HCI Midterm Review

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Contents

Based on these slides

1 Chapter 1: Usability Goals and Measures

Intuitive software should achieve usability, universality, and usefulness via

1. Thoughtful planning
2. Sensitivity to user needs
3. Thorough requirements analysis
4. Design alternatives
5. Diligent testing
6. Extensive evaluations

The main goals of usability, universality, and usefulness are **high quality**, **dependable** software that leads to **enhanced user satisfaction**.

1.1 The Five Measures

Five usability measures central to community evaluation RESTS:

1. **Retention over time**: how well do users maintain their knowledge over time? Frequency of use and ease of learning increase user retention
2. **Error rate**: how many and what kinds of errors do users make during benchmark tasks?
3. **Speed of performance**: how long does it take to perform benchmark tasks?
4. **Time to learn**: how long does it take for typical members of the community to learn relevant tasks?
5. **Satisfaction**: how much did the users like the interface? Obtain subjective user feedback via interviews, free-form comments and satisfaction scales.

1.2 Trade-Offs

Design options frequently warrant trade-offs.

1. **Version consistency**: Changes to the interface in a new version may create consistency problems with the previous version, but the changes may improve the interface in other ways or introduce new needed functionality
2. **Prototype accuracy**: The basic tradeoff is getting feedback early and perhaps less expensively in the development process versus having a more authentic interface evaluated

Trade-offs are also needed between RESTS usability measures. Design alternatives can be evaluated by designers and users via mock-ups or prototypes

1.3 Interface Domains

1. Consumer electronics, e-commerce and social media
2. Home, games and entertainment applications
3. Professional environments
4. Life-critical systems
5. Exploratory, creative and collaborative systems
6. Socio-technical systems

1.4 Goals for Our Profession

1. Computer scientists aim to **provide tools**, techniques, and knowledge for system implementers
2. Well made contemporary tools can lead to **rapid prototyping**
3. Computer scientists use general or self-determined guideline **documentation** written for specific audiences
4. Computer scientists both create new and **improve existing systems** by using feedback from users
5. Accessible software **educates the public** by raising their computer consciousness
6. **Include novices** that are fearful due to experience with poor product design. Good software can encourage new users to take the time to learn. Good software is clear, competent, and non-threatening.

2 Chapter 2: Universal Design

Universal design revolves around designing technology that is equally usable to everyone irrespective of their individual, cultural, physical or cognitive differences.

Make an inaccessible accordion, go to jail. That's the law.

Some examples of legislation and legislative bodies that mandate accessibility

1. The **Rehabilitation Act, Section 508** that outlines accessibility requirements for developed and procured government software
2. The **Americans with Disabilities Act** which outlines accessibility requirements for government websites and public accommodations (e.g., stores, hotels, video rentals)
3. The **US Justice Department** outlines regulations for university websites and instructional materials
4. **European Union Mandate 376** outlines accessibility requirements for procured software

Those who don't follow these principles suffer loss of user base and risk of lawsuit. Approximately 16% of Earth's population suffers from a disability.

2.1 People Differ

1. **Physically**: Certain disabilities change the way that the user interacts with the world around them. Some differences include
   (a) Arousal and vigilance
   (b) Fatigue and sleep deprivation
   (c) Perceptual (mental) load
   (d) Knowledge of results and feedback
   (e) Monotony and boredom
   (f) Sensory deprivation
   (g) Nutrition and diet
   (h) Fear, anxiety, mood, and emotion
   (i) Drugs, smoking, and alcohol
   (j) Physiological rhythms
2. **Personality**-wise: While there is no way of categorizing peoples' personality for sure, there have been attempts. For example, the Meyers-Briggs Type Indicator measures extroversion vs. introversion, sensing vs. intuition, perceptive vs. judging, and feeling vs. thinking.
3. **Culturally**: The same symbol, color, or number can mean different things in different cultures. Some cultures read left to right while others read right to left. Differences include
   (a) Social-security, national identification, and passport numbers
   (b) Capitalization and punctuation
   (c) Sorting sequences
   (d) Icons, buttons, colors
   (e) Pluralization, grammar, spelling
   (f) Etiquette, policies, tone, formality, metaphors

3 Chapter 3: Guidelines, Principles, and Theories

1. **Guidelines** are low-level focused advice about good practices and cautions against dangers
2. **Principles** are mid-level strategies or rules to analyze and compare design alternatives
3. **Theories** are high-level widely applicable frameworks to draw on during design and evaluation, as well as to support communication and teaching. Theories can also be predictive, such as those for pointing times by individuals or posting rates for community discussions.

3.1 Guidelines

A guideline document helps by developing a shared language and promoting consistency among multiple designers (in terminology usage, UI appearance, and action sequences). Their critics claim that they're too specific, incomplete, hard to apply, and sometimes wrong. Their proponents point out that they encapsulate experience and contribute to improvements.

Guidelines are powerful. Make them well and everyone benefits.

3.1.1 Organizing the Display

Smith and Mosier (1986) offer five high-level goals

1. **Consistency** of data display (terminology, formats, colors, delimiters, capitalization)
2. **Efficient information** assimilation by the user / minimal input actions by user (justification, spacing, number of decimal points, appropriate units, comprehensible labels, abbreviations, etc.; avoid duplications)
3. **Minimal memory** load on the user
4. **Compatibility of data** display with data entry
5. **Flexibility** for user control of data display

3.1.2 Mobile Devices

Design constraints for mobile devices include

1. Smaller screen size
2. Touch data entry can cause errors
3. Battery-power limitations
4. Data download speed or access

Design guidelines for mobile devices

1. Ensure spatial consistency
2. Show high-level information
3. Minimize number of steps (taps)
4. Minimize data entry
5. Focus on goals and optimize tasks
6. Follow emerging standards from manufacturers

3.1.3 Attention Grabbing Traits

1. **Intensity**: use two levels only, with limited use of high intensity
2. **Marking**: underline the item, enclose it in a box, point it with an arrow, use an asterisk, bullet, dash, + or X sign
3. **Size**: use up to 4 sizes
4. **Choice** of font: use up to 3 fonts
5. **Blinking**: use this method cautiously [2-4 Hz]
6. **Color**: use up to 4 standard colors
7. **Animation**: use it only when meaningful
8. **Audio**: soft tones [regular] vs. harsh tones [emergency]

The traits above are like seasoning: use them in good combinations and with restraint and you'll cook a delicious curry. Put too much and it'll have an interesting taste.

3.1.4 Facilitate Data Entry

Follow these guidelines and the user won't even notice they're filling out a 1040:

1. Tend to **similar sequences** of actions as they speed up learning: fewer input actions mean greater operator productivity, and usually less error; avoid redundant data entry.
2. **Avoid memorization**: users should not be required to remember lengthy lists of codes
3. **Force desired input formats**: the format of data entry information should be linked closely to the format of displayed information, such as dashes in telephone numbers. If a user has to think about the datatype they're entering, re-think the interface.
4. **Tailor the interface to user knowledge** as experienced users prefer to enter information in a sequence that they can control, such as selecting the color first or size first, when clothes shopping

3.2 Principles

Principles are more fundamental, widely applicable, and more enduring than guidelines

Fundamentals:

1. Determine user's skill levels: "Know thy user"
2. Identify the tasks
3. Choose between 5 primary interaction styles
4. Apply 8 golden rules of interface design
5. Prevent errors: Make error messages **specific**, **positive** in tone, and **constructive**. Gray out inappropriate actions, have selection rather than freestyle typing, integrate automatic completion
6. Ensure human control while increasing automation

3.2.1 5 Primary Interaction Styles

1. Direct manipulation
2. Menu selection
3. Form fill-in
4. Command language
5. Natural language

3.2.2 The 8 Golden Rules of Interface Design

1. Strive for **consistency**
2. Cater to universal **usability**
3. Offer informative **feedback**
4. Design dialogs to yield **closure**
5. **Prevent errors**
6. Permit easy **reversal** of actions
7. Keep users in **control**
8. Reduce short term **memory load**

3.2.3 Automation

Supervisory control needs to deal with real world open systems e.g., air-traffic controllers with low frequency, but high consequences of failure. FAA: design should place the user in control and automate only to improve system performance, without reducing human involvement.

Goals for autonomous agents:

1. Know user's likes and dislikes
2. Make proper inferences
3. Respond to novel situations
4. Perform competently with little guidance
5. Tool-like interfaces vs. autonomous agents
6. Avatars representing human users, not computers, more successful

3.3 Theory

Theory supersedes the specifics of guidelines.

Some theories are descriptive (describe interfaces and their uses). They're **explanatory** (they describe sequences of actions), **prescriptive** (they offer guidelines to make decisions), and **predictive** (offer predictions, e.g., on speed or errors).

Some theories are based on human capacity. They're **motor** (which involves pointing, clicking, dragging, and other movements), **perceptual** (these are visual, auditory, and tactile), and **cognitive** (involving problem solving with short and long-term memory).

3.3.1 Action Theory

Norman's seven stages of action model

1. Forming the goal
2. Forming the intention
3. Specifying the action
4. Executing the action
5. Perceiving the system state
6. Interpreting the system state
7. Evaluating the outcome

Norman's contributions include the context of cycles of action and evaluation.

Gulf of **execution**: the mismatch between the user's intentions and the allowable actions
Gulf of **evaluation**: the mismatch between the system's representation and the users' expectations

3.3.2 Four principles of good design

1. State and the action alternatives should be **visible**
2. Have a good conceptual model with a **consistent system image**
3. Interface should include **good mappings** that reveal the relationships between stages
4. User should receive **continuous feedback**

3.3.3 Four critical points where user failures can occur

1. **No support**: users can form an inadequate goal
2. **Cryptic UI**: Might not find the correct interface object because of an incomprehensible label or icon
3. **Inexperience**: May not know how to specify or execute a desired action
4. **Bad response**: May receive inappropriate or misleading feedback

4 Chapter 4: Design

Design is the outcome or process of creating specifications for synthetic artifacts (manufactured objects). They're the software's form and function. Usability engineering has evolved into a recognized discipline with maturing practices and a growing set of standards.

4.0.1 Process

Rosson and Carroll (scenario-based) design philosophy:

1. Design is a process, not a state
2. The design process is nonhierarchical
3. The process is radically transformational
4. Design intrinsically involves the discovery of new goals

4.0.2 Frameworks

1. **User-centered** design (UCD) takes the needs, wants, and limitations of the actual end users into account during each phase of the design process
2. **Participatory** design (PD) sees the direct involvement of people in the collaborative design of the things and technologies they use
3. **Agile interaction** design involves development methods for self-organizing, dynamic teams and that facilitate flexible, adaptive, and rapid development that is robust to changing requirements and needs

4.0.3 Design Methods

Practical building techniques that form the actual day-to-day activities in the design process:

1. Ideation and creativity
2. Surveys, interviews and focus groups
3. Ethnographic observation
4. Scenario development and storyboarding
5. Prototyping

4.0.4 Interaction Design Pattern

1. **Model View Controller** (MVC) is an architectural pattern that governs how information should flow between three specific components in the interface: models that represent the state (e.g., a string for an input field or a number for a dial), views that render the state on the display (e.g., the text box or the spinner), and controllers that change the models (e.g., editing the string or increasing/decreasing the number) as well as the views (e.g., scrolling through a long document).
2. **Document Interface** involves many applications, allow opening more than one document at the same time. Document interface patterns capture different ways of managing multiple documents for an application:

(a) Single Document Interface (SDI)

(b) Multiple Document Interface (MDI)

(c) Tabbed Document Interface (TDI)

3. Web Application Page Architecture

   (a) **Multi-page** applications (MPA) involve the traditional way of building web applications. It uses multiple pages, one for each specific function in the application. However, the separate pages requires reloading for each page and may cause disruption in the user experience.

   (b) **Single-page** applications (SPA) fit on a single webpage — thus mimicking a desktop application, and require no reloading or mode changes — thereby making the user experience fluid and uninterrupted. Instead of page loads, the application state changes dynamically through communication with the web server using modern web technologies such as JavaScript, HTML, and CSS.

5 Chapter 5: User Experience

Designers can become so entranced with their creations that they may fail to evaluate them adequately, which results in the curse of knowledge.

5.0.1 The determinants of the evaluation plan

1. Stage of design (early, middle, late)
2. Novelty of project (well-defined vs. exploratory)
3. Number of expected users
4. Criticality of the interface (life-critical medical system vs. museum exhibit support)
5. Costs of product and finances allocated for testing
6. Time available
7. Experience of the design and evaluation team

5.0.2 Expert Reviews and Heuristics

1. Usability Testing and Laboratories
2. Survey Instruments
3. Acceptance Tests
4. Evaluation during Active Use and Beyond
5. Controlled Psychology Oriented Experiments

6 Chapter 7: Direct Manipulation and Immersive Environments

6.1 Introduction

Direct manipulation involves the dragging, dropping, and resizing of elements. It promotes ease of use and good, instant feedback – especially for new users. Immersive environments include virtual and augmented reality displays.

6.2 Attributes

1. Novices can learn basic functionality quickly, experts can work rapidly to carry out a wide range of tasks
2. Knowledgeable intermittent users can retain operational concepts
3. Error messages are rarely needed
4. Users immediately see whether their actions are furthering their goals
5. Experience less anxiety because the interface is comprehensible and because actions can be reversed easily
6. Multi-touch gestures expands the number of actions a user can perform
7. Gain a sense of confidence and mastery because they are the initiators of action and feel in control

6.3 Issues

1. Spatial or visual representations can be too spread out
2. High-level flowcharts and database-schema can become confusing
3. Designs may force valuable information off of the screen
4. Users must learn the graphical representations
5. The visual representation may be misleading
6. Typing commands with the keyboard may be faster

7 Chapter 10: Devices

7.1 Keyboards and Keypads

Text entry is one of the most common input tasks. The primary mode of text entry is still the keyboard, the most efficient text-entry mechanism. For rapid data entry, several keys can be pressed simultaneously, i.e. key chords and stenotyping.

7.2 Pointing Tasks and Control

1. **Select**: A choice from a set of items
2. **Position**: A point in an n-dimensional space
3. **Orient**: A direction in an n-dimensional space
4. **Path**: The definition of a series of positioning and orientation operations
5. **Quantify**: The specification of a numeric value
6. **Gesture**: The execution of an action via a predefined motion

7.2.1 Direct vs Indirect

Direct control involves input directly onto a display in the same physical space, i.e. touchscreens and styli. When using direct control, a user touches what they manipulate. It feels intuitive but can cause occlusion and fatigue.

Indirect control involves input from a mapped device, separate from display, i.e. mice, trackpads, and joysticks. It requires hand-eye coordination, is more comfortable for long use, and is more precise.

7.2.2 Absolute vs. Relative Mapping

Absolute mapping is where each point on the device corresponds directly to a point on the screen. For example, a stylus on a graphics tablet or a finger on a touchscreen. It's great for precision and spatial awareness.

Relative mapping involves movement changes position relative to current cursor location, for example using mice and trackpads. It allows unlimited scrolling and large movements in small space.

Applications of mappings include

1. **Digital Art and Design**: graphics tablets and stylus allow for high precision, pressure sensitivity
2. **Public Kiosks and ATMs**: touchscreens are intuitive, durable, low moving parts
3. **Gaming and Simulation**: joysticks, game controllers allow for multi-axis input + haptics
4. **Accessibility**: eye-trackers, foot controls, speech, and touch hybrids allow for inclusive pointing
5. **Mobile Devices**: multi-touch gestures like scroll, pinch, and rotate facilitate everyday tasks

7.2.3 Fitts' Law

Predicts hand movement time based on distance (D) and target size (W) Formula: $MT = a + b \log_2 \frac{2D}{W}$

Fitts' Law dictates that longer distances and smaller targets lead to slower selection while larger targets and shorter distances lead to faster selection. a and b are constants based on the device type, motion direction, target shape, and arm position in question.

7.2.4 Accessibilty Applications

1. **Large targets reduce selection time**: Bigger buttons and icons help users with motor impairments point more accurately.
2. **Minimize movement distance**: Position keys, buttons, or interactive elements close together to speed up interaction for users with limited mobility.
3. **Device choice affects efficiency**: Trackballs, joysticks, or touch-sensitive devices change the effective distance and precision, influencing Fitts's Law performance.
4. **Feedback aids precision**: Audio, tactile, or visual cues help users hit targets accurately, reducing errors predicted by Fitts's Law.

7.3 Displays

7.3.1 Properties

1. Physical size, usually dictated by diagonal dimension
2. Resolution
3. Number of available colors and color correctness
4. Luminance, contrast, and glare
5. Power consumption
6. Refresh rates (sufficient to allow animation and video)
7. Cost
8. Reliability

7.3.2 Characteristics

Usage characteristics distinguish display devices

1. Portability and privacy
2. Saliency (need to attract attention)
3. Ubiquity (ability to locate/use)
4. Simultaneity (number of simultaneous users)
5. Immersion

7.3.3 Technologies

1. **LCD** displays are energy efficient, have a light form factor, and have low energy requirements
2. **LED** displays offer a wide variety of colors and are frequently used in large public displays
3. **OLED** displays is a frontier technology as it affords flexible displays and higher contrast
4. **E-Ink** displays have a limited refresh rate and color range, but are extremely energy efficient and don't strain the eyes

8 Chapter 11: Communication and Collaboration

8.1 Models of Collaboration

1. **Focused partnership** involves a group of around 2-3 people who need to complete one task
2. **Lectures/Demos** involve one person sharing information to a group
3. **Conferences** involve many-to-many communication

8.2 Specific Goals and Contexts

People collaborate because doing so is satisfying or productive. Collaboration allows individuals to reap the **emotional rewards** of socializing and interacting with others, accomplish **greater goals** than they could alone, and **meet with people** that they otherwise could not.

8.3 Design Considerations

1. Cognitive Factors
   (a) Common Ground
   (b) Social Cues
   (c) Activity Awareness
   (d) Interruptions
2. Individual Factors
   (a) Privacy
   (b) Identity
   (c) Trust and Reputation
   (d) Motivation
   (e) Leadership
3. Collective Factors
   (a) Deviance
   (b) Moderation
   (c) Policies and Norms