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CSCC10H3: Human-Computer Interaction
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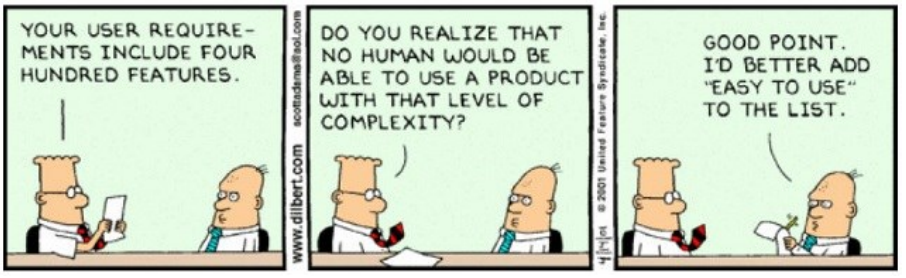
May 18, 2022

Lecture 2: Usability - Guidelines, Principles and Theories

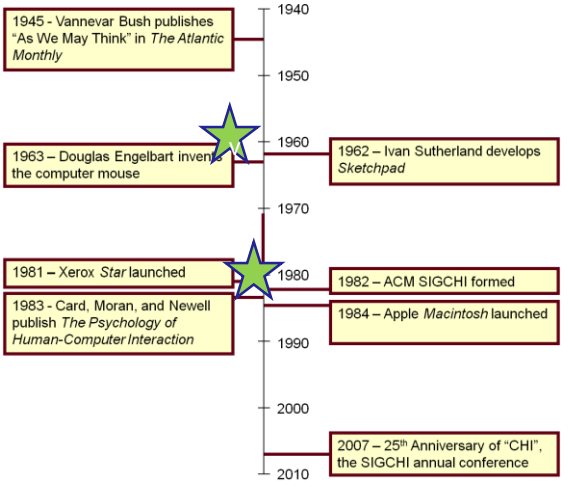


Administrivia

- Discussion Questions
  - Weekly Discussion Questions - respond before your next class (Wednesday before 12 pm).
- Project Phase I
  - Posted – Due: May 31, 2022
- This Week's Tutorial
  - Project and sample projects will be shown.
  - Form Groups/Fill out the form
- Any questions!

Recap

- Human-Computer Interaction
  - Introduction
  - History
  - Why study HCI?



The plan for today…

- Focus on Usability
  - Usability of Interactive Systems
  - Universal Usability
  - Guidelines, Principles and Theories

Slides from: Designing the User Interface: Strategies for Effective Human-Computer Interaction (6th ed.)

What is Usability?

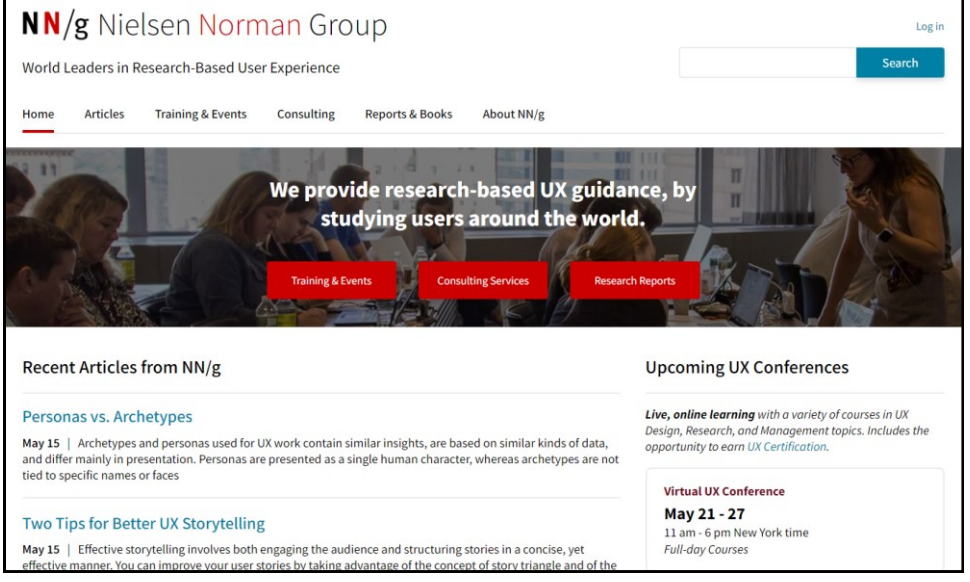
"Usability is a **quality attribute** that assesses how easy user interfaces are to use. The word "usability" also refers to methods for improving ease-of-use during the design process." *Jakob Nielsen*

- "the king of usability" (Internet Magazine)
- "the guru of Web page usability" (The New York Times)
- One of the "world's most influential designers" (Businessweek)

Jakob Nielsen holds a Ph.D. in human–computer interaction (HCI) from the Technical University of Denmark in Copenhagen.

Source: https://www.nngroup.com/people/jakob-nielsen/

https://www.nngroup.com/



What is Usability?

- **Usability** is one of the key concepts in HCI. It is concerned with making systems easy to learn and use.

- A **usable** system is:
  - easy to learn
  - easy to remember how to use
  - effective to use
  - efficient to use
  - safe to use
  - enjoyable to use

What is Usability?

Lynch & Horton (2009):

Usability is both a **qualitative** measure of the experience of using a tool and a phenomenon that can be measured and **quantified** as a concrete means to judge a design's effectiveness.

Quantitative Measure:

- How quickly we complete the tasks and how many errors we make in the process

Qualitative Measure:

- How much satisfaction we derive in using a tool
- How quickly we learn to use a tool
- How well we remember how to use it the next time

Why Usability is Important?

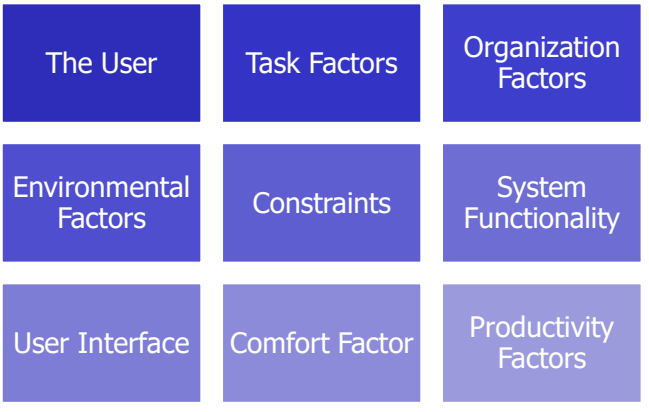
Nielsen's (2003):

On the Web, usability is a necessary condition for survival.

- If a website is difficult to use, people **leave**.
- If the homepage fails to clearly state what a company offers and what users can do on the site, people **leave**.
- If users get lost on a website, they **leave**.
- If a website's information is hard to read or doesn't answer users' key questions, they **leave**.

- What does it mean?
  - Spending ~10% of your project budget on Usability!

Factors to consider!



Usability Goals & Measures

Successful designers:

- go beyond vague notions of "user friendliness", "intuitive", and "natural" doing more than simply making checklists of subjective guidelines
- have a thorough understanding of the diverse community of users and the tasks that must be accomplished
- Study evidence-based guidelines and pursue the research literature when necessary
- US Web Design Standards

Usability Goals & Measures

- Ensure reliability
  - Actions must function as specified
  - Database data displayed must reflect the actual database
  - Appease the user's sense of mistrust
  - The system should be available as often as possible
  - The system must not introduce errors
  - Ensure the user's privacy and data security by protecting against unwarranted access, destruction of data, and malicious tampering

Usability Goals & Measures

- Promote standardization, integration, consistency, and portability
  - ***Standardization***: use pre-existing industry standards where they exist to aid learning and avoid errors (e.g. the W3C and ISO standards)
  - ***Integration***: the product should be able to run across different software tools and packages (e.g. Unix)
  - ***Consistency***:
    - compatibility across different product versions
    - compatibility with related paper and other non-computer based systems
    - use common action sequences, terms, units, colors, etc. within the program
  - ***Portability***: allow for the user to convert data across multiple software and hardware environments

Usability Goals & Measures

- Define the target **user** community and class of **tasks** associated with the interface
- 5 human factors central to community evaluation:
  - ***Time to learn***
    How long does it take for typical members of the community to learn relevant task?
  - ***Speed of performance***
    How long does it take to perform relevant benchmarks?
  - ***Rate of errors by users***
    How many and what kinds of errors are made during benchmark tasks?
  - ***Retention over time***
    Frequency of use and ease of learning help make for better user retention
  - ***Subjective satisfaction***
    Allow for user feedback via interviews, free-form comments and satisfaction scales

Usability Goals & Measures

Universal Usability

Topics

1. Variations in physical abilities and physical workplaces
2. Diverse cognitive and perceptual abilities
3. Personality differences
4. Cultural and international diversity
5. Users with disabilities
6. Older adult users
7. Children

1. Variation in Physical Abilities & Physical Workplaces

- There is no average user, either compromises must be made or multiple versions of a system must be created
- Account for variances of the user population's sense perception
  - Vision: depth, contrast, color blindness, and motion sensitivity
  - Touch: keyboard and touchscreen sensitivity
  - Hearing: audio clues must be distinct
- Workplace design can both help and hinder work performance

2. Diverse cognitive and perceptual abilities

- The human ability to interpret sensory input rapidly and to initiate complex actions makes modern computer systems possible
- The journal Ergonomics Abstracts offers this classification of human cognitive processes:
  - Long-term and semantic memory
  - Short-term and working memory
  - Problem solving and reasoning
  - Decision making and risk assessment
  - Language communication and comprehension
  - Search, imagery, and sensory memory
  - Learning, skill development, knowledge acquisition, and concept attainment

3. Personality Differences

- There is no set taxonomy for identifying user personality types
- Designers must be aware that populations are subdivided and that these subdivisions have various responses to different stimuli
- Myers-Briggs Type Indicator (MBTI)
  - extroversion vs. introversion
  - sensing vs. intuition
  - perceptive vs. judging
  - feeling vs. thinking

4. Cultural and International Diversity

- Characters, numerals, special characters, and diacriticals
- Left-to-right versus right-to-left versus vertical input and reading
- Date and time formats
- Numeric and currency formats
- Weights and measures
- Telephone numbers and addresses
- Names and titles (Mr., Ms., Mme.)
- Social-security, national identification, and passport numbers
- Capitalization and punctuation
- Sorting sequences
- Icons, buttons, colors
- Pluralization, grammar, spelling
- Etiquette, policies, tone, formality, metaphors

4. Cultural and International Diversity (cont'd)

Designing for cell phones can open the door to a wider audience, e.g. in developing countries where:

- feature phones often are the only way to access the internet
- literacy may be an issue
- users have very low monthly limits on the data volume they can use

5. Users with Disabilities

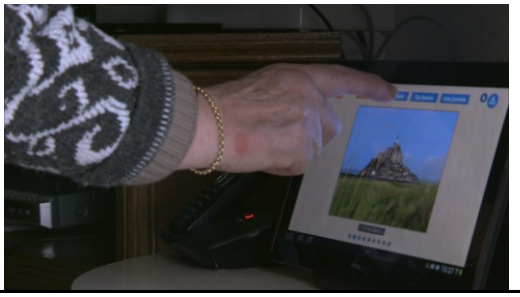
- Designers must plan early to accommodate users with disabilities (cost efficient)
- Businesses must comply with the Disabilities Act
- Growing world-wide support

A user with disability is using a television with the help of assistive technology

United Nations Convention on the Rights of Persons with Disabilities (CRPD), an international human rights agreement (http://www.un.org/disabilities/convention/conventionfull.shtml)

6. Older Adult Users

- As the world's population ages, designers in many fields are adapting their work to serve older adults, which can benefit all users
- Designers should allow for variability within their applications via settings for sound, color, brightness, font sizes, etc. with less distracting animation



7. Children

Source: http://www.freemake.com/blog/kids-and-gadgets/

Exercise 1

In your groups, explore the "Raising the Floor" website:

[https://raisingthefloor.org/]

Discuss the different features it offers and the different types of users the website caters to?

Is there anything that you would change about the website?

Guidelines, Principles and Theories

Guidelines: Low-level focused advice about good practices and cautions against dangers.

Principles: Mid-level strategies or rules to analyze and compare design alternatives.

Theories: 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.

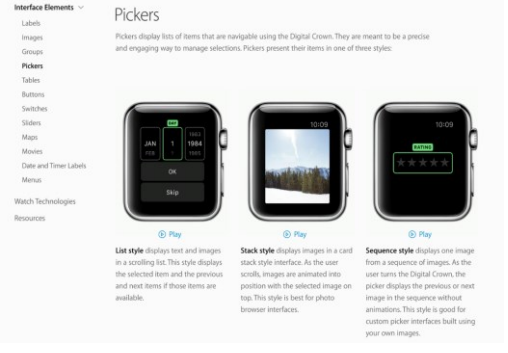
Guidelines

- Shared language to promote consistency among multiple designers in terminology usage, appearance, and action sequences
- Based on best practices
- Pros
  - Contribute to steady improvements
- Cons
  - Too specific, incomplete, hard to apply, and sometimes wrong

Guidelines (cont'd)

- The early Apple and Microsoft guidelines, which were influential for desktop-interface designers, have been followed by dozens of guidelines documents for the Web and mobile devices

Example of Apple guidelines for designing menus for the iWatch:



Accessibility Guidelines

Sample Guidelines:

- Provide a *text equivalent* for every non-text element
- For any *time-based multimedia* presentation, synchronize equivalent alternatives
- Information conveyed with *color* should also be conveyed without it
- Title each frame to facilitate identification and navigation

References:

- U.S. Access Board
  - http://www.access-board.gov/508.htm
- World Wide Web Consortium (W3C)
  - http://www.w3.org/TR/WCAG20/
- Web Aim
  - http://webaim.org/

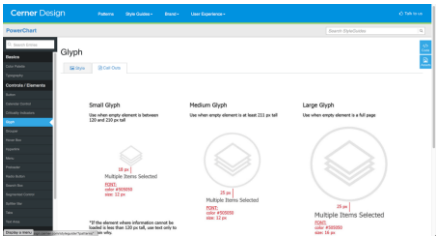
Mobile HCI Guidelines

- Design constraints
  - Smaller screen size
  - Touch data entry can cause errors
  - Battery-power limitations
  - Data download speed or access
- Design Guidelines
  - Spatial consistency
  - Show high-level information
  - Minimize number of steps (taps)
  - Minimize data entry
  - Focus on goals and optimize tasks
  - Emerging standards from manufacturers

Data Entry Guidelines

- Consistency of data-entry transactions
- Minimal input actions by user
- Minimal memory load on users
- Compatibility of data entry with data display
- Flexibility of user control of data entry

(Smith and Mosier, 1986)



Navigating the Interface

- National Cancer Institute (2006)
  - 388 guidelines to assist gov't agencies website design
  - Some examples:
    - Standardized task sequences
    - Embedded links should be descriptive
    - Headings should be unique and descriptive
    - Radio button for mutually exclusive choices
    - Pages should print properly
    - Thumbnail images to preview larger images

Principles

- More fundamental, widely applicable, and enduring than guidelines
- Need more clarification
- Fundamental principles
  - Determine user's skill levels (USERS)
  - Identify the tasks (TASKS)
- 5 primary interaction styles
- 8 golden rules of interface design

Determine User's Skill Levels

- "Know thy user"
- Age, gender, physical and cognitive abilities, education, cultural or ethnic background, training, motivation, goals and personality
- Design goals based on skill level
  - Novice or first-time users
  - Knowledgeable intermittent users
  - Expert frequent users
- Multi-layer designs

Identify the Tasks

- **Task Analysis** usually involve long hours observing and interviewing users
- Decomposition of high level tasks
- Relative task frequencies:
  - Frequent
  - Less frequent
  - Infrequent

Identify the Tasks (cont'd)

	TASK				
Job Title	Query by Patient	Update Data	Query across Patients	Add Relations	Evaluate System
Nurse	**	**			
Physician	**	*			
Supervisor	*	*	**		
Appointment personnel	****				
Medical-record maintainer	**	**	*	*	
Clinical researcher			***		*
Database programmer		*	**	**	*

FIGURE 3.3

Frequency of Task By Job Title

Hypothetical frequency-of-use of data for a medical clinic information system. Answering queries from appointment personnel about individual patients is the highest-frequency task (****), and lower-frequency use is shown with ***, **, or *.

Choose an Interaction Style

- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Advantages	Disadvantages
Direct manipulation	
Visually presents task concepts	May be hard to program
Allows easy learning	May require graphics display and pointing devices
Allows easy retention	
Allows errors to be avoided	
Encourages exploration	
Affords high subjective satisfaction	
Menu selection	
Shortens learning	Presents danger of many menus
Reduces keystrokes	May slow frequent users
Structures decision making	Consumes screen space
Permits use of dialog-management tools	Requires rapid display rate
Allows easy support of error handling	
Form fill-in	
Simplifies data entry	Consumes screen space
Requires modest training	
Gives convenient assistance	
Permits use of form-management tools	
Command language	
Flexible	Poor error handling
Appeals to "power" users	Requires substantial training and memorization
Supports user initiative	
Allows convenient creation of user-defined macros	
Natural language	
Relieves burden of learning syntax	Requires clarification dialog
	May not show context
	May require more keystrokes
	Unpredictable

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

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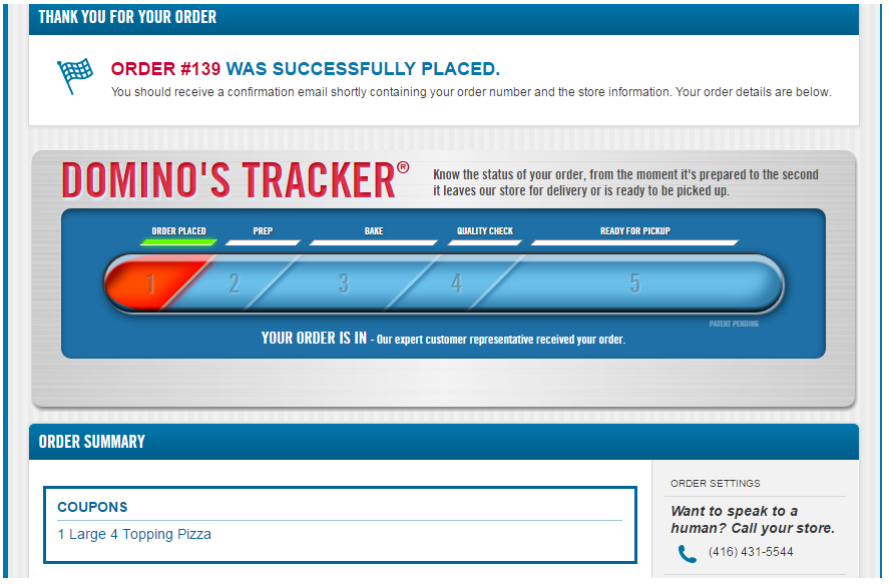

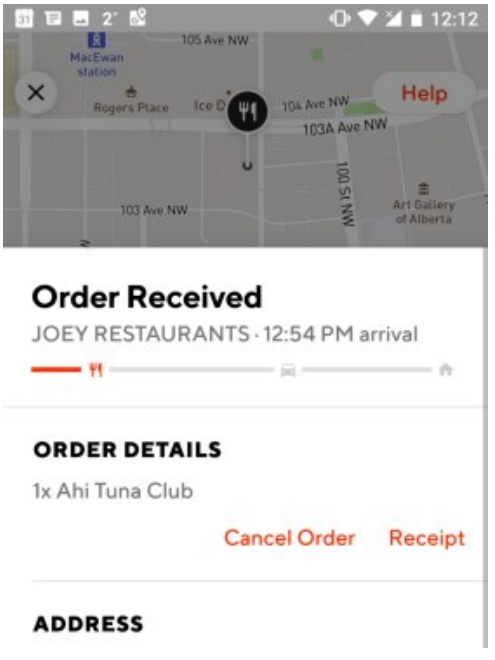

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Theories

- Beyond the specifics of guidelines
- Principles are used to develop theories
- Some theories are:
  - **Descriptive** - Develop consistent terminology for objects and actions
  - **Explanatory** - Describe sequences of events and cause and effect
  - **Prescriptive** - Give designers clear guidance for their choices
  - **Predictive** -Enable designers to compare proposed designs for execution times and error rates

Design-by-levels Theories

Foley and van Dam* four-level approach

- *Conceptual level:*
  - User's mental model of the interactive system
- *Semantic level:*
  - Describes the meanings conveyed by the user's command input and by the computer's output display
- *Syntactic level:*
  - Defines how the units (words) that convey semantics are assembled into a complete sentence that instructs the computer to perform a certain task
- *Lexical level:*
  - Deals with device dependencies and with the precise mechanisms by which a user specifies the syntax

Approach is convenient for designers

- Top-down nature is easy to explain
- Matches the software architecture
- Allows for useful modularity during design

Stages-of-action Theories

Norman's seven stages of action (1988)

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 (4 principles of good design)

1. State and action should be visible
2. Good conceptual model with consistent system image
3. Interface should include good mappings that reveal the relationship between stages
4. Users should receive continuous feedback.

Consistency Theories

Consistent user interface goal

Inconsistent action verbs

Take longer to learn, cause more errors, slow down users, and are harder for users to remember

Contextual Theories

Micro-HCI Theories

Focus on measurable performance (such as speed and errors) on multiple standard tasks taking seconds or minutes in laboratory environments

- Design-by-levels
- Stages of action
- Consistency

Macro-HCI Theories

Focus on case studies of user experience over weeks and months, in realistic usage contexts with rich social engagement

- Contextual
- Dynamic

Next Class

User-Centered Design (UCD)

UCD is a method for achieving usability!