The Design of Interactive Computational Media

Class 5: 9 Oct. 2002

Activity Design

Hour 1:
Design Methodologies and Principles

Hour 2:
Activity Design; Metaphors and Mental Models

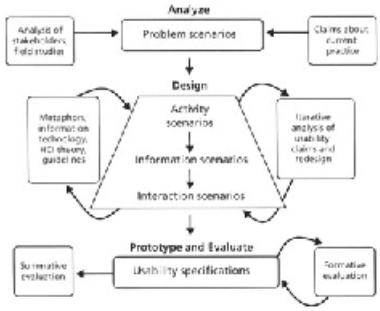
Design Methodologies and Principles

- Design methodologies
- Examples
  - Rosson and Carroll
  - BGBG
- Design principles and guidelines
- Examples
- One set of design principles

Design Methodologies

- Systematic procedures for organizing design processes for interactive computational media

Rosson and Carroll Design Methodology



BGBG design methodology

- A user-centred, iterative, design philosophy
  - Not intended as a rigid formula
  - Illustration of a philosophy
  - Examples of how to proceed
- Design —>Prototype- —>Evaluate —>Redesign —>Implement —>Evaluate —>Redesign —>Revise implementation —>Evaluate —>etc..

BGBG design process example (MAD)

	DESIGN	IMPLEMENT	ANALYZE AND EVALUATE
Information collection and requirements analysis	Reflections, studies, classes on filmmaking	No "Problem Scenario" developed (weakness)	Some contact with real filmmakers (should have had more contact)
Activity, information & interaction design	Initial design concepts	Design sketches, Director prototypes, small C programs	Feedback only from research group (weakness)
Prototyping and prototype system	System functionality and look-&-feel	Critical mass C prototype	Demos, first real projects, observations, filmmaker interviews
Production prototype and its evolution	Complete system, incorporating evaluation insights	Implementation of significantly useable C++ system	More demos, real projects, observations, interviews, multimedia summer camps
Production system and its evolution	Deliverable system, incorporating evaluation insights	Java implementation	Intensive internal use, beta testing, client use

BGBG design process in tabular form

	DESIGN	IMPLEMENT	ANALYZE AND EVALUATE
Information collection and requirements analysis	Questionnaires, interviews, observation of potential users	Task analyses, artifact analyses, "day in the life" "problem" scenarios	e.g., interviews with users to get reactions to scenarios
Activity, information & interaction design	Initial design concepts	Design mockups, prototypes, activity scenarios	e.g., interviews with users to get reactions to prototypes, heuristic evaluations
Prototyping and prototype system	System functionality and look-&-feel	"Smoke and mirrors" prototype, partially working system	e.g., usability tests
Production prototype and its evolution	Complete system, incorporating evaluation insights	Real working system, implemented and installed	e.g., heuristic evaulation, usability tests, beta tests
Production system and its evolution	Deliverable system, monitoring and feedback system	Production system, including monitoring and feedback system	e.g., interviews, surveys of real users

Design principles (guidelines)

- Even if you follow a methodology, how do you know that you are proceeding uphill rather than downhill?
- Design principles or guidelines: statements which advise a designer on how to proceed
- Example (Hansen, 1971)
  - Know thy user
  - Minimize memorization
  - Optimize operations
  - Engineer for errors

Macintosh Human Interface Guidelines

- "...describes the way to create products that optimize the interaction between people and Macintosh computers" (Apple Computer, Addision-Wesley, 1992)
  - Ch. 1: Human Interface Principles
  - Ch. 2: General Design Considerations
  - Ch. 3: Human Interface Design and the Development Process
  - Ch. 4: Menus
  - Ch. 5: Windows
  - Ch. 6: Dialog Boxes
  - Ch. 7: Controls
  - Ch. 8: Icons
  - Ch. 9: Colour
  - Ch. 10: Behaviours
  - Ch. 11: Language

Tog On Interface

- Bruce "Tog" Tognazzini (Addison-Wesley, 1992) answers specific questions about user interface design for the Macintosh, and presents 200 guidelines dealing with, e.g.:
  - The Design Process
  - Positively Determining System Behaviour
  - Positively Influencing User Perceptions and User Behaviour
  - Promoting Consistency
  - Making the Interface "Visible"
  - Reducing or Eliminating Navigation
  - Conceptual Models and the System Image
  - Human-Computer Conversation, Vocabulary
  - Screen Objects, Menus, Icons, Fonts, Error Messages
  - User Testing
  - Minimizing Impact of New Releases on Old Users

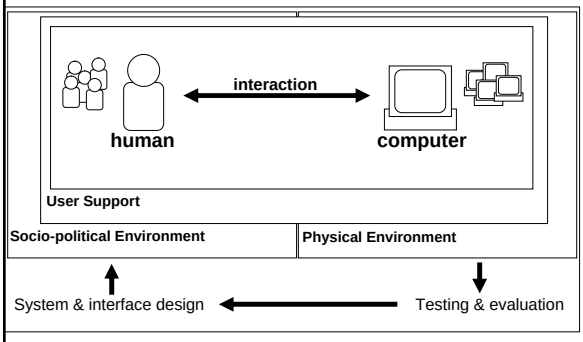
Guidelines

- Pros of guidelines
  - Stimulate ideas and insights
  - Good checklists giving helpful advice
  - Use in *heuristic evaluation*
- Cons of guidelines
  - Occasionally incorrect
  - Usually vague
  - Sometimes contradictory (need for tradeoffs)
  - Very often not at the appropriate level of specificity
  - Often difficult to apply to real design problems
  - Can get out of hand, e.g., Smith and Mosier: 679 (!!?) guidelines (1984)

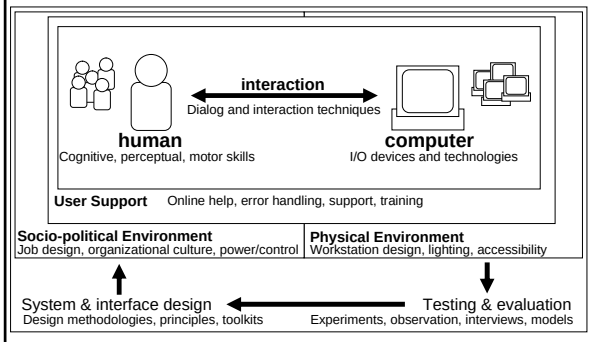
My Design Guidelines (Principles)

- Heavily influenced by 30 "design elements" in P. Heckel, *The Elements of Friendly Software Design*, The New Edition, Sybex, 1991
- Interface examples courtesy of Aaron Marcus and Associates, www.amanda.com

Computational media design process



Computational media design process



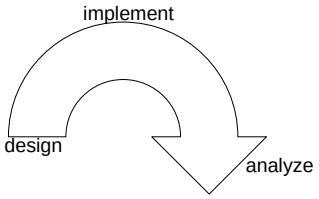
Computational media design principles

- The design and the design process
- The user
- The technology and the interaction
- User support
- The computational medium

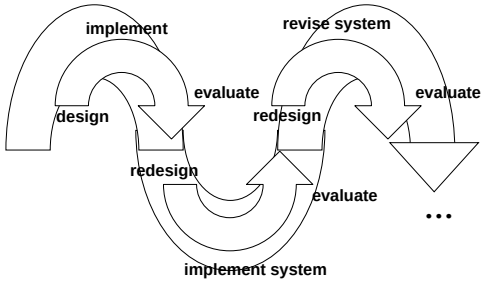
Design principles: The designer and the design process

- 1. Be humble, and iterate often
  - You won't get it right the first time …
  - Or the second time either :-)
- 2. Follow a user-centred design process
  - Study work practice
  - Observe, "test" users as they use a system
  - Ask users with surveys, questionnaires, interviews
  - *Also ask external experts in a systematic way*

The iterative design process



The iterative design process



Design principles: The designer and the design process

- 3. Use multidisciplinary design teams
  - Software
  - User interface design
  - Social/behavioural science
  - Visual/graphic design
  - Domain expertise
- 4. Really know the subject matter
  - Deep domain expertise required

Design principles: The designer and the design process

- 5. Consider the physical environment
  - Example: Workstation ergonomics
  - Example: Mobile use
- 6. Consider the social and political environment
  - Example: IBM Speech Filing System

Design principles: The user

- 7. Really know "the user"
  - Who is a typical user? Who are all the users?
  - Observe, ask, have users participate on design team
- 8. Employ the user's knowledge
  - Communicate with appropriate metaphors (next hour)
    - Example: Virtual museum
    - Example: Electronic book
  - Speak the user's language
    - The user's jargon, not computer jargon
    - Example: Points, picas, em dashes for typographers

Design principles: The user

- 9. Build a mental model in the user's mind (next hour)
  - Begin with the metaphor
  - Example: Images made of pixels (painting program) or lines (drawing program)
  - Example: Financial data on a gridded worksheet with rows and columns
- 10. Design for varieties of user expertise
  - Example: novice and experienced users
  - Example: the role of user tailorability (McGrenere)

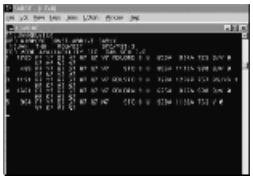
Design principles: The technology and the interaction

- 11. Exploit new hardware paradigms
  - Example: mobile devices linked at high-bandwidth
  - Example: speech I/O, non-speech audio
- 12. Communicate visually and articulately
  - Focus the user's attention
    - Key information at the tracking symbol
    - Graceful methods to grab the user's attention
  - Structure the user's interface
    - A frame of reference, a mental map
    - The role of design grids

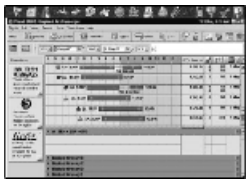
Prototypes: Samsung Advanced Mobile Device Concepts

Prototypes: Message Manager For a Wrist-top Device

Application Example: Sabre Travel Booking Development



Before



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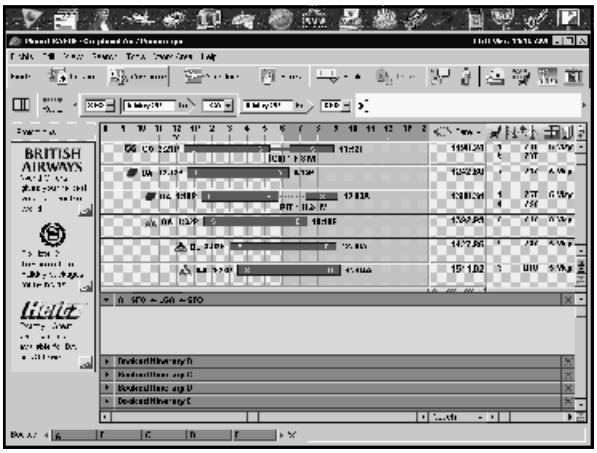
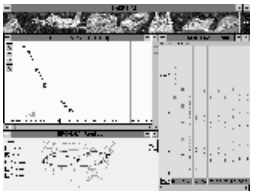
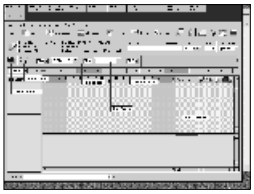


Sabre: Information-Visualization and User-Interface Design



Information Visualization



Interactive UI Guidelines

Website: J. Paul Getty Trust Portal and Museum Website Development

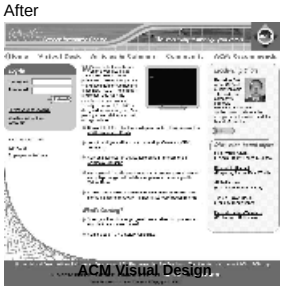
Home Page

Visitor Guide Page

Website: ACM.org Portal Career Resource Centre Development

Before

After



Design principles: The technology and the interaction

- 13. Respond articulately to the user's actions
  - Speed and predictability of response
  - Complete, terse, comprehensible feedback
  - Hidden system state (modes) kept to a minimum
    - Example: My TV Zapper
- 14. Orient the user in the world
  - Where am I? Where have I been? Where can I go?
- 15. Enable articulate expression by users
  - Example: Widgets for controlling rectangular areas

Design principles: User support

- 16. Anticipate that users will have "problems"
  - Huge varieties of users, tasks, contexts
  - Need to anticipate and if possible prevent "errors"
  - Need for online help, error handling, training, support
- 17. Minimize user frustration
  - Consistency whenever possible
  - Error message language to reduce defensiveness

Design principles: User support

- 18. Support collaborative and individual use
  - Example: Technical support via knowledge base *and* links to experts
- 19. Make your product reliable
  - If it doesn't work well, the interface won't save it!
- 20. Make your design simple
  - Elegance and simplicity aid everyone involved — the designer, the implementer, *and* the user

Summary

- Methodologies: Systematic design processes
- Principles or guidelines: "Rules" of design advice

Questions and Discussion

Break

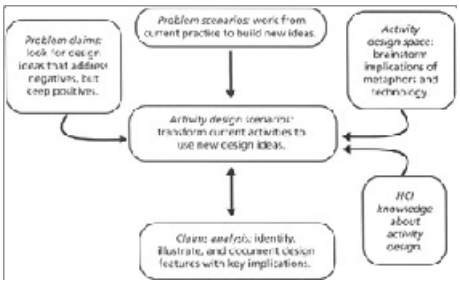
Activity Design; Metaphors & Mental Models

- Activity design
- Process from Rosson and Carroll
- Metaphors
- Examples
- Mental models

Activity Design

- "Problem scenario" shows issues in current practice
- Designer has a concept for a solution to problems
- Activity design develops functionality for the solution
- Goal is to make activities
  - Effective
  - Comprehensible
  - Satisfying
- Activity scenarios
- Claims about features of these scenarios

Activity Design (Rosson & Carroll)



Activity Design: Effectiveness

- How to we know we are solving the right problem?
- Careful analysis of results of requirements analysis
- Collaborative (participatory) design
  - *User-centred —> user-involved —> user-directed*
  - Origins in Scandinavia
  - Developers and users: equal partners on design team
  - Mutual knowledge
  - See Reading #8, *Situated Design*, Greenbaum & Kyng

Activity Design: Satisfaction

- We want computer use to be
  - Productive
  - Comfortable and satisfying
- It should not be
  - Counter-intuitive
  - Frustrating
  - Stressful
- Role of task analysis
  - Currrent practice (useful for "problem scenarios")
  - Desired practice (useful for "activity scenarios")

Class Exercise: Task Analysis for Electronic Classroom

- *Let's do this together!*

Activity Design: Comprehensibility

- User needs, task analysis, and user work practices — How users think about their work — their "conceptual models"
- Example of a familiar users' conceptual model
  - The Xerox Star — The origins of the electronic desktop and the GUI — Predecessor to Lisa, Macintosh, and Windows
  - A "simulated desktop" with electronic equivalents of *paper, filefolder, file cabinets, mailboxes*
  - Key cognitive issues
    - Users' conceptual (mental) model
    - Building parallels to office concepts, objects, and operations
    - A computer system **is** an electronic office (a metaphor)

Metaphors

- What are these mental models? What are they like? How can they be conceptualized?
- Very often they relate presumed structure and function of a system to that of another, "simpler", familiar system
- The goal is to exploit the specific prior knowledge that users have of this other domain
- We use *metaphor* (an X is a Y) meaning X is like Y in certain (many) respects
- See Erickson, *Working with Interface Metaphors*, Reading #9

Examples of Metaphors

- Football is (like) war
- War is (like) football
- Text editor is (like) a typewriter
- Memory is (like) a set of pigeonholes
- Screen is (like) a television
- Screen is (like) a desktop in an office
- LOGO procedures are (like) cooperating "little people"

Examples of Metaphors

Application area	Metaphor	Exploits knowledge of
Word processing (e.g., Word)	Typewriting	Typewriting, typing paper, keyboard
Spreadsheets (e.g., Excel)	Ledger sheet	Numerical data and calculations in rows and columns
Personal financial management software (e.g., Quicken)	Checkbook, financial register	Working with a checkbook
Shared electronic workspaces (e.g., Smart Technologies)	Chalkboard, whiteboard	Writing, sketching, and collaborating on a chalkboard or a whiteboard
Idea processors, outline processors (e.g., More)	Outline	Organizing, decomposing, combining, and rearranging ideas and concepts
Virtual science fair exhibit	Lab notebook	Taking notes, recording "work in progress"
Virtual science fair exhibit	Documentary	Telling a story (in text, voice, film)
Virtual science fair exhibit	Web site	Constructing a story out of separate pages, linking them together

Metaphors are not Identities

- An X is a Y
- But X ? Y, else we would have identity, not metaphor
- Interesting aspects are areas of mismatch, breakdown
- Divide into metaphor {works, doesn't work, doesn't apply}
- Example: Text editor is a typewriter
  - Works: Input of text, form of text, appending text
  - Does not work: Rather than *type over,* we have *insert* or *change*
  - Doen't apply: *Block move* (e.g., cutting/pasting pieces of paper)

Recommendations regarding metaphors

- Find appropriate metaphors for teaching system to novice user
- Given choice between two metaphors, favour one based on:
  - Congruence to system (Isomorphism between entities and relationships in system and in metaphor)
  - Coverage of system's objects, features, operations
- Use related metaphors where appropriate, ideally from similar real-world domains (e.g., filing cabinet, storage boxes)
- Choose the emotional tone of the metaphor appropriately (e.g., war vs. peace, work vs. play, science vs., art, writing vs. drawing)

Recommendations regarding metaphors

- Choose metaphors that have distinctive visual and auditory representations (icons, auditory icons as a goal)
- Think through probable consequences of metaphor to users
  - Worry about apparently small details, e.g., objects using book metaphor should have page numbers, tables of contents, indices
- Point out limitations of metaphors
- Look for sequences of metaphors or models – replace one by the next when the first begins to break down
- e.g., IBM Speech Filing System – Audio Distribution System
  - Telephone Answering Machine
  - Telephone Answering Machine w. Remote Control Playback

Mental models

- Metaphors and mental models
  - "Metaphors function as natural models, allowing us to take our knowledge of familiar, concrete objects and experiences and use it **to give structure to more abstract concepts**." (Erickson, L, p. 66)
- Definition of mental models (Carroll, 1984):
  - "...structures and processes imputed to a person's mind in order to account for that person's behaviour and experience."
- More generally (Carroll & Olson, 1988):
  - "...all of what a user knows about using a particular piece of software, including *how to use it*, and how it works."

Role of mental model

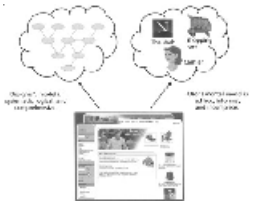
- To answer questions like:
  - What is X?
  - What happens when you do Y?
  - Why do Z?
- Example: Mental model of simple line drawing system
  - *Objects*: Page, line, point
  - *Relations*
    - Page contains 0 or more lines
    - Line connects 2 points
  - *Actions on objects*
    - Clear a Page
    - Create, delete, move points and lines
  - *Attributes of objects*
    - Color, style, weight of lines
    - Type of point
  - *Actions on attributes*: Change these attributes

Examples: Prototyping tools (later in term)

- HyperCard
  - Card, stack of cards
- Director, Flash
  - Animation, sequencing images through time
- Visual Basic
  - Set of active elements on a page with associated code
- Dreamweaver
  - Web site, collection of web pages

Kinds of models

- Designer=====> System <======> User
- Need to distinguish among the system and
  - *Designers' Conceptual Model* of the System
  - Users' Image of the System – *System Image*
  - *Users' Mental Model* of the System
  - Scientist's *Conceptualization* of that Mental Model (will ignore for now)



Kinds of models

- System built by designer
- Designers' conceptual model
  - Coherent structure behind the design
  - Goal is logic, unity, consistency
- System Image –view of system seen by user
  - Objects, commands, options, states, etc.
  - Not necessarily coherent, logic may not be apparent
  - For learners, a view through a peephole, system emerges little by little through training, use, exploration
- Users' mental model
  - Eventually, if structure is there, user may discover it, induce a coherent model of the system
  - If design is appropriate, if learning environment works, users' mental model will reflect designers' conceptual model

Remarks re (users') mental models (Norman, BB, pp. 241-244)

- Incomplete
- Unstable, decays through forgetting
- Can't be “run” perfectly
- Similar devices have overlapping mental models
- "Unscientific" – Coloured by superstitious beliefs
- Parsimony – People build the simplest possible mental models

Scientific study of models

- Researchers attempt to build more and more complete, formal, and precise models of:
  - Cognitive processes of user
  - Their mental models
  - Methods such as metaphor that assist in the development of mental models
- More about this in advanced courses in HCI

Metaphors, models, and learning

- Carroll and Mack (Reading #19) description of how users learn a computer system
- Learning by doing
  - Desire to try things out
  - Tendency to jump the gun
  - Difficult in following written sequences of instructions
- Learning by thinking
  - Attempting to construct reasonable interpretations, proper *mental models* (sense-making)
  - Purposeful problem solving activity
- Learning by knowing
  - Making use of prior knowledge, from *metaphors* and work experience

Summary

- Designing activities so that they are
  - Effective
  - Comprehensible
  - Satisfying
- Metaphors
- Mental models

Questions and Discussion