HUMAN MACHINE INTERACTION

DEPARTMENT OF COMPUTER ENGINEERING
SEMESTER VIII

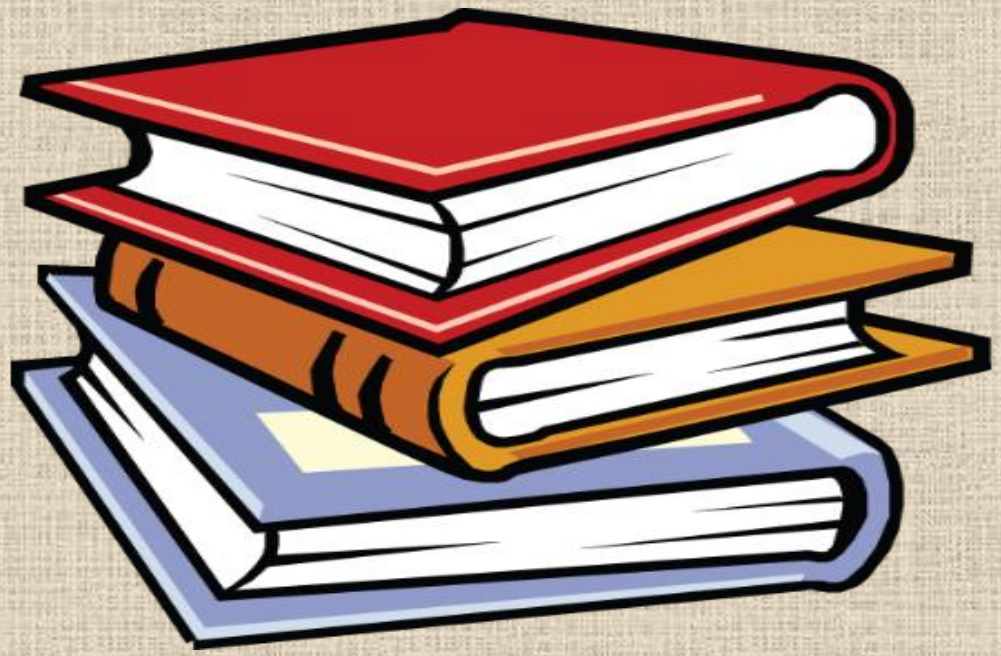
Prof. Swapnil Sonawane

MODULES :

1. Foundations of HMI
2. Design and Software Process
3. Graphical User Interface
4. Screen Designing
5. Interface Design for Mobile Devices
6. Interaction Styles and Communication

Text Books

1. Galitz's Human Machine Interaction, Dr. Dhananjay Kalbande, Wiley Publication
2. Human Computer Interaction, Alan Dix, Janet Finlay, Pearson Publication
3. The Essential Guide to User Interface Design, Wilbert O. Galitz, Wiley Publication
4. Mobile Design and Development, Brian Fling, O'Reilly Media



RUBRIC FOR MARKING OF TERM WORK

Lecture + Practical (% Attendance) & Marks	Assignments (2 Assignments) + Notebook	Lab / Practical Performance and Assessment	Mini Project	Total
05 Marks (Total attendance of Theory + Lab will get converted into 5 marks)	05 Marks	10 Marks	05 Marks	25 Marks

INTERNAL ASSESSMENT (IA) EXAM

IA1	IA2	Total
17/02/2020 10:00 am to 11:00 am	13/04/2020 10:00 am to 11:00 am	20 Marks

BLUE PRINT OF MU QP

Modules	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
#1	√	√				√
#2	√		√	√		
#3	√	√				√
#4	√		√		√	
#5	√			√		√
#6	√				√	√
	20 Marks	20 Marks	20 Marks	20 Marks	20 Marks	20 Marks

Chapter 1- Foundations of HMI

What is HMI?

It is the way in which the machine is presented to the human

Hardware, Software and Operating Environments (HMI Components or IO Channels)

1. Hardware

- Most important utility
- Used to drive software
- Today we choose hardware as per our requirements
- Plenty hardware options are available and no need to compromise

2. Software

- Tool to create an effective user interface
- Based on requirements and hardware we need to choose software
- It can use LLL, Assembly language or HLL
- Many front end development tools using audio/visual experience to user

3. Operating environment

- **Fulfill user level acceptance test and can provide modification**
- **Key points of user interface**
  - ✓ **Friends, family members, colleagues are not representatives of target users**
  - ✓ **User requirements should be understood by a team and not by an individual**
  - ✓ **Goal should be to minimize user difficulties**
  - ✓ **The hardware (device) and software balance should be maintained**

The Psychopathology of everyday things

Human-Centered Design (May 16)

- Considering different users and their aspects

Experience, knowledge, intelligence of users

1. Feedback
2. Constraints
3. Affordances (Convey the rules by leaving visual clues)
4. Power of observation

Norman's Fundamental Principles of Interaction

- Affordance (Visual clues that lead the user to understand functionality of the object)
- Signifiers
- Perceived Affordance
- Mapping (Mapping of actions and consequences)
- Feedback
- Conceptual Models

Psychology of Everyday Action

Seven Stages of Action (May 17, Dec 18)

1. **Forming the goal**

Execution

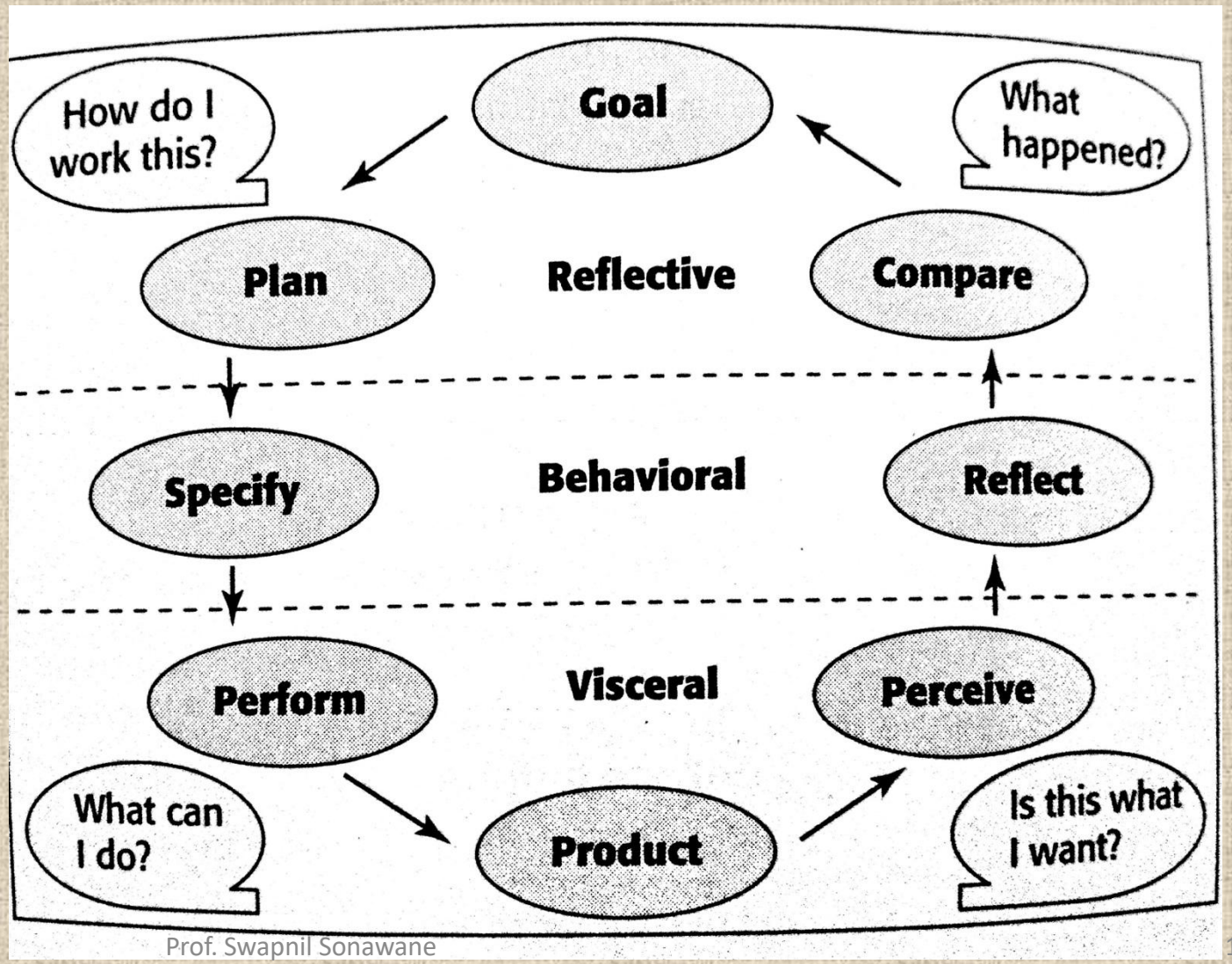
2. **Forming the intention (plan)**
3. **Specifying an action (specify)**
4. **Executing the action (perform)**

Evaluation

5. **Perceiving the state of the world (perceive)**
6. **Interpreting the state of the world (reflect)**
7. **Evaluating the outcome (compare)**

Three levels of Processing (May 16, Dec 16, May 17, Dec 18)

1. Visceral level
2. Behavioral level
3. Reflective level



Devices

Different Types of Devices

Text entry devices	The alphanumeric keyboard, QWERTY keyboard, Chord Keyboards, Phone pad or T9 Entry
Positioning, Pointing and Drawing	Mouse, Touchpad, Trackball/ Thumbwheel, Joystick, Touchscreens, Stylus or light pen, Eye gaze
Display Devices	Cathode ray tube (CRT), LCD, Large displays, Digital paper
Displays for virtual reality and 3D interaction	
Physical controls, Sensors and special devices	

Memory

RAM or Short term memory (STM)

Disks or Long term memory (LTM)

Processing and Networks

Limitations on interactive performances:

1. **Computation bound**
2. **Storage channel bound**
3. **Graphics bound**
4. **Network capacity**

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Models of Interaction

What is interaction?

The execution-evaluation cycle

1. **Establishing the goal**
2. **Forming the interaction**
3. **Specifying the action sequence**
4. **Executing the action**
5. **Perceiving the system state**
6. **Interpreting the system state**
7. **Evaluating the system state with respect to the goals and intentions**

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Ergonomics

It mainly represent the study of people's efficiency in their working environment

It is a study of physical characteristics of interaction, how the controls are designed, the physical environment in which the interaction takes place, and the layout and physical qualities of the screen

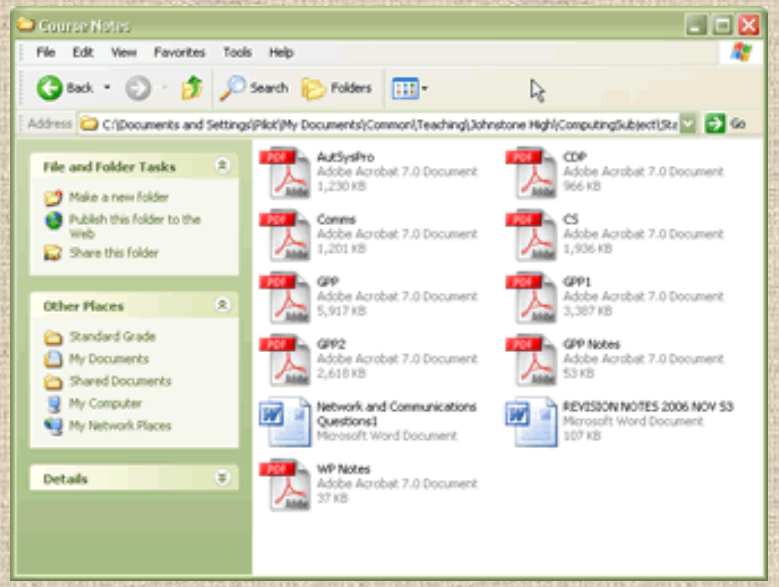
Interaction Styles

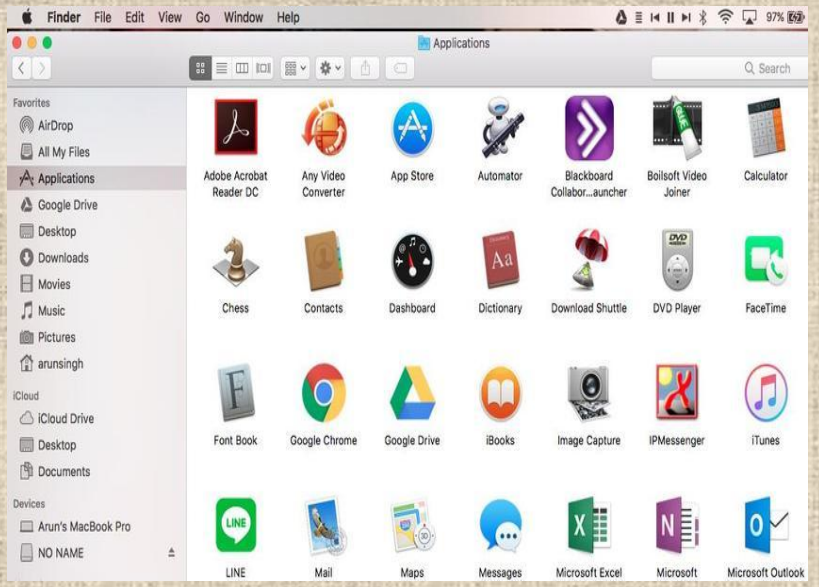
Types of Interaction Styles:

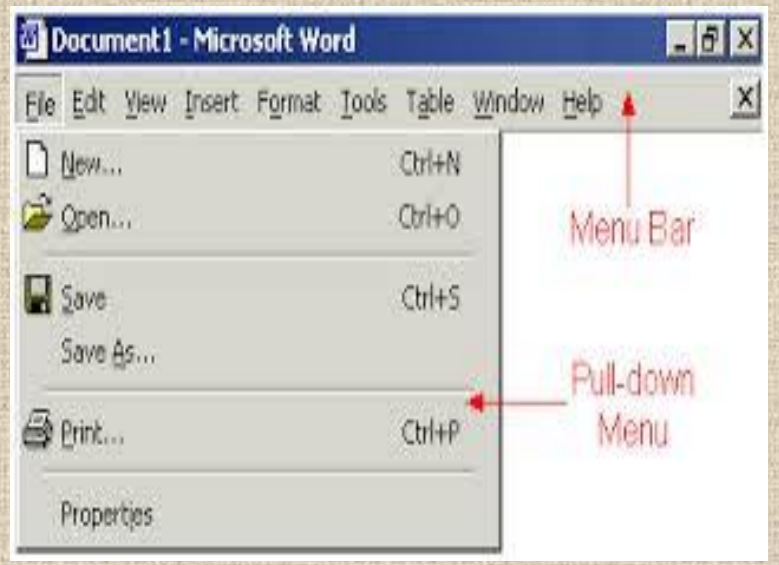
1. **Command line interface**
2. **Menus**
3. **Natural language**
4. **Question/Answer and query dialog**
5. **Form-fills and spreadsheets**
6. **WIMP**
7. **Point and click**
8. **Three-dimensional interface**

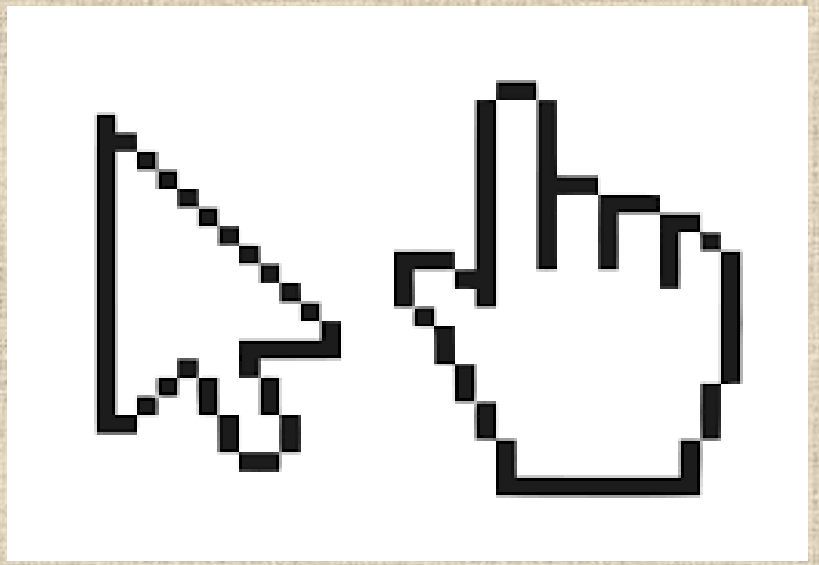
Elements of WIMP Interface

1. Windows
2. Icons
3. Menus
4. Pointers









Paradigms

1. Time sharing
2. Video display units
3. Toolkits
4. Personal Computing
5. Window system and WIMP interface
6. The metaphor
7. Direct manipulation
8. Language versus action
9. Hypertext
10. Multi-modality
11. Computer supported cooperative work
12. World wide web
13. Agent-based interface
14. Ubiquitous computing
15. Sensor-based and context aware interaction

CHAPTER 2- DESIGN AND SOFTWARE PROCESS

Mistakes performed while designing a computer system

1. **Developers expect people to think like computers**
2. **Developers asks user to perform difficult operations (that may not be difficult for developers)**
3. **The resultant software design will have poor behaviour**
4. **Users are ignored**

Why people have trouble with computers

1. Use of jargon
2. Non obvious design
3. Fine distinctions
4. Disparity in problem solving strategies
5. Design inconsistency

Responses to poor design

Psychological	Physical
Confusion	Abandonment of the system
Annoyance	Partial use of the system
Frustration	Indirect use of the system
Panic or Stress	Modification of the task
Boredom	Compensatory activity
	Misuse of the system
	Direct programming

Human Characteristics in Design

1. Perception
2. Memory
3. Sensory storage
4. Visual acuity
5. Foveal and peripheral vision
6. Information processing
7. Mental model
8. Movement control
9. Learning
10. Skill
11. Individual differences

Human Considerations in Design

The user's knowledge and experience	The user's tasks and needs
○ Computer literacy ○ System experience ○ Application experience ○ Task experience ○ Other system use ○ Education ○ Reading level ○ Typing skill ○ Native language and culture	○ Mandatory or discretionary use ○ Frequency of use ○ Task or need importance ○ Task structure ○ Social interactions ○ Primary training ○ Turnover rate ○ Job category ○ Lifestyle
The user's Psychological characteristics	**The user's Physical characteristics**
○ Attitude and Motivation ○ Patience ○ Stress level ○ Expectations ○ Cognitive style	○ Age ○ Gender ○ Handedness ○ Disabilities

Human Interaction Speeds

1. Reading
2. Listening
3. Speaking
4. Keying

What is Design

Achieving goals within constraints

1. Goals
2. Constraints
3. Trade-off

Golden Rule of Design

1. Understand your materials
2. Understand computers

   limitations, capacities, tools, platforms
3. Understand people

   psychological, social aspects, human errors

The Process of Design

1. Requirements- What is wanted
2. Analysis
3. Design
4. Iteration and prototyping
5. Implementation and deployment

User Focus

Know your users

- **Who they are?**
- **Probably not like you!**
- **Talk to them**
- **Watch them**
- **Use your imagination**

Scenarios

Communicate with others

Validate other models

Express dynamics

Time is linear

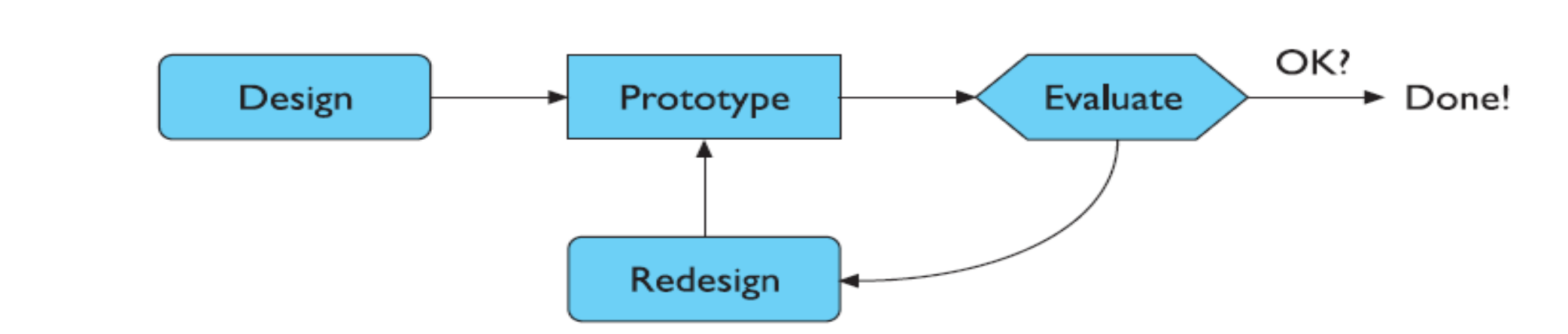
But no alternatives

Iteration and Prototyping

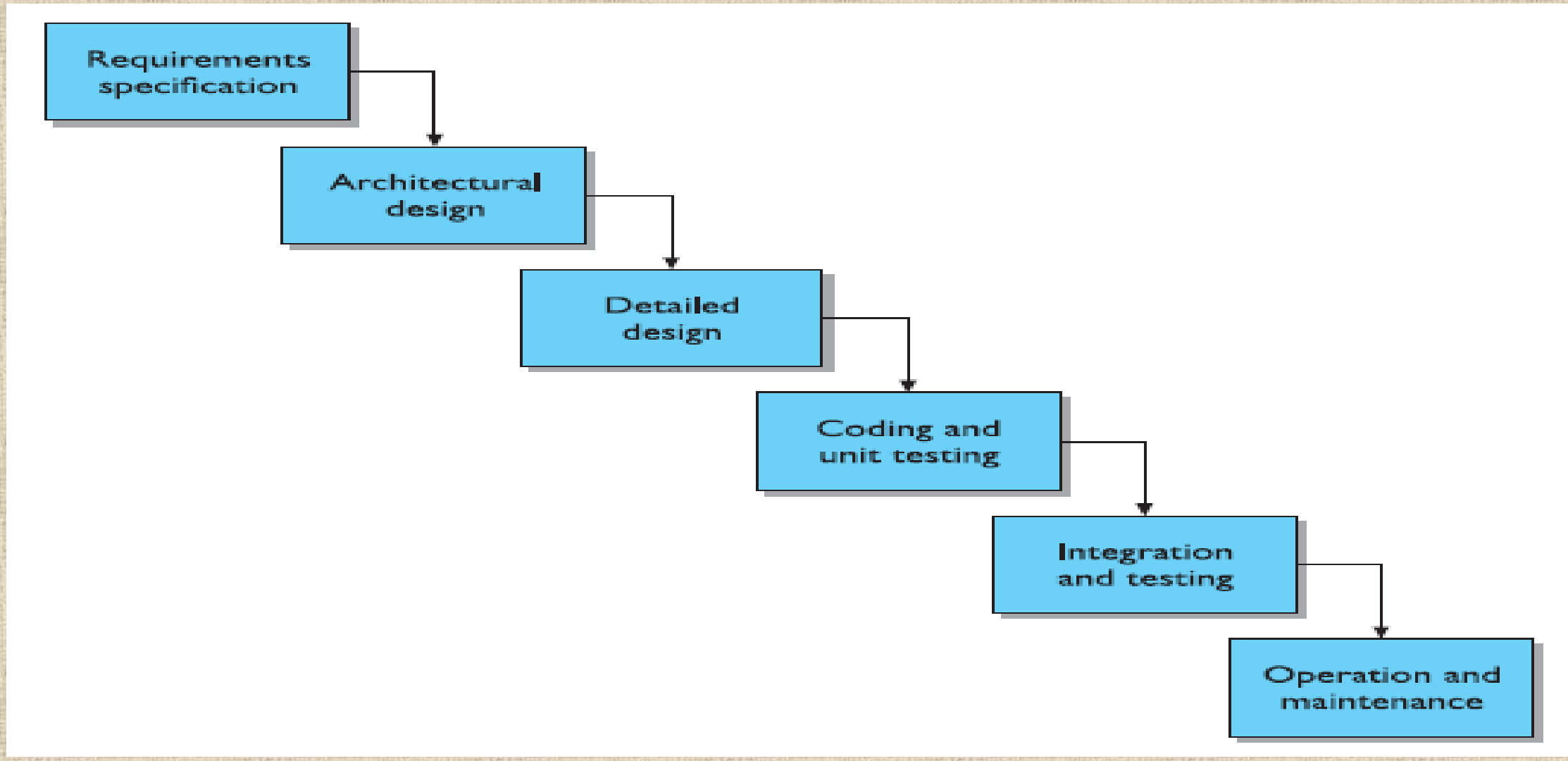
Formative Evaluation

Summative Evaluation

Role of prototyping:



Software Life Cycle



Usability Engineering

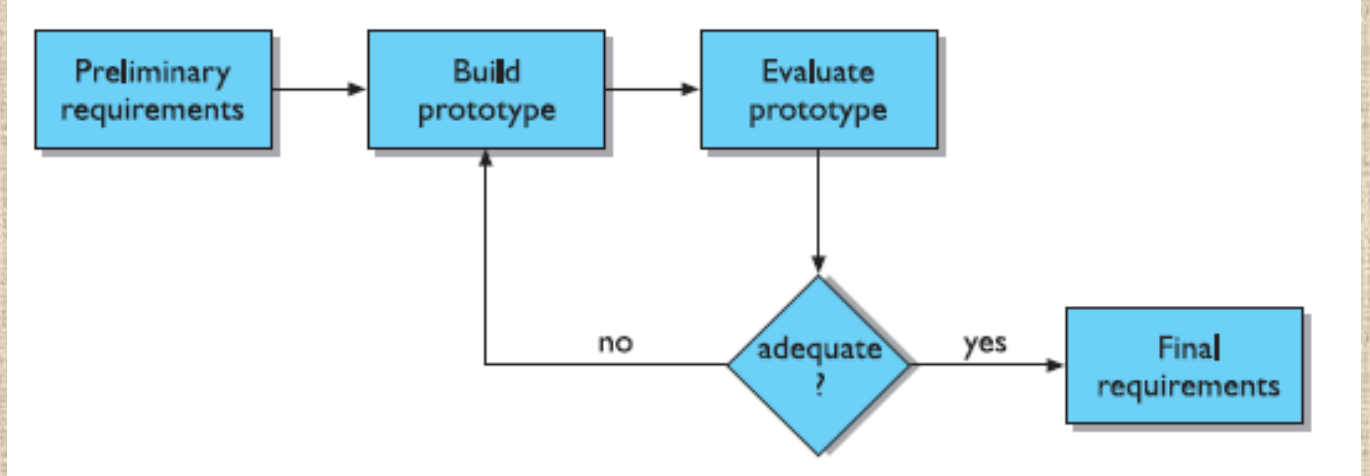
The engineering that depends on interpretation against a shared background of meaning, agreed goals and an understanding of how satisfactory completion will be judged.

The emphasis for usability engineering is in knowing exactly what criteria will be used to judge a product for its usability.

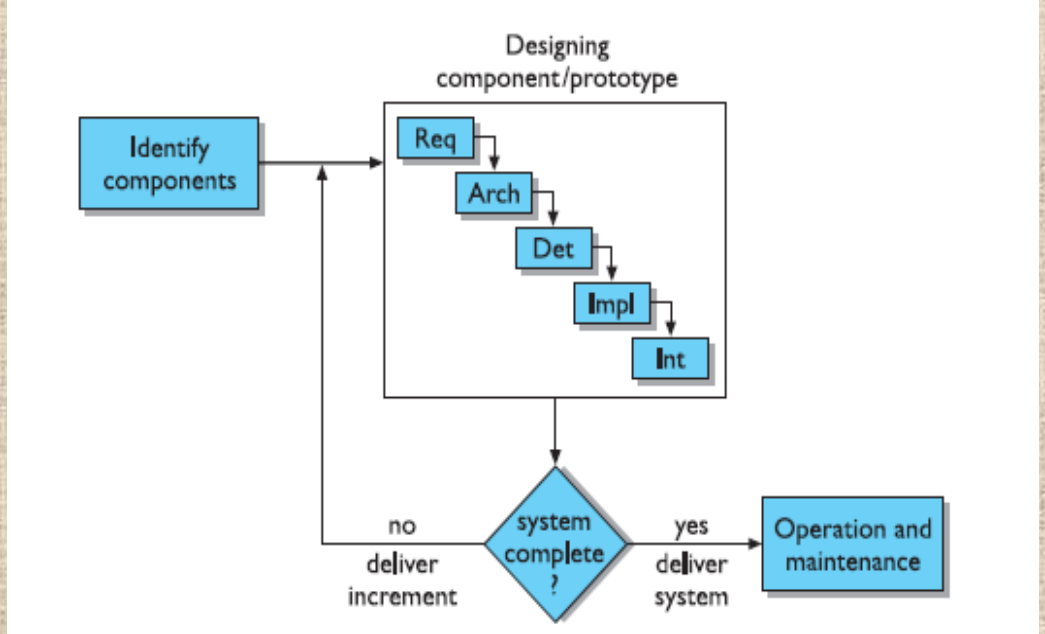
The ultimate test of a product's usability is based on measurements of users' experience with it. Therefore, since a user's direct experience with an interactive system is at the physical interface, focus on the actual user interface is understandable.

Iterative Design and Prototyping

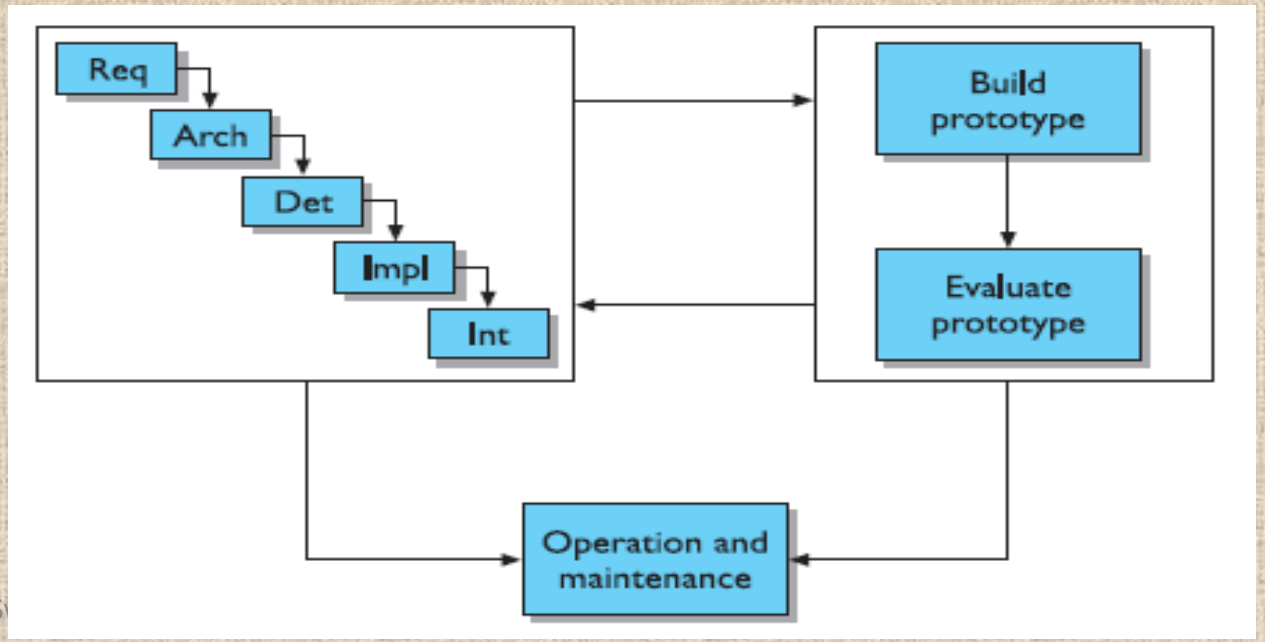
Throw-away prototyping



Incremental prototyping



Evolutionary prototyping



Design Rationale

- ✓ It provides a communication mechanism among the members of a design team
- ✓ Accumulated knowledge in the form of design rationales for a set of products can be reused to transfer what has worked in one situation to another situation which has similar needs.
- ✓ The effort required to produce a design rationale forces the designer to deliberate more carefully about design decisions.
- ✓ There is usually no single best design alternative. Even if an optimal solution did exist for a given design decision, the space of alternatives is so vast that it is unlikely a designer would discover it.
- ✓ The usability of an interactive system is very dependent on the context of its use.

Design Rules/ Principles to Support Usability

Learnability	Flexibility	Robustness
Predictability	Dialog initiative	Observability
Synthesizability	Multi-threading	Recoverability
Familiarity	Task migratability	Responsiveness
Generalizability	Substitutivity	Task conformance
Consistency	Customizability	

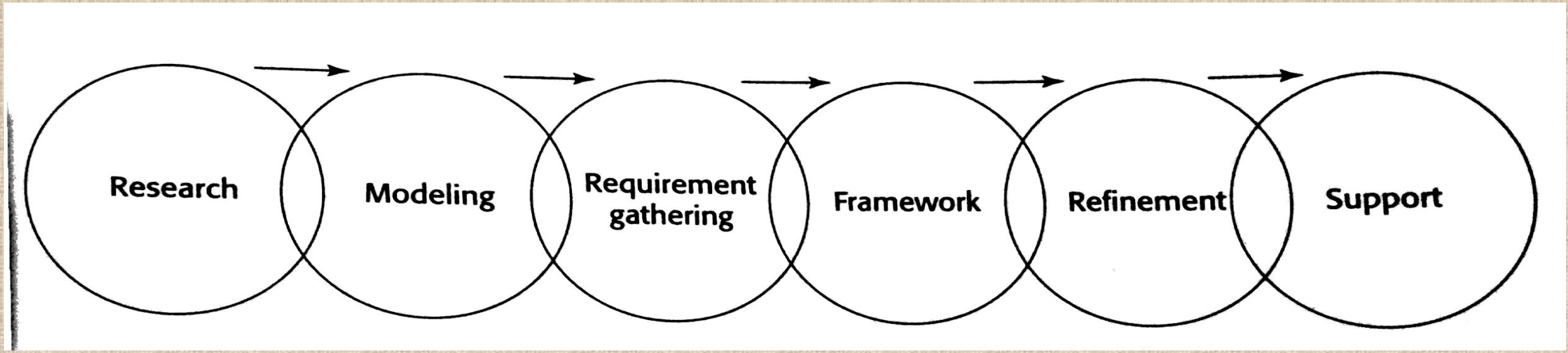
Shneiderman's Eight Golden Rules

1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogs to yield closure
5. Offer error prevention and simple error handling
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short term memory load

Norman's 7 Principles to Transforming Difficult Tasks Into Simple Ones

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
6. Design for error
7. When all else fails, standardize

Goal Directed Design Process (Dec 17, May 17, Dec 16, Dec 18)



CHAPTER 3- GRAPHICAL USER INTERFACE

The Concept of Direct Manipulation (Dec 17, Dec 16, May 16)

Characteristics:

1. The system should portrayed as an extension of the real world
2. Continuous visibility of objects and actions
3. Actions should rapid and incremental with visible display and results
4. Incremental actions should easily reversible

Graphical Systems (Dec 17, Dec 16, Dec 18)

Advantages:

1. Symbols recognized faster than text
2. Faster learning
3. Faster use and problem solving
4. Easier remembering
5. More natural
6. Fewer errors
7. Less difficult for new user
8. More attractive
9. Replaces natural languages
10. Low typing requirements

Disadvantages

1. Greater design complexity
2. Learning still necessary
3. Not always familiar
4. Human comprehension limitations
5. Window manipulation requirements
6. Production limitations
7. Inefficient for expert users
8. Increased chances of clutter and confusion
9. May consume more screen space
10. Hardware limitations

Characteristics of Graphical user interface

1. Sophisticated visual presentation
2. Pick and click interaction
3. Restricted set of interface options
4. Visualization
5. Object orientation
    1. Collection
    2. Constraints
    3. Composites
    4. Container
6. Use of recognition memory
7. Concurrent performance of functions

Principles of User interface design (May 17)

1. Visual pleasing
2. Availability
3. Clarity
4. Compatibility
5. Configurability
6. Directness
7. Efficiency
8. Familiarity
9. Flexibility
10. Forgiveness
11. Predictability
12. Recovery
13. Responsiveness
14. Simplicity
15. Transparency

GUI versus Web Page Design (May 16)

Characteristics	GUI	Web
Devices	Hardware variations are limited	User hardware variations enormous
User Focus	Data and application	Information and navigation
User Tasks	Install, Configure, Personalize, use and upgrade programs etc	Linking, Browsing, Filling forms, Downloading, Saving etc
Presentation Elements	Windows, menus, controls, toolbars, messages and so on	Browser and page
Navigation	Through menus, lists, trees, dialogs etc	Through links, bookmarks and typed URLs
Interaction	Clicking menu choices, pressing buttons, selecting list choices and cut/copy/paste	Basic interaction is single click. This can cause extreme changes in context
Response Time	Nearly instantaneous	Quite variable depending upon transaction speeds, page content and so on
Visual Style	Visual creativity allowed but difficult	Fosters a more artistic, individual and unrestricted presentation style

Characteristics	GUI	Web
Task Efficiency	Targeted to a specific audience with specific tasks	Actual user audience usually not well understood, often intended for anyone and everyone
User Assistance	Integral part of most systems and applications	No similar help system is normally available
Security	Tightly controlled	Not effectively secure and renowned for security exposures
Reliability	Tightly controlled in business systems	Susceptible to disruptions caused by user, telephone line, ISP, Servers etc.

Printed Pages versus Web Pages (Dec 17)

Characteristics	Printed Pages	Web Pages
Page Size	Larger than web pages and fixed in size	Normally lesser than printed pages and variable in size
Page Rendering	Superior than web pages as they are presented as complete entities and their entire contents are available for reading and review immediately upon appearance	Web pages elements are often rendered slowly, depending upon speed and page content
Page Layout	Layout is precise with much attention given to it	Layout is more of an approximations
Reading	More better and reading is faster	Screen reading is slower than reading from document
User Focus	It present people with entire set of information	Present people with individual snapshots of information and body of web information is almost unlimited
Page Navigation	Simple as page turning	It requires innumerable decisions concerning which of the many possible links should be followed

Characteristics	Printed Pages	Web Pages
Sense of Place	With proper documents you derive a sense of where you are through proper organization	Electronic documents none of any physical clues
Interactivity	It involves letting the eyes traverse static information selectively looking at information and using spatial combinations to make page elements enhance and explain each other	It involves letting the hands move the information in conjunction with the eyes
Page Independence	Printed pages are not considered independent	Moving between web pages is so easy and any page from site can be accessed from anywhere else, every page is independent and topic and contents must be explained without assumptions about any previous page seen by the user

The merging of Graphical business systems and the Web
Intranet vs Internet

Characteristics	Intranet	Internet
Users	Organization employees who know about organization	Customers and others who know much less about the organization
Tasks	Everyday activity including transactions, queries and communication	Find information and simple transactions
Type of information	Detailed information needed for organization functioning which often be added and modified	Stable information includes marketing, customer reports etc.
Amount of information	Much larger than internet site	Less than intranet site
Hardware and Software	Computers, monitors, browsers, and other software are restricted and standardized	Rich graphics, multimedia and screen elements are high definitions
Design Philosophy	Text based and GUI applications	GUI and Web applications

CHAPTER 4- SCREEN DESIGNING

Design Goals:

1. **Reduce visual work**
2. **Reduce intellectual work**
3. **Reduce memory work**
4. **Reduce motor work**
5. **Minimize or eliminate any burdens or instructions imposed by technology.**

Ordering of Screen Data and Contents

1. Conventional
2. Sequence of use
3. Frequency of use
4. Function or category
5. Importance
6. General to specific

Visually Pleasing Composition

1. Balance
2. Symmetry
3. Regularity
4. Predictability
5. Sequentiality
6. Economy
7. Unity
8. Proportion
9. Simplicity
10. Groupings

Focus and Emphasis

Brightness

Reverse polarity

Fonts

Underlining

Blinking

Line rulings and surrounding boxes or frames

Colors

Other emphasis techniques

De-emphasize less important elements

Avoid too much emphasis

Presenting Information Simply and Meaningfully

Legibility

Readability

Usability

Contrast display features

Visual lines

Consistency

Information Retrieval On Web

A. Reading on web

1. Initial focus of attention
2. Page perusal

Scanning guidelines:

a. Organization

b. Writing

Concisely write the page text

Bulleted and numbered lists

c. Presentation

Information Retrieval On Web

B. Browsing

1. Facilitate scanning
2. Provide multiple layers of structure
3. Respect the user's desire to leave
4. Upon returning, help the users reorient themselves

Information Retrieval On Web

C. Searching

Problems with search facilities:

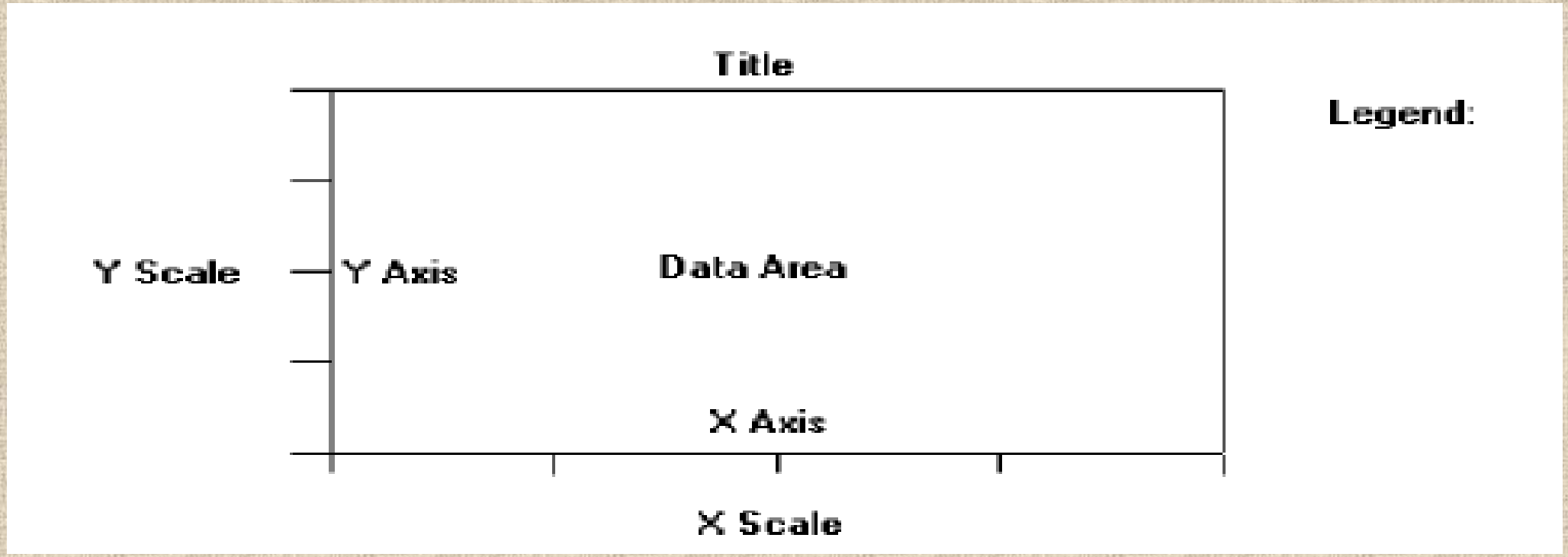
1. Not understanding the users
2. Difficulties in formulating the search
3. Difficulties in presenting meaningful results

Search facility guidelines:

1. Know your search users- Expertise/ Anticipate/ Switching purposes
2. Express the search- What/ Where/ How
3. Progressive search refinement
4. Present meaningful results

Statistical Graphics

Components of statistical graphics



1. **Data presentation**
    1. **Emphasis on data minimize on non data elements**
    2. **Redundant data**
    3. **Proper context**
    4. **Restrict information carrying dimensions**
    5. **Employ data in multiple ways**
    6. **Avoid unnecessary embellishment**
    7. **Fill the display area**

2. Axes

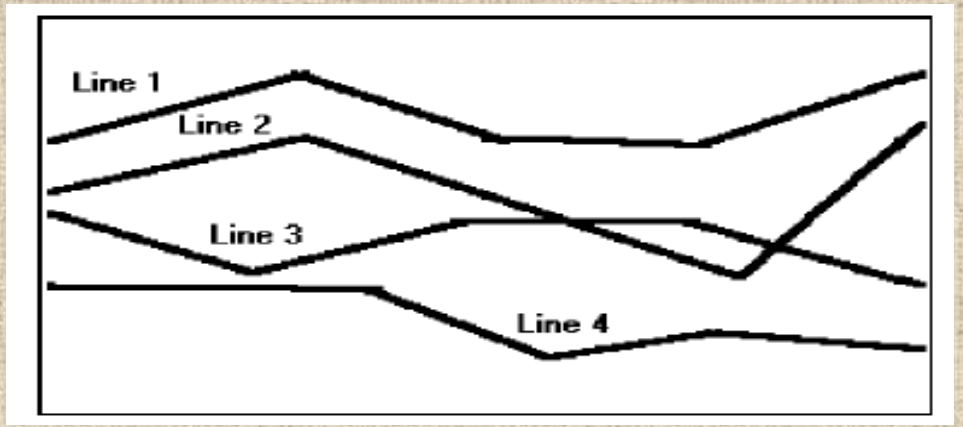
3. Scales and scaling

    1. Tick marks
    2. Linear Scales
    3. Scale markings
    4. Starts a numeric scales at zero
    5. Minimization of scale digits
    6. Single scale on each axes
    7. Duplicate axes for large matrics
    8. Scale interpretation
    9. Consistency
    10. Labeling

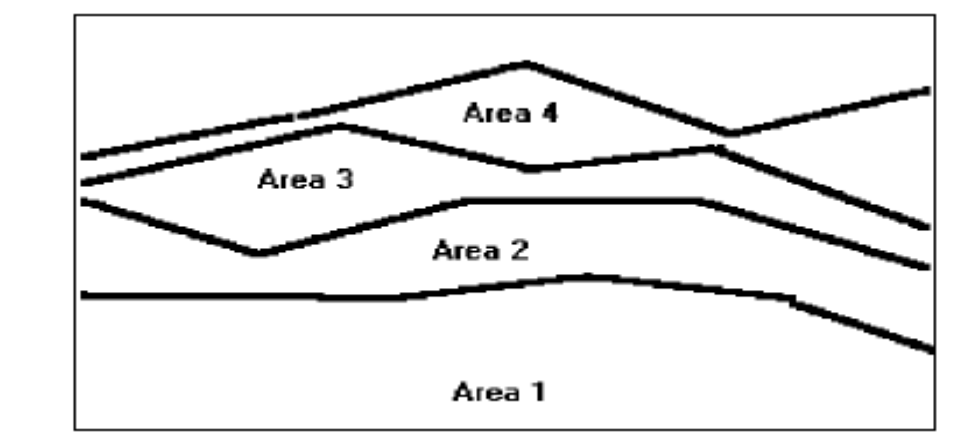
4. Proportion
5. Lines
6. Labeling
    1. Clear and detailed
    2. Left to right
    3. Integrate
    4. Separation
    5. Source
    6. Legends
7. Title
8. Aiding interpretation of numbers

Types of statistical graphics

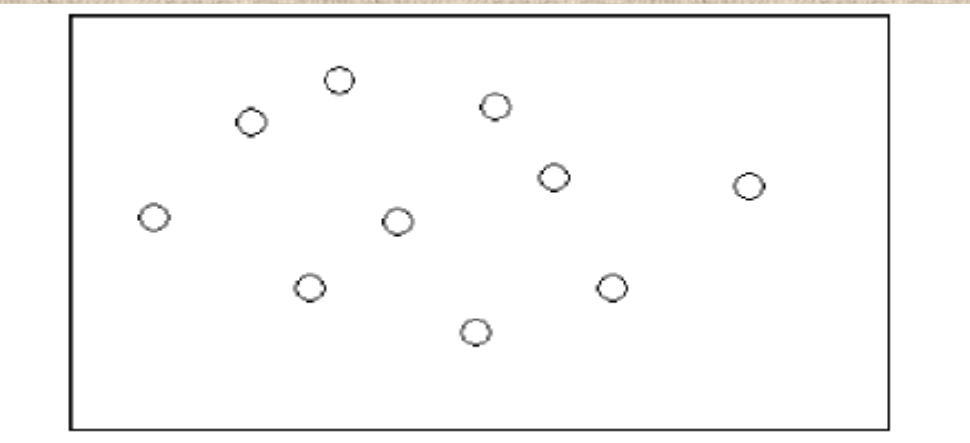
1. Curve and line graphs
    1. Single graphs
    2. Four or five maximum
    3. Label identification
    4. Tightly packed curves or lines
    5. Important or critical data
    6. Comparing actual or projected data



2. Surface charts
    1. Ordering
    2. Coding schemes
    3. Labels

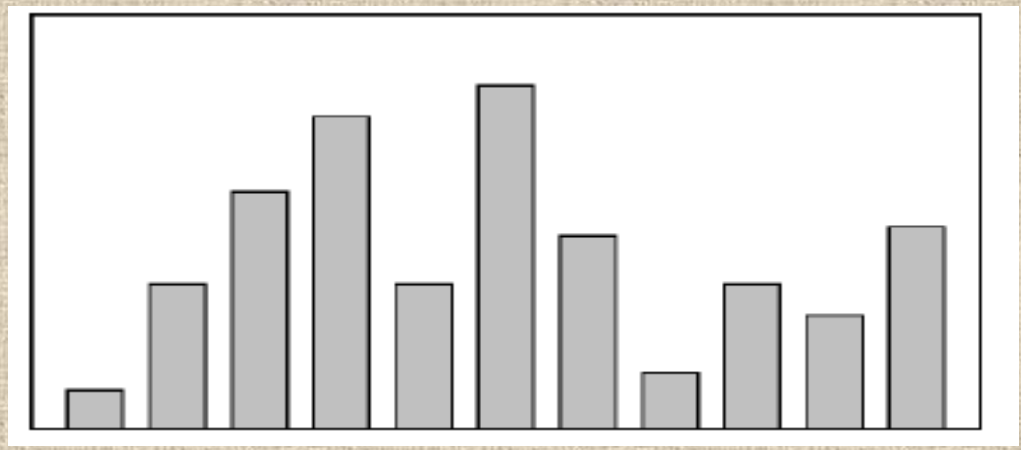


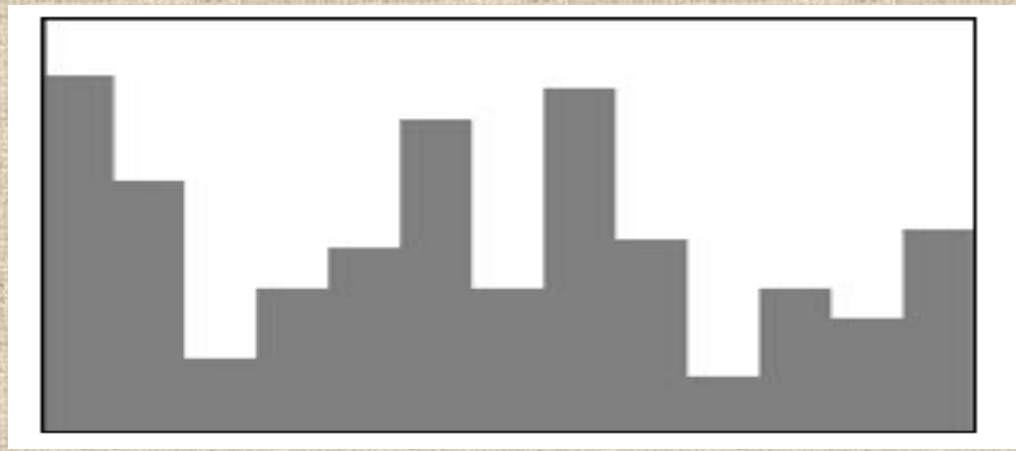
3. Scatter plots
    1. Two dimensions
    2. Consistent intervals
    3. Distinguishable plots
    4. Multiple data sets



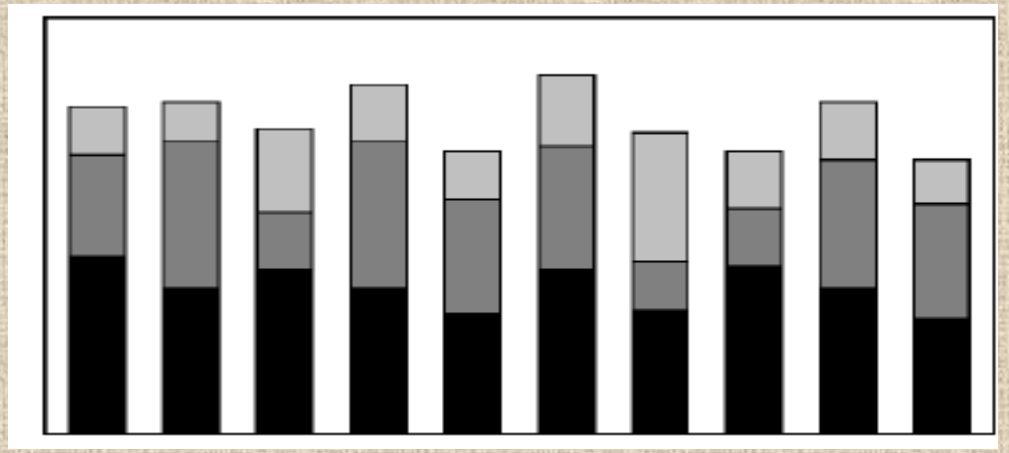
4. Bar graphs

1. Consistent orientation
2. Meaningful orientation
3. Bar spacing
4. Differentiation
5. Important or critical data
6. Reference index
7. Labeling
8. Histogram or step charts

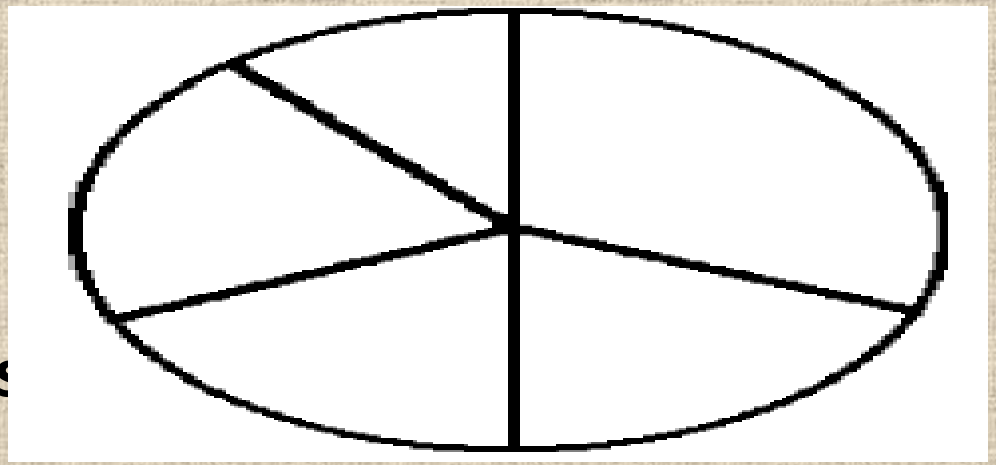




5. **Segmented or stacked bar**
    1. Data category ordering
    2. Large segments
    3. Coding schemes
    4. Labeling



6. **Pie charts**
    1. Total 100 percent
    2. Five segment or fewer
    3. Minimum five percent
    4. Start at 12.00
    5. Labeling
    6. Numbers with segment labels
    7. Highlighting
    8. Tilting



7. Flow chart

1. Order of steps
2. Orientation
3. Coding conventions
4. Arrows
5. Highlighting
6. Only one decision at each step
7. Consistency

Technological Considerations in System Design

1. Graphical Systems
    1. System Power
    2. Screen size
    3. Screen resolution
    4. Colors
    5. Other display features
    6. Platform compatibility
    7. Development and implementation tool compatibility
    8. Style guide compatibility

2. Web Systems

1. Browser

1. Compatibility
2. Monitor size and resolution
3. Fonts
4. Colors
5. Bandwidth
6. Versions

2. Other Web Considerations

1. Downloading
2. Currency
3. Page printing
4. Maintainability

CHAPTER 6- INTERACTION STYLES AND COMMUNICATION

Windows Characteristics:

1. A name or title, allowing to be identified
2. A size in height and width
3. A state, accessible or active, or not accessible
4. Visibility- the portion that can be seen
5. Display boundary
6. Presentation
7. Management capabilities
8. Its highlight, that is, the part that is selected
9. The function, task, or application to which it is dedicated

Components of Windows

1. Frame
2. Title bar
3. Title bar icon
4. Window sizing buttons
5. What's this ? Button
6. Manu bar
7. Status bar
8. Scroll bars
9. Split box
10. Toolbar
11. Command area
12. Size grip
13. Work area

Window Presentation Styles (May 17)

1. Tiled Windows
2. Overlapping Windows
3. Cascading Windows

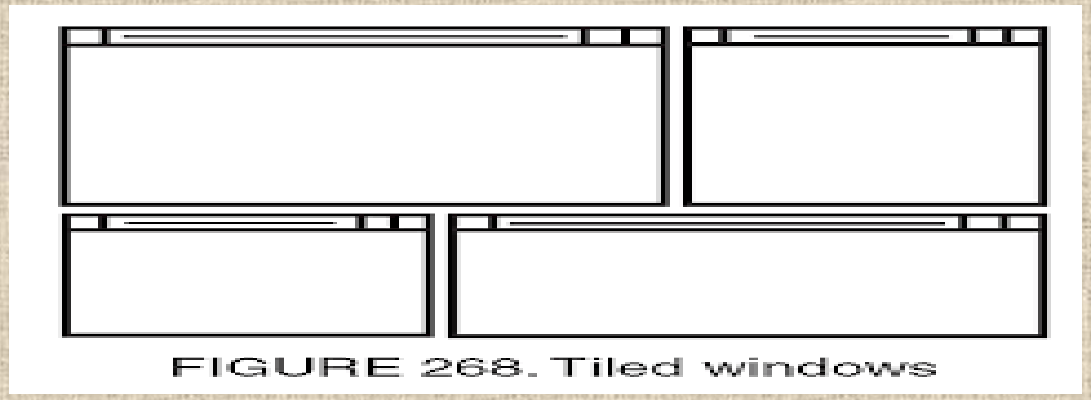
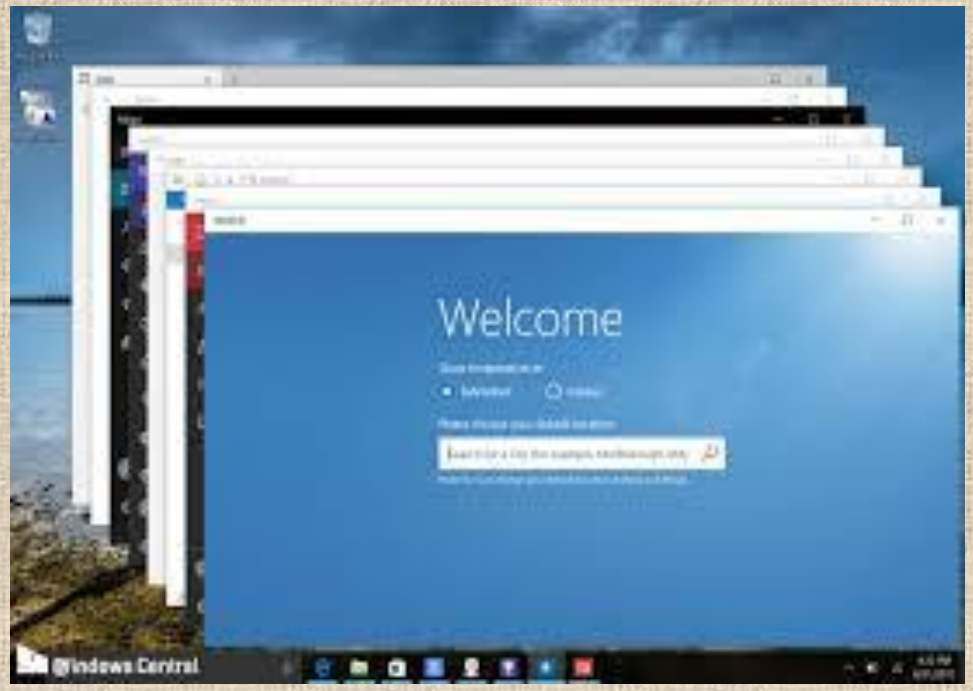
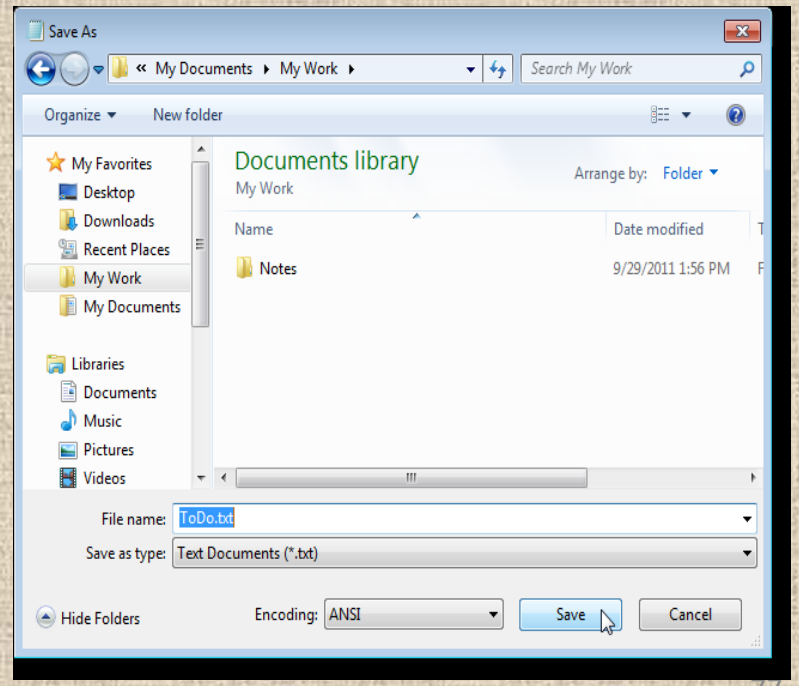


FIGURE 268. Tiled windows



Types of Windows (Dec 17, May 16)

1. Primary Windows
2. Secondary Windows
   a) Modal and Modeless
   b) Cascading and Unfolding
3. Dialog Boxes
4. Property Sheets and Property Inspectors
5. Message Boxes
6. Palette Windows
7. Pop-up Windows



Window Management

1. Single-document interface
2. Multiple-document interface
3. Workbooks
4. Projects

Organizing Window Functions (Window Operations)

1. Window organization
2. Number of windows
3. Active window
4. General guidelines
5. Opening a window
6. Sizing or resizing windows
7. Window placement
8. Window separation
9. Moving a window
10. Other operations- Maximizing/ Minimizing/ Shuffling
11. Closing a window

Words, Sentences, Messages and Text

Words

1. Jargon
2. Abbreviations or acronyms
3. Short familiar words
4. Complete words
5. Positive terms
6. Consistent words

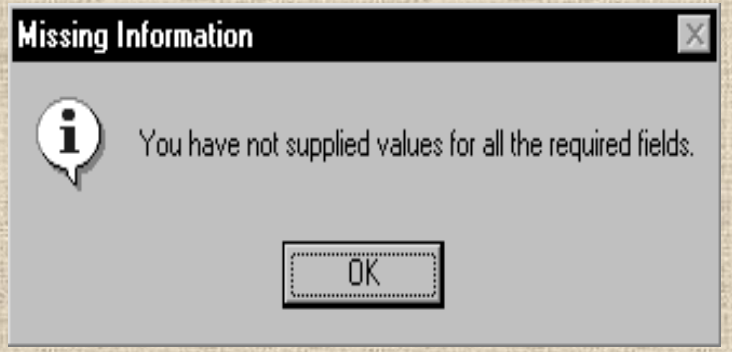
Sentences

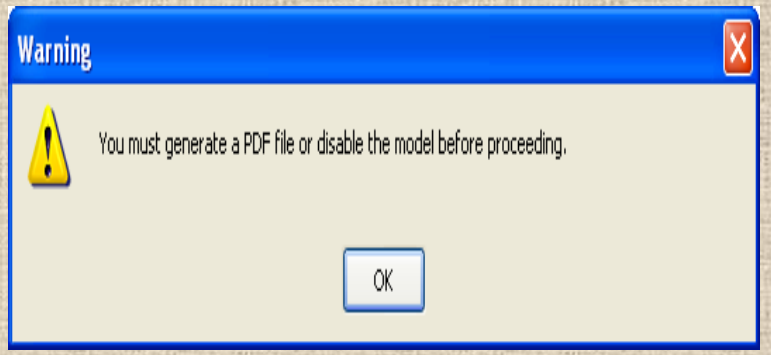
1. Brief and simple
2. Directly and immediately usable
3. Affirmative statement
4. Active voice
5. Temporal sequence
6. Main topic at beginning
7. Non authoritarian
8. Non threatening
9. Punishment and humor

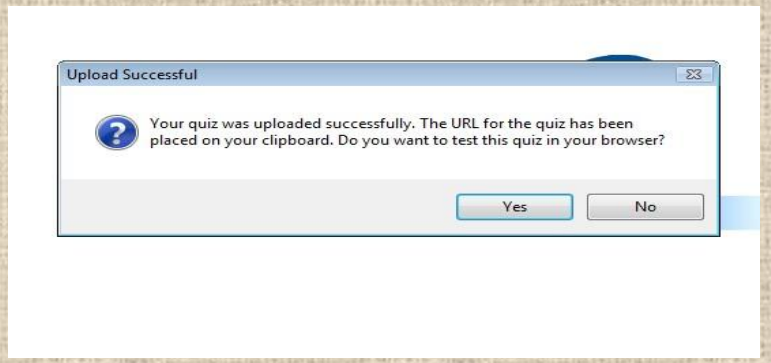
Messages (May 16)

A. System messages

1. Status messages
2. Informational messages
3. Warning messages
4. Critical messages
5. Question messages







B. Instructional messages

Text

Presenting text

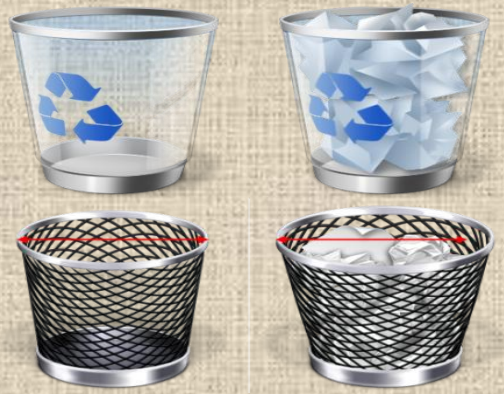
1. Fonts
2. Content
3. Style
4. Miscellaneous

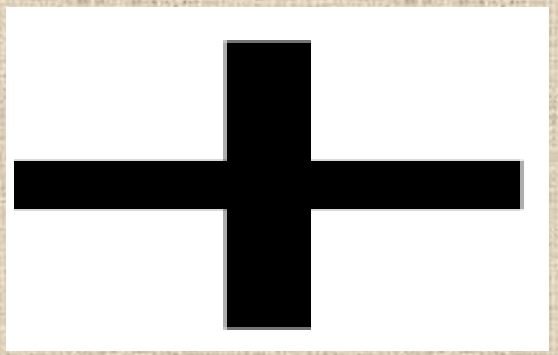
Icons and Multimedia

Icons

A. Kinds of icons

1. Resemblance
2. Symbolic
3. Exemplar
4. Arbitrary
5. Analogy





B. Technical qualities

1. Syntactics
2. Semantics
3. Pragmatics

C. Characteristics

1. Clarity
2. Familiarity
3. Simplicity
4. Consistency
5. Directness
6. Efficiency
7. Discriminability
8. Expectancies

D. Choosing icons

1. A successful icons
2. Size
3. Color
4. Icon selection
5. Hot zone

E. Choosing images

1. Existing icons
2. Nouns
3. Traditional images
4. Cultural or social norms

F. The design process

1. Define purpose
2. Collect, evaluate and sketch ideas
3. Draw in black and white
4. Test for expectations, recognition and learning
5. Test for legibility
6. Register new icon in the system registry

Multimedia

A. Graphics

1. Supplement textual content
2. Convey information not possible using text
3. Limit long loading graphics
4. Enhance navigation

Multimedia

B. Images

1. Standard images
2. Consistency
3. Legibility
4. Descriptive text or labels
5. Navigational and decorative images
6. Minimize number of images
7. Minimize size of an image
8. Thumbnail size
9. Minimize animation
10. Minimize the number of colors
11. Appropriate format

Multimedia

C. Photographs/Pictures

1. Use
2. Guidelines

D. Videos and audios

1. Use
2. Guidelines

Multimedia

E. Diagrams and drawings

1. Use
2. Guidelines

F. Animation

1. Use
2. Guidelines

Colors (Dec 17, Dec 16)

A. Possible problems with colors

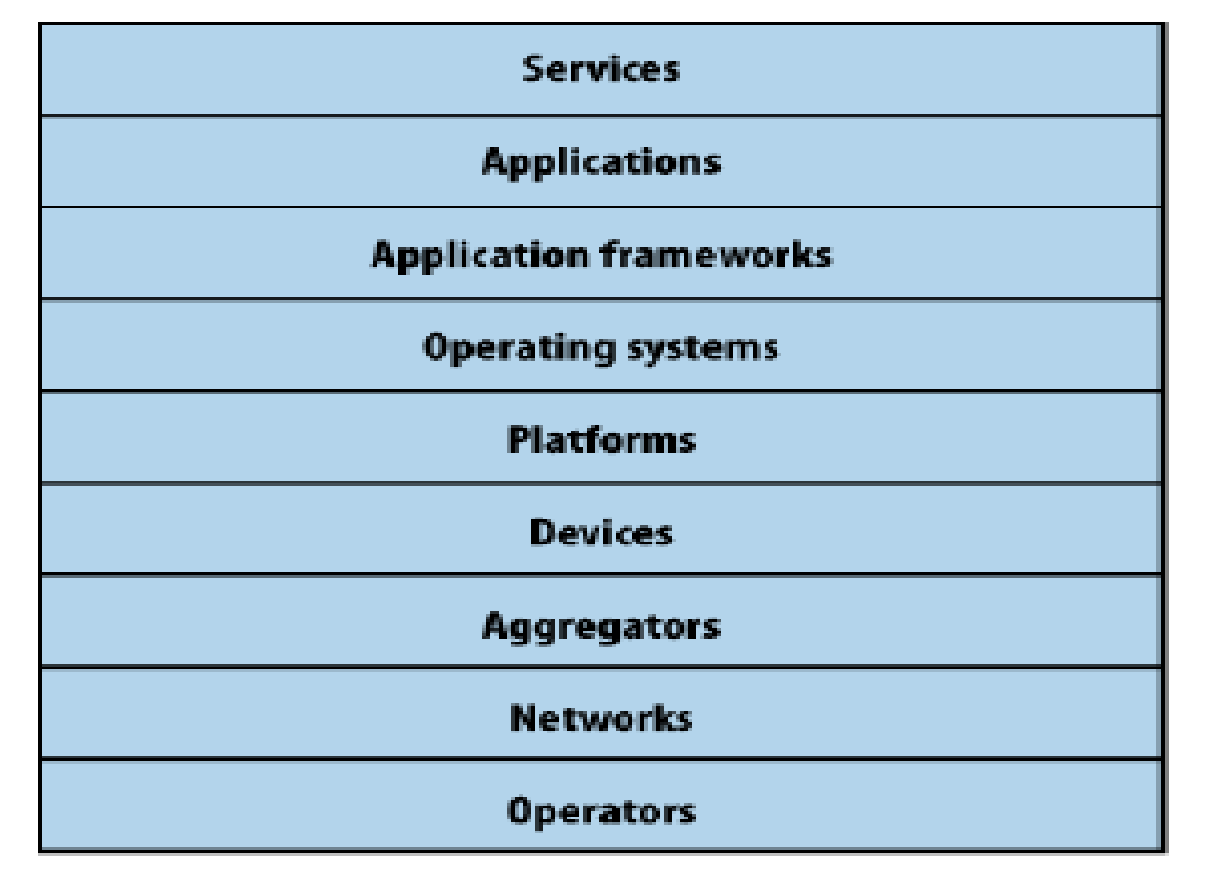
1. High attention getting capacity
2. Interference with use of other screens
3. Varying sensitivity of the eyes to different colors
4. Color viewing deficiencies
5. Cross disciplinary and cross cultural differences

B. Choosing colors

1. Choosing colors for categories of information
2. Discrimination and harmony
3. Emphasis
4. Common meanings
5. Location
6. Foreground and background
7. Color palette, defaults and customization
8. Gray scale
9. Monochromatic screens
10. Consistency
11. Cultural, disciplinary considerations

CHAPTER 5- INTERFACE DESIGN FOR MOBILE DEVICES

Mobile Ecosystems:



JAVA, Flash light, Web, COCOA touch etc.

Licensed, Proprietary, Open Source

Types of Mobile Applications

- SMS
- Mobile websites
- Mobile web widgets
- Mobile web applications
- Native applications
- Games
- Informative applications

Mobile Information Architecture

- Site maps
- Simplicity (Keep it simple)
- Clickstreams (Behaviour)
- Wireframes
- Prototyping
    1. Paper prototype
    2. Context prototype
    3. HTML prototype

Mobile 2.0

- Mobile 2.0: The Convergence of the Web and Mobile
- The Mobile Web Browser As the Next Killer App
- Mobile Web Applications Are the Future
- JavaScript Is the Next Frontier
- The Mobile User Experience Is Awful
- Mobile Widgets Are the Next Big Thing
- Mobile Needs to Check Its Ego
- We Are Creators, Not Consumers

Elements of Mobile Design

- Context
- Message
- Look and feel
- Layout
- Colour
- Typography
- Graphics