Human-Computer Interaction

CS 188 § 1 — Spring 2019

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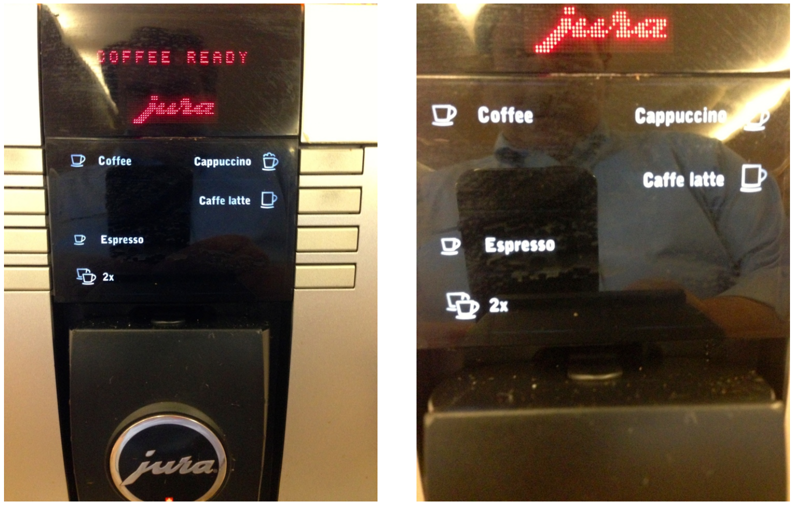
Acknowledgements and caveat

These slides draw liberally, with permission, from the Informatics 131 slides of Profs. Alfred Kobsa and Matthew Bietz.

Caveat (beware): At best, PowerPoint slides are only a pale imitation of the entirety of a class meeting. In this course in particular, the lectures will cover topics beyond what appears in these slides. Don't rely on them as a substitute for attending class.



How do you get a double espresso?

HCI Course Overview

- The field of HCI
- Human characteristics
- Development and evaluation methodology
- Menu of technologies
- Guidelines and results

Why are we here?

- User interfaces matter: for efficiency, for convenience, for commercial success, even for life and death
- People time is more expensive than computer time
- Everyone has stories of bad user interfaces
- Further examples ◊

What is HCI?

- Narrowly: 1 user, 1 computer
  - – Focus on software, layout and operation of UI
- Broadly: people and computers
  - – Users' mental processes, work practices
  - – Training; collaboration; management
  - – Social/organizational/health issues
- No longer just about the desktop: Most human activities can involve technology

Six aspects of HCI

- Human abilities (perception, memory, …)
- Technologies (windowing, mouse, VR, …)
- Design methods (prototyping, lifecycles, …)
- Evaluation methods (experiments, observation, …)
- Guidelines and results (what has been proven to work in particular situations, e.g., typography)
- Implementation tools and techniques (another course)

HCI Course's place in the spectrum

- CS 180 Algorithms (math) [eternal]
- CS 151B, 118, 131 Systems (arch., networks, PLs) [verifiable but subject to technology changes]
- CS 130 SW Engr [software focus]
- HCI [user focus]
- Social Impact [social focus, few experiments possible]

HCI Course Recurring Themes

- People are diverse, unpredictable, messy, and ill-understood
- You (the designer) may not be qualified to know what the user needs
- You have to evaluate constantly, at every stage of development
- The later you are in the development cycle, the more it costs to make changes

How did we get here?

- Once, it was enough if the system just worked (most of the time)
- Once, the burden was on the user
- Today, you have to care: Success of a product (and well-being of users) depends on good UI

Administrative Stuff

- Syllabus
- Your “HCI Notebook”: Carry it with you always!

How do we know a UI is good?

- Analyze using “common sense”
- Develop a theory of “human cognitive processing” to predict users’ problems
- Test the UI on actual users; problems arise
  - Generalize findings, develop guidelines for avoiding problems: Usability Engineering
- But how can we know it’s problem-free?

Usability goals

- Satisfaction (utility, effectiveness, experience)
- Safety/robustness
- Efficiency (time, movement)
- Learnability (to get work done)
- Memorability (when using infrequently)

Usability principles/heuristics (Jakob Nielsen)

- Visibility of system status
- Match between system and real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition over recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

Interface Design Golden Rules (Ben Shneiderman)

- Strive for consistency
- Seek universal usability
- Offer informative feedback
- Design dialogs to yield closure
- Prevent errors
- Permit easy reversal of actions
- Keep users in control
- Reduce short-term memory load

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Human perception and cognition

- If we're designing web sites for human users, it only makes sense to know something about "how people work"
- Our brains don't just "take pictures": They process, select, categorize, model

Cognition

- Attention ◊ ◊
- Perception/recognition
- Memory
- Learning
- Reading, speaking, listening
- Problem-solving, planning, reasoning, decision-making

Gestalt principles

- Whole picture, perception in context
- Use these to reinforce meaning, guide user ◊
- Proximity ◊
- Similarity ◊
- Closure ◊
- Continuity ◊ ◊
- Symmetry ◊

Memory

- Sensory, pre-attentive
- Short-term
- Long-term (with practice, repetition)

- Recognition vs. recall
- Active vs. passive learning

Pre-attentive processing

- Before you get to conscious attention
- Examples: length, width, size, number, closure, color, intensity, flashing, direction of motion ◊ ◊

Conceptual/mental models

- Model: abstraction, simplification
- How user thinks of system/device/product
- Functional (how it works, how to use)
  - Should match the task
- Structural (how it's organized, built)
  - Harder to acquire from experience
  - Useful for extension, integration
- May not match reality
  - Maybe that's okay

Metaphors

- A package of elements
  - Analogy with real-world items
  - Draw on user's knowledge, experience
- Metaphors only go so far
- Typewriter, desktop, book, filing cabinet ◊ ◊, office, library, building ◊, city ◊, agent ◊
- Skeuomorphism: design derived from a different medium

Agents

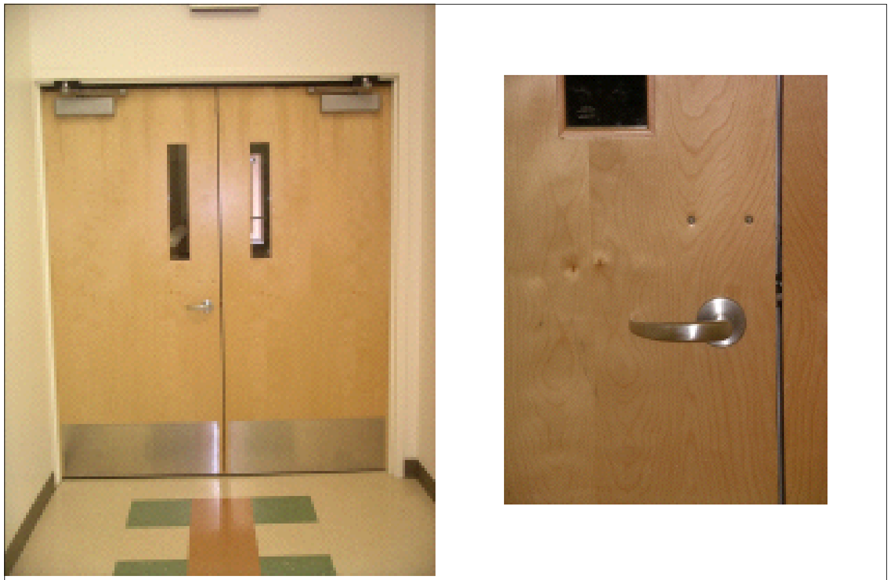
- Another metaphor
- Abstract, animated, embodied/physical
- Credibility comes from
  - Agency: take action, deliver results
  - Responsiveness: infer goals, learn about user
  - Predictability on basis of character
  - Trustworthiness: consistent actions for character

Guidelines to Reduce Memory Burden

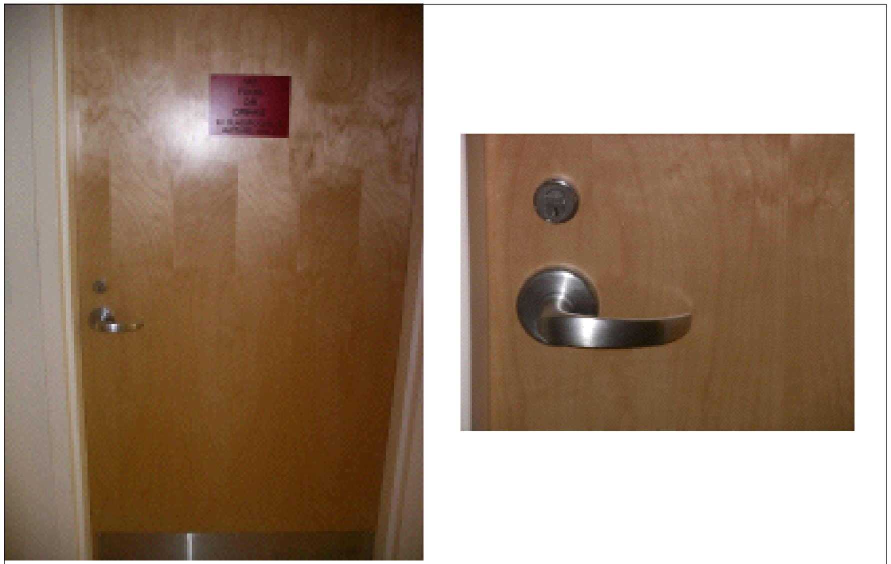
- Use recognition instead of recall
- Help users chunk information
- Require as little short-term memory as possible
- Consider users' mental models
- Provide visual clues and memory aids
- Provide feedback: Let users know their input was received

Affordances: giving a clue

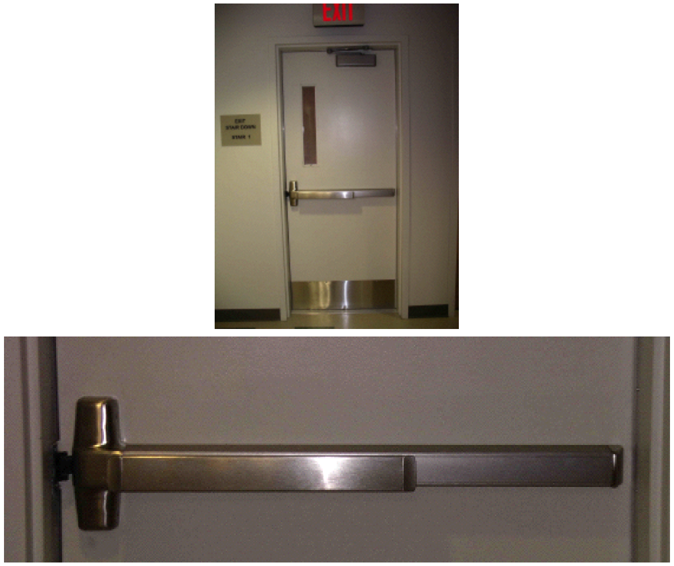
- What the user can see that an object does
- Chairs afford sitting; handles afford pulling
- By now, many users are used to on-screen conventions (affordances are just perceived)
  - Learned conventions
  - E.g., buttons and scrollbars—clear to novices?
  - Metaphors, e.g. play/pause button



Pull the handle. Does the door open?

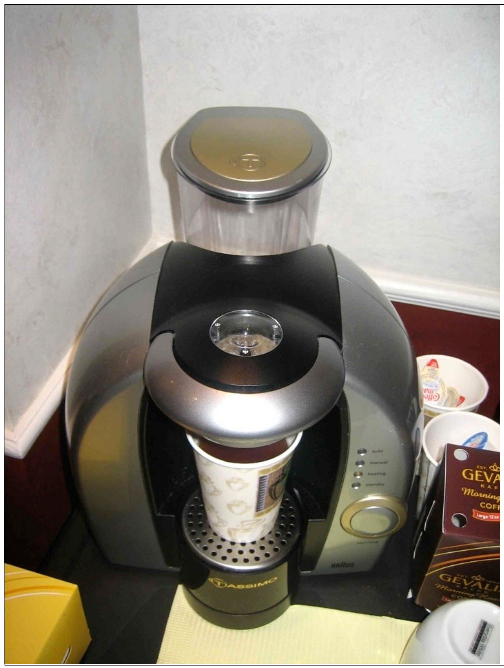


Twist the handle; it doesn't turn. Is the room locked?



An affordance for pushing

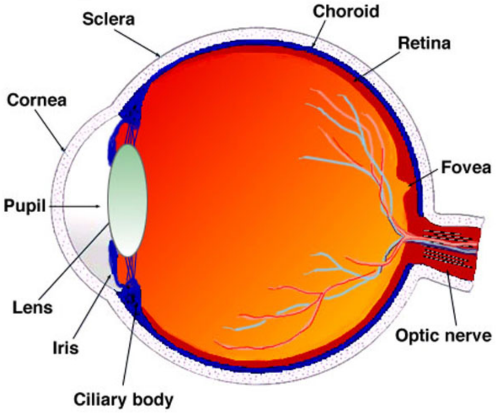
An espresso machine in a dentist’s waiting room



The coffee capsule goes under the clear plastic part of the “bull’s eye.” How do you insert it?

Human vision for color

- About 180° of arc
- Light reception happens in retina (back of eye)



The retina

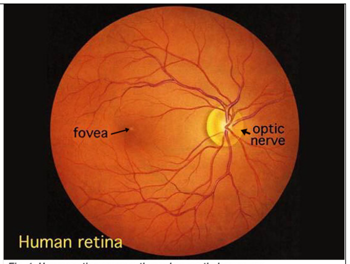


Fig. 1. Human retina as seen through an opthalmoscope.

- Fovea (highest-resolution area)
  - Just 2° of arc
  - 75% of visual operations
- Not like a camera; doesn’t take the whole picture at once ◊

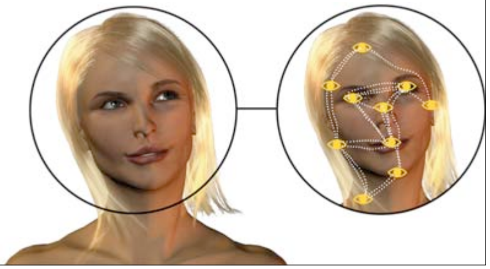
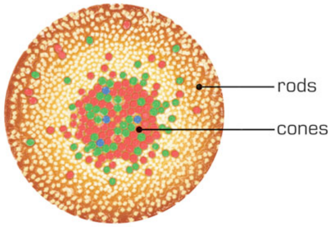


Photo-receptors in retina



- Rods: Degrees of brightness; not in fovea
- Cones: Colors; in fovea mainly.
  - Red-sensitive (64%): many in fovea
  - Green-sensitive (32%): many in fovea
  - Blue-sensitive (2%): not in fovea; evenly distributed over retina

Guidelines based on physiology

- Avoid blue for small objects
- Blue is good for background
- Neighboring objects should not differ just by amount of blue a a a
- Put small red and green objects in center
- Add other emphasis to red and green warning signals on the periphery
- Black, white, yellow, blue OK on periphery

Graphical coding

- We can use differences in

    color / shape / words / line width / size / …

  to distinguish objects of the same type (icons, controls, data, lines in a graph, …)

- What kinds of differences are most effective?

Table from Maguire (1987) ◊

Menu selection time

- Selection time = search time ("S") +
  - if using keyboard, time to press key(s)
  - if using pointer, positioning time ("P") + activation time (e.g., to click mouse)
- For beginners searching menu size *n*:
  - if label unknown, examine all items, S ~ *n*
  - if label known, search linearly or randomly; in either case, S ~ *n*
- Experts can remember position; S is constant

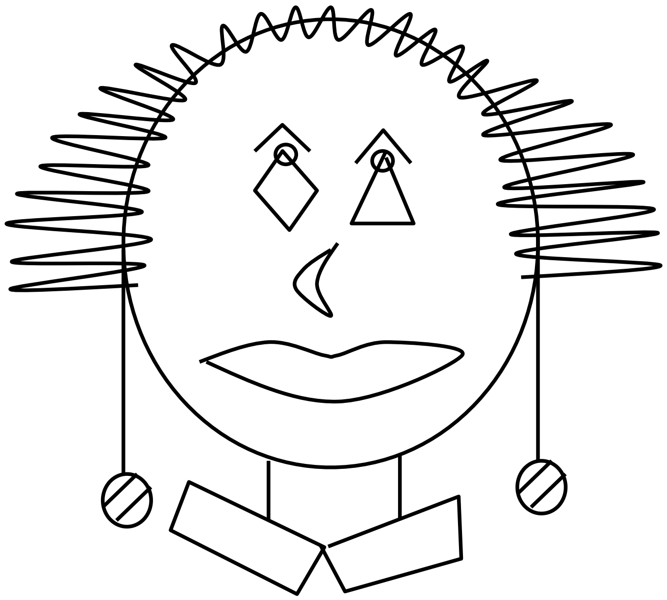
Menu positioning time ("P")

- Fitts's Law: $P = C1 + C2(\log_2(2D/W))$
  - C1 and C2 are constants depending on device
  - D is distance to the center of the target
  - W is size (width) of the object (how much can you miss its center by?)
- The time to acquire a target is a function of the distance to and size of the target
- Screen edge: no chance to overshoot (size is effectively infinite)

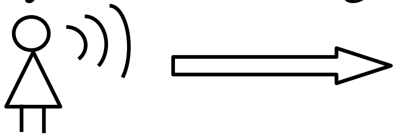
Learning modes (sensory input)

- Visual
- Auditory
- Kinesthetic

- Exercise from Saundra Sparling



Why is natural language hard?



UNDERSTANDING
(APPROP. RESPONSE)

- It's hard to recognize speech
  - Continuous
  - Individual differences
  - Rapid speech
- Understanding (even written language) is harder still
  - Paraphrase
  - Ambiguity (disambiguate by providing context)

How interfaces affect users

- Design to evoke positive responses
  - Feel at ease, enjoy experience, trust system
  - Play to users' emotions
- Avoid user frustration
  - Gimmicks, error messages, overburdened users
- Anthropomorphism

Communication & collaboration

- People work in a social context
- Rules and conventions for social interaction
  - Conversation (facilitate flow)
    - Synchronous, asynchronous
  - Coordination (facilitate action)
  - Awareness of status
- Computer-supported cooperative work
- Ethnography: Observe people and describe

What affects trust?

- If less is at risk, less trust expected
- Perceived similarity: Users trust sites they think reflect concerns similar to their own
- Status or standing: Social leader endorsement
- Consistent behavior: Actions match words?
- Certification: Doctors, e.g., are licensed
- Referrals: Users are likely to trust someone they know (or someone like them, as above)

How to foster trust

- List what security precautions the site takes
- Observe good business practices (follow through on delivery dates, return policy, ...)
- Have a privacy statement: what info is gathered, how it will be used, allow opt-in or opt-out of use

HP Cooltown ◊ (ubiquitous comp.)

- What inferences does the system make?
- What connections are necessary?
- What are possible pitfalls?
- What’s your (emotional) reaction?

Try it: Reduce phone interruptions

- People’s phones still go off in class/meetings (or they miss calls because they didn’t un-silence afterwards)
- Design ways to fix or reduce this problem
- Assume, if you like, that we’re thinking about smartphones (rather than phone-only)
- Form groups of 3–4, design solutions, keep notes, present very briefly. At end turn in notes page with group members’ names.

Interaction styles (traditional)

- Command entry
- Menus
- Direct manipulation
- Form fill-in
- Natural language

Interaction styles (new)

- Immersive/virtual reality
- Ubiquitous/pervasive computing
- Robotics
- Games

Conceptual models for activities

- Giving instructions
- Conversing
- Manipulating, navigating
- Exploring, browsing

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HCI design

- Many roles (HCI designers, graphic designers/artists, tech writers, user reps, management reps, programmers)
- Determining users' needs, requirements
- Must precede coding
- Guidelines to follow
- Evaluation throughout process

User-centered design

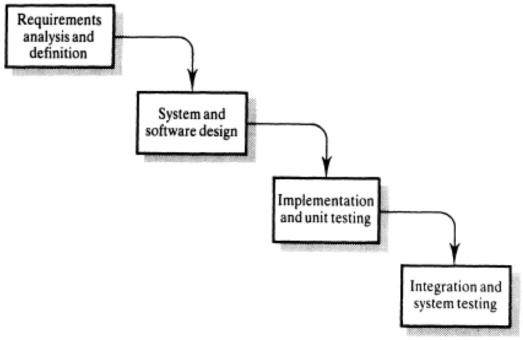
- Early focus on users (cognitive, behavioral, attitudinal characteristics) and tasks
- Actual measurement: observe, record, analyze users' reactions and performance
- Iterative design: find problems, fix them, test again
- Users' involvement in process

User-centered design

- Affects product acceptance and success
- Makes users active stakeholders
- Manages expectations
- Gets head start on training
- Communicates without sales hype
- Provides vital information about needs, requirements, usability

Traditional software development "waterfall model"

This is *not* how we do user-centered HCI design



Requirements analysis and definition

System and software design

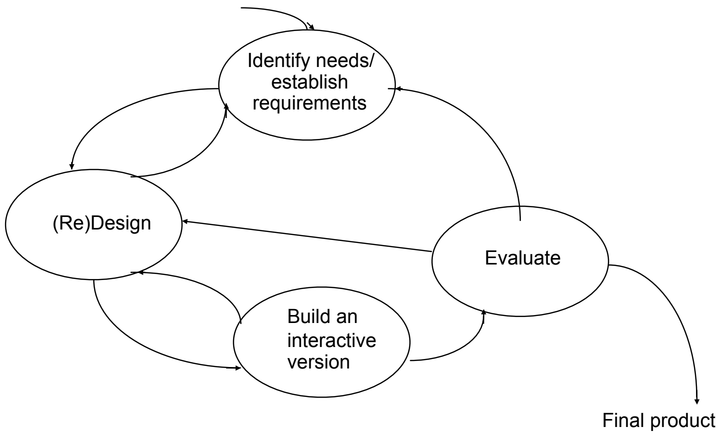
Implementation and unit testing

Integration and system testing

ID process (Preece)

- Identify needs, establish requirements
- Develop alternative designs (unlike software design)
- Build interactive versions of designs (prototypes)
- Evaluate designs
- Iteration is inevitable

ID process model (Preece)



Identify needs/ establish requirements

(Re)Design

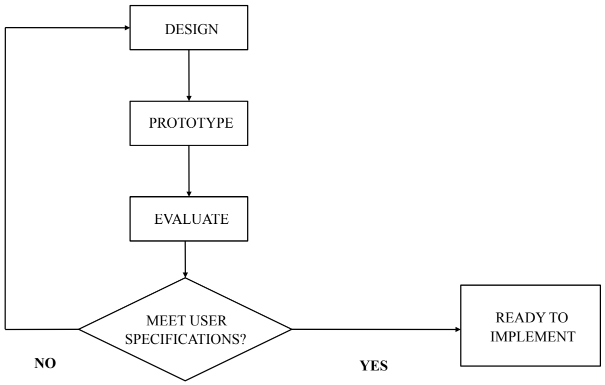
Evaluate

Build an interactive version

Final product

HCI design process (McCracken)

- Needs analysis
- User and task analysis
- Functional analysis
- Requirements analysis
- Setting usability specifications
- Design
- Prototyping
- Evaluation



DESIGN

PROTOTYPE

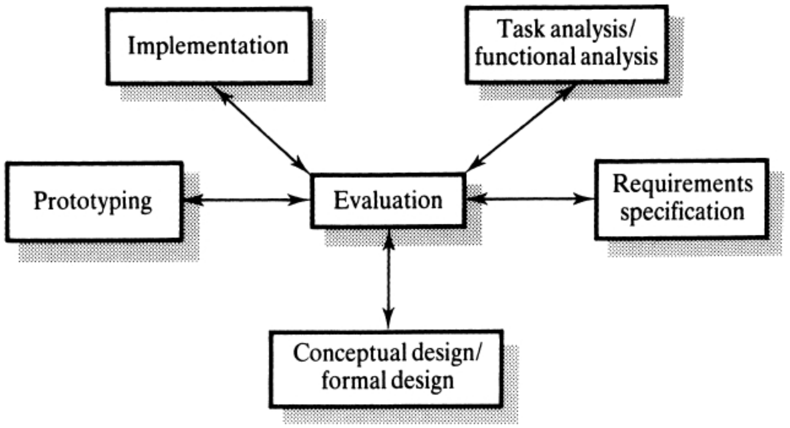
EVALUATE

MEET USER SPECIFICATIONS?

NO

YES

READY TO IMPLEMENT



Implementation

Task analysis/ functional analysis

Prototyping

Evaluation

Requirements specification

Conceptual design/ formal design

The star life cycle (adapted from Hix and Hartson, 1993).

Doing user-centered design

- Who are the users (and other stakeholders)?
- What are their needs and requirements?
- Are there external (environmental) considerations?
- Where do we find users to test our design?
- How do we measure success/usability?

Identify all the stakeholders

- Primary (directly interacting) users, but also:
- Secondary users (e.g., grocery customer)
- Managers
- Recipients of product's results
- Purchasing decision makers
- Competitors' users

Human users are diverse

- Physically (hand size, height, strength, coordination, disabilities)
- Cognitively
- Culturally
- Experientially
- Motivationally

Needs and requirements

- Want to understand users, task, context
- Kinds of requirements
  - Functional: what it does
  - Non-functional: e.g., memory reqts, delivery time
  - Data: what info is stored, in what form
  - Environmental: physical, social, org'l context
  - User: what users will be like
  - Usability: what balance of factors

Gathering requirements data

- Questionnaires
- Interviews
- Workshops and focus groups
- Naturalistic observation
- Studying documentation
- Choose based on kind of task, on data provided, cost, time required, what analyst needs to know

Problems gathering data

- Identifying, involving stakeholders
- Availability of key stakeholders
- Ownership of reports, versions
- Communication (with users, within team)
- Domain info hard to get or articulate
- Political problems in organization
- Changes in economic or business situation

Data gathering guidelines

- Focus on identifying stakeholder needs
- Involve all stakeholder groups, more than one person from each
- Combine techniques; use props, prototypes
- Run a pilot session (user testing!)
- Decide how to record data (audio, video, notes)

Data analysis

- Don’t let data get stale
- Do this iteratively, too
- Decide which tools, how much formalism
  - Quantitative vs. qualitative
  - Scenarios (narrative) and personas
  - Use cases (describe interaction with system, alternative paths)

HCI design process (again)

- Identify needs and requirements (using some evaluation techniques, e.g. observation)
- Design alternative solutions
- Build interactive prototypes
- Evaluate the prototype designs
- Repeat as needed
- Implement the final design

Generating alternative designs

- No automatic way to come up with ideas
- What kind of interaction (instructing, conversing, manipulating, exploring)?
- Look at similar systems, at very different systems
- Build up your repertoire, your toolbox; expose yourself to a lot of things.
- Techniques: brainstorming, attribute listing and variation, …

Prototyping

- Present ideas for evaluation without getting in too deep (in time, money, commitment)
- Use sketches, storyboards, slide shows, video simulations, physical objects, mock-ups, skeleton software
- Build model of work flow, task design, screen layout, information display, difficult or critical aspects

High-fidelity prototyping

- Same materials as final product
- Realistic-looking results
- Tools include Dreamweaver, VB, Photoshop, …
- Users' expectations and focus?

Low-fidelity prototyping

- Unlike the final form
- Quick, cheap, easily changeable
- Examples
  - Sketches
  - Index cards
  - Storyboards
  - Sticky notes
- Paper prototyping ◊ ◊ ◊

Prototyping considerations

- Models necessarily omit detail
- Horizontal vs. vertical approach (breadth vs. depth)
- Other tools
  - “Wireframe” systems (e.g., balsamiq.com, gomockingbird.com)
  - Scripting languages (e.g., Tcl/Tk)

Do it: Design a system for reserving movie or theater tickets

- Groups of 3 or 4: each of you will act as a user and as a designer
- Don’t be constrained by existing systems
- Determine the context, requirements, tasks
- Come up with two alternative designs and (low-fidelity) prototypes of each
- Deliverables: A five-minute overview of your alternatives and highlights (innovations, hard decisions, disagreements)

Do it: Design a UI for a home automation system

- Assume wireless addressing of appliances. Platform: Choose computer or smartphone.
- Groups of about 5
- Determine the context, requirements, tasks
- Come up with (low-fidelity) prototype
- Deliverable: 5 min. overview of your design’s highlights (innovations, hard decisions, disagreements); paper sketch with date and group members’ names

Evaluation

- Formative vs. summative
- Four paradigms
  - Informal feedback
  - Usability testing
  - Field studies
  - Predictive evaluation
- Goals: find problems or new opportunities, check conformity with guidelines, standards, requirements, …

Evaluation planning

- Determine high-level goals
- Explore questions to be answered
- Choose evaluation paradigm and techniques
- Identify practical issues
- Decide how to handle ethical issues
- Evaluate, interpret, and present results

Designing a study

- Reliability: results are repeatable
- Validity: measuring what you want to measure
- Biases: should not be introduced by process
- Scope: breadth of findings' applicability

Interviews

- Structured/scripted vs. unstructured/open-ended
- Avoid long, compound questions
- Avoid unfamiliar terms
- Avoid questions that embody assumptions
- Avoid biases
- Intro, warm-up, main body, cool-off, closing

Questionnaire development

- Paper vs. electronic, closed vs. open-ended
- Checkboxes, rating scales, prose responses
- Design
  - – Start off-line even if goal is electronic
  - – Questions all positive, all negative, mixed
  - – Pilot-test questions for clarity, sufficient space
  - – Consider analysis

Increasing questionnaire response

- Expect 20%–40% rate (less online)
- Make purpose clear
- Promise anonymity
- Design well
- Offer short version
- Provide stamped return envelope
- Follow up
- Provide incentive

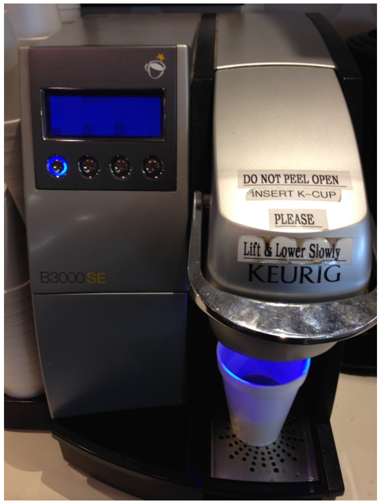
Expert critiques

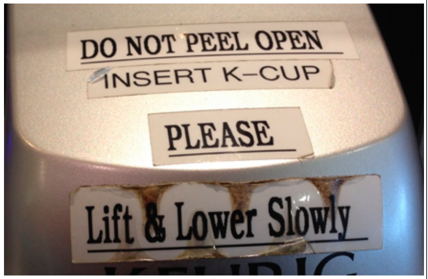
- Heuristic evaluation w/ guidelines (Nielsen)
  - – Brief 3–5 experts
  - – Each works separately 1–2 hours, two passes
  - – Debrief experts together
- Cognitive walkthrough
  - – Tell expert assumptions, context, task
  - – Expert walks through prototype w/ usage scenarios
  - – Will user know what to do? Will user see correct action is available? Will user understand response?

Observing users

- In the lab
  - – Walkthroughs with low-fi prototypes
  - – Instrumented sessions with higher-fi systems
- In the field
- Consider, as always, who's involved, their goals, their actions, their feelings, the relevant objects and events

Clues to usability problems





Usability walkthroughs

- Make an explicit test scenario (test plan)
- Test the test (pilot study)
- Recruit subjects
- Conduct test
- Debrief subjects

Roles in walkthroughs

- Greeter gets user settled
- Facilitator talks to user during testing
- Computer (a person) manipulates interface elements
- Observer(s) take notes

User testing

- A part of usability testing
- Smaller-scale, less formal, more focused than full-blown usability research
- Can be quantitative: time to complete, number of errors, number of help requests, number of users completing task successfully
- Can include keystroke-level monitoring
- How many users?

Le mieux est l’ennemi du bien.
(The best is the enemy of the good.)

—Voltaire
[“Dramatic Art” in *Philosophical Dictionary,* 1764]

Evaluation exercise

- Start with your home automation system
- Decide on the one aspect that most needs testing/evaluation (maybe a controversial issue in your group)
- Design an evaluation plan to test that aspect (give specific task, technique, design)
- Describe your plan on one page (informally, possibly with outline or sketches)
- Present to the class
- Turn in page with names of group

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Direct manipulation

- GUI objects representing task objects/funcs
- Pointing device
- Based on consistent metaphor
- Congruent operations, always available
- Immediate feedback
- Form of icon or cursor on rollover can indicate possible operations

Interface hardware (I/O devices)

- Appropriate for users’ tasks
- Suitable for intended work environment
- Match user’s physical characteristics
  - age, dexterity, impairments, injury avoidance ◊
- Match user’s psychological characteristics
  - computer skills, capacity for learning

Survey of output devices

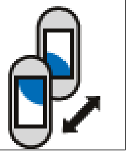
- Printers, of course; 3D printers
- Displays (CRT, LCD, …)
  - Wearable ◊ ◊ ◊ or room-scale ◊ ◊
- Audio (speech or non-speech)
- Tactile ◊
- Olfactory ◊
- Specialized for disabilities (e.g., Braille ◊)

Survey of input devices

- Keyboards: QWERTY, Dvorak ◊, chording ◊ ◊, thumb ◊, numeric, arrows; split/concave ◊
- Pointers: Mouse, trackball ◊ ◊, trackpad, joystick, pen ◊, 3D ◊
- Touchscreen
- Speech input
- Handwriting, gestures, “Graffiti” ◊
- Data gloves ◊ ◊, data suits, wearables ◊
- Accelerometers, gyroscopes, proximity sensors
- Specialized for disabilities

Hand-held devices

- Often used without watching (“eye-less”), so highly tactile keypads helpful (Cf. iPhone)
- Highly targeted info (personalization)
- Modern interaction paradigms:
  - Motion-invariant displays ◊
  - Touchscreen dragging (page-flipping) ◊
  - Hand mirror metaphor ◊
  - Keyhole/flashlight metaphor



Body-area networks

- Watches, glasses
- Continuous monitoring
- …

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Design principles (indep. of style)

- Consistency (internal, external)
- Advance information ◊
- Immediate feedback ◊
- Easy reversal (undo ◊)
- Error prevention, help ◊
- Minimal short-term memory
- User control
- User diversity, personalization ◊
- Shortcuts for experts
- Online help ◊
- Learning aids ◊

How do we organize information?

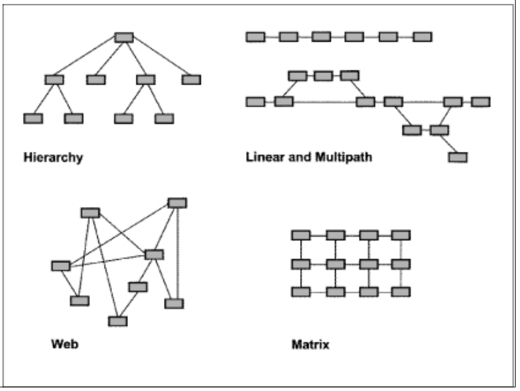
- How do users group concepts together?
- How do we name the groups?
- How do the groups relate to each other?

Organizational schemes

- Exact: alphabetical, chronological, geographical
- Inexact/ambiguous: topical, task-oriented, audience-specific
- Combinations

Organization structures

- Shape can be hierarchical, linear/multipath, network/web, matrix
- Unrestricted linking makes orientation hard
- Network/web structures hard for beginners
- Database ◊



Hypermedia and the WWW

- Nodes (info in many media)
- Visible links to other nodes
- HCI view: navigation between pages, information presentation, multimedia layout
- More than just HCI design ◊ ◊ ◊ ◊ ◊

Visual organization principles

- Use proximity, alignment, consistency, contrast to good effect
- More closely related things should be closer, aligned, consistent
- Less closely related: further, contrasting
- Every difference (in size, color, type, placement) should have a reason or meaning

HCI for Web (Farkas & Farkas)

- 1.1: All links indicate they're links ◊
- 1.2: Help viewers notice links
- 1.3: Links clearly indicate destinations
- 2.1: Effective breadth and depth in hierarchies ◊
- 2.2: Add secondary/shortcut links where approp.
- 2.3 Allow branches to converge where approp.
- 2.4 Reveal underlying information structure ◊

HCI for Web (Farkas & Farkas) 2

- 3.1: Clear, conspicuous orientation at top ◊
- 3.2: Support exploration ◊ ◊ ◊ ◊
- 4.1: Use site maps for structure and direct access ◊ ◊ ◊
- 4.2: Provide search facility or index for direct access
- 4.3: Provide links to home page throughout

"Information scent"

- Link should "smell right" to user: confidence before clicking, feel closer afterwards
- Practical measure (Spool 1998):
  - Ask users before clicking what they think they'll get
  - Ask how confident they are (–2 to +2)
  - Ask users after clicking if they felt closer (–2 to +2)
  - Add the two figures
  - Accumulate those sums as you go from link to link; the result should keep increasing

Advance information

- What's possible now? What will happen next? What can I do now?
- Prevent errors, unexpected results
- Guidelines
  - Give visual indicators, not just text ◊
  - Distinguish unselectable menu items, objects
  - Change cursor shape ◊
  - Show submenus on rollover ◊
  - Show data entry format ◊ ◊
  - Indicate long operations, ask permission ◊

Feedback

- User action, system reaction (ideally < 0.1 sec)
- Guidelines
  - Highlight items on rollover
  - Mark selected items ◊
  - Show path in navigation hierarchy
  - Report errors immediately
  - Use status or progress indicators
  - Use visual, auditory, and tactile modes
  - Make reaction time uniform

Undo

- Encourages users to explore functionality
- Guidelines
  - Special-purpose undo (e.g., backspace) supplements general
  - Try to make everything undoable (external effects clearer to users than internal)
  - Multiple undo (undo/redo or linear sequence)

Error avoidance

- Provide advance information
- Keep dangerous controls away from frequently used ones
- Warn users of irreversible effects; don't make them the default; request confirmation
- Turn safety options on by default
- Recognize errors and react ASAP

Error messages and actions

- Explain nature of problem, how user can solve it (at least with correct examples)
- Describe in terms of user's task
- Use polite language ◊ ◊ ◊
- On crash, give opportunity to save
- Support force quit and relaunch

Shneiderman’s error message guidelines

- Avoid “fatal,” “invalid,” “bad”
- Avoid ALL CAPS, cryptic numbers
- Give control over audio feedback
- Give precise messages
- Provide context-sensitive help

Help: different types

- Tutorial or getting-started manuals
- Guided tours
- Reference manuals
- Reminders (reference cards, keyboard templates, rollovers)
- Wizards (to walk through tasks)
- Tips
- On-line help (searchable)

Online help

- Available, consistent for all system functions
- Including currently unavailable options
- Situation-sensitive and concrete
- Written in terms of user’s task
- Not obscuring relevant items; movable
- Initially short with details on request
- Good ID reduces need for explicit help

Tours, tutorials, manuals

- Tour should be short, hit highlights
- Encourage active learning (e.g., user actions, quizzes), address users directly, give examples
- Manuals are last-resort, comprehensive sources
- Use tech writing specialists where possible

Command interface guidelines

- Use action words, verb first (`move a b`), direct object as first argument
- Use congruent names (advance/retreat, not move/back)
- Allow abbreviations, syntax flexibility, aliases
- Provide command history (edit, re-enter recent commands)
- Multiple args, wildcards, macros, scripts

Menu interaction overview

- Activities: navigation, selection, activation
- Selection: mouse, keys, key + return, touch
- Types of menus ◊:
  - Text, graphical ◊, combination
  - Linear, tabular ◊
  - Static (e.g., menu bar), pull-down, pop-up
  - Isolated, connected (hierarchical)
  - Pie menus ◊

Menu item guidelines ◊◊

- Head/title: short, meaningful, centered, upper/lower case, clean design
- Show: selectable items, non-selectable items, already-selected items, submenu availability, how to select (besides mouse)
- Entries: short, meaningful, distinguishable (most significant word first)
- Shortcuts (first letter); external consistency

Menu length, item order guidelines

- Keep short for beginners
- Group according to task
- Put frequent items near top for beginners
- When multiple selection allowed, group frequent combinations
- Separate dangerous items from frequent ones
- As last resort, use alpha, time, numerical order

Menu dynamics guidelines

- Highlight item under cursor
- Show submenus of item under cursor
- Maintain indication of selected items
- Allow leaving without any selection
- Maintain positional constancy (grey out)
- Maintain visibility against all backgrounds ◊

Menu hierarchy guidelines

- Avoid deep nesting
- Top, bottom level menus can be longer
- Longer menus better when under pressure
- Avoid scrolling
- Construct hierarchy by theme
- As before: show submenus, moderate length, external consistency, shortcuts to deeper items

Graphical menu guidelines

- Make items (icons) recognizable, distinct
- Emphasize global properties (form, color, size) over fine details
  - Abstract icons faster than concrete, text ◊ ◊
- Give similar icons to similar objects/functions
- Use easily understandable (or learnable) icons
- Textual labels help beginners, infrequent users

Adaptable vs. adaptive menus

- Adaptable: user (or admin) can change (shortcuts, hide/delete/move/duplicate items)
- Adaptive: automatic change (e.g., based on usage frequency) violates constancy

Form design guidelines

- Allow entry in tables or labeled data fields ◊
- Left-align labels, fields, columns in tables ◊
- Arrange sequences in columns ◊
- Use meaningful, unambiguous labels
- Mirror layout of paper source document
- Use adequate white space ◊ ◊
- Tell user expected form of data; indicate if required
- Allow enough space for expected data

Data entry in forms

- Tab or return should move to next field
- Fill fields with default/most recent/inference
- Allow entry in arbitrary order
- Allow abbreviation/expansion
- Show alternatives if entry not unique ◊
- Don’t supply dangerous values as auto entries
- Detect, indicate, explain errors; allow multiple corrections
- Don’t require re-entry of correct data

General screen guidelines

- Reflect structure of task, not of implementation
- Group info for coherent subtask on one screen
- With multiple, related screens
  - Use same headlines
  - Present necessary info on each screen in same place
  - Allow navigation to previous screen, access to help, ability to exit subtask or whole program

Special screen areas

- Title at top, distinguished
- Can use bottom for status info, explanation, warnings
- Logos typically upper left or upper right
- Clocks (no seconds, no ticking)

Screen layout

- Use proximity, alignment, consistency, contrast
- Use adequate whitespace (60%–80%)
- Alternatives to whitespace for grouping:
  - Lines
  - Boxes
  - Colored/shaded backgrounds

Guidelines for windows

- Windows make it easy to distinguish
  - applications
  - info or objects within applications
  - events stacked in time (e.g., errors, dialogs)
- Tiled windows easiest for beginners, but overlapping ones are far more flexible
- Signal which window is on top or active
  - partial occlusion
  - 3D effects (shadow, lighting) or graying out

Color depends on context

- Adds information, interest, emotion
- Perception affected by what other colors are nearby ◊
- Cultural connotations
- Color harmony schemes (kuler.adobe.com, colorschemedesigner.com)

Recommended uses of color

- Emphasis, grouping (especially as background)
- Coding discrete or continuous data ◊ ◊
- Distinguishing window types
- Visual separation of overlapping graphics
- Depth in 3D graphics (red closer, blue farther)
- Warnings, status reports
- Increasing attractiveness (within guidelines)

Users with disabilities

- Manual/dexterity; visual; auditory; cognitive
- Various legal requirements to make software and websites accessible:
  - Americans with Disabilities Act (ADA ◊)
  - 1998 amendment to Rehabilitation Act of 1973 (www.section508.gov ◊)
  - Institutional directives (e.g., UCI's Electronic Communications Policy)
  - Web Accessibility Initiative (www.w3.org/WAI ◊)

Vision

- Blindness, impaired vision, color blindness, photosensitive epilepsy
- Technologies
  - Screen-reading software
  - Braille "displays"
  - Descriptive audio
  - Screen magnifiers (software, hardware)
  - Software to simulate and compensate for color blindness ◊ ◊

Considerations/guidelines (visual)

- Allow magnification
- Color-code only large areas
- Avoid frequent color switches
- Color deficiencies ("color blindness"): 8% of European-descended males (0.5% of females) see red/green as medium gray
  - Design for monochrome first; add color for redundancy; at least don't just differ by red vs. green
- Special devices, software, design guidelines

Hearing

- Technologies
  - Captioning
  - American Sign Language (automatically generated by an animated avatar, asl.cs.depaul.edu ◊)

Mobility

- Trouble with keyboard and/or mouse
- Caused by disease, injury, RSI, aging
- Technologies
  - One-finger sequential typing for, e.g., Ctl-X
  - Ignore brief or repeated keystrokes
  - Move pointer using keyboard
  - Predictive typing; cycle-until-stop
  - Head/foot/mouth/gaze/speech control devices

Considerations/guidelines (manual)

- Provide access by keyboard and by pointer
- Provide alternative to simultaneous keystrokes
- Provide alternatives to voluminous data entry (defaults, completion, aliases/shortcuts, cycling through until user hits key to stop)
- Provide special devices

Evaluation of accessibility

- Try turning off images, sound, Java
- Try larger-than-normal font sizes
- Try smaller-than-normal screen or window
- Try monochrome display
- Try it without a mouse
- Try it with a text-only or voice browser
- Use Wave ◊, other evaluation tools ◊
- Do user testing

Globalization

- They don’t call it world-wide for nothing
- Internationalization: Identify and isolate culture-specific items
  - Text
  - Numbers (34.50 vs. 34,50, $ vs. £, units)
  - Dates/times (y/m/d, AM/PM, time zones)
  - Colors (different cultural connotations)
- Localization: Translate or create text appropriate to a given location

Don’t rely on automated translation

- For 60 years, a goal of computing (still unmet)
- It’s far tougher than dog = perro = chien = 犬
- Idioms, nuances, cultural issues, non-overlapping grammatical categories
- Not just waiting for the next, faster machine: We just don’t know enough about language
- (You shouldn’t rely on the grammar checker in Word, for the same reason)
- Use professional human translators

Other tricky cultural issues

- Icons: Symbols and gestures differ
- Addresses
- Reading direction —> page layout
- Space for text (Exit, Salir, Quitter, Verlassen)
- User testing: in target locale and language

Virtual reality

- Three-dimensional objects and environments
- Multi-sensory input (visual, auditory, haptic)
- User feels immersed: user controls scene movement, receives feedback
- Integrated technologies: displays, position sensing for head/hand, force feedback, audio input/output

Virtual reality applications

- Scientific exploration ◊
- Architectural exploration
- Augmented reality
- Training
- Virtual co-presence (meetings, entertainment)

Guidelines for Games

- Action, shooter, adventure, role-playing, …
- General goals: Reduce errors, increase speed, user satisfaction, …
- Plus “fun”: Challenges, rewards, fantasy, immersion, surprises, control, social interaction
- Guidelines for story, interface, mechanics, play (see H. Desurvire, CHI 2004)
- “Serious” applications: simulation, training …

Improving immersion

- Match input from at least two sensors
- Provide high refresh rate
- Minimize response time
- Provide stereoscopic vision
- Provide three-dimensional sound

Guidelines for Speech Interaction

- Train system for individual user
- Give system control (e.g., guided questions)
- Limit user’s responses (e.g., to yes/no)
- Verify understanding of each user input
- Abbreviate instructions after a while
- Allow user to request a human agent
- Redirect to human being after repeated recognition failure

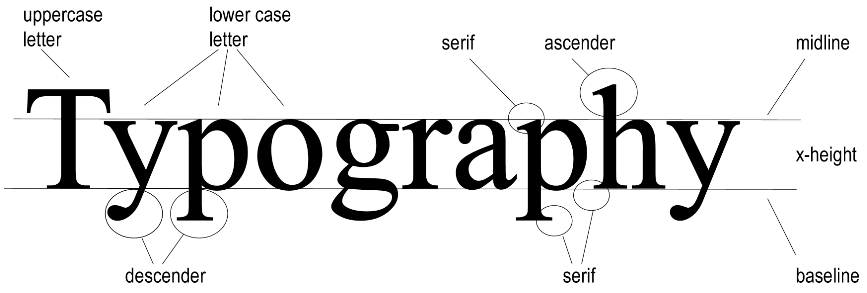
Design a form

- Form groups of about 4 people
- Identify some mobile app (existing or new) that might expect the user to enter form-based data; any kind of app is okay
- Decide precisely what data you will ask the user to enter
- Carefully design and sketch a form for entering the data on the mobile device
- Turn in a sheet with group members’ names

Typography

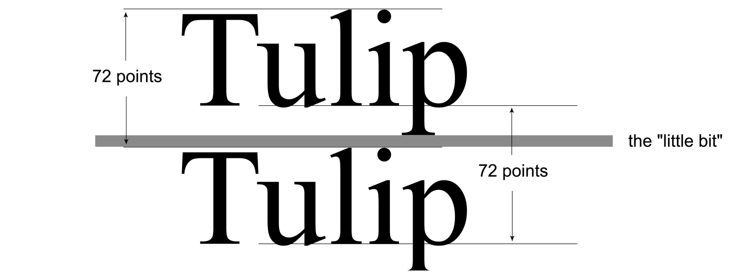
- HCI for documents, affects effectiveness
- Display type vs. body type
  - Quick recognition of letters, words, lines
- Great control now in user's hands
  - "With more power comes the power to mess up in new and more spectacular ways." —DGK
- Differences between displays and paper
- Less designer control for text on the WWW

Typography terms



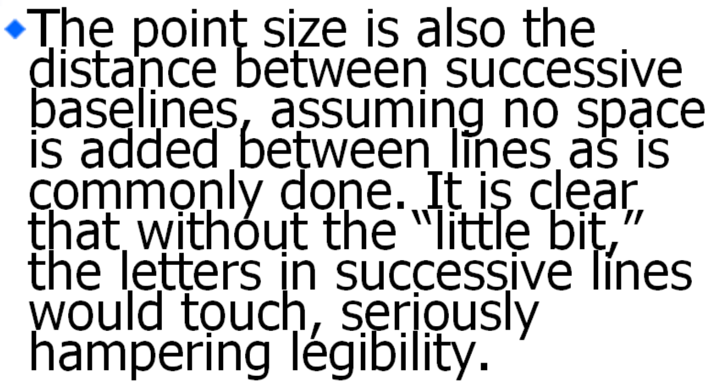
From McCracken and Wolfe,
User-Centered Website Development

Font size: baseline to baseline



From McCracken and Wolfe,
User-Centered Website Development

Line spacing (leading) matters



- The point size is also the distance between successive baselines, assuming no space is added between lines as is commonly done. It is clear that without the "little bit," the letters in successive lines would touch, seriously hampering legibility.

From McCracken and Wolfe,
User-Centered Website Development

Serif vs. sans serif

Times New Roman

Georgia

Arial

Verdana

Monospace vs. proportional spacing

```
f("It’s")-1; // Courier
f("It’s")-1; // Andale
```

f(“It’s”)-1; // Times

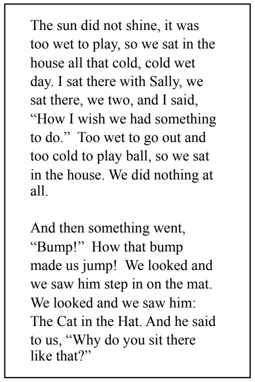
f(“It’s”)-1; // Georgia

f(“It’s”)-1; // Helvetica

Typeface guidelines (characters)

- Mix upper and lower case
- Choose proportional spacing over monospace
- Use fonts with varying stroke width
- Choose serif over sans-serif fonts
  - But on the web …

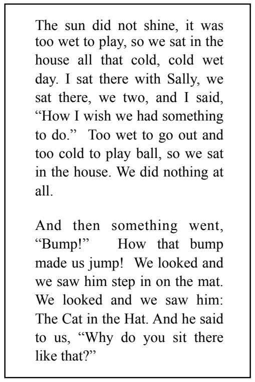
Margin justification



The sun did not shine, it was too wet to play, so we sat in the house all that cold, cold wet day. I sat there with Sally, we sat there, we two, and I said, “How I wish we had something to do.” Too wet to go out and too cold to play ball, so we sat in the house. We did nothing at all.

And then something went, “Bump!” How that bump made us jump! We looked and we saw him step in on the mat. We looked and we saw him: The Cat in the Hat. And he said to us, “Why do you sit there like that?”

Rag-right



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Flush right

Typography/text guidelines

- Favor visuals over text
- Keep lines short (10–12 words; ~40 chars)
- Don’t justify margins
  - Extra white space
  - Justification and monospace fonts
- Consider extra leading
- Minimize number of fonts
- Use emphasis minimally

Graphic design critique

www.ics.uci.edu/~kay/whatswrong.pdf ◊

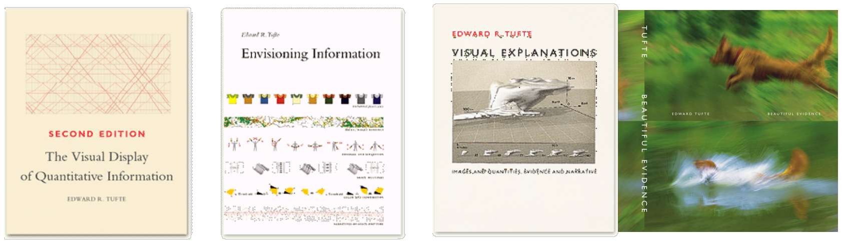
Information visualization

- Allows understanding of huge amounts of data
- Allows perception of unanticipated properties
- Reveals problems with data itself
- Facilitates understanding of large- and small-scale features of data
- Facilitates hypothesis formation

Ware, *Information Visualization*

Edward Tufte (Yale)

- *The Visual Display of Quantitative Information*
- *Envisioning Information*
- *Visual Explanations*
- *Beautiful Evidence*



Tufte on graphical integrity

- Make physically measured representation proportional to quantity being represented
- Use clear, detailed, thorough labeling
- Show data variation, not design variation
- Deflate and standardize monetary figures
- Dimensions in representation ≤ dimensions in the data
- Don’t quote data out of context

Tufte on producing data graphics

- Above all else show the data
- Maximize the data-ink ratio
- Erase non-data-ink
- Erase redundant data-ink
- Revise and edit

Tufte on graphical excellence

- Well-designed presentation of interesting data—substance, statistics, design
- Complex ideas communicated with clarity, precision, efficiency
- Greatest number of ideas in the shortest time with the least ink in the smallest space
- Multiple variables presented
- Data represented truthfully

What would Tufte say
about reducing his principles
to bullet points?

HCI Course Overview

- The field of HCI
- Human characteristics
- Development and evaluation methodology
- Menu of technologies
- Guidelines and results

End-of-quarter logistics

- Final exam
  - Thursday 13 June, 8:00–11:00 a.m., Kaplan 169 (here)
  - Covers the whole course, more or less evenly
  - Mostly similar to midterm in form
  - You may bring any paper materials, as before
- Please do the course evaluation (for this class and every class)

Related courses (e.g., at UCI)

- Informatics 131, HCI (like this course)
- Informatics 132, Project in HCI Requirements and Evaluation
- Informatics 133, User Interaction Software
- Informatics 134, Project in UI Software
- Informatics 143, Information Visualization
- Informatics 153, Computer-Supported Cooperative Work