

SIMPLICITY AND THE ART OF SOMETHING MORE: A COGNITIVE–SEMIOTIC APPROACH TO SIMPLICITY AND COMPLEXITY IN HUMAN–TECHNOLOGY INTERACTION AND DESIGN EXPERIENCE

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Abstract: *In human–technology interaction, the balance between simplicity and complexity has been much discussed. Emphasis is placed on the value of simplicity when designing for usability. Often simplicity is interpreted as reductionism, which compromises both the affective nature of the design and usability itself. This paper takes a cognitive–semiotic approach toward understanding the dynamics between the utilitarian benefits of simplicity in design and the art of something more: considerate complexity. The cognitive–semiotic approach to human–technology design experience is a vehicle for explaining the relationship between simplicity and complexity, and this relationship’s multisensory character within contemporary art-design, information technology product design, and retail design. This approach to cognitive semiotics places emphasis on the design, object, mental representation, and the qualitative representation. Our research contributes on the levels of theoretical development and methodology, having direct design implications through articulating that simplicity exists as the careful organization of complex elements.*

Keywords: *cognitive semiotic, simplicity, complexity, design, multisensory experience.*



INTRODUCTION

“If we stand on the shore and look at the sea, we see the water, the waves breaking, the foam, the sloshing motion of the water, the sound, the air, the winds and the clouds, the sun and the blue sky, and light; there is sand and there are rocks of various hardness and permanence, color and texture... It is always as complicated as that...”

(Feynman, 1963, Section 2-1, para. 2)

The above quote, taken from physicist Richard Feynman, characterizes the complexity of the world and the information that people process in their everyday lives. While the everyday and the natural world are often called the simple things in life, as Feynman mentioned, they are, in fact, complicated. The realms of human–computer interaction (HCI), and what we authors prefer to name as human–technology interaction (HTI), are complex as well. Not only are the natures of information systems in question multidimensional, requiring multidisciplinary teams to design and develop everything from hardware to software and design form, but also the users of these technologies are highly diverse. There is no way of speaking of the average user. Technology users—for instance, smartphone or tablet users—range from comprehensive school-aged children (and younger) to the elderly (aged 65 years and above), each possessing a diverse cultural and social background, unique personal history and experiences, and physical and mental realities. For this reason, much debate has taken place in the realms of HTI and design alike regarding the importance of simplicity and its role in aiding usability (Krug, 2014; Marcus & Gould, 2000; Nielsen, 1999; Tilson, Dong, Martin, & Kieke, 1998). The general argument for simplicity holds that the fewer features, options, and functions available on a device or in the user interface (UI), the less information people need to mentally process in achieving end-usage goals (Nielsen, 1999; Tilson et al., 1998). However, as John Maeda (2006) pointed out, simplicity and designing for simplicity are not that simple. The process of decreasing features, choices, and interactive elements in a design is reductionism, which does not necessarily result in simplicity, particularly when discussing, for example, ease of use in HTI.

Our aim in this paper is to theoretically scrutinize and emphasize the matter that simplicity cannot and should not be equated with reductionism, even if its characteristics are those of being graspable and easily understood (Karapanos, 2013). Simplicity is complex (Maeda, 2006) and, in the case of technological design experience, multisensory. Simplicity, and more importantly the experience of simplicity, is distinct from reductionism.

Reductionism in itself often is defined with a derogatory inference and usually is applied in academia to describe the act of depicting and analyzing complex phenomena through basic or principle, often static, constituents (McLeod, 2008). In the design context, the term has been used at times as a polar concept: greedy reductionism as opposed to careful, thoughtful, or good reductionism (Dennett, 1995). Greedy reductionism is characterized by the tradeoff scientists and professionals make in trying to discover too much too fast. For example, Daniel Dennett (1995) explained greedy reductionism in reference to B.F. Skinner and his ideas of radical behaviorism regarding Skinner skipping the layers involved in understanding cognition and instead denying the existence of mental states. In particular, Dennett described superficial treatment of scientific concepts and phenomena via explanations utilizing imagery of the mystic. In the UI design setting, for instance, greedy reductionism can be seen when executing the design as reducing the presentation of functions and interactive touchpoints, with disregard

for the functions or the nature of these functions, and lack of understanding of the users and their cognition. The “shrink it, pink it” approach to designing information technology products for women can be seen to represent this type of thoughtless approach. One such example of this is found in the United Arab Emirates’-based company EuroStar’s ePad Femme. The device was to be purchased with a set amount of predownloaded applications to avoid the necessity of women having to learn how to download applications for themselves. The applications included yoga programs, beauty tips, and software for tracking female monthly cycles. Furthermore, the background color was either pink or purple (Newall, 2013).

On the other hand, careful, thoughtful, or good reductionism refers to the process of demonstrating what specific elements reduce to. The BauBax Travel Jacket is an example of this and has been referred to as the Swiss Army Knife of clothing (Stone, 2015). The jacket is a 15-in-one bomber jacket designed to accommodate a multitude of gadgets (including iPads, passports, money, etc.) a person typically carries while traveling. The pockets and compartments do not appear bulky or clumsy; instead, they have been carefully designed to be hidden. Another innovation exhibiting careful good reductionism can be seen in LP&M’s Ticket Books—books that have been designed with radio frequency identification (RFID) tags in order to be readable by ticket scanners in subways. This allows consumers to enjoy their books without the necessity of producing separate metro-cards or tickets. Thus, complex systems are incorporated into a seemingly simplistic design solution.

In the careful or thoughtful reduction process, designers carefully balance the functionality and options afforded by a design with the maximum level of simplicity they can establish within the design’s operation (Maeda, 2006). Thus, careful or thoughtful reduction is manifested as a negotiation between how simple a design can be made with how complex it actually needs to be. Senseless reductionism (Fadeyev, 2016), on the other hand, is used to describe how designers oftentimes compromise their own subjectivity by striving for an undefined ideal. Frederick van Amstel (2015) compared scientific notions of reductionism with design and understandings of the design process. Amstel applied Russell Ackoff’s (1991) explanation of reductionism to design theory, demonstrating that a reductionist approach to design entails a generic problem-solving process. The greatest concern with taking a reductionist approach to design is that, after reducing the design problem into subproblems and subsolutions, it is very difficult to arrive at a synthesis (i.e., a final overall design solution). Amstel (2015) noted that the reassembling of a design object is difficult in the event that the design object has been entirely deconstructed. The point of emphasis here is that if important steps and elements of the object, how it is supposed to perform, and the area or problem it is supposed to compliment or improve is overlooked or omitted from the design and its process, it is difficult to reintroduce it back into the design without completely rethinking the design.

Simplicity, however, can be conceived of as an aesthetic attribute rather than a reduced reality (Karvonen, 2000). For example, one only needs to look at natural phenomena that are often considered to be simple and comprising few uncomplicated elements, such as wave formation and snowflakes (see Figure 1), to understand that beauty lies in the cognitively graspable organization of complex structures (Feynman, 1981; Tammet, 2014). Moreover, while notions such as careful or thoughtful reduction have been named by scholars as part of the process toward attaining simplicity in design (e.g., Maeda, 2006; Mullet & Sano, 1995), reductionism does not necessarily equate to simplicity in and of itself. This interpretation seems to come across in the writings of scholars such as Don Norman (2007, 2008), who claimed that



Figure 1. A snowflake demonstrates the concept of simplicity in complex natural structures.
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simplicity is overrated. Yet, even reductionism from another perspective, as seen in Mies van der Rohe’s idea of less is more (cited in Johnson, 1947, p. 49), suggests that the reduction process of removing elements from the design (see, e.g., Wigmore, 2014) presents a powerful and complex process. The process of reduction in design and, for instance, art perception, opens opportunities for viewers to mentally construct the remaining parts that are absent in the visual representations (Wilde & Wilde, 2000). In fact, simplicity is complex and, as we argue in this working paper, multisensory.

To fulfill the aim of theoretically scrutinizing the concept of simplicity, we will, in the balance of the paper, (a) illustrate the dynamics of simplicity and complexity in HTI design from the perspective of cognition science; (b) discuss simplicity and complexity through multisensory experience; and (c) elaborate on trends in technology aesthetics. The intention behind the article also is to provide an overview on how the relationship between simplicity and complexity has been discussed in the fields of cognitive science and HTI in reference to cognitive fluency, the cognition of patterns, aesthetics and evaluations of beauty, information density and quantity sizes, and simplicity in the psychology of perception (e.g., Gestalt psychology). Here, we use Chater and Vitányi’s (2003) discussion on simplicity as a unifying principle in cognitive science, merging thought from epistemology, mathematics, and computational theory, and the philosophy of science to describe the mind’s tendency to seek patterns to easily make sense. The paper progresses to describe this interrelationship between simplicity and complexity in view of multisensory perception and the paradox of increased sensorial information and ease of understanding. This is furthered through discussing trends in the aesthetics of contemporary technology and retail designs—the example cases being smartphones and a retail display—and establishing the “something more” encounter between perceiver/experiencer and design. From an experiential perspective, the art of giving something more, or offering a sensory “surprise” (see Arhippainen, 2013), is crucial to establishing a deeper communicational exchange between the design and the perceiver. This is due to the increase in information revealed to a person about a product and its disclosure occurring in a

meaningful way—that is, making visible the relationships between layers, components, and even processes of a design object, service, or system. This results in people receiving more (information and detail) for less (cognitive load), while also being able to return repeatedly to the design and receive something more in terms of information and benefit.

This is a theoretical paper that utilizes presented examples to illustrate the multidimensional nature of the relationship between simplicity and complexity. The article progresses by firstly describing simplicity in tangent with its cognitive apperceptive functions of supporting cognitive fluency and affective preference. That is, here simplicity is described regarding the interaction between the design and its properties that are being perceived, and the way in which it is mentally constructed or represented (apperceived). Thus, the way in which the designs are understood, either from the perspective of simplicity or complexity, is also contingent upon how people interpret (mentally construct) the design. This is then followed by an overview of the psychological nature of simplicity as characterized by Gestalt psychologists. The cognitive–semiotic approach to HTI is explained. Here, we elaborate on a proposed cognitive–semiotic model, the model’s structure, and how it is applied to this study. The article concludes with a discussion of the implications for design and theory with emphasis on the relevance of the cognitive–semiotic approach for crossing the boundaries of design disciplines.

The Cognitive Apperceptive Meaning of Simplicity, Fluency, and Preference

The discipline of cognitive science has a long history of measuring and defining the parameters of simplicity in terms of cognitive processing, such as (a) the problem of induction—a deep philosophical debate relating to the obtainment of truth or a real understanding of phenomena and its reasoning;¹ (b) infinite or endless numbers of patterns (or symbols and sequences) being compatible with finite data sets (Chater & Vitányi, 2003), which can be demonstrated by limitless amounts of curves passing through the same set of finite points, programming logic (differing algorithms to achieve the same programming outcome) and even radically different painting techniques and mark-making (i.e., dots, line drawings, geometrical approaches) that in the end resemble familiar objects and forms; (c) repetition of stimuli (Bornstein, 1989; Zajonc, 2001), seen in phenomena such as the mere exposure effect, whereby through exposure people learn and recognize patterns toward which an attraction is developed; and (d) prototypicality (the ability to connect phenomena to categories²), semantics (the study of meaning), and ontological categorization—the process of deriving cognitive categories of phenomena (Hekkert & Wieringen, 1990). Cognitive science is a highly interdisciplinary field, combining theories and approaches from psychology, social science, aesthetics, and design, to name a few. In addition to cognition, cognitive science allows the study of the relationships between and among many factors, such as embodied experience or embodiment (physical and multisensory experience), emotions, and, quite crucially, the way in which cultures influence these processes (Norman, 1980). From a pragmatic point of view, cognitive–emotional processes operate in relation to action and what is occurring within the external environment (Dewey, 1938; Dewey & Tufts, 1909; Peirce, 2009). Thus, the senses (sight, sound, touch, smell, and taste) and the subsequent perception through these vehicles serve as the interface between the mind and the world outside the human body.

The perceptive processes involve acts of finding patterns in received sensory data and high-level cognition (i.e., indirect or more abstract thinking that involves processes of classification, association, reflection, evaluation against other information held by the individual, as opposed to low-level cognition in which reactions to the external world happen almost instantaneously) require the recognition of patterns of information in order to create and develop categories of meaning (Chater & Vitányi, 2003). The problem of induction accounts for the complexity involved in establishing patterns: Infinite numbers of patterns exist even for finite data sets (Chater & Vitányi, 2003; Saariluoma & Rousi, 2015). That is, through limited tools and choices, the possibilities for differing patterns are unfathomable. For instance, numerous studies have researched the dynamics between decision-making, creativity, convergent thinking, and the ability to generate new solutions from scarcity in terms of limited options or resources (Amabile, 1983; Mehta & Zhu, 2015; Sternberg & Lubart, 1999). To give one example of how numerous patterns or solutions may derive from scarcity, participants of a study (Mehta & Zhu, 2015) involving three resource availability conditions (scarcity, abundance, and control) were assigned a task of solving a problem involving an image of a candle, box of matches, and container of tacks. Participants were required to solve the problem of attaching the candle to the wall through the use of the provided materials, ensuring that the candle would burn properly (in the correct direction) without dripping wax on the floor or table. The results proved that scarcity, or a limited number of resources, is not purely a question of material reality but also mental state. As the study showed, those who were confronted with a scarcity condition clearly displayed higher levels of creativity for correctly solving the problem (e.g., emptying the tack box, tacking it to the wall, placing the candle upright in the box, and lighting it), than the other two conditions of abundance (where people were given a narrative alluding to the participant existing in conditions in which resources were vast) and control (where people were not given any narrative to prime them for any specific conditions). In the control and abundance conditions there was no significant difference in the rate of successfully solving the problem, yet between the scarcity and the other two there was a significant increase in the rate of success solutions. Other examples that physically and informationally demonstrate infinity in finite units include Gabriel's horn—a geometric figure featuring a finite volume with an infinite surface area (Havil, 2007), and the traditional binary code modern societies live by, the 1s and 0s in computer programming.

The reality of infinity in finite units also brings implications for addressing reductionism in design; even decreasing levels of information may stimulate creativity and imagination in the user (Inoue, Rodgers, Tennant, & Spencer, 2015). In other words, while people are surrounded by infinite pieces of data about anything and everything they encounter, it is the smaller sets of information—such as a piece of paper, string and a pair of scissors—that prove most useful and fruitful for undertaking creative activities, such as transforming these materials (the paper and string, with the help of the scissors) into an item of clothing. Thus, to establish limits (in materials and/or information) increases one's ability to imagine more options for that controlled quantity of resources. This is due to the fact that people are only capable of making sense of smaller chunks of information that align with the internalized idiosyncratic logic of their mental schema (Rugg & Gerrard, 2014; Saariluoma, 2003).

Information perceived through the senses is not simply understood and experienced through its raw form. That is, what each individual knows about the world is not based on an exact replica of the physical world; rather, the mental world and its contents are

interpretations—reconstructions or compositions—combining the perceived sensory information with various types of other mentally bound information and contents, such as memories and emotions (Helfenstein & Saariluoma, 2006). Thus, it is more apt to describe the perception–experience relationship as apperception (Saariluoma, 2005; Silvennoinen, 2017; Silvennoinen, Rousi, Jokinen, & Perälä, 2015).

Apperception can be described as “seeing something as something” (Saariluoma, 2005, p. 77). In this apperceptive meaning-making process, already existing mentally based information is integrated with new information obtained through multiple senses and constructed into a meaningful mental representation (Husserl, 1936/1970; Kant, 1787/1998; Saariluoma, 1995, 2003, 2005; Silvennoinen et al., 2015). Experiencing something as something—for instance, microscopic images of snowflakes or even granules of sand (see Figure 2) as complex and intriguing—involves apperceptive attention in detecting meaningful parts of the encountered entity (Saariluoma, 1995). Apperception differs from mere perception in terms of the act in which people mentally represent information contents that are not perceivable by nature, whether in terms of sense data or remembered sensory experience (Russell, 1917/1951) or qualia, the solely subjective qualities that shape the experience for the individual and cannot be entirely communicated to another individual (Jackson, 1982). Unperceivable contents or phenomena additionally include concepts of time, such as eternity or future instances (i.e., tomorrow; Saariluoma & Rousi, 2015). In other words, unperceivable contents cannot be reduced to perceptual stimuli but can be informed by past experiences and ideas of what such concepts may mean. Thus, apperception does not require the occurrence of sensory perception (e.g., Saariluoma, 2005; Silvennoinen, 2017). Further, certain patterns of information are easier to recognize cognitively than others (Chater & Vitányi, 2003). Mach (1959) suggested that perhaps the human cognitive system both should and does prefer patterns that present data in simple descriptions, such as the bullet point lists of recipes, headings and subheadings, or even images containing a few clearly defined objects or actors without too much clutter. Descriptions such as seen in the example of headings or subheadings enable the reconstruction of data, whereby the level of simplicity or complexity is defined by



Figure 2. When sand, which is typically understood as uniform in composition, is magnified, the heterogeneity of the substance becomes evident. This figure shows some components from a magnified sand sample. (Permission to reprint from www.sandgrains.com)

the description's length. That is, the longer a heading and/or its subheading is, the more complex the text is to comprehend. Thus, in terms of cognitive processing, the shorter the heading (data code or description), the less redundant the representation and the easier it is not only to comprehend but also remember (Attneave, 1954; Barlow, 1959). This rule applies equally to machines as it does to human beings (Watanabe, 1960). Thus, people's cognitive systems prefer patterns that give the shortest codes of data, and these data codes, such as simple shapes (e.g., triangles, circles) are most easily recognized against perceptive noise, such as clutter or too many figures and objects in an image (Chater & Vitányi, 2003; Hochberg & McAlister, 1953; Van der Helm & Leeuwenberg, 1996).

However, although the cognitive system prefers patterns that comprise shorter code, it also can be seen that people (and their sensory systems) are attracted to patterns that give the most information in understandable packages. For example, research has revealed that people are more likely to gaze at informative areas of objects, scenes, and other phenomena, that is, the areas revealing the most information about the art or design, such as two or more people in an image who are interacting (Antes, 1974; Loftus & Mackworth, 1978; Mackworth & Bruner, 1970; Mackworth & Morandi, 1967; Pollack & Spence, 1968). This means that people are cognitively predisposed to gaining as much information as possible in as concise a way as possible. This phenomenon functions in favor of simplicity and has been researched in design aesthetics through the concept of the maximum effect for minimum means principle (Hekkert, 2006). It should be noted that, from an experiential perspective, for example, the areas of an image or scene that are deemed informative (i.e., with more detail in terms of objects and characters and, for example, reference to a narrative or action) also are the areas that comprise areas of physical discontinuity or surprise and somehow offer "something more" in relation to the rest of the image (Mackworth & Morandi, 1967; Yarbus, 1967).

From an information processing point of view, simplicity can be considered as the ease of interpretation. Devices that capitalize on simplicity in the design process are, for instance, prototypes and mashups (i.e., the assemblage of various elements to represent a design idea). Prototypes and mashups are, by nature, materialized versions of ideas and concepts that demonstrate the form and potential product envisioned by the end of the design and development process (Garrard, Lambon, Hodges, & Patterson 2001; Rugg & Gerrard, 2014). These can be seen in paper prototypes, three-dimensional printed prototypes and sketches, and/or even collages of various elements, including images and materials that attempt to convey ideas of values and emotional qualities (such as in the case of mashups). Without these material manifestations, ideas remain on the abstract level of thought and are open to unlimited interpretations by individuals encountering the concepts. Through embodying ideas, that is, giving physical form to concepts, there is the possibility to generate a common understanding among people regarding the concept in practice. Moreover, prototypes are easier on the mind of those to whom the designer is wishing to communicate than are verbal descriptions. For example, in icon design, a prototypical icon for printing with only the most essential visual features displayed is easier and quicker for the viewer to cognitively grasp than a printing icon with highly complex and detailed visual features (particularly when the features are not necessary for communicating the icon's represented function). Prototypes allow others to experience design concepts as well as to afford the possibility of the concept being experienced as aesthetically pleasing through the beholder's ability to simultaneously understand the object and utilize various cognitive

processes involved in appreciation and imagination (Winkielman, Halberstadt, Fazendeiro, & Catty, 2006; Yu, Benatallah, Casati, & Daniel, 2008). Prototypes and aesthetic appeal have been found to be intertwined when experiencing paintings (Hekkert & Wieringen, 1990; Nedungadi & Hutchinson, 1985) and furniture (Whitfield & Slatter, 1979). However, according to Reber, Schwartz, and Winkielman (2004), while processing fluency can predict aesthetic appeal, several other processes contribute to relative preferences for complexity. For instance, the repetition of a stimulus that was either unknown or experienced as neutral at the beginning can enhance the likelihood of people developing a positive relationship with that stimulus (Bornstein, 1989; Lane, 2000; Zajonc, 2001). This principle has played a major role in advertising, marketing, and brand building for decades (Belch, 1982; Campbell & Keller, 2003; Mitchell & Olson, 1977; Schumann & Clemons, 1989). For example, repeating stimuli to increase its likability has been found to work in a variety of stimuli, such as faces, words, and melodies (Bornstein, 1989). However, this effect cannot be generalized to more complex relationships between people or between people and objects. For example, it does not possess explanatory power to explicate how exposure to one's husband's face in a 20-year marriage affects the probability of liking or disliking of one's husband. Thus, this effect does not take into account established long-term affective relationships with complex meaning structures between people and between people and objects, but applies to more simple settings in describing cognitive processing fluency (in terms of repetition) in increasing affective responses in short-exposure times with fairly unknown stimuli.

However, this effect for less complex stimuli is known as the mere-exposure effect (see Zajonc, 2001), is influenced by the number of times a person is exposed to the phenomenon. Consequently, while repeated exposure has been found to steadily enhance the level of liking of a particular product, Van den Bergh and Vrana (1998) noticed an exposure threshold at around nine presentations. Subsequent presentations after this threshold result in a decline in the level to which a person favors the stimulus (Van den Bergh & Vrana, 1998). This effect is also influenced by the complexity of the stimuli: The more complex the stimulus is, the greater the number of presentations a person can endure before experiencing a decrease in fondness or an increase in disinterestedness, boredom, or dislike (Bornstein, Kale, & Cornell, 1990). Even though a more simplistic stimulus is easier to process, the dynamics of the mere-exposure effect indicate the necessity for complexity in meaningful experiences of repetition.

The Aesthetics of Simplicity in Gestalt and Experimental Psychology

From the cognitive to the psychological, the issue of simplicity plays a major role among Gestalt psychologists in their quests to ascertain the objective determinants of aesthetic beauty. The notion of beauty is broad and much contested (Münsterberg, 1909; Soderholm, 1997; Zuckert, 2007). In fact, due to its subjective nature and vast array of interpretations, understandings, and preferences demonstrated throughout societal dimensions such as culture, technological development, and social construction (the type that occurs through, e.g., the mere-exposure effect [e.g., Bornstein, 1989] of advertising and trends), the quest of defining objective determinants of beauty is highly criticized particularly in the fields of art and design (Ostrow, 2013). Beauty was typified by historian George Bancroft as being “the sensible image of the infinite” (cited in Hotchkiss, 1895/2009, p. 22). Questions surrounding

beauty have regarded its definition, components, whether or not there is a universal beauty, and the types of physiological, sociological, and psychological effects associated with experiencing it (Danto, 2003). In particular, researchers in the field of aesthetics continually seek to describe and determine the principles involved in the experience and understandings of beauty (Chandrasekhar, 1987; Jacobsen, Buchta, Köhler, & Schröger, 2004).

Thus, this section focuses on the attempts in determining the elements of what is considered beautiful in relation to simplicity from the perspective of Gestalt and experimental psychology. According to Gestalt psychology, the so-called objective determinants of beauty include symmetry, contrast, and clarity (e.g., Gombrich, 1995; Solso, 1997). Furthermore, according to Gestalt psychologists, the motivation behind the formation of any visual pattern is that it should be perceived as effortlessly as possible. This is almost always achieved by understanding all perceived information as a part of a greater whole (Wertheimer & Reizler, 1944). This process is afforded by the context and conditions of the encounter between a person and specific artistic or design phenomena (Arnheim, 1974). Thus, while the notions of simplicity and beauty are not interchangeable, there is a relationship between the two that is highly intricate from both the cognitive and the psychological perspectives (Arnheim, 1974; Wertheimer & Reizler, 1944). This is why the aesthetics of simplicity is of great interest.

Any visual representation can be experienced as simple if the viewer is not aware of the intricacy of the artifact. In this case, although learning and exposure to various phenomena enable the simplicity of understanding, people also learn about the complexity of phenomena through exposure or repeated encounters. Thus, the effect is twofold: Complexity is confusing in instances where people do not have previous experiences of certain phenomena, yet phenomena that appear simple initially can reveal themselves as complex through subsequent experiences. In terms of initial exposures in which there is a lack of experience or previous knowledge upon which to build or apperceive the presented information, complexity is not generally positively favored. This holds especially for HTI and user interface design. In HCI, the task traditionally has been to design for simplicity, which also is emphasized as minimalistic design (e.g., Nielsen, 1999). In user interface design, simplicity requires abstraction and emphasis on the most essential parts of the design and not merely to reduce the number of elements (Maeda, 2006; Mullet & Sano, 1995). A detailed example of this process can be seen in the area of visual art, in works such as Pablo Picasso's *Bull* etchings³ (1945). In fact, John Brownlee (2014) described how Picasso's *Bull* influenced the new designers at Apple in terms of increasing their understanding of product design, while simultaneously teaching them to think like Steve Jobs. In other words, the Apple brand language was transferred to new employees through highlighting the iteration process involved in constructing a sophisticated design in a concise way. Picasso's *Bull* (1945) serves as an example of the complexity and steps taken toward depicting simplistic forms—particularly iconic and symbolic forms that may be recognized in relation to their more complex originals. Charles Sanders Peirce (1998) discussed this process in terms of the notion of diagrammatology in which focus is placed on simple qualities such as icons and their mechanisms of color, form, shape, and sound that maintain a relationship with the original. According to Stjernfelt (2006, p. 72), the idea behind Peirce's diagrammatical logic is that knowledge always "involves a moment of observation." This observation in turn facilitates the ability to deductively reason or to add information to symbols or sketches that

have been carefully simplified. Thus, simplification—or the end result of simplicity—is always a deductive process of production and subsequent understanding through the means of apperception.

One might say that simplicity is boring, or even overrated, as stated by Donald Norman (2007). This notion has long been acknowledged in the pictorial arts. Through viewer research on Picasso's *Bull*, for instance, it has been documented that the parts of the artwork that gain the most attention are those that are complex and more detailed (Antes, 1974; Mackworth & Bruner, 1970; Pollack & Spence, 1968). In aesthetics, the gratifying experience of a work of art often requires the presence of both simplicity and complexity. For example, a composition of a painting can be based on symmetry and balancing visual elements across the canvas to be easily understood, but to make it more interesting, elements, for example, diagonal lines can be added to break up the unity of composition. This relationship has been referred to through terms such as “unity in variety” (Hekkert, 2006, p. 166; Post, Blijlevens & Hekkert, 2013, p. 217), “uniformity in variety” (Berlyne, 1972, p. 277), and “simplicity in complexity” (Dickie, 1997). The experience of this relationship is influenced by expectations. Encounters with phenomena seen as simplistic when expecting the complex often induce a pleasant experience, and often the reverse can be said to occur (see, e.g., Antes, 1974; Gombrich, 1984; Pollack & Spence, 1968). For example, expecting to encounter complex and detailed information regarding changes in the Finnish economic situation of the past century yet finding it represented in one easily interpretable visualization can induce a positive experience. In addition, research conducted in experimental aesthetics corroborates a positive correlation between arousal, complexity, and preference. More complex and unusual pictorial representations are in turn experienced as more interesting and fascinating (Berlyne, 1971, 1974).

On this note, in terms of HTI, simplicity is often equated with ease-of-use, particularly regarding the decrease of clutter or digestible information (Chater & Vitányi, 2003; Maeda, 2006). Norman (2007, 2008) argued that, during the act of choosing a technological product, people typically do not choose the product with the fewest features. Rather, as seen in Norman's South Korean example of consumers preferring washing machines with more operations and buttons (2008), people actually want more functions and complexity. In the realm of HTI aesthetics, especially considering the implications of money and consumer choice, cultural and social forces are at play in terms of both immaterial values and value for money. Thus, the design decision to simplify in HTI is not that simple, as there are parallel cognitive and emotional processes at play. These parallel cognitive and emotional processes entail the ability to manipulate the products (i.e., the physical, practical, and functional objects, in line with our cognitive–semiotic approach), on the one hand, and the reflection of status (i.e., the more expensive the product, the more that product can do: the immaterial object of the present cognitive–semiotic approach) and the satisfaction of getting more for less money on the other (Norman, 2007, 2008). Additionally, as Norman (2008) noted, the fewer functions or options a person has in terms of operating a device, the less control they have over the device. Similarly to Norman (2007, 2008), Maeda (2007) stated in a TED talk on designing for simplicity that, “People love complexity.” Yet, at the same time, people do not like to have to put in the effort to understanding or learning this complexity (relating to the principle of least effort; see, e.g., Zipf, 1949). Thus, the number one challenge of design is to tame complexity (Norman,

2008), make it beautiful (Maeda, 2006), and remember that there is no simplicity without complexity (Maeda, 2007).

THE COGNITIVE–SEMIOTIC APPROACH TO HUMAN–TECHNOLOGY AND DESIGN EXPERIENCE

A cognitive–semiotic approach has been adopted for the analysis presented below. This cognitive–semiotic approach involves multiple steps:

1. Identify signifying elements. The process of isolating specific elements within the design syntax (e.g., formalistic elements pertaining to the construction, execution, and presentation of designs, such as color, form, size, materials), referred to as the design (code or signifying element), sets the foundation for the analysis process.
2. Explore multiple levels of signifying elements. In examining these signifying elements in relation to the object that is being signified, both on the material and immaterial level (e.g., a tangible and functional smartphone that represents or possesses immaterial qualities for the perceiver, such as values, ideologies, and qualities, surfaces a multitude of design elements useful for analysis.
3. Consider the qualitative representation. In user studies, qualitative (and even quantitative) data are seen as a signifying element or construction of how a person experiences design. In this case, the qualitative representation found is that of the researchers and how they interpreted the designs, their contexts, and the interplay between simplicity and complexity.
4. Acknowledge the mental representation (interpretant). A result of and a constant negotiator in the perception-apperception relationship, the mental representation supports the recognition, associations, and impressions of designs.

Due to its function of isolating concrete design and contextual properties, the cognitive-semiotic approach is beneficial for examining the dynamics of simplicity and complexity in HTI. Simplicity and complexity are then analyzed in relation to the object (i.e., the material and immaterial intentions, that is, what the signifying element [the design or symbol] refers to) and through the expression of the subsequent experience (i.e., mental representation or interpretation of the encountered design).

The philosophical and linguistic field of semiotics—the theorization of science and human understanding, as John Locke (1690) had claimed—has become increasingly popular and useful in the analysis of HTI (Andersen, 2001; Benyon, 2001; Saariluoma & Rousi, 2015). In particular, semiotics has been used systematically in the design and examination of graphical user interfaces and their components (e.g., icons) to understand the optimal language (natural or otherwise) and semiosis of user interface design (Souza & Leitão, 2009). This approach is known as semiotic engineering (Souza, Barbosa & Prates, 2001; Souza & Leitão, 2009). Yet, semiotics also can be utilized in the most traditional sense in relation to the study of conscious experience and logic when encountering designed technological artifacts. Charles Sanders Peirce’s (2009) basic semiotic model comprises three main elements. The first element is the object or phenomenon that is being referred to

(designatum). The second is the signifying element—the sign or symbol (representamen)—that conveys or embodies the message or reference to the object or phenomenon under analysis. Finally, the interpretant signifies the mental representation or interpretation of the event, the encounter, or what is derived from perceiving the signifying element in its interaction context. The interpretation and, in particular, the representation of this interpretation (e.g., how someone describes what he/she is thinking), can be used as a basis to investigate cognition and affective experience when people interact with designs (Rousi, 2013a, 2013b). This entire process is contingent upon the interpreter and context in which the sign is encountered (Morris, 1971, p. 416).

In order to gauge this relationship between the design and the experience derived from people’s encounters with the design, a cognitive–semiotic model of user experience was developed (Rousi, 2013a; see Figure 3). This model uses Peircean and Morrisian models as platforms through which to describe the process of mental representation formation (interpretation) as the human element of sign systems. Additionally, the model serves to articulate the qualitative representation or the linguistic construction of the mental component as an extension of the signification process. Thus, in the cognitive–semiotic model presented here, the qualitative representation (i.e., the communicative representational account of the experience, that is, how an individual describes what he/she is feeling and how he/she interprets the design, such as “These grey colors make the user interface feel dreary and dull”) embodies concrete signifying vehicles, or symbolic accounts that can be connected to the sign components of the design and the object. Awareness of this semiotic

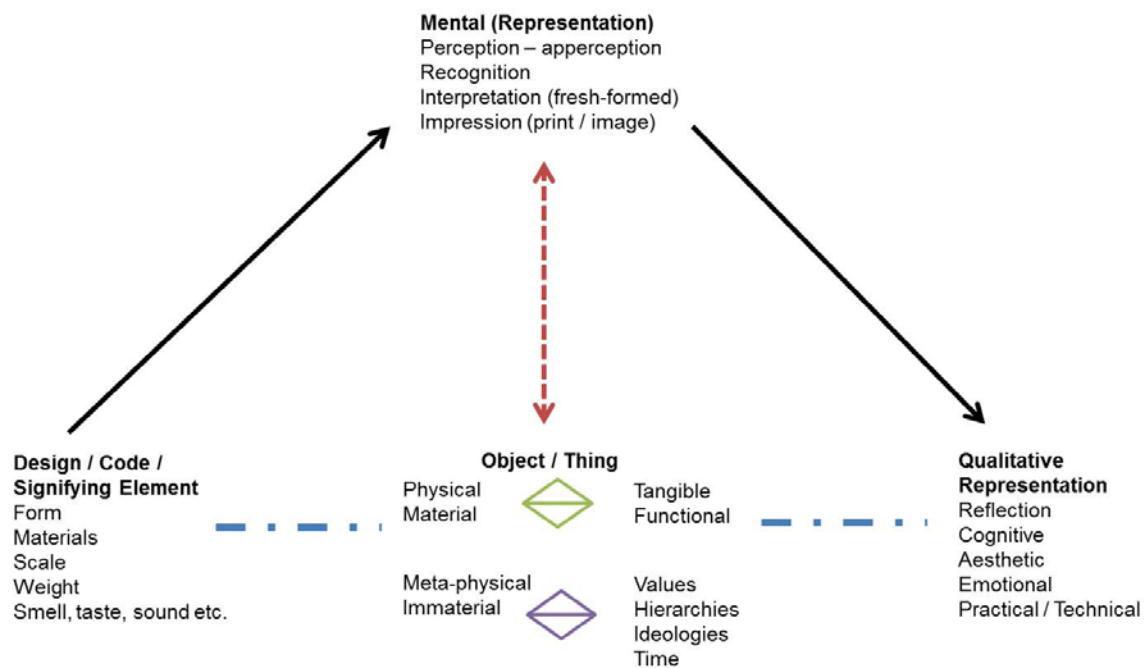


Figure 3. Cognitive–semiotic model of human–technology and design experience explaining the relationships between the design, the object to which it alludes or represents, how these are interpreted (mentally represented), and how the mental representation is subsequently qualitatively described (Rousi 2013a).

component in design experience allows for richer insight into what is being mentally represented. That is, the “grey colors,” or the colors of the background of a user interface in this example are triggering emotional qualities such as dreary and dull, which, in terms of the object, possess immaterial characteristics that are negative or less desired against the values (i.e., shaping expectations) an individual holds toward how the design should be. Thus, this cognitive–semiotic model actively includes what users provide to researchers as an extension to the previous semiotic models by Peirce and Morris, with the understanding that a sign may comprise the signifying element, object, and interpretation. However, in order to come closer to comprehending the interpretation, researchers need to systematically understand the relationship between what a person is saying, about what, and how it presented.

According to the cognitive–semiotic model of human–technology and design experience, there are two sign vehicles: the design/code/language/symbol—the expression of the designer’s mental processes, intention, and the qualitative expression of the experience—and a user’s communication of his/her mental representation (or interpretation). Thus, a qualitative component and an observed component are readily available for analyzing (i.e., the design and what users say about the design). The signifying element of the design consists of a physicalized (even in virtual settings) manifestation of design intention through form, materials, scale, weight, smell, taste, sound, and so on. It is the message or point of contact a person has between an object and its interpretation, which is ready to be perceived (intentionally or unintentionally) through the multiple senses. The qualitative representation of the interpretation a person obtains through perceiving and apperceiving the design (and even in quantitative expression, as quantitative evaluations are always operationalized through qualitative counterparts such as adjectives or propositions) possesses elements that reflect cognitive, emotional, aesthetic, reflective, practical, and functional properties.

The object, or thing, that is referred to by the signifying element can be tangible or intangible (Peirce 1998; Saussure 1916/1983) and, in many circumstances, both. If the object is material, immaterial properties, such as particular qualities (i.e., sensory, e.g., how things feel or look and enable smooth operation), values (i.e., ideals that are attached to the design, e.g., locally or ethically produced), and beliefs (i.e., brand-based or religious, to name two) always are involved. Material or physical objects are tangible, or at least physically perceivable through the senses; they also typically are functional. The immaterial objects constitute the values, hierarchies, beliefs, time, ideologies, and so forth, that are alluded to through choices in, for example, colors, images, language (including choice of wording), and arrangement, to name some. Meanwhile, the components of these signs—the cognitive–semiotic model of human–technology and design experience—are composed in the mind of the user by the mental representation. The mental representation makes sense of the signifying element or design in relation to the object (i.e., the functions, values, and/or overall message it represents). Then, subsequently, the element of the cognitive–semiotic process that we, as researchers and designers, encounter when studying design experience are the qualitative nonverbal (i.e., facial gestures, body language) and verbal representations of the mental representations. This is what occurs as well when the following examples are analyzed. The textual expression of our analysis in this paper represents the qualitative representation element of the cognitive semiotic model.

SIMPLICITY AS A COMPLEX MULTISENSORY EXPERIENCE

In this section, we describe the role of the multiple senses in affording the experience of simplicity. Here, multisensory design and artworks are used to demonstrate the dynamic play between the ways in which information complexity can be observed through compositions of a multitude of materials and revealing internal structures of what otherwise would be experienced as simplistic phenomena, such as Times New Roman font or a giant shoe display. Thus, this section contains three examples that we discuss. Firstly, an artwork by Dan Hoopert (2013) is outlined in terms of its revelation of the complex construction of text font. This is then followed by an example of a shoe display that employed the use of thousands of wooden pegs to create the illusion of the minimalistic form of a two dimensional shoe, while in fact the construction was a carefully assembled three dimensional structure comprising thousands of wooden pegs. And finally, the application of alternative materials to heighten the multisensory experience of seemingly basic smartphone cases is also discussed.

A recent example of artwork that plays upon the dynamics of simplicity and complexity is a digital piece called *Wire Typography* by Dan Hoopert (2013; Figure 4). This piece demonstrates the interplay between simplicity of form, seen in the use of the Latin alphabet, and complexity of structure, observed in the wire three-dimensional (3D) compositions of the letters. In balancing the dimensions of simplicity and complexity, the forms appear as though they can be touched and studied with both the eyes and hands. However, Hoopert modeled an alphabet in serif styling that was stripped to bare wires, thus rendering an intriguing perspective on the letters (Nelson, 2013). Such a design is effective, Ashley Nelson (2013) explained, because most people in their everyday environments simply scan text without considering the elements involved in letter or textual construction. Given this, Hoopert’s work of art—or design as it is described—demonstrates the complex processes that occur in establishing what is perceived as simple. Moreover, the work itself resonates with what is witnessed in nature: tangible, easily understandable forms (such as leaves, waves, snowflakes etc.) that are the unifying element of highly complex networks of building blocks and structures. In both examples—Hoopert’s work and nature—the structures are difficult, if not impossible to sensorially perceive (via touch or sight) with or without technological assistance.

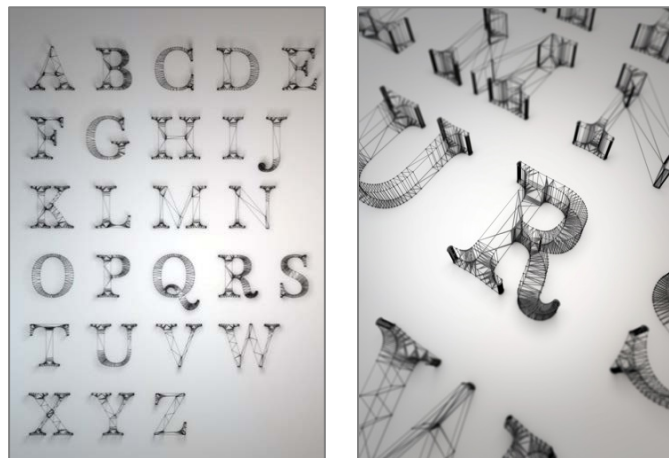


Figure 4. Example of the complexity of text font construction seen in *Wire Typography*, Dan Hoopert (2013). Reprinted with permission from Dan Hoopert.

However, the evidence of the multidimensionality (the depth combined with width and height) is there through shadows, opening possibilities for other sensory experiences that may also include smells, tastes and what is sensed as infinities of interactions between layers and channels of the lines in the font structures.

Thus, within the cognitive–semiotic perspective and from a viewer’s perspective, the designer’s intention can be seen as rendering explicit the complex mechanisms of simplicity. The viewer is somehow teased with the illusion that the images may be touched and manipulated. There is a play between signifying elements that are both physical (i.e., the actual print and projected representations of the material wire frames) and virtual in nature (i.e., the wire frames, layers and networks digitally existing within and behind the user interface design). The object that is referred to exists both in the references to functional, usable phenomena, and the devices of literacy and languages themselves. The languages referred to here are those that utilize the Latin alphabet with their many historical, cultural, and political levels such as colonization, cultivation (cultural conditioning of the mind) and literacy (i.e., the ability to understand the written symbolic system of languages utilizing the Latin alphabet). Thus, the object is not simply tangible, but in tangible due to its embodiment of norms, ideologies, and histories. This subsequently bears a relationship within the interpretation, according to the interpreter (Morris, 1971) and the viewer’s (interpreter’s) context of perceiving Hoopert’s work.

The next example takes place in the retail environment, where the value of offering something more with every gaze also has economic impact. The simplistic design of a Bagua footwear display,⁴ created by utilizing platform pins (wooden pegs), generally serves a utilitarian purpose for supporting the array of footwear. However, rather than remaining solely utilitarian, the pins are composed in a 3D versus two-dimensional (2D) form, in other words, a 3D form of a 2D design representing a Bagua shoe. Thus, while appearing basic in terms of idea and consistency of form, the display demands further attention through the understanding of the human effort involved in construing this large-scale shoe representation, in addition to the quantity of elements (pegs) present. Further, the *how* factor plays a role in drawing focus toward the individual elements that make the whole—the pins—demonstrating the practical relationship between the pins and the shoes (to hold them up for display), with the aesthetic function that this oversized shoe has in drawing people closer to the shoe(s).

Once again, as witnessed in the example of Hoopert’s *Wire Typography*, there is the promise of touch. Here, more literally, consumers can touch the wooden pegs if so desired. Of all the senses, touch plays a major role in determining purchase decisions: Every design decision that leads to tactile interaction with the product increases the likelihood of a positive outcome in purchase behavior (e.g., Lindstrom, 2005a). The sense of touch can also be designed for mental representation through the other senses. This can be achieved, for instance, through careful selection and design of visual and/or audiovisual information to allude to tactile qualities, such as the visual patterns and impressions of texture, as well as the sounds of touch-based interactions (e.g., finger nails scraping against the corrugated impressions of woven fabric). Thus, the enticement of the 3D yet still stagnant representation of the giant shoe, generating attention toward the space of the Bagua shoe display, also plays a role in accentuating the desirable physical qualities of the real shoes, that is, softness, flexibility, lightweight, comfortable, and highly mobile.

At first glance, obtaining tactile information could be considered a simple process, in that people tactually can sense different textures, warmth, and hardness of materials. However, the physical experience of touch involves different active movements in constructing the sensation (Sonneveld & Schifferstein, 2008), such as maintaining static contact to assess warmth and coldness, exerting pressure in evaluating weight, conducting lateral movements to sense texture, and grasping to understand shape and size (Gibson, 1966). Yet, even while obtaining sensory information through touch, other senses come into play. Thus, the experience involves mentally constructed information that incorporates all the senses, a process often referred to as sense data (Firth, 1949; Russell, 1917/1951; Wittgenstein, 1968). Sense data are the information individuals already possess as the result of experiencing an object or phenomenon via the senses at an earlier point in time that are subsequently connected to other forms of mentally-bound information, such as remembered scenarios, sentiments, and emotions (Russell, 1917/1951). These are ultimately carried into future experiences with other objects and phenomena through the process of apperception (Huemer, 2001; Jackson, 1977; Saariluoma, 2003). Thus, a current sensory experience comprises not just the sense that is explicitly and physically involved in the interaction but also all the senses that a person may have experienced, with the notions of the perceived object or phenomena assisting in the apperceptive meaning-making process (Rousi, 2013b; Silvennoinen et al., 2015). This means that perceived or mentally-bound multisensory information is always involved in the immediate apperceptive process.

From the cognitive–semiotic perspective, the interpretation or mental representation of the encounter also plays a role in implying qualities of the perceivable signifying element. That is, just as tactile qualities of the display of shoes can be imagined through visual perception, so too can qualities pertaining to other senses, such as taste and smell. This additionally renders the dynamics of simplicity–complexity as not simply a physical organizational relationship but also a mental sensory organizational relationship. Impressions, associations, and attributions made toward the object (i.e., the shoes and their qualities) are formed in the interplay between what is sensorially perceived and what *could be* perceived—perhaps a potential peppermint taste of the white pegs, or the actual smell of the plywood display combined with the leather of the shoes. The connection between the signifying element of the 3D-2D peg shoe display and the material object regarding the simplicity of the shoes is quite iconic (Peirce, 2009) or direct. The way in which this simplicity is experienced—both in interpretation (mental representation) and understanding of the immaterial values that also are somewhat overtly expressed through simplicity and shoes just being shoes—enables the qualitative representation of the experience to be closely related to the other components of the cognitive–semiotic process. Limiting the options and alternatives in design expression (signifying element) and display, and intimately tying these expressions to values (immaterial object) eases both the cognitive processing and interpretation, and subsequent linguistic recollection of the encounter (Rousi, 2013a).

Understanding the intertwining between the simple and the complex, with the multisensory (multimodal) material and immaterial, is steadily gaining footing also in the area of information technology. The controversial liaison between reducing information in terms of form or presentation (and representation) to achieve ease in comprehension and use, while yet increasing information in terms of sensory input—designing not just for one of the senses but several—actually increases the touchpoints of designs. These touchpoints are the elements that

physically and linguistically connect the consumers or users to the designs. That is, through paying careful attention to how the modalities inform one another (i.e., how sound and touch may compliment sight, and how smell and sight may compliment taste, etc.), increased sensory information boosts ease in product comprehension. This in turn aids a person's ability to cope with the growing demands of multisensory information flows (Ludden & van Rompay, 2015). Subsequently, greater affect within users or potential customers results due to the heightened likelihood that the product will be remembered. This is specifically relevant when looking at the influence that multisensory information has on recall.

Further, studies have demonstrated how the capacity of working memory is increased when perceiving information designed for multiple senses as compared to information that is sense specific (Beauchamp, 2005; Quak, London, & Talsma, 2015; Sauls & Cowan, 2007). In other words, from the cognitive–semiotic perspective, the meaning-making component of design experience or the connection between the intepretant, signifying element (design), and the object (links between working memory and the semantic dimensions of long term memory, see Quak et al., 2015) is strengthened through more touchpoints—that is, defining elements—within the design.

Figure 5 illustrates the trend toward a tactile material approach to smartphone design. The author of the “20 Best Phones 2015” blog entry, Chris Martin (2015), characterized the role of touch in smartphone purchases and use as definitive in that consumer preferences in design come down to personal taste, with most of the top smartphones now having a very thin and lightweight chassis. The best smartphones, according to pcadvisor.co.uk (Martin, 2015), typically use premium materials like glass, aluminum, or even steel. Further, Martin (2015) asserts that consumers are better served by trying a phone in the flesh to see whether it feels good for the size of their hands.

From the cognitive–semiotic perspective, personal taste and its relationship to perceived (and apperceived) sensory data are intrinsically linked. The way in which people physically



Figure 5. Smartphones designed to be touched through being designed and manufactured in differing materials, shapes and weights (Martin, 2015).

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perceive and apperceive is not only highly subjective but also greatly influenced by the physical reality of the user. For instance, sensory perception is known to decline as people age (Anstey, Wood, Lord, & Walker, 2005). This means that while the mind possesses information pertaining to certain sensory experiences—including memories or scenarios and situations, sentiments and emotions—the physically acquired information does not necessarily correspond with the stored sensory data. Furthermore, the needs of the users or consumers that change as well with age also shape how information is experienced. For example, haptic feedback of touchscreens would be highly valuable to those who are poor of sight, or are uncertain regarding the outcomes of their interactive actions. A leather case, for example, may additionally provide extra grip for feeble, arthritic hands that have trouble clasping a hard, smooth, and slippery plastic case.

Interestingly, attached to Martin’s (2015) blog post, was a poll for readers to vote for their favorite smartphone material. Thus, the multisensory and embodied nature of the design directions of smartphones were acknowledged not simply through the text of the article, but through engaging the readers in interaction to provide insight as to material preferences and intriguing material design possibilities.

In the poll soliciting favorite smartphone materials, readers of “20 Best Smartphones 2015” (Martin, 2015) had a choice between metal, plastic, wood, leather, glass, and ceramic. As of August 13, 2015, the two top materials were metal and plastic. These materials should not be surprising due to the prominence of these materials in application. Even though the poll is not a scientific study, its results are to some extent indicative of phone-users’ preferences, such as the overwhelming preference for metal (64% in comparison to 10% for plastic). This may allude to one of two things. Firstly, metal may be the preferred smartphone material due to its durability. Secondly, and a matter that should be quite obvious considering the dominance of iPhone advertising on the page, is the connection made to brand, that is, Apple and its metal casing. This theory may be supported in light of the third most popular choice (the leather casing; 9%), as similar to the example phones utilized in the poll (see Figure 6, some new smartphones are sporting leather casings). Wood and glass scored the same results (7%), while only 3% preferred ceramic covers.

The material qualities of the casings are one aspect of the technology design. The relationship between material properties and brand is another. That is, brand experience is constructed through assembling an array of elements, none the least, tangible compositions of materials, signature forms and logic. Jonathan Ives designed and inspired Apple products are classic examples of the systematic application of material, color and form choices to embody the look and feel of the Apple brand. From the perspective of the complexity involved in designing for seeming simplicity—corporate or product—branding is a multicomponent process in which a company develops an image or identity of itself and its products for specific target groups (or publics). These tangible or visible design qualities are intended to identify with and reflect ideas and values for the purposes of triggering certain types of emotions (Thompson, Rindfleisch, & Arsel, 2006). Branding is achieved through a number of initiatives ranging from strategic public relations, corporate alignments, and advertising to developing a design language that is reflected in products and their material components and communication. Material branding has been operationalized for decades in companies such as Apple, Nike, and the Finnish companies of Marimekko and Iittala. Other companies, such as hotels and restaurants even go as far as scent branding (Lindstrom, 2005b, 2006). These are all

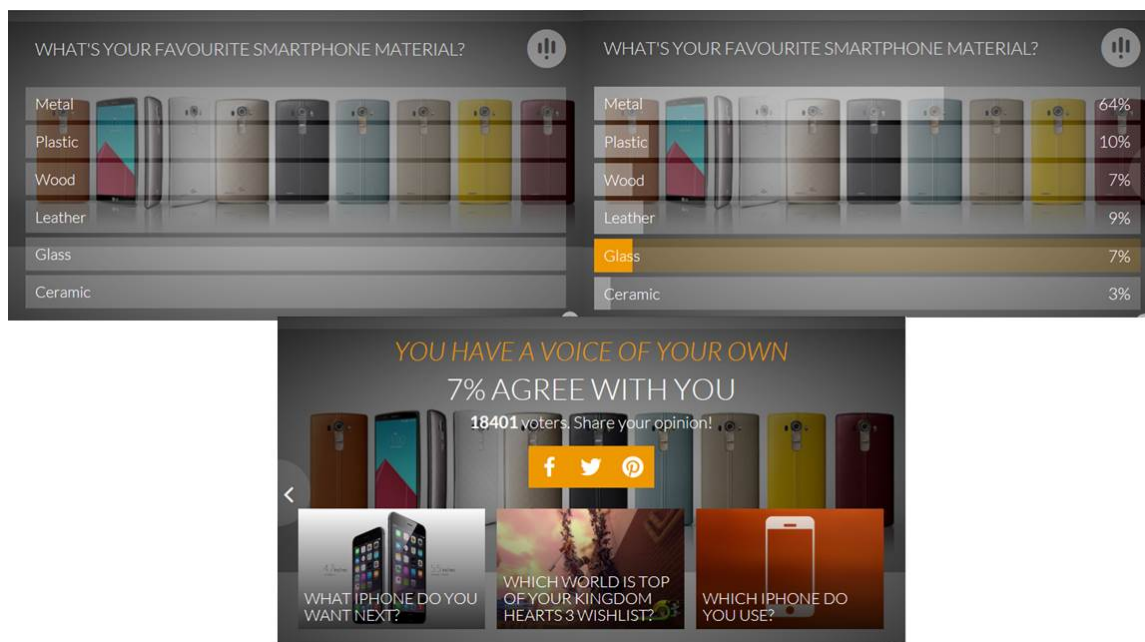


Figure 6. Screenshots of the online poll “What’s your favorite smartphone material?” The above left shows what respondents saw before responding; after responding (above right); after the poll results were tallied (below). (Permission to reprint granted by Matt Egan, courtesy of www.pcadvisor.co.uk.)

acts of sensory branding (Kim, Koo, & Chang, 2009; Lindstrom, 2005b, 2006). Appealing to the senses, particularly in terms of touch and smell, is a strategic act to induce primal emotional responses (Mueller & Szolnoki, 2010). In particular, the sense of smell has a close connection to the limbic system, the area of the brain responsible for emotion, motivation, learning, and memory (Porcherot et al., 2010; Spinella, 2002; Willander & Larsson, 2006). Thus, if a company is aiming to be memorable in a specific way, they will strategically align their products and brand through careful selection of olfactory qualities.

Through presence and repetition, a brand becomes familiar. Strategic multisensory design to appeal to and encourage certain emotions enables and eases the learning process and the memorable nature of the brand and its material and immaterial associations and qualities (the object in the cognitive semiotic process). Through branding, customers are more readily able to learn about companies, or at least the products and values that the companies represent (Thompson et al., 2006). According to Maeda (2006, 2007) and Feynman (1981), learning makes things simple: The more individuals are exposed to and are familiarized with phenomena, the more complete their own mental representation of the design becomes. Thus, learning enables the experience of simplicity. That is, the more familiar people become with phenomena and their associated information, the easier design is to understand and the faster these designs and their associated parties may be recognized and connected with the information it is built upon. Learning occurs through patterns (Chater & Vitányi, 2003) or chunks of information (Neath & Surprenant, 2003). Thus, learning is where chunks of information are broken down into smaller pieces and mentally assembled in meaningful ways. Patterns not only facilitate learning but learning makes patterns more readily visible. As Feynman (1981) mentioned, the more people learn, the more complex

they understand the systems to be, yet through familiarity the complexity becomes simpler. Thus, simplicity is complex, and complexity enhances simplicity (Maeda, 2006).

CONCLUSIONS

Throughout the article, a cognitive–semiotic approach, operationalized into a cognitive–semiotic model, has been integrated into a discussion of the dynamics of simplicity and complexity and through examples of information–technology design, retail design, and art design. We have characterized the interdependent relationship of the concepts of simplicity and complexity in light of the cognitive–semiotic model of design experience (Rousi, 2013a). We have depicted the multifaceted qualities of simplicity in terms of preference (i.e., preference induced by understandability and the ability to recognize patterns) as well as the aesthetic qualities of simplicity (e.g., symmetry, contrast, and clarity) by drawing on Gestalt psychology (Gombrich, 1995; Solso, 1997; Wertheimer & Riezler, 1944). At the same time, we have demonstrated that objects and phenomena recognized as simple often, in essence, are highly complex. This type of complexity affords interest and learnability, which has constantly been present in nature, historically visible in art, and is gradually being utilized more frequently in contemporary product design, particularly of information–technology products and their components (e.g., smartphone casing).

Moreover, we have articulated the nature of simplicity as the successful organization of complex elements, particularly in relation to multisensory design. The cognitive–semiotic model of human–technology and design experience (Rousi, 2013a) was utilized to explicate the dynamics of simplicity and complexity in the examples of Dan Hoopert’s (2013) *Wire Typography*, a retail display of Bagua shoes, and the material design of smart phones. Operationalization of the model enabled examining how the various material and immaterial components are communicated through the designs via various perceived and mentally-bounded sensory data. All examples, at first glance, appeared somewhat simple in nature through their signifying element (the design syntax). Yet, all revealed and upon further inspection, the complexity in their construction becomes apparent, whether that is through implied structural qualities, their actual construction, or their materials. This also impacts the object, that is, the phenomenon toward which the signifying element is referring. *Wire Typography* (Hoopert, 2013), for example, alluded not just to the complexity involved in the formalistic structures of the Latin alphabet but also to the virtual–physical nature of contemporary communication and the complexity of language in itself. The mental representation, or the way in which these examples are experienced or apperceived, depends on the existing mentally bound informational content the observer (e.g., user or customer) possesses. But, these contents are also highly dependent on facets such as culture, socialization, and the context within which designs are encountered. Finally, the qualitative representation, the signifying element representing a user’s mental interpretation of the design, is the qualitative expression or description of these experiences. That is, what people say about how they experience design should be treated as a signifying element (a sign or symbol) of what is being thought about the experience.

From the perspectives of cognition and the schools of Gestalt and experimental psychology, designing for the multiple senses instead of just one allows for a greater

likelihood for the memorability of a product due to its increased ability to generate emotional response (Porcherot et al., 2010; Quak et al., 2015; Spinella, 2002; Willander & Larsson, 2006). Thus, through increasing sensory information, designers are in fact making products simpler (i.e., easier) to understand and remember. This is achieved through adding more details regarding the physical nature and properties of the designs as experienced through increasing interactive qualities, such as texture, weight, scent, and so forth, while simultaneously connecting these designs and their elements more directly to the limbic system of the viewer or user. The limbic system is a part of the brain responsible for learning, emotions, and memories, to name a few (Quak et al., 2015; Willander & Larsson, 2006). Multisensory design increases touchpoints in products, and this is being explored in the domains of psychology and marketing through, for instance, sensory branding (Lindstrom, 2005a, 2006).

This matter also rings true in the realm of usability, whereby the reduction of options or functions does not necessarily heighten simplicity or ease of use. Instead, it may also have the adverse effect of increasing complexity through decreasing user control (Norman, 2007, 2008, 2010). Thus, rather than making things easier in terms of minimizing options for interacting with functions, reductionism actually can make things difficult. In reality, the nature of simplicity is complex. When designing—whether for Web pages, information-technology software, or hardware, physical products and services, or commercial touchpoints, such as retail displays and advertising—it pays to carefully consider the relationship between the elements and their qualities (material and immaterial) and contemplate how they afford the understanding and memorability of products from a cognitive processing perspective, and how they are linked to basic emotions.

The cognitive-semiotic approach to analyzing these relationships is useful on both practical and theoretical levels. Not only does it assist understanding in how the designs (signifying elements) are reflecting the intention (object) of the product, but also how the expression (qualitative representation) of this understanding (interpretant) manifests as another linguistic, cultural, and socially shaped signifying element of the design.

Thus, the contribution of this paper exists within its theoretical development of the relationship between simplicity and complexity in the areas of design and cognitive-emotional processing, via cognitive-semiotic engagement in its implementation within the areas of information technological design, retail design, and art design (Rousi, 2013a). Furthermore, through connections made in the multidimensional links between simplicity and complexity (e.g., physical versus virtual, philosophical and metaphorical versus literal), this article also has highlighted direct design implications from the perspectives of user experience, cognition, emotional design, branding, and longer term people-product relationships (Hassenzahl, 2003).

IMPLICATIONS FOR THEORY, EMPIRICAL RESEARCH AND DESIGN

This article brings implications for various areas of design and art for theory building, ongoing empirical research in HTI and design, and ongoing product and service design processes. To begin with, this is among the first publications to apply Rousi's (2013a) cognitive-semiotic model of human-technology and design experience to the analysis of

the dimensions of simplicity and complexity. This model and perspective can be used to not only understand the nature of experience when considering the dynamic relationship between simplicity and complexity but also to understand (a) the connection between sensory input and what this input refers to in terms of function, qualities and values, and (b) how the qualitative representation of the experience relates to the process of encountering and mentally representing the experience. When considering qualitative representation, contemplation of quantitative data is beneficial, for even in cases of quantitative results, respondents need to qualitatively interpret questions that connect the design they are evaluating to how they think about the design. If used in a systematic way, the cognitive–semiotic model is useful for designers because the components of the model serve as explanatory nodes of how design decisions and user interpretations operate on material, immaterial, and representational levels. The cognitive–semiotic model of design experience, when employed during iterative design, provides designers with greater ability to understand the relationships between how people talk about their impressions of the designs, how these are connected to syntactic design decisions seen in the signifying element (the design itself), and how these reflect the interpretation of the relationships between the design and the object it represents.

ENDNOTES

1. David Hume (1739/2000) is the philosopher most commonly associated with the problem of induction. His concern was for understanding the reasoning and explanatory power of how people come to the conclusions and beliefs that they come to, whether this is through observation or relations of ideas that can also be demonstrated, yet still may have no empirical basis (Henderson, 2018)
2. Nedungadi and Hutchinson (1985) provided a detailed description of how prototypicality can be applied to explain brands and brand relationships.
3. In order to see an illustration of Picasso’s Bull etchings, please visit the ArtyFactory website at http://www.artfactory.com/art_appreciation/animals_in_art/pablo_picasso.htm
4. To view an image of this Bagua shoes display, please see the Artica Web log at <http://retaildesignblog.net/2012/08/08/bread-butter-berlin-2012-summer-bagua/>

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Authors' Note

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