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**SPECIAL ISSUE
SADE: SEMIOTICS + ART AND DESIGN =
EXPERIENCE**

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Guest Editor's Introduction**EXPLORING AESTHETICS, DESIGN, AND EXPERIENCE
IN THE AGE OF SEMIOTIC TECHNOLOGY**

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Where there is technology, there is semiotics. Semiotics refers to the science of signs; the study of symbols, markings, and their meanings in the way people interpret them. The human and, arguably, animal worlds are literally littered in signs, both natural (Eco, 1976; Peirce, 1958, p. 172) and artificial (i.e., intentional; de Saussure, 1916/1983). How these are understood and studied depends on the context, purpose, and individual. The built and designed human world can be equated to a massive sign system, in which every form, color, quantity, material, and logic has a communicative function. Architecture, for example, is a classic realm of technology in which form, style, material, and scale have been systematically used to impose societal hierarchy and order upon those who encounter it (Crouch, 1999). Architecture, as with any form of art, design, or technological form, communicates the logic, the values, and the actions of the times. In other words, from a technological perspective, designs are only available at certain periods of time if they serve a purpose, whether functionally through operation or from the perspective of societal ideologies and systems, through style. What is more, the physical nature in which they are realized is also instrumentally linked to public, political, and historical discourses that reinforce their meaning and significance in relation to the public that receives them (Crouch, 2010). When considering contemporary consumption, and that of information technology, this is particularly evidenced in regard to brand value, for instance. That is, bountiful significance and meaning can be obtained from design form through analyzing the technological items' forms, materials, scale, style, and functions as compositions. The meaning derived from these elements, in connection to brand recognition, act in a very similar way to that of architecture over the centuries. That is, messages inherent in the technology shape people's lives through molding their behaviors and exposing them to aesthetic compositions that contribute to formulating peoples' worldviews and norms.



Signs and their comprehension have always played an important role in survival across the animal kingdom (Morris, 1946; Nöth, 1995), many of which humans have had to decipher for their own survival. However, it can be said that through the infiltration and dispersion of digital technology across myriad aspects of daily life, the relationship between humans and more abstract, symbolic, or intangible (i.e., nonrelated to the physical world) signs has become ever more interdependent (Saariluoma & Rousi, 2015). Already in the basic models of semiotics developed by mathematician and philosopher Charles Sanders Peirce in the late 1800s, reference was made to differing types of signs (see Peirce, 1982/2009). Symbols, for instance, were described as signs not bearing any direct relationship to physical phenomena, yet were understood through social and cultural consensus. Indices were seen to be causal signs for phenomena that could not directly graphically be represented (such as speed, temperature, time, etc.). Icons were indeed the signs that directly bore a relationship to the phenomena they were representing.

Nearly a century and a half on, with rapid developments of information technology in contemporary society, semioticians find the need to rethink the field and its terminology. The challenge, readily foreseeable for the future, is that people's imaginations and a variety of commonplace phenomena do not have bodies (i.e., cannot be physically represented), yet have emerged through discourse, language, and fantasy. For instance, if a person living in the year 2018 were to travel back to the year 1958, how would he/she describe to the residents of that time something used every day and everywhere called the Internet? Even these days the Internet represents many different things to many people. It certainly is about information streams and masses of information. But the nature of the information—how it works, what it delivers, and what it can do, and the kinds of connectivity that enables hackers, for example, to take over and drive the family car remotely from a mobile phone (and, incidentally, how would smartphones be perceived in the 1950s?)—would not likely have entered the consciousness of most people back then, if at all.

It is through this realization that information technology is rendering the impossible possible, that an awareness is developing toward the fact that it is not enough to understand how people use and behave in relation to technology. Rather, semiotics undergirds understanding how people experience life (in general and in specific contexts) in light of technology and its design. Semiotics, through these sign systems, can explain how the information provided in designs (form, color, scale, logic, etc.) is understood on the basis of people's already accumulated lived experience. As demonstrated in the articles of this special issue, titled SADE: Semiotics + Art and Design = Experience, understanding of human–technology interaction can be enriched by analyzing the aesthetic and semantic levels of the designs in question. This is achieved through not only drawing on knowledge from the past decades of scholarship in human–technology or computer interaction, but also from centuries worth of philosophy, practices, and theories in aesthetics, embodiment, and art experience, to name a few.

It is therefore a pleasure to introduce the articles of this special issue. The articles are, to varying degrees, essayistic and explorative in style in making their contributions. The issue opens with a philosophical discussion on challenging popular notions of aesthetics in human–computer interaction design. **Mads Nygaard Folkmann's** article, "Exploring Aesthetics in Design: Implications for Human–Computer Interaction," focuses on expanding readers' understanding of aesthetics by drawing on theory and observations from humanist disciplines

including design and art. Folkmann addresses the user interface by shifting its context from the screen to other design areas. This is necessary to illustrate how the aesthetic experience exists in relation to how people approach the world, and subsequently, it is this logic, particularly the logic instilled by culture, that informs the factors, values, and qualities that combine to compose the experience. For example, Folkmann uses the design company HAY to exemplify the ways in which not simply the design, but also its presentation or mediation (remediation), encourages reflectivity in the way designs are experienced. That is, through both multi- and transmodality of the ways in which the designs are presented (and thus exist), other entities or cultural products (e.g., image compositions) are formed. Through the framing of design and their contexts as design or aesthetic pieces in their own right—as well as the interaction between the designs themselves and their alter egos seen in the advertising compositions—aesthetics represents the interface between the world within the person and external to the person. Thus, Folkmann's article discusses the need for deconstructing designs and their cultural framing to understand that the aesthetic experience of technological products that do not lie within the designs themselves, but rather how they are culturally related to the public and private perceptions.

From a slightly different perspective, yet observing the influence of overall emotional sentiments as reflected in culture or cultural products such as architecture, **Lewis Urquhart and Andrew Wodehouse** propose a novel way of measuring emotion through lines and time. The authors also delve into the realms of ancient philosophy to argue that the term *form* has numerous meanings and that the ways in which forms are perceived comprise both material, or matter, and the shape of the matter. Urquhart and Wodehouse propose that emotions and cultural sentiments of specific periods in history are framed and represented through the structures formed by artistic and architectural practice. Thus, thought, intention, and emotion can be witnessed through technology (i.e., anything intentionally created by human beings for differing purposes; e.g., architecture and design objects) and its form. In other words, the form reflects a nonverbal account of the narratives, associations and, traditions of particular societal eras. The authors draw from decades of psychological research regarding the relationships between form (specifically form being constructed through lines) and emotions—and specifically how lines communicate emotions. Urquhart and Wodehouse utilize examples from text font to optical illusions, and from classical artistic landscapes to architecture, to demonstrate how the line or form inherent in products are communicative in terms of an interaction between ideologies embedded in cultural and political movements and overall underlying societal sentiments. Based on the authors' scholarship of the past, they have constructed a model for applying their observations of the emotional qualities of line expression to the analysis of any kind of technological artifact. Thus, this article presents the line model of form and emotion that typifies major movements and their styles in one concise diagram. Furthermore, what the authors emphasize in this article is that not only are the cultural and technological structures a reflection of intention and emotion, but they indeed change the mental and emotional state of those who encounter them. Thus, human–technology interaction is not simply an interaction between people and objects or machines, but an interaction between thoughts and emotions from differing states and contexts.

In the article, “Simplicity and the Art of Something More: A Cognitive–Semiotic Approach to Simplicity and Complexity in Human–Technology Interaction and Design Experience,” **Rebekah Rousi and Johanna Silvennoinen** examine the dynamic and intertwined nature of the relationship between simplicity and complexity. Their article applies a

cognitive–semiotic model (Rousi, 2013) of technology design experience to explain the relationship between the sign or symbol (as seen in the design), what it refers to (the object, e.g., function or values), how it is interpreted or mentally represented, and how, in the end, researchers and/or designers access these mental interpretations of users through qualitative, often verbal, representations of their experiences. Rousi and Silvennoinen additionally problematize common perceptions of simplicity as reductionism and instead argue that simplicity is complex, yet is afforded through the careful ordering of and design for the multiple senses. In other words, the creation of seemingly simple-to-comprehend designs often entails complex systems of information directed toward the multiple senses of the user, thus allowing for greater understanding of the forms and products that are encountered. From Rousi and Silvennoinen’s cognitive–scientific perspective of the technological design experience, deliberate orchestration of sensory components (i.e., visual, tactile, olfactory, audio, and even taste-related elements) increases the “chunkable” (i.e., easily processed) information about the designs, and thus revealing more about their nature without overloading any one sense.

Finally, **Tore Gulden**’s article, “Engagement by Lamination of Autopoietic Concentric Interaction Systems in Games: A Study of Football and Pokémon GO,” compares two popular games and forms of play. Gulden applies Niklas Luhmann’s (1990) notion of autopoiesis—a theory of self-producing systems—to analyze how play, engagement, and experience are elicited through differing game types, as evidenced in the traditional physical team sport of soccer and the relatively recent, single-player augmented reality (AR) game Pokémon Go. Gulden’s argument is that autopoiesis, or the phenomenon in which social systems are constantly interacting with themselves (Luhmann, 1995; Maturana & Guilloff, 1980), can be applied to the study of games in which an explanatory framework of social lay experience can be extracted through paying attention to the structures, constraints (e.g., boundaries and rules), and contexts in which they are played. Gulden’s novel approach to comparing two distinctly differing games gives way to larger questions in modern game design and contemporary social systems through allowing the reader to reflect on why it is that single-player AR games with seemingly no physical boundaries or team interaction are so popular among both the public and game developers themselves. He proposes five concentric interaction systems that can help game designers analyze current and develop future games that improve the players’ engagement in games across the spectrum from real-world to AR to the virtual and for multiple purposes: entertainment, learning, or service.

Overall, while all of the articles in this current special issue are about semiotics, design, and experience in human–technology interaction, they also represent a diverse scope on both the interpretation of technology and how these concepts may be understood through the implementation of semiotic approaches. The diversity of papers sets the stage for readers to form a deeper and expanded insight into not simply the nature of experience relating to particular designs, but also the extent and complexity of these matters in relation to decades, if not centuries-worth, of theorization of and scholarship into aesthetics and experience.

Finally, I would like to dedicate this special issue, SADE: Semiotics + Art and Design = Experience, to the memory of Viktor Hjort af Ortnäs of Chalmers University of Technology, Sweden. This issue specifically grew out of the 2015 Nordcode seminar of the same name that Viktor so insistently encouraged to be held at the University of Jyväskylä, Finland. The seminar, as with this thematic issue, concentrated on exploring the relationship between art, design, and experience through applying semiotics to explain and to develop the connection

between form, application, context, and cognitive–emotional experience. As these papers testify, such research is essential for the ongoing advancement in understanding myriad aspects of human–technology interaction. Viktor’s legacy embodies not only that Nordcode seminar and this special issue but the foundation he helped establish in bridging art and semiotics disciplines with ongoing research on the intersection of humans and technology. I am grateful for his encouragement of this specific topic.

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EXPLORING AESTHETICS IN DESIGN: IMPLICATIONS FOR HUMAN–COMPUTER INTERACTION

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Abstract: *In this article, I enter into a discussion of how aesthetics can be conceptualized in the context of design and related to the field of human–computer interaction (HCI). I contest the current trend in design aesthetics that primarily focuses on beauty, pleasure, and the creation of emotional appeal by means of the sensual and visual elements of the design. Conversely, I advocate for a series of concepts related to aesthetics, such as reflectivity, representation, and epistemology, as these point aesthetics beyond the immediate sensual and visual. Through these concepts, a deeper understanding of the character of the relationship between humans and design can be obtained: Design objects and HCI solutions can be more accurately described in their roles as interfaces for how humans approach the world. This broader perspective on aesthetics has implication for practice when designers set the task of creating new experiences for the users.*

Keywords: *aesthetics, HCI, representation, reflectivity, epistemology.*

INTRODUCTION

In the last 30 years, design has increasingly become more technological, either as the product outcome or as a tool in the process. Many design objects contain digital technology, and the field of human–computer interaction (HCI) has developed as a response to the challenge posed by computer technology and the resulting new types of interfaces. In this context of technological design, the focus on use and function has been dominant. However, in recent years, researchers in the field of HCI have broadened their interests from function and efficiency in the interaction between users and artifacts to the larger consideration of the user’s social context and emotional responses. In brief, the “focus of HCI design has expanded from *interface to experience*” (Jung, Wiltse, Wiberg, & Stolterman, 2017, p. 26, *italics in original*).

Even if it may be too bold to label this as an aesthetic turn, researchers in the field have testified to have a growing interest in aesthetic value. Attention has been directed towards the nature of aesthetic experiences in relation to HCI, such as a dynamic and contextually bound “interaction aesthetics” (Xenakis & Arnellos, 2013, p. 59) or “user interest, excitement and satisfying experiences” (Sutcliffe, 2010, p. vi; see also Engholm, 2010; Lindegaard, 2007; Silvennoinen, Rousi, & Mononen, 2017). Moreover, the focus of research has been on the role of beauty in the designed interfaces and devices (e.g., Bollini, 2017; Tractinsky, 2004; Tuch, Roth, Hornbæk, Opwis, & Bargas-Avila, 2012) or on questions of visual styles in interfaces and interactive design (e.g., Buur & Stienstra, 2007; Engholm, 2008), such as website design.

The emphasis on experiences aligns with a trend in the wider field of design research to investigate how design objects may be evaluated positively by users. Beginning in the 2000s, focus has been increasingly on the pleasurable in relation to products and how emotions may play various roles in product design. In particular, Patrick Jordan’s *Designing Pleasurable Products* (2000) and Don Norman’s *Emotional Design* (2004) have been influential in describing a paradigm shift in research perspectives beyond product usability and acknowledging the various responses humans can have to products (see also Green & Jordan, 2003). In general, the recognition of the pleurability of design objects marks a desire to understand aspects of design other than functionality and, further, how these aspects affect the process of designing (Da Silva, Crilly, & Hekkert, 2016; Desmet, 2012; Hekkert, 2014; Hekkert & Leder, 2008). For example, a lemon squeezer may solve the task of providing lemon juice, but also may be a pleasure to handle. In particular, Jordan’s (2000) framework of four different pleasures, building on Lionel Tiger’s (2017, p. 276) assertion of the “moral, scientific, and political authority of pleasure,” has demonstrated the potential for understanding products through their appeal to pleasure. Pleasure not only relates to physical sensation in the interaction with products but also may relate to social well-being, psychological responses of satisfaction or of fulfilling a task, and the ideological level of feeling alignment with personal values and beliefs. To take the lemon squeezer again as an example, it could be a social status object to have in one’s kitchen and aligns with notions of identity and lifestyle. Philippe Starck’s famous lemon squeezer, Juicy Salif for Alessi (created in 1990), is designed to be such an object (Figure 1). Additionally, pleasurable appeal is at the core of the psychologically oriented Dutch project Unified Model of Aesthetics (UMA), where researchers seek to predict how “aesthetic pleasure results from a balance between two opposing forces” (UMA, 2017, line 7), for example, unity and variety or typicality and novelty.



Figure 1. Lemon squeezer *Juicy Salif* designed by Philippe Starck for Alessi, Italy in 1990. This lemon squeezer is probably one of the most discussed in the literature on material design (cf. Julier, 2014) and is on the cover of Don Norman's book *Emotional Design* (2004). The lemon squeezer provokes by being on the verge of nonfunction; it invites reflection, interpretation, and debate. Image credits: Alessi S.P.A.

In this article, I propose another perspective on aesthetics in design that is valuable for the field of HCI. Thus, the article can be read as a contribution to the character and role of aesthetics within the interdisciplinary field of HCI. The central research question is this: Which concepts deriving from aesthetic theory can be relevant for understanding how HCI solutions operate as interfaces for how humans approach the world? My approach is theoretical in the sense that I explore sources of aesthetic theory and contest their relevance and application for HCI and design. The method is to revisit aesthetic concepts not normally related to HCI or design and to explore their potential for a deeper understanding of how these influence the operation of interface. The disciplinary approach is a combination of philosophical aesthetics and art-related hermeneutics. Through this approach, my scientific contribution is to expand the understanding of aesthetics in HCI by going beyond aesthetics as a concept for describing the beauty of objects or the satisfying or positive pleasurable experiences users get from them. I propose three analytical concepts that raise questions related to reflectivity, representation, and epistemology involved in the perception, apprehension, and understanding of design. Hereby, the common association of the concept of aesthetics with the concept of beauty is challenged, as much aesthetic theory deals with questions of the complexity and communicative capabilities of the aesthetic artifact rather than beauty.

THE INTERFACE: HOW HUMANS APPROACH THE WORLD

Aesthetic theory can describe the interface between humans and design. In this context, the term interface should be understood broadly as humans' conditions for meeting the designed world, whether it may be through designed objects, graphic representations, or digital interfaces. Of course, digital interfaces abide by specific technological conditions (Stalder, 2016); still, the interface can be seen at a general structural level as the touching point between humans and the designed world. My reflection will relate to design in general, but, in the end, the analysis will be most beneficial for investigating various aesthetic concepts relevant for the field of HCI.

Design—in its many forms as products, interfaces, and graphics—is a central component of people’s interface with the modern world: People see, perceive, and understand contemporary culture through its design and its expressions and representations. Richard Buchanan’s (1992, p. 19) idea of “design as a liberal art of technological culture,” which has been seminal in design research, may be helpful as an entrance to this approach to design. Buchanan proposed that the technology of design exists in disciplines of systematic thinking and different modes of conceiving and planning the artificial world. He stated that design, as part of the culture of technology, “points forward to a new attitude about the appearance of products,” where the appearance “must carry a deeper, integrative argument about the nature of the artificial in human experience” (p. 20). Buchanan did not specify what this means in practice, but his approach has been carried forward by a philosophical ambition of defining design’s role in the world as a driver for the creation of artificiality and as the horizon for human experience (see also Dilnot, 2015).

Aesthetics is, however, as a concept lacking in Buchanan’s approach. Yet, what aesthetics describes in relation to design is exactly the question of how products appear and how design operates as the artificial component in human experience. In order to ground the question of the artificial in a framework of aesthetic reflection, I will discuss how aesthetics evolves in a relationship between subjects and objects. Before coming to this, I will position my approach within the field of aesthetics.

DIFFERENT APPROACHES TO AESTHETICS

One approach to aesthetics derives from the disciplinary context of the philosophy of aesthetics, where researchers in recent years have shown interest to the field of design. A prime example of this can be found in the book *The Aesthetics of Design* (2013), where philosopher Jane Forsey attached the aesthetics of design to the experience of beauty in and of the functional. According to Forsey, a coffee pot may not be beautiful just because it looks or feels in a certain way but because it has a high use quality (see also Feige, 2018; Steinbrenner & Nida-Rümelin, 2010). By discussing the beauty of the functional, Forsey (2013) aimed to define the aesthetics of design between a general and broad focus on everyday life, on the one hand, and a philosophical focus on beauty with reference to Kant’s *Kritik der Urteilskraft* (1790/1995) on the other. Forsey’s philosophical point was that finding something “beautiful is a product of the form of our aesthetic judgments” (2013, p. 128), and aesthetic judgments may then adjust to the beauty of use in everyday objects, such as coffee pots. Typically, philosophical aesthetics is carried by an interest in aesthetic evaluation (i.e., how things are evaluated to be beautiful), the location of the aesthetic in an interchange of objective reality and subjective response (i.e., where to locate beauty), and the character of aesthetic experiences evoked by this process.

In a different approach, the psychologically motivated interest in aesthetics is carried by an interest in the nature of experience, especially how aesthetic experiences of beauty may be positive and lead to pleasure. This approach has led to a general interest in the nature of the aesthetic experience in its generic character of emotional and psychological responses (cf. Schaeffer, 2015). The psychological approach has been dominant within practice-oriented approaches to design and often has been led by an ambition to improve the practice of designing,

as discussed above. In accord with a recent trend within aesthetic theory to focus on the sensual matter and its effect on aesthetic experience, for instance, by Martin Seel (2000, 2007) and Gernot Böhme (2001, 2013), the focus is on how aesthetic objects may create some kind of (positive) sensual appeal and effect in look, feel, sound, and even smell.

In addition, art theory seems to be closely linked to a reflection of the aesthetic. In art theory, aesthetics is related to a conceptualization of the aesthetic medium; “aesthetics” in art theory may often simply signify a “theory of art,” as in Theodor W Adorno’s (1970) approach to aesthetic theory in his seminal posthumous work on the topic, for example. The term art is often implicitly understood as visual arts, especially when reflected in relation to design, but may in my perspective also relate to literature (as also done by Adorno). Art-related aesthetic theories have only partially been taken into consideration in relation to design and HCI because art represents something distinct from design solutions. Furthermore modern art-related aesthetic theories, to a high degree, not have had the concept of beauty as its primary topic (cf. Rebentisch 2013), while this perspective often is seen as central in design. I argue, however, that art-related aesthetic theories are relevant for conceptualizing aesthetics in design because they deal with central questions of how objects of design may create not only sensual beauty but also entail a critical reflection of the objects themselves as sites of meaning production embedded within cultural contexts. Consequently, objects may have the kind of agency whereby they point not only beyond themselves as means for use and function, but also operate as a medium for a reflection upon themselves as objects of design or a means of technology. When discussing reflectivity, I will in the remainder of the article attribute this kind of agency to the objects. The design of a lemon squeezer or a website may not only encourage pleasurable use and interaction but also points to its own being as design objects or websites. Elsewhere, I have proposed this as the conceptual–hermeneutical level of design aesthetics, in opposition to a sensual–phenomenological and a discursive–contextual levels (Folkmann, 2013).

METHOD

My hypothesis is that a deeper understanding of aesthetics than what normally is testified to in the field of design and HCI may provide knowledge regarding how design objects and HCI solutions operate as interfaces in how humans approach the world. In terms of epistemology, HCI solutions may create structures of how humans engage with the world and, in this way, frame what human understanding and recognition may be. To engage with computers is to engage with designed artifacts and interactive interfaces that organize knowledge and perception in the human mind. By exploring aesthetic theories, many of which relate to art, the scope of aesthetic experiences may be expanded from describing single subject–object encounters, which may evoke pleasure in the subject, to a more comprehensive understanding of what experience is in relation to HCI. In conceptualizing aesthetics beyond sensual and visual appeal, my aim is to demonstrate that HCI solutions may reflect their own meaning in relation to other designs and traditions. An interactive interface not only enables interaction but also relates, directly or indirectly, to other interfaces. As a consequence, aesthetics gains in importance as a disciplinary approach to HCI and design. Aesthetics deals not only with visual styles, expressions, or, in rough, the choice of color but also provides conceptual entries for understanding the role of human creations in experiencing the world.

In this article, I investigate the tradition of aesthetic theory in order to search for concepts with the potential to be reactualized within the context of HCI and design. In this regard, I posit that the understanding of aesthetics in design and HCI has too narrowly focused on beauty and sensual effects and that, as a result, much aesthetic theory has not been taken for consideration. Whereas most design and HCI research deals with positivist notions aesthetic, even to a degree where aesthetic impact becomes measurable and calculable, the kind of aesthetic theory I argue for in relation to design and HCI is more abstract and even “slippery,” as it implies a higher degree of interpretation. In my exploration for relevant concepts, I present this article as essayistic in method, which to a high degree reflects its origin as an explorative paper in the setting of the Nordcode seminar in Jyväskylä, Finland, in 2015. Also, when revisiting aesthetic concepts and relating them to the field of HCI and design, the concepts may diverge from, but remain related to, their original meaning. As Michel Foucault, the founding father of discursive archeology, already pointed out, concepts as forms of discursive knowledge are not fixed but rather are constituted as becoming, in that they are explorative (Foucault, 1969). In my conceptual approach, this article does not build on a gathering of empirical data; instead, empirical examples are employed to demonstrate the theoretical points. At the end of each subsection on the key concepts of reflectivity, representation, and epistemology, I will pose illustrative rhetorical questions to understand how design objects can be understood in relation to the proposed concepts.

By focusing on aesthetics as an entry point for investigating how humans meet the world through design objects, I take a philosophical starting point in the question of how aesthetic experience evolves as a result of the relationship between subject and object. Building on this starting point, I then ask how aesthetic meaning comes into being. By investigating how the world is met through, for example, a tablet computer, I mean to investigate how the experience of this meeting is aesthetic (not only as beautiful) and how it is constituted as such.

THE AESTHETIC RELATIONSHIP

In its philosophical tradition, reaching back to Immanuel Kant and beyond, to Alexander Gottlieb Baumgarten, the originating father of the discipline of aesthetics, and the English empiricists, aesthetics has dealt with human experience, judgment, and appreciation of specific sensually or cognitively appealing phenomena. Consequently, a dominant discussion in aesthetic theory has been about the location of the aesthetic, specifically its site in the act of aesthetic appreciation. Kant’s seminal *Kritik der Urtheilskraft* (1790/1995) is symptomatic of this discussion. Kant spoke of value judgment and taste, that is, of matters of subjective concern, while he simultaneously presented the purpose of his thorough philosophical investigation of the field of aesthetics as a search for trans-subjective criteria for aesthetic evaluation in a *sensus communis* (Kant, 1790/1995, p. 172). In his conception, the judgment of taste is bound to the objective condition and not submitted to arbitrary subjective evaluation.

To take this reflection beyond Kant, the challenge is what kind of special *subjective* experiences does aesthetics call for: for example, coherence, harmony, and unity (Dewey, 1934/2005; Shusterman, 2000), a feeling of “pure presence” (Seel, 2007, p. 13), or “moments of intensity” (Gumbrecht, 2003, p. 204). All sorts of interfaces and objects (e.g., websites, chairs, refrigerators, tables, garden gnomes, lemon squeezers, and works of art) may serve as vehicles for

aesthetic appreciation according to idiosyncratic taste. At the same time, the question may also be raised regarding which concrete elements in design objects are capable of evoking aesthetic experiences. Objects, according to literary scholar Gérard Genette, have an “intentional aesthetic function” (Genette, 1999, p. 2) aimed at being perceived and experienced aesthetically. Genette looked at works of art.

In this conception, aesthetic meaning can be described as a relationship between a subject with an intention to see and perceive something as aesthetic, as well as to have aesthetic experiences, and an object with features that are encoded to be experienced aesthetically. The process of aesthetic meaning evolving between subjects and objects is what I understand by the aesthetic relationship. By this, aesthetics describes a theory of investigating how designed objects and solutions may be conceived and implemented in a way that elicits responses from humans perceiving and engaging with these objects. It needs to be considered, however, that not all aesthetic experiences in design and elsewhere are intentionally evoked. Aesthetic experiences may be induced simply by the aesthetic properties of the designs that were not intentionally conceived to induce aesthetic effect. For analytical purposes, however, it is valuable to focus on properties that can be said to be aesthetically coded (and thus intentional).

In addition, it is important to acknowledge differences in traditions regarding the concept of experience. The pragmatist, Anglo-American tradition has tended to promote aesthetic experiences as special moments of sensation. Dewey (1934/2005) pointed to the special character of “having an experience” that, for instance, can be facilitated by works of art. (Even though Dewey aimed at general experience, he often pointed to works of art as examples of special catalysts.) In his view, works of art may “concentrate and enlarge an immediate experience” and present a “pure experience” freed “from factors that subordinate an experience as it is directly had to something beyond itself” (Dewey, 1934/2005, pp. 285–286). In contrast, in the aftermath of Kant, philosophers of the European Continental tradition have been interested in questions of perception and epistemology regarding how experience contributes to knowledge. The German coining of the concept *ästhetische Erfahrung* (aesthetic experience) aimed at understanding the dichotomy of subject and object in which subjects—on the basis of certain objects, primarily objects of art—may be affected and thus experience the world in new ways. This then can form, for instance, a deeper or enhanced sensation of the everyday life, or even a feeling of “emancipation” (Lehmann, 2016, p. 22). In German, a difference in words exists between *Erlebnis* (being in a special moment of experience) and *Erfahrung* (pointing to the structure of experiencing), whereas this difference is blurred in English, with the single term experience designating both.

Through aesthetics—a way of describing the interface between objects and humans—it is possible to understand how the “technological culture” of design (cf. Buchanan, 1992), which creates an interface for how humans approach the world, operates on a concrete level. This approach may be applied to static design objects, such as furniture and kitchen utensils, to dynamic interfaces in HCI, and to digital design objects, which may be labeled “half-things,” as they are objects that still have the character of a material thing to be grasped but which, due to the embedded digital technology, always can perform more in function than can be detected by the eye (cf. Selle, 2014). Of course, there are variations in the degree of aesthetic coding, that is, how the design in question calls for aesthetic appreciation. This may, further, call for different concepts of aesthetics depending on the specific design.

AESTHETICS BEYOND THE SENSUAL

Several reasons justify considering aesthetics in design as more than the sensually and emotionally appealing qualities of design. First, design objects are artificial constructs that may promote (or even provoke) new ways of understanding and engaging with the world. Additionally, they may reflect their own status as sites of meaning production, which can be described adequately by aesthetic theories. Second, aesthetic theories cover, as discussed above, a larger field than theories related to sensual or emotional responses. In particular, theories of art may prove fruitful because they often deal with the question of how works of art may operate as mediums for special experiences or new understandings, for instance, when the “method” of a text by Tolstoy is to let the reader see the world through the eyes of a horse (Shklovsky, 1993). In my view, these theories can contribute to a deeper understanding of the aesthetic relationship in design, especially regarding the aesthetic coding of the object in question.

Therefore, in this section I take as the starting point the theories that investigate how aesthetic artifacts may operate as vehicles for constructing meaning and patterns of understanding. I primarily concentrate on positions in the European Continental tradition because the clearest statements on this perspective can be found there. In his book *Ästhetische Erfahrung*, philosopher Rüdiger Bubner (1989) raised the question of how artworks may condition new modes of experience. In this line of thought, the aesthetic experience does not deal with pleasure as a feeling of fulfillment (Jordan, 2000) but rather as a reflective “Form des Erkennens,” where the viewer “meets herself and the world” (Ebert, 2010, p. 155). Consequently, it may be asked what the meaning of design objects is beyond their purpose, even if they are still regarded as objects of use (Ebert, 2010). It may be asked how the design object may have “content that points beyond the object” (Foraita, 2011, p. 49) in the same reflective way objects of art do.

The kind of reflective–epistemological notion of aesthetics dealt with in this section can be traced back to Kant’s *Kritik der Urteilskraft* (1790/1995), where aesthetics was conceived as a basic aspect of epistemology that bridged sensual appearance and conceptually formulated meaning. For Kant, this was transmitted through the experiences of the beautiful and the sublime (especially in nature). However, aesthetic theories in the European Continental tradition have developed subsequently into more general considerations of meaning construction in artworks with only minor association with beauty in the art-oriented aesthetic theories influenced by Kant (see, e.g., Adorno, 1970; Bubner, 1989; Menke, 1991, 2013; Seel, 2000). Thus, that tradition will be my main platform for argumentation.

I focus my discussion of aesthetic theories in relation to design by relating it to concepts of reflectivity, representation, and epistemology. Of course, these have a scope wider than being concepts related to aesthetics; however, they also can show the different dimensions of aesthetics. A central interest induced by this line of aesthetic theories has been the reflection of how the aesthetic medium (as a matter of “form” with communicative abilities) relates to its idea or meaning content, which I will deal with in the next section on reflectivity. In the section of representation, I will deal with the question how aesthetics also entails questions of relating to underlying meaning systems. Further, a key area of interest deriving from these theories relates to the extra- and trans-communicative effects of the aesthetic artifact, meaning that it is possible to convey a meaning in these artifacts that is not possible elsewhere and often not even translatable to a meaning beyond the artifacts. In particular, Adorno (1970) dealt with this matter, as demonstrated in the epistemology section below.

REFLECTIVITY

Design objects may create not only sensual or emotional appeal but also reflect back upon themselves as media for meaning articulation in addition to their natural aesthetic status and constitution. Additionally, design objects may direct the user's attention to themselves as objects of a certain category or type of design and hereby engage the user in a reflection of what the object is about. Objects where the function is difficult to determine, such as clocks hiding their function as clocks or kitchen utensils with overt ornamentation leading astray from the function, may lead to such reflection. The effect may be a matter of pleasure, even though not in terms of an immediate sensually effective pleasure of using the object or the purposeful gain of social or ideological satisfaction, as in Jordan's (2000) notion of pleasure. Instead, it is a nonpurposeful cognitive joy of acknowledging and understanding the code of communication: The object is meant not only for a purpose but can be enjoyed as well for its ability to point to itself as a medium of communication.

To illustrate the reflectivity concept, Philippe Starck's 1990 lemon squeezer, *Juicy Salif* for Alessi (Figure 1), provides a good example. This lemon squeezer is not only aesthetically pleasing in the common sense of being sensually appealing, and perhaps even beautiful, but invites interpretation of its function. As a device, *Juicy Salif* squeezes lemons, but it also, and perhaps even more, presents an invitation for contemplative reflection. The *Juicy Salif* is not intended for habitual, nonreflective use as a lemon squeezer but points to itself as an object, that of being a lemon squeezer. It may even be argued that it problematizes this being as it is not obvious that it functions as a lemon squeezer. Further, as an object positioned as "design" in the context of "design culture" (Julier, 2014), the *Juicy Salif* opens for a reflection about what an object of "design" is in terms of function, appearance and consumer appeal.

In a more mundane application, that is, website design, the potential for reflective meaning also can be found. From a historical perspective (Engholm, 2008), much website design of the in the late 1990s experimentally explored the communicative potential of websites. Two different generations of websites from the Danish furniture company HAY may illustrate a development in website design in terms of how they relate to and reflect the code of communication. In the year 2000 version (Figure 2), the appearance is dense and opaque. Structure and readability are put to the test on a canvas in constant motion, where the user does not have an overview but must try to see what is clickable. This design is representative of many websites of that era and cannot be captured in a static shot. In contrast, the 2016 version (Figure 3) is functional in appearance and easy to decode. As a static picture, the 2000 version may seem as just a confusing structure; seen from the perspective of interaction, the website had the character of an exploration of how to interact with it. This version was not just a transparent medium for the goal of information about HAY, but a central part of the communication of how HAY saw itself as an experimenting company.

Many images in contemporary media culture may prove to be transparent and, hence, easily comprehensible vehicles for communicating some meaning. They also may display and explore the code of communication, that is, how the images convey meaning and thus not only communicate a message but also convey what the images are about (Sturken & Cartwright, 2009).



Figure 2. HAY Website, 2000. The early version of www.hay.dk is an example of deconstructive graphic expression, where the surface elements of the website do not create an immediate access to the information about the company. Instead of directly transmitting the content of the website, which is to be found beneath the surface, the dense graphic appearance points to the aesthetic code of communication on the website.

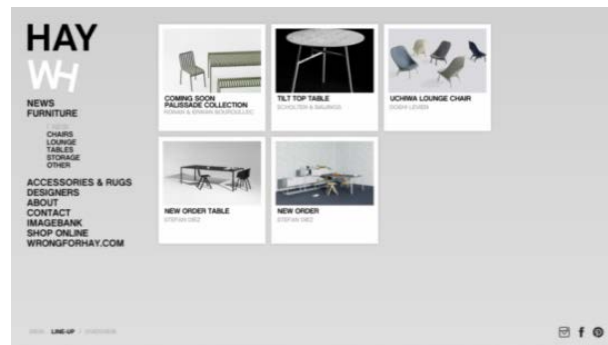


Figure 3. HAY Website, 2016. In the later version of the company website, the basic principle is transparency of content: The navigation menu is easy to read and access, and the website displays its structural organization. Although the website still presents information in a formal expression, it is in opposition to the 2000 version (Fig. 2) and relates directly to the content.

To take another example from HAY, the company presents media ads that stage its furniture items not only as sensually appealing design objects but also position them in an image that clearly reflects their constitution as an image (Figure 4). In other words, as a form of metacomposition, HAY's ad designers overtly played with the idea of a two-dimensional image with three-dimensional products as components, or building blocks, of this image. The furniture and its representation are no longer only about function and demonstrated potential use but also about a self-conscious creation of style. Objects and image are engaged in reflexive dialogue, rendering both as interdependent—as form that contributes to image and image mediating and verifying form. This thereby destroys the illusionary effect of the image yet creates a new kind of aesthetic experience by engaging the viewer with the reflectivity of the image.

Within the context of formalism and linguistics, this kind of reflectivity has been described as metacommunication. This is a way for language to reflect its own constitution as a vehicle of meaning that does not point beyond itself to a message. This was formulated in terms of an “aesthetic function” in the 1930s, for example, in Jan Mukarovsky's (1979) early writings. Mukarovsky belonged to the so-called Prague School of Aesthetics. Later, famously, linguist



Figure 4. Reflective presentation of furniture by HAY, 2016. In its furniture catalogues, the company HAY presented the furniture in a setting that breaks the illusion of the image as immediate access to the objects depicted on the image. In doing this, the catalogue designers present an image that both informs and provides a means for viewers' reflective meaning construction. Photo used with permission.

Roman Jakobsen (1960) labeled this the “poetic function” of language. Even if originally attached to language, this aspect of making the code of communication visible in the act of communicating can be transferred to other media.

In the context of design, I point to two distinct types of reflective strategies. First, design solutions explicitly reflecting their own status as sites of meaning construction (and not just being transparent vehicles for different kinds of experiences) may be found in experimental design on the verge of being art. Examples of this can be found in deconstructive graphics and website design, the 1960s Italian Radical Design movement, and the Critical Design movement of the 2000s (cf. Dunne & Raby, 2013). These examples demonstrate a reflection of design as a phenomenon of contemporary culture rather than being only a means for a purpose. On an implicit level, the mode of reflection in design may be seen as a relationship between the physical manifestation and the inherent idea of the design (cf. Folkmann, 2013). This relationship may be direct, immediate, and unproblematic, where the physical manifestation points directly to the idea (as in much design of everyday life), or be indirect and mediate in the sense of the design solution having an intricate relationship between physical manifestation and idea (such as the both the 2000 version of the HAY Website and *Juicy Salif* have). In these two latter examples, the idea of not being directly purposeful is foregrounded in the design.

This aspect of reflection has been a topic of modern aesthetic theory through the question of how a work of art is constituted through a specific form that may or may not reveal its meaning or resists or challenges understanding (Adorno, 1970; Bubner, 1989). I have elsewhere called this element of aesthetic communication “aesthetic coding” (Folkmann, 2013, p. 44). This concept allows for examining how design solutions can attract attention and appeal to the senses while being constituted in a way where they demand or even command a specific order of alignment or mode of understanding what the design is about. Further, reflectivity in design plays a role in the cultural–historical process of aestheticization, where more and more design is created and positioned as aesthetic and as having a consciously constructed and reflected meaning content. The HAY commercial image (Figure 4) testifies to this tendency.

Generally, the question can be raised about how HCI solutions and design objects evoke a reflection about their being as solutions with a specific function. In a purely functional understanding, smartphones and tablet computers may be conceived of as a means for the purpose of useful interaction. Thus, the physical manifestation of the phone or the computer should convey the idea of their function. In actual use, these objects may be treated differently, when, for instance, smartphones are covered in colorful covers that sometimes may contain nonpurposeful elements such as fur or ears. This kind of treatment may indicate that the idea of smartphones is not just to be purposeful in interaction but, on this ground, also be an object that is being reflected as special in the actual appropriation by the user. As a direction for future design, this kind of aesthetic appropriation by the user may be reflected in the technology design, as opposed to related purchases. In addition, the question can be raised regarding whether the design is positioned as aesthetic and how it testifies to being so. When a smartphone is constructed with a high focus on materials, such as glass or aluminum, the idea of this feature may to encourage a reflection about the object as special in the product category.

REPRESENTATION

Raising the question of representation here implies questioning what design solutions mean for the user and how they represent meaning. In brief, design is not just a physical manifestation but also medium of representation. As researchers within the culturally oriented theoretical discourse on design have pointed out, design is always embedded within cultural and social contexts (cf. du Gay, Hall, Janes, & Mackay, 1997; Julier, 2014). Beyond being physical manifestations (which can take many shapes and even be intangible, as in service solutions), design always has effect as signifying entities for a symbolic meaning equally ascribed to the solutions and referring to meaning complexes beyond themselves. Thus, humans encounter designs as both material and culturally influenced entities, which can impact the meanings ascribed to the object.

The concept of representation is well established in aesthetic theory as a question of how aesthetic media, that is, artificial constructs such as works of art, may be articulated in accord with various codes, for example, beauty, the sublime, the comic, or the uncanny (Schweppenhäuser, 2007). By this, representation points to ways of coded expression, that is, of “how phenomena of mimesis and expression unfold through modes of interpretation” (Schweppenhäuser, 2007, p. 8). Thus, representation, in this context, should not be understood as a reflection of some kind of reality in a specific medium but rather as a question of meaning systems lying behind the aesthetic media that may impact both meaning content (i.e., what the message of a medium is) and formal constitution (i.e., how the message is conveyed). In design, this can be seen in objects carrying with them specific coded meaning systems, such as being kitsch or claiming to be beautiful. In kitsch objects, for instance a pair of sneakers carrying US President Obama’s portrait (Volkers & Flagmeier, 2013, p. 148), the meaning of the objects do not derive only from the specific design in form, material, and texture but also from the cultural–contextual status of being kitsch.

Traditionally, researchers exploring aesthetic theory have been interested in many different forms of representation. An example is Jean Paul’s work *Vorschule der Ästhetik* (1804/1990), which dealt with, for instance, the comic and ironic in the arts. Further, Karl

Rosenkranz' (1853/2015) important work *Ästhetik des Häßlichen* testified an interest in all possible expressions of the sheer opposite of beauty, that is, the ugly, the grotesque, the un- and deformed. Rosenkranz (1853/2015) was a dialectical thinker in the tradition of G.W.F. Hegel (and a student of his) and was only interested in the ugly as a reversal of beauty whereby he stated, in accord with his time, that beauty is absolute whereas *das Häßliche*, the ugly and nasty, is relative to beauty. Further, the interest in the many different expressions of aesthetic media and their possible meaning systems is a continuous line in aesthetic theory. In this way, the interest in aesthetics has broadened into popular phenomena, such as film and music (Carroll, 1999; Menke & Küpper, 2003)

By looking at design solutions not only as objects of sensual appeal but also as media of representation, designs can be viewed at their cultural coding and symbolic meaning, and questions can be raised about how design objects may be related to different conventions and traditions in aesthetics. Lemon squeezers and smartphones are not just specific objects; they also are objects implicitly relating to other objects of the same category and to the previous traditions leading up to the actual design. The previous design history of smartphones encompasses mobile phones and landline phones. Moreover, even if smartphones, in their constitution as a black screen carried within a handheld casing, have significantly diverged from the traditional uses and formal conventions of previous phones, the basic designs and uses still currently form the foundation for smartphones.

Beauty may play a role and is often considered as part of a modernist convention of simplicity and balanced clarity in the expression of form and function, as was reflected in the architecture and furniture designs of the 1930s to the 1950s. Today, alternative aesthetic value systems have taken over. Thus, cultural theorist Sianne Ngai stated that “aesthetic experience has been transformed by the hypercommodified, information-saturated, performance-driven conditions of late capitalism,” whereby new aesthetic categories and, thus, reference systems, have developed (Ngai, 2012, p. 1). Society has changed and so has, in her analysis, the character of aesthetical experiences. In Ngai's analysis, the major aesthetic categories of the late 18th century, such as beauty and the sublime, are in part replaced with the new, minor, and more trivial categories of the cute, the zany, and the interesting. Actually, she did away with the approbation of beauty that has been regarded as bound to the aesthetic discussions of the 18th and 19th century, although she considered that the sublime still has relevance. Ngai did not, however, relate her analysis to the developments in digital design or HCI but rather to avant-garde art. Nevertheless, her questioning of traditional aesthetic categories may lead to the proposal of new categories, such as interactive openness and the modern enigmatic, as can be the case with digital design objects that play out the digital magic of being more than meets the eye. Some wireless loudspeakers serve as examples. Their designs encourage interaction but disguise the interface for interaction, thus appearing as enigmatic boxes not directly displaying their function and interactive potential (Folkmann, 2015). Furthermore, when aesthetics as a discipline no longer embodies a specific domain of objects—for example, art—but is experienced generally, such as dispersed by the recent trend in “everyday aesthetics” (Leddy, 2012; Oldemeyer, 2008; Saito, 2010), the categories for contemporary aesthetics are open for contestation.

In relation to design, the question of representation reveals how design solutions may operate with multiple aesthetic meaning systems, perhaps simultaneously, in relation to traditions and conventions. Which aesthetic conventions and codes are in play? What does it convey for the meaning of a calculator app on a contemporary smartphone to imitate the design of the Braun

calculator of the 1970s? Or what is the effect of installing a rotary dial app on the smartphone as a way of letting representations of previous technologies be a part of the interaction? Present and past and innovation and tradition intersect in the creation of new experiences.

EPISTEMOLOGY

As interfaces for how humans approach the world, design objects may provide new conditions for experiencing the world. In this context, the concept of epistemology may be employed to conceptualize how the relationships humans have with the world is co-organized by aesthetic media because these provide the frames for humans' access to and interpretation of the world. This current path into aesthetic theory was initiated by Immanuel Kant in his work *Kritik der Urtheilskraft* (1790/1995). This generative work can be viewed primarily as an exploration of epistemology, that is, how humans deal with and understand sensual phenomena that point to the ungraspable or incomprehensible dimensions of meaning. Kant designated this as *Vernunftideen*.

Kant (1790/1995) dealt with beauty and the sublime, but he approached them foremost as vehicles in a larger mechanism of epistemology: How can something beautiful or sublime frame one's experience of something that could not otherwise be comprehended? Through the notion of reflective judgment, Kant demonstrated how aesthetic judgment operates according to a kind of conceptual reflection that starts from the sensual material but does not from the outset has a concept to fit it that would make the sensual material understandable. Philosophers from Schelling and Hegel to Adorno have attached this kind of reflection to the work of art and asked how art could be a medium for a representation of an otherwise impossible cognition.

I point to two different possible HCI- and design-relevant actualizations of this epistemological approach to aesthetic theory. First, the concept of the sublime may be relevant in this context as a process of engagement that may lead to a new mode of experiencing. The sublime (*das Erhabene*, in German) is a concept that, in its modern definition, derives from the empiricist discussions of the 18th century and was formulated by Kant to describe a feeling of an abyss or being overwhelmed by something immensely large that cannot immediately be comprehended. Sublimity is normally not something to be expected when sitting on a sofa or handling a smartphone and may not seem to apply to the prevalent functionalism of design and the context of design in use. Nevertheless, the concept describes a specific variant of the human-object relationship, and the question is how design objects may evoke a feeling of the sublime.

For Kant, the beautiful evokes pleasure (*Wohlgefallen*, in German), whereas the sublime evokes a feeling of awe (*Achtung*; Kant, 1790/1995, p. 125), where the subject, in meeting something immensely large, experiences an "expansion of imagination" (p. 116). Kant spoke foremost of the sublime being evoked by experiences in nature. The analytical question in the aftermath of Kant that has been raised by, among others, Jean-François Lyotard (1994), has been how works of art may point to kinds of experiences where the limit of the comprehensible is challenged in general. These experiences do not necessarily point to otherwise ungraspable *Vernunftsideen*, as in Kant, but operate as a challenge of the mode and habitual coordinates of experiencing and understanding. Examples of design challenging given modes of understanding can be found in encapsulating interior designs with strong colors and unexpected forms and textures (such as the designs by Verner Panton in the 1960s and 1970s) aimed at dissolving normal perception. A similar effect of challenging normal

perception can also be seen in HCI environments of virtual reality or augmented reality, where the virtual layer of reality imposed on the physical reality provides new dimensions of this reality and, hence, reflects what “reality” is.

Second, philosopher Martin Seel (2000) spoke of how human creations may establish new frames of understanding that serve as media for comprehending and meeting the world. For instance, works of art and literature may provide new perspectives on how the world is seen, as when the reader of Tolstoy’s text sees world through the eyes of a horse. In this way, Seel was interested in the function of human perception in the process of confronting something “other,” claiming that works of art may “bring forward otherwise unrepresentable circumstances” (Seel, 2000, p. 184). In his understanding, works of art have to do with

ways of human commitment in the real or the unreal, in conditions of the world in the past, the present, or the future. Ways of *meeting the world* [Weltbegegnung] are put forward, whereby ways of *meeting the meeting of the world* [Begegnung mit Weltbegegnung] will be possible. (Seel, 2000, p. 184, italics in original)

Thus, when Seel talks of meeting the world and also of meeting this meeting of the world, works of art do not present only experiences but also metaexperience, that is, the experience about what “experience” is.

HCI and design solutions, however, often do not visibly contain the potential for being self-reflective or operating as creators of meeting points between humans and the world, nor do they frequently create sensations of sublimity where humans’ ordinary coordinates in experiencing the world are challenged. Nevertheless, these kinds of human creations can be seen in the light of how they are conceived and operate as meeting points (reflective or not) between humans and the world in the same manner that the experimental 2000 version of the HAY website (see Figure 2) framed an approach to and engagement with the interface when meeting and exploring it. Indeed, the website may have a sensual appeal, but the attention is led to the epistemological consequence of this appeal and how the site created new ways of engaging with the interfaces humans meet and, ultimately, of humans’ being in the world.

The interest may be directed, then, towards design intended at creating a sublime feeling or challenging perception and understanding as is the case of experimental design. For instance, designers in the Critical Design movement have explored how digital technology has affected the interaction between products and humans (Dunne, 1999; Malpass, 2017). The sublime feeling of meeting the limits of experience also may be evoked, even if just marginally, when one’s encounter with design solutions creates surprise or astonishment. Examples of this approach to design can be found in the context of Critical Design, where Anthony Dunne and Fiona Raby, in the 2007 project *Technological Dream Series* (cf. Dunne & Raby, 2013), explored how robots may not only be passive servants of humans but may be demanding or even needy in their requirement for interaction. Another example of a marketed product operating with a slight surprise in its interaction is the Cube Click Clock, a simple alarm clock that reveals its function only when touched; otherwise, it appears as a simple block with an artificial wood finish.

Often, however, nonpurposeful, experimental design objects most clearly demonstrate how design objects may operate as interfaces for humans’ meeting with the world. A concrete example of this is Thomas Thwaites’ art school project *Do-It-Yourself (DIY) Toaster* that was an attempt to investigate whether the creation of ordinary design objects was possible without

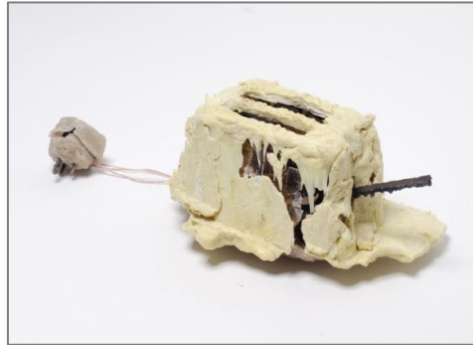


Figure 5. *Do-It-Yourself (DIY) Toaster*, designed by Thomas Thwaites, 2008-2009. The DIY toaster was a school project, affiliated with the Critical Design movement, at the Royal College of Art in London. The project aimed to create a toaster from scratch by finding the necessary fundamental, core materials, for instance, from a mine. By this, the toaster is not a design object made for a functional purpose but for an investigation of what it takes to create a simple, everyday object. Photo credit: Daniel Alexander & Thomas Thwaites. Photo used with permission.

the prerequisites of civilization (Thwaites, 2011; Figure 5). Thwaites tried to build a toaster from scratch, including finding the raw material for the various components. Thus, the process of designing the toaster displayed the complexity of modern production, as it became clear that a seemingly simple product comprised a large number of complex materials. According to Thwaites, the project showed that even a simple product like a toaster is impossible to design without taking a whole series of cultural prerequisites into account. These regard, for example, the history of refining materials and technology (Thwaites, 2011). In my interpretation, the DIY toaster functions as a reflection of what design objects are made of and how they come into being as objects that humans engage with. The DIY toaster does not function as a toaster (Thwaites reported that its electrical cord burned out 5 seconds after being plugged into an electrical socket), but rather operates as a vehicle for reflecting upon design as a part of civilization.

The DIY toaster is by no means a pleasurable product but one that creates a disruption in the state of things that may let new ways of meeting the world and new modes of the state-of-the-given evolve. The nonusable toaster presented a cultural reflection of the conditions of design and what design means in the modern world.

Adorno (1970) offered a radical notion of the capability of the aesthetic media to criticize the ontology of the given and surfaced other versions of the world or an all-encompassing reversal of things. In this way, he discussed art as a medium that is bound inevitably to the reality of the given while, at the same time, offering the potential to transcend the given and point to new meaning that may ultimately prove subversive or utopian. This transcendence is, of course, a paradox, as it cannot, in its constitution, transcend the conditions of the given. Put another way, in Adorno's view, art often must be critical of the status quo and propose alternative interpretations of the world even as it is bound by the status quo and the world.

In this way, Adorno (1970, p. 258) stated that "fantasy" cannot be "that cheap ability to escape being in proposing a non-being as if it existed"; instead it can transform "what the works of art always absorbed from being" and remake this material "into constellations, through which they become the other of being, if only through the specific negation of being." What Adorno aimed at, therefore, was to describe a work of art as a location for something impossible, that is, the opposition of the existing condition in society, even if it only takes place in the limited sphere of

the work of art. For Adorno, the ability to be in opposition to society is a general, constitutive feature of works of art. Consequently, for Adorno, a work of art is not to be seen as a means of representing something, as this would confirm the existing social condition as it is, but rather as an “apparition” (1970, p. 130), which in itself creates momentary traces of that which is not existing or not yet existing and is yet to come.

Much (commercial) design, however, affirms the existing reality and does not contain or evoke this kind of radical otherness or disruption. Some design is, however, conceived to have the potential to break with existing patterns of meaning and to be disruptive, as does design within the movements of Critical Design or Design Activism (see Markussen, 2013). Thwaites’ DIY toaster may be disruptive in provoking a reflection upon humans’ dependency on developments of civilization. Other types of design may be disruptive through engaging the users to new types of interaction, such as how the introduction of a graphical user interface (with computer interaction via visual icons instead of computer code) by Apple in the 1980s “changed forever the way people think of computers” (Atkinson, 2014, p. 89).

As design of all sorts engages with possibilities and with humans’ engagement with the world, the question is how the design, from traditional product design to HCI and digital design, creates possibilities and stages ways of meeting and engaging with the world. Regarding the epistemological reflection on design in relation to aesthetics, the questions are many. How can design solutions be seen as media for meeting the world in perhaps new and reflective ways, where new kinds of experience and forms of experiencing are evoked? How do digital interfaces, for instance, create new ways of meeting the world? The cue from the avant-garde of design, such as Thomas Thwaites’ DIY toaster and its discussion of the prerequisites of civilization necessary for modern design, can be related to ordinary design. How does design, as a medium of aesthetic meaning articulation, encourage reflection, and how does it relate to the existing reality? Does it mirror it, criticize it, try to overcome it in a disruption or propose alternative or thought-provoking, innovative approaches to it? These questions are relevant—and perhaps even essential—to pose because design, seen through this kind of aesthetics, always stages a meeting with the world. When designers devise an interface, they design for an experience where they, knowingly or not, also contribute to the metaexperience of reflecting what experiences are.

CONCLUSION

This article serves a corrective to a broad trend in contemporary design aesthetics and HCI to relate aesthetics solely to the sensually and emotionally appealing aspects of design solutions. Aesthetics does not need to be only about positive looking or feeling objects; aesthetics equally deals with experiences that reflect the world and identify new possibilities. The ambition is not, however, to abandon the kinds of aesthetic theories aimed at sensual–emotional appeal and pleasure because they certainly are a part of the broader picture. Instead, my claim is that it is fruitful, necessary even, to relate design to concepts such as reflectivity, representation, and epistemology within a framework of aesthetics. These concepts describe a deeper engagement between humans and the world—particularly experienced through various types of technology—that may be facilitated by design. Through engaging these concepts, the nature of aesthetic relationships may be investigated more deeply regarding their implications for human experience.

The broader view on the various aspects of aesthetics in design also enables a reflection upon how to understand HCI and design as a matter of the human world and as a part of the technology employed when engaging with and relating to the world. When design is taken seriously as a medium for a human reflection on the interface between humans and the world, an exploration of the aesthetics in design is needed in order to reflect the different ways design operates as this interface.

IMPLICATIONS FOR THEORY AND APPLICATION

As a consequence of this article, aesthetic theories need to be acknowledged as an asset for product development in a way that extends beyond consideration of beauty and sensual appeal. Fundamentally, aesthetics deals with the question of how design objects operate as artificial interfaces for how humans approach the world. In the broad conception of aesthetics proposed in the article, aesthetics provides concepts (i.e., reflectivity, representation, and epistemology) for investigating and understanding how this artificial interface in design is constituted. Acknowledgement and conscious instrumentalization of the concepts presented in this article enable designers, artists, and others to gain a deeper understanding of the character of the relationship between humans and design.

The proposed areas of reflection, representation, and epistemology are important to consider in design processes as well as in philosophical considerations of design because they elaborate how aesthetics is not just about superficial form but also about structures of experience. In HCI, the relation between humans and artificial creations is directly at stake as the interface and as an object for design. Accordingly, the field of HCI will gain from acknowledging that design solutions not only create sensually appealing surfaces for how to engage with the world but also are sites of reflective meaning construction and may, on the most general level of reflection, structure the access to and understanding of the world. This insight may be beneficial in the process of designing, especially for products and interfaces aimed at creating experiences for the users that may evoke reflection or even disruption.

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THE LINE MODEL OF FORM AND EMOTION: PERSPECTIVES ON WESTERN DESIGN

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Abstract: *This paper introduces a new model of form, emotion, and semantics through a process of form abstraction utilizing lines. Understanding the emotional and semantic value of form is a complex task, and many theories have been developed. Analyzing the visual arts through line relationships and interactions is a conceptually novel approach and offers new avenues for advancing studies in form theory, theories of emotion and perception, and design generally. By examining literature in visual perception, form theory, and emotion, and by historically analyzing changes in form through the aesthetic arts and then reducing these aesthetic elements into basic linear foundations, we developed the line model of form and emotion. This preliminary model presents form at its structurally most abstract, simplifying three dimensionally defined shapes into line relationships, and portrays their emotive and semantic associations for human observers. The model also visualizes the historical changes in form and emotional and semantic meaning across time, from the 18th century to the present day.*

Keywords: *form theory, design emotion, aesthetics, semantics.*

INTRODUCTION

Understanding the emotive and semantic relationships of form¹—the boundaries and structural composition of shape (Arnheim, 1954)—and the perception of form have been research focuses in science and philosophy for generations and is now an expanding area of design research (Desmet & Hekkert, 2014). Industrial design and architecture are perhaps the disciplines where understanding emotional experience of form properties is most pertinent and where the expressions of societal values through objects possibly become the most tangible and the most emotionally relevant. Having the knowledge to conclude that one form is objectively more desirable from an emotional point of view, at least within a specific societal context, can help designers create more desirable or more beautiful objects. Indeed, such an analysis can even help designers to understand themselves and their place within an ever-evolving culture of aesthetic arts and technological change.

This recent interest regarding the emotional content of form, objects, or products in the Western world² opposes the brand of rationalism implicit within the modernist design philosophies that so dominated the early 20th century. The modernists of the mid-20th century, such as Alvar Aalto or Greta Grossmann, slowly rebranded traditional modernist design into a kind of rational-beauty: Design could reach a certain degree of elegance and perfection where the idea of a brute functionalism was less dominant, and the designs were more emotionally attuned. The user of a product could engage both with its function and its elegant beauty. Over the final decades of the century, design became much more intertwined with what became known as user experience largely due to the emergence of the digital interface and the personal computer (Hassenzahl & Tractinsky, 2006). Part of the success of Apple Macintosh's product line of personal computers was due to the meticulously designed interface combined with tangible experiential qualities encompassing properties of form, sound, and tactility: Product construction was fused with a more abstract emotional experience (Norman, 2004). Work such as Alan Cooper's *The Inmates are Running the Asylum* (1999) presented an early analysis of what is now referred to as experience design by decisively arguing that poorly designed technological interfaces frustrated users. Since then, some of the important studies on design, emotion, and experience, such as British industrial designer Patrick Jordan's *Designing Pleasurable Products* (2000) or cognitive scientist and designer Don Norman's *Emotional Design: Why We Love (or Hate) Everyday Things* (2004), have paved the way for many more detailed studies of these phenomena. Norman's influential work introduced several concepts into a model for understanding emotional design that fused affordance theory developed by Gibson (1979) and modern design interaction psychology (see Norman 1988, 1999, for more detail). His three levels of emotional engagement—visceral, behavioral, and reflective design—express the differing qualities that design can exhibit, properties that depend on an artifact's form and interaction characteristics.

Recent work by design theorists Hekkert and Berghman (2016) in experimental aesthetics has introduced a unified model of aesthetics that describes the aesthetic experience in product design and the built environment. This model postulates that aesthetic appreciation is constructed from three main principles of conflicting aesthetic qualities: unity-in-variety; most-advanced-yet-acceptable (MAYA), or an artifact displaying typicality, and novelty simultaneously; and symbolized connectedness and autonomy. A comprehensive analysis found that these conflicting qualities—unity-in-variety, in particular—do influence aesthetic

appreciation overall (Hekkert & Berghman, 2016). Other recent work has extended the MAYA concept to explicitly develop a process of form-driven meaning innovation using radical curvilinear and rectangular forms to innovate away from a design archetype and to imbue designed objects with meaning (Lee, Self, & Andrietc, 2016).

The emotional desirability of a product is now a central concern for much contemporary design, as illustrated by these studies. A new belief has arisen where (according to Hekkert, 2006, among others) elegance, beauty, and novelty in form can translate into a meaningful product experience. Indeed, the emergence of techniques such as Kansei engineering, which explicitly orientates design around the subjective emotional experiences of users through cognitive and physiological testing, is emblematic of this philosophical and cultural shift (Lévy, 2013). This research is an examination of the fundamental aesthetic principles that underlie this supposed experience of form: geometry and its emotional and semantic connotations.

In this paper, we firstly analyze four strands of literature: form theory and perception, psychology of emotional experience, semantic theory of form, and recent historical changes in aesthetics. Secondly, we propose a novel method for distilling form into its critical abstract components by making use of Rowena Reed Kostellow's (cited in Hannah, 2002) design and composition theory and Panofsky's (1939) iconographic approach to compositional analytics. Our method considers a range of examples from industrial design and architecture. All of these are expressions of complex creative, philosophical, social, and technological developments across time. The aim of the analysis is to present some understanding of how the form and structure of designed objects, architecture, and the built environment can influence human emotion, which is a highly relevant concern for contemporary design practice (Desmet & Hekkert, 2014). Ultimately, we present an initial draft of the line model of form and emotion, where form is presented as a theoretical abstraction—as two-dimensional line relationships that can be related to specific emotive states and semantic values. Line is the starting element in design work, whether it is digital or utilizing drawing tools, and concepts are formed from sets of line arrangements in two-dimensions that create a representation of structure (Hann, 2012). By analyzing objects through line abstraction, we lay bare the underlying structure of the designs and are afforded the possibility of unpacking their emotional content.

Our paper takes a discursive and philosophical approach, combining many forms of literature with the central aims: (a) to develop a deeper understanding of changing aesthetic form motifs across the recent history of Western design and architectural output, and (b) to link emotional experience to these form developments and changing semantic values. Using an iconographic method (described in the chapter Form and Line), sets of form and structural qualities can be shown to be archetypal features of designs from certain historical periods. The psychological experience of form and its relation to emotion and other cultural aspects, what has been called the aesthetic encounter, is highly complex and any explanatory model must consider a broad range of societal and physical factors (Csikszentmihalyi & Robinson, 1990). Given this intrinsic complexity, our model is not a complete picture and, although we have set out and followed a procedural distillation and allocation of form elements in relation to emotion and historical contexts, we acknowledge that other interpretations are possible and equally valid. The presented model is an initial draft that attempts to unify historical time, form, and emotion in a way that is meaningful and helpful for designers and researchers wishing to understand, discuss, or apply contextually and experientially attuned form elements. The model

should be advanced and adapted with insights from future research. The overall limitations of the work are discussed at length in the Discussion chapter.

FORM AND EMOTION

Form has many different meanings, from something entirely homogeneous and definable (e.g., a table or chair) to something with high levels of abstraction (e.g., a point or a line). The arguments concerning the nature of form have been debated for millennia. Plato's extremely influential work from the 3rd–4th centuries BC defined form as an answer to questions such as what is a cube or what is a horse? Plato theorized a state of form that is both aspatial and atemporal, transcendent to both space and time, existing in a kind of perfect metaphysical position (Cornford, 1957). Aristotle's later theory of hylomorphism (3rd century BC) changed elements of Plato's theory by stating that human perception of objects is built of two elements: the matter and the form of that matter (Ainsworth, 2016). Matter in this respect is changeable and malleable, like a sculptor creating a statue. At the start of the work, marble exists in the form of a crude cube; over time, its form is transformed to that of a Roman emperor, for instance. This theory of form, where form (*morphē*) is independently conceived by a human actor and imposed upon matter (*hyle*), has become, as argued by anthropologist Tim Ingold (2009), a pervasive feature of Western thought, form theories, and modern conceptions of design.

Design theorist Michael Hann extensively detailed elements of form and human perception of it, and has proposed that form consists of sets of structural elements. Geometry flows from points and lines and is organized by principles such as balance, contrast, and rhythm that influence human perception of it (Hann, 2012). Indeed, Hann argued that a line can be considered either a moving point or the path between two points. He simultaneously argued, following Ingold (2009), that lines can be conceptualized as a leap from one state to another, a flow of continuous energy that forms the basis of structure.

Both Hann's (2012) and Ingold's (2009) concepts present form as a more fluid phenomenon, perceptually in flux and changeable. Plato and Aristotle's traditional ideas have had a profound influence on much of the subsequent European artistic practice (Rockmore, 2013). Modern conceptions of relating specific forms to certain semantic ideas and specific emotive values still relate to these classical conceptions very strongly—where people see human intentions manifest through the very structures humans create. Delving more deeply, it is possible to examine what the character of form is and the associations that human observers draw from visual interaction with it. What, for instance, does a curved form, as opposed to a rigid and angular one, mean to human observers emotively or semantically? Or what does it mean to experience a form? A body of scholarship and empirical work has attempted to deal with these questions.

The Character of Form

The form of objects and the built environment acquire meaning through emotional engagement with them (Desmet, 2003). In the 18th century, artist and critic William Hogarth (1753/1997) argued in his aesthetics treatise, *The Analysis of Beauty*, that a representation of beauty can be

found in a simple wavy line. From his diagram (Figure 1), Hogarth indicated that line number four has the true essence of a beautiful form, with the others being described as bulging, clumsy, mean, and poor (Hogarth, 1753/1997, Chapter 10). Hogarth's thesis presented protomodern empirical ideas relating abstract shapes and lines to specific emotive and semantic properties. Modern work in cognitive psychology analyzing visual perception has presented evidence that suggests human beings have a natural inclination to prefer curved forms to angular ones, partially validating Hogarth's initially subjective insights (Bertamini, Palumbo, Gheorghes, & Galatsidas, 2016). Curves, it seems, have long been a prominent feature of artistic or creative expression; examples of curving imagery, such as waves and abstract impressions of animal movement, are present even in the cave painting of Paleolithic humans dating back some 20,000 years (Clottes, 2016).

Questions concerning the experience of form—shape, curves, angularity, and form's overall structural foundation—often have been approached using categorizations of form qualities. Research within perception and emotion has tended to focus on form as an abstract entity: a nondescript, isolated shape or simply a line, usually characterized by implicit angularity or curvature. Research in the psychological sciences has shown consistently that humans are inclined toward curved forms (Bertamini et al., 2016). This experimental work typically utilized isolated form abstractions in a variety of contexts to demonstrate this inclination. Early work by psychologists Poffenberger and Barrows (1924) showed that angular stimuli were associated semantically with words such as powerful, serious, or hard. Their experimental work used 18 variations of simple line drawings, all with a wave-like sinusoidal structure and varying in frequency, and participants were asked to assign sets of adjectives to each. The curved forms were associated with words such as gentle, quiet, and playful, meaning people identified important experiential distinctions among the different lines. Notably, small changes in the axis angle of the lines altered their semantic value. For example, a wavy line initially associated with the word *gentle* became associated with the word *lazy* when rotated clockwise slightly. Similar results have been recorded more recently by Collier (1996) and by Bar and Neta (2006), who utilized common objects and what they termed meaningless patterns, that is, sets of arranged

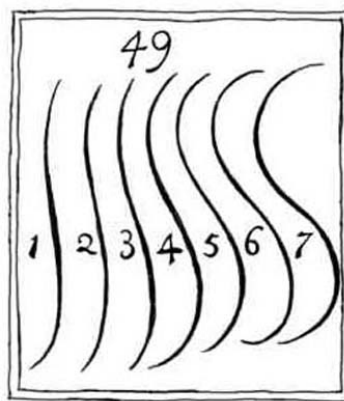


Figure 1. Hogarth (1753/1997), in his aesthetic treatise, *The Analysis of Beauty*, related line styles to emotional and semantic categories. Hogarth considered a selection of different line stylings and argued that line number 4 represented the ideal form of beauty.

Note. William Hogarth [Public domain], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Serpentine_lines_from_William_Hogarth%27s_The_Analysis_of_Beauty.jpg

abstract shapes. Both studies showed participants had a higher preference for curved objects and patterns as opposed to the angular variations. Additional work relating expressly to industrial design has noted a trend in recent automotive interior design toward curved structures and away from the angularity so extensively seen in the 1980s and '90s (Leder & Carbon, 2005).

Research by psychologist Marco Bertamini and others (2016) has sought to understand the curvature response more comprehensively by evaluating how perception of form and lines of abstract shapes is influenced by other factors, such as perceived complexity, visual information, and color. In a set of experiments, the researchers found that curved forms were preferred in a wide variety of contexts. In one experiment, abstract curved forms were preferred over angular ones, and angularity was notably associated with complexity. Critically, the context of the lines did not seem to affect the propensity for curvature preference.

Many studies suggest that some visual preferences are innate or possibly are instilled at a very early age (Lewalski, 1988). At the biological and cognitive levels, however, explanations vary. Some researchers have concluded that the human propensity to dislike angular structures is some form of primitive threat response, reminding humans of teeth or treacherous environments (Bar & Neta, 2006). Related work by design theorist Del Coates (2003) attempted to integrate form perception with cognition and information theory using a concept named concinnity, broadly defined as a sense of harmony. Coates considered two types of concinnity: (a) objective, which speeds the process of pattern finding or the intelligibility of interacting with an object, for example, and (b) subjective, defined as emotional cues that speed up the mental processing of an object's meaning (Coates, 2014). Thus, a sphere can be said to have the maximum amount of objective concinnity in a three-dimensional environment, given its bilateral symmetry across any central axis (Coates, 2003). The concept of concinnity relates directly to mathematical theories of smoothness. In this context, the rate of curvature is known as curvature continuity. Figure 2 illustrates through line relationships the differences between the geometric categories with the definable tangent points marked. What is called G-0 continuity is positional, where two surfaces share a single and definable edge. G-1 continuity is tangent where the surfaces share an edge but there is no discernible break in the transition from one surface to the next. G-2 continuity, or curvature continuity, is defined by surface planes having equivalent rates of curvature before joining; in this way, the points of surface transition become theoretically undefinable as one curved surface moves into another (Foster & Halbstein, 2014). Thus, any object capable of being visually perceived by humans can be abstracted into one of these simple line relationships. Indeed, work by the computational design theorists Mothersill and Bove (2015) has directly applied this psychological work to develop a form and emotion typology.

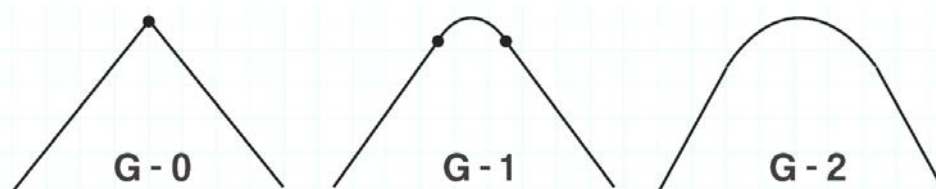


Figure 2. Three levels of curvature continuity that form is geometrically abstracted into for use in mathematical analysis and computer aided drawing software. G-0 represents positional continuity, G-1 represents tangent continuity, and G-2 represents curvature continuity.

The Experience of Emotion

Although we have considered literature that demonstrates how humans relate form to emotional experiences, we further examined what we mean by *emotion* and *experience* and how emotions can be categorized. American philosopher John Dewey wrote extensively on aesthetics and described the term experience as an event that is demarcated by a clear beginning and end, ultimately creating a whole. Discrete activities shape the experience, what Dewey referred to as the relationship between “doings and undergoings” (Dewey, 1934, p. 44). This definition is useful when examining human interactions with form. The experience of having an emotional response to an aesthetic object can be viewed, in Dewey’s terms, as a discrete activity that shapes the overall experience cognitively.

Work on emotional experiences is extensive and many theories have been proposed (see Izard, 2009, for a detailed summary). Some of the earliest theories were purely physiological: It was understood that emotions could relate to differing facial expressions. Delving back even further, the ancient concept of the four humors (blood, black bile, yellow bile, and phlegm) considered emotion as a constituent part in producing disease by causing imbalance in the secretion of one of the four fluids. Notably, historic conceptions of emotion were physiological: An emotion could affect the body in a tangible way. In the 17th century, following the influential work of Descartes (1641/1911), the mind and, by extension the experiences of the mind, were demarcated from the physical object of the brain. This idea, known today as mind–brain duality, led to the view that emotions were beyond the realms of empirical understanding. Because the mind was considered separate from the brain, a nonphysical and nonspatial substance, it could not, by definition, be empirically examined. The reality of how physical body parts create huge varieties of subjective experiences is still a major challenge in philosophy and science, conceptualized by Chalmers (1995) as the hard problem of consciousness. Regardless, this dualistic view began to break down toward the end of the 19th century, when the emerging psychological sciences started to examine discrete experiences such as perception and emotion. Some of the earliest research into what constitutes a human emotional experience that is meaningfully scientific begins with William James, the American psychologist and philosopher of the pragmatist school. James’ (1884) theory proposed that emotion was a function of an antecedent arousal state. The body’s experience of physiological change as the result of an incident or event and the emotional sensations that follow constitute much of the physiological alterations through a system of feedback (e.g., a quickening heart beat when one is frightened). This inversion of the more linear approaches to emotion understanding was radical and has proved challenging to disprove with elements of it being integrated into modern neuroscientific theories (Dalgiesh, 2004). Aspects of the theory have however been criticized since its development and, more recently, theories have considered other factors as the central mode by which emotions operate. The Cannon-Bard theory, for instance, presented evidence that directly opposed James’ theories by proposing that stimulation of the hypothalamus led to emotional experiences rather than a process of feedback (Cannon, 1927). Work by Barbalet (1999), however, suggested that James’ views on emotion have been consistently misunderstood and that the apparent Cannon-Bard disproving of his theory amounts more to a misinterpretation of James’ thought.

Because it became abundantly clear through competing theories that emotions as discrete experiences were difficult to analyze, researchers began to question what role emotions play

and why they are present at all in human experience. Research from the mid-20th century considered the functional role that emotion plays both in terms of human development across time and the social functions of emotion. One prominent theory posited that an emotional experience is built from physiological stimuli and contextual cues of a process of cognitive labeling that allow the experience to be understood (Schachter & Singer, 1962). This two-factor theory demonstrated how emotion cannot necessarily be understood in simple terms of physiological change; it requires an intelligible contextual foundation without which an emotional state can be misattributed (Dutton & Aron, 1974). Other theories, such as those from the behaviorist school of thought, proposed that human emotion is a learned behavior that is determined by environmental changes or by systems of reinforcement or punishment, that is, a kind of conditioning (Staats & Eifert, 1990).

Some of the most influential theories of emotion have drawn on the perspective of cognition, meaning the mental processing of stimuli. Lazarus (1991), for instance, considered emotions of high importance in general human reasoning, in what has come to be called appraisal theory. This model developed the earlier two-factor theories by incorporating a factor of cognitive intentionality. As Lazarus argued, the fact that an event can be interpreted and understood in a particular way will lead to an emotional response followed by an action of some description—a cognitive appraisal—followed by a physiological change characteristic of an emotion, followed by an action response. This model has proved influential in situations where emotion serves as a functional tool that can guide the body in some manner. A theory from Frijda (1986) explored the possibility that emotions elicit action tendencies that, in turn, advance certain behavior. Thus, the cognitive appraisal is more closely associated with an end action. This multifaceted behaviorist view proposed that emotions serve certain fundamental human needs, a view also held by Solomon (1977), who argued that emotions are types of judgments that can be adapted and revised ways similar to beliefs. In opposition to James' (1884) view, Solomon (1977) argued that one could experience anger without displaying any physiological characteristics of anger (Glazer, 2017). The cognitive theories are generally utilitarian in approach; the abstract sensation or a feeling of emotion has a tangible function that assists in the understanding of an event, ultimately aiding survival in an evolutionary framework.

More modern work on emotional experience has posited a wide range of theories and concepts. These can be considered broadly in two categories: physical theories and phenomenological theories. For the purposes of this work, we will be considering the phenomenological approaches whereby the characteristics of emotional experiences are examined. Physical theories are extensive (see Dalgiesh, 2004, for a summary) and fundamental in an overall understanding of how brain functioning might cause emotion. However, these theories do less to advance the understanding of the experience itself. Indeed, Lisa Feldman Barrett's (2006) theory of constructed emotions took a psychosocial approach and indicated the experience of emotion as a function of interoception, or the feeling of an internal bodily state, a person's understanding or interpretation of discrete concepts, and the social context from which the individual comes. From this point of view, each discrete experience of an emotion has been constructed by a range of factors, including sets of powerful cultural influences. Other work (e.g., Butler, 2017) has suggested that emotions extend beyond individuals and operate as a kind of social system, a temporal structure that exists between and among people as they communicate. Another prominent contemporary theory explores the possibility that human understanding of emotions is driven only by a so-called direct perception;

for example, when someone is smiling, this is the only way that the emotional experience of that person (happiness) can be epistemically known (Gallagher & Zahavi, 2012). This conclusion can, however, be challenged by pointing out that expressions may mean different things in different cultures.

Categorizing Emotions

While the various theories explore the process and origin of emotional experience, work also has been undertaken to describe and categorize the varieties of emotional experiences. The idea of classifying emotions dates to ancient times. Gradually, factors of discrete human experience and facial expressions became related to particular feelings or sensations, such as pain or nausea, and specific emotions. In a process that Dixon (2003, p.180) referred to as the “creation of the emotion,” the experience of emotion was recast as a physical mechanism during the late 18th century.

This consideration of emotions as distinct categories of experience has been followed until the present day and is a useful tool when examining human emotional responses to stimuli (visual form, for example). One of the most influential modern theorists, American psychologist Paul Ekman, proposed a model of basic emotions, where emotions are discrete and measurable states. In a seminal set of studies, he put forward that emotion can be split into six broad categories: anger, disgust, fear, happiness, sadness, and surprise (Ekman, 1980). The categories were produced from facial expression studies across various national cultures. Later, this list was expanded to include amusement, contempt, contentment, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure, and shame (Ekman, 1992).

Similar to the work of Ekman is the prominent model of emotion categories developed by American psychologist Robert Plutchik (1980). Known as the wheel of emotions, it attempts to show the relationships between distinct classes of emotions and how emotive categorizations are not necessarily discretely definable and emotional states themselves are highly transient, a point also intimated by the more recent models of Russell (2003). For example, the intensity and character of feeling in the emotion known as joy is similar (according to Plutchik, 1980) to that of anger. What makes the experiences of these two emotions distinct is the context: What has been experienced and to whom it has occurred are points considered paramount in many of the theories described earlier. Other useful models include the work of Shaver, Schwartz, Kirson, & O'Connor (1987) and Cowen and Keltner, (2017), who defined 27 distinct categories of emotion. This discussion of categories of emotional experience brings up a question: If there are categories of emotional experience, can there be categories of form experience that relate in some way to emotive states?

Relating this back to the discussion regarding form experience, the context of form is important. Much research has shown that isolated geometry can relate to distinct emotive classes. The task of understanding emotional responses to aesthetics has been challenging for researchers due to an aesthetic sense in the human animal not having an immediately obvious evolutionary advantage. Clearly, emotion serves a range of very complex functions and it must be considered how emotive responses to form serve both fundamental human needs, such as cognitive processing, and understanding of the environment and socially constructed

needs and values, such as taste or fashion. Categorization is critical to consider and will help to provide foundation to the form and emotion model presented later.

Emotion may be the principal factor for an experience of form. Recent architectural theory has associated aesthetic ideals with human needs and values. Gaston Bachelard's (1958/1994) work, *The Poetics of Space*, explicitly considered the emotive experience of architectural form from a phenomenological perspective. Similarly, Pallasmaa (2012), in his *The Eyes of the Skin*, argued that modern architecture should be multisensorial and posited that there is a current bias toward the visual experience of form, rather than an experience that values other senses, such as touch and hearing. Modern research in aesthetics, drawing on Dewey's (1934) initial foundation, has considered the process of aesthetic appreciation as an experience. The model proposed by Leder, Belke, Oeberst, & Augustin (2004) considered the experience of art or form to be constructed by a complex system of feedback, where an analysis of the form, emotional affective state, memory, prior knowledge, and social setting all play a role in a resultant aesthetic judgment and emotion. In an updated version, more prominence was given to the emotional affective state of the observer as the driver of the overall experience (Leder & Nadal, 2014).

Semantic Properties of Form

Certain forms acquire meaning, either spontaneously or with repeated exposure to them, in what can be considered a semiotic process. In the context of design, particular forms have become iconic design archetypes. One of the best examples is the push button, which is now a near ubiquitous feature in consumer electronics interfaces (both physical and digital). In a broad sense, the meaning being conveyed by this type of design component is change. When a button is pushed, when force is applied, one expects something to happen. Norman (1988, p. 9) described this expectation as an "affordance," expanding the original affordance concept developed by vision psychologist J. J. Gibson (1979). This also relates to what Gaver (1991) described as hidden and perceptible affordances. The form of an object conveys a meaning—a button suggests "pressability" and the handle of a mug suggests "holdability" (You & Chen, 2007). The form possesses certain characteristics suggesting manipulation, and from these its meaning is derived. Indeed, it has been shown that these form–affordance relationships are present in a wide variety of products where form manipulation, interaction, and function are critical (Urquhart & Wodehouse, 2016).

The seminal work on semantics was undertaken principally by Krippendorff and Butter (1984), and in a later text by Krippendorff (2005), as part of a major paradigm shift in design thinking. Krippendorff and Butter (1984, p. 4) described product semantics as the study of the "symbolic qualities of man-made forms in the context of their use." This was recognized as an important field of research during the computer revolution in the 1980s, when graphical user interfaces had to be intelligible and convey meaning for users who held little knowledge of computer systems. Design was recast as process of communication with an explicit link between the designer's intention and the user's interpretation (Vardouli, 2015). As Krippendorff (2005, p. 45) stated, meaning matters more than function in the context of design: "The engineers' functions are meaningful to engineers, but these functions are not the only truth and not necessarily shared by nonengineers." Meaning is thus defined as a manifestation of perception, functionally equal to an object's affordances or its imagined uses. Moreover, meaning is always a construction, is not conceptually fixed, and emerges as a result of language use. When

humans interact with form, its meaning to them is a construction and can change gradually over time or abruptly with the input of new information or sensory experience. Other research has accumulated illustrating the importance of form in the context of user experience and how products are commercially successful (see Bloch, 1995, for a detailed study). Additionally, recent work has suggested that the form of an object articulates interaction aesthetics and interaction affordances (Xenakis & Arnellos, 2013). The interaction aesthetic influences the selection of best action options with respect to an object's characteristics through a process of dynamic presupposition of interaction.

In the wider world of the visual arts, semantics and semiotics are of considerable importance and interest. Objects that appeared in paintings from the European-Christian medieval period, for example, were widely known symbols or metaphors and many of these are still present: The apple represents the fall of man into sin and the white lily suggests godly purity, to name but two examples. The main difference to address here between these semantic properties and the emotive ones is that the former are social constructions that develop semiotically over periods of time, whereas emotive reactions are more innate. As Hekkert (2006) described, many factors can influence the attribution of meaning, such as interpretation, memory, and natural associations. Over time, meaning experienced through form at the individual level can become more stable, becoming archetypal and symbolic and representing specific cultural concepts (Sudjic, 2008).

Forty (1986) studied the development of designed artifacts from the perspective of societal use and value and noted a large array of form variations across many different products. The notable examples are the differences in design and form features for products aimed respectively at men or women or the upper versus lower classes of society. (A similar effect, but much more explicit, is seen in products designed for children as opposed to adults.) Forty (1986) noted that products such as watches designed for women, historically, would have a higher frequency of ornamentation; designs for males were less ornate. McCracken (1986) noted that preferences for product form are shaped by powerful social and cultural forces. The implication of this is that products have different meanings to different users. Similar examples are seen in the different strata of society: There is a complex relationship between form, gender, class, society, and meaning (Forty, 1986). Indeed, postmodern philosophers Deleuze and Guittari (cited in Porter, 2009) saw the expression of form, in designed objects or buildings, as indelibly connected to the political and where initial form abstractions are actualized and become tangible symbols of change across time. Form, even abstractly conceived, is replete with emotive and semantic value in which many things are designed with the expressed intention of conveying a meaning. As design critic Deyan Sudjic (2008, 2011) observed, the popular typeface Helvetica (Figure 3) was designed as a symbol of Swiss precision and discipline, and similarly, the architecture of fascist-controlled Europe was deliberately symbolic of an imposing power and control.

Deriving Meaningful Forms

The Gestalt theorists of the early 20th century were some of the first to analyze perception in detail. The central concern of the Gestalt theorists lay in how objects, forms, and structures are cognitively grouped and/or abstracted as they are viewed. Their central mantra maintains that the whole is other than the sum of its parts (Ellis, 1938). They proposed several principles that

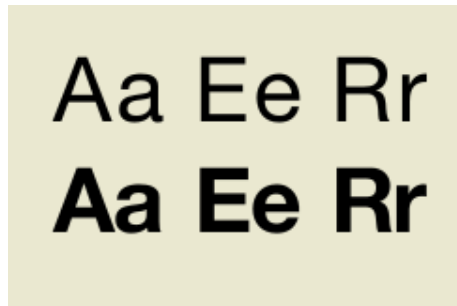


Figure 3. The Helvetica typeface was created to be symbolic of Swiss discipline. Standard and bold variations are shown.

Note. By GearedBull Jim Hood (Own work) [GFDL (<http://www.gnu.org/copyleft/fdl.html>)] via Wikimedia Commons <https://commons.wikimedia.org/wiki/File:HelveticaSpecimenCH.svg>

influence visual perception, the so-called principles of grouping that include proximity and symmetry, among others (Wertheimer, 1923). These principles are part of a wider theory of how humans cognitively process visual elements and how (to include Gestalt's recent research trends) shapes can lead to meaning creation (Pinna, 2010).

The famous optical illusions produced by the Gestalt school (see Figure 4) illustrate their theories of the holistic perception and processing of forms. Review work by Pinna (2010) explored a wide variety of optical illusions constructed and explained by the principles of Gestalt. Pinna extended the Gestalt principles to incorporate a meaning-making process. As Pinna argued, the Gestalt principles of grouping forms cannot fully explain the nature of these meanings, but there appears to the observer a sense of “happening” within the structure of the observed forms: The meaning spontaneously grows from the context.

Norman's (2004) model of form experience differs from the Gestalt theories of perception; he argued, for example, that the superficial appearance of a product—that is, the visceral level of engagement—is but one in a trinity of distinct experiences. While Gestalt theorists argue that object perception is cognitively processed as a single whole, Norman suggested that two additional

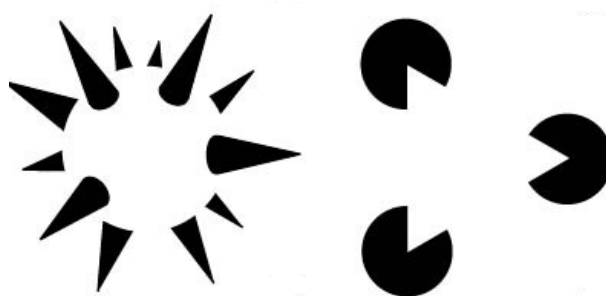


Figure 4. Gestalt optical illusions illustrate how our perception creates a shape that is not in fact there. With the image on the left, a sphere is visualized in the center with conical objects extruding out from it. In reality, there is no sphere and there are no protruding cones; the illusion of three dimensions is a product of how the entire image is cognitively processed. Instead of being understood as a number of discrete elements, it is understood as a whole and acquires meaning. The same effect can be considered for the image to the right.

Note. By Gestalt7.PNG: User: Albert Kok: (Gestalt7.PNG) [Public domain], via Wikimedia Commons <https://commons.wikimedia.org/wiki/File:Gestalt7.svg>

dimensions of behavioral design—namely pleasure during product use and reflective design described as an abstract experience of nostalgia or positive memory recollection—are also at play. In his earlier work, Durgee (1988) agreed with Norman's (2004) model by suggesting design is experienced atomistically, meaning that product experience is linear, where each design element, the presence of a door or button, for instance, is processed one at a time, contrasting the holism of Gestalt theory. Bloch (1995), however, argued that both interpretations may be true for different contexts.

Seminal work by art theorist and psychologist Rudolf Arnheim (1954) also explored the experience of viewing art, objects, and the built environment. In *Art and Visual Perception* (1954), Arnheim described how the experience of viewing geometry, whether highly structured or more abstract, is fundamentally a process of reasoning or a form of visual judgment, one which is indispensable from the act of seeing itself. Arnheim explored a substantial number of visual perception phenomena that influence how forms are interpreted semantically and emotively. "Perceptual force" (Arnheim, 1954, p. 6) is one of the principle concepts that gives visual perception its dynamic qualities. This force is derived from the visual context of geometry, in logic similar to the Gestalt theorists. For instance, a set of shapes may appear to have a sense of direction and movement as if being acted upon by forces (echoing the later work of Ingold, 2009). Regarding the nature of shape and form directly, Arnheim (1954) noted that form is interpreted holistically: A person will identify the doggishness of a shape before he/she is able to discuss the differences between various dogs (the Platonic ideal where a generic form will supersede specific varieties). This observation distills how meaning is indelibly linked to form perception. Arnheim (1954, p. 37) defined the concept of shape as the "boundaries of masses" and form as a kind of orientation and configuration of shapes whereby certain connotations can emerge from dynamic interactions. This overlapping of visual elements can lead to a sense of unity, for example.

Summary: Key Characteristics of Form

Before introducing the development of our theoretical model, we summarize the critical points of the last sections. We noted that the definitions of form have been debated for millennia. Hann (2012) argued coherently that the main properties of form can be reduced to interactions of points and lines, interactions from which all geometry arises. The line itself and other forms of isolated abstract geometry have been studied extensively, with new movements of perception research generally concluding that humans associate geometric elements with emotive categories or categories of experience. Broadly speaking, humans seem to hold an emotive preference for curvature. This preference, some have also argued, is the result of cognitive processing: It is simply easier to understand curved forms that have less perceptible visual information to process (Coates, 2014). The experience of emotion was also considered closely. Many theories considering the roots of emotion were examined, recognizing the complexities of human emotional experience that is driven by fundamental needs and hugely varied social interactions. Theorists of perception such as Arnheim, the Gestalt psychologists, and the semantics theorists were also considered. They argue that the context of geometry, either isolated and abstract or within the built environment, can radically alter understanding and perception of shapes, allowing them to take on semantic meaning. Arnheim (1954) argued that this process of visual interaction

with form is a process of reasoning, and artistic, design, and architectural developments over the centuries relate to essential aspects of human nature.

In the next chapter, we describe working definitions of form and structure more closely that allowed us to build the model. We understood that our reflections on form and emotion must echo the diversity of theoretical perspectives formed over the centuries regarding emotion, meaning making, perception, and form—as well as the cultural and other influences of all of the above.

FORM AND LINE

The following sections describe the development of our line model of form and emotion as a means of analyzing the emotive and semantic experience of form. The model also shows how the various manifestations of form across time can be interpreted and understood from the perspective of emotional experience, specifically, discrete categories of experience, such as joy or anger. Outlined in this section is our overall method for distilling and analyzing form. We firstly set out the principle of form and structural archetypes to set clear boundaries for our analysis. Secondly, we describe our method for extracting the key two-dimensional line relationships. The method was closely informed by the work of design theorist and educator Rowena Reed Kostellow (cited in Hannah, 2002), specifically how her principles of dominant and subdominant structural elements are applied to refine the understanding of the visual elements. Erwin Panofsky's (1939) iconographic approach to art analysis also informed the method.

Archetypes of Form and Structure

The key challenge we needed to address is how to reasonably find examples from the various epochs in the history of art or design; the nature of this task is intrinsically subjective. Aesthetic development cannot be viewed in a simplistic and reductionist way; it must be approached holistically, with the complex connections, both historical and cultural, laid bare. Thus, in developing our model, we considered the idea of a form archetype. An archetype, in our context, refers to an element of form or structure that is coherent and stable enough to be identified in a multiplicity of places during various historical periods. For example, what we now call neoclassicism has many archetypal features: Doric and Corinthian pillar styles, for instance. While there may be small variations due to factors such as artistic expression, the form can be clearly linked to a certain style prominent during a certain time historically. In this sense, our approach relied upon known and well-developed historiographic narratives. This guided our establishing and analyzing form archetypes.

Similarly, structural archetypes need to be considered. To take neoclassicism again, the overarching structural design is one of order, proportion, and symmetry. The paintings of this period often employed the rules of proportion and perspective conscientiously, following a strict structure (Aristides, 2016). The form around this structure, however, is much more fluid and ornamental, usually consisting of carefully configured curving shapes dominant within the composition. As an example, consider the depictions of the human bodies against the background of a classical city in art of Claude Lorraine (see Figure 5). The organic forms are subordinate to an overall sense of order provided by careful use of perspective and proportion.



Figure 5. Claude Lorraine, Classical cityscape (late 17th century). The prominent art of this period and later sought to represent an idealized version of civilization that was thought to have been lost since ancient Graeco-Roman times.

Note. Claude Lorrain [Public domain], via Wikimedia Commons

[https://commons.wikimedia.org/wiki/File:Paisaje_con_el_embarco_en_Ostia_de_Santa_Paula_Romana_\(Gell%C3%A9\).jpg](https://commons.wikimedia.org/wiki/File:Paisaje_con_el_embarco_en_Ostia_de_Santa_Paula_Romana_(Gell%C3%A9).jpg)

By contrast, the movement now called modernism was, in terms of form, much more abstract, with a dominant use of angularity. However, its structural design, meaning its use of proportion and symmetry, for instance, is strikingly similar to the output of the period 150 years earlier. This relationship will be explored below.

By establishing sets of form and structural archetypes, our analysis could progress. In summary, we established a range of criteria for identifying form and structural archetypes that was useful for developing the line model.

Form Archetypes

We next established how an archetypal form feature could be classified. In our model, we take a historical approach by analyzing changes across time, from the beginning of the neoclassical period (approximately 1750) to the present, so it is essential to clarify how critical changes are measured and categorized. We proposed four critical elements that defined a form archetype, namely (a) a recurrent aesthetic feature, (b) a feature with an identifiable underlying structure, (c) an identifiable character to the form, built from tangent, positional, or curved geometric continuities (see Figure 2), and (d) the possible presence of tangible semantic properties (i.e., the forms conveyed a discrete meaning). These four elements can theoretically be used to broadly categorize dominant features of historical movements in aesthetics. Although these form archetypes represent a more refined form of analysis, we felt the archetypes of structure—or the underlying foundation from which forms are framed and developed—must also be considered.

Structural Archetypes

Structure provides a foundation for form (Hann, 2012), so we considered structural archetypes within this discussion. We proposed three elements to define a structural archetype: (a) an identifiable framework or foundation around which the form is developed, (e.g., a square grid structure from which other, more complex features can be built); (b) conformity (or lack of) to certain rules or formalities, such as proportion, symmetry, and rhythm, or the repetition of elements and motifs, and (c) scalability of the structural design, meaning the design can be identified on the macro scale as well as applied to features of smaller scales, such as ornamentation. Both types of archetypal elements (i.e., form or structural) were crucial to consider in our line analytics. By establishing these key elements, our analytics was more grounded and constrained for developing the model.

Developing the Model

This section will elucidate how the model was developed. As we brought together many elements from a wide range of disciplines, it was important to carefully map our methods that unified several conceptual approaches from art history, design theory, and philosophy.

Theoretical and Philosophical Underpinnings

Our methods relied primarily on theories regarding the interpretation of form from the point of view of emotion and semantics. We considered several notable research methods from the empirical sciences and theoretical and philosophical approaches, such as the Gestalt psychologists. Our base assumption is that form, as it exists to be experienced by humans, has tangible effects on them leading to interpretations of meaning (semantics) and emotional experience. In the previous section, we considered large areas of study in the psychological sciences that demonstrate how particular geometric characteristics, such as curvature, can be emotively more pleasurable for human beings to observe. This essential nature has been discussed and formalized philosophically since at least the 18th century (see Hume, 1757/2017), and modern theorists continue in this line of reasoning attempting to dissect the enigma of aesthetic experience. Arnheim (1954) proposed that the visual senses are the primary sources of reasoning, perhaps more important and primal than the comprehension of language. Arnheim argued that the visual arts were not so much expressions of an abstract creativity but rather other forms of reasoning: There is an inherent logic in the creation of form, with its exploration and development as essential aspects of the nature of the human animal. Given this narrative of form analytics, we propose it be extended to include an investigation of the history of ideas and cultural changes.

Iconographic Historical Approach

A historical approach must be considered for this exercise, as we relied on antecedently defined historical categories. The goal of creating a model that represents both historical changes in form expression and categories of emotive human experience, such as awe and excitement through form, demanded us to look for the semantic meaning in form. Within art history, this approach can be considered iconographic, where specific formalisms give way to social context and the

overall cultural meaning of the work (D'Alleva, 2005). This approach principally followed the logic of art historian and theorist Erwin Panofsky, who argued that the form of a work cannot be isolated from its content. In his work *Studies in Iconography* (1939), Panofsky defined three levels of analysis that we used to assist our examinations of form and the built environment and to align the literature strands we were exploring: (a) identification of formalisms within the work; (b) identification of key characteristics, motifs, or representations that, traditionally in art history, may be a known story or myth; and (c) the deciphering of meaning within the work considering time, place, and cultural elements. Panofsky was greatly influenced by the German philosopher Ernst Cassirer (cited in Barash, 2008), who argued that images, both physical artifacts and artistic works, have a deep symbolic value that act to document aspects of civilization and culture. Formalism was also important to consider because our analysis relied on the identification of specific compositional elements. However, this principally was used to situate the examples of analytical value within the appropriate artistic genre; this position within art history has been defined as moderate formalism (Zangwill, 2001). Our method involved both the identification of sets of formal properties (i.e., the archetypes described earlier) and an analysis of what these qualities mean culturally, semantically, and emotively.

Reed Kostellow's Principles of Composition

Design theorist Rowena Reed Kostellow (cited in Hannah, 2002) studied the structural makeup of visual relationships in sculpture and industrial design and proposed an influential model for establishing the most critical elements within a form composition. Our methodology was influenced by her compositional theory, and we applied it directly to establishing the important elements of a designed object within the paradigm of an iconographic analysis. Reed Kostellow's compositional theory split form and structural elements into three categories: dominant, subdominant, and subordinate elements, defined by size and visual weight. Compositions of abstract geometry help to illustrate what is meant by the distinct elements (see Figure 6). These relationships between the dominant, subdominant, and subordinate elements were crucial for the

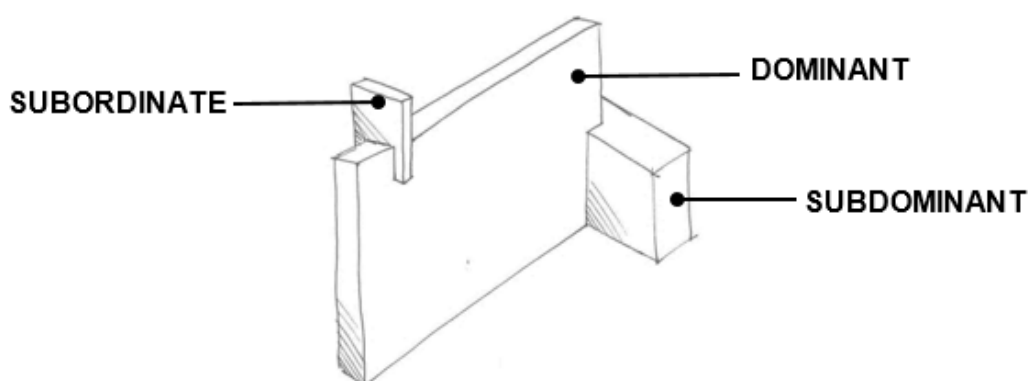


Figure 6. Reed Kostellow's form classifications showing the dominant, subdominant and subordinate forms in a hypothetical composition (adapted from Hannah, 2002). The dominant form is typically the largest of the focus of the composition. The subdominant and subordinate elements are typically smaller or away from the visual center and are used to frame and visually balance the dominant elements.

development of our model and allowed us to trace the importance of specific form motifs through time. While nearly all movements of art, design, and architecture incorporate a large range of geometric manifestations, it remains the case that certain geometric features can be identified as more compositionally important through size and visual weight—dominant, in Reed Kostellow’s terminology. The cuboidal angularity of high modernism is a good example.

Isolation of Points and Lines

Our approach used the analysis of images, where the most important form relationships were highlighted using superimposed lines following Hann’s (2012) and Arnheim’s (1954) respective theses: the line as the basis of structure from which geometric shapes flow and shape as the foundation of form experience. We used broad black lines to outline the dominant structural visual elements, and thinner blue lines to outline the subdominant or subordinate elements, following the Kostellow Reed’s (cited in Hannah, 2002) design compositional theories. This method allowed us to identify archetypal elements of form and structure and ultimately formed the basis of our model. Eleven prominent movements in Western art, architecture, and design encompassing the last three centuries were considered for our visual analysis: neoclassicism, Gothic revival, art and crafts, art nouveau, early modernism, art deco, mid-20th century modernism, brutalism, functionalism, high tech, and postmodernism. Sets of examples were amassed using an iconographic approach by examining the literature focusing on these specific historical periods and considering their key defining traits or archetypes.

Open-source image resources and personal photographic endeavors for finding and documenting appropriate examples were used because it was deemed the most efficient approach to acquiring and examining many types of forms. Keyword Internet searches were conducted using terms such as “neoclassical architecture” or “mid-century modern design” to isolate relevant sets of images and personal photography. Our primary focus was the built environment so the majority of the examples were either architecture or industrial design. Paintings were sometimes included to examine the nature of an art movement more directly. For the set of 11 aesthetic categories that we deemed historically influential, 30-40 images were amassed per historical periods following our guidelines for form and structural archetypes. From this initial set, 20 were chosen for the more detailed stage of analytics. The first phase of this is illustrated in Figure 7, where the key structural features of a built object—in this example, a brutalist building—are identified and marked manually (free-hand) on the image. The marking method followed our predefined form and structural archetype criteria and Reed Kostellow’s composition principles (see Hannah, 2002) detailed earlier.

Following the manual identification process, the important form relationships were processed digitally. This digitization allowed for a clearer representation of the form structures and allowed us to view the geometric elements in isolation, which facilitated our undertaking of the iconographic historical analysis. Figure 8 shows an example of the process of digitizing the manually assessed image. As shown, the critical form features were highlighted. From this point, we could isolate the form features even further as shown on the right.

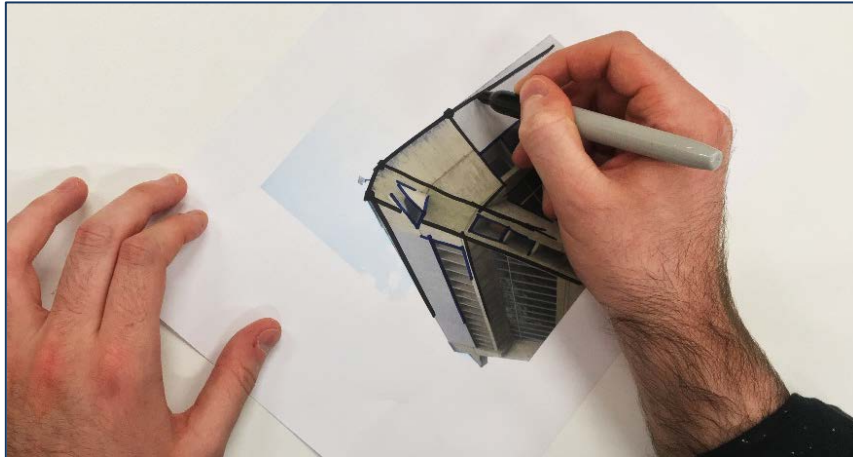


Figure 7. Manual identification stage where images are superimposed with line. In this image lines are being superimposed upon an image of an example of brutalist architecture which dominated architectural design in the 1970s and 1980s. The key dominant features are being picked out through visual inspection of the image.

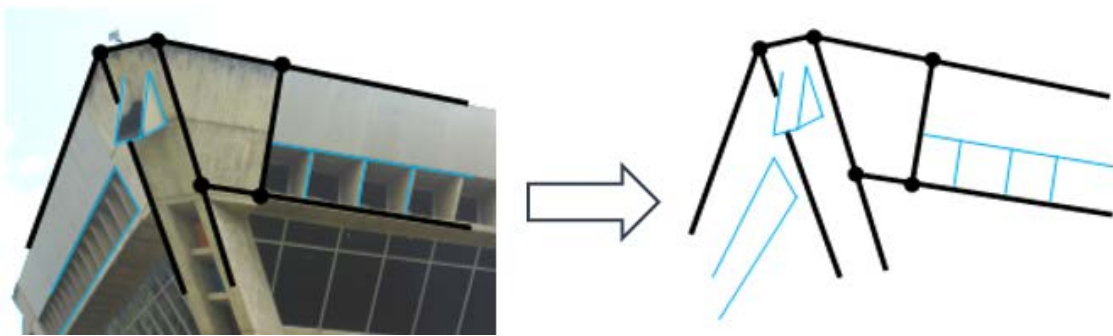


Figure 8. Isolating points and lines where the lines are digitally superimposed atop of an image allowing the line relationships to be revealed in more detail. Following from the manual identification stage, this example from the brutalist architectural tradition was gradually abstracted into sets of line relationships. The black heavier lines represented the dominant features and blue was used to represent subdominant or subordinate features.

Note. Original image includes photo by Liliana Amundaraín from Caracas, Venezuela ([1]) (<http://creativecommons.org/licenses/by/2.0>), via Wikimedia Commons & [https://commons.wikimedia.org/wiki/File:Campo_de_Carabobo_\(1\).jpg](https://commons.wikimedia.org/wiki/File:Campo_de_Carabobo_(1).jpg)

Integration with Emotional Experience

From the analysis using line abstractions, we could see how particular characteristics helped define specific art or design movements, underscoring how form relates strongly to emotion and semantic meaning at the level of experience. The final stage in the methodology was to relate these raw geometric elements with emotional experience and delve deeper into the historical context of the examples we were examining. Figure 8 is a typical example of Brutalist design, and it could be determined that its emotive associations are likely to be semantically negative (i.e., generating negative emotions such as frustration or anger) based on its high dynamic angularity, in line with prior research (see Bertamini et al., 2016; Collier, 1996; Palumbo & Bertamini, 2016; Poffenberger & Barrows, 1924). This information allowed

us to build the subsequent line model of form and emotion presented later. The following sections articulate the methods in greater detail by considering four examples—two with dominant curved forms and two with dominant angular forms.

Curvature

Figure 9 displays examples from the neoclassical tradition that dominated Europe from the mid-18th century until roughly the mid-19th century (Bietoletti, 2005). The movement is a reinvention of the classical styles typical of the ancient European civilizations such as the Greeks and Romans. When we abstracted the structures into line relationships, we identified several notable features. Firstly, the forms were highly precise and had been designed, following Vitruvian standards, to exact proportional rules such as the golden section (i.e., two visual elements may have a golden section if their ratio is the same as the ratio of the sum of the larger of the two elements), which some have argued is, aesthetically, an innate design preference for human observers (Doczi, 1981). Curvature had a more dominant role in the structures; angularity was used to order and frame the designs. This seemed to be a design archetype because these structural features were repeated many times. During the neoclassical period, which ran concurrently to the period now referred to as the Enlightenment, Europe experienced an outpouring of industrial, scientific, and philosophical advances that would eventually culminate in much of modern Western culture (Zafirovski, 2011). This, coupled with a shift in aesthetic output from the visual arts, allowed the grand structures of the period to be realized. One of the central beliefs of the Enlightenment period was that humankind could use the power of reason to control the natural world (Robertson, 2015). This belief helps explain the aesthetic that emerged during the 18th century across Europe and North America. These forms were set within imposing

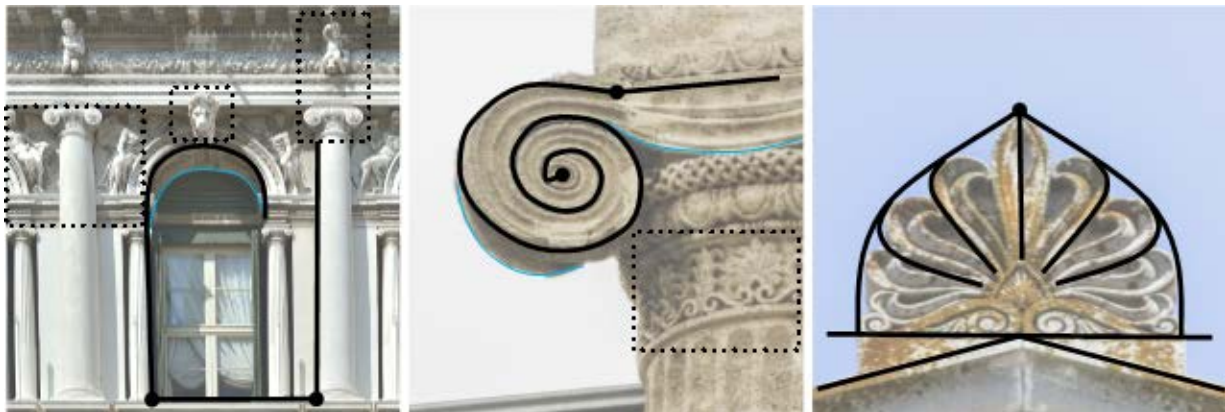


Figure 9. Neoclassical architecture and decoration showing various neoclassical motifs including organic imagery and use of proportion and symmetry highlighted by superimposed lines (18th & 19th century). The left image shows decoration surrounding a neoclassical style window, the middle an ionic style pillar, and the right image a piece of building ornamentation. In each image the dominant form features are represented with superimposed black lines, the subdominant or subordinate features with blue lines, and visual motifs or representations with dotted boxes.

Note. Original art includes sources from (a) photo by Wolfgang Moroder, https://commons.wikimedia.org/wiki/File:Ala_Napoleonica_Procuratie_dettaglio_centrale_finestre.jpg (b and c) free to use images: <https://pxhere.com/en/photo/612657> and <https://pxhere.com/es/photo/600775>

structures and presented a strong sense of visual order. Organic forms that aesthetically relate to the natural world were apparent, but they were subordinate to the dominant, inorganic structures surrounding and framing them. Ornate sculpture (another archetypal feature of neoclassicism highlighted with superimposed dotted boxes) also is nearly ubiquitous in design of this period. From an iconographic point of view, this work was abounding with symbolic meaning, often incorporating representations of classical myths or historical events triumphed by the people of a certain place or culture. Our use of line abstraction revealed extensive use of ordered curvature in the underlying structure. Significantly, architecture and design from the neoclassical period is often semantically associated with traditional ideals of beauty, order, and elegance (Bietoletti, 2005).

Art nouveau, which was a design movement beginning roughly at the end of the 19th century, has many structural similarities to neoclassical art and is notably dominated by curved forms. Principally, it stood in opposition to academic art, a style that had become associated with the French academies of painting that were favored across Europe (Duncan, 2001). Aesthetically, the art nouveau style is characterized by the frequent use of organic themes and symbolism, features we would argue are archetypal. In some ways, art nouveau was an early use of what is now called biomimicry or biomimetics, with the explicit use of forms found in nature serving as design inspiration (Benyus, 1997). As can be seen in the examples shown in Figure 10, there is almost no use of straight lines, and academic use of proportion appears not to be considered strongly. Curvature dominates both the underlying structures and the forms themselves. The movement overall had strong emotive, semantic, and symbolic characteristics (Raizman, 2003). As a rejection of the academic nature of art at the time, the artists and designers of art nouveau found inspiration in the nonrational, nonlinear world of nature, often explicitly employing plant and flower motifs and asymmetrical and undulating lines (Howard, 1996).



Figure 10. Art-Nouveau art, architecture and design showing unorthodox uses of proportion and highly organically inspired decorative motifs highlighted by superimposed lines (late 19th century). The left image shows a decorative pattern design, the middle interior architecture and the right a household utensil. In each image the dominant form features are represented with superimposed black lines, the subordinate or subordinate features with blue lines and visual motifs or representations with a dotted box.

Note. Original work includes (a) Walter Crane [Public domain], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Swan_and_Rush_and_Iris_wallpaper_Walter_Crane.jpg (b) photo by Hans A. Rosbach (Own work) [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/>)] sourced from pxhere.com and (c) sourced from <https://pixabay.com/en/carafe-art-nouveau-glass-mug-1346661>

Angularity

Modernism became one of the widest spread and most influential aesthetic and philosophical movements in art and design of the 20th century, with manifestations in architecture, industrial design, music, painting, and many others. Particularly within architecture and industrial design, the modernist aesthetic has notable coherence. The examples shown in Figure 11 are paradigmatic cases of early modernist design. To use Reed Kostellow's guide (cited in Hannah, 2002), the dominant and subdominant structures within the modernist designs can be identified. These designs follow careful grid structures creating dominant vertical and horizontal box forms that frame other box forms. Considering the forms iconographically, they all interplay with a sense of logic and coherence. The modernist philosophy was a radical rejection of many of the prevailing ideas that came before, specifically the notion of representation and ornamentation, often expressed explicitly within the manifestos of the time (see, e.g., *Ornament and Crime*, Loos, 1913/1976). An antecedent of this can be seen in the work of the impressionist and postimpressionist artists of the 19th century, where exact representation according to visual perception was radically challenged (House, 2004).

The modernists were pioneers of abstraction: Complexity did not have to be represented by intricate form, but rather abstracted and viewed from multiple perspectives at once (see, e.g., the work of the Cubists). We argue that it is this quality of abstraction and simplicity that provides Modernism with its aesthetic coherence and is its principal archetypal quality. While there are exceptions—the art of Kandinsky or Picasso, for instance, can be viewed as highly complex and intricate—a quality of abstraction is consistent, and a type of geometric reductionism to simplicity and isolation led to the loss of subject recognizability (Dickerman & Affron, 2012).



Figure 11. Modernist architecture and painting showing dominant use of angular forms highlighted by superimposed lines (early 20th century). The left image shows a house within the Weissenhof Estate designed by Le Corbusier, the middle the Bauhaus school building in Dessau designed by Walter Gropius and the right early abstract art by Piet Mondrian. In each image the dominant form features are represented with superimposed black lines, the subdominant or subordinate features with blue lines.

Note. Original work includes (a) photo by Andreas Praefcke (Self-photographed) [CC BY 3.0 (<http://creativecommons.org/licenses/by/3.0>)] and sourced from pxhere.com (b) sourced from <https://pxhere.com/en/photo/1110518> and (c) photo by Piet Mondrian [Public domain], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Composition_A_by_Piet_Mondrian_Galleria_Nazionale_d%27Arte_Moderna_e_Contemporanea.jpg

Dominant angularity and heavy use of positional form structures are archetypal features of modernism, particularly within industrial design and architecture. Additionally, the buildings and products of the modernist movement are highly proportioned and ergonomic, expressly designed for use by human beings, tailored to human needs, and a bit machine-like (Smock, 2009). Abstraction was the critical component of the movement generally; it could be argued, for instance, that modernist buildings are abstract versions of the preceding neoclassical. Modernist buildings lack what Arnheim (1954) described as dynamic obliqueness, meaning they appear very stable and structured. Through a process of line abstraction, we saw that the designers associated with the movement were interested in arrangements of right angles and cuboids. Functionalism was the central belief of modernist design; aesthetics was viewed as secondary to the utility of the building or the product. Possibly the greatest exponents of the tradition, the Bauhaus school in Germany (1919–1933), were instrumental in developing this approach. Abstraction was taught to be appreciated and that products could achieve a certain quality of functional elegance through a radical philosophy of simplicity and modernization (Droste & Bauhaus-Archive, 2002). Modernism is a direct descendant of the rationalism that was implicit within neoclassical styles, while simultaneously being a rejection of its traditionalist and academic values (Pevsner, 1960). The central difference between modernism and neoclassicism is modernism took forms to high levels of abstraction, ostensibly devoid of symbolic meaning and cohering around a philosophy of brute functionalism and where the social and philosophical changes in society directly translated into a shift in aesthetics (Greenhalgh, 1990). One could posit that design utilizing controlled angularity is a semantic representation of utility, functionality, and order.

Mid-century modernism followed on the traditions associated with the first modernists with noticeable differences in form and structural output. Analyzing the work of North American design provided an important insight into the aesthetic and cultural shifts that took place. Technological development in manufacturing during the 1940s (largely stimulated by the onset of war) presented a new scope for form experimentation in product design as the mid-century beckoned. Abstracting the forms into their underlying line relationships, both the presence of curvilinear and angular structural relationships, both equally strong as structural elements, became clear (Figure 12). The development of mass-producible plastics meant curved structures could more simply be applied within a product context. Additionally, we propose that these new, arguably more organic, forms are a reaction against some of the functionalism of early modernist tradition that perhaps seemed too dogmatic. During this time, the United States and many areas of Europe were experiencing a counter-culture movement. This new hippie culture manifested itself in industrial design and architecture by the presence of more sweeping curves, bulbous forms, and brighter colors. A small sample of work from the Eames', Raymond Loewy, Greta Grossman, Eero Saarinen, the Finnish, Nordic, and Danish design schools clearly demonstrates this aesthetic trend. The forms were more emotionally resonant with the inclusion of generous curves; they were less intellectual by not adhering to a doctrine of strict functionalism and were mass marketed to consumers (Quinn, 2004). While these designers were not explicitly part of the counter-culture movements, we argue that the broad changes in society—specifically in culture and politics—had a tangible, emergent effect on form expression among professional designers. Following the logic of Deleuze (cited in Quinn, 2004), where the expression of form is always connected to the world of the political,

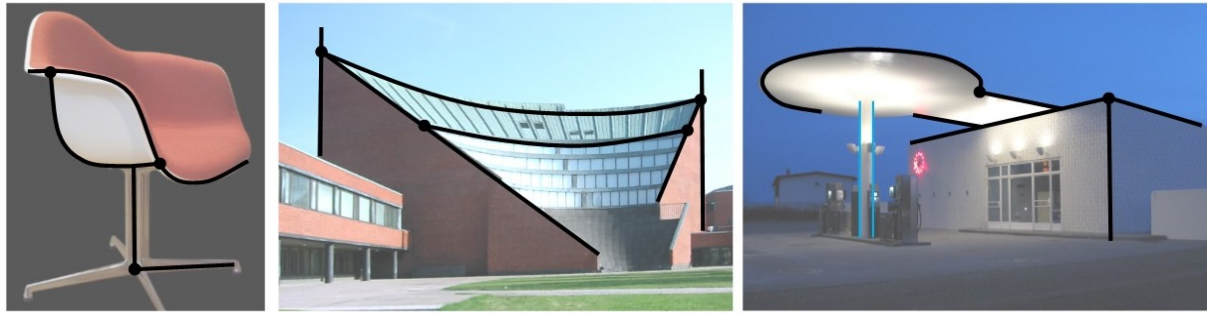


Figure 12. Mid-century modern design and architecture showing the inclusion of generous curving features and less use of dominant angular features highlighted by superimposed lines (mid-20th century). The left image shows an iconic chair by Charles and Ray Eames, the middle architecture by Alvar Aalto and the right architecture by Arne Jacobsen. In each image the dominant form features are represented with superimposed black lines, the subdominant or subordinate features with blue lines.

Note. Original work includes (a) Photo by Rama, Wikimedia Commons, Cc-by-sa-2.0-fr [CeCILL (http://www.cecill.info/licences/Licence_CeCILL_V2-en.html) via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Eames_chair-IMG_4624.jpg (b) Photo by J.-P. Kärnä [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0>) via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Helsinki_University_of_Technology_auditorium.jpg and (c) photo by Christian Lylloff (Own work) [Public domain], via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Arne_Jacobsen_benzintank_Moerke.jpg

we state that the designs of the mid-20th century did, in some ways, reflect the liberalization of culture that was taking place and the renewed emotional optimism and progressivism of post-war America and Europe (Kaplan, Tigerman, Adamson, & Los Angeles County Museum of Art, 2011).

Summary of Analysis

Line, it has been shown here, is a powerful tool for analysis. The examples illustrate the relevance of this approach. By applying a line abstraction, the underlying structure of the form can be revealed partially. While only four historical genres of design were detailed here, we analyzed 11 in the process of this research. Going through each one here, however, would have been a tedious exercise for the reader. From here we have categorized commonly seen form characteristics and archetypes, the known historical movements, and the empirically acquired emotive and semantic relationships following the historical analysis described in the preceding paragraphs and the visual perception work from Poffenberger and Barrows (1924), Collier (1996), Bertamini and others (2016), and Mothersill and Bove (2015). This is summarized in Table 1

THE LINE MODEL OF FORM AND EMOTION

Our methodology of line abstraction and art-historical analysis allowed us to probe the meaning and the emotive layers of form through an iconographic historical approach. The model, shown in Figure 13, is presented as a flowing line. Inspired by Hann (2012) and Poffenberger and Barrows (1924), we present the line in a form similar to a sinusoidal wave that varies in frequency and structure. There is no start or end necessarily; the line should be viewed as a continuum in the same way emotional experience is both constant and changeable (Dewey, 1934). The model was

Table 1. Summary of Form Characteristics, Emotive Experience, and Semantic Connotations of 11 Western Aesthetic Movements since Approximately 1750 AD.

Dates	Form Characteristics	Emotive Experience	Semantic Connotations	Common Form Features
NEOCLASSICISM				
1750s onward	Dominant curved forms framed by precise angular forms. Frequent use of symmetry and organic and symbolic forms	Peace, calm, awe	Romantic, organic, beauty, strength (Bietoletti, 2005)	
GOTHIC REVIVAL				
1750-1860	Dominant use of curves and angularity. Frequent use of symbolic and organic forms – highly complex	Awe, amazement	Power, authority, prestige (Frankl & Crossley, 2000)	
ARTS AND CRAFTS MOVEMENT				
1880-1910	Dominant organic and curved forms. Frequent use of floral imagery	Peace, calm, happiness	Organic, floral, decorative, romantic (Blakesley, 2006)	
ARTS NOUVEAU				
1890-1910	Dominant organic and curved forms. Frequent use of floral imagery and symbolism	Peace, calm, happiness	Organic, floral, decorative, romantic (Howard, 1996)	
EARLY MODERNISM				
Approx. 1900 onward	Dominant angular forms, highly precise. Some use of curved forms. Little use of symbolism	Serenity, calm, pensiveness,	Functional, utilitarian, simple, rational (Pevsner, 1960)	
ART DECO				
1920-1940	Frequent use of angular and curved forms. Frequent use of symbolism	Intrigue, awe, agitation	Vibrant, geometric, organic (Bayer, 1999)	
MID-CENTURY MODERNISM				
1930-1965	Dominant curved forms with frequent use of angular forms	Happiness, calm, serenity	Functional, beautiful, elegant, quiet, smooth (Quinn, 2004)	

BRUTALISM				
1950-1975	Dominant angular forms, little use of curved forms	Surprise, intrigue, frustration	Harsh, authoritative, functional, strange, cruel (Clement, 2012)	
FUNCTIONALISM				
1950 onward	Dominant angular forms, little use of curved forms. Some symbolic value	Surprise, earnestness, tension	Utilitarian, functional, (Bürdek, Dale, Richter, & Hausmann, 2015)	
HIGH TECH				
1970 onward	Use of both angular form domination and curved form domination	Joy, awe, surprise, tension	Technological, precise, organic, rational, structural (Abel, 2004)	
POSTMODERN				
1980s onward	Use of both angular form domination and curved form domination (typically angular). Frequent use of ornamentation	Surprise, confusion, intrigue	Geometric, strange, juxtaposed, comedic (Kolb, 1992)	

Note. Table presents a summary of historical movements in aesthetics charting characteristics, emotive, and semantic connotations with line abstractions. The semantic connotations have been considered with reference to art history scholarship. The form features or archetypes have been derived from the line abstraction method.

developed iteratively until we were satisfied that the range of line abstractions of form we investigated was suitably represented. Naturally, all the movements in aesthetics from recent history could not have been considered; this was beyond the scope of this research. Nevertheless, our research has generated a picture of the more influential movements in the Western aesthetic tradition.

Features of the Model

The line model of form and emotion has distinct features that bring together several narratives from form, emotion, and semantic theories in the visual arts and, in particular, design. The model considers four key aspects:

- emotive and semantic qualities related to form categories
- the embodiment of these qualities with aesthetic movements across recent history (form and structural archetypes)
- form as a representation of information
- the intensity of the emotive and semantic values.

Resulting from our review of the previous studies in form perception, a great deal of evidence suggests a dichotomy of perception, that is, curvature versus angularity relating to

positive versus negative emotional states respectively. While actual cognitive processing of form is much more complex, dichotomy of perception presented a good starting point. We therefore split the model into two halves, respectively displaying curved geometric continuities transitioning into angular continuities (see Figure 13).

DISCUSSION

Lines of Emotion and Historical Transitions

One of the central themes of the model is the psychological experience of emotion. We reviewed some of the critical research into emotional experience and categorization and have used it to inform our model. Importantly, we have considered the work of Plutchik (1980, 2001), who recognized the inherent complexities of human and animal emotion and the difficulties in supplying absolute definitions and categories. His models describe emotional states that have a certain fuzziness. Joy, for example, is composed of aspects of love and optimism and, in turn, stands between serenity and ecstasy in terms of intensity. This relates to the experiential qualities of emotion that are multifaceted, complex, and challenging to define unequivocally (Scherer, 2005).

In the line model, drawing on the order of emotional character and intensity as defined by Plutchik (1980, 2001), joy does not stand alone; it is changeable and dependent on other experiential qualities like optimism. Similarity between emotional experiences in terms of their character, feeling or intensity is also a point of interest. Although a good deal of difference exists between joy and anger in terms of intensity and composition, it is more challenging to distinguish between anger and hostility or disgust and surprise. These emotive distinctions are illustrated on the model where joy, for example, is placed above a large curve and is assigned a high degree of intensity. The same can be observed for rage on the angular end of the model. These emotions are driven by more intense states of arousal and, as Coates (2003, 2014) noted, contain more visual information (i.e., edges, corners, or changes in directionality), making them more challenging to cognitively process.

The changing nature and nonlinearity of emotional states when observing art, buildings, and objects are the points we intended to convey with this model. Although there is some experiential stability, the context of form can lead to dynamic emotive associations. As the line flows, emotions flow with it. When humans encounter structure, they are also encountering states of change and the dynamic forms of experience and perception described by Dewey (1934) and Arnheim (1954). The holistic thought of the Gestalt also is relevant where visual experiences of form and the relationships between elements are processed as a whole and assigned meaning before being broken down in the mind. Sometimes this meaning is understood through culture or a social context, and sometimes through innate preferences and psychological drives. Angular forms have some connection to aesthetic conceptualizations of nervousness and fear, but their association with rationalism may be a gradual cultural construction derived from the principles of engineering and functionalism.

Connection to the historical past and the history of ideas is a fundamental component of the model. Its visual information conveys form structures associated with clear aesthetic movements within the history of art, architecture, and design. The model was developed using

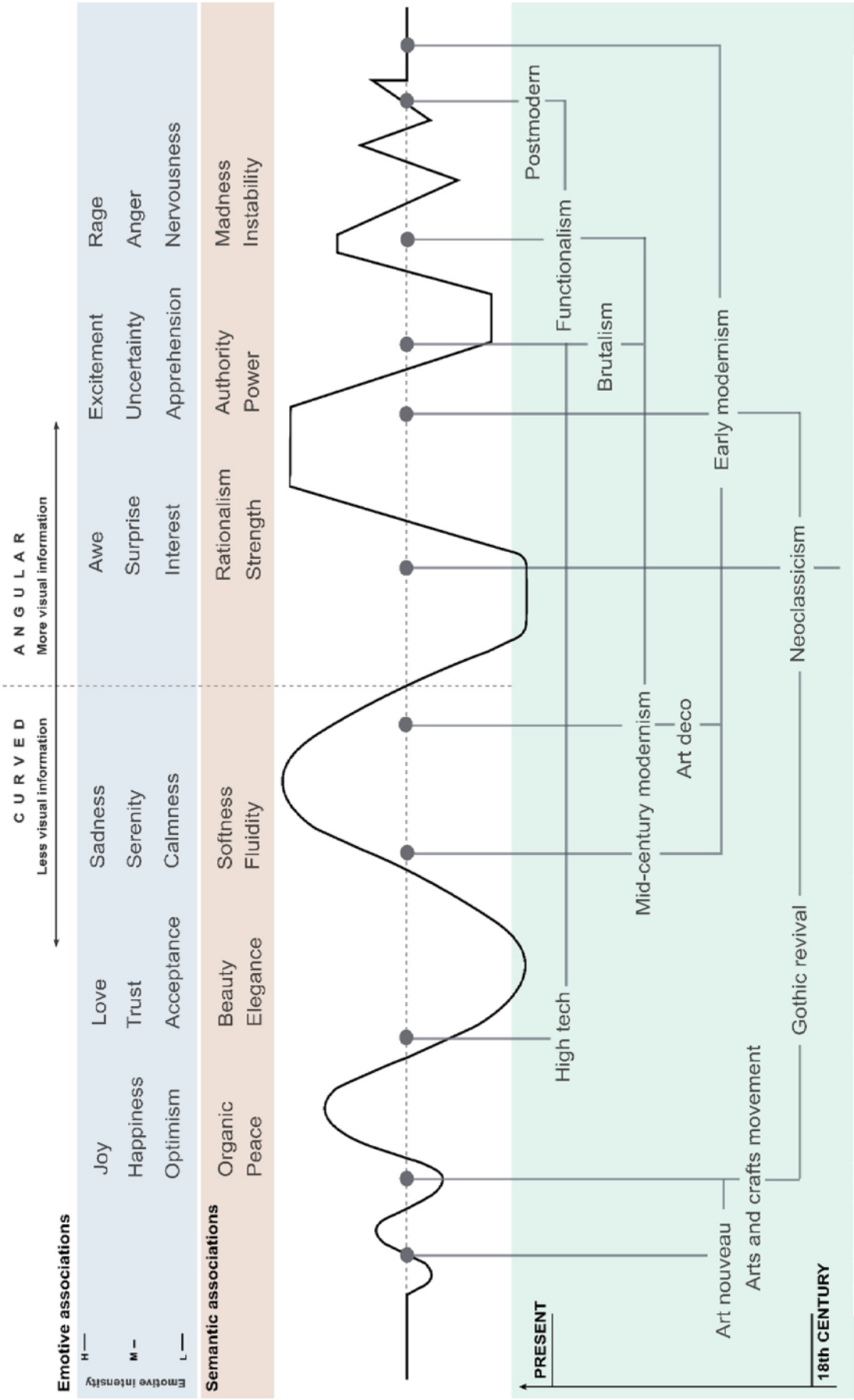


Figure 13. The line model of form and emotion. The top half details the emotive and semantic connotations of the line form; the bottom half considers the historical changes in form across time from roughly the mid-18th century until the present day. The emotive categories highlighted at the top are derived from Plutchik (1980), Shaver et al., (1987) and Cowen and Keltner (2017).

the iconographic approaches developed by Panofsky (1939), where compositional form elements are examined structurally and then in terms of semantic meaning, thus establishing relationships between the forms and the visual experience of observers. Importantly, the historical movements examined within the model show no linear path in form evolution and no clear inevitability. We argue that some features of form and structure can relate to societal feelings and philosophies, but the diversity of thought within artistic and design practices make them very difficult to pin down in an absolute sense. Although modernism can lead to its mid-20th century variant, which was thematically and philosophically similar, the same is not seen in the transitions from art nouveau to modernism because the underlying philosophies were very divergent. Our model clearly demonstrates this divergence in the dominant styles.

The movements are placed in the model on a time scale that spans from roughly the beginning of the 18th century to the present. When lines intersect the central axis of the line model (Figure 13), this indicates that the surrounding line abstractions are the archetypal form features of a particular movement. For example the brutalist and functionalist movements intersect at points where the line is highly angular. The complexity of some movements—art deco, for example, which incorporates both elements of angular form and curvilinear form dominantly—is indicated by intersection with multiple points of the model. The connections between and among the various aesthetic movements become more apparent when applying our model. If there is one root from which many of the modern and contemporary movements come, it is arguably the neoclassical tradition. Due to its dominance in Western art, architecture, and design, the movement has exerted a profound influence on subsequent work, both aesthetically and philosophically (Bietoletti, 2005). While early modernism strove toward a radical abstraction, it still adopted the structural underpinning of the neoclassical traditions. Contemporary high-tech architecture, also known as structural expressionism, includes both curves and angularity in a wide variety of forms. Although this movement has been abstracted from its initial roots in the neoclassical and classical traditions, the core semantic message of achieving beauty through the principles of reason remains. Our line abstraction method has allowed us to reveal these relationships with greater clarity.

Additionally, technological advance is a critical element that has not been directly considered within the context of the model but much of the tangible aesthetic shifts we considered have been influenced by these changes. Indeed, it has been argued that the constraints of available manufacturing technology are a significant influence upon the final form of a product (Crilly, Moultrie, & Clarkson, 2009). Therefore, form development may be a function of emotional needs and socio-semantic reasoning fused with structural preferences, technological capability, and clear functional requirements. The novelty of certain aesthetic movements may come from a coherence in form and structural archetypes that allows for more stable emotional engagement.

Relevance for Design

How can this work advance contemporary design practice, be it product, architectural, or technological? While this model, in its current iteration, is theoretical and draws upon a variety of sources to advance the arguments, it can provide some tangible insights. Firstly, the model is significant for design practitioners wanting to create more emotionally resonant products. The work of Jordan (2000) set out the relevance for understanding of human factors in industrial

design including aesthetic pleasure and the pleasure derived from using a product. As Jordan (p. 7; italics in original) stated, “Products are not merely tools: they can be seen as *living objects* with which *people* have *relationships*.” This transition from products seen as tools or ornaments to something embodying experiential value is highly significant and can extend to architecture and the built environment. Factors of emotional experience are becoming vital components in modern design practice, as Norman (2004) also noted. Our model, while not dealing with use factors directly, can be used as a guide for aesthetic factors and experiential factors relating to aesthetics, particularly emotion. Within a particular context, a product or architectural structure could be designed with insights from the relationships between emotional experience and form elements. A recent study has in fact suggested that emotionally pleasurable forms can be meaningfully categorized within defined semantic and experiential boundaries (see Chang & Wu, 2007), and another found that form can even convey types of personalities (Desmet, Ortíz Nicolás, & Schoormans, 2008). These are complex relationships humans can have with designed objects, and increased understanding in this area could lead to improved societal well-being. Through our novel form abstraction method, we seek to show the value in a deeper knowledge of emotional experience, categories of emotional experiences, historical change in form expression, and semantic theory. The key benefits of the work and the model in its current iteration to general design practice are summarized here:

- (a) provides to designers critical visual direction as they design products, spaces, or buildings for a category of emotional experience;
- (b) provides examples of how form has been emotionally expressed since the 18th century through the historical breakdown of form development;
- (c) provides designers with a deeper understanding of form semantics when they attempt to configure emotionally sensitive products, spaces, or buildings; and
- (d) provides a heuristic framework to inspire discussion on form and emotion.

Limitations of the Model

The line model of form and emotion presents a theoretical synthesis of information and it is important to discuss its limitations at this stage. Our model is not traditionally empirical due to the lack of a direct study, but we sought to discursively bring together a wide variety of literature in a novel approach to distinguishing form characteristics. We stress that this model is theoretical, is in its early stages of development, and must be advanced and refined through future research. Currently it can be used as a visualization tool for designers, but it provides, in this initial iteration, an incomplete picture. A more systematic and empirical approach may validate the model through psychological studies, a point when other research efforts can add to the ideas within this work. We suggest utilizing our line abstraction methods in a more systematic way. Future scholars could analyze larger arrays of images and create more refined categories of forms. Or perhaps, they could use sets of line relationships derived from abstraction approaches and psychologically test them. Two critical aspects that were not considered in this analysis are material properties and color. The model does have a central focus on form abstractions, but future research could consider the material aspects of design and architecture. For instance, what are the emotional differences between experiencing a sandstone building and one made from glass or steel? Would there be a difference between

experiencing a brightly colored object as opposed to one of more muted colors? These are interesting questions that our model does not yet answer. Adding these dimensions to the model would be valuable for both design practitioners and future researchers.

One important concern is that the model currently is limited to European and North American cultures. The influential artistic movements from Asia, Africa, South America, and the Middle East are not included in this iteration of the model. Further work must consider these movements in providing a more complete picture of form development paired with emotional experience across time. For instance, the aesthetic of traditional Japanese interiors was a major influence on Western modernist architects (Tanizaki, 1933). Including all of these movements was simply beyond the scope of this paper, but future iterations of the model could and should map these aesthetic histories. Visually comparing the differing stories of Eastern and Western art may be a useful tool for scholars examining parallel periods in history.

Additionally, the model does not capture the variety implicit within the movements. We made generalizations that are useful for understanding the key form trends and relating them to emotion or philosophies of a particular time. Modernism, for example, was dominated by rigid and angular forms but was never confined to this; the modernist philosophy also was expressed through other geometric endeavors. We suggest that the coherence of modernism as an aesthetic depends on abstraction and the angular symbols of functionalism. For this reason, our model could be considered too reductionist.

Further, our method of abstraction also needs some scrutiny. While we used well-developed theories of composition to break down our examples and followed the logic of Hann (2012), who defined the foundation of all geometry as coming from points and lines, we acknowledge that compositions can be broken down in alternative ways. An example could be applying discrete sets of whole shapes.

Finally, other methods of art history could have been explored, such as pure formalism or Marxist analytics, which would consider social and class dynamics as the axis by which artistic developments move (D'Alleva, 2005). Either of these movements may have proved valuable, but our iconographic approach appeared the most suitable due to its method of analyzing critical aspects of both form and culture, which can subsequently be examined from the perspective of emotional experiences.

CONCLUSIONS

Following an examination of form theory and the models of design and emotion, we developed an initial iteration of the line model of form and emotion. Taking inspiration from various sources—including early and more recent work in experimental aesthetics, psychologists of emotion and experience, the Gestalt theorists, art and design historians, and modern work in semantics—we built a general model of abstract form relationships connected with emotive and semantic values. From this, we illustrated how form evolution is a nonlinear, organic, and highly dynamic process with many variations across recent history that can relate to a wide variety of emotive states and semantic values. The model is incomplete in its historical analysis and would benefit from further development, but we have tried to include the most historically influential movements within Europe and North America.

With respect to this, we hope this model can be used as a point of reference for designers or architects interested in creating emotionally rich objects. Additionally, we hope it can be used as a heuristic tool for inspiring discussion around form, aesthetics, and emotion. There is a requirement in contemporary design—architectural or industrial—to emotionally engage with users, to offer the user a specialized emotional experience. The model supplies clear information regarding the emotive and semantic connotations of form and helps place form in a particular historical and cultural context.

These conclusions also open the door to further questions. Can these ideas be successfully applied in actual design practice? What are the implications of considering form in this abstract way? Can these methods enhance understanding of the history of the visual arts, design, and architecture more effectively? The line model of form and emotion provides a starting point for further studies to explore our arguments and conclusions on the experiential, emotional, and semantic qualities of form. There are a number of implications of the work that this section will look at in more detail; three areas where this research could possibly be applied and expanded. Firstly, the expanding field of user experience design and design emotion, secondly, design and art education and theory, and thirdly, creative practice generally.

Future User Experience Design

In this article, we explored a number of avenues of scholarship but were primarily concerned with the emotional value of form and how this can manifest in designed objects, works of art, or architecture. Multiple researchers, including Desmet (2003), Hekkert (2006), Crilly, Moultrie, & Clarkson (2004), and Crilly et al. (2009), have explored, and others have applied, this thinking to create new modes of user experience. Work by Niedderer (2012), for instance, designed a novel fruit bowl in silver using symbolic representations of emotion and soma-semiotic interpretations of movement. The bowl was explicitly designed to elicit an emotional response based on its form, which was based on curves and its interaction properties. Overall, the bowl was described as joyous by participants in a series of visual and tactile tests. This sense of representation through form is becoming more explicit in design and can be seen directly in the work of artist and designer Ane Christensen, who is inspired by feelings, sensations, and movement. Her Kinetic sculptures explore concepts such as symbiosis and connectivity. Similarly, the work of designer Thomas Heatherwick has contributed to several radical form-driven architectural projects, such as the Seed Cathedral. It certainly seems that the modernist ideal of beauty through utility, though influential, is being questioned, and our research contribution may help others to anticipate what the future may hold for designed objects and the built environment.

Ultimately, understanding that particular forms or geometric relationships can inspire very negative or very positive emotions may influence the way products are created in the future. The digital world must also be considered here. Computer interfaces have paved the way for designers' ongoing concern for emotional experience in design generally (Cooper, 1999). Yet computer systems will evolve to become more immersive, meaning that the emotional experience of users will become even more important. At a more complex level, virtual reality gaming, for instance, offers a new world of sensory experience for which well-designed aesthetics will be critical for users. A good understanding of form and emotion, and indeed the history of form, may bring the most resonant emotive experiences for users. Symbolically capturing a sense of excitement, fear, or joy through various aesthetic techniques is something

that is already practiced within film media (Plantinga & Smith, 1999), but the immersion of virtual reality may need a more considered and layered set of form motifs and archetypes. At a less complex level, virtual reality systems are being developed for various types of software, such as photo and film editing, CAD, and even admin software like email interfaces and data exchange (Whyte, Bouchlaghem, Thorpe, & McCaffer, 2000). The form and structure of these new spaces of human experience must draw upon the best knowledge of form and space, as designers serve as architects in a nonmaterial world.

It is not hard to see how a deeper understanding of experience and emotion can translate into certain rules or standards for designers, standards explicitly detailing how product forms or digital environments can be configured for higher degrees of user enjoyment. Additionally, there is opportunity for using advances in emotional design research to benefit the environment. Design academic Jonathan Chapman (2005) argued strongly that the products created should be more emotionally durable and constructed in such a way as to decay and change meaningfully. Chapman (2005) pointed out, for example, that a ripped pair of jeans, a stained T-shirt, or a scratched phone casing has a kind of value, one drawn for its use and interaction with a person over a period of time. Could digital environments also be configured this way? Even the design of packaging could have more emotional resonance and relevance, leading to less waste and new categories of use (Norman, 2004). Small changes to human technological approaches can have meaningful impact.

Design and Art Education and Theory

This paper is principally building towards a new theory and it is worth examining how it could potentially be applied within design and art education. Although in-depth discussion of how design and art education is structured across the Western world is beyond the scope of this paper, the topics constitute various approaches and methods, including iconographic (as applied in this work), formalist, and sociological approaches (D'Alleva, 2005). Future education programs could include the psychological analysis that has been used throughout this work. While recognizing the symbolic power and value of form is paramount within the analysis of aesthetics, the tangible and measurable psychological or neurological affects have received only limited consideration (Silvia, 2005). If students of art or design were more attuned to the wealth of scientific evidence relating forms to emotional experience, it could offer new avenues of study and creative expression.

In terms of the theoretical implications of this work, a few points warrant consideration. Firstly, the attempt to map how form has changed across time offers new avenues of interpretation for researchers. Integrating the history of ideas, semantics, emotion psychology, and the study of artifacts may lead to a wealth of new theory from future researchers. Secondly, this work challenges the idea of the artist, designer, or creator as the sole arbiter of his/her work. Our analysis leads to a much more complex conclusion, where designed objects, art, or architecture is a function of multitudinous interactions of beliefs, practices, materials, needs, and meanings, as Forty (1986) broadly iterated.

Creativity and Form Expression

Finally, it is important to consider the value of this work for the practice of design, art, architecture, or urban, interior, or graphic design. The line model could be used for creative

purposes and as a heuristic tool to stimulate discussion around form, but other options could be explored that apply the model more directly as a design tool. Mothersill and Bove (2015) developed a CAD tool (i.e., the EmotiveModler) for configuring emotively expressive forms. Taking cues from their work, the line model could be applied in a similar way and digitized for direct use in CAD software. Elements within a model could be analyzed for emotively resonant features and forms. Relating back to the discussion of positional, tangent, and curved line continuities described earlier, these could be given some broad emotive significance and meaning within CAD software itself, allowing designers greater control over form expression. Indeed, the principle could be extended to other areas of digital creativity, for example, graphic design or typeface design. A technology of this kind, however, would require more research and data to be realized.

Although developing the model or its future iterations into a digital analysis tool is possible, computation is another avenue that is being explored within design practice. The interesting work of Neri Oxman (2012), for example, has used the computational rules associated with biology and growth to design seating and jewelry. Information contained in the line model could be applied computationally. Given certain inputs, an emotive design could develop from simple line elements. Currently, this is speculative and beyond the scope of this work but, with future development, many new spaces of creative possibility could open.

IMPLICATIONS FOR THEORY, APPLICATION, OR POLICY

There are several immediate implications this research could have for the wider research community, design practitioners or policy constructors, several outlined in the Conclusions section. Here we presented work in form theory and human emotive responses to form and have argued that this knowledge can be applied in design and architectural practice. In drawing on form theory and human emotive responses to form, the outcomes of this research can support and enhance the emerging work in design emotion. For this research output and others in technological applications, our research can open avenues for better theoretical understanding of form perception but also provide insights useful for designers or researchers focusing on emotive products or aesthetics.

ENDNOTES

1. Form can be defined in a variety of ways, including as a type of something, a procedure, a linguistic operation, etc. In this article, form is defined to mean specifically visual form.
2. In this article, we refer to Western design (also Western world/culture/art) as a design tradition that is practiced particularly in Europe and North America. We acknowledge the attribute Western allows multiple interpretations (see Bavaj 2011), but believe it is accurate enough application in this article.

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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.
(Image © by Gerd Altmann, with permission to reprint by pixabay.com and Gerd Altmann)

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; Yarbush, 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 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

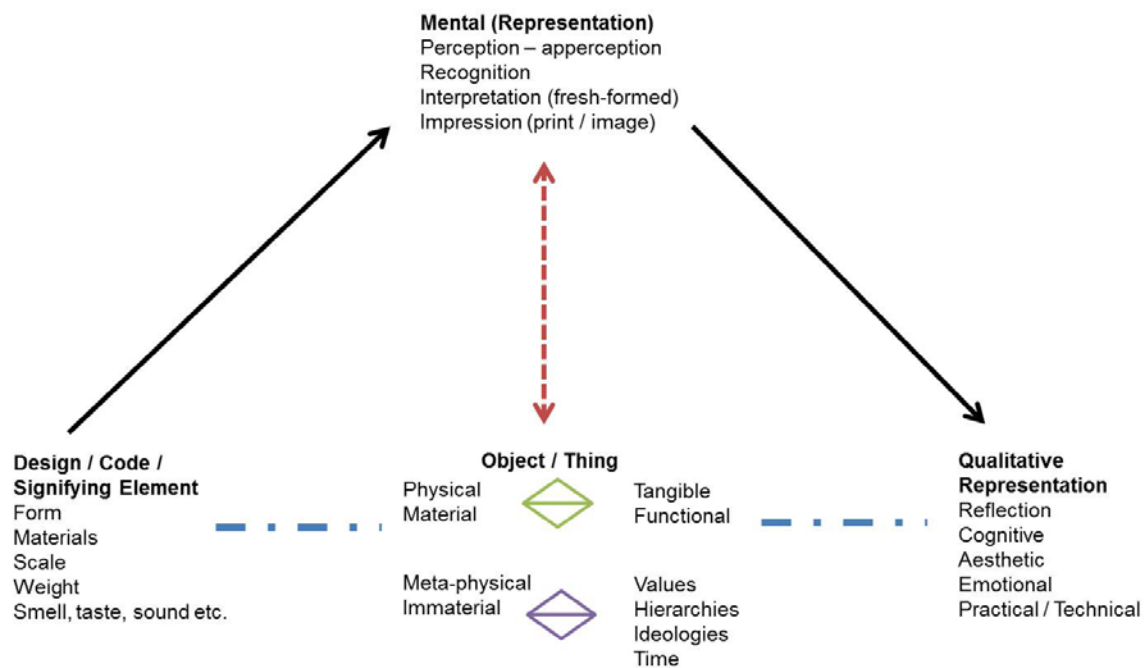


Figure 3. Cognitive–semiotic model of human–technology and design experience explaining the relationships between the design, the object to which it alludes or represents, how these are interpreted (mentally represented), and how the mental representation is subsequently qualitatively described (Rousi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

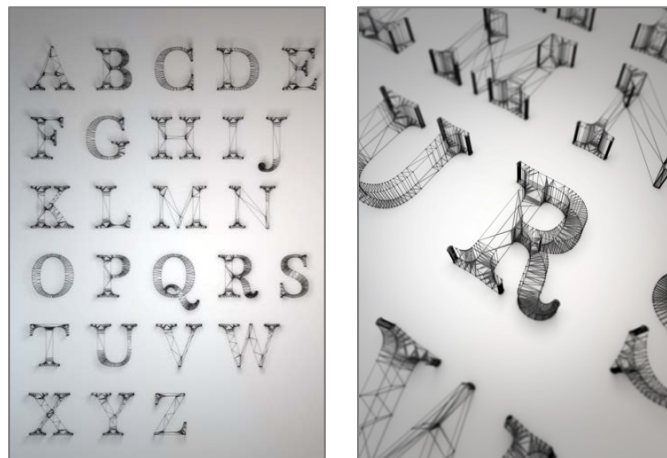


Figure 4. Example of the complexity of text font construction seen in *Wire Typography*, Dan Hoopert (2013). Reprinted with permission from Dan Hoopert.

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 interpretant, 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

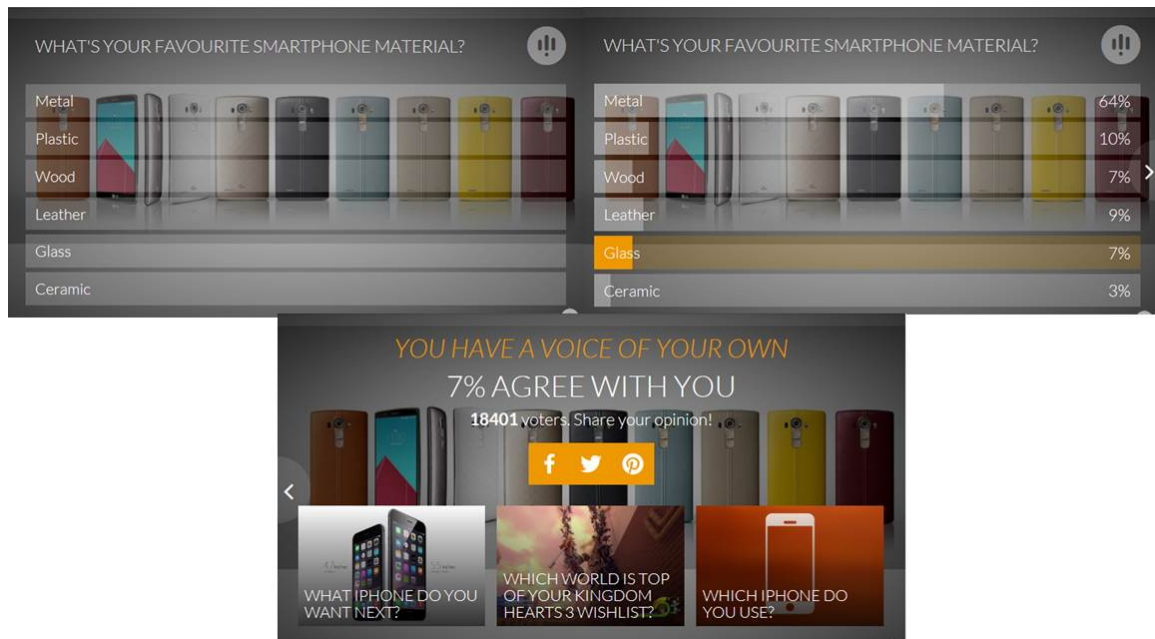


Figure 6. Screenshots of the online poll “What’s your favorite smartphone material?” The above left shows what respondents saw before responding; after responding (above right); after the poll results were tallied (below). (Permission to reprint granted by Matt Egan, courtesy of www.pcadvisor.co.uk.)

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.artifyfactory.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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ENGAGEMENT BY LAMINATION OF AUTOPOIETIC CONCENTRIC INTERACTION SYSTEMS IN GAMES: A STUDY OF FOOTBALL AND POKÉMON GO

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Abstract: *The aim of this paper is to rethink games and game design within the theory of self-producing interaction systems. With this research, I seek to identify several dynamics of play and engagement elicited by games that, by extension, can serve as game design parameters. The research is oriented toward an analysis of football (soccer) and Pokémon GO within the context of Niklas Luhmann's (2002/2012) theoretical framework of autopoiesis (i.e., self-producing interaction systems). The theoretical discussion of play situations in the two games reveals five concentric interaction systems through which games motivate play and engagement. These game dynamics are continuing simultaneous communication, multiple observations, double expectations, system autonomy, and unexpectedness through system coupling. The study further shows that when a game succeeds in eliciting these dimensions, functional, continuous, and changing structures allow for the emergence of numerous behaviors and the production of new interaction systems.*

Keywords: *game design, autopoiesis, self-producing systems, interaction systems, engagement, game structures, systems design.*

INTRODUCTION

The aim of this article is to rethink game functioning and design by analyzing games within the concept of autopoiesis and autopoietic systems as dimensions of communication, following the theory proposed by Niklas Luhmann (2002/2012). Autopoiesis describes how communication (i.e., a network of processes) between various components of a system leads to producing and reproducing the components that the very same system comprises (Maturana, 1975, p.18). The autopoietic system thus is not produced by something outside the system, but rather the components “reproduce themselves from within themselves, as for example a plant reproduces its own cells with its own cells” (Seidl 2004, p. 2). From a game perspective, autopoiesis could be exemplified by how the great masses of people (networks of processes) who played Pokémon GO interacted (with each other and their immediate environments) and, by such, established communication systems that produced additional communication systems associated with the gameplay, but in varying locations and with a different organization and intention. Thus, a communication system (play) produced a distinctly different communication system (also play).

Luhmann’s (1990, p. 83) statement that “meaning is the link between the actual and the possible” formed the grounds for a theoretical analysis of how games can elicit play that leads to autopoietic systems and, in turn, meaningful experiences of play and engagement over longer periods of time. The intention with autopoiesis as an angle for the analysis is to allow a broader understanding of the functions of play and games. It also allows for further investigation of how these may represent engagement and, by extension, how the degree of complexity of play behavior relates to engagement and experienced meaning. Engagement is a vital component of game functioning, particularly in regard to how people relate to objects and to other people within the game system.

With this study, I seek to identify and define systems of interaction contingent on or created by games by way of a real-world team sport and an online collaborative game in order to identify the general properties of games that may describe engagement. To analyze the concepts of engagement and autopoiesis in greater detail, I selected the real-world game and team sport of football (also known as soccer) and the augmented reality (also known as mixed or hybrid reality) game Pokémon GO as the online collaborative game. Both games have experienced worldwide popularity. Although football maintains ongoing interest at various levels, Pokémon GO has seen a decline in popularity. The differences between the games (e.g., real-world vs. augmented reality, steady vs. declining popularity) provide an interesting stage to compare play behavior between the two games in regard to play, autopoiesis, and in-game communication. Further, analysis of these differences supports better understanding of what drives game popularity.

The study of engagement, or immersion, in game play is a new and interesting research line for understanding better what instigates players to join a game and, more importantly, remain playing (see, e.g., Abbasi, Ting, & Hlavacs, 2017; Brown & Cairns, 2004; Jørgensen 2011; Linderoth, 2012; McMahan, 2003; Schoenau-Fog, 2011). For example, Linderoth (2012, p. 490) found that children fantasized through role-playing as an associated activity when playing the computer game World of Warcraft to become more engaged in the game play. Subsequent to this role-playing, expectations emerged for future narratives to occur in forthcoming play. Accordingly, World of Warcraft served as a platform for autopoiesis, as a

new game of role-playing emerged, or was produced, by the network of processes originated by the game itself. The role-playing game fused into the entire game experience for these children. World of Warcraft (including role-playing) thus served as agency for engagement for either team play or independent-but-collaborative play. Pokémon GO, which functions both in the real world and in the fictional digital world (see the Appendix for an explanation of the game), comprises similar functions. The coincidental stimuli that happen outside game play but as a result of play—for example, the encounters with other players in a park—influence the total experience of the game play itself. Within this understanding, Pokémon GO is the origin for autopoietic functions in that the game leads to new networks of processes outside the game play that contribute to the total experience and increased engagement of play. In research on Pokémon GO, these functions often are referred to as social benefits or motivation and, to some extent, engagement (see, e.g., Kaczmarek, Misiak, Behnke, Dziekan, & Guzik, 2017; Rauschnabel, Rossmann, & tom Dieck, 2017; Tang, 2017). Immersion is foremost studied as a dimension of computer games and mainly described as “being caught up in the world of the game’s story” (McMahan, 2003, p. 68), which McMahan referred to as the diegetic level. However, immersion also refers to the nondiegetic level that illustrates “the love of the game and the strategy that goes into it” (McMahan, 2003, p. 68).

Engagement, on the other hand, is understood somewhat differently in research on sports. Best (1980) used the notion “purpose” for purposive sports and “aim” for aesthetic sports. In aesthetic or “nonpurposive” (Kreft, 2015, p. 132) sports, such as freestyle skiing, the significance, and thus the degree of engagement, is influenced by “the manner of execution” in addition to the level of competitiveness (i.e., one’s score is determined by turning technique, air maneuvers, and speed). However, in purposive sports, such as a 100-meter track sprint, solely the drive for a result elicits engagement (Kreft, 2015, p. 131). Nonpurposive sports and games thus, within this argumentation, incorporate engagement and an inner drive that can be described as a condition rather than a goal, a condition similar to the role-playing activity that Linderöth (2012) identified in children playing World of Warcraft. Accordingly, a nonpurposive activity introduces a drive that may not or cannot be fulfilled (i.e., there often is no objective outcome but rather subjective assessment of skill). Thus, it is the numerable experiences or feelings elicited during the sport that is of importance. Within this understanding, aim and drive in sports and games represent agency for people to become engaged, which can be described as the desire to participate in the game and to influence other players or the outcome. In purposive sports and games, similar mechanisms may be at work, however the lack of nonpurposive drives and aims narrow the space for variable experiences beyond the one of competition.

In this research, the term engagement is utilized to describe involvement: the drive for involvement and the manner in how this involvement is executed in a game unbound by the game’s result. Thus, engagement is considered a nonpurposive condition (Kreft, 2015, p. 132) even in a purposive sport. The research on play behavior elicited by the games in this article is thus not oriented toward the particulars of the various experiences of engagement during play as much as *how* engagement is generated by play behavior (Brown & Cairns, 2004), play systems, and specifically, by autopoiesis.

Unlike stable social systems, dynamic communication systems may appear and disappear quickly. Dynamic communication systems are driven mainly by the expectations and needs of the people within the functioning system, which are, as well, based on a history of expectations and interactions (Maturana, 1975; Maturana & Guilloff, 1980), or “interaction systems,” which

is the term Luhmann (2012) used to describe such autopoietic systems. Interaction systems, like all social systems, “reproduce themselves on the basis on communication” (Seidl 2004, p. 14–15), and thus they are autopoietic. Interaction describes personal encounters, meaning they are contingent on active physical (or virtual) presence in contrast to any other social system. “Since the interacting objects involved in interaction, [*sic*] act too,” interaction is contingent as well on a player’s “interaction for intervention in the course of events” (Luhmann, 1995, p. 523). Interaction thus describes an active communication role in personal encounters performed in order to intervene and influence—but may also describe the act of playing—a complete game, both which can be understood as autopoietic interaction systems. However, in order to explore engagement during play, I have separated play into distinct temporarily subordinated interaction systems or encounters that emerge in a timeline of playing a game. The sequence of encounters of the kind that is produced by play itself to enrich play is what Goffman called “concentric frames” or “keying” (Davis & Goffman, 1975, p. 599). Concentric frames embody subordinated interdependent frames during play that make up the total frame of play. The concentric frames within the context of play, which function as autopoietic interaction systems yet compose only small sequences of a strip (or sphere) of playing a game, are referred to as concentric interaction systems in this article (see Figure 1). Concentric interaction systems thus represent the various subordinated frame levels. An example of a concentric interaction system could be the encounter by and interaction with Pokémon GO players, who transform the basic elements of play into the further experience of play.

The focus of this paper thus is the role of autopoiesis (i.e., self-producing systems of interaction that are self-organizing structures) in games and game engagement, whether the game is online or offline. The extant discourse within the research field of computer games contributed

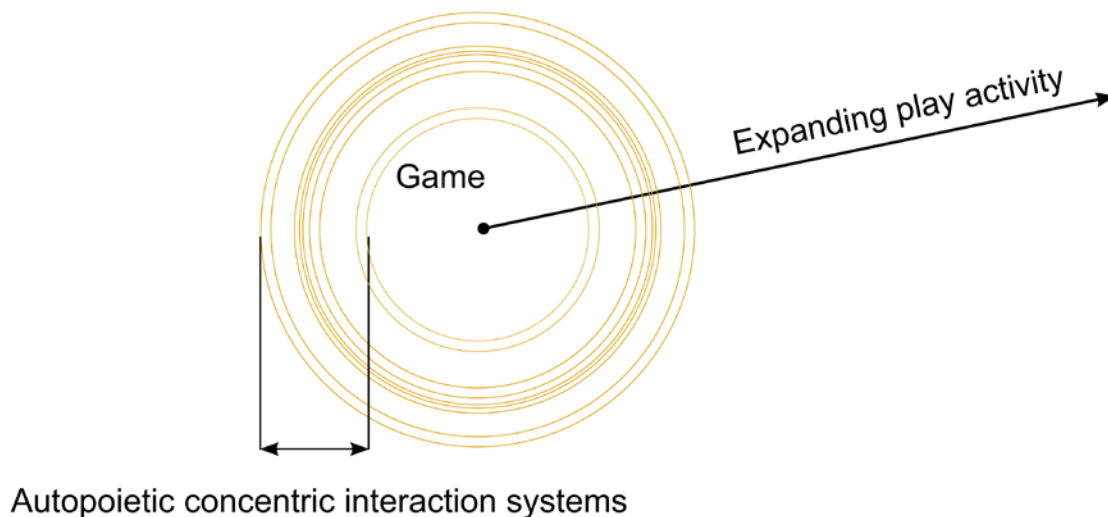


Figure 1. Intertwined layers of autopoietic concentric interaction systems (circles) emerge during play. The play activity is a complex process that expands in all directions once the activity begins. Thus, the play activity is illustrated here as starting in the center with the initiation of play; the graph widens and the laminations thicken as play continues. The layers of autopoietic concentric interaction system are designated as circles. The composition of the concentric layers is quite varied by type of game or how a particular game is played; they also vary throughout the game based on the changing circumstances of play.

contributed to the research design I established to explore engagement in Pokémon GO and football. As a reciprocal effect, the gained understanding of engagement in football may contribute to the description of immersion on the nondiegetic level in computer game research. The concentric interaction systems recognized as eliciting engagement, identified in both games by theory on autopoiesis, contribute to rethinking game theory, game design methodology in general, and specifically in augmented reality games and sports. The presentation of these systems as layers (sequences) of play that elicit engagement may represent a way of thinking that can lead to the identification of additional systems based on a similar research design. In addition, the concentric interaction systems can serve as analytic tools for understanding other games, as well as design methodology for creating new games—from offline reality to digital virtuality—for the full range of gaming experiences. In addition, the findings support a methodology in both service and product design that is capable of activating and motivating users.

METHODS

The role of this paper is to investigate concentric interaction systems and processes and to explore how they may serve as engagement in play. In doing so, this research extends the concept of autopoiesis into the exploration of game design. My research seeks to answer two primary questions: How can football and Pokémon GO be described through theory on autopoiesis? How does autopoietic concentric interaction systems relate to feelings of engagement and the processes of keying?

Football and Pokémon GO (see the Appendix for brief descriptions of each game) were selected from myriad virtual, augmented reality, and physical games because I wanted to study two games with different dynamics that clearly elicited engagement. As a general criterion, I considered the popularity of the two games a consequence of play engagement. Both games were highly popular worldwide in 2016. Just a few weeks after Pokémon GO was released, over 100 million players from 30 countries had downloaded the game and played 1 hour per day on average (Zsila et al., 2017). Secondly, research on both games suggested that the social or communicational facet of playing these games is a key factor for their popularity (Giulianotti, 1999; Tang, 2017). Third, I wanted to study games that had similar levels of accessibility. Both games are easy to grasp and were at the point of this study typically played by people of all ages, gender, social status, and skill levels (Giulianotti, 1999; Kogan, Hellyer, Duncan, & Schoenfeld-Tacher, 2017; Tong et al., 2017). That is, the players of the two games do not need to be gamers nor elite performers. Additionally, at the point of writing this article, both games were common activities in various cultures, making it natural to talk about and observe play in numerous public spaces.

The two games are different in many ways. Accordingly, a direct comparison of the game mechanics is not the major intention of the research design. The differences between the two games are significant and one may criticize the choice of the two games as being too diverse. I could have chosen a massively multiplayer online role-playing game (MMORP) for this study due to its degree of stimulating online communication among the players (Linderoth, 2012) and it being more in line with the practices in real-world football play. However, Pokémon GO represents a game that elicits few types of play yet it enables

activities that are both physical in a geographical sense and online (Tong et al., 2017). Thus, the choice of this game opens analysis of hybrid gaming. In regard to the challenges in comparing the selected games, I saw no need to search for equality in game structure and ways of play; on the contrary, I found that the absence of a dimension in one game served to elicit insights about the other.

The study is primarily a theoretical exploration supported by examples identified in qualitative research through fieldwork based on typical ethnographic principles that stress the immersion of the researcher within a specific social setting to “engage with the group on its own ground” in order to attain a holistic understanding of a situation (Hobbs, 2006, p. 3). The fieldwork consisted mainly of my own playing and observing of others while playing football and Pokémon GO. My aim in undertaking this approach was to gain insights into concentric interaction systems and their complexity and the communication among players and its influence on gameplay (see Mortensen, 2002). My ethnographic approach builds primarily on a synthesis of self-ethnography (Alvesson, 2003, p. 168), or autoethnography (Allen, 2017, p. 2), which represent similar concepts, and “virtual ethnography” (Hine, 2008, p. 2). For this research, virtual ethnography was employed to some extent to explore the “social interactions that take place in virtual environments (Kozinets, 2012, p. 2).” Although Pokémon GO represents an augmented reality environment, the observed in-game online communication was marginal. Therefore, the virtual ethnographical study concentrated both on communication within the game and, to some degree, communication through Instagram, where players informed each other about aspects of game play. Autoethnography, which is an autobiographical type of ethnography that “emphasizes the lived experiences of researchers to access culture as communicative accomplishment” (Allan, 2017, p. 2), was chosen as a method to collect data from the two games because I was “highly familiar with” and “had direct access to” (Alvesson, 2003, p. 167) the particular play situations for the study. Alvesson (2003, p. 168) underscored the struggle researchers face between “utilizing closeness to [an] empirically rich situation” and of being a native, which implies familiarity that may hinder a richness in the approaches for collecting data. However, by playing both games, I have had the opportunity to be an “active participant, more or less on equal terms with other participants” (Alvesson, 2003, p. 174), as well as benefiting from play that involved a “personal engagement with the subject [which] is the key to understanding a particular culture or social setting (Hobbs, 2006, p. 102).

The quality of the empirical data collected by autoethnographic studies in skill-demanding games relates to the skills of the ethnographer (Linderoth, 2012). I have attained experience as a football player through playing the game in arranged and recreational settings for 25 years. As for Pokémon GO, I played on a daily basis for 6 months, beginning with the game’s release in Norway in July 2016. The emphasis of this study thus lies on playing these games rather than spectating. Accordingly, the insights attained about the games are derived from theory, my own play experiences, and some observation of other players. The findings emerged during my analysis of play within the framework of sociology and Luhmann’s (1995) theory of autopoiesis.

The autoethnographic study generated by playing the two games and the comparative analysis between the empirical data and the theory on autopoiesis led me to identify and define several (autopoietic) concentric interaction systems (i.e., engagement, communication, and complexity in gameplay). By extension, I analyzed these concentric interaction systems from

the perspectives of game and play theory (see, e.g., Caillois, 1961; Goffman, 1961, 1986; Huizinga, 1949/1980; Juul, 2011; Perinbanayagam, 2006; Salen & Zimmerman, 2004; Suits & Hurka, 1978/2005; Sutton-Smith, 1997), with an emphasis on the concept of framing (Goffman, 1986), in order to discuss how the game dynamics relate to feelings of engagement. The empirical data support a theoretical argument for discussing the phenomena (e.g., Pedhazur & Schmelkin, cited in Nelson & Nilsson, 2002) rather than substantiating them. The engendered data built upon the observation of systems, but the discussion in this paper focuses on understanding exceedingly complex communication systems as a facet of play.

The epistemological position for systems theory lies somewhere between a positivistic/systemic view and a social-constructivist view. For example, Varela (cited in Reynolds, 2005, p. 540) acknowledged existing systems as “closed organizations” and thus possibly observable entities, while Churchman (cited in Reynolds, 2005, p. 541) noted that “systems are predominantly in the mind of the observer rather than in the real world.” The views of Maturana (cited in Reynolds, 2005, p. 541) lie somewhat between these perspectives and in line with second-order cybernetics (i.e., self-observing and adjusting systems). Rather than approaching reality as observable and outside oneself, the researcher recognizes him/herself as a participant of the same reality that is the object for the study (Pickering, 2010). Accordingly, the researcher “is being a co-creator of that reality” (Budruss, cited in Bell & Morse, 2008), a description that also illustrates the ethnographic method for this study.

Because a player has agency and is nurtured by a game’s structure and rules to behave in a certain manner, the “theory of action must have difficulty imagining how the recursive closure of the social system and the production of something from its own products might take place” (Vanderstraeten, 2012, p. 384). That is, believing the possibility that the creation of something new by playing a game (systems of communication, behavior, etc.) in accord with the very rigid structure established by the game (i.e., predefined behavior by rules) presents a dichotomous position to the constructivist. This is because social constructivism explains how a given context constructs specific ideology, behavior, skills, knowledge, and attitude (see, e.g., Hacking, 1999; Latour & Woolgar, 1986), which is opposed to theory of autopoiesis that describes the creation of something new (known and unknown) on the basis of given and new contexts (structures).

Luhmann (2002/2012) sought to explain social behavior through communication as a dimension of interaction systems in order to distinguish systems theory from the action-oriented constructivist view. In this research project, I acknowledge Luhmann’s perspective, but I also recognize that interaction systems can be part of or function by movements and behavior (Gibson, 2015; Kreft, 2015). Behavior in this context can be understood as a living being’s perspective or attitude that is observable as movements or actions (Maturana & Varela, 1987, p. 136). The emphasis of this study, therefore, is on communication in social interaction in its broadest sense, in line with Porter and Samovar (1997), who defined communication as encompassing all behavior (i.e., speech and body movements) that has meaning to another, whether or not it is intended. This research project draws on research that explores communication created among players as one example of autopoiesis in action.

Finally, the benefit of autopoiesis as a tool for analysis is that it also can be a metatheoretical approach. Maturana (cited in Luhmann, 1995) suggested that autopoiesis is a metatheory because it engenders instructions for empirical research by asking “What if?” questions. Systems thus can

be understood as whole systems judgments used primarily to raise people's understanding through enabling the right questions to be asked.

LAMINATION OF COMMUNICATION LAYERS IN GAMES AND PLAY, DEFINITIONS

A clarification on how game and play are understood is necessary in order to perform the analysis of this research. I therefore introduce some ideas and definitions from central works within research on game and play. Further, I synthesize and discuss these works toward a suitable understanding for this research context, which covers both video and physical games.

Games and Play

Games, as seen by Salen and Zimmerman (2004, p. 96), are systems. Within these systems, a player's "agency is based on cognitive processes that are oriented to the others in the relationship as they are put into practice" (Perinbanayagam, 2006, p. 11). Hence, games invite a "reciprocal relationship of some kind between two elements [players or things] in a system" (Salen & Zimmerman, 2004, p. 58) that influences game play. Juul (2011) categorized games by how they challenge players through either an emergence or progression structure. An emergence challenge is characterized by small sets of rules that "combine and yield large numbers of game variation for which the players must design strategies to handle" (Juul, 2011, p. 5). These actions typically take place in sports (particularly team sports), card games, and strategy games. Progression structures involve leading the player through a "predefined set of actions in order to complete the game" (Juul, 2011, p. 5), typically seen in video games. Within this distinction, football represents an emergent structure because it is easily accessible and has rules eliciting an abundance of varieties of play. Pokémon GO, on the other hand, may fit both categories. The game introduces several predefined sets of actions to perform (i.e., catching Pokémon); however, the manner of how the player approaches these activities may vary. For example, the player decides where to go, which Pokémon to catch, and how to pursue whichever parts of the game s/he finds most interesting: merely collecting Pokémon, finding rare spots, competing in gyms, and so forth.

Juul (2011) argued that fantasy and rules in games are so intertwined that they create a complete experience and stimulate each other by establishing circumstances that are experienced as "half-real" for the player. Thus, if a person who is deeply engaged in the Lord of the Rings storyline plays a related computer game, s/he may become so immersed when playing that the gaming world or activity may feel somewhat real. Hence, games can be seen as a relation between rules and fiction (Juul, 2011). Linderöth (2012), in contrast, found that engagement is not achieved by a game's rules and fiction alone but includes personally constructed narratives through, for example, role playing as described in the World of Warcraft example. He also found that a technological progression structure may hinder the occurrence of role-playing. In Pokémon GO, the player functions simultaneously as a real person in the material world and as an avatar in the fictional augmented game reality, a situation that resembles role-play in description and the half-real play experience. However, even though some Pokémon GO players also share communication among real players via

the Internet or through personal encounters during play, the progression structure does not rely on encounters of any sort nor role-play. Role-playing and fiction serve different functions in football but may be present by, for example, children acting similarly to their heroes, choosing teams as imaginative settings for a match, and so forth.

Play, on the other hand, can exist either within the structure of a game or as an autonomous activity, although I focus in this research on play in relation to games. Sutton-Smith (1997), a play theorist who investigated play through interdisciplinary approaches, described play as a phenomenon that comprises several dimensions, depending on the complexity and variability of the situation. Based on Fagen's understanding of play, Sutton-Smith (1997) suggested that the psychological side of play represents a continuous variation that creates a condition in which social simulation can occur alongside the player's mastery of skills or failure to take control. Within this framework, play is dependent on imaginative eventualities, potentiality, and/or experiences, which in turn form the foundation for fantasy and imitation, which may further lead to the creation of play narratives, fiction, and rules. Huizinga (1949/1980) defined play as a fun, voluntary, and free activity outside ordinary life. Similarly, Fagen (cited in Sutton-Smith, 1997, p. 34) understood play as "aesthetic performance" and a "motivational attitude of well-being." Drawing on Piaget, Sennett (1977) argued that infants often take risks and abandon existing sensations of pleasure during play in order to find new kinds of pleasure. Thus, by extension, when people direct a play activity through experimentation and risk-taking, that is, taking control over one's own self and in cooperation with others, they "step away from immediate desire or instant gratification" (Sennett, 1977, pp. 315, 318). They pursue new and complex play situations in their quests for variation, socialization, pleasure, or fun. This is in line with Huizinga (cited in Mandoki, 2007, p. 220), who stated that "the opposite to play is not seriousness but the automatic."

Thus, play relies on engagement and games elicit engagement. Suits and Hurka (1978/2005, p. 10) described games as a "voluntary attempt to overcome unnecessary obstacles." This definition considers both rules and playfulness, but fails to include the importance of engagement or the affective and communicational dimensions of playing a game. Juhl's (2003, p. 36) version takes this dimension into account, noting that "a game is a rule-based formal system with a variable quantified outcome, where different outcomes are assigned different values... and the player feels attached to the outcome." The engagement or emotional facet that Juul (2003) referred to, however, describes how a player becomes emotionally attached to the outcome of play and not to the play itself. Perinbanayagam (2006), however, incorporated the engagement, social, and dialogic dimensions of games, indicating that games are

acts that human agents undertake, as players or spectators, to achieve cognitive involvement and emotional engagement with the other. The playing of games is, in fact, a conversation, a dialogic activity that systematically involves other agents, a continuation of the other processes of everyday life. It is also a means by which a human agent achieves intercourse with the other by using a range of symbols that is broader than language. (Perinbanayagam, 2006, p. 3)

Perinbanayagam's (2006) understanding of game play is that it involves aspects of daily life, but it does not include how personal interactions have direct consequences for reality. However, Perinbanayagam underscored that the degree of complexity of communication within

game play, particularly in team sports, is broader than general language use. Such complexity within an emergent structure such as football involves tactical and motoric activity as well as simultaneous communication among multiple players.

Framing

Goffman looked upon a game as a frame that serves as a boundary or membrane that allows “world building activities” (Goffman, 1961, p. 21) in that the frame isolates personal encounters (planned or unplanned) within focused gatherings (1961, p. 8). Thus, a frame serves as the “principles of organization which govern events—at least social ones—and our subjective involvement in them” (Goffman, 1986, p. 10–11). A frame then is a temporary shared environment for the participants within an activity (Linderoth, 2012) where they solve challenges posed by the activity parameters by abiding by common rules (Goffman, 1961). The frame becomes established by the rules and/or by the physical and augmented environment. Goffman’s (1986) concept of frame is presented as permeable, and thus differs from Huizinga’s “magic circle” (1949/1980, p. 10), which is consciously outside the conception of daily life. Permeability illustrates how the frame membrane allows the passage of something, which explains how a player is connected with real-life situations while playing. Further, permeability reflects how the choices and actions during play can have consequences not only for the fictional part of the game, but also for players’ (and spectators’) lives beyond the game.

Goffman’s (Davis & Goffman, 1975) frame analysis presented two components: the cellular and the concentric (peripheral). The cellular dimension in Goffman’s conception of frames involves describing the specific or temporal membrane that surrounds an activity. With games/play as the example, the description of the cellular dimension of the frame involves distinguishing what is considered the play itself, which represents the cell nucleus, from the plasma (i.e., the variety of outer activities involved in allowing the nucleus to take place) and from the concentric dimensions of a frame. Concentric analysis describes the break-down of various peripheral layers, like onion peels, that frame a moment of activity and the specification of the ways a primary social event is transformed into less fundamental ones (Davis & Goffman, 1975), such as, for example, the communication layer that transforms the concept of a fight into a play fight. Accordingly, analyzing the concentric transformation layers, or layers of “keying,” as Goffman (1986, p. 82) called it, involves investigating the added concentric layers of transformation to the experience of an activity. Playful fighting then is an act of keying because of the transformation of the primary activity of fighting into a ludic activity (Caillois, 1961; Mortensen, Linderoth, & Brown, 2015). A frame, however, is a vulnerable construct, and if a participant in this playful fight suddenly demands the activity to stop because s/he is afraid, the activity is drawn back toward reality, in what Goffman called downkeying. The action of adding layers within a frame that elevate play away from reality is called upkeying (Goffman, 1986, pp. 352–366). A primary activity also can be upkeyed by rekeying. In this process, the nature of the activity is changed to allow keying, done for example by adding a layer of fiction to the activity in order to adjust the narrative within a culture toward a ludic activity. As an example, a game inspired by the systemic organization of World War II could be rekeyed by involving fictional countries to avoid the need to address the ideology of Nazism (Chapman & Linderoth, 2015, p. 141). Moreover, concentric transformations may allow or protect play activity from the norms

within the culture that would normally prevent it. For example, football allows legal moves that are appropriate in football but not on the street, such as a tackle.

The second kind of a frame transformation that Goffman mentioned was “fabrication,” which is the intentional effort by one player to induce the other players to develop a “false belief of what it is that is actually going on” (Goffman, 1986, p. 83). All players agree upon the function of keying but only some parties are aware of the fabricated transformation (Davis & Goffman, 1975, p. 599). An example of fabrication is known as the “backdoor move,” often exhibited in basketball (Schmidt, O’Brien, & Sysko, 1999, p. 576). Such a move involves an attacker advancing the ball toward his/her opponents’ goal then suddenly turning around and taking a couple of steps toward his/her own goal, followed by a quick turn back toward the opponents’ goal. The backdoor move aims to exploit “the space just created behind the ensuing defender” (McGarry, Anderson, Wallace, Hughes, & Franks, 2002, p. 778). The offensive player created in the mind of the defender a false expectation that the first move toward the goal was the actual play, when in fact it was the second move forward.

The concept of framing involves different levels of communication and interaction systems. Thus, in order for the game to function, the players must inform and agree upon the terms of the frame and to influence and follow the wavering of up- and downkeying during play, as well as shown and hidden information. Fabrication and keying are dimensions of engagement when functioning. Downkeying can only take place when play has already added concentric layers of upkeying; it may serve to destroy or end play. That is, if a child in the middle of play proclaims that s/he does not want to be a superhero any more, play loses a layer of keying as the child turns into just being a child again, and play may end. Similarly, if a football player leaves his/her designated attacking position during a match and decides only to prevent goals by the adversary team by standing in front of his/her home goal, a layer of keying or engagement is taken away. Moreover, that strategy may result in altered or distorted communication and/or cooperation.

In his work, Goffman highlighted games and fun, but his primary emphasis was on developing “the study of face-to-face interaction as a naturally bounded, analytically coherent field—a sub-area of sociology” (Goffman, 1969, p. ix). However, researchers have found Goffman’s theories useful in the sociology of sports (see Birrell & Donnelly, 2004) and within research on videogames, analogue games, and sports (see, e.g., Chapman, 2016; Giulianotti, 2005; Kreft, 2015; Linderroth, 2012; Stenros, 2014).

Theory on framing in light of Goffman (see, e.g., Linderroth 2012) provides an understanding for how the function of keying can initiate and alter play engagement. Keying depends on a common agreement among the players and occurs in multiple layers and forms. Hence, when communication among players in a game serves as an influencer on the way the game proceeds, play activities will waver, take many directions, and cause exceedingly complex interaction systems to occur. In order to understand how concentric interaction systems are experienced, I find the concept of framing an important basis for analysis, given the exceedingly complex systems in games. Further, an analysis can be performed without the need to reflect on narratives, and thus the diegetic dimension, but yet include the fictive or fantasized.

Rethinking game design within the concept of autopoiesis may then be illustrated as an investigation of the lamination of communication layers that autopoietic concentric interaction systems create in games. Additionally, the analysis involves how these layers serve as keying and fabrication, and thus engagement.

AUTOPOIESIS

In systems theory, autopoiesis explains how new systems emerge from given settings through interaction and how these emerged systems can produce additional new systems. Autopoiesis was first proposed by Maturana and Varela (1987) and describes the nature and functioning of nonlinear self-producing systems in biology. Luhmann (1995) reapplied this theory to sociology. Complexity theorists also found these concepts useful in the study of dynamic, exceedingly complex systems (see Hernes & Bakken, 2003; Pickering, 2010). Tangen (2004) utilized Luhmann's theory to explore behavior in relation to sports and sport facilities.

In any activity in which two or more entities are involved, communication forms an essential means to bind them within the goals and interpersonal interaction of the activity. This is true whether the entities are humans or technology. Luhmann (2002/2012) was inspired by cybernetics and by Gregory Bateson, who defined information as "a difference which makes a difference" (Bateson, 2000, p. 315; see also Vanderstraeten, 2012). By this statement, Bateson meant that the entities not cognizant of someone (e.g., a person passed by in a park but not seen by a Pokémon GO user because of the user's concentration on the game interface) do not inform a situation, in that people do not get stimuli from things that, even though present, are not perceived. Communication then is formed by a person's selections from observed information made available through functioning systems (Shannon & Weaver, 1949, p. 218; also van Assche, Duineveld, Verschraegen, During, & Beunen, 2011). However, individuals do not have to discover entities themselves. In other words, people may also perceive because of the shared perception of others in that the decisions and selections made on the basis of information by others is communicated by behavior. For example, a Pokémon GO player may not see a Pokémon on his/her screen, but through discovering and following running by other players toward a rare Pokémon, the one player who did not see the Pokémon on his/her screen is suddenly informed.

Accordingly, when information is (re)acted upon by another, an individual is given a new or parallel possibility to discover (interpret) information. This secondary layer of communication thus works similarly to an augmented filter in that the player can react (play) on the basis of other players' understanding of a situation (interaction systems). Such a possibility may facilitate the emergence of interaction systems (including parallel or subordinate systems). Logically, it also increases the complexity of the interaction system. In such a context, an interaction system can be understood as an aspect of language itself. Yet the comprehensibility of any communication system relies on participants or spectators understanding the linguistic/behavioral code and the dynamic nature of communicative applications (Hughes & Bartlett, 2002).

Autopoietic systems emerge amid specific contexts, constraints, and structures. Within these systems, communication among entities or participants is created and influenced, resulting in actions that impact the structures, contexts, and constraints. At times, the process results in entirely new systems and structures that, at times, can exist and operate simultaneously alongside the originating system.

Structures and Self-Organization

A structure is what makes a functioning system possible. Everything that the system makes use of is what defines the structure (Luhmann, 2002/2012). Luhmann understood society as a variety of complex and intertwined interaction and communication systems. Each system

(games, people, things, microorganisms, etc.) emerges out of and exists within an enclosed structure, thus creating its own reality and forming the basis for sustenance, necessities, decisions, and selections of information, among many processes. The autopoietic activity influences the structure that makes the basis for the system, and the structure influences the activity. As a result, the structure is “self-organizing, in the sense that [it is] produced by the systems’ own operation” (Luhmann, 2002/2012, p. 70). Any operating self-organized structure “serves as the point of departure for many further operations” (Luhmann, 2002/2012, p. 70) and structures. Accordingly, a system may emerge and function because of a structure while it concurrently influences or reproduces the structure. As an example, people may create a game and start to play (self-produced system) because of a sudden awareness of a round object and a flat ground (structures), and the play (functioning system) ultimately may influence the structure by, for instance, the decision to add baskets to catch the ball, which again may stimulate the emergence of rules (structure) that will change the original structure (e.g., by adding lines on the ground). The structure served as the origin for new systems to emerge (autopoiesis) and the restructuring of the subsequent systems result from experiences of play and self-organization (Luhmann, 2002/2012, p. 72). Structures are temporal in that they exist only when they are part of a functioning system. Accordingly, a set of rules, a field, or a board game does not represent a functional structure unless it influences interaction or play (e.g., the use of the game or talking about the game). Furthermore, physical constructions (i.e., buildings, goals, fields, smart phones, computers, game systems) and physical characteristics (e.g., players, locations on the field, field quality, ball velocity) form part of a structure only if they contribute to the system. Hence, if a seagull should fly just above the grass of a football field during a match without influencing the play in any sense, the game structure is not affected: The bird is neither part of the structure nor the system.

As a result, a functional structure presents a specific, transitory context in which a system is active, and the context consists of everything limited to the functional structure or confined environment (Luhmann, 2002/2012). These dynamic systems result from activities that are always in flux and are driven primarily by assumptions based on expectation phylogeny, current intentions, and future goals (Maturana, 1975; Maturana & Guilloff, 1980), which, in this context, is the game.

For this research, my view is that play elicited by emergence game structures (Juul, 2003, p. 73) produces concentric interaction systems enabled by functions of framing and keying. The player must take risks to create something new or advance toward the intended outcome. Concentric interaction systems in games rely on adaptability and change and hence play. According to systems theory, it is possible that automatic behavior in games may stimulate autopoietic processes. That is, just doing what is always done may unintentionally serve to influence or create when colliding with a new type of organization. For example, playing with the very same type of game strategy regardless of what kind of opponent a team may encounter in a football match may produce new autopoietic interaction systems. Therefore, even though the organization is unchanged from one match to another by one team, the structure (conditions) of the match changes because of the differences in football philosophy by the opponents, the players, field conditions, atmospheric conditions, and so on. However, automatic behavior, echoing play behavior from many other occasions, lessens the chance of play and/or engagement and the creation of new concentric interaction systems. Creating a new organization or system thus relies on engagement and the will to change the organization of the frame (Luhmann, 2009).

When communication among players leads to self-organization of any kind, play defines the game structure, as well as ongoing and further communication. Then play is autopoietic, in that interaction is produced by interaction. Communication in play systems are therefore influenced by autopoietic processes, the consequent communication history, and the ultimate change as a result of these processes. The communication that emerges during play does not work outside the frame of play as it happens, in that the play is dependent upon the structure for which it was created to function. This is because the play system involves self-referentiality, meaning it reorganizes without obtaining resources from outside the system (Luhmann, 1995, p. 62). Thus, play may establish “a kind of internal environment through which one can peruse, feed, and correct communication” (Luhmann 1995, p. 414) explicitly because they are self-driven. These internal environments are autopoietic interaction systems (Luhmann, 1995, p. 409). Therefore, interaction systems are autopoietic systems in that they produce interaction systems without external resources. They require nothing from outside the system to function, to stimulate interaction, or to reproduce interaction. However, they are easily interrupted or perturbed by the nearby or surrounding environment (Luhmann, 1995, p. 414), such as, with football as an example, by a sudden thunderstorm or unruly fans. Thus autopoietic systems function in ways similar to permeability within frames as described in Davis and Goffman (1975).

Concentric Interaction Systems

In this research, concentric interaction systems are understood as layers of self-producing communication that serve the keying that occurs during gameplay. Concentric interaction systems in this conceptualization, thus, are autopoietic in nature. And at their most fundamental, they comprise the activity of playing a game.

For the purposes of this analysis, I have focused on concentric interaction systems and how these can be understood in an analysis of game engagement from an autopoietic view. In many ways, a functional structure resembles a frame as described by Goffman (1961). The functional structure and interaction systems thus equate to a game in a cellular perspective, and the self-organization of these structures and systems represents autopoiesis or concentric interaction systems layers. The specific concentric interaction systems represent functions of keying. For my purposes in this analysis, I focused on a few concentric interaction systems identified in literature on autopoiesis and through my autoethnographic field studies (i.e., playing and observing football and Pokémon GO) that come into play during game engagement and autopoiesis: These are continuing simultaneous communication, multiple observations, double expectations, system autonomy, and unexpectedness by systems coupling. These concentric interaction systems are not hierarchical; rather, they can be observed at any stage during play, be absent, or reoccur. However, as will be explained below, some concentric interaction systems impact the presence of other related systems.

Continuing Simultaneous Communication

Luhmann (2002/2012, p. 53) saw communication as “the synthesis of information, utterance, and understanding” that can be either understood or misunderstood. Researchers in cybernetics, such as Ross Asby (cited in Pickering, 2010), worked with and described systems that adjust or restructure themselves to maintain stability in accord with exterior influences. Based on a

helical thinking model, Luhmann (2002/2012, p. 54) stated that “communication is connected to communication” and, furthermore, autopoiesis is formed by “communication’s triggering further communication” (Luhmann, 1995, p. 218). Thus,

communication should not be understood as mere information transmitted from a sender to a receiver, in the sense that the information is seen as parcels of information that move from one to the other. Instead, information is seen as being created with the receiver through interaction with his/her existing cognitive framework. (Maturana, cited in Hernes & Bakken, 2003, p. 1513)

In terms of game play, particularly team play, communication in all manners (verbal, nonverbal, behavioral) takes place continually and frequently simultaneously. Thus, when communication is created with a receiver through simultaneous interaction, the system instigates “continuing communication” (Tangen, 2004) or, rather, continuing simultaneous communication. Perinbanayagam (2006, p. 145) stated that only theories that do not insist on analyzing network and nodes separately can handle simultaneous occurrences. Yet, he did not fully utilize this concept to understand or study the possible simultaneous creation of communication as a facet of network communication. The concept of simultaneity describes a slightly different communication system than the network of multiple dialogues Perinbanayagam (2006) suggested. That is, simultaneous communication should be conceived not as dialogic but as a means to allow everybody to communicate (or create communication) at the same time.

In fast-moving sporting games, information sharing through verbal communication often is less important than nonverbal and behavioral for a variety of reasons, such as distance between the players, the quick pace of the game, and for executing offensive or defensive strategies. Verbal communication, then, could serve to delay or destroy actions in play, like functions of fabrication, for example, when luring the attacking team into an offside trap¹ in football. Moreover, the primary way to inform and to receive information in such dynamic and immediate activities is through communication created within the moment. In affordance theory, it is precisely elements like the movements, postures, placement, glances, and positions of hands that form the basis for selection of information that leads to interpretations, understanding, or misunderstanding (Gibson, 2015). When a player conceals intentions by movements to fabricate, s/he makes explicit use of movements to communicate, as in the backdoor move.

During the experience of play, many movements are meant to communicate; yet, some are not. A player thus may give off additional unintentional “expressions in its posture, emotions, gestures, and that these telegraph one’s intentions to act” (Collins, 1981/2013, p. 242) by his/her “incapacity to inhibit warning signs of self-consciousness” (Goffman, 1969, p. 33). Thus, players cannot always control how their behavior communicates intentions (even hidden ones). Players perform movements to highlight planned tactics or sudden plans (based on unexpected opportunities) to teammates and to deceive or trick opponents. Thus, behavior in this context is defined not through a metaperspective, as described by Luhmann (2002/2012), but as an aspect of direct and indirect communication. It is clear that the acts, glances, and movements performed in team games such as football elicit reactions. Accordingly, these serve as a basis for the selection of information and, by extension, understanding (within the receivers’ cognitive frameworks) and communication (Vanderstraeten, 2012). This is in line with Perinbanayagam’s (2006, p. 3) definition of games, in which communication occurs with a range of symbols broader than a spoken language. Such broadened language builds upon simultaneous communication and

involves observation on multiple levels due to the constant ontogenies² caused by the interaction systems. Similar functions of simultaneous communication may function in computer games or augmented reality games by, for example, the nondiegetic aspects of a game. Sounds within a game (e.g., warnings, music) that do not influence the communication between the characters or avatars may be picked up by the player and therefore influence the choices made.

Multiple Observations

In all games, observation is a key element in that the player, whether working alone or with others, cannot achieve the goal without clarity on what is happening within the game and/or with other players. Particularly in team sports, multiple layers of observation are necessary and players learn to attend to planned and unplanned actions of their teammates and opponents. In football, for example, a midfielder with the ball needs to quickly scan and perceive the potentialities available and then make a split-second decision on how to proceed; this process is happening simultaneously with other players as well. This instantaneous activity includes numerous eventualities concerning what other players (both offensive and defensive) on the field may be thinking, choosing to do, are capable of doing, and strategizing. The actions of one or more players can either open up or eliminate options and, as a result, require a new round of observations and decisions. On the opposing team, the defenders will attempt to predict what the midfielder might do with the ball by examining the situation. Accordingly, football players engage in a great deal of communication and information exchange through their movements, prior movements, knowledge, expectations, and (to a small degree) verbal communication, all of which influence the play.

This same process takes place, although in slightly different form, in video and augmented reality games, particularly online collaborative strategic games. Gamers need to continually observe the environment and behaviors of other entities (other players' avatars or game-generated characters) and possess knowledge of previous events within the game. As in live games, the players of online games often make quick determinations of potential actions and split-second decisions/reactions. For example, as a Pokémon GO player, it would be essential to observe the screen depicting the Pokémon environment, the real world, and the movement of others. The player's skills in observation influence the journey within Pokémon GO as it takes the player to new places and people. However, the progressive structure of this particular game and its simplicity results in only marginal player influence on game play and, by extension, the number of levels to observe.

In summary, observations—particularly in games with multiple players and/or dynamic action and/or changing environments—happen at multiple instances and levels. This process involves observation; interpretation of expectations communicated, verbally and behaviorally; and deciphering environmental clues. Thus, the player's situation analysis is connected to communication, self-observation, observations of others, and the environmental conditions.

Double Expectations

In-game communication, particularly continuous and simultaneous communication, is influenced by players' expectations and "expectations of expectations" (Tangen, 2004), or double expectations. Players' expectations are fed by the players' phylogeny, that is, their history of

ontogenesis, or interactions, exchanges, and expectations. It would be impossible for teammates to execute a backdoor move or any multiplayer action without personal expectations and the interpretations of the expectations of others acquired through multiple levels of observations, current and in past play, tempered by the context. Thoughts like, “I expect that s/he expects me to...,” occur as a result of the specifics of the game. Such cognitive–rhetorical questions may thus prepare players for what will happen or serve as obstacles to new possible moves. Thus, expectations form “the basis for a definition of structures” that “consist of mere experience or action” (Luhmann, 2002/2012, p. 72) in games, particularly multiplayer games. Such structures make it possible to “imagine that stimulus and response do not stand in a fixed relation to each other but instead are controlled by the expectations of the system. A system can only be identified if one has certain expectations” (Luhmann, 2002/2012, p. 72).

Although such expectations can come into play in many video or online games, particularly in the transfer of previously mastered skills, in line with Luhmann (2002/2012), Pokémon GO elicits no expectations in a systemic communication perspective. That is, the algorithms are based on fixed stimulus and response relations and cannot be tricked, and the expectations of the player can only be detected as a variant of play progress. Thus, tricking in Pokémon GO is not possible in the present version of the game.

System Autonomy

When stimulus and response do not stand in a fixed relation to each other, communication contexts build on the eventualities, decisions, and expectations produced by the interaction systems prior to and during the act of communication (Maturana & Guilloff, 1980; Tangen, 2004; Varela, Maturana, & Uribe, 1991). For interaction systems to function, these context-dependent factors of the present produce a system’s autonomy, which is the basis for autopoiesis (Maturana & Guilloff, 1980). A system is autonomous “when it can specify its own laws” (Maturana & Varela, 1987, p. 61) or rules for what is suitable for its functioning.

For researchers or game designers to understand the autonomy of players in a game, “we must understand the organization [the game] that defines them as unities” (Maturana & Varela, 1987, p. 63), in this context what Goffman (1986) would call frames. The players’ autonomy becomes explicit when it becomes apparent that what defines them as unities is their autopoietic organization, such as the team, rules, formations, expectations, communication, and structure. The degree of a system’s complexity and the subsequent autopoietic organization thus seems to relate to the autonomy of the system and players. Moreover, communicative ability is related to the players’ general experience and skill. For example, a novice may experience much of the communication on the field as an unfamiliar language.

In both Pokémon GO and football, unities form. In Pokémon GO, it happens through the physical encounters in the real world, by communication during play, and somewhat through digital media. Football, on the other hand, is based on teams as units, and the constant flux of continuous simultaneous communication and other behaviors form numerous additional unities (dialogues) of play, such as described by Perinbanayagam (2006). The formation of such a unity “always determines a number of phenomena associated with the features that define it” and, by extension, “the phenomena they generate in functioning as autopoietic unities depend on their organization and not on the physical nature of their components” (Maturana & Varela, 1987, p. 65).

Accordingly, Pokémon GO and football form autopoietic organizations. The autopoietic organization in football comprises phenomenon such as relations and hierarchy, formation, ideology, and history of actions, all of which represent expectations within a team and for the adversary team. As a result, autopoietic organization also involve a potential autonomous act of braking free from these aspects that, again, represents an extreme diversity in behavior, couplings (see the chapter below), and expectations and, thus, a higher degree of autonomy. Such diversity in behavior is what Maturana and Varela termed third-order couplings or cybernetics (1987, p. 170). By contrast, actions performed while playing Pokémon GO have little autonomy, even though the seeking of Pokémon may result in the forming of crowds existing of thousands of individuals who may meet and interact. The communication among these individuals does not change the game beyond its cellular membrane. Potentially members of the group support a possible catch—an action that is to be expected due to the rules of the game—but that is not necessarily the sole purpose of the gathering.

Unexpectedness by Systems Coupling

Being part of a game or play structure or system involves the coupling between systems and structures. Systems coupling may be described as the “history of recurrent interactions leading to the structural congruence” (Maturana & Varela, 1987, p. 75). These scholars characterized this concept through the biological process of cells combining with other cells.

A cell’s reproduction is autopoietic and the process is ontogenetic, meaning a structural change takes place without loss of the organizational basis (Maturana & Varela, 1987). In the sports context, for example, interaction systems in football create interaction systems (self-production), and the interaction systems will alter ontogenies (i.e., structural change brought about by players and the ball being in different positions or new players entering the game and being communicated with in a different manner). However, the character of the interaction systems remain (i.e., same organization controlled by the rules).

Ontogenesis generated by playing Pokémon GO, for example, may involve the change caused by (and agreement in) the coupling among systems functioning at schools and in traffic, which in turn involves the coupling with other crowds of pupils, cars, pedestrians, and players. These interactions and perturbation will interfere with issues of safety, destroy or trigger attention, or impact the immersion of play at school, in social situations, and so forth.

When two systems meet in a football match, each team typically tries to measure during the initial phase of the game how the other team works or manages their expectations of the ontogenesis and thus structural changes that they will undergo during a match. Although both teams often use scouting reports and analyze the content of former matches (phylogeny of coupling with other systems) and team standings, every team’s play is influenced by the play of the opponents and the ontogeny that occurs within the interaction systems within the specific context of that match. Communication must therefore be tailored by and among players through the convergence of concentric interaction systems, such as double expectations, continuing simultaneous communication, and multiple observations. Such encounters or couplings represent whole systems that merge or interact, thus creating new systems of interaction beyond those initially expressed, communicated, and created by the teams. During the coupling of two teams or systems, the complexity and diversity of behavior increase, resulting in an autopoietic organization that causes autonomy and, ultimately, an

unexpectedness produced by the organization (game). This leads to new nodes, units, interaction systems, and framing of situations (e.g., fabrication and backdoor moves) that continually change and emerge during a match (Perinbanayagam, 2006). Thus, the combination of entities or players forms units that may lead to further communication or noncommunication, depending on the plasticity and unexpectedness of the structure (Maturana & Guiloff, 1980). Accordingly, if an understanding of a coupling does not occur, one of the teams may fail to understand the play of the opposing team, resulting in misinterpreted or mistaken expectations and the inability to plan, resulting further in unexpected actions and outcomes. However, over time, the tactics and structures that initially served as perturbation eventually trigger a system change, illustrating the intelligence of the system of play (Maturana & Guiloff, 1980).

These examples show that although a tactical surprise or unexpected system change may be identified instantly by an opponent, the process of altering established double expectations must develop over time amid changes in one component of the system and the eventual acquisition of the skills necessary to address the new overall system. In other words, although systems have plasticity, altering them takes time (Maturana & Guiloff, 1980).

Expectations and double expectations as facets of interaction systems and the degree of their influence in play are connected to the organization of the systems. Fabricating a move in football, for example, in comparison to similar functions in computer games, and Pokémon GO specifically, differs. In football, fabrication can lead to unexpected changes, and thus opportunities for tricking or deceiving. Trickery in computer games however (e.g., by short cuts in game progression) is based on algorithms (i.e., procedures for how a sequence of play must be executed in order to function), and thus coded and already known by the creator of the game. Such tricks will open up unknown situations for the player, but the conditions for these variations to happen are limited by the game design. That is, they are designed by the creators of the games and not the player. In Pokémon GO, the possibilities associated with self-initiated activities are many, but tricking or fabricating as part of the game seems impossible.

Similar functions may be observed in computer games that are difficult to learn. The threshold of skills necessary to be able to play is sometimes so high that some players give up and leave the game. The players that endure, however, attain the required systems, understanding, and skills to continue. These skills often make the rest of the game easy to play unless they couple with other systems and novel ontogenetic situations occur. The Pokémon GO system, however, couples, perturbs, and is perturbed by several other systems, but the game rules do not elicit interaction with other play systems, and thus the game does not produce autonomous play systems. Obviously, a player can connect to other types of play (e.g., to explore the arts and cultural creations that Pokéstops introduce), but the game does not rely on coupling. Moreover, some couplings are unwanted and are expressed by the Pokémon GO system warning the player not to play while driving or not to trespass on private property while playing.

THE CASES OF FOOTBALL AND POKÉMON GO

Football

Football has been played in a similar form for more than two millennia and formalized within the last 150 years (Giulianotti, 1999; Fédération Internationale de Football Association [FIFA],

2007; see the Appendix for basics on the game). The game depends on a frame that involves physical boundaries and elements (e.g., the pitch [i.e., the playing field], goals, the ball) in order to function. These physical boundaries and elements partly make the structure in which autopoietic systems may emerge and function. However, football exists in many versions (keyed), from improvised play in random spaces like street junctions and schoolyards, with the number of players available, to up against walls and to the formal events such as cups and series. The nature of the sport has been described as social interaction (Best, 1980; Birrell & Donnelly, 2004; Kreft, 2015; McGarry et al., 2002; Perinbanayagam, 2006), interpersonal communication (Passos, Davids, & Chow, 2016), “dialogic,” “dynamical systems,” and “complex interactions” (McGarry et al., 2002, p. 771), “dynamical self-organizing system[s]” (Best, 1980; Frencken, Lemmink, Delleman, & Visscher, 2011; McGarry et al., 2002), and “self-organizing processes” (Schmidt et al., 1999, p. 558). In this article, football is described as an interaction system that comprises several embedded subordinated concentric interaction systems, autopoietic in nature.

The elements and players of football partially lead to and enable the activity on the pitch by the representation of agency, the teleological meaning the elements have, and the restrictions the elements and players establish for the activity. However, football cannot form an active structure without rules. As Goffman (1986) noted, the rules serve to frame the structure. Tin (2011) found that creative practitioners become more inventive and transgressive within specific frames (such as graffiti) when they are restricted by rules. Thus, the rules invite and inspire football players to explore possible new ways of play within the norms of the game by seeking unconventional behaviors in order to surprise, exhibit, perform, and win, among other objectives. Within the restricted space that the rules create, the players possess a type of autonomy that allows them to explore dimensions of play and to exhibit nearly endless variations in play moves and strategies and the combination of these in order to break with what the adversary players may expect. In action, these variations of moves and strategies function as concentric interaction systems.

In a team sport, such as football, the rules demand complex communication and system thinking among players. One example of such rules is an offensive player being offside. Thus, in the attempts to avoid or cause a foul, teammates must devise numerous strategies that demand precise communication for either the defense to lure the adversary team into offside positions or the offensive players to time runs exactly to avoid an offside call. The attackers, in addition to their own play strategies, must be aware of and seek to understand the different functions of the defense system. Moreover, these concentric interaction systems typically take place within split-second decisions amid larger play strategies and fast-break opportunities for both teams.

The game structure thus motivates players to communicate in specific ways to advance their strategic goals. In actuality, the structure is what makes the system functional. The constant shifting of the structures through, for example, various formations of the players on the pitch and the location of the ball, allows for the emergence of new subordinate concentric interaction systems that may serve as keying factors in that they add layers of communication that are only functional in the game structure and within context-specific situations. Unlike dyadic sports, in which pairs compete, structures that occur in multiplayer team sports such as football allow multiple communication and interaction systems to exist simultaneously, creating communication patterns and structures that are, at times, difficult to grasp. This is especially true for novice footballers, who often demonstrate a lack of understanding in strategic ways of thinking as well

as the concentric interaction systems of the game that happens among the other players. Often this can be seen in inexperienced players solely running after the ball. It certainly influences play but perhaps not in a desired way because the act describes an individual process rather than systems interaction. Team play in football fundamentally involves irregular, flexible, and varied events that, along with structural change and momentary couplings and decouplings, create several concentric interaction systems (McGarry et al., 2002, p. 788).

Accurate and changing communication is essential when teams or players attempt fabrication, such as the backdoor move (Schmidt et al., 1999), so that, depending on the application, a player can (or does not) misinterpret or be tricked (or trick), as described by the backdoor move. Therefore, playing football gives rise to certain functional structures. The happenings within the players' agreed-upon frame change constantly and, as the structure changes, interaction systems occur, evolve, and influence the production of new systems. The situation of a midfielder with the ball and the need to quickly scan and create communication simultaneously with many others in order to decide for how to proceed is one such elicited concentric interaction system. For the many subsequent moves, the structure will re-form (i.e., self-organization of players in relation to goals, ball, and pitch) and new concentric interaction systems emerge due to the structural change.

The complexity of the communication needs for achieving strategies in football, ultimately, stimulates the emergence of self-organized (autopoietic) systems. A main driver for the emergence of autopoiesis is expectation. The backdoor move can be effective because a defender expects the continuance of the first move. The expectation can lead to misunderstanding of the play in action—and a misjudgment of an appropriate defensive strategy. Thus, the sequence and content of experiences, activities, and operations during play are related to expectations as stimuli for the players in this context (Luhmann, 2002/2012, p. 72).

In analyzing the activity on the pitch, however, it becomes clear that football gives rise to nonlinear and dynamic systems in terms of play selection, communication, defensive posture, and so on. These are not stable social systems; rather, they represent “many degrees of freedom in a constant flux” (McGarry et al., 2002, p. 772), appearing and disappearing and drawing on expectations phylogeny and interactions, that, when taken together, are considered interaction systems (Maturana, 1975; Maturana & Guilloff, 1980). Expectations of playing football, thus, involve or rely on players' competencies with respect to knowledge, skills, tactics, interpretations, planning, tactical understanding, prior expectations, and expectations by others. Accordingly, in football, where structures change, merge, and collide constantly, new expectations emerge continually and serve as a basis for communication within an autopoietic environment.

Pokémon GO

Pokémon GO became the world's most popular digital game in July 2016, motivating 45 million people a day to walk, run, and drive to find and capture Pokémon (Kawa & Katz, 2016). However, its meteoric success was short-lived. By August 2016, according to Kawa and Katz (2016), 15 million daily users had left the game. Nevertheless, the game remains popular (Smith, 2017).

Pokémon GO (see the Appendix for an explanation of the game) presents an augmented reality system within smartphone technology (Salen & Zimmerman, 2004). In action, Pokémon GO relies on two keying levels: the graphical user interface (GUI) on the smartphone and the

physical playing field upon which the GUI is applied or augmented. This playing field typically consists of urban, suburban, and village areas unhindered by size; it is defined by the saturation of PokéStops, the spawning of Pokémon, and gym locations. The GUI filter serves as a very concrete example of keying in that it provides an alternative reality to the real world for the players. Unfortunately, this has led to numerous situations where fully engaged players seemed to forget that the playing field actually consisted of real-world locations. Consequently, several players have crashed into other people, street signs, and buildings, or had crossed streets with moving cars without noticing (Joseph & Armstrong, 2016; Rauschnabel et al., 2017, p. 280). Not surprisingly, augmented reality games such as Pokémon GO have been associated with a rise in reports of distraction-related injury (Joseph & Armstrong, 2016; Sharma & Vassiliou, 2016).

The focus of the game is to capture Pokémon visible via the GUI, either for the personal satisfaction in the hunt or for later combat with other players. Pokémon GO is a typical Skinner box game³ in that it builds on people's urge to collect (Portnow, 2010), and thus game play relies heavily on reward systems. For example, although players typically manage to capture spawned Pokémon, they sometimes fail. Hence, the capture is a reward in itself, and the awareness that not every Pokémon can be captured reinforces a player's drive to continue his/her quest. Players also are stimulated to witness the evolution of their Pokémon, to earn points and currency, to capture rare Pokémon, to earn medals and bonuses for catching, walking, gathering of resources, and so on (see Figure 2), to battle and win, and to station Pokémon at gyms.

The systems used in Pokémon GO are related to communication and movement. While playing the game, players move in certain patterns defined by the geographical positions of PokéStops, gyms, and Pokémon. Through such movements, players can engage and interact with other players if they wish (see Figure 3). Although players may either plan routes or let the game lead them, in all cases the behavioral choices do not determine game outcomes. The main



Figure 2. Medals overview in the Pokémon GO game, depicting medals (bronze, silver and gold) for various achievements such as walking distance, number of evolved Pokémon, number of catches (divided into the different types of Pokémon), number of hatched eggs, and more.



Figure 3. Children gathering around a PokéStop in Namsos, Norway. Although Pokémon GO is an individual-player game, the nature of the game is enhanced by collaborative play and communication via in-person, online, and social media channels outside the game.

argument for this statement is that playing Pokémon GO does not demand contact with other players or a change in routes in order to play. However, curious players may experience different and new places by playing and may meet and interact with a variety of people and, by so doing, possibly find a wider range of Pokémon (Kaczmarek et al., 2017; Kogan et al., 2017; Marquet, Alberico, & Hipp, 2018; Tabacchi, Caci, Cardaci, & Perticone, 2017; Tang, 2017; Zsila et al., 2017). However, it seems spending time with the game, rather than actual performance, is the most influential process for the game progress.

The resulting communication that may occur by playing Pokémon GO systems is based on sharing collections, seeking common goals, gathering around PokéStops, chasing rare Pokémon, posting information on Instagram or Twitter, and talking about the game in general. Communication also happens through the collective movements of players. For instance, a player might come across masses of people walking and running toward a rare Pokémon, showing, first of all, that they are playing and, secondly, engaging in play-related discussion or indicating where other interesting Pokémon are available to catch. (Numerous videos have been posted on YouTube depicting such situations.) Social gatherings emerge and are self-produced as a result of playing Pokémon GO.

Comparing Football and Pokémon GO

Analyzing the concentric interaction systems in football and Pokémon GO through the lens of autopoiesis results in interesting distinctions between the phenomena in these two games. In Pokémon GO, autopoiesis takes place as a result of the game, while in football it occurs both during and as a result of the game.

In looking at Pokémon GO, the self-producing systems or concentric interaction systems involving other players while playing Pokémon GO is not necessary for gameplay. Basic gameplay is not designed as social, and because all possible social interaction happens outside the game, playing Pokémon GO does not represent an interaction system. Playing Pokémon GO can motivate social activities and encourage people to gather around PokéStops and gyms and exchange catches and progress. However, since the communication among players is limited to the transmission of information about catches, locations of rare Pokémon, and so forth, the communicational facet of the play activity represents a sort of parallel play in which, for example, players catch the same Pokémon together. Therefore, although the communication patterns and system structures of Pokémon GO only minimally influence gameplay, they may serve as additional activities for some players, but at the players' own initiation. Therefore, playing Pokémon GO is an individual activity that can be shared.

In football, concentric interaction systems emerge and disappear continuously as the structure changes. Thus, when two team's couple, the ball moves, the players initiate and run, and the constantly changing structure demands or stimulates new communication, and as a result, new concentric interaction systems emerge. For example, when double expectations function or serve as a concentric interaction system, they influence subsequent thoughts and, (re)actions. Moreover, if the double expectations served to give understanding of a situation that produced a desired outcome, it will influence the next instance of a similar system occurrence. Hence, football is a group activity that depends on sharing and creating continuous simultaneous communication or concentric interaction systems for the play system to function.

CONCENTRIC INTERACTION SYSTEMS, ENGAGEMENT, AND KEYING

The aim of this study was to rethink game design within the concept of self-producing systems, or autopoiesis, based on two research questions: (a) How can football and Pokémon GO be described through theory on autopoiesis? and (b) How does autopoietic concentric interaction systems relate to feelings of engagement and the processes of keying?

In the process of illuminating various aspects of this research question, I introduced play and game theory with an emphasis on Goffman's (1961, 1986) concept of framing. Game and play theory was further explored through the perspective of communication within and among systems and autopoiesis, in line with Luhmann (2002/2012). By a combination of identifying and explicating these theories and my ethnographic fieldwork, I identified and defined five concentric game dynamics that explain various dimensions of self-producing interaction systems. These concentric interaction systems describe game dynamics in football and, to an extent, in Pokémon GO, namely: continuing simultaneous communication, multiple observations, double expectations, system autonomy, and unexpectedness through system coupling. Each of these concentric interaction systems manifests a separate frame level, hierarchically unbound in game dynamics but entangled and variable in a play situation.

This research contributes to game theory in several ways but more specifically in regard to autopoiesis, the nature of concentric interactions systems, and framing. Autopoietic organization is comparable to the notion of framing in that it describes a situation that stimulates dynamics and subsequent change. The specific contextualization for exploring autopoietic organization in this research, however, contributes to the theories on framing and on

games and play through the identification of five concentric interaction systems. These subordinate frames describe game dynamics that potentially create diversity in behavior that stimulates exceedingly complex and autopoietic interaction systems. This occurs especially when interaction systems couple to create a new and distinct system. The production of new systems not only serves to add concentric layers (keying) within a game's functioning, but it also refers to the permeability and succeeding dynamics within a game's periphery. Further, it describes what happens when such systems couple with other systems within an organization or frame. Thus, the concentric game dynamics broaden the understanding of keying. These build upon Goffman's (1986) crucial work on framing and keying and Luhmann's (2002/2012) understanding of autopoiesis.

Concentric Interaction Systems as Framing

In practice, the concentric interaction systems produce and describe exceedingly complex interaction systems during play and, consequently, they function as "world building activities...that it is seen by the participants to be something quite else" (Goffman, 1961, pp. 21, 43-44). The descriptions of the five concentric interaction systems extend the concept of framing, thus opening opportunities for applications in various practices.

Concentric Interaction Systems as Fabrication, Keying, and Engagement

The identified concentric interaction systems describe behaviors that demand a certain presence and engagement in order to function. The emergence of concentric interaction systems leads to unexpectedness and the production of new interaction systems (i.e., autopoiesis). Thus, they describe the manner of execution in complex systems of play that represents an aim to change or to create new purposes within the game limits. Accordingly, concentric interaction systems stimulate a drive in a player not only to reach a goal but also to create conditions that engage, test the limits of the game organization, and potentially over time, influencing the future development of the game. Thus, they describe a journey that the player chooses to take that, by extension, uplifts the internal and self-referential experience of play to an experience beyond the reality of life outside the game. Hence, the concentric interaction systems function as dimensions of keying that serve to generate engagement and further ensure system functioning (see Figure 4).

Particularly in multiplayer games, the player must have an inner drive to inform and agree upon the terms of the frame and its influence, follow the wavering of up- and downkeying during play, and to show and hide information for the game to function. That is, in light of autopoiesis, fabrication and keying are dimensions of engagement and interdependence in a functioning interaction system of play. A backdoor move, for example—which in itself represents upkeying in that it characterizes a dialogue where all concentric interaction systems are at work within the bigger play system—cannot function if the defending player is not trying to hinder the attacker performing the move. In other words, if the defender does not react to the initiation of the backdoor move (i.e., is not deceived by the movement), then s/he is not part of the dialogue in play, and thus influencing the game by downkeying and system dysfunction.

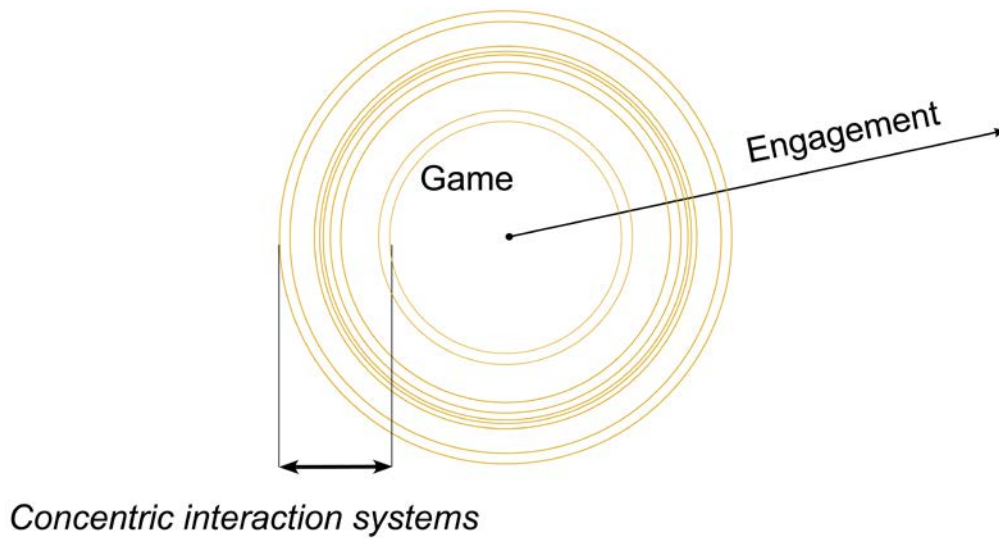


Figure 4. Engagement by transformation of play through the emergence of concentric interaction systems that serve as keying. The layers of autopoietic concentric interaction system are designated as circles.

The play activity is a complex process that expands in all directions once the activity begins.

Thus, the play activity is illustrated here as starting in the center with the initiation of the game; the graph widens and the laminations thicken as play continues. The circles also indicate how the concentric interaction systems serve as framing in that they create a protected environment inside the circle (play), which is different from the real world outside the circles. Furthermore, the number and composition of concentric interaction layers also tell something about the degree of complexity of play and how these intertwined layers define communication and future expectations. The composition of the concentric layers varies not only by the nature of the game but also as a result of a game in progress.

Concentric Interaction Systems in Light of Football and Pokémon GO

According to Huizinga (1949/1980), play is the opposite of automatic behavior. One way to understand automatic behavior is that it does not involve the search for new or more complex experiences; rather, it involves pursuing instant gratification (Sennett, 1977). Moreover, to Sennett (1977), play is achieved through experimentation and risk-taking, which by extension is a process of taking control over one's own self and cooperating with others. Hence, automatic behavior hinders play and certainly engagement.

Both Pokémon GO and football are games easy to grasp in terms of understanding the rules. However, while the interaction systems in football are progressively challenging for the players to understand, to orient oneself toward, and to perform while simultaneously supporting the emergence of new systems, the same is not true for Pokémon GO. Because of the design of the game, Pokémon GO demands the same type of gameplay regardless of one's location, communication setting and whether a player is a beginner or veteran. Therefore, football stimulates play, and Pokémon GO induces automatic behavior.

Pokémon GO does engender autopoietic behavior and thus ontogenesis; however, these systems lie primarily outside gameplay. For example, there is no autonomy in playing the game, except in the choice of which Pokémon to catch, where to go to find Pokémon, or which Pokémon to battle against at which gym. Pokémon GO thus elicits no expectations in a systemic communication perspective and therefore it represents a goal-driven activity, easily

fulfilled, where progress depends solely on the amount of time invested and motivation driven by gamification. The game does not depend on the involvement of other players, nor does it give players any influence over the game experience explicitly, the play outcome, or the opportunities for future play. Risk-taking and engagement that the five concentric interaction systems can elicit by functioning as keying do occur while playing Pokémon GO. However, they function outside gameplay, not during play. Because the game is performed individually, the activity does not form interaction systems in play; instead, the social aspect of the game can be described as a sort of parallel play, in that the communication with others happens outside the gameplay and only if the player desires. The aspects that have made Pokémon GO as successful, therefore, must lie beyond the concentric interaction systems dimensions identified in this research. Exploring that aspect of Pokémon GO would be an interesting future study.

The concentric interaction systems describe football as a game that creates or meets an inner drive. Football thus is opposite of Pokémon GO in that the emerging (and changing) structures stimulate and depend on concentric interaction systems, inner drive, and engagement to function. Any skillfulness in or lack of it, attention or carelessness, or (in)ability to contribute or (mis)interpretations of a concentric interaction system will have great impact on the game. Additionally, these systems that are integrated within play serve as keying, along with the teleological aspects of the game.

Concentric Interaction Systems as a Game Design Method

This research suggests that when specific concentric interaction systems (i.e., continuing simultaneous communication, multiple observation, double expectations, systems autonomy, and unexpectedness by system coupling) are infused into a game design process, whether for online or offline engagement, the chances of engaging players in the game over long periods of time improve. Although the intent of the game (particularly those aimed at individual players) may influence which of these concentric interaction systems that can be integrated, how it would take form, and how it relates to the other identified or still-to-be identified concentric interaction systems of game design, a clear understanding of the concepts of play, communication, expectations, and framing can open up elements of games that provide for autopoiesis and thus player engagement in the present and over time (see Figure 4).

Accordingly, I suggest that Pokémon GO would have been more successful in the long run if its creators had infused the concentric interaction systems identified in this research as functions of complexity and keying in the game's dynamics. Dynamics such as autopoiesis, observation of expectations, game autonomy, and multiplayer systems couplings, for example, could have transformed an individual game into a collaborative game, even if temporarily or for specific goal-related outcomes. For example, how would the Pokémon GO play experience changed if the game rules had set premises for a minimum number of players to collaborate in approaching, surrounding, and/or collecting specific Pokémon or game enhancements?

The various concentric interaction systems that games such as football engender create situations of simultaneous and consecutive functions. Various skills and understandings useful in these game contexts may be communicative, physical, or strategic, among others. Thus, when the concentric interaction systems identified in this study are implemented in a game, various entry points are generated that support the engagement of people with different interests, experience, and skills, thus expanding the range of players participating in the game and diversifying ways to play.

CONCLUSIONS

This research utilized Goffman's (1986) notions of framing and keying and demonstrated how the theory on autopoiesis can be applied to analyze communication systems or subordinate frames within games and play. Further, it has shown how these theories are applicable in exploring individual play and players, groups of players, and teams as a function of games. The rethinking of games within the concept of autopoiesis led to the description of five concentric interaction systems (i. e., continuing simultaneous communication, multiple observations, double expectations, systems autonomy, and unexpectedness by systems coupling) that describe subordinate lamination of frame levels of concentric interaction systems in play elicited by games. These concentric interaction systems may also serve as methods for creating new games that elicit keying and thus engagement.

The five concentric interaction systems illustrate that the process of designing new games requires an emphasis on what games can never be as physical objects or digital user interfaces. This involves accepting that structures are temporal in that they exist only when they are part of a functioning system. Knowledge about concentric interaction systems thus underscores the necessity to emphasize designing for potential variable structures that may stimulate the needed autonomy for autopoietic systems and thus keying and engagement to emerge by, for example, the occurrence of numerous (and not all yet known) functional concentric interaction systems during play. To design games that engage players over a long period of time requires an elaboration on the structure or structures that can be made active and changeable by functional concentric interaction systems that may emerge during play, how these are experienced, how these are influenced or altered, and in what way they are facilitated.

A game that succeeds in eliciting the concentric interaction systems will be capable of performing within both the unexpected and the expected (or automatic) gameplay. The creative activities on which these dimensions rely may also serve as continuous stimuli for honing and developing new skills, game variations, and interaction systems.

This research involved the study of two very different games, one played in the physical world and one employing augmented reality. Given the limitation of the empirical data in this research project and its theoretical focal point, the five concentric interaction systems would benefit from additional validation through the analysis of other games and game types. The massive number of games on various platforms that currently exist exemplify various qualities of engagement in play; study of these games within the context of autopoiesis and systems theory may contribute to a deeper understanding of the five concentric interaction systems identified in this research. Additional outcomes of such research could possibly engender additional concentric interaction systems that describe and elicit engagement through games.

The dynamics of the identified concentric interaction systems describe functions of change that may be difficult to implement in an algorithm and thus computer or video games such as Pokémon GO. Some MMORPG games do allow considerable freedom in player behavior that is not specifically coded within the game. Yet even so, the variation in play behavior does not extend beyond the potential that the game creator established within the game design. That is, the player cannot influence play within the rules (or parameters) of the game that the designer has not thought of, such as an offside trick or back door move possible in real-world team sports. In future research that builds on this study, it would be interesting to explore how the identified concentric interaction systems can describe or serve as a platform for creating individual or

MMORPG games that can specify their own laws. As in football, the digital players could, within the organization of play, specify and hone their very own variant of play (a concentric interaction system in itself that leads to engagement) that, when coupled with other teams, may produce different or new concentric interaction systems that lead to victorious outcome. This could result even if the players who initiated these variations of concentric interaction systems were considered far less skilled than their opponents (general expectations). That is, it is not always the most recognized or talented team that wins or produces the most attractive play. Rather, it can be the teams that are skilled or creative in handling and generating new concentric interaction systems that exhibit exciting play and influence the game. Adaptive, autonomous, or cybernetic systems represented by, for example, players' influence on the structural dimension of play or artificial intelligence (AI) would seem logical directions to study for implementing such game dynamics. AI, in its nature, involves ontogenesis. The change of play that AI can support and the history of such ontogenesis that can be further conveyed in the game allow for exceedingly complex systems of interaction to occur, change, and reproduce.

Accordingly, the emphasis of future research should be within experimentation on how the concentric interaction systems can serve as parameters for creating new games, not merely for the analysis of existing games with unchangeable structures or systems. Future research on the concentric interaction systems as premises for designing and testing new games would offer much insight to how interaction systems stimulate upkeying and engagement in play.

The identified concentric interaction systems in this research primarily describe play behavior bound by abstract dimensions such as rules. Accordingly, they have a transfer value to other fields of design. The result of playing games with the identified concentric interaction systems implemented is that they stimulate autopoietic interaction systems. Thus, research on the effect of their implementation as part of service or product systems would open new insights into the functioning of the concentric interaction systems in other fields and areas (gamification) as well as how to elicit engagement.

IMPLICATIONS FOR RESEARCH AND DESIGN

My analysis strongly suggests specific approaches to game design would improve the notion and experience of play for physical, virtual, and hybrid games. The integration of the five identified concentric interaction systems (i. e., continuing simultaneous communication, multiple observation, double expectations, systems autonomy, and unexpectedness by system coupling) in new game designs will initiate and support autopoietic systems during play. Moreover, this research suggests that the concentric interaction systems will serve to enhance complexity and keying and therefore stimulate engagement within the frame of the game.

The five concentric interaction systems contribute to the understanding of game dynamics in design, framing, and game and play theory. They also allow for and support the analysis of exceedingly complex autopoietic systems in games and play. Collectively, the research results provide insights and practices that could be employed in various entertainment, learning, and service applications.

ENDNOTES

1. In football (soccer), a player is in an offside position if “any part of the head, body or feet is in the opponents’ half ...and any part of the head, body or feet is nearer to the opponents’ goal line than both the ball and the second-last opponent” (FIFA, 2017, p. 91–95). It is not a foul for an offensive player to be in offside position unless that player is made active by a pass or intended pass from a teammate. The law is further described with several conditions or subrules defined for various situations (FIFA, 2017). In short, it prohibits an attacking team player to pass the ball to a teammate who has no adversary player in between him/herself and the adversary keeper. Thus, an offside trap is a defensive play in which the defenders set a play to increase the chance that an attacking player is offside and thus causing a foul.
2. Ontogenesis is a “structural change without loss of organization in that unity” (Maturana & Varela, 1987, p. 74). The history of ontogenesis is called phylogeny, which also influences future ontogenesis by way of expectations (Maturana & Varela, 1987, p. 76). Thus, ontogeny represents a current activity while the phylogeny represents a continuity (or longitudinal collection) of the various ontogenetic processes.
3. Skinner box can be described as the making of an illusion of engagement through operant conditioning. The term Skinner box games is used in the game design discourse to describe games that are played merely because of such reward systems, also often referred to as gamification (Portnow, 2010). That is, the player learns to associate a particular behavior with a consequence (reward or not). This theory is based on an experiment performed by Burrhus Frederic Skinner, a psychologist who discovered that when pigeons actively performed something (pecking a button with their beak in a box) to get food or a reward, they were more likely to continue or increase the activity. The active role is what modifies behavior in that it involves more than just automatic reaction to stimuli even though the activity has no causal relation between natural behavior and presentation of food (i.e., pecking a button or running in circles are not functional strategies the birds in the wild use to find food). The forming of behavior can be reinforced by holding back rewards at arbitrary instances; this makes the drive to continue stronger.

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APPENDIX

Football (also known as soccer)

The official rules for adult players exists of two teams each with 11 players on a field (known as the pitch) with the size of approximately 50 x 100 meters, although FIFA has rules for different pitch and team sizes with 9, 7, 5, and 4 players (FIFA, 1994, 2012). Similarly, FIFA has defined different timespans for different types of matches and various ages, but the official game for adults lasts 90 minutes, in two 45-minute time periods (plus stoppage time). The street corner version of football may consist of no teams but where the players do tricks and passes without pursuing goals for winning. However, the type of football that is analyzed in this study exists of two competing teams. Thus, a competitive system serves as keying (Cailliois, 1961, p. 18).

The general setup for a match consists of a pitch, a ball, 2 goals, lines on the ground depicting some rules (e.g., play stops and the ball is given to the adversary team as a throw-in when a player causes the ball to cross the two longest outer lines of the field), two teams, and a minimum of one referee. The team that places the ball into the adversary's goal most often wins (and acquires three points in a series). When the game result is that both teams have the same score, nobody wins (and both teams acquire one point in a series), unless the match is played in a cup where one team must win and therefore settled by either extended time (2 x 15 minutes) or penalty kicks.

To win, the players must both attack and defend. Typically, the players represent a specific team structure based on their coach's philosophy and where each player or group of players has a different role. A typical formation for the national team in Brazil, for example, is 4–3–3 (meaning four defenders, three midfielders, and three forwards, which is considered an emphasis on the offensive), plus the goalkeeper. In this formation, the four defenders are placed nearby their own goal. They have the collective responsibility to defend their own goal against adversary attackers in addition to an offensive role, typically occurring when the ball is intercepted in their defense zone and they need to initiate an attack. The three people in the midfield have similar defending concerns but they also function as playmakers for the three attackers (forwards), whose main role is to score goals on the other side of the field. Almost exclusively, teams place one player in the goal; this is the "keeper," whose role is to prevent goals and to start play when the ball has crossed the short end line of the pitch or has been intercepted. The keeper is the only player who can touch the ball with his/her hands, although with one restriction. The rest of the players can use any part of the body except their hands and arms.

The regulation of the game takes place by 17 laws defined by Fédération Internationale de Football Association (FIFA).

Pokémon GO

Pokémon GO builds on the early versions of the Pokémon role-playing video games (RPGs) developed for the Nintendo Game Boy in 1996. The games were strategy games and part of the total transmedia storytelling toy concept Pokémon (Jenkins, 2010). In these games, the player would immerse him/herself in the world of Pokémon and control the actions of a

chosen character (the trainer). The Game Boy versions of Pokémon were played via a controller and against either a machine or other players.

Pokémon GO differs from the Game Boy versions in that it presents an augmented reality system within smartphone technology (Salen & Zimmerman, 2004), serving as a second reality for viewing environments, and thus a keying layer. The second reality seen on the game display of one's smartphone provides an additional layer that superimposes game elements onto reality (see Figure A1). These elements comprise Pokémon creatures, Pokémon gyms, and PokéStops (where trainers can gather Poké Balls and other resources). All these virtual elements are positioned geographically on a GPS map and become available when players draw close. The main objective of the game is for a player (or, rather, a player's avatar, i. e., his/her Pokémon trainer [see Figure A2]) to catch Pokémon that spawn into the map, to gather resources, to increase the combat abilities for the Pokémon, and to prepare for battles against other Pokémon in gyms, which provide the only platforms for competition. The player must catch a certain number of Pokémon before the game allows the player to evolve the various Pokémon (a process similar to the metamorphosis that a butterfly caterpillar goes through that increases the power of the Pokémon). A player (via his/her avatar) can catch the Pokémon with Poké Balls that are either gathered through gameplay or purchased with game currency. The catch is done



Figure A1. A screenshot from Pokémon GO during gameplay in Oslo, Norway. The user's avatar is shown in the portrait in the lower left and illustrated in full person (1) when walking (shows real position in the map by the GPS functions in the smartphone) toward a virtual PokéStop (3). A virtual gym (2) is presented in the top right corner, and the spawned Pokémon Spearows is at multiple positions (4).

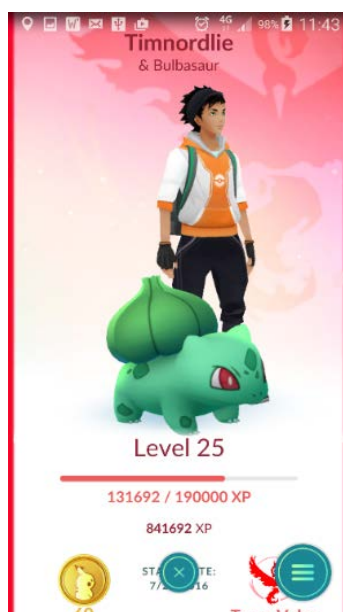


Figure A2. The Pokémon trainer Timnordlie (the boy), which was my avatar, and my buddy Bulbasaur (the green creature by the feet of my avatar). The Gold Pikachu coin in the lower left takes you to a shop and the medals overview. The red symbol in the lower right (underneath the menu button) shows the “team” or tribe that my avatar belongs to (Team Valor).

by moving a finger on top of a Poké ball on the screen, which gives it speed and direction, when the finger is lifted away from the screen, the ball is thrown, and mostly, if the ball lands close to the Pokémon, it will capture it. The game currency can be earned by placing a Pokémon at a gym after defeating Pokémon that were placed there by others (see Figure A5). Pokémon gyms are virtual locations in each digital environment in which a player’s Pokémon can be tested for strength; winners remain in the gym for future completion but losers remain in the player’s cache of Pokémon to continue evolving (when it has recovered its health). The competition at gyms involves choosing (or letting the game chose for you) the suitable Pokémon for the match (with its programmed skills) and by moving the Pokémon with a finger to attack or jump away from attacks. These actions are, to some degree, skill dependent, but there is little variation in possible moves.

The game builds largely on the game platform for the art-catching game Ingress. Thus, PokéStops are located at places or monuments of cultural importance, such as sculptures or churches (see Figures A3 & A4). Shortly after the release of the game, Niantic, the game creator, allowed users to suggest spots for PokéStops. This possibility allowed companies and cultural destinations to use Pokémon GO to attract visitors.

Some Pokémon are rare and difficult to catch. For every Pokémon a player captures, the player earns experience points (XP) and Pokémon-specific “candy” that can be used to evolve the Pokémon from one evolutionary stage to another (three stages maximum). Evolving a Pokémon increases its fighting abilities by increasing its combat power (CP). Users can also battle against other Pokémon stationed at gyms (see Figure A5).

The outcome of each battle depends on the Pokémon chosen by the player, its characteristics, its combat points (CP) that are upgradeable with stardust and candy, and the agility of the player. In the current version (still in play in 2018), users do not battle against other players but against



Figure A3. Activated PokéStop showing a sculpture in Oslo. The users can gather more info about the sculpture, artist, when it was created, and so on, by tapping the circle.



Figure A4. Screen save of a PokéStop from when I entered the vicinity of a PokéStop at St. Hanshaugen, Oslo. The three bubble-like objects are resources granted the player (two Poké-balls used to capture Pokémon and one raspberry used to increase the chances of capturing a Pokémon) by spinning the inner circle (with a finger movement on the screen) with the picture of the building that is the center of the PokéStop in the real world and virtually.



Figure A5. A screen save that shows the Pokémon Dragonite that the player (avatar) Salapalmer has left in the gym after beating the those that were stationed in the gym beforehand. To take over the gym at this point, one has to battle against Dragonite.

the game itself. Players who succeed in battle can place their own Pokémon in the gym. When a player succeeds in placing a Pokémon in a gym, s/he earns game currency that can be used to purchase various items and benefits. Game currency can also be purchased with actual money. Pokémon with high CP and health points (HP) perform best in gyms. As a player progresses through the game, s/he gains access to new functions and items, such as better Poké Balls, more efficient Pokémon medicine (potions), and new Pokémon. Spawned Pokémon often will have higher CP levels as the game progresses. Furthermore, as a player collects more Pokémon, s/he will be awarded with medals (e.g., the ‘Collector’ medal for capturing 2,000 Pokémon; see Figure F2).

Pokémon GO has experienced several iterations. For example, some months after the release, Niantic allowed individuals to buddy up with their favorite Pokémon to earn extra candy (see Figure A2) where the avatar Timnordlie is standing with his Pokémon buddy Bulbasaur). In November 2016, the reward system was extended to give players bonus rewards for the first catch and PokéStop visit of each day, as well as an additional bonus for 7 consecutive days of catches and PokéStop visits. In February 2017, Niantic released 80 new Pokémon, along with special items capable of evolving eight specific Pokémon to stages that were previously not available.

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