

CPT208 Human-Centric Computing

10. Interfaces and Research Considerations

Dr Teng Ma

Interface Metaphors

Chapter 3

Interface metaphors

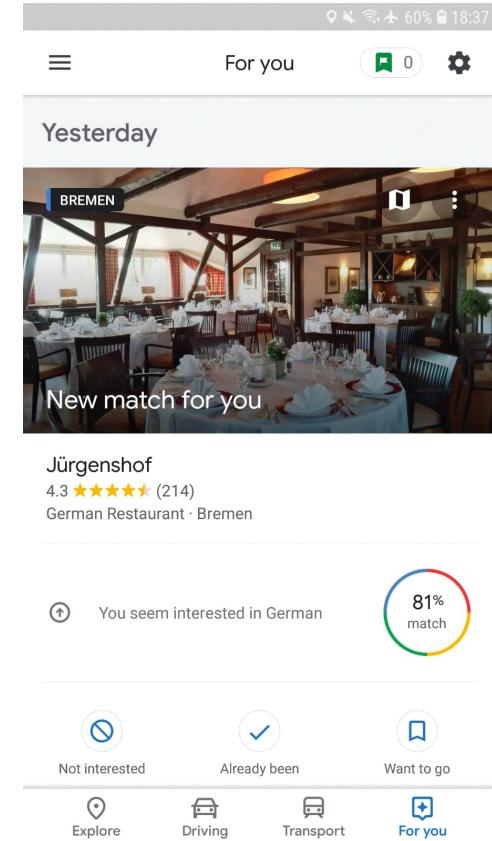
- Interface designed to be similar to a physical entity but also has own properties
 - For example, desktop metaphor, and web portals
- Can be based on activity, object, or a combination of both
- **Exploit user's familiar knowledge**, helping them to understand 'the unfamiliar'
- Conjures up the essence of the unfamiliar activity, enabling users to leverage this to understand more aspects of the unfamiliar functionality

Examples of interface metaphors

- Conceptualizing what users are **doing**
 - For instance, **surfing** the Web
- A conceptual model instantiated at the **interface**
 - For example, the **desktop** and **card** metaphor
- Visualizing an **operation**
 - For instance, an icon of a shopping cart into which the user places items

The card metaphor

- The card is a very popular UI. Why?
 - It has familiar form factor
 - It can easily be flicked through, sorted, and themed
 - It structures content into meaningful chunks (similar to how paragraphs are used to chunk a set of related sentences into distinct sections)
 - Its material properties give the appearance of the surface of paper



Google Now card for restaurant recommendation in Germany

Source: [Johannes Shonning](#)

Benefits of interface metaphors

- Makes learning new systems easier
- Helps users understand the underlying conceptual model
- Can be very innovative and enable the realm of computers and their applications to be made more accessible to a greater diversity of users

Problems with interface metaphors

- Break conventional and cultural rules
 - For instance, recycle bin placed on desktop
- Can constrain designers in the way that they conceptualize a problem space
- Conflicts with design principles
- Forces users to understand only the system in terms of the metaphor
- Designers can inadvertently use bad existing designs and transfer the bad parts over
- Limits designers' imagination in coming up with new conceptual models

Interaction Types

Chapter 3

Interaction types

1. Instructing
2. Conversing
3. Manipulating
4. Exploring
5. Responding

More domain and context-specific activities, such as learning, working, socializing, playing, browsing, writing, problem-solving, decision-making, searching, driving, navigating, etc.

1. Instructing



- Where users instruct a system and tell it what to do
 - For example: Tell the time, print a file, or save a file
- Very common conceptual model underlying a diversity of devices and systems
 - For instance: Word processors, and vending machines
- The main benefit is that instructing supports quick and efficient interaction
 - Good for repetitive kinds of actions performed on multiple objects

Which one is easier and why?



2. Conversing

- Underlying model of having a conversation with another human
- Ranges from simple **voice recognition** menu-driven systems to more complex '**natural language**' dialogs
- Examples include timetables, search engines, advice-giving systems, and help systems
- Also virtual agents, chatbots, toys, and pet robots designed to converse with you



Hey Siri

LLM-based conversation system

The screenshot shows the XJTLU AI Chat interface. On the left, there's a sidebar with icons for AI Chat, Knownled..., Agent, Gallery, Music, Video, and App. The main area has a message input field at the bottom with placeholder text "Input chat content", a microphone icon, and a "Send" button. Above it is a large message bubble containing a response from the AI. The AI's message starts with "Thinking Time:11.18s" and discusses the user's request for an introduction to interaction design in English, mentioning user-centered approach, usability, accessibility, and aesthetics. It also notes the user specified "in English" and provides a clear overview, defining interaction design, its goals and principles, research, prototyping, testing, and examples like apps or websites. It emphasizes understanding user needs, methodologies like UX design or human-computer interaction, and the importance of being structured, accessible, and inclusive. The AI concludes by mentioning technology's role in evolving interaction design. Below this message is a detailed definition of Interaction Design (IxD) as a discipline focused on creating meaningful, user-centered experiences between people and digital products, systems, or services. It emphasizes how users interact with interfaces, aiming to make these interactions intuitive, efficient, and inclusive. At the bottom of the screen, there are configuration options: "Config", "Bubble", "DeepSeek-R1", "Export", and "Clear". The user's profile information "Teng.Ma Teng.Ma@xjtl..." is visible at the bottom left.

Please introduce interaction design in English

Thinking Time:11.18s

Okay, the user wants an introduction to interaction design in English. Let me start by recalling what interaction design is. It's about creating meaningful relationships between people and the products or services they use. I should mention the key aspects like user-centered approach, usability, accessibility, and aesthetics.

Wait, the user specified "in English," so the response needs to be in English. They might be a student or someone interested in the field. They probably want a clear, concise overview. I should define interaction design first, then maybe its goals and principles.

Also, need to touch on the process—research, prototyping, testing. Maybe include examples like apps or websites. Oh, and emphasize the importance of understanding user needs. Should I mention any methodologies like UX design or human-computer interaction?

Make sure to keep it structured: definition, key elements, process, importance, maybe future trends. Avoid jargon but still be informative.

Let me check if I missed any core components. Accessibility and inclusivity are important points. Also, mention technology's role in evolving interaction design.

Okay, that should cover the basics without being too technical. Need to present it in a clear, organized manner so the user gets a comprehensive introduction. Alright, putting it all together now.

Interaction Design (IxD) is a discipline focused on creating meaningful, user-centered experiences between people and digital products, systems, or services. It emphasizes how users interact with interfaces, aiming to make these interactions intuitive, efficient, and inclusive.

Config Bubble DeepSeek-R1 Export Clear

Teng.Ma Teng.Ma@xjtl...

Pros and cons of conversational model

- Allows users, especially **novices**, to interact with a system in a way that is familiar to them
 - Can make them feel comfortable, at ease, and less scared
- **Misunderstandings** can arise when the system does not know how to parse what the user says
 - For example, voice assistants can misunderstand what children say



"If you'd like to press 1, press 3.
If you'd like to press 3, press 8.
If you'd like to press 8, press 5..."

3. Manipulating

- Exploits users' knowledge of how they move and manipulate in the physical world
- Involves dragging, selecting, opening, closing and zooming actions on virtual objects
- Can involve actions using physical controllers (e.g., Nintendo Switch) or air gestures (e.g., Microsoft Kinect) to control the movements of an on-screen avatar
- Tagged physical objects (e.g., balls) that are manipulated in a physical world result in physical/digital events (e.g., animation being played)

Direct Manipulation (DM)

- Ben Shneiderman (1983) coined the term DM
- Three core properties:
 - Continuous representation of objects and actions of interest
 - Rapid reversible actions with immediate feedback on object of interest
 - Physical actions and button pressing instead of issuing commands with complex syntax
- Example: Drag and drop to move files

Benefits of direct manipulation

- Novices can learn the basic functionality quickly
- Experienced users can work extremely rapidly to carry out a wide range of tasks – even defining new functions
- Intermittent users can retain operational concepts over time
- Error messages rarely needed
- Users can immediately see if their actions are furthering their goals, and if not, do something else
- Users experience less anxiety
- Users gain confidence and mastery and feel in control

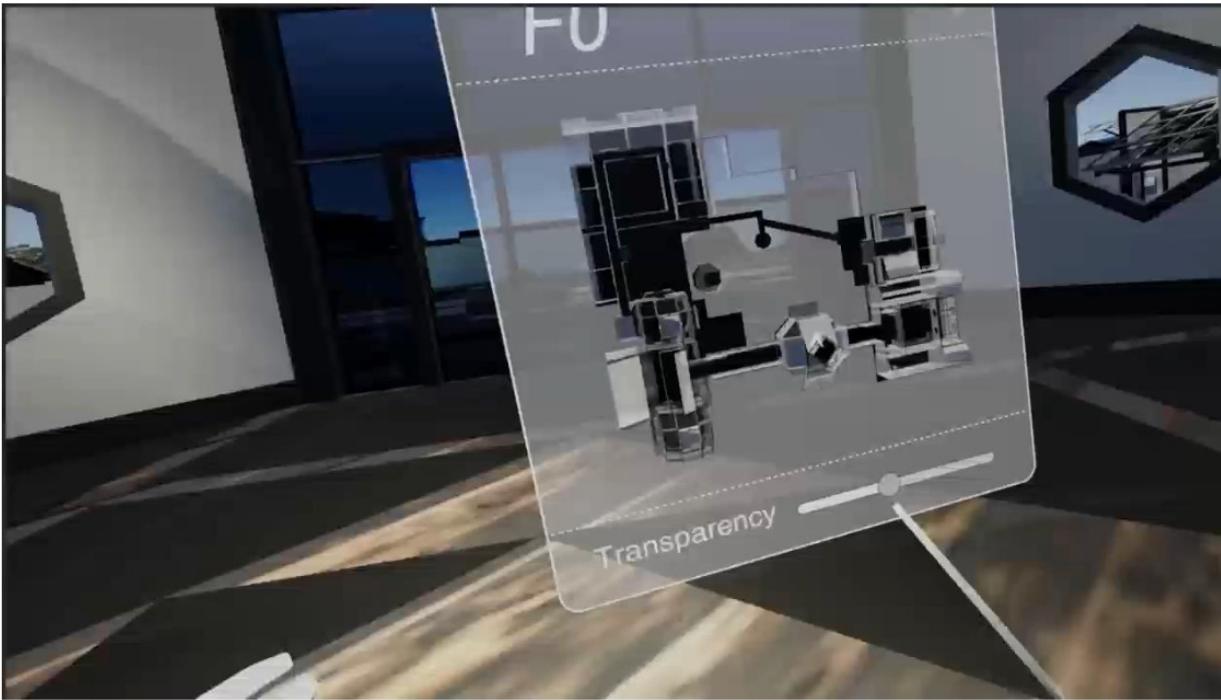
Disadvantages of direct manipulation

- Some people take the metaphor of direct manipulation too literally
 - E.g., playing guitar on iPad
- Moving a cursor using a mouse or touchpad can be slower than pressing function keys to do the same actions
 - E.g.,: find all and replace
- Repetitive tasks are not well supported.
- Some gestures can be more error-prone than typing.
 - E.g., drag a drop a picture width to 2.00 cm.

4. Exploring

- Involves **moving** through virtual or physical environments
 - Users can explore aspects of a virtual 3D environment
 - Physical environments can also be embedded with sensors that when detect the presence of someone will trigger digital or physical events to happen
- Many examples of virtual environments, including cities, parks, buildings, rooms, and datasets
 - Enable users to fly over them and zoom in and out of different parts

Virtual museum exploration with a map



5. Responding



- System takes the initiative to alert user to something that it “thinks” is of interest
- System does this by:
 - Detecting the location and-or presence of someone in a vicinity and notifies them on their phone or watch
 - What it has learned from their repeated behaviors
- Examples:
 - Alerts the user of a nearby coffee bar where some friends are meeting
 - User’s fitness tracker notifies them of a milestone reached
- Automatic system response without any requests made by the user

Choosing an interaction type

- Direct manipulation is good for ‘doing’ types of tasks, for example, designing, drawing, flying, driving, or sizing windows
- Issuing instructions is good for repetitive tasks, for example, spell-checking and file management
- Having a conversation is good for certain services, for instance, finding information or requesting music
- Hybrid conceptual models are good for supporting multiple ways of carrying out the same actions

Interaction and interface

- Interaction:
 - A description of **what the user is doing** when interacting with a system
 - E.g., instructing, talking, browsing, or responding
- Interface:
 - **The kind of interface** used to support the interaction
 - E.g., command, menu-based, gesture, or voice

Interfaces

Chapter 7

20 interface types covered

- 1. Command
- 2. Graphical
- 3. Multimedia
- 4. Virtual reality
- 5. Web
- 6. Mobile
- 7. Appliance
- 8. Voice
- 9. Pen
- 10. Touch
- 11. Gesture
- 12. Haptic
- 13. Multimodal
- 14. Shareable
- 15. Tangible
- 16. Augmented reality
- 17. Wearables
- 18. Robots and drones
- 19. Brain–computer interaction
- 20. Smart

1. Command line interfaces

- Commands such as abbreviations (for instance, `ls`) typed in at the prompt to which the system responds (for example, by listing current files)
- Some are hard wired at keyboard, while others can be assigned to keys
- Efficient, precise, and fast
- Large overhead to learning set of commands

Example

Second Life command line-based interface for visually-impaired users



TextSL

```
>move north 20
moving 20m to north
You are in Virtual Ability (148,79,22).
You see 2 people.
You see 4 objects
>describe people
You see: Smile LoreField and Cool Magic
>move to Smile
Moving to person Smile Lorefield.
>describe objects
You see: a bench, a campfire, a tree and a flower
>describe flower
The flower is a red poppy and is for sale for L10
Smile LoreField says Hello Bei how are you doing?

say Hello Smile good to see you!!
```

Submit

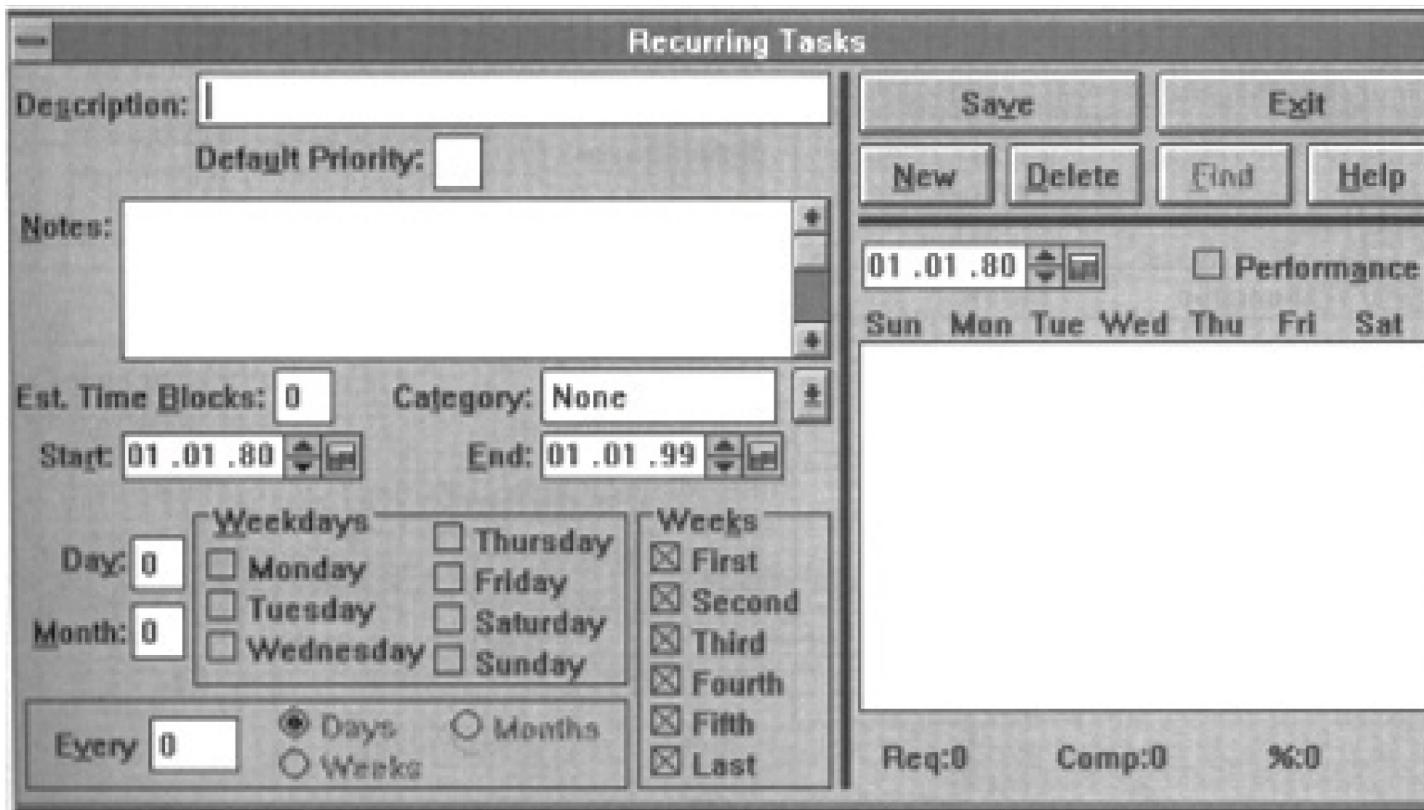
Research and design considerations

- Form, name types and structure are key research questions
- **Consistency** is the most important design principle
 - For example, always use first letter of command
- Command interfaces popular for web scripting

2. Graphical user interfaces (GUIs)

- Xerox Star first **WIMP** gave rise to GUIs
- **Windows**
 - Sections of the screen that can be scrolled, stretched, overlapped, opened, closed, and moved around the screen using the mouse
- **Icons**
 - Pictograms that represent applications, objects, commands, and tools that were opened when clicked on
- **Menus**
 - Lists of options that can be scrolled through and selected
- **Pointing device**
 - A mouse controlling the cursor as a point of entry to the windows, menus, and icons on the screen

Example of first generation GUI



Example of smartwatch GUI

Simple smartwatch menus with 1, 2, or 3 options



One Action



Two Actions

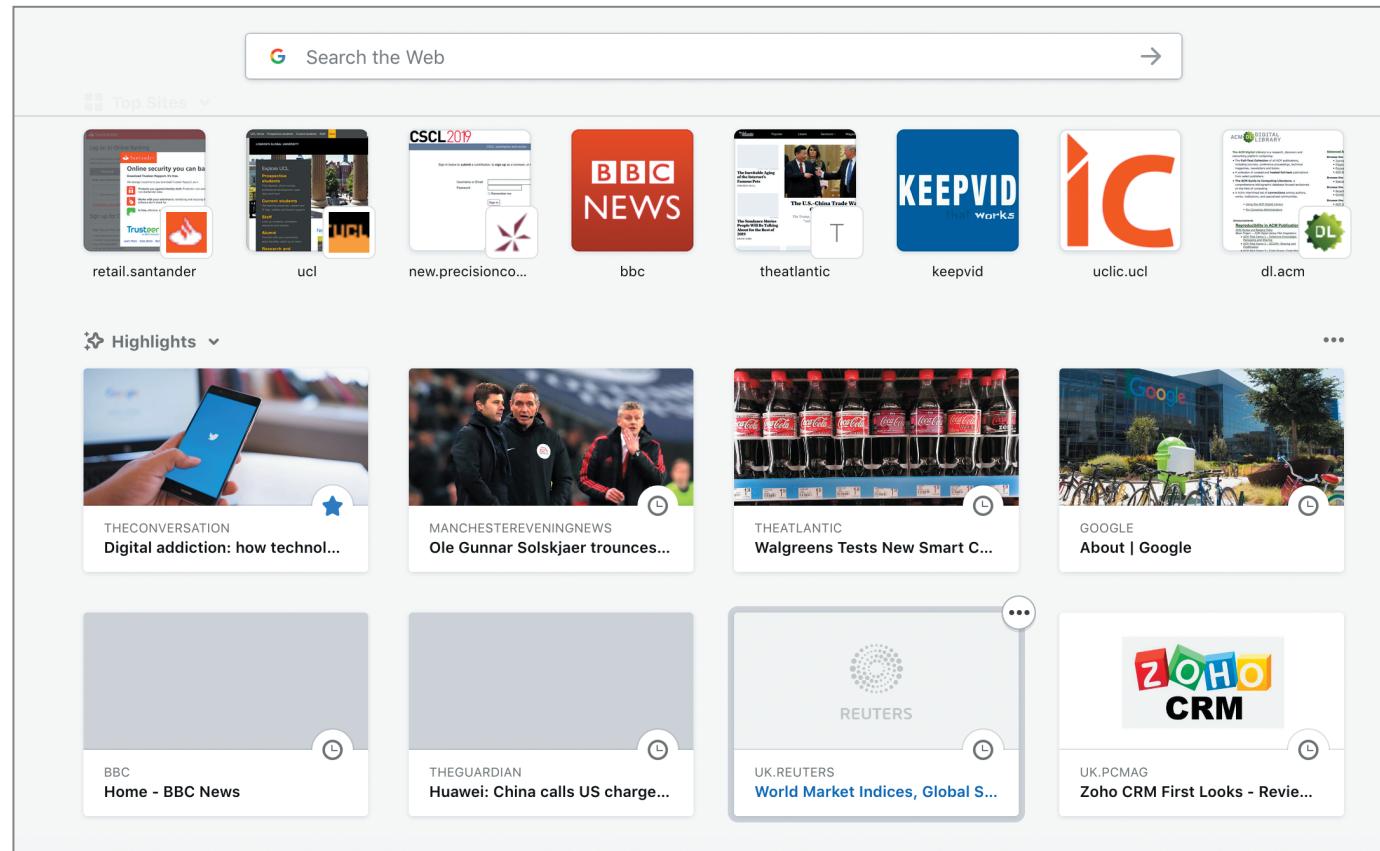


Three Actions

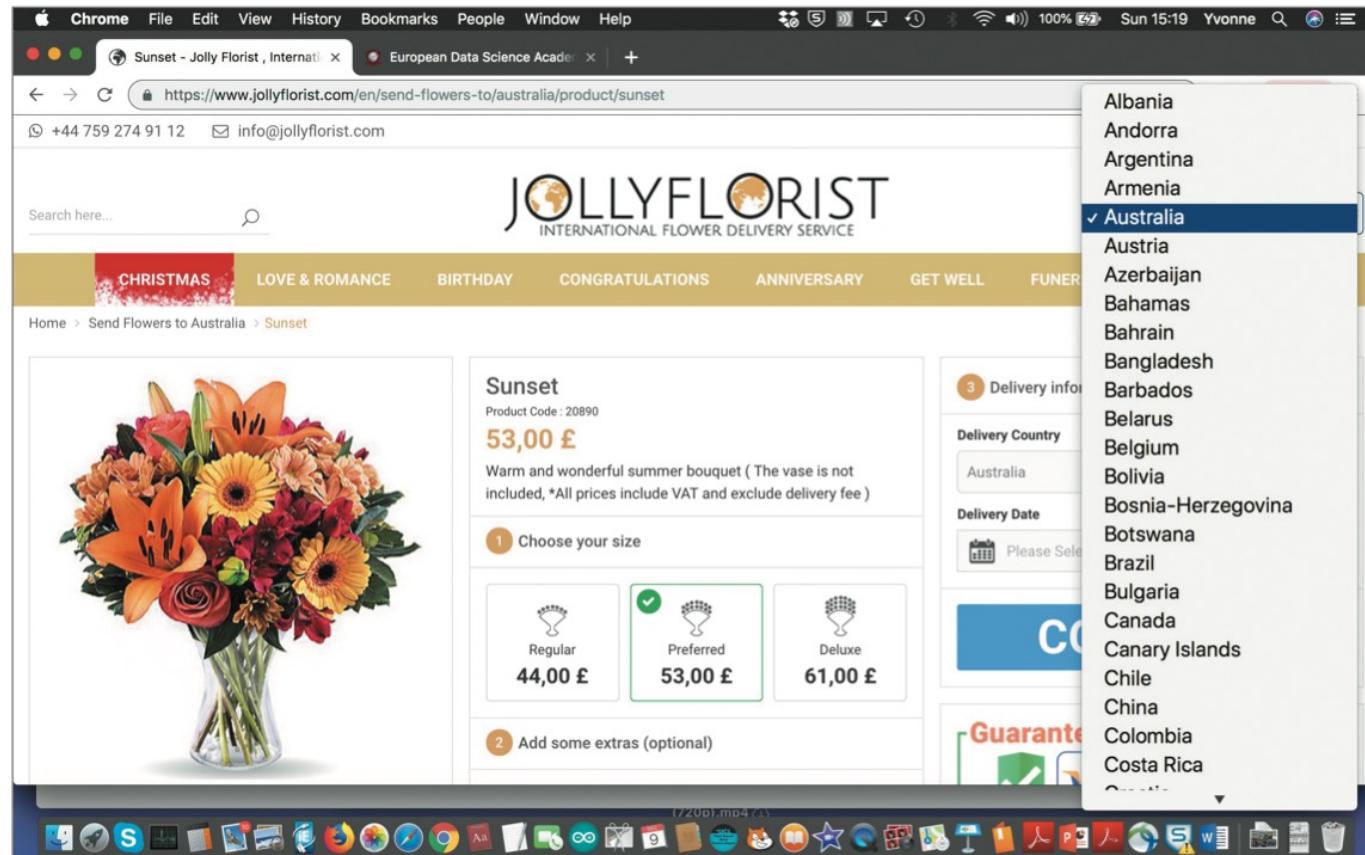
Window design

- Windows were invented to overcome the physical constraints of a computer display
 - They enable more information to be viewed and tasks to be performed
- Scroll bars within windows enable more information to be viewed
- Multiple windows can make it difficult to find desired one
 - Listing, tabbing, and thumbnails are techniques that can help

Thumbnails



A scrolling window



Is this method any better?

F	G	H	I	J
Fiji	Gabon	Haiti	Iceland	Jamaica
Finland	Germany	Holland	India	Japan
France	Gibraltar	Honduras	Indonesia	Jordan
French Guyana	Greece	Hong Kong	Iran	
French Polynesia	Greenland	Hungary	Ireland	
	Guadeloupe		Israel	
	Guam		Italy	
	Guatemala		Ivory Coast	

Menu styles

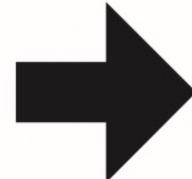
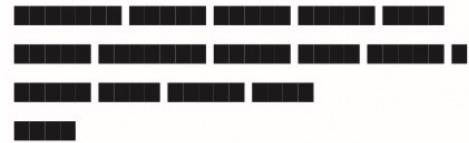
- Flat list: Good for showing large number of options at the same time when display is small
- Drop down: Shows more options on same screen (for example, cascading)
- Pop-up: When pressed, command key for relevant options
- Contextual: Provides access to often-used commands associated with a particular item
- Collapsible: Toggles between + and - icons on a header to expand or contract its contents
- Mega: All options shown using 2D drop-down layout

Template for a collapsible menu

Section 1



Section 2



Section 1

Section 2

Section 3

Section 4

Section 5

A mega menu



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Search product or brand Q

Create an account [Sign in](#)   

Home & Garden [Furniture & Lights](#) Electricals Women Men Beauty Baby & Child Sport & Leisure Gifts Offers

Furniture by Room	Furniture by Type	Lighting	Lighting By Room	Don't Miss
Bedroom	Beds	Sofas & Armchairs	View all Lighting	New in: Lighting
Living Room	Mattresses	Sofa Beds	Ceiling Lighting	New in: House by John Lewis
Dining Room	Wardrobes	Coffee Tables	Wall Lighting	New in: Made to Order Upholstered Beds
Kitchen	Bedside Tables	Side Tables	Desk & Table Lamps	Bring the outdoors in: Conservatory Furniture
Bathroom	Chests of Drawers	Console Tables	Floor Lamps	Try our new Sofa Discovery Tool
Children's	Dressing Tables	TV Stands	Ceiling & Lamp Shades	20% off Mattresses
Nursery	Headboards	Cabinets & Sideboards	Line, Fairy & Novelty Lights	20% off Sofas & Armchairs
Home Office	Bookcases, Shelving Units & Shelves	Dining Tables	SAD & Wake Up Lighting	20% off Living & Dining Furniture
Hallway	Office Desks	Dining Chairs	Cabinet Lighting	20% off Fitted Bedrooms
Garden	Office Chairs	Dining Furniture Ranges	Light Bulbs	30% off Special Buy Fitted Kitchens
	Bathroom Cabinets	Bar Chairs & Stools	Lighting & Electrical Accessories	

Research and design considerations

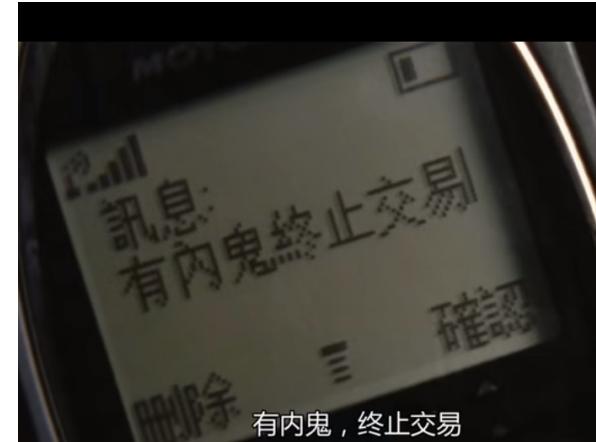
- Window management
 - Enables users to move fluidly between different windows (and monitors)
- How to switch attention between windows without getting distracted
- Design principles of spacing, grouping, and simplicity should be used
- Which terms to use for menu options (for example, “front” versus “bring to front”)
- Mega menus are easier to navigate than drop-down ones

Icon design

- Icons are assumed to be easier to learn and remember than commands
- Icons can be designed to be compact and variably positioned on a screen
- Now pervasive in every interface

Icons

- Since the Xerox Star days, icons have changed in their look and feel:
 - Black and white
 - Color, shadowing, photorealistic images, 3D rendering, and animation
- Many designed to be very detailed and animated making them both visually attractive and informative
- Can be highly inviting, emotionally appealing, and feel alive

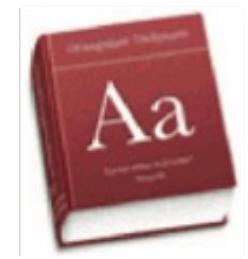


Icon forms

- The mapping between the representation and underlying referent can be:
 - Similar (for example, a picture of a file to represent the object file)
 - Analogical (for instance, a picture of a pair of scissors to represent 'cut')
 - Arbitrary (such as the use of an X to represent 'delete')
- The most effective icons are similar ones
- Many operations are actions making it more difficult to represent them
 - Use a combination of objects and symbols that capture the salient part of an action

2 types of icon styles

→ User



→ Utility



Icon examples

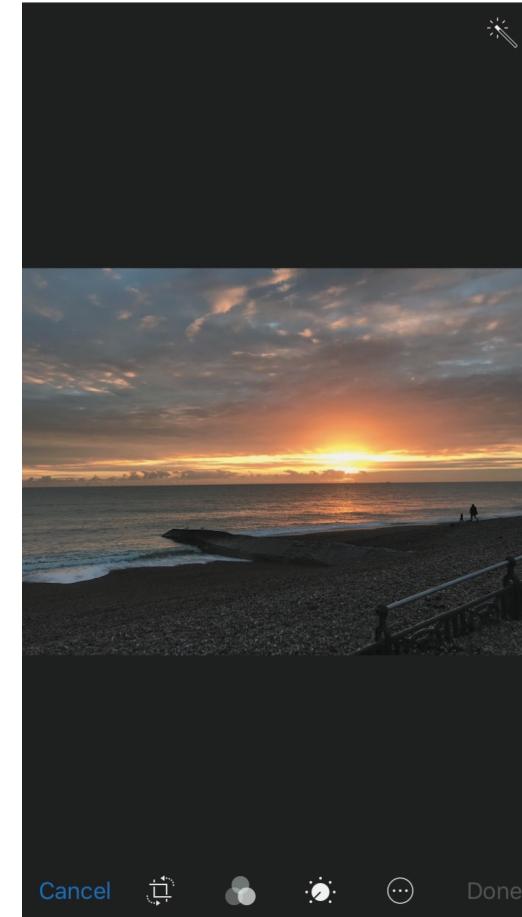
Flat 2D icons for a smartphone and a smartwatch



(a)



(b)



Research and design considerations

- There is a wealth of resources for creating icons
 - Guidelines, style guides, icon builders, libraries, online tutorials
- Text labels can be used alongside icons to help identification for small icon sets
- For large icon sets (for instance, photo editing or word processing) can use the hover function

3. Multimedia

- Combines different media within a single interface with various forms of interactivity
 - Graphics, text, video, sound, and animation
- Users click on links in an image or text
 - Another part of the program
 - An animation or a video clip is played
 - Users can return to where they were or move on to another place
- Can provide better ways of presenting information than a single media can

Pros and cons

- Facilitates rapid access to multiple representations of information
- Can provide better ways of presenting information than can any media alone
- Can enable easier learning, better understanding, more engagement, and more pleasure
- Can encourage users to explore different parts of a game or story
- Tendency to play video clips and animations while skimming through accompanying text or diagrams

Example

Multimedia learning app
designed for tablet



Research and design considerations

- How to design multimedia to help users explore, keep track of, and integrate the multiple representations
 - Provide hands-on interactivities and simulations that the user has to complete to solve a task
 - Provide quizzes, electronic notebooks, and games
- Multimedia good for supporting certain activities, such as browsing, but less optimal for reading at length

4. Virtual reality

- Computer-generated graphical simulations providing:
 - “the illusion of participation in a synthetic environment rather than external observation of such an environment” (Gigante, 1993)
- Provide new kinds of experience, enabling users to interact with objects and navigate in 3D space
- Create highly-engaging user experiences

Pros and cons

- Can have a higher level of fidelity with objects that they represent compared to multimedia
- Induces a sense of **presence** where someone is totally engrossed by the experience
 - “a state of consciousness, the (psychological) sense of being in the virtual environment” (Slater and Wilbur, 1999)
- Provides different viewpoints: first and third person
- Early head-mounted displays were uncomfortable to wear and could cause motion sickness and disorientation
- Lighter VR headsets are now available (for example, HTC Vive) with more accurate head tracking

Application areas

- Video games
- Arcade games for social groups
- Therapy for fears
- Experience how others feel emotions
 - For example, empathy and compassion
- Enrich user's planning experience for travel destinations
- Architecture, design, and education

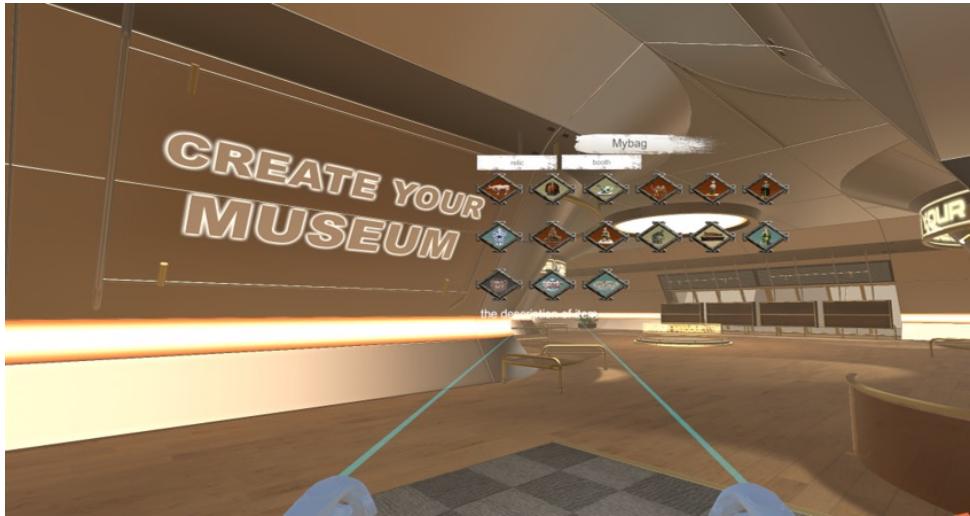
Examples

Polygon graphics used to represent avatars for the We Wait VR experience



Examples

VR for experiencing cultural heritage



Research and design considerations

- Much research on how to design safe and realistic VRs to facilitate training
 - For example, flying simulators
 - Help people overcome phobias (for example, spiders or talking in public)
- Design issues
 - How best to navigate through them (for instance, first versus third person)
 - How to control interactions and movements (for example, by using head and body movements)
 - How best to interact with information (for instance by using keypads, pointing, and joystick buttons)
 - Level of realism to aim for to engender a sense of presence

5. Website design

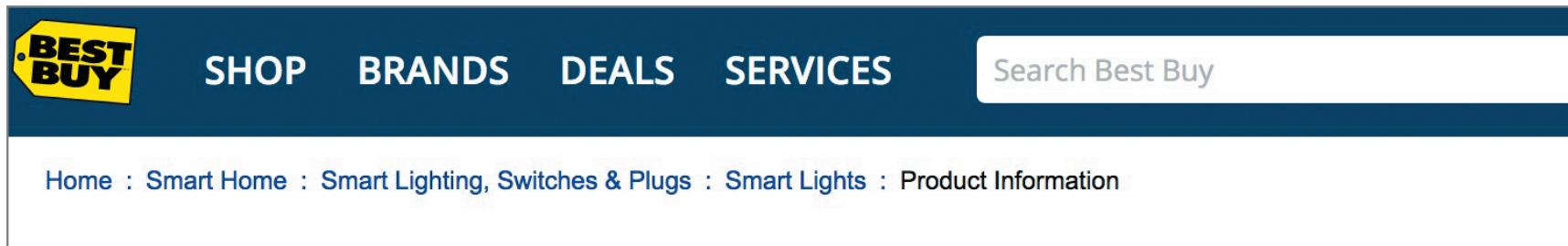
- Early websites were largely text-based, providing hyperlinks
- Concern was with how best to structure information to enable users to navigate and access them easily and quickly
- Nowadays, more emphasis is on making pages distinctive, striking, and aesthetically pleasing
- Need to think of how to design information for multiple platforms—keyboard or touch?
 - For example, smartphones, tablets, and PCs

Usability versus aesthetics?

- Vanilla or multi-flavor design?
 - Ease of finding something versus aesthetic and enjoyable experience
- Web designers are:
 - “thinking great literature”
- Users read the web like a:
 - “billboard going by at 60 miles an hour” (Krug, 2014)
- Need to determine how to brand a web page to catch and keep ‘eyeballs’

Breadcrumbs for navigation

- Breadcrumbs are category labels:
 - Enable users to look at other pages without losing track of where they have come from
 - Very usable
 - Enable one-click access to higher site levels
 - Attract first time visitors to continue to browse a website having viewed the landing page



In your face Web ads

- Web advertising is often intrusive and pervasive
- Flashing, aggressive, persistent, and annoying
- Often requires action to get rid of
- What is the alternative?
 - Use of ad blockers

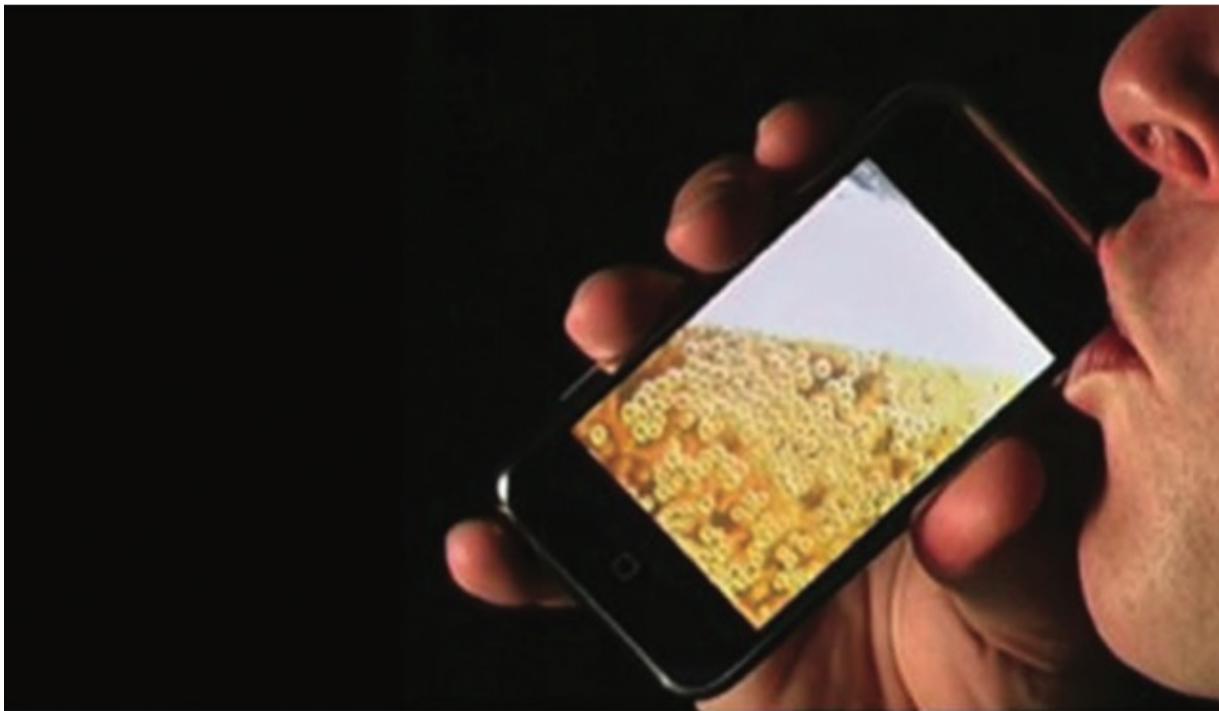
Research and design considerations

- Many books and guidelines on website design
- Veen's (2001) three core questions to consider when designing any website:
 - Where am I?
 - Where can I go?
 - What's here?

6. Mobile interfaces

- Handheld devices intended to be used while on the move
- Have become pervasive, increasingly used in all aspects of everyday and working life
 - For example, phones, fitness trackers, and smartwatches
- Larger-sized tablets used in mobile settings
 - Including those used by flight attendants, marketing professionals, learning in the classroom

iBeer app



hottrixdownload.com

QR codes and smartphones



Research and design considerations

- Mobile interfaces can be cumbersome to use for those with poor manual dexterity or ‘fat’ fingers
- Key concern is hit area:
 - Area on the phone display that the user touches to make something happen, such as a key, an icon, a button, or an app
 - Space needs to be big enough for all fingers to press accurately
 - If too small, the user may accidentally press the wrong key
 - Fitts’ law can be used to help design right spacing
 - Minimum tappable areas should be 44 points x 44 points for all controls

7. Appliances

- Everyday devices in home, public places, or car
 - For example, washing machines, remotes, toasters, printers, and navigation systems)
- And personal devices
 - For instance, digital clock and digital camera
- Used for short periods
 - For example, starting the washing machine, watching a program, buying a ticket, changing the time, or taking a snapshot
- Need to be usable with minimal, if any, learning

Simple toaster control



Research and design considerations

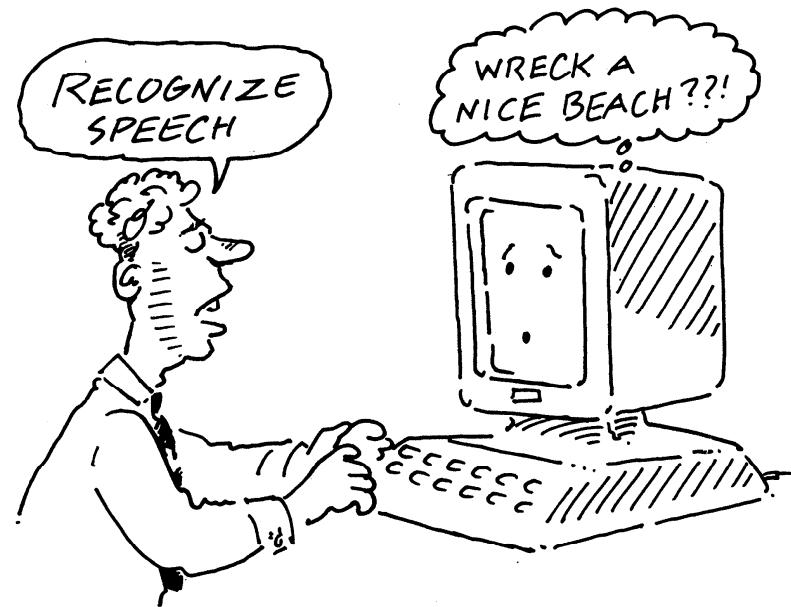
- Need to design as transient interfaces with short interactions
- Simple interfaces
- Consider trade-off between soft and hard controls
 - For example, use of buttons or keys, dials, or scrolling



8. Voice User Interfaces

- Involves a person talking with a spoken language app, for example, timetable, travel planner, or phone service
- Used most for inquiring about specific information, for example, flight times or to perform a transaction, such as buying a ticket
- Also used by people with visual impairments
 - For example, speech recognition word processors, page scanners, web readers, and home control systems

Have speech interfaces come of age?



Modeling human conversations

- People often interrupt each other in a conversation
 - Especially when ordering in a restaurant, rather than let the waiter go through all of the options
- Speech technology has a similar feature called ‘barge-in’
 - Users can choose an option before the system has finished listing all of the options available

Structuring VUI dialogs

- Directed dialogs are where the system is in control of the conversation
 - Where it asks specific questions and requires specific responses
- More flexible systems allow the user to take the initiative:
 - For example, “I’d like to go to Paris next Monday for two weeks.”
- But more chance of error, since caller might assume that the system is like a human
- Guided prompts can help callers back on track
 - For example, “Sorry I did not get all that. Did you say you wanted to fly next Monday?”

Voice assistants (for example, Alexa)

- Have become popular in many homes
- Allow all to use rather than being single use
- Support families playing games, interactive storytelling, jokes, and so forth
- Can encourage social and emotional bonding
- Young children (under 4), however, find it difficult to be understood by the voice assistants
 - Frustrating for them

Research and design considerations

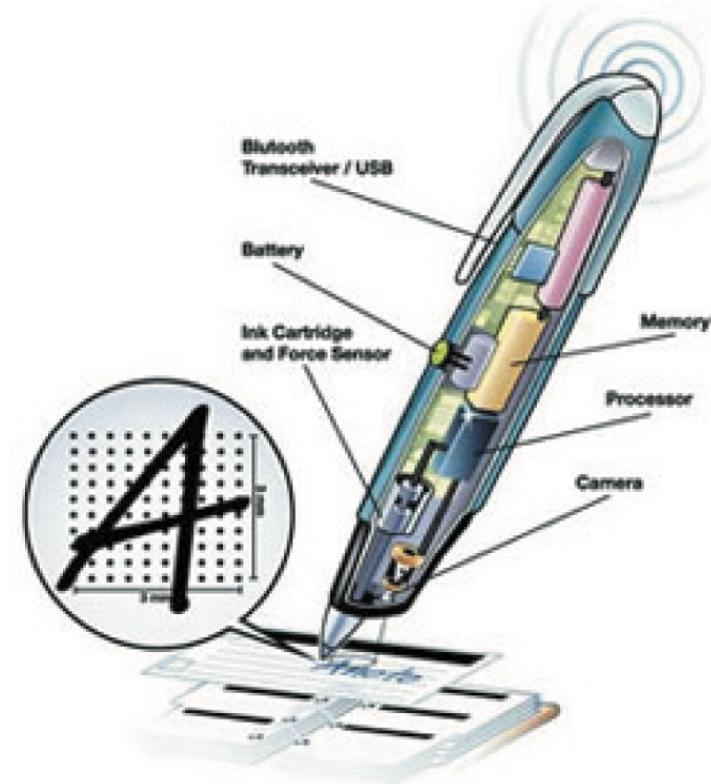
- How to design systems that can keep conversation on track
 - Help people navigate efficiently through a menu system
 - Enable them to recover easily from errors
 - Guide those who are vague or ambiguous in their requests for information or services
- Type of voice actor (for example, male, female, neutral, or dialect)
 - Do people prefer to listen to and are more patient with a female or male voice, a northern or southern accent?

9. Pen-based devices

- Enable people to write, draw, select, and move objects at an interface using light pens or styluses
 - Capitalize on the well-honed drawing skills developed from childhood
- Digital ink, for example, Anoto, use a combination of ordinary ink pen with digital camera that digitally records everything written with the pen on special paper

Example

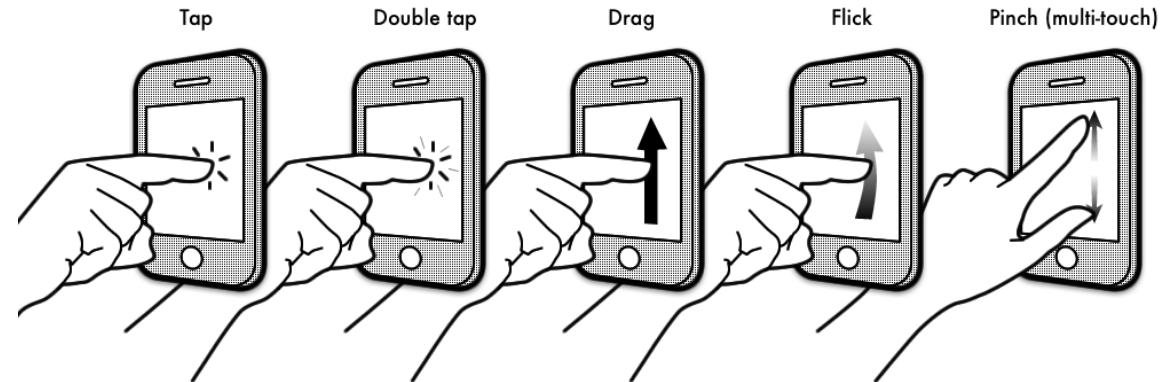
The Anoto pen being used and its internal components



Advantages

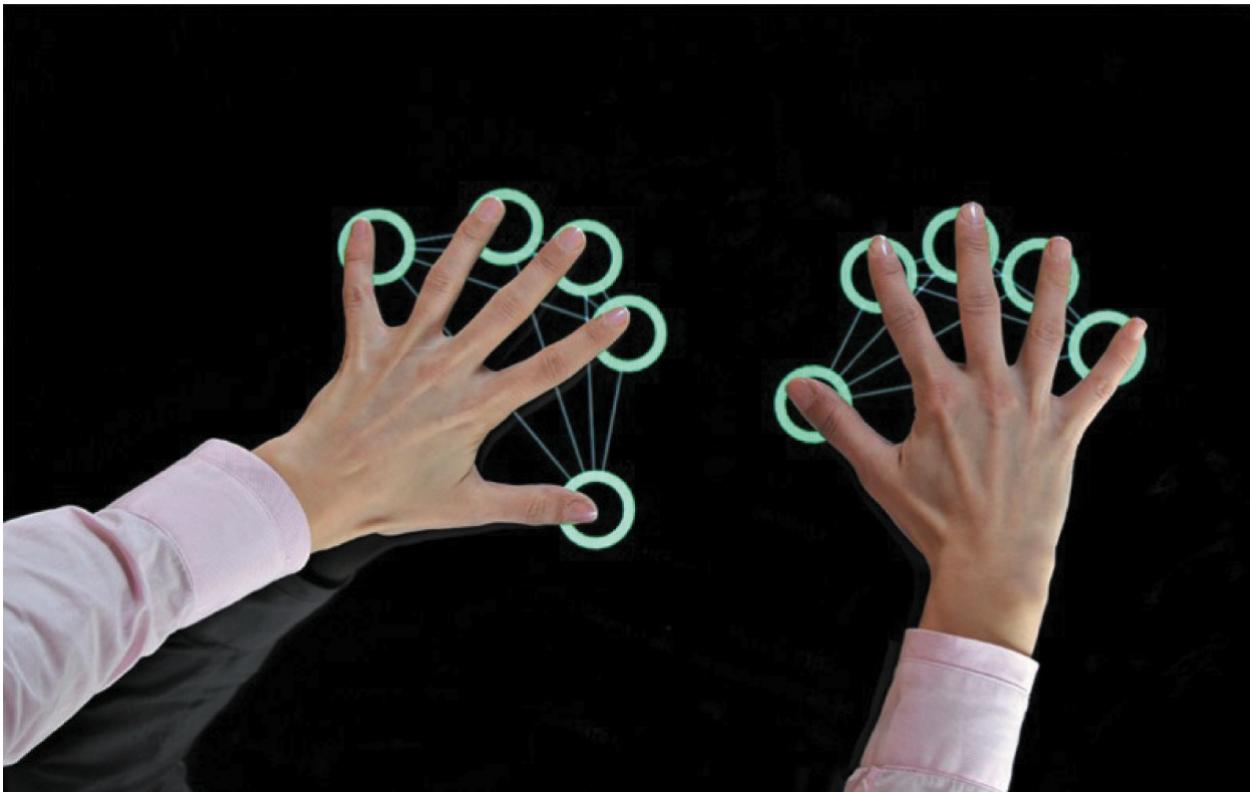
- Allows users to annotate existing documents quickly and easily
- Can be used to fill in paper-based forms that can readily be converted to a digital record using standard typeface
- Can be used by remote teams to communicate and work on the same documents

10. Touchscreens



- Single touchscreens are used in walk-up kiosks (such as ticket machines and ATMs) to detect the presence and location of a person's touch on the display
- Multi-touch surfaces support a range of more dynamic finger tip actions, for example, swiping, flicking, pinching, pushing, and tapping
- They do so by registering touches at multiple locations using a grid
- Now used for many kinds of displays, such as smartphones, iPods, tablets, and tabletops
 - Supports one and two hand gestures, including tapping, zooming, stretching, flicking, dwelling, and dragging

A multi-touch surface



Research and design considerations

- Provides fluid and direct styles of interaction involving freehand and pen-based gestures for certain tasks
- Core design concerns include whether size, orientation, and shape of touch displays effect collaboration
 - Much faster to scroll through wheels, carousels, and bars of thumbnail images or lists of options by finger flicking
 - Gestures need to be learned for multi-touch, so a small set of gestures for common commands is preferable
 - More cumbersome, error-prone, and slower to type using a virtual keyboard on a touch display than using a physical keyboard

11. Gesture-based systems

- Gestures involve moving arms and hands to communicate
- Uses camera recognition, sensor, and computer vision techniques
 - Recognize people's arm and hand gestures in a room
 - Gestures need to be presented sequentially to be understood (compare with the way sentences are constructed)

Gestures used in the operating theater



Recognizes core gestures for manipulating MRI or CT images using Microsoft Kinect

Research and design considerations

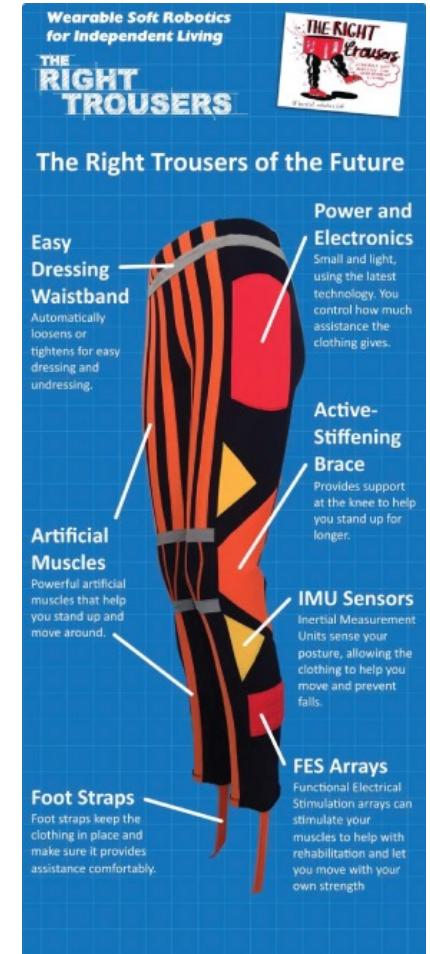
- How does computer recognize and delineate user's gestures?
 - Start and end points?
 - Difference between a deictic gesture (a deliberate pointing movement) and hand waving (an unconscious gesticulation)
 - How realistic must the mirrored graphical representation of the user be in order for them to be believable?

12. Haptic interfaces

- Provide tactile feedback
 - By applying vibration and forces to a person's body, using actuators that are embedded in their clothing or a device they are carrying, such as a smartphone
- Vibrotactile feedback can be used to simulate the sense of touch between remote people who want to communicate
- Ultrahaptics creates the illusion of touch in midair using ultrasound to make the illusion of 3D shapes

Realtime vibrotactile feedback

- Provides nudges when playing violin incorrectly
- Uses motion capture to sense arm movements that deviate from model
- Nudges are short vibrations on arms and hands
- Exoskeleton with artificial muscles that uses bubble haptic feedback



Research and design considerations

- Where best to place actuators on body
- Whether to use single or sequence of 'touches'
- When to buzz and how intense
- How does the wearer feel it in different contexts?
- What kind of new smartphone/smartwatch apps can use vibrotactile creatively?
 - For example, slow tapping to feel like water drops meant to indicate that it is about to rain, and heavy tapping to indicate a thunderstorm is looming

13. Multimodal Interfaces

- Provide enriched user experiences
 - By multiplying how information is experienced and detected using different modalities, such as touch, sight, sound, and speech
 - Support more flexible, efficient, and expressive means of human-computer interaction
 - Most common is speech and vision
- Can be combined with multi-sensor input to enable other aspects of the human body to be tracked
 - For example, eye gaze, facial expression, and lip movements
 - Provides input for customizing user interfaces

Tracking a person's movements

- Kinect camera can detect multimodal input in real time using RGB camera for facial recognition and gestures, depth camera for movement tracking, and microphones for voice recognition
- Used to build model of person and represented as avatar on display programmed to move just like them



Research and design considerations

- Need to recognize and analyze user behavior, for example, speech, gesture, handwriting, or eye gaze
- Much harder to calibrate these than single modality systems
- What is gained from combining different input and outputs
- Is talking and gesturing, as humans do with other humans, a natural way of interacting with a computer?

14. Shareable interfaces

- Designed for more than one person to use:
 - Provide multiple inputs and sometimes allow simultaneous input by co-located groups
 - Large wall displays where people use their own pens or gestures
 - Interactive tabletops where small groups interact with information using their fingertips
 - For example, DiamondTouch, Smart Table, and Surface

A smartboard and an interactive tabletop interface



Benefits

- Provide a large interactional space that can support flexible group working
- Can be used by multiple users
 - Can point to and touch information being displayed
 - Simultaneously view the interactions and have the same shared point of reference as others
- Can support more equitable participation compared with groups using single PC

Research and design considerations

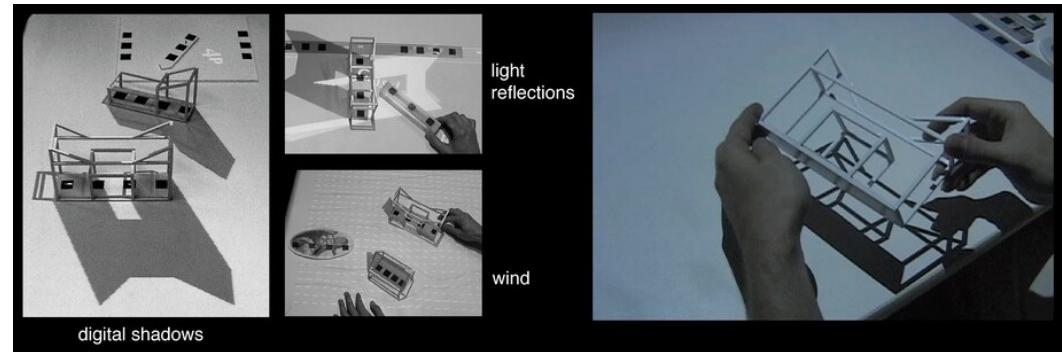
- Core design concerns include whether size, orientation, and shape of the display have an effect on collaboration
- Horizontal surfaces compared with vertical ones support more turn-taking and collaborative working in co-located groups
- Providing larger-sized tabletops does not improve group working but encourages more division of labor
- Having both personal and shared spaces enables groups to work on their own and in a group
 - Cross-device systems have been developed to support seamless switching between these, for example, SurfaceConstellations

15. Tangible Interfaces

- Type of sensor-based interaction, where physical objects, for example, bricks, are coupled with digital representations
- When a person manipulates the physical object/s, it causes a digital effect to occur, for example, an animation
- Digital effects can take place in a number of media and places, or they can be embedded in the physical object

Examples

- Urp
 - Physical models of buildings moved around on tabletop
 - Used in combination with tokens for wind and shadows
 - Digital shadows surrounding them to change over time
- CubeMuseum AR
 - Digital models of museum artifacts
 - Physical cube for manipulation



Benefits

- Can be held in one or both hands and combined and manipulated in ways not possible using other interfaces
 - Allows for more than one person to explore the interface together
 - Objects can be placed on top of each other, beside each other, and inside each other
 - Encourages different ways of representing and exploring a problem space
- People are able to see and understand situations differently
 - Can lead to greater insight, learning, and problem-solving than with other kinds of interfaces
 - Can facilitate creativity and reflection

Research and design considerations

- What kinds of conceptual frameworks to use to help identify novel and specific features
- What kind of coupling to use between the physical action and digital effect
 - If it is to support learning, then an explicit mapping between action and effect is critical
 - If it is for entertainment, then it can be better to design it to be more implicit and unexpected
- What kind of physical artifact to use
 - Bricks, cubes, and other component sets are most commonly used because of flexibility and simplicity
 - Stickies and cardboard tokens can also be used for placing material onto a surface
- With what kinds of digital outputs should tangible interfaces be combined?

16. Augmented Reality

- Augmented reality: Virtual representations are superimposed on physical devices and objects
- Pokémon Go made it a household game
 - Used smartphone camera and GPS to place virtual characters onto objects in the environment as if they really are there
- Many other applications including medicine, navigation, air traffic control, games, and everyday exploring

Other examples

- In medicine
- Virtual objects, for example, x-rays and scans, are overlaid on part of a patient's body
- Aid the physician's understanding of what is being examined or operated
- In air traffic control
- Dynamic information about aircraft overlaid on a video screen showing the real planes, and so on landing, taking off, and taxiing
- Helps identify planes difficult to make out

Augmented reality overlay on a car windshield



AR that uses forward facing camera

- Enables virtual try-ons (for example, Snapchat filters)
- AT mirrors set up in retail stores for trying on make-up, sunglasses, jewelry
 - Convenient, engaging, and easy to compare more choices
 - But cannot feel the weight, texture, or smell of what is being tried on
- Can be used to enable users to step into a character (for example, David Bowie, Queen Victoria)

Example

Singers trying on the virtual look of two characters from the opera Akhnaten



(a)



Research and design considerations

- What kind of digital augmentation?
 - When and where in physical environment?
 - Needs to stand out but not distract from ongoing task
 - Needs to be able to align with real world objects
 - What happens if the AR is slightly off?
- What kind of device?
 - Smartphone, tablet, head up display or other?

17. Wearables

- First developments were head- and eyewear-mounted cameras that enabled user to record what was seen and to access digital information
- Since then, jewelry, head-mounted caps, smart fabrics, glasses, shoes, and jackets have all been used
 - Provides the user with a means of interacting with digital information while on the move
- Applications include automatic diaries, tour guides, cycle indicators, and fashion clothing

Google Glass (2014)

Why was there so much excitement and concern about people filming what they could see right in front of them?



Research and design considerations

- Comfort
 - Needs to be light, small, not get in the way, fashionable, and preferably hidden in the clothing
- Hygiene
 - Is it possible to wash or clean the clothing once worn?
- Ease of wear
 - How easy is it to remove the electronic gadgetry and replace it?
- Usability
 - How does the user control the devices that are embedded in the clothing?

18. Robots

- Remote robots used in hazardous settings
 - Can be controlled to investigate bombs and other dangerous materials
- Domestic robots helping around the house
 - Can pick up objects and do daily chores like vacuuming
- Pet robots as human companions
 - Have therapeutic qualities, helping to reduce stress and loneliness
- Sociable robots that work collaboratively with humans
 - Encourage social behaviors

Social robots: Mel and Paro

- Cute and cuddly
- Can open and close eyes and make sounds and movements



Source: Images courtesy of Mitsubishi Electric Research Labs.

Drones

- Unmanned aircraft that are controlled remotely and used in a number of contexts
 - For example, entertainment, such as carrying drinks and food to people at festivals and parties
 - Agricultural applications, such as flying them over vineyards and fields to collect data about crops, which is useful to farmers
 - Helping to track poachers in wildlife parks in Africa
- Can fly low and stream photos to a ground station where images can be stitched together into maps
- Can be used to determine the health of a crop, or when it is the best time to harvest the crop

Example

Drone being used
to survey the state
of a vineyard



Research and design considerations

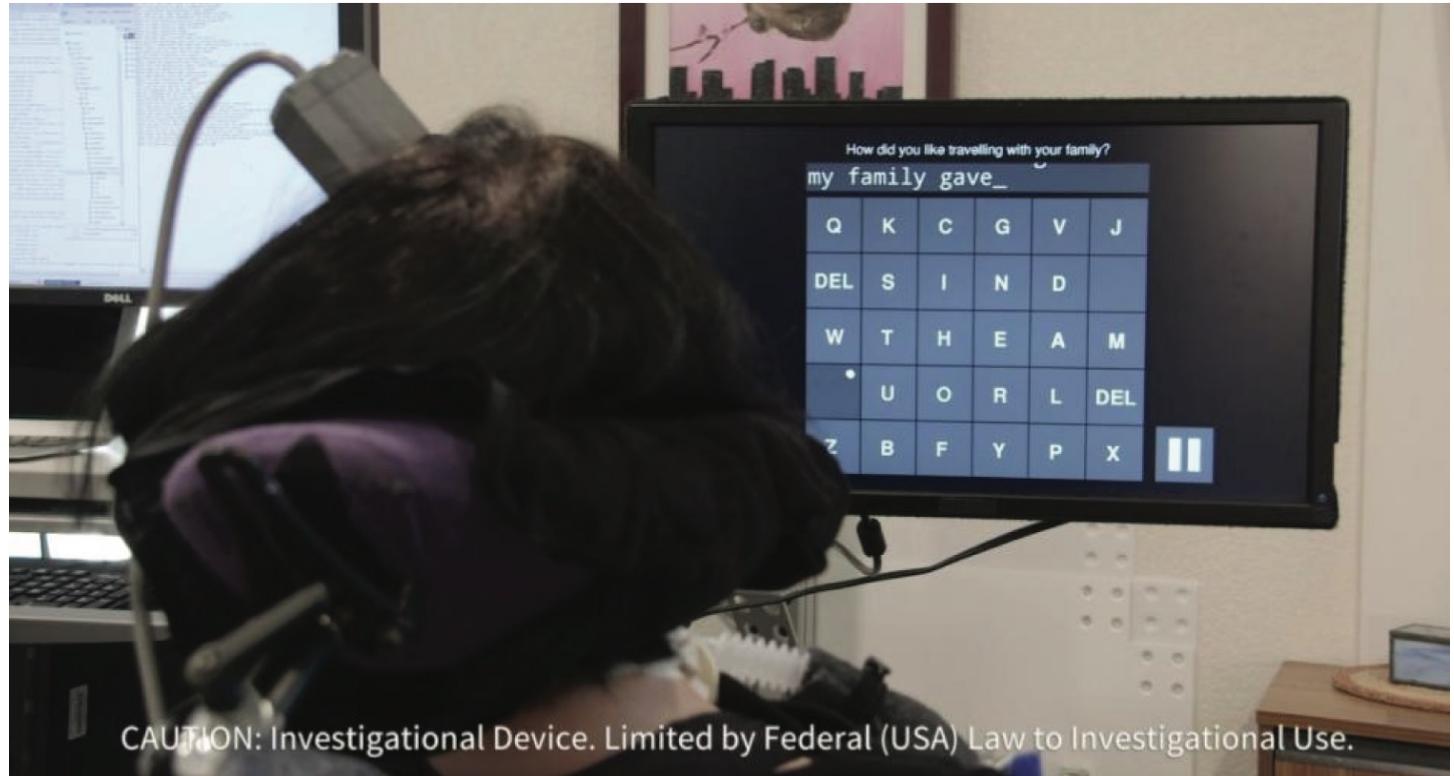
- How do humans react to physical robots designed to exhibit behaviors (for example, making facial expressions) compared with virtual ones?
- Should robots be designed to be human-like or look like and behave like robots that serve a clearly-defined purpose?
- Should the interaction be designed to enable people to interact with the robot as if it was another human being or more human-computer-like (for example, pressing buttons to issue commands)?
- Is it acceptable to use unmanned drones to take a series of images or videos of fields, towns, and private property without permission or people knowing what is happening?

19. Brain-computer interfaces

- Brain-computer interfaces (BCI) provide a communication pathway between a person's brain waves and an external device, such as a cursor on a screen
- Person is trained to concentrate on the task, for example, moving the cursor
- BCIs work through detecting changes in the neural functioning in the brain
- BCIs apps:
 - Games (for example, Brain Ball)
 - Enable people who are paralyzed to control robots

Example

A brain-computer interface being used by a woman who is paralyzed to select letters on the screen



20. Smart interfaces

- Smart: phones, speakers, watches, cars, buildings, cities
- Smart refers to having some intelligence and connected to the internet and other devices
- Context-aware
 - Understand what is happening around them and execute appropriate actions, for example, a Nest thermostat
- Human-building interaction
 - Buildings are designed to sense and act on behalf of the inhabitants but also allow them to have some control and interaction with the automated systems

Which interface?

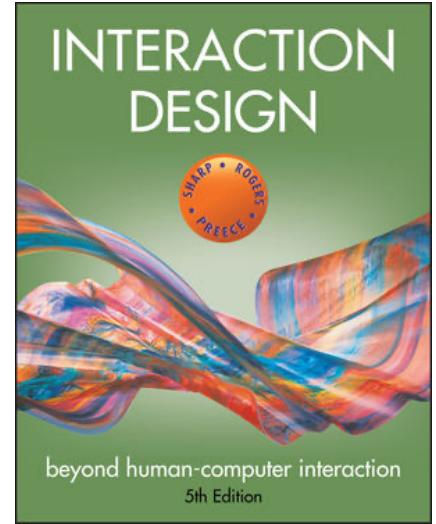
- Which interface to use will depend on task, users, context, cost, robustness, and so on
- Is multimedia better than tangible interfaces for learning?
- Is speech as effective as a command-based interface?
- Is a multimodal interface more effective than a mono-modal interface?
- Will wearable interfaces be better than mobile interfaces for helping people to find information in foreign cities?
- Are virtual environments the ultimate interface for playing games?
- Are shareable interfaces better at supporting communication and collaboration compared with using networked desktop PCs?

Summary

- Many innovative interfaces have emerged in last 30 years, including speech, wearable, mobile, brain, and tangible
- This raises many design and research questions as to decide which to use
 - For example, how best to represent information to the user so that they can carry out ongoing activity or task
- New smart interfaces that are context-aware and monitor people
 - Raising new ethical issues concerned with what data is being collected and what it is used for

Readings

- Chapter 3: Conceptualizing Interaction
- Chapter 7: Interfaces



Any Questions?

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