

Module 2.1 – Interacting with Computers

i. Learning Objectives (Syllabus 9597)

2.1 Interacting with computers

- Students will apply good design principles and techniques for effective user interfaces and interactions so as to facilitate navigation and usability of computer systems, and data input and output for computer systems.
- Students will understand the effects of technology advancements and the use of technology on people and organisations, and in society.
- Students should know and understand:
 - 2.1.1 types of user interfaces (e.g. command-line, menu, form-based, graphical)
 - 2.1.2 specifications of appropriate interface and user interaction
 - 2.1.3 design considerations for user interfaces
 - 2.1.4 interaction techniques such as mouse click, key press, use of voice, gesture, and eye movement
 - 2.1.5 interaction styles such as command line, menu, graphical user interface and virtual reality
 - 2.1.6 social, ethical and economic effects of the use of computers at work, in life and play

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iii. Reading List

- Cambridge International AS and A Level Computing Coursebook (9691)
 - Chapter 1.2d: Types of user interface 7 – 11;
13 – 14
 - Chapter 1.9: Designing the user interface 87 – 90
- Cambridge International AS and A Level Computing Revision Guide (9691)
 - Chapter 2.2: User interfaces 9 – 12
 - Chapter 9: Designing the User Interface 74 – 78
- Online Sources
 - Teach-ICT website on User Interfaces:
http://www.teach-ict.com/as_a2_ict_new/ocr/AS_G061/312_software_hardware/user_interfaces/miniweb/index.htm
 - CIE Wiki-book Section on User Interfaces:
https://en.wikibooks.org/wiki/A-level_Computing/CIE/Computer_systems_communications_and_software/System_software/User_interfaces
 - OCR Revision Summary on User Interfaces:
<http://www.ocrcomputing.org.uk/f451/software/interfaces.html>
 - OCR Revision Summary on Interface Design:
http://www.ocrcomputing.org.uk/f452/solution_design/interface.html

Interfacing with Computers

1. Introduction

User interface design and user interaction design are two closely related disciplines. One focuses on the design of the **visual interface**, the other more on the design of the global **interaction behaviour** of the system.

2. Types of User Interfaces

There are many different forms of User Interface, including:

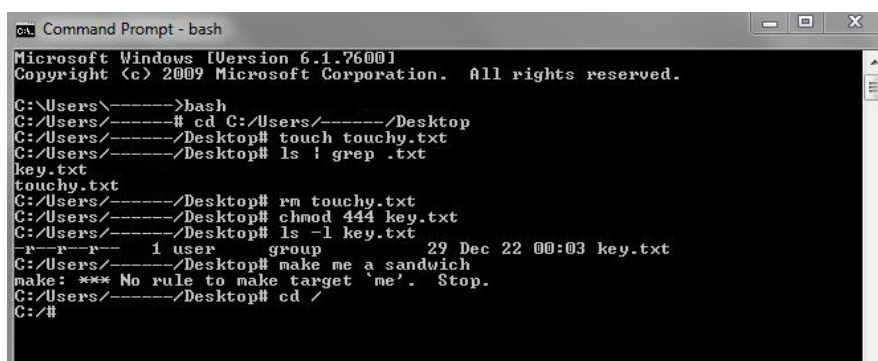
- Command Line
- Graphic User Interface (GUI)
- Touch GUI
- Menu Driven
- Form-based
- Natural Language
- Gesture Driven
- Virtual Reality

2.1 Command Line Interfaces

With this type of interface, a user provides input by **typing a command string** with the computer keyboard and the system **provides output by printing text** on the computer monitor.

This type of interface is typically used by **programmers and system administrators** in engineering and scientific environments, and also by technically advanced personal computer users.

Examples: Bash, Cygwin, Windows Terminal.



```
Command Prompt - bash
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\----->bash
C:/Users/-----# cd C:/Users/-----/Desktop
C:/Users/-----/Desktop# touch touchy.txt
C:/Users/-----/Desktop# ls | grep .txt
key.txt
touchy.txt
C:/Users/-----/Desktop# rm touchy.txt
C:/Users/-----/Desktop# chmod 444 key.txt
C:/Users/-----/Desktop# ls -l key.txt
-r--r--r-- 1 user      group      29 Dec 22 00:03 key.txt
C:/Users/-----/Desktop# make me a sandwich
make: *** No rule to make target 'me'.  Stop.
C:/Users/-----/Desktop# cd /
C:/#
```

Bash on Windows

Source: <http://linuxhive.blogspot.sg/2012/05/bash-on-windows.html>

2.2 Graphical user interfaces (GUI)

With this type of interface, a user provides input using devices such as a **computer keyboard and mouse** by interacting with **graphical icons and visual indicators** such as secondary notations (properties like position, indentation, colour, symmetry), and receives articulated **graphical output**.

Actions in GUIs are usually performed through direct manipulation of its graphical elements. It was introduced in reaction to the perceived steep learning curve of Command-Line interfaces.

Examples:

WIMP (Windows, Icons, Menu, Pointer) Interfaces – With such interfaces, users use a pointing device to control a pointer on a screen, which directly manipulates screen elements to initiate action. Such interfaces are very good at abstracting work-spaces, documents, and their actions; they are easy to introduce to other users because they would be used to the real-world analogy of using documents (i.e., sheets of paper) and folders.

WYSIWYG (what you see is what you get) Interfaces – Examples of a WYSIWYG include text-editors such as Microsoft Word, Microsoft PowerPoint, and Google documents. Such interfaces are typically used by content editing applications; a WYSIWYG editor is a system in which content (text and graphics) can be edited in a form closely resembling its appearance when printed or displayed as a finished product.

Post-WIMP/Touch Interfaces – A subset of GUIs, Touch GUIs use a **touchpad or touchscreen** display as a combined input and output device.

WIMP interfaces are not optimal for working with complex tasks such as computer-aided design, working on large amounts of data simultaneously, or interactive games.

Applications for which WIMP is not well suited include those requiring continuous input signals, showing 3D models, or simply portraying an interaction for which there is no defined standard widget; Post-WIMP interfaces typically focus on such considerations.

Examples of such interfaces include the interface of the classic MP3 player iPod and a bank's automated teller machine screen. Essentially, these interfaces include:

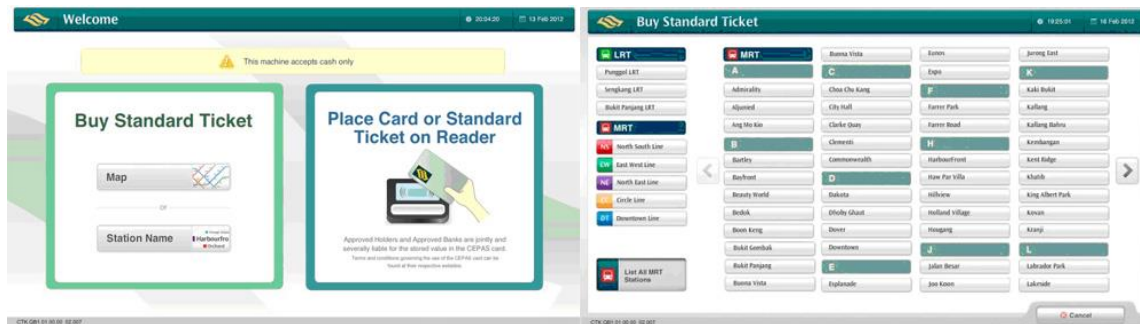
- Virtual reality systems
- Gesture-based interfaces
- Voice user interfaces
- See-through tools
- Smartphones and mobile apps
- Zooming user interfaces
- Tangible user interfaces
- Web applications

2.3 Menu-based Interfaces

Menu interfaces comprise a series of menus and submenus. A user is provided with a set of predefined actions, which he can select. After choosing one of the options, the user is then provided with another menu to decide the course of action.

Usually accessed by pressing buttons or touch screens with GUI interfaces, it can also be presented verbally as a telephone call (e.g., "Press 1 to check balance. Press 2 to top up card. Press...")

Examples: ATM Machines, General Ticketing Machines.



Welcome Screen of General Ticketing Machines

Selection Screen of Destinations

Source: <http://www.transitlink.com.sg/NewsDetail.aspx?id=69>

2.4 Form-based Interfaces

Form-based interfaces comprise a mixture of drop-down lists, radio buttons and check-boxes for users to choose from a predefined set of options, as well as text boxes and text areas for users to fill-in. These interfaces are typically utilised in online forms, where users are required to enter data so that it can be collected and stored in a system.

Such interfaces are commonly used for user registration and survey websites in order to minimise/facilitate user input, and to perform validation.

Examples: Google Forms, User Registration Forms.

amazon [Your Account](#) | [Help](#)

Registration
New to Amazon.com? Register Below.

My name is:

My e-mail address is:

Type it again:

My mobile phone number is: (Optional)
[Learn more](#)

Protect your information with a password
This will be your only Amazon.com password.

Enter a new password:

Type it again:

[Create account](#)

By creating an account, you agree to Amazon.com's [Conditions of Use](#) and [Privacy Notice](#).

Amazon User Registration Form

3. Specifications of Appropriate User Interface and User Interaction

3.1 Touch Design

Interface Considerations:

- Large enough buttons
- Using icons to represent functions in order to reduce clutter
- Use of drop down menu when screen is too small for multiple icons (e.g. smartwatch)
- Large font size but less text
- No hover functionality
- Consider the form of the device – e.g., is it small enough for one-thumb operation or does it require the grip on both sides?



Interaction Considerations:

- Preference for touch and voice commands (which would reduce the need for typing)
- Smartphone - One thumb
- Tablet - Gripped on both sides

3.2 Form GUI Design

Interface and Interaction Considerations:

- Appropriate controls
 - **Text boxes:** for free text of restricted length – e.g., name field
 - **Text areas:** for free text with general character length restrictions – e.g., email
 - Varying field size (i.e., the size of the free text box/area) can be used to provide guidance/hints about the input length restrictions
 - **Dropdown selection box:** for selection of a single option out of many fixed options – e.g. country of residence
 - **Radio buttons:** for selection of a single option out of limited (and typically a small number), fixed options – e.g. gender
 - **Checkboxes:** for selection of multiple options – e.g. purchases
- Double masked text field for password input in order to verify both input passwords match
- Built-in validation
 - e.g. ajax backend check for duplicate username, valid numeric input for phone numbers, valid email address
- Placeholder, label text to assist/remind user of appropriate info/format
- Options to facilitate/minimize input
 - e.g. checkbox for billing address same as shipping address
- Default pre-populated information
 - e.g. country to minimize user input/selection based on IP address (but might be ambiguous as user might be travelling or using a Virtual Private Network)
- Stay logged-in checkbox to reduce sign-in hassle for users

When considering the design of such interfaces, one should also **consider using single sign-on** by leveraging on existing social network accounts such as Google+, Facebook, Twitter. This would facilitate greater convenience for user and reduce the hassle of multiple logins.

4. User Interface Design Considerations

Principle	Description
User familiarity	The interaction should be based on terms and concepts drawn from the experience of the people who will make most use of the system
Consistency	The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way.
Minimal surprise	Users should never be surprised by the behaviour of a system.
Recoverability	The interface should include mechanisms to allow users to recover from errors (e.g. Undo button).
User guidance	The interface should provide meaningful feedback when errors occur and provide context-sensitive user help facilities.
User diversity	There should be appropriate interaction facilities for different types of system users (e.g. Support for handicapped users).

5. Types of Interaction Techniques

An interaction technique is the fusion of input and output, consisting of all software and hardware elements, that provides a way for the user to accomplish a task.

Mouse Click; Key Press	<p>The mouse allows users to provide input/actions by navigating/interacting with a GUI.</p> <p>The Keyboard allows users to provide pre-defined input/actions through buttons pre-mapped with commands.</p>
Voice Commands	<p>Allows users to deliver voice input with fixed commands.</p> <p>Always-on voice recognition: allows user voice input from home screen (i.e. without having to launch dedicated voice recognition app); allows for faster/more convenient input without being overly taxing on battery life through use of low-power contextual processor cores (e.g. Moto X, Nexus 5, OnePlus One)</p>

5.1 Relevant Hardware

Mouse, Keyboard	Wireless mouse/ keyboard Less workspace clutter, more convenient use in tight spaces (e.g. on airplanes)	
Touchscreen	3 types, resistive, capacitive, surface acoustic wave	
	Resistive Touchscreen	2 layers: 1 resistive and 1 capacitive; held apart by spacers. Electric current is constantly passed through. When layers touch, current changes, and location of touch can be computed. Cheap, can sense touch of any material (not humans), only 75% of light can pass through.
	Capacitive Touchscreen	1 capacitive layer, sense touch of only for conductive materials (usually human touch only), 90% light can pass through.
	Surface Acoustic Wave Touchscreen	No metallic layers. Transducer on edge of screen sends ultrasonic wave through screen glass, where receiver on other end sense disturbances and compute location of touch. Expensive, doesn't block screen light, dirt can be sensed.
GPS sensor	Global positioning system, senses location. Used for navigation, social apps track nearby users, etc.	
Gyroscope	Senses orientation of device.	
Accelerometer	Measures change in velocity of device, often paired with gyroscope to sense full 6-degrees of freedom (called an Inertial Measurement Unit (IMU)). Examples: Wii Nunchucks, Smartphones, Cameras, Pedometers.	
Proximity/Gesture Sensor	Uses infrared rays to track body movements or presence. Examples: Smartphone Unlock, xbox Kinect.	
Camera	Computer vision.	

6. Types of Interaction Styles

Interaction Style	Main Advantages	Main Disadvantages	Application Examples
Command Language	<ul style="list-style-type: none">• Powerful and flexible• Appeals to expert users• Supports creation of user-defined 'scripts' or macros• Suitable for interacting with networked computers even with low bandwidth	<ul style="list-style-type: none">• Retention of commands is generally very poor• Hard to learn• High error rates• Poor error management• Not suitable for non-expert users	<ul style="list-style-type: none">• Operating systems• Command and control systems• System penetration
Form Fill-in	<ul style="list-style-type: none">• Simple data entry• Easy to learn• Guides the user via predefined rules• Checkable	<ul style="list-style-type: none">• Consumes screen space• Causes problems where user options do not match the form fields• Usually sets the scene for rigid formalisation of the business processes	<ul style="list-style-type: none">• Stock control• Personal loan processing
Menu Selection	<ul style="list-style-type: none">• Ideal for novice or intermittent users• Affords exploration• Avoids user error• Little typing required	<ul style="list-style-type: none">• Slow for experienced users• Can become complex if many nested menu options	<ul style="list-style-type: none">• Most general-purpose systems
Direct Manipulation	<ul style="list-style-type: none">• Fast and intuitive interaction• Easy to learn• Recognition memory• High subjective satisfaction	<ul style="list-style-type: none">• May be hard to implement (programme)• Only suitable where there is a visual metaphor for tasks and objects	<ul style="list-style-type: none">• Video games• CAD systems
Natural Language	<ul style="list-style-type: none">• Accessible to casual users• Easily extended• Useful when user hands are pre-occupied	<ul style="list-style-type: none">• Natural language understanding systems are unreliable• Lack of support for less widely used languages	<ul style="list-style-type: none">• Driving GPS• Mobile voice commands