Lecture 1
Introduction & Overview

2110646 User Interface Design

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Introduction

- 3W1H
  - What?
  - Who?
  - Why?
  - How?

What is involved?

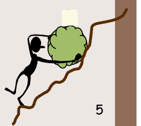
- What is involved in UI?
  - H/W
  - Behavior of S/W
  - Supporting Documentation

Who Builds Interfaces?

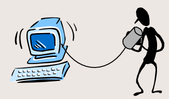
- A team of specialists (ideally)
  - graphic designers
  - interaction / interface designers
  - technical writers
  - marketers
  - test engineers
  - software engineers
  - customers

Why Study User Interfaces?

- Major part of work for "real" programs
  - approximately 50%
- You will work on "real" software
  - intended for people other than yourself
- Bad user interfaces cost
  - money (5%↑ satisfaction -> up to 85%↑ profits)
  - lives (Therac-25)
- User interfaces hard to get right
  - people are unpredictable



Human-Computer Interaction (HCI)



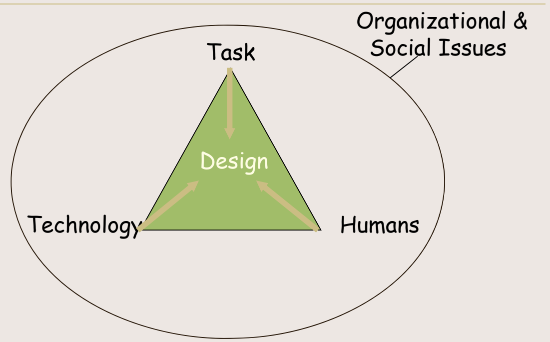
- Human
  - the end-user of a program
  - the others in the organization
- Computer
  - the machine the program runs on
  - often split between clients & servers
- Interaction
  - the user tells the computer what they want
  - the computer communicates results

Definition of HCI

Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.

[ACM SIGCHI Curricula for Human-Computer Interaction]

What is HCI?



About HCI: Interdisciplinary area

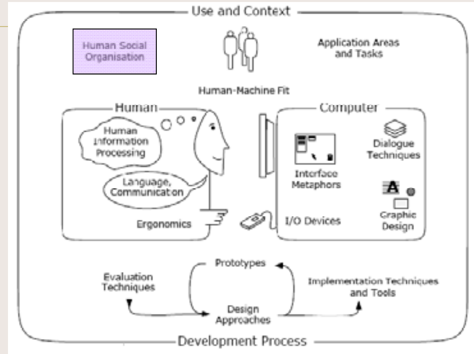
- computer science
  - application design and engineering of human interfaces
- psychology
  - the application of theories of cognitive processes and the empirical analysis of user behavior
- sociology and anthropology
  - interactions between technology, work, and organization
- industrial design
  - interactive products
- art and graphic design
  - user interface design
- and more …

Concerns in HCI

- the joint performance of tasks by humans and machines
- the structure of communication between human and machine
- human capabilities to use machines
- algorithms and programming
- software engineering concerns
  - –specification, design, and implementation of interfaces
- and design trade-offs.

Human-computer interaction thus has science, engineering, and design aspects.

The nature of HCI



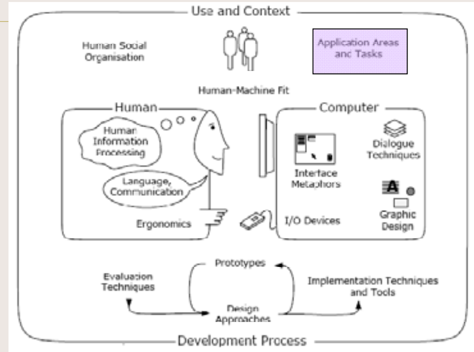
Human Social Organization

- interacting social being.
  - nature of work
- Points of view
  - e.g., industrial engineering, operations research, etc.
- Models of human activity
  - e.g., opportunistic planning, open procedures

Human Social Organization

- Models of small-groups, organizations
- Models of work, workflow, cooperative activity, office work
- Socio-technical systems,
- Quality of work life and job satisfaction

The nature of HCI



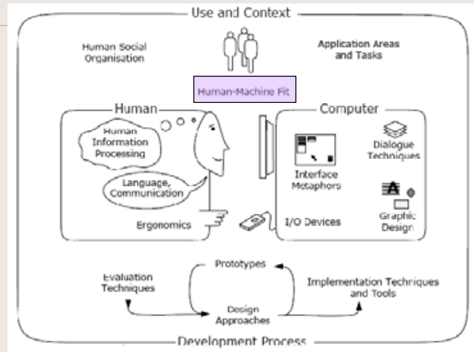
Application Areas and Tasks

- Classes of application domains and areas.
- Characterization of application areas
  - e.g., individual vs. group, paced vs. unpaced
- Document-oriented interfaces:
  - Text-editing, document formatting, illustrators, spreadsheets, hypertext
- Communications-oriented interfaces:
  - Electronic mail, computer conferencing, telephone and voice messaging systems

Application Areas and Tasks

- Design environments:
  - programming environments, CAD/CAM
- On-line tutorial systems and help systems
- Multimedia information kiosks
- Continuous control systems:
  - process control systems, virtual reality systems, simulators, cockpits, video games
- Embedded systems:
  - Copier controls, elevator controls, consumer electronics and home appliance controllers (e.g., TVs, VCRs, microwave ovens, etc.)

The nature of HCI



Human-Machine Fit

- To arrange a fit between the designed object and its use.
- Several dimensions to this fit
  - (1) either at design time or at time of use
  - (2) by either changing the system or the user and
  - (3) the changes can be made by either the users themselves or, sometimes, by the system.
- To improve its fit.

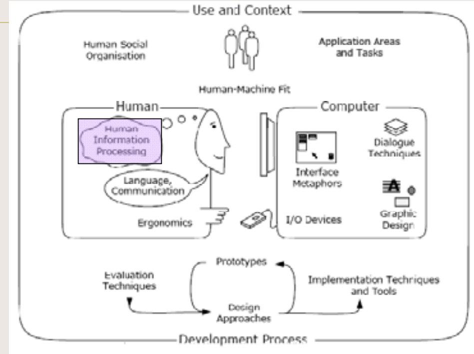
Human-Machine Fit

- Alternate techniques for achieving fit
- Nature of adaptive systems, adaptations of human systems
- System selection: theories of system adoption

Human-Machine Fit

- System adaptation:
  - customization and tailorability techniques
- User selection:
  - compatibilities of user and system characteristics
- User adaptation:
  - ease of learning, training methods (e.g., on-line tutorials), relation to system design
- User guidance:
  - help techniques, documentation, error-handling techniques

The nature of HCI



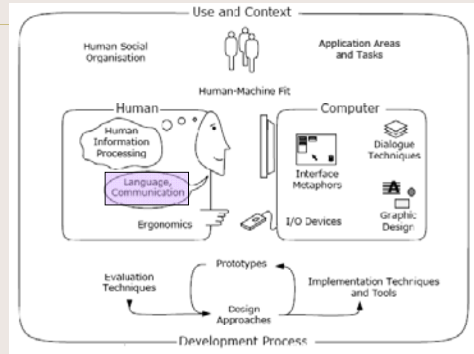
Human Information Processing

- processor of information.
- Cognitive architecture model:
  - symbol-system models,
  - connectionist models,
  - engineering models
- Theories of
  - memory
  - perception
  - motor skills attention

Human Information Processing

- Theories of
  - problem solving
  - learning and skill acquisition
  - motivation
- Users' conceptual models
- Human action models
- Human diversity, including disabled populations

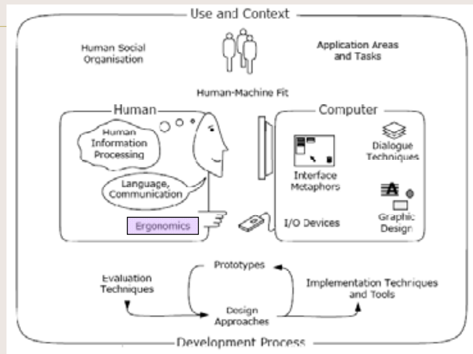
The nature of HCI



Language, Communication

- Language as a communication and interface medium. Communication phenomena.
- Aspects of language: syntax, semantics, pragmatics
- Formal models of language

The nature of HCI



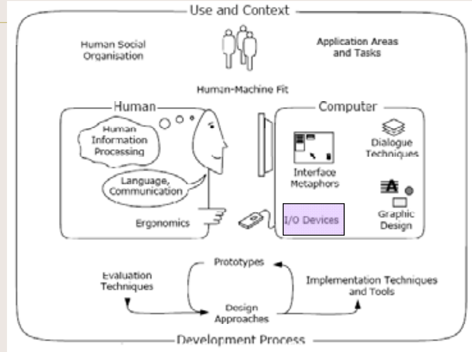
Ergonomics

- Anthropometric and physiological characteristics of people and their relationship to workspace and environmental parameters.
  - workspace design
  - Arrangement of displays and controls, link analysis
  - Human cognitive and sensory limits
  - Sensory and perceptual effects of CRT and other display technologies, legibility, display design

Ergonomics

- Control design
- Fatigue and health issues
- Furniture and lighting design
- Temperature and environmental noise issues
- Design for stressful or hazardous environments
- Design for the disabled

The nature of HCI



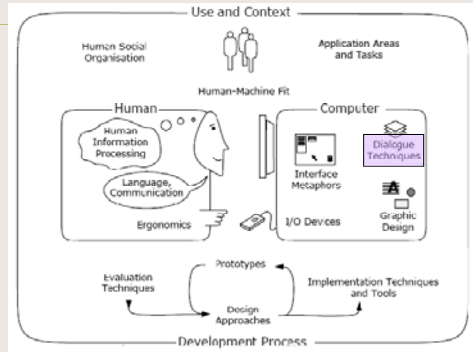
Input and Output Devices

- The technical construction of devices for mediating between humans and machines.
- Input devices:
  - survey,
  - mechanics of particular devices,
  - performance characteristics (human and system),
  - devices for the disabled,
  - handwriting and gestures,
  - speech input,
  - eye tracking,
  - exotic devices (e.g., EEG and other biological signals)

Input and Output Devices

- Output devices:
  - survey,
  - mechanics of particular devices,
  - vector devices,
  - frame buffers and image stores,
  - event handling, performance characteristics,
  - devices for the disabled,
  - sound and speech output,
  - 3D displays, motion (e.g., flight simulators), exotic devices
- Characteristics of input/output devices
  - e.g., weight, portability, bandwidth, sensory modality
- Virtual devices

The nature of HCI



Dialogue Techniques

Dialogue Inputs:

- Types of input purposes
  - e.g., selection, discrete parameter specification, continuous control
- Input techniques:
  - keyboard techniques
    - e.g, commands, menus
  - mouse-based techniques
    - e.g., picking, rubber-band lines
  - pen-based techniques
    - e.g., character recognition, gesture
  - voice-based techniques

Dialogue Techniques

Dialogue Outputs:

- Types of output purposes
  - e.g., convey precise information, summary information, illustrate processes, create visualizations of information
- Output techniques
  - e.g., scrolling display, windows, animation, sprites, fish-eye displays
- Screen layout issues
  - e.g., focus, clutter, visual logic

Dialogue Techniques

Dialogue Interaction Techniques:

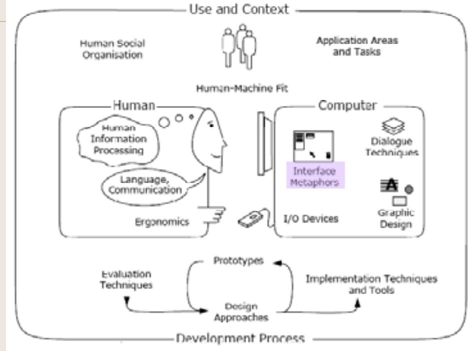
- Dialogue type and techniques
  - e.g., alphanumeric techniques, form filling, menu selection, icons and direct manipulation, generic functions, natural language
- Navigation and orientation in dialogues, error management
- Multimedia and non-graphical dialogues:
  - speech input, speech output, voice mail, video mail, active documents, videodisc, CD-ROM
- Agents and AI techniques
- Multi-person dialogues

Dialogue Techniques

Dialogue Issues:

- Real-time response issues
- Manual control theory
- Supervisory control, automatic systems, embedded systems
- Standards
- "Look and feel," intellectual property protection

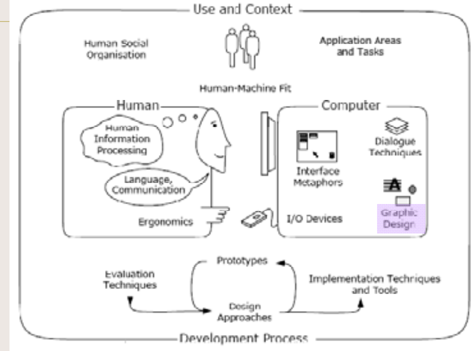
The nature of HCI



Interface Metaphors

- Interaction metaphors
  - e.g., tool metaphor, agent metaphor
- Content metaphors
  - e.g., desktop metaphor, paper document metaphor
- Persona, personality, point of view
- Workspace models
- Transition management
  - e.g., fades, pans
- Relevant techniques from other media
  - e.g., film, theater, graphic design
- Style and aesthetics

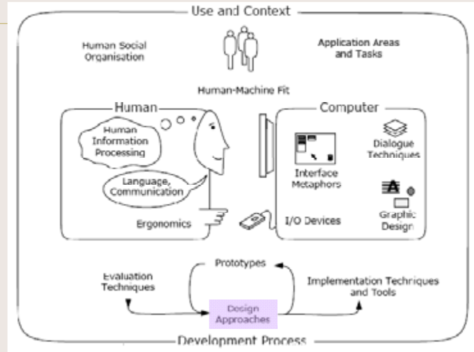
The nature of HCI



Graphics Design

- Basic concepts from computer graphics that are especially useful to know for HCI.
- Geometry in 2- and 3- space, linear transformations
- Graphics primitives and attributes:
  - bitmap and voxel representations, raster-op, 2-D primitives, text primitives, polygon representation, 3-D primitives, quadtrees and octtrees, device independent images, page definition languages
- Solid modeling, splines, surface modeling, hidden surface removal, animation, rendering algorithms, lighting models
- Color representation, color maps, color ranges of devices

The nature of HCI



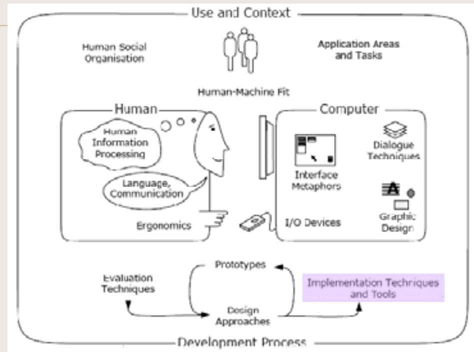
Design Approaches

- Graphic design basics
  - e.g., design languages, typography, use of color, 2D & 3D spatial organization, temporal sequencing, etc.
- Alternative system development processes
  - e.g., waterfall model, participatory design,
  - lifecycle model, iterative design, choice of method under time/resource constraint
- Task analysis techniques
  - e.g., field studies, analytical methods, task allocation, market analysis

Design Approaches

- Design specification techniques
- Design analysis techniques
  - e.g., objects and actions
- Industrial design basics
- Design case studies and empirical analyses of design

The nature of HCI



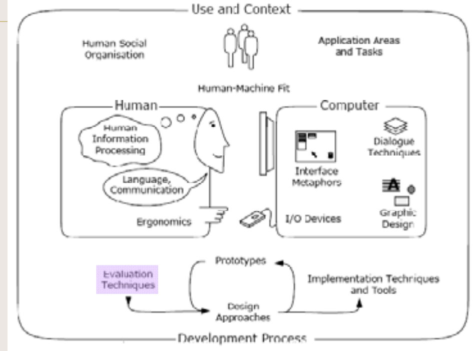
Implementation Techniques and Tools

- Tactics and tools for implementation.
- Relationships among design, evaluation, and implementation
- Independence and reusability, application independence, device independence

Implementation Techniques and Tools

- Prototyping techniques
  - e.g., storyboarding, video, "Wizard of Oz", HyperCard, rapid prototype implementations
- Dialogue toolkits
  - e.g., MacApp, NextStep, UIMS's, HyperCard
- Object-oriented methods
- Data representation and algorithms

The nature of HCI



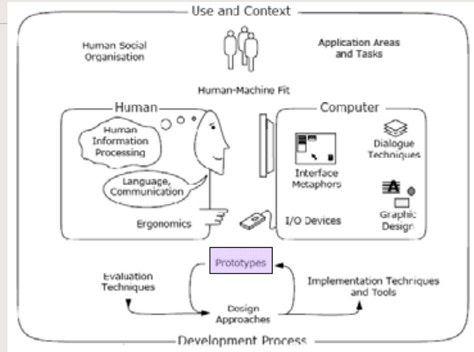
Evaluation Techniques

- Philosophy and specific methods for evaluations.
- Productivity
- Evaluation without user
  - cognitive walkthrough
  - usability heuristics and guidelines
- Figures of merit
  - e.g., time, errors, learnability, design for guessing, preference, etc.

Evaluation Techniques

- Usability testing techniques, linking testing to specifications
- Empirical evaluation
  - field observation methods,
  - participant observation,
  - interviewing techniques,
  - questionnaire design,
  - psychometric methods,
  - video protocols,
  - system logging,
  - experiment design
    - e.g, concern with sample bias, etc.

The nature of HCI



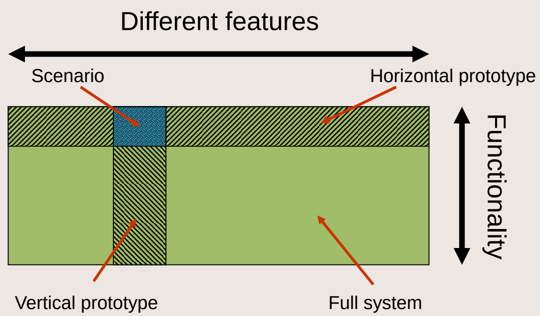
Prototypes

- Verbal prototypes
  - textual description of choices and results
- Paper mock-ups
  - sketches of screen designs
  - printouts of screen designs
- Interactive sketches
  - interactive composition of hand-drawn sketches
- Working prototypes
  - interactive

Prototypes

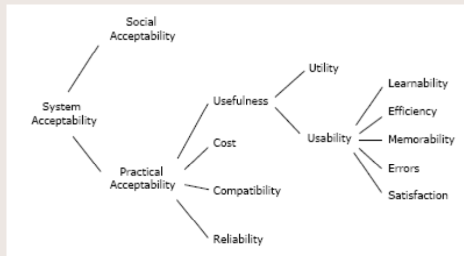
- Horizontal prototypes
  - reduce the level of functionality
- Vertical prototypes
  - cutting down the number of features

Prototypes



Goal of HCI

- Usability



Usability

- Learnability
  - ease of learning for novice users
- Efficiency
  - steady state performance of expert users
- Memorability
  - ease of using system intermittenly for casual users
- Errors
  - low error rate
- Subject Satisfaction
  - how pleasant system is to use

Usability Considerations

- Who are the users, what do they know, and what can they learn?
- What do users want or need to do?
- What is the general background of the users?
- What is the context in which the user is working?
- What has to be left to the machine? What to the user?

Other considerations

- Can users easily accomplish their intended tasks?
- How much training do users need?
- Documentation and support.
- Errors
- Error recovery

Usability problems

- Defect types
  - Program error (bug)
  - Missing functionality
  - Ease-of-use problem

Usability problems examples		
P1	Cannot figure out how to start the search. Finally finds out to use F10.	
P2	Believes he has completed the task, but forgot to press Update.	
P3	Sees the discount cod field, but cannot figure out which code to use.	
P4	Says it is craze to use six screen to fill in 10 fields	
P5	Wants to print a list of discount codes, but the system cannot do it.	

Severity classes

- Missing functionality
- Task failure
- Annoying
- Medium problem
- Minor problem

Measurements

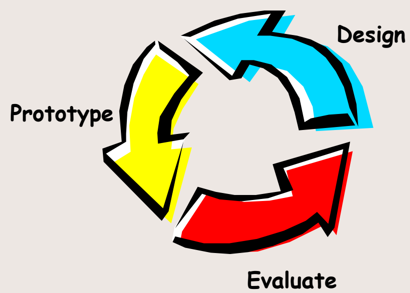
- Task time
- Problem counts
- Keystroke counts
- Opinion polls
- Etc.

"There is little correlation between subjective satisfaction and objective performance. "

Keys to Designing & Building Successful Interfaces

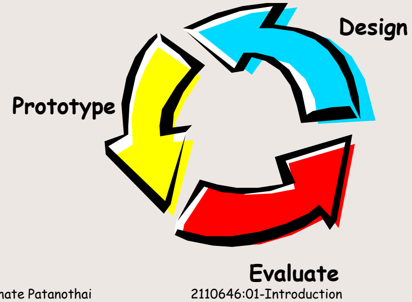
- Design cycle
- Customer-centered design
- Task analysis & contextual inquiry
- Rapid prototyping
- Evaluation
- Programming
- Iteration

Interface Design Cycle



Iteration

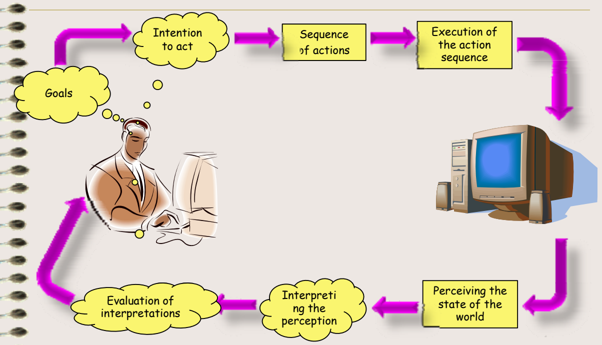
At every stage!



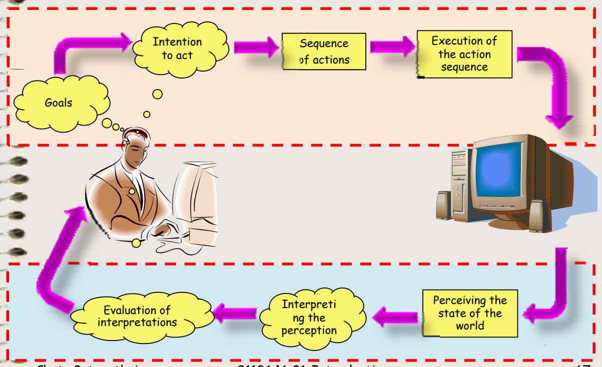
Donald Norman's model

- Seven stages
  - forming the goal
  - forming the intention
  - specifying the actions at interface
  - executing the action
  - perceiving the system state
  - interpreting the system state
  - evaluating the outcome respect to goal
- Norman's model concentrates on user's view of the interface

Human Activity Cycle



Human Activity Cycle



Know the User

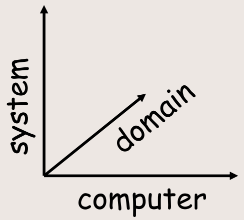
- who?
- characteristics?

Categories of User

- Novice User of System vs. Expert User of System
- Minimal Computer Experience vs. Extensive Computer Experience
- Ignorant about Domain vs. Knowledgeable about Domain

  * Difference between individual user is very high.

Categories of User



Types of user

- Novice
- Intermittent
- Expert

Accommodation of Human Diversity

- Physical abilities and physical workplaces
  - There is no average user
  - Physical measurement of human dimensions are not enough,
  - Dynamic measurement needed, e.g., reach, strength, or speed
  - Vision: depth, contrast, color blindness, and motion sensitivity
  - Touch: keyboard and touchscreen sensitivity
  - Hearing: audio clues must be distinct
  - Workplace design

Accommodation of Human Diversity

- Cognitive and perceptual abilities
  - Cognitive process/central process
    - short-term memory
    - long-term memory and learning
    - problem solving
    - decision making
    - attention and set
    - search and scanning
    - time perception

Accommodation of Human Diversity

- Cultural and international diversity
  - Characters, numerals, special characters
  - Left-to-right versus right-to-left versus vertical input and reading
  - Date and time formats
  - Weights and measures
  - Telephone numbers addresses

Accommodation of Human Diversity

- Cultural and international diversity
  - Names and titles
  - Social-security, national ID, and passport numbers
  - Capitalization and punctuation
  - Sorting sequences
  - Icons, buttons, colors
  - Pluralization, grammar, spelling

Accommodation of Human Diversity

- Users with disabilities
  - Designers must plan early to accommodate user with disabilities
  - Early planning is more cost efficient than adding later
- Elderly Users
  - Including the elderly is fairly ease, designers should allow for variability with in their applications via settings for sound, color, brightness, font size, etc.

Motivations for HF in Design

- Life-critical systems
  - Air traffic control, nuclear reactors, power utilities, police & fire dispatch systems
  - High costs, reliability and effectiveness are expected
  - Length training periods are acceptable provide error-free performance
  - Subject satisfaction is less an issue due to well motivated users memorability via frequent use and practice.

Motivations for HF in Design (2)

- Industrial and commercial uses
  - Banking, insurance, order entry, inventory management, reservation, billing, and POS systems
  - Lower cost may sacrifice reliability
  - Training in expensive, learning must be easy
  - Speed and error rates are relative to cost.

Motivations for HF in Design (3)

- Personal applications
  - Word processing, electronic mail, computer conferencing, and video game systems
  - Choosing functionality is difficult because of the wide range of users
  - Competition cause the need for low cost

Motivations for HF in Design (4)

- Exploratory, creative, and cooperative systems
  - Database, artist toolkits, statistical packages, and scientific modeling systems
  - Benchmarks are hard to describe due to the wide array of tasks
  - With these applications, the user can be absorbed in their task domain

Cost saving

- Rotary telephone dial, speeded up ~0.15 sec/digit, saving ~$1,000,000 in reduced demand on the central switches
- An Australian insurance company save A$536,023 from redesign its application form w/ less error

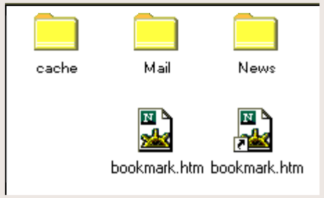
Cost saving

- A study of SE cost estimates showed that 63% of large project overran estimates
- 24 different reasons
- 4 highest responsibility relate to <u>usability engineering</u>
  - Frequent requests for changes
  - Overlooked tasks
  - Users' lack of understanding of their own requirements
  - Insufficient user analyst communication and understanding

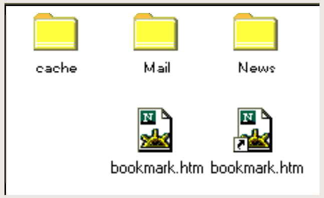
Project Description

- Groups
  - 3 students to a group
  - work with students w/ different skills/interests
- Proposal & 1st Prototype
  - Domain selection.
  - What & how?
- 2nd Prototype
  - After evaluations
- Final Prototype
  - Complete evaluations details

Interface Hall of Shame or Fame?



Interface Hall of Shame



- Hard to tell the difference between the two icons & names

Resources

- **HCI Bibliography** : Human-Computer Interaction Resources http://www.hcibib.org/
- Common Front Group at Cornell http://cfg.cit.cornell.edu/cfg/design/contents.html
- http://www.aw.com/DTUI/
- http://developer.java.sun.com/developer/techDocs/hi/jlf-home.html
- http://www.useit.com