

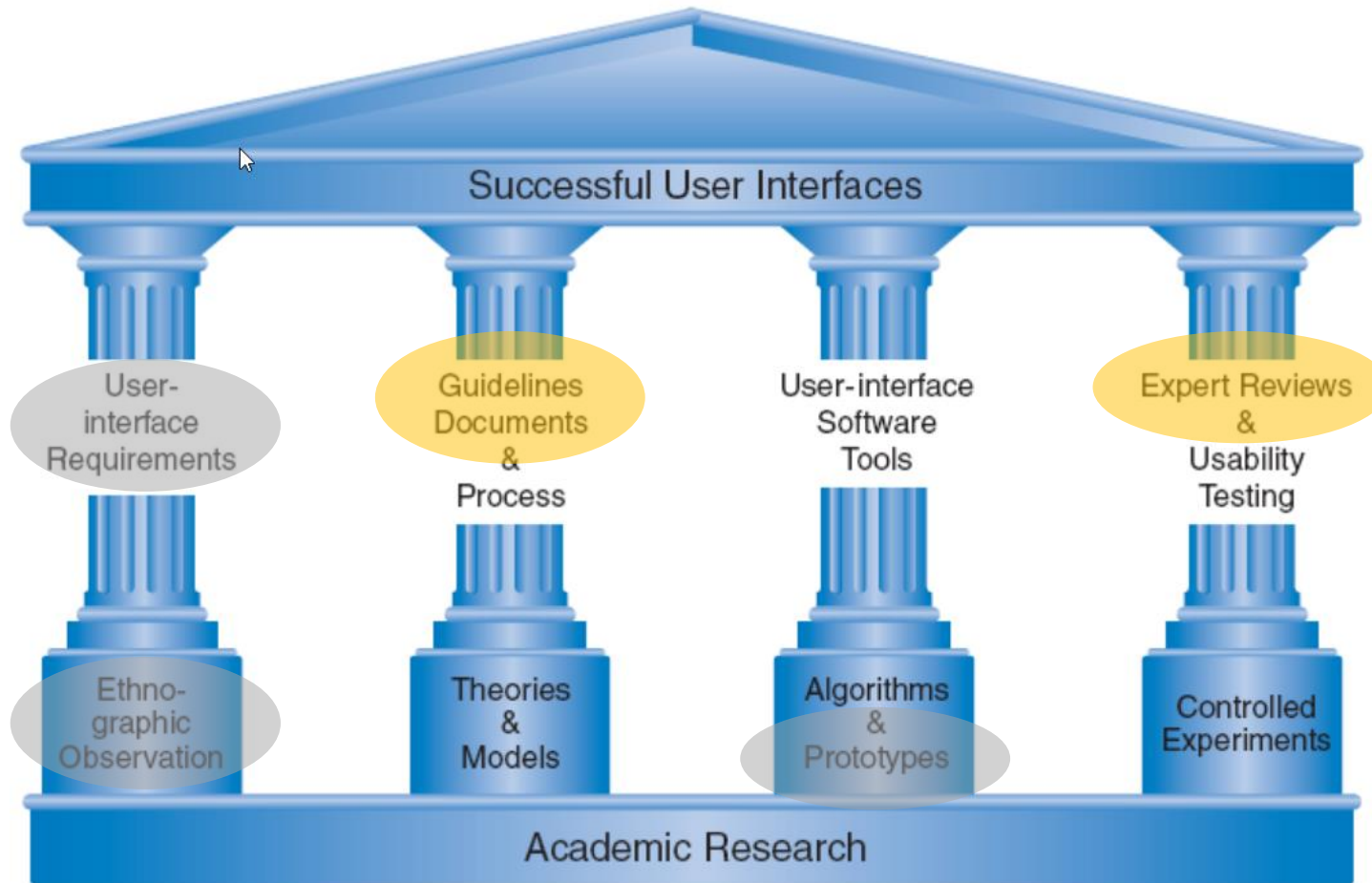
# Design Guidelines, Theories and Principles

**Human Computer Interaction**

Luigi De Russis, Fulvio Corno

Academic Year 2021/2022

# 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

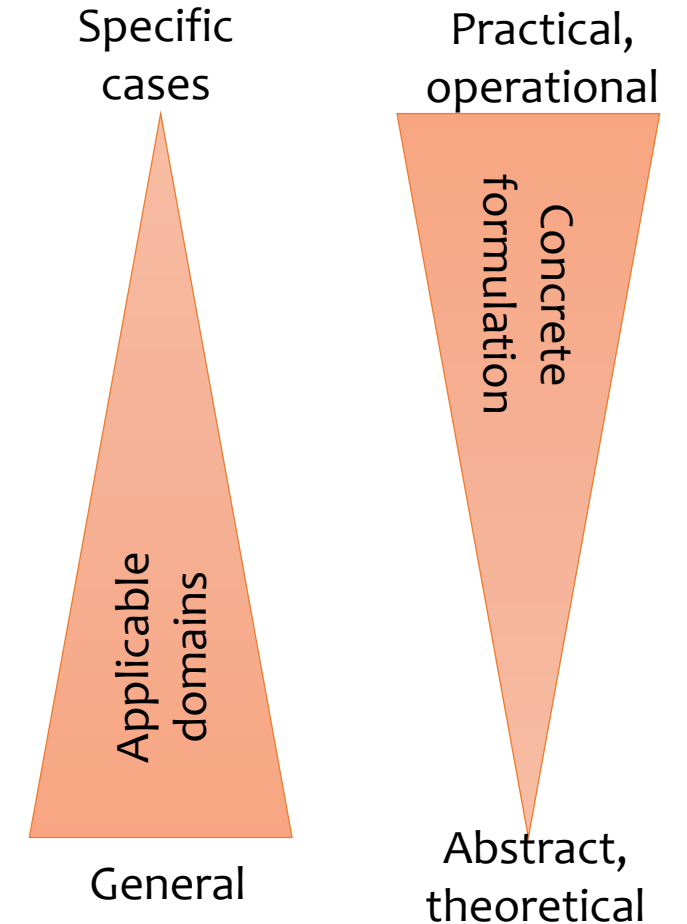
## Evaluating generated designs



- 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

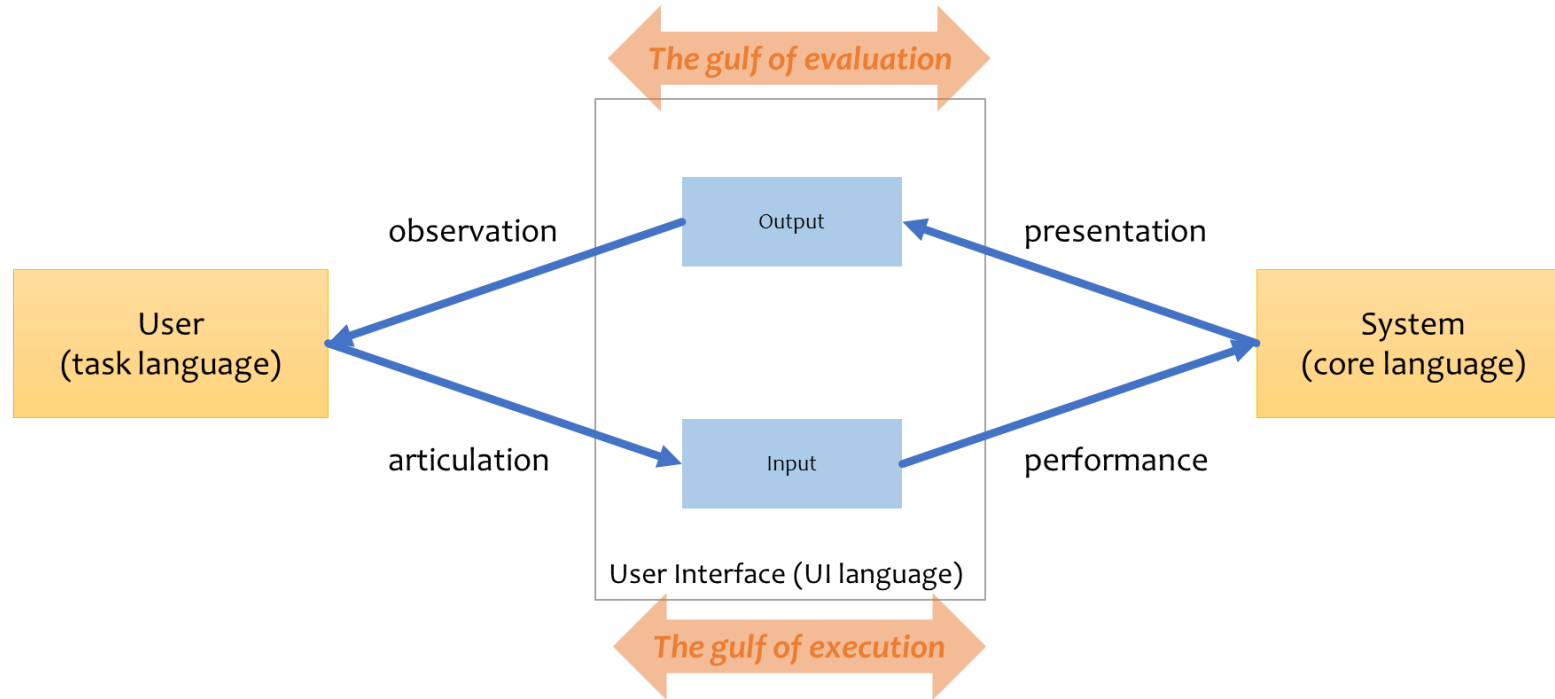
## Types of theories

- 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

# 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

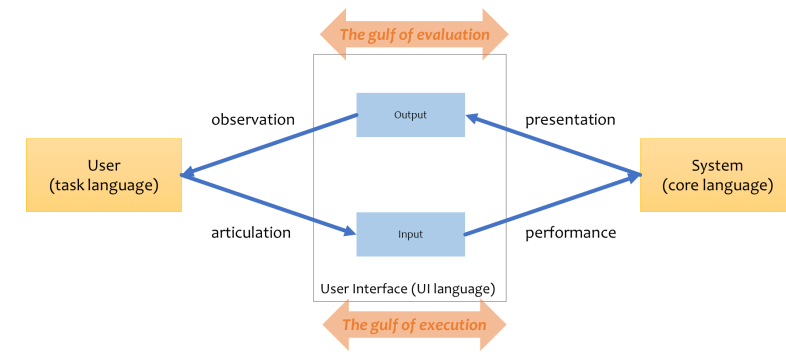
- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Advantages	Disadvantages
<b>Direct manipulation</b> Visually presents task concepts Allows easy learning  Allows easy retention Allows errors to be avoided Encourages exploration Affords high subjective satisfaction	May be hard to program May require graphics display and pointing devices
<b>Menu selection</b> Shortens learning Reduces keystrokes Structures decision making Permits use of dialog-management tools Allows easy support of error handling	Presents danger of many menus May slow frequent users Consumes screen space Requires rapid display rate
<b>Form fill-in</b> Simplifies data entry Requires modest training Gives convenient assistance Permits use of form-management tools	Consumes screen space
<b>Command language</b> Flexible Appeals to "power" users  Supports user initiative Allows convenient creation of user-defined macros	Poor error handling Requires substantial training and memorization
<b>Natural language</b> 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
- Prevent errors
- Permit easy reversal of actions
- Keep users in control
- Reduce short-term memory load

# The 8 Golden Rules of Interface Design

## ▪ Strive for consistency

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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

---

**Order Timing:**



- 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?

# Inconsistency for Drawing Attention

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

## Merge button

When merging pull requests, you can allow any combination of merge commits, squashing, or rebasing. At least one option must be enabled.

- Allow merge commits**  
Add all commits from the head branch to the base branch with a merge commit.
- Allow squash merging**  
Combine all commits from the head branch into a single commit in the base branch.
- Allow rebase merging**  
Add all commits from the head branch onto the base branch individually.

After pull requests are merged, you can have head branches deleted automatically.

- Automatically delete head branches**  
Deleted branches will still be able to be restored.

## GitHub Pages

GitHub Pages is designed to host your personal, organization, or project pages from a GitHub repository.

- Source**  
GitHub Pages is currently disabled. Select a source below to enable GitHub Pages for this repository. [Learn more.](#)
- None** ▾
- Theme Chooser**  
Select a theme to publish your site with a Jekyll theme using the `master` branch. [Learn more.](#)
- Choose a theme**

## Danger Zone

- Make this repository private**  
Please [upgrade TdP-prove-finali](#)
- Transfer ownership** **Transfer**  
Transfer this repository to another user or to an organization where you have the ability to create repositories.
- Archive this repository** **Archive this repository**  
Mark this repository as archived and read-only.
- Delete this repository** **Delete this repository**  
Once you delete a repository, there is no going back. Please be certain.

# The 8 Golden Rules of Interface Design

- Strive for consistency
- **Cater to 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
- 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

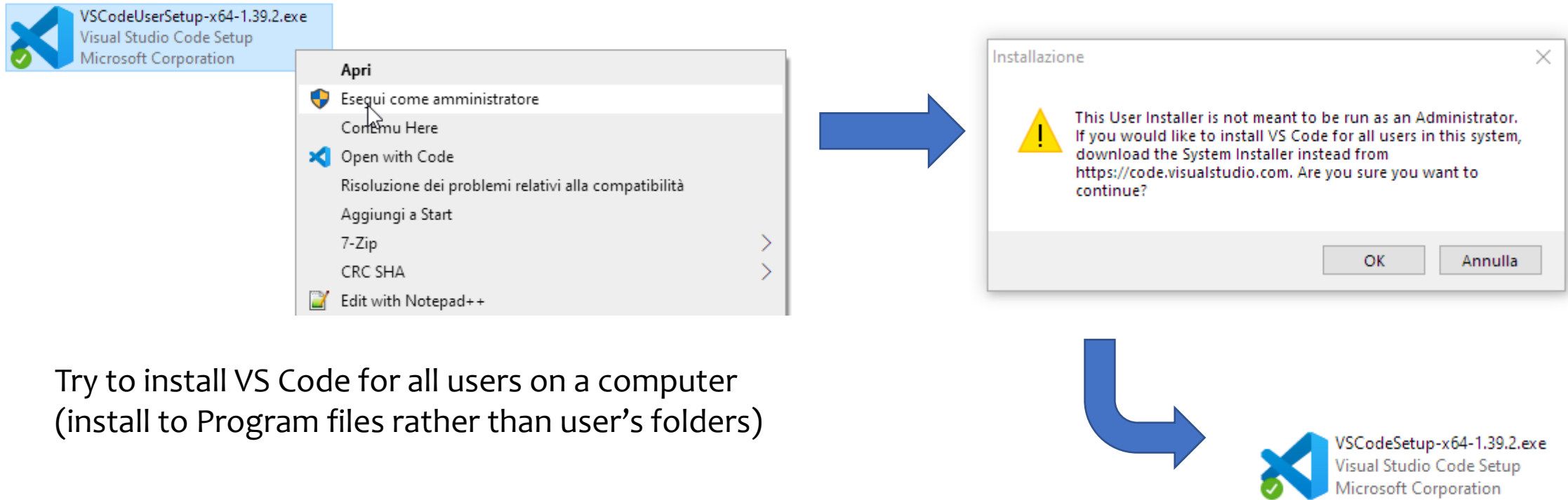
# The 8 Golden Rules of Interface Design

- Strive for consistency
  - Cater to universal usability
  - **Offer informative feedback**
  - Design dialogs to yield closure
  - Prevent errors
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  - Keep users in control
  - Reduce short-term memory load
- 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



# 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...

```
GW-BASIC 3.23
(C) Copyright Microsoft 1983,1984,1985,1986,1987,1988
60300 Bytes free
Ok
10 INPUT X

RUN
? Fulvio
?Redo from start
? _
```

1|LIST 2|RUN← 3|LOAD" 4|SAVE" 5|CONT← 6, "LPT1 7|TRON← 8|TROFF← 9|KEY 0|SCREEN



# The 8 Golden Rules of Interface Design

- Strive for consistency
- Cater to 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
- 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



**smat**  
gruppo

**COME ACQUISTARE L'ACQUA FRIZZANTE CON LA PROPRIA CARTA DI PAGAMENTO**

**Dal 16 settembre** sarà funzionante la nuova modalità di pagamento tramite POS che consentirà, registrando la propria carta bancaria, postale, di debito, di credito o prepagata (dotata di lettura "contact-less"), il pagamento dell'acqua potabile frizzante, trattata e refrigerata prelevabile da tutti i Punti Acqua SMAT.

➔ **Registrare la propria carta bancaria, postale, di debito, di credito o prepagata**  
Inserisci la carta di pagamento nel POS  
Le carte accettate sono: Pagobancomat, VISA, Maestro, Mastercard (dotate di lettura "contact-less")  
Premi "START" (pulsante verde) per registrare la carta  
Se l'operazione non viene effettuata entro 15 secondi viene annullata. A registrazione avvenuta sul display comparirà il messaggio "credito 0,00"

➔ **Caricare o ricaricare con una carta già registrata**  
Inserisci la carta di pagamento nel POS  
Premi "START" (pulsante verde): se il credito è inferiore a 1 euro apparirà sul display il messaggio "vuoi ricaricare?" A questo punto occorrerà estrarre la carta ed avvicinarla per consentire la lettura "contact-less" e trasferire il credito di 5,00 euro sul tuo "borsellino virtuale". Al termine dell'operazione di ricarica comparirà il messaggio "ricarica eseguita correttamente"

➔ **Attivare l'erogazione**  
Inserisci la carta e attendi il riconoscimento  
Premi "START" (pulsante verde) ed estrai la carta dal POS  
Per ottenere l'erogazione premi il pulsante presente sul chiosco  
Per terminare l'erogazione premere il pulsante STOP

**Utilizzare il POS conviene dopo 5 ricariche ne riceverai 1 in omaggio**

**N.B.** La nuova modalità di pagamento non sostituisce l'attuale tessera *Smat* ma è un ulteriore strumento a disposizione dell'utenza.

In caso di anomalie di funzionamento è a disposizione il Servizio Assistenza Utenti

Numero Verde **800 010 010**

# Clear dialog sequence

**SPORTELLO ON LINE**

ID STUDENTE: 447623

LA TUA RICHIESTA SCADRA' TRA **66:23:52:23** BANDO DI CONCORSO

gg hh mm ss

## Integrazione

**ATTENZIONE:**

Dal momento che hai dichiarato di esserti immatricolato nell'a.a. 2017/2018 e stai richiedendo i benefici EDISU per il settimo semestre puoi aggiungere la richiesta anche per il primo anno di laurea magistrale. Sei interessato?

SI  NO

REGIONALE PER IL DIRITTO ALLO STUDIO UNIVERSITARIO DEL PIEMONTE

OK

Submit

Confirm

Next

...?

# The 8 Golden Rules of Interface Design

- Strive for consistency
- Cater to 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
  - 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

**ACCEDI ALL'AREA RISERVATA**

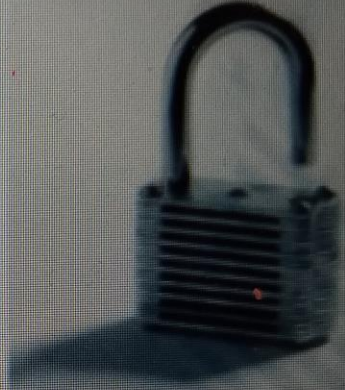
Attenzione: se la username è un codice fiscale  
inserirlo con le lettere MAIUSCOLE

Username

Password

Hai dimenticato la password? Clicca [QUI](#)

Sei un professionista della salute? [Registrati](#)



# The 8 Golden Rules of Interface Design

- Strive for consistency
  - Cater to 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
- 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

# The 8 Golden Rules of Interface Design

- Strive for consistency
  - Cater to 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
- 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

# Example

\*Come docente, quali problemi hai avuto nello svolgimento degli esami?

! Scegliere una o più delle seguenti opzioni

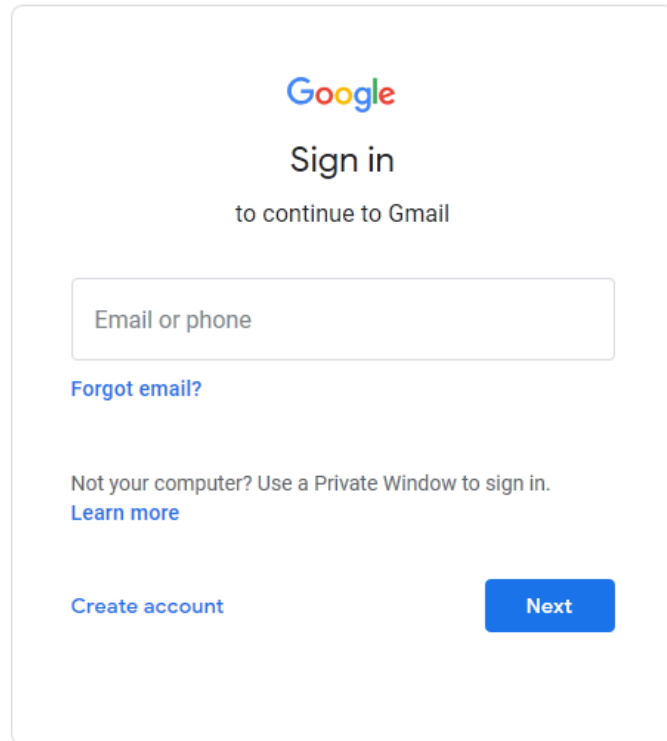
- Non ho avuto problemi
- Organizzazione dell'esame (poca chiarezza nella spiegazione delle modalità, sovrapposizione di date, procedure troppo confuse, deposito e consultazione documentazione complesso, ecc.)
- Dispongo di hardware/software inadeguato
- La connessione che uso è lenta/non continua
- Problemi ambientali (troppo rumore, confusione, scarsa possibilità di concentrazione)



# The 8 Golden Rules of Interface Design

- Strive for consistency
  - Cater to 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**
- Rule of thumb:
    - People can remember  $7 \pm 2$  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?)



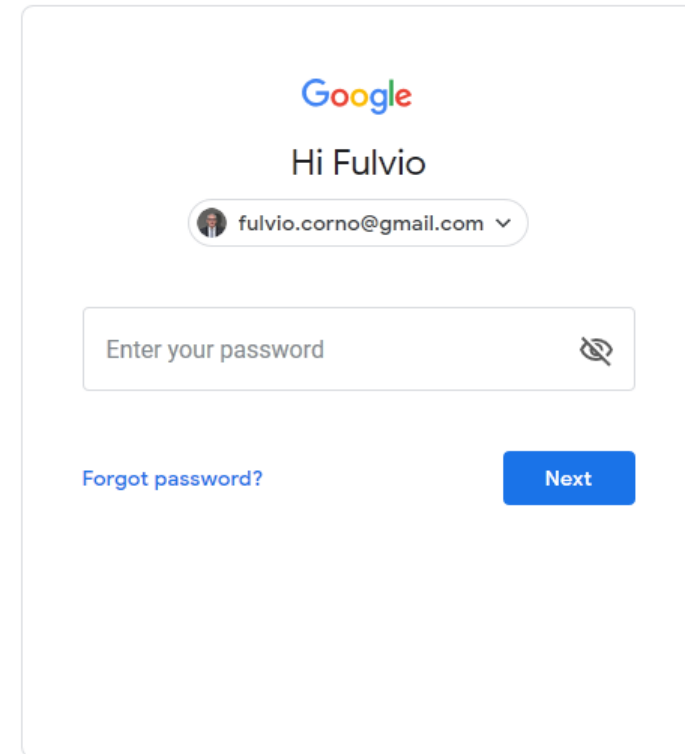
Google  
Sign in  
to continue to Gmail

[Forgot email?](#)


Not your computer? Use a Private Window to sign in.  
[Learn more](#)


[Create account](#)

English (United States) ▾ [Help](#) [Privacy](#) [Terms](#)



Google  
Hi Fulvio

 fulvio.corno@gmail.com ▾

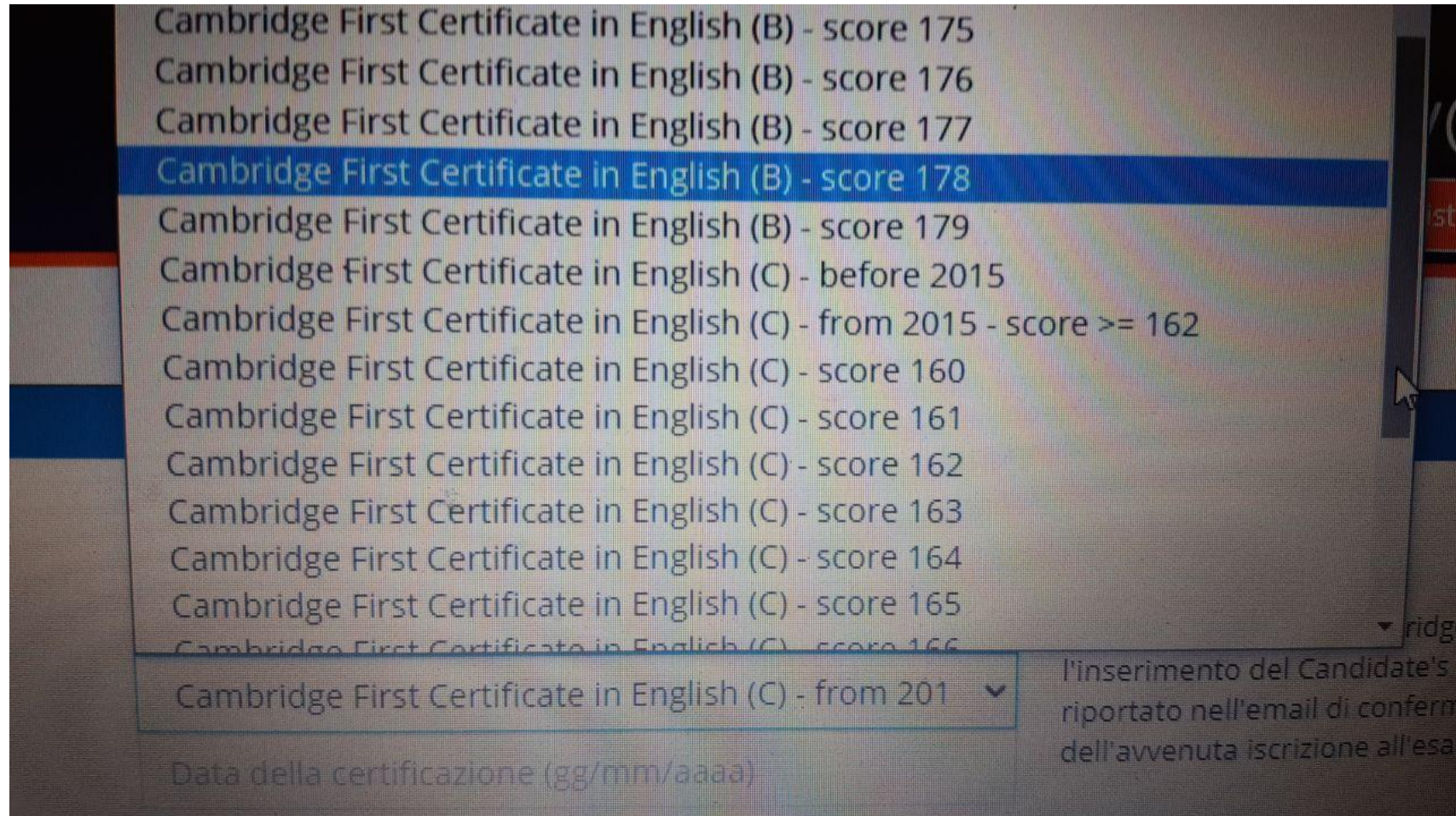
 

[Forgot password?](#)

English (United States) ▾ [Help](#) [Privacy](#) [Terms](#)

# Exceptions...

## sometimes entering is better than selecting



# 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



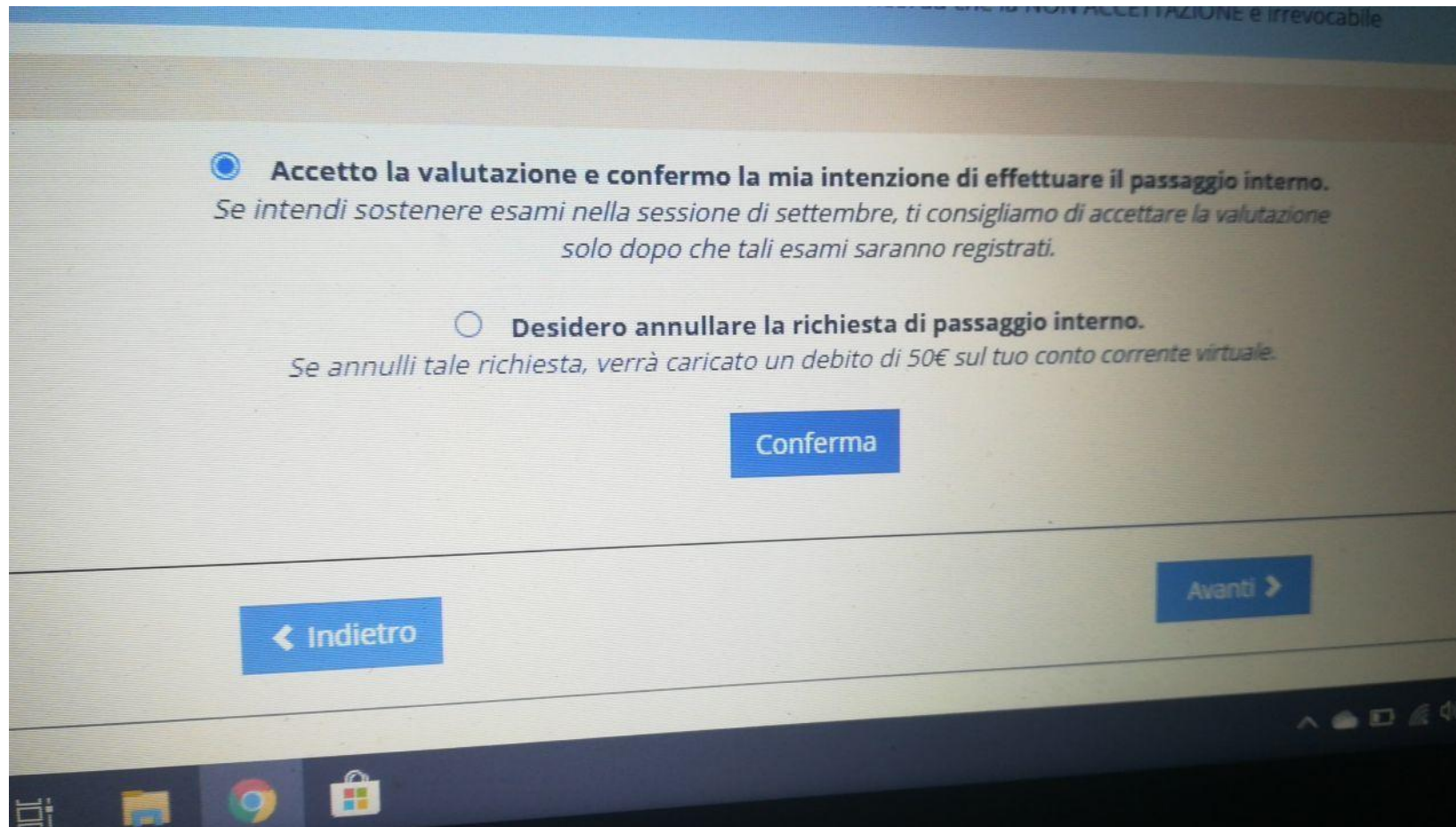


# Design Principles by Benyon (II)

(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)

# Example: Navigation and Control?





# Design Principles by Benyon (III)

(adapted from Norman, Nielsen and others)

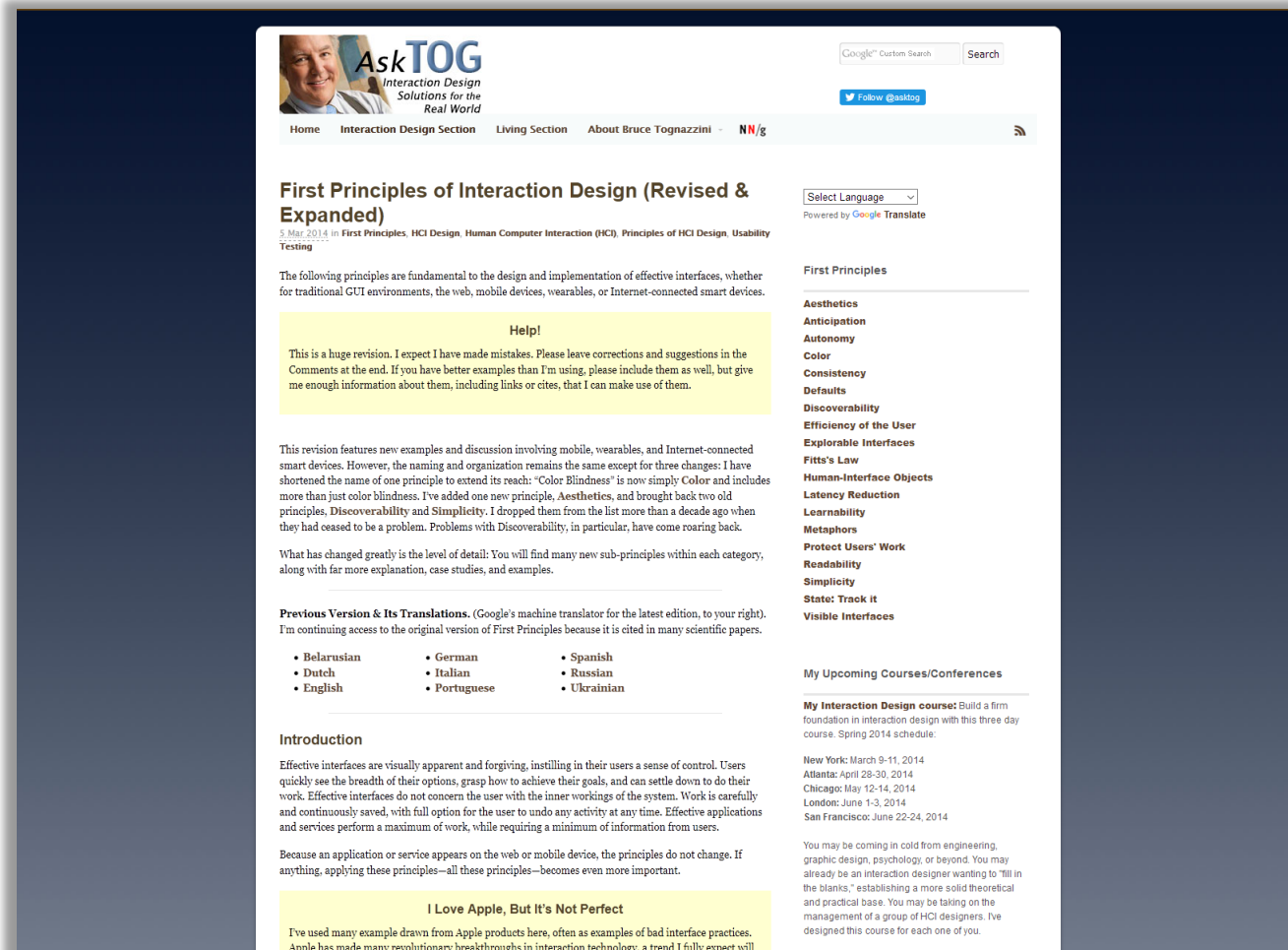
- **Safety and Security**
  - *Recovery* (→error recovery)
  - *Constraints* (→prevent errors)
- **Accommodation** – offer an interaction way that suits the users
  - *Flexibility* (→universal usability)
  - *Style* – stylish, attractive, nice-looking
  - *Conviviality* – polite, friendly, pleasant. 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



# First Principles of Interaction Design (Bruce Tognazzini, 2014)



- [Aesthetics](#)
- [Anticipation](#)
- [Autonomy](#)
- [Color](#)
- [Consistency](#)
- [Defaults](#)
- [Discoverability](#)
- [Efficiency of the User](#)
- [Explorable Interfaces](#)
- [Fitts's Law](#)
- [Human-Interface Objects](#)
- [Latency Reduction](#)
- [Learnability](#)
- [Metaphors](#)
- [Protect Users' Work](#)
- [Readability](#)
- [Simplicity](#)
- [State: Track it](#)
- [Visible Interfaces](#)

# 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/>

The screenshot shows the usability.gov website. At the top, there is a navigation bar with the logo "usability.gov Improving the User Experience" and a search box. Below the navigation bar, there are three tabs: "What & Why of Usability", "How To & Tools", and "Get Involved". The "How To & Tools" tab is selected. The main content area is titled "Guidelines" and contains the following text:

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](mailto:info.usability@hhs.gov).

**Search HHS Web Guidelines**

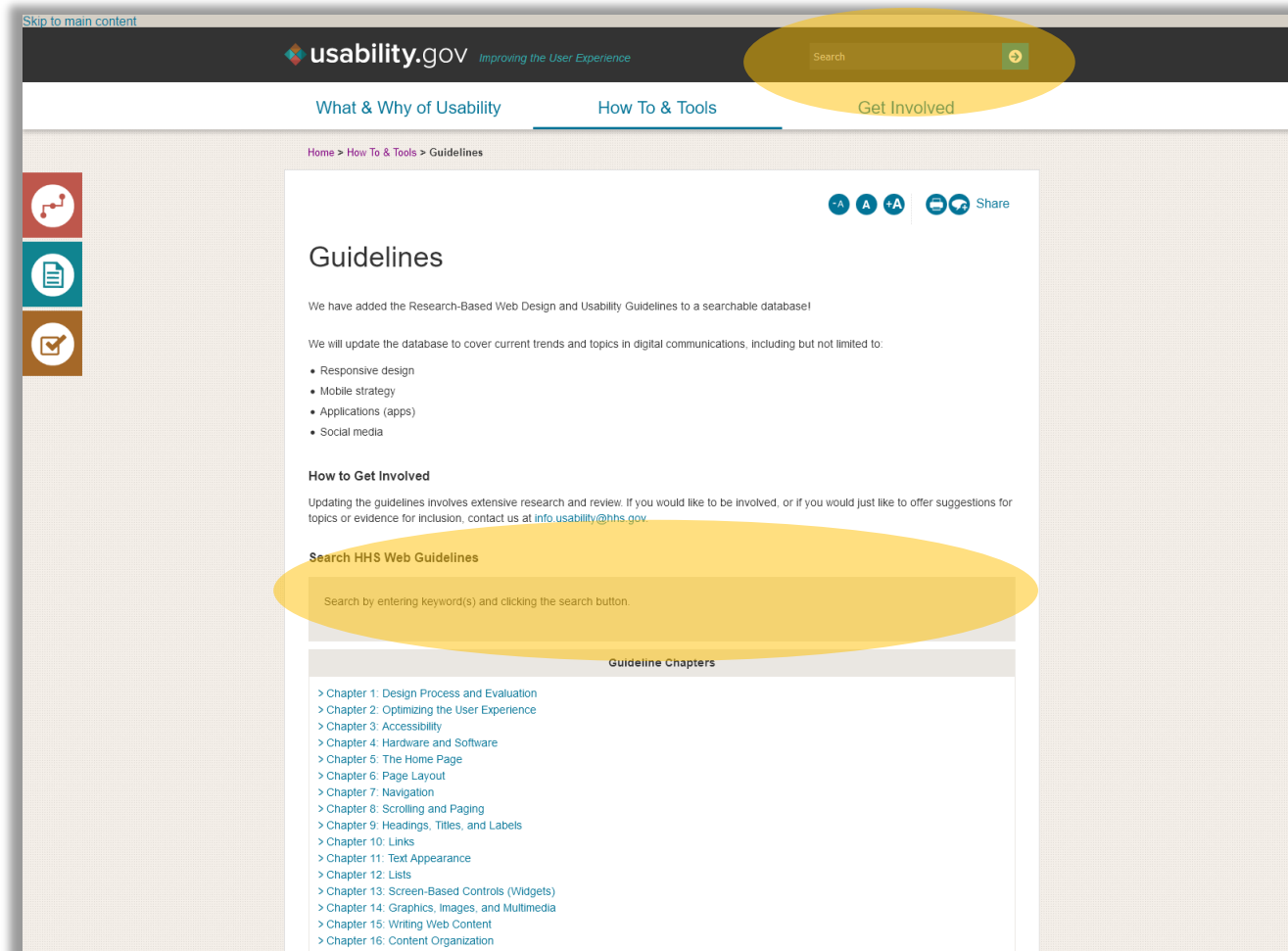
Search by entering keyword(s) and clicking the search button.

**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

The cover of the book "Research-Based Web Design & Usability Guidelines" features a large graphic of a tilted rectangular box. Inside the box, the text "Relative Importance" and "Strength of Evidence" is repeated twice, with numbers 1 through 5 in red circles. Below the graphic, the title "Research-Based Web Design & Usability Guidelines" is written in a bold, sans-serif font. Underneath the title, the forewords by Michael O. Leavitt (Secretary of Health and Human Services) and Ben Shneiderman (Professor of Computer Science, University of Maryland) are listed. At the bottom, the logos for the U.S. Department of Health and Human Services and the General Services Administration (GSA) are displayed.

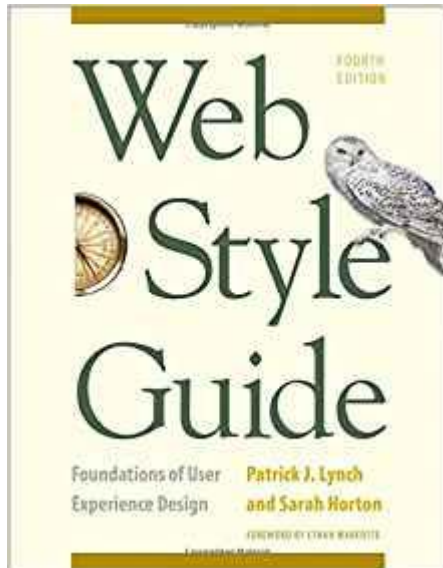
# But...



# Web Style Guide



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



Web Style Guide by Patrick J. Lynch and Sarah Horton

## Contents

- [Front Matter](#)
- [Chapter 1: Strategy](#)
- [Chapter 2: Research](#)
- [Chapter 3: Process](#)
- [Chapter 4: Information Architecture](#)
- [Chapter 5: Site Structure](#)
- [Chapter 6: Page Structure](#)
- [Chapter 7: Interface Design](#)
- [Chapter 8: Graphic Design](#)
- [Chapter 9: Typography](#)
- [Chapter 10: Editorial Style](#)
- [Chapter 11: Images](#)
- [Chapter 12: Video](#)
- [Back Matter](#)

## About the authors

Patrick J. Lynch and Sarah Horton have been working together on award-winning interface and graphic design projects since 1991. They began collaborating on *Web Style Guide* in 1997, moving from a web-only version to print and web in 1999. The book is in its 4th edition and has been translated into more than eight languages.

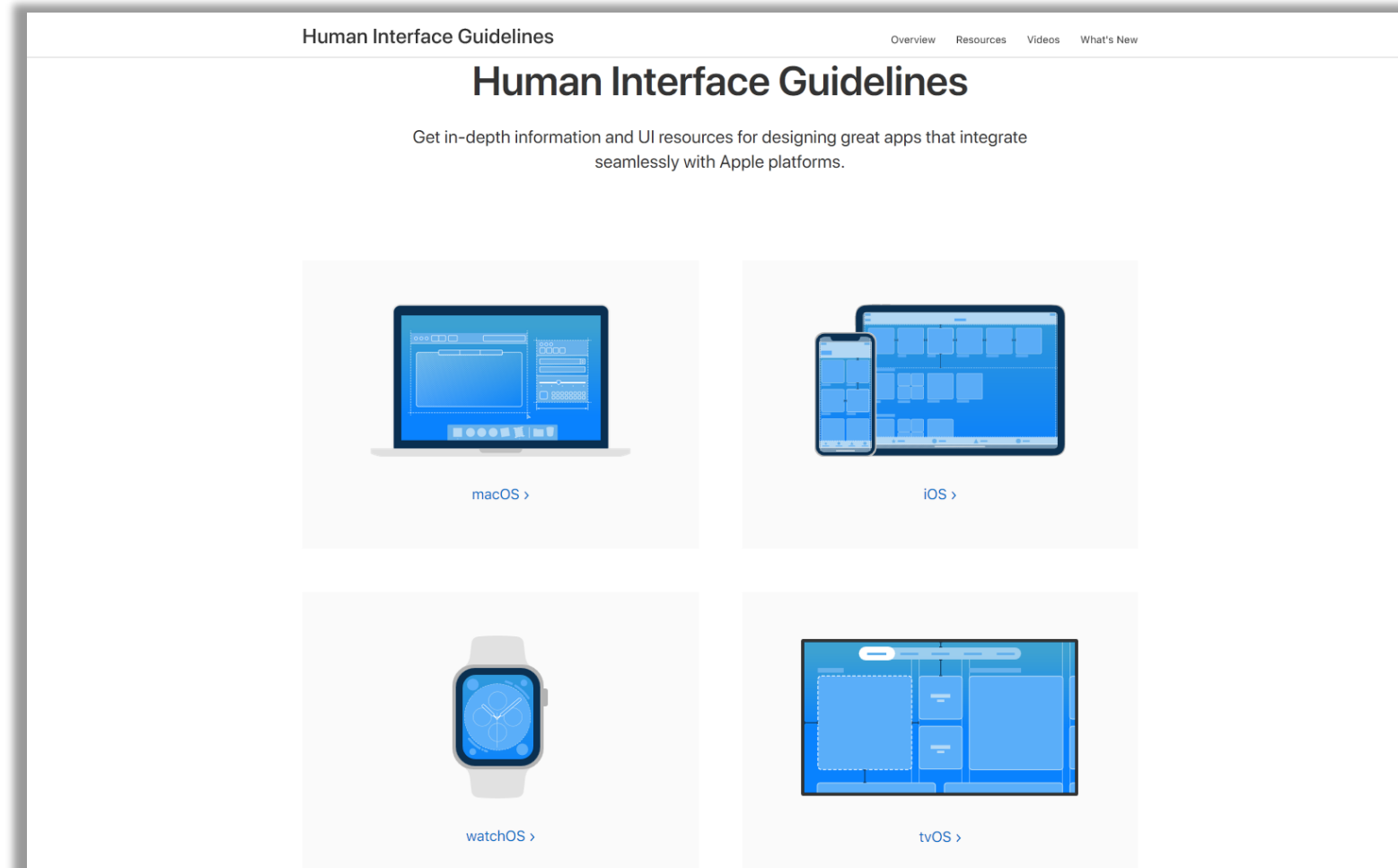
- [Learn more about Pat and Sarah](#)
- [Web Style Guide, 4th Edition: Foundations of User Experience Design on Amazon](#)

## Praise for the 4th Edition of Web Style Guide

Contents      Search      Front Matter



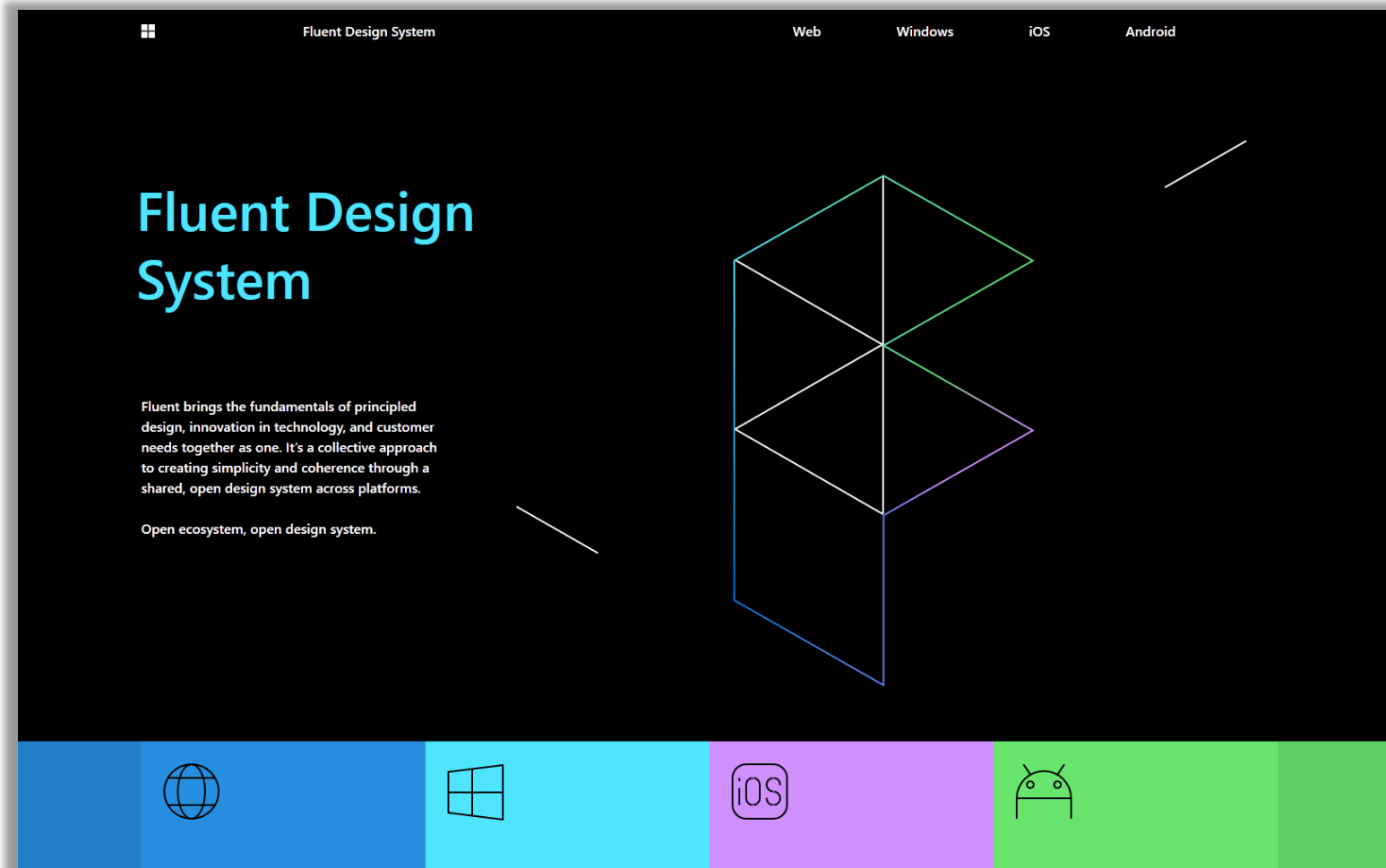
# Example: Apple





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

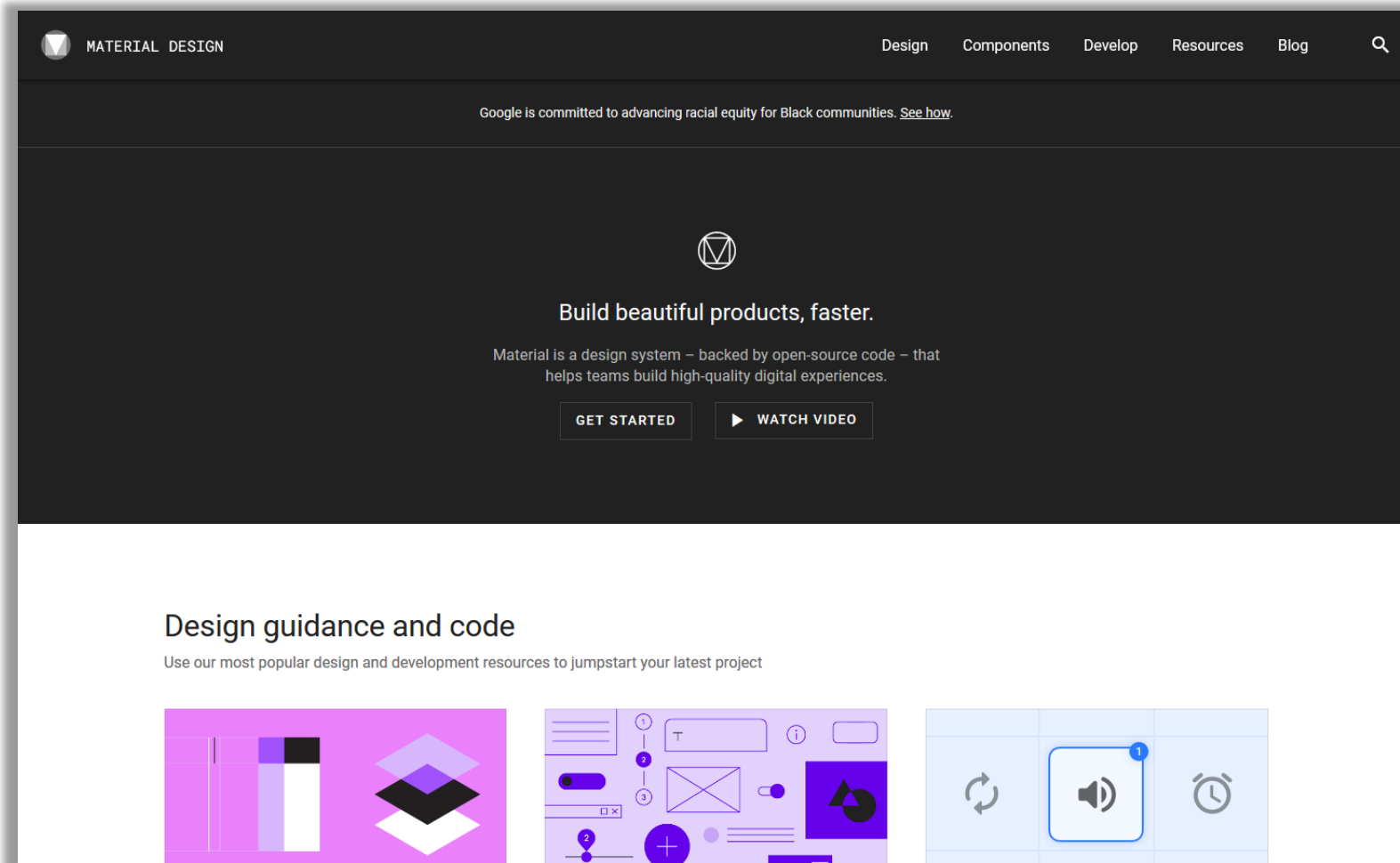
# Example: Microsoft «Fluent» design





<https://material.io/>

# Example: Google «Material» design





# Example: UI Design Patterns

Also by us: [Learning Loop](#) [UI Shop](#) [UI Teardowns](#) [UI Talks](#) [UI Weekly](#) [Feedstrap](#)

**UI Patterns** the ultimate design pattern library Design Patterns Screenshots Blog Shop 0 Upload shot Sign in Search for content...

## Design patterns

Adobe Creative Cloud for Teams starting at \$33.99 per month.  
ADS VIA CARBON

User Interface Design patterns are recurring solutions that solve common design problems. Design patterns are standard reference points for the experienced user interface designer. Dwell into the patterns below to learn a common language of web design.

Design patterns provide a common language between designers. They allow for debate over alternatives, where merely mentioning the name of a design pattern implicitly carries much more meaning than merely the name.

### User Interface Design Patterns

Getting input	Navigation	Dealing with data	Social
<b>Forms</b> WYSIWYG Password Strength Meter Input Feedback Calendar Picker Input Prompt Structured Format Fill in the Blanks Expandable Input Undo Keyboard Shortcuts Autosave Captcha Drag and drop	<b>Tabs</b> Module Tabs Navigation Tabs <b>Jumping in hierarchy</b> Notifications Breadcrumbs Modal Fat Footer Shortcut Dropdown Home Link <b>Menus</b> Vertical Dropdown Menu Accordion Menu	<b>Tables</b> Table Filter Sort By Column Alternating Row Colors <b>Formatting data</b> Dashboard Copy Box Frequently Asked Questions (FAQ) <b>Images</b> Slideshow Gallery Image Zoom	<b>Reputation</b> Collectible Achievements Leaderboard Testimonials <b>Social interactions</b> Friend list <small>Mini</small> Activity Stream Auto-sharing <small>Mini</small> Chat Friend Reaction Invite friends Follow

**DOWNLOAD**  
our top  
Persuasive Patterns  
**Motivate users to act!**



# U.S. Web Design System (USWDS)

An official website of the United States government [Here's how you know](#) ↓

**U.S. Web Design System (USWDS)**

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New to USWDS? [Learn how to adopt and adapt the design system incrementally.](#)

A design system for the federal government.

We make it easier to build accessible, mobile-friendly government websites for the American public.



## Components

Browse all USWDS components and get UX, accessibility, and implementation guidance.

[Browse the components](#)



## Design tokens

Learn how to get started using design tokens, the building blocks of USWDS component design.

[View design tokens](#)



## Utilities

Adapt your designs and deliver prototypes quickly and consistently, without touching a line of CSS.

[Build with utilities](#)



## Page templates

Use our basic page templates as a starting point for your design and development process.

[Start from a template](#)

# 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=PLLsT5z\\_DsK\\_nusHL\\_Mjt87THSTlgrsyJ](https://www.youtube.com/playlist?list=PLLsT5z_DsK_nusHL_Mjt87THSTlgrsyJ)



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