

Human Computer Interaction: An Overview

- What is Human Computer Interaction (HCI)?
- Importance of HCI
- Good and Poor Design Examples
- What and Who are involved in HCI design?
- General Principles of HCI Design
- Norman's Principles of Usability

What is HCI?

How Human **interacts** with Computer:

- Not primarily the study of Human
- Not primarily the study of Computer
- The study of **bridge** between them, which includes
 - **Observation** of **interactions** between people & computers, e.g., Find examination papers via our library Web
 - **Analysis** of the involved interactions, e.g., Are all the steps involved are necessary?
 - Human **consequences** after interacting with computers, e.g., Can the user perform his task? Does he enjoy working with the computer?

What is HCI?

The term HCI was adopted in mid-1980s:

Association for Computing Machinery (ACM): “discipline concerned with the **design**, **evaluation** & **implementation** of interactive computer systems for human use & with the **study** of major phenomena surrounding them” (1992)

Dix: “HCI is **study** of people, computer technology and the ways these influence each other. We study HCI to determine how we can make this computer technology more **usable** by people” (1998)

Carroll: “HCI is the **study** and **practice** of **usability**. It is about understanding and creating software and other technology that people will want to use, will be able to use, and will find effective when used.” (2002)

What is HCI?

Human:

Individual user, a group of users working together, a sequence of users in an organization

Computer:

Desktop computer, large-scale computer system, Pocket PC, embedded system (e.g., photocopier, microwave oven), software (e.g., search engine, word processor)

User interface:

Parts of the computer that the user contacts with

Interaction:

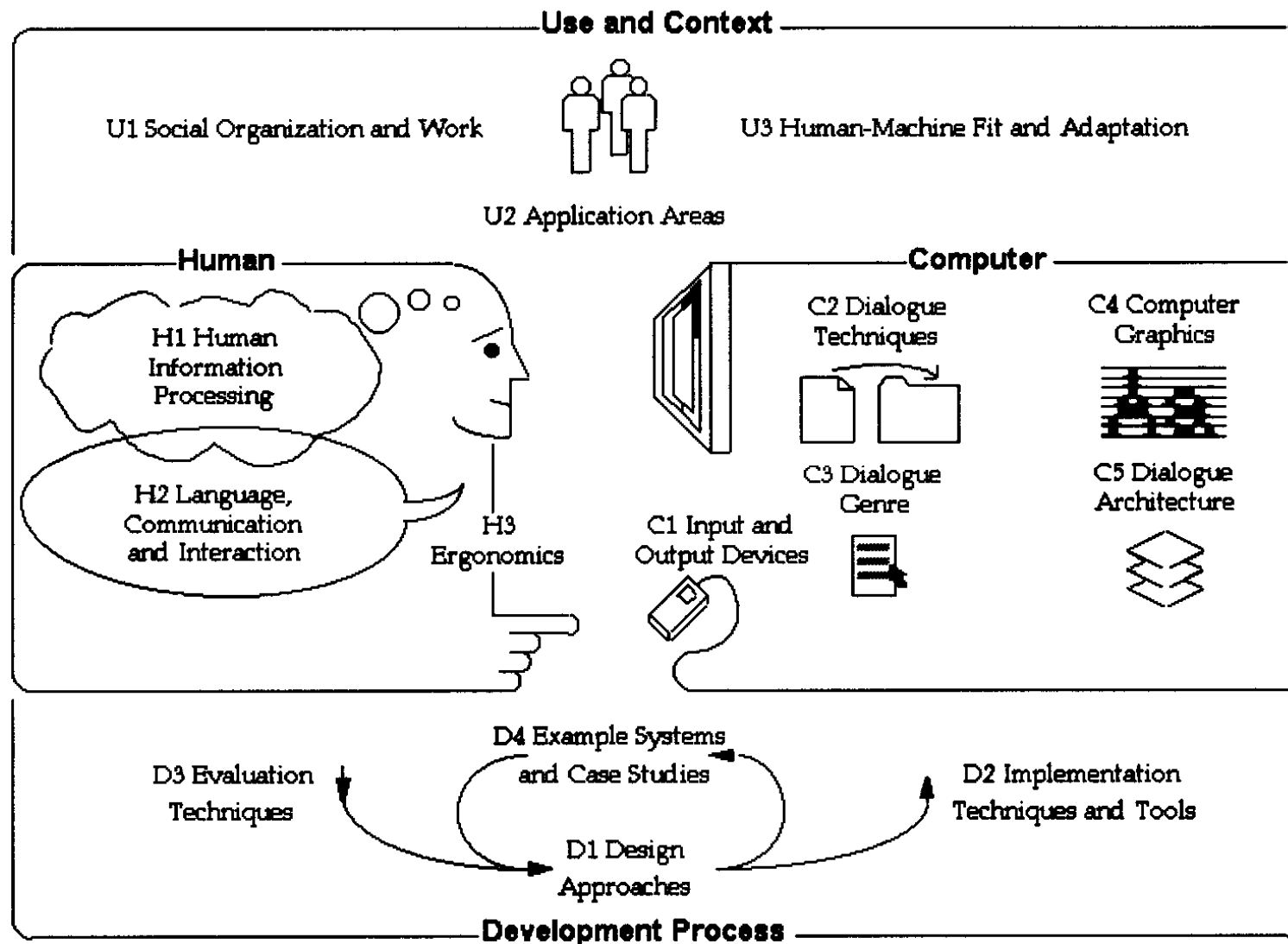
Usually involve a dialog with feedback & control throughout performing a task (e.g., user invokes “print” command and then interface replies with a dialog box)

Why HCI?

- In the past, computers were expensive & used by technical people only
- Now, computers are cheap and used by non-technical people (different backgrounds, needs, knowledge, skills)
 - ⇒ Computer and software manufacturers have noticed the importance of making computers “user-friendly”: easy to use, save people time, etc.

How to achieve “user-friendliness” in computer design?

HCI Scope



HCI Scope

Use & Context: Find application areas for computers

Human: Study psychological & physiological aspects
e.g., study how a user learns to use a new product, study human typing speed

Computer: Hardware & software offered
e.g., input & output devices, speed, interaction styles, computer graphics

Development: Design, implementation & evaluation

HCI Goals

- At physical level, HCI concerns the selection of the most appropriate **input devices** and **output devices** for a particular interface or task
- Determine the best **style** of interaction, such as direct manipulation, natural language (speech, written input), WIMP (windows, icons, menus, pointers), etc.
- Develop or improve
 - **Safety**
 - **Utility**
 - **Effectiveness**
 - **Efficiency**
 - **Usability**
 - **Appeal**of systems that include computers

HCI Goals

- **Safety**: protecting the user from dangerous conditions and undesirable situations
- **Users**
 - Nuclear energy plant or bomb-disposal – operators should interact with computer-based systems remotely
 - Medical equipment in intensive care unit (ICU)
- **Data**
 - Prevent user from making **serious** errors by reducing risk of wrong keys/buttons being mistakenly activated
 - Provide user with means of recovering errors
 - Ensure privacy (protect personal information such as habits and address) & security (protect sensitive information such as passwords, VISA card numbers)

HCI Goals

- **Utility**: extent of providing the right kind of functionality so that users can do what they need or want to do
 - **High utility**
 - Scientific calculator provides many mathematical operations, built-in formulae, and is programmable
 - **Low utility**
 - Software drawing tool does not allow free-hand drawing but supports polygon shape drawing
- **Effectiveness**: concern a user's ability to accomplish a desired goal or to carry out work
 - Find a master thesis in our library Web

Any difference between utility and effectiveness?

HCI Goals

Consider the scenario: a shopping Web provides all the information, instruction and server-side support required to perform an on-line purchase. However, the users cannot figure out how to find the items they want to buy.

- **Efficiency**: a measure of how quickly users can accomplish their goals or finish their work using the system
 - Find a book “human computer interaction” in our library Web
 - How about a master thesis whose author’s last name is “Cheng”?
 - How about the newest book in the subject of “human computer interaction”?

HCI Goals

- **Usability**: ease of learning and ease of use
 - Can I use the basic functions of a new digital camera without reading the manual?
 - Does the software facilitate us to learn new functions easily?
- **Appeal**: how well the user likes the system
 - First impression
 - Long-term satisfaction

HCI Goals

- Use Microsoft WORD as an example:

Goals	Achieved?	Example
Safety	Yes	Warning for "Exit before Save"
Utility	Yes	A lot of word processing functions is provided
Effectiveness	Yes	A science student can edit equations
Efficiency	Yes	Default template avoids initial document setting
Usability	Yes	Icons help ease of learning
Appeal	Yes	Interface is attractive

HCI Benefits

- Gaining market share

- People intend to buy/use products with higher usability
- e.g., Google's search engine has the largest market share because it is easy to use with higher efficiency

- Improving productivity

- Employees in a company perform their jobs in a faster manner
- e.g., Workers in a mainland company needed to press a lengthy sequence of buttons in performing a task. An IAS student helped to increase their productivity via writing a batch program for the button pressing operation
- e.g., Intranet can increase employees' efficiency

HCI Benefits

- e.g., Cafe de Coral uses a business management system (BMS) to increase productivity, e.g., food photos are available on cashier display and operators do not need to memorize food codes, automatic collection of sales information at all shop saves staffing cost

Hong Kong Economics Times (8 Oct. 2004)

大家樂新銷售系統

生產力增30%



大家樂集團總監李愛珍（右）指出，開發「業務管理系統」後，集團生產力提高約30%。旁為自動系統集團董事總經理賴音廷。（陳國峰攝）

「大家樂推出一哥火鍋船優惠價（8時半後39元）後，每晚各店的銷售數據，可即晚傳送回寫字樓，哪家分店售罄都會一目了然。」大家樂集團專業事務總監李愛珍昨在記者會表示，自從開發「業務管理系統」（BMS）後，集團整體生產力提高約30%。

大家樂過去三年投資約6,500萬元，委託自動系統集團開發該系統。同一場合，自動系統集團董事總經理賴音廷透露，該公司首次替食肆度身訂造BMS軟件，並花3年時間研製。

記錄各店銷售 利分配補給

李愛珍表示，系統可記錄前綫店舖的銷售情況、現金出入及其偏差等，每晚把資料傳送到後勤部門，讓寫字樓了解各店生意，以便分配補給。

後勤部門透過該系統，可預先設定當日出售的產品及價格，並把資料傳送到前綫。「員工每天開市前都知道最新餐單，減省以往人手輸入的偏差，又可按市場反應，加快更新餐單。」

李愛珍續說，該系統亦把原本長達1星期的員工培訓，縮至2至3天，「因員工現可於屏幕上看到食物圖片，不用牢記4,000多款食品的編號。」

她又指出，由於電腦可計算每店日常營業額，財務部不再須以人手計算總額，故生產力提高約30%。

集團預計，未來數年還要多花千多萬元安裝。集團亦有意在3年內，將華南地區的分店進行電腦化。

■本報記者 羅羽庭

HCI Benefits

■ Lowering support costs

- If the product is not usable, calls to customer support can be enormous
- e.g., If a washing machine is difficult to use even after reading the instruction manual, many users will call the customer service and the cost per call can be over \$100

■ Reducing development cost

- Avoid implementing features users don't want and creating features that are annoying or inefficient
- e.g., If there are too many unnecessary confirmation dialog boxes in using a word processor, it is likely this product needs to be redeveloped

Good and Poor Design Examples

HCI arises in our daily life, e.g.

- Elevator controls and labels on the bottom row all look the same, so it is easy to push a label by mistake instead of a control button (www.baddesigns.com)



- People do not make same mistake for the labels and buttons on the top row. **Why not?**

Any suggestions to improve the interface?

Good and Poor Design Examples

- This is a lamp switch (www.baddesigns.com)



There are 3 modes: "I", "O" and "II" correspond to Low, Off and High, respectively

Is it a good design? Why?

Good and Poor Design Examples

- Nokia 6800: Users can write messages with the cover closed, or open the cover to reveal a full keyboard for easy messaging (www.nokia.com)



Is it a good design? Why?

Good and Poor Design Examples



- Inside a lift at Yau Ma Tei

Any problems?

Good and Poor Design Examples



Do you know how to use them?

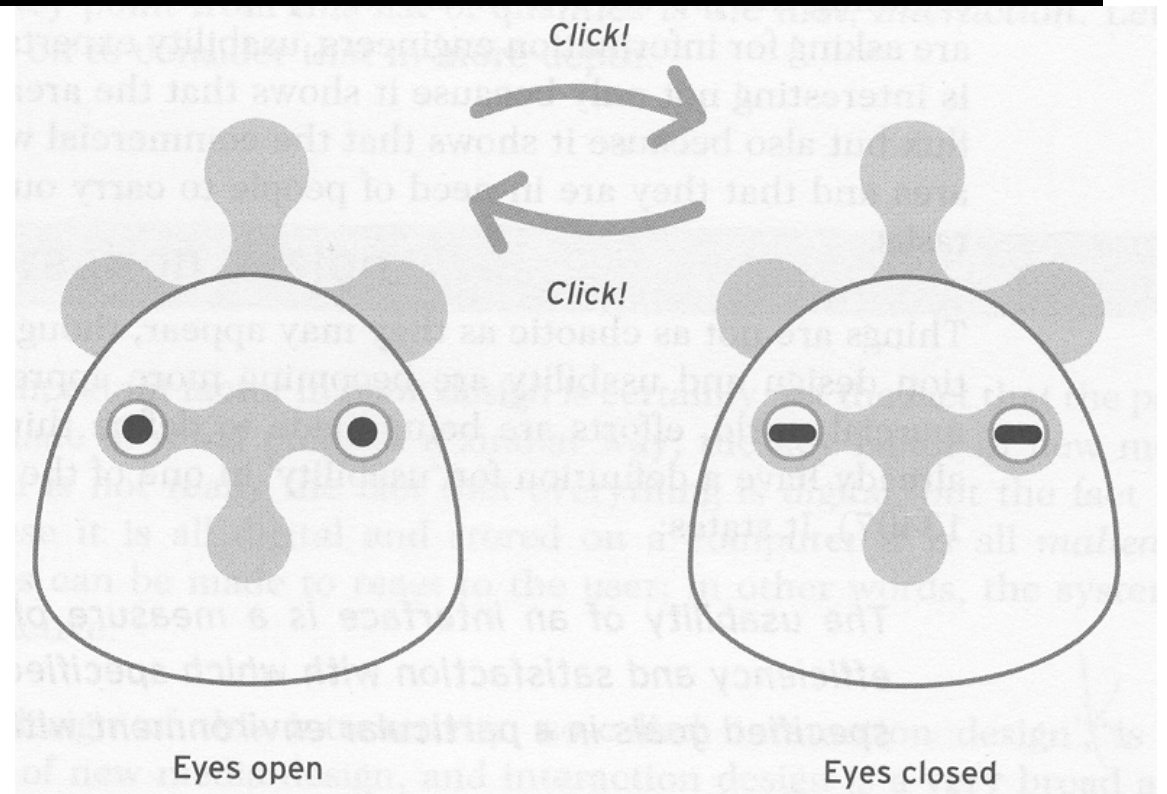
Good and Poor Design Examples



- DYMO and Brother label makers

Which one is more preferable?

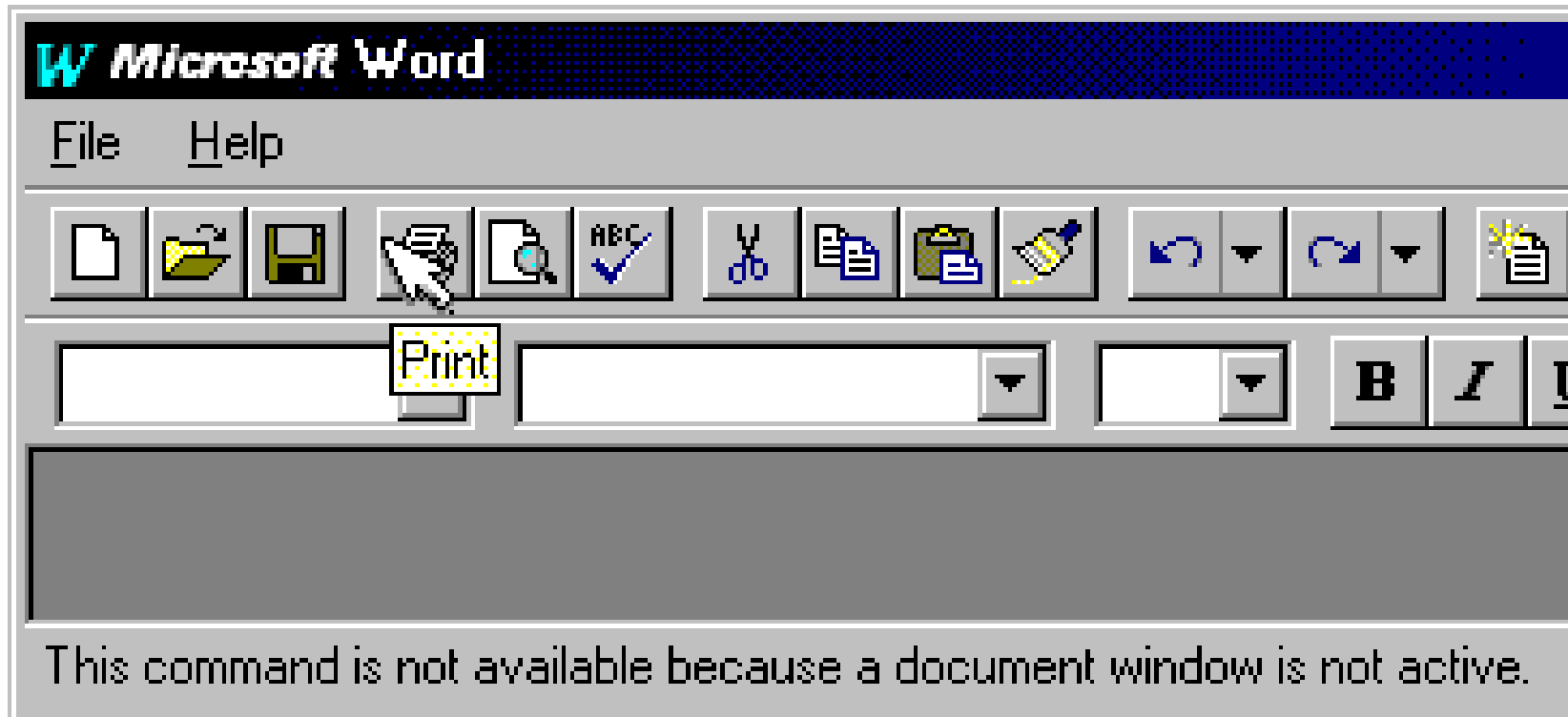
Good and Poor Design Examples



Is there any problem for the alarm clock?

Good and Poor Design Examples

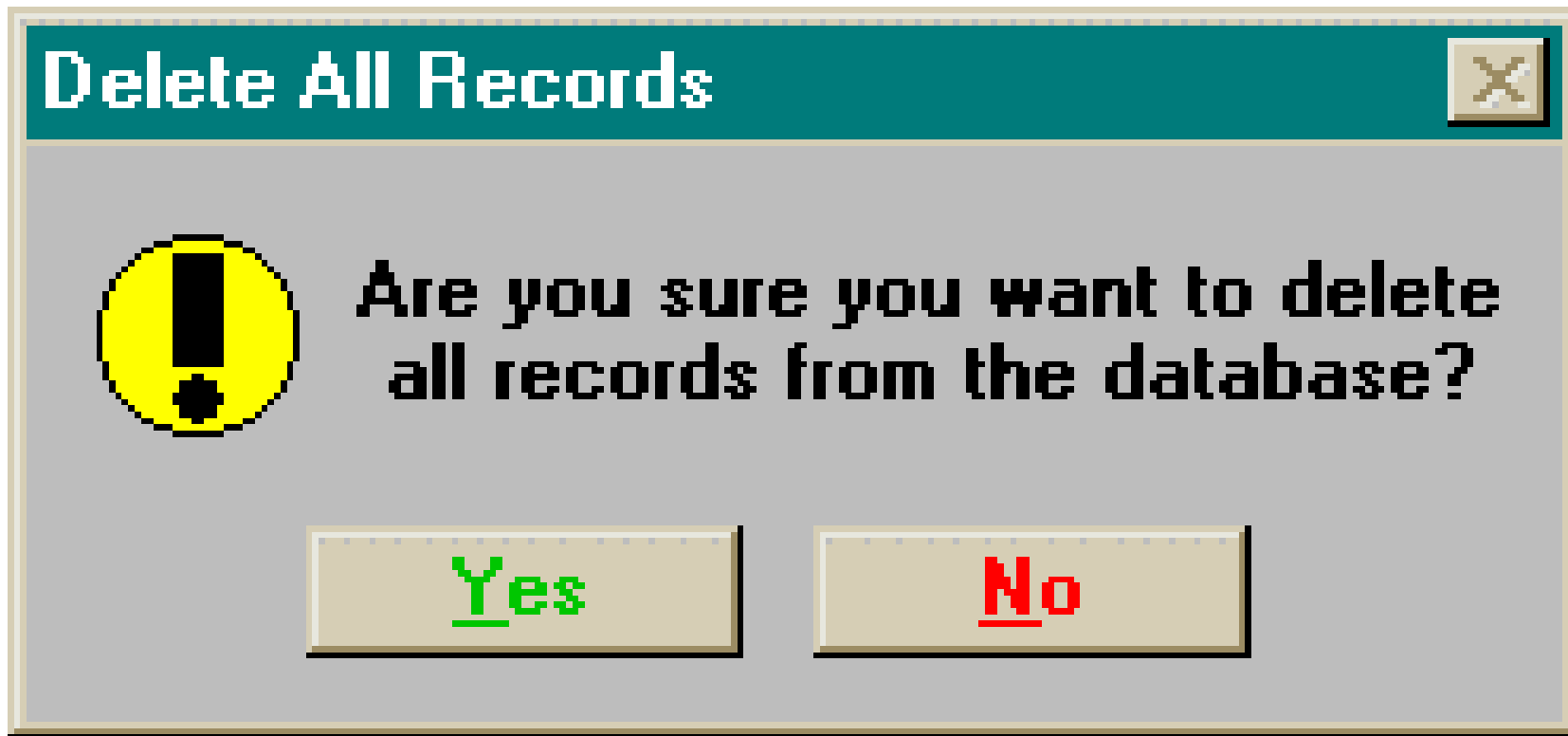
- This is the interface for WORD 97



Any suggested improvement?

Good and Poor Design Examples

- This is an interface of a dialog box



Is it a good design?

Disciplines Contribute to HCI

Academic Disciplines:

- **Computer Science**
 - Develop programming languages, system architectures, etc. of the computing systems
- **Engineering**
 - Provide faster and cheaper equipment
- **Linguistics, Artificial Intelligence**
 - Speech synthesis and recognition, natural language processing, etc.
- **Psychology**
 - Provide information about human mental capabilities (e.g., memory, decision making)
- **Ergonomics (Human Factors)**
 - Provide information about human physical capabilities

Disciplines Contribute to HCI

- **Sociology**

- How people interact in groups

Design Practices:

- **Graphic Design**

- Art of combining **text** and **graphics** and communicating an effective message in design of posters, brochures, signs, logos & other type of visual communications

- **Product Design**

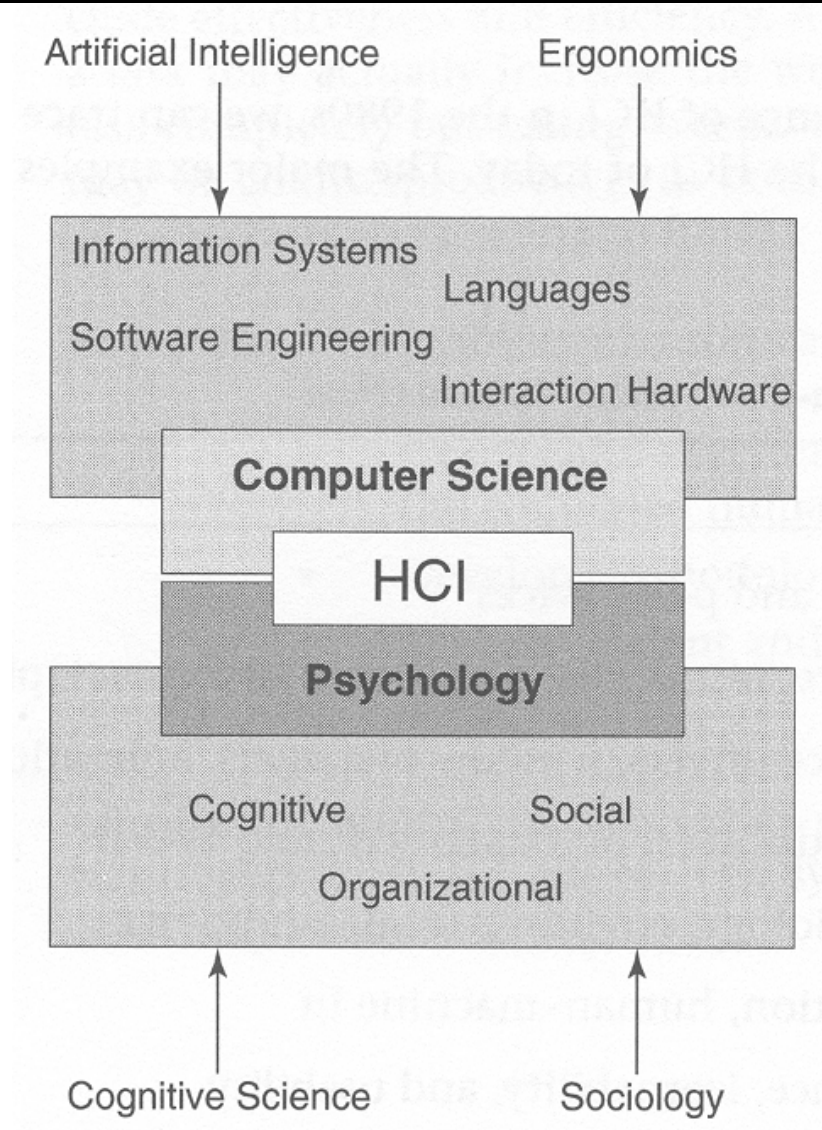
- Process of planning the product's specification

- **Industrial Design**

- Applied art whereby **aesthetics** and **usability** of products may be improved. Aspects include overall shape of the object, colors, textures, sounds & product ergonomics

- **Film Industry**

Disciplines Contribute to HCI



Disciplines Contribute to HCI

**黃錦輝**
香港中文大學工程學院副院長(外務)、香港資訊科技聯會會長

蓋茨：成功科研 結合創

比爾·蓋茨(Bill Gates)於8日12日旋風式訪港，並在微軟亞洲研究院10周年創新論壇演講。除演講外，他也與中文大學劉遵義、科技大學朱經武及香港大學徐立之3位校長進行研討探索



未來科技的發展趨勢。

◆來港演講 論未來科技趨勢◆

筆者藉本文扼要地歸納蓋茨演講的重點，演講主要集中在資訊科技，他簡述了3個現今熱門的研究領域，也就是微軟亞洲研究院的主流研究方向。

1.「普適計算」(Pervasive Computing)的研究目標是使人類能在任何地方、任何時間都能獲取及處理不同媒體的資訊。較為大家熟悉的應用包括無線上網(例如Wi-Fi)、利用無線射頻識別RFID電子標籤實時處理物流、流動電視……等。除了技術上的挑戰外，蓋茨也提到一些科學家要注意的「軟」性問題，例如當某用戶採用普適計算時，他的行蹤便會容易被他人發現；又例如利用無線傳送的資料也較容易被人盜取。這些牽涉個人私隱的問題，絕非I.T.人的專長，需要社會科學、法律、教育等專家攜手解決。所以每一個學生都不應該只專注自己的學科，要擴闊自己的視野去了解其他事物，這也是通識教育的宗旨。

微軟主席比爾·蓋茨早前訪港，並在微軟亞洲研究院10周年創新論壇演講。(資料圖片)

Disciplines Contribute to HCI

創意與應用

2.「雲計算」(Cloud Computing)是現時互聯網研究上最膾炙人口的課題。互聯網將會是人類工作的主要平台，而「雲計算」提倡開放式網上應用服務，在這技術環境下，用戶再毋須擁有自己的應用軟件，甚至乎自己的伺服器。當要解決問題時，用戶只需利用他人在網上提供的服務。另外「雲計算」可解決海量數據處理

大會雖以創新為主題，但講者的內容卻沒有給筆者帶來太大的驚喜。客觀來說，論壇的內容仍然為一般普羅大眾帶來一些新概念。

的問題。由於網上的資訊流量愈來愈大，內容也愈來愈複雜，超越了一般私人電腦或工作站的處理能力範圍，在這情況下用戶將可以把問題交由「雲計算」服務站去解決。同樣地，這領域也牽涉到私人數據的問題，例如用戶把數據放在他人的服務站上，不良商人便會有機可乘盜取資料。

3.「人機互動」(Human Computer Interaction, HCI)。不久將來不同的資訊網絡(電話、電視、互聯網等)將會融合一起，現有的介面(Interface)技術將會很快便被淘汰，取而代之將會是一站式的介面。例如利用錄像片段中某一用詞，在互聯網上尋找相關的電視節目。這過程中牽涉以語言識別(Speech Analysis)技術自動抽取片段中的用詞，把語言轉換成文字後再利用網上信息檢索(Information Retrieval)技術從茫茫網海中搜尋有關的資訊，繼而把結果分類(Clarification)並根據用戶的要求排序(Relevance Ranking)。雖然個別技術已頗為成熟，但集合它們去處理各媒體的資訊，將帶來一連串科研上的新挑戰。

◆主題創新 惟內容無太大驚喜◆

大會雖以創新為主題，但講者的內容卻沒有給筆者帶來太大的驚喜。不論在論壇的程序或內容上都似乎已是預先設計好，在已既定的框架下討論又豈能有很大的突破呢？話雖如此，筆者有這樣的想法可能只是鑑於自己在科研和學術的背景所致才作此結論，客觀來說論壇的內容仍然為一般普羅大眾帶來一些新概念。

蓋茨在演講中盛讚香港各所大學的學術及研究水平，他又多番提到成功科研需要創意與應用的結合，這點筆者絕對認同。大學是創新人才及科技的主要搖籃，可是本地大學偏重發掘創意，在鼓勵教授、學生多發表學術論文方面不遺餘力，但卻輕視技術轉移(Technology Transfer)的發展，導致不少傑出的發明跑不出校門之外。

People in HCI Business

- **Interactive / Interaction Designers:** People involved in the design of all the interactive aspects of a product
- **Usability Engineers:** People who focus on evaluating products using usability methods and principles
- **UI Designers:** People experienced in user-centered design methodologies
- **UI Design Engineers:** People who develop and model the end user experience
- **Web Designers:** People who develop and create the visual design of websites, such as layouts & animations
- **Information Architects:** People who come up with ideas of how to plan and structure interactive products
- **User Experience Designers:** people who do all the above

People in HCI Business

User experience is

- An important concept in interaction design
- About how people feel about a product and their pleasure and satisfaction when using it, looking at it, holding it, opening it, closing it, etc.
- Examples: how smoothly a switch rotates, the sound of a click, the touch of a button when pressing it

People in HCI Business

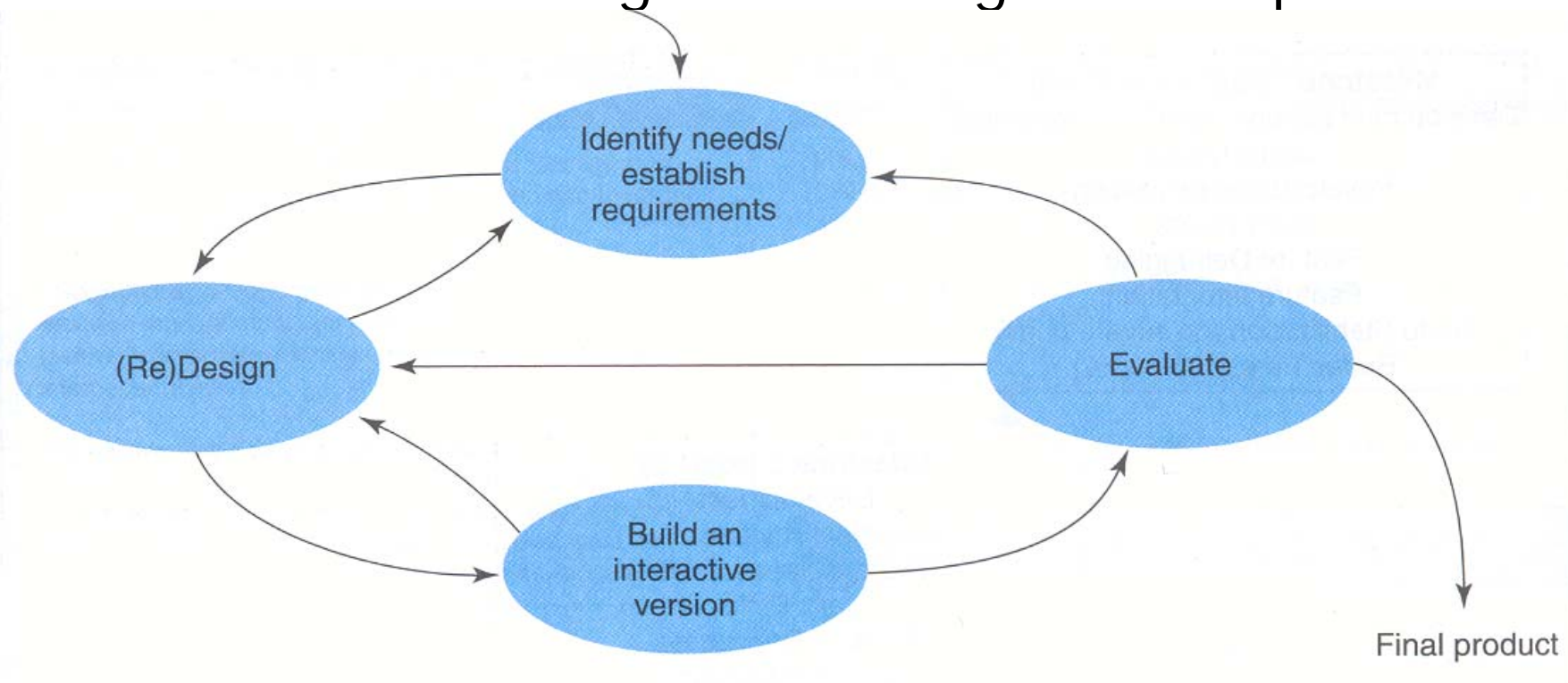
Famous companies which provide HCI consultancies:

- **Nielsen Norman Group**: “help companies enter the age of the consumer, designing human-centered products and services” (www.nngroup.com)
- **Swim**: “provide a wide range of design services, in each case targeted to address the product development needs at hand” (www.swimstudio.com)
- **IDEO**: “create products, services and environments for companies pioneering new ways to provide value to their customers” (www.ideo.com)



Activities in HCI Design

1. Identify needs and establish requirements
2. Develop alternative designs
3. Build interactive prototypes that can be communicated and assessed
4. Evaluate what is being built throughout the process



Activities in HCI Design

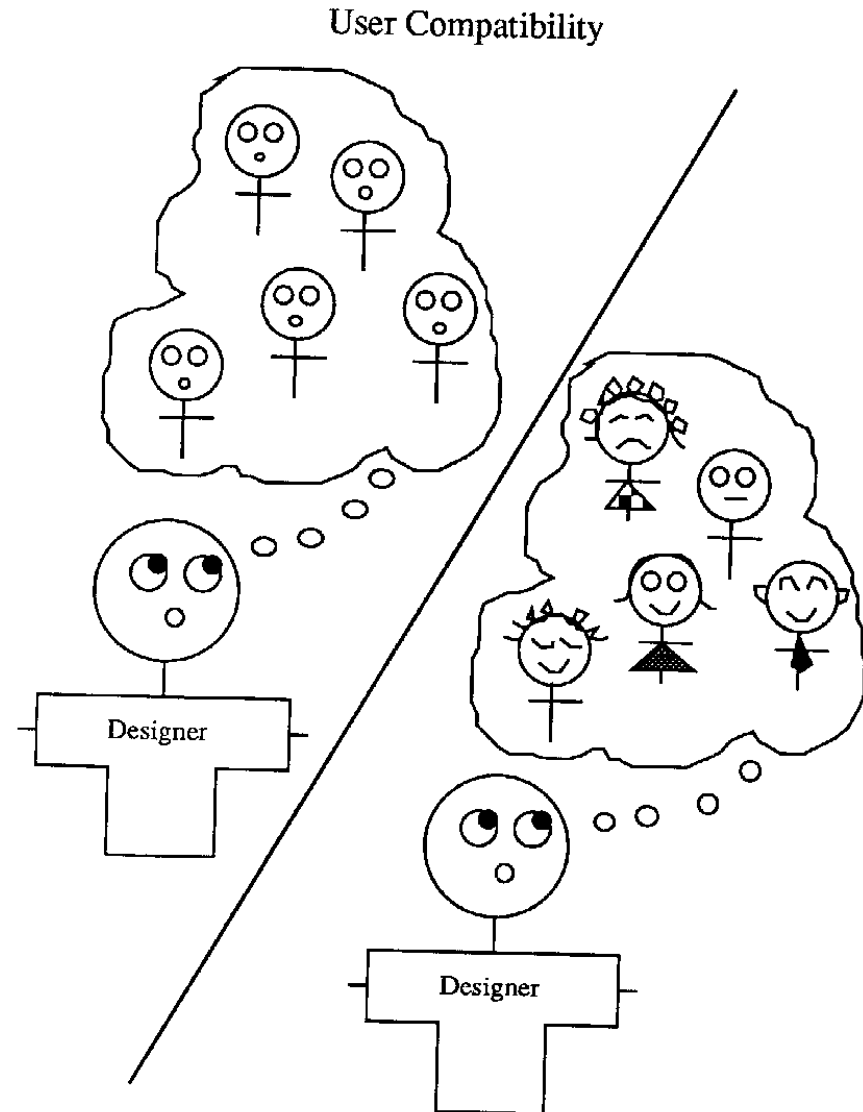
- Users should be involved through the development of the project
- Specific usability and user experience goals need to be identified, clearly documented and agreed at the beginning of the project
- Iteration is needed throughout the core activities

General Principles of HCI Design

- Making systems **easy to use & learn**
- **Usability** applies to all aspects of a system
- Some principles to support usability are:
 - **Compatibility**
 - **Ease of Learning**
 - **Memorability**
 - **Predictability**
 - **Simplicity**
 - **Flexibility**
 - **Responsiveness**
 - **Protection**
 - **Invisible Technology**
 - **Control**
 - **WYSIWYG**

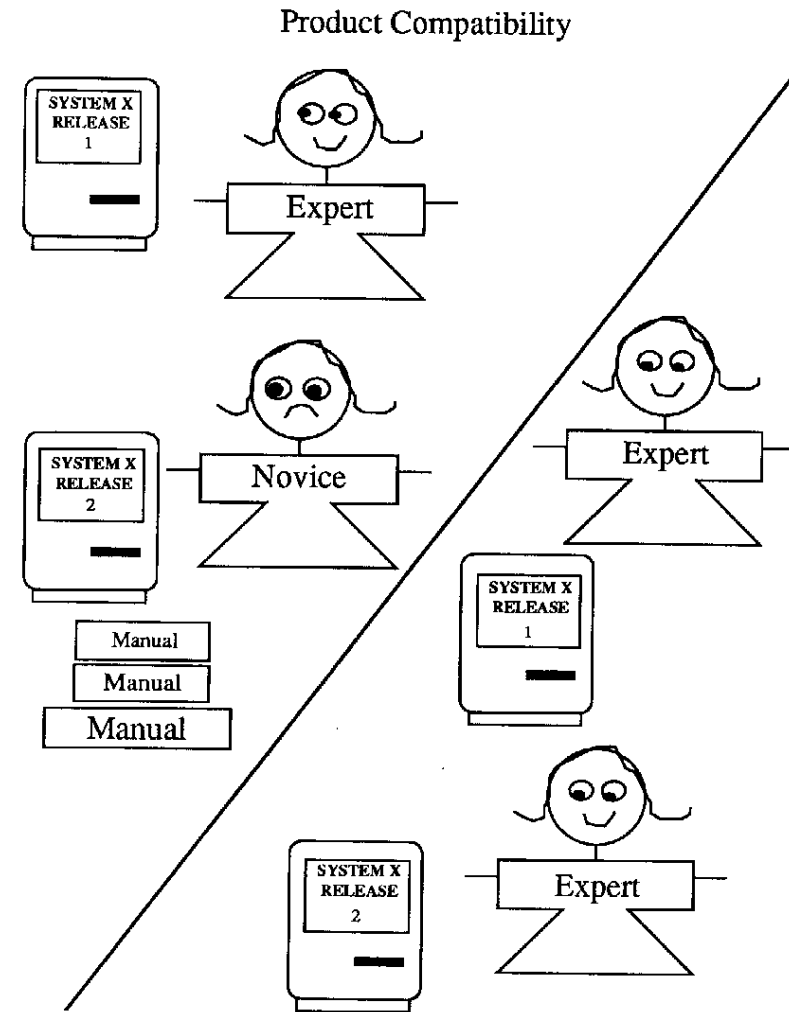
Compatibility

- **User** – know the user



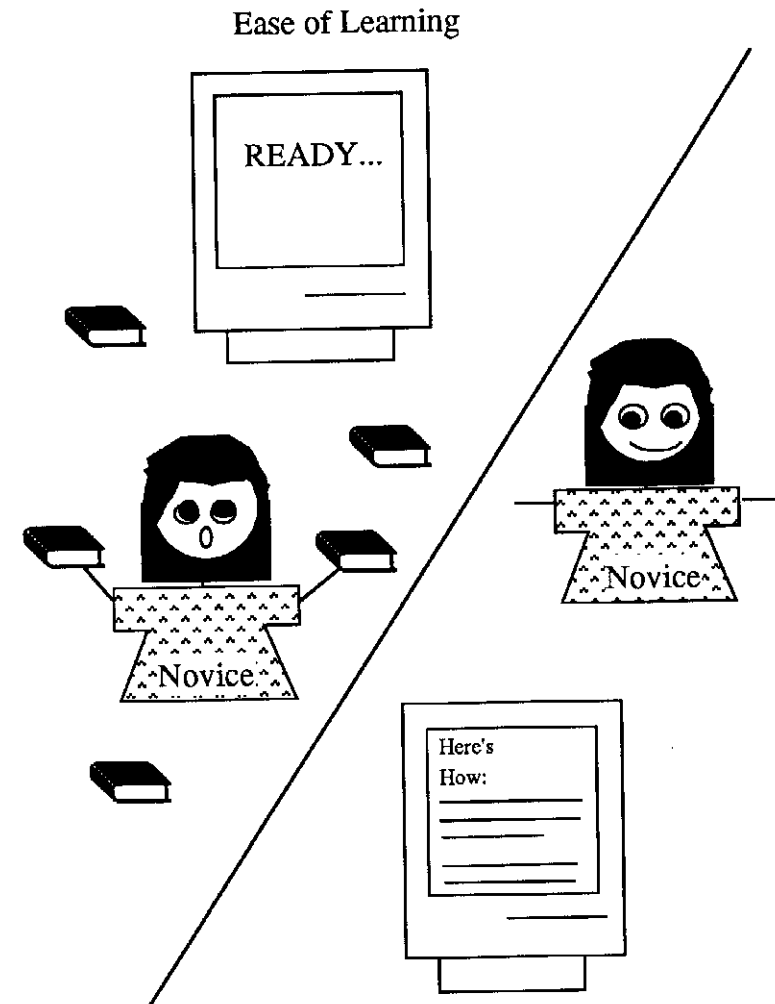
Compatibility

- **Product** – can reduce both learning time & errors
Any disadvantage?




Ease of Learning

- **Ease of learning** – the system should be easy to learn so that the user can rapidly start getting some work done with the system



Memorability

Interfaces that have high memorability will be easier to learn and use. Factors which affect memorability include

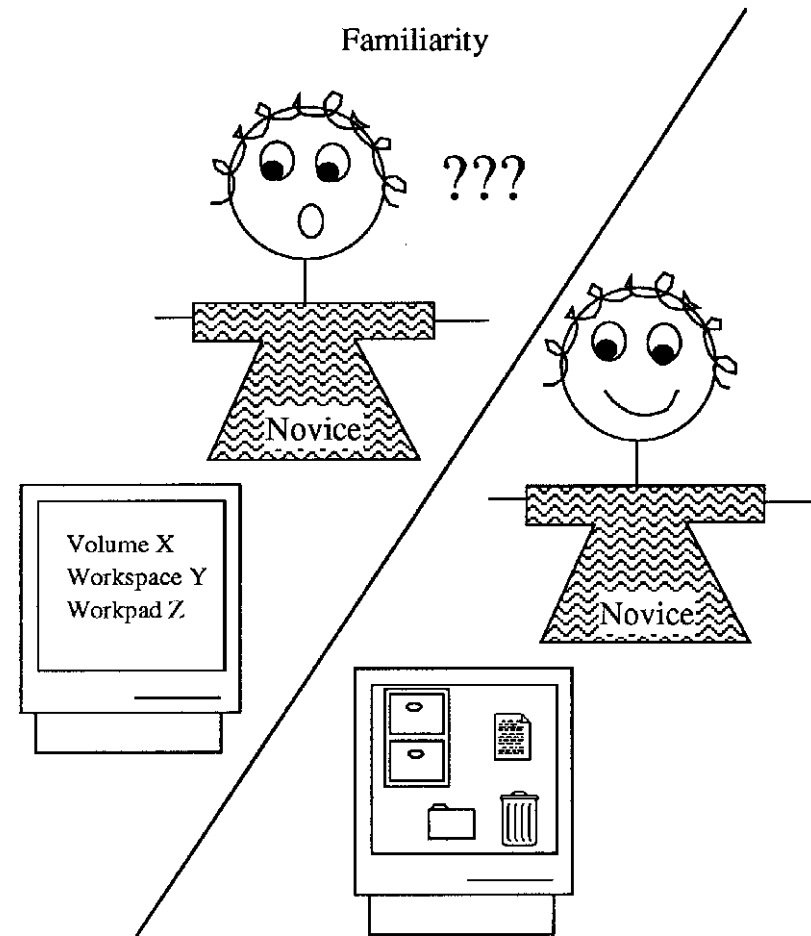
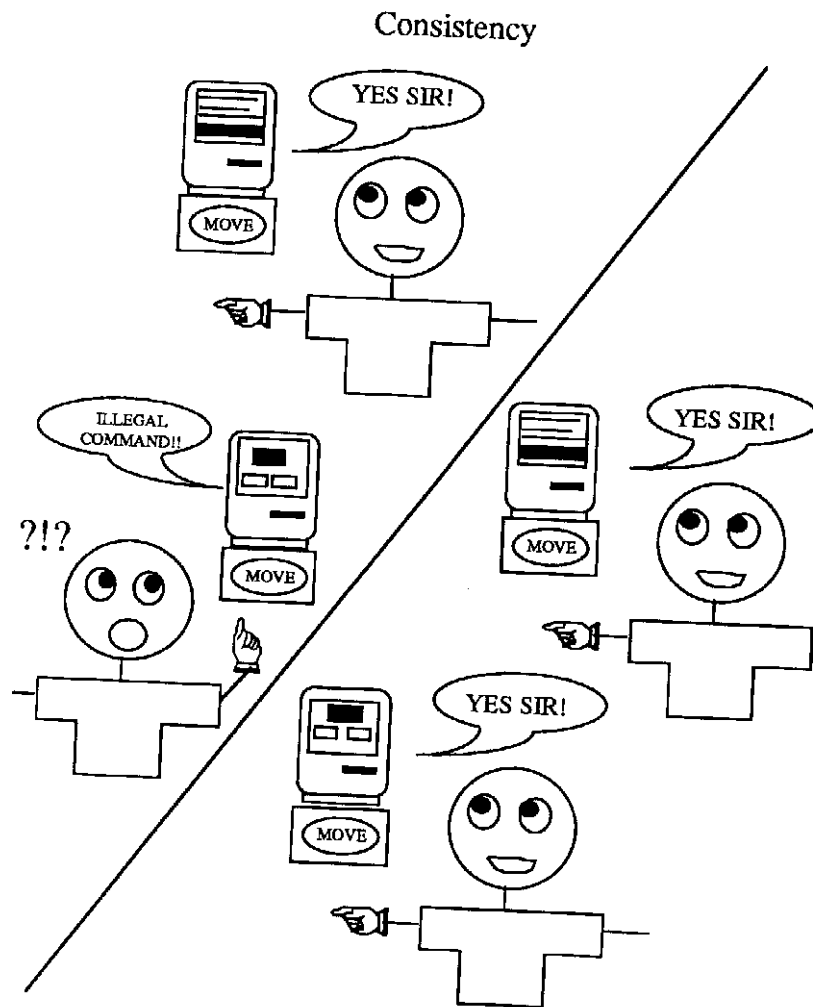
- Location: It will be easier to remember if a particular object is placed in a consistent location, e.g., always putting the search box in the upper right-hand corner of a Web page
- Logical grouping: It will be easier to remember if things are grouped logically, e.g., putting related options together in a menu
- Conventions: Conventional objects and symbols will be easier to remember, e.g., shopping cart symbol 

Predictability

Predictability involves a person's expectations and his/her ability to determine the results of actions ahead of time. It includes:

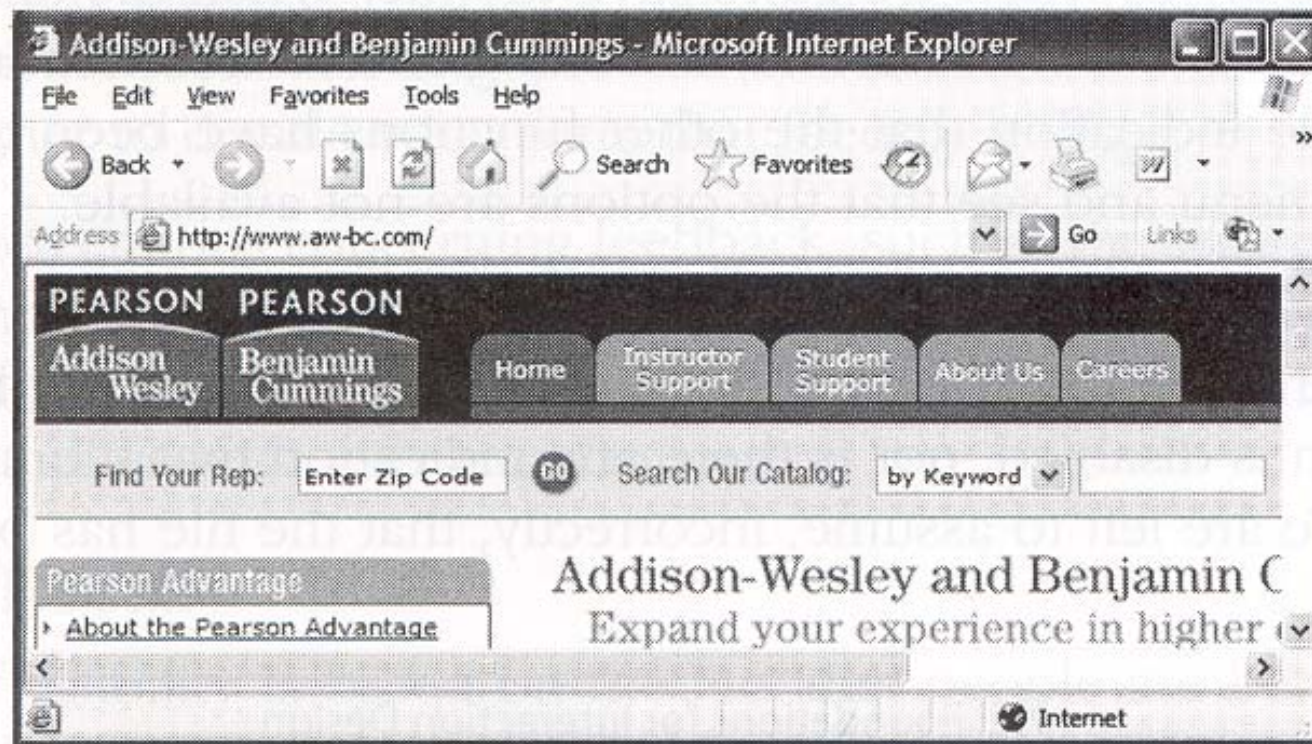
- **Consistency** – reinforce our associations and therefore increase our ability to remember and predict outcomes and processes
- **Generalizability** – Help us use the knowledge we gathered from previous experience and apply it to similar situations
- **Familiarity** – e.g., familiar menu names and options help users locate objects and functions more easily

Predictability



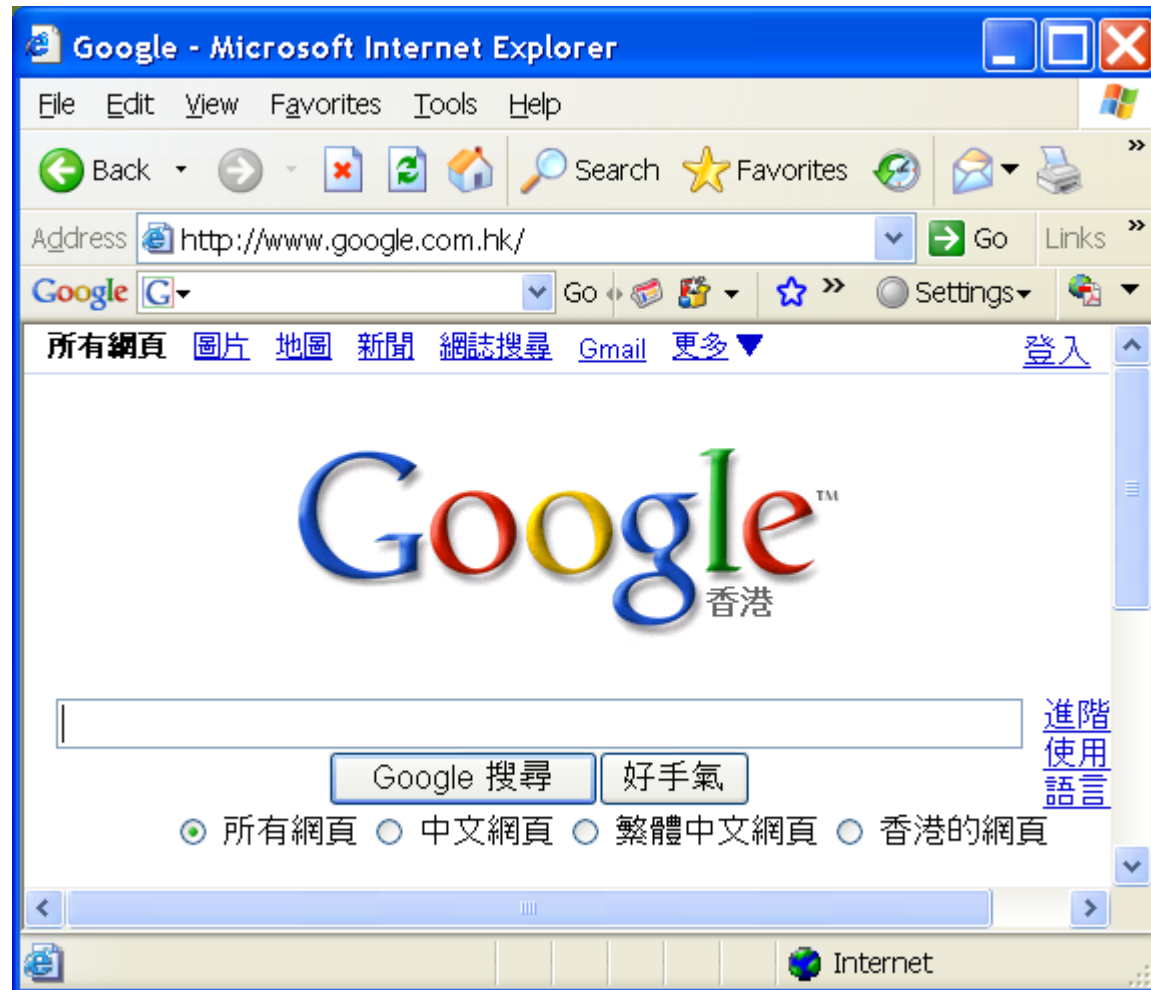
Predictability

- **Conventions** – Allow us to use our intuitions which are based on previous experience and logic; if something is consistently done in a particular way, it will eventually become the conventional way of doing it



Simplicity

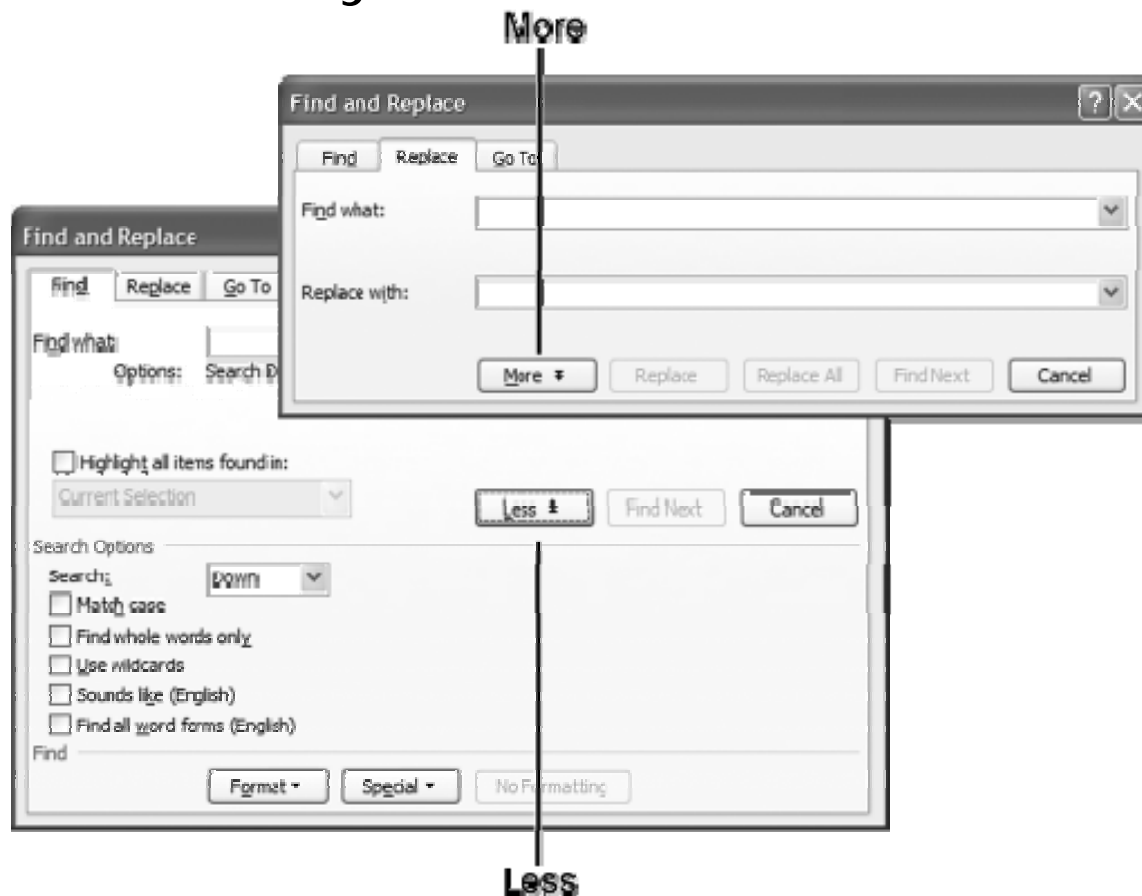
If things are simple they will be easy to understand and thus easy to learn and remember



Simplicity

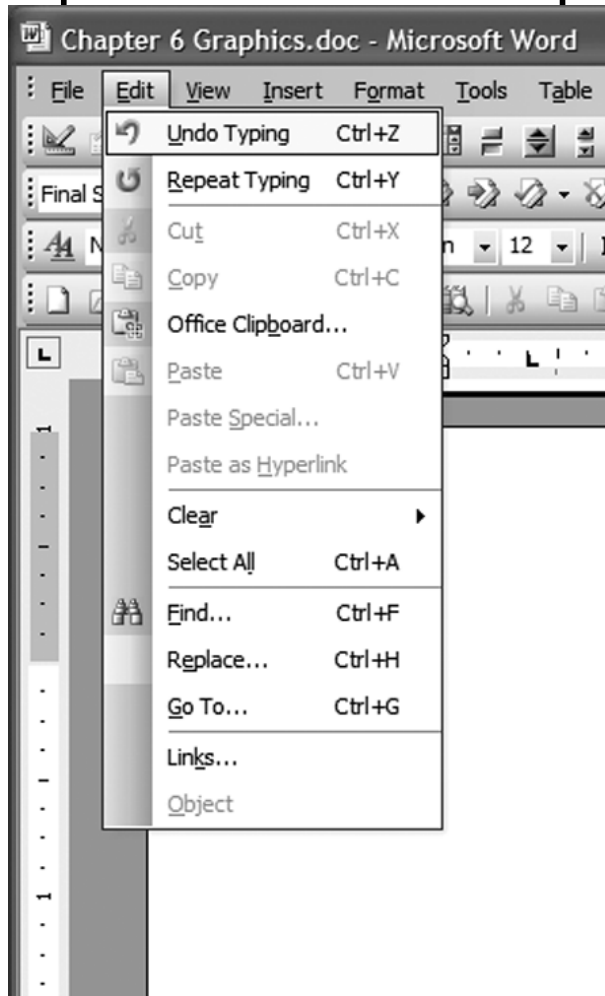
It includes:

- **Progressive disclosure** – Show the user only what is necessary



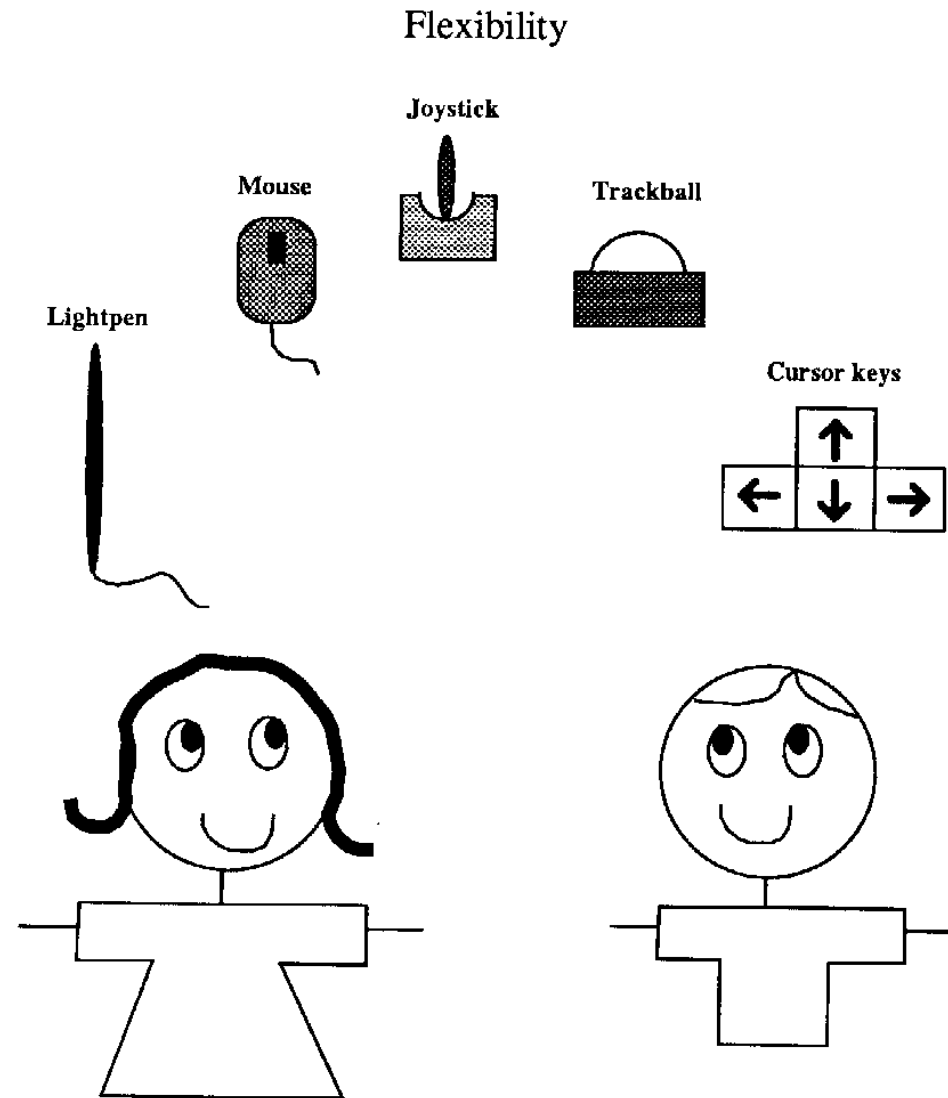
Simplicity

- **Constraints** – Involve limiting the actions that can be performed in a particular design



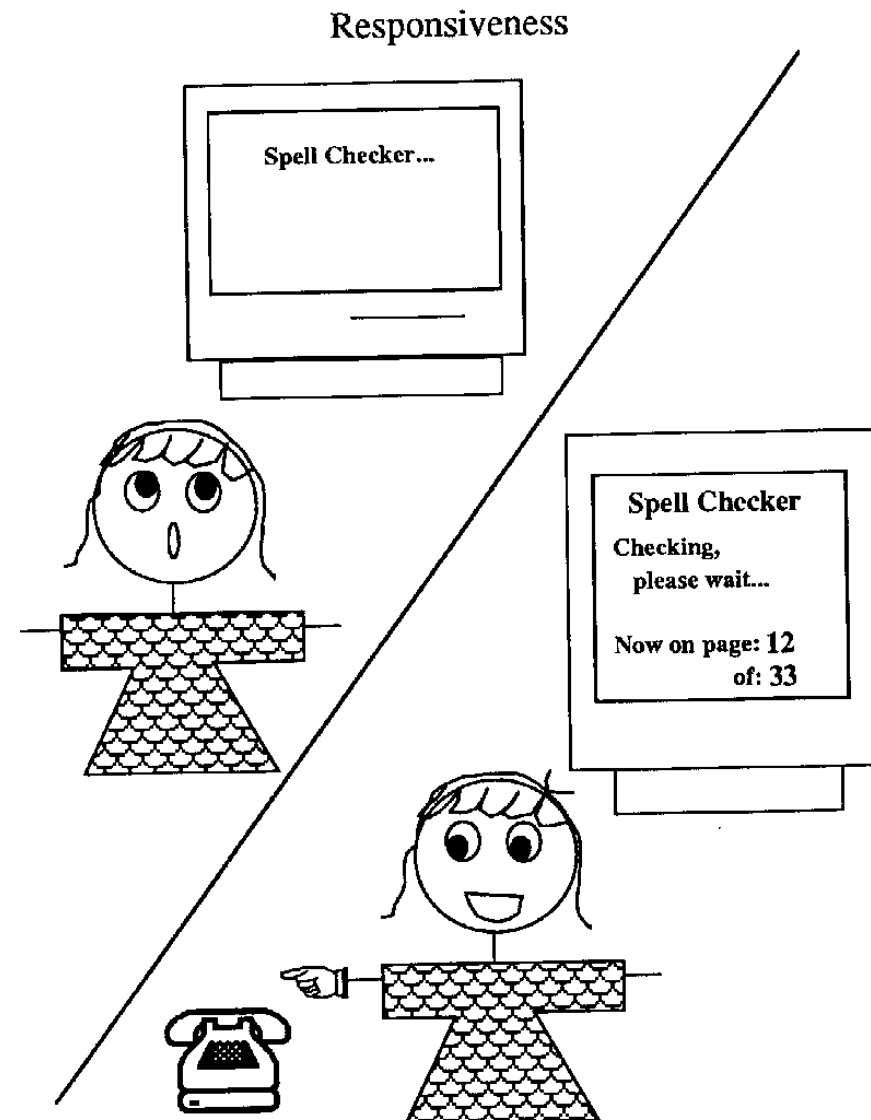
Flexibility

- Allow more user control & accommodates variations in user skill and preferences, i.e., give users **choices**
- Hardware
- Styles of interaction
- Data format



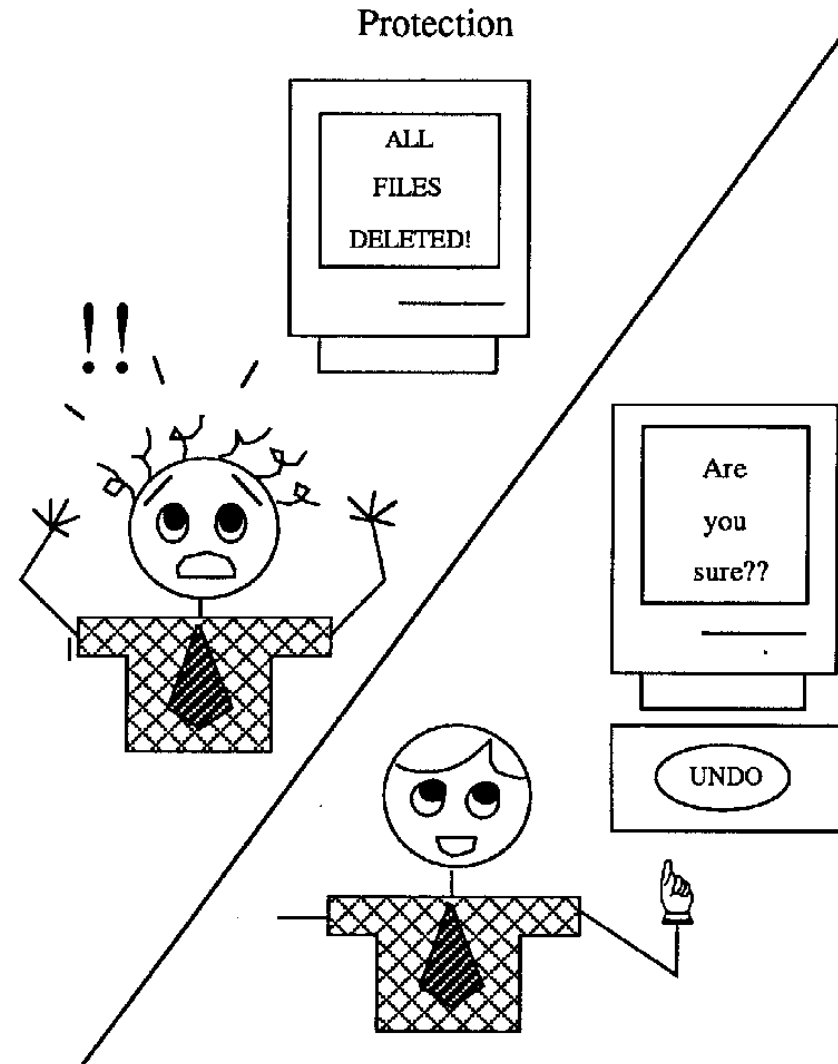
Responsiveness

- Computer should respond immediately to a user's input or inform the user when long delays are unavoidable



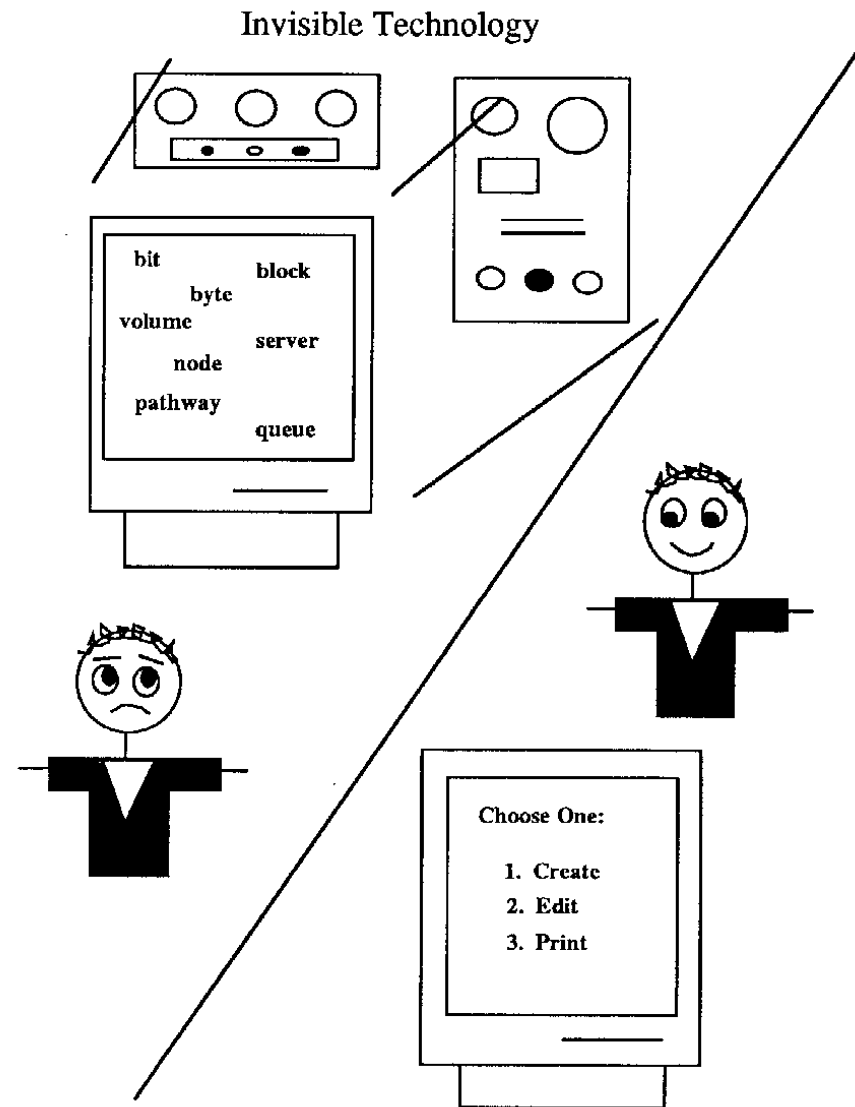
Protection

- Protect users against disastrous results of common human error



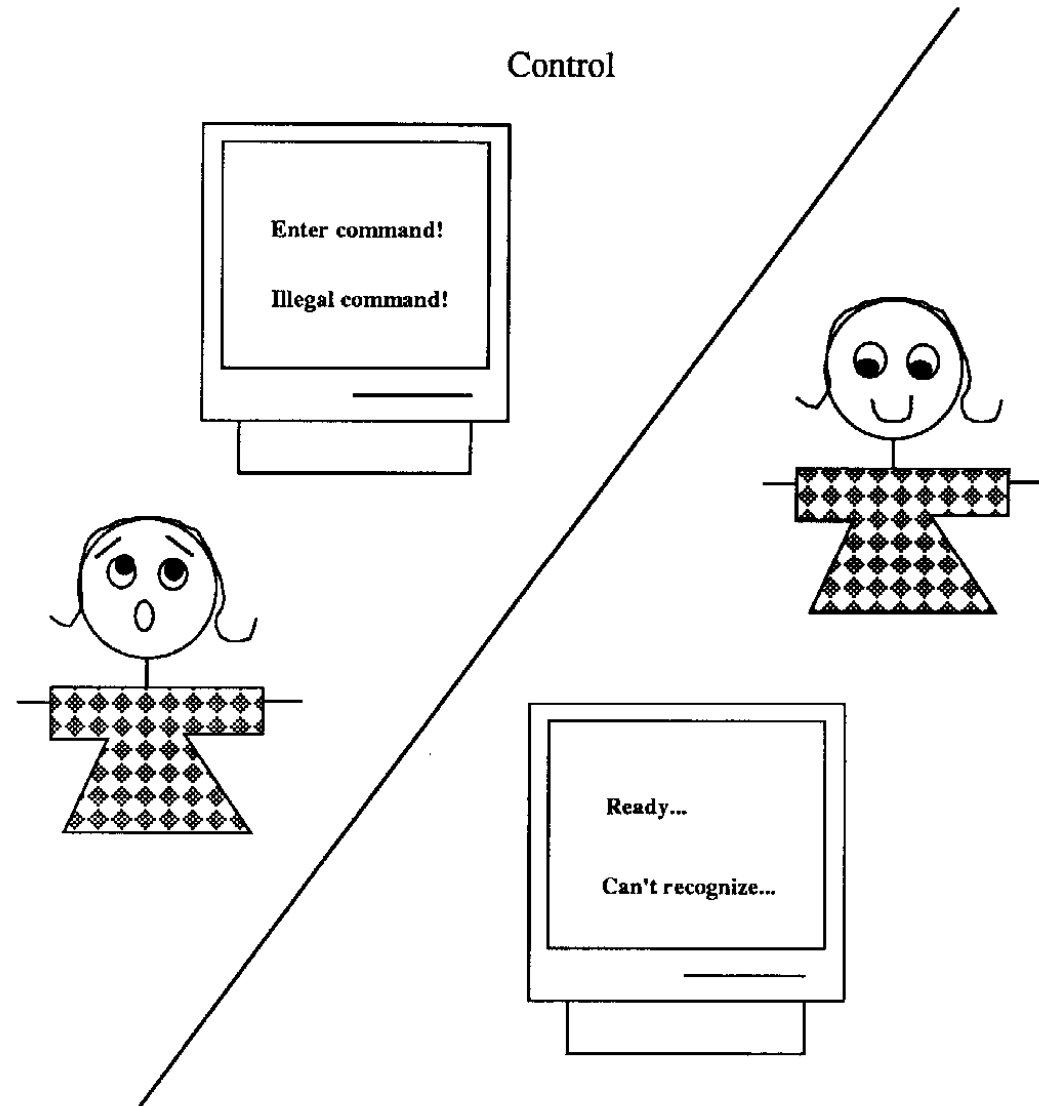
Invisible Technology

- No need to know the technical details



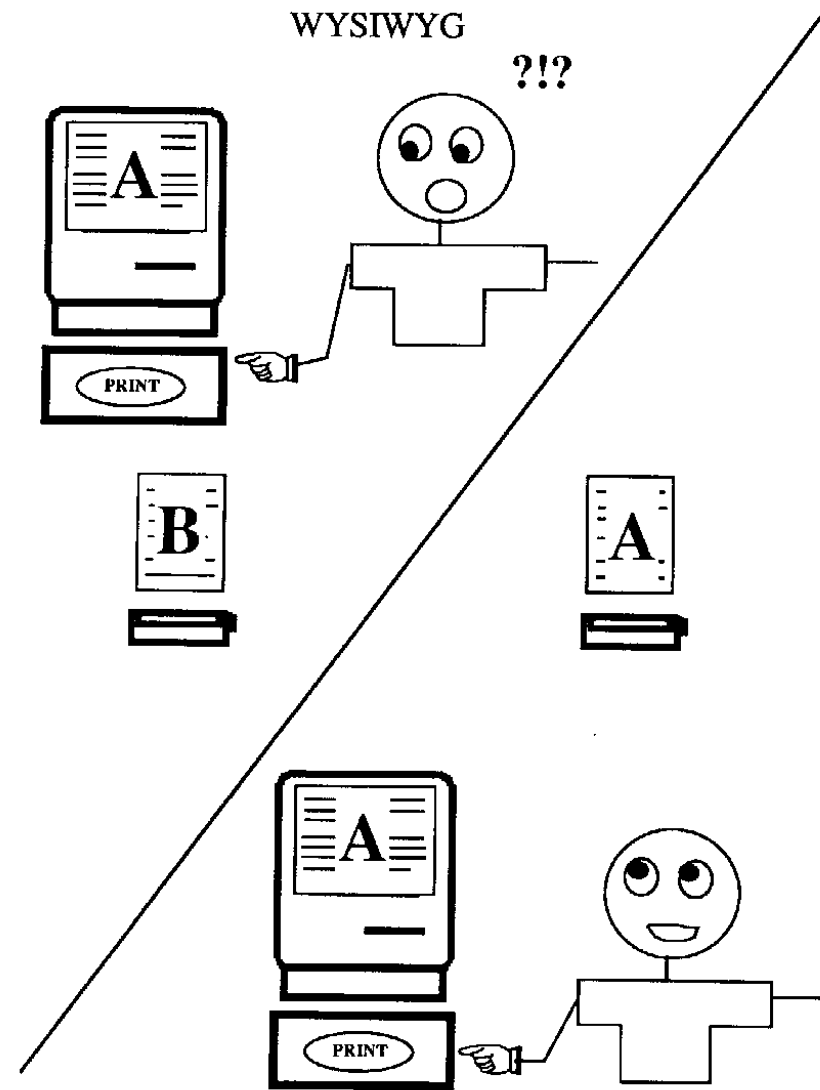
Control

- Users should feel more in control if the interface is passive



WYSIWYG

- What you see is what you get

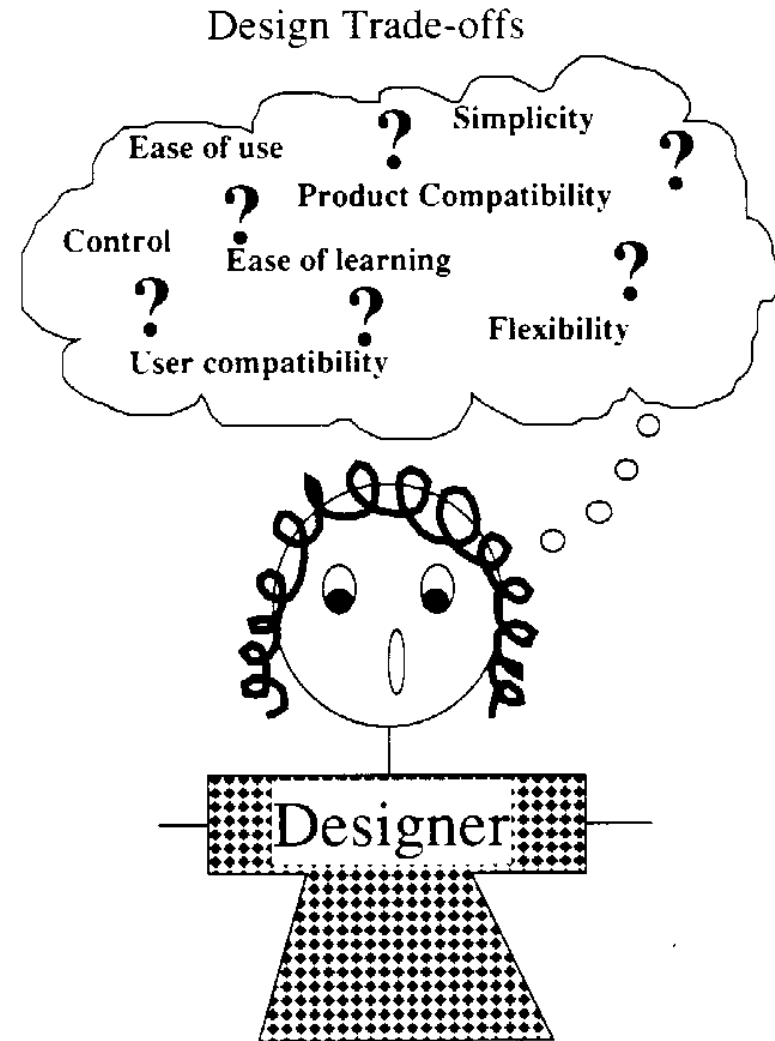


General Principles of HCI Design

- Principles which do / do not support **user experience**
 - Satisfying
 - Fun
 - Enjoyable
 - Entertaining
 - Helpful
 - Surprising
 - Aesthetically pleasing
 - Rewarding
 - Supportive of creativity
 - Emotionally fulfilling
 - Boring
 - Frustrating
 - Annoying

General Principles of HCI Design

- Principles are often in direct conflicts with one another. In order to make the trade-offs intelligently, a thorough understanding of the intended users is required
- These principles are very general and designers may not know how to apply them directly



Norman's Principles of Usability

Norman is a cognitive psychologist, expertise in computers
Cognition refers to how we gain **knowledge**, includes understanding, remembering, reasoning, acquiring skills, creating new idea

- **Visibility**

- Interface feature is accessible to a human sense organ? (e.g., Can an answering machine indicate the presence of incoming voice mails? The number of mails?)
- Indicate what parts operate & how
- Indicate how user is to interact with the device (e.g., on/off key on a calculator)
- The more visible functions are, the more likely users will be able to know what to do next

Norman's 7 Principles

1. Use both knowledge in the world and knowledge in the head
2. Simplify the structure of tasks
3. Make things visible
4. Get the mappings right
5. Exploit the power of constraints, both natural and artificial
6. Design for error
7. When all else fails, standardise



Norman's Principles of Usability



Norman's Principles of Usability



- This is a control panel for an elevator (www.baddesigns.com)
 - How does it work?
 - Push a button for the floor you want?
 - Nothing happens. Push any other button? Still nothing. What do you need to do?
- ⇒ It is not visible as to what to do!

Norman's Principles of Usability



Need to insert your room card in the slot first!

How would you make this action more visible?

- Make the card reader more obvious
- Provide an auditory message, that says what to do
- Provide a big label next to the card reader that flashes when someone enters
- Make relevant parts visible
- Make what has to be done obvious

Norman's Principles of Usability

■ Feedback

- This principle is nature: when you talk to somebody, you expect a reply
- Send back to user information about what action has actually been done. This allows a person to continue with the activity
(e.g., press a key on a telephone)
- Include sound, highlighting, animation and combination of these
- Indicate what result has been accomplished
(e.g., copy a file in PC, progress of downloading a file from internet)

Norman's Principles of Usability

- **Constraints**
 - Restricting some kinds of user interaction to take place at a given moment
(e.g., some menu options will be deactivated by shading them at some occasions)
 - Avoid wrong uses of thing
 - 3 main types:
 - Physical
 - Logical
 - Cultural

Norman's Principles of Usability

Physical Constraints

- Refer to the way physical objects restrict the movement of things
- How many ways can you insert an electrical plug to a socket?
- How about inserting a CD into a computer?

Which of them has a better physical constraint?

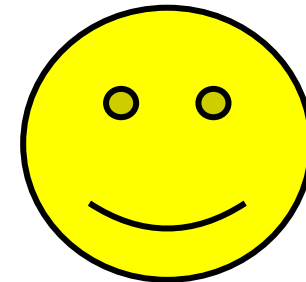
Logical Constraints

- Exploit people's common sense reasoning about actions and their consequences
- When no object is selected, it is not allowed to use the "Cut" command in WORD

Norman's Principles of Usability

Cultural Constraints

- Rely on learned conventions
- Red colour stands for danger while green colour stands for safe
- Smiling face stands for happy emotion



Which one is universal and which one is culturally-specific (i.e., accepted by a cultural group only)?

Norman's Principles of Usability

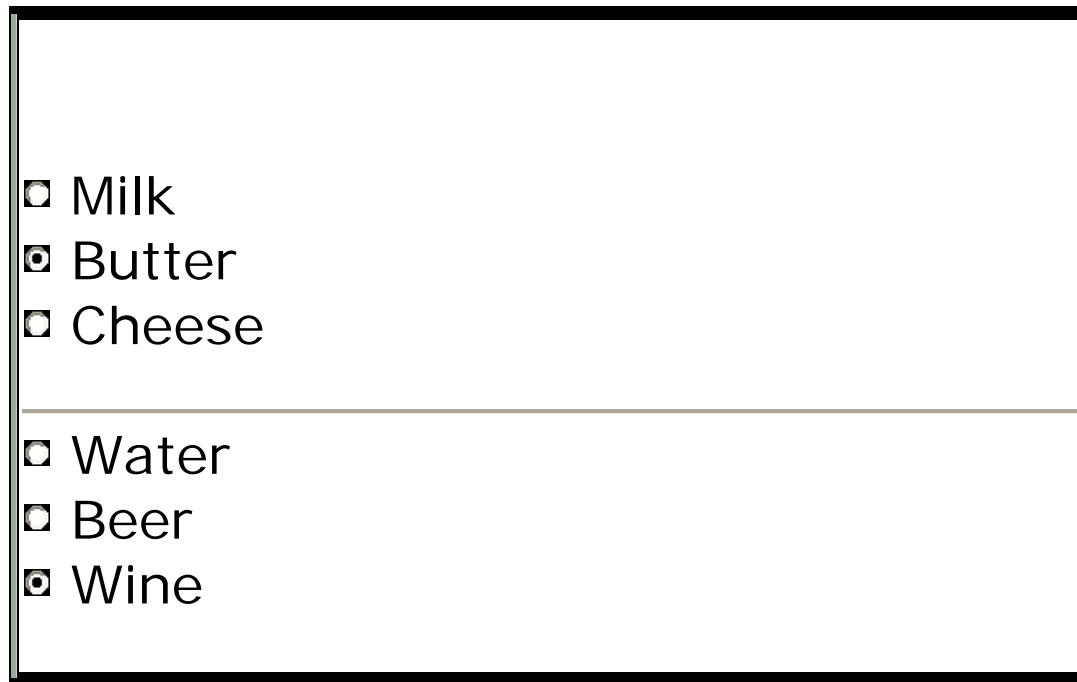
- **Affordance**

- Mean to give clues to operations of things
- Indicate what thing is for (e.g., a door handle affords pulling, a cup handle affords grasping)



- Indicate how thing could possibly be used (e.g. knobs are for turning, slots are for inserting things into)

Norman's Principles of Usability



☐ Milk
☒ Butter
☐ Cheese

☐ Water
☒ Beer
☒ Wine

A radio button in a Web page **affords** you to choose 1-of-many choice by clicking one of the items

Norman's Principles of Usability

Effects

<input type="checkbox"/> Strikethrough	<input type="checkbox"/> Shadow	<input checked="" type="checkbox"/> Small caps
<input checked="" type="checkbox"/> Double strikethrough	<input type="checkbox"/> Outline	<input type="checkbox"/> All caps
<input type="checkbox"/> Superscript	<input type="checkbox"/> Emboss	<input type="checkbox"/> Hidden
<input checked="" type="checkbox"/> Subscript	<input checked="" type="checkbox"/> Engrave	

A check box **affords** you to choose 0 to all choices

Is it true for Microsoft WORD?

There are two kinds of affordance:

- **Real**: for physical objects and do not have to be learned
- **Perceived**: for screen-based interfaces and can be considered as learned conventions

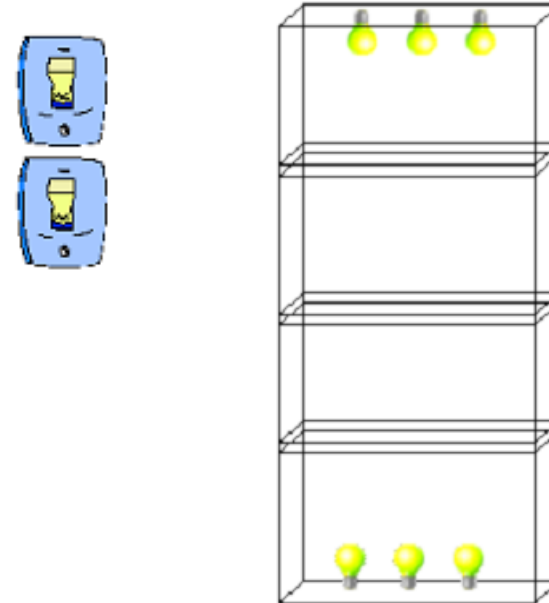
Norman's Principles of Usability



Norman's Principles of Usability

■ Mapping

- Natural relationship between controls & their effects (e.g. move mouse to left, pointer goes left)
- Upper button controls upper bulbs while lower controls lower bulbs (button **affords** you to press)



Norman's Principles of Usability

- The timer knob in a microwave oven is of good mapping because turning it clockwise implies increasing cook time (the knob **affords** you to turn as well)



- The volume knob in a Hi-Fi system is of good mapping because turning it clockwise implies increasing volume (the knob **affords** you to turn as well)

Norman's Principles of Usability



A



B



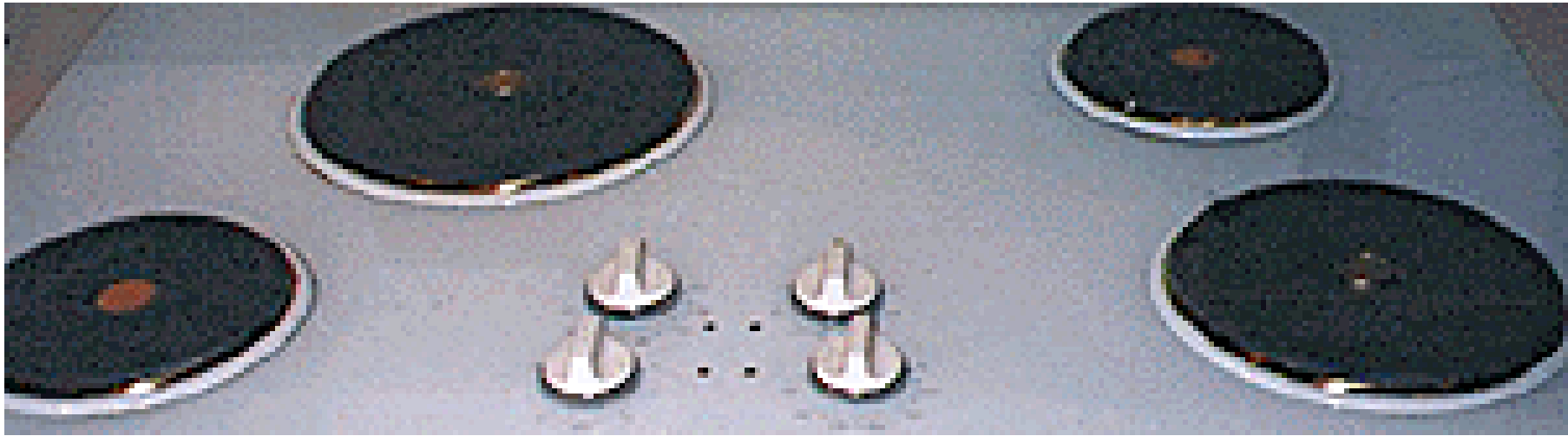
C



D

Which controls go with which burner rings?

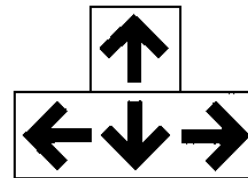
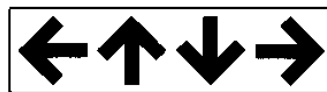
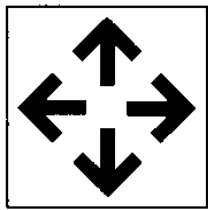
Norman's Principles of Usability



Is it better?

Norman's Principles of Usability

Which arrow-key layout is the best?



Which Norman's principle has been used?

Norman's 7 Principles

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Norman's Principles of Usability



- Pull or Push?
- Which Norman's principle has been used?

Norman's Principles of Usability



- Pull or Push?
- Which Norman's principle has been used?

Norman's Principles of Usability



Which Norman's principle has been used in this LeapFrog's education toy?