



Design Theory, Principles and Guidelines

Human Computer Interaction

Luigi De Russis

Academic Year 2022/2023

Hall of Fame or Shame?

Did we make you smile?

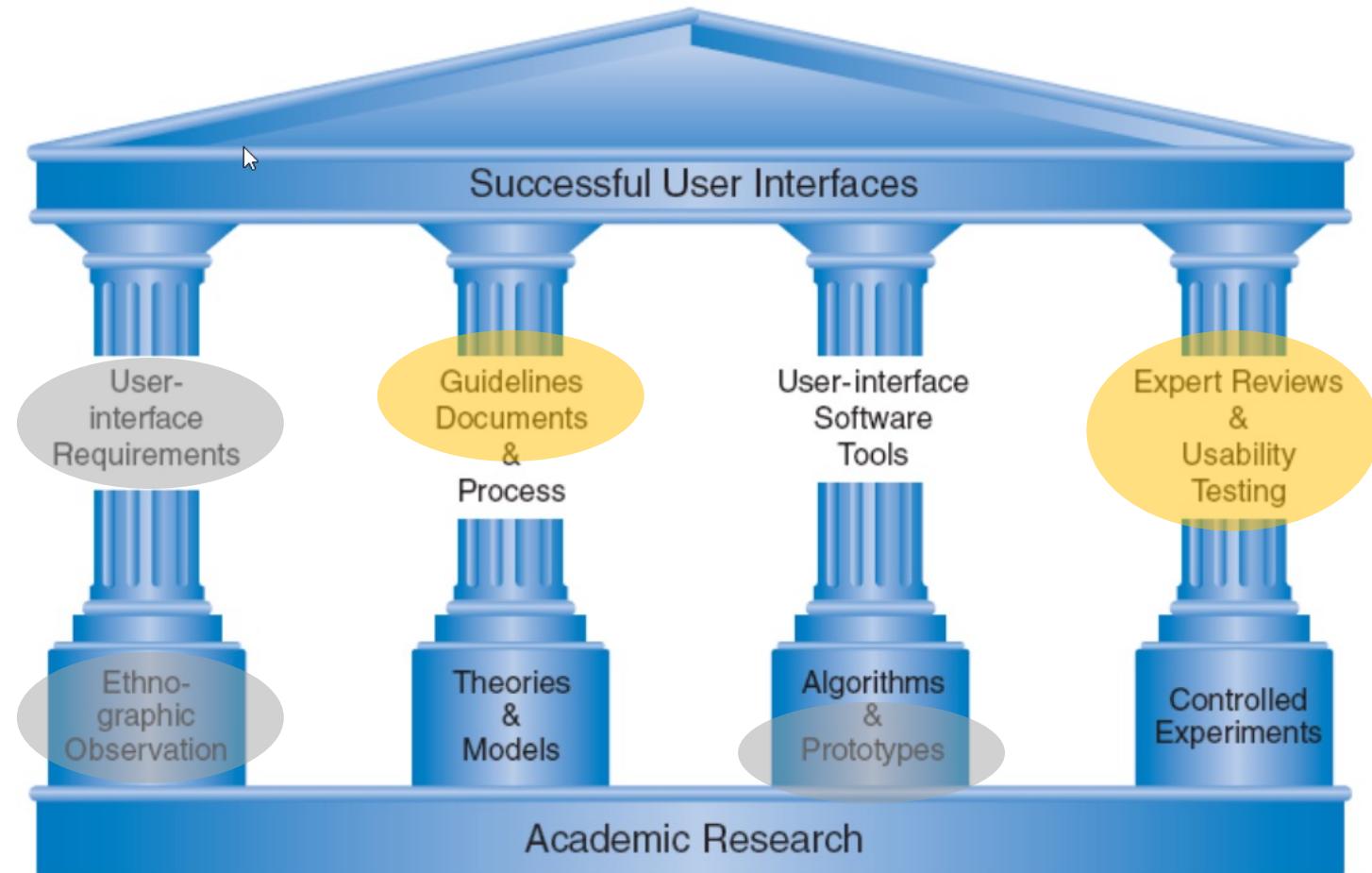
Based on your shopping experience,
how likely are you to recommend us on
a scale of 0 - 10?

Extremely unlikely

0 1 2 3 4

Extremely likely

The Four Pillars of Design



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

Goals

Generating design solutions

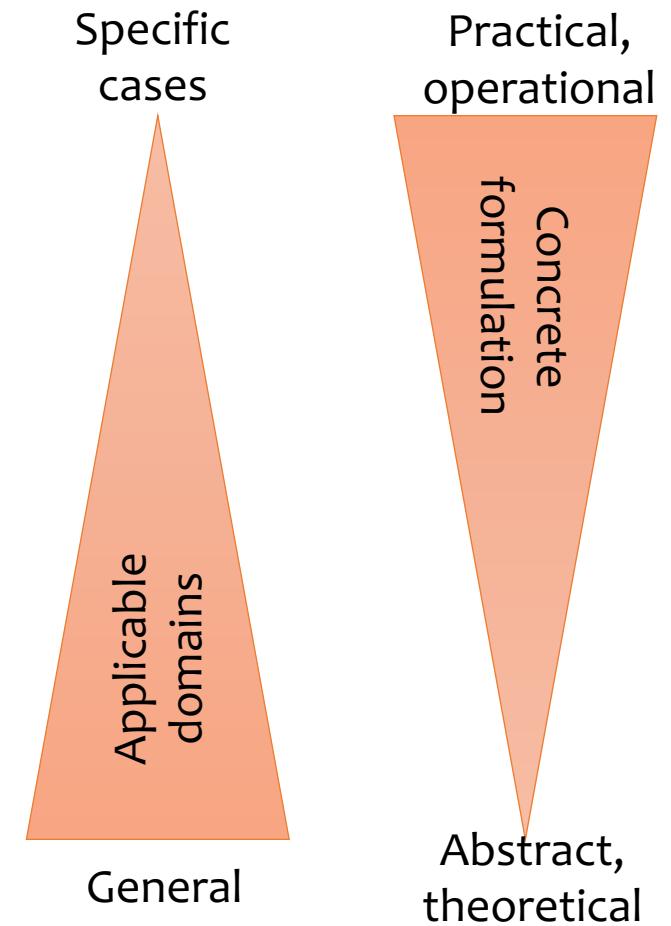
- Guidelines
- Principles
- Theories

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

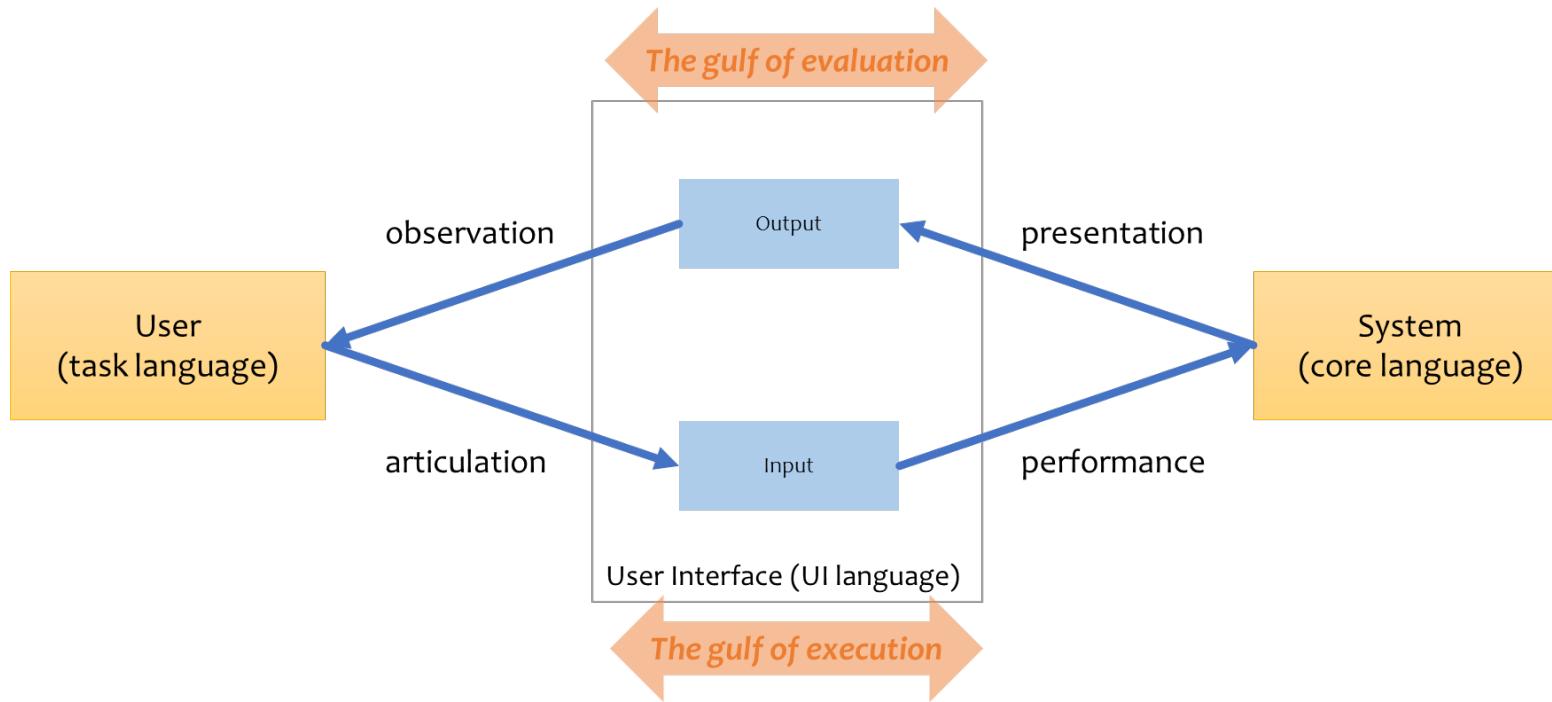
Types of theories

- 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

Consistency Theories (Prescriptive)

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

- **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

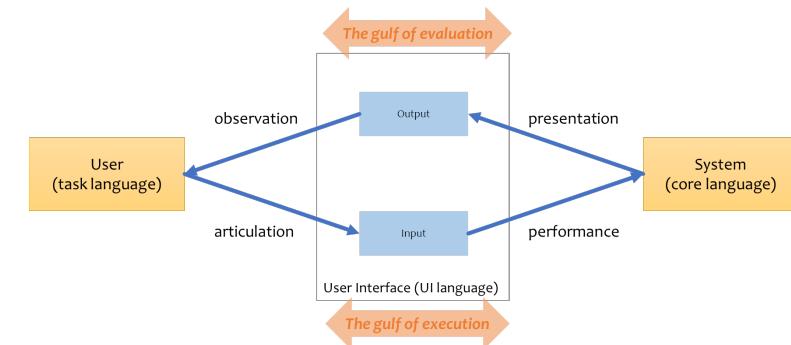
- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Advantages	Disadvantages
Direct manipulation Visually presents task concepts Allows easy learning	May be hard to program 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 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
Form fill-in Simplifies data entry Requires modest training Gives convenient assistance Permits use of form-management tools	Consumes screen space
Command language Flexible Appeals to "power" users	Poor error handling 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
- Prevent errors
- Permit easy reversal of actions
- Keep users in control
- 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

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-final](#)

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](#)

The 8 Golden Rules of Interface Design

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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

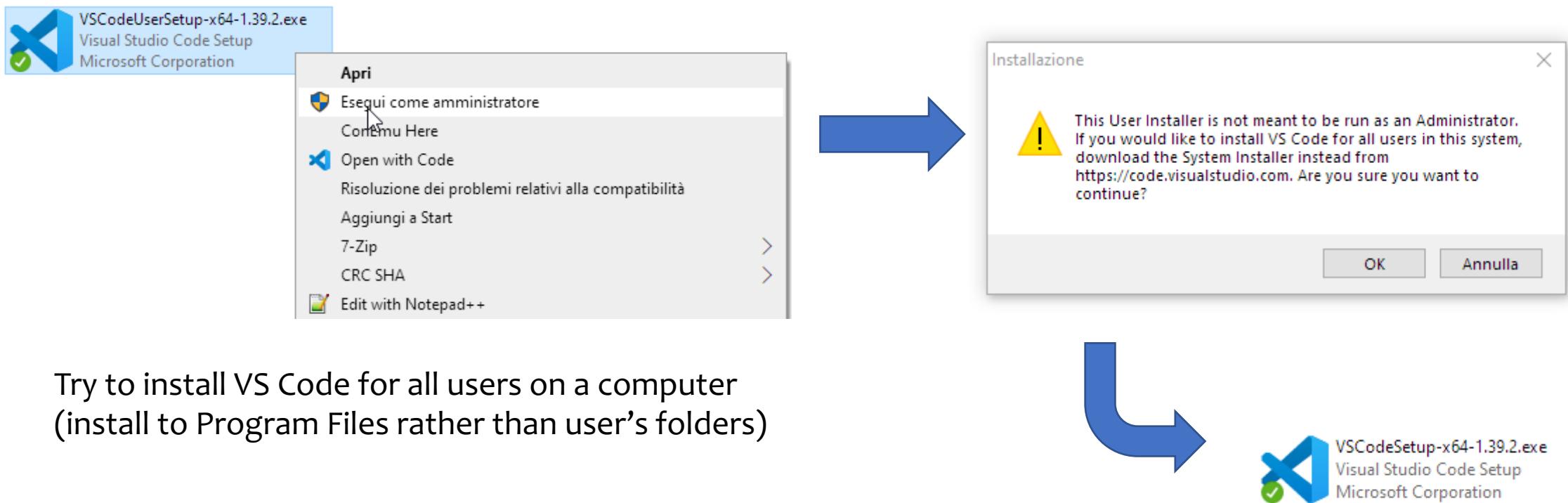
The 8 Golden Rules of Interface Design

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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



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

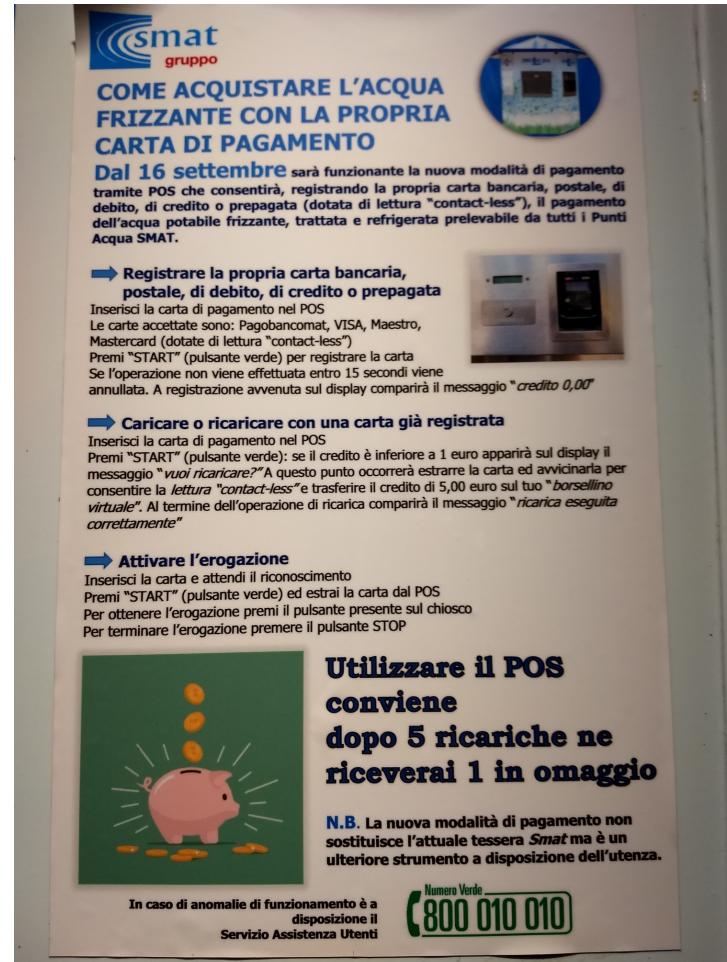
RUN
? Fulvio
?Redo from start
? _
```

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

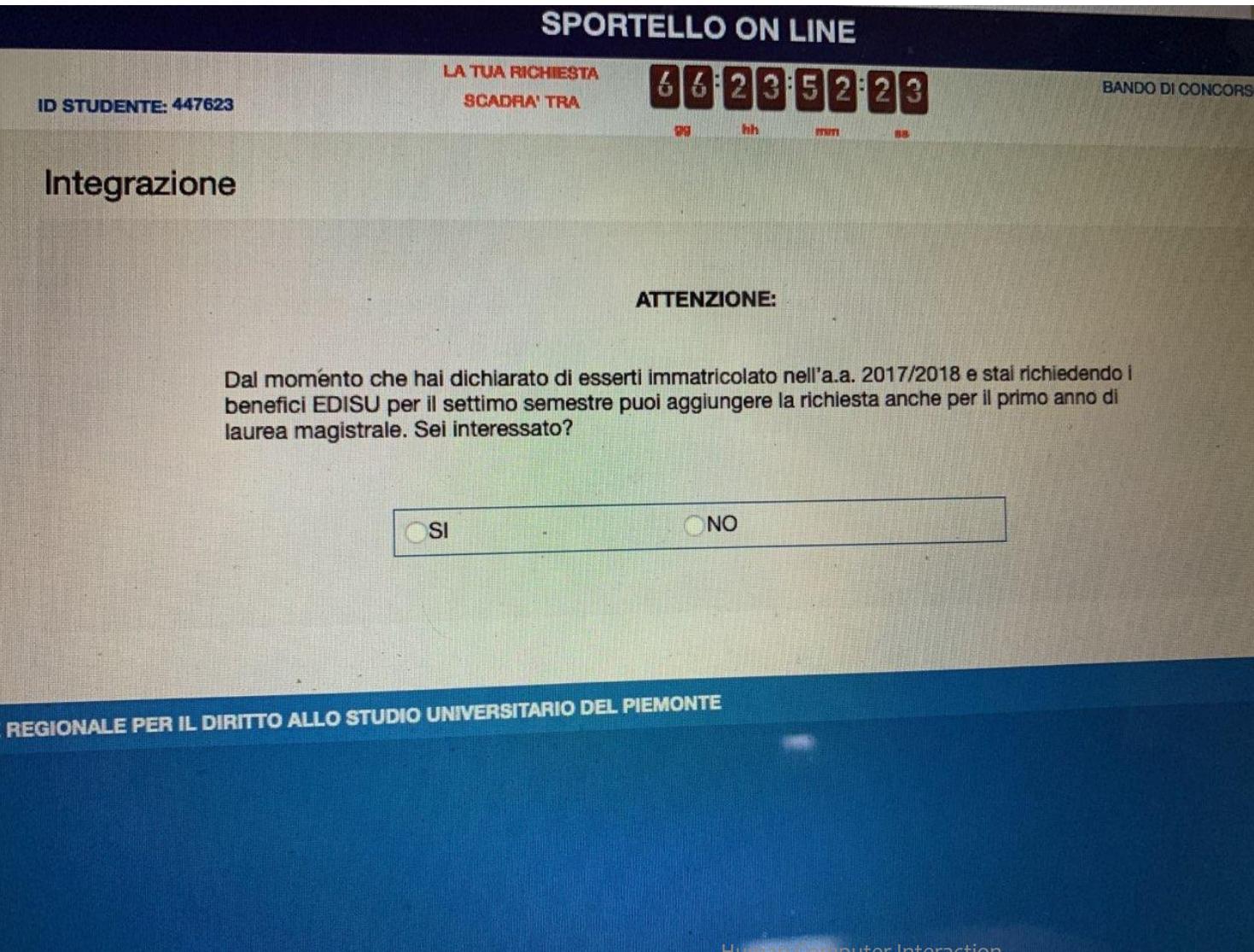
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-
- Every sequence of actions should have
 - Beginning
 - Development
 - End
 - Provide clear feedback at end
 - Satisfy users
 - ‘Delete’ current task from their working memory, prepare for the next

Clear Dialog Sequence



Clear Dialog Sequence



OK

Submit

Confirm

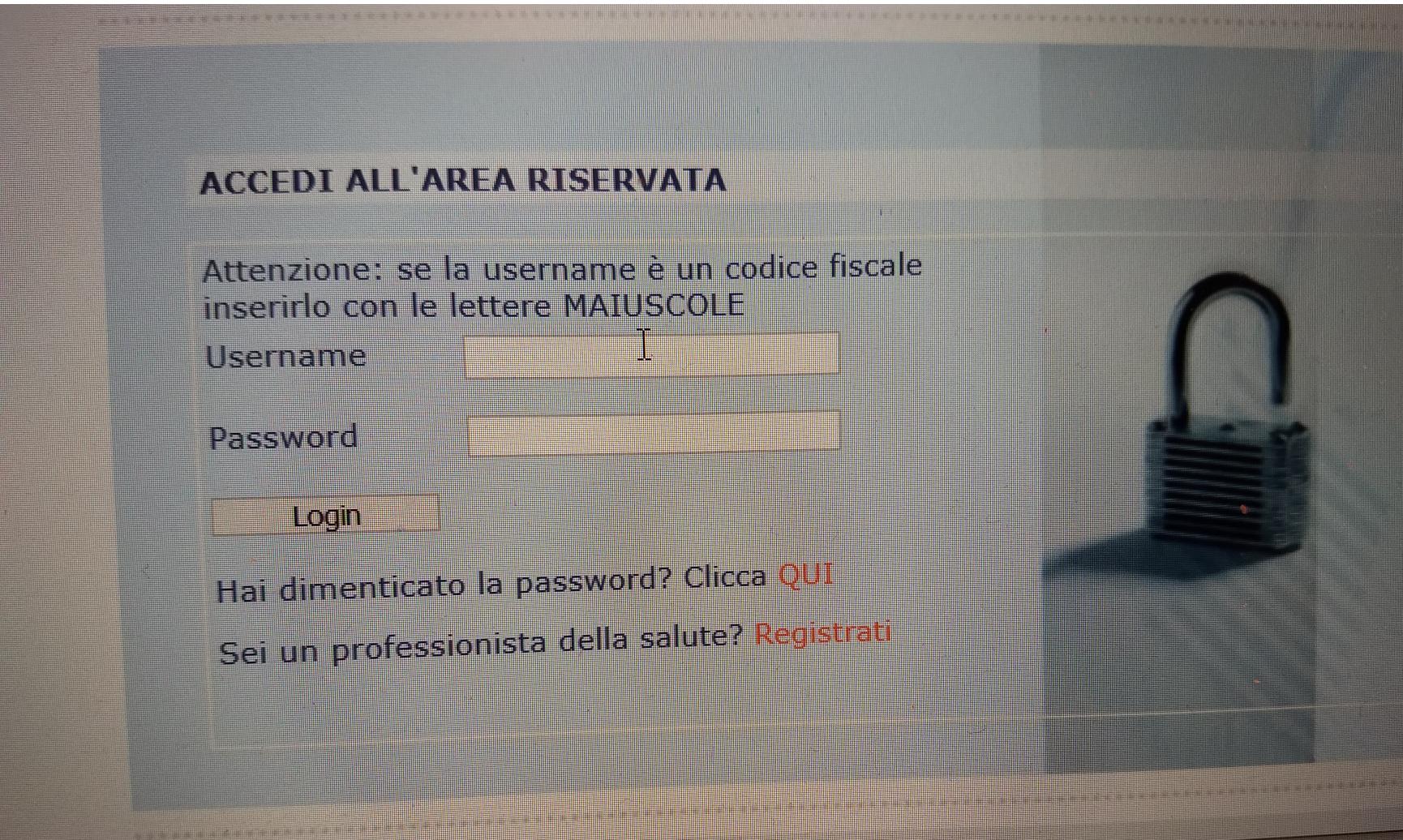
Next

...?

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



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?

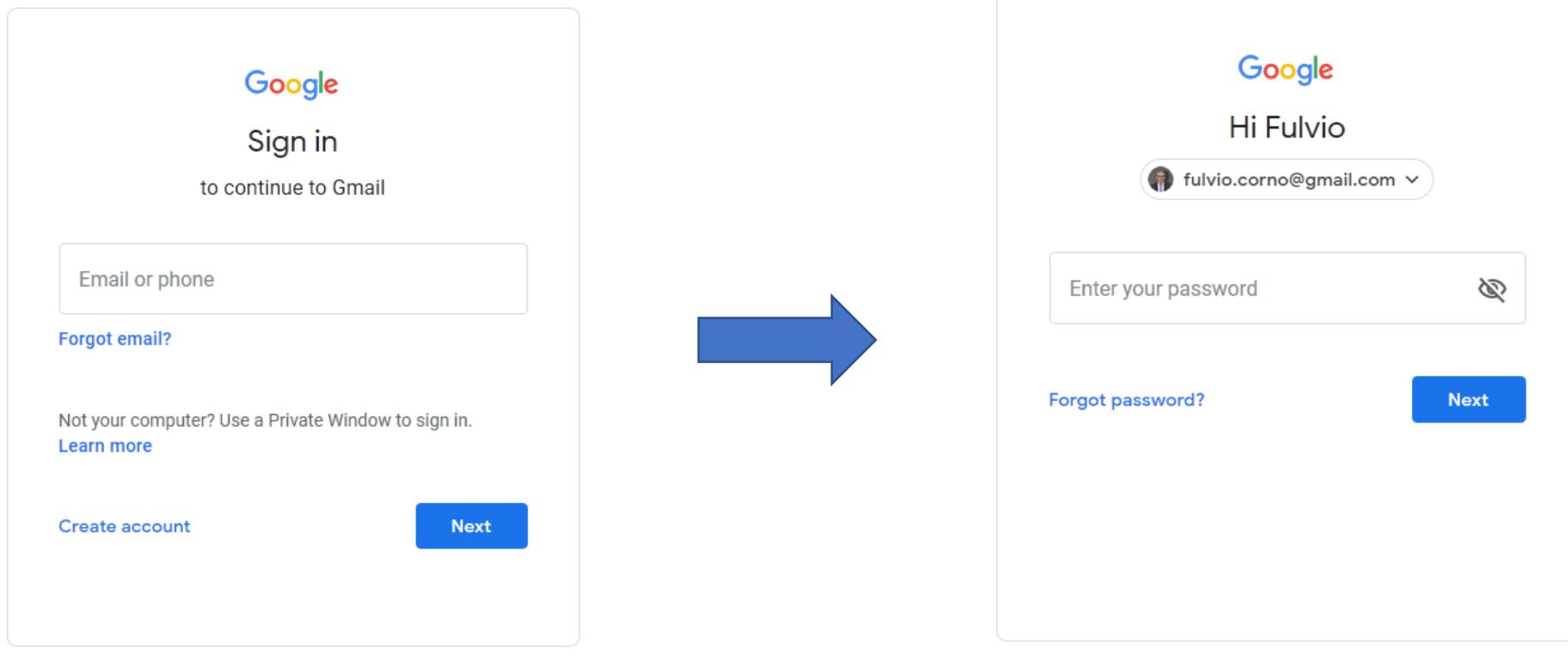
! Scegliere una o più delle seguenti opzioni

- 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)

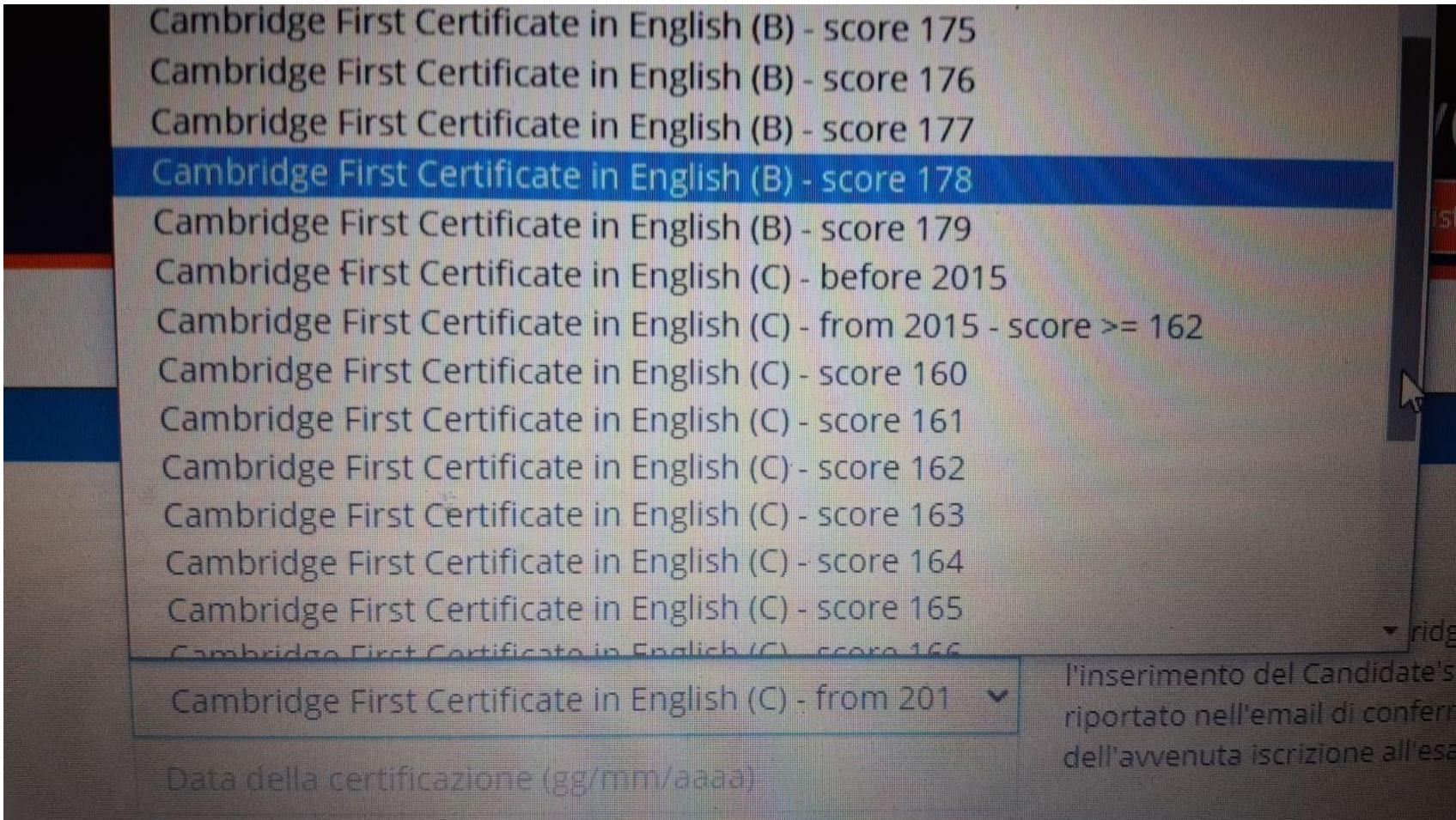
The 8 Golden Rules of Interface Design

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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?



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



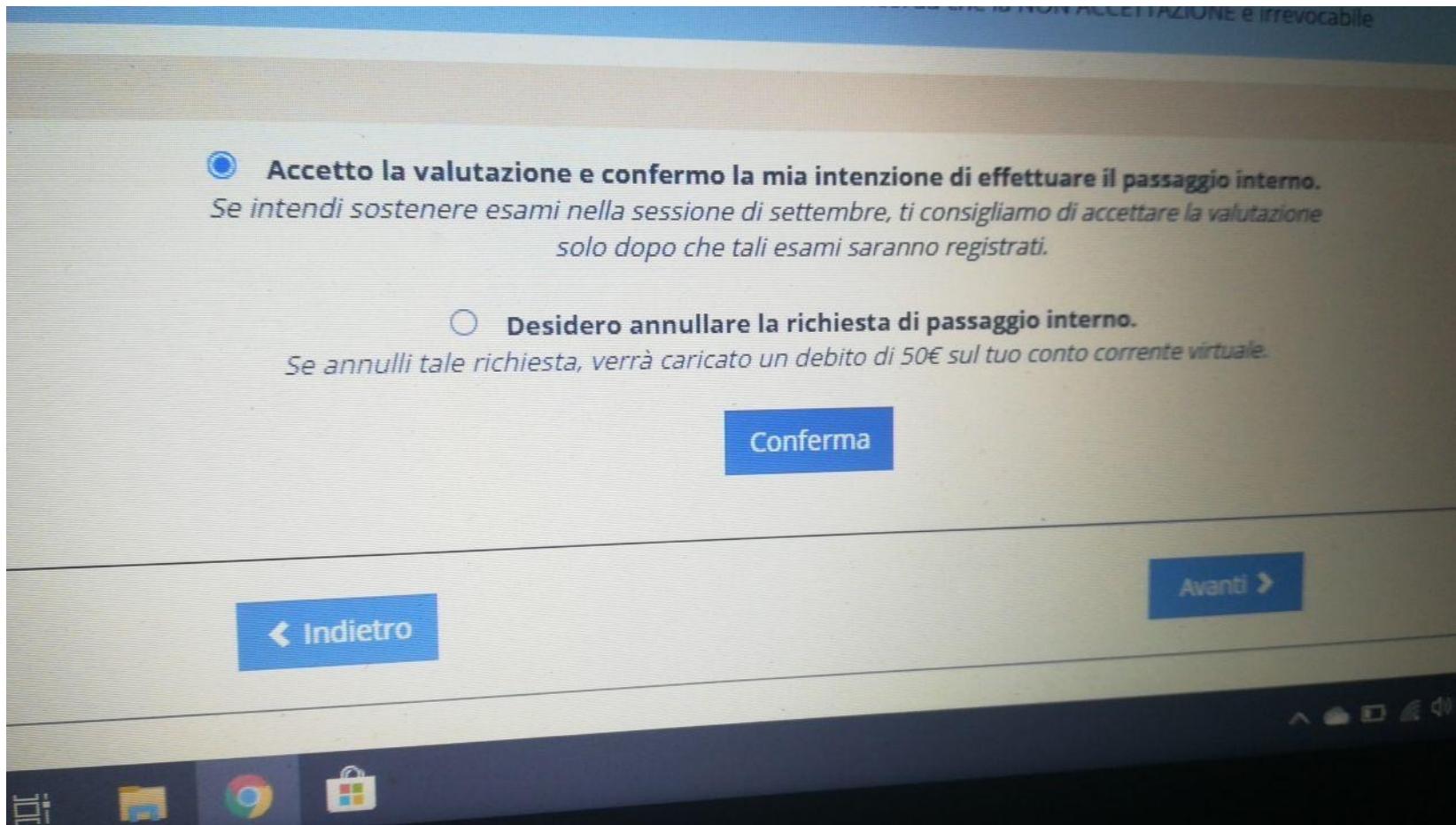


Design Principles by Benyon (II)

(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

D. Norman, The Design of Everyday Things

First Principles of Interaction Design

(Bruce Tognazzini, 2014)

The screenshot shows the Ask TOG website with the title "First Principles of Interaction Design (Revised & Expanded)". The page includes a sidebar with links to various 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, and Visible Interfaces. The main content area discusses the principles and their implementation.



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

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

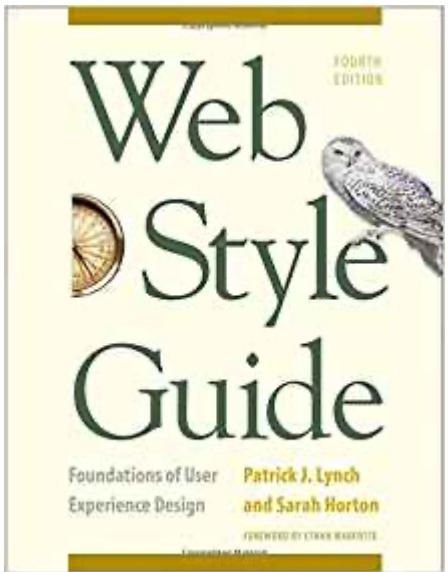
Shared language to promote consistency among multiple designers in terminology usage, appearance, and action sequences

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

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

...
1
Contents Search Front Matter



<https://www.w3.org/WAI/standards-guidelines/wcag/>

Web Content Accessibility Guidelines (WCAG)

Skip to Content | Change Text Size or Colors | This page in: English • Español • Français | All Translations | Hide Options

W3C Web Accessibility Initiative WAI | Strategies, standards, resources to make the Web accessible to people with disabilities

Accessibility Fundamentals | Planning & Policies | Design & Develop | Test & Evaluate | Teach & Advocate | Standards/Guidelines

Home / Standards/Guidelines / Web Content – WCAG 2

Standards/Guidelines

Web Content – WCAG 2

- How to Meet WCAG 2 (Quick Reference)
- At a Glance
- The Documents
- Applying to Non-Web ICT
- New in 2.2 Draft
- New in 2.1
- Translations
- Commenting
- Conformance Logos
- FAQ
- WCAG 3 Draft
- Authoring Tools – ATAG

WCAG 2 Overview

Summary

This page introduces the Web Content Accessibility Guidelines (WCAG) international standard, including WCAG 2.0, WCAG 2.1, and WCAG 2.2. WCAG documents explain how to make web content more accessible to people with disabilities.

A different page [introduces WCAG 3](#).

WCAG is not an introduction to accessibility. For introductions, see [Accessibility Fundamentals Overview](#).

Quick links to resources:

- [How to Meet WCAG 2 \(Quick Reference\)](#)
- [WCAG 2.2 Draft, What's New in WCAG 2.2 Draft with status and timeline](#)
- [WCAG 2.1 Standard](#)
- [WCAG 2.0 Standard](#)

Page Contents

- [Introduction](#)
- [WCAG 2.0, 2.1, 2.2](#)
- [Who WCAG is for](#)
- [What is in WCAG 2](#)

U.S. Government Mobile User Experience Guidelines



U.S. General Service Administration
<https://digital.gov/resources/mobile-user-experience-guidelines/>

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

Digital.gov

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[← All Resources](#)

Mobile User Experience Guidelines

Six user experience guidelines for creating a mobile product.

If your app doesn't have a good user experience, it goes to the [app graveyard](#).

The need for digital products to work better is not new in the federal government. Resources like the [Digital Playbook](#) and [Public Participation Playbook](#) have had impact helping agencies become user-friendly and both of these resources note the importance of developing usable products for mobile users.

As more agencies develop mobile apps and websites, they need quick guidance on mobile user experience Do's and Don'ts. To answer their call, we asked [MobileGov Community of Practice](#) members to choose their top Mobile UX Guidelines from the original group of 42 created in 2013 at community events in late 2014 and early 2015. From that feedback, we have distilled the following six mobile user experience guidelines:

Guideline 1: Make sure your content is structured and chunked appropriately for multiple devices

Guideline 2: Follow industry user interface guidelines and government regulations (like 508) in the development of your mobile product

In this page

Join a Community

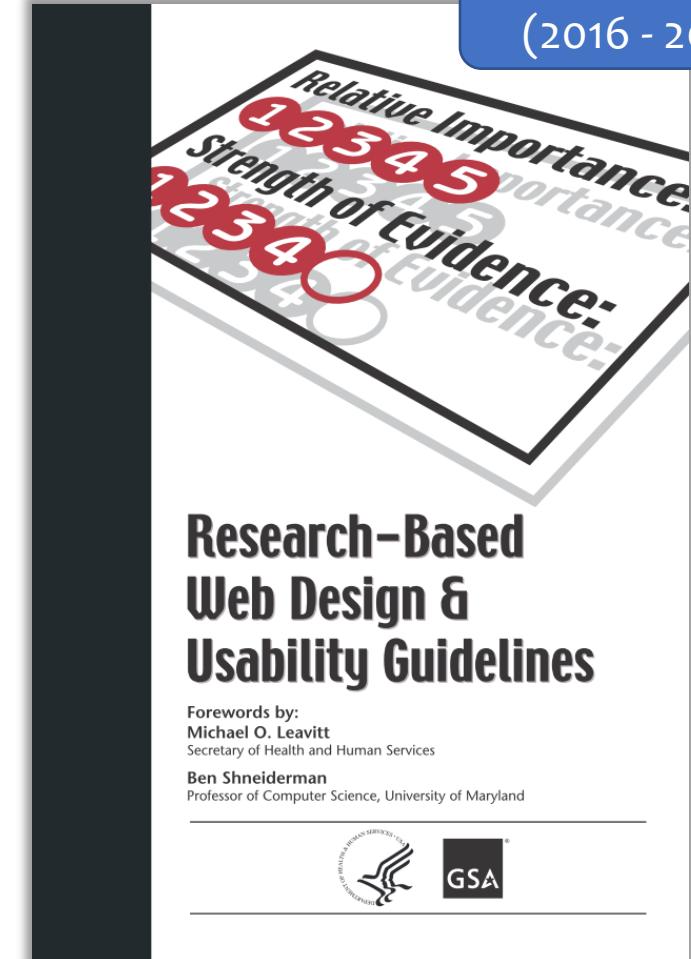
Mobile

Web Analytics and Optimization

Web Managers

User Experience

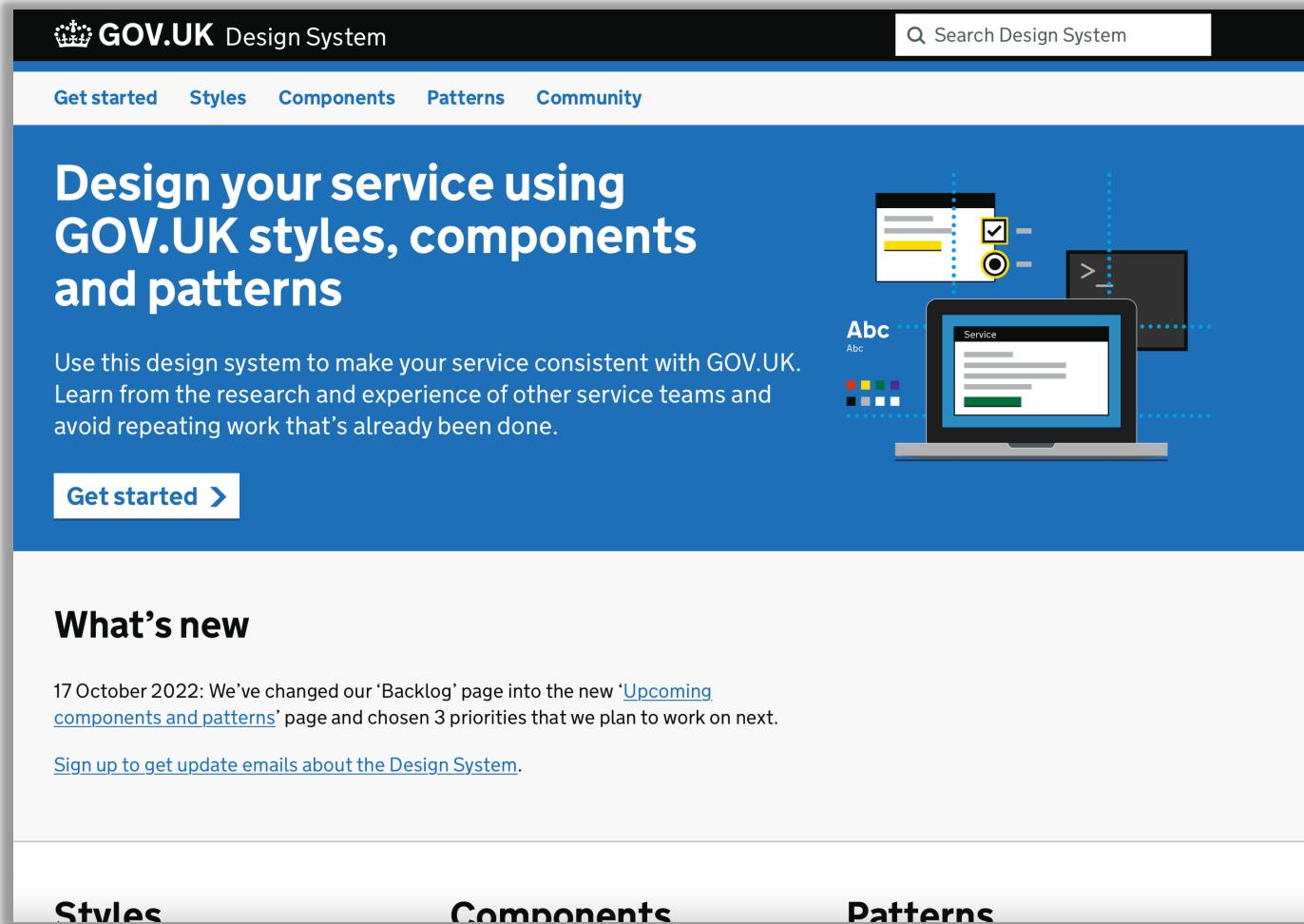
U.S. Web Design System





<https://design-system.service.gov.uk>

U.K. Government Design System



The screenshot shows the homepage of the GOV.UK Design System. At the top, there's a navigation bar with the GOV.UK logo, a search bar containing 'Search Design System', and links for 'Get started', 'Styles', 'Components', 'Patterns', and 'Community'. The main content area has a blue background. It features a large heading 'Design your service using GOV.UK styles, components and patterns' and a subtext explaining the purpose of the design system. Below this is a 'Get started >' button. To the right, there's a graphic illustrating design components like a laptop displaying a service interface, a color palette, and various icons. A sidebar on the left contains a 'What's new' section with a message about changes to the backlog page and a link to sign up for updates.

GOV.UK Design System

Get started Styles Components Patterns Community

Search Design System

Design your service using GOV.UK styles, components and patterns

Use this design system to make your service consistent with GOV.UK. Learn from the research and experience of other service teams and avoid repeating work that's already been done.

Get started >

What's new

17 October 2022: We've changed our 'Backlog' page into the new '[Upcoming components and patterns](#)' page and chosen 3 priorities that we plan to work on next.

[Sign up to get update emails about the Design System.](#)

Styles Components Patterns

Italian Government Guidelines and Design System



<https://designers.italia.it/linee-guida/>

The screenshot shows the homepage of the 'Designers Italia' website. At the top, there's a blue header bar with the text 'Dipartimento per la trasformazione digitale + Agenzia per l'Italia digitale' and a navigation menu with links like 'Piano Triennale', 'Developers', 'Designers' (which is highlighted in blue), 'Forum', 'Docs', and 'GitHub'. Below the header, the 'Designers Italia' logo is displayed, along with social media links for Twitter and LinkedIn. A navigation bar below the logo includes 'Linee guida e manuale' (which is underlined in blue), 'Kit', 'Modelli', 'Piano attività', and 'Notizie'. To the right of the navigation bar are 'Partecipa' and 'Team' buttons. The main content area features a large title 'Linee guida e manuale operativo di design' and a descriptive paragraph about the technical rules and operational guidelines for digital service design. At the bottom of the page, there are links to 'Le linee guida' and 'Il manuale operativo di design'. On the right side, there's a grid of six icons representing various design concepts: a pencil on a board, a document, a lightbulb above three people, a magnifying glass over a person's head, a video camera, and a heart.



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

Apple HIG

The screenshot shows the Apple Developer website's Design section. The top navigation bar includes links for News, Discover, Design, Develop, Distribute, Support, Account, and a search icon. Below this, a secondary navigation bar for the Design section offers links to Overview, What's new, Guidelines, Design Awards, Videos, and Resources. On the left, a sidebar lists categories: Platforms, Foundations, Patterns, Components, Inputs, and Technologies. The main content area features a large title "Human Interface Guidelines" and a subtext explaining its purpose: "The HIG contains guidance and best practices that can help you design a great experience for any Apple platform." Below this, a section titled "New and updated" highlights three recent additions: "Charting data" (Patterns), "Live Activities" (Components), and "Designing for iPadOS" (Platforms). A final section titled "Featured" displays three more items: "Secondary Primary" (Patterns), a hand icon (Components), and a circular arrow icon (Platforms).

Apple Developer

News Discover Design Develop Distribute Support Account

Design

Overview What's new Guidelines Design Awards Videos Resources

Platforms Foundations Patterns Components Inputs Technologies

Human Interface Guidelines

The HIG contains guidance and best practices that can help you design a great experience for any Apple platform.

New and updated

Patterns Charting data

Components Live Activities

Platforms Designing for iPadOS

Featured

Secondary Primary



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

Microsoft «Fluent» Design

The screenshot shows the official website for the Microsoft Fluent Design System. At the top, there's a navigation bar with icons for a grid, the 'Fluent Design System' logo, and links for 'Web', 'Windows', 'iOS', and 'Android'. The main content area has a black background. On the left, the text 'Fluent Design System' is displayed in large, light blue, sans-serif font. Below it is a paragraph of smaller text: 'Fluent brings the fundamentals of principled design, innovation in technology, and customer needs together as one. It's a collective approach to creating simplicity and coherence through a shared, open design system across platforms.' Further down, another line of text reads 'Open ecosystem, open design system.' To the right of the text, there's a large, three-dimensional wireframe cube composed of thin lines in cyan, green, purple, and blue. At the bottom of the page is a horizontal bar divided into five colored segments: blue, cyan, magenta, and two shades of green. Each segment contains a white icon representing a different platform: a globe for the web, the Windows logo, the iOS logo, and the Android logo.



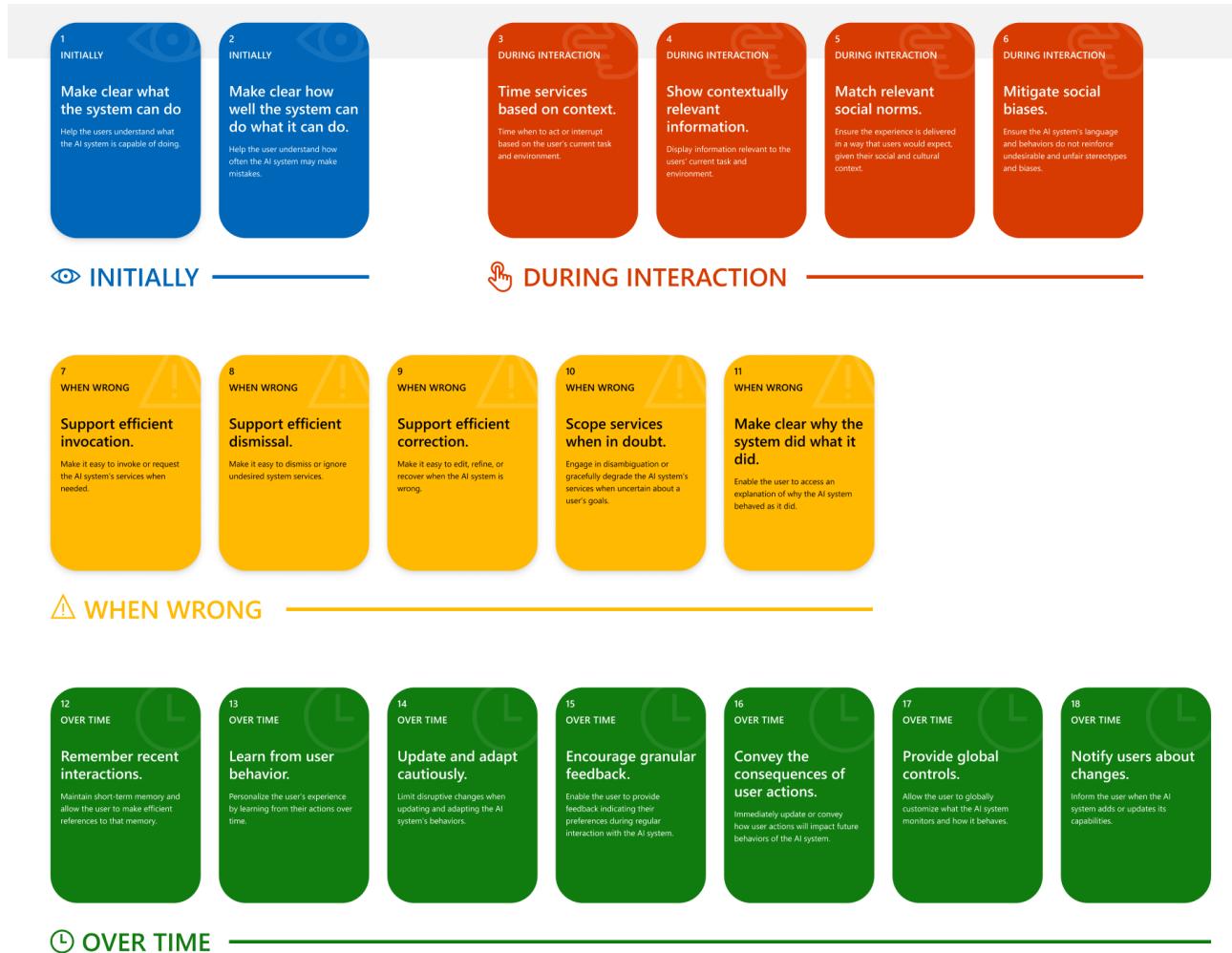
<https://material.io/>

Google Material Design

The screenshot shows the Material Design website's homepage. On the left, there is a vertical navigation bar with icons and text links: Home (selected), Get started, Develop, Foundations, Styles, Components, and Blog. The main content area features a large, colorful background image of overlapping sheets of paper in shades of blue, yellow, and purple. In the center, the word "Material Design" is displayed in a large, bold, black sans-serif font. Below it, a smaller text block reads: "Material 3 is the latest version of Google's open-source design system. Design and build beautiful, usable products with Material 3." A blue button with the text "Get started" is positioned below the text. At the bottom of the page, there is a section titled "News & launches" with three cards: one showing abstract purple and green shapes, another showing a dark background with a white "Relay" logo and the word "ALPHA" in small letters, and a third showing a colorful gradient background with the Material Design logo and a stylized "B" icon.

Guidelines for Human-AI Interaction

- By Microsoft Research:
 - <https://www.microsoft.com/en-us/research/project/guidelines-for-human-ai-interaction/>
 - <https://www.microsoft.com/en-us/hax toolkit/ai-guidelines/>



Guidelines for Human-AI Interaction: Examples

2

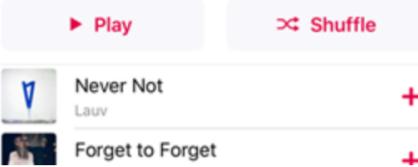
INITIALLY

Make clear how well the system can do what it can do.

Help the user understand how often the AI system may make mistakes.

EXAMPLE IN PRACTICE

Discover new music from artists we think you'll like.
Refreshed every Friday.



The recommender in **Apple Music** uses language such as "we think you'll like" to communicate uncertainty.

Make clear how well the system can do what it can do.

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WHEN WRONG

Support efficient correction.

Make it easy to edit, refine, or recover when the AI system is wrong.

EXAMPLE IN PRACTICE

All Images Videos Maps

757,000 Results Any time ▾

Including results for **keanu reeves**. Do you want results only for **keanu reaves**?

When **Bing** automatically corrects spelling errors in search queries, it provides the option to revert to the query as originally typed with one click.

Support efficient correction.

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Guidelines for Augmented Reality

- By Apple Design:

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

Creating an engaging, comfortable experience

Let people use the entire display. Devote as much of the screen as possible to displaying the physical world and your app's virtual objects. Avoid cluttering the screen with controls and information that diminish the immersive experience.

Strive for convincing illusions when placing realistic objects. Design detailed 3D assets with lifelike textures to create objects that appear to inhabit the physical environment in which you place them. Using information from ARKit, you can scale objects properly and position them on detected real-world surfaces, reflect environmental lighting conditions and simulate camera grain, cast top-down diffuse object shadows on real-world surfaces, and update visuals as the camera's position changes. To help avoid breaking the illusion you create, make sure your app updates scenes 60 times per second so objects don't appear to jump or flicker.

Consider how virtual objects with reflective surfaces show the environment. Reflections in ARKit are approximations based on the environment captured by the camera. To help maintain the illusion that an AR experience is real, prefer small or coarse reflective surfaces that downplay the effect of these approximations.

Use audio and haptics to enhance the immersive experience. A sound effect or bump sensation is a great way to confirm that a virtual object has made contact with a physical surface or other virtual object. Background music can also help envelop people in the virtual world. For guidance, see [Playing audio](#) and [Playing haptics](#).

Minimize text in the environment. Display only the information that people need for your app experience.

References and Acknowledgments

- Ben Shneiderman, Catherine Plaisant, Maxine S. Cohen, Steven M. Jacobs, and Niklas Elmquist, 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_Mjt87THSTIgrsyJ
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