User Interface Design: An Introduction and Overview

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Topics in User Interfaces

- Understanding Humans -- Psychology
- Human-Computer Interaction
- Design Process and Strategies
- Interface Evaluation
- Tools for Interface Development
- Technology of Interfaces and Tools

Goals for Today

- Overview of Field
- A Sampling of Psychology
- A Design Process -- TCUID
- Some Usability Engineering Issues
- a little pitch for further education …

- Have some fun, play some games!

Psychology

- Human capabilities and limitations
- Perception and cognition
- Implications for UI design

- *Design of Everyday Things* by Donald Norman

A Two-Player Game

- Start with the numbers 1 ... 9
- Pick alternatingly without replacement
- A winner has exactly 3 numbers that add up to 15
- If all numbers are used, and nobody wins, it is a draw

A Two-Player Game

Human Capabilities

- Humans are very good at:
  - » recognizing (images, voices, etc.)
  - » associative memory
  - » explaining phenomena
- Humans are very limited in:
  - » short-term memory
  - » complex, multi-layered tasks
  - » perfection

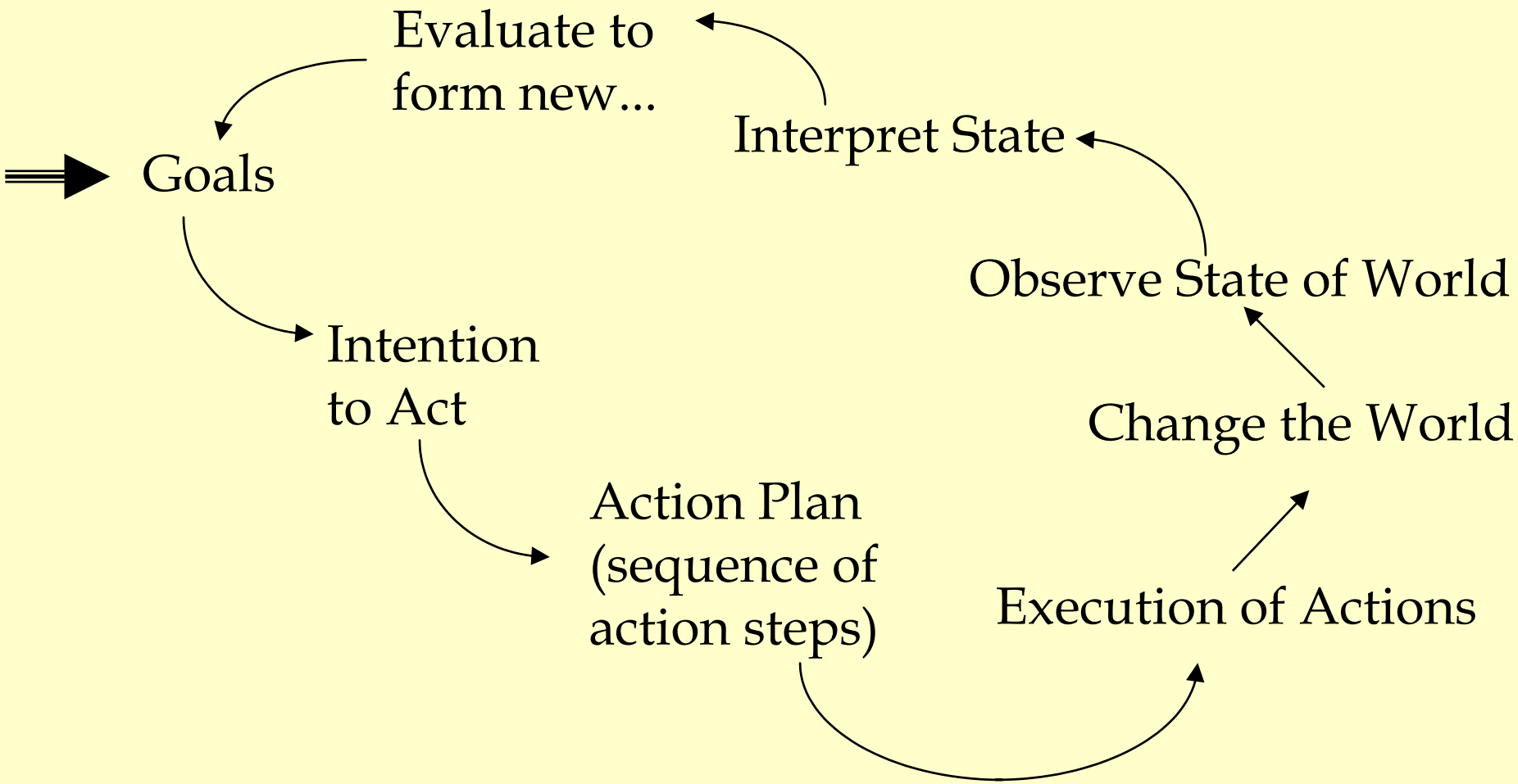
Brain Hemisphere Research

- "Left Brain"
  - » methodical, logical, step-by-step
  - » symbolic, works with components
  - » generally dominant
- "Right Brain"
  - » holistic, intuitive, rapid
  - » handles missing values
  - » works with gestalts

Limits of Human Memory

- Short-Term Memory
  - » instant recall
  - » limited capacity
  - » fragile
- Long-Term Memory
  - » slower recall, depends on organization
  - » rote memory vs. relationships vs. explanation
  - » “muscle memory”

Models of User Action



Humans Err

- Humans are not perfect!
- Slips -- errors in automatic actions
  - » tied to skilled behaviors
  - » easy to detect
- Mistakes -- errors in intention or logic
  - » e.g., false generalizations
  - » may be hard to detect

Where Does This Put Us?

- The Problem
  - » humans are imperfect!!
- Possible Solutions
  - » yank them out of the process
    - – lose benefits of human strengths
  - » design for imperfect users

Put Support into the Interface

- Affordances
- Visibility of Controls
- Feedback
- Conceptual Models
- Mappings
- Information in the World
- Constraints
- Error Avoidance and Handling
- Standardization

Affordances

- What something can be used for
  - » a button (or plate) affords pushing
  - » a knob affords turning
- Cultural (and learned) affordances
  - » a scrollbar affords scrolling
  - » various cursors afford operations
- Key: helps the user discover possibilities
  - » where would you hide a safe in your house?

Visibility of Controls and Information

- Don’t hide the controls!
  - » telephone systems: hold, transfer, etc.
  - » VCR programming
- Make status available
  - » well-designed display (34% complete)
  - » use sound if needed (click/beep/etc.)
- Don’t distract with irrelevant displays
  - » dynamics and prominence reflect importance

Feedback

- Don’t hide the results!
- Make feedback immediate
  - » did I hit the button? (visual or audio)
  - » did I have an effect? (cursor change?)
- Each action should have an effect
  - » promote exploration

Conceptual Models

- Rote memorization prevents inference and adaptation
  - » users *will* develop conceptual models
    - – but they will likely be wrong!
- Models should help people adapt to new situations
  - » gulf of execution -- not knowing *how*
  - » gulf of evaluation -- not knowing *whether it worked*

Mappings

- Humans infer from mappings
  - » layout of light switches in a room
  - » controls on a range
- Natural mappings are easiest, but ...
  - » avoid mappings that don’t generalize

Information in the World

- Avoid relying on memory alone
  - » menus and toolbars
- Support memory aids
  - » never require remembering information between screens
- Great precision is not required

Constraints

- Narrow the task search space
- Physical Constraints
- Semantic Constraints
- Cultural Constraints
- Logical Constraints

Error Avoidance/Handling

- Design to prevent slips
  - » different things should look different
  - » consistent confirmation is useless
  - » immediate confirmation can be nearly useless
- Simplify tasks
  - » make decision trees narrow or shallow

Error Avoidance/Handling

- Support recovery from errors
  - » undo operations and back-up versions
  - » support exploration towards a goal
- Prevent errors with forcing functions
  - » don't make illegal operations available
  - » disable buttons or menus
  - » turn illegal operations into legal ones

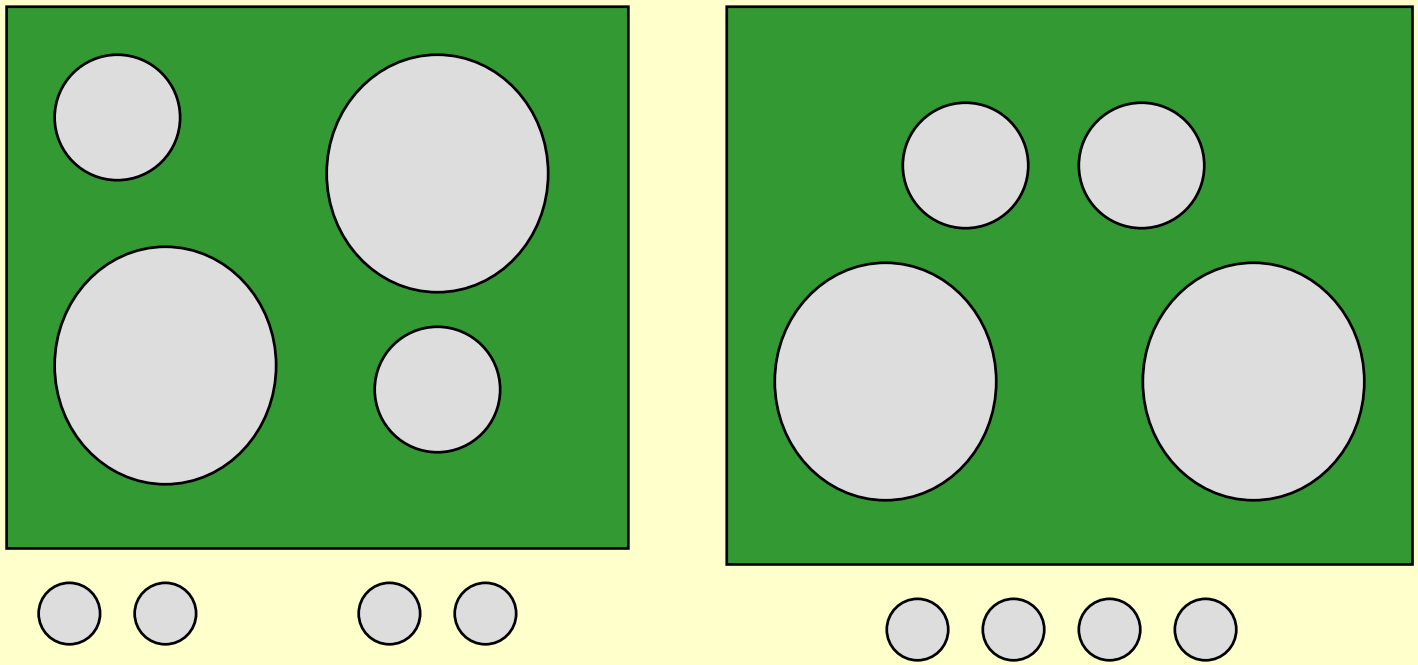
Standardization

- If all else fails, ...
  - » fewer things to memorize
  - » shorter learning time
  - » clocks should run clockwise

Examples

- Stove Control Design
- Refrigerator controls
- Light Switches
- One-button slide projectors
- Doors
- Phones

Stove Control Design



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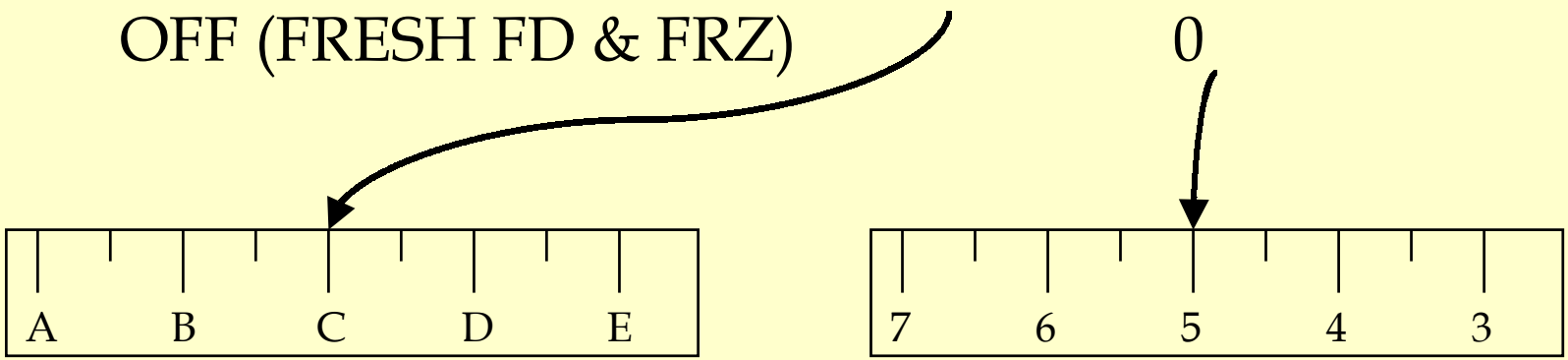
Refrigerator Controls

NORMAL SETTINGS	C	AND	5
COLDER FRESH FOOD	C	AND	6 - 7
COLDEST FRESH FOOD	B	AND	8 - 9
COLDER FREEZER	D	AND	7 - 8
WARMER FRESH FOOD	C	AND	4 - 1
OFF (FRESH FD & FRZ)			0



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The UI Design Process

- Several processes “promoted”
- Common elements
  - » Focus on users
    - – tasks, scenarios
    - – activities, work context
    - – communication
    - – personas

Task-Centered User Interface Design

- Identify users and tasks
- Develop tasks into scenarios
- Use tasks/scenarios in design and evaluation

- Based on book by Lewis and Rieman
  (ftp://ftp.cs.colorado.edu/pub/distribs/clewis/HCI-Design-Book/)

Users

- Who is going to use the system?
  - » if you can't find a user -- you're in trouble
  - » "everyone" is not a user
  - » "the designer" is not a good user
- Go talk with the user
  - » too busy?
    - – how will they have time to evaluate/use it?
    - – are there good surrogate users?

Talking with the Users

- What do they know?
  - » systems, skills, etc.
- What do they do?
  - » tasks
- How do they do it now?
  - » scenarios
- What do they want to do?
  - » new tasks

Users Sometimes Bite!

- Users aren't all-knowing
  - » they may not understand the possibilities
  - » they may have a very narrow view
- They aren't designers
  - » learn about the tasks from the users
  - » use your design skills to create a design
  - » get user feedback on the design/prototype

Tasks

- What is a task?
  - » a specific description of a complete job that specific users want to accomplish
  - » not tied to how they would do the job
- Detailed
  - » some typical details are important
- Complete job
  - » covers transitions between sub-tasks

Example Task

- Professor Konstan receives a phone call from his department head asking whether he can attend a one-hour meeting the following Friday morning at 9. He should check his calendar, add the meeting unless he is teaching or traveling then, and send e-mail to reschedule any appointments that have to be missed for this meeting.

Why Tasks

- Tasks are fundamental to TCUID
  - » determine who actually uses the system
  - » sets goals for system functionality
  - » basis for system design
  - » basis for comparative evaluation
  - » basis for user testing

How Many Tasks?

- Depends on nature of problem
  - » 3-5 general-purpose tasks for a simple system
  - » separate tasks for special-purpose cases (maintenance, installation)
  - » 10+ tasks for complex systems
  - » depth/quality more important than number of tasks

From Task to Design

- Write-up tasks, circulate among users
  - » clarify missing details
- Rough out an interface, using existing systems or designs where possible
- Sketch out how each task would be accomplished in the interface: develop *scenarios*

Scenarios

- Specific instance of system use
  - » for a particular task
  - » for a particular interface
  - » what would the user do, in detail
- Example
  - » double-click on Outlook icon, click the calendar icon, …

Properties of Scenarios

- Interface-dependent
- Detail appropriate to user, task, interface
- Brings forward issues
  - » how components work together
  - » design arguments
  - » tricky parts of the interface
- Guideline to create prototype

Interface Design Strategies

- Find a tool that does all/part of the job
  - » don't write a new spreadsheet -- extend!
  - » you won't live long enough to re-invent Excel
- Work within an existing framework
- Borrow intelligently
  - » know why the interactions were selected
    - – Mac tool palette vs. menus
- Invent only when absolutely necessary

Interface Prototyping

- Why prototype?
  - » easier/cheaper than building & discarding
  - » learn about interface problems early
    - – before extensive resources committed
  - » identify hard parts of the design
- Can you use the final prototype as the product?
  - » often

Goals of Interface Prototyping

- Bring out issues that are hard to see in the abstract
- Better gestalt for the interface
- Something to evaluate using heuristics
- Something for users to evaluate
  - » informally
  - » user testing

Prototyping Techniques

- Functioning Programs
- Stand-Alone Interfaces
- Dedicated Prototypes
- Paper Prototypes

A Surprising Finding

- In many circumstances, sketches work *better than* higher quality prototypes for user evaluation.
  - » users feel freer to suggest major changes
  - » users focus on high level rather than color, labels, graphical details
  - » some groups have generated sketches from high-quality prototypes for focus groups and other user evaluations.

TCUID Summary

- Who is going to do what?
- Choose representative tasks
  - » scenario for current systems
- Rough out a design, borrowing where possible
- Think, evaluate
- Create a prototype
- Test it (with and without users)
- Iterate
- Build and maintain it

Interface Development Methodology

- Prototype and Iterate
  - » keep iterating until it is good enough
  - » evaluate along the way to assess
- What is Good? What is Good Enough?
  - » set usability goals
  - » should relate to tasks

Evaluation

- Without users
  - » walkthroughs
  - » heuristic/checklist
  - » action analysis
- With users
  - » test design/evaluation

Tricky Issues in Usability Engineering

- Not software engineering
  - » don't know requirements or specs
- Prototype/iterate
  - » when to stop
- Quantitative usability goals?

Yeah, But Why Should I Care?

- Usability = $$$
  - » Support costs
  - » Reputation
  - » Product reviews

Yeah, But What Can I Do?

- Hire people with HCI/UI background
  - » Psych & Computer Science
- Make people aware of issues
- Train people!
  - » Good place to pitch courses ....

Reference Materials

- Courses and Conferences
  - » UPA (in two weeks, Scottsdale)
  - » CHI 2004 (Vienna); CHI 2005 (Portland)
- Books
  - » Highlights -- no system-specific books
- On-line resources
  - » Well-connected on the web

Courses and Conferences

- Typical Computer Science Courses
  - » UI Design, Evaluation, and Implementation
  - » GUI Toolkits and their Implementation
  - » HCI and UI Technology
  - » Specialty Topics (CSCW, Ubicomp, Wearables, etc.)
- Annual Conferences
  - » CHI*, UPA, CSCW, UIST, DIS/DUX, IUI, and many more …
  - » see SIGCHI home page for details

References for Further Reading

- *Task-Centered User Interface Design* by Clayton Lewis and John Rieman (ftp://ftp.cs.colorado.edu/pub/cs/distribs/clewis/HCI-Design-Book/)
- *The Design of Everyday Things* by Donald Norman
- *A Guide to Usability* by Jenny Preece
- *Usability Engineering* by Jakob Nielsen
- *Developing User Interfaces* by Dan Olsen

References for Further Reading

- *Designing the User Interface* (3rd edition) by Ben Shneiderman
- *Human-Computer Interaction* by Jenny Preece et.al.
- *Developing User Interfaces: Ensuring Usability through Product and Process* by Hix and Hartson
- *Cost-Justifying Usability* by Bias and Mayhew
- *Readings in Human-Computer Interaction (1st and 2nd editions)* edited by Ronald Baecker, et. al.
- *Handbook of Human-Computer Interaction* (2 editions, edited by Martin Helander)

References for Further Reading

- *Interactive System Design* by Newman and Lamming
- *Human-Computer Interface Design: Success Stories, Emerging Methods, Real-World Context* edited by Marianne Rudisill, et.al.
- *Bringing Design to Software* edited by Terry Winograd
- *The Art of Human-Computer Interface* Design by Brenda Laurel
- *The Visual Display of Quantitative Information* by Edward Tufte
- *The Human Computer Interaction Handbook* by Julie Jacko and Andrew Sears

Useful Resources on the Internet

- HCI Reference Pages
  - » http://www.usableweb.com/
  - » http://www.degraaff.org/hci/
  - » http://www.hcibib.org/
- ACM SIGCHI
  - » http://www.sigchi.org/
- Usability Professionals Association
  - » http://www.upassoc.org/