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ELEC S313

Emerging Technologies (Free Courseware)



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Chapter 1 Graphic user interface and interaction model

1.1 About this module



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Welcome to this free courseware module 'Graphic user interface and interaction model'!

This module is taken from the OUHK course *ELEC S313 Emerging Technology* (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154015000&lang=eng), a 10-credit, higher-level course that is part of BSc in Communications Technology, BSc (Hons) in Communications Technology, and BSc (Hons) in Communications Technology with Management. offered by the [School of Science and Technology](http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcSubWeb&l=C_ST&lid=191133000200&lang=eng) (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcSubWeb&l=C_ST&lid=191133000200&lang=eng) of the OUHK. This course aims to introduce advanced technologies in communications and related management.

ELEC S313 (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154015000&lang=eng) is mainly presented in printed format and comprises ten study units. Each unit contains study content, activities, self-tests, etc for students' self-learning. **This module (The materials for this module, taken from Unit 4 of the print-based course ELEC S313, have been specially adapted to make them more suitable for studying online. In addition to topics on 'graphical user interface' and 'Interaction models in a multi-system, mobile, computing environment', the original unit also includes topics on 'The human computer and fundamentals of human-computer interaction', 'Haptic, natural language and multisensory interfaces', 'Embedded interfaces in pervasive systems', 'Persuasive interfaces and captology', and 'Immersive and virtual environments'.)** retains most of these elements, so you can have a taste of what an OUHK course is like. Please note that no credits can be earned on completion of this module. If you would like to pursue it further, you are welcome to enrol in *ELEC S313 Emerging Technology* (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154015000&lang=eng).

This module will take you about **3 hours** to complete, including the time for completing the activities and self-tests.

Good luck, and enjoy your study!

1.2 Introduction



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Despite all advances in computing technologies, the human-computer interface and the interactions that it provides are the most fundamental. Some of the most anticipated advancements in computer technology lie in the area of interfaces – not least because the unlimited computing power and innovative Internet applications must have an outward face and the ability to communicate effectively with users.

Consumers of these resources have an expectation that the interfaces should be just as compelling and useful as the resources themselves. The interfaces should be adaptable to the consumers' lives and useful in all applicable environments – home, office and, most certainly, mobile.

But there remain many unanswered questions in the study of human-computer interfaces. How much more interactive or rich is it realistic to expect device interfaces to become? What interfaces now in the laboratory might be able to address the mobile and distributed computing demands of the future? What interactions will replace the familiar graphical user interface (GUI)?

This module begins to explore these questions. We'll start with a quick tour of the evolution of the graphical user interface, then consider some more advanced interaction models.

Good luck, and enjoy your study!

1.3 Evolution of the graphical user interface (GUI)



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The graphical user interface (GUI) has become synonymous with personal computing. The usability of its familiar WIMP toolset is apparent in the Apple Macintosh™ and Microsoft Windows™ operating systems. Prior to GUI systems, the most common interaction style was the command *line interface*. WIMP tools replaced system commands with *direct manipulation (an HCI style that involves continuous representation of objects of interest, and rapid, reversible, incremental actions and feedback methods)* methods such as *cut-and-paste (Cut-and-paste and copy-and-paste offer user interface paradigms for transferring text, data, files or objects from a source to a destination.)* and *drag-and-drop (the technique of dragging an item, such as a graphic or selected text, and dropping it on a suitable destination.)*

In addition to the *point-and-click/hypertext style* mentioned in [Table 1.1](#), the Web has popularized many of the other elements found in the GUI/WIMP philosophy. HTML provides native support for most of the common WIMP features, e.g. menus, dialog boxes, links, etc. The Web has also perhaps provided many application developers with their first opportunity to directly design and implement interfaces. Given the global recognition of the Web, its interface has become a *metaphor (implicit*

comparison made between two unlike things that actually have something in common) for other UIs that are not Web-based.

Style	Characteristics
Command line interface	Uses a fixed set of commands peculiar to the underlying computing systems that are explicitly entered (e.g. typed) by the user
Menus	Uses a fixed set of commands presented to the user in menu form; users select the appropriate command from the menu
Natural language	Input and/or output is presented as natural language (Natural language processing (NLP) is a field of computer science and linguistics concerned with the interactions between computers and human (natural) languages.) either written or spoken
Query dialogue	Interaction between the user and computing system is accomplished by means of a series of questions and answers
Form completion	Input is accomplished using forms; such interaction is commonly used in Web-based commerce, searching and database queries
WIMP	A suite of interaction methods (windows, icons, menus and pointers) commonly identified as GUI
Point and click/hypertext	The interaction style most commonly associated with the Web
Three-dimensional interfaces/immersion	Support of interaction in three-dimensional environments; it often provides the user with the illusion of being immersed within the process or data being interacted with
multimodal	Interactions involving more than one modality (input or output channel) ; for example, a combination of audio and kinesthetic (pertaining to sensations derived from muscles and movement)

Table 1.1: Interaction styles

Adopting the Web metaphor takes advantage of a user's knowledge of the Web thereby promoting the interface design goals of *learnability* and *predictability*. An example of a system using a Web metaphor might be a ticket kiosk that takes advantage of links and menus for customer navigation. The designer of the kiosk interface may assume that its users are familiar with the Web interaction style and that they would therefore find the interface immediately usable.

As Web applications are moving to more diverse devices (e.g. mobile telephones), however, the GUI/WIMP metaphor is becoming less effective. For example, the use of scrollbars for view management on a desktop or laptop system becomes quite awkward on the small display of a telephone. As new interface techniques evolve to accommodate such devices, the technology will likely move away from the GUI/WIMP style. Likewise, to support device consistency, these new styles will move across the usage spectrum including adoption by Web systems.

In the following video, Prof. White assesses some of the current issues affecting interface design.

Video (http://learn.ouhk.edu.hk/~etpmisp/ouhk_courses/elects313/apr11/unit4/part05/Default.htm#event=1#nopreload=1)

1.3.1 Case study 1



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The *Xerox Alto* was an early personal computer developed at **Xerox PARC (Palo Alto Research Center)** (<http://www.parc.com/about/>) in 1973. It was the first computer to use the desktop metaphor and graphical user interface (GUI). Legend has it that the Alto interface inspired **Steve Jobs** (http://en.wikipedia.org/wiki/Steve_Jobs) in the design of the Apple Lisa™ and Macintosh™ computers. Below you can see a screenshot from the Alto showing its use of the WIMP interaction style.

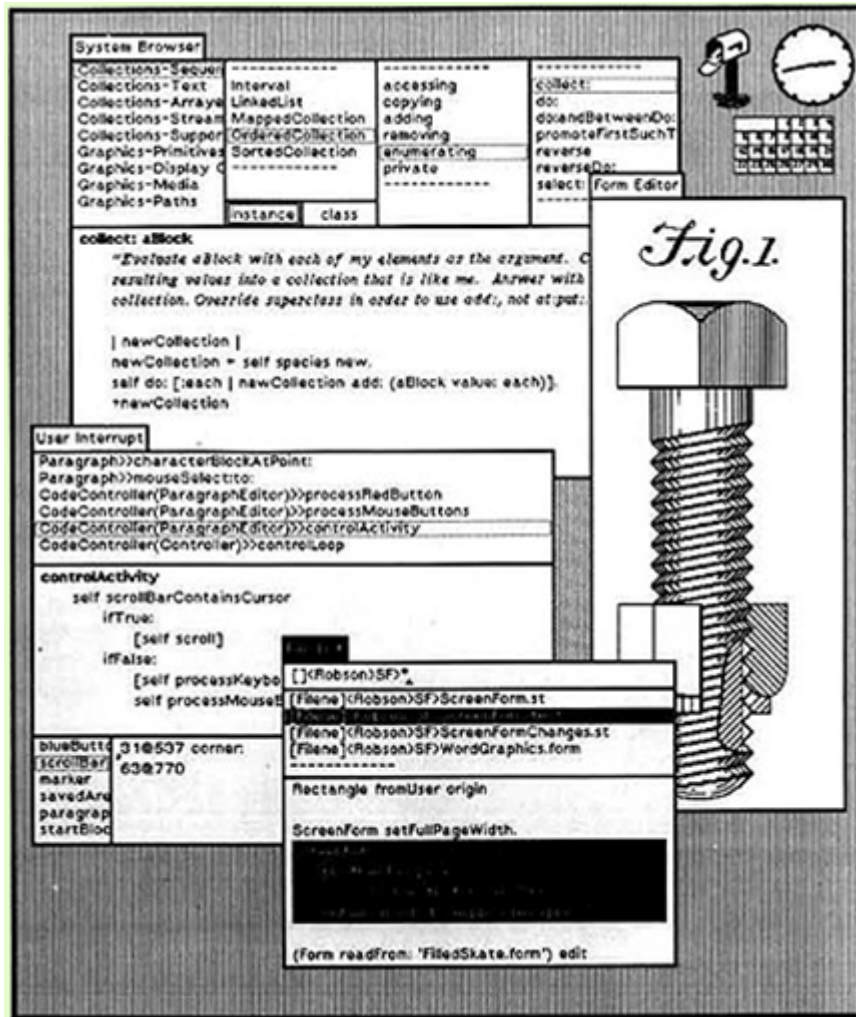


Fig. 1.1: Early implementation of the WIMP interaction style on the Xerox Alto

What do you think the implications of the WIMP interaction style turned out to be?

1.3.1.1 Case study 1 feedback



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Prior to the invention of the Alto, computer user interfaces were *all command line* driven. Introducing a GUI interface was a huge step towards making personal computers possible. While it is often mentioned that the Alto was an inspiration for the Macintosh™ computer, it is interesting to note that the Alto was introduced in 1973 and the Macintosh™ did not appear until 1984. Xerox's successful demonstration of a GUI interface indicates how innovative research begins in a laboratory environment and is gradually adopted by mainstream computer manufacturers. This suggests that the interfaces being developed in the research laboratories today represent the widespread interfaces of the future.

1.3.2 Self-test 1



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Developments of GUI/WIMP technologies revolutionized HCI but have not remained static. Look at [youtube \(http://www.youtube.com/watch?v=TZGGUrom1Mg\)](http://www.youtube.com/watch?v=TZGGUrom1Mg) and consider those elements of the technologies that have evolved/changed and those that have remained constant. What factors might have influenced this change or lack thereof?

1.3.2.1 Self-test 1 feedback



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The use of windows and/or frames to separate workspaces, tasks and data has remained the same. Also, the usage of moveable objects, icons and menus is remarkably similar to that of the early GUI systems. Some elements that have changed include graphical presentation of file systems (e.g. folders, hierarchies).

While use of the mouse (or a similar device such as a trackball, trackpad, etc.) has remained, its functionality has changed in some systems. For example, witness the introduction of one-button, two-button and three-button mouse devices wherein tasks are assigned to the mouse other than just the familiar 'point and click' or 'drag and drop.'

Implementation of changes in GUI/WIMP technologies has occurred for both technical and non-technical reasons. Clearly, computer processor speed has played a major role by increasing interaction time. In addition, GUI functionality has changed due to the diverse nature of roles and applications that must be supported. Market pressure has influenced interface design as computing system manufacturers seek to gain an advantage over their competitors by offering more *friendly* and *functional* interfaces.

1.4 Interaction models in a multi-system, mobile computing environment



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When the inventors of the Xerox Alto adopted the GUI/WIMP interaction model, they revolutionized computing. The model was a perfect fit for the type of computing system that they visualized and for the first generation of personal computing to come. It is, however, unlikely that they could have imagined the breadth of coming systems that exist now and are anticipated in the future. New interaction models as revolutionary as the GUI/WIMP was at that time need to be identified.

User interfaces of the future are being driven by a number of key advancements in computing technology.

Key advances in computing driving user interface design

The following factors are changing the way user interfaces are designed:

1. **Computing power** – Vast amounts of computing resources are now available to users either on readily available devices (e.g. smart telephones) or in the *cloud* (Unit 2). Processing demands that used to require execution on the *server-side* can now be done on the *client-side*. Innovative UIs must support adaptable access to these resources.
2. **Connectivity** – Access to the Internet is now readily available at low cost. Wireless and high-speed broadband connections are the norm rather than the exception. UIs must provide efficient access to resources in increasingly diverse environments and situations.
3. **Device proliferation** – More and more varieties of devices provide access to the Internet and computing resources – mobile telephones, game systems, music players, televisions, GPS devices, etc. Each of these devices supports unique interface elements that should be supported.
4. **Internet standards** – The adoption of standards amongst service providers and device manufacturers should allow the development of interoperable and compatible UIs. XML-based integration using such standards as **XSL (Extensible Stylesheet Language)** (<http://www.w3.org/Style/XSL/>) and **XSLT (XSL Transformations)** (<http://www.w3.org/TR/xslt>) support the easy re-purposing of general data/resources into device-dependent formats.
5. **User interface research** – The multidisciplinary nature of HCI has led to the development of new interaction models and techniques that are adaptable to the functionalities of new technologies. For example, **gestural (referring to the motion of the limbs or body to express or help express thought or intention)** interfaces will be discussed later in this unit.

The simplest of these new UI styles can be categorized as post-WIMP interactions.

New UI styles

New UI styles, including the following, are currently being adopted in some applications:

- **Marking menus** – Circular menus that appear directly under the cursor; excellent examples of the use of marking menus can be found [here](http://www.markingmenus.org/) (<http://www.markingmenus.org/>).
- **Draggable tools** – User tools that can be 'dropped' anywhere in the user workspace and 'grabbed'/retrieved later; an example of how to use and implement draggable *objects* can be found [here](http://jqueryui.com/droppable/) (<http://jqueryui.com/droppable/>).
- **Graspable interfaces** – Using physical objects as input to manipulate virtual objects; providing graspable objects has become a popular feature in e-commerce websites; the goal of such interfaces can be viewed as an attempt to compensate for the fact that online customers do not have physical access to products. An example of such an interface can be found [here](http://www.3drev.com/fla/test.php?title=Ladies+Seksy+Curve&movie=wsuk-seksy-4009-400-400.swf&width=400&height=400&path=http://www.3drev.com/fla/) (<http://www.3drev.com/fla/>).
- **Dynamic queries** – Updating data quickly as a means to filter data in and out of the user's view; introduced in 2010, [Google Instant](http://www.google.com/insidesearch/features/instant/about.html) (<http://www.google.com/insidesearch/features/instant/about.html>) attempts to bring Google users this level of functionality. Many Google searchers appeared to readily accept this new feature; others found it to be intrusive. [Pivot](http://www.ted.com/talks/gary_flake_is_pivot_a_turning_point_for_web_exploration) (http://www.ted.com/talks/gary_flake_is_pivot_a_turning_point_for_web_exploration) is another application can filter and present data in new and potentially powerful ways.
- **Zoomable user interfaces** – Provides user navigation through the interface quickly and intuitively. Websites incorporating data from Google Maps often do so in order to provide their visitors with the ability to zoom and pan through the site interface. For example, visitors to the OUHK are able to quickly and easily look through [the area surrounding the university](https://www.google.com/maps?oe=UTF-8&ie=UTF8&q=open+university+of+hong+kong&fb=1&gl=us&hq=open+university+of+hong+kong&hnear=open+university+of+hong+kong&hl=en&view=map&cid=863760660156860363&iwloc=A&ved=0CD4QpQY&sa=X&ei=BiUyTdaPM5u8tAO8nOnfCw%5D) (<https://www.google.com/maps?oe=UTF-8&ie=UTF8&q=open+university+of+hong+kong&fb=1&gl=us&hq=open+university+of+hong+kong&hnear=open+university+of+hong+kong&hl=en&view=map&cid=863760660156860363&iwloc=A&ved=0CD4QpQY&sa=X&ei=BiUyTdaPM5u8tAO8nOnfCw%5D>).

The following video analyses advances in UIs, and begins looking beyond current UI features and metaphors.

Video (http://learn.ouhk.edu.hk/~etpmsp/ouhk_courses/elects313/apr11/unit4/part06/Default.htm#event=1#npreload=1)

If these current styles and examples are any indication, future interfaces will:

- emphasize direct manipulation;
- move away from the use of metaphors (e.g. icons, desktops, etc.); and
- build upon human and social interaction.

Direct manipulation

Direct manipulation is a powerful concept in the design of UIs. Its goal is to make operations more *natural* and thereby increase the *transparency* of the interface. This is accomplished by means of providing the user a continuous representation of an object of interest. This object can then be manipulated by the user by means of physical actions or labeled button presses instead of with commands that are likely to have complex and ambiguous syntax. Actions on an object are rapid, incremental, reversible operations whose impact on the object of interest is immediately visible. The typical GUI/WIMP operation of *drag-and-drop* is an earlier implementation of the *direct manipulation* concept.

As mentioned earlier, numerous UIs currently take advantage of the power of *zoomable interfaces*. These interfaces typically provide users with the display of an infinite flat surface that can be viewed at any resolution. Pan and zoom interactions allow the user to determine dynamically which objects present in the interface are visible or not and to what level of detail/scale. This interaction model can readily be adapted to give the user a sense of *immersion* within the interface.

The following video discusses this move toward direct manipulation and toward immersion.

Video (http://learn.ouhk.edu.hk/~etpmsp/ouhk_courses/elects313/apr11/unit4/part07/Default.htm#event=1#nopreload=1)

Second Life (SL) (http://en.wikipedia.org/wiki/Second_Life) is a *virtual world* (http://en.wikipedia.org/wiki/Virtual_world) (computer-based simulated environment) that is accessible on the Internet. A free client program called the *Viewer* enables its users, called *residents*, to interact with each other through **avatars (a computer user's representation of himself/herself or alter ego)**. Residents can explore, meet other residents, socialize, participate in individual and group activities, and create and trade virtual property and services with one another, or travel throughout the world. You can see a scene from Second Life here.

Interaction in Second Life



As you can see in the screen capture above, Second Life provides its users with a number of post-WIMP interfaces. The avatar is capable of communicating with the environment via *gestures* (either controlled by key presses, joysticks, mouse, etc.) to perform such operations as opening doors, sitting, etc. Objects within the environment (e.g. clothing) can be *directly manipulated*. Spatial orientation within the environment can be controlled via a customized menu. Data within the environment (e.g. avatar name, 'seat,' etc.) are dynamically created and displayed when relevant. The image above shows an example of a *marking menu* previously described as a post-WIMP interaction element. The Second Life *Viewer* client is especially designed to support these interaction capabilities since they cannot be provided in a Web environment with standard HTML elements. Second Life does plan to support Web browser functionality in the near future.

1.4.1 Activity 1



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Create an identity in Second Life just, at a minimum, to observe and experiment with the interaction capabilities provided in a virtual world. (You should not be concerned

about doing this since inactive accounts are regularly deleted.) New accounts in Second Life are directed to 'orientation islands' (http://secondlife.wikia.com/wiki/Orientation_Islands) where basic interface operations are discussed.

Based on your observations, which Second Life interface capabilities still draw from the GUI/WIMP model, and which are genuinely innovative?

1.4.1.1 Activity 1 feedback



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The interface designers in Second Life appear to have consciously provided multiple mechanisms for accomplishing the same functions. For example, avatar movement can be done with a mouse, keyboard arrow keys, or more sophisticated peripherals (e.g. joystick, 3-D mouse) if available. Ample keystroke shortcuts and hot keys are also available. Menus and dialog boxes (familiar in GUI/WIMP interfaces) are provided.

1.4.2 The iPhone interface



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The iPhone™ is a line of smart phones first introduced by Apple in 2007. It functions as a camera phone, including text messaging and visual voicemail, a portable media player, and an Internet client, with email, Web browsing and Wi-Fi connectivity.

The iPhone's interface is one of the most sophisticated ever introduced on a consumer product. Almost all input is given through the touch screen, which understands complex gestures using multi-touch. The iPhone's™ interaction techniques enable the user to move the content up or down by a touch-drag motion of the finger. For example, *zooming* in and out of webpages and photos is done by placing two fingers on the screen and spreading them farther apart or bringing them closer together, a gesture known as pinching. *Scrolling* through a long list or menu is achieved by sliding a finger over the display from bottom to top, or vice versa to go back. In either case, the list moves as if it is pasted on the outer surface of a wheel, slowly decelerating as if affected by friction. In this way, the interface simulates the physics of a real object.

Other user-centred interactive effects include horizontally sliding sub-selection, the vertically sliding keyboard and bookmarks menu, and widgets that turn around to allow settings to be configured on the other side. Menu bars are found at the top and bottom of the screen when necessary. Their options vary by program, but always follow a consistent style motif. In menu hierarchies, a 'back' button in the top-left corner of the screen displays the name of the parent folder.

1.4.2.1 Activity 2



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This video (http://www.youtube.com/watch?v=s_f-KK140vM&feature=Playlist&p=DF26E1B51A297C95&playnext_from=PL&playnext=1&index=17) is an introduction to the interactive capabilities of the iPhone™.

Watch the video (https://www.youtube.com/watch?v=s_f-KK140vM&feature=Playlist&p=DF26E1B51A297C95&playnext_from=PL&playnext=1&index=17), then try to classify the iPhone's interface features: which are holdovers from the GUI/WIMP era? Which are examples of future interface technologies?

1.4.2.1.1 Activity 2 feedback



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The iPhone provides its users with an interesting introduction to the evolution of interfaces from the GUI/WIMP era, to post-WIMP and finally a demonstration of future elements. These features, along with its functionality, have made it very popular and easy to learn and use. Its uses of WIMP include icons, menus and pointing. Its zooming and direct manipulation capabilities integrate WIMP and post-WIMP interactions. Finally, its use of sliding and spatial recognition are examples of future interface technologies.

1.4.2.2 Self-test 2



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It is quite common for individuals to have access to and be regular users of multiple computing systems. Many have desktops/laptops at home and/or work and/or school. Smart mobile devices such as telephones, netbook computers and tablet computers represent the majority of computing systems worldwide. Entertainment systems represent yet another form of access to powerful computing functionality. A major research question has been whether this multiplicity of computing systems, each with its own interface capabilities, provides a benefit or a distraction to users. How would you address this question?

You can draw upon your responses to the following scenarios:

1. Consider the multiple computing systems that you have access to. Compare the interface capabilities, features and metaphors present in each. Which capabilities are dependent upon where the device is used, and/or how the device is used?
2. You may not have a choice in the use of some computing systems (e.g. those at home or at work), but with others you may. How important to you are the interface capabilities of a computing system? How likely would you be to select a device based upon the similarity of interface capabilities (e.g. if you were an

iPhone user, would you be more attracted to an [Apple Macbook Air](http://www.apple.com/macbook-air/) (<http://www.apple.com/macbook-air/>) because of interface similarities)?

1.4.2.2.1 Self-test 2 feedback



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Future user interfaces must be able to address the personal computing environments anticipated in the future. The key points you should have addressed are that interfaces are expected to be multiple, distributed and communication-centric:

- Computers are increasingly used for communication rather than for computation. This is substantiated by the current usage of the Web, email and mobile digital devices.
- Computers are a major mechanism for person-to-person mediation. Applications supporting **CSCW (Computer-Supported Cooperative Work)** (http://en.wikipedia.org/wiki/Computer-supported_cooperative_work) and distance education are expected to become more prevalent in the future. It cannot be assumed that participants in these collaborations will have either similar computing systems or UIs.
- Individuals will be using multiple devices. Convenient tools will be required for data sharing and device synchronization.

1.5 Additional references



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Below are the resources referred to or cited by the developer(s) of the original unit:

ACM SIGCHI, <http://sigchi.org/publications/>.

Fogg, B (2003) *Persuasive Technology: Using Computers to Change What We Think and Do (Interactive Technologies)*, San Francisco: Morgan Kaufmann.

Garrett, J (2010) *The Elements of User Experience: User-Centered Design for the Web and Beyond (Voices That Matter)*, 2nd edn, Berkeley CA: New Riders.

Kurzweil, R (1999) *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, New York: Penguin Books.

MIT Media Lab, <http://www.media.mit.edu/>.

Saffer, D (2009) *Designing Gestural Interfaces: Touchscreens and Interactive Devices*, Sebastopol, CA: O'Reilly Media.

Sharp, H, Rogers, Y and Preece, J (2007) *Interaction Design: Beyond Human-Computer Interaction*, Chichester, UK: J Wiley & Sons.

Stanford University HCI Group, <http://hci.stanford.edu/>.

Stibel, J (2009) *Wired for Thought: How the Brain Is Shaping the Future of the Internet*, Boston: Harvard Business School Publishing.

Tidwell, J (2010) *Designing Interfaces*, Sebastopol, CA: O'Reilly Media.

White, B (2008) *Second Life: A Guide to Your Virtual World*, Indianapolis: Que Publishing.

1.6 Conclusion



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The future of computing system interfaces promises to be very exciting and challenging. Many opportunities for HCI researchers and application interface designers will become available. New and innovative user interfaces and interaction models will be required for:

- computer-based devices and services; and
- computer-based applications.

These new UIs will be based upon:

- technological advancements;
- a better understanding of communication methods, sensory pathways and **cognition (the psychological result of perception and learning and reasoning)**; and
- sociological and generational factors.

History suggests that these future interfaces will become *pervasive* in all areas of *human-computer interaction* just as the Web interface has become a mainstay in modern culture. Multidisciplinary involvement in the design and implementation of these interfaces will revolutionize key critical application areas such as education, business, entertainment and social interaction/involvement.

If you would like to learn more on this subject, you are welcome to enrol in *ELEC S313 Emerging Technology* (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154015000&lang=eng) offered by the School of Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcSubWeb&l=C_ST&lid=191133000200&lang=eng) of the OUHK.