Chapter 6

Interfaces
Overview

• **Interface types**
  – highlight the main design and research issues for each of the different interfaces

• **Consider which interface is best for a given application or activity**
<table>
<thead>
<tr>
<th>Interface type</th>
<th>See also</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Command-based</td>
<td>WIMP and web</td>
</tr>
<tr>
<td>2. WIMP and GUI</td>
<td>Augmented and mixed reality</td>
</tr>
<tr>
<td>3. Multimedia</td>
<td>Multimedia</td>
</tr>
<tr>
<td>4. Virtual reality</td>
<td>Mobile and multimedia</td>
</tr>
<tr>
<td>5. Information visualization</td>
<td>Mobile</td>
</tr>
<tr>
<td>6. Web</td>
<td>Augmented and mixed reality</td>
</tr>
<tr>
<td>7. Consumer electronics and appliances</td>
<td>Shareable, touch</td>
</tr>
<tr>
<td>8. Mobile</td>
<td>Shareable, air-based gesture</td>
</tr>
<tr>
<td>9. Speech</td>
<td>Tangible</td>
</tr>
<tr>
<td>10. Pen</td>
<td>Multimodal</td>
</tr>
<tr>
<td>11. Touch</td>
<td>Speech, pen, touch, gesture, and haptic</td>
</tr>
<tr>
<td>12. Air-based gesture</td>
<td>Touch</td>
</tr>
<tr>
<td>13. Haptic</td>
<td></td>
</tr>
<tr>
<td>14. Multimodal</td>
<td></td>
</tr>
<tr>
<td>15. Shareable</td>
<td></td>
</tr>
<tr>
<td>16. Tangible</td>
<td></td>
</tr>
<tr>
<td>17. Augmented and mixed reality</td>
<td></td>
</tr>
<tr>
<td>18. Wearable</td>
<td></td>
</tr>
<tr>
<td>19. Robotic</td>
<td></td>
</tr>
<tr>
<td>20. Brain–computer</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.1 The types of interfaces covered in this chapter
1. Command-based

- Commands such as abbreviations (e.g. ls) typed in at the prompt to which the system responds (e.g. listing current files)
- Some are hard wired at keyboard, others can be assigned to keys
- Efficient, precise, and fast
- Large overhead to learning set of commands
Second Life command-based interface for visually impaired users
Research and design issues

• Form, name types and structure are key research questions

• Consistency is most important design principle
  – e.g. always use first letter of command

• Command interfaces popular for web scripting

yubnub
a (social) command line for the web
2. WIMP and GUI

- Xerox Star first WIMP -> rise to GUIs
- Windows
  - could be scrolled, stretched, overlapped, opened, closed, and moved around the screen using the mouse
- Icons
  - represented applications, objects, commands, and tools that were opened when clicked on
- Menus
  - offering lists of options that could 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
GUIs

• Same basic building blocks as WIMP but more varied
  – Color, 3D, sound, animation,
  – Many types of menus, icons, windows

• New graphical elements, e.g.
  – toolbars, docks, rollovers
Windows

• Windows were invented to overcome physical constraints of a computer display
  – enable more information to be viewed and tasks to be performed

• Scroll bars within windows also enable more information to be viewed

• Multiple windows can make it difficult to find desired one
  – listing, iconising, shrinking are techniques that help
Apple’s shrinking windows
Safari panorama window view
Selecting a country from a scrolling window
Is this method any better?
Research and design issues

- **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**
Menus

• A number of menu interface styles
  – flat lists, drop-down, pop-up, contextual, and expanding ones, e.g., scrolling and cascading

• Flat menus
  – good at displaying a small number of options at the same time and where the size of the display is small, e.g. iPods
  – but have to nest the lists of options within each other, requiring several steps to get to the list with the desired option
  – moving through previous screens can be tedious
iPod flat menu structure

A sequence of options selected shown in the 4 windows
Expanding menus

• Enables more options to be shown on a single screen than is possible with a single flat menu

• More flexible navigation, allowing for selection of options to be done in the same window

• Most popular are cascading ones
  – primary, secondary and even tertiary menus
  – downside is that they require precise mouse control
  – can result in overshooting or selecting wrong options
Cascading menu
Contextual menus

- Provide access to often-used commands that make sense in the context of a current task
- Appear when the user presses the Control key while clicking on an interface element
  - e.g., clicking on a photo in a website together with holding down the Control key results in options ‘open it in a new window,’ ‘save it,’ or ‘copy it’
- Helps overcome some of the navigation problems associated with cascading menus
Windows Jump List Menu
Research and design issues

- What are best names/labels/phrases to use?
- Placement in list is critical
  - Quit and save need to be far apart
- Many international guidelines exist emphasizing depth/breadth, structure and navigation
  - e.g. ISO 9241
Icon design

• Icons are assumed to be easier to learn and remember than commands
• Can be designed to be compact and variably positioned on a screen
• Now pervasive in every interface
  – e.g. represent desktop objects, tools (e.g. paintbrush), applications (e.g. web browser), and operations (e.g. cut, paste, next, accept, change)
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
• GUIs now highly inviting, emotionally appealing, and feel alive
Icon forms

- The mapping between the representation and underlying referent can be:
  - similar (e.g., a picture of a file to represent the object file),
  - analogical (e.g., a picture of a pair of scissors to represent ‘cut’)
  - arbitrary (e.g., the use of an X to represent ‘delete’)

- 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
Early icons
Newer icons
Simple icons plus labels

- Delete
- Redo
- Undo
- Properties
- Cut
- Copy
- Paste
- Folder Options
- Views

- Back
- Forward
- Stop
- Refresh
- Home
- Search
- Favorites
- History
- Mail

- Up
- Move To
- Copy To
- Folders
- Open
- Save
- Print
- New
- Print Preview
Activity

• Sketch simple icons to represent the operations to appear on a digital camera LCD screen:
  – Delete last picture taken
  – Delete all pictures stored
  – Format memory card
Toshiba’s icons

- Which is which?
- Are they easy to understand?
- Are they distinguishable?
- What representation forms are used?
- How do yours compare?
Research and design issues

- There is a wealth of resources now so do not have to draw or invent new icons from scratch
  - guidelines, style guides, icon builders, libraries
- Text labels can be used alongside icons to help identification for small icon sets
- For large icon sets (e.g. photo editing or word processing) use rollovers
3. Multimedia

- Combines different media within a single interface with various forms of interactivity
  - graphics, text, video, sound, and animations
- Users click on links in an image or text
  -> another part of the program
  -> an animation or a video clip is played
  -> can return to where they were or move on to another place
BioBlast multimedia learning environment
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
Research and design issues

• 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
  – Use ‘dynalinking,’ where information depicted in one window explicitly changes in relation to what happens in another (Scaife and Rogers, 1996).

• Several guidelines that recommend how to combine multiple media for different kinds of task
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 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: 1st and 3rd person

• Head-mounted displays are uncomfortable to wear, and can cause motion sickness and disorientation
Virtual Gorilla Project
Research and design issues

- Much research on how to design safe and realistic VRs to facilitate training
  - e.g. flying simulators
  - help people overcome phobias (e.g. spiders, talking in public)

- Design issues
  - how best to navigate through them (e.g. first versus third person)
  - how to control interactions and movements (e.g. use of head and body movements)
  - how best to interact with information (e.g. use of keypads, pointing, joystick buttons)
  - level of realism to aim for to engender a sense of presence
Which is the most engaging game of Snake?
5. Information visualization

- Computer-generated interactive graphics of complex data
- Amplify human cognition, enabling users to see patterns, trends, and anomalies in the visualization (Card et al, 1999)
- Aim is to enhance discovery, decision-making, and explanation of phenomena
- Techniques include:
  - 3D interactive maps that can be zoomed in and out of and which present data via webs, trees, clusters, scatterplot diagrams, and interconnected nodes
Research and design issues

• whether to use animation and/or interactivity
• what form of coding to use, e.g. color or text labels
• whether to use a 2D or 3D representational format
• what forms of navigation, e.g. zooming or panning,
• what kinds and how much additional information to provide, e.g. rollovers or tables of text
• What navigational metaphor to use
6. Web

• Early websites were largely text-based, providing hyperlinks
• Concern was with how best to structure information at the interface to enable users to navigate and access it easily and quickly
• Nowadays, more emphasis on making pages distinctive, striking, and pleasurable
Usability versus attractive?

• 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, 2000)

• Need to determine how to brand a web page to catch and keep ‘eyeballs’
In your face ads

- Web advertising is often intrusive and pervasive
- Flashing, aggressive, persistent, annoying
- Often need to be ‘actioned’ to get rid of
- What is the alternative?
Research and design issues

- Need to consider how best to design, present, and structure information and system behavior.
- But also content and navigation are central.
- Veen’s design principles
  1. Where am I?
  2. Where can I go?
  3. What’s here?
Activity

- Look at the Nike.com website
- What kind of website is it?
- How does it contravene the design principles outlined by Veen?
- Does it matter?
- What kind of user experience is it providing for?
- What was your experience of engaging with it?
Nike.com
7. Consumer electronics and appliances

- Everyday devices in home, public place, or car
  - e.g. washing machines, remotes, photocopiers, printers and navigation systems)

- And personal devices
  - e.g. MP3 player, digital clock and digital camera

- Used for short periods
  - e.g. putting the washing on, watching a program, buying a ticket, changing the time, taking a snapshot

- Need to be usable with minimal, if any, learning
A toaster
Research and design issues

• Need to design as transient interfaces with short interactions
• Simple interfaces
• Consider trade-off between soft and hard controls
  – e.g. buttons or keys, dials or scrolling
8. Mobile

- Handheld devices intended to be used while on the move
- Have become pervasive, increasingly used in all aspects of everyday and working life
- Applications running on handhelds have greatly expanded, e.g.
  - used in restaurants to take orders
  - car rentals to check in car returns
  - supermarkets for checking stock
  - in the streets for multi-user gaming
  - in education to support life-long learning
The advent of the iPhone app

- A whole new user experience that was designed primarily for people to enjoy
  - many apps not designed for any need, want or use but purely for idle moments to have some fun
  - e.g. iBeer developed by magician Steve Sheraton
  - ingenious use of the accelerometer that is inside the phone
iBeer app
QR codes and cell phones
Mobile challenges

• Small screens, small number of keys and restricted number of controls
• Many smartphones now use multi-touch surface displays
• Innovative physical designs including:
  – roller wheels, rocker dials, up/down ‘lips’ on the face of phones, 2-way and 4-way directional keypads, softkeys, silk-screened buttons
• Usability and preference varies
  – depends on the dexterity and commitment of the user
Simple or complex phone for you and your grandmother?
Research and design issues

- Mobile interfaces can be tricky and cumbersome to use for those with poor manual dexterity or ‘fat’ fingers.
- Key concern is designing for small screen real estate and limited control space.
  - E.g. Mobile browsers allow users to view and navigate the internet, magazines etc., in a more streamlined way compared with PC web browsers.
9. Speech

- Where a person talks with a system that has a spoken language application, e.g., timetable, travel planner
- Used most for inquiring about very specific information, e.g. flight times or to perform a transaction, e.g. buy a ticket
- Also used by people with disabilities
  - e.g. speech recognition word processors, page scanners, web readers, home control systems
Have speech interfaces come of age?
Get me a human operator!

• Most popular use of speech interfaces currently is for call routing
• Caller-led speech where users state their needs in their own words
  – e.g. “I’m having problems with my voice mail”
• Idea is they are automatically forwarded to the appropriate service
• What is your experience of speech systems?
Format

• Directed dialogs are where the system is in control of the conversation
• Ask specific questions and require specific responses
• More flexible systems allow the user to take the initiative:
  – e.g. “I’d like to go to Paris next Monday for two weeks.”
• More chance of error, since caller might assume that the system is like a human
• Guided prompts can help callers back on track
  – e.g. “Sorry I did not get all that. Did you say you wanted to fly next Monday?”
Research and design issues

• How to design systems that can keep conversation on track
  – help people navigate efficiently through a menu system
  – enable them to easily recover from errors
  – guide those who are vague or ambiguous in their requests for information or services

• Type of voice actor (e.g. 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?
10. Pen

• Enable people to write, draw, select, and move objects at an interface using lightpens or styluses – capitalize on the well-honed drawing skills developed from childhood

• Digital pens, e.g. Anoto, use a combination of ordinary ink pen with digital camera that digitally records everything written with the pen on special paper
Pros and cons

• Allows users to quickly and easily annotate existing documents
• Can be difficult to see options on the screen because a user’s hand can occlude part of it when writing
• Can have lag and feel clunky
11. Touch

• Touch screens, such as walk-up kiosks, detect the presence and location of a person’s touch on the display

• Multi-touch support a range of more dynamic finger tip actions, e.g. swiping, flicking, pinching, pushing and tapping

• Now used for many kinds of displays, such as Smartphones, iPods, tablets and tabletops
Research and design issues

- More fluid and direct styles of interaction involving freehand and pen-based gestures
- 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
- More cumbersome, error-prone and slower to type using a virtual keyboard on a touch display than using a physical keyboard
Research and design issues

- Will finger-flicking, stroking and touching a screen result in new ways of consuming, reading, creating and searching digital content?
12. Air-based gestures

- Uses camera recognition, sensor and computer vision techniques
  - can recognize people’s body, arm and hand gestures in a room
  - systems include Kinect and EyeToy
- Movements are mapped onto a variety of gaming motions, such as swinging, bowling, hitting and punching
- Players represented on the screen as avatars doing same actions
Home entertainment

- Universal appeal
  - young children, grandparents, professional gamers, technophobes
Research and design issues

• How does computer recognize and delineate players’ gestures?
  – Deictic and hand waving

• Does holding a control device feel more intuitive than controller free gestures?
  – For gaming, exercising, dancing
13. Haptic

- **Tactile feedback**
  - 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 cell phone

- Can enrich user experience or nudge them to correct error

- Can also be used to simulate the sense of touch between remote people who want to communicate
Realtime vibrotactile feedback

- Provides nudges when playing incorrectly
- Uses motion capture
- Nudges are vibrations on arms and hands
Research and design issues

- 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?
14. Multi-modal

- Meant to provide enriched and complex user experiences
  - multiplying how information is experienced using different modalities, i.e. touch, sight, sound, speech
  - support more flexible, efficient, and expressive means of human–computer interaction
  - Most common is speech and vision
Research and design issues

• Need to recognize and analyse speech, gesture, and eye gaze
• 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?
15. Shareable

- Shareable interfaces are 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
  - e.g. DiamondTouch, Smart Table and Surface
A smartboard

Summary

- Divided into 6 regions
- Costs calculated for
  - new buildings
    - 49% of total
  - additions
    - 31% of total
  - renovations
    - 20% of total
DiamondTouch Tabletop
Advantages

• 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 same shared point of reference as others
• Can support more equitable participation compared with groups using single PC
The Drift Table
Research and design issues

• More fluid and direct styles of interaction involving freehand and pen-based gestures
• 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
16. Tangible

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

• **Chromarium cubes**
  – when turned over digital animations of color are mixed on an adjacent wall
  – facilitates creativity and collaborative exploration

• **Flow Blocks**
  – depict changing numbers and lights embedded in the blocks
  – vary depending on how they are connected together

• **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
Flow blocks
Urp
Benefits

• Can be held in 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 issues

- Develop new conceptual frameworks that identify novel and specific features
- The 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 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
17. Augmented and mixed reality

- Augmented reality - virtual representations are superimposed on physical devices and objects
- Mixed reality - views of the real world are combined with views of a virtual environment
- Many applications including medicine, games, flying, and everyday exploring
Examples

• In medicine
  – virtual objects, e.g. 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, etc. landing, taking off, and taxiing
  – Helps identify planes difficult to make out
An augmented map
‘Smart’ augmented reality?

- Smartphone apps intended to guide people walking in a city
  - arrows and local information (e.g. nearest McDonalds) are overlaid on a picture of the street the person is walking in
  - Will this mean people spending most of their time glued to their smartphone rather than looking at the sites?
Research and design issues

• **What kind of digital augmentation?**
  - When and where in physical environment?
  - Needs to stand out but not distract from ongoing task
  - Need to be able to align with real world objects

• **What kind of device?**
  - Smartphone, head up display or other?
18. Wearables

- First developments were head- and eyewear-mounted cameras that enabled users to record what was seen and to access digital information.
- Since, jewellery, head-mounted caps, smart fabrics, glasses, shoes, and jackets have all been used.
  - provide 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.
Steve Mann - pioneer of wearables

Steve Mann’s "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.
Research and design issues

• **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?
19. Robots

- **Four types**
  - remote robots used in hazardous settings
  - domestic robots helping around the house
  - pet robots as human companions
  - sociable robots that work collaboratively with humans, and communicate and socialize with them – as if they were our peers
Advantages

• Pet robots are assumed to have therapeutic qualities, being able to reduce stress and loneliness

• Remote robots can be controlled to investigate bombs and other dangerous materials
Research and design issues

- How do humans react to physical robots designed to exhibit behaviors (e.g. 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 (e.g. pressing buttons to issue commands)?
20. Brain–computer

• 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, e.g. moving the cursor
• BCIs work through detecting changes in the neural functioning in the brain
Brainball game
Which interface?

- 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 monomodal interface?
- Will wearable interfaces be better than mobile interfaces for helping people find information in foreign cities?
- Are virtual environments the ultimate interface for playing games?
- Will shareable interfaces be better at supporting communication and collaboration compared with using networked desktop PCs?
Which interface?

• Will depend on task, users, context, cost, robustness, etc.
• Mobile platforms taking over from PCs
• Speech interfaces also being used much more for a variety of commercial services
• Appliance and vehicle interfaces becoming more important
• Shareable and tangible interfaces entering our homes, schools, public places, and workplaces
Summary

• Many innovative interfaces have emerged post the WIMP/GUI era, including speech, wearable, mobile, brain and tangible

• Many design and research questions need to be considered to decide which to use

• An important concern that underlies the design of any kind of interface is how information is represented to the user so they can carry out ongoing activity or task