Chapter 10: Human–Computer Interaction Layer Design

Objectives

- Understand several fundamental user interface (UI) design principles.
- Understand the process of UI design.
- Understand how to design the UI structure.
- Understand how to design the UI standards.
- Understand commonly used principles and techniques for navigation design.

Objectives (cont'd)

- Understand commonly used principles and techniques for input design.
- Understand commonly used principles and techniques for output design.
- Be able to design a user interface.
- Understand the effect of nonfunctional requirements on the human-computer interaction layer.

Introduction

- Interface Design defines how the system will interact with external entities (e.g., customers, users, other systems)
  - *System Interfaces* are machine-machine and are dealt with as part of systems integration
  - *User Interfaces* are human-computer and are the focus of this chapter
- Principles for UI design
- The UI design process
- Navigation, Input, Output Design
- Mobile & social media UI design
- Non-functional requirements and UI design

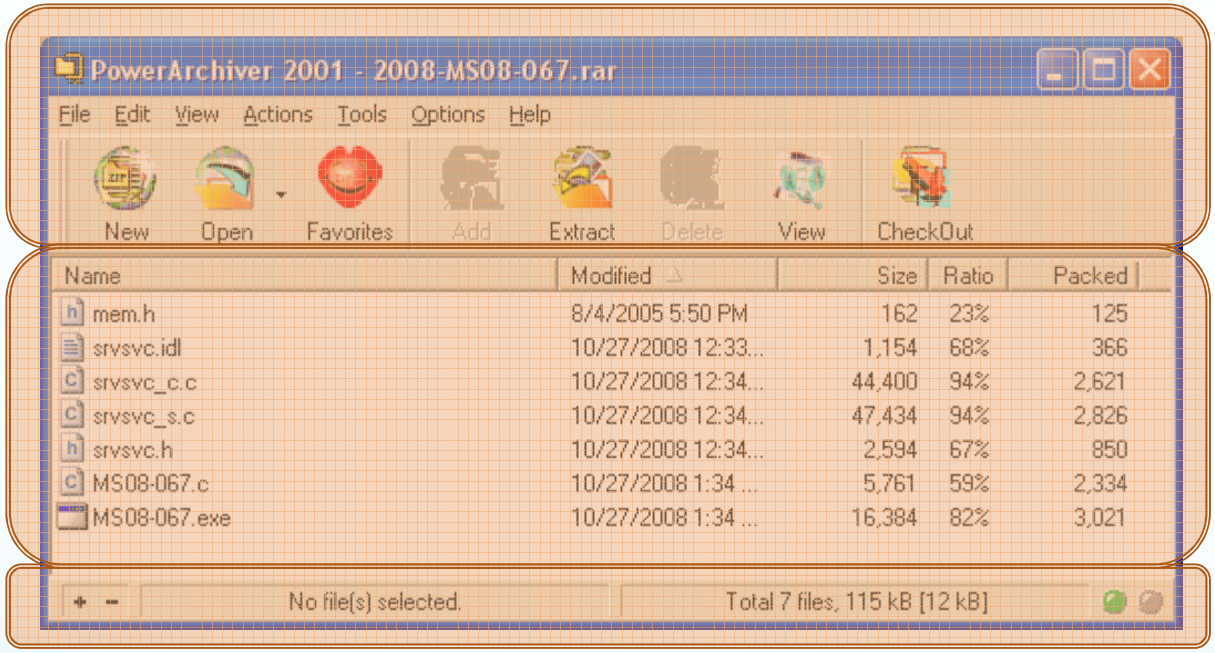
Principles of User Interface Design

- Layout of the screen, form or report
- Content Awareness—how well the user understands the information contained
- Aesthetics—how well does it appeal to the user
- User Experience—is it easy to use?
- Consistency—refers to the similarity of presentation in different areas of the application
- Minimal User Effort—can tasks be accomplished quickly?

Layout

- The arrangement of items on the screen
- Like items are grouped into areas
  - Areas can be further subdivided
  - Each area is self-contained
  - Areas should have a natural intuitive flow
    - Users from western nations tend to read from left to right and top to bottom
    - Users from other regions may have different flows

General Layout



Navigation Area

Reports & Forms Area

Status Area

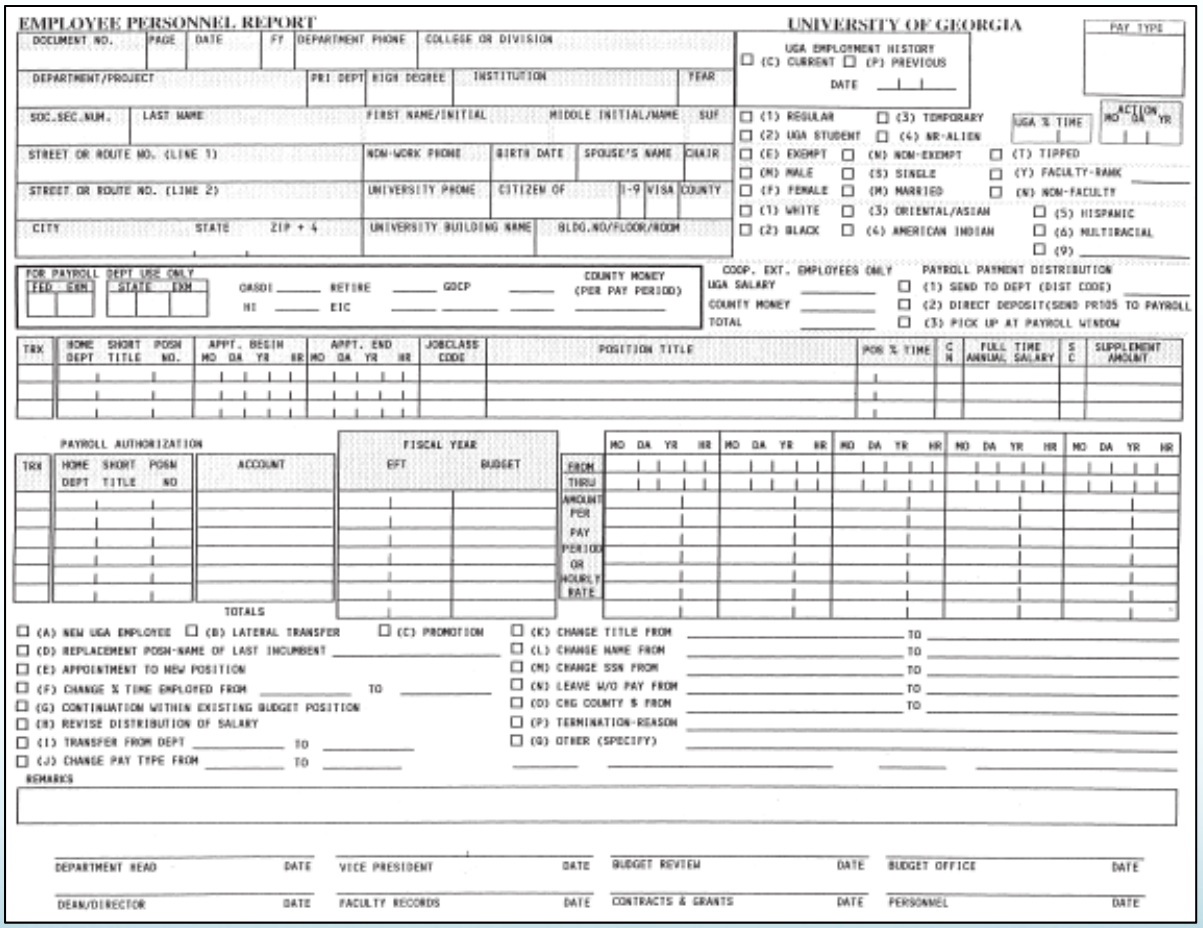
Content Awareness

- Applies to the interface in general, to each screen, to each area on a screen and to sub-areas as well
- Include titles on all interfaces
- Menus should show where the user is and how the user got there
- All areas should be well defined, logically grouped together and easily discernible visually

Aesthetics

- Interfaces should be functional, inviting to use, and pleasing to the eye
- Simple minimalist designs are generally better
- White space is important to provide separation
- Acceptable information density is proportional to the user's expertise
  - Novice users prefer lower density (< 50%)
  - Expert users prefer higher density (> 50%)
- Text design: size, serif vs. sans serif, use of capitals
- Color and patterns (e.g., don't use red on blue)

High Density Example



EMPLOYEE PERSONNEL REPORT

UNIVERSITY OF GEORGIA

DOCUMENT NO. | PAGE | DATE | FF | DEPARTMENT PHONE | COLLEGE OR DIVISION

UGA EMPLOYMENT HISTORY
☐ (C) CURRENT ☐ (P) PREVIOUS
DATE

PAY TYPE

DEPARTMENT/PROJECT | PRI DEPT | HIGH DEGREE | INSTITUTION | YEAR

SOC.SEC.NUM. | LAST NAME | FIRST NAME/INITIAL | MIDDLE INITIAL/NAME | SUF

STREET OR ROUTE NO. (LINE 1) | NON-WORK PHONE | BIRTH DATE | SPOUSE'S NAME | CHAIR

STREET OR ROUTE NO. (LINE 2) | UNIVERSITY PHONE | CITIZEN OF | I-9 | VISA | COUNTY

CITY | STATE | ZIP + 4 | UNIVERSITY BUILDING NAME | BLDG.NO/FLOOR/ROOM

☐ (1) REGULAR ☐ (3) TEMPORARY
☐ (2) UGA STUDENT ☐ (4) NR-ALIEN
☐ (E) EXEMPT ☐ (N) NON-EXEMPT ☐ (T) TIPPED
☐ (M) MALE ☐ (S) SINGLE ☐ (Y) FACULTY-RANK
☐ (F) FEMALE ☐ (M) MARRIED ☐ (N) NON-FACULTY
☐ (1) WHITE ☐ (3) ORIENTAL/ASIAN ☐ (5) HISPANIC
☐ (2) BLACK ☐ (4) AMERICAN INDIAN ☐ (6) MULTIRACIAL
☐ (9)

UGA % TIME

ACTION MO DA YR

FOR PAYROLL DEPT USE ONLY
FED EXM | STATE EXM
OASDI ____ RETIRE ____ GDCP ____ COUNTY MONEY (PER PAY PERIOD)
HI ____ EIC ____

COOP. EXT. EMPLOYEES ONLY
UGA SALARY
COUNTY MONEY
TOTAL

PAYROLL PAYMENT DISTRIBUTION
☐ (1) SEND TO DEPT (DIST CODE)
☐ (2) DIRECT DEPOSIT(SEND PRTDS TO PAYROLL
☐ (3) PICK UP AT PAYROLL WINDOW

TRX	HOME DEPT	SHORT TITLE	POSN NO.	APPT. BEGIN MO DA YR HR	APPT. END MO DA YR HR	JOBCLASS CODE	POSITION TITLE	POS % TIME	C N	FULL TIME ANNUAL SALARY	S C	SUPPLEMENT AMOUNT

PAYROLL AUTHORIZATION

TRX	HOME DEPT	SHORT TITLE	POSN NO	ACCOUNT	FISCAL YEAR EFT	FISCAL YEAR BUDGET		MO DA YR HR	MO DA YR HR	MO DA YR HR	MO DA YR HR	MO DA YR HR
							FROM					
							THRU					
							AMOUNT PER PAY PERIOD OR HOURLY RATE					
				TOTALS								

☐ (A) NEW UGA EMPLOYEE ☐ (B) LATERAL TRANSFER ☐ (C) PROMOTION
☐ (D) REPLACEMENT POSN-NAME OF LAST INCUMBENT ____
☐ (E) APPOINTMENT TO NEW POSITION
☐ (F) CHANGE % TIME EMPLOYED FROM ____ TO ____
☐ (G) CONTINUATION WITHIN EXISTING BUDGET POSITION
☐ (H) REVISE DISTRIBUTION OF SALARY
☐ (I) TRANSFER FROM DEPT ____ TO ____
☐ (J) CHANGE PAY TYPE FROM ____ TO ____

☐ (K) CHANGE TITLE FROM ____ TO ____
☐ (L) CHANGE NAME FROM ____ TO ____
☐ (M) CHANGE SSN FROM ____ TO ____
☐ (N) LEAVE W/O PAY FROM ____ TO ____
☐ (O) CHG COUNTY $ FROM ____ TO ____
☐ (P) TERMINATION-REASON ____
☐ (Q) OTHER (SPECIFY) ____

REMARKS

DEPARTMENT HEAD DATE | VICE PRESIDENT DATE | BUDGET REVIEW DATE | BUDGET OFFICE DATE

DEAN/DIRECTOR DATE | FACULTY RECORDS DATE | CONTRACTS & GRANTS DATE | PERSONNEL DATE

User Experience

- Ease of learning
  - Significant issue for inexperienced users
  - Relevant to systems with a large user population
- Ease of use
  - Significant issue for expert users
  - Most important in specialized systems
- Ease of learning and use of use are related
  - Complementary: lead to similar design decisions
  - Conflicting: designer must choose whether to satisfy novices or experts

Consistency

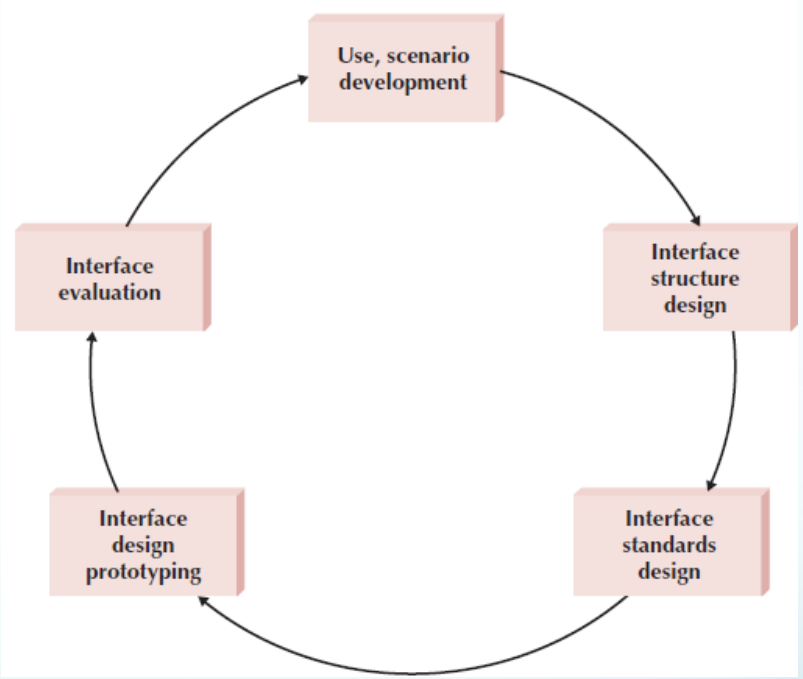
- Extremely important concept in making the system simple
  - It allows the users to *predict what is going to happen*
  - All parts of the system work in the same way
  - Users learn how one portion works and immediately apply it to others
- Key areas of consistency are
  - Navigation controls
  - Terminology—use the same descriptors on forms & reports

Minimal User Effort

- Interfaces should be designed to minimize the effort needed to accomplish tasks
- A common rule is the *three-clicks rule*
  - Users should be able to go from main menu of a system to the information they want in no more than three mouse clicks

User Interface Design Process

- Consists of 5 steps
- Process is iterative and analysts may move back & forth



Use Scenario Development

- Use scenarios outline the steps performed by users to accomplish some part of their work
- A use scenario is *one* path through an essential use case
- Presented in a simple narrative description
- Document the most common cases so interface designs will be easy to use for those situations

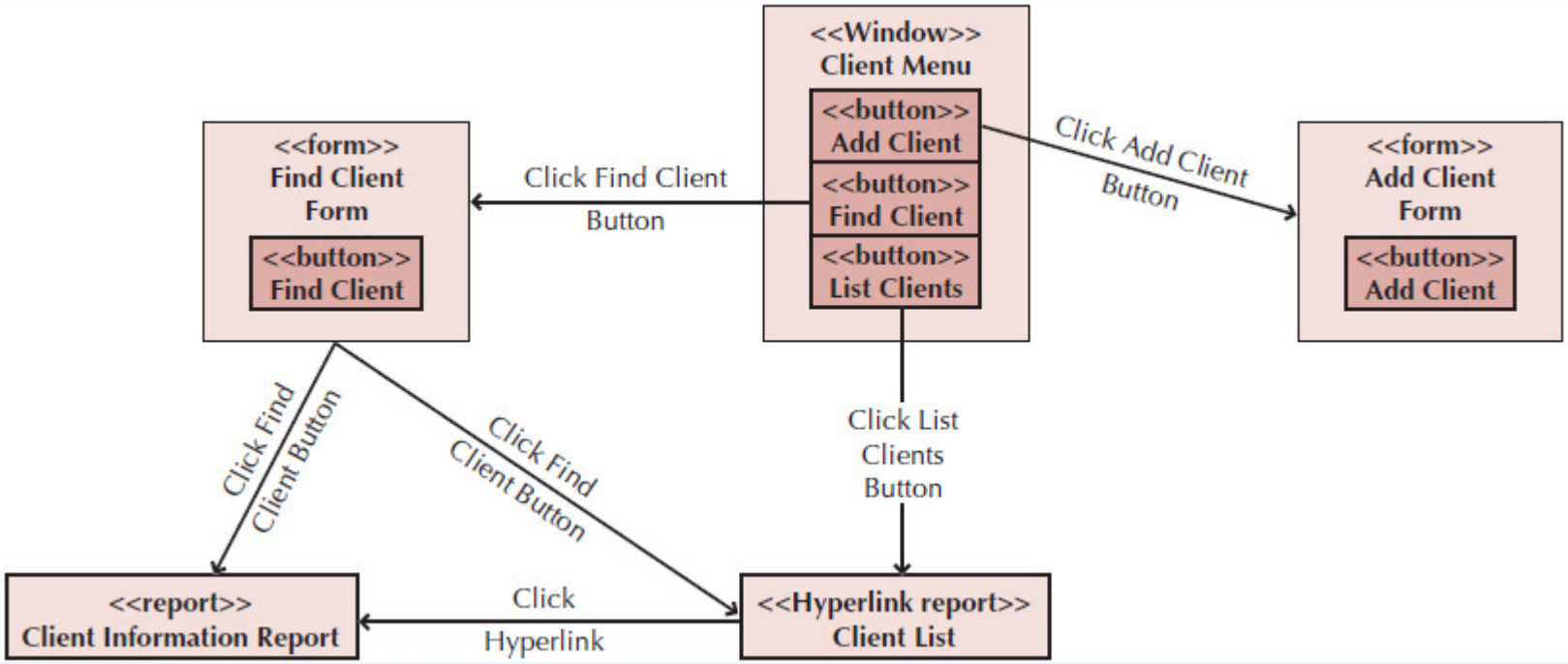
Interface Structure Design

- The interface structure defines
  - The basic components of the interface
  - How they work together to provide functionality to users
- Windows Navigation Diagrams (WND)
  - Similar to a behavioral state machine
  - Shows the relationship between all screens, forms, and reports used by the system
  - Shows how the user moves from one to another
  - Boxes represent components
  - Arrows represent transitions from and to a calling state
  - Stereotypes show interface type

Windows Navigation Diagrams

- Like a state diagram for the user interface
  - Boxes represent components
    - Window
    - Form
    - Report
    - Button
  - Arrows represent transitions
    - Single arrow indicates no return to the calling state
    - Double arrow represents a required return
  - Stereotypes show interface type

Sample WND



Interface Standards Design

- Interface standards are basic design elements found across the system user interface
- Standards are needed for:
  - Interface metaphor: defines how an interface will work (e.g., the shopping cart to store items selected for purchase)
  - Interface objects
  - Interface actions
  - Interface icons
  - Interface templates

Interface Design Prototyping

- Mock-ups or simulations of computer screens, forms, and reports
- Four common approaches (listed in increasing detail)
  - Storyboard: hand drawn pictures of what the screens will look like
  - Windows layout diagram: a computer generated storyboard that more closely resembles the actual interface
  - HTML prototype: web pages linked with hypertext
  - Language prototype: more sophisticated than HTML
    - Built in the programming language with no real functionality
    - User does not have to guess about the final appearance of the screen

Interface Evaluation

- Goal is to understand how to improve the interface design before the system is complete
- Have as many people as possible evaluate the interface
- Ideally, interface evaluation is done while the system is being *designed—before it is built*
  - Help identify and correct problems early
  - Designs will likely go through several changes after the users see it for the first time

Approaches to UI Evaluation

- Heuristic—compare the design to known principles or rules of thumb
- Walkthrough evaluation—design team presents prototype to the users & explains how it works
- Interactive—the users work with the prototype with a project team member
- Formal Usability Testing—performed in labs with users on a language prototype

Common Sense Approach to User Interface Design

- Users should not have to think about how to navigate the user interface
- The number of clicks should relate to the complexity of the task and should be unambiguous
- Minimize the number of words on the screen

Navigation Design

- The component that enables the user to navigate through the system
- Also provides messages of success or failure of actions performed
- Make it simple so that the user never really notices
- Basic principles:
  - Prevent the user from making mistakes
  - Simplify recovery for the user when mistakes are made
  - Use a consistent grammar order (e.g., File ▸ Open vs. Open ▸ File)

Types of Navigation Controls

- Language
  - Command language—user types in a command to be executed
  - Natural language—system interprets the user's language
- Menus
  - User is presented a list of choices
  - Comes in different forms (e.g., menu bars, popups, drop downs)
- Direct manipulation (e.g., drag and drop)

Messages

- How the system informs the user of the status of an interaction
  - Error messages—user did something that is not permitted
  - Confirmation messages (e.g., “Are you sure?”)
  - Acknowledgment messages (e.g., “Order entered”)
  - Delay messages—provides feedback to the user that the process is running
  - Help messages—provides additional information about the system to assist the user in performing a task

Navigation Design Documentation

- Done using WNDs and real use-cases
- Real use-cases are implementation dependent
  - Detailed description of how to use the implemented system
  - Essential use-cases evolve into real use cases by specifying them in terms of the actual user interface

Input Design

- Screens that are used to input data
- Data can be structured or unstructured
  - Structured: Dates, names, products, etc.
  - Unstructured: Comments, descriptions
- Basic principles
  - Online vs. batch processing
  - Capture data at the source (e.g., barcode vs. RFID)
  - Minimize keystrokes (e.g., by using defaults for frequently used values)

Types of Inputs

- Free form controls
  - Text boxes for alphanumeric information
  - Number boxes with automatic formatting
    - Example: Enter a phone number as 3451236789; automatically formats as (345)-123-6789
  - Password boxes that hide characters with stars and do not allow cutting or copying
- Selection boxes
  - Check boxes when several items can be selected
  - Radio buttons when items are mutually exclusive
  - List boxes to present a set of choices
  - Sliders—a pointer that can be moved along a scale

Input Validation

- Data should be validated prior to entry to ensure accuracy
- Do not accept invalid data (e.g., input text when a number is required)
- Validation checks:
  - Completeness
  - Format (e.g. MM/DD/YYYY)
  - Range (e.g. a number falls within a minimum and maximum value)
  - Check sum digit—reduces errors in entering numbers
  - Consistency—data are related
  - Database check—does not violate entity or referential integrity

Output Design

- Reports produced from the data generated by the system
- Basic principles:
  - Report usage and its frequency will affect its layout
  - Manage the information load in a report—provide only what is needed and place most important information near the top
  - Minimize bias, especially in graphical displays (charts)

Types of Outputs

- Detail reports—users need full information
- Summary reports—details are aggregated (e.g., sums, averages)
- Exception reports
- Turnaround documents—outputs turn around and become inputs
- Graphs—for easy visual comparison
- Media for reports can be electronic (seen on the screen) or hard copy (printed on paper)

Mobile Computing and UI Design

- Smaller devices have limited space, touch screens and haptic feedback
- Necessitate design from the ground up, not simply porting a web interface already designed for a larger computer
- Capabilities of devices varies widely and are used everywhere under highly variable conditions (ambient light and noise levels)

Suggestions for Mobile Design

- Focus on user needs, not user wants
- Remove all “fluff” from big websites
- Utilize the capabilities of the device (e.g., built-in GPS, accelerometers, etc.)
- Make things vertically scrollable, not horizontally
- Reduce interactions with the network to the extent possible
- Make use of reusable patterns (e.g., vertically stacking web pages)

Social Media and UI Design

- Social media presents alternative opportunities and challenges
  - Facebook, Twitter, Flickr™, YouTube™
  - Wikis, blogs
- Who is the target audience?
- What is the purpose of the application? (e.g., marketing channel)
- Which type of social media works best for your functional requirements?

Guidelines for Social Media

- Post and update information often
- Use a combination of push and pull approaches
- Keep your sites synchronized to the extent possible
- Allow customers to share your content
  - Provide a voting or "like" mechanism to encourage customers to become involved in your site
- Design the site for longer term engagement
- Build a sense of community—users "belong" to something
- Take into account international and cultural issues

International & Cultural Issues in UI Design

- Websites have a global presence
- Considerations:
  - Multilingual requirements
  - The meaning of certain colors
  - Cultural differences
    - Power distance
    - Uncertainty avoidance
    - Individualism vs. collectivism

Non-Functional Requirements

- Operational Requirements—choice of hardware and software platforms
  - Technologies that can be used (e.g. GUI, 2 or 3 button mouse)
- Performance Requirements
  - Mobile computing and web browsing inject additional performance obstacles
- Security Requirements
  - Appropriate log on controls and possibly encryption
  - Wireless networks are especially vulnerable
- Political & Cultural Requirements
  - Date formats, colors, and currencies

Summary

- Principles of User Interface Design
- User Interface Design Process
- Navigation Design
- Input Design
- Output Design
- Mobile Computing and UI Design
- Social Media and UI Design
- International & Cultural Issues and UI Design
- Nonfunctional Requirements