

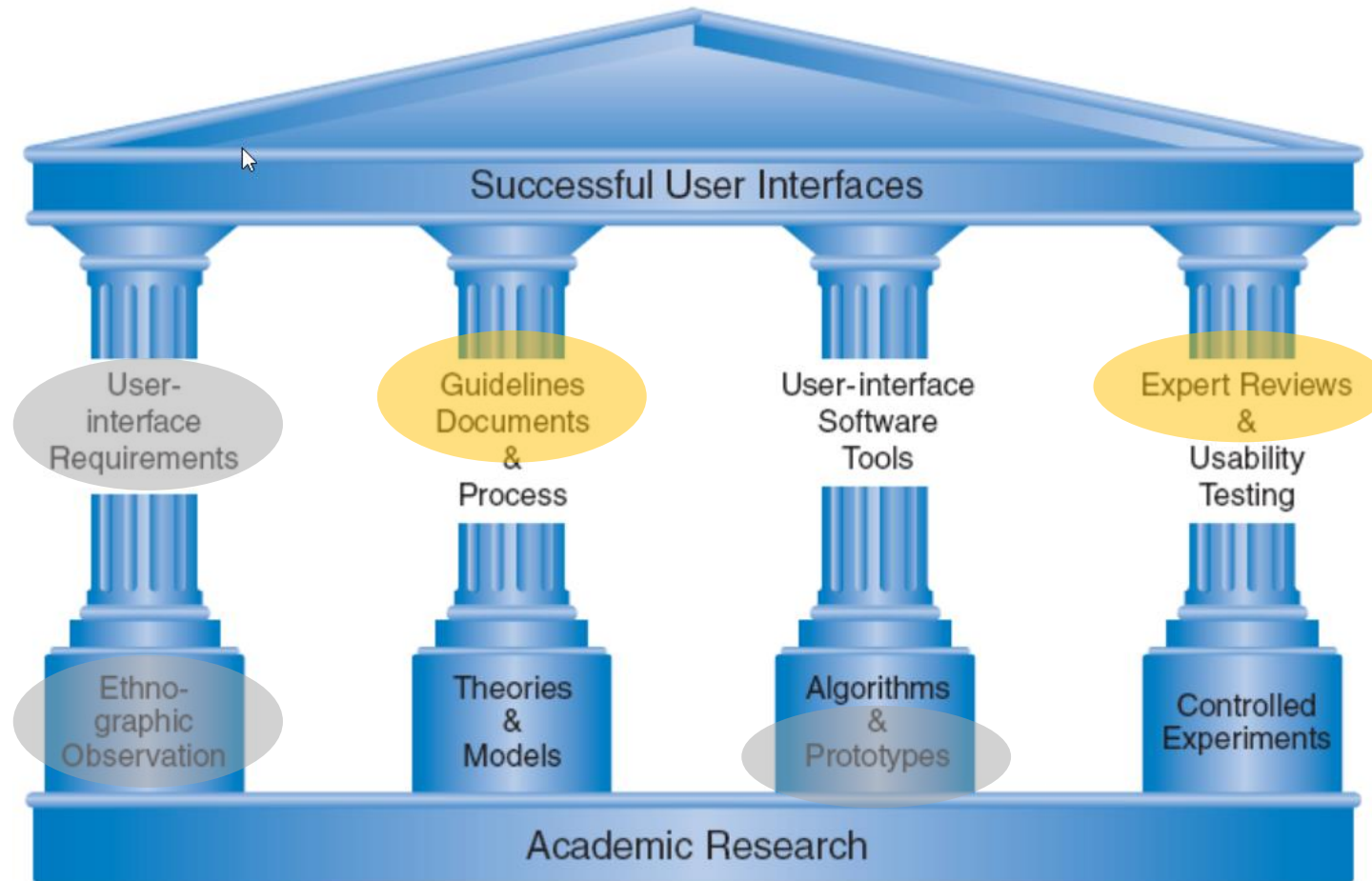
# Design Guidelines, Theories and Principles

**Human Computer Interaction**

Fulvio Corno, Luigi De Russis

Academic Year 2019/2020

# 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



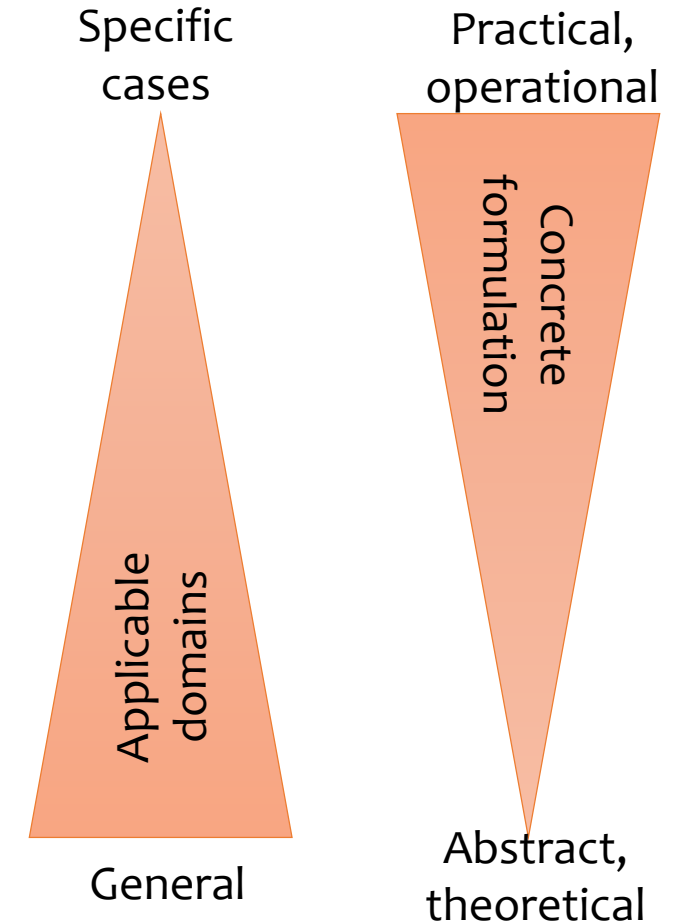
☐ Expert reviews and heuristics

☐ 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

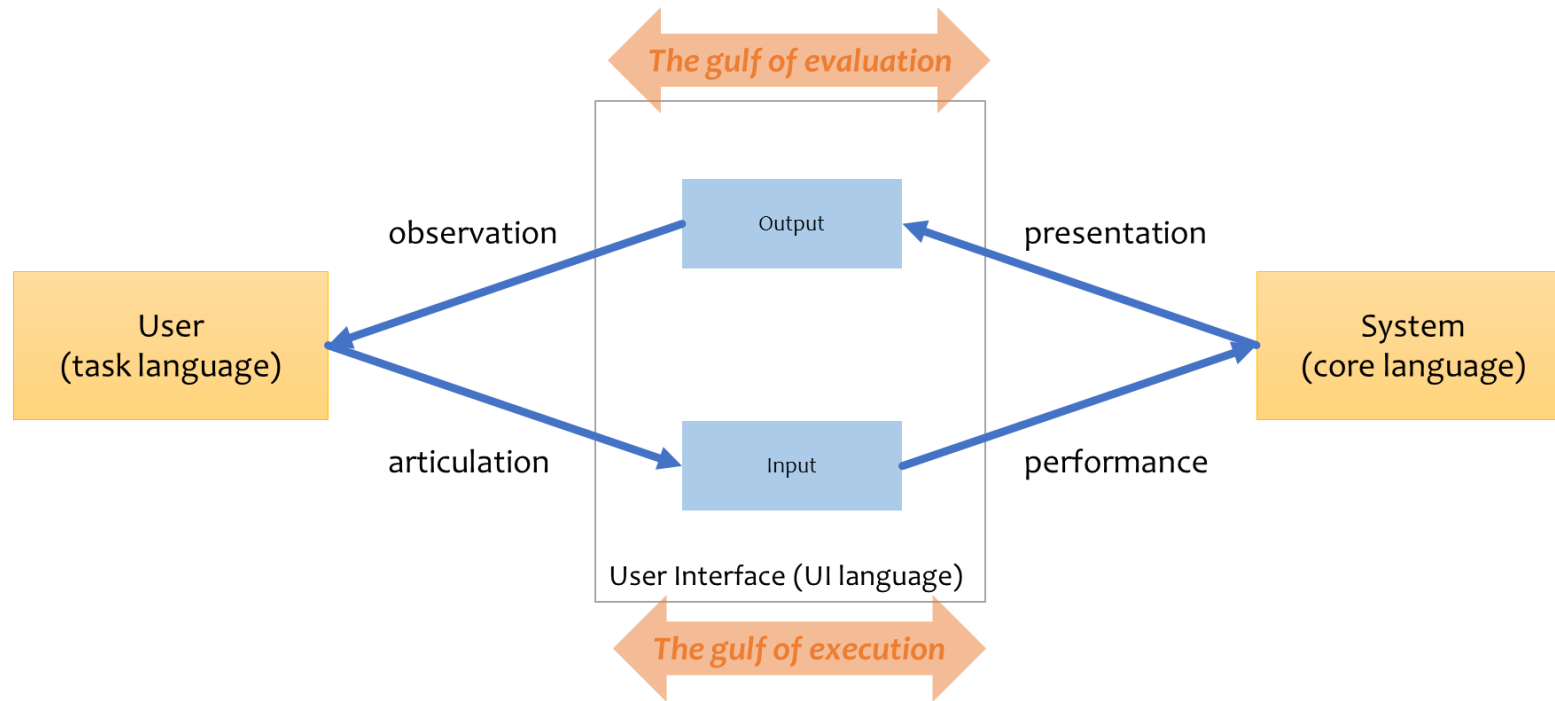
## Types of theories

- 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

## 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 this repository to another user or to an organization where you have the ability to create repositories. **Transfer**
- Archive this repository**  
Mark this repository as archived and read-only. **Archive this repository**
- Delete this repository**  
Once you delete a repository, there is no going back. Please be certain. **Delete this repository**

# 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

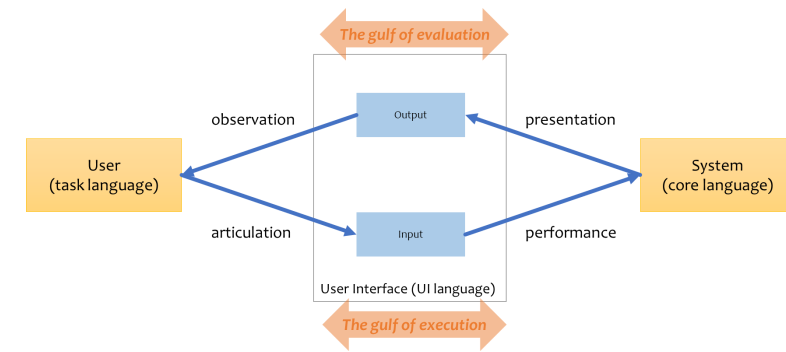
- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

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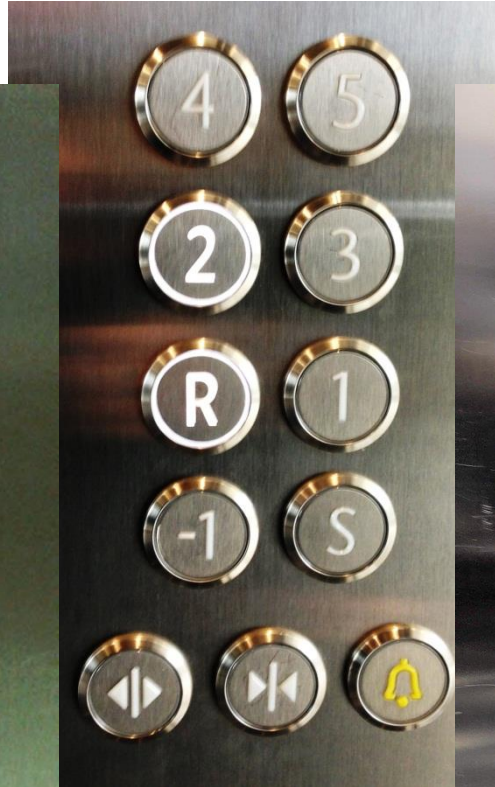
- Similar situations should lead to similar sequences of actions
- Same terminology in prompts, menus, help
- Color, layout, capitalization, fonts, ...
- Exceptions should be comprehensive and limited
  - E.g., delete, password echo



# Internal consistency



# Consistency with mental models



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

# The 8 Golden Rules of Interface Design

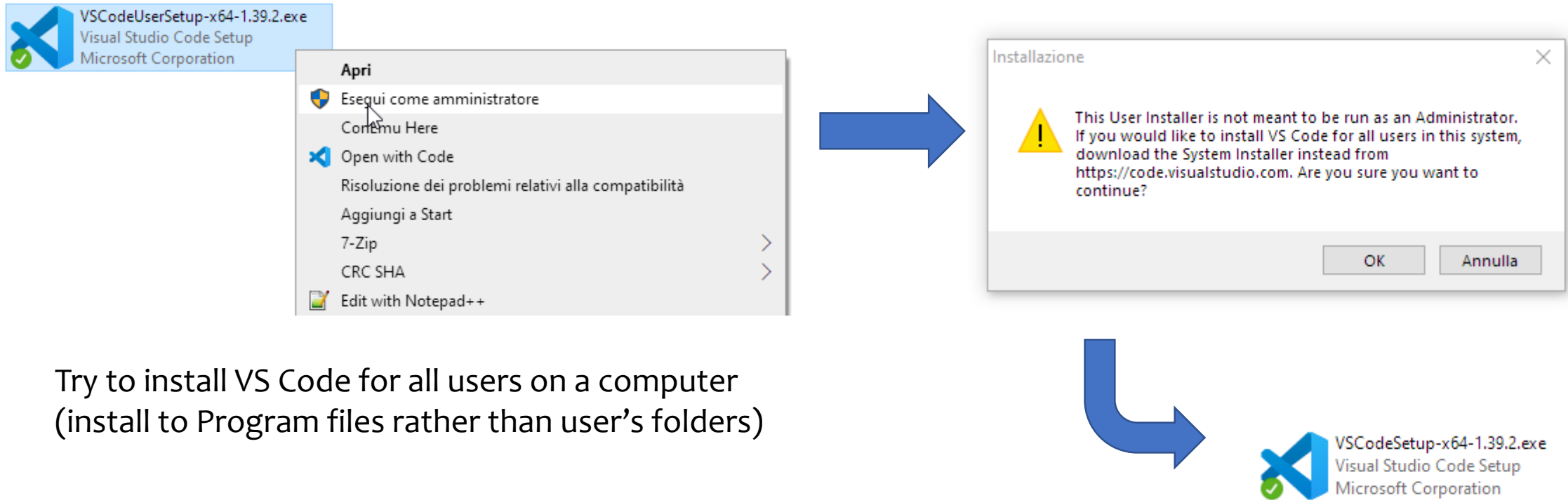
- Strive for consistency
  - **Cater to universal usability**
  - Offer informative feedback
  - Design dialogs to yield closure
  - Prevent errors
  - Permit easy reversal of actions
  - Keep users in control
  - Reduce short-term memory load
- Users with different needs: let the interface *adapt*, 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**
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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



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
? _
```

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

# 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**



# 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**

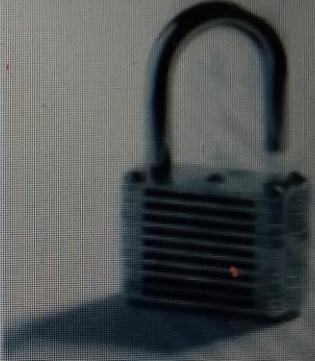
Attenzione: se la username è un codice fiscale  
inserirlo con le lettere MAIUSCOLE

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

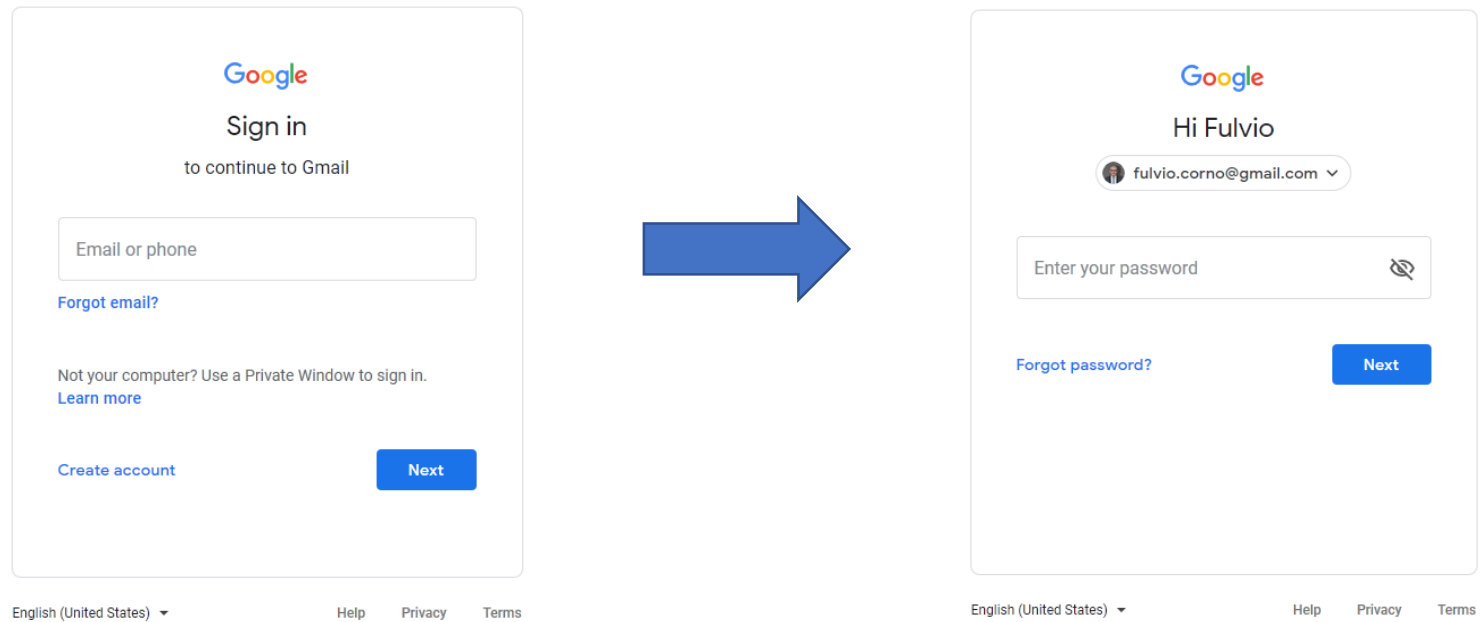
- Strive for consistency
  - Cater to universal usability
  - Offer informative feedback
  - Design dialogs to yield closure
  - Prevent errors
  - Permit easy reversal of actions
  - **Keep users in control**
  - Reduce short-term memory load
- The interface should *always* respond to user actions
  - Minimize the tedious and lengthy tasks
  - Avoid surprises or changes in familiar behavior
  - Provide undo/redo, cancel/confirm

# 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?)



The diagram illustrates a user's progression through the Google sign-in process. A large blue arrow points from the initial sign-in screen to the subsequent password entry screen.

**Initial Sign-in Screen:**

- Google logo
- Sign in to continue to Gmail
- Input field: Email or phone
- Link: [Forgot email?](#)
- Text: Not your computer? Use a Private Window to sign in. [Learn more](#)
- Link: [Create account](#)
- Button: Next

**Second Screen (after password entry):**

- Google logo
- Greeting: Hi Fulvio
- User profile: fulvio.corno@gmail.com
- Input field: Enter your password (with a toggle icon)
- Link: [Forgot password?](#)
- Button: Next

Both screens include a footer with: English (United States) ▾, Help, Privacy, and Terms.

# 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)

# 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



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

# First Principles of Interaction Design

(Bruce Tognazzini, 2014)

**AskTOG**  
Interaction Design  
Solutions for the  
Real World

Home Interaction Design Section Living Section About Bruce Tognazzini - NN/g

**First Principles of Interaction Design (Revised & Expanded)**  
5 Mar 2014 in First Principles, HCI Design, Human Computer Interaction (HCI), Principles of HCI Design, Usability Testing

The following principles are fundamental to the design and implementation of effective interfaces, whether for traditional GUI environments, the web, mobile devices, wearables, or Internet-connected smart devices.

**Help!**

This is a huge revision. I expect I have made mistakes. Please leave corrections and suggestions in the Comments at the end. If you have better examples than I'm using, please include them as well, but give me enough information about them, including links or cites, that I can make use of them.

This revision features new examples and discussion involving mobile, wearables, and Internet-connected smart devices. However, the naming and organization remains the same except for three changes: I have shortened the name of one principle to extend its reach: "Color Blindness" is now simply Color and includes more than just color blindness. I've added one new principle, Aesthetics, and brought back two old principles, Discoverability and Simplicity. I dropped them from the list more than a decade ago when they had ceased to be a problem. Problems with Discoverability, in particular, have come roaring back.

What has changed greatly is the level of detail: You will find many new sub-principles within each category, along with far more explanation, case studies, and examples.

**Previous Version & Its Translations.** (Google's machine translator for the latest edition, to your right). I'm continuing access to the original version of First Principles because it is cited in many scientific papers.

- Belarusian
- German
- Spanish
- Dutch
- Italian
- Russian
- English
- Portuguese
- Ukrainian

**Introduction**

Effective interfaces are visually apparent and forgiving, instilling in their users a sense of control. Users quickly see the breadth of their options, grasp how to achieve their goals, and can settle down to do their work. Effective interfaces do not concern the user with the inner workings of the system. Work is carefully and continuously saved, with full option for the user to undo any activity at any time. Effective applications and services perform a maximum of work, while requiring a minimum of information from users.

Because an application or service appears on the web or mobile device, the principles do not change. If anything, applying these principles—all these principles—becomes even more important.

**I Love Apple, But It's Not Perfect**

I've used many example drawn from Apple products here, often as examples of bad interface practices. Apple has made many revolutionary breakthroughs in interaction technology, a trend I fully expect will

**First Principles**

- 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

**My Upcoming Courses/Conferences**

**My Interaction Design course:** Build a firm foundation in interaction design with this three day course. Spring 2014 schedule:

New York: March 9-11, 2014  
Atlanta: April 28-30, 2014  
Chicago: May 12-14, 2014  
London: June 1-3, 2014  
San Francisco: June 22-24, 2014

You may be coming in cold from engineering, graphic design, psychology, or beyond. You may already be an interaction designer wanting to "fill in the blanks," establishing a more solid theoretical and practical base. You may be taking on the management of a group of HCI designers. I've designed this course for each one of you.

[Aesthetics](#)  
[Anticipation](#)  
[Autonomy](#)  
[Color](#)  
[Consistency](#)  
[Defaults](#)  
[Discoverability](#)  
[Efficiency of the User](#)  
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[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”

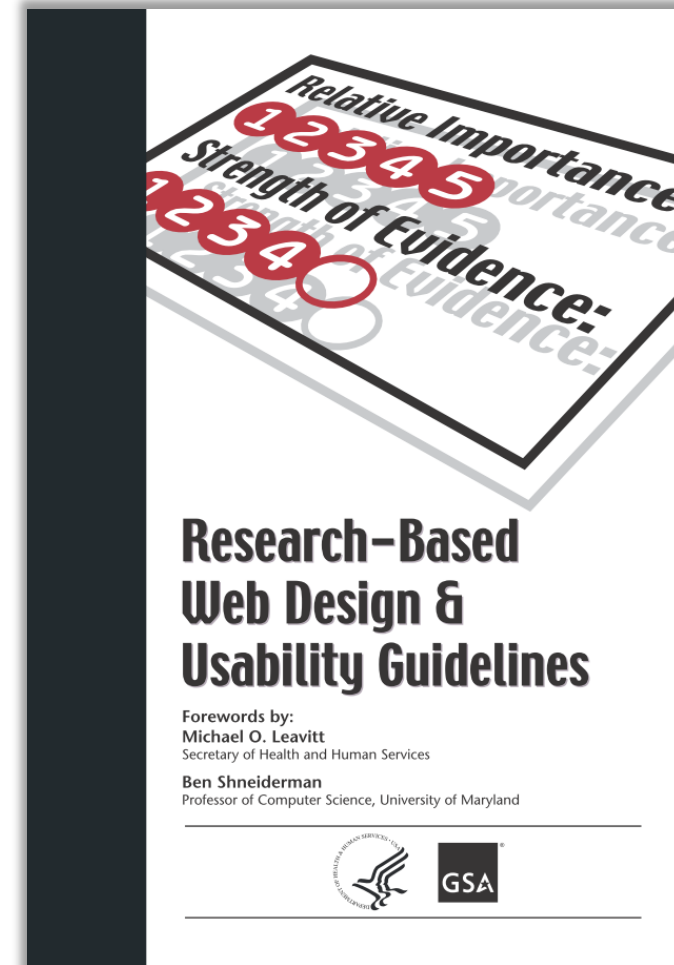
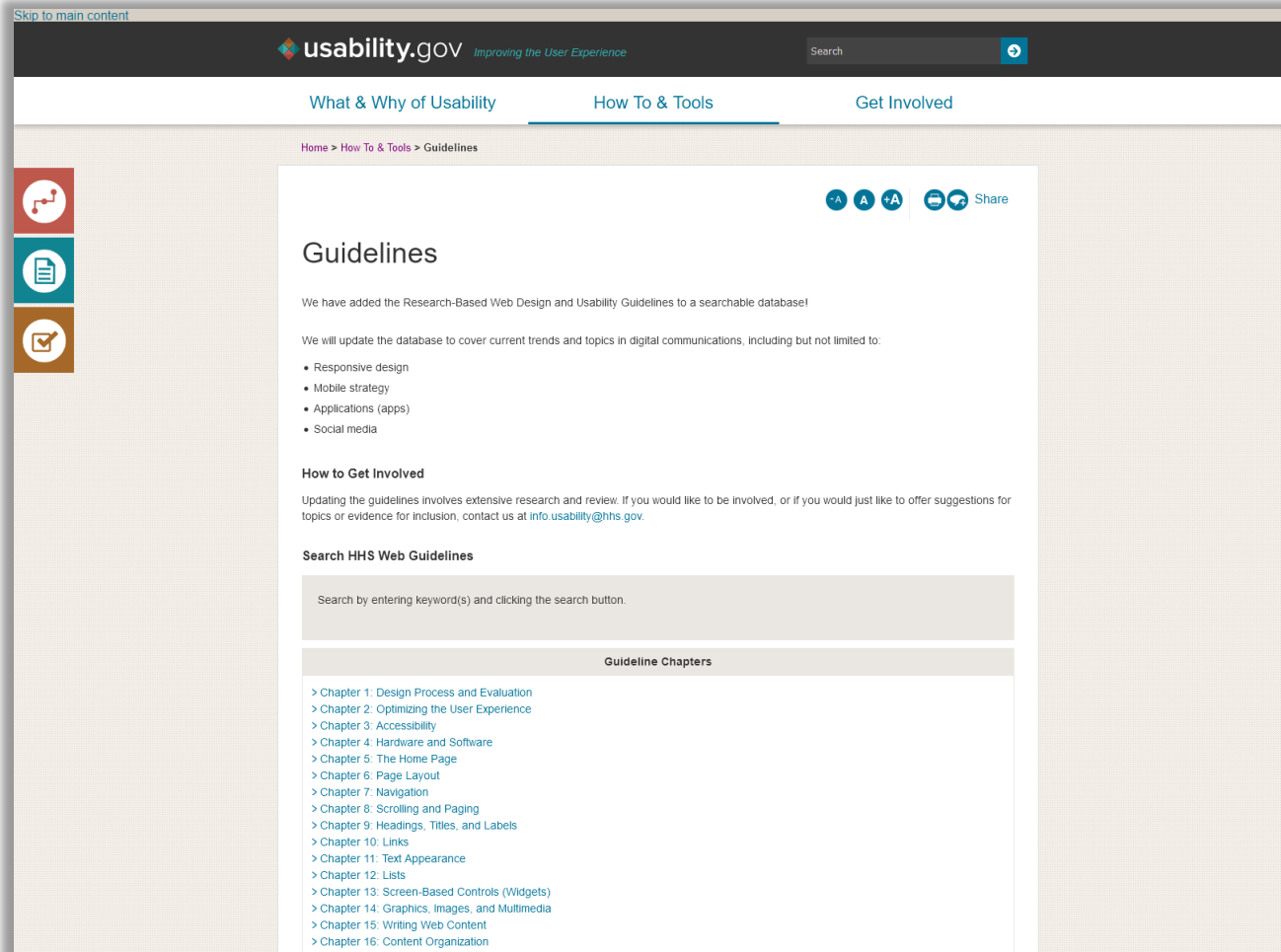
# Design Guidelines

- 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

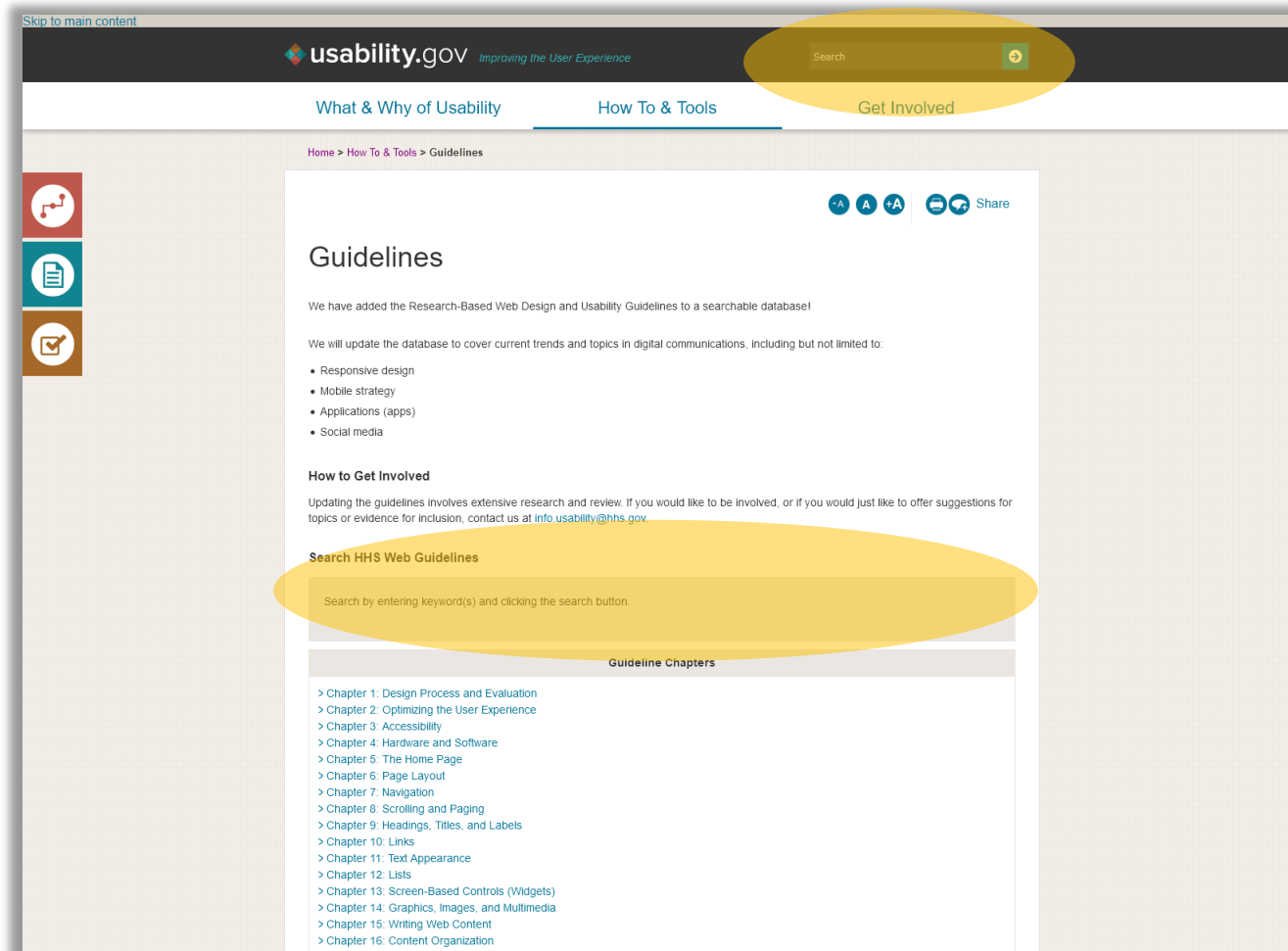


U.S. Dept. of Health and Human Services. The Research-Based Web Design & Usability Guidelines, Enlarged/Expanded edition. Washington: U.S. Government Printing Office, 2006.  
<https://guidelines.usability.gov/>





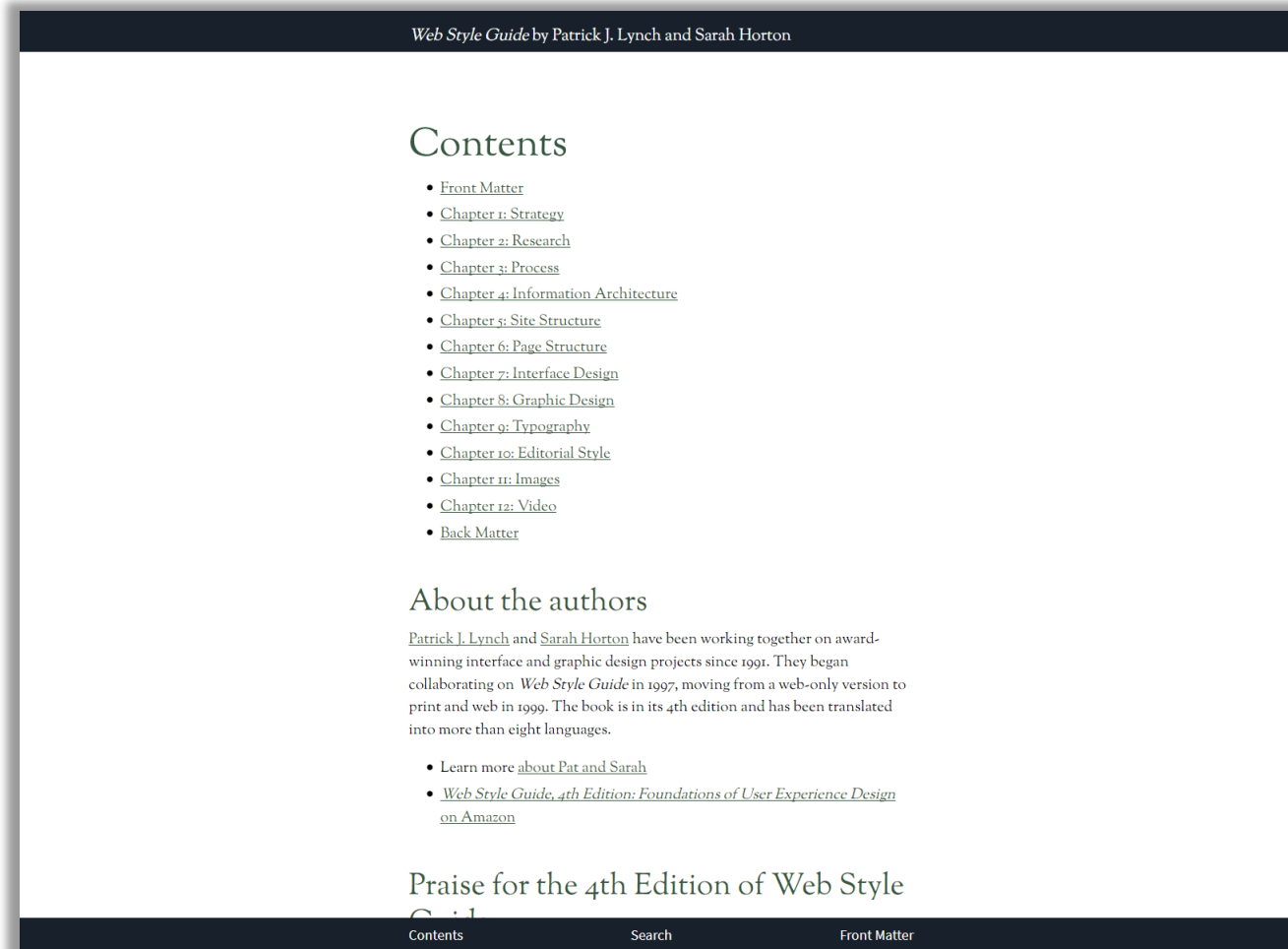
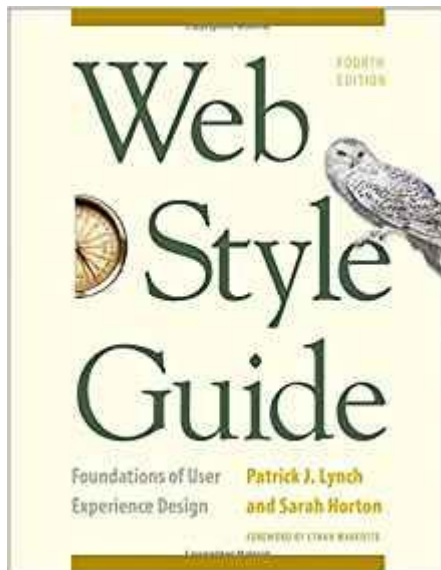
# But...



# Web Style Guide



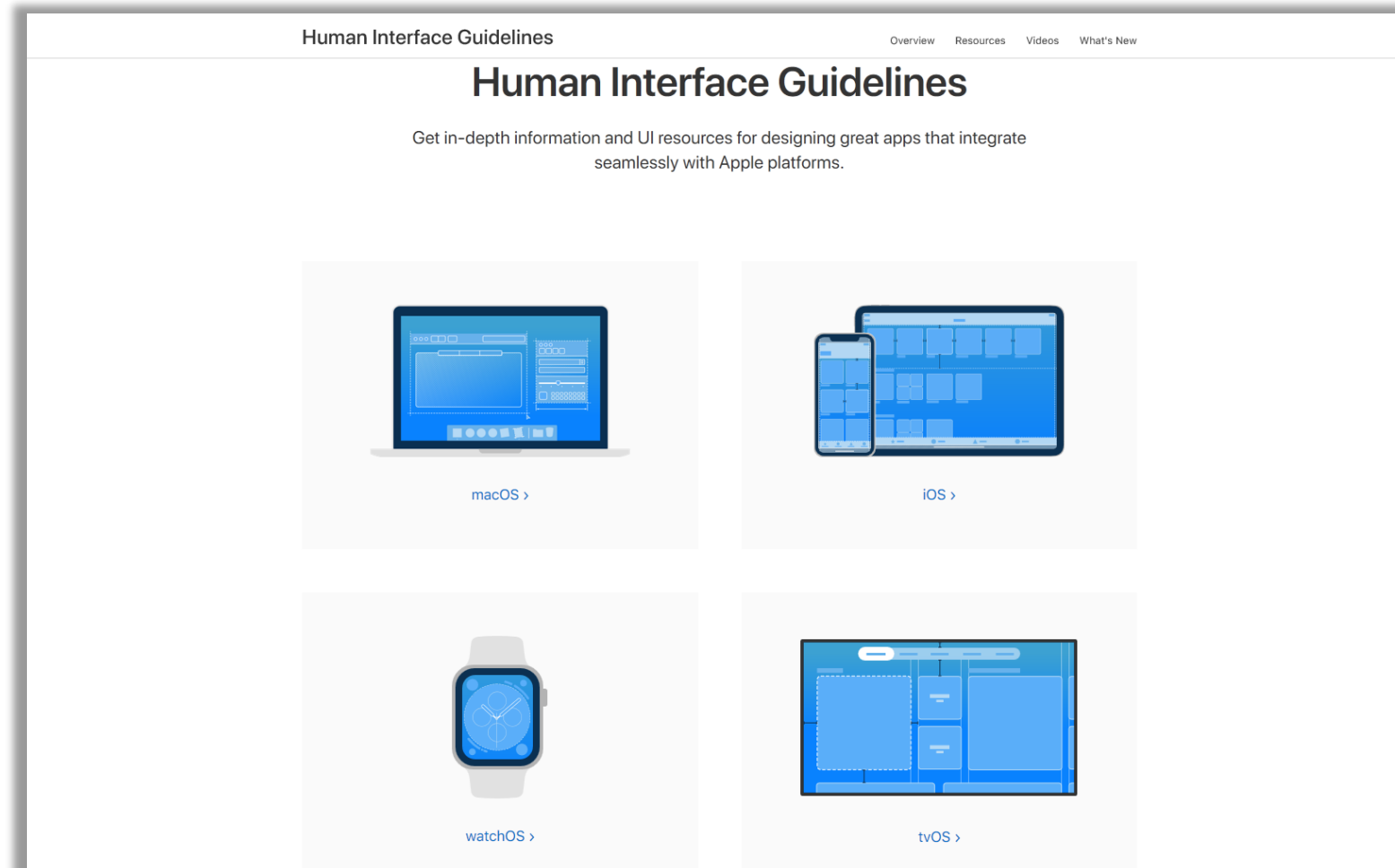
Web Style Guide, 4th Edition: Foundations of User Experience Design (2016)  
<https://webstyleguide.com/>





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

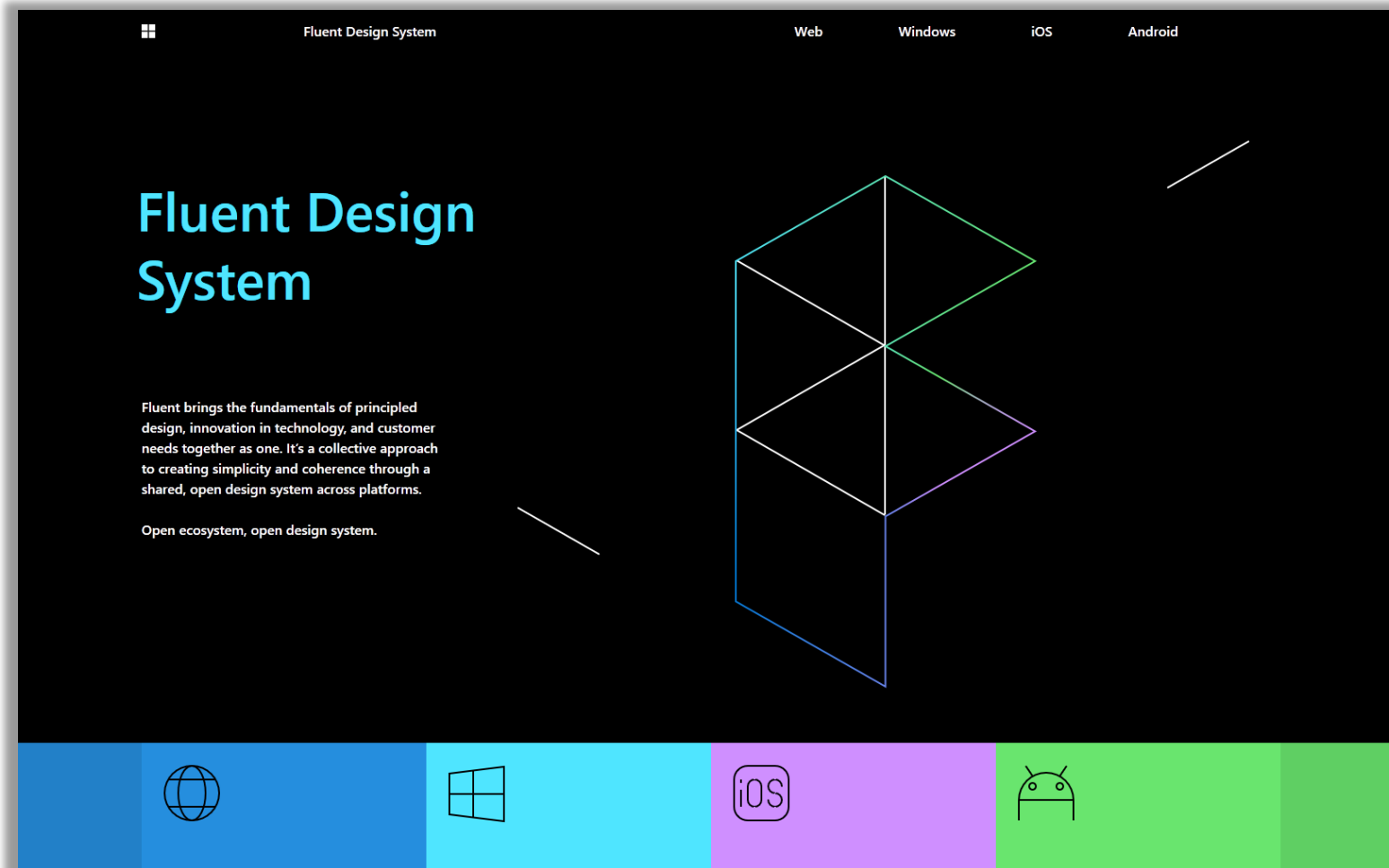
# Example: Apple





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

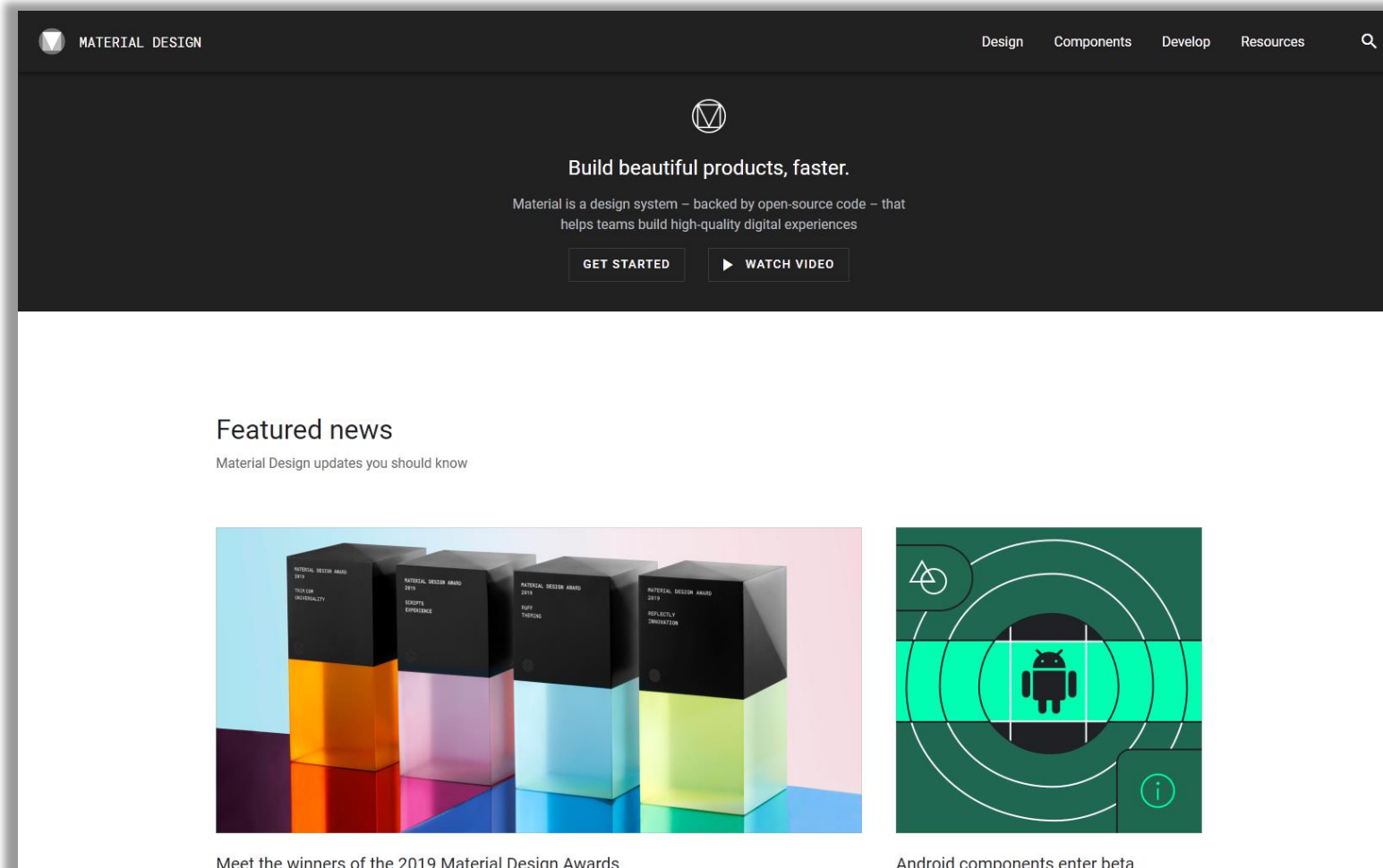
# Example: Microsoft «Fluent» design





<https://material.io/>

# Example: Google «Material» design





<http://ui-patterns.com/patterns>

# Example: UI Design Patterns

The screenshot shows the UI Patterns website. The header includes a navigation bar with links like 'Also by us: Learning Loop, UI Shop, UI Teardowns, UI Talks, UI Weekly, Feedstrap'. The main content area is titled 'Design patterns' and features an advertisement for Adobe Creative Cloud. Below the header, there are two paragraphs explaining the concept of design patterns. The main section is titled 'User Interface Design Patterns' and is divided into four columns: 'Getting input', 'Navigation', 'Dealing with data', and 'Social'. Each column lists various UI patterns such as Forms, Tabs, Tables, Reputation, and Social interactions. A green button labeled 'DOWNLOAD our top Persuasive Patterns' is visible in the bottom right corner of the screenshot.

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

**UI Patterns** your favorite design pattern library [Design Patterns](#) [Screenshots](#) [Blog](#) [Shop](#) [0](#) [Upload shot](#) [Sign in](#)

## 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> <ul style="list-style-type: none"><li>WYSIWYG</li><li>Password Strength Meter</li><li>Input Feedback</li><li>Calendar Picker</li><li>Input Prompt</li><li>Structured Format</li><li>Fill in the Blanks</li><li>Expandable Input</li><li>Undo</li><li>Keyboard Shortcuts</li><li>Autosave</li><li>Captcha</li><li>Drag and drop</li></ul>	<b>Tabs</b> <ul style="list-style-type: none"><li>Module Tabs</li><li>Navigation Tabs</li></ul> <b>Jumping in hierarchy</b> <ul style="list-style-type: none"><li>Notifications</li><li>Breadcrumbs</li><li>Modal</li><li>Fat Footer</li><li>Shortcut Dropdown</li><li>Home Link</li></ul> <b>Menus</b> <ul style="list-style-type: none"><li>Vertical Dropdown Menu</li><li>Accordion Menu</li></ul>	<b>Tables</b> <ul style="list-style-type: none"><li>Table Filter</li><li>Sort By Column</li><li>Alternating Row Colors</li></ul> <b>Formatting data</b> <ul style="list-style-type: none"><li>Dashboard</li><li>Copy Box</li><li>Frequently Asked Questions (FAQ)</li></ul> <b>Images</b> <ul style="list-style-type: none"><li>Slideshow</li><li>Gallery</li><li>Image Zoom</li></ul>	<b>Reputation</b> <ul style="list-style-type: none"><li>Collectible Achievements</li><li>Leaderboard</li><li>Testimonials</li></ul> <b>Social interactions</b> <ul style="list-style-type: none"><li>Friend list <small>Mini</small></li><li>Activity Stream</li><li>Auto-sharing <small>Mini</small></li><li>Chat</li><li>Friend</li><li>Reaction</li><li>Invite friends</li><li>Follow</li></ul>

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

# 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](https://www.youtube.com/playlist?list=PLLssT5z_DsK_nusHL_Mjt87THSTlgrsyJ)

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