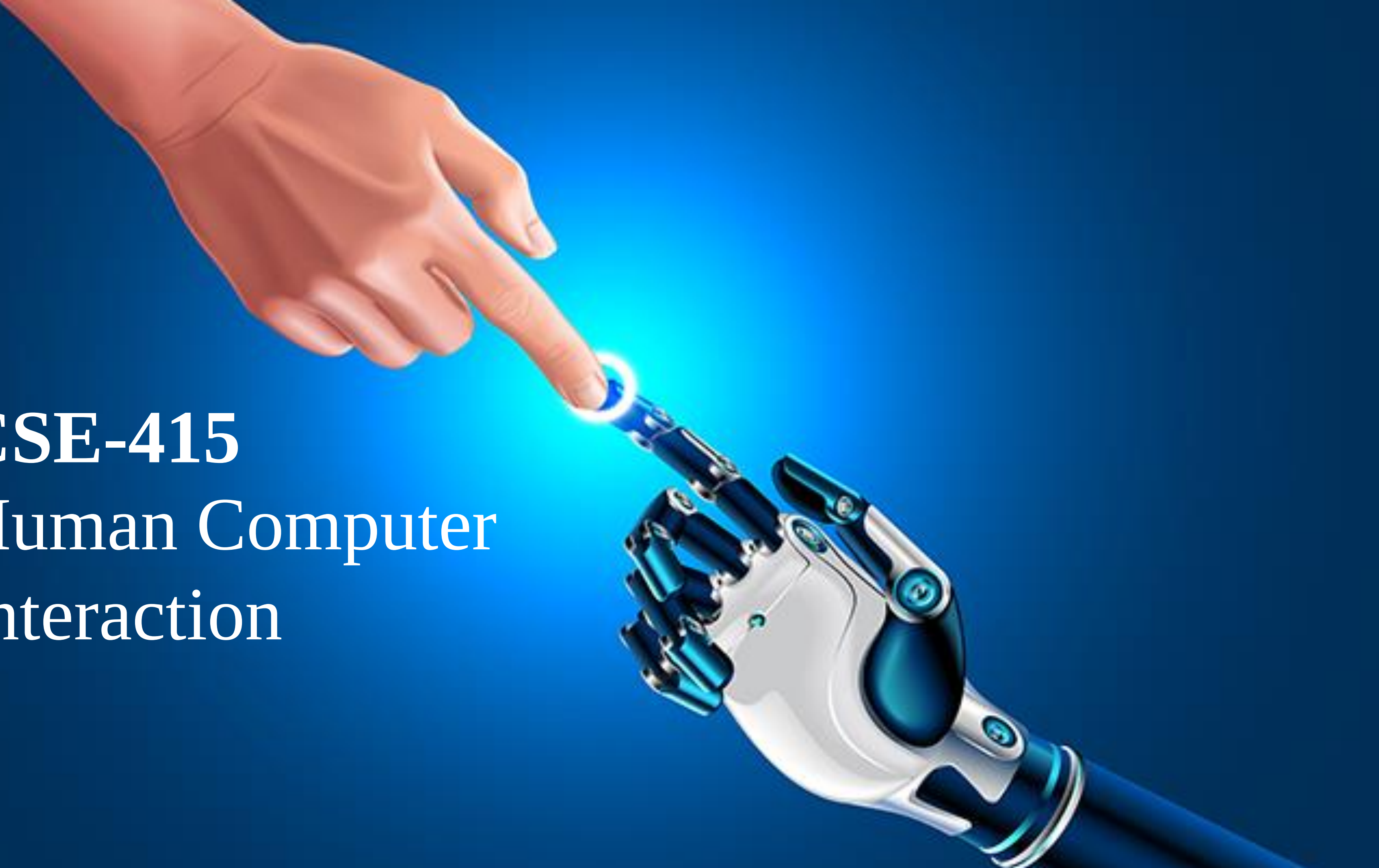


CSE-415

Human Computer Interaction

Course Instructors

- Lt Col Muhammad Nazrul Islam, PhD
- Maj Nazmul Hasan, PhD

Objective of the Course

- To understand the definitions and foundations of the HCI domain.
- To design interfaces and interactive solutions using user-centered techniques.
- To apply evaluation methods, quality factors, and data analysis techniques.
- To explore research frontiers of HCI, including universal design, responsive design and pervasive computing.

Course Outcomes (CO)

- Understand and applying the fundamentals of HCI and Interaction design.
- Analyse the focused users and system requirements, and to design different kind of UIs and Interaction systems for building intuitive usable software solutions.
- Apply (design) evaluation methods for assuring the enhanced usability including effectiveness, efficiency and satisfaction
- Develop the communication skill by presenting topics on HCI.

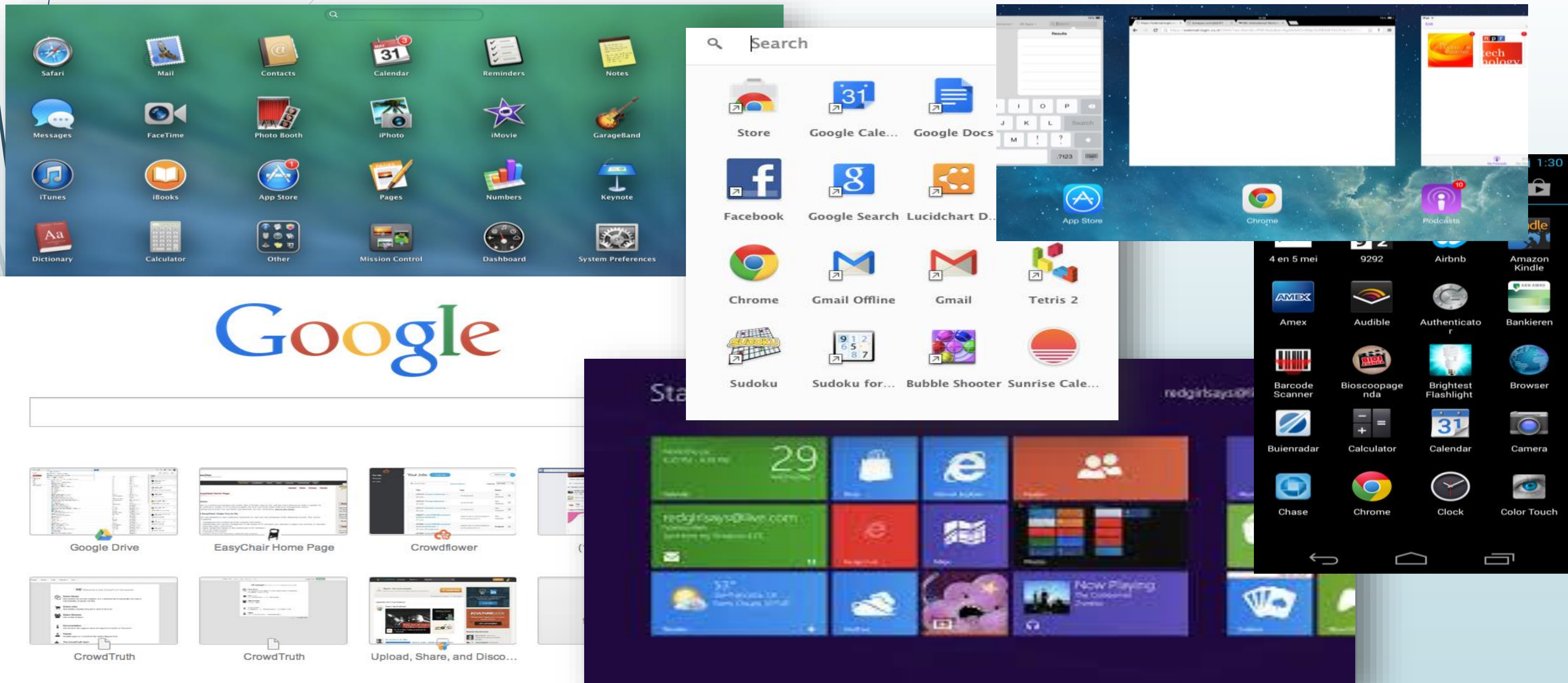
Assessment Strategy

Class Performance	5%
Class Test/Assignment	20%
Mid-Term Assessment (Exam/Project)	10%
Class Attendance	5%
Final Examination (Section A & B)	60%
Total	100%



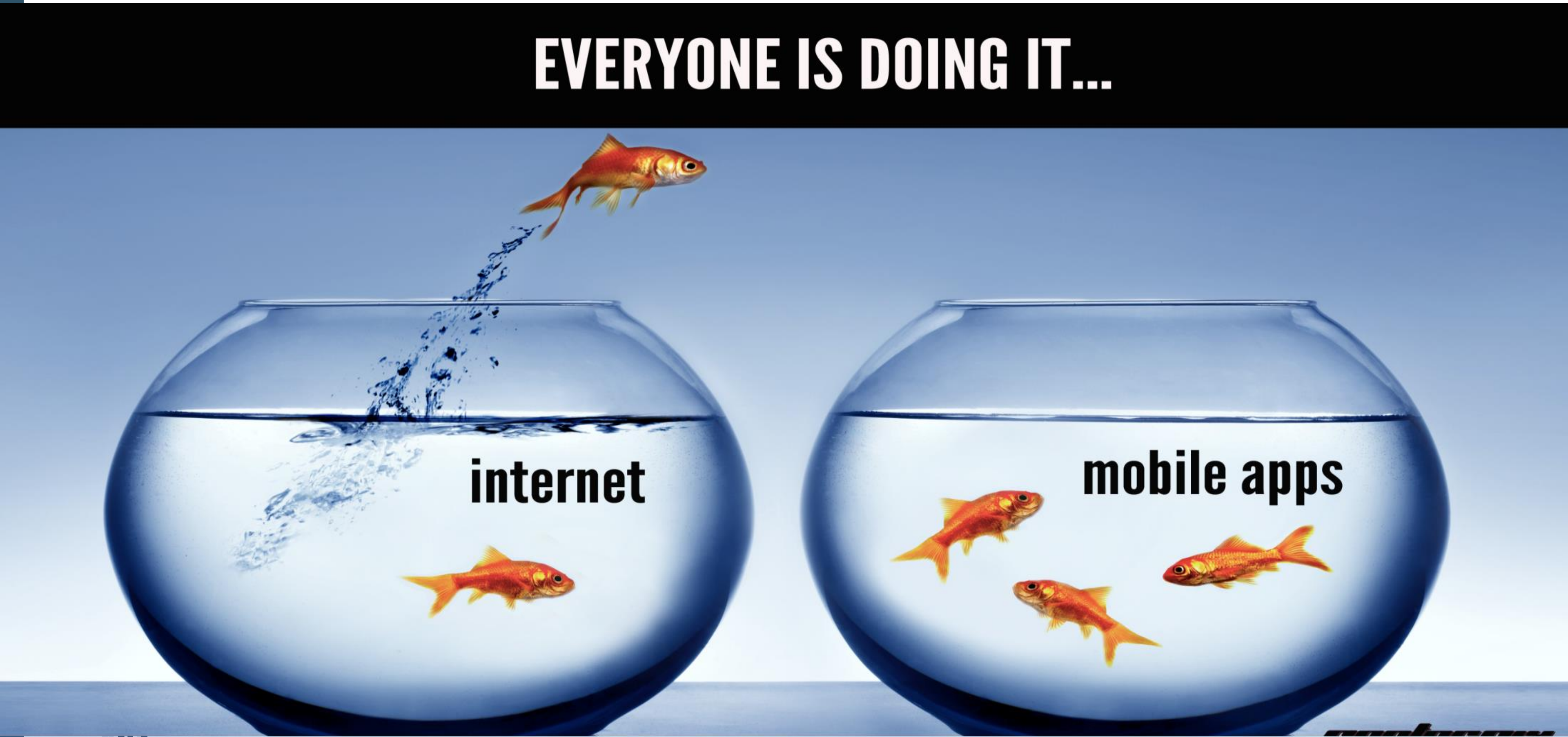
HOW PEOPLE INTERACT WITH COMPUTERS?

Dashboards



Safari
Mail
Contacts
Calendar
Reminders
Notes
Messages
FaceTime
Photo Booth
iPhoto
iMovie
GarageBand
iTunes
iBooks
App Store
Pages
Numbers
Keynote
Dictionary
Calculator
Other
Mission Control
Dashboard
System Preferences
Search
Store
Google Cale...
Google Docs
Facebook
Google Search
Lucidchart D...
Chrome
Gmail Offline
Gmail
Tetris 2
Sudoku
Sudoku for...
Bubble Shooter
Sunrise Cale...
App Store
Chrome
Podcasts
1:30
4 en 5 mei
9292
Airbnb
Amazon Kindle
Amex
Audible
Authenticator
Bankieren
Barcode Scanner
Bioscoopagenda
Brightest Flashlight
Browser
Buienradar
Calculator
Calendar
Camera
Chase
Chrome
Clock
Color Touch
Google
Google Drive
EasyChair Home Page
Crowdflower
CrowdTruth
CrowdTruth
Upload, Share, and Disco...
29
Now Playing


WEB
VS
APPS
SugarSync
Google apps
Start Uploading
Take the Tour
What is Upload Robots?
280 Slides
BillsAreIn
Account Overview

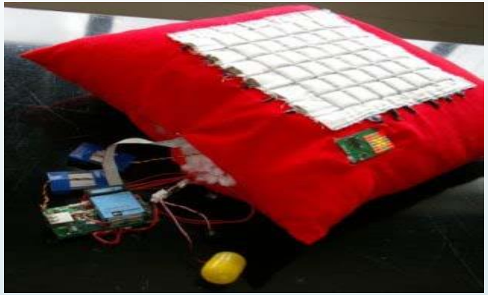

EVERYONE IS DOING IT...
internet
mobile apps

Wearables

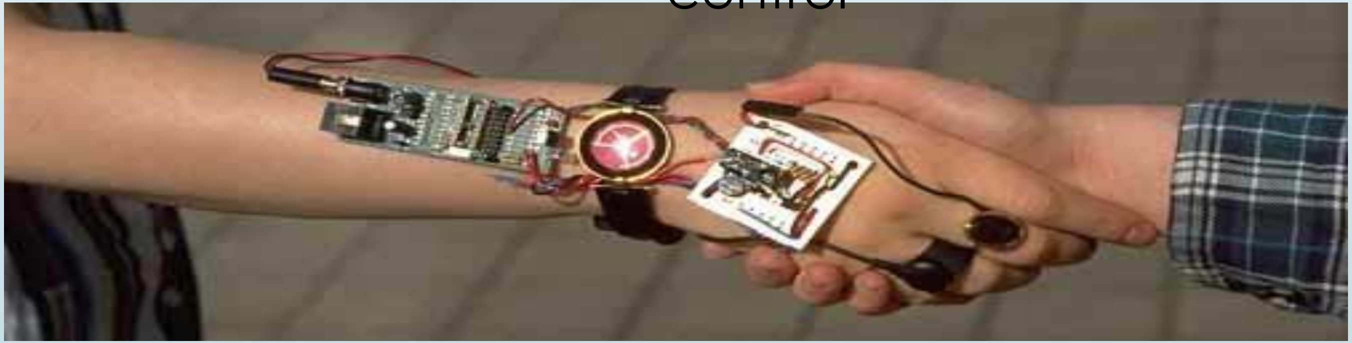
Sensing Affect

Blood Volume Pressure (BVP) earring

Interactive Pillow as a TV remote control

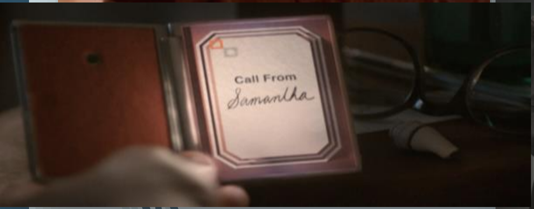


Galvanic Skin Response (GSR) rings and bracelet



Speech, Mobile & Augmented Interaction

“Her” (2014)



“Minority Report” (2002)

“Star Trek: In to the Darkness” (2013)

“Avengers” (2012)

“Star Trek: TOS” (1967)

Virtual Reality

- VR is the use of computer technology to create a simulated environment.
- VR places the user inside an experience instead of viewing a screen in front of them.
- Users are immersed and able to interact with 3D worlds.

Interactive Workspaces

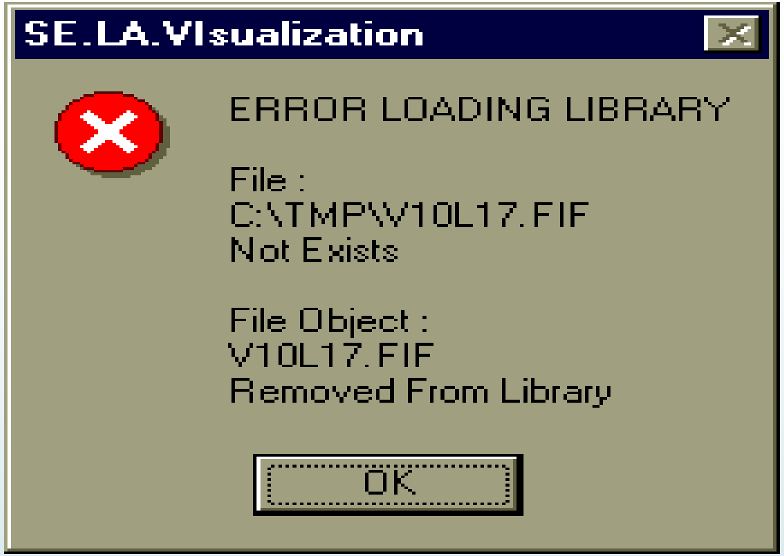
Mimio

Stanford Interactive Workspaces Project

BendDesk

What is HCI?

- What is a user interface?
- Why do we care about design?



- We see this all the time.
  - What's good about the design of this error box?
    - The user knows there is an error
  - What's poor about the design of this error box?
    - Discouraging
    - Not enough information
    - No way to *resolve* the problem (instructions or contact info)

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 HCI (Hewett et al. 1992)

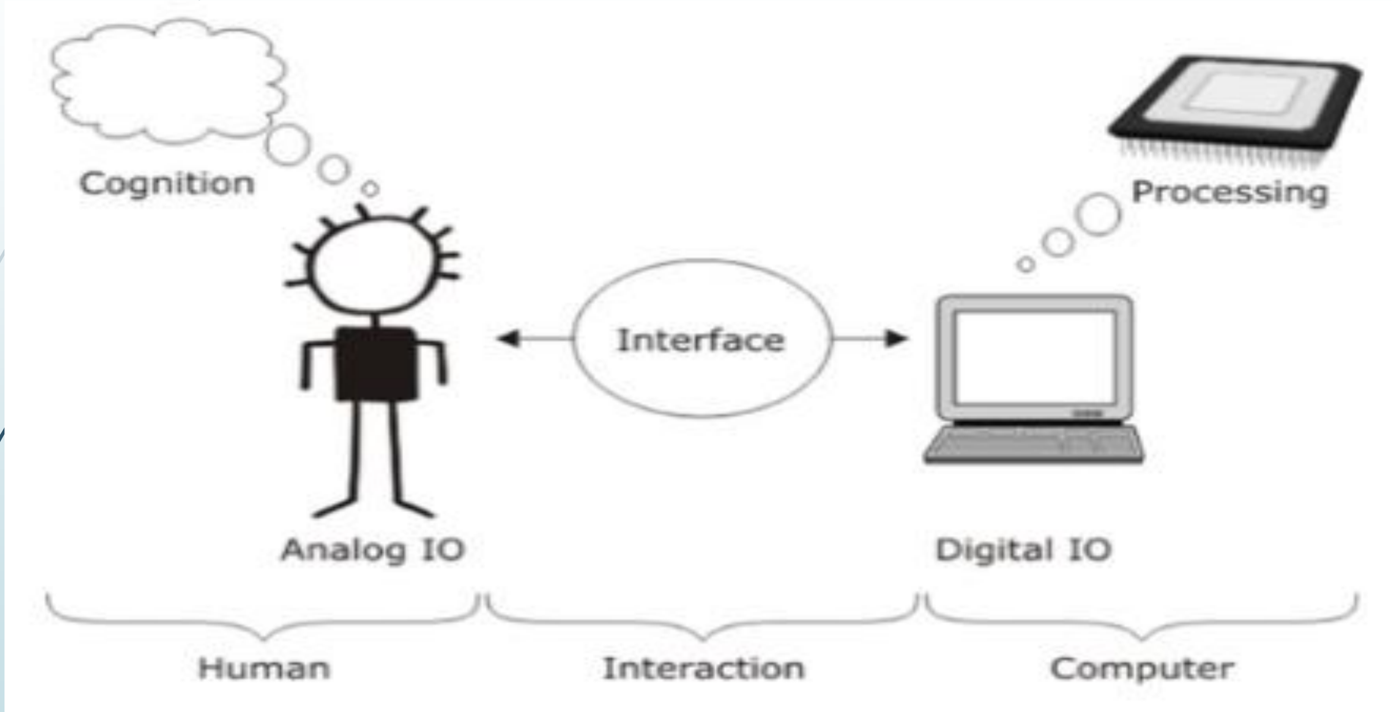
https://dl.acm.org/citation.cfm?id=2594128

Definition of HCI

- HCI studies how a computer systems is designed more practically, more easily, and more intuitively; and it also studies **how users interact** with computer systems.

- HCI can be viewed as two powerful information processors (human and computer) attempting to communicate with each other via a narrow-bandwidth, highly constrained **interface** (Tufte, 1989)

Definition of HCI

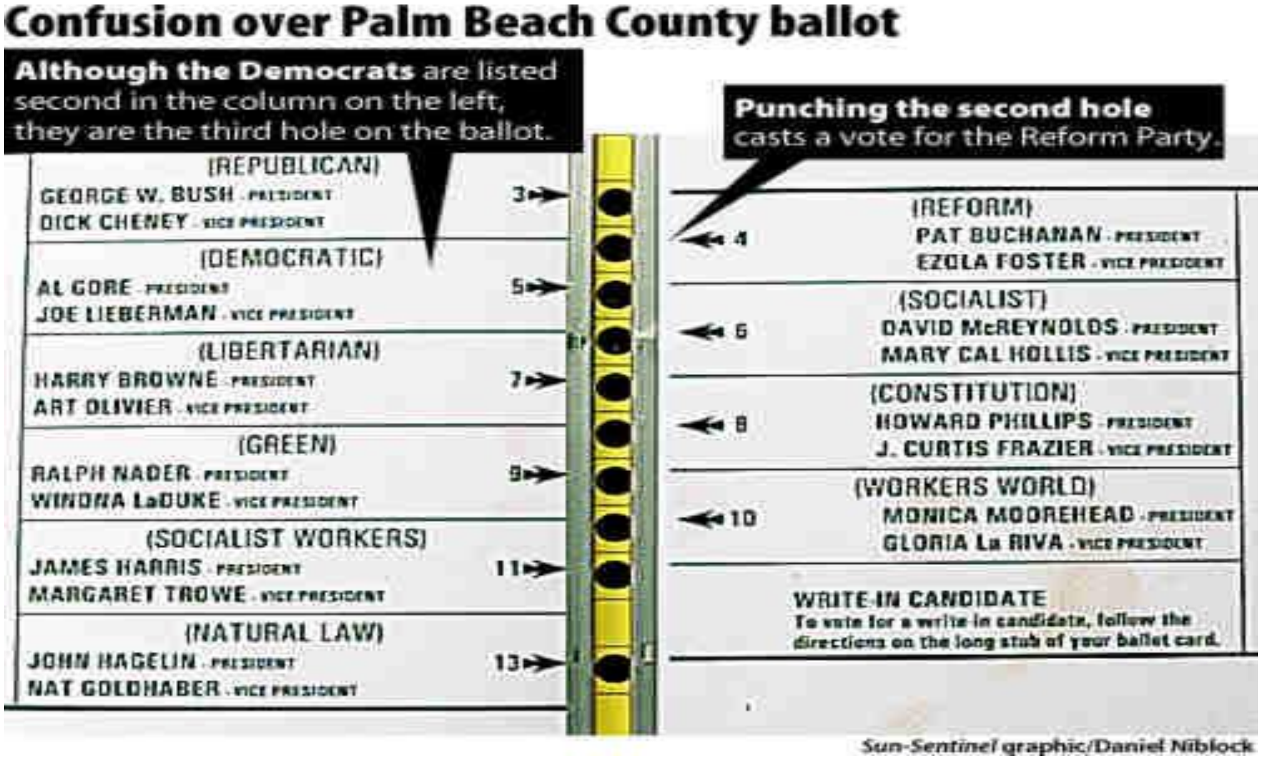


WHY HCI?

Typical Frustrations

- Can′t figure out how to do simple things
- Many not frequently used functions
- Many hidden functions
- Operations outcome not visible
- Can’t remember combinations of digits * #
- How do we know whether it worked
- How can we remember that this option is ON

…elections



The sample ballot looked different

… Additional Context Limitations

- People vote infrequently
- Rushed, uncomfortable circumstances
- Elderly

My Choice

- iPod by Apple Computers
- Pros:
  - portable
  - power
  - ease of use
  - # of controls
- Cons:
  - scratches easily
  - proprietary

Take 5 minutes for everyone to write down one common device with substantial HCI design choices and discuss with the neighbor the pros and cons. How does it affect you or other users?

HCI is Important

- It is not just ‘how big should I make buttons’ or ‘how to layout menu choices’
- (Good/Bad) UI can affect
  - Effectiveness
  - Productivity
  - Satisfaction
  - Safety
  - Learnability
- Example: a car with poor HCI

Bad Interfaces

- ✓ Encumbering
- ✓ Confusing
- ✓ Slow
- ✓ Trust

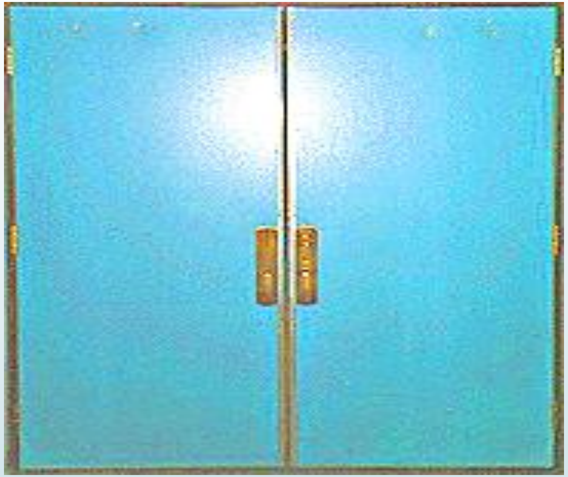
- What makes it hard?
  - Varies by culture
  - Multiple platforms
  - Variety of users

Bad Interface

Bad Interface May Cause Users to:

- need more time for performing their tasks
- make more errors
- feel dissatisfied
- need more time for learning how to use the software
- not learn/use the full functionality of the software
- (if given a choice:) refrain from using the software

- What’s wrong with each?
  - Who is affected
  - Impact
- What’s a redesign solution?



Good UI Design is Important

- Examples of bad UI are easy
  - Try to find examples of good UI
- Good UI *(very subjective):*
  - Easy, natural & engaging interaction
  - Users can carry out their required tasks
  - Accounts for human limitations
- Usefulness is often context-dependent!

Interface Design Goals

- Goals:
  - Usability
  - Universality
  - Usefulness

- Achieved by:
  - Planning
  - Sensitivity to user needs
  - Devotion to requirements analysis
  - Testing

Why HCI?

Lecture Schedule

Week	Lecture	Topics
1	1	Introduction to HCI and Interaction design: HCI, Interaction design, The process of design
	2	User focus, Scenarios, Navigation design
	3	Screen design and layout, Iteration and prototyping.
2	4	HCI in the software process: The software life cycle,
	5	Usability engineering
	6	Iterative design and prototyping, Design rationale.
3	7	Design rules: Principles to support usability, Standards
	8	Guidelines, Golden rules and heuristics
	9	HCI patterns
4	10	Evaluation techniques: What is evaluation? What, why, and when to evaluate, Goals of evaluation
	11	Evaluation through expert analysis
	12	Evaluation through user participation, Choosing an evaluation method.

Lecture Schedule

Week	Lecture	Topics
5	13	Evaluation paradigms and techniques,
	14	The D E C I D E framework to guide evaluation.
	15	The D E C I D E framework to guide evaluation. (Contd.)
6	16	Observing users: Participant observation, ethnography, Data collection
	17	Analyzing, interpreting and presenting data
	18	Qualitative analysis, Feeding the findings back into design
7	19	Asking users and experts: Interviews
	20	Asking users and experts: Questionnaires,
	21	Asking users and experts: Inspections
8	22	Asking users and experts: Inspections (Contd.)
	23	Asking users and experts: walkthroughs.
	24	Asking users and experts: walkthroughs (Contd.)
9	25	Universal design: Universal design principles
	26	Multi-modal interaction
	27	Designing for diversity

Lecture Schedule

Week	Lecture	Topics
10	28	Task analysis: Differences between task analysis and other techniques, Task decomposition
	29	Knowledge-based techniques, Entity-relationship-based techniques
	30	Sources of information and data collection, Uses of task analysis.
11	31	Modeling rich interaction: Status-event analysis, Rich contexts
	32	Low intention and sensor
	33	Low intention and sensor (Contd.)
12	34	Ubiquitous computing and augmented realities: Ubiquitous computing applications research.
	35	virtual and augmented reality
	36	Information and data visualization
13	37	Hypertext, multimedia and the world wide web: Understanding hypertext,
	38	Understanding hypertext(Contd.)
	39	Finding things
14	40	Web technology and issues
	41	Static web content
	42	Dynamic web content

Text and Ref Books

- Julie A. Jacko (Ed.). (2012). Human-Computer Interaction Handbook (3rd Edition). CRC Press. ISBN 1-4398-2943-8
- Alan Dix, Janet Finlay, Gregory Abowd, and Russell Beale (2003): Human–Computer Interaction. 3rd Edition. Prentice Hall, 2003. http://hcibook.com/e3/ ISBN 0-13- 046109-1
- Yvonne Rogers, Helen Sharp, Jenny Preece (2019): Interaction Design: Beyond Human Computer Interaction (5th Edition), John Wiley & Sons.
- Schneiderman B. and Plaisant, C.: Designing the User Interface (5th Edition), Addison-Wesley. Jonathan Lazar, Jinjuan Heidi Feng, & Harry Hochheiser Research Methods in Human-Computer Interaction, Wiley, 2010. ISBN 0-470-72337-8, 978-0-470-72337-1

Thank You

Interaction Design Basics

Lt Col Muhammad Nazrul Islam

Interaction Design Basics

- design:
  - what it is, interventions, goals, constraints
- the design process
  - what happens when
- users
  - who they are, what they are like …
- scenarios
  - rich stories of design
- navigation
  - finding your way around a system
- iteration and prototypes
  - never get it right first time!

Interactions and Interventions

- Not just thinking about the design of interactive systems, but about the interaction itself. Design interactions not just interfaces, not just the immediate interaction…….
  - e.g. stapler in office – technology changes interaction style
    - manual: write, print, staple, write, print, staple, …
    - electric: write, print, write, print, …, staple
    - The stapler influences the whole pattern of interaction
- Designing interactions not just artefacts that is produced, but also
    - Understanding and choosing how that is going to affect the way people work.
    - documentation, manuals, tutorials
    - what we say and do as well as what we make

It is better not to think of designing a system, or an artifact, but to think instead about 'designing interventions'. □ intervene to change the situation as it is for the better!!

what is design?

what is design?

achieving goals within constraints

- goals - purpose
  - who is it for, why do they want it
- constraints
  - materials, platforms
- trade-offs
  - Choosing which goals or constraints can be relaxed so that others can be met. Ex. eye-mounted video display

Golden Rule of Design

understand your materials

(chair-steel frame/ wooden frame)

understand your materials

- understand computers
  - limitations, capacities, tools, platforms
- understand people
  - psychological, social aspects
  - human error
- and their interaction …

To err is human

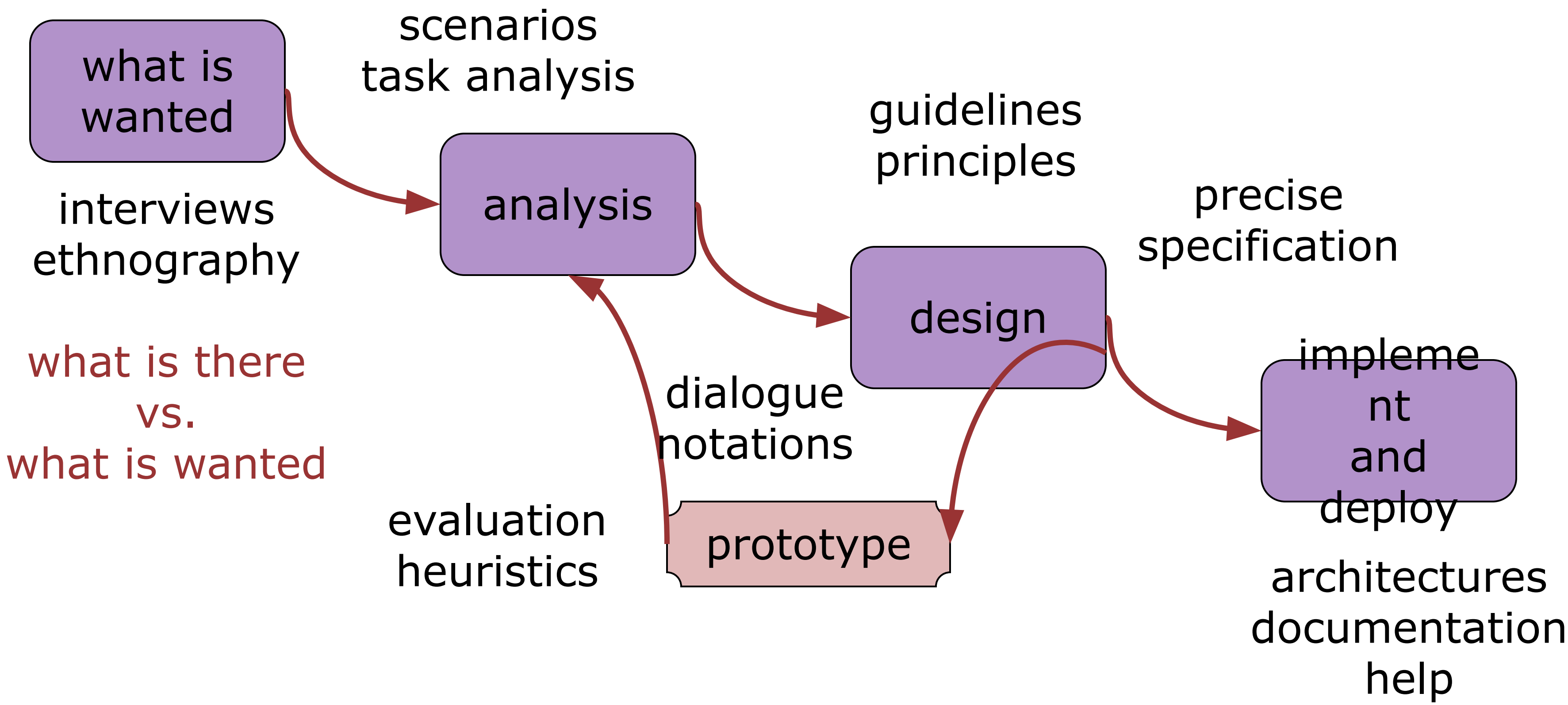
- accident reports ..
  - aircrash, industrial accident, hospital mistake
  - enquiry … blames … 'human error'
- but …
  - concrete lintel breaks because too much weight/ building collapse
  - blame 'lintel error' ?
    … no – design error
        we know how concrete behaves under stress
- human 'error' is normal
  - we know how users behave under stress
  - so design for it!
- treat the user at least as well as physical materials!

Central message …

the user

put the user first, keep the user in the center and remember the user at the end

The Process of Design



Steps …

- requirements
  - what is there and what is wanted …
- analysis
  - ordering and understanding
- design
  - what to do and how to decide
- iteration and prototyping
  - getting it right … and finding what is really needed!
- implementation and deployment
  - making it and getting it out there

… but how can I do it all ! !

- limited time ⇒ design trade-off (length of a design period and the quality of the final design)

- usability?
  - finding problems and fixing them?
  - deciding what to fix?

- a perfect system is badly designed
  - too good ⇒ too much effort in design

user focus

know your user

personae

cultural probes

know your user

- who are they?
- probably <u>not</u> like you!
- talk to them
- watch them
- use your imagination --- Persona

persona

- description of an ‘example’ user
  - not necessarily a real person
- use as surrogate/substitute user
  - what would Betty think
- details matter
  - makes her ‘real’

example persona

Betty is 37 years old, She has been Warehouse Manager for five years and worked for Simpkins Brothers Engineering for twelve years. She didn't go to university, but has studied in her evenings for a business diploma. She has two children aged 15 and 7 and does not like to work late. She did part of an introductory in-house computer course some years ago, but it was interrupted when she was promoted and could no longer afford to take the time. Her vision is perfect, but her right-hand movement is slightly restricted following an industrial accident 3 years ago. She is enthusiastic about her work and is happy to delegate responsibility and take suggestions from her staff. However, she does feel threatened by the introduction of yet another new computer system (the third in her time at SBE).

cultural probes

- direct observation
  - sometimes hard
    - in the home
    - psychiatric patients, …
- probe packs
  - items to prompt responses
    - e.g. glass to listen at wall, camera, postcard
  - given to people to open in their own environment
    they record what is meaningful *to them*
- used to …
  - inform interviews, prompt ideas, enculture designers

scenarios

stories for design use and reuse

scenarios

- stories for design
  - communicate with others
  - validate other models
  - understand dynamics
- linearity
  - time is linear - our lives are linear
  - but don't show alternatives

scenarios …

- what will users want to do?
- step-by-step walkthrough
  - what can they see (sketches, screen shots)
  - what do they do (keyboard, mouse etc.)
  - what are they thinking?
- use and reuse throughout design

scenario – movie player

Brian would like to see the new film "Moments of Significance" and wants to invite Alison, but he knows she doesn't like "arty" films. He decides to take a look at it to see if she would like it and so connects to one of the movie sharing networks. He uses his work machine as it has a higher bandwidth connection, but feels a bit guilty. He knows he will be getting an illegal copy of the film, but decides it is OK as he is intending to go to the cinema to watch it. After it downloads to his machine he takes out his new personal movie player. He presses the 'menu' button and on the small LCD screen he scrolls using the arrow keys to 'bluetooth connect' and presses the select button. On his computer the movie download program now has an icon showing that it has recognised a compatible device and he drags the icon of the film over the icon for the player. On the player the LCD screen says "downloading now", a percent done indicator and small whirling icon. … … …

also play act …

- mock up device (sketches and pictures story boards)
- pretend you are doing it
- internet-connected swiss army knife …

use toothpick as stylus

but where is that thumb?

… explore the depths

- explore interaction
  - what happens when
- explore cognition
  - what are the users thinking
- explore architecture
  - what is happening inside

use scenarios to ..

- communicate with others
  - designers, clients, users
- validate other models
  - ‘play’ it against other models
- express dynamics
  - screenshots – appearance
  - scenario – behaviour

linearity

Scenarios – one linear path through system

Pros:

- life and time are linear
- easy to understand (stories and narrative are natural)
- concrete (errors less likely)

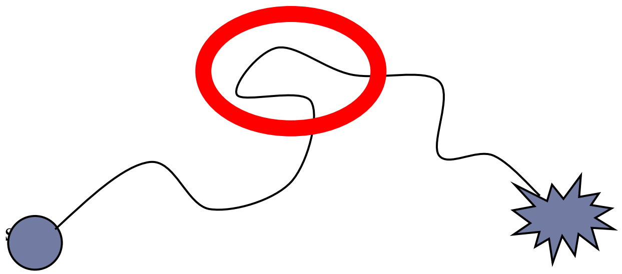
Cons:

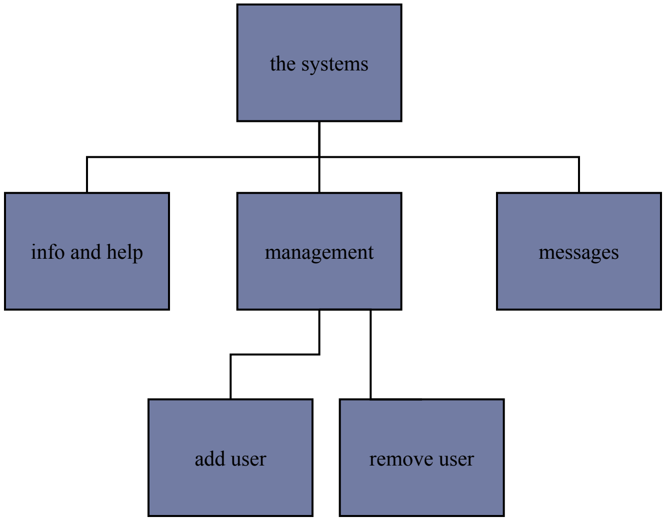
- no choice, no branches, no special conditions
- miss the unintended

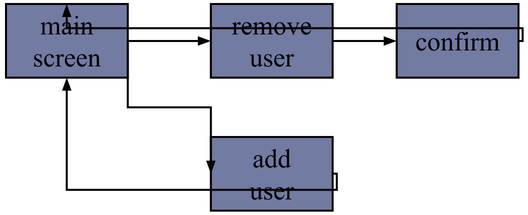
- So:
  - use several scenarios
  - use several methods

navigation design

local structure – single screen
global structure – whole site







Levels of Interaction

- widget choice
  - menus, buttons etc.
- screen design
- application navigation design
- environment
  - other apps, O/S

the web …

- widget choice
- screen design
- navigation design
- environment

- elements and tags
  - `<a href="...">`
- page design
- site structure
- the web, browser, external links

physical devices

- widget choice
- screen design
- navigation design
- environment

- controls
  - buttons, knobs, dials
- physical layout
- modes of device
- the real world

think about structure

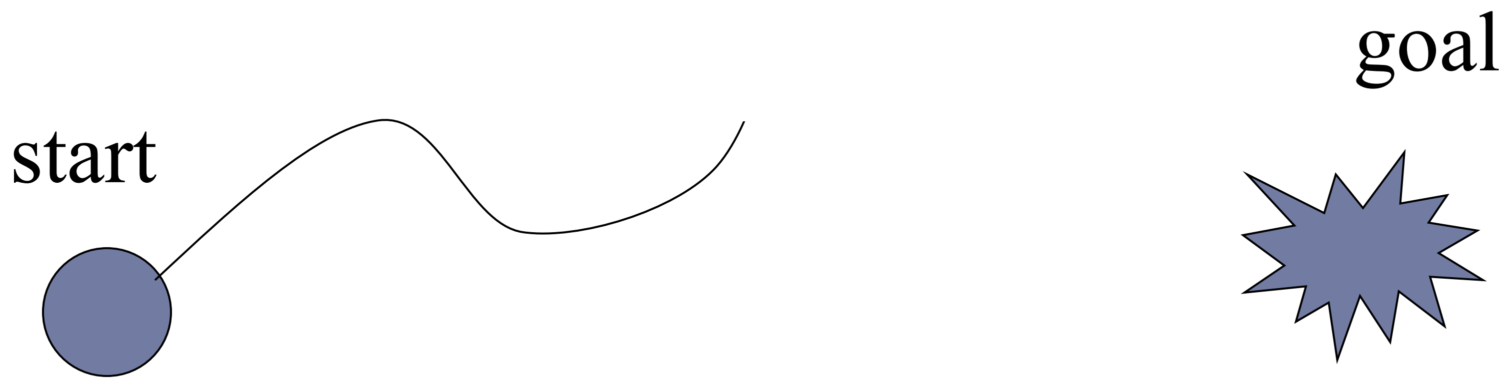
- local
  - looking from this screen/page out
- global
  - structure of site, movement between screens

Local

from one screen looking out

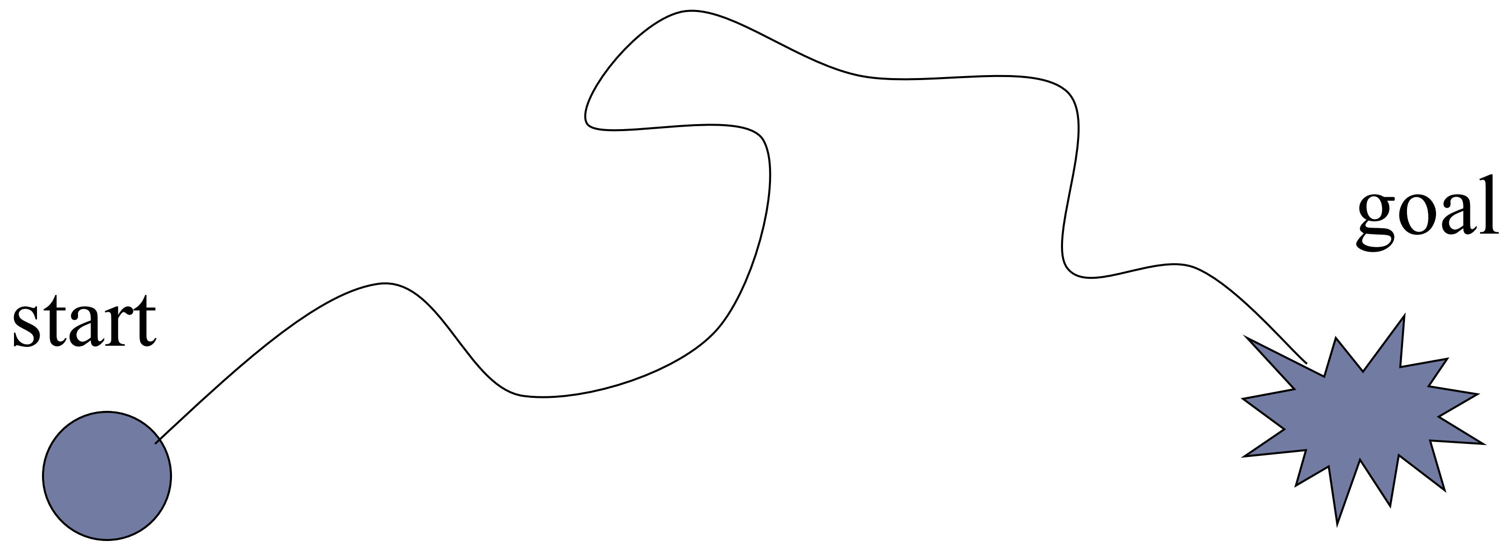
goal seeking

goal seeking



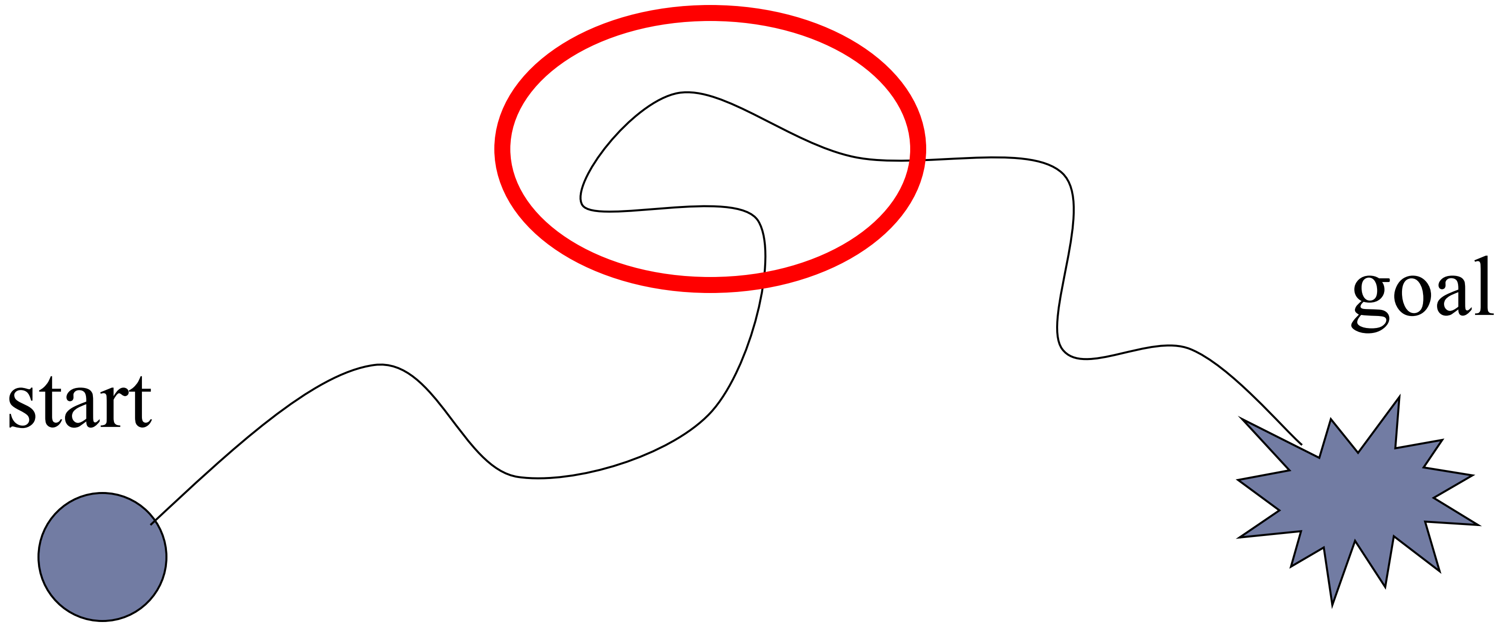
progress with local knowledge only ...

goal seeking



… but can get to the goal

goal seeking



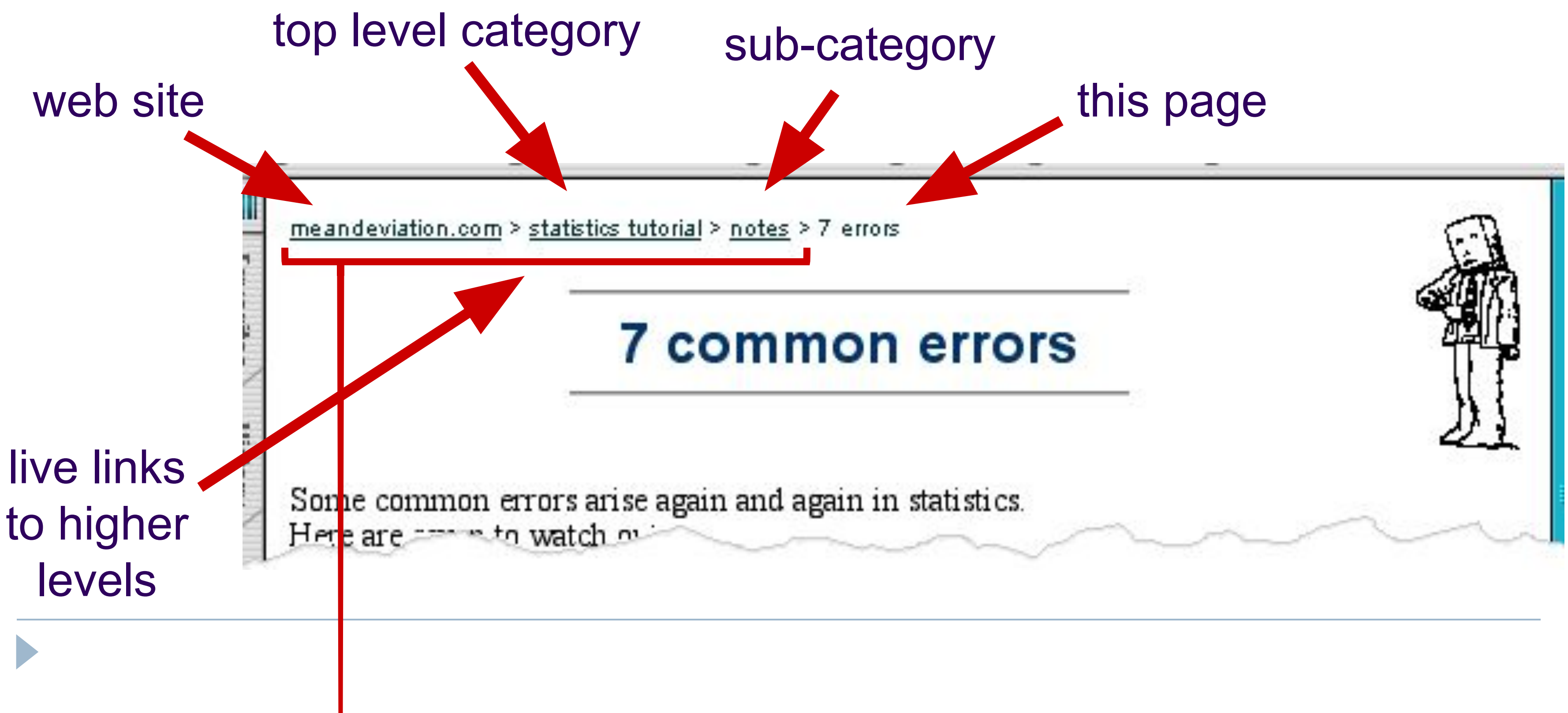
… try to avoid these bits!

four golden rules

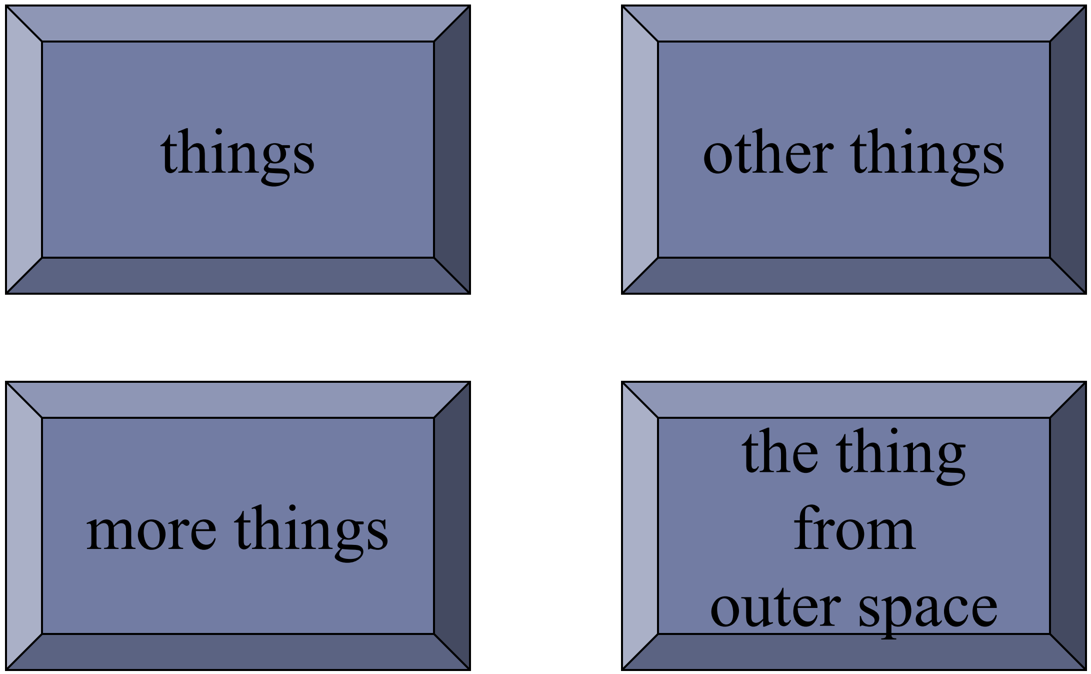
- knowing where you are
- knowing what you can do
- knowing where you are going
  - or what will happen
- knowing where you've been
  - or what you've done

where you are – breadcrumbs

- shows path through web site hierarchy



beware the big button trap

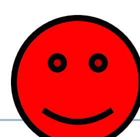


- where do they go?
  - lots of room for extra text!

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

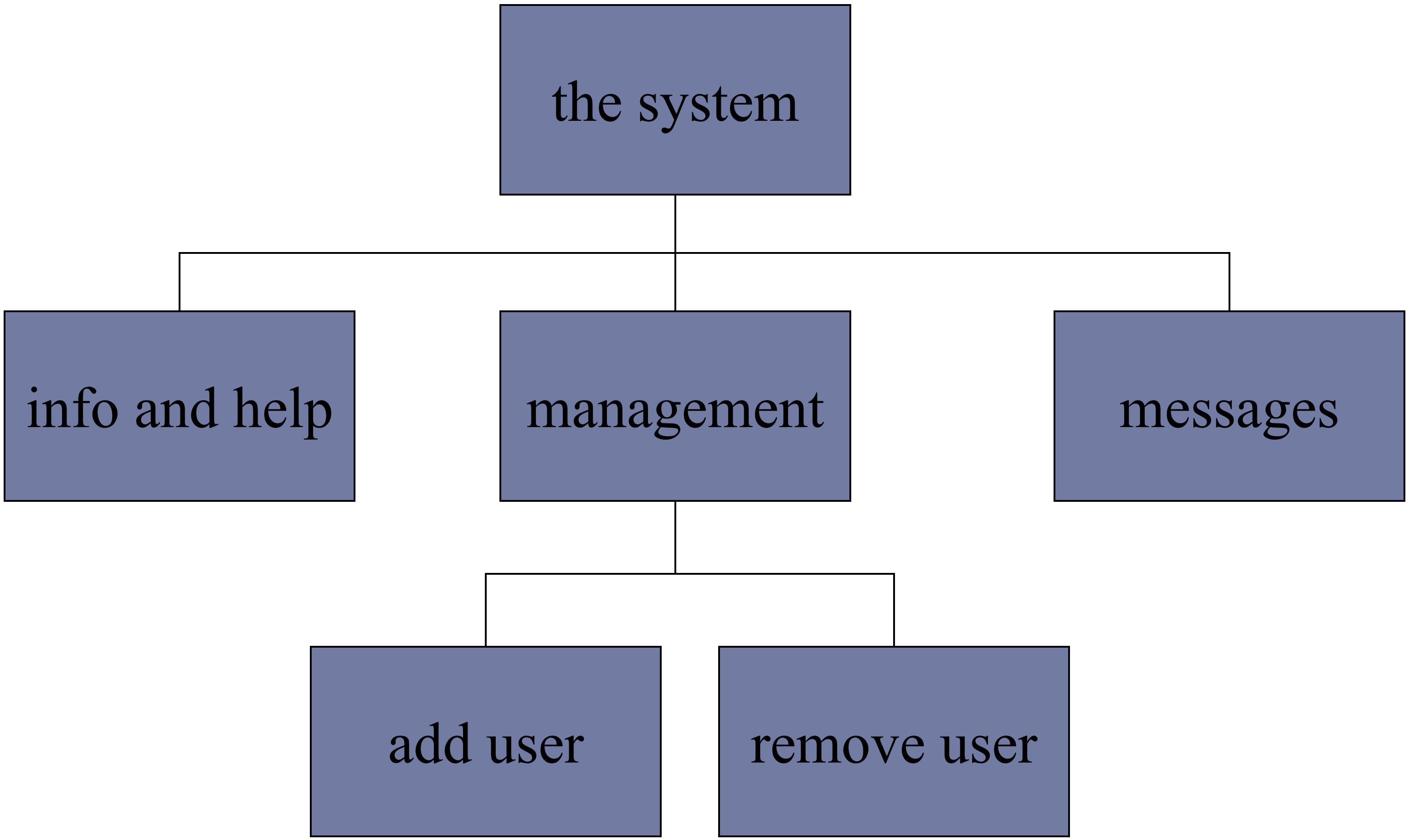
  … oops !



Global

between screens within the application

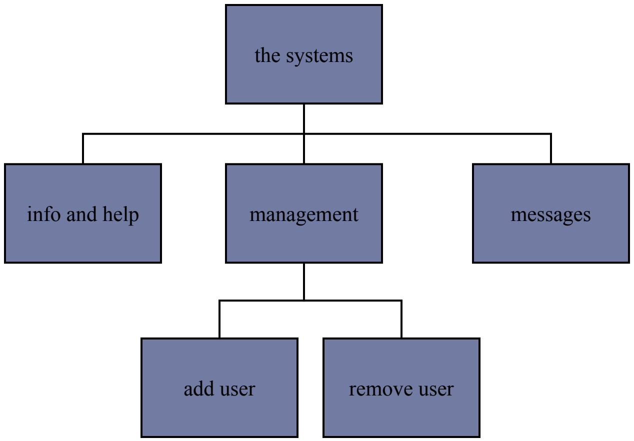
hierarchical diagrams



hierarchical diagrams ctd.

- parts of application
  - screens or groups of screens

- typically functional separation



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

see /e3/online/menu-breadth/

think about dialogue

what does it mean in UI design?

Minister: do you *name* take this woman …
Man: I do
Minister: do you *name* take this man …
Woman: I do
Minister: I now pronounce you man and wife

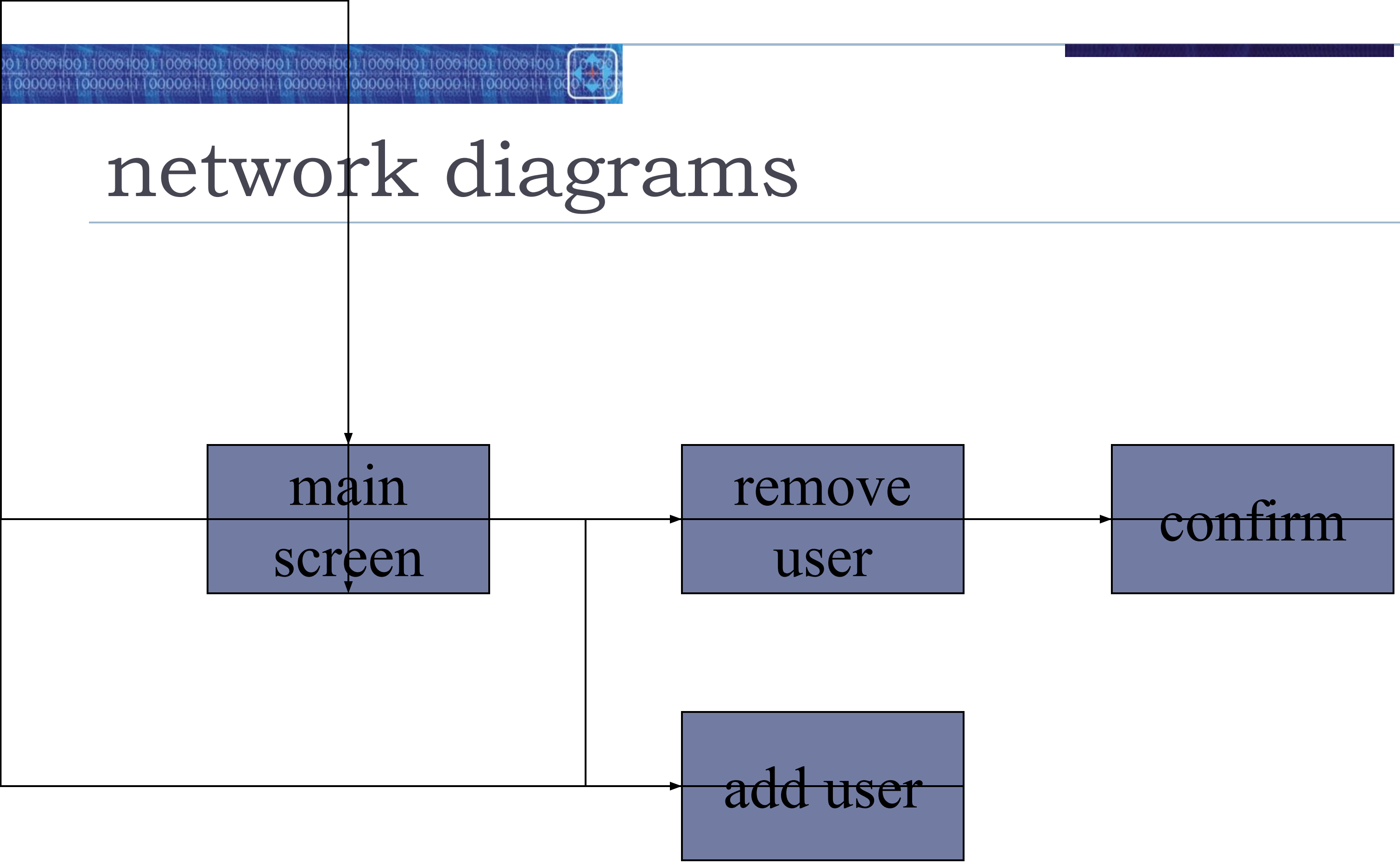
think about dialogue

what does it mean in UI design?

Minister: do you *name* take this woman …

- marriage service
  - general flow, generic – blanks for names
  - pattern of interaction between people
- computer dialogue
  - pattern of interaction between users and system
  - but details differ each time

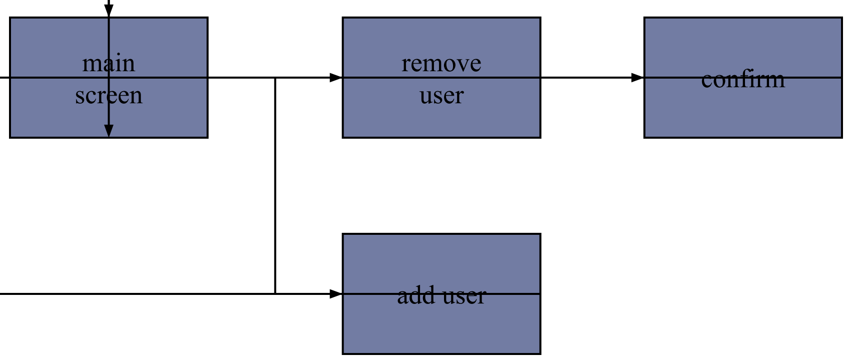
network diagrams



- show different paths through system

network diagrams ctd.

- what leads to what
- what happens when
- including branches
- more task oriented then hierarchy



wider still

between applications

and beyond …

wider still …

- style issues:
  - platform standards, consistency
- functional issues
  - cut and paste
- navigation issues
  - embedded applications
  - links to other apps … the web

Screen Design & Layout

basic principles
grouping, structure, order
alignment
use of white space

Basic Principles

- Ask : What is the user doing?
- Think: What information is required? What comparisons may the user need to make? In what order are things likely to be needed?
- Design: Form follows function: let the required interactions drive the layout.

Available tools

- grouping of items
- order of items
- decoration - fonts, boxes etc.
- alignment of items
- white space between items

grouping and structure

logically together ⇒ physically together

Billing details:
Name
Address: …
Credit card no

Delivery details:
Name
Address: …
Delivery time

Order details:

item	quantity	cost/item	cost
`size 10 screws (boxes)`	`7`	`3.71`	`25.97`
……	…	…	…

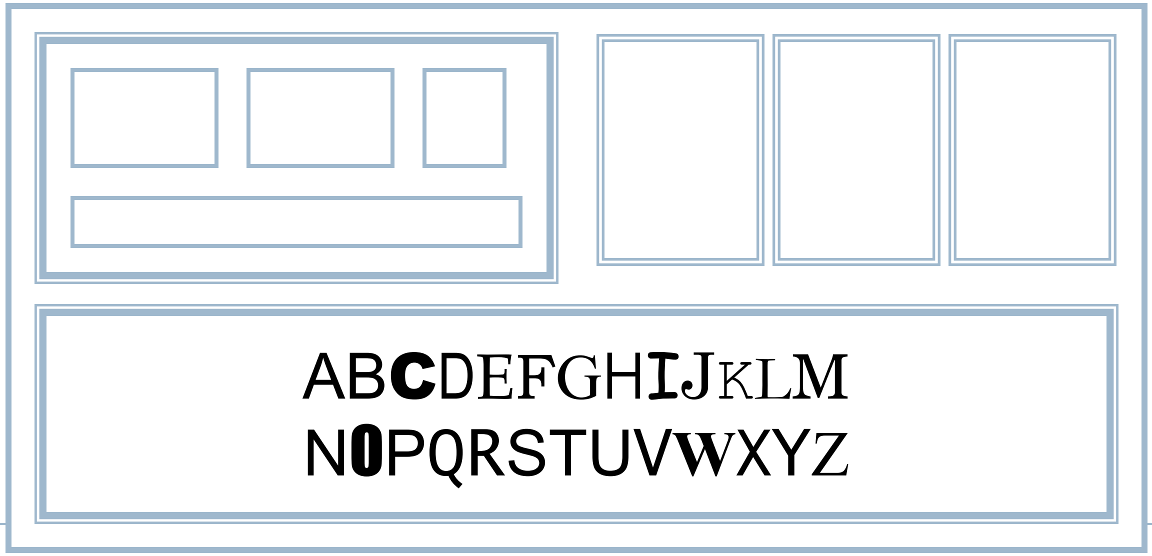
order of groups and items

- think! - what is natural order
- should match screen order!
  - use boxes, space etc.
  - set up tabbing right!
- instructions
  - beware the cake recipie syndrome!

    … mix milk and flour, add the fruit
    after beating them

decoration

- use boxes to group logical items
- use fonts for emphasis, headings
- but not too many!!



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

Alan	Dix
Janet	Finlay
Gregory	Abowd
Russell	Beale

Dix , Alan
Finlay, Janet
Abowd, Gregory
Beale, Russell

alignment - numbers

think purpose!

which is biggest?

532.56
179.3
256.317
15
73.948
1035
3.142
497.6256

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:

  (often hard to avoid with large data base fields)

sherbert   75
toffee 120
chocolate 35
fruit gums 27
coconut dreams 85

multiple columns - 2

- use leaders

sherbert 75 ____________________
toffee 120 ____________________
chocolate 35 ____________________
fruit gums 27 ____________________
coconut dreams 85 ____________________

multiple columns - 3

- or greying (vertical too)

sherbert	75
toffee	120
chocolate	35
fruit gums	27
coconut dreams	85

multiple columns - 4

- or even (with care!) ‘bad’ alignment

sherbert 75
toffee 120
chocolate 35
fruit gums 27
coconut dreams 85

white space - the counter

WHAT YOU SEE

white space - the counter

WHAT YOU SEE

THE GAPS BETWEEN

space to separate

space to structure

space to highlight

physical controls

- grouping of items
  - defrost settings
  - type of food

defrost settings

type of food

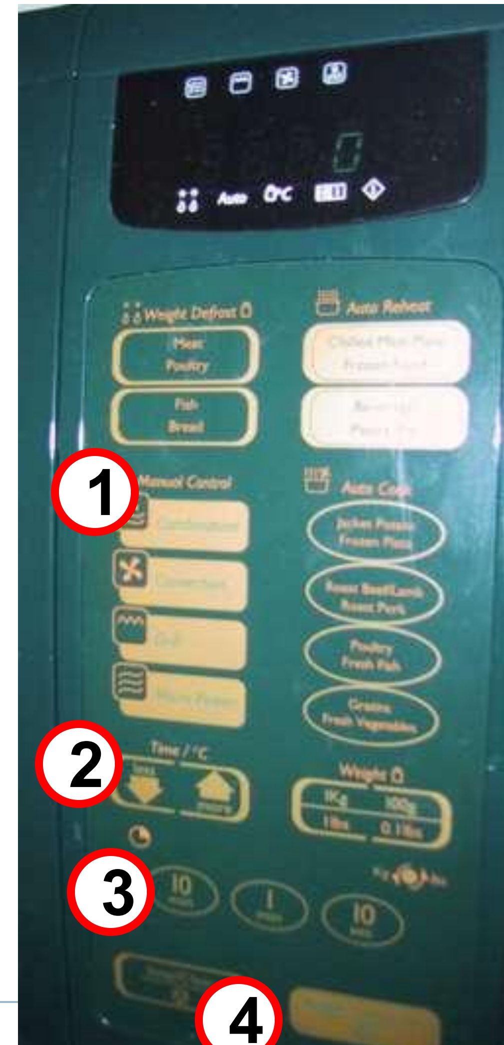
time to cook

physical controls

- grouping of items
- order of items

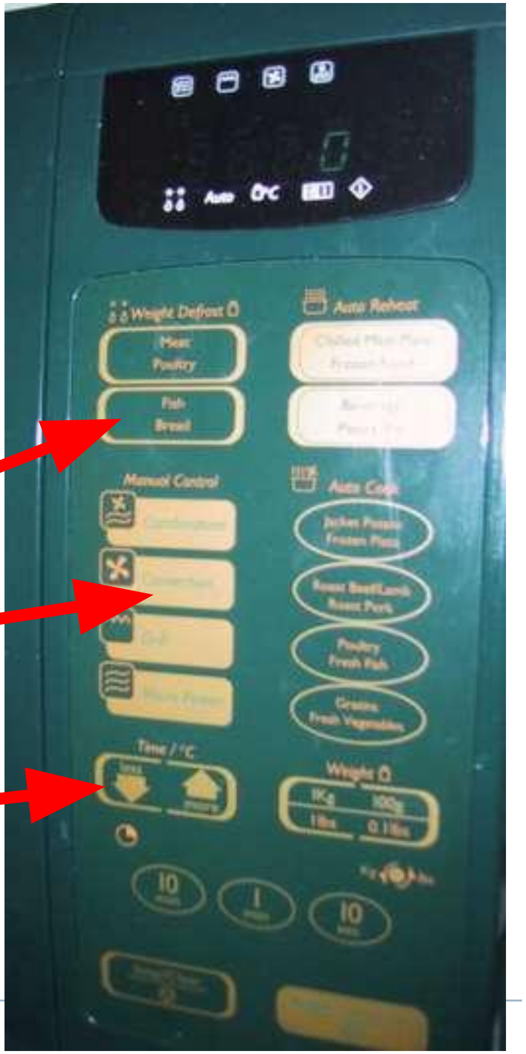
1) type of heating
2) temperature
3)
4)

1) type of heating
2) temperature
3) time to cook
4) start



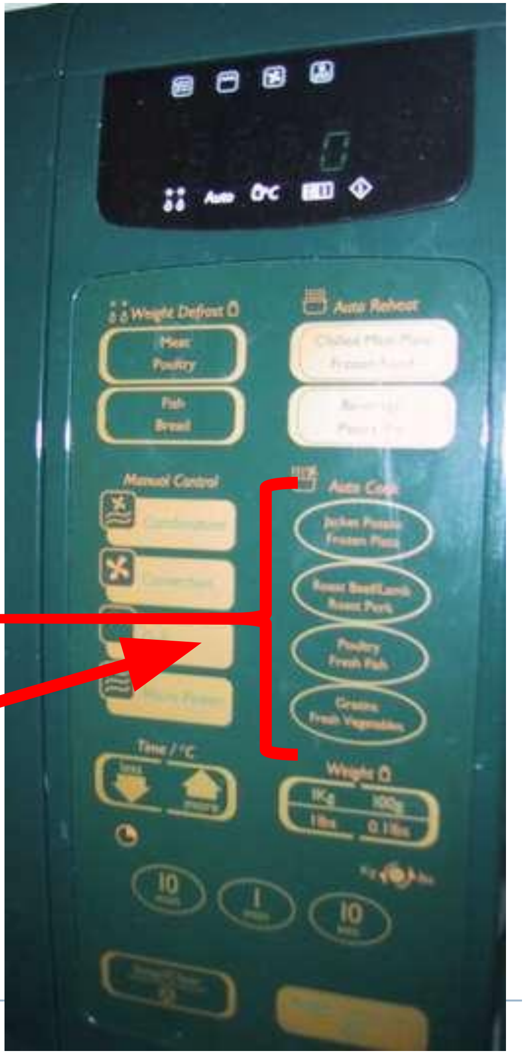
physical controls

- grouping of items
- order of items
- decoration
  - different colours for different functions
  - different colours for different functions
  - lines around related buttons (temp up/down)



physical controls

- grouping of items
- order of items
- decoration
- alignment
  - centered text in buttons
    ? easy to scan ?



centred text in buttons

? easy to scan ?

ALAN DIX, JANET FINLAY,
GREGORY D. ABOWD, RUSSELL BEALE
HUMAN-COMPUTER
INTERACTION
THIRD EDITION

physical controls

- grouping of items
- order of items
- decoration
- alignment
- white space
  - gaps to aid grouping

gaps to aid grouping

User Action & Control

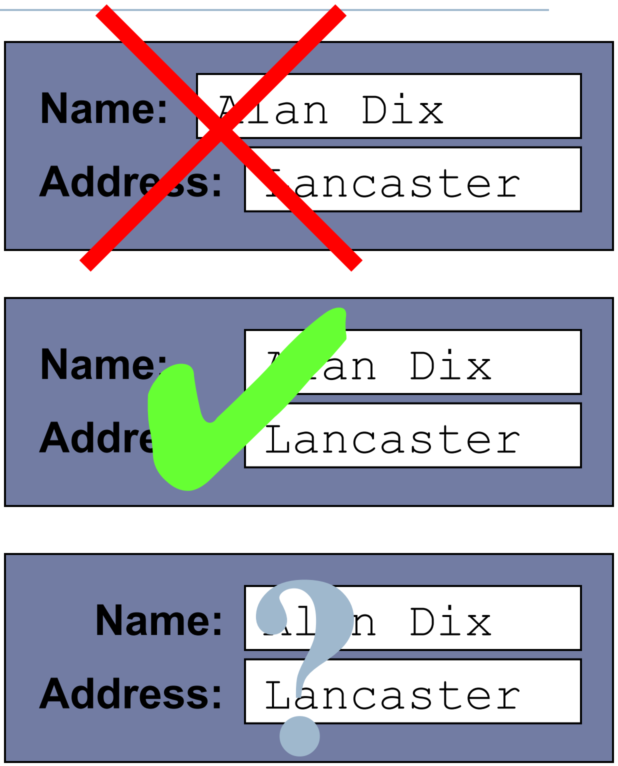
Entering information

Knowing what to do

Affordances

Entering information

- Forms, dialogue boxes
  - presentation + data input
  - similar layout issues
  - alignment
- Logical layout
  - use task analysis (ch15)
  - groupings
  - natural order for entering information
    - top-bottom, left-right (depending on culture)
    - set tab order for keyboard entry



knowing what to do

- What is active & what is passive
  - where do you click
  - where do you type
- Consistent style helps
  - e.g. web underlined links
- Labels and icons
  - standards for common actions (e.g., save, print)
  - language – bold = current state or action

Affordances

- psychological term
- for physical objects
  - shape and size suggest actions
    - pick up, twist, throw
  - also cultural – buttons 'afford' pushing
- for screen objects
  - button–like object 'affords' mouse click
  - physical-like objects suggest use
- culture of computer use
  - icons 'afford' clicking
  - or even double clicking … not like real buttons!

mug handle

'affords' grasping

Appropriate Appearance

Presenting Information

Aesthetics and Utility

Colour and 3D

Localisation & Internationalisation

Presenting information

- purpose matters
  - sort order (which column, numeric alphabetic)
  - text vs. diagram
  - scatter graph vs. histogram
- but add interactivity
  - softens design choices
    - e.g. re-ordering columns
    - ‘dancing histograms’ (chap 21)

name	size
chap10	12
chap5	16
chap1	17
chap14	22
chap20	27
chap8	32
…	…

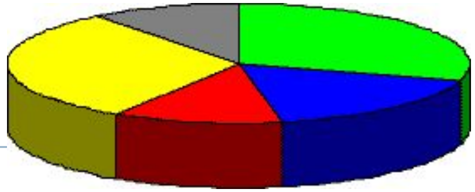
Aesthetics and Utility

- aesthetically pleasing designs
  - increase user satisfaction and improve productivity
- beauty and utility may conflict
  - mixed up visual styles ⇒ easy to distinguish
  - clean design – little differentiation ⇒ confusing
  - backgrounds behind text
    … good to look at, but hard to read
- but can work together
  - e.g. the design of the counter
  - in consumer products – key differentiator (e.g. iMac)

colour and 3D

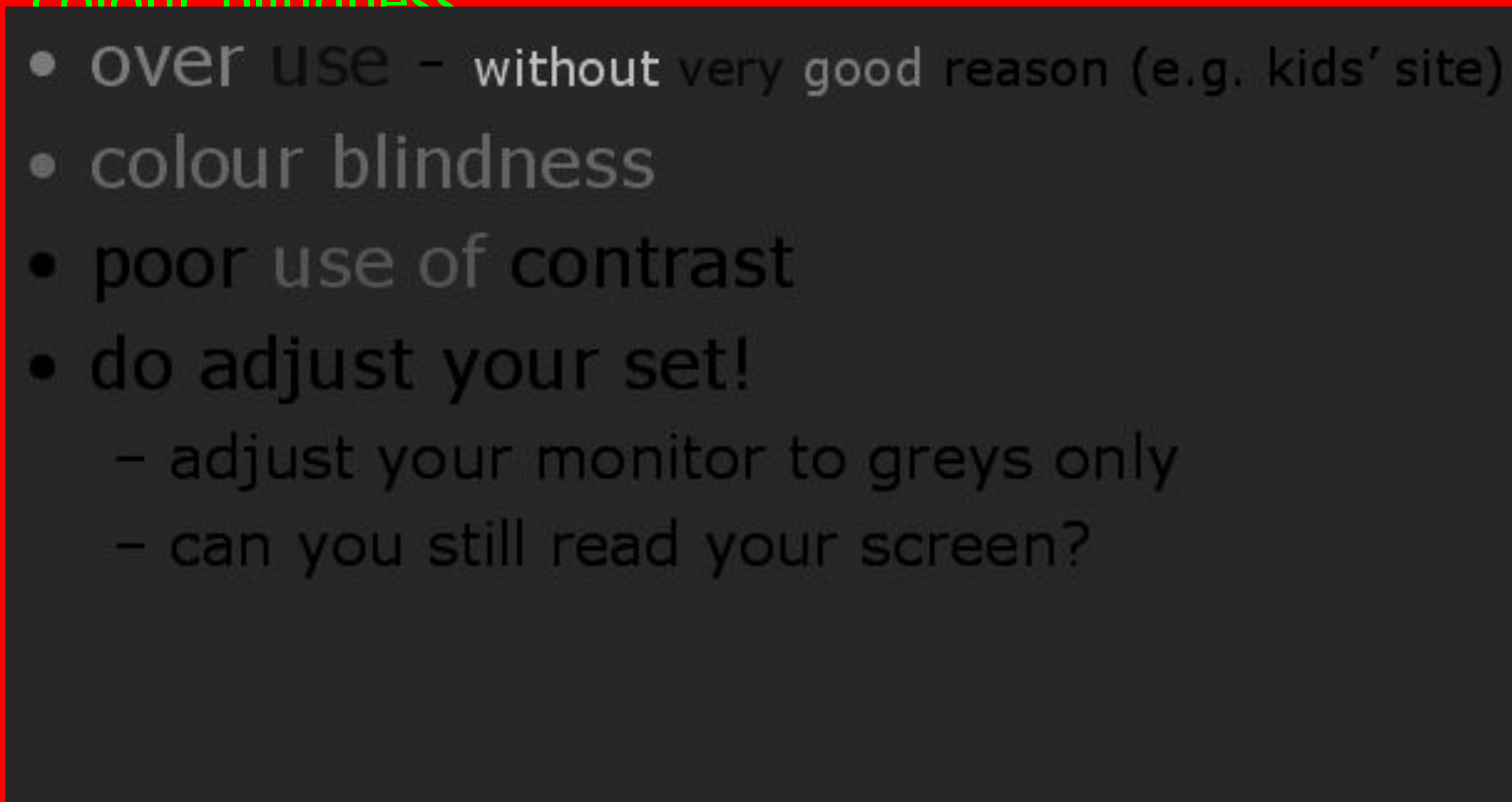
- both often used very badly!
- colour
  - older monitors limited palette
  - colour over used because ‘it is there’
  - beware colour blind!
  - use sparingly to reinforce other information
- 3D effects
  - good for physical information and some graphs
  - but if over used …

    e.g. text in perspective!! 3D pie charts



bad use of colour

- over use - without very good reason (e.g. kids' site)
- colour blindness



across countries and cultures

- localisation & internationalisation
  - changing interfaces for particular cultures/languages
- globalisation
  - try to choose symbols etc. that work everywhere

- simply change language?
  - use ‘resource’ database instead of literal text
    … but changes sizes, left-right order etc.
- deeper issues
  - cultural assumptions and values
  - meanings of symbols
  - e.g tick and cross … +ve and -ve in some cultures
    … but … mean the same thing (mark this) in others

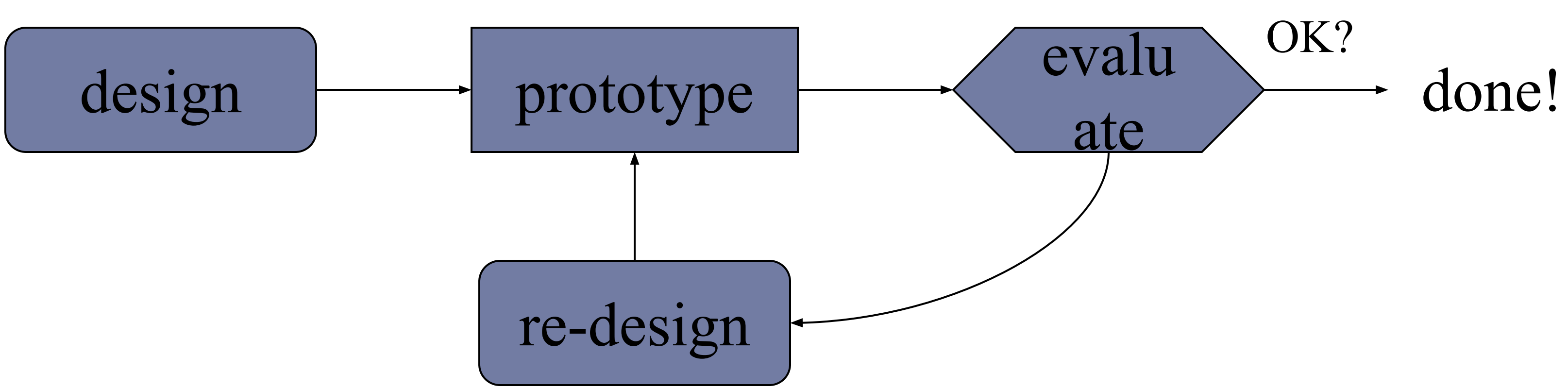
prototyping

iteration and prototyping

getting better …
… and starting well

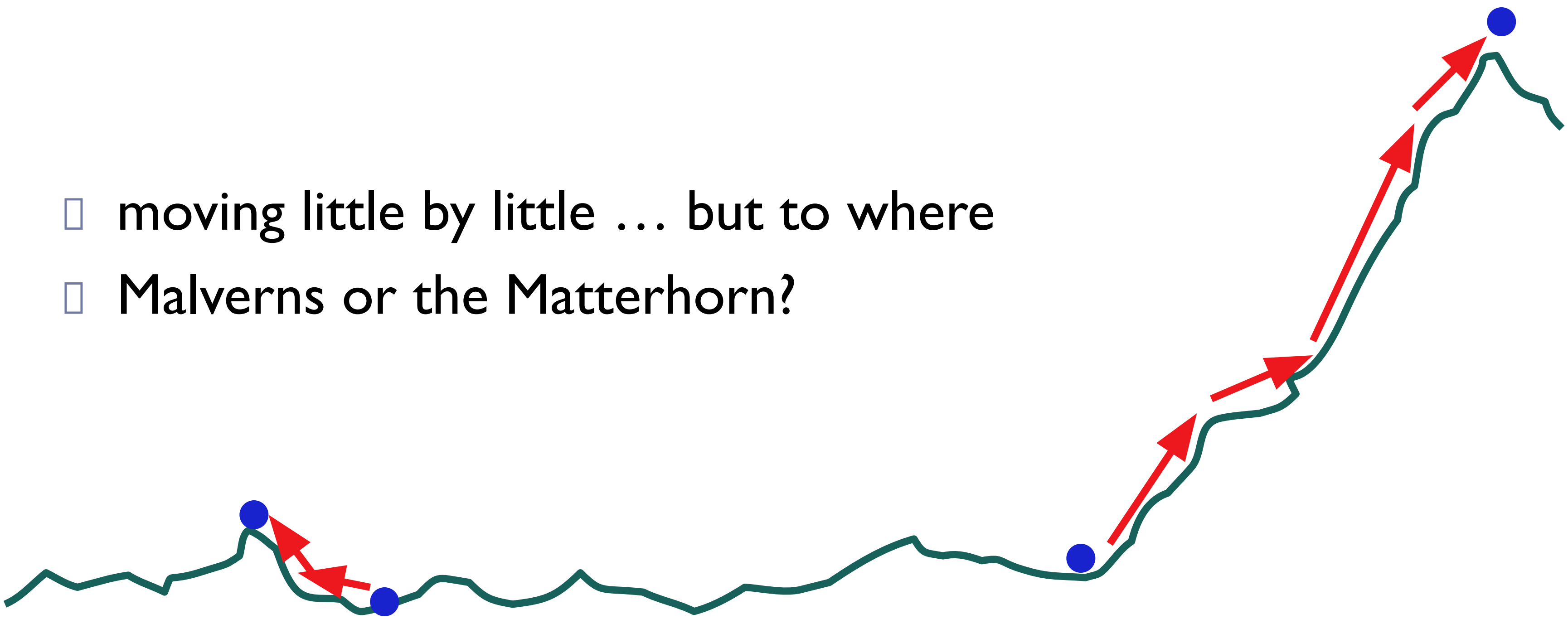
prototyping

- you never get it right first time
- if at first you don't succeed …



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

Evaluation Techniques

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 of Evaluation

- assess extent of system functionality
- assess effect of interface on user
- identify specific problems

Evaluating Designs

Cognitive Walkthrough
Heuristic Evaluation
Review-based evaluation

Task- Centered Design

- Task-centered design focuses on REAL, COMPLETE, REPRESENTATIVE tasks.
- Traditional requirements analysis looks at ABSTRACT, PARTIAL task elements.
- How to evaluate a design without users? One approach is a *cognitive walkthrough*.

Cognitive Walkthrough

Proposed by Polson *et al.*

- evaluates design on how well it supports user in learning task
- usually performed by expert
- Identify problems based on psychological principles
- Requires some expertise in cognitive psychology
- forms used to guide analysis

Polsom P., Lewis, C., Rieman, J., and Wharton, C. (1992). Cognitive walkthroughs: A method for theory-based evaluation of user interfaces

Cognitive Walkthrough (ctd)

- For each task walkthrough considers
  - what impact will interaction have on user?
  - what cognitive processes are required?
  - what learning problems may occur?

- Analysis focuses on goals and knowledge: does the design lead the user to generate the correct goals?

Cognitive walkthrough

- Formalized way of imagining people's thoughts and actions when they use an interface for the first time.
- First select a task that the design is intended to support.
- Then try to tell a believable story about each action a user has to take to do the task.
- To make the story believable, you have to motivate each of the user's actions, relying on the user's general knowledge and on the prompts and feedback provided by the interface. If you can't tell a believable story about an action, then you've located a problem with the interface

Cognitive walkthrough

1. Select tasks
2. Write-down the desired path
3. 4 questions to ask:
   - Will the customer realistically be trying to do this action? (Is effect of current action same as user's goal? – conceptual model)
   - Is the control for the action visible?
   - Is there a strong link between the control and the action? (Will user recognize action as the correct one?)
   - Is feedback appropriate? (Will user understand feedback?)

http://www.userfocus.co.uk/articles/cogwalk.html, 2010

Cognitive walkthrough

- ✔ No need for users
- ✔ Explicit account of user's task
- ✔ Suggestions to improve learnability
- ✔ Any phase
- ✔ Quick and inexpensive

- Expertise skills / evaluator effect
- Tends to focus on words and graphics
- No frequency and severity of problem
- Artificial context

Heuristic Evaluation

- Proposed by Nielsen and Molich.

- usability criteria (heuristics) are identified
- design examined by experts to see if these are violated

- Example heuristics
  - system behaviour is predictable
  - system behaviour is consistent
  - feedback is provided

- Heuristic evaluation 'debugs' design.

Heuristic Evaluation

- Several (3 to 5) evaluators independently critique a system to come up with potential usability problems.
- Relatively cheap approach--- *Discount usability* technique
- A set of 10 heuristics are provided to aid the evaluators in discovering usability problems.
- Heuristics are almost same like the *principles* and *guidelines*.

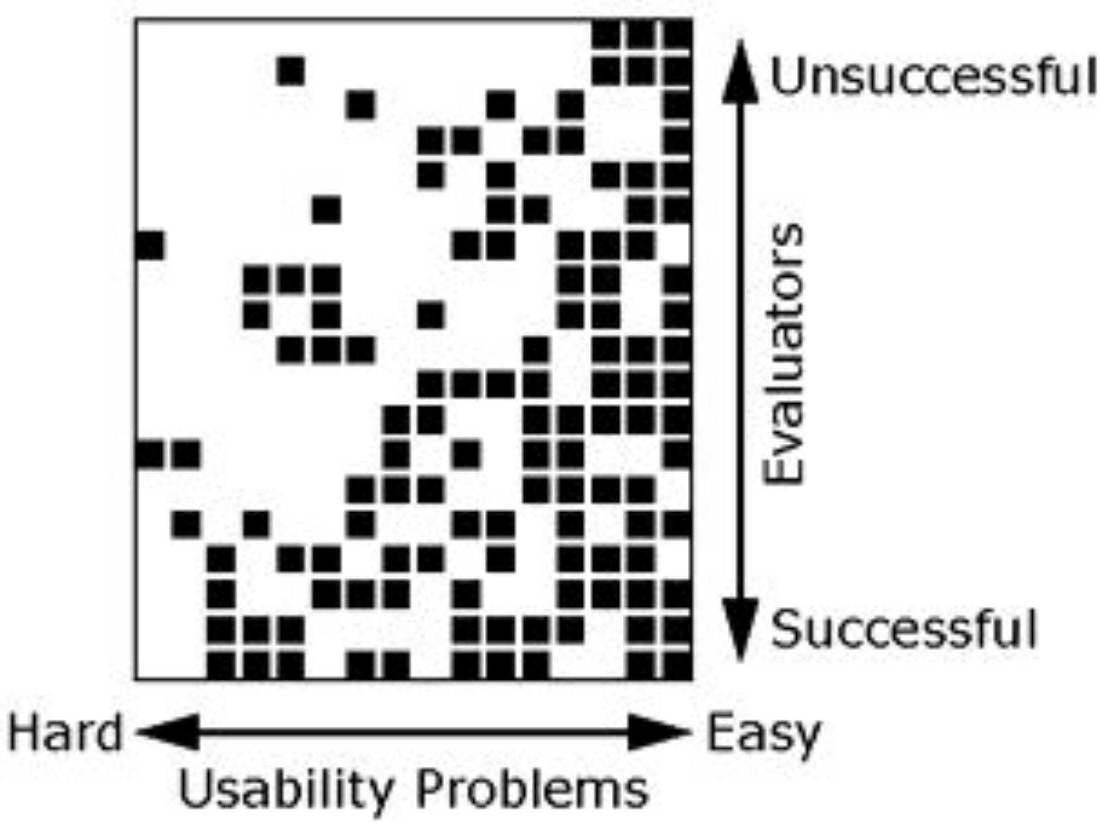
Heuristic evaluation

- Developed by Jakob Nielsen
- Heuristics ☐ general principles for interaction design
  - Adjusted versions for particular cases
- Identify where design does not follow these principles
- Requires some expertise in usability (3-5 evaluators)
  - independently check for compliance with usability principles (“heuristics”)
  - different evaluators will find different problems
  - evaluators only communicate afterwards
  - findings are then aggregated

Nielsen, J. (1994). Heuristic evaluation

Why Multiple Evaluators?

- Every evaluator doesn't find every problem
- Good evaluators find both easy & hard ones



Heuristic evaluation process

1. Select system and tasks to review
2. Select heuristic set
3. Inspect the interface alone
4. Communicate and aggregate findings
5. Categorize and prioritize findings to be effectively reported

Severity Rating of HE

- The severity of a usability problem is a combination of three factors:
  - The **frequency** with which the problem occurs: Is it common or rare?
  - The **impact** of the problem if it occurs: Will it be easy or difficult for the users to overcome?
  - The **persistence** of the problem: Is it a one-time problem that users can overcome once they know about it or will users repeatedly be bothered by the problem?

Severity Rating of HE

- The following 0 to 4 rating scale can be used to rate the severity of usability problems:

0 = I don't agree that this is a usability problem at all

1 = Cosmetic problem only: need not be fixed unless extra time is available on project

2 = Minor usability problem: fixing this should be given low priority

3 = Major usability problem: important to fix, so should be given high priority

4 = Usability catastrophe: imperative to fix this before product can be released

Heuristic evaluation

- ✔ Relatively inexpensive (incl. planning)
- ✔ Expert skills are not a must
- ✔ Can be used early, but more efficient later

- – Evaluator effect (thus, multiple are needed)
- – Not as effective as usability testing (minor issues)
- – Not always readily suggest solutions
- – Prone to false alarms

Heuristic Evaluation Guidelines

- Nielsen’s 10 principles
- Shneiderman’s 8 golden rules
- Tognazzini’s 16 principle

Nielsen's 10 Heuristics

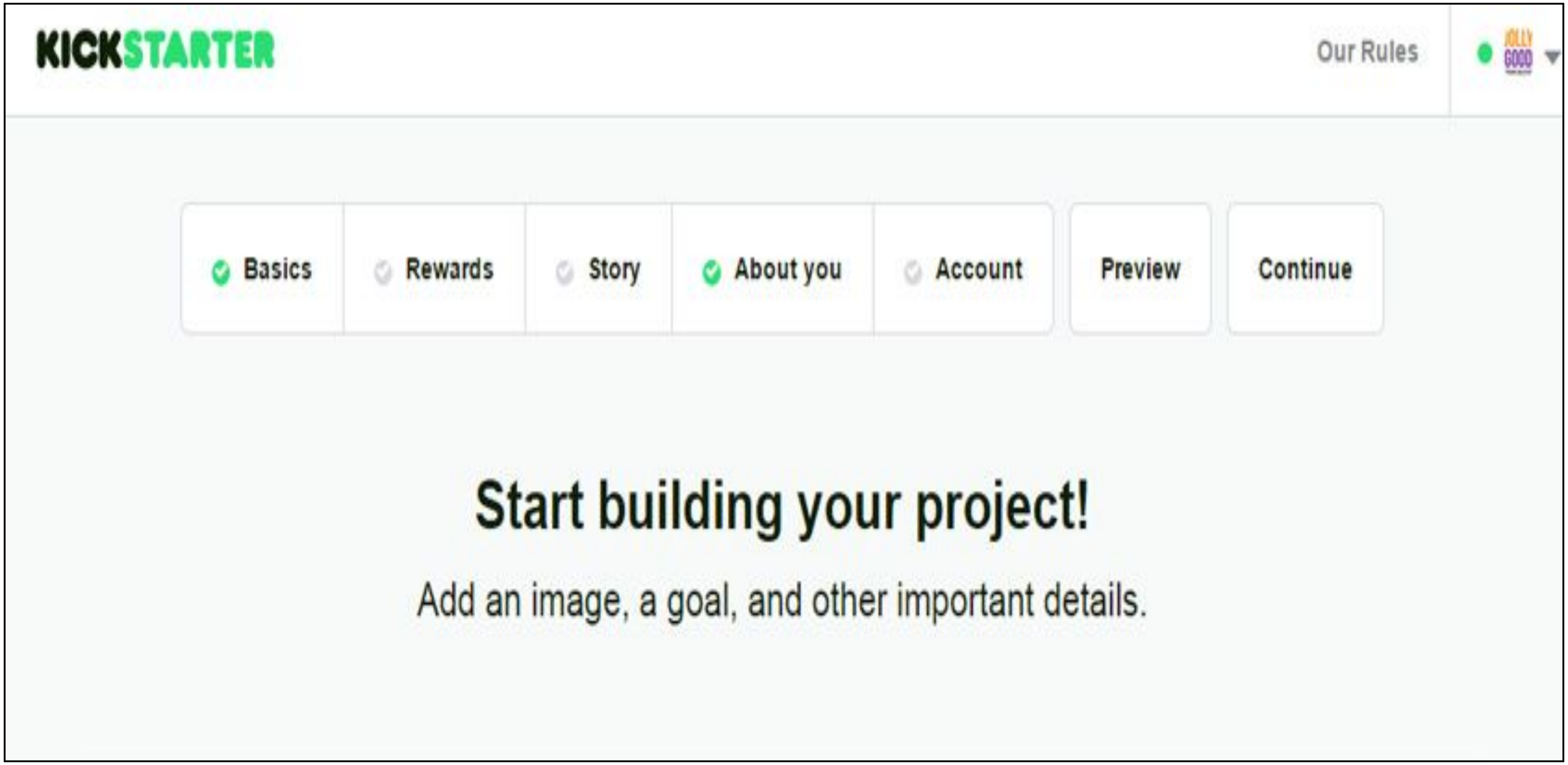
1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Help users recognize, diagnose, and recover from errors
10. Help and documentation

1. Visibility of system status

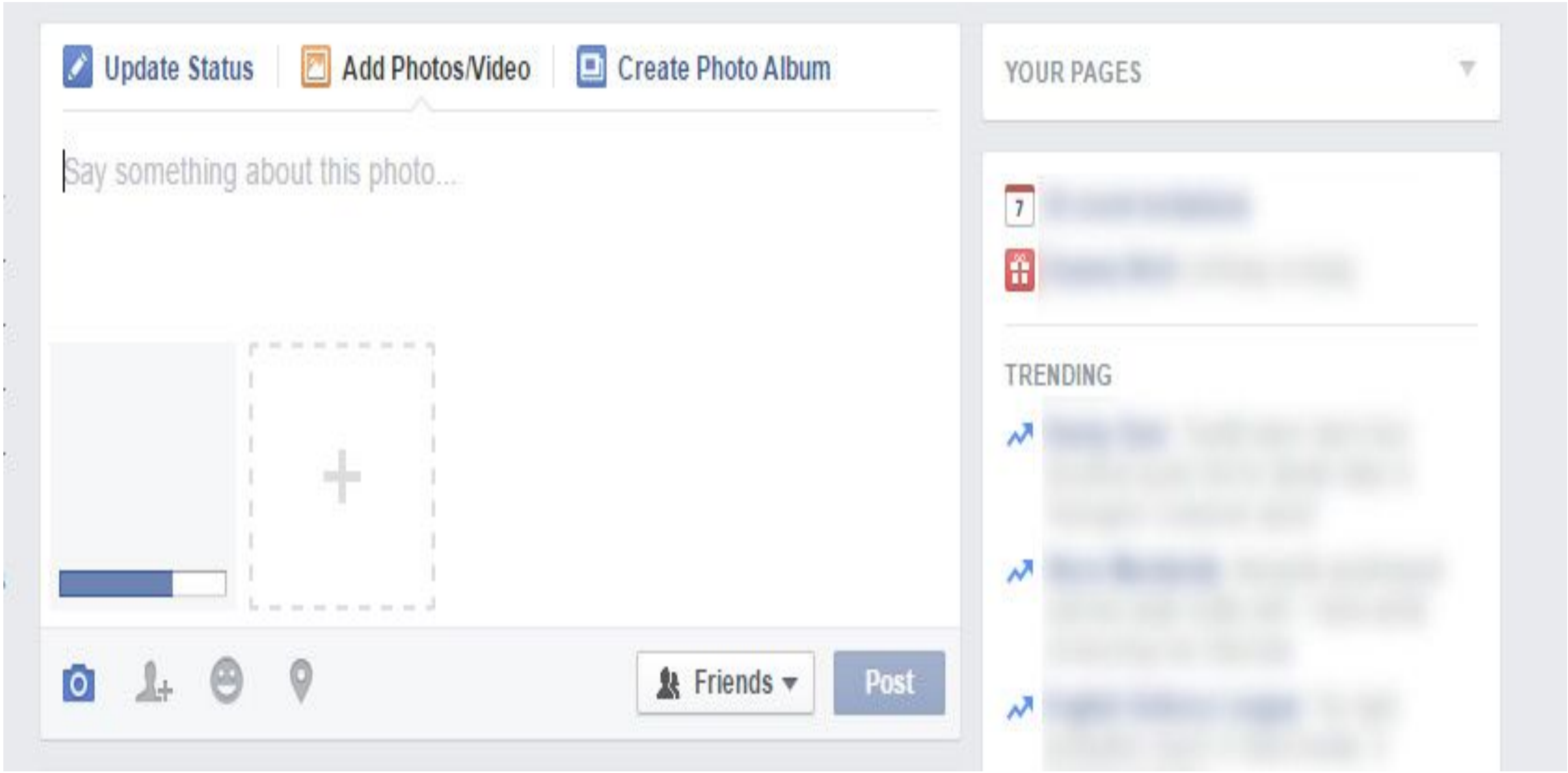
- Provide users timely and appropriate feedback about the system's status.
- Does the system tell the users
  - what operation it is performing?
  - how much longer they need to wait?
  - which mode it is in?

Example: If it takes a long time to load a screen, display a progress bar and/or an estimate of the time it may take to load, so users know what to expect.

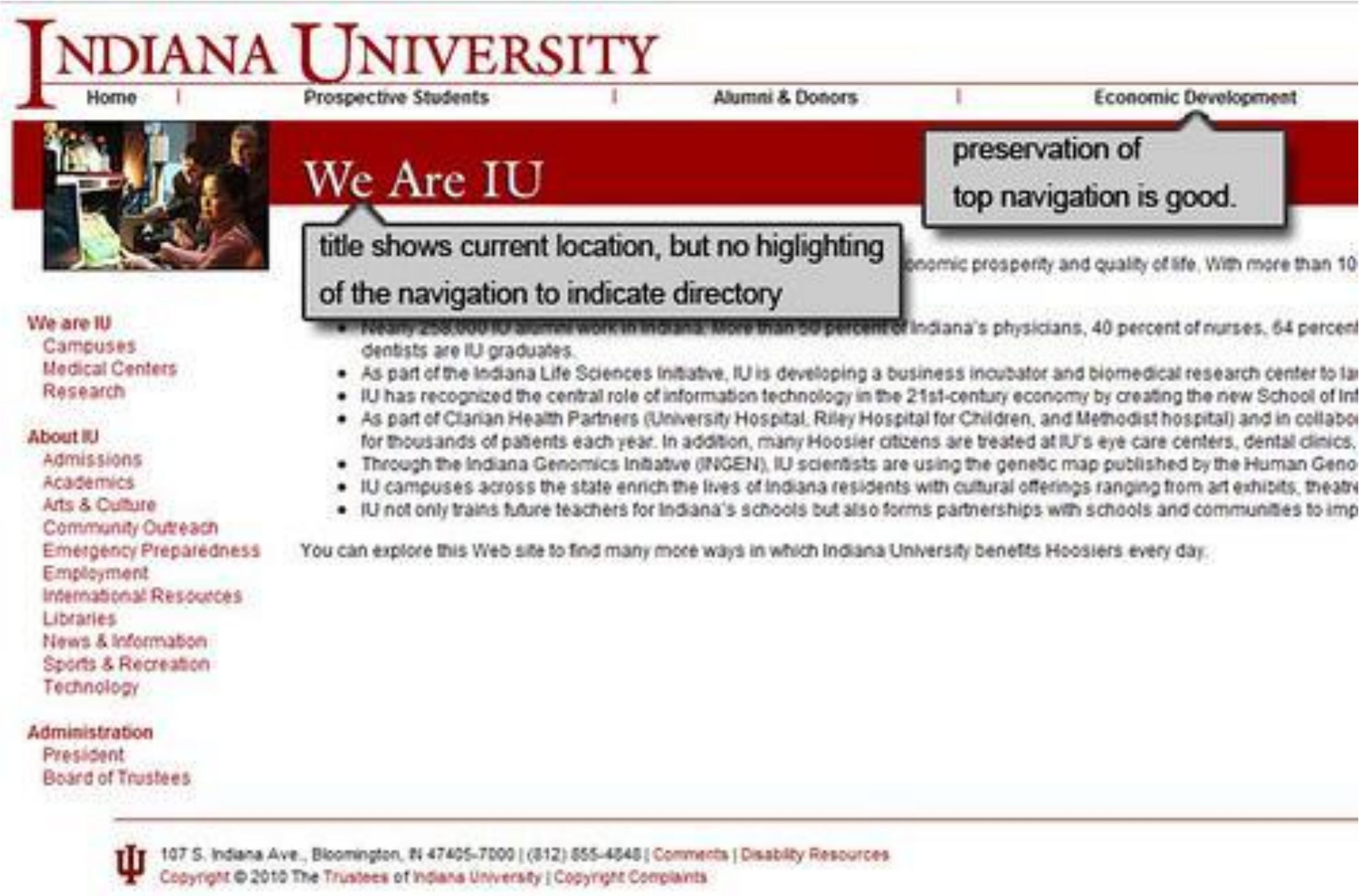
1. Visibility of system status



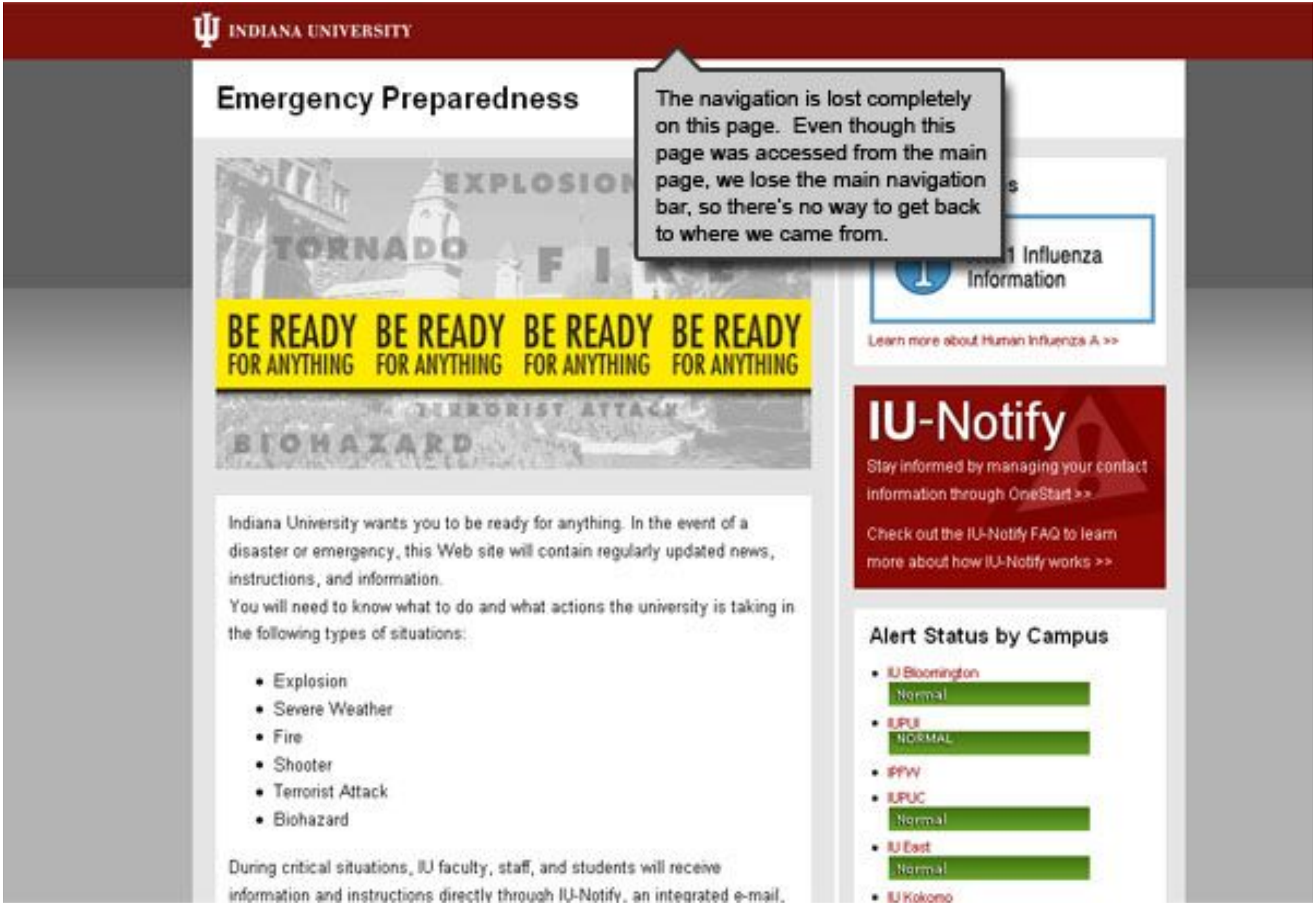
1. Visibility of system status



1. Visibility of system status



1. Visibility of system status

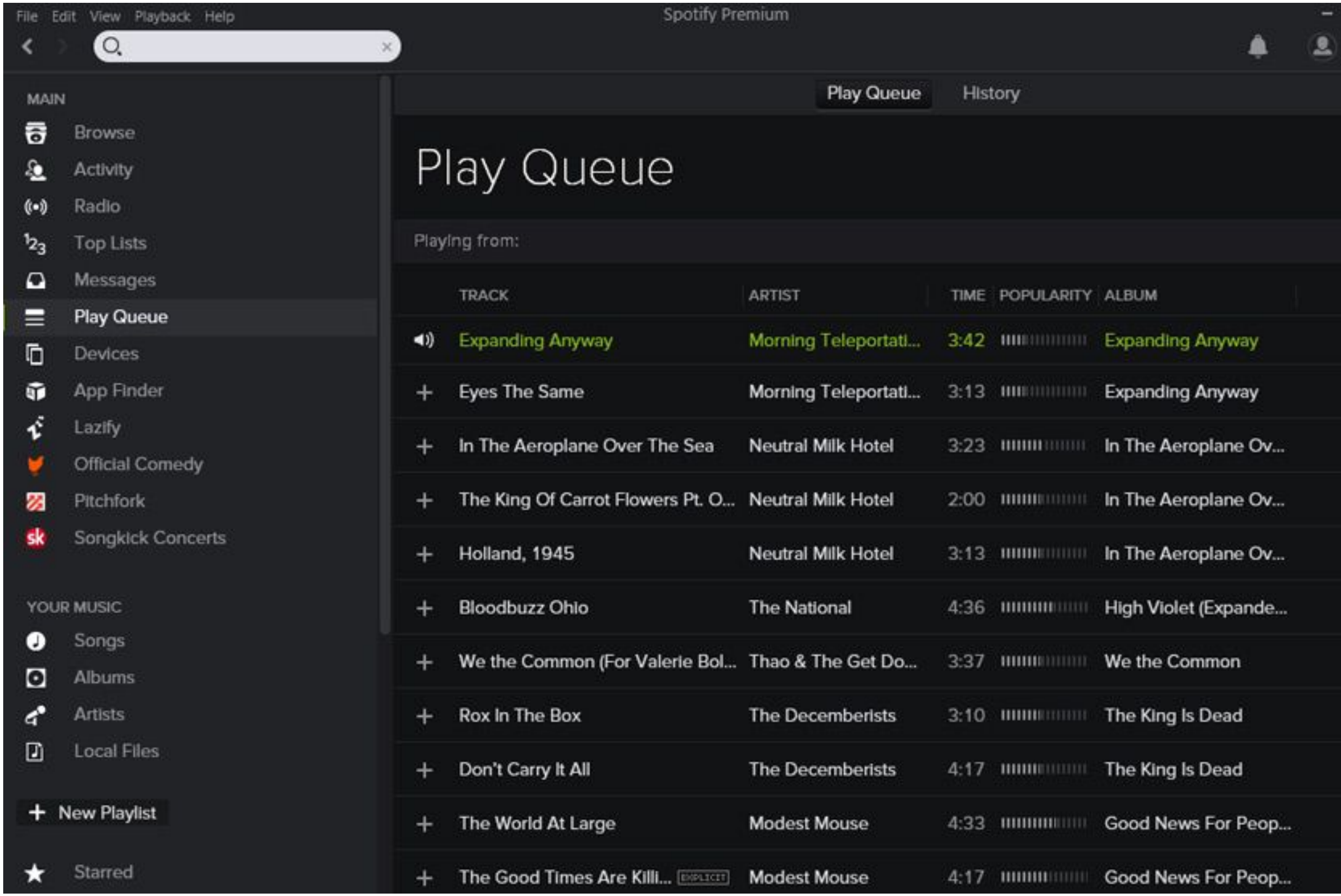


2. Match between system and the real world

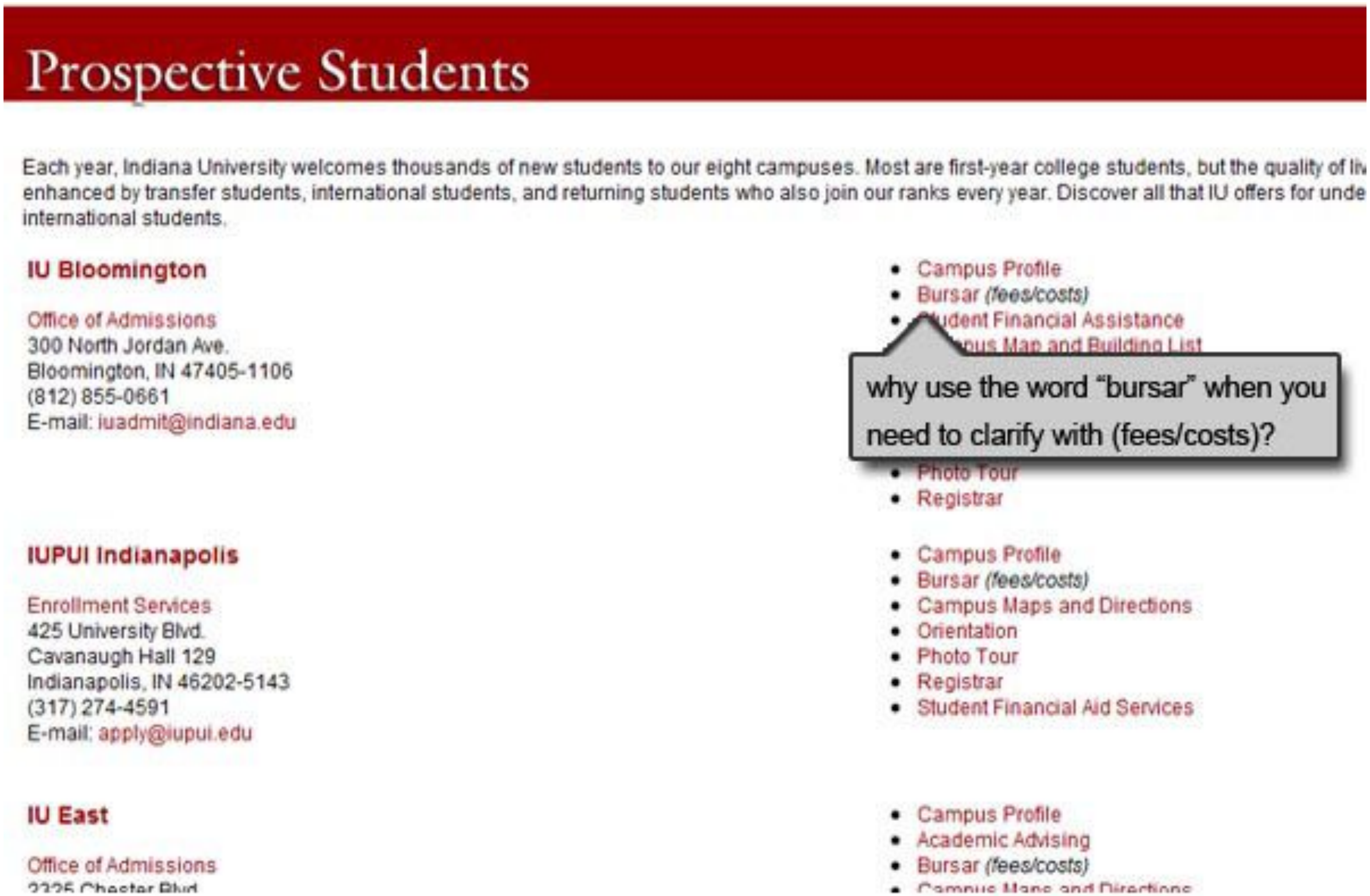
- Speak the user’s language using terms and concepts that are familiar to the intended audience. Information should be organized naturally and logically based on what users are accustomed to seeing in the real world.
- Does the system
  - speak users’ language?
  - follow real world convention?

Example: When designing a website for children, use terms with which they are familiar and display information in formats they are used to seeing.

2. Match between system and the real world



2. Match between system and the real world



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300 North Jordan Ave.
Bloomington, IN 47405-1106
(812) 855-0661
E-mail: iuadmit@indiana.edu

- Campus Profile
- Bursar *(fees/costs)*
- udent Financial Assistance
- pus Map and Building List
- Photo Tour
- Registrar

why use the word “bursar” when you need to clarify with (fees/costs)?

IUPUI Indianapolis

Enrollment Services
425 University Blvd.
Cavanaugh Hall 129
Indianapolis, IN 46202-5143
(317) 274-4591
E-mail: apply@iupui.edu

- Campus Profile
- Bursar *(fees/costs)*
- Campus Maps and Directions
- Orientation
- Photo Tour
- Registrar
- Student Financial Aid Services

IU East

Office of Admissions
2325 Chester Blvd

- Campus Profile
- Academic Advising
- Bursar *(fees/costs)*
- Campus Maps and Directions

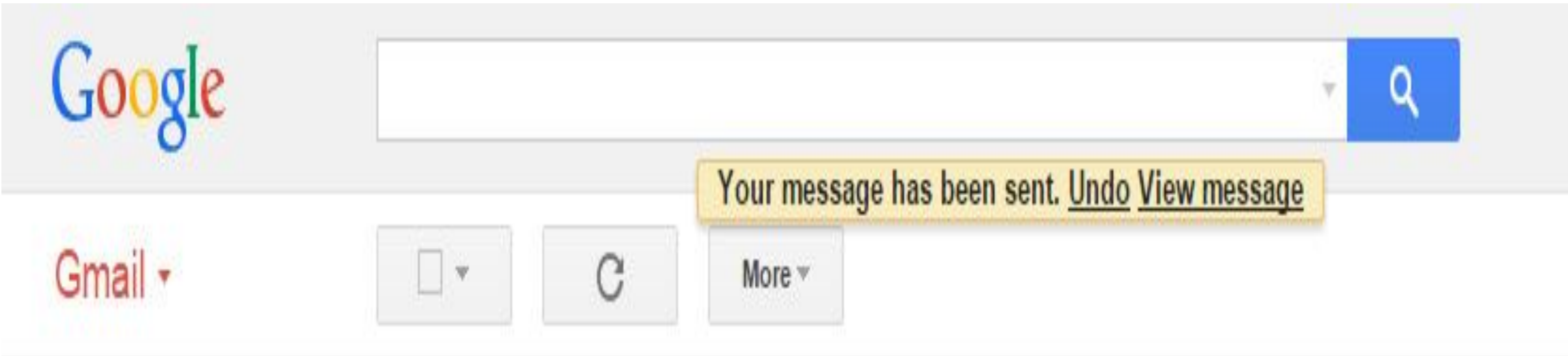
2. Match between system and the real world

3. User Control and Freedom

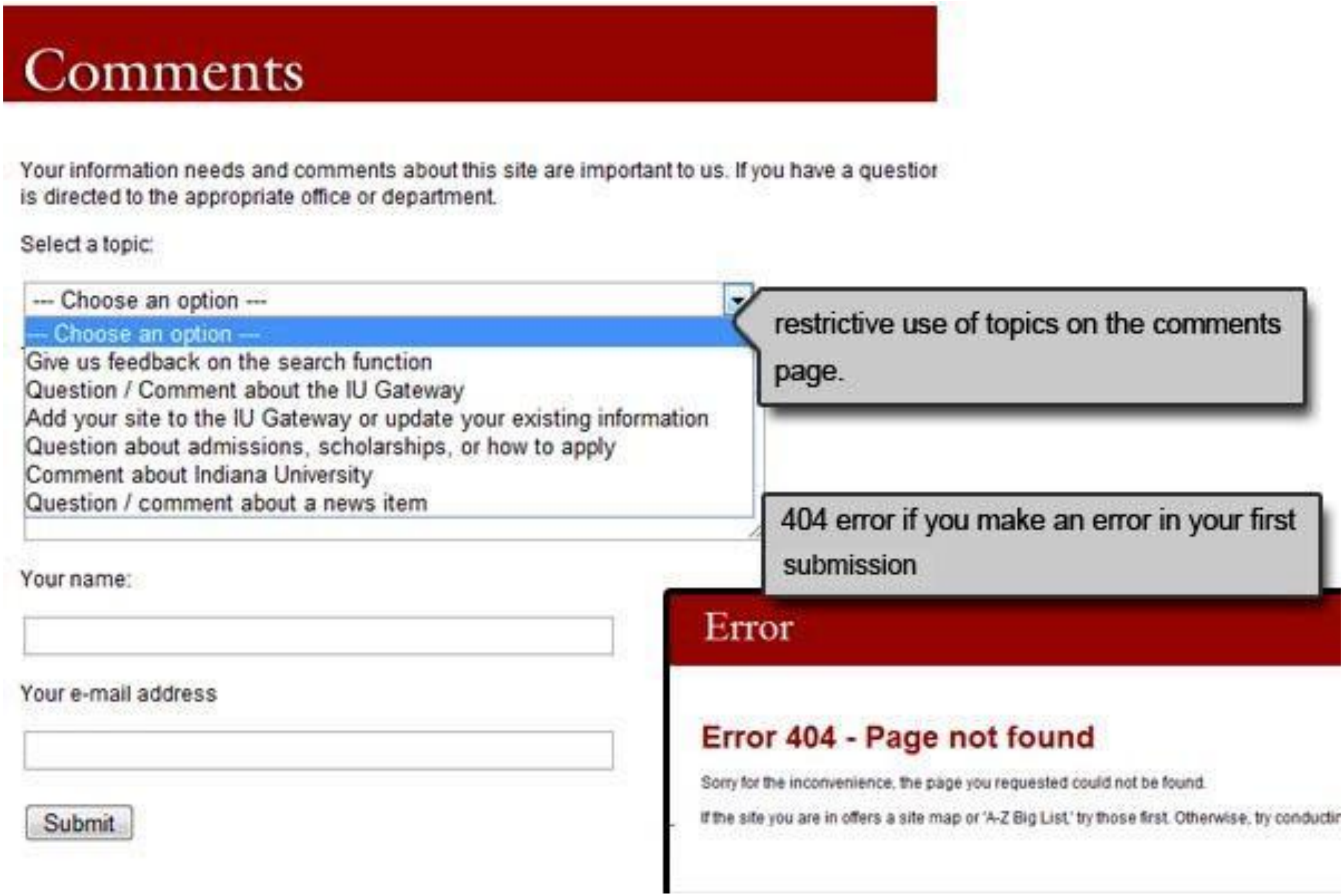
- Users should experience perceived control as they interact with the system. Users should have the ability to “go back” and fix mistakes without hassle.
- *Does the system*
  - *provide clearly marked exists?*
  - *support undo and redo*

Example: Provide the functionality to Undo and Redo actions and to easily exit the system.

3. User Control and Freedom



3. User Control and Freedom

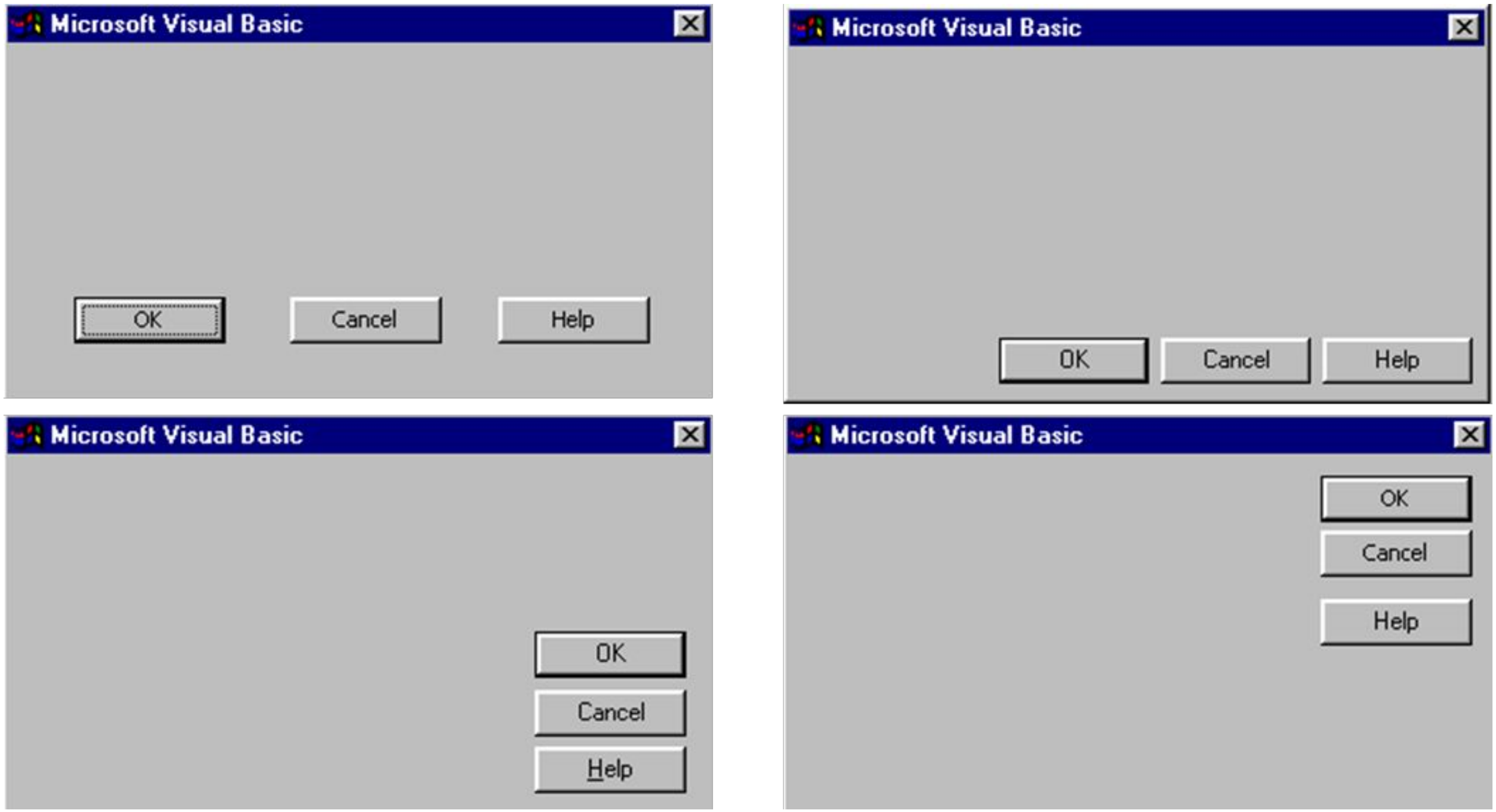


4. Consistency and Standards

- User controls, icons, terminology, and error messaging should be consistent throughout the interface. Where appropriate, industry and platform standards should be applied.
- Does the system use the same term to refer to the same thing?
- Does the system let users perform the same action by the same UI?

Example: Use icons with which people are familiar, rather than creating new designs that mean the same thing. Users are more likely to be scanning around the page for the phrase "About Us" than "Get to know the team".

4. Consistency and Standards

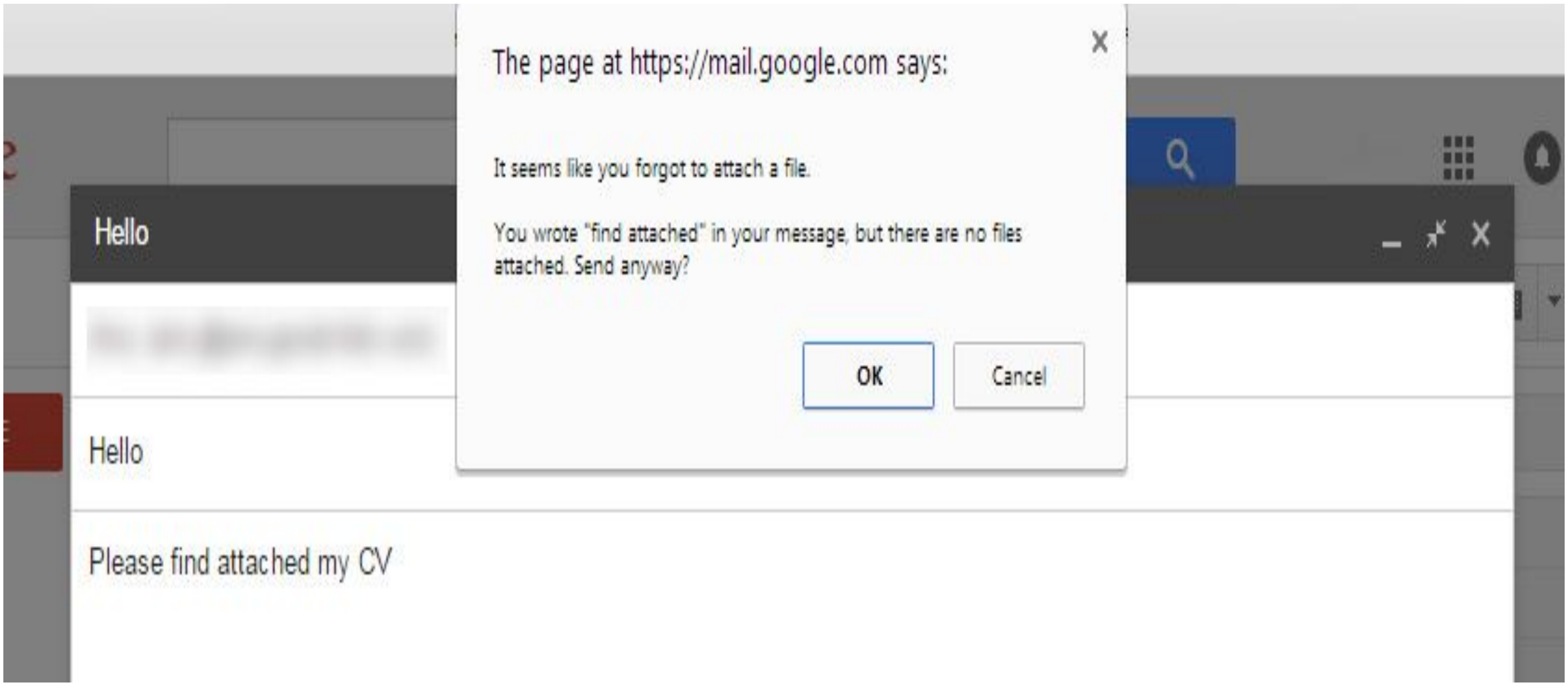


5. Error Prevention

- Prevent user errors by identify problem areas for typical users and re-designing it to more clearly communicate the consequences of users' actions.
- When deleting information that may be difficult to recreate, offer users a confirmation to delete the data. Additionally, provide the ability to Undo actions that users could accidentally commit and, consequently, lose important information.
- Does the system eliminate or check for error-prone conditions?

Example: does an email client help users avoid common errors such as
- typing the wrong address
- making spelling mistakes
- missing an attachment

5. Error Prevention

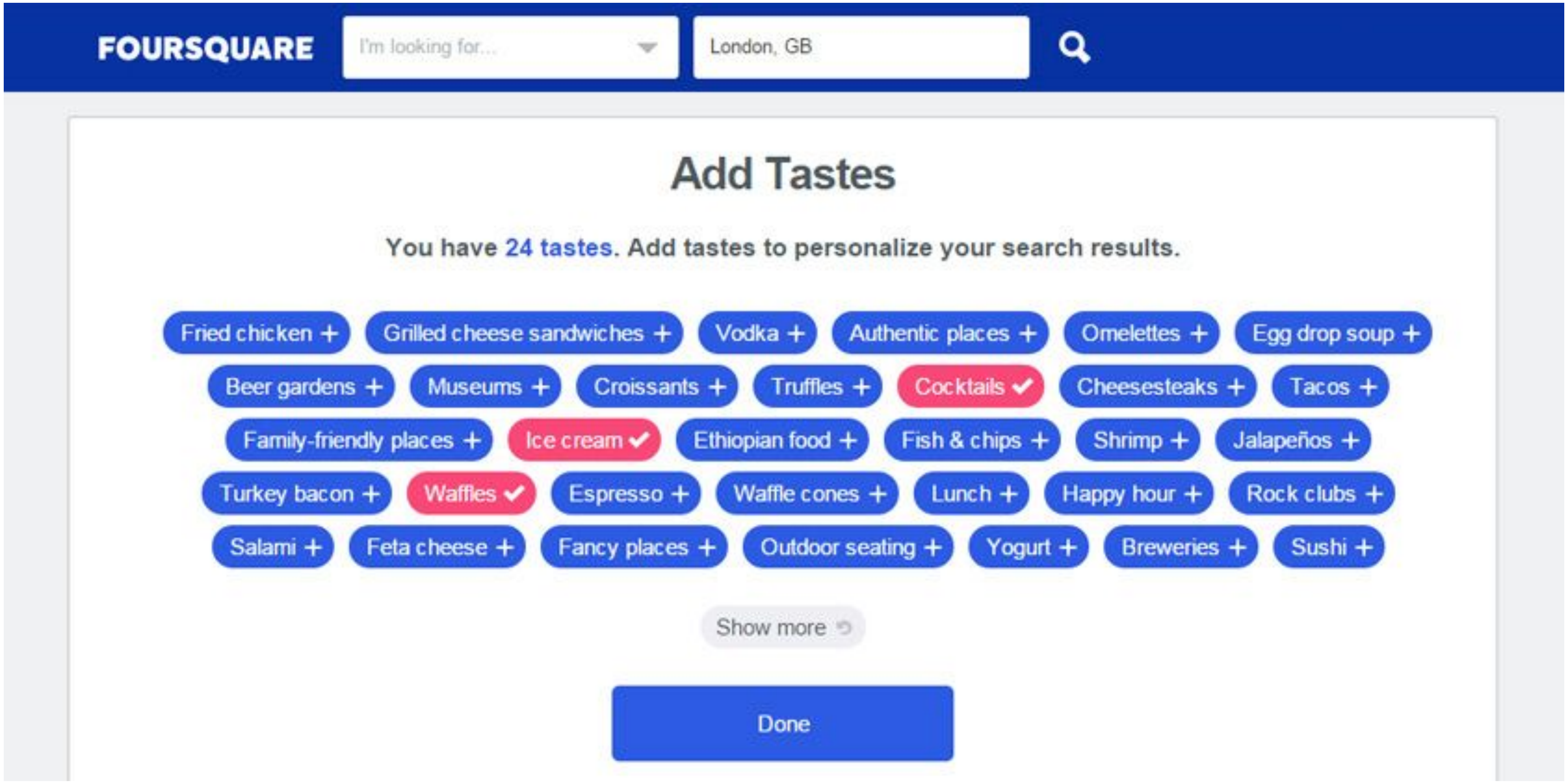


6. Recognition rather than recall

- Reduce the memory load of users by presenting familiar icons, actions, and options whenever possible.
- Do not require the user to recall information from one screen to another.
- Use mouse-over tooltips to describe the functionality of icons which may be unfamiliar.
- Does the system present options for users to recognize the one they want?

Example: On a web form, allow easy access to previously entered information, such as serial numbers, so the user does not need to recall the information or write it down.

6. Recognition rather than recall

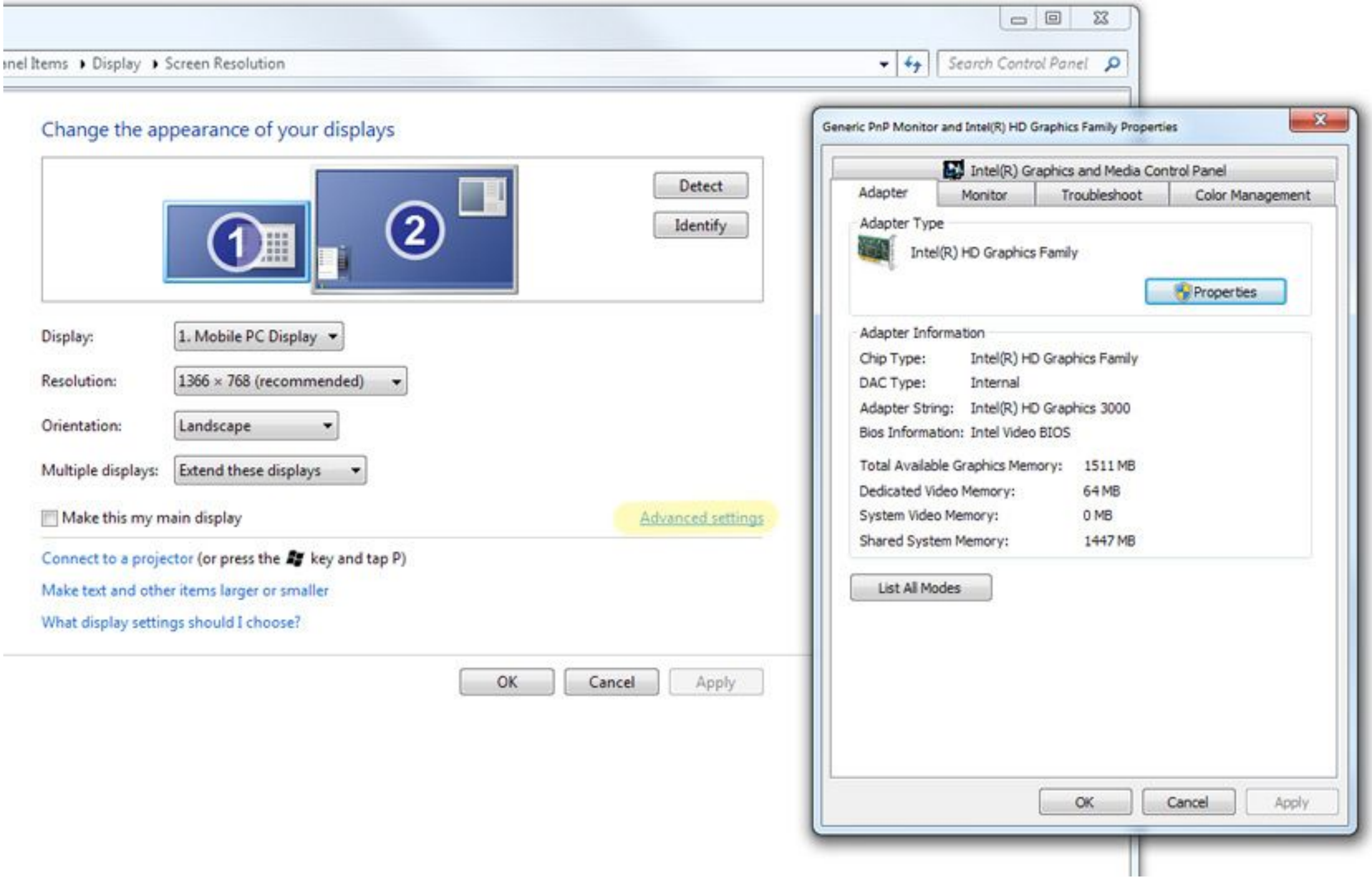


7. Flexibility and efficiency of use

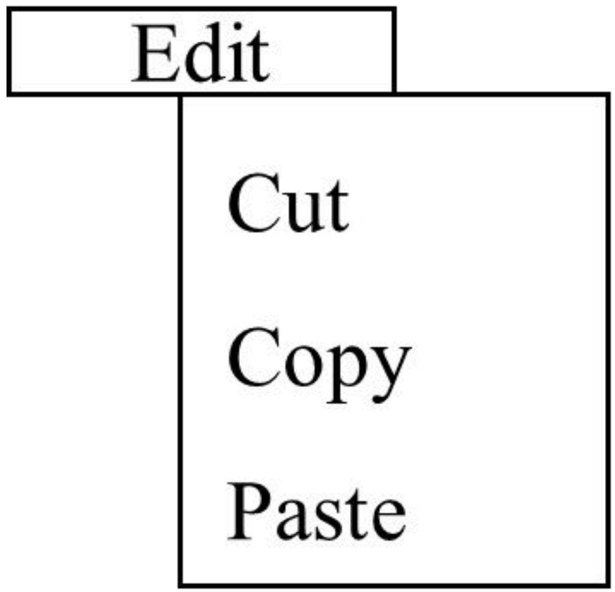
- Novice and expert users use systems differently. The system should be easy and efficient to use by novices and experts alike.
- Provide "accelerators" for expert users to more efficiently navigate your application to complete the most frequent tasks.
- Does the system provide ways for users to access a file or application quickly?
- Does the system provide shortcuts users can learn to do things faster?

Example: An accelerator can be a keystroke shortcut, such as Macintosh's Command+Q to quit an application.

7. Flexibility and efficiency of use



7. Flexibility and efficiency of use



KB Shortcut:

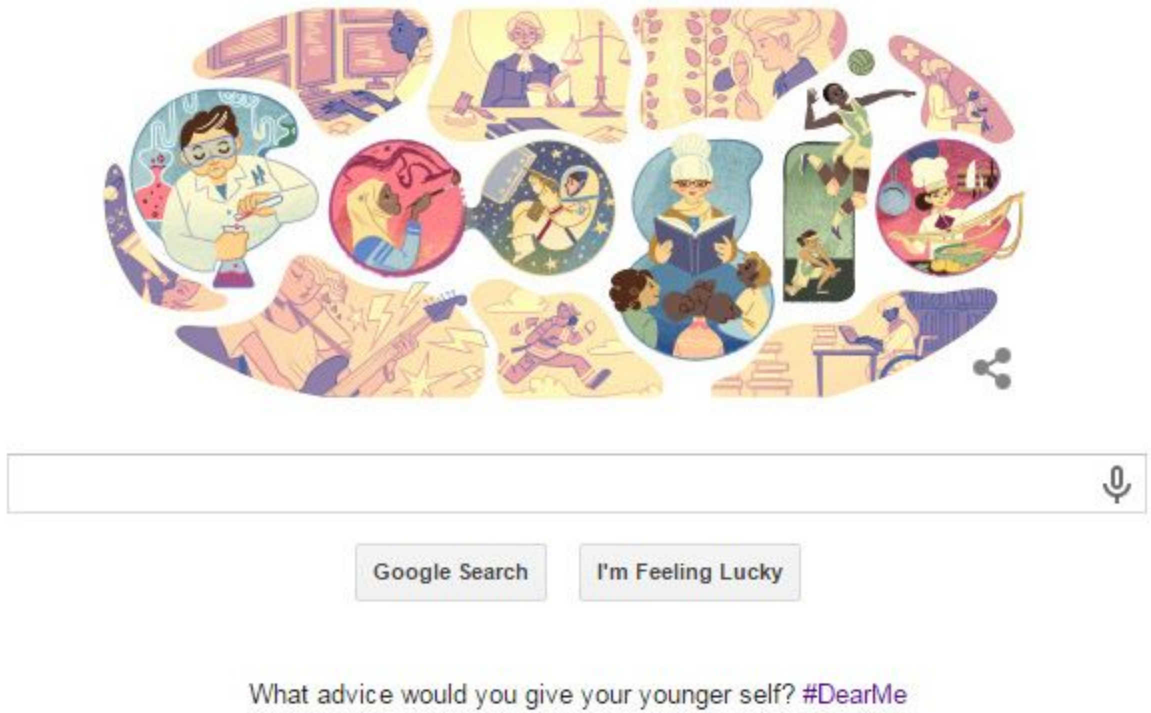
Ctrl + X
Ctrl + C
Ctrl + V

8. Aesthetic and minimalist design

- Avoid displaying excessive information and design elements, as they will visually compete with more relevant information on the screen.
- Does the system minimize irrelevant or rarely needed elements?
- Does the system look aesthetically appealing?

Example: Background graphics can make viewing text difficult.

8. Aesthetic and minimalist design



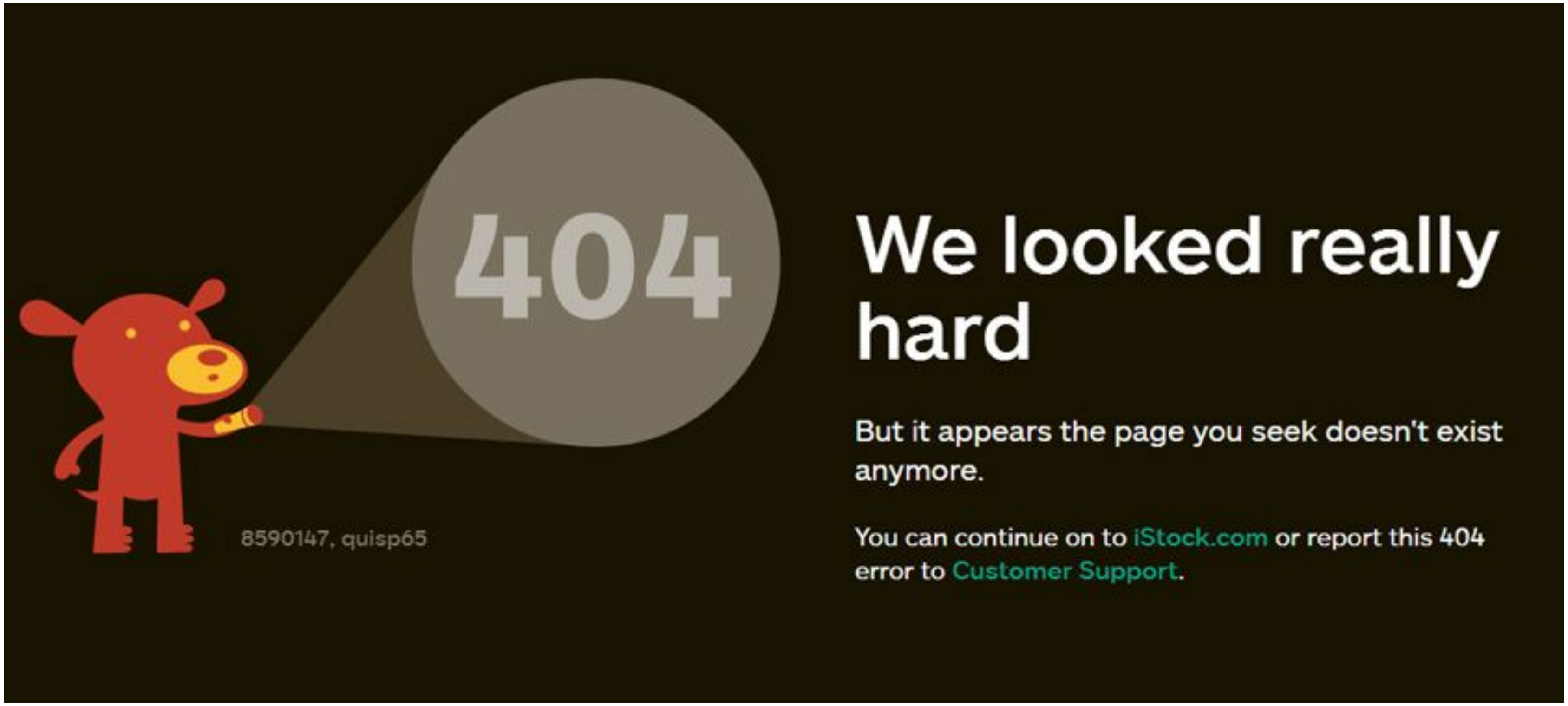
8. Aesthetic and minimalist design

9. Help Users Recognize, Diagnose, and Recover from Errors

- Present error messages that give users instructions about how to recover from an error, rather than cryptic codes that users do not understand.
- Does the system explain well why an error occurs and how to fix it?

Example: If the user enters an invalid email address on a web form that requests the address, the error message could read, "That email address is not in our records. Please enter an email address in this format: email@address.com."

9. Help Users Recognize, Diagnose, and Recover from Errors

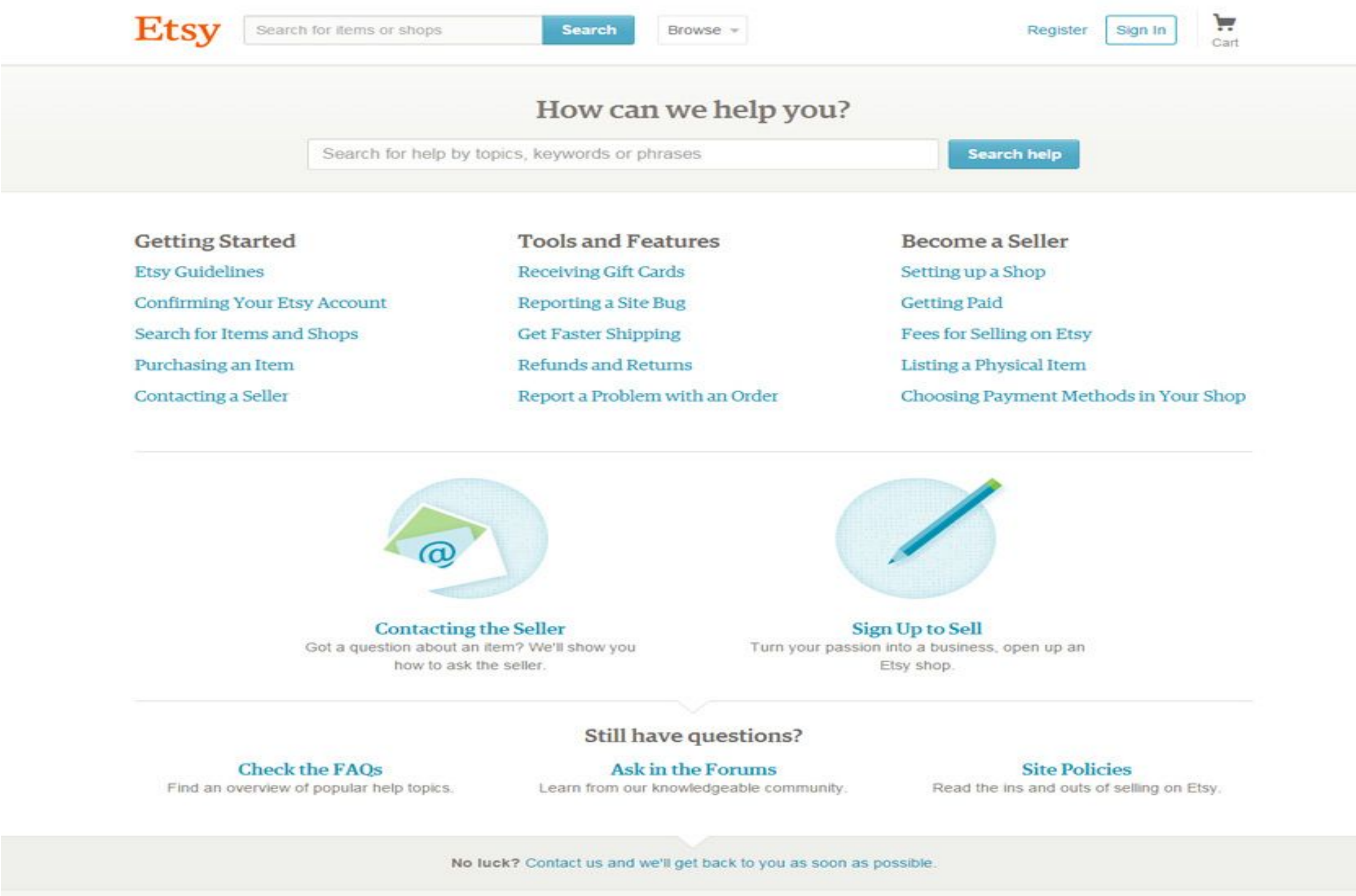


10. Help and Documentation

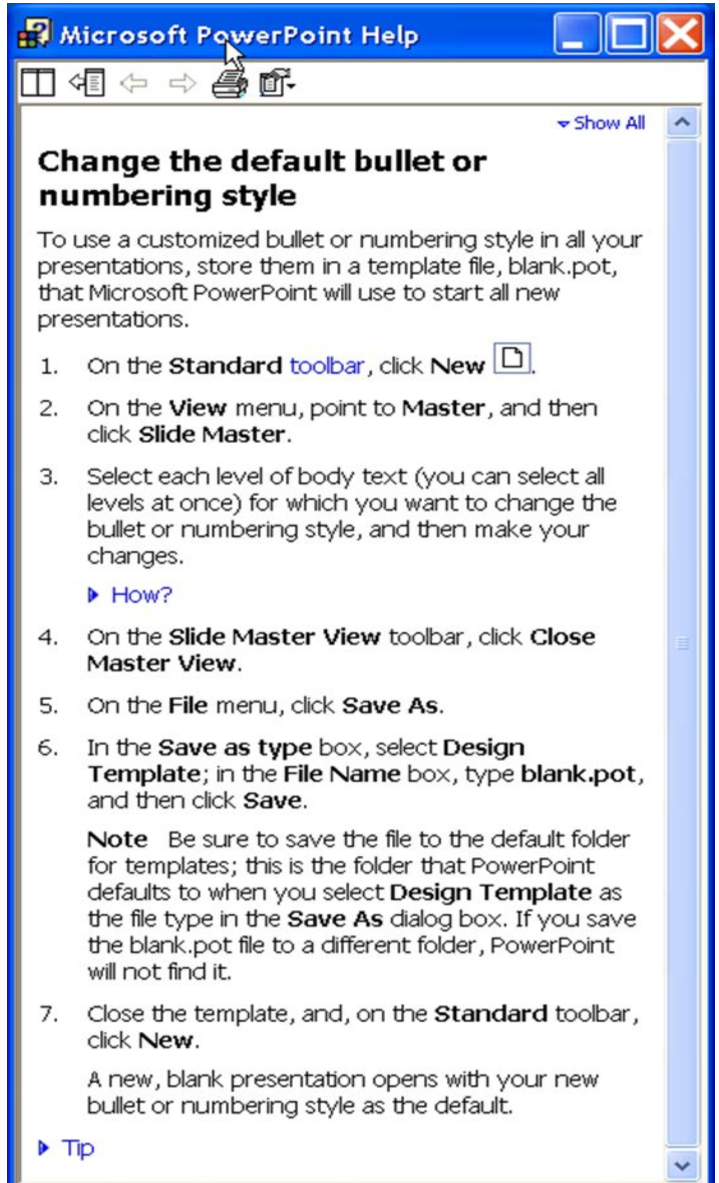
- It is usually best to design an interface to be so simple to use that Help and Documentation is unnecessary; however, there may be times when it is necessary to access Help.
- In those cases, Help documentation and user support should be easy to search, and instructions should be easy to follow.
- It may be useful to provide video tutorials and examples for complex procedures or controls that are hard to locate.
- Does the system help? Does the system provide help where and when it is needed? Is the system adequately documented?

Example: If there is not enough reason to produce an entire Help section, and there are a couple form fields that may be confusing to some users, it is appropriate to include “in-line help” in the form of a link that opens a small help dialogue next to the form field. Alternatively, next to a form field text box or field label, provide users an example of how to input the information using the required formatting, such as entering a phone number as xxx-xxx-xxxx.

10. Help and Documentation



10. Help and Documentation



Heuristic evaluation

10 Usability Heuristics Video:

https://www.youtube.com/watch?v=hWc0Fd2AS3s

Further Reading Materials (Must-Read)

- Nielsen's papers on his website: http://www.useit.com/papers/heuristic/
- 1 document (given during the lecture slides)
- http://designmodo.com/usability-heuristic-evaluation/
- http://www.mattsoave.com/old/cogs187a/iu_site_eval/1visibility.html
- Search in Google and read articles/blog/documents related to heuristic evaluation and its example cases.

Review-based evaluation

- Results from the literature used to support or refute parts of design.
- Care needed to ensure results are transferable to new design.
- Model-based evaluation
- Cognitive models used to filter design options
  e.g. GOMS prediction of user performance.
- Design rationale can also provide useful evaluation information

Evaluating through user Participation

Evaluating through User Participation

1. Laboratory studies
2. Field studies

Laboratory studies

- Advantages:
  - specialist equipment available
  - uninterrupted environment

- Disadvantages:
  - lack of context
  - difficult to observe several users cooperating

- Appropriate
  - If system location is dangerous or impractical (space station)
  - For constrained single-user tasks (systems)
  - To allow controlled manipulation of use
  - To compare alternative designs within a controlled context

Field Studies

- Advantages:
  - natural environment
  - context retained (though observation may alter it)
  - longitudinal studies possible
- Disadvantages:
  - distractions
  - noise
- Appropriate
  - where context is crucial for longitudinal studies

Evaluating Implementations

Requires an artefact:

- simulation
- prototype
- full implementation

Experimental Evaluation

- Controlled evaluation of specific aspects of interactive behaviour
- Evaluator chooses hypothesis to be tested
- A number of experimental conditions are considered which differ only in the value of some controlled variable.
- Changes in behavioural measure are attributed to different conditions

Experimental factors

- Subjects/participants
  - who – representative, sufficient sample
- Variables
  - things to modify and measure
- Hypothesis
  - what you'd like to show
- Experimental design
  - how you are going to do it

Participants

- Choice of participants is vital to the success of any experiment
- Should be chosen to match the expected user population as closely as possible
- Computer science UG students are not a good choice to test an application developed for general public.
- Sample size must be large enough to be representative of population, taking into account the design of the experiment and the statistical methods chosen.

Variables

- Independent Variable (IV)
  characteristic changed to produce different conditions
  e.g. interface style, number of menu items
- Dependent Variable (DV)
  characteristics measured in the experiment
  e.g. time taken, number of errors.

Hypothesis

- prediction of outcome
  - framed in terms of IV and DV

    e.g. "error rate will increase as font size decreases"

- null hypothesis:
  - states no difference between conditions
  - aim is to disprove this

    e.g. null hyp. = "no change with font size"

Experimental design

- within groups design
  - each subject performs experiment under each condition.
  - transfer of learning possible
  - less costly and less likely to suffer from user variation.
- between groups design
  - each subject performs under only one condition
  - no transfer of learning
  - more users required
  - variation can bias results.

Analysis of data

- Before you start to do any statistics:
  - look at data
  - save original data
- Choice of statistical technique depends on
  - type of data
  - information required
- Type of data
  - discrete - finite number of values
  - continuous - any value

Analysis - types of test

- parametric
  - assume normal distribution
  - robust
  - powerful
- non-parametric
  - do not assume normal distribution
  - less powerful
  - more reliable
- contingency table
  - classify data by discrete attributes
  - count number of data items in each group

Analysis of data (cont.)

- What information is required?
  - is there a difference?
  - how big is the difference?
  - how accurate is the estimate?
- Parametric and non-parametric tests mainly address first of these

Experimental studies on groups

More difficult than single-user experiments

Problems with:

- subject groups
- choice of task
- data gathering
- analysis

Subject groups

larger number of subjects
$\Rightarrow$ more expensive

longer time to `settle down'
… even more variation!

difficult to timetable

so … often only three or four groups

The task

must encourage cooperation

perhaps involve multiple channels

options:

- creative task e.g. ‘*write a short report on …*’
- decision games e.g. desert survival task
- control task e.g. ARKola bottling plant

Data gathering

several video cameras
+ direct logging of application

problems:
- synchronisation
- sheer volume!

one solution:
- record from each perspective

Analysis

N.B. vast variation between groups

solutions:

- within groups experiments
- micro-analysis (e.g., gaps in speech)
- anecdotal and qualitative analysis

look at interactions between group and media

controlled experiments may `waste' resources!

Field studies

Experiments dominated by group formation

Field studies more realistic:

- *distributed cognition* ⇒ work studied in context
- real action is *situated action*
- physical and social environment both crucial

Contrast:

- psychology – controlled experiment
- sociology and anthropology – open study and rich data

Observational Methods

Think Aloud
Cooperative evaluation
Protocol analysis
Automated analysis
Post-task walkthroughs

Think Aloud

- user observed performing task
- user asked to describe what he is doing and why, what he thinks is happening etc.

- Advantages
  - simplicity - requires little expertise
  - can provide useful insight
  - can show how system is actually use
- Disadvantages
  - subjective
  - selective
  - act of describing may alter task performance

Cooperative evaluation

- variation on think aloud
- user collaborates in evaluation
- both user and evaluator can ask each other questions throughout

- Additional advantages
  - less constrained and easier to use
  - user is encouraged to criticize system
  - clarification possible

Protocol analysis

Methods for recording user actions include the following:

- paper and pencil – cheap, limited to writing speed
- audio – good for think aloud, difficult to match with other protocols
- video – accurate and realistic, needs special equipment, obtrusive
- computer logging – automatic and unobtrusive, large amounts of data difficult to analyze
- user notebooks – coarse and subjective, useful insights, good for longitudinal studies

- Mixed use in practice.
- audio/video transcription difficult and requires skill.
- Some automatic support tools available

automated analysis – Experimental Video Annotator (EVA)

- Workplace project
- Post task walkthrough
  - user reacts on action after the event
  - used to fill in intention
- Advantages
  - analyst has time to focus on relevant incidents
  - avoid excessive interruption of task
- Disadvantages
  - lack of freshness
  - may be post-hoc interpretation of events

post-task walkthroughs

- transcript played back to participant for comment
  - immediately → fresh in mind
  - delayed → evaluator has time to identify questions
- useful to identify reasons for actions and alternatives considered
- necessary in cases where think aloud is not possible

Query Techniques

Interviews
Questionnaires

Interviews

- analyst questions user on one-to -one basis usually based on prepared questions
- informal, subjective and relatively cheap

- Advantages
  - can be varied to suit context
  - issues can be explored more fully
  - can elicit user views and identify unanticipated problems
- Disadvantages
  - very subjective
  - time consuming

Questionnaires

- Set of fixed questions given to users

- Advantages
  - quick and reaches large user group
  - can be analyzed more rigorously
- Disadvantages
  - less flexible
  - less probing

Questionnaires (ctd)

- Need careful design
  - what information is required?
  - how are answers to be analyzed?

- Styles of question
  - general
  - open-ended
  - scalar
  - multi-choice
  - ranked

Physiological methods

Eye tracking
Physiological measurement

eye tracking

- head or desk mounted equipment tracks the position of the eye
- eye movement reflects the amount of cognitive processing a display requires
- measurements include
  - fixations: eye maintains stable position. Number and duration indicate level of difficulty with display
  - saccades: rapid eye movement from one point of interest to another
  - scan paths: moving straight to a target with a short fixation at the target is optimal

physiological measurements

- emotional response linked to physical changes
- these may help determine a user's reaction to an interface
- measurements include:
  - heart activity, including blood pressure, volume and pulse.
  - activity of sweat glands: Galvanic Skin Response (GSR)
  - electrical activity in muscle: electromyogram (EMG)
  - electrical activity in brain: electroencephalogram (EEG)
- some difficulty in interpreting these physiological responses - more research needed

Choosing an Evaluation Method

when in process: design vs. implementation

style of evaluation: laboratory vs. field

how objective: subjective vs. objective

type of measures: qualitative vs. quantitative

level of information: high level vs. low level

level of interference: obtrusive vs. unobtrusive

resources available: time, subjects, equipment, expertise

Design Rules

Design Rules

- Designing for maximum usability
  - the goal of interaction design
- Principles of usability
  - general understanding
- Standards and guidelines
  - direction for design
- Design patterns
  - capture and reuse design knowledge

Design Rules

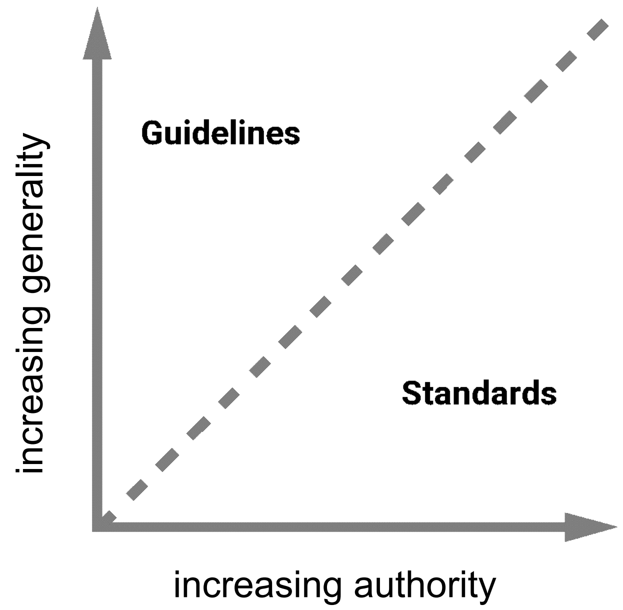
- **Design rules** are rules that a designer can follow in order to increase the usability of the eventual software product.

- Rules also vary in their level of abstraction, with some abstracting away from the detail of the design solution and others being quite specific.

- Rules can be classified along two dimensions: rule's authority and generality.
  - Authority is the indication of whether or not the rule must be followed in design or whether it is only suggested.
  - Generality is the indication of whether the rule can be applied to many design situations or whether it is focused on a more limited application situation.

Types of Design Rules

- principles
  - abstract design rules
  - low authority
  - high generality
- standards
  - specific design rules
  - high authority
  - limited application
- guidelines
  - lower authority
  - more general application



Principles to Support Usability

Learnability

the ease with which new users can begin effective interaction and achieve maximal performance

Flexibility

the multiplicity of ways the user and system exchange information

Robustness

the level of support provided to the user in determining successful achievement and assessment of goal-directed behaviour

Principles of learnability

Predictability

- determining effect of future actions based on past interaction history
- operation visibility

Synthesizability

- assessing the effect of past actions on the current state
- immediate vs. eventual honesty

Principles of learnability (ctd)

Familiarity
- how prior knowledge applies to new system
- guessability; affordance

Generalizability
- extending specific interaction knowledge to new situations

Consistency
- likeness in input/output behaviour arising from similar situations or task objectives

Principles of Learnability

Table 7.1 Summary of principles affecting learnability

Principle	Definition	Related principles
Predictability	Support for the user to determine the effect of future action based on past interaction history	Operation visibility
Synthesizability	Support for the user to assess the effect of past operations on the current state	Immediate/eventual honesty
Familiarity	The extent to which a user's knowledge and experience in other real-world or computer-based domains can be applied when interacting with a new system	Guessability, affordance
Generalizability	Support for the user to extend knowledge of specific interaction within and across applications to other similar situations	–
Consistency	Likeness in input–output behavior arising from similar situations or similar task objectives	–

Principles of flexibility

Dialogue initiative
- freedom from system imposed constraints on input dialogue
- system vs. user pre-emptiveness

Multithreading
- ability of system to support user interaction for more than one task at a time
- concurrent vs. interleaving; multimodality

Task migratability
- passing responsibility for task execution between user and system

Principles of flexibility (ctd)

Substitutivity

- allowing equivalent values of input and output to be substituted for each other
- representation multiplicity; equal opportunity

Customizability

- modifiability of the user interface by user (adaptability) or system (adaptivity)

Principles of Flexibility

Table 7.2 Summary of principles affecting flexibility

Principle	Definition	Related principles
Dialog initiative	Allowing the user freedom from artificial constraints on the input dialog imposed by the system	System/user pre-emptiveness
Multi-threading	Ability of the system to support user interaction pertaining to more than one task at a time	Concurrent vs. interleaving, multi-modality
Task migratability	The ability to pass control for the execution of a given task so that it becomes either internalized by the user or the system or shared between them	–
Substitutivity	Allowing equivalent values of input and output to be arbitrarily substituted for each other	Representation multiplicity, equal opportunity
Customizability	Modifiability of the user interface by the user or the system	Adaptivity, adaptability

Principles of robustness

Observability

- ability of user to evaluate the internal state of the system from its perceivable representation
- browsability; defaults; reachability; persistence; operation visibility

Recoverability

- ability of user to take corrective action once an error has been recognized
- reachability; forward/backward recovery; commensurate effort

Principles of robustness (ctd)

Responsiveness

- how the user perceives the rate of communication with the system
- Stability

Task conformance

- degree to which system services support all of the user's tasks
- task completeness; task adequacy

Principles of Robustness

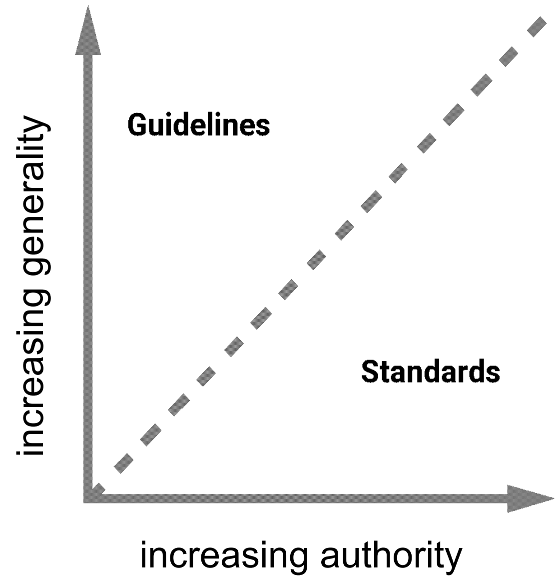
Table 7.3 Summary of principles affecting robustness

Principle	Definition	Related principles
Observability	Ability of the user to evaluate the internal state of the system from its perceivable representation	Browsability, static/dynamic defaults, reachability, persistence, operation visibility
Recoverability	Ability of the user to take corrective action once an error has been recognized	Reachability, forward/backward recovery, commensurate effort
Responsiveness	How the user perceives the rate of communication with the system	Stability
Task conformance	The degree to which the system services support all of the tasks the user wishes to perform and in the way that the user understands them	Task completeness, task adequacy

Using design rules

Design rules

- suggest how to increase usability
- differ in generality and authority



Standards

- Set by national or international bodies to ensure compliance by a large community of designers

- Standards require sound underlying theory and slowly changing technology

- Hardware standards more common than software standards (high authority and low level of detail)

- Standard institutions are: the British Standards Institution (BSI), the International Organization for Standardization (ISO), and a national military agency. [has had standards for hardware in place before any for software]

Standards

For example, the UK Ministry of Defence has published an Interim Defence Standard 00–25 on *Human Factors for Designers of Equipment*, produced in 12 parts:

- Part 1 Introduction
- Part 2 Body Size
- Part 3 Body Strength and Stamina
- Part 4 Workplace Design
- Part 5 Stresses and Hazards
- Part 6 Vision and Lighting
- Part 7 Visual Displays
- Part 8 Auditory Information
- Part 9 Voice Communication
- Part 10 Controls
- Part 11 Design for Maintainability
- Part 12 Systems

Standards

According to ISO standard 9241, *usability* is defined as: The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments.

a) Effectiveness- The accuracy and completeness with which specified users can achieve specified goals in particular environments.

b) Efficiency- The resources expended in relation to the accuracy and completeness of goals achieved.

c) Satisfaction- The comfort and acceptability of the work system to its users and other people affected by its use

Guidelines

- More suggestive and general
- Many textbooks and reports full of guidelines
- Abstract guidelines (principles) applicable during early life cycle activities
- Detailed guidelines (style guides) applicable during later life cycle activities
- Understanding justification for guidelines aids in resolving conflicts

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

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.*
3. *Make things visible: bridge the gulfs of Execution and Evaluation.*
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
- A pattern is an invariant solution to a recurrent problem within a specific context.
- Patterns do not exist in isolation but are linked to other patterns in *languages* which enable complete designs to be generated

HCI design patterns (cont.)

- Characteristics of patterns
  - capture design practice not theory
  - capture the essential common properties of good examples of design
  - represent design knowledge at varying levels: social, organisational, conceptual, detailed
  - embody values and can express what is humane in interface design
  - are intuitive and readable and can therefore be used for communication between all stakeholders
  - a pattern language should be generative and assist in the development of complete designs.

Summary

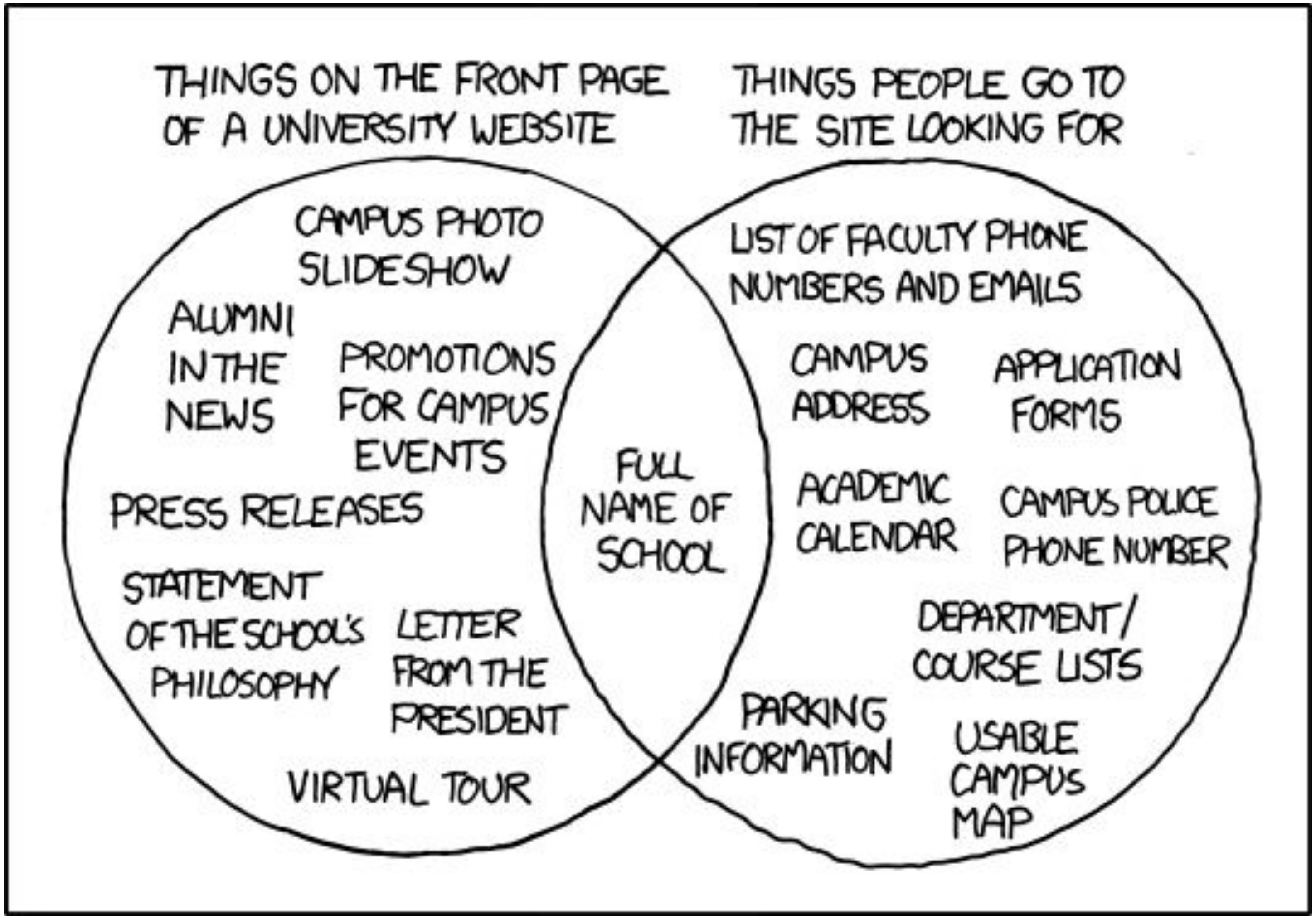
Principles for usability

- repeatable design for usability relies on maximizing benefit of one good design by abstracting out the general properties which can direct purposeful design
- The success of designing for usability requires both creative insight (new paradigms) and purposeful principled practice

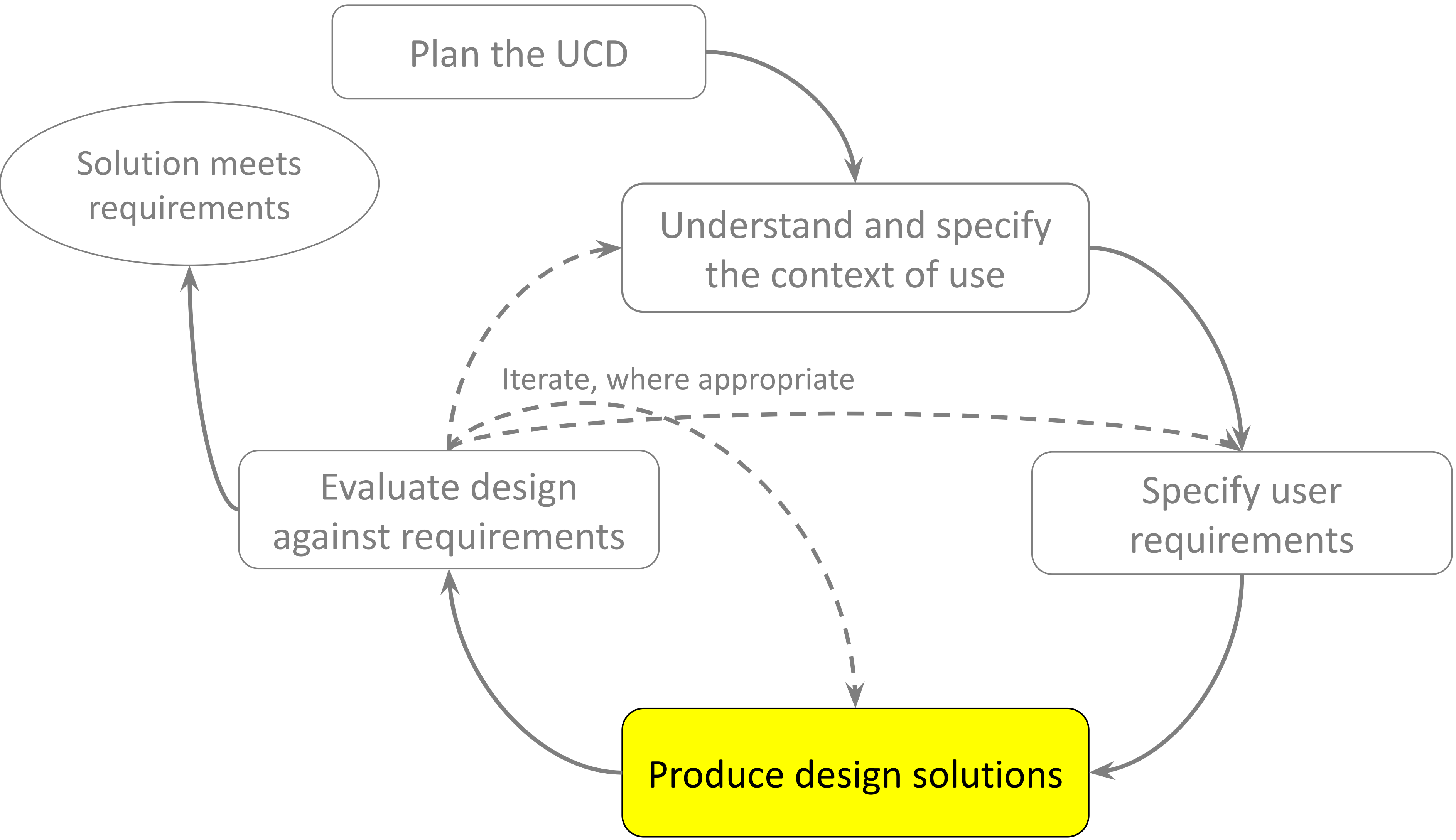
Using design rules

- standards and guidelines to direct design activity

Content design



http://xkcd.com/773/



ISO 9241-210, 2010

Today

1. Information architecture
2. Card sorting

What do people do online?

information foraging

* forage = search widely for food or provisions

Information scent:

users estimate a given hunt's likely success from the spoor

*scent = a trail of evidence or other signs assisting someone in a search

Nielsen, 2003

Information scent:

users assess whether their path exhibits cues related to the desired outcome

Nielsen, 2003

On the Web, people come to:

Satisfy goals

Do tasks

find answers to specific questions

* not only web(sites), but any IS solution

Redish, 2007

They want information that:

- Answers a question
- Help to complete a task
- Easy to find and understand
- Accurate, up to date, credible

Redish, 2007

What is information architecture?

What?

the practice of organizing and presenting information in human-friendly ways, in order to <u>transform information into structured knowledge</u>

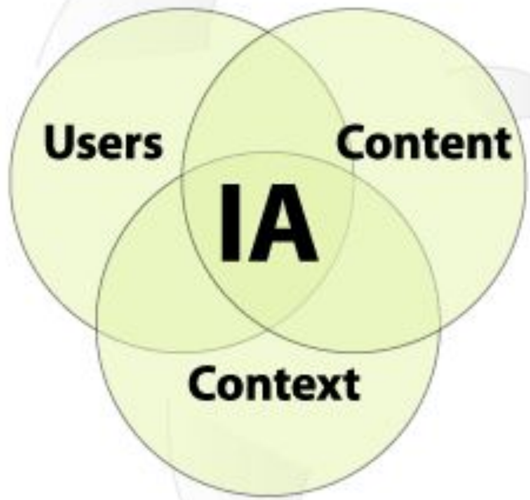
Cummings, 2009

IA Areas of Practice

Users + Context + Content = IA

Professional Development? Balance your strengths by exploring other areas....

We all come from a background that fits into one of these areas. For example, you might have a background in technical communications and therefore may feel very comfortable working with content. Or you might have an MBA and feel especially strong about your skills in the business context area. I suggest taking one of these "majors" and complementing it with a "minor" in one or two of the other areas. So if you're that MBA, consider boning up on ethnography or UE to address gaps you may feel in your understanding of users.
http://www.louisrosenfeld.com



Of course there's overlap in these skills and roles. Where does card sorting fit in - under Users or Content? The important thing to remember is that we're a multi-faceted bunch, and that it's a rewarding experience to explore outside your own area of expertise as you develop your career.

Users

who they are, what their information-seeking behaviors and needs are

Skills and Roles
- Contextual Inquiry
- Personas
- Ethnography
- Task Analysis
- Usability Testing
- Usability Inspection
- Articulating User Needs
- Documenting User Experience Requirements

Content

volume, formats, metadata, structure, organization

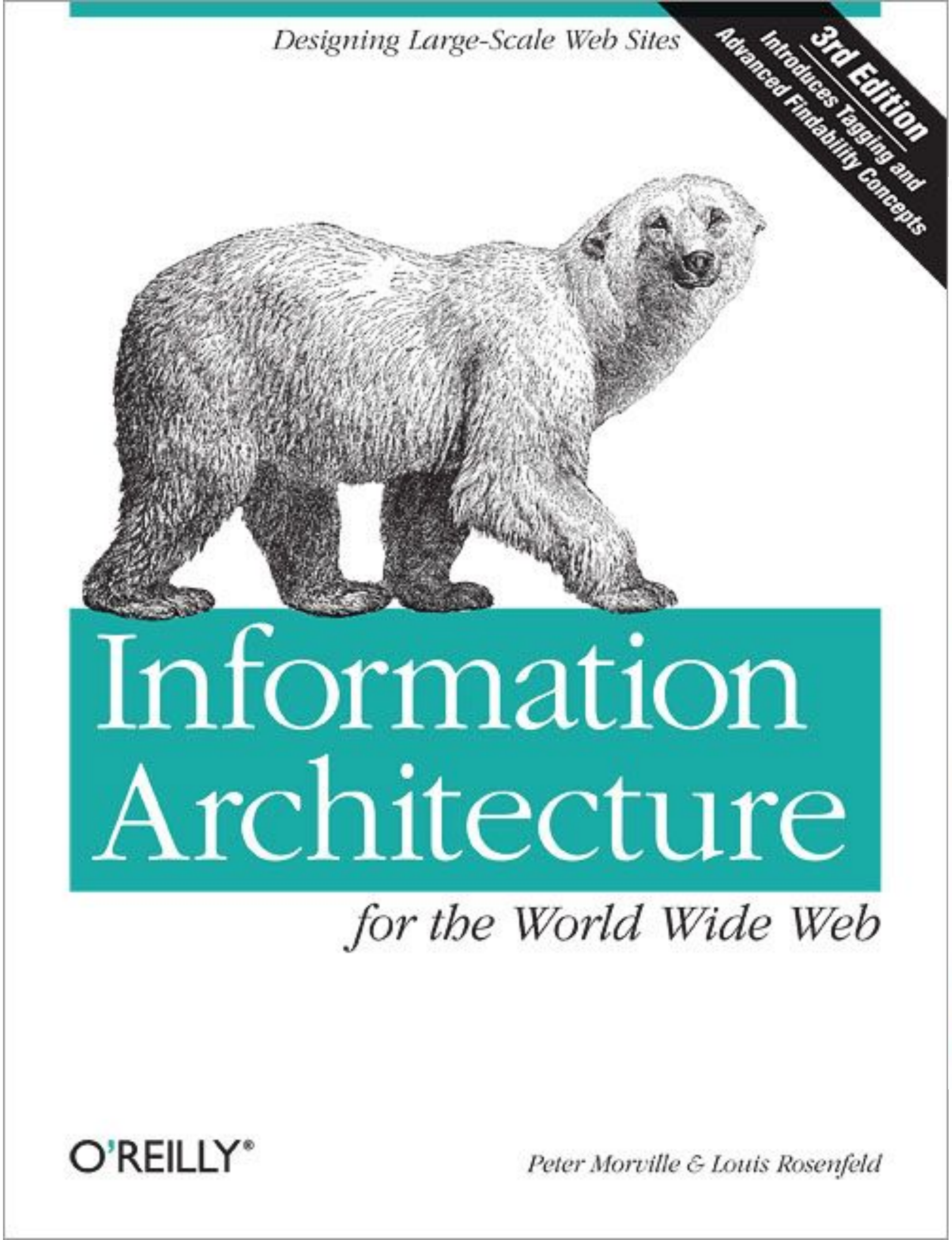
Skills and Roles
- Indexing & Cataloging
- XML and Metadata
- Thesaurus Development
- Site Architecture
- Writing
- Content Management
- Navigation and Labeling

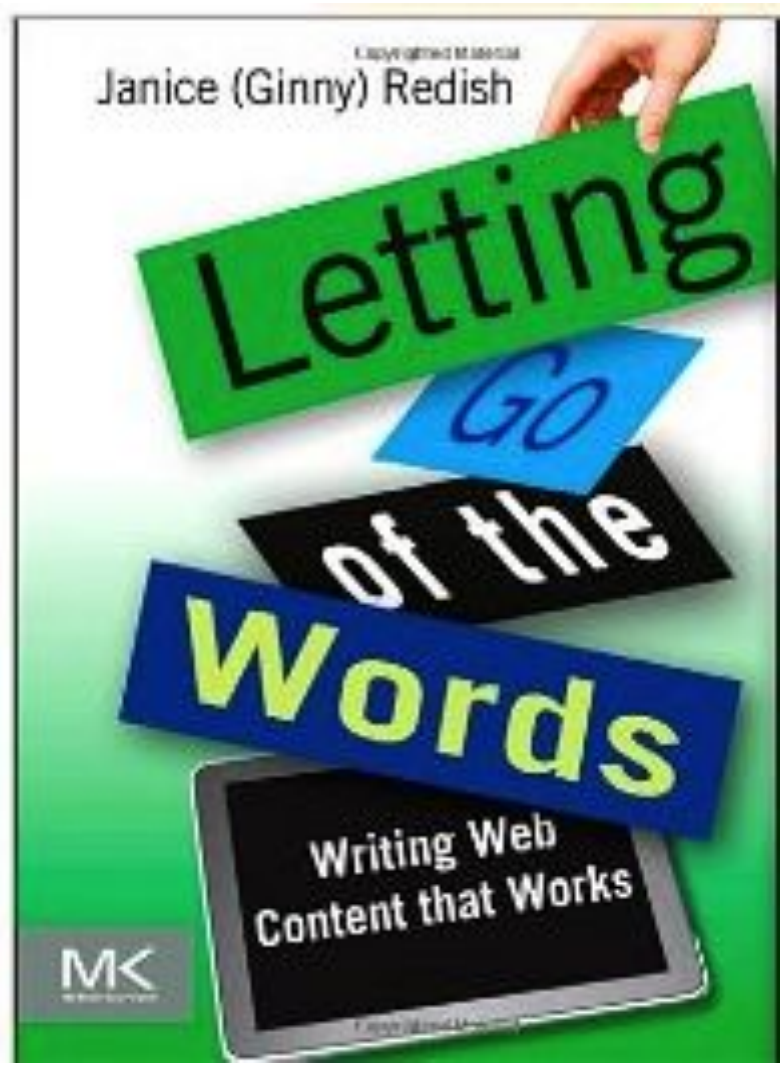
Context

business model, business value, politics, culture, resources and resource constraints

Skills and Roles
- Defining Business Needs
- Project Management
- Project Scope and Definition
- Business Analysis
- Systems Analysis
- ROI Calculation
- Managing Client Expectations
- Technical Constraints

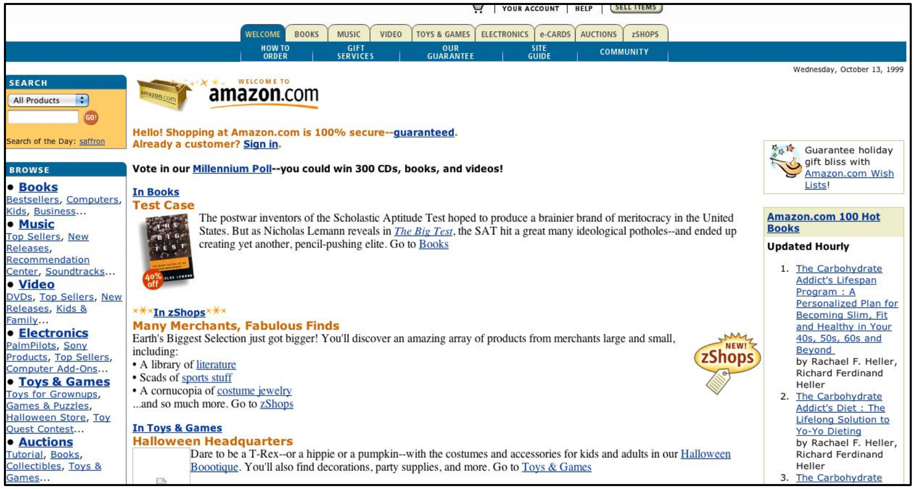
Rosenfeld, 2001


Designing Large-Scale Web Sites
3rd Edition
Introduces Tagging and
Advanced Findability Concepts
Information
Architecture
for the World Wide Web
O'REILLY
Peter Morville & Louis Rosenfeld


Janice (Ginny) Redish
Letting
Go
of the
Words
Writing Web
Content that Works
MK

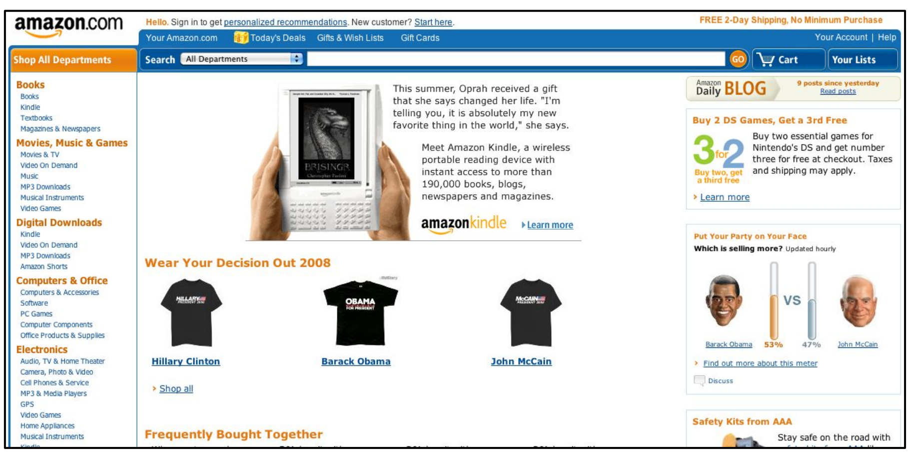
IA in practice

Oct. 1999

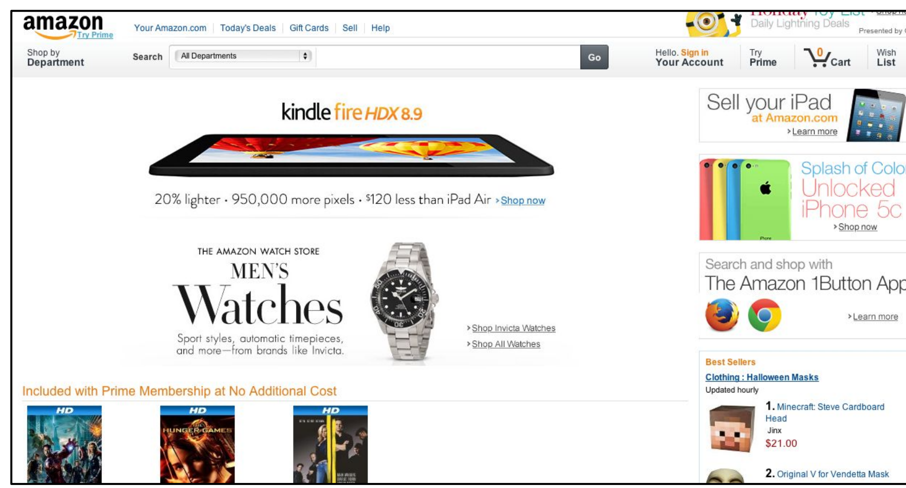


Oct. 2003

Oct. 2008



Oct. 2013



Audience splitting

- Students, researchers, administrative staff
- Technology expertise
- Customer type
- Product type

Navigation design

- Where am I?
- Users are focused on the hunt (information)
- Meaningful links, menus, sections, feedback
- Concise descriptions
- Organization of content
- Site map
- Path analysis (for task completion)

Webpage content

Title

Purpose of webpage

Content (extent, break into topics)

Content maintenance (who?)

Forms

List, tables, headings

Illustrations and photos

Consistency (style guide)

6 guidelines to focus on your essential messages

Give people only what *they* need

Cut! Cut! Cut! And cut again!

Start with the key point (inverted pyramid style)

Break down walls of words

Market by using useful information

Layer information

Redish, 2007

Tools, techniques, standards:

- Content inventory
- Content hierarchy / **card sorting**
- Site flows
- Content model
- Vocabularies and taxonomies
- Site/content maps

Card sorting

Light weight technique to

- Understand how actual users group items
- Identify terms and labels that may be unclear
- Get suggestions for new items
- Website content structure
- Content type and scope
- Scaling up

Why?

- Cognitive models of actual users
- Information findability
- Website navigation and structure
  - Information type
  - Process
  - Topics

How to do card sorting?

How?

- Basic process
  - Identify the items to be categorized
  - Write items on cards
  - Group items in a way that makes sense to participants
  - Groups are predefined
  - or participants create group labels
  - Analyze groupings to identify commonalities
- Different variations exist
- Software tools for cluster/category analysis
  (http://measuringuserexperience.com/CardSorting/index.htm)

Card sorting

https://www.youtube.com/watch?v=FTzHeYPB9c8

Universal Design

Introduction

People :

- Have different abilities and weaknesses
- Come from different backgrounds and cultures
- Have different interests, viewpoints and experiences
- Are different ages and sizes.

- All of these things have an impact on the way in which an individual will use a particular computing application and, indeed, on whether or not they can use it at all.
- Given such diversity, we cannot assume a ‘typical’ user or design only for people like ourselves.

Universal Design

Universal design is the process of designing products so that they can be used by as many people as possible in as many situations as possible

- This means particularly designing interactive systems that are usable by anyone, with any range of abilities, using any technology platform.

- This can be achieved by designing systems either:
   a) To have built in redundancy - an interface that has both visual and audio access to commands; or
   b) To be compatible with assistive technologies - a website that provides text alternatives for graphics, so that it can be read using a screen reader.

Universal Design Principles

- North Carolina State University (NCSW) proposed seven general principles of universal design:
    1. Equitable use
    2. Flexibility in use
    3. Simple and intuitive to use
    4. Perceptible information
    5. Tolerance for error
    6. Low physical effort
    7. Size and space for approach and use
- According to the Center for Universal Design in NCSU, the Principles "may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments."

Universal Design Principles

Principle 1: Equitable Use

The design is useful and marketable to people with diverse abilities.

Guidelines:

1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.

1b. Avoid segregating or stigmatizing any users.

1c. Provisions for privacy, security, and safety should be equally available to all users.

1d. Make the design appealing to all users.

Universal Design Principles

Principle 2: Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

Guidelines:

2a. Provide choice in methods of use.

2b. Accommodate right- or left-handed access and use.

2c. Facilitate the user's accuracy and precision.

2d. Provide adaptability to the user's pace.

Universal Design Principles

Principle 3: Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Guidelines:

3a. Eliminate unnecessary complexity.

3b. Be consistent with user expectations and intuition.

3c. Accommodate a wide range of literacy and language skills.

3d. Arrange information consistent with its importance.

3e. Provide effective prompting and feedback during and after task completion.

Universal Design Principles

Principle 4: Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Guidelines:

4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.

4b. Provide adequate contrast between essential information and its surroundings.

4c. Maximize "legibility" of essential information.

4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Universal Design Principles

Principle 5: Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Guidelines:

5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.

5b. Provide warnings of hazards and errors.

5c. Provide fail safe features.

5d. Discourage unconscious action in tasks that require vigilance.

Universal Design Principles

Principle 6: Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

Guidelines:

6a. Allow user to maintain a neutral body position.

6b. Use reasonable operating forces.

6c. Minimize repetitive actions.

6d. Minimize sustained physical effort.

Universal Design Principles

Principle 7: Size and Space for Approach and Use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Guidelines:

7a. Provide a clear line of sight to important elements for any seated or standing user.

7b. Make reach to all components comfortable for any seated or standing user.

7c. Accommodate variations in hand and grip size.

7d. Provide adequate space for the use of assistive devices or personal assistance.

Sources: Chapter 10 (section 10.2) and https://universaldesign.ie/what-is-universal-design/the-7-principles/#p2

Case Study

TEAM-WORK

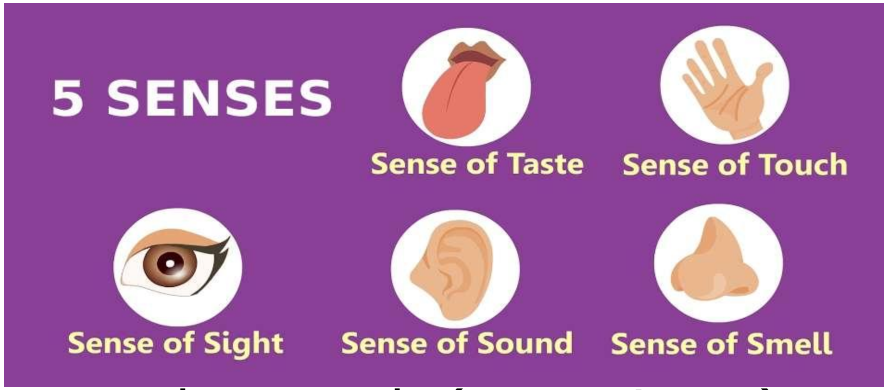
Select any digital system and evaluate the system based on the principles of universal design. Briefly pointed out the missing considerations/principles and possible way of redesign/improvement.

Multi-Sensory or Multi-Modal Systems

- Providing access to information through more than one mode of interaction is an important principle of universal design. Such design relies on multi-modal interaction
- More than one sensory channel in interaction
  - e.g. sounds, text, hypertext, animation, video, gestures, vision
- Used in a range of applications:
  - particularly good for users with special needs, and virtual reality
- Multi-modal interaction is not just about enhancing the richness of the interaction, but also about redundancy.
- Redundant systems provide the same information through a range of channels, so, for example, *information presented graphically is also captioned in readable text or speech, or a verbal narrative is provided with text captions*.
- The aim is to provide at least an equivalent experience to all, regardless of their primary channel of interaction.

Usable Senses

- The 5 senses (sight, sound, touch, taste and smell) are used by us every day
  - each is important on its own
  - together, they provide a fuller interaction with the natural world
- Computers rarely offer such a rich interaction
- Can we use all the available senses?
  - ideally, yes
  - practically – no



- We can use • sight • sound • touch (sometimes)
- We cannot (yet) use • taste • smell

Multi-modal vs. Multi-media

- Multi-modal systems
  - use more than one sense (or mode) of interaction

    e.g. visual and aural senses: a text processor may speak the words as well as echoing them to the screen

- Multi-media systems
  - use a number of different media to communicate information

    e.g. a computer-based teaching system:

    - may use video, animation, text and still images.
    - different media all using the visual mode of interaction.
    - may also use sounds, both speech and non-speech.
    - two more media, now using a different mode

Sounds in the Interface

- Sound is an important contributor to usability.

- There is experimental evidence to suggest that the addition of audio confirmation of modes, in the form of changes in key-clicks, reduces errors.

- Video games offer further evidence, since experts tend to score less well when the sound is turned off than when it is on; they pick up vital clues and information from the sound while concentrating their visual attention on different things.

Sounds in the Interface

- The dual presentation of information through sound and vision supports universal design, by enabling access for users with visual and hearing impairments respectively.

- It also enables information to be accessed in poorly lit or noisy environments.

- Sound can convey transient information and does not take up screen space, making it potentially useful for mobile applications.

- There are two types of sound that we could use: speech and non-speech.

Speech

Human beings have a great and natural mastery of speech

- makes it difficult to appreciate the complexities

but

- it’s an easy medium for communication

Structure of Speech

phonemes

- 40 of them (24 consonants and 16 vowel)
- basic atomic units
- sound slightly different depending on the context they are in, these larger units are …

allophones

- all the sounds in the language
- between 120 and 130 of them
- these are formed into …

morphemes

- smallest unit of language that has meaning.
- Can be either parts of words or whole words, and they are built into sentences using the rules of grammar of the language

Speech (cont'd)

Other terminology:

- prosody
  - alteration in tone and quality
  - variations in emphasis, stress, pauses and pitch
  - impart more meaning to sentences.
- co-articulation
  - the effect of context on the sound
  - transforms the phonemes into allophones
- syntax – structure of sentences
- semantics – meaning of sentences

Speech Recognition Problems

- Different people speak differently:
  - accent, intonation, stress, idiom, volume, etc.
- The syntax of semantically similar sentences may vary.
- Background noises can interfere.
- People often “ummm.....” and “errr.....”
- Words not enough - semantics needed as well
  - requires intelligence to understand a sentence
  - context of the utterance often has to be known
  - also information about the subject and speaker

e.g. even if “Errr.... I, um, don’t like this” is recognised, it is a fairly useless piece of information on it’s own

The Phonetic Typewriter

- Developed for Finnish (a phonetic language, written as it is said)
- Trained on one speaker, will generalise to others.
- A neural network is trained to cluster together similar sounds, which are then labelled with the corresponding character.
- When recognising speech, the sounds uttered are allocated to the closest corresponding output, and the character for that output is printed.
  - requires large dictionary of minor variations to correct general mechanism
  - noticeably poorer performance on speakers it has not been trained on

The Phonetic Typewriter (ctd)

a	a	a	ah	h	æ	æ	ø	ø	e	e	e
o	a	a	h	r	æ	l	ø	y	y	j	i
o	o	a	h	r	r	r	g	g	y	j	i
o	o	m	a	r	m	n	m	n	j	i	i
l	o	u	h	v	vm	n	n	h	hj	j	j
l	u	v	v	p	d	d	t	r	h	hi	j
.	.	u	v	tk	k	p	p	p	r	k	s
.	.	v	k	pt	t	p	t	p	h	s	s

Speech Recognition: useful?

- Single user or limited vocabulary systems
  e.g. computer dictation
- Open use, limited vocabulary systems can work satisfactorily
  e.g. some voice activated telephone systems
- general user, wide vocabulary systems … … still a problem
- Great potential, however
  - when users hands are already occupied
    e.g. driving, manufacturing
  - for users with physical disabilities
  - lightweight, mobile devices

Speech Synthesis

The generation of speech

Useful

- natural and familiar way of receiving information

Problems

- similar to recognition: prosody particularly

Additional problems

- intrusive - needs headphones, or creates noise in the workplace
- transient - harder to review and browse

Speech Synthesis: useful?

Successful in certain constrained applications when the user:

- is particularly motivated to overcome problems
- has few alternatives

Examples:

- screen readers
  - read the textual display to the user
    utilised by visually impaired people
- warning signals
  - spoken information sometimes presented to pilots whose visual and haptic skills are already fully occupied

Non-Speech Sounds

boings, bangs, squeaks, clicks etc.

- commonly used for warnings and alarms
- Evidence to show they are useful
  - fewer typing mistakes with key clicks
  - video games harder without sound
- Language/culture independent, unlike speech

Non-Speech Sounds: useful?

- Dual mode displays:
  - information presented along two different sensory channels
  - redundant presentation of information
  - resolution of ambiguity in one mode through information in another
- Sound good for
  - transient information
  - background status information

e.g. Sound can be used as a redundant mode in the Apple Macintosh; almost any user action (file selection, window active, disk insert, search error, copy complete, etc.) can have a different sound associated with it.

Auditory Icons

- Use natural sounds to represent different types of object or action
- Natural sounds have associated semantics which can be mapped onto similar meanings in the interaction

  e.g. throwing something away
  ~ the sound of smashing glass
- Problem: not all things have associated meanings

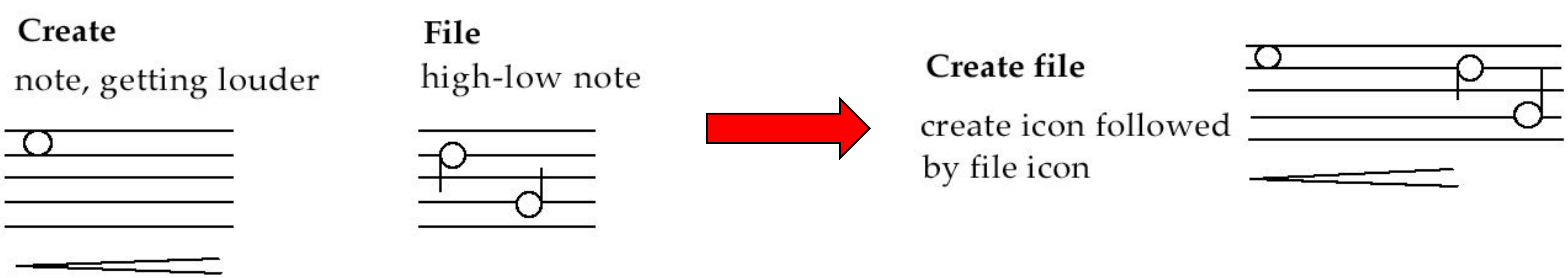
- Additional information can also be presented:
  - muffled sounds if object is obscured or action is in the background
  - use of stereo allows positional information to be added

SonicFinder for the Macintosh

- items and actions on the desktop have associated sounds
- folders have a papery noise
- moving files – dragging sound
- throwing something in the wastebasket – smashing sound
- copying – a problem …
  - sound of a liquid being poured into a receptacle
  - rising pitch indicates the progress of the copy
- big files have louder sound than smaller ones

Earcons

- An alternative to using natural sounds is to devise synthetic sounds.
- An earcon is a brief, distinctive sound that represents a specific event or conveys other information.
- Earcons are a common feature of computer operating systems and applications, ranging from a simple beep to indicate an error, to the customizable sound schemes of modern operating systems that indicate startup, shutdown, and other events.
- Structured combinations of notes (motives) represent actions and objects
- Motives combined to provide rich information
  - compound earcons
  - multiple motives combined to make one more complicated earcon



Earcons (ctd)

- family earcons

  similar types of earcons represent similar classes of action or similar objects: the family of “errors” would contain syntax and operating system errors

Earcons easily grouped and refined due to compositional and hierarchical nature

Harder to associate with the interface task since there is no natural mapping

touch

- The use of touch in the interface is known as - haptic interaction
  - cutaneous perception
    - tactile sensation; vibrations on the skin
  - kinesthetics
    - movement and position; force feedback
- information on shape, texture, resistance, temperature, comparative spatial factors
- example technologies
  - electronic braille displays
  - force feedback devices e.g. Phantom
    - resistance, texture

Handwriting recognition

Handwriting is another communication mechanism which we are used to in day-to-day life

- Technology
  - Handwriting consists of complex strokes and spaces
  - Captured by digitising tablet
    - strokes transformed to sequence of dots
  - large tablets available
    - suitable for digitising maps and technical drawings
  - smaller devices, some incorporating thin screens to display the information
    - PDAs such as Palm Pilot
    - tablet PCs

Handwriting recognition (ctd)

- Problems
  - personal differences in letter formation
  - co-articulation effects
- Breakthroughs:
  - stroke not just bitmap
  - special 'alphabet' – Graffeti on PalmOS
- Current state:
  - usable – even without training
  - but many prefer keyboards!

gesture

- applications
  - gestural input - e.g. “put that there”
  - sign language
- technology
  - data glove
  - position sensing devices e.g MIT Media Room
- benefits
  - natural form of interaction - pointing
  - enhance communication between signing and non-signing users
- problems
  - user dependent, variable and issues of coarticulation

Users with disabilities

- visual impairment
  - screen readers, SonicFinder
- hearing impairment
  - text communication, gesture, captions
- physical impairment
  - speech I/O, eyegaze, gesture, predictive systems (e.g. Reactive keyboard)
- speech impairment
  - speech synthesis, text communication
- dyslexia
  - speech input, output
- autism
  - communication, education

… plus …

- age groups
  - older people e.g. disability aids, memory aids, communication tools to prevent social isolation
  - children e.g. appropriate input/output devices, involvement in design process
- cultural differences
  - influence of nationality, generation, gender, race, sexuality, class, religion, political persuasion etc. on interpretation of interface features
  - e.g. interpretation and acceptability of language, cultural symbols, gesture and colour