Design Guidelines, Theories and Principles

Human Computer Interaction

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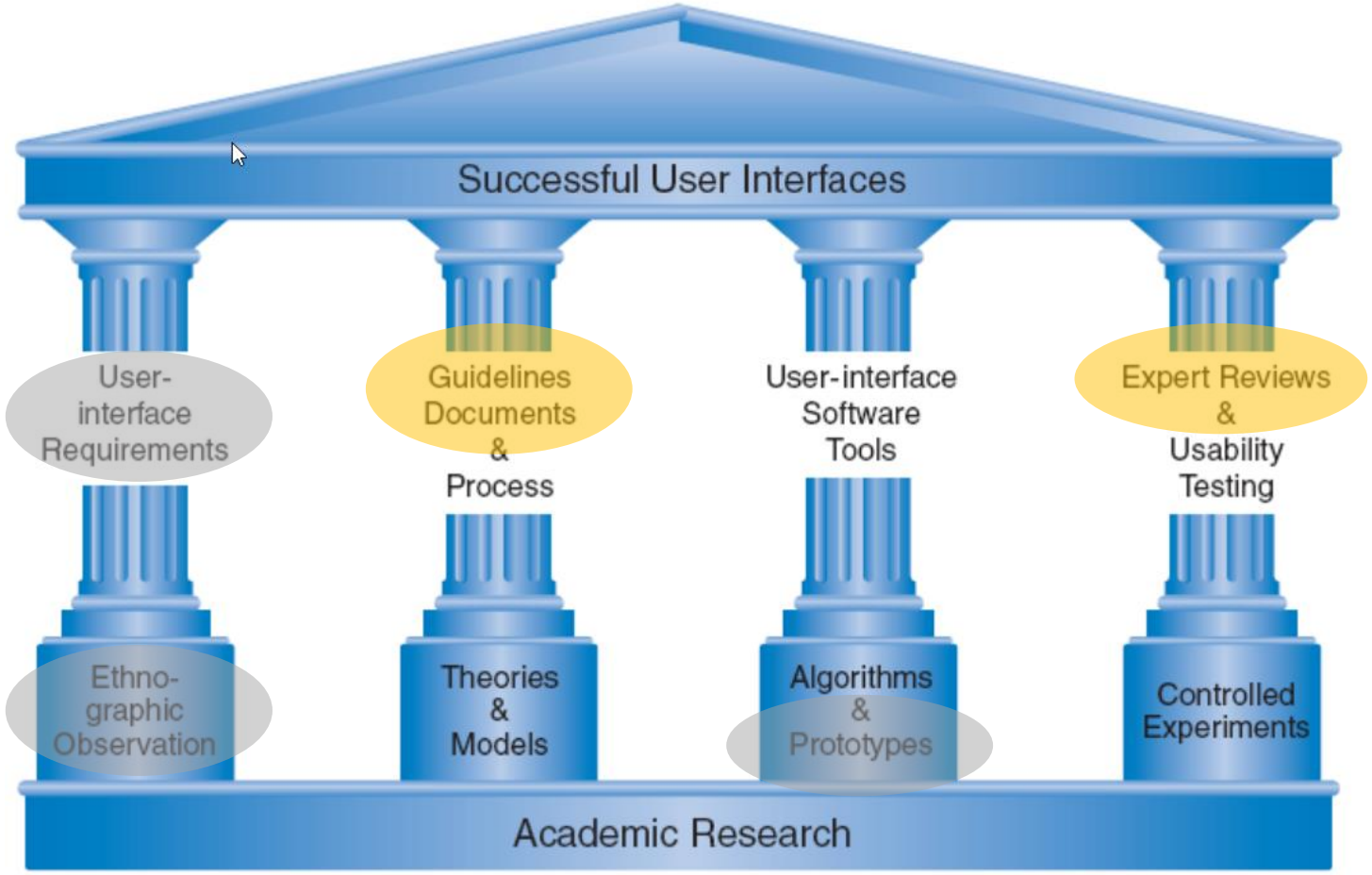
Academic Year 2020/2021

The Four Pillars of Design



Ben Shneiderman & Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction

Goals

Generating design solutions

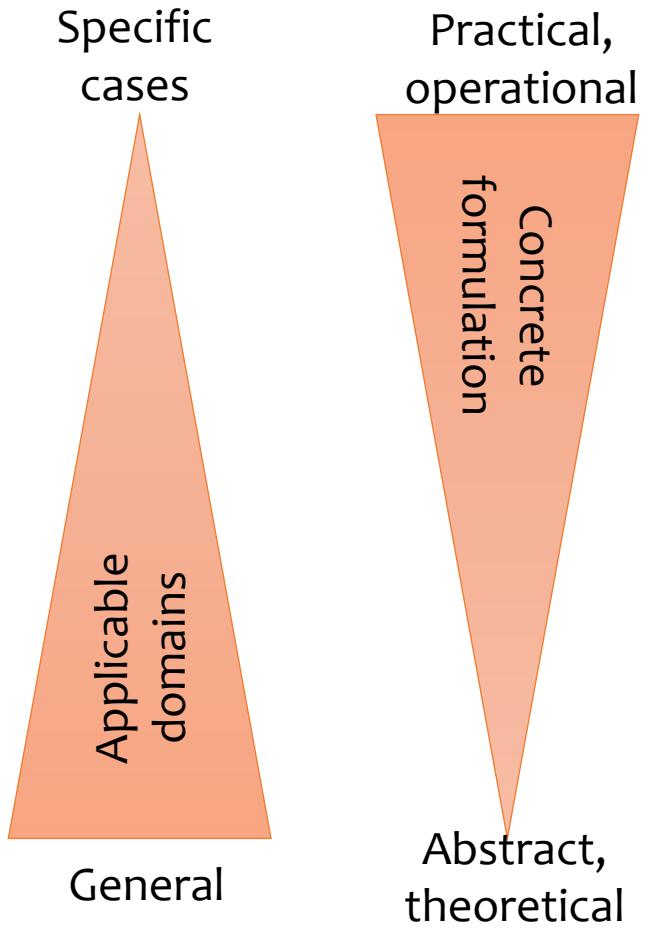
- Guidelines
- Principles
- Theories

Evaluating generated designs

- Expert reviews and heuristics
- Usability testing
- Controlled experiments

Generating design solutions

- **Guidelines**: Low-level focused advice about good practices and cautions against dangers.
- **Principles**: Mid-level strategies or rules to analyze and compare design alternatives.
- **Theories**: High-level widely applicable frameworks to draw on during design and evaluation, as well as to support communication and teaching.



Design Theories

Theoretical frameworks enabling foundational research

The “Why”

Design Theories

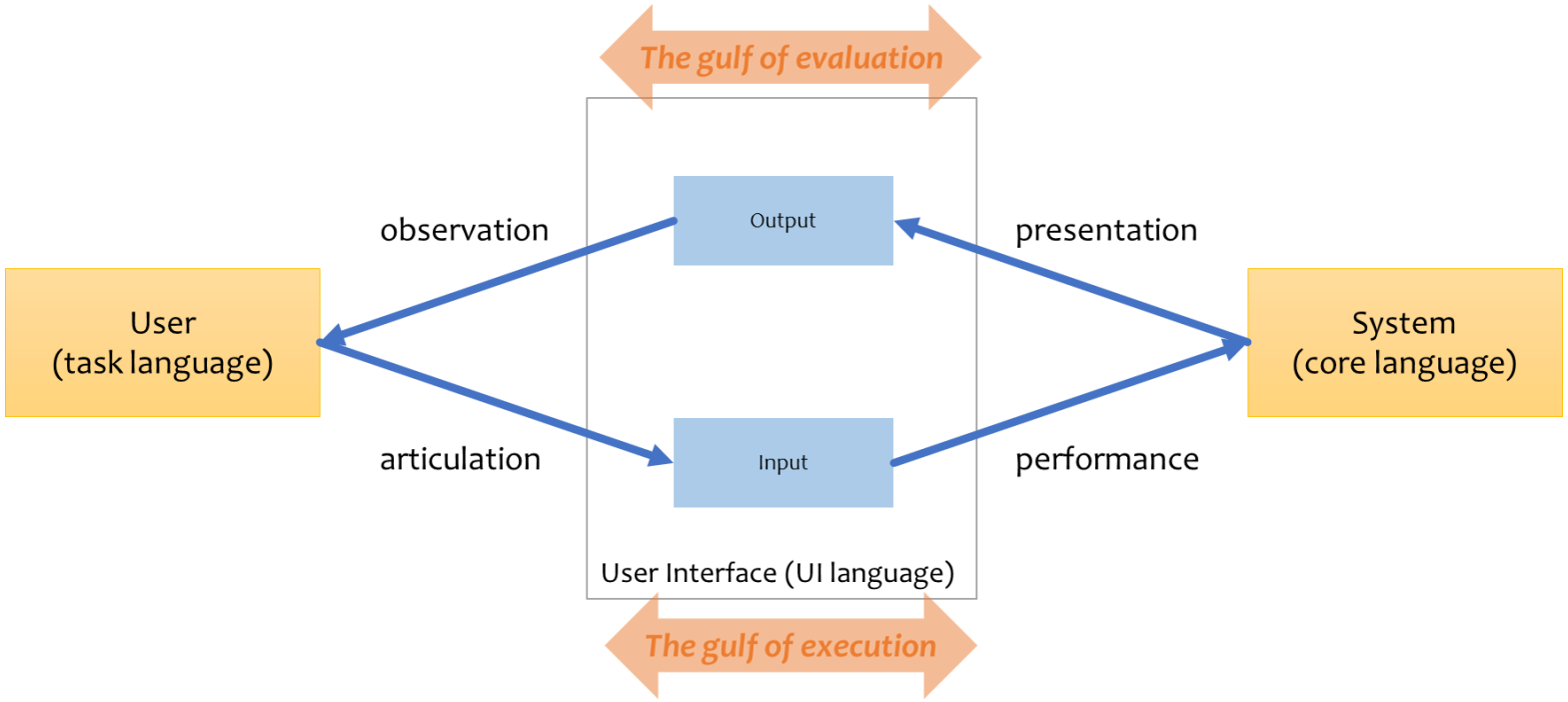
Types of theories

- Descriptive
  - UI elements, terminology, semantics
- Explanatory
  - Sequences of events with causal relationships
- Prescriptive
  - Guidelines for designers to make decisions
- Predictive
  - Comparison of design alternatives based on performance figures

Human capacity

- Motor task
  - Skill in pointing, clicking, … movements
- Perceptual
  - Sensory inputs
- Cognitive
  - Problem-solving, short-/long-term memory

Norman's Action Models (Explanatory)



1. **Goal** (form the goal)
2. **Plan** (the action)
3. **Specify** (an action sequence)
4. **Perform** (the action sequence)
5. **Perceive** (the state of the world)
6. **Interpret** (the perception)
7. **Compare** (the outcome with the goal)

Foley and van Dam four-level approach (Descriptive)

- **Conceptual** level
  - User's mental model of the interactive system
- **Semantic** level
  - Describes the meanings conveyed by the user's command input and by the computer's output display
- **Syntactic** level
  - Defines how the units (words) that convey semantics are assembled into a complete sentence that instructs the computer to perform a certain task
- **Lexical** level
  - Deals with device dependencies and with the precise mechanisms by which a user specifies the syntax

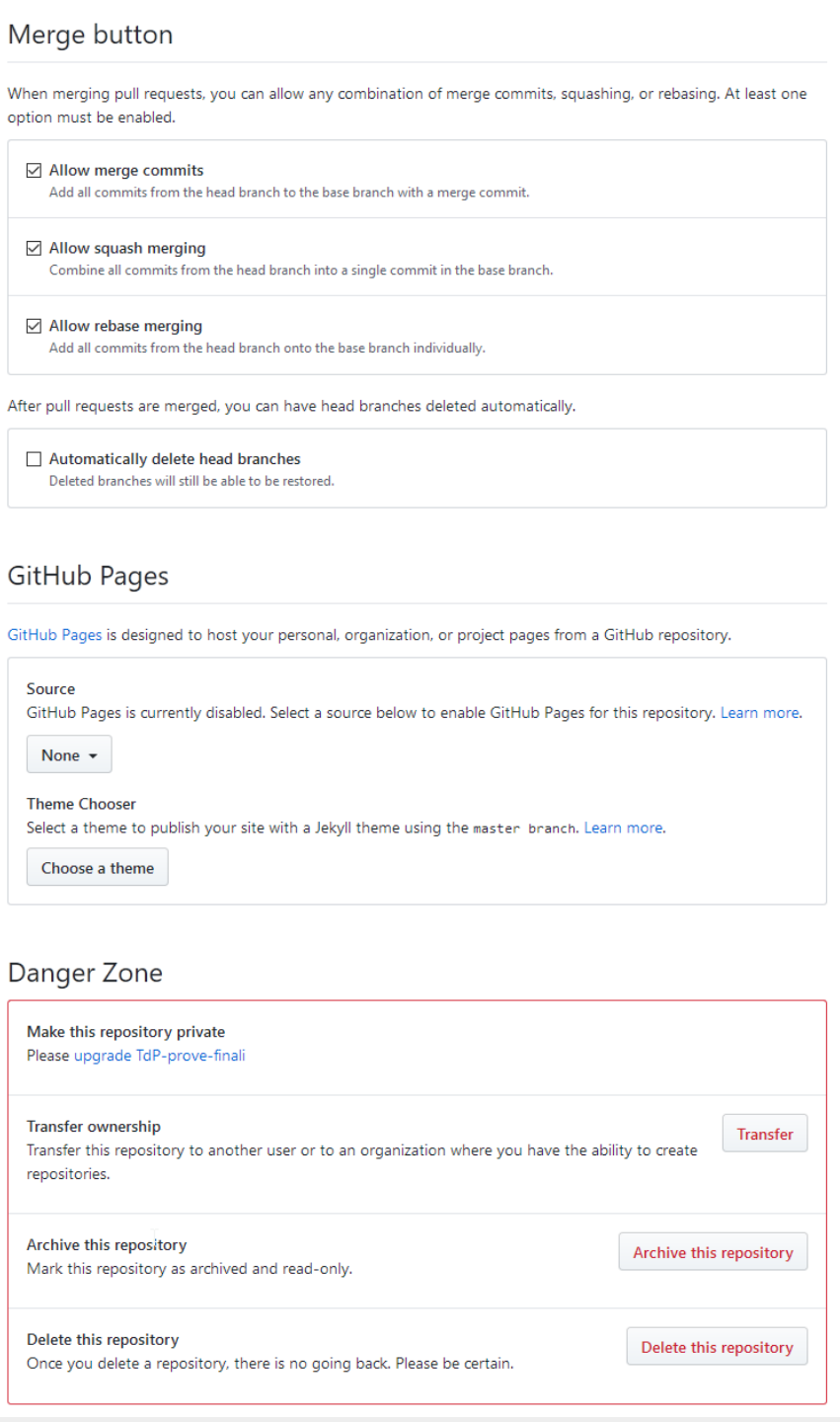
Consistent
delete/insert character
delete/insert word
delete/insert line
delete/insert paragraph

Consistency Theories (Prescriptive)

- **Consistency** of nouns (objects) and verbs (actions)
  - Reduces learning time and errors
- Consistency of
  - Color
  - Layout
  - Icons
  - Fonts and Font sizes
  - Button sizes
  - …
- Inconsistencies might be used (sparingly!) for drawing attention

Inconsistency for Drawing Attention

The border color and button text color in the “danger zone” are deliberately different than the rest of the page



Design Principles

The important aspects that we need to consider when creating a design.

The “What”

Design Principles

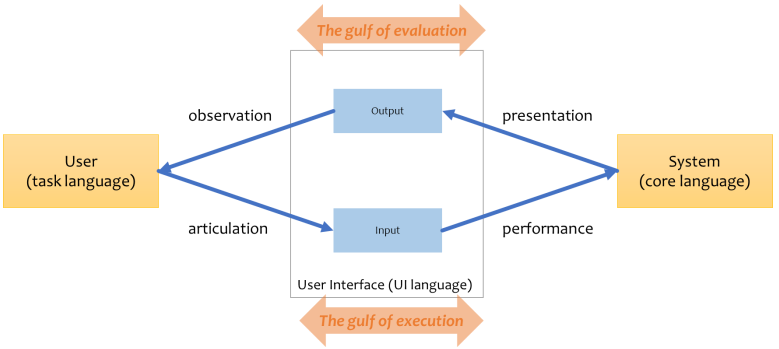
- More practical than Theories
- More fundamental, widely applicable, and enduring than Guidelines
- Fundamental principles (→ from Needfinding)
  - Determine user's skill levels
  - Identify the tasks
- 5 primary interaction styles
- 8 golden rules of interface design
- Prevent errors
- Automation and human control

Interaction styles

- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Advantages	Disadvantages
Direct manipulation	
Visually presents task concepts	May be hard to program
Allows easy learning	May require graphics display and pointing devices
Allows easy retention	
Allows errors to be avoided	
Encourages exploration	
Affords high subjective satisfaction	
Menu selection	
Shortens learning	Presents danger of many menus
Reduces keystrokes	May slow frequent users
Structures decision making	Consumes screen space
Permits use of dialog-management tools	Requires rapid display rate
Allows easy support of error handling	
Form fill-in	
Simplifies data entry	Consumes screen space
Requires modest training	
Gives convenient assistance	
Permits use of form-management tools	
Command language	
Flexible	Poor error handling
Appeals to "power" users	Requires substantial training and memorization
Supports user initiative	
Allows convenient creation of user-defined macros	
Natural language	
Relieves burden of learning syntax	Requires clarification dialog
	May not show context
	May require more keystrokes
	Unpredictable

Norman's Principles from Action Models



Principles of good design

- State and the action alternatives should be visible
- Should be a good conceptual model with a consistent system image
- Interface should include good mappings that reveal the relationships between stages
- User should receive continuous feedback

User failures can occur

- Users can form an inadequate goal
- Might not find the correct interface object because of an incomprehensible label or icon
- May not know how to specify or execute a desired action
- May receive inappropriate or misleading feedback

The 8 Golden Rules of Interface Design

- Strive for consistency
- Cater to universal usability
- Offer informative feedback
- Design dialogs to yield closure
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- Reduce short-term memory load

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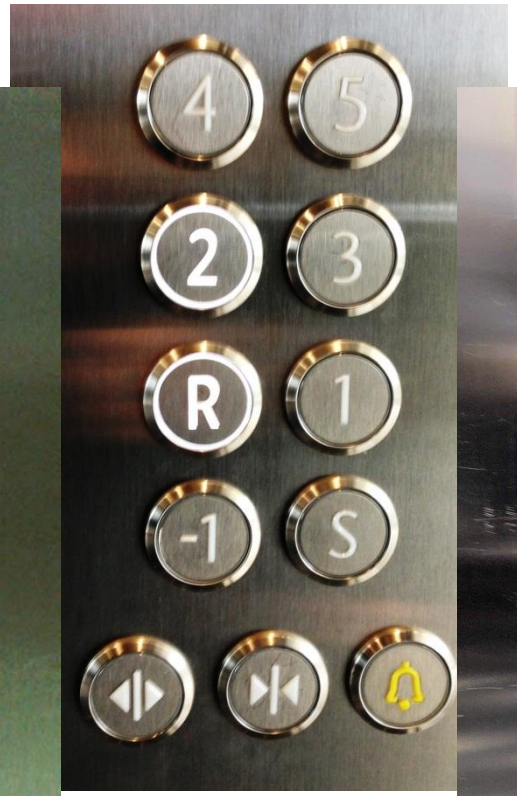
- Similar situations should lead to similar sequences of actions
- Same terminology in prompts, menus, help
- Color, layout, capitalization, fonts, …
- Exceptions should be comprehensive and limited
  - E.g., delete, password echo

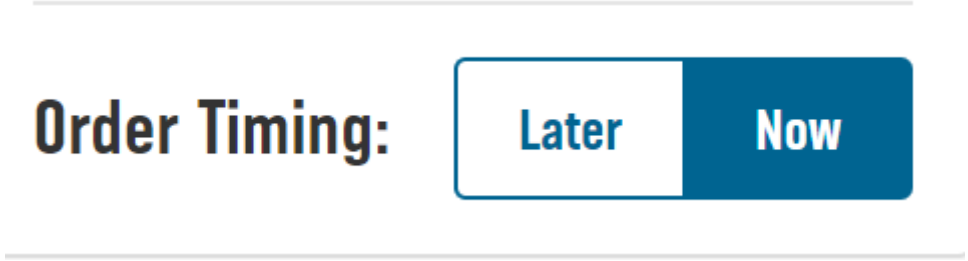
Internal consistency

Consistency with mental models



https://twitter.com/grmcall/status/1182586857814659073?s=20

Consistency of interpretation



- Which one is the selected one?
  - Color codes are ambiguous
  - No further internal clues
  - No external clues
- Does it represent the current status?
- Does it represent the status that we want to achieve?

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- Users with different needs: let the interface *adapt*, let content be *transformed*
- Novices vs. experts. Young vs elderly. Web vs. mobile. Users with disabilities (→Accessibility)
- **Responsive** design
- International (and cultural) variations

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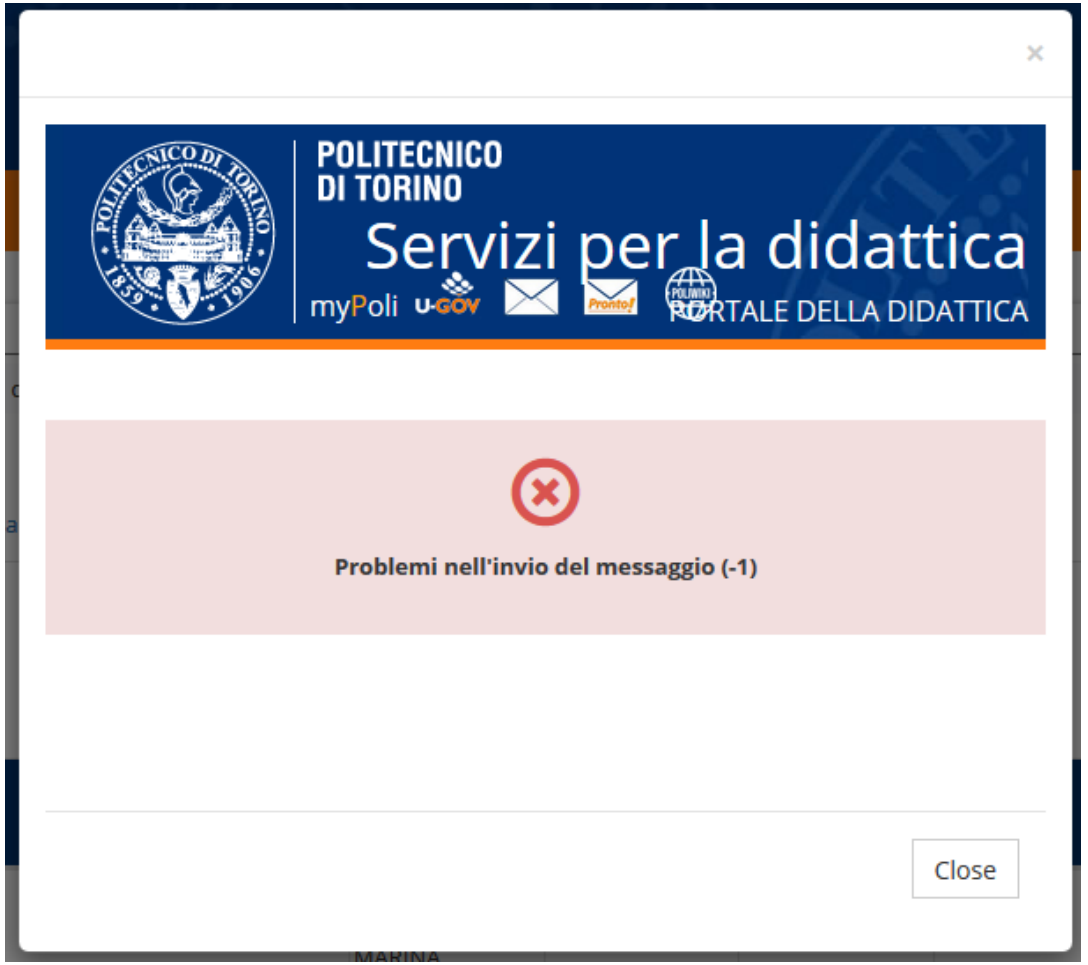
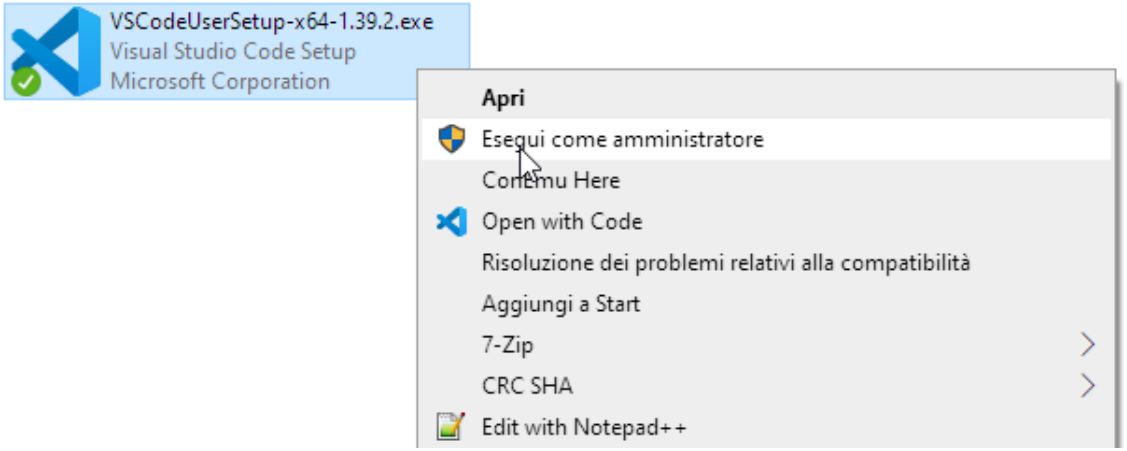
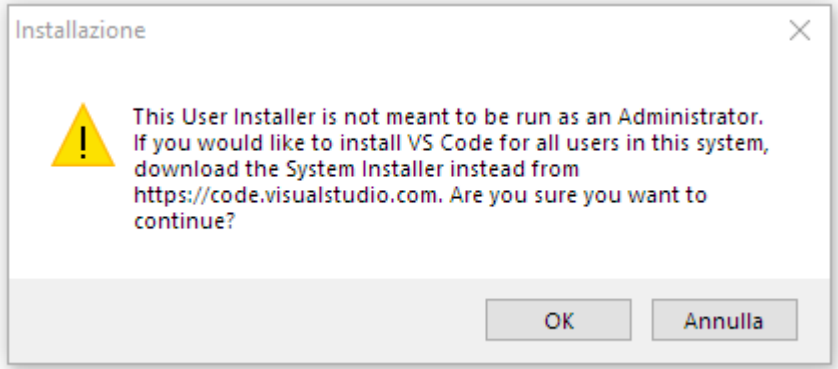
- For ***every*** human action, there should be an interface feedback
- Frequent and minor actions: light feedback
- Infrequent and major actions: stronger feedback
- Visual presentation of objects helps showing the changes (e.g., dim, highlight, grey out, …)

Example

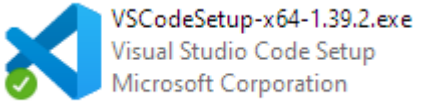

POLITECNICO
DI TORINO
Servizi per la didattica
myPoli
PORTALE DELLA DIDATTICA
Problemi nell'invio del messaggio (-1)
Close

Example





Try to install VS Code for all users on a computer (install to Program files rather than user's folders)



We went a long way from…

The 8 Golden Rules of Interface Design

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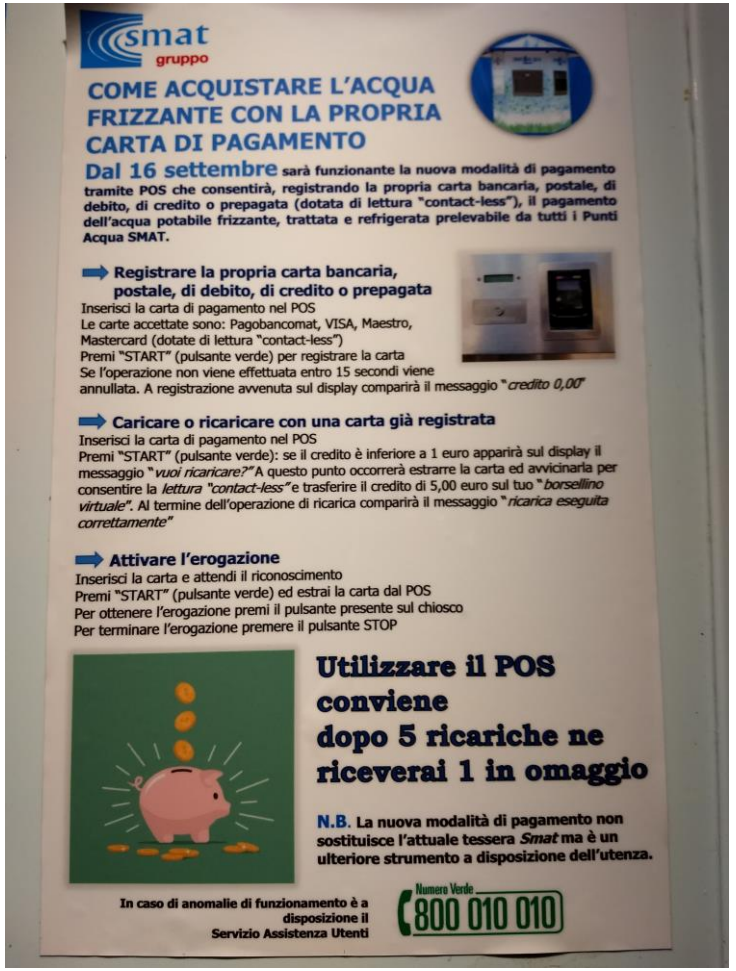
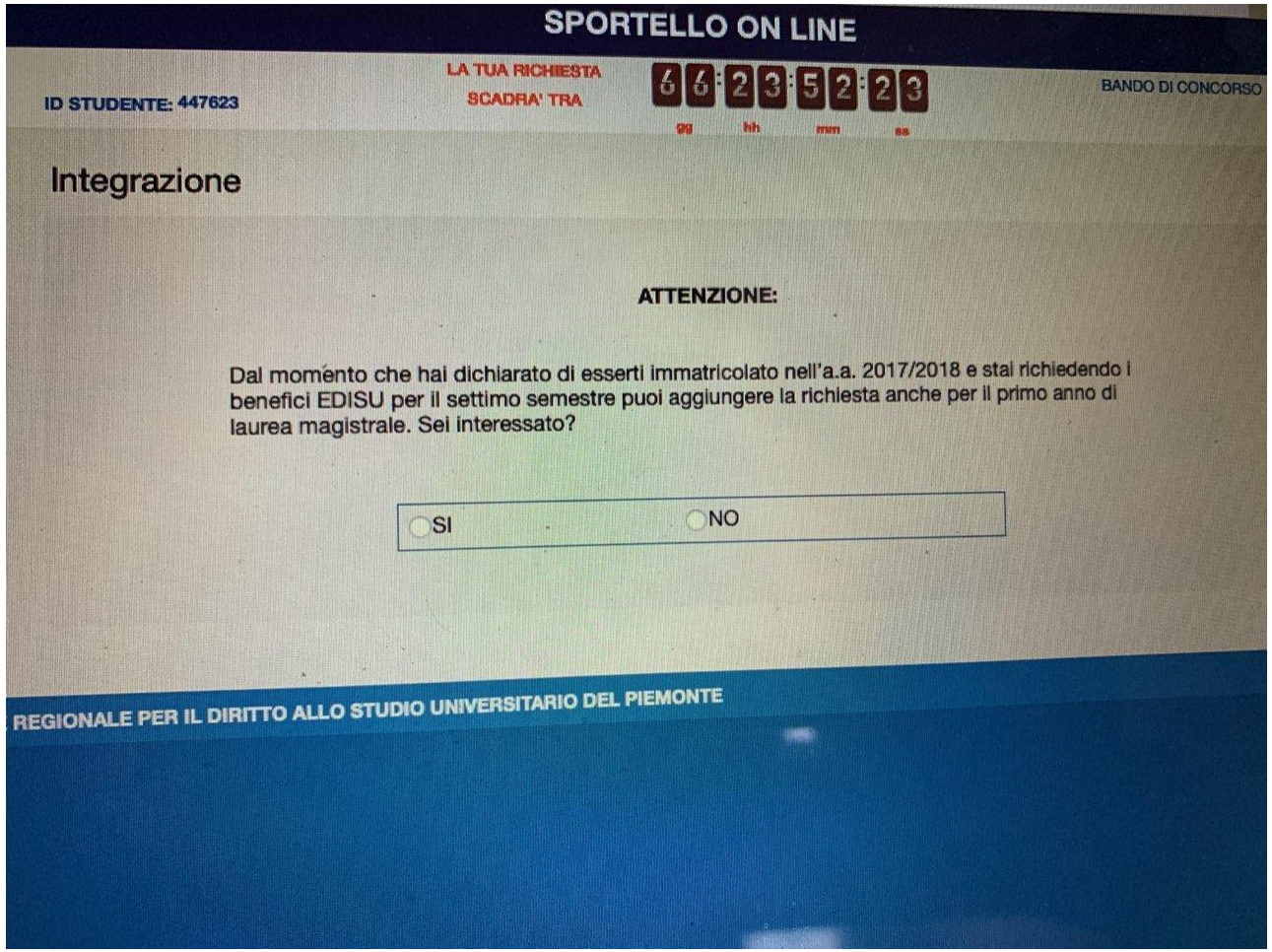
- Every sequence of actions should have
  - Beginning
  - Development
  - End
- Provide clear feedback at end
  - Satisfy users
  - ‘Delete’ current task from their working memory, prepare for the next

Clear dialog sequence



Clear dialog sequence



The 8 Golden Rules of Interface Design

- Strive for consistency
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- Design dialogs to yield closure
- **Prevent errors**
- Permit easy reversal of actions
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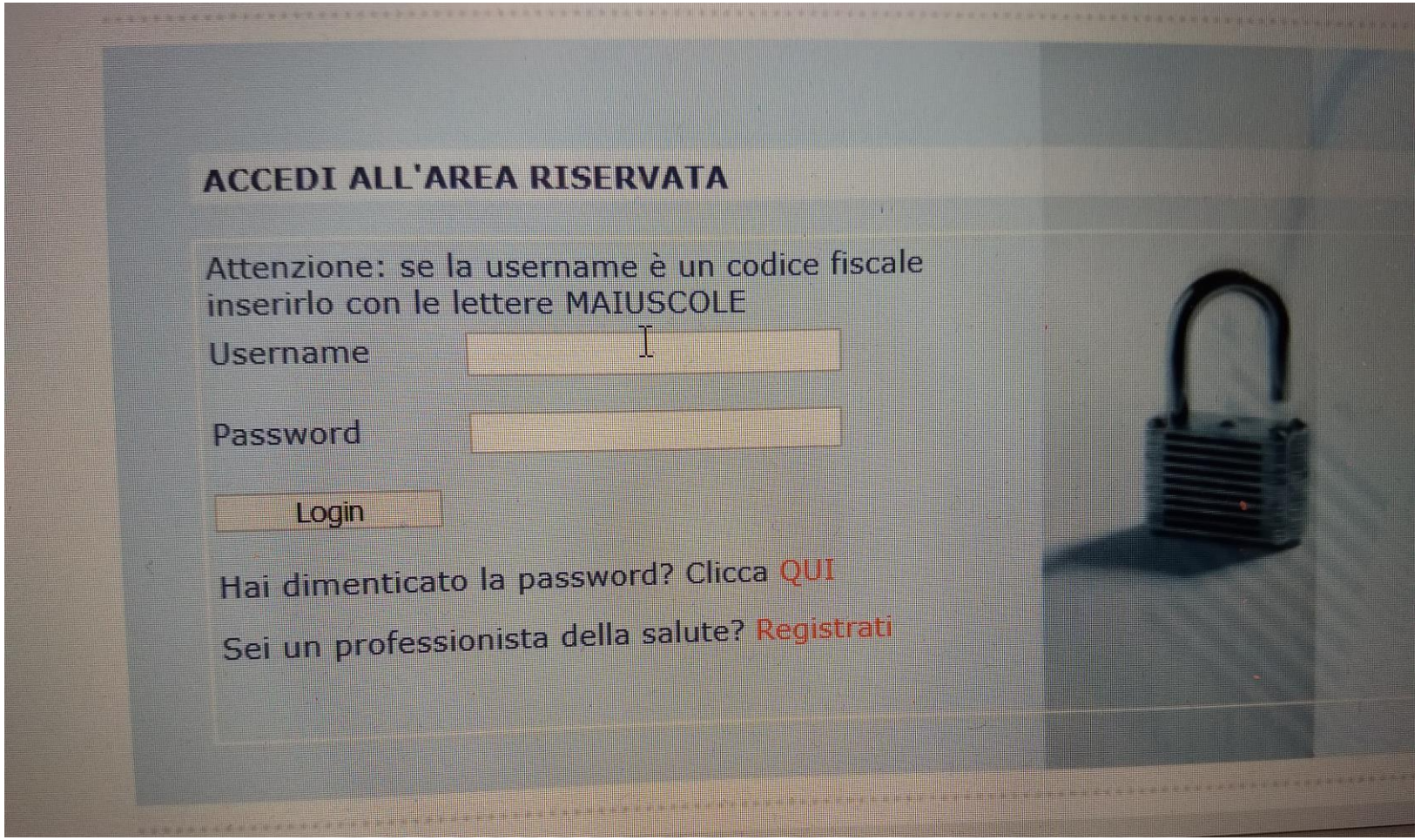
- Avoid the possibility of making errors
- Disable menu items, buttons, links, … that are not applicable
- Prevent entering illegal characters
- Offer simple, constructive and specific instructions for recovery
  - Repair only the faulty part
- Errors should not alter application state (or make it easy to restore)

Error prevention



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- **Permit easy reversal of actions**
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- Actions should be reversible (at the cost of extra development effort)
  - Relieves anxiety
  - Encourages exploration
- Different levels of reversibility
  - A single action
  - A data-entry task
  - A complete group of actions

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- **Keep users in control**
- Reduce short-term memory load

- The interface should *always* respond to user actions
- Minimize the tedious and lengthy tasks
- Avoid surprises or changes in familiar behavior
- Provide undo/redo, cancel/confirm

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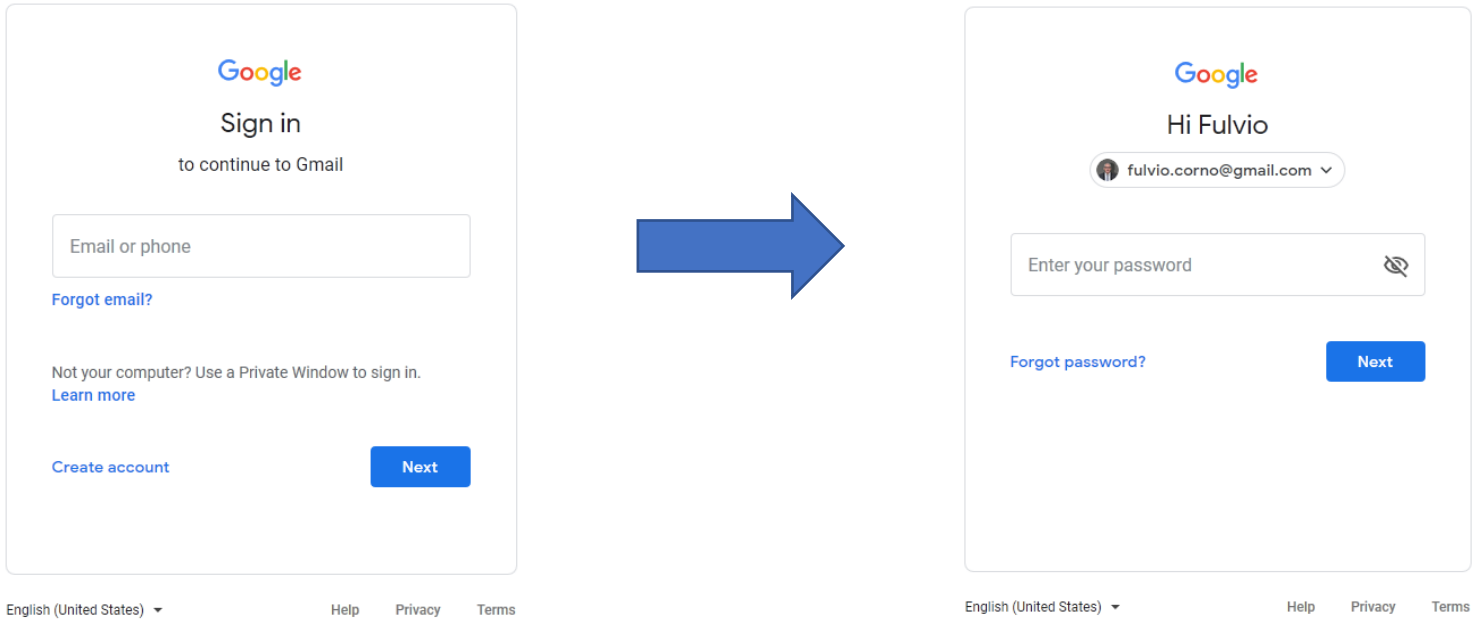
- Keep users in control
- **Reduce short-term memory load**

- Rule of thumb:
  - People can remember 7±2 chunks of information
- Information on a screen should not be needed (remembered) in the next screen
- No entry of phone numbers (collect from addressbook), show website location, fit long forms in a single page, …

Discussion (an exception?)



Design Principles by Benyon (I)
(adapted from Norman, Nielsen and others)

- **Learnability** – helping people access, learn and remember the system
  - *Visibility* – ensure that things are visible, so users can see what functions are available and what the system is currently doing
  - *Consistency* (→above)
  - *Familiarity* – use language and symbols that the intended audience will be familiar with
  - *Affordance* – design things so it is clear what they are for (e.g., buttons should be pushed). Maps the (perceived) properties of the objects with how they can be used

Affordance


CDs/DVDs
PILES
BOMBETES
BOMBETES BAIX CONSUM
CARTUTXOS TINTA
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Separar

Design Principles by Benyon (II)
(adapted from Norman, Nielsen and others)

- **Effectiveness** – giving users the sense of being in control, knowing what to do and how to do it
  - *Navigation* – support people in moving around the different sections: maps, directional signs, information signs
  - *Control* – who is in control for the next interaction? Clear and logical mapping between controls and their effect. Relationships with the "side effects" in the real world
  - *Feedback* (→feedback above)

Design Principles by Benyon (III)
(adapted from Norman, Nielsen and others)

- **Safety and Security**
  - *Recovery* (→error recovery)
  - *Constraints* (→prevent errors)
- **Accommodation** – offer an interaction way that suits the users
  - *Flexibility* (→universal usability)
  - *Style* – stylish, attractive, nice-looking
  - *Conviviality* – polite, friendly, pleasant. No abrupt interruptions

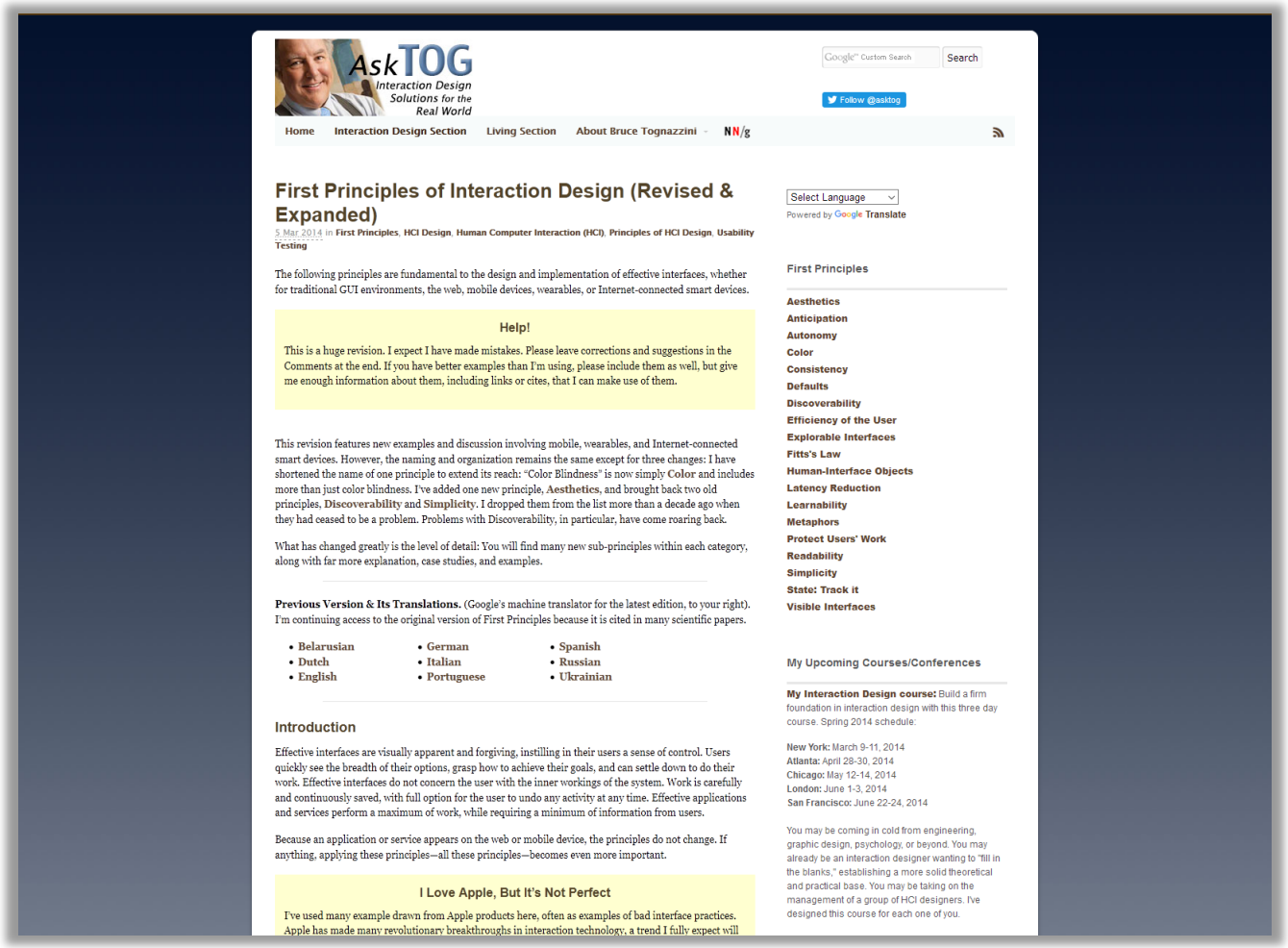
Norman's Seven Principles for Transforming Difficult Tasks into Simple Ones

- Use both knowledge in the world and knowledge in the head
- Simplify the structure of tasks
- Make things visible
- Get the mappings right
- Exploit the power of constraints, both natural and artificial
- Design for error
- When all else fails, standardize

D. Norman, The Design of Everyday Things

First Principles of Interaction Design
(Bruce Tognazzini, 2014)

https://asktog.com/atc/principles-of-interaction-design/



Design Guidelines

Shared language to promote **consistency** among multiple designers in terminology usage, appearance, and action sequences

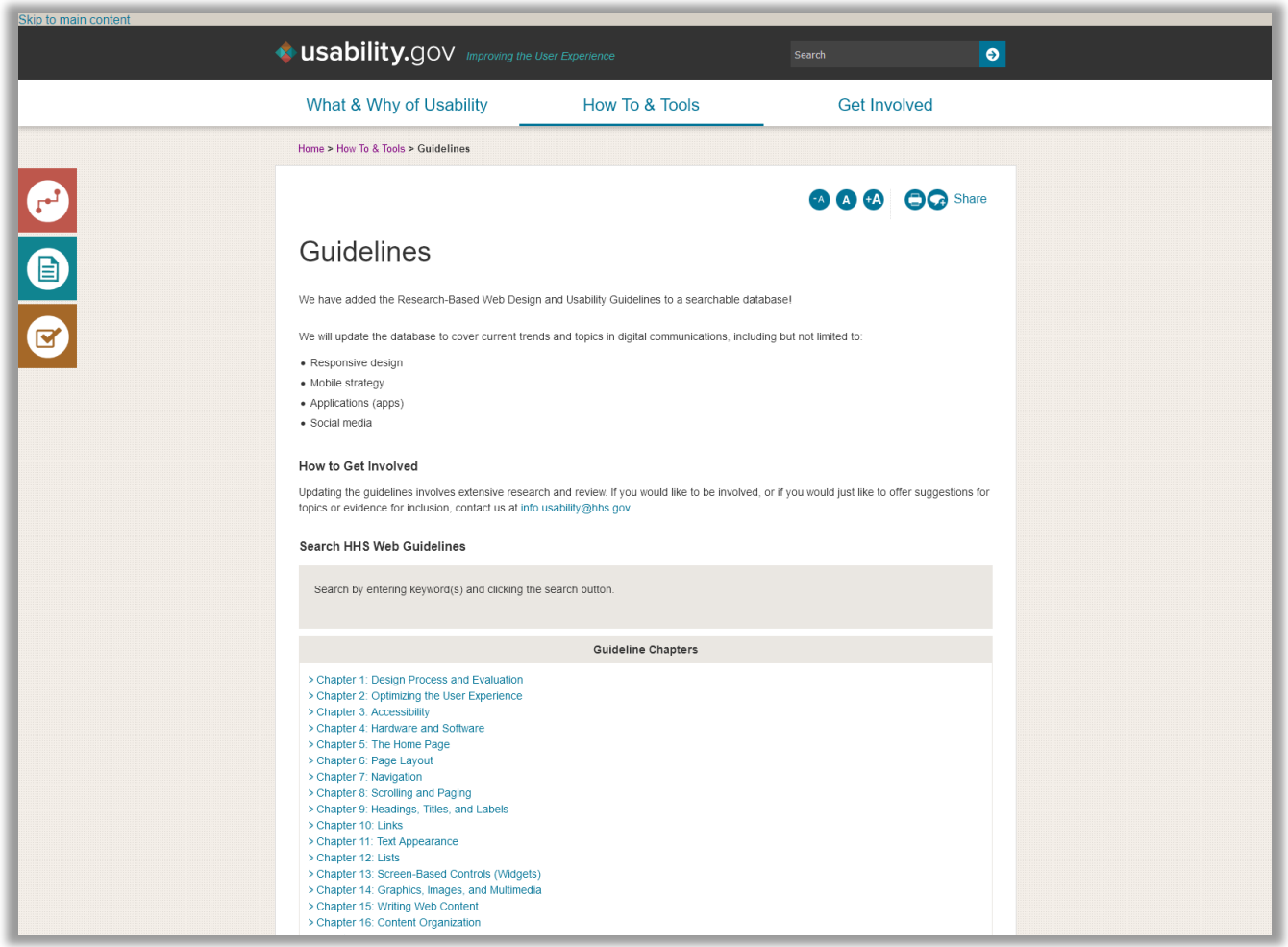
The “How”

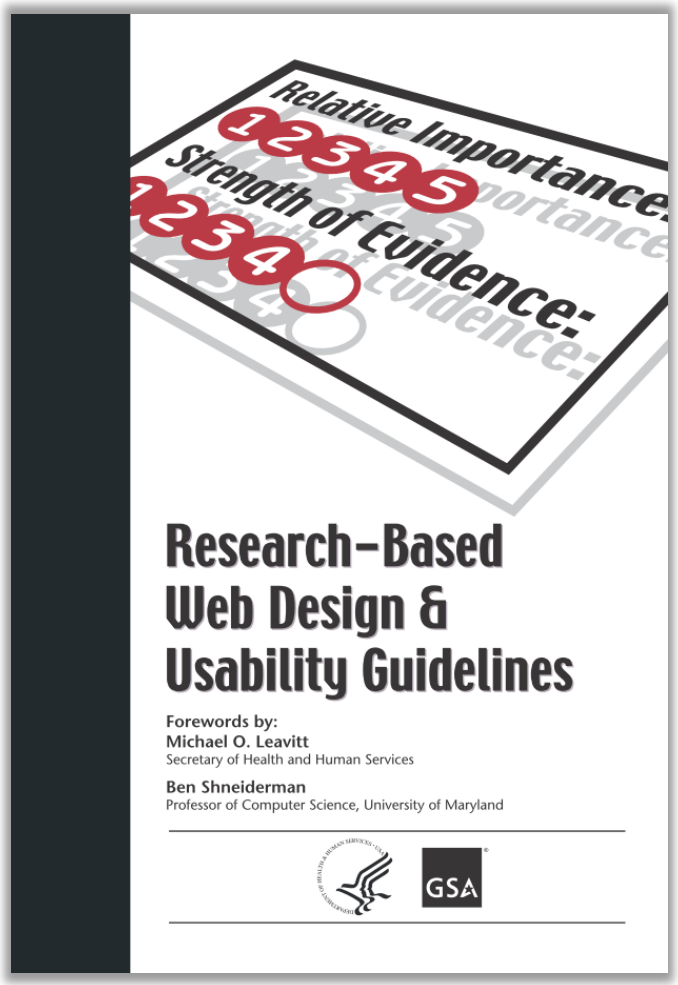
Design Guidelines

- Concrete suggestions about “How” the Principles may be satisfied
- Often rule-based
- Based on best practices
- Encapsulate experience of expert designers
- Sometimes blessed as «standards»
- But:
  - May be too specific and hard to apply to your situation
  - Difficult to develop a general-purpose guideline

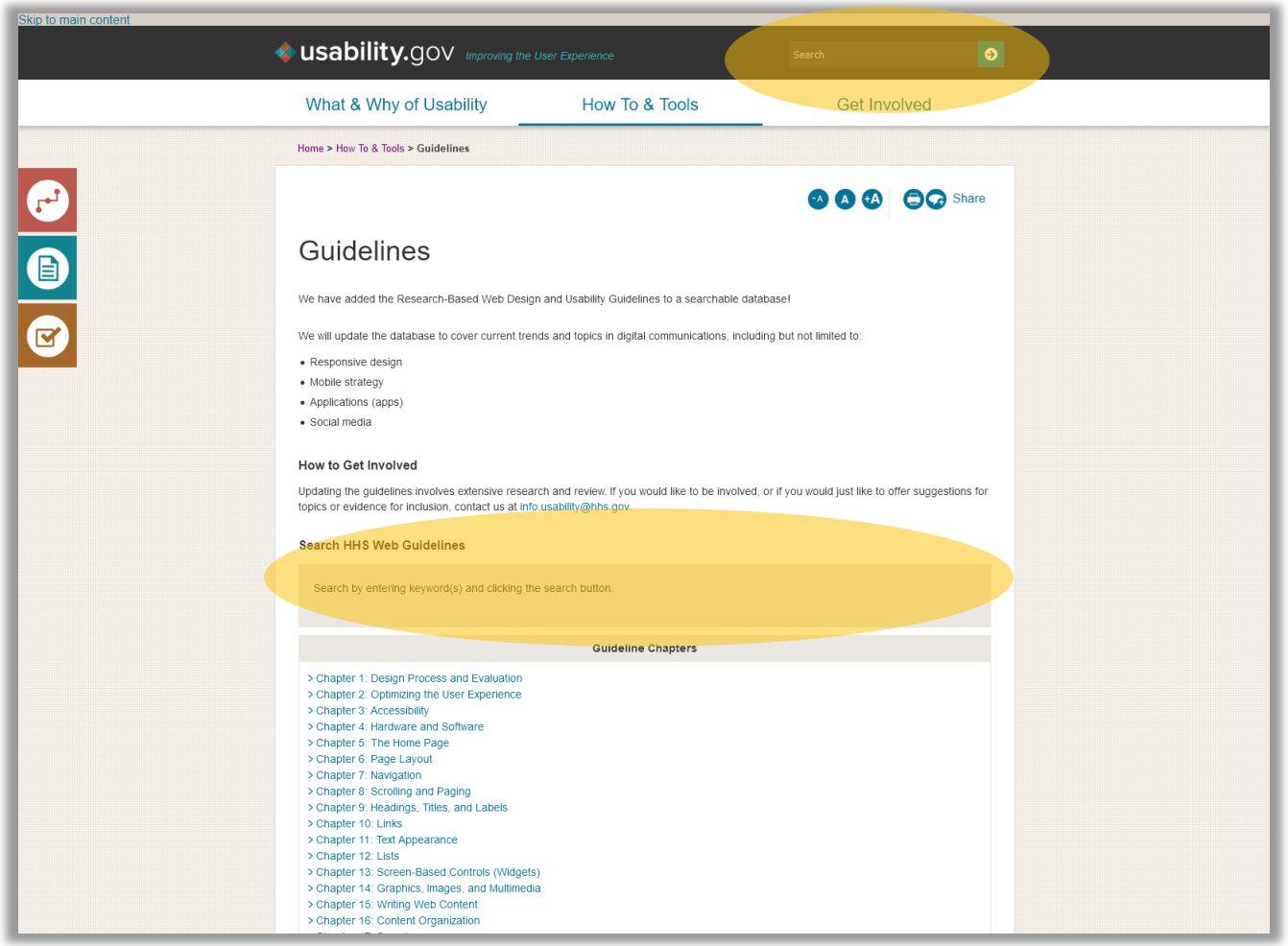
Research-based Web Design and Usability Guidelines

U.S. Dept. of Health and Human Services. The Research-Based Web Design & Usability Guidelines, Enlarged/Expanded edition. Washington: U.S. Government Printing Office, 2006. https://guidelines.usability.gov/



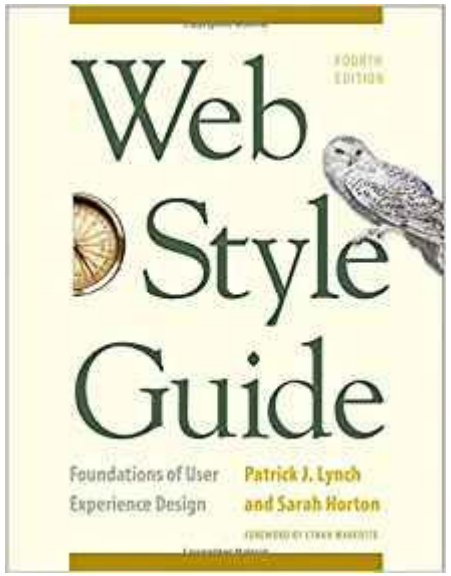


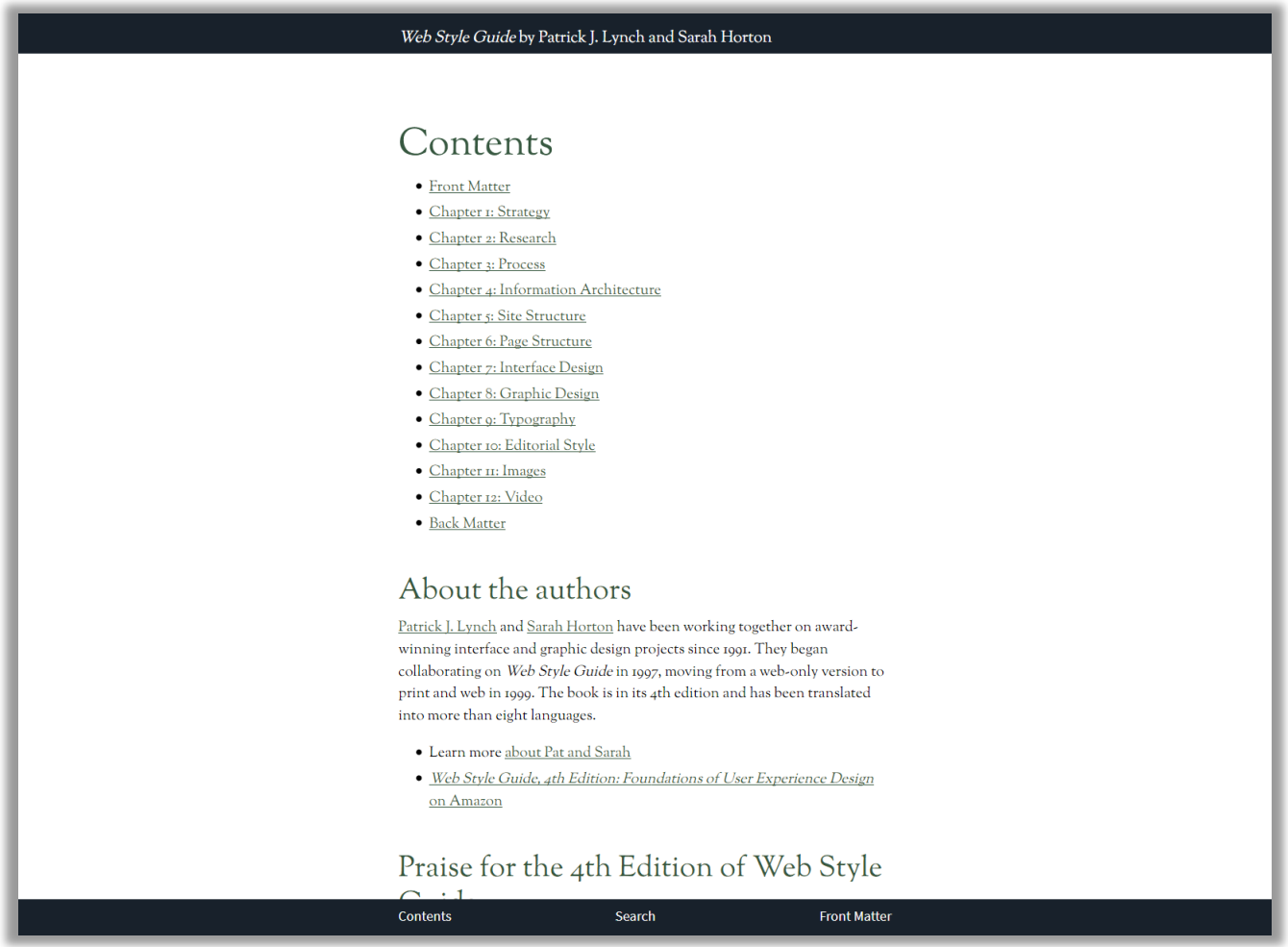
But...


Skip to main content
usability.gov
Improving the User Experience
Search
What & Why of Usability
How To & Tools
Get Involved
Home > How To & Tools > Guidelines
Share
Guidelines
We have added the Research-Based Web Design and Usability Guidelines to a searchable database!
We will update the database to cover current trends and topics in digital communications, including but not limited to:
• Responsive design
• Mobile strategy
• Applications (apps)
• Social media
How to Get Involved
Updating the guidelines involves extensive research and review. If you would like to be involved, or if you would just like to offer suggestions for topics or evidence for inclusion, contact us at info.usability@hhs.gov.
Search HHS Web Guidelines
Search by entering keyword(s) and clicking the search button.
Guideline Chapters
> Chapter 1: Design Process and Evaluation
> Chapter 2: Optimizing the User Experience
> Chapter 3: Accessibility
> Chapter 4: Hardware and Software
> Chapter 5: The Home Page
> Chapter 6: Page Layout
> Chapter 7: Navigation
> Chapter 8: Scrolling and Paging
> Chapter 9: Headings, Titles, and Labels
> Chapter 10: Links
> Chapter 11: Text Appearance
> Chapter 12: Lists
> Chapter 13: Screen-Based Controls (Widgets)
> Chapter 14: Graphics, Images, and Multimedia
> Chapter 15: Writing Web Content
> Chapter 16: Content Organization

Web Style Guide

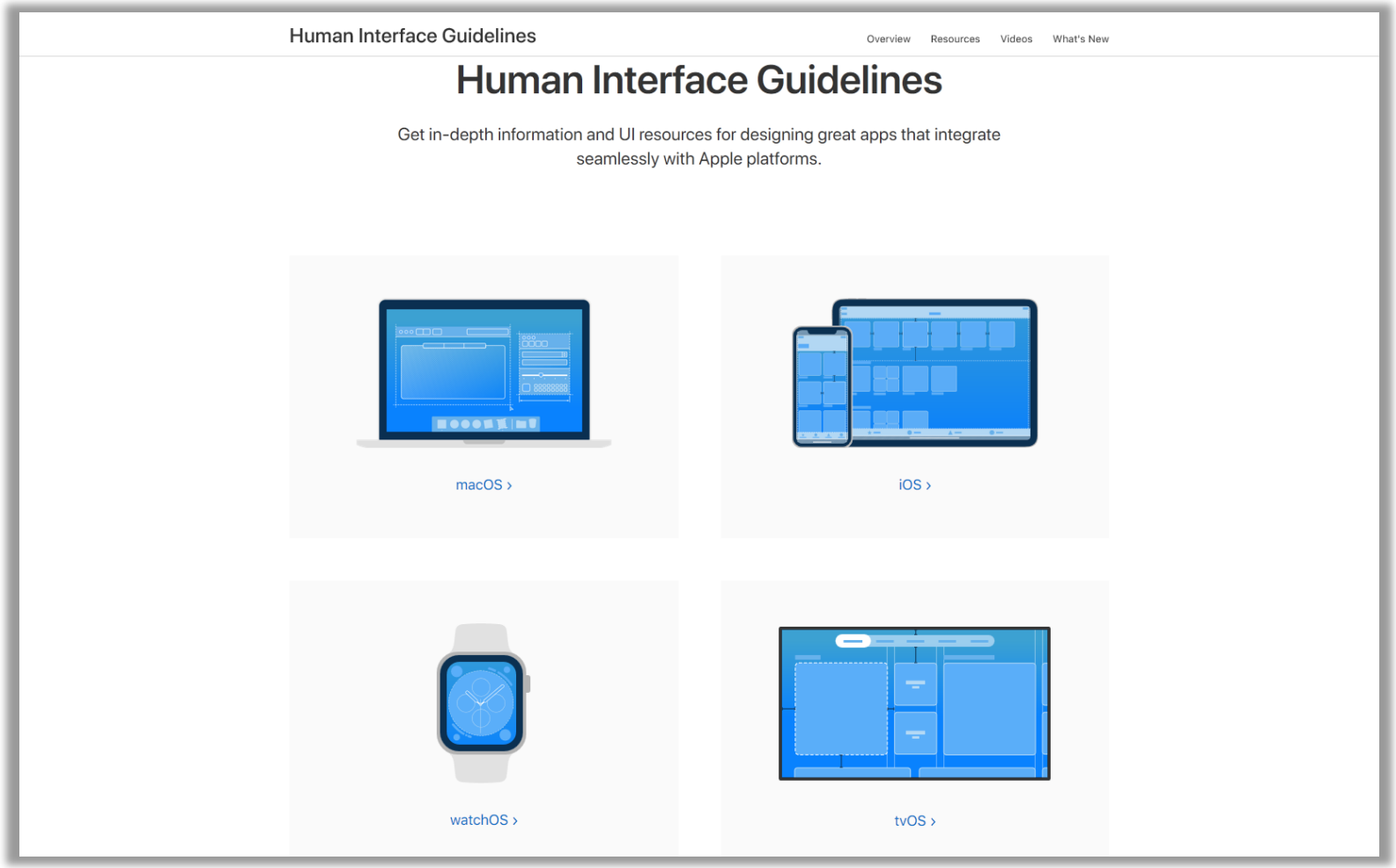
Web Style Guide, 4th Edition: Foundations of User Experience Design (2016)
https://webstyleguide.com/





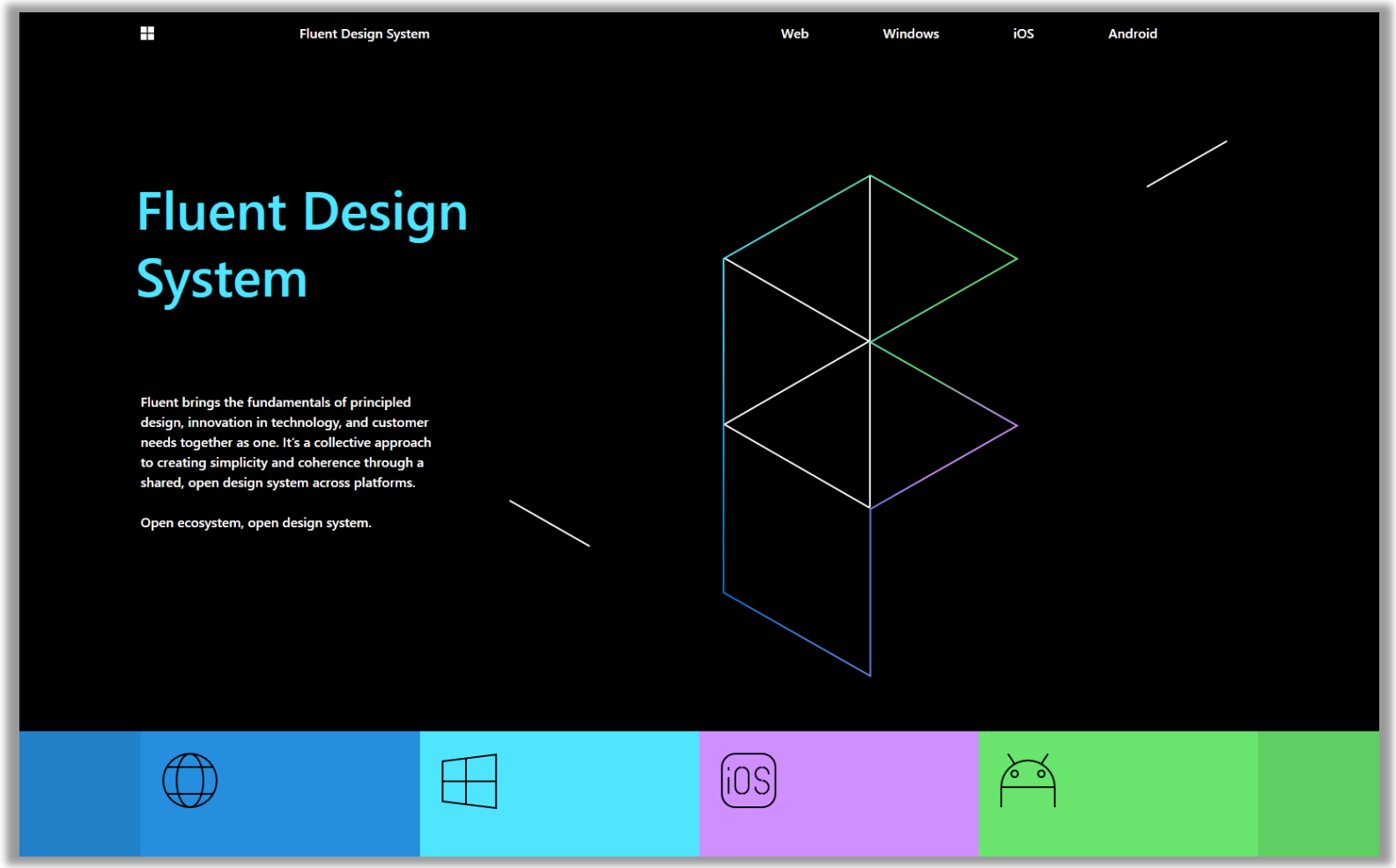
Example: Apple

https://developer.apple.com/design/human-interface-guidelines/



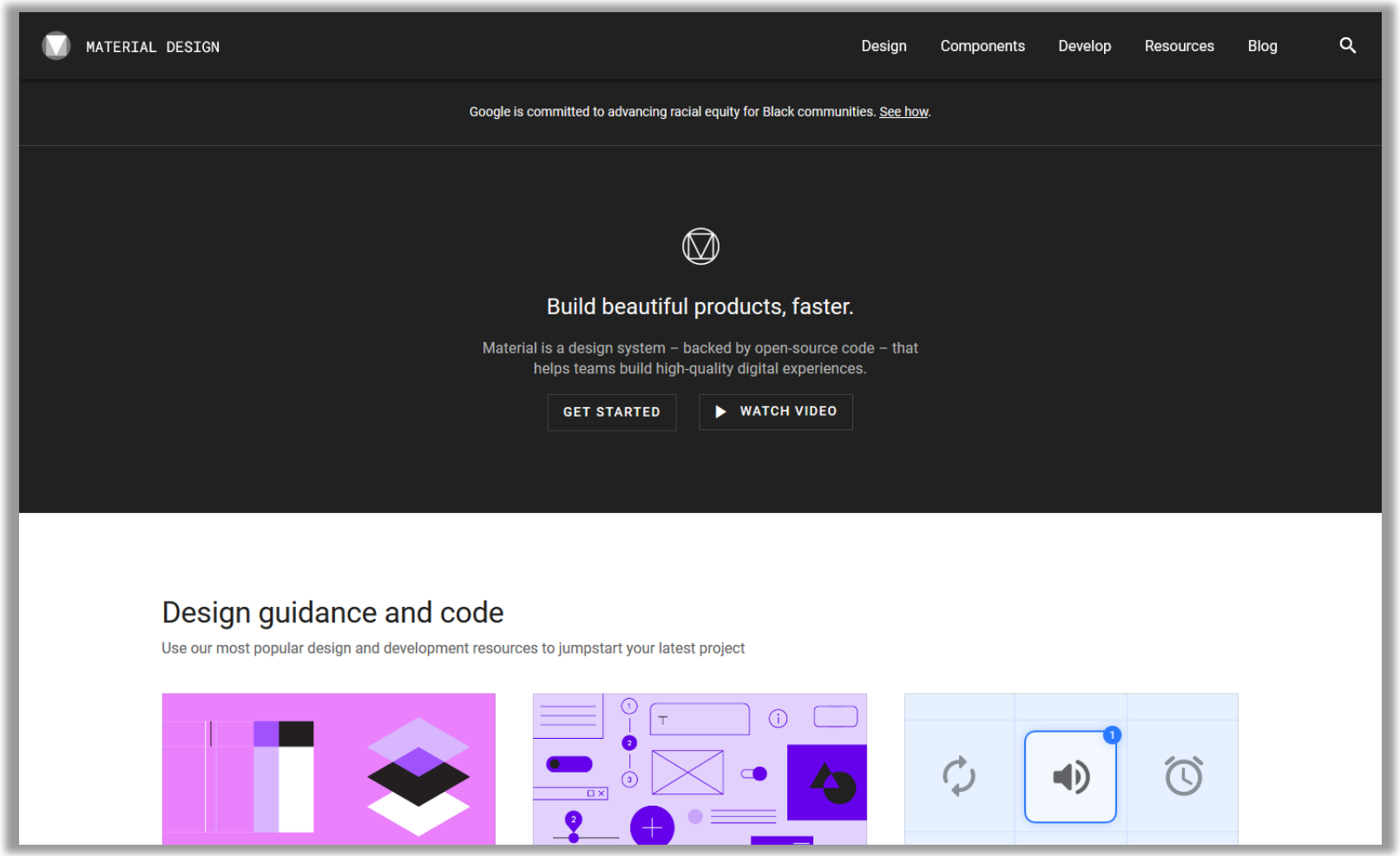
Example: Microsoft «Fluent» design

https://www.microsoft.com/design/fluent/#/



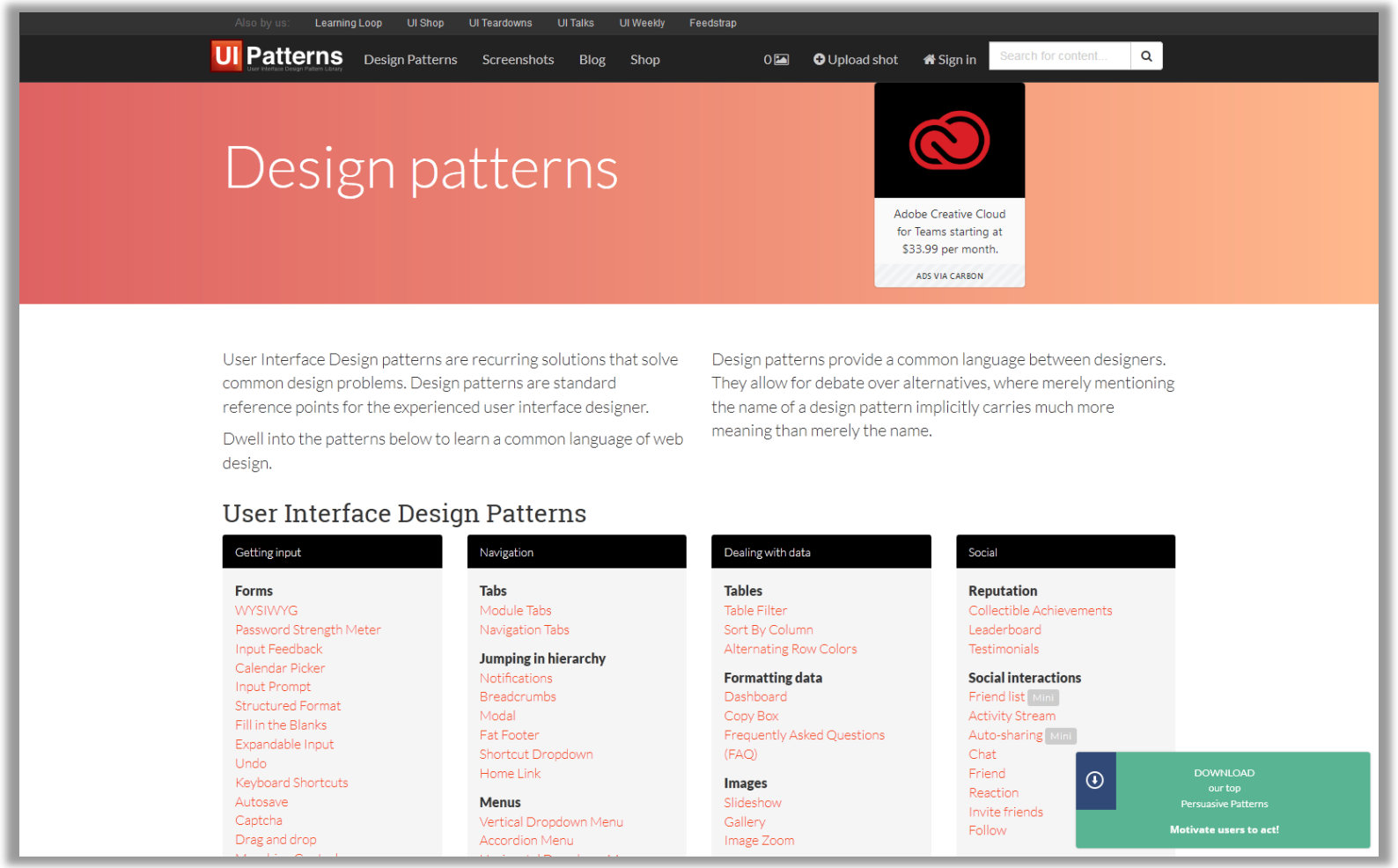
Example: Google «Material» design

https://material.io/



Example: UI Design Patterns

http://ui-patterns.com/patterns



References

- Ben Shneiderman, Catherine Plaisant, Maxine S. Cohen, Steven M. Jacobs, and Niklas Elmqvist, Designing the User Interface: Strategies for Effective Human-Computer Interaction
  - Chapter 3: Guidelines, Principles, and Theories
- David Benyon: Designing Interactive Systems, Pearson, 2014
  - Section 4.5: Design Principles
- COGS120/CSE170: Human-Computer Interaction Design, videos by Scott Klemmer, https://www.youtube.com/playlist?list=PLLssT5z_DsK_nusHL_Mjt87THSTlgrsyJ

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