An ATM Encounter

The goal: to withdraw some cash from one account and deposit it to another. How hard can it be? Isn’t ATM user interface design an established, known thing? Apparently not, as I found out...

I walked up (with a helper friend) to a cashpoint (the “hole in the wall”) which had a big colour screen with buttons [on] either side of it and more buttons in a keypad below. The screen rotated through some adverts and included no instructions as to what [to] do: I inserted my card to make a withdrawal. Nothing happened. We both stared at the screen and start pressing some buttons – nothing. Eventually she went in to the bank to ask for instructions while I continued tapping on the screen and buttons for a little longer. I got bored so withdrew my card... and after a couple of seconds, guess what? It asked me for the PIN number! Wow! You have to pull the card out in order for it to operate... good thing I didn’t walk away immediately as the next person could have come along and played “guess the PIN” without ever getting hold of my card! Anyway, in the end the withdrawal succeeded and I had $500 in $20 denominations which is what it gave out. Next step: deposit that cash into another account. I insert the other card, nothing happens but now I know the trick so I pull the card out and I get prompted for the PIN (after a brief delay). It asks how much I want to deposit. I enter the amount of $500. It dispenses an envelope and instructs me to insert the cash in the envelope and stick it back in the slot; it states that the envelope must not contain more than 10 banknotes! How am I to deposit $500 that it just gave me in 20s by using only 10 notes?! If that is its limitation why didn’t it state that before asking me how much I wanted to deposit? This is yet another example of getting the steps in the wrong order. Anyway, since I couldn’t find a cancel button (or some other Ctrl+Z option) I put $200 in the envelope and stuffed it in the slot. It gave me a receipt thanking me for depositing $500 :-) By this stage, the person working at the bank comes out and after hearing the story says: “Yeah that happens all the time, I’ll correct it on the computer”. Sigh.

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Graphical User Interfaces and User Interactions

- Sudipto Ghosh, Geri Georg (adapted slightly by James Bieman)

References:
- Object-Oriented Software Engineering, Chapter 7 (CS314 text pp. 478 – 508).

Don't Redefine Concepts

Confusing

Issues:
- Simplicity is best: Cancel E-mail Subscription
- Incomplete instruction label: Enter e-mail address to remove
- Already have e-mail
- 1st button unnecessary, awkward
- 2nd button label cumbersome: OK

Outline
- Users and User Centered Design
  - Interaction Design
    - Usability and the user experience
    - Modeling and modeling frameworks
    - Design concepts
    - Prototyping
    - Evaluation

User centered design
- Software development should focus on the needs of users
  - Understand your users
  - Design software based on an understanding of the users’ tasks
  - Ensure users are involved in decision making processes
  - Design the user interface following guidelines for good usability
  - Have users work with and give their feedback about prototypes, on-line help and draft user manuals
Importance of focusing on users

- Reduced time to learn the system ⇒ lower training and support costs
- Greater efficiency of use
- Reduced cost since only developing features that are needed
- Better prioritizing of work for iterative development
- Users become advocates!

Characteristics of Users

- Software engineers must develop an understanding of the users
  - Goals for using the system
  - Potential patterns of use
  - Demographics
  - Knowledge of the domain and of computers
  - Physical ability
  - Psychological traits and emotional feelings

Visual Elements

Issues:
- (above) font, color, background make text almost completely unreadable
- (right) dockable menu in Office '97

Outline

- Users and User Centered Design
- Interaction Design
  - Iterative development in interaction design
  - Usability and the user experience
  - Modeling and modeling frameworks
  - Design concepts
  - Prototyping
  - Evaluation

Iterative Development

Interaction design activities

Requirements:
- Usability & User experience goals
- Model

Develop prototypes

Implementation:
- Interactive workings

Evaluate
designs:
- low fidelity
- storyboards

Design:
- paper prototypes
- wireframe diagrams

Testing:
- what is built
- user experience
Two equivalent interfaces:
(a), (c) Japanese
(b), (d) Israeli
(a), (b) rated more usable

Usability goals:
- effectiveness
- efficiency
- safety
- utility
- learnability
- memorability

User experience goals:
- satisfying
- enjoyable
- engaging
- exciting
- challenging
- boring
- cute
- frustrating
- pleasurable
- entertaining
- helpful
- motivating
- aesthetically pleasing
- supporting creativity
- cognitively stimulating
- rewarding
- fun
- provocative
- surprising
- emotionally fulfilling
- enhancing sociability
- annoying

Usability & User Experience Exercise
In groups of two:
- Pick a handheld device you have with you.
- What is good and bad about how it works?
- What is your user experience with it?
- What usability and user experience goals are most pertinent to your experience with the device?
- Transform these goals into several specific questions.
- Assess your device in terms of these questions.

User Cognition
- What goes on in our brains while we carry out activities.
- Two modes (Norman):
  - Experiential:
    - perceive, act, react to events effectively and effortlessly
    - requires higher levels of expertise and engagement
  - Reflective:
    - thinking, comparing, decision-making
- Processes:
  - Attention
  - Perception, recognition
  - Memory
  - Learning
  - Reading, speaking, listening
- Problem-solving, planning, reasoning, decision-making

Outline
- Users and User Centered Design
- Interaction Design
  - Usability and the user experience
  - Modeling and modeling frameworks
    - User cognition
    - Donald Norman
    - Abowd/Beale
    - Distributed cognition
    - Activity Theory
    - Conceptual Models
    - Design concepts
    - Prototyping
    - Evaluation

Visual Elements
Issues:
- arrange options vertically (easy scanning)
- fields need to be long enough for info/input
- left-align labels in a group
- use significant letters for mnemonics ("Wait")
Donald Norman's model
- Seven stages
  - user establishes the goal
  - formulates intention
  - specifies actions at interface
  - executes action
  - perceives system state
  - interprets system state
  - evaluates system state with respect to goal
- Norman's model concentrates on user's view of the interface

Abowd and Beale framework
- Extension of Norman...
- Their interaction framework has 4 parts
  - user
  - input
  - system
  - output
- User intentions → translated into actions at the interface
  → translated into alterations of system state
  → reflected in the output display
  → interpreted by the user
- Problems in interaction = problems in translation

Distributed Cognition
- Nature of cognitive phenomena across:
  - Individuals
  - Artifacts
  - Internal representations
  - External representations
- Describes cognitive system:
  - Interactions among people
  - Artifacts used in interactions
  - Environment where interactions take place
- How is information represented as it moves across individuals and the artifacts they use during activities

Activity Theory
- All human activity is mediated by artifacts
  - A person acts on an object to achieve a goal, and that action is mediated by the tools used to act on the object.
  - A person is part of and interacts with a community and that interaction is mediated by explicit and/or implicit rules.
  - The object is acted upon by the community and actions are mediated by the division of labor within the community.

Activity Theory Concepts
- A goal is a comprehensive activity such as completing a software project.
- An activity is accomplished through actions that require planning and other reflective cognitive skills.
- An action is accomplished through operations that require little thought or planning.
- As actions become more efficient/automatic, they may become operations.
- Actions may be grouped to become new activities.

Conceptual Models
- Concepts and relations between them
- Four parts:
  - Major metaphors and analogies
  - Concepts
  - Relationships between concepts
  - Mappings to task domain
Tabs

Issues:
- number of tabs
- icons as labels
- icon colors
- nested tabs

Outline

- Users and User Centered Design
- Interaction Design
  - Usability and the user experience
  - Modeling and modeling frameworks
- Design concepts:
  - techniques
  - navigation
  - interaction styles
- Prototyping
- Evaluation

Techniques

Persona
- description of an ‘example’ user

Cultural Probes
- users open in own environment, record what is meaningful to them

Scenarios
- stories for design (actions, what users see, do, and think)

Approaches to task analysis

- Task decomposition
  - splitting task into (ordered) subtasks
- Knowledge based techniques
  - what the user knows about the task and how it is organised (take advantage of common knowledge between tasks)
- Entity/object based analysis
  - relationships between objects, actions (events) and the people who perform them

Scenarios

- Used to express proposed or imagined situations
- Stakeholders actively involved to create
- Purpose (Bødker, 2000):
  - Design basis
  - Implementation details
  - Design team cooperation
  - Cross–team communication
- Plus/minus scenarios capture positive/negative consequences of an interaction

Unnoticeable

Issues:
- easy to misread
- easy to miss severity
- Alternative: critical message box (has X in it): not successful
4 golden rules
- knowing where you are
- knowing what you can do
- knowing where you are going
  - or what will happen
- knowing where you've been
  - or what you've done

Navigating hierarchies
- deep is difficult!
- misuse of Miller's 7 ± 2
  - short term memory, not menu size
- optimal?
  - many items on each screen
  - but structured within screen

Common interaction styles
- command line interface
- menus
- natural language
- question/answer and query dialogue
- form-fills and spreadsheets
- WIMP/GUI
  - Windows, Icons, Menus, Pointers OR
  - Windows, Icons, Mice, Pull-down menus
- speech
- pen, gesture, touch screens
- sharable interactions

Outline
- Users and User Centered Design
- Interaction Design
  - Usability and the user experience
  - Modeling and modeling frameworks
  - Design concepts:
    - specifics in UI design
      - buttons, modes, screen layout, decoration, alignment, columns, white space
    - Prototyping
    - Evaluation

Review Your Icons
http://www.componenthouse.com/article-21
beware the big button trap

- where do they go?
  - lots of room for extra text!

• modes
  - lock to prevent accidental use ...
    - remove lock - 'c' + 'yes' to confirm
    - frequent practiced action
  - if lock forgotten
    - in pocket 'yes' gets pressed
    - goes to phone book
    - in phone book ...
      'c' – delete entry
      'yes' – confirm
      ... oops !

screen design and layout: basic principles

• ask
  - what is the user doing?
• think
  - what information, comparisons, order
• design
  - form follows function

screen design and layout: grouping and structure

logically together ⇒ physically together

<table>
<thead>
<tr>
<th>Billing details:</th>
<th>Delivery details:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>Address: …</td>
<td>Address: …</td>
</tr>
<tr>
<td>Credit card no</td>
<td>Delivery time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Order details:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>item</td>
<td>quantity</td>
<td>cost/item</td>
</tr>
<tr>
<td>size 10 screws</td>
<td>7</td>
<td>3.71</td>
</tr>
<tr>
<td>(boxes)</td>
<td></td>
<td>25.97</td>
</tr>
<tr>
<td>……</td>
<td>……</td>
<td>……</td>
</tr>
</tbody>
</table>

Unrelated information shouldn’t be displayed together

- use boxes to group logical items
- use fonts for emphasis, headings
- but not too many!!
screen design and layout:
alignment - text
• you read from left to right (English and European) ⇒ align left hand side
  *Willy Wonka and the Chocolate Factory
  *Winston Churchill - A Biography
  *Wizard of Oz
  *Xena - Warrior Princess
  *boring but readable!

Willy Wonka and the Chocolate Factory
Winston Churchill - A Biography
Wizard of Oz
Xena - Warrior Princess

fine for special effects but hard to scan

alignment - names
• Usually scanning for surnames ⇒ make it easy!

Alan Dix
Janet Finlay
Gregory Abowd
Russell Beale

X: X. Alan
D: Dix, Alan
F: Finlay, Janet
A: Abowd, Gregory
B: Beale, Russell

alignment - numbers
visually:
  long number = big number
align decimal points
or right align integers

| 627.865 | 1.005763 |
| 382.583 | 2502.56 |
| 432.935 | 2.0175  |
| 652.87  | 56.34   |

multiple columns
• scanning across gaps hard:
  – add leaders, or use graying

| sherbet | 75 |
| toffee  | 120|
| chocolate| 35 |

| sherbet | 75 |
| toffee  | 120|
| chocolate| 35 |

screen design and layout:
white space

WHAT YOU SEE

THE GAPS BETWEEN

space to space & structure
Use the right punctuation or appropriate separators

Outline

- Users and User Centered Design
- Interaction Design
  - Usability and the user experience
  - Modeling and modeling frameworks
  - Design concepts:
    - principles, guidelines, and heuristics
    - Prototyping
    - Evaluation

Golden rules and heuristics

- "Broad brush" design rules
- Useful check list for good design
- Better design using these than using nothing!
- Different collections e.g.
  - Nielsen’s 10 Heuristics (see Chapter 9)
  - Shneiderman’s 8 Golden Rules
  - Norman’s 7 Principles
- BUT...
  - always test with users
  - address different sets of users
  - address “non-functional” requirements (e.g. response time, security, …)

Creativity saves the day

Nielsen’s 10 Heuristics

- Make system status visible
- Concepts in the system should match user’s world
- Provide way to leave unwanted states: undo, redo
- Follow conventions, standards to provide consistency
- Prevent errors
- Minimize need for recall by providing recognition
- Provide accelerators for expert use too
- Only present relevant dialog/information
- Show understandable errors, give constructive advice
- Provide documentation/help focused on user tasks
Shneiderman’s 8 Golden Rules

1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogs to yield closure
5. Offer error prevention and simple error handling
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load

Norman’s 7 Principles

1. Use both knowledge in the world and knowledge in the head.
2. Simplify the structure of tasks.
4. Get the mappings right.
5. Exploit the power of constraints, both natural and artificial.
6. Design for error.
7. When all else fails, standardize.

HCI design patterns

- An approach to reusing knowledge about successful design solutions
- Originated in architecture: Christopher Alexander
- A pattern is an invariant solution to a recurrent problem within a specific context.
- Examples
  - Light on Two Sides of Every Room (architecture)
  - Go back to a safe place (HCI)
- Sites: http://designinginterfaces.com/ - 2006
  http://ui-patterns.com/patterns

Metaphors: “Stop Light”

- All info entered
- Some info entered
- Required info missing
- Related to 1st tab
- Related to 3rd tab

Issues:
- stoplight labels/corresponding tab labels
- distance between stoplight and tab
- too much detail

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Techniques for prototyping

Storyboards
need not be computer-based
can be animated

Limited functionality simulations
some part of system functionality provided by designers
tools like HyperCard are common for these
Wizard of Oz technique

Warning about iterative design
design inertia - early bad decisions stay bad
diagnosing real usability problems in prototypes...
... and not just the symptoms

Sites:
http://designinginterfaces.com/
http://ui-patterns.com/patterns
http://homepage.mac.com/bradster/iarchitect/
Storyboarding

- Low fidelity prototype: doesn’t look like the final product
- Purpose:
  - Get user feedback
  - Encourage designers/developers to consider system use in detail
- Developed from scenarios:
  - Break scenario into series of steps focused on interactions
  - Create one scene for each step
  - Series of drawings showing how user performs a task
  - Adds detail to a scenario
  - Lets users role play with prototype

pitfalls of prototyping

- moving little by little ... but to where
- Malverns or the Matterhorn?

1. need a good start point
2. need to understand what is wrong

Remove Conflicting Ideas

Evaluation Techniques

- Evaluation
  - tests usability and functionality of system
  - occurs in laboratory, field and/or in collaboration with users
  - evaluates both design and implementation
  - should be considered at all stages in the design life cycle
- Goals
  - assess extent of system functionality
  - assess effect of interface on user
  - identify specific problems

Outline

- Users and User Centered Design
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  - Prototyping
  - Evaluation

Methods

Cognitive Walkthrough
- evaluates design on how well it supports user in learning task

Heuristic Evaluation
- usability criteria identified, design checked for violations (e.g. predictable, consistent behaviour, feedback provided)

Review-based
- literature & design rationale used to support design models

Laboratory Studies
- useful if on-site is impractical for single-user controlled manipulation

Field Studies
- useful when context critical

Experimental Evaluation
- controlled evaluation
Methods ... Observational

- **Think Aloud**
  - user observed performing task
- **Cooperative evaluation**
  - user collaborates in evaluation
- **Protocol analysis**
  - user or observation
- **Automated analysis**
  - post-task walkthrough to determine user intent
- **Post-task walkthroughs**
  - transcript “played back” for comment
- **Query**
  - interviews, questionnaires
- **Physiological**
  - eye tracking, physiological measurements

---

**Questionnaires**

- Ordering of questions can influence response
- May need different versions for different user types/populations
- Provide instructions!
- Balance length with white space (crowding issues)
- Response types:
  - Check boxes (ranges)
  - Likert scales
    - Measure opinions, attitudes, beliefs
    - Short statements: e.g. “home page instructions are clear”
    - Decide on scale: e.g. “strongly agree, agree, don’t know, disagree, strongly disagree”
    - Semantic differential scales
    - Explore range of bi-polar attitudes: “clear ... OK ... confusing”
- **Physiological**
  - eye tracking, physiological measurements

---

**Data Gathering Techniques**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Purpose</th>
<th>Data</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>Exploring</td>
<td>Mostly qual, some quant</td>
<td>Can guide interviewee</td>
<td>Time can intimidate interviewee</td>
</tr>
<tr>
<td>Focus groups</td>
<td>Collect multiple viewpoints</td>
<td>Some qual, mostly qual</td>
<td>Finds consensus, conflict</td>
<td>Dominant personalities</td>
</tr>
<tr>
<td>Questionnaires</td>
<td>Specific question answers</td>
<td>Quant and qual</td>
<td>Many people</td>
<td>Design crucial response can be low</td>
</tr>
<tr>
<td>Direct observation in field</td>
<td>Understand context</td>
<td>Mostly qual</td>
<td>Insights not otherwise possible</td>
<td>Very time consuming, lots of data</td>
</tr>
</tbody>
</table>

---

**Analyzing Data**

- How do you feel about the MS Paperclip?
  - Qualitative information: helpful, annoying, ...
  - Answers not homogeneous, must be treated individually
  - Good starting point for questions on future evaluations
- In your opinion, is the MS Paperclip amusing, irritating, or neither?
  - Quantitative: n out of m respondents find the paperclip amusing, ...
- In your opinion, the MS Paperclip is amusing:
  - Likert scale: strongly disagree, disagree, neither, agree, strongly agree
  - Quantitative: n out of m respondents agreed with the statement that the paperclip is amusing

---

**Usability vs. Utility**

- Does the system provide the raw capabilities to allow the user to achieve their goal?  
  - This is utility.
- Does the system allow the user to learn and to use the raw capabilities easily?  
  - This is usability.
- Both utility and usability are essential
  - They must be measured in the context of particular types of users.
Accessibility should work in practice

http://www.componenthouse.com/article-21

Representative example only. The actual panel covers the whole wall of the control room. Manual override is only enabled in RED alarm state.

http://www.hcibook.com/e3/scenario/nuclear/

Emergency Scenario
Jenny, the Nuclear Power Plant operator has normal sight and no physical or perceptual impairments. Her shift started at 11pm and it is now 5am in the morning. So far the plant has been operating within normal parameters and the current alarm state is therefore green.

1. Jenny notices the core reaction rate has risen very rapidly.
2. She realises she must immediately change the reactor target pressure to correct this.
3. She goes to the Alarm Control Panel on the far right of the main reactor control panel and presses '+' twice (as it is starting off in green state).
4. The Emergency Confirm button glows red.
5. She moves across to the Manual Override panel on the far left of the main reactor control panel.
6. She selects ‘Pressure’ from the pull down on the Manual Override panel.
7. She types in the new value ‘6000’ using the keypad.
8. She realises she forgot to press the SET button on the Manual Override panel.
9. She selects ‘Pressure’ from the pull down again.
10. She types into the new selected value ‘6000’ using the keypad.
11. The value still doesn’t change.
12. An automatic audio warning sounds “60 seconds to core meltdown.”
13. She presses the SET button repeatedly.
14. Still the value doesn’t change.
15. She starts again, selects ‘Pressure’ from the pull down, types ‘6000’ and presses SET.
16. Still the value doesn’t change.
17. The audio warning says “30 seconds to core meltdown.”
18. Jenny runs across the room to the Emergency Shutdown panel.
19. “20 seconds to core meltdown.”
20. She presses “Immediate Emergency Commence” button.
21. The emergency confirm button glows red.
22. “10 seconds to core meltdown.”
23. She presses the “Emergency Confirm” button.
24. She hears the crash of the explosive bolts sending the control rods into the reactor.
25. The audio system announces “reactor shutdown successful.”

Exercise
- Individually or in groups of two, create a short discussion of:
  - Use of color
  - Layout
  - What happened and why?
  - Potential changes