HCI – Human Computer Interaction

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We could design the product with a simple point-and-click interface...

Or we could require the user to choose among thousands of poorly documented commands, each of which must be typed exactly right on the first try.

Bear in mind, we’ll never meet a customer ourselves.

Make it so they have to reboot after every typo.

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HCI – A Multi-disciplinary Subject

The ideal designer needs expertise in:

- Psychology and cognitive science
- Ergonomics
- Sociology
- Computer science and engineering
- Business
- Graphic design
- Technical writing
- …
No general and unified theory available

But there are four major issues of concern:
- the human,
- the computer,
- the tasks to be performed, and
- usability.
HCI Basics
Humans

- Limited in their capacity to process information
- Information is received and responses given via multiple I/O channels:
  - visual,
  - auditorial,
  - haptic,…
- Users share common capabilities but are individuals
- Emotion effects human capabilities
Computers

- screen, or monitor, on which there are windows
- keyboard
- mouse/trackpad

- variations
  - desktop
  - laptop
  - PDA

the devices dictate the styles of interaction that the system supports
If we use different devices, then the interface will support a different style of interaction
Interactions

- interaction models
  - translations between user and system
- ergonomics
  - physical characteristics of interaction
- interaction styles
  - the nature of user/system dialog
- context
  - social, organizational, motivational
Norman’s Interaction Model

1. Form the goal
2. Form the intention
3. Specify the action
4. Execute the action
5. Perceive the system state
6. Interpret the system state
7. Evaluate the outcome
Ergonomics

- Study of the physical characteristics of interaction
- Also known as human factors – but this can also be used to mean much of HCI!
- Ergonomics good at defining standards and guidelines for constraining the way we design certain aspects of systems
Ergonomics Examples

- arrangement of controls and displays
  e.g. controls grouped according to function or frequency of use, or sequentially

- surrounding environment
  e.g. seating arrangements adaptable to cope with all sizes of user

- health issues
  e.g. physical position, environmental conditions (temperature, humidity), lighting, noise,

- use of colour
  e.g. use of red for warning, green for okay, awareness of colour-blindness etc.
Interaction Styles

- command line interface
- Menus (e.g. OSD)
- natural language
- question/answer and query dialogue (e.g. SQL)
- form-fills and spreadsheets
- WIMP
- point and click
- three-dimensional interfaces
Interaction affected by social and organizational context

- other people
  - desire to impress, competition, fear of failure
- motivation
  - fear, allegiance, ambition, self-satisfaction
- inadequate systems
  - cause frustration and lack of motivation
Interaction Design

- Scenario/Task Design
- Navigation Design
- Screen Design and Layout
Architectural Patterns for User Interfaces
Model-View-Controller

View  Controller

Model

MVC
Presentation-Abstraction-Control

PAC

Presentation
Control
Abstraction

C
P
A
C
P
A
C
P
A
Hybrid Architectures

PAC - Amodeus

HMVC
User Interface Models
Significant Models

- Task models
- Cognitive models
- User models
- Domain models
- Context models
- Presentation models
- Dialog models
CHI ’97 Metamodel

Task Model

Business Model

Process

Architecture

Interactive System Model

Domain Model

User Interface

Functional Core

Internal Interface

Notation

Implementation

Traceability
Examples

Domain model

Task model

Multiple presentation models
**Glossary**

- **Scenarios**: “sequences of actions aimed at accomplishing some task goal”
- **Goals**: “partially specified states that the user considers desirable”
- **Functions**: “effects achieved by some entity”
- **Tasks**: “pieces of work that a person or other agent has to (or wishes to) perform”
Task Analysis

Goals:
- Elicit descriptions of what people do
- Represent those descriptions
- Predict difficulties, performance
- Measure learnability, transfer of knowledge between systems
- Evaluate systems against usability and/or functional requirements

Problem:
- Instantiate current tasks in new system, rather than redesigning flow of work to achieve desired higher-level function …
Types of Task Analysis

- Hierarchical Task Analysis (e.g. HTA, CTT)
- Cognitive Task Analysis (e.g. MHP – Model Human Processor)
- Modeling “how-to” knowledge (e.g. GOMS)
Hierarchical Task Analysis

- Graphical representation
- Decomposition of high level task into constituent subtasks, operations, plans, relationships
ConcurTaskTrees

- Focus on Activities
- Hierarchical Structure
- Graphical Syntax
- Rich set of temporal operators
- Task allocation
- Objects and task attributes
CTT – ConcurTaskTrees
Cognitive Task Analysis

- Inform the design process through application of cognitive theories
- Some tasks, actions are cognitive – define these
  - Examples:
    - decide which button to press
    - recall previously stored knowledge from memory
    - compare two objects
- Model the internal representation and processing that occurs for the purpose of designing tasks that can be undertaken more effectively by humans
Modeling “how-to” Knowledge

- “how to do it” knowledge
- Focuses on task to action mapping
- GOMS (Goals, Operations, Methods, Selection Rules) is most famous approach
A method to describe user tasks and how a user performs those tasks with a specific interface design

- Assumes error-free, goal-directed, and rational behavior
- Bridges task analysis with a specific interface design

Views humans as information processors

- Small number of cognitive, perceptual, and motor operators characterize user behavior

To apply GOMS:

- Analyze task to identify user goals (hierarchical)
- Identify operators to achieve goals
- Sum operator times to predict performance
- **Goals:** What a user wants to accomplish
- **Operators:** Cognitive or physical actions that change the state of the user or the system
- **Methods:** Groups of goals and operators
- **Selection rules:** Determine which method to apply
GOAL: CLOSE-WINDOW
. [select GOAL: USE-MENU-METHOD
  . MOVE-MOUSE-TO-FILE-MENU
  . PULL-DOWN-FILE-MENU
  . CLICK-OVER-CLOSE-OPTION
GOAL: USE-ALT-F4-METHOD
. PRESS-ALT-F4-KEYS]

For a particular user:

Rule 1: Select USE-MENU-METHOD unless another rule applies
Rule 2: If the application is GAME, select ALT-F4-METHOD
Envisioning New Tasks

Three task design concerns to keep in mind:

- **Effectiveness**: Designing tasks that meet real needs

- **Comprehension**: Designing concepts and services that your users can predict, understand

- **Satisfaction**: Designing tasks that are motivating and lead to feelings of accomplishment, satisfaction
Designing for Effectiveness

- Innovation is good, but how much is too much?
  - Build on what is already working well
  - Engage stakeholders in *cooperative design*

- What parts of a task to support via technology?
  - Leverage other aspects of the work context, both people and things (*distributed cognition*)

- Balance tendency toward general solutions with the needs of specific tasks
  - Predict and support exceptions, provide special cases for common or critical tasks
Designing for Comprehension

- Cannot directly observe comprehension
  - Must rely on users’ behaviors, reactions, comments
  - Make inferences about their mental models

- **Metaphors** play a crucial role in this
  - Designers explore metaphors to get new ideas
  - Users evoke metaphors to understand new concepts

- Try to leverage users’ existing knowledge
  - Anticipate and support analogical reasoning
  - But look for ways to “break” current understandings
Designing for Satisfaction

- Automate tedious tasks, but try not to remove sources of reward or accomplishment
  - Carefully examine sources of reward, maintain or enhance opportunities for feelings of achievement
  - Use the computer to make tasks more personal, more stimulating, more “fun”

- Balance the needs of individuals with those of the groups they work with
  - The people who do the most “work” when using a system may not be those who get the most “benefit”
Presentation Models

- Presentation model: describes the visual aspects of the interface. It is divided into Abstract presentation model and concrete presentation model.
  - Abstract presentation model provides an abstract view of an interface that is independent from the underlying concrete model.
  - Concrete Presentation model is the concrete instance of an interface which can be presented to a user; there may be many concrete instances of an abstract presentation model.
Example – Abstract Presentation Model
User Interface Design Processes
Typical HCI Development Phases

- User Identification
- Task Analysis
- User Concept Modeling
- Interaction Design
- Visual Design
- Usability Evaluation
Categories of HCI Design Processes

- Participatory Design
  - Nygaard 70’s
- Scenario- and Task-Based Design
  - Carroll, Paterno,…
- Use-Case-Based / Usage-Based Design
  - Constantine and Lockwood
- User-Centered Design
  - Norman and Draper 1986
Participatory Design

- Users are 1st class members in the design process
  - Active collaborators vs. passive participants
  - Work together with engineers
- Users considered subject matter experts
  - Know all about the work context
- Iterative process
  - Artifacts: task flows, task objects, GUI objects
  - All design stages subject to revision
- Examples: CARD, PICTIVE, METAPHOR
Participatory Design

Pros:
- users are excellent at reacting to suggested system designs (*designs must be concrete and visible*)
- users bring in important “folk” knowledge of work context (*knowledge may be otherwise inaccessible to design team*)
- greater acceptance for the system often results

Cons:
- hard to get a good pool of end users (*expensive, reluctance ...*)
- users are not expert designers (*don’t expect them to come up with design ideas from scratch*)
- the user is not always right (*don’t expect them to know what they want*)
Scenario/Task-Based Design

- Scenarios for user interactions
  - Focus on situations most likely to impact usability
  - Emphasize the mental experience of the users

- Scenarios used for:
  - Object identification
  - System’s functionality specification
  - Concrete user interface design

- Examples: SBD (Carroll), IDIOM, CTT
Usage-Centered Design

- Focus is on usage (work users are doing)
- Usage-centered design is a systematic, model-driven approach to improving product usability.
- A few simple but powerful models guide the user interface design toward a better fit with the real needs of users:
  - user roles,
  - tasks, and
  - interface content
- Examples: UI in RUP, Wisdom, Essential Use Cases
Primary Models in Usage-Centered Design

- **Operational Model** (environmental and contextual factors)
- **User Roles**
  - User-Role Map
- **Use Cases**
  - Use-Case Map
- **Context Model**
  - Navigation Map
- **Visual and Interaction Design**

- **Domain Model** (glossary, data model, or object-class model)
User-Centered Design

Main three factors:
- User studies to understand their needs
- Rapid paper prototyping to get user feedback for design iterations
- Usability testing

Examples: ISO 13407
User-Centered Design

ISO 13407: Human-centred design processes for interactive systems (1999)

1. plan the human centered process
2. specify the context of use
3. specify user and organizational requirements
4. produce design solution
5. evaluate designs against user requirements

complete
Comparison

- **User-Centered Design**
  - Focus is on users: user experience and satisfaction
  - Driven by user input
  - Substantial user involvement
  - Design by iterative prototyping
  - Highly varied, informal processes
  - Design by evolution

- **Usage-Centered Design**
  - Focus is on usage: improved tools supporting task accomplishment
  - Driven by models
  - Selective user involvement
  - Design by modeling
  - Systematic, fully specified processes
  - Design by engineering
Methodology for object-oriented user interface design

Iterative Process:

Images from IBM Ease of Use Website
OVID – Discovery Phase

Who are the real users?  
What are the users' goals?  
How are the users' goals currently achieved?  
What does the system need to support?

User Class  
User Goals  
User Experience Use Cases  
User's Current Task Models
OVID – Abstract Design Phase
OVID - Real Design Phase

Abstract Design

Visual Design

Interaction Design

Environment
- Audience
- Visual Trends
- Task Domain
- Brand

Technology
- Hardware Platform
- Software Platform

Record the design for implementation
Resources

- CARD (Collaborative Analysis of Requirements and Design):

- PICTIVE (Plastic Interface for Collaborative Technology Initiatives through Video Exploration):

- IDIOM:

- OVID (Object, view and interaction design):
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