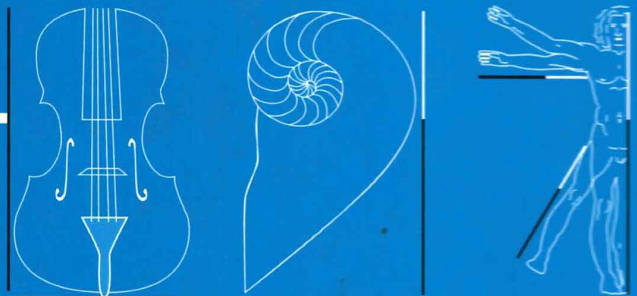


80/20 RULE
ACCESSIBILITY
ADVANCE ORGANIZER
AESTHETIC-USABILITY EFFECT
AFFORDANCE
ALIGNMENT
ARCHETYPES
ATTRACTIVENESS BIAS
BABY-FACE BIAS
CHUNKING
CLASSICAL CONDITIONING
CLOSURE
COGNITIVE DISSONANCE
COLOR
COMMON FATE
COMPARISON
CONFIRMATION
CONSISTENCY
CONSTANCY
CONSTRAINT
CONTROL
CONVERGENCE
COST-BENEFIT
DEFENSIBLE SPACE
DEPTH OF PROCESSING
DEVELOPMENT CYCLE
ENTRY POINT
ERRORS
EXPECTATION EFFECT
EXPOSURE EFFECT
FACE-ISM RATIO
FACTOR OF SAFETY
FEEDBACK LOOP
FIBONACCI SEQUENCE
FIGURE-GROUND RELATIONSHIP
FITTS' LAW
FIVE HAT RACKS
FLEXIBILITY USABILITY TRADEOFF
FORGIVENESS
FORM FOLLOWS FUNCTION
FRAMING
GARBAGE IN-GARBAGE OUT
GOLDEN RATIO
GOOD CONTINUATION
GUTENBERG DIAGRAM
HICK'S LAW
HIERARCHY
HIERARCHY OF NEEDS
HIGHLIGHTING
ICONIC REPRESENTATION
IMMERSION
INTERFERENCE EFFECTS
INVERTED PYRAMID
ITERATION
LAW OF PRÄGNANZ
LAYERING
LEGIBILITY
LIFE CYCLE
MAPPING
MENTAL MODEL
MIMICRY
MNEMONIC DEVICE
MODULARITY
MOST AVERAGE FACIAL APPEARANCE EFFECT
NORMAL DISTRIBUTION
OCKHAM'S RAZOR
OPERANT CONDITIONING

Universal Principles of Design

William Lidwell
Kritina Holden
Jill Butler



100 Ways to Enhance Usability,
Influence Perception, Increase Appeal, Make Better
Design Decisions, and Teach through Design

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Influence Perception, Increase Appeal, Make Better
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For our dads...

John C. Butler
Larry W. Lidwell

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Affordance

A property in which the physical characteristics of an object or environment influence its function.

Objects and environments are better suited for some functions than others. Round wheels are better suited than square wheels for rolling; therefore, round wheels are said to better afford rolling. Stairs are better suited than fences for climbing; therefore, stairs are said to better afford climbing. This is not to say that square wheels cannot be rolled or fences climbed, rather that their physical characteristics influence the way they function and are likely to be used.¹

When the affordance of an object or environment corresponds with its intended function, the design will perform more efficiently and will be easier to use. Conversely, when the affordance of an object or environment conflicts with its intended function, the design will perform less efficiently and be more difficult to use. For example, a door with a handle affords pulling. Sometimes, doors with handles are designed to open only by pushing—the affordance of the handle conflicts with the door's function. Replace the handle with a flat plate, and it now affords pushing—the affordance of the flat plate corresponds to the way in which the door can be used. The design is improved.

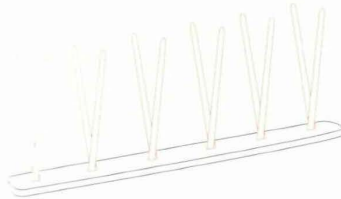
Images of common physical objects and environments can enhance the usability of a design. For example, a drawing of a three-dimensional button on a computer screen leverages our knowledge of the physical characteristics of buttons and, therefore, appears to afford pressing. The popular “desktop” metaphor used by computer operating systems is based on this idea—images of common items like trash cans and folders leverage our knowledge of how those items function in the real world and, thus, suggest their function in the software environment.²

Whenever possible, you should design objects and environments to afford their intended function, and negatively afford improper use. For example, stackable chairs should only stack one way. Mimic familiar objects and environments in abstract contexts (e.g., software interfaces) to imply the way in which new systems can be used. When affordances are successfully employed in a design, it will seem inconceivable that the design could function or be used otherwise.

See also Constraint, Mapping, Mimicry, and Wayfinding.

¹ The seminal work on affordances is “The Theory of Affordances” by James Gibson, in *Perceiving, Acting, and Knowing* by R. E. Shaw & J. Bransford (Eds), Lawrence Erlbaum Associates, 1977; and *The Ecological Approach to Visual Perception* by James Gibson, Houghton Mifflin, 1979. A popular treatment of affordances can be found in *The Design of Everyday Things* by Donald Norman, Doubleday, 1990.

² Note that the term *affordance* refers to the properties of a physical object or environment only. When images of physical objects or environments are used (e.g., image of a button), the images, themselves, do not afford anything. The knowledge of button affordances exists in the mind of the perceiver based on experience with physical buttons—it is not a property of the image. Therefore, the affordance is said to be *perceived*. See, for example, “Affordances and Design” by Donald Norman, www.jnd.org.



Outdoor lighting structures often afford landing and perching for birds. Where birds perch, birds poop. This anti-perch fixture is designed to attach to such structures and reduce the perching affordance.

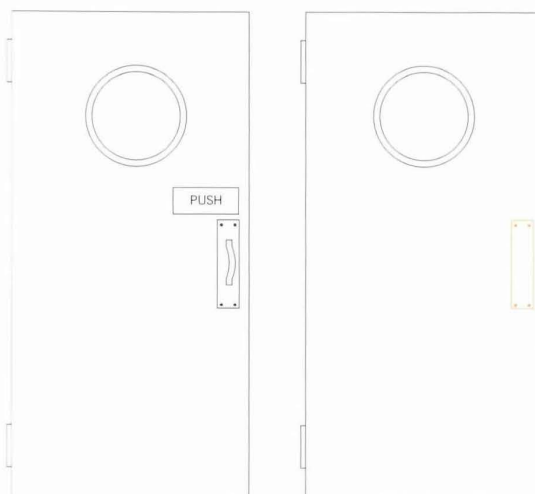


OXO is well known for the handle designs of their products; shape, color, and texture combine to create irresistible gripping affordances.

With opposing male and female surfaces and featureless sides, Legos naturally afford plugging into one another.



Door affordances frequently conflict, as shown in the door on the left. The "push" affordance of the door is knowable only because of the sign, which conflicts with the powerful "pull" affordance of the handle. By replacing the handle with a flat plate, the conflict is eliminated and the sign is superfluous.



The recessed footplates and handlebar orientation of the Segway Human Transporter afford one mounting position for the user—the correct one.



Affordance 21

Iteration

A process of repeating a set of operations until a specific result is achieved.

Ordered complexity does not occur without iteration. In nature, iteration allows complex structures to form by progressively building on simpler structures. In design, iteration allows complex structures to be created by progressively exploring, testing, and tuning the design. The emergence of ordered complexity results from an accumulation of knowledge and experience that is then applied to the design. For example, a quality software user interface is developed through a series of design iterations. Each version is reviewed and tested, and the design is then iterated based on the feedback. The interface typically progresses from low fidelity to high fidelity as more is learned about the interface and how it will be used. Iteration occurs in all development cycles in two basic forms: design iteration and development iteration.¹

Design iteration is the expected iteration that occurs when exploring, testing, and refining design concepts. Each cycle in the design process narrows the wide range of possibilities until the design conforms to the design requirements. Prototypes of increasing fidelity are used throughout the process to test concepts and identify unknown variables. Members of the target audience should be actively involved in various stages of iterations to support testing and verify design requirements. Whether tests are deemed a success or failure is irrelevant in design iteration, since both success and failure provide important information about what does and does not work. In fact, there is often more value in failure, as valuable lessons are learned about the failure points of a design. The outcome of design iteration is a detailed and well-tested specification that can be developed into a final product.²

Development iteration is the unexpected iteration that occurs when building a product. Unlike design iteration, development iteration is rework—i.e., unnecessary waste in the development cycle. Development iteration is costly and undesirable, and generally the result of either inadequate or incorrect design specifications, or poor planning and management in the development process. The unknowns associated with a design should ideally be eliminated during the design stage.

Plan for and employ *design* iteration. Establish clear criteria defining the degree to which design requirements must be satisfied for the design to be considered complete. One of the most effective methods of reducing development iteration is to ensure that all development members have a clear, high-level vision of the final product. This is often accomplished through well-written specifications accompanied by high-fidelity models and prototypes.

See also Development Cycle, Fibonacci Sequence, Prototyping, and Self-Similarity.

¹ A seminal contemporary work on iteration in design is *The Evolution of Useful Things* by Henry Petroski, Vintage Books, 1994. See also *Product Design and Development* by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill Higher Education, 2nd ed., 1999. See also "Positive vs. Negative Iteration in Design" by Glenn Ballard, *Proceedings of the Eighth Annual Conference of the International Group for Lean Construction*, 2000.

² A common problem with design iteration is the absence of a defined endpoint—i.e., each iteration refines the design, but also reveals additional opportunities for refinement, resulting in a design process that never ends. To avoid this, establish clear criteria defining the degree to which design requirements must be satisfied for the design to be considered complete.



Quality design does not occur without iteration. For example, the design of the SnoWalkers snowshoes is the result of numerous design iterations over a two-year period. The design process made ample use of prototypes, which allowed designers to improve their understanding of design requirements and product performance, and continually refine the design with each iteration.



Iteration 119

Prototyping

The use of simplified and incomplete models of a design to explore ideas, elaborate requirements, refine specifications, and test functionality.

Prototyping is the creation of simple, incomplete models or mockups of a design. It provides designers with key insights into real-world design requirements, and gives them a method to visualize, evaluate, learn, and improve design specifications prior to delivery. There are three basic kinds of prototyping: concept, throwaway, and evolutionary.¹

Concept prototyping is useful for exploring preliminary design ideas quickly and inexpensively. For example, concept sketches and storyboards are used to develop the appearance and personality of characters in animated films well before the costly process of animation and rendering take place. This approach helps communicate the concepts to others, reveals design requirements and problems, and allows for evaluation by a target audience. A common problem with concept prototyping is the *artificial reality problem*, the plausible presentation of an implausible design. A good artist or modeler can make most any design look like it will work.

Throwaway prototyping is useful for collecting information about the functionality and performance of certain aspects of a system. For example, models of new automobile designs are used in wind tunnels to better understand and improve the aerodynamics of their form. The prototypes are discarded once the needed information is obtained. A common problem with throwaway prototyping is the assumption that the functionality will scale or integrate properly in the final design, which of course it often does not.

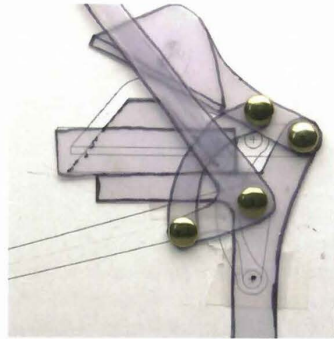
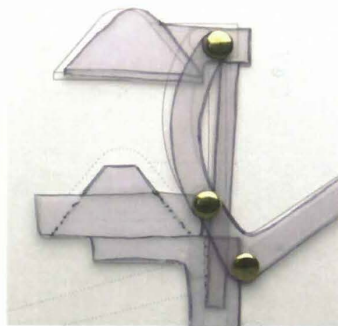
Evolutionary prototyping is useful when many design specifications are uncertain or changing. In evolutionary prototyping, the initial prototype is developed, evaluated, and refined continuously until it evolves into the final system. Design requirements and specifications never define a *final product*, but merely the next iteration of the design. For example, software developers invariably use evolutionary prototyping to manage the rapid and volatile changes in design requirements. A common problem with evolutionary prototyping is that designers tend to get tunnel vision, focusing on tuning existing specifications, rather than exploring design alternatives.²

Incorporate prototyping into the design process. Use concept prototypes to develop and evaluate preliminary ideas, and throwaway prototypes to explore and test design functionalities and performance. Schedule time for prototype evaluation and iteration. When design requirements are unclear or volatile, consider evolutionary prototyping in lieu of traditional approaches. Consider the common problems of artificial realities, scaling and integration, and tunnel vision when evaluating prototypes and design alternatives.

See also Feedback Loop, Satisficing, and Scaling Fallacy.

¹ See, for example, *Human-Computer Interaction* by Jenny Preece, et al., Addison-Wesley, 1994, p. 537–563; *The Art of Innovation* by Tom Kelley and Jonathan Littman, Doubleday, 2001; and *Serious Play: How the World's Best Companies Simulate to Innovate* by Michael Schrage, Harvard Business School Press, 1999.

² Evolutionary prototyping is often contrasted with incremental prototyping, which is the decomposition of a design into multiple stages that are then delivered one at a time. They are combined here because they are invariably combined in practice.



The function and elegance of the Ojex Juicer clearly demonstrate the benefits of prototyping in the design process. Simple two-dimensional prototypes were used to study mechanical motion, three-dimensional foam prototypes were used to study form and assembly, and functional breadboard models were used to study usability and working stresses.



Credits

Accessibility

For more information about accessible design, please visit the Center for Universal Design at www.design.ncsu.edu/cud. Special thanks to Sally Haile for her assistance.

Aesthetic-Usability Effect

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Affordance

Photograph of Segway courtesy of Segway, LLC. Photograph of teakettle and peeler courtesy of OXO International.

Archetypes

Images courtesy of Sue Weidemann Brill. Design concepts by Michael Brill, illustrations by Safdar Abidi. Other team members involved in the project included Dieter G. Ast, Ward H. Goodenough, Maureen Kaplan, Frederick J. Newmeyer, and Woodruff Sullivan. Michael Brill passed away unexpectedly on July 26, 2002, during the development of this book. The design community is poorer for his absence. For more information about Michael Brill's work, please visit www.bosti.com.

Attractiveness Bias

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Mapping

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Map courtesy of Pittsburgh Zoo and PPG Aquarium. Illustration by David Klug.

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More information about *Universal Principles of Design*—including updates, recommended readings, and author information—can be found at www.stuffcreators.com/upod.

Universal Principles of Design

- Provides the first one-stop reference and resource for designers of all disciplines
- Pairs descriptive text for common design concepts with illustrated examples of each in practice
- Covers the core building blocks of design theory for disciplines ranging from graphic design to architecture to user-interface design

Whether a marketing campaign or a museum exhibit, a video game or a complex control system, the design we see is actually the culmination of many concepts and practices brought together from a variety of disciplines. Because no one can be an expert on everything, designers have always had to search through different references and resources to find the information and know-how required to make a design work—until now.

Universal Principles of Design is the first cross-disciplinary reference of design. Richly illustrated and easy to navigate, this book pairs clear explanations of the design concepts featured with visual examples of the concepts applied in practice. From the “80/20 rule” to “chunking,” from “baby-face bias” to “Ockham’s razor,” and from “self-similarity” to “storytelling,” readers will expand their knowledge of 100 common design concepts.

This landmark reference will become the standard for designers, engineers, architects, and students who seek to broaden and improve their design expertise.

William Lidwell is a partner and chief research and development officer at the Applied Management Sciences Institute. Kritina Holden is a lead usability engineer at BMC Software. Jill Butler is the founder and president of Stuff Creators Design Studio. The authors live in Houston, Texas.

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