IN4MATX 133: User Interface Software

Lecture 17:
Small & Large Displays

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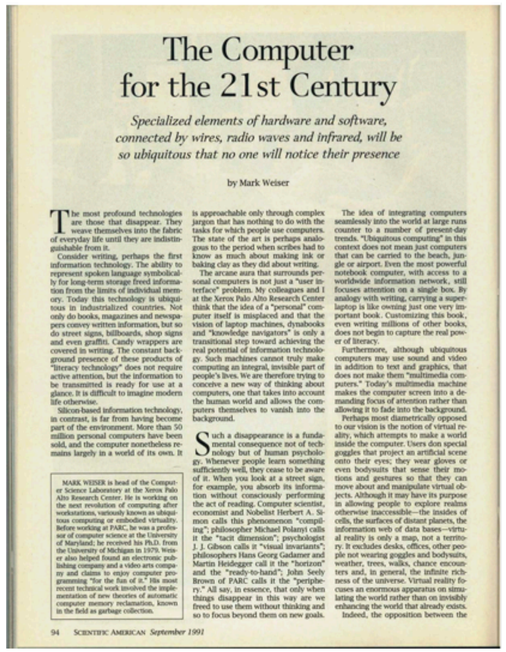
Today's goals

By the end of today, you should be able to…

- Describe some of the history of wearable computing and large scale displays
- Explain key principles for designing a good wearable experience
- Articulate some principles for creating experiences with large displays
- Identify a few potential libraries for developing wearable and TV apps

Third wave: ubiquitous computing

- Weiser speculated people would interact with three types of computers
  - Tabs: inch-scale devices, like post-its
  - Pads: foot-scale devices, like paper
  - Boards: yard-scale devices, like whiteboards
- Speculated devices would have shared ownership



The Computer for the 21st Century

Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence

by Mark Weiser

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Consider writing, perhaps the first information technology. The ability to represent spoken language symbolically for long-term storage freed information from the limits of individual memory. Today this technology is ubiquitous in industrialized countries. Not only do books, magazines and newspapers convey written information, but so do street signs, billboards, shop signs and even graffiti. Candy wrappers are covered in writing. The constant background presence of these products of "literacy technology" does not require active attention, but the information to be transmitted is ready for use at a glance. It is difficult to imagine modern life otherwise.

Silicon-based information technology, in contrast, is far from having become part of the environment. More than 50 million personal computers have been sold, and the computer nonetheless remains largely in a world of its own. It is approachable only through complex jargon that has nothing to do with the tasks for which people use computers. The state of the art is perhaps analogous to the period when scribes had to know as much about making ink or baking clay as they did about writing.

The arcane aura that surrounds personal computers is not just a "user interface" problem. My colleagues and I at the Xerox Palo Alto Research Center think that the idea of a "personal" computer itself is misplaced and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. Such machines cannot truly make computing an integral, invisible part of people's lives. We are therefore trying to conceive a new way of thinking about computers, one that takes into account the human world and allows the computers themselves to vanish into the background.

Such a disappearance is a fundamental consequence not of technology but of human psychology. Whenever people learn something sufficiently well, they cease to be aware of it. When you look at a street sign, for example, you absorb its information without consciously performing the act of reading. Computer scientist, economist and Nobelist Herbert A. Simon calls this phenomenon "compiling"; philosopher Michael Polanyi calls it the "tacit dimension"; psychologist J. J. Gibson calls it "visual invariants"; philosophers Hans Georg Gadamer and Martin Heidegger call it the "horizon" and the "ready-to-hand"; John Seely Brown of PARC calls it the "periphery." All say, in essence, that only when things disappear in this way are we freed to use them without thinking and so to focus beyond them on new goals.

The idea of integrating computers seamlessly into the world at large runs counter to a number of present-day trends. "Ubiquitous computing" in this context does not mean just computers that can be carried to the beach, jungle or airport. Even the most powerful notebook computer, with access to a worldwide information network, still focuses attention on a single box. By analogy with writing, carrying a superlaptop is like owning just one very important book. Customizing this book, even writing millions of other books, does not begin to capture the real power of literacy.

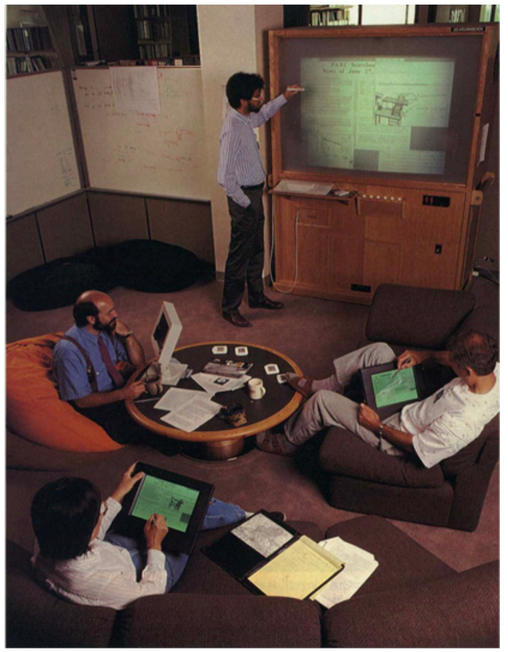
Furthermore, although ubiquitous computers may use sound and video in addition to text and graphics, that does not make them "multimedia computers." Today's multimedia machine makes the computer screen into a demanding focus of attention rather than allowing it to fade into the background.

Perhaps most diametrically opposed to our vision is the notion of virtual reality, which attempts to make a world inside the computer. Users don special goggles that project an artificial scene onto their eyes; they wear gloves or even bodysuits that sense their motions and gestures so that they can move about and manipulate virtual objects. Although it may have its purpose in allowing people to explore realms otherwise inaccessible—the insides of cells, the surfaces of distant planets, the information web of data bases—virtual reality is only a map, not a territory. It excludes desks, offices, other people not wearing goggles and bodysuits, weather, trees, walks, chance encounters and, in general, the infinite richness of the universe. Virtual reality focuses an enormous apparatus on simulating the world rather than on invisibly enhancing the world that already exists.

Indeed, the opposition between the

MARK WEISER is head of the Computer Science Laboratory at the Xerox Palo Alto Research Center. He is working on the next revolution of computing after workstations, variously known as ubiquitous computing or embodied virtuality. Before working at PARC, he was a professor of computer science at the University of Maryland; he received his Ph.D. from the University of Michigan in 1979. Weiser also helped found an electronic publishing company and a video arts company and claims to enjoy computer programming "for the fun of it." His most recent technical work involved the implementation of new theories of automatic computer memory reclamation, known in the field as garbage collection.

94 SCIENTIFIC AMERICAN September 1991



Third wave: ubiquitous computing

What is a wearable computer?

A MUCH More Diversified Market Than Investors Realize

CREDIT SUISSE

What is a wearable computer?

- A computer on the body that is:
  - Always on
  - Always accessible
  - Always connected
- Other actions:
  - It augments user actions
  - Is aware of the user and their surroundings

Rhodes, B.J. 1997. The wearable remembrance agent: a system for augmented memory. *Personal Technologies*, 1(4), 2018-224.

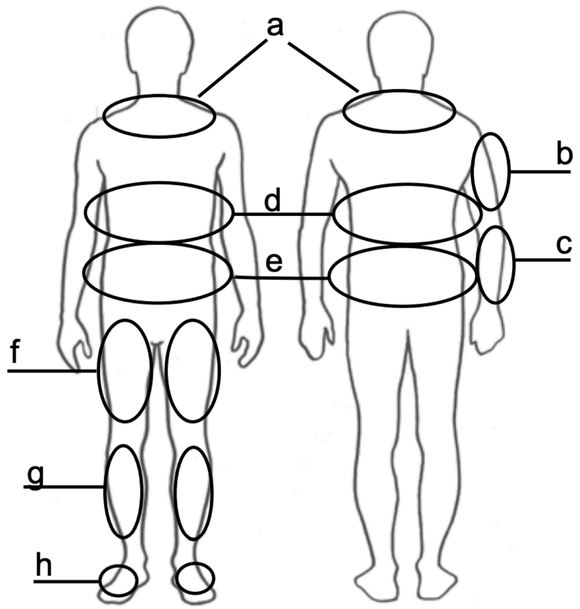
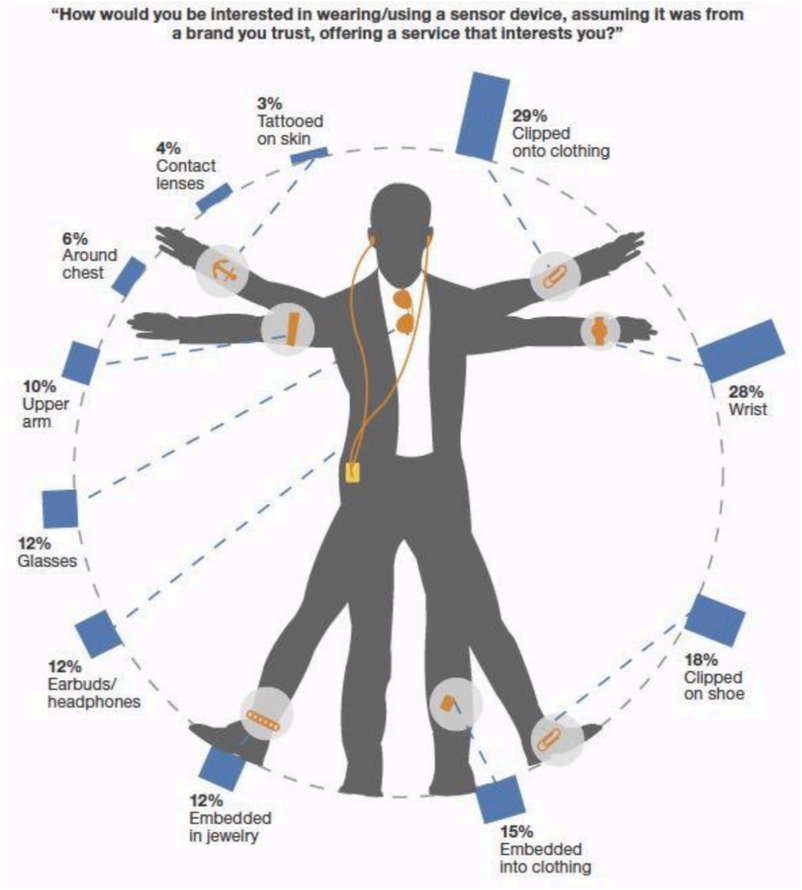


Fig. 1, The general areas we have found to be the most unobtrusive for wearable objects are: (a) collar area, (b) rear of the upper arm, (c) forearm, (d)rear, side, and front ribcage, (e) waist and hips, (f) thigh, (g) shin, and (h) top of the foot.

Gemperle, F. Kasabach, C., Stivoric, J. Bauer, M. Martin, R. Design for Wearability. ISWC 1998.



North American Technographics Consumer Technology Survey, 2013.

Body and head-mounted wearables

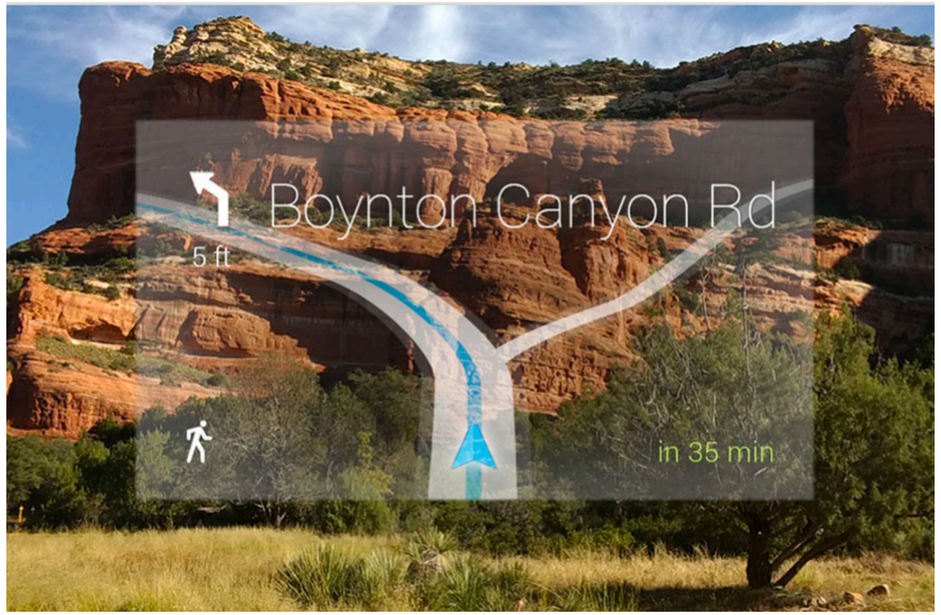
MIT Wearable Computing (1996)

Google glass

- Commercial smart glasses, released in 2013
  - Technology lead by Thad Starner, part of the MIT group
- Front-facing camera, rear-facing display
- Gyroscope/accelerometer/ magnometer
- Natural language input capabilities

https://www.x.company/glass/

Google glass



https://www.x.company/glass/

Google glass

- Privacy and safety concerns prevented take-off in the consumer space
- Lives on in enterprise spaces
  - New version released in 2017
  - Used in manufacturing, healthcare

https://www.x.company/glass/

Wrist-worn wearables

Fitbit (2011)

- One of the first commercially successful digital pedometers
- Early versions were hip-worn, now almost exclusively wrist-worn
- Current models are “fitness-first” smartwatches
  - Activity prominently included on the home screen
- Acquired by Google in 2019

Pebble (2013)

- Arguably the first commercially successful smartwatch
  - Two of the most funded Kickstarter projects ever
- E-ink display led to high battery life (a week vs. a day)
- Paired with a phone via Bluetooth
  - Could retrieve email, control music, receive notifications, etc.
- Acquired by Fitbit in 2016

Apple Watch (2015)

- From the onset, it was intended to be a “second screen” companion to iOS devices
- Original versions could do almost nothing without pairing to an iOS device
- Apps add a secondary component to an existing iOS app

Design recommendations for (wrist-worn) wearables

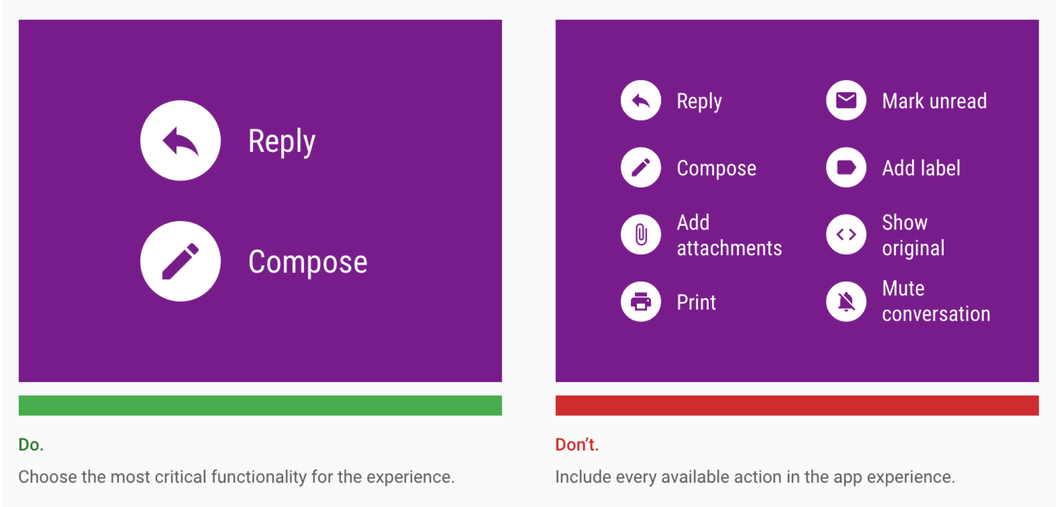
One visual thought per screen

- Real estate is extremely valuable on watches
- Shrinking a mobile or desktop app will create a bad experience
- Keep words and interactions to a minimum

https://mayvendev.com/blog/10-tips-for-designing-for-wearables-and-watches

Reduce input options

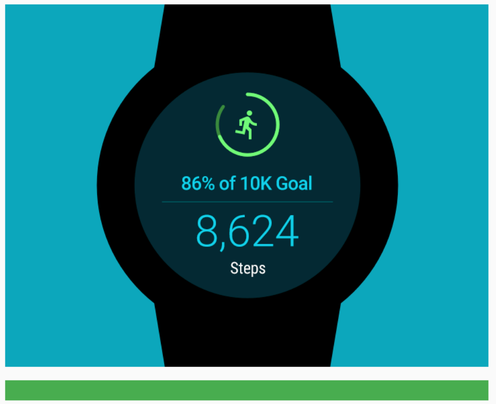
- Have only a couple of buttons per screen
- This may mean a watch app has fewer features than a mobile app
  - That’s okay!
  - The watch augments the experience
- Consider voice input when longer instruction is needed



https://designguidelines.withgoogle.com/wearos/wear-os-by-google/designing-for-watches.html

Some apps don’t need a watch interface

- For some apps, a watch app may not add to the experience
- Focus on use cases which make sense
  - Quick input
  - Glanceable feedback



Do.

Design experiences where tasks can be accomplished easily using the watch interface.

Don’t.

Complex, detailed apps that include items like spreadsheets may be difficult to edit and view on a watch.

https://designguidelines.withgoogle.com/wearos/wear-os-by-google/designing-for-watches.html

Question

iwatch

New York Times (news)
Dark Sky (weather)
Fandango (movie purchase)
RunKeeper (fitness)
OneNote (notetaking)

These are all Apple Watch apps. Which have a compelling use case?

Pick whichever choice is closest to what you believe.

A. None of them have a compelling use case

B. Dark Sky

C. Dark Sky, RunKeeper, Fandango

D. Dark Sky, RunKeeper, New York Times, OneNote

E. All of them have a compelling use case

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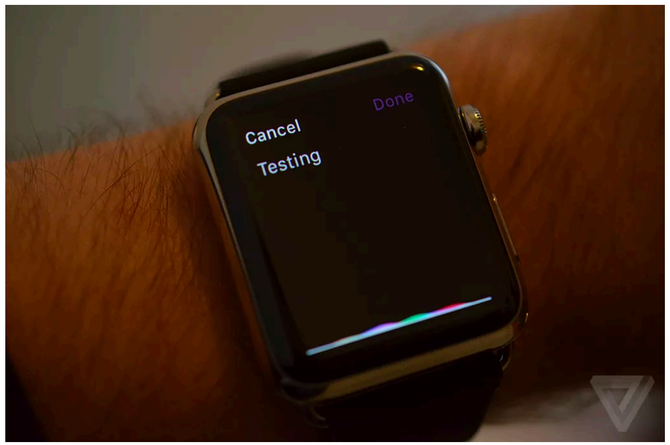
Open to interpretation,
I think NYT and Fandango are a stretch but there are potential uses

Microsoft apps for Apple Watch

Powerpoint remote

Skype messaging



OneNote voice memos

Are these compelling use cases?

https://www.theverge.com/2015/4/28/8508445/microsoft-apple-watch-apps-hands-on

Questions to consider

- Would a watch app add anything to my mobile app?
  - Is there timely information the app needs to provide?
  - Can it be shown in a very small format?
  - Are there simple controls to the app that would be added to a watch?
- Do I have the resources/time to do this?
  - Currently limited market impact, but growing
- What type of interaction do you want the user to have?

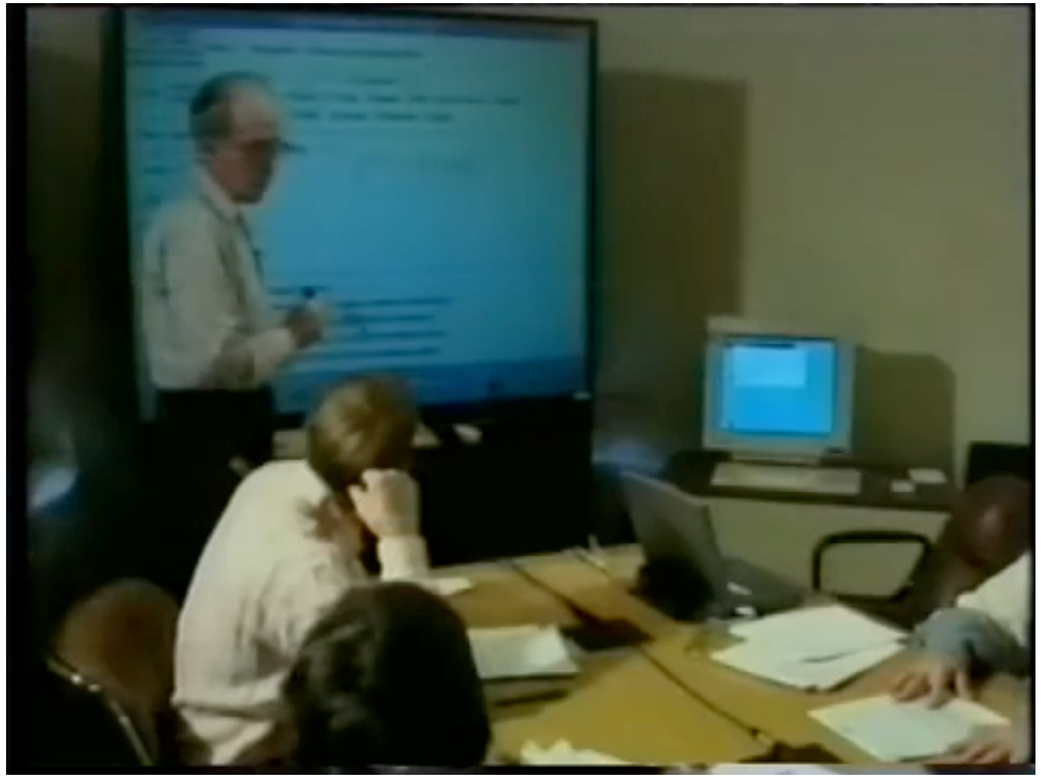
Implementing watch apps

- Requires native development for many watches
  - WatchKit for iOS, Wear OS for Android
- Requires a companion iOS or Android app for building/deploying, though may be able to run as a standalone
- However, you can develop a hybrid mobile app and connect it to a native watch app

https://developer.android.com/training/wearables/apps
https://developer.apple.com/documentation/watchkit

Large-scale displays

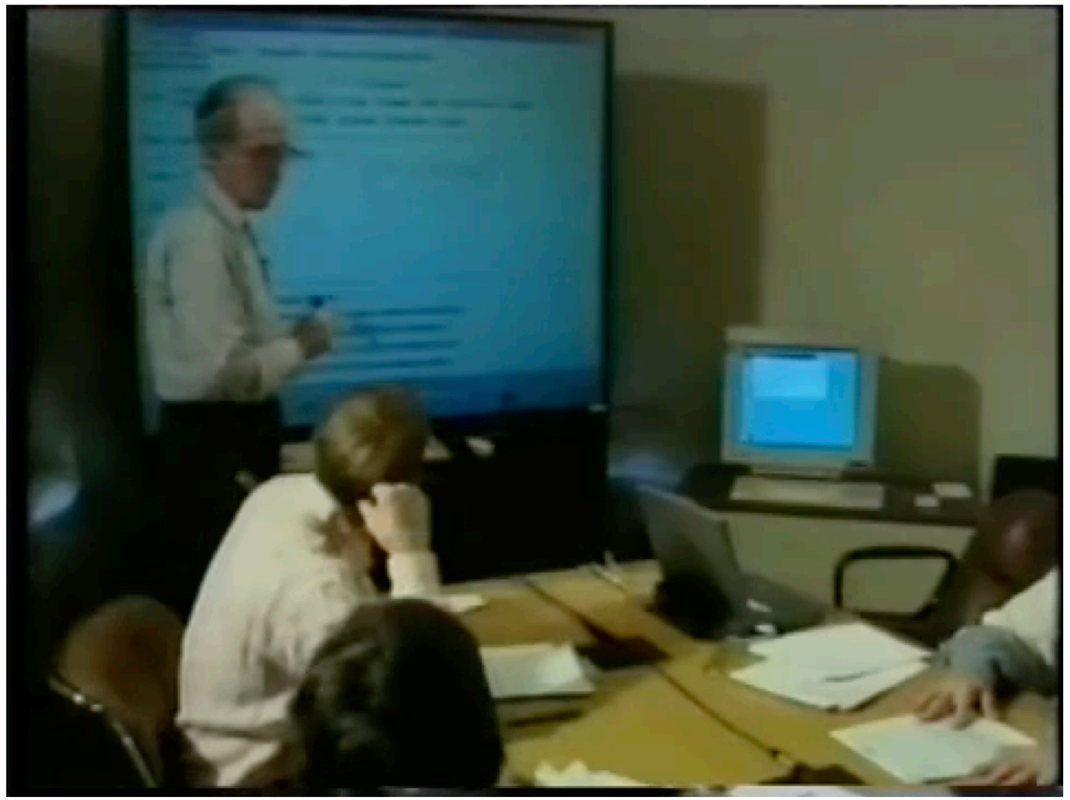
Project Tivoli



Tivoli: An Electronic Whiteboard for Informal Workgroup Meetings. INTERCHI, 1993.

Project Tivoli

- Pen-based gestures
  - Writing
  - Increasing size
  - Pick up and drag
- Inherently collaborative use
- Value in connecting information to other computers



Tivoli: An Electronic Whiteboard for Informal Workgroup Meetings. INTERCHI, 1993.

Interactive Whiteboards (~2005)

- Widely introduced for educational purposes
- Mostly served as external monitors for computers
- Operated as a projector with a resistive touchscreen

Public Displays

- Often focused on immersion
- Close integration with the environment is important, from both a technical and a design perspective
- Very few libraries or toolkits to help with development

Large-scale displays

- Rarely for consumer use
- Often blend personal with interpersonal interaction

Question

large

Would touching a button be easier on a tablet computer or a typical monitor, assuming the button is scaled?

A. Large display

B. Typical monitor

C. They would be about the same

D.

E.

Question

large

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A. Large display

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D.

E.

Designing for large displays

Scale everything up

- A person is likely to be viewing the screen from further away
- Displays are often in public spaces, so large elements can encourage someone to come interact
- Often in new or unfamiliar environments, so interaction needs to be obvious

https://designshack.net/articles/ux-design/tips-for-designing-oversized-touchscreens/

https://uxdesign.cc/designing-for-large-touch-screen-always-have-the-user-context-in-mind-878b6d2e02a9

Enable more complex gestures

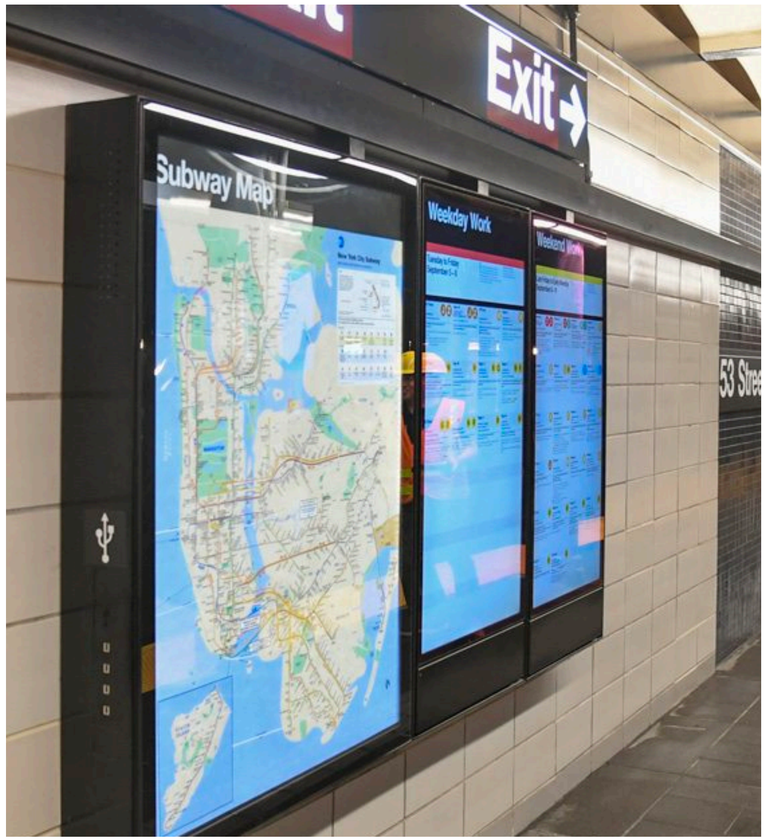
- Consider using a person's entire hand
- Movement will be exaggerated, avoid requiring high precision
- Minimize overall arm movement, avoid long swipes

https://designshack.net/articles/ux-design/tips-for-designing-oversized-touchscreens/

https://uxdesign.cc/designing-for-large-touch-screen-always-have-the-user-context-in-mind-878b6d2e02a9

Respect privacy

- The bigger the screen, the more likely someone else can see the interaction
- Large screens will often have smaller pop-ups for data entry
- Consider risks of requiring internet connection



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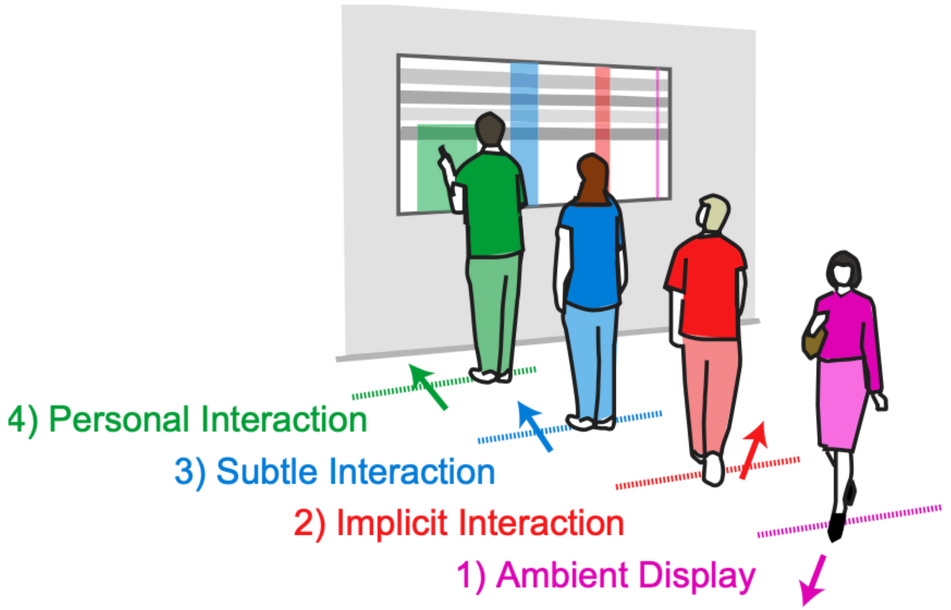
Respect interaction phases

- There are different “phases” of interaction in public spaces
- Layout needs at each phase are different
- Can draw people in with large elements, then start presenting more personal information



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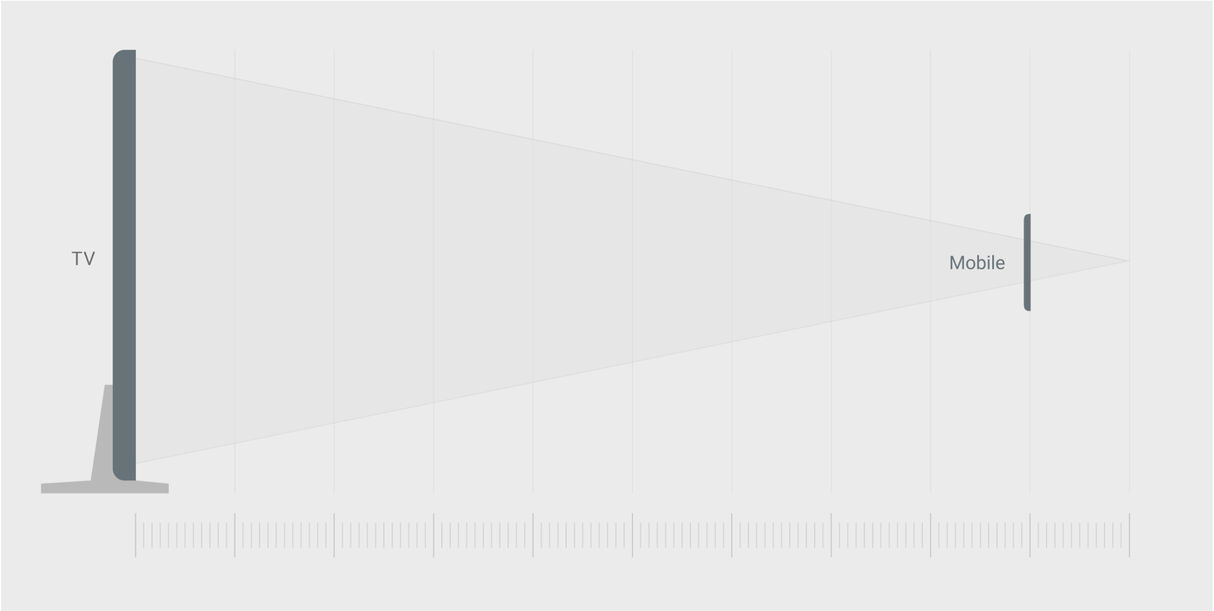
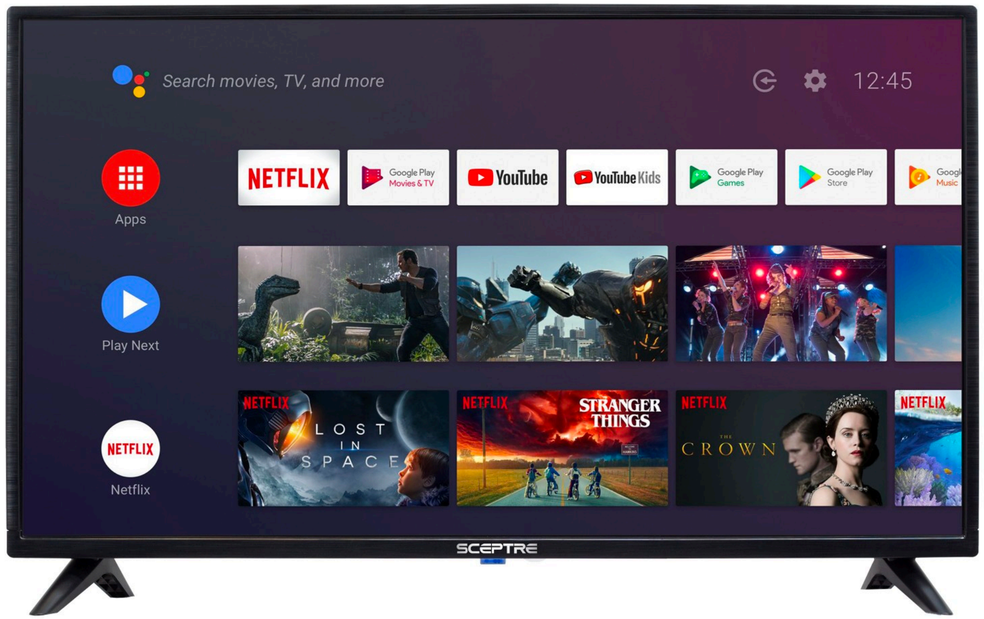
Smart TVs

- The “smart” implies internet access
- Can safely assume that people are far away

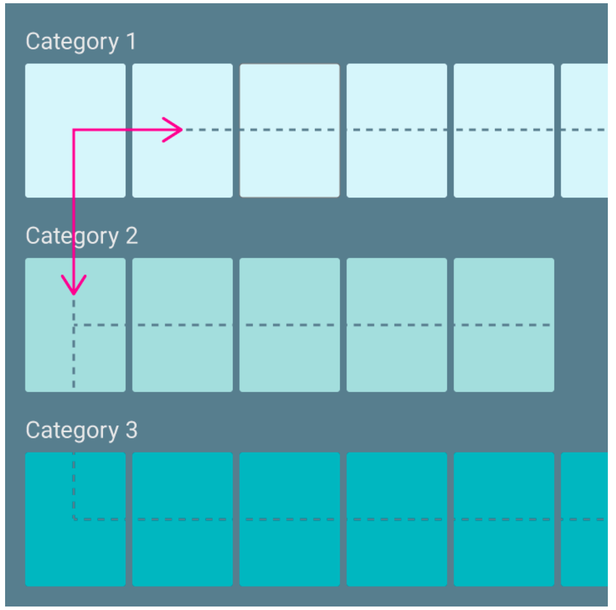




https://tv.withgoogle.com/design-principles/designing-for-tv.html

Smart TVs

- Interaction is often via directional pads, so axis-based navigation is important



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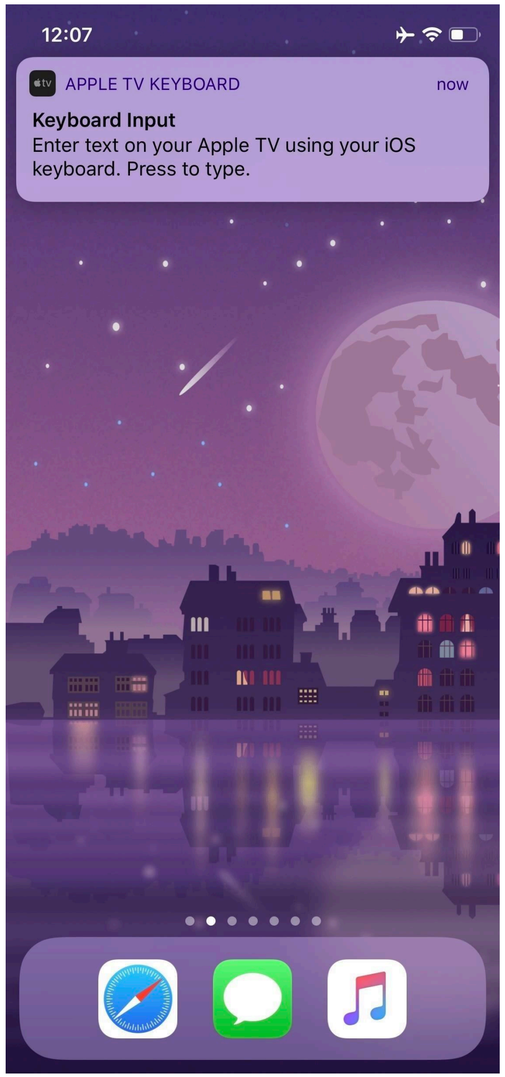
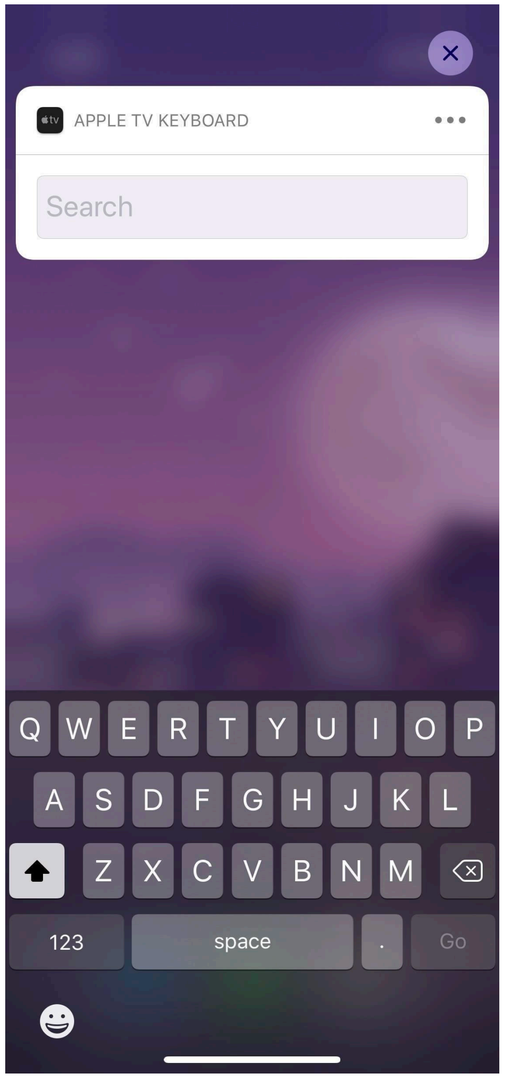
Smart TVs

- Text input via D-pads is slow
  - Voice-based interaction can help
  - Can offload to mobile devices, if paired





https://tv.withgoogle.com/design-principles/designing-for-tv.html

Developing for large displays

Developing for large displays

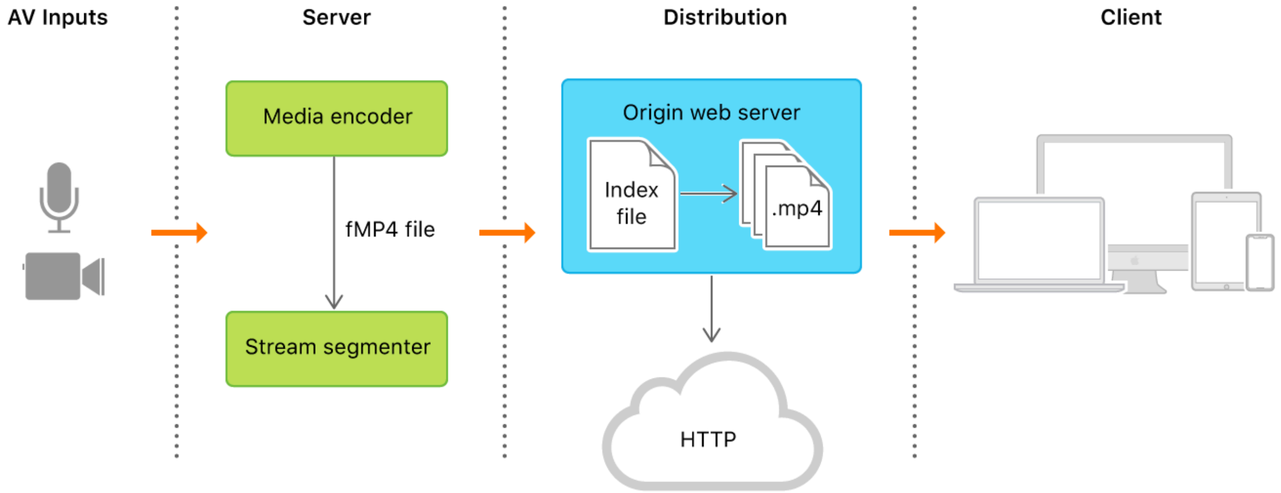
- Displays often have access to browsers, even offline
- Can use plain old HTML, CSS, and JavaScript
  - Bootstrap has an xl class for extra large displays
- More complex environments require custom software for gesture recognition, integrating other sensors

Developing for large displays

- Android TV
  - https://developer.android.com/tv
- tvOS (Apple)
  - https://developer.apple.com/tvos/
- Both provide native apps for interaction
  - Swift for tvOS, Java for Android TV

Developing for large displays

- Most media is still streaming, so falling back to HTTP and JavaScript is useful
  - Webservers host media content to play



https://developer.apple.com/documentation/http_live_streaming

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