O'REILLY

Understanding Industrial Design

PRINCIPLES FOR UX AND INTERACTION DESIGN

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Chapter 1

Introduction

Historical background on Industrial and Interaction Design

Throughout the last century, the discipline of Industrial Design has refined an understanding of how to design physical products for people. More recently, as computation and network connectivity extend beyond the screen, Interaction Designers and UX professionals also find themselves addressing design problems in the physical world. Although the context is new, much can be learned by looking to the long-standing principles of Industrial Design. Technology evolves rapidly, but the underlying qualities that define the products we love have not changed.

In this book, we will look at ten principles of Industrial Design that can inspire new ways of approaching UX challenges, both on-screen and in the physical world. Each principle will be explored through numerous product examples, both historical and contemporary, and related to present or near-future Interaction Design challenges.

This chapter will provide a brief grounding in the history of Industrial and Interaction Design. We will cover key people and moments in each discipline, highlighting pivotal events and noting points of divergence and convergence. The history of personal computing will be used to trace advances in Interaction Design, with particular attention given to the virtual or physical nature of different computing platforms. Additional background on Industrial Design is interspersed throughout the book in conjunction with the examples that illuminate each principle.

Industrial Revolution

For most of history, when people needed a particular object, they either created it themselves or found someone to make it for them. Individuals may have specialized in their production, such as shoemakers or carpenters, but their output was still largely a unique creation.

There is evidence that generalized fabrication was used to standardize crossbows and other weaponry as early as the 4th century BC in China.[1] However, it was the rapid improvement of manufacturing capabilities during the Industrial Revolutions of the 18th and 19th centuries that signaled the radical shift to mass production of identical goods. For the first time, the act of design became separated from the act of making.

Driven by this change in technology, the field of Industrial Design emerged to specialize in the design of commercial products that appealed to a broad audience and could be manufactured at scale. In contrast to the craftsmen of the past, these designers were challenged with meeting

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[1] Needham, Joseph. 1954. Science and Civilisation in China: Volume 1, Introductory Orientations. United Kingdom: Cambridge University Press.

the needs of a large population, balancing functionality, aesthetics, ergonomics, durability, cost, manufacturability, and marketability.

The Industrial Designers Society of America (IDSA) describes Industrial Design as a professional service that optimizes "function, value, and appearance for the mutual benefit of both user and manufacturer."[2] It is the study of form and function, designing the relationship between objects, humans, and spaces. Most commonly, Industrial Designers work on smaller scale physical products, the kind you buy and use every day, rather than larger scale complex environments like buildings or ships.

Whether you realize it or not, Industrial Design is all around you, supporting and shaping your everyday life. You are likely to recognize numerous examples cited throughout this book, perhaps from your childhood, your office, or even sitting next to you as you read this. The mobile phone you are fidgeting with, the clock on your wall, the coffee maker brewing in your kitchen, and the chair you are sitting on. Everything you see, touch, and are surrounded by was designed by someone, and thus influenced by Industrial Design.

Throughout the 20th century, along with balancing the needs of the user and manufacturer, differences in politics and culture were evident in the design of objects. A rising consumer culture in the post-WWII period meant that manufactured goods doubled as a cultural proxy, intertwining national pride and economic reinvention. Along with regional differences, numerous philosophical and stylistic periods created distinct and recognizable eras within Industrial Design, including the Bauhaus school, Art Deco, Modernism, and Postmodernism.

Design for Business

On a more individual level, there are many famous Industrial Designers who have had an outsized influence on the history of the discipline. Raymond Loewy, a French-born American, is often referred to as the "Father of Industrial Design."[3] Loewy is widely considered to have revolutionized the field by pioneering the role of designer as consultant, working for a wide variety of industries and mediums.

Loewy designed everything from streamlined pencil sharpeners, Coca-Cola vending machines, Studebaker automobiles, and NASA spacecraft interiors. He brought design into the mainstream business spotlight, gracing the cover of Time magazine in October of 1949, where they noted that he "made products irresistible at a time when nobody really wanted to pay for anything."[4] Loewy intertwined culture, capitalism, and style, establishing a template for how design and business could be mutually beneficial.

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[2] 2015. What Is Industrial Design? Accessed January 22. http://www.idsa.org/education/what-is-id.

[3] 'Raymond Loewy'. 2015. The Official Site of Raymond Loewy. Accessed January 22. http://www.raymondloewy.com/.

[4] 'Google Doodle Honors Raymond Loewy, the "Father of Industrial Design".' 2015. TIME.com. Accessed January 22. http://newsfeed.time.com/2013/11/05/google-doodle-honors-raymond-loewy-the-father-of-industrial-design/.

Design for People

Henry Dreyfuss is another famous American Industrial Designer whose work and influence from the mid-20th century are still felt today. Among his iconic designs are the Honeywell T87 thermostat, the Big Ben alarm clock, the Western Electric 500 desk telephone, and the Polaroid SX-70 camera.[5]

Figure 1.x Henry Dreyfuss measurement image

Dreyfuss was renowned not only for his attention to formal details, but his focus on the user's needs. He founded the field of ergonomics and pioneered research into how human factors should be considered and incorporated into Industrial Design. After retiring, this focus on anthropometry and usability led him to author two seminal books: *Designing for People* in 1955 and *The Measure of Man* in 1960. His interest in universal accessibility extended to graphics as well, as evidenced by *Symbol Sourcebook: An Authoritative Guide to International Graphic Symbols*, in which Dreyfuss catalogs and promotes the use of internationally recognizable symbols over written words.

Dreyfuss felt that "well-designed, mass-produced goods constitute a new American art form and are responsible for the creation of a new American culture."[6] But he emphasized that good design was for everyone, that "these products of the applied arts are a part of everyday American living and working, not merely museum pieces to be seen on a Sunday afternoon."[7] He promoted this approach through his own work, but also more broadly in his role as a founding member of the American Society of Industrial Design. In 1965 he became the first president of the IDSA.

Design for Technology

Along with the needs of business and users, the history of Industrial Design has been strongly shaped by the introduction of new technologies, which present an opportunity to redesign and improve products. Industrial Design has always been a conduit for innovation, translating the latest discoveries of science to meet the needs of everyday people.

Figure 1.x Composite image of chairs highlighted in text below

Take for an example the humble chair, a ubiquitous object that has become a laboratory for variation in form and materials. Figure 1.x shows four chairs, each highlighting a shift in the possibilities of material use and manufacturing capability.

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[5] 'Henry Dreyfuss, FIDSA'. 2015. IDSA. Accessed January 22. http://www.idsa.org/content/henry-dreyfuss-fidsa.

[6] Dreyfuss, Henry. Designing for People. New York: Simon and Schuster, 1955. 82-83.

[7] Ibid.

The No. 18 Thonet chair (1876), was an evolution of experimentation begun by Michael Thonet, with this variation released after his death in 1971.[8] Thonet pioneered a new process of bending beech wood to reduce the number of parts involved, simplifying and strengthening the chair while increasing efficiency in shipping and assembly. The aesthetic was influenced by the technology, with generous curves honestly reflecting the bent wood process.

The Eames Molded Fiberglass chair (1950) features a smooth and continuous organic form, unique in appearance and extremely comfortable. It was originally designed in stamped metal, which proved too costly and prone to rust. Instead, a new manufacturing technique was utilized that allowed fiberglass to cure at room temperature. A boat builder, who was familiar with fiberglass, helped build early prototypes to prove out the concept.[9]

Jasper Morrison's Air chair (1999) takes reduction of parts to the extreme, since it is constructed out of a single piece of injection-molded polypropylene. Inert gas is pumped into the center of molten plastic, resulting in a solid, light, and economical product that comes off the assembly line fully formed.

Konstantin Grcic's Chair_One (2004) uses a die-cast aluminum process to achieve an original form that is at once full of voids, yet very solid; angular and sculptural at a glance, yet surprisingly more comfortable than it looks. Grcic says that "a bad chair is one that performs all the requirements, but remains just a chair. One that I use to sit on, but then I get up and it didn't mean anything to me."[10] He believes that what makes good design is something hidden in the relationship you have with the object.

Design for Context

Of the chairs mentioned above, the fiberglass model by the husband and wife design team of Charles and Ray Eames deserves further attention. The Eames are known for their enduringly popular classic furniture designs, most of which are still being manufactured by Herman Miller. Their work often utilized new materials such as molded plywood, wire mesh, and the aforementioned fiberglass.

The Eames Molded Fiberglass chair won second prize in the 1949 International Low-Cost Furniture Competition, primarily for its innovative base that allows it to adapt to different uses and environments such as nursery, office, home, or school. This notion of adaptability to context is a theme that runs through much of Eames' multidisciplinary work, which spanned products, photography, film, and architecture.

Figure 1.x Powers of Ten image

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[8] 'History - Thonet'. 2015. Accessed January 22. http://www.thonet.com.au/history/.

[9] 'Molded Plastic Chairs | Eames Designs'. 2015. Accessed January 22. http://eamesdesigns.com/library-entry/molded-plastic-chairs/.

[10] NOWNESS'. 2015. Accessed January 22. https://www.nowness.com/series/on-design/on-design-konstantin-grcic.

In 1977, Charles and Ray made *Powers of Ten,* a short documentary film that explores context by examining the effect of scale. The film begins at the level of human perception, with a couple having a picnic on the Chicago lakeshore, and then zooms out by consecutive factors of ten to reveal the entire universe before zooming inward to the scale of a single atom. The film has been influential in encouraging designers to consider adjacent levels of context — the details of how a design relates to the next level of scale, whether that's a room or a body part. These details are often overlooked, but as Charles once explained, "The details are not the details, they make the product."[11]

Designing for Behavior

Continuous evolution of manufacturing capabilities, business needs, human factors, materials, and contexts created a wide spectrum of ways in which Industrial Designers could express a particular product. However, it was the embedding of electronics into products that resulted in the most radical shift in both design possibilities and people's relationships with objects. For the first time, the potential behavior and functionality of a product was disconnected from its physical form.

Consider the difference between a chair and a radio. Although chairs vary widely in form and materials, the way that a person uses them is largely self-evident, without instruction or confusion. With a radio, the functionality is more abstract. The shape of a knob may communicate its ability to turn, but not necessarily what it controls.

A designer of electronic products uses a mix of different controls, displays, colors, and words to communicate the purpose of various components and provide clarity in how they work together. Done poorly, a user can be overwhelmed and confused by the possibilities and interrelationships, requiring them to read a manual before operating a product.

Figure 1.x Dieter Rams image (*TBD)*

German Industrial Designer Dieter Rams is a master at simplifying these complex electronic products to their essential form. Rams designed simple, iconic products for German household appliance company Braun for over 40 years, where he served as the Chief Design Officer until his retirement in 1995. His understated approach and principle of "less but better" resulted in products with a timeless and universal nature. He was restrained in the amount of language used to label knobs and switches, relying on color and information graphics to communicate a product's underlying behavior in an intuitive manner.

In a similar spirit to this book, Dieter Rams has compiled a list of "Ten Principles of Good Design"[12] that is rooted in his Industrial Design experience, but relevant to designers of any

[11] 'Designers Charles and Ray Eames - Herman Miller'. 2015. Accessed January 22. http://www.hermanmiller.com/designers/eames.html.

[12] 'Dieter Rams: Ten Principles for Good Design'. 2015. Vitsoe. Accessed January 22. https://www.vitsoe.com/gb/about/good-design.

discipline. Our principles overlap with Rams' choices, emphasizing those that best relate to UX and Interaction Design challenges. Much has been written about Rams' ten principles, and we encourage you to review it as a jumping off point for further learning and inspiration.

Rams' has influenced many contemporary designers, and between 2008 and 2012 the *Less and More* retrospective of his work travelled around the world, showcasing over 200 examples of his landmark designs for Braun.[13] During an interview with Gary Hustwit for his 2009 film *Objectified,* Dieter Rams said that Apple is one of the few companies today that consistently creates products in accordance with his principles of good design.

Figure 1.x Apple / Jonathan Ive example *(TBD)*

It's no surprise that Jonathan Ive, Apple's Senior Vice President of Design, is a fan of Rams' work and ethos. Since joining Apple in the early 1990s, the British industrial designer has overseen the launch of radical new product lines with unique and groundbreaking designs, including the iMac, iPod, and iPhone. Regarding these disruptive innovations, he emphasizes that being different does not equate to being better. In reference to the first iMac design, Ive has said that "the goal wasn't to look different, but to build the best integrated consumer computer we could. If as a consequence the shape is different, then that's how it is."[14]

Ive's approach seems to echo and build upon Rams' motto of "less but better," although the products that Apple makes are significantly more complex than the ones that Rams' designed for Braun. The physical enclosure and input controls of a computing device are similar to legacy electronics, but the mutable functionality of software on a screen is its own world of complexity. The introduction of the personal computer significantly widened the separation of form and function.

In 2012, Ive was knighted by Queen Elizabeth for his landmark achievements. In the same year Sir Jonathan Ive's role at Apple expanded, from leading Industrial Design to providing direction for all Human Interface design across the company.[15] This consolidation of design leadership across physical and digital products speaks to the increasing overlap between these two mediums. The best user experience relies on a harmonious integration of hardware and software, an ongoing challenge throughout the history of computing.

Computing Revolution

Interaction with the first personal computers was entirely text-based. Users typed commands and the computer displayed the result, acting as little more than an advanced calculator.

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[13] 'Less and More: The Design Ethos of Dieter Rams'. 2015. SFMOMA. Accessed January 22. http://www.sfmoma.org/exhib_events/exhibitions/434.

[14] Kahney, Leander. 2013. Jony Ive: The Genius Behind Apple's Greatest Products. United States: Penguin Putnam Inc.

[15] 'Apple Announces Changes to Increase Collaboration Across Hardware, Software & Services'. 2015. Apple Inc. Accessed January 22. https://www.apple.com/pr/library/2012/10/29Apple-Announces-Changes-to-Increase-Collaboration-Across-Hardware-Software-Services.html.

Computers had shrunk in size, but this direct input and output echoed the older mainframe technology. Even the common screen width of 80 characters per line was a reference to the number of holes in a punch card. In the relationship between people and technology, these early computers favored the machine, prioritizing efficient use of the small amount of available processing power.

This early personal computing era can be likened to the time before the Industrial Revolution, with digital craftsmen making machines primarily for themselves or their friends. These computers were the domain of hobbyists, built from kits or custom assembled by enthusiasts who shared their knowledge in local computer clubs.

In 1968, at the Fall Joint Computer Conference in San Francisco, Douglas Engelbart held what became known as "The Mother of All Demos," in which he introduced the oN-Line System, or NLS. This 90-minute demonstration was a shockingly prescient display of computing innovation, introducing for the first time modern staples such as realtime manipulation of a graphical user interface, hypertext, and the computer mouse.

Early computing pioneer David Liddle talks about the three stages of technology adoption: enthusiasts, professionals, and consumers. It was the introduction of the graphical user interface, or GUI, that allowed the personal computer to begin its advancement through these phases.

The GUI was the key catalyst in bringing design to software. Even in its earliest incarnations, it signaled what computers could be if they prioritized people, increasing usability and accessibility despite the incredible amount of processing power required. But making software visual did not automatically make computers usable by ordinary people. That would require designers to focus their efforts on the world behind the screen.

In his book *Designing Interactions*, IDEO co-founder Bill Moggridge relates a story about designing the first laptop computer, the GRiD Compass, in 1979.[16] The industrial design of the Compass had numerous innovations, including the first clamshell keyboard cover. It ran a custom operating system called GRiD-OS, which featured an early graphical user interface, but with no pointing device. Using this GUI prompted him to realize for the first time that his role as a designer shouldn't stop at the physical form, but include the experiences that people have with software as well.

Years later, Bill Moggridge, along with Bill Verplank, would coin the term "Interaction Design" as a way of distinguishing designers who focus on digital and interactive experiences from traditional Industrial Design.

Pioneering computer scientist and HCI researcher Terry Winograd has said that he thinks "Interaction Design overlaps with [Industrial Design], because they both take a very strong user-

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[16] Moggridge, Bill. *Designing Interactions*. Cambridge, Mass.: MIT, 2007.

oriented view. Both are concerned with finding a user group, understanding their needs, then using that understanding to come up with new ideas."[17] Today we take for granted this approach of designing software by focusing on people but in Silicon Valley of the 1980s, the seeds of human-centered computing were only just being planted.

The Bifurcation of Physical and Digital

In the 1970's, influenced by Douglas Engelbart's NLS demonstration, numerous research projects at Xerox PARC explored similar topics. The Xerox Star, released in 1981, was the first commercially available computer with a GUI that utilized the now familiar desktop metaphor. This structure of a virtual office correlated well with the transition that computing was attempting to make from enthusiasts to professional users.

The graphical desktop of the Star featured windows, folders, and icons, along with a "What You See Is What You Get" (WYSIWYG) approach that allowed users to visually see and manipulate text and images in a manner that represented how they would be printed. These features, amongst others, were a direct influence on both Apple and Windows as they developed their own GUI-based operating systems.

In 1983 Apple released the Lisa, their first computer to utilize a GUI. A year later they launched the Mac, which became the first GUI-based computer to gain wide commercial success. Microsoft debuted Windows 1.0 in 1985 as a GUI overlay on its DOS operating system, but adoption was slow until 1990 with the release of the much-improved Windows 3.0.

Although their operating systems had many similarities, the business models of Apple and Microsoft could not have been more different. Apple was a product company, and made money by selling computers as complete packages of hardware and software. Microsoft made no hardware at all. Instead, they licensed Windows to run on compatible computers made by third-party hardware manufacturers that competed on both features and price.

As businesses embraced computers in every office they overwhelmingly chose Windows as a more cost effective and flexible option than the Mac. This majority market share in turn created an incentive for software developers to write programs for Windows. Bill Gates had found a way to create a business model for software that was completely disconnected from the hardware it ran on. In the mid-1990s even Apple briefly succumbed to pressure and licensed their Mac OS to officially run on Macintosh "clones."

The potential for design integration that Bill Moggridge had seen between hardware and software was difficult within this business reality. The platform approach of the Windows operating system had bifurcated the physical and digital parts of the personal computer. Companies tended to focus on hardware or software exclusively, and designers could make few assumptions about how they were combined by end users.

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[17] Preece, Jenny, Yvonne Rogers, and Helen Sharp. *Interaction Design: Beyond Human-computer Interaction*. New York, NY: J. Wiley & Sons, 2002.

Although the GUI used a spatial metaphor, the variety of monitor sizes and resolutions made it difficult to know how the on-screen graphics would be physically represented. The mouse and the standard 102-key keyboard acted as a generic duo of input devices, dependable but limited. Software emerged as a distinct and autonomous market, which contributed to the largely separate evolution of Interaction and Industrial Design.

As software took on new and varied tasks, Interaction Designers sought inspiration and expertise not only from traditional design fields but also from psychology, sociology, communication, and computer science. Meanwhile, Industrial Designers continued to focus primarily on the physical enclosures of computers and input devices. After all, computing was only one of the full range of industries within Industrial Design's purview.

Information Revolution

In 1982 the Association for Computing Machinery (ACM) recognized the growing need to consider users in the design of software by creating the Special Interest Group on Computer–Human Interaction (SIGCHI). Shortly after, the field of Human-Computer Interaction (HCI) emerged as a recognized sub-discipline of computer science.

Because designing how people use digital systems was so new, and because the task required integrating so many fields of knowledge, it became a vibrant research area within multiple fields of study (psychology, cognitive science, architecture, library science, etc.).
However, at the end of the day, making software always required the skills of a software engineer. That changed in 1993 with the launch of the Mosaic web browser, which brought to life Tim Berners-Lee's vision for the World Wide Web.

The web was an entirely new medium, designed from the ground up around networks and virtuality. It presented a clean slate of possibility, open to new forms of interaction, new interface metaphors, and new possibilities for interactive visual expression. More importantly, it was accessible to anyone who wanted to create their own corner of the web, using nothing more than the simple HyperText Markup Language (HTML).

From the beginning, web browsers always came with a "View Source" capability that allowed anyone to see how a page was constructed. This openness, combined with the low-learning curve of HTML, meant a flood of new people with no background in computer science or design began shaping how we interact with the web.

The web hastened the information revolution and accelerated the idea that "information wants to be free." Free to share, free to copy, and free of physicality. Microsoft Windows had distanced software from the machine it ran on, but the web pushed interactive environments into an entirely virtual realm. A website could be accessed from any computer, regardless of size, type, or brand.

By the mid-1990s Wired Magazine described web users as Netizens, socializing in virtual reality was an aspiration, and there was growing excitement that e-commerce could replace brick-and-mortar stores. The narrative of progress in the late 20th century was tied to this triumph of the virtual over the physical. The future of communication, culture, and economics increasingly looked like it would play out in front of a keyboard, in the world on the other side of the screen.

Standing on the shoulders of previous pioneers, the flood of designers native to the web used the very medium they were building to define new interaction patterns and best practices. The web had brought about the consumer phase of computing, expanding the scope and influence of Interaction Design to a level approaching its older, Industrial cousin.

Smartphones

Early mobile phones had limited functionality, primarily centered on making voice calls and sending SMS messages. The introduction of the Wireless Application Protocol (WAP) brought a primitive browser to phones so they could access limited information services like stocks, sports scores, and news headlines. But WAP was not a full web experience, and its limited capabilities, combined with additional usage charges, led to low adoption.

Even as mobile phones began accumulating additional features such as color screens and high-quality ringtones, their software interactions remained primitive. One contributing factor was the restrictive environment imposed by the carriers. The dominant wireless networks (AT&T, Sprint, T-Mobile, and Verizon) didn't make the operating systems that powered their phones, but they controlled how they were configured and dictated what software was pre-installed.

Decisions about which applications to include were often tied to business deals and marketing packages, not consumer need or desire. The limited capabilities and difficult installation process for third-party apps meant that they were not widely used. This restrictive environment was the opposite of the openness on the web, a discrepancy that was strikingly clear by 2007 when Apple launched the iPhone and disrupted the mobile phone market.

Just as Microsoft's Windows OS created a platform for desktop software to evolve, it was Apple's turn to wield a new business model that would dramatically shift the landscape of software and interaction.

Although the original iPhone was restricted to the AT&T network, the design of the hardware and software was entirely controlled by Apple. This freedom from the shackles of the carrier's business decisions gave the iPhone an unprecedented openness.

For the original release, that openness was focused on the web. Mobile Safari was the first web browser on a phone to render the full web, not a limited WAP experience. A year later, an update to iOS allowed third-party applications to be installed. This was the beginning of yet another new era for Interaction Design, as the focus shifted not only to a mobile context but to the reintroduction of physicality as an important constraint and design opportunity.

The interaction paradigm on the iPhone, and the wave of smartphones that have since emerged, uses direct touch manipulation to select, swipe, and pinch as you navigate between and within apps. Touchscreens had existed for decades, but this mass standardization on one particular screen size awoke Interaction Designers to consider the physical world in a way that desktop software and the web never did. Respecting the physical dimensions of the screen became critically important to ensure that on-screen elements were large enough for the range of hands that would interact with them.

Knowing the physical dimensions of the touchscreen also led to new opportunities, allowing designers to craft pixel-perfect interface layouts with confidence in how they would be displayed to the end user. This ability to map screen graphics to physical dimensions was concurrent with the rise of a new graphical interface style that directly mimicked the physical world. This visual style, often called skeuomorphism, presents software interfaces as a mimic of physical objects, using simulated textures and shadow to invoke rich materials such as leather and metal.

Although often heavy-handed and occasionally in bad taste, these graphical references to physical objects, combined with direct touch manipulation, reduced the learning curve for this new platform. Katherine Hayles, in her book *How We Became Posthuman* describes skeuomorphs as "threshold devices, smoothing the transition between one conceptual constellation and another."[18] The skeuomorphic user interface helped smartphones become the most rapidly adopted new computing platform ever.[19]

Today, skeuomorphic interface styles have fallen out of favor. One reason is that we no longer need their strong metaphors to understand how touchscreens work; we have become comfortable with the medium. Another factor is that touchscreen devices now come in such a wide variety of sizes that designers can no longer rely on their design rendering with the kind of physical exactness that the early years of the iPhone afforded.

The iPhone was also a bellwether of change for Industrial Design. Smartphones are convergence devices, embedding disparate functions that render a variety of single-purpose devices redundant. Examples of separate, physical devices that are commonly replaced with apps include the calculator, alarm clock, audio recorder, and camera. Products that traditionally relied on Industrial Designers to provide a unique physical form were being dematerialized, a phenomena that investor Marc Andreessen refers to as “software eating the world.”[20]

At the same time, the physical form of the smartphone was very neutral, designed to disappear as much as possible, with a fullscreen app providing the device’s momentary purpose and

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[18] Hayles, Katherine. How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics. Chicago, IL: University of Chicago Press, 1999. 17.

[19] DeGusta, Michael. "Are Smart Phones Spreading Faster than Any Technology in Human History?" Accessed January 20, 2015. http://www.technologyreview.com/news/427787/are-smart-phones-spreading-faster-than-any-technology-in-human-history/.

[20] "The Man Who Makes the Future: Wired Icon Marc Andreessen | WIRED." Wired.com. Accessed December 17, 2014. http://www.wired.com/2012/04/ff_andreessen/5/.

identity. This was a shift from the earlier mobile phones, where the carriers differentiated their models primarily through physical innovation such as the way a phone flipped open or slid out to reveal the keypad.

Even as Interaction Designers introduced physical constraints and metaphors into their work, Industrial Designers saw their expertise underutilized. The rise of the smartphone made inventor and entrepreneur Benny Landa's prediction that "everything that can become digital, will become digital" seem truer than ever. For Industrial Design, which throughout the 20th century had always defined the latest product innovations, this was a moment of potential identity crisis.

Smart Everything

The general purpose smartphone continues to thrive, but today these convergence devices are being complemented by an array of single-use "smart" devices. Sometimes referred to as the Internet of Things, these devices use embedded sensors and network connectivity to enhance and profoundly change our interactions with the physical world.

This introduces design challenges and possibilities well beyond a new screen size. Smart devices can augment our natural interactions that are already happening in the world, recording them as data or interpreting them as input and taking action. For example:

- The Fitbit activity tracker is worn on your wrist, turning every step into data.
- The Nest Protect lets you wave away a smoke alarm caused by a faulty detection, such as accidently setting it off while cooking.
- The August Smart Lock senses your approach and automatically unlocks the door.
- The Apple Watch lets you pay for goods by simply raising your wrist to a checkout reader.

The smartphone required designers to consider the physicality of users in terms of their fingertips. These new connected devices require a broader consideration of a person's full body and presence in space.

Over the last few decades, opinions have oscillated on the superiority of general purpose technology platforms versus self-contained "information appliances." Today's "smart devices" represent a middle ground, since these highly specialized objects often work in conjunction with a smartphone or web server that provides access to configuration, information display, and remote interactions.

Open APIs allow devices to connect to and affect each other, using output from one as the input to another. Services such as IFTTT (IF This Then That) make automating tasks between connected devices trivial. For example, one IFTTT recipe turns on a Philips Hue light bulb in the morning when your Jawbone UP wristband detects that you have woken up.

Unfortunately, seamless experiences between connected devices are rare and too often the smartphone is treated as the primary point of interaction. This makes sense when you want to change your home's temperature while at the office, or check the status of your garage door while on vacation. But if adjusting your bedroom lighting requires opening an app, it certainly doesn't deserve the label "smart."

We find ourselves in yet another transitional technology period, where physical and digital blur together in compelling but incomplete ways. There is potential for connected devices to enhance our lives, giving us greater control, flexibility, and security in our interactions with everyday objects and environments. There is promise that we can seamlessly combine our digital and physical lives, reducing the need for constant engagement with a glowing screen in favor of more ambient and natural interactions within our surroundings. But there is also a danger that connecting all of our things simply amplifies and extends the complexity, frustration, and security concerns of the digital world.

The technical hurdles for the Internet of Things are being rapidly overturned. The primary challenge today lies in designing a great user experience.

Industrial Design Principles for UX and Interaction Design

Connected devices represent a new era for both Industrial and Interaction Design. Because this new paradigm intertwines physical and digital, designing a good experience will require the two disciplines to overlap like never before. Industrial Designers will need new sensitivities towards complex system states, remote interactions, privacy considerations, and the open-ended potential of how input can map to output. Interaction Designers will need to embrace physical and spatial possibilities, consider a person's whole body, and use new forms of feedback less reliant on a screen.

In the past, we could often draw a clean line between hardware and software. As that line blurs, both Industrial and Interaction Design will need to combine their expertise. In the 1990s the emergence of the web led designers to develop new interaction patterns for an entirely new medium. A similar definition of best practices for connected devices will need to occur, but this time the process can be more integrative, drawing from knowledge embedded in both disciplines. The principles that have informed and defined Industrial Design for the last century are a good starting point for Interaction Designers to find new ways of approaching, framing, and evaluating their work.

The ten principles in this book represent ways that Industrial Designers have approached design problems across a diverse array of industries and eras. Each principle is explained and situated within Industrial Design history, and then reframed for a modern Interaction Design context. The chapters can be read in any order, so you can return to and review relevant principles when starting a new project.

The goal is not that all Interaction Designers should become Industrial Designers, or vise versa, but that these two design disciplines should find an overlap of skills and approaches appropriate to a world where the traditional distinctions between physical and virtual are increasingly blurred.

Chapter 2

Sensorial

Engage as many senses as possible

We connect with the world around us through our senses, and describe the process of understanding something new as “making sense of it.” The pervasiveness of sensing makes it easy to take for granted, as we integrate our five common senses of touch, hearing, sight, smell, and taste without conscious thought or effort. Similarly, as designers create objects and interactions, it can be easy for them to overlook the richness of human sensorial capabilities. By primarily considering the unavoidable senses of sight and touch, many designers seem to treat humans as little more than eyeballs and fingers.

Industrial Designers, because of the physicality of their work, have historically been able to engage a broader range of senses than Interaction Designers. We obviously see and touch objects, but we also hear something when we place an object on a surface, or even smell certain materials when we hold them closely. We generally don’t eat our objects, but increasingly designers are collaborating with chefs and food companies to support the smell and taste of our eating experiences.

Beyond the traditional five senses, we perceive our presence in the physical world through non-traditional and combinatorial senses as well. We have a sense of balance that helps us walk and carry objects, a sense of pain that keeps us from over damaging our body, and a sense of temperature that is finely tuned to our human tolerances. Our kinesthetic sense tells us the position of our body parts relative to each other, and helps us detect weight and tension when we grasp and hold an object.

All of these senses are commonly used with intention by Industrial Designers. The weight of a fountain pen, the balance of a snow shovel, the smell of a leather wallet, and the warm welcome of a heated car seat are all purposefully designed. In this chapter, we will demonstrate how sensoriality is central to Industrial Design by looking at the core foundations of the discipline such as formgiving, color, materials, and finish. We’ll look at products that transition between multiple states, where engaging the senses through action feels good enough to be addictive. We’ll look at ways that products can delight us through sensorial reaction to our input, and how designers may even influence the smell and taste of food.

As digital systems escape the screen, the sensorial methods that Interaction Designers can utilize for both input and output will expand. Engaging this full range of human senses, in ways both obvious and subtle, is one of the most important things that Interaction Designers and UX professionals can learn from Industrial Design.

Formgiving

Fundamental to Industrial Design is idea of formgiving, the process of determining the best shape, proportion, and physical architecture for a three-dimensional object. This additional dimension, beyond the flat 2D world of a screen, presents a multitude of new challenges and sensorial possibilities. This is why Industrial Designers often start sketching physically first, shaving foam or wood with their hands to craft the basic depth, dimensionality, and proportions of an object before modeling it on a computer. Should an object be thick and narrow, or thin and wide? Feeling the difference in your hand is often the only way to know.

In giving an object form, a designer is trying to both meet a human need and create a product with character, something that is unique, differentiated, and better in the marketplace. As the form evolves through the design process it must be evaluated holistically, seeing how each change affects the front, back, and sides from every angle. Additional constraints might be informed by the way an object will be held, or what function it performs. Certain challenges, such as accommodating bulky embedded electronics, might be addressed by prioritizing particular viewing angles, creating the illusion of an object being thicker or thinner when viewed from particular sightlines. A good example of this is the wedged-shaped side profile of the MacBook Air.

On-screen elements in a user interface tend to default to rectangular shapes: windows, buttons, bars, and lists. Obviously, it is possible to make interfaces with other shapes, but the very idea that there is a default can influence and limit Interaction Designers. Even if less conventional shapes are used within an interface they are framed within a larger system of rectangles that a designer has little control over, not least of which is the screen itself. While some physical objects are part of a branded family, most are standalone forms that free Industrial Designers to consider a much wider range of shapes. This allows shape to become a defining personality for an object, whether round, square, sharp, soft, or organic. A product’s shape is the first thing you see.

Rarely is a product constructed from a single shape, so formgiving usually includes a process of composition as well, shaping various individual elements and then arranging them into a greater form. Consider a simple FM radio with a frequency dial, volume knob, screen, and speaker grill. The overall shape of the radio may be a starting point, but the form is not complete until all of the elements are composed in relationship to the whole.

Similar to composition, the way that elements connect to each other is a key consideration in more complex formgiving. The joint on a chair, the hinge on a laptop, the clamshell or slider on a mobile phone. For products with moving parts, these connections and architectures are fundamental to the overall form and act as a bridge between multiple states of the product. A laptop can be open or closed, and both of those states should feel related and work together.

Color, Materials, Finish (CMF)

Along with formgiving, Industrial Designers craft sensorial experiences by utilizing the building blocks of color, materials, and finish, or CMF. Combining these three in an acronym makes sense since they are often chosen and used in combination with each other to create a perception of quality, indicate affordances for use, and communicate brand identity.

All three elements involve consideration for the sense of vision, but materials and finishes provide designers with the additional opportunity to purposefully engage the sense of touch. Should an object feel hard or soft when you touch it? Should it be cold or warm against your skin? Should it be glossy or matte? Light or heavy? These are all carefully considered and often combined to create a desired product experience.

The unique properties of a material can be the catalyst for a design idea, even before explorations of formgiving have begun. However, this inspiration requires that designers have physical access to new materials so they can feel and experiment with them. In 1999, IDEO started their Tech Box project,[1] which collects examples of interesting materials and mechanisms from a range of products and industries and distributes them to all the company's offices. Designers can rummage through the collection for inspiration when starting a new project. This kind of reference library is an important tool in allowing materials to spark new design ideas.

Like formgiving, CMF is a balancing act between the desired sensorial experience, feasibility of manufacturing at scale, and overall cost of the product. To achieve that balance, designers must maximize the impact of every CMF choice. An example of a company that has made the most from simple materials and color is Fiskars, whose classic orange-handled scissors have sold more than 1 billion units since their introduction in 1967.

Figure 2.x: Fiskars "Classic" orange-handled scissors

Fiskars has been making scissors since the 1830s,[2] originally for professional use, with wrought iron handles that matched the material of the blades, and later with brass to increase comfort. In the 1960s, new manufacturing capabilities made it possible to create scissors with ground metal blades that could outperform their forged counterparts. These lightweight blades were paired with another mid-century innovation, the molded plastic handle. The combination of these two materials allowed Fiskars to offer higher quality, more comfortable scissors at a price that was affordable to everyone, not just tailors and seamstresses.

The recognizable orange color of the scissor's handle has a serendipitous origin story. At the time that the first plastic-handled scissor prototypes were made, Fiskars also had a line of juicers in production. The injection molding machine had leftover orange dye in it, so the initial handles were produced in orange. Other colors were tried as well, including red, green, and

[1] "Tech Box." IDEO. Accessed January 25, 2015. http://www.ideo.com/work/tech-box/.

[2] Kulvik, Barbro, and Antti Siltavuori. The DNA of a Design: 40 Years, 1967-2007. Helskinki: Fiskars, 2007.

black, but orange was selected by the Fiskars board in a final vote of 9 to 7. That decision has had a profound influence on the company.

Today, the Fiskars Orange® color is an essential part of the company's brand. It was registered as a trademark in the USA in 2007, following its Finish trademark in 2003.[3] The color has successfully extended beyond the scissor line to other Fiskars products, making their garden tools and crafting supplies instantly recognizable, even at a distance. In recognition of their simple appeal and design legacy the Classic orange-handled scissors are part of the permanent collection of the Museum of Modern Art (MoMA) in New York.[4]

Another company whose innovative handle design can be found in the MoMA collection is OXO,[5] whose soft rubber grips with ribbed finishes transformed the commodity utensil category and launched an entire product portfolio built around the sense of touch.

Figure 2.x: OXO Good Grips Peeler

The origin story of OXO comes not from the introduction of new manufacturing capabilities like Fiskars, but with observation of an unmet need in the marketplace. Founder Sam Farber, who was ostensibly retired from a career in the kitchenware business, was inspired by seeing his wife Betsy struggle when using a standard metal vegetable peeler. Betsy was suffering from arthritis in her hands, and the design of the all-metal implement was optimized not for comfort or support, but to be manufactured as cheaply and easily as possible.

Farber worked with Smart Design in New York to make a better handle based on the principles of Universal Design, a philosophy that prioritizes designing for the broadest group of people possible, including those with special or marginalized needs.[6] Smart Design prototyped forms that would be easy to hold, regardless of hand size, and explored materials that would support varying levels of physical capability.

The final design is a handle made of a soft rubber called Santoprene,[7] in an oval shape that evenly distributes the user's force during use. The non-slip material provides comfort and grip, even when wet, while withstanding exposure to kitchen oils and dishwashers. On the sides, small ribs or "fins" are cut into the rubber, providing an affordance for where to hold. These tactile elements make the OXO brand recognizable at first touch, even without looking.

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[3] "Orange-Handled Scissors: Superior Cutting Since 1967." Fiskars. Accessed January 25, 2015. http://www2.fiskars.com/content/download/22952/394664/file/OHS Backgrounder.pdf.

[4] "Olof Backstrom. Scissors (1960)." MoMA.org. Accessed January 25, 2015. http://www.moma.org/collection/object.php?object_id=3250.

[5] "Smart Design, New York. Good Grips Peeler (1989)." MoMA.org. Accessed January 25, 2015. http://www.moma.org/collection/object.php?object_id=3758.

[6] "About OXO." About Us. Accessed January 25, 2015. http://www.oxo.com/AboutOXO.aspx.

[7] "FAQs." OXO. Accessed January 25, 2015. http://www.oxouk.com/faq.aspx.

The Good Grips handle design has been applied to 100s of products since its introduction 1990. But unlike Fiskars, which used materials innovation to reduce the cost of the scissors, OXO products are often more expensive than their traditional counterparts.[8] It's a compelling demonstration that people are willing to pay for good design, and that taking a Universal Design approach can lead to products with broad appeal.

The stories of both Fiskars and OXO show how simple and disciplined use of colors, materials, and finishes can define a brand that extends across an entire product line. This might remind Interaction Designers of the consistency that permeates an operating system, where signature elements such as menu bars or drop-down lists are presented in a consistent manner so that users know immediately what to expect and how to perform similar actions.

Beyond consistency though, it is often the CMF of a product that draws us to it. As objects become increasingly connected and computational, it's important not to lose these positive, tactile qualities that makes us want to have them in our lives. For example, instead of a raw LED providing feedback, a light might be placed under a frosted glass surface. Or, instead of a touchscreen for input, sensors might be placed under a thin veneer of wood. This is not about hiding technology, but finding ways to integrate it with the same rigor that goes into all CMF selections.

Multi-sensorial and Luxury Products

Straightforward use of color or a single material can be an innovative advancement for simple tools, but just as most digital products require multiple interconnected states to result in a good experience, a more complex physical product requires bringing together a mix of sensorial moments. By engaging multiple senses, at every scale and detail, the overall experience can transcend its parts.

Figure 2.x: Leica Camera

"Shooting with a Leica is like a long tender kiss, like firing an automatic pistol, like an hour on the analyst's couch." —Henri Cartier-Bresson

Cameras can inspire intense loyalty from photographers based not only on how they perform, but also how they feel. A good camera becomes an extension of the photographer's sense of vision, capturing what they see with minimal interruption. Few brands have spawned as much obsession amongst photographers as the German manufacturer Leica.

Leica has been making cameras since the mid-1800s, and even though today's models are digital, they feature tactile, analog controls similar to the earliest models. This decision is driven by more than nostalgia, since familiar physical controls allow a photographer to keep their eye

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[8] "Identifying New Ideas for Breakthrough Products." Accessed January 25, 2015. http://www.ftpress.com/articles/article.aspx?p=24132&seqNum=4.

looking through the viewfinder while they adjust the dials for shutter speed, aperture, and focus. Unlike selecting on-screen menu items, twisting an aperture control can be done without looking, and the reassuring click of each demarcation on the dial can be felt and heard.

A Leica is a triumph of engineering, but also of form and finish, the feel of each dial and marking on the camera body building muscle memory through use, avoiding a fumble that could lead to a missed shot. It's the integration of these tiny details, along with the build quality and craftsmanship that fosters such passion and commands a premium price.

Leica craftsmanship is celebrated to the point of fetish. For example, the Leica T camera body is machined out of a solid block of aluminum.[9] The marketing materials for the camera boast that the body is hand polished, and a video ad[10] released on their website showcases the entire 45 minute process in closely cropped shots of gloved hands at work. The ad's voiceover boasts that it takes "around 4,700 strokes to finish each body," asking the viewer in the end if they can see the difference, and reassuring them that "you can most certainly *feel* it."

The Leica M9-P, Edition Hermès[11] is an example of how detailed finishes and subtle sensorial experiences can elevate a product to the level of luxury. In collaboration with the eponymous Parisian fashion house, this limited edition camera is wrapped in a soft, ochre-colored calfskin leather. The metal body underneath was redesigned for this special edition by the automotive designer Walter de'Silva, and the exposed portions of the metal are even smoother than the well polished standard edition. The contrast of materials heightens the user's awareness of each as their fingers shift from holding the warm, soft, natural leather to adjusting the cold, hard aluminum controls.

The sensorial experience extends beyond the camera itself though, with a strap made of matching calfskin, an Hermes designed camera bag, and a two-volume book of photographs from Jean-Louis Dumas, shot with a Leica M. These items are packaged alongside the camera lenses, in a fabric-coated custom display box that includes a set of white gloves, further emphasizing the museum-like quality of the overall package. All of this can be yours for only $25,000 or $50,000, depending on which limited edition package you choose.

As we've seen, there are examples of CMF choices that can make a product more affordable, or push it well out of reach for all but the most wealthy. The more senses that a product engages, through high-quality materials or finishes, the more luxurious it can appear.

Lightweight scissors that still cut well are desirable, but a lightweight luxury item might appear "cheap." Even with the use of aluminum bodies, Leica cameras are known for their significant heft. It's well documented that people perceive weight as a signifier of quality. One of the studies documenting this phenomena can be found in 2009 issue of the journal Psychological

[9] "Leica T Camera System." Accessed January 25, 2015. http://us.leica-camera.com/Photography/Leica-T/Leica-T-Camera-System.

[10] "The Most Boring Ad Ever Made?" Vimeo. Accessed January 25, 2015. http://vimeo.com/92073118.

[11] "Leica Creates M9-P Hermès 18MP Rangefinder Special Editions." DPRreview. Accessed January 25, 2015. http://www.dpreview.com/articles/5424047475/leica-creates-m9-hermes-edition-18mp-full-frame-rangefinder-camera.

Science,[12] where researchers published a paper entitled “Weight as an Embodiment of Importance.” In their study, they found that varying the weight of a clipboard used by participants altered their behavior and influenced their opinions. Designers wishing to capitalize on this kind of psychological influence can make the appropriate materials decisions, though care should be taken that these choices are still authentic to the purpose of the product. This topic is explored in more depth within the *Honesty* chapter.

On top of high-quality design, scarcity is often utilized to further differentiate a standard and luxurious product. This invocation of luxury is something that has traditionally been very difficult for Interaction Designers to achieve. After all, what is a luxurious interaction? For purely digital products, the ability to create unlimited copies of digital resources makes scarcity too artificial to resonate as luxurious. Offering a limited edition with an improved user experience also comes off as more unfair than special. Digital experiences seem to be evaluated through a more egalitarian lens.

However, for the increasing number of products that integrate digital and physical, there are many untapped opportunities to explore and define luxurious interactions. For all of its fine materials and finishes the Leica M9-P, Edition Hermès uses the same firmware, on-screen graphics, and interactions on its digital screen as the less luxurious standard edition. How might the on-screen interactions better match the overall feel of the camera? How might digital and physical be integrated in a way that seems inherent and specific to this particular camera? At what point will luxury consumer’s changing perception of quality require stronger digital and physical integration to command a premium price?

Addictive Action

Many products reveal their full set of sensorial qualities only through use. For physical products with multiple states, such as open/closed or on/off, the transition between those states can itself be sensorially satisfying, something more than a means to an end.

The opening and closing of a Zippo lighter feels good. Zippo has used the same design throughout its 80-year history and the “click” of a Zippo flipping open is recognizable enough to serve as a dramatic moment in over 1,500 television shows and films.[13] Smokers who use Zippo lighters find themselves addicted to more than their cigarettes, absentmindedly flipping their lighter open and closed repeatedly. It would be hard to estimate the ratio of Zippo clicks to lit cigarettes, but it’s safe to say that it is far from 1:1.

What fosters this kind of delightfully addictive feeling? What triggers us to do something repeatedly with no apparent purpose? Is this kind of enjoyable transition something that happens by accident, or can it be intentionally designed for? In 1933, the differentiating

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[12] Jostmann, Nils B., Daniël Lakens, and Thomas W. Schubert. "Weight as an Embodiment of Importance." Psychological Science: 1169-174.

[13] "Zippo : Then and Now." Zippo. Accessed January 25, 2015. http://www.zippo.com/about/article.aspx?id=1574.