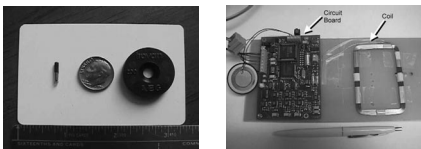
Readings for Next Time

- Anthony Webster, Steven Feiner, Blair MacIntyre, William Massie, Theodore Krueger. "Augmented Reality in Architectural Construction, Inspection, and Renovation". *Proc. ASCE Third Congress on Computing in Civil Engineering*, Anaheim, CA, June 17-19, 1996, 913-919. Available at <http://www.cs.columbia.edu/graphics/publications/asceLOW-RES.pdf>

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Wireless Tagging Technology

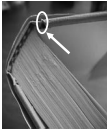
- Trovan radio frequency passive ID tags
 - Powered by reader - no battery
 - 4 different size/range tag readers
 - range (version 1) - up to 12 cm
 - Many (40 typical) bits of unique ID (550 billion)



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RF tags are nice because...

- Ubiquitous and Flexible



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Robust, no line of sight



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Tags are getting better

- Much energy/interest from industry
- Main focus is tagging/tracking packages
 - FedEx, UPS
 - Airline baggage
 - Inventory/warehouse management
 - E.g. US Army, Gillette, Libraries

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