Design Guidelines for the Application of Product Semantics

by

Trevor Christian Johnson

A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Industrial Design

Auburn, Alabama
May 4, 2019

Keywords: archetype, affordance, design, industrial, product, semantics

Approved by

Jerrod Windham, Chair, Associate Professor of Industrial Design
Tin Man Lau, Professor of Industrial Design
Richard Britnell, Professor of Industrial Design

Abstract

This paper features a comprehensive review of the concepts and procedures of product semantics, as well as a historical account of how this field of study has evolved, from an observation of signs and symbols to a larger study of how meaning relates to man-made objects. Product semantics is the "study of the symbolic qualities of forms in the context of their use and the application of this knowledge to industrial design" (Krippendorff, 1984, p. 4). This paper will discuss the concepts and ideas of product semantics and will review other related knowledge and procedures that fall within the realm of this field of study. This paper shows that current procedures for the application of product semantics in industrial design is lacking and requires a synthesis of ideas and methods to create a more simplified and effective design tool for designers. This thesis features a combination and reorder of product semantics, as well as additions through observation and understanding of this field. The guidelines presented are then illustrated through the use of a design project in order to show its application as a design tool.

Acknowledgments

I would like to thank my family and friends for their continued support and encouragement during both my undergraduate and graduate studies while at Auburn University. Their support has guided me through this very difficult but rewarding academic program. Their encouragement and guidance have helped me overcome many obstacles in my life and I owe much of my success to them. I especially would like to thank my mother Cindy Johnson and my father Don Johnson for their love and belief in me. Even in times that I struggled while at Auburn they still supported and encouraged me to never give up and I owe much of my academic achievement to them.

To my graduate committee, Jerrod Windham, Tin-Man Lau, and Rich Britnell, thank you for being on my committee and for your guidance in completing this thesis. I appreciate both your time and your instruction while at Auburn. I have gained a great many skills and knowledge through your teaching, which I consider to be of the highest caliber. Your time and dedication as professors have greatly impacted my life and I know it has prepared me for the road ahead in my professional endeavors.

Finally, I would like to thank the rest of the Industrial Design faculty and staff at Auburn University. They have provided me with invaluable teaching through their professionalism, instruction, and support. I am honored to have been taught by such a successful, and a rightfully distinguished group of design educators.

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Definition of Key Terms

Affordance	The ability to perform an action, which is allowed through the use of a product.
Archetype	An ideal type within a person's mind of what a certain product is.
Artifact	Something that is created by a human being.
Attention paid	Purposefully concentrating on something.
Casual attention	Not purposefully concentrating on something.
Categories	The separation of products into cognitive groups by similar functions and visual attributes.

Character trait	An aspect of a product that makes up its overall appearance which is expressed as an adjective or a specific style.
Cognition	The mental process of acquiring knowledge and understanding.
Context	The specific environment or setting of a product which clarifies its own meaning.
Distinguisher	Separates aspects of a product by different qualities that express specific meanings.
Expressive	An aspect of a product that expresses an ability to do something and how to do it.
Extrinsic motivation	A sensed ability to accomplish something with the expectation of a reward or an escape from punishment.
Feedback	The outcome produced when a user interfaces with a product.
Identifier	An aspect of a product that communicates what the product is.

Ideo-pleasure	Enjoyment gained through aligning personal values and beliefs
Interface	An afforded interaction between a person and a product.
Interpretant	A concept created from the observation that the understanding of a sign requires the understanding of human language.
Intrinsic motivation	The enjoyment of an action for its own sake that brings pleasure through participation.
Mapping	The understanding gained through interfacing with a product and receiving feedback.
Meaning	Something a person understands by making sense of it.
Metaphor	A meaning that is realized in a new domain from another.
Perception	Meanings that arise in the awareness of the possibility of different ways of seeing.

Physio-pleasure	Enjoyment received through sensory organs within the human body.
Pointer	An aspect of a product that draws attention to another area or the element of the product.
Product Semantics	The study of the symbolic qualities of forms in the context of their use and the application of this knowledge to industrial design.
Psycho-pleasure	Enjoyment gained by improved cognitive function and emotional response.
Referent	An object or artifact in relation to a sign.
Science for design	A collection of design practices, methods, and outcomes that are utilized and evaluated by the design community.
Science of design	A field of research that aims at improving the understanding of design.
Semantic dimensions	A group of methods that are used to define the character of a product.

Semantic infelicities	Aspects of a product that lies about what it is or does.
Sense	Creates meaning through the feeling that something is the case.
Sign	Something that conveys meaning.
Signifiers	Meanings that are placed in products and are realized by their users.
Socio-Pleasure	Enjoyment gained from personal relationships, social status, and one's own sense of identity.
Thought	A person's own cognition and process of thinking.
Stakeholder	A person that has a shared interest or stake in the outcome of a design project.
Understanding	A realization through meanings, sense, and action.

Visibility	How easily an affordance can be sensed.

Chapter 1: Introduction

1.1 Problem Statement

We live in the information era. We may see more pictures in a single week than people just one hundred years ago may have seen in their entire lifetime. We can talk to anyone in the world in a matter of seconds, and we can search for information and answers on devices as small as a wristwatch. Why, with all this information and data at our fingertips, do we still struggle using and understanding everyday products? The problem is not money, or infrastructure, or technology, but it is the lack of accounting for human psychology during the design process. Until recently the field of psychology and industrial design were separate. Products were designed based solely on set criteria such as performance, return on investment, or other limitations.

A new field called Product Semantics was created to solve this problem. This field combines human psychology with product design. Its main focus is on how to create products that can communicate or be understood through their form or other design principles. Product semantics is an important concept in the field of industrial and product design because it makes objects easier to use and understand. This concept, however, is not easily understood due to sparse and confusing literature; therefore, it is not easily accessible as a (design) tool for designers.

This problem stems from how product semantics is studied. Product semantics is largely a study on how meanings and symbols are embedded in forms and how people perceive these meanings when using the object. This study makes us aware of existing cause and effect relationships between products and the people using them, however, the study of design

semantics is largely focused on identifying these relationships instead of developing ways to use them in product design. Although there are some examples in the literature on how to use design semantic in product design, there is not a well laid out process for utilizing design semantic principles in design.

1.2 Need for Study

It was stated in a spring issue of Innovation magazine, a professional quarterly for industrial designers, that the theory of product semantics was still in its "infancy". (Krippendorff & Butter, 1984, p. 9) Though there have been additions to the available literature and understanding of this theory since then, perhaps this sentiment is still true today. The information is still largely clouded in lengthy academic writing and complicated terms. In addition, many of the concepts presented make eloquent, noble aims without specific real-world examples or a simple proposed framework. Authors, in recent history, have expressed similar sentiments. In 2007, Martyn Evans and Simon Sommerville referred to the subject of product semantics as "complex" (p. 1). This belief was supported by the subtitle of their paper; The Challenge of Product Semantics in the Curriculum. At the end of their paper they state, "There are many experienced designers that do not fully understand the many nuances of product semantics; indeed, many design educators are not fully conversant with this area" (Evans & Sommerville, 2007, p. 5).

A lack of clear instruction or specific methods of use makes the use of product semantics difficult for designers to apply to products or designed objects. Due to the current state of this theory, it appears obvious that the concepts of product semantics require a careful extraction of its ideas and purpose. A reorder and categorical approach, in combination with real-world

examples, are needed to present clear and concise guidelines to improve its potential. This study will seek to remedy the situation by surveying existing literature and examples of product semantics. It will be important to take a categorical approach in both the literature review and when developing the proposed guidelines, in order to clearly inform the reader and prevent confusion when explaining concepts.

1.3 Objectives of Study

The objectives of this study are to survey the available literature on product semantics and relating ideas and to extract that knowledge for review. The next step is to select the ideas, methods, and observations from that review that are or can become effective design guidelines. Then those selections will be simplified and categorize in the form of a design guide so that designers can clearly understand product semantics and apply it effectively in their designs. Finally, the strategies and guidelines presented will be illustrated through a product design project that will show how the product semantic guidelines can be used to create products that can be easier to use, easier to understand, and more enjoyable.

Objectives.

- Research the history of symbolism and meanings of forms
- Research the theories of product semantics
- Research methods and strategies of product semantics
- Research ideas and observations that could be constructed into methods for product semantics
- Conduct case studies on products and forms that utilize product semantics

- Develop guidelines for designers to use or consider when designing products that utilize product semantics
- Design a product using the developed framework to show how the guidelines can be used

1.4 Assumptions

For this study, there is an assumption that product semantics and the theories behind it, work and affect us both consciously and unconsciously. It is assumed that the relevant literature featured, pertaining to psychology and design, is correct and that the ideas, methods, and observations within in them are true and exist in the real world. It is also assumed that the amount of research presented in this paper is adequate for this subject of study and that the personal ideas, statements, and commentary of the author are both well-intentioned and correct. Also, the research presented should be expandable as new studies in psychology and product semantics are conducted and as new observations on how symbols and meaning in products are made.

The research presented assumes that designers want to develop products that are more relatable, easy to use and understand. The study itself is based on the assumption that product semantics is an important idea in product design and that the ideas are not clearly presented in a way that the designer can utilize it. The paper assumes that the reader does not have an extensive working knowledge of product semantics and that they require supporting principles and explanations to back up the methods presented.

The proposed guidelines will assume the designer requires the use of product semantics in their design. It is assumed that the designer can use their own judgment to select which proposed guidelines are applicable to their own designs. It is also assumed that they can consult the information provided and apply it effectively based on the tasks required. The framework

presented is not a set-in-stone formula, but rather a list of possible guidelines that can be applied to varying tasks.

1.5 Scope & Limits

The area of study for this thesis is focused in the fields of psychology and product design. The research will include the emergence of meaning and symbolism in product design, the creation and application of product semantics today, and the possible future of how product semantics can be used. The field of psychology is very broad and the amount of research within it extends to many different fields of application. For this paper, we will focus specifically on how human psychology can be applied to product design. The field of product semantics is concerned with how meanings and symbolism can be expressed through forms and how it can be applied to product design. We will look at all of the theories that fall under product semantics and specifically existing methods or knowledge that can produce guidelines which can be applied in product design.

1.6 Anticipated Outcomes

It is anticipated that the outcome of this research will provide designers with guidelines, composed and developed from the research,that can be applied in the design process. These proposed guidelines should allow designers to make informed decisions on what attributes from product semantics they should incorporate into the product they are designing. The designer should be able to look at the product itself, the user of that product, and the environment or context of the product and, by using the guidelines provided, add symbolism and meaning to the products form. The ultimate goal of the guidelines is to develop a framework that designers can

use to make a product more relatable, understandable, easy to use, easy to identify, and enjoyable.

Chapter 2: Literature Review

2.1 History of Product Semantics

The theory of Product Semantics is relatively new. The study of meaning and signs of form dates back to the late nineteen-hundreds, however, the study of signs and symbolism dates back much further. Examples of products that use signs and communication through form can be seen during the colonial period and perhaps substantially older examples exist, but the understanding of this concept, at least in literature, is not discussed until quite later. The evolution of the field of product semantics is characterized by several key periods in history and is tied with new ideas and thought.

Signs and meaning.

The founding of semiotics is credited to Saussure and Peirce, known for discovering concepts relating to signs and their cultural context (Leblanc, 2011, p. 3). Saussure is credited with defining a relationship between the *signifier* and the *signified*, which is the difference between the form of a sign, such as words or sound, and the thing the sign represents (Leblanc, 2011, p. 3). Peirce added the concept of *interpretant*, which is the idea that signs are not understandable without a knowledge of language (Leblanc, 2011, p.3). Saussure and Peirce's work was crucial for the evolution of product semantics, which served as the framework for other conceptual ideas, specifically how meanings and signs relate to products or artifacts.

Theory of product language.

In Offenbach Germany during the mid-1970's, Jochen Gros and Richard Fischer developed the theory of product language. (Steffen, D) This theory reorganized aspects of product design into two categories, the physical areas of ergonomics and economics, and a new area focusing on the communication or meaning of the product. The new category was separated into aesthetics referring to form without meaning and semantics referring to symbolism through form. The theory distinguished traditional styling from form giving that communicates purpose or function. This theory eventually led to the birth of product semantics and began the study of how people understand products and how those products communicate their function or purpose.

Product semantics.

Klaus Krippendorff wrote an article in Innovation magazine, a quarterly industrial design publication, with Reinhart Butter in 1984. The article was titled Product Semantics: Exploring the Symbolic Qualities of Form. This was the first major design publication on product semantics. The paper, while short, described this new field of study and how it relates to design and creating products that communicate meaning through symbolism in form. Krippendorff went on to write more lengthy publications on the subject and designers have since adopted the theory and implemented its ideas in their designs.

2.2 Objectives of the Literature Review

- Review the original theories of product semantics.
- Review additional ideas and theories that have been added to product semantics.
- Review other theories or methods that may relate to product semantics.
- Conduct case studies on products that use product semantics or communicate through form

and signs.

It is important to note that the field of product semantics is broad in its very nature. This is because product semantics combines psychology with a design which can be applied in many different products and applications. Because of this, this literature review will focus only on ideas which:

1. Have an existing framework or guidelines that can be applied to product design.
2. Contain insight or knowledge that can generate design guidelines or tools for product semantics.
3. Can support ideas or guidelines featured in this paper.

2.3 Exploring the Symbolic Qualities of Form

Krippendorff and Butter (1984), in the first paper on the subject, summarize this new area of study as, "Product semantics is the study of the symbolic qualities of man-made forms in the context of their use and the application of this knowledge to industrial design" (p. 4). Though product semantics is often called a theory today it is interesting that Krippendorff himself refers to it as a field of study. Even in his next paper on the subject in 1989, he presents four separate design theories under the title of product semantics. The idea that many theories help make up product semantics appears logical because there are various ways to communicate through form, and numerous signs and signifiers. These ideas will be discussed later; however, it is good to view product semantics in this way going forward because we will discuss many different ideas that can be considered product semantics, which was not discussed in Krippendorff's original theories.

The semantic triangle.

The first paper on product semantics, by Krippendorff and Butter, starts by referencing traditional semantic theory and shows how product semantics differs. Traditional semantic theory uses the semantic triangle (Figure 1), also commonly referred to as the Ogden and Richards triangle, to illustrate the connection between a *sign*, *referent*, and *thought* (Krippendorff & Butter, 1984, p.3). The sign is the thing that is being represented, the referent is the object, and the thought is someone who makes the cognitive connection between them (Krippendorff & Butter, 1984). The paper goes on to distinguish how product semantics differs from this idea. In product semantics, the relationship between the sign and referent disappear and become one (Krippendorff & Butter, 1984). They go on to explain that this new relationship is a process of the user using the object and receiving feedback, or gaining understanding through its use (Krippendorff & Butter, 1984). This is the main idea of product semantics, which covers a long list of possible symbolism and, therefore, applications in design. This may seem like a confusing idea, because it distills down this observable principle to its basic elements, however, when applied to examples later in this paper, the principle and its effects become clearer.

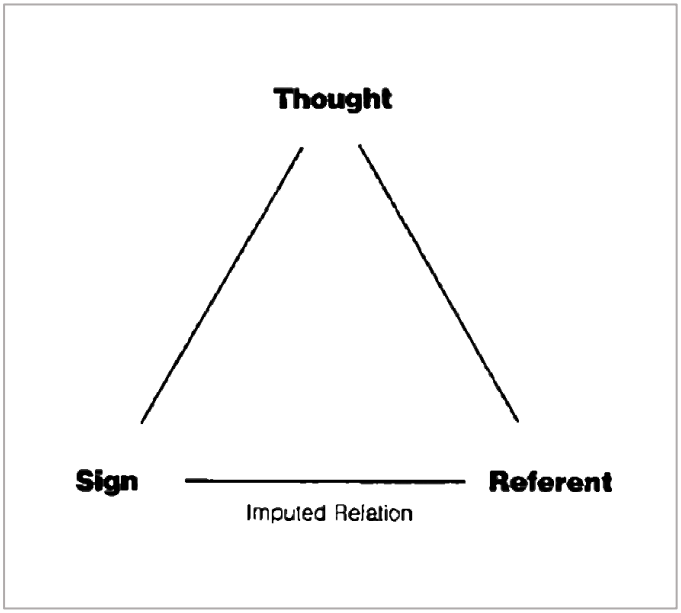

Figure 1: The semantic triangle. Reprinted from Semantics: Exploring the Symbolic Qualities of Form (Krippendorff & Butter, 1984, p. 1).

Four channels of product use.

There are four symbolic channels or ways in which meanings can be communicated in product design:

1. Information displays such as screens, speakers, and changing signage;
2. Graphic elements or two-dimensional markers, which include labels, color coding, and written instruction;
3. A products form, shape and texture;
4. An indication of a product's internal state, which can include three-dimensional forms like dials and on-off switches, or graphic elements such as moving pointer of a dial or an LED light like a battery indicator (Krippendorff & Butter, 1984, p. 5).

While it is mentioned in the article that a designer can use all four of these channels in

product design, channel three and four are the two the relate most to product semantics. There are also overlapping of these channels, for instance, some products indicate their internal state using sounds from a speaker, or certain products may indicate their function through a change in form, shape, or information display.

Four semantic infelicities in design.

The paper also mentions that symbolism in products are best explained through the use of conflicts and paradoxes, or in other words, using the wrong symbols with form aids in the understanding of how they relate (Krippendorff & Butter, 1984, p. 6). Krippendorff & Butter (1984) refer to this wrong or lying relationship between product forms and their context as *infelicities* in design (p. 6). The first infelicity in design is the consequence of making products that are unable to be recognized by their user, which can be very dangerous in situations where identification is paramount, such as emergency equipment like fire extinguishers (Krippendorff & Butter, 1984, p. 6). The second is a product that is unable to be manipulated in ideal ways (Krippendorff & Butter, 1984, p. 6). An example of this would be scissors without handles or a weed eater where the power button is located close to the blades. Krippendorff and Butter (1984) state that the third infelicity is the prevention of a user's ability to learn through the use of the product, which limits the possibility of improving the operation of an object or in finding other applications for it (p. 6). It is suggested that products encourage their own use and invite users to be inquisitive in order to overcome this infelicity (Krippendorff & Butter, 1984, p. 6). The final infelicity is a product's inability to work within its own context or its symbolic environment, which can be social, technological, or other reasons (Krippendorff & Butter, 1984, p. 6). A technological example would be a VHS player, because the technology is largely abandoned, or a social example would be an all gas-powered vehicle marketed at an electric-vehicle

convention. These infelicities highlight key aspects and areas that designers can intervene between products and the potential meanings and symbolism within them.

A good example of semantic infelicities is *The Uncomfortable* collection by architect Katerina Kamprani. The project is a collection of "deliberately inconvenient everyday objects" (Kamprani, 2017). When looking at these objects the absurdity of products without context becomes clear (See figures 2,3,4,5).

Figure 2: The uncomfortable watering can. (Kamprani, 2017)

Figure 3: Uncomfortable chair #2. (Kamprani, 2017)

Figure 4: The uncomfortable broom. (Kamprani, 2017)

Figure 5: The uncomfortable pot. (Kamprani, 2017)

2.4 A Triangulation of Four Design Theories

In 1989, Krippendorff wrote another paper on product semantics. In the opening statements of his paper, he discusses how his original intentions for product semantics have been misused (Krippendorff, 1989). He explains that some used it as another word for styling, some took it as a playful use of form giving by using "metaphors, similes and allegories", while others took it as a suggestion to use graphics or added form giving on products that traditionally were plain objects. (Krippendorff, 1989, p. 1) More examples were given, but the main point was that his idea of product semantics was being utilized incorrectly. This new paper sought to remedy the situation by explaining product semantics further and correcting the misconceptions that so many designers had over the previous four years since the term product semantics was coined. Krippendorff's first suggestion was to stop using representational meanings in product design (1989). He said that adding meaning that is representative in nature to products creates the tendency for designers to make consumers believe they purchased something they did not, and helps facilitate "fake facades" (Krippendorff, 1989, p. 3) It is important to note that although this

suggestion is well-intentioned, it limits designers from using meanings in forms and that there are examples that will be discussed later that do not confuse users or misrepresent what the product is. Therefore, it is suggested that designers be careful to not create fake facades, but also to remain open to the careful use of embedding meanings in a product's form where applicable. Krippendorff's answer to avoiding fake facades is that "product semantics be concerned with human interfaces" (1989, pg. 4).

2.5 The Semantic Turn

The Semantic Turn: a new foundation for design is the title of Klaus Krippendorff's book published in 2006, in which, he discusses in depth the field of product semantics and the role of meanings within design. A *semantic turn* refers to a shift towards the consideration of meaning in the industrial design profession, a stark difference from the long history of "Functional, aesthetic, and market considerations that justified the products of design in the past…" (Krippendorff, 2006,). Krippendorff discusses the history of product semantics in the first chapter of his book which, besides his own papers on the subject, cover mainly specific conferences and workshops on the subject. Actually, the only specific academic writing on product semantics, found in this study, were from Krippendorff himself. There are however several conference papers, featured in this study, and books that relate to different facets of product semantics, though it is important to mention that the main authority on product semantics, even today, is still Klaus Krippendorff.

"In this information-rich, fast-changing, and increasingly individualistic culture, contemporary design discourse is no longer compelling. Thus, industrial design finds itself at a critical turning point" (Krippendorff, 2006, Introduction) This statement foreshadows the coming chapters of the writing and expresses a need for designers to adopt this new outlook on how

things should be designed. The ideas and framework of this book are indeed both a reintroduction and evolution of Krippendorff's ideas from his previous two papers written in 1984 and 1989. The ideas in the book are presented as a shift away from traditional methods and procedures used historically in design. From different styling movements like streamlining and art-deco, to the mass production age of the industrial revolution, and the adoption of marketing and business to design. All of these were periods in history in which designers utilized a specific driving force, a reasoning behind how and why they designed products the way they did.

Krippendorff (2006) argues that the current state of design, which is largely based on the dictum *Form Follows Function,* fails to integrate or succeed in the current state of society today (pp. 5-6). "It is fair to say that today's world is more complex, more immaterial, and more public than the world out of which this dictum grew" (Krippendorff, 2006, p. 6). This dictum, credited to Louis Sullivan (1896), is a belief that the creation of the form of products evolve naturally from the understanding of the function the product serves (Krippendorff, 2006, p. 5). This functionalist approach was prevalent in many design schools and movements within design after the industrial revolution (Krippendorff, 2006, p. 5). Krippendorff (2006) further argues that "Design evolved beyond what the dictum could handle and designers are facing unprecedented challenges" (p. 6).

A shift in design focus.

There are four observations made by Krippendorff that are presented to show how design is changing from this approach. The first observation is that in order to find answers to design problems today, design cannot be limited to industrial era concepts (Krippendorff, 2006, p. 12). These concepts were largely concerned with developing functional products that could compete in the marketplace, but today the realm of design has evolved beyond simply creating pleasing

products into areas such as interfaces, systems, projects, and discourses (Krippendorff, 2006, p. 12). The second observation is that the artifacts designers are concerned with today are becoming more fluid, more immaterial, and harder to discern (Krippendorff, 2006, p. 12). Krippendorff (2006) gives examples, such as, how the design of a brand becomes an artifact that resides in the memory of a customer, or how design projects are based on user's cognitive processes, political beliefs, or how they interact with them (p. 12). The outcome of these designs become much harder to predict because of their nature (Krippendorff, 2006, p. 12). This makes functionalist design approaches much less effective. Third, artifacts are now becoming more and more embedded in language and there is a shift from designing functional mechanisms to more constructive uses of language in design (Krippendorff, 2006, p. 12). Finally, Krippendorff (2006) states, there is a move toward human-centeredness, an acknowledgment that meaning in design matters (p. 13). This is a change from the idea that technology determines the design and that humans must adapt to these technological changes with the designer simply intervening to make the process more painless (Krippendorff, 2006, p.13). The new idea presented is that humans should influence the direction of technological advancement and that designers are now responsible for supporting "diverse practices of living, community, and the sense needed for individuals to feel at home", which Krippendorff states are the core of the semantic turn (2006, p. 13).

This book does a good job of highlighting the shortcomings of traditional design processes and procedures that were born out of an industrialized era. These ideas, are not irrelevant, however, indeed Gestalt theory and many other ideas that shaped design today are still important to designers and can still aid them in creating attractive products and making design decisions. However, it is important to realize that many of these ideas were created out of a need for mass production and a demand for creating products that must survive in competitive

markets. Krippendorff's answer is not an abandonment of traditional design ideas, but rather a shift in focus of what a designer should pay attention to in order to create meaningful, communicative products today. Krippendorff (2006) explains the purpose of his book as: "The semantic turn is a seed for design to redesign itself by means of its own discourse" (p. 12).

The changing environment of design.

Krippendorff's observation of a shift in design focus correlates with major intellectual, cultural and philosophical changes that also include social and technological advancements in design today (p. 13). These changes are categorized and summarized below:

- Society: Includes the shift from industrial era concerns to postindustrial era needs (figure 6). Also included is the move from a technology-centered design approach to a more human-centered approach;
- Technology: Includes the miniaturization of electronics which has removed restraints on an object's form requirements. And there is also the high level of technology and intelligence in products that allow new qualities of human involvement with them;
- Manufacture: Customization within mass manufacture, allowing designers to become concerned with variables of how users and customers think. Also, Programmable manufacture of a smaller number of products on the assembly line, reducing conformity and freeing designers to concentrate on usability, desirability, and diversity;
- Computer-aided design (CAD): First is rapid prototyping, which shortens product design cycles significantly. Second is cooperative software, which allows many team members from different fields to work parallel with each other on the same project;
- Design management: The ability to shape and organize design projects on a larger scale;
- Market Research: The ability to focus on the culture and individual users that design

affects and hopefully a shift away from a focus purely on sales;

- Philosophy's linguistic turn: The understanding that language creates perception through use i.e. conversation, dialogue, etc. Also, the study of how the use of language distinguishes forms, materials, functions, and problems and how designers can use this understanding to make design decisions (Krippendorff, 2006, pp. 13-23).

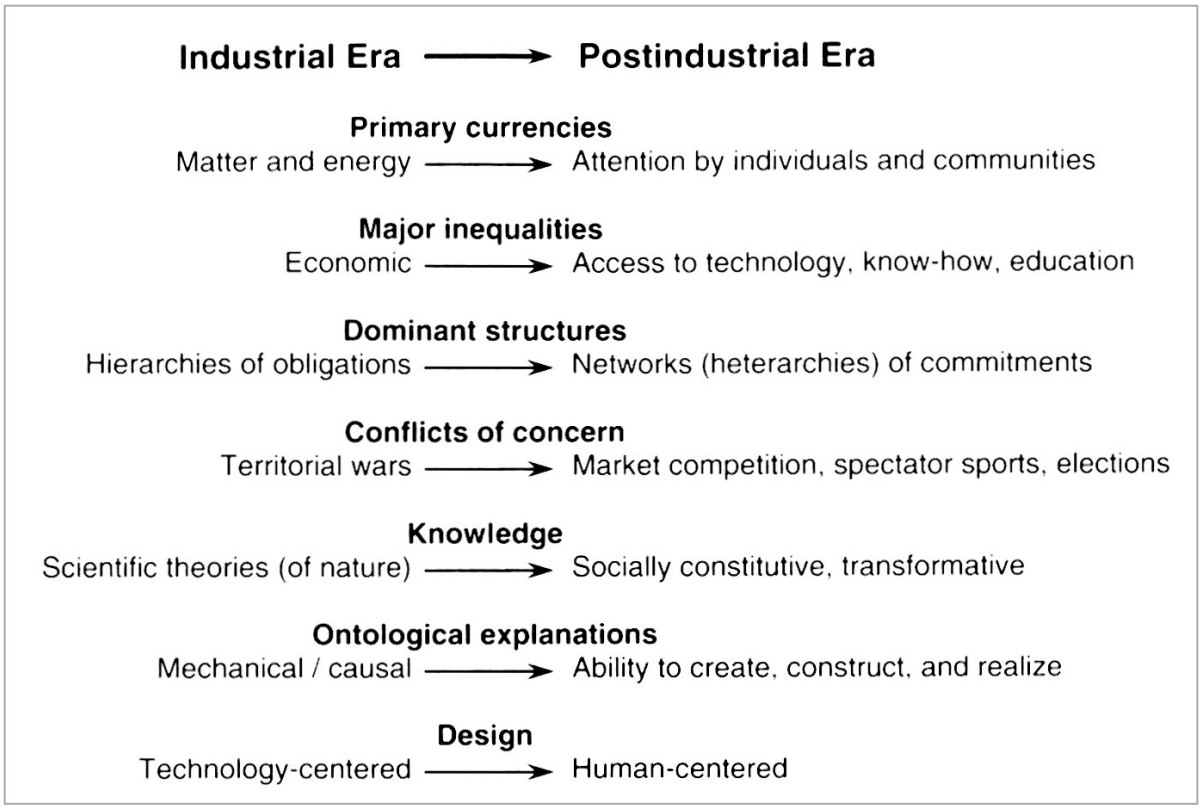

Figure 6: Industrial era to post-industrial era shift diagram. Reprinted from Semantics: Exploring the Symbolic Qualities of Form (Krippendorff & Butter, 1984, p.14).

Human-centered design.

The book mentions many examples of the ideas and philosophies that lead to a human-

centered design approach, which is a manifestation of product semantics. One such example was the ideas of Johann Wolfgang von Goethe which opposed the views of Isaac Newton's theory of the color spectrum. Goethe thought the experience of colors was created inside the human eye rather than by wavelengths of light which Newton suggested (Krippendorff, 2006, p. 41). Goethe's observation turned out to be correct and we now know the experience of color is a phenomenon produced solely in the human organ used for sight; the eye (Krippendorff, 2006, p. 41). This example and many others show a shift of focus away from a technological-centered view of the world and towards studying how humans see the world through their senses and the biological processes of the human body (figure 7). The idea that design can be combined with how humans think, see, and feel can allow designers to create the experience of what a product is to the user. Krippendorff (2006) states "Humans do not see and act on the physical qualities of things, but on what they mean to them" (p. 47). This insight is the basis for human-centered design and provides a framework for processes and procedures that he presents later in his book.

Technology-Centered View		Human-Centered View	
People	**Machines**	**People**	**Machines**
Vague	Precise	Creative	Unoriginal
Disorganized	Orderly	(accommodating)	Rigid
Distractible	(focused)	(context sensitive)	(context insensitive)
Emotional	(rational)	Resourceful	Unimaginative
Illogical	Logical	(many intelligences)	(fast but repetitious)

Figure 7: A shift in view diagram. Reprinted from Semantics: Exploring the Symbolic Qualities of Form (Krippendorff & Butter, 1984, p. 40).

Meaning, sense, and context.

Krippendorff, explains what makes up human understanding in his book, which is critical within human-centered design. He explains the first key to understanding is through meaning and discusses five key areas, which are: in perception, in reading, in language, in conversations with others, and in re-presentation (Krippendorff, 2006, p. 52). We will discuss several of these concepts here because they show a correlation with how artifacts and meaning connect. The concepts within this section can be hard to comprehend, but including these is crucial to both, the holistic understanding of product semantics, and the methods and procedures presented in this paper.

Perception.

"In perception, meaning arises in the awareness of the *possibility of different ways of seeing"* (Krippendorff, 2006, p. 52). An example of a *flip-figure* (figure 8), an image that can change based on how it is viewed, is given in order to illustrate the concept. Krippendorff (2006) explains that without much attention, the figure is just a curved line on a page, but with closer attention, the figure can be seen as the head of a duck or a rabbit (p. 52). It is with this distinction, between *casual attention* and *attention paid*, that we can see how sense and meaning relate. Casual perception restricts meaning to a singular sense; without looking, one cannot see alternatives of meaning (Krippendorff, 2006, p. 53). This is contrasted with paying attention, which leads to seeing two or more meanings within the artifact (Krippendorff, 2006, p. 53). It is at this divergence that sense intersects meaning. Krippendorff (2006) explains that one can sense, a chair, but also, one can see something, and sense that it is like a chair (p. 53). Sensing something, and seeing something as, creates a perception of difference, and in turn, separates

sense and meaning (Krippendorff, 2006, p. 53).

Krippendorff (2006) frames the previous observations of sense and meaning, with a theory by James Gibson (1979) that uses the concept of *affordances* (p. 53). He explains that Gibson's affordances are meanings which suggest an ability of the perceiver to act, in order to change an existing sense to a favored one (Krippendorff, 2006, p.53). He calls the existing sense, the favored one, and all the possible choices between them a *sequence of senses* (Krippendorff, 2006, p. 53). For example, the ride-ability, share-ability, transport-ability, and show-off-ability of a skateboard, are all affordances. The meaning of the artifact, a skateboard, include those affordances and many more. A person can sense their own skateboard's current affordances and also the possibilities that exist. Krippendorff (2006) summarizes this as "artifacts mean their affordances, the set of their imaginable uses" (p. 52).

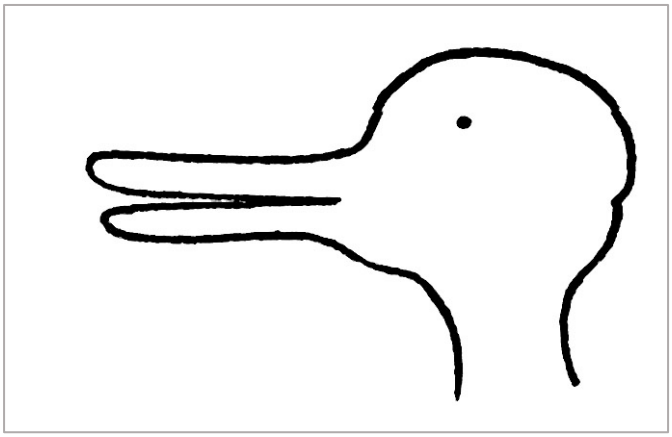

Figure 8: Flip-figure example. Reprinted from Semantics: Exploring the Symbolic Qualities of Form (Krippendorff & Butter, 1984, p. 52).

Conversation with others.

Krippendorff (2006) explains that the meanings of others, and how others sense things, cannot be understood without asking them open-ended questions and carefully considering their answers (p. 55). He concludes that this creates storytelling about the artifact in question, and this allows the person asking the questions to understand the meaning of artifacts to others

Re-presentation.

Photographs have meaning and are sensed by other people, but they are understood as something present that occurred elsewhere at a different time (Krippendorff, 2006, p. 55). Photographs are images that can be sensed, again and again, perhaps differently, therefore, images create meaning from what they represent to the viewer (Krippendorff, 2006, p. 55). These images can be embedded in artifacts causing the viewer to sense meaning through the representation in it.

Meaning in artifacts.

Krippendorff list five applications of meaning and states that meanings of technical artifacts almost always included possible uses. These applications of meaning are:

- Spaces, expected senses, and a number of possibilities. For example, pushing a button causes a doorbell to ring. The doorbell has no choice in the matter, but how a person responds to the ring creates an action or set of options that a person can choose;
- A person's own construction and they are fixed with that person. Meanings cannot be fully shared, even through communication they can only be described to one another and this expression is not a substitute for personal experience and our own understanding;
- Created through using language, especially with human interaction of artifacts. Meanings

are not natural to the physical or material aspects of things, but rather they emerge through the use of them;

- Not fixed, they are built from past experiences. Meanings are expanded on and change;
- Invoked by sense. Sense is always connected with what it creates, the meanings that arise from it (Krippendorff, 2006, p. 56).

Krippendorff also mentions semantic contradictions which are products with meanings that lie about what they are. Krippendorff gives examples, such as a clothing iron with spikes on the bottom that would damage clothing and a cup and saucer covered in fur that renders them useless as such (2006, pg.57). These semantic contradictions are just another term for semantic infelicities that were mentioned in 1984 by Krippendorff and Butter. A diagram of how understanding arises out of meaning, sense, and action can be seen in figure 9.

Meanings, said by Krippendorff (2006), are not observable, but rather, the behavior created from them are (p. 60). An example of watching someone use a chair for other uses than sitting, such as a stepstool, something to dry clothing on, or securing a door by wedging it underneath the handle, these are observable behaviors that allow us to conclude that the uses of that object are permitted because of their meaning to the user (Krippendorff, 2006, p. 60). A good summary of how artifacts and meanings relate is "Re-cognizing what it does, the many ways it can be of service, is its meaning, and this is what human-centered design is to assure" (Krippendorff, 2006, p. 56). *Re-cognizing,* in this context, is referring to recognizing, but the word cognitive is separated to show it is in a person's own mind that recognizing takes place.

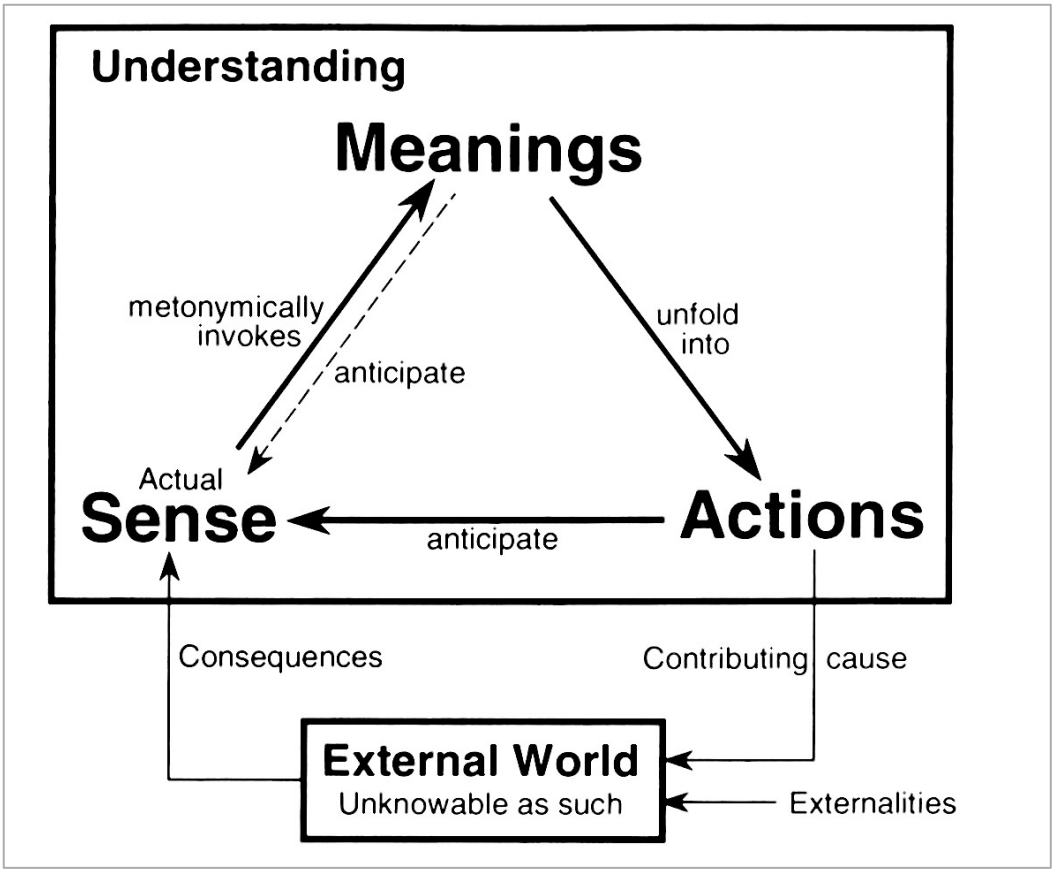

Figure 9: Understanding diagram. Reprinted from Semantics: Exploring the Symbolic Qualities of Form (Krippendorff & Butter, 1984, p. 58).

Context.

Meanings and contexts are "twins", according to Krippendorff (2006), but they behave differently (p. 59). Krippendorff (2006) explains what contexts do and concludes that artifacts mean what their context permits (p. 59). Firstly, meanings occur in multiples, for example, without a context, a dictionary can include multiple meanings of a word (Krippendorff, 2006, p. 59). Further, users of a dictionary can understand which meaning applies to the word based on their sense of what context it was used in (Krippendorff, 2006, p. 59). The context of artifacts behave much the same way, though they are physical, unlike words. Krippendorff (2006) gives

examples, such as a hammer used by a craftsman being recognized as a tool, but when the hammer is placed next to a dead body, it is viewed as a murder weapon (p. 59).

We can simplify the understanding of context, in relation to product design, as the meanings that arise when the product is placed in a specific environment or setting. For example, a high-performance race car, in the context of a rural village, may be understood as an object that simply provides transportation from place to place. However, if we place that vehicle in the context of a racetrack, it may be viewed as an object that affords the ability to win a race. Context is an important concept for designers because it changes what an object can mean or afford to the user.

Interfaces.

Krippendorff (2006) mentions a type of artifact that has become part of design language with the invention of personal computers (p. 78). While this type of interface is largely concerned with informing the user about processes that are going on inside a computer, Krippendorff (2006) expands the term *interface* to include anything that concerns human interacting with technology (p. 78). While examples of electronic interfaces are given such as a remote controls, aircraft controls, and telephones, he also lists scissors, hand cranks, and stools as interfaces because they are objects that humans interact with (p. 80). Almost anything we can use or interact with can be considered an interface according to Krippendorff. This concept is a big part of product semantics and it is a way for designers to focus attention on not only what interfaces are, but also how they can be improved in order to develop communicative and interactive products.

Methods, research, and a science for design.

To conclude this section on Krippendorff's writing we will discuss the methods and procedures that he presents in his book. A large portion of the book includes concepts with examples, in fact, some of the writing covered in this literature review can be used because the concepts themselves elicit application. This is the nature of product semantics, because the application of it explains its own concepts, and understanding the concepts allow you to use them. It is this circle of understanding that can make product semantics so confusing, but once you understand it, you will hopefully realize that product semantics as a whole, is a way of seeing things differently. This new way of seeing, combined with guidelines presented in this paper, will hopefully allow designers to create successful products using product semantics.

A new science of design.

Krippendorff contrasts the *science of design*, a field of research that aims at improving our understanding of design, with a *science for design*, a collection of design practices, methods, and outcomes that are utilized and evaluated by the design community. (2006, pg. 209) Krippendorff states further that this new field of study includes knowledge that supports design decisions, teamwork with stakeholders, project-focused research, and providing methods for design validation. (2006, pg. 209)

Krippendorff lists five features that a science for design needs to acknowledge or address below:

- Designers work with artifacts, products, and practices that do not exist and could not occur without intervention. "Design is a discipline that cannot be disciplined by what worked previously, by conventions or rules established by an authority" Because designers are responsible for creating new products, in which the users and environment

change, design methods or rules that are not adaptable or prevent variability cannot be successful design practices. Therefore, any methods or rules developed for product semantics must focus on variability or adaptability;

- Designers need to understand which possibilities in design deserve or require improvement. Those possibilities or potential futures can be found in the designers own head or in the minds of the stakeholder, but these visions emerge through imagination or conversation and are created through language. Krippendorff explains that because of this, "a science for design must speak a language of possibilities – not just of the designers' – but foremost of those whom the design is intended and those whose life is affected by it";
- An ability to process the understandings of design stakeholders and use that knowledge to drive design decisions. Designers in this new science for design must favor methods that focus on people, communities, how decisions affect industry, and how artifacts affect one another. This is a big contrast to the engineering principles concerned with producing functioning, durable, efficient products of the past;
- A provisioning for designers to validate their own claims within design. Because this new science focuses primarily on criteria of meaning rather than that of function, designers must use semantic claims to substantiate their design decisions and must appeal to the stakeholders of them;
- It must be self-examining, self-correcting, promote design success, and expand itself. This is a recipe for success of any discourse and will help sustain itself (Krippendorff, 2006, pp. 210-212).

Possible futures.

The first methods and guidelines presented by Krippendorff are ones that are geared towards generating new possibilities. This comes from his previously mentioned plan of a science for design. These methods include brainstorming, reframing, and combinatorics. *Brainstorming* is the popular design method of using idea driven conversations in social settings to generate innovative ideas. Though not mentioned explicitly by Krippendorff, brainstorming can be focused on any topic and if combined with product semantic principles it could become a very effective design tool for product semantics. *Reframing*, according to Krippendorff (2006), is similar to brainstorming because it creates many possibilities, however reframing is different because it is concerned with trying a multitude of possibilities and selecting ones that prove useful (p. 215). These reframing methods include *transforming the known*, such as morphing product forms, making hidden parts visible, or turning a product inside out (Krippendorff, 2006, pp. 215-216). Some other methods included are trying different metaphors, applying theoretical views from other disciplines, and adding stakeholder's views (Krippendorff, 2006, p. 216). There are other methods of reframing mentioned, but Krippendorff (2006) summarizes these principles as "Reframing makes visible, solvable, or understandable what any one medium of representation hides" (p. 216) Finally, *combinatorics* is mentioned which is an engineering principle where a product is separated into individual parts or categories and then the possibilities within that category are explored separately (Krippendorff, 2006, p. 217). This method is similar to systems design, where a product is viewed not only by the subsystems it is made up by, but also in its larger context, such as how a car is a component of transportation, and how transportation is a component of human activity.

Stakeholders.

Krippendorff (2006) again discusses the importance of understanding stakeholder desires, their possible meanings and understanding of the object being created, and predicting how their interaction with the product could change (p. 222). He suggests many methods including, surveys, interviews, focus groups, user observation, and ethnography (Krippendorff, 2006, pp. 223-226). Krippendorff (2006) also recommends the participation of stakeholders in the design of products (p. 228). These methods are well known in design education because they are usually applied to product users, and therefore, these methods will not be discussed in further detail here. The importance of this concept, with respect to this paper, lies in the utilization of stakeholder ideas and opinions within the design process.

Human-centered design methods.

In this section, Krippendorff (2006) discusses product semantic methods to be used in the design process of objects (p. 230). He lists and explains these methods, but he also mentions that these methods "still need to be formulated and tried" (Krippendorff, 2006, p. 231). The first method is the reformulation of characters or traits of objects. This method consists of aligning the product with its archetype, outlining desired and undesirable traits and product-culture identities, and referencing stakeholder desires (Krippendorff, 2006, p. 232).
Krippendorff gives five separate steps for this method which are listed below:

1. Explore and expand on the selected character traits of the product;
2. Categorize and review those attributes while separating them into ones created by the designer, stakeholders, and those to avoid;
3. Devise ways to implement those traits into the product, either visually or in a way that can be sensed by the user;

4. Fix incompatible traits that work against the overall character of the product;
5. Test each implemented characteristic against the attributes developed in step two (Krippendorff, 2006, pp. 232-234).

The second method discussed is designing products that inform users of the product's identity and function (Krippendorff, 2006, p. 240). The objective of this method focuses on designing products that express what they do, and how they work and operate. This method also involves five steps listed below:

1. Separate the design or product into components based on aspects that contribute to the understanding of the product as a whole. These components could be functional aspects of a product or how the order of parts allow the identity of the product to be realized;
2. Create options for how each component can be constructed and made recognizable. An example given is understanding a part that is too hot to be touched can be realized by the application of a heat shield;
3. Explore the context of use of the product and use it to define limitations or requirements. Examples include a vacuum cleaner needing to fit into small spaces or a humidifier's appearance complementing the décor of a room;
4. Fix incompatibilities between the order of components. These can be functional or technical limitations that would prevent the product from being useful;
5. Test the product on how easy it is to identify, understand its components, realize its function, understand its context, and how it compares to previous designs or archetypes (Krippendorff, 2006, pp. 242-244).

Thirdly, Krippendorff presents a method for the creation of new or novel products. The steps

of this method are outlined below:

1. Collect applicable metaphors by taking to design clients, experts in other technology centered disciplines, and other people whose own ideas and opinions could create new ideas;
2. Analyze them through *narrative sequencing* which is creating a story about a fictional product and placing the story into a scenario. This process creates understand of the product and can be "Translated into interfaces";
3. Explore technical details that supplement narrative sequencing. A story about a product in use can explain what it does, but it does not show how it works. These technical details are important to develop products that do what they say they do;
4. Develop a product using the previous steps that can be realized in the real world and that is no longer a fantasy;
5. Test to make sure the stakeholder's story that created the product fits its realization. In other words, make sure the ideas about what the product is and does are true (Krippendorff, 2006, pp. 248-251).

Other methods are presented by Krippendorff, but these three are the most pertinent to product semantics and applicable to the development of simplified product semantic guidelines. The methods presented by Krippendorff have merit and are certainly useful in product semantics, but their organization and explanation are still far removed from a simple design approach. It appears evident that the reason product semantics has not been fully implemented into design education today is that much of its concepts and ideas are clouded in academic writing and its methods are not easily understood.

2.6 Other Voices on Product Semantics

As mentioned earlier, Krippendorff is the main authority on product semantics, and so it is by no coincidence that a major portion of this literature review is from Krippendorff himself. There are however others that have contributed to both the scope of product semantics, as well as methods and procedures for application. The following henceforth will cover ideas and concepts from sources other than Krippendorff.

2.7 Communication through Form

Don Norman (1988) Lists four main elements that are necessary for effective communication of a product's functionality: 1. Visibility, 2. Affordances, 3. Mapping, and 4. Feedback. Elaver (2012) gives an example of these elements using a light switch. The *affordance*, in this case, is not the light switch itself, but the ability it provides, allowing the user to flip it up and down. The *feedback* is given when the user sees the light come on. The *mapping* is the resulted understanding of the cause and effect of these two elements. Finally, *visibility* is allowing the user to see the light switch, which becomes an issue in this case when the light is switched off.

An interesting cultural and technological change today is that many vehicles no longer require physical keys and now feature push-button ignitions (figure 10). These systems require a key fob to physically be inside the vehicle, but many of these key fobs no longer feature a key that physically interacts with the vehicle. This marks a cultural change in the traditional archetype of what a car key is, however this new product-system relationship still relies on the previous understanding of what a car key was in order to communicate its function to the user. If we apply Don Norman's four elements of communication to this new product we will notice a

change from the traditional archetype. In the old car key ignition model, the ignition slot was the affordance, the shape of the key and the matching key slot provided the visibility. The car starting when the key is turned was the feedback and the mapping resulted from performing this process. Now let us look at how the new keyless start differs using Norman's four elements. The affordance, in this case, is the ability of the key fob to start the car when it is within range of the wireless security system. The visibility is nonexistent because the process is wireless. An argument could be made that the owner's manual explaining the process could be the visibility, however, it is not evident in the process itself making the communication less effective. The feedback is both the vehicle starting when the key fob is in the vehicle and also the vehicle not starting when the key fob is outside the vehicle. The mapping results from learning the two feedbacks, the car starting with the key fob, and the car not starting without it.

Understanding these four elements is important to develop products that are easier to use and comprehend. Usability is an important responsibility of the designer and creating methods that utilize these four elements is a possible semantic tool that can improve the ease of use of products.

Figure 10: Ignition push-button start. (Ignition, n.d.).

2.8 Usability Heuristics

Another potential tool for product semantics is the use of usability heuristics. These guidelines are often used in computer software design to help identify problems and to help improve understanding and usability of the program. While the development of these guidelines was focused on computer software, they have potential applications within product design. Jakob Nielson (1994), largely considered the father of usability heuristics, reviews several published sets of usability heuristics. (p. 1) In this paper, Nielsen (1994) derives a set of nine heuristics that are categories focused on identifying different types of problems of usability (p. 1). These 9 heuristics are "visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, and helping users recognize, diagnose, and recover from errors" (Nielsen, 1994, p. 1). Explanations of each of these heuristics are re-listed from Nielsen below:

- Visibility of system status: The system should inform users about what is going on through feedback and within a reasonable time;
- Match between system and the real world: “The system should speak the user’s language, with words, phrases, and concepts familiar to the user.” It should “follow real-world conventions, making information appear in a natural and logical order”;
- User control and freedom: “Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo”;
- Consistency and standards: “Users should not have to wonder whether different words, situations, or actions mean the same thing”;
- Error prevention: “Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action”;
- Recognition rather than recall: “Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.”;
- Flexibility and efficiency of use: “Accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.”;
- Aesthetic and minimalist design: “Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with

the relevant units of information and diminishes their relative visibility.";

- Help users recognize, diagnose, and recover from errors: "Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution." (Nielsen, 1995, p. 1).

These guidelines provide a great explanation of what aspects of usability can be improved upon. These principles have a potential to be applied to product semantics and could be used in the development of product interfaces to increase their usability.

2.9 Form as language

Elaver (2012) states that "Products are signifiers within a cultural context, both the result and the conveyor of the memes of that culture (p. 3)." He gives an example of a car key and says there is no meaning unless the two concepts of a key and lock and a car and ignition are understood (Elaver, 2012, p. 3). He further states that the cultural concept of key holder equals car owner is an important relationship between this product and the user (Elaver, 2012, p. 3). Elaver (2012) says this cultural meaning which is embedded in form is sensed through the understanding of similar products and can communicate cultural messages about the person with it (p. 3). An example of this concept is shown by the use of three separate keys and the cars associated with them (figure 11).

Figure 11: Keys and associated cars. Reprinted from Form, Function, Emotion: Designing for the Human Experience (Elaver, 2012, p. 3).

2.10 Designing with Emotion

Donald Norman (2004) states "Our attachment is really not to the thing, it is to the relationship, to the meanings and feelings the thing represents" (p. 48). If designers can understand this they are better equipped to create products that are more meaningful to the user. Elaver (2012) explains that because of this it is nearly impossible to create for the individual because of their specific life experiences. However, it is possible to communicate through cultural signs, that is, through the symbolism of culture or historical references (Elaver, 2012, p. 4). Elaver (2012) uses the example of the new VW beetle that represents the iconic VW beetle design from the 1900's (figure 12) (p. 4). This new product was marketed towards the generation that grew up with the previous design and therefore became meaningful for the individuals of that specific culture.

By using cultural signs in their designs, a designer is able to create more meaningful products that emotionally resonate with the user. This is important, not only to create desirable

and successful products but also to create products that users connect with on a psychological level. Elaver (2012) also states that it is possible to leave room for personal connections and gives the example of mass-customization as a way to accomplish this (p. 4). In summary, using cultural signs and mass-customization are viable options for product semantic guidelines and can help create products that are more meaningful, relatable, and emotionally connected.

Figure 12: VW Beetles: 2013 model left, 1930 model right. (VW, n.d.).

2.11 Archetypes

Tim Parsons (2009) explains the term *archetype*, as it relates to industrial design, as "An "archetype" – a standard or classic example conjured in the mind when an object type is mentioned – is rarely, if ever, based on one specific object but is formed through amalgamating experiences of seeing many of the same kind." (p. 37). This refers to a specific understanding of what an object or form is. From birth we begin to use objects and products and create these subconscious categories of what those objects do and what they look like. It is an understanding of the typical or what we are accustomed to. How confusing would it be to be handed a blob-like

object the size of an apple and given no instruction of what it is or what it does? Now, what if you were handed a flat rectangular object with a screen and perhaps some buttons, you would probably recognize this as a cell phone and immediately know you can turn it on, call someone, and in the case of the smartphone, do all sorts of digital media activities. Now, what if someone told you both objects were cellphones and could complete the same tasks. How would you operate the first object, where would you start? The second object is the archetype, it is what millions of people own and use today.

If you own or have used a smartphone, you are perhaps aware that it's form and overall appearance changes very little year to year. The iPhone by Apple is a great example of this because they release new phones almost every year, but besides the performance on the inside of the phone, the size, shape and overall appearance have changed very little. This is purposeful, they are slowly evolving the archetype of the product to not alienate the user. The famous designer Raymond Lowey (2002) explained this phenomenon as "The adult public's taste is not necessarily ready to accept the logical solutions to their requirements if the solution implies too vast a departure from what they have been conditioned into accepting as the norm." (p. 278).

The archetype may seem like a constraint, something that hinders designers from innovation and creativity. This can sometime become the case (see figure 13). However, an understanding of archetypes can allow the designer to make design decisions that push the envelope while still allowing the product to be understandable and easy to use. Designer Robin Levien explained this balance, between innovative and recognizable, as "the extraordinary within the framework of the ordinary." (Parsons, 2002, p. 38).

Figure 13: “an archetypal shape” of an electric iron (Lee, 2012, p. 8).

Applying archetypes.

In 2012, Jungha Lee published a master thesis project on product archetypes at Konstfack University in Stockholm, Sweden. The project was titled “Using archetypes in the design process” (Lee, 2012, p.1) In this project, Lee took products that utilized archetypes and grouped them into categories based on how the archetype was used. The study looked at the diverse uses of archetypes in industrial design. This process resulted in a formulation of different types of archetypes.

The first category is “Applying an archetype of whole product” (Lee, 2012, p. 12). Lee noticed that these types of products resembled “other objects or things”. (Lee, 2012, p. 12). Some of the examples included a CD player that resembled a ventilation fan and operated with a pull string (figure 14), a funnel that looked like an elephant with the trunk functioning as the spout (figure 15), and a wall mounted key holder shaped like a cloud (figure 16). Lee further separated the category by suggesting that some of the products make a connection between their use and the form of the archetype they utilize. For instance, the funnel makes sense in its use because of

the commonly understood notion of an elephant and water being sprayed from its trunk. Lee stated that other products in the category copied the form of the archetype but didn't make a connection with its functionality. An example of this was a USB hub shaped like a battleship (figure 17) and a pair of salad tongs shaped like cartoon dinosaurs (figure 18).

Figure 18: Dinosaladservers by All lovely stuff. (Lee, 2012, p. 14).

Figure 14: Muji wall-mounted CD player. (Lee, 2012, p 14).

Figure 15: Ele funnel by Quality Design. (Lee, 2012, p. 14).

Figure 16: Cloud key holder by Duncan Shotton. (Lee, 2012, p. 12).

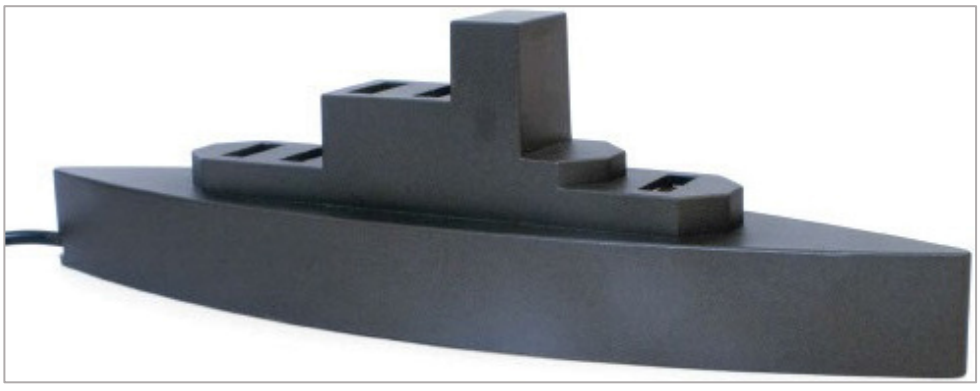

Figure 17: Battleship USB hub. (Lee, 2012, p 14).

Though not mentioned by Lee, all of the examples within this category are metaphors. An important take away from this part of the study is that products can utilize archetypes for communicating the functionality of a product through metaphors. Though sometimes this approach can create products that don't come across as serious, there are opportunities through this approach to create products that better communicate function and purpose.

A couple other products that successfully use archetypes with metaphors were found through research, a USB flash drive in the shape of a key (figure 19) (figure 20), and Tesla's key fob that mimics the form of the car (figure 21). These examples use metaphors to transfer meaning through form, and then the associated meaning communicates how the new product works. The USB drive uses the concept of a key to communicate that it is meant to be inserted into a USB slot. It also communicates the contextual relationship of how it should be carried, since keys are often associated with key chains. In the tesla fob example, the buttons on the fob resemble and control those actual parts on the car. By clicking the front of the fob, the hood will open, and when the rear of the fob is pressed, the trunk will open. Through these examples we can see how intuitive products can be when they utilize archetypes through metaphors.

Figure 19: USB drive by GIGAFLASH. (Key-Shaped, n.d.).

Figure 20: USB drive in use. (Key-shaped, n.d.).

Figure 21: Key Fob by Tesla. (AP images, n.d.).

Lee (2012) presents his next category called “Applying an archetype on a part of the product” (p. 12). As the name suggests, the product examples within this category include products that use archetypes of other objects in one or multiple components of itself. Some of the examples include a bag with a rubber shoe sole for its bottom (figure 22), A trashcan with a clown nose lid (figure 23), USB thumb drives in the form of a paperclip (Figure 24), and an electronic access key with the shape of a physical key (figure 25).

Figure 22: Sole bag by Naoto Fukasawa. (Lee, 2012, p.17).

Figure 23: Clown nose by Thomas Kral. (Lee, 2012, p.17).

Figure 24: Data Clip by Nendo for elecom. (Lee, 2012, p.17).

Figure 25: Card key by Design Studio S. (Lee, 2012, p.17).

This category of archetype transfers the functional meaning from another product in order to communicate its use and purpose. This process uses metaphors to change the meaning of the new product and utilizes archetypes to make its function clear. The concept of archetypes is an important tool that can be used to create and communicate meaning in new products. Lee goes on to suggest in his paper how archetypes can be used within the design process.

Lee (2012) discusses how to categorize product archetypes through icons in order to clearly identify its function and how it is communicated (p. 18). The categories include 'Tools/cutleries" (figure 26), "Electric home appliances" (figure 27), "Electronic gadgets" (figure 28), and "Computer devices" (figure 29), which he then graphically represents as icons and color codes them based on their function (Lee, 2012, p. 18-19).

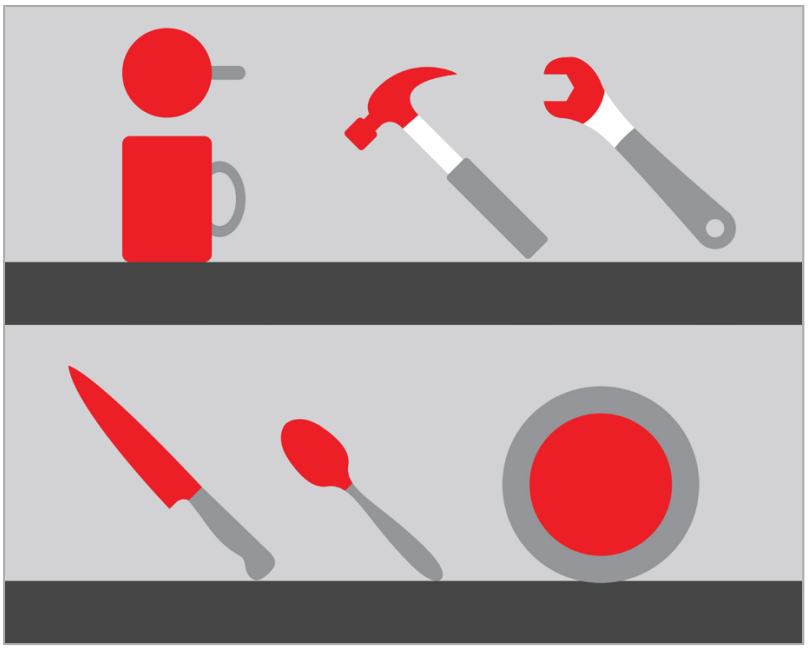

Figure 26: Tools/Cutleries. (Lee, 2012).

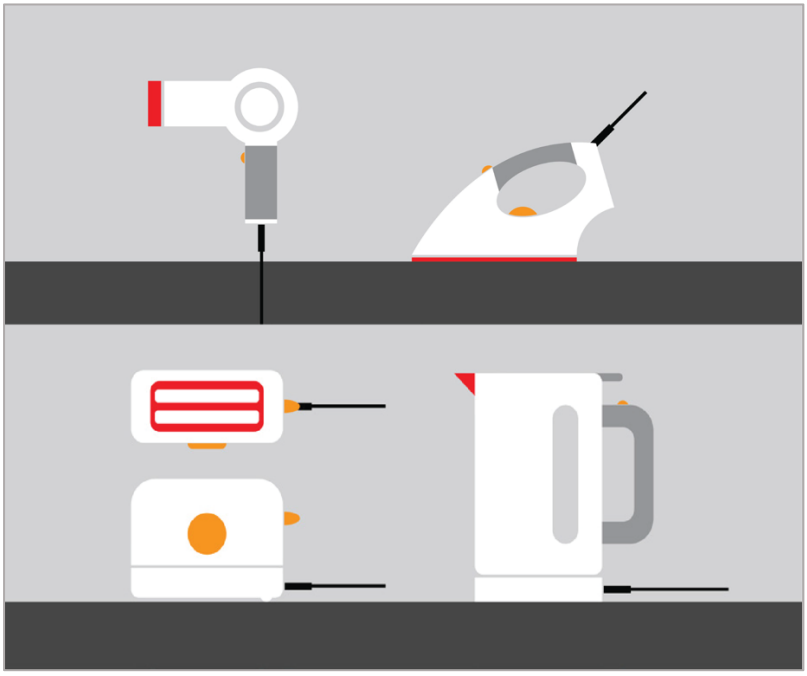

Figure 27: Electronic home appliances. (Lee, 2012).

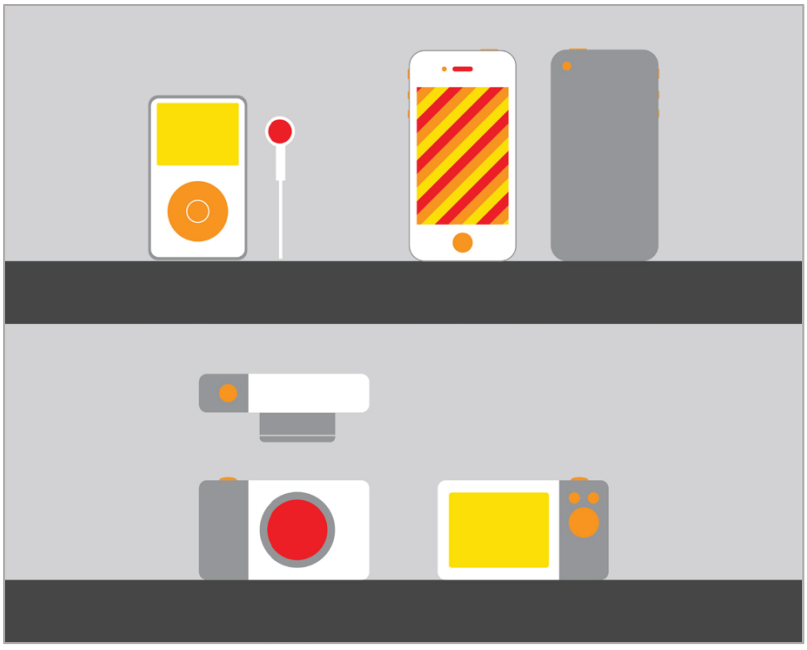

Figure 28: Electronic gadgets. (Lee, 2012).

Figure 29: Computer devices. (Lee, 2012).

These icons highlight the areas on the product that serves a purpose or function that the user interacts with. The colors highlight the areas that are different, for example, the category tools call out the handle where the user holds it, and the blade of the knife or the hammer-head that serves the function. This process is the basis for how Lee uses archetypes within the design process. Lee has several case studies in his paper that use this icon system, we will look at one of those studies to see how this approach works.

Lee first conducts research about the product in question, this case study attempts to redesign a Wi-Fi router by using applied archetypes (Lee, 2012, p. 24). The research included looking at existing Wi-Fi routers. Lee (2012) found two different categories, the kind with external antennas (figure 30), and those with internal antennas. It was noticed by Lee (2012) that the internal antenna routers were harder to recognize and thus attempted to make their function and purpose more recognizable through applied archetypes (p. 24). Because Wi-Fi signals are

invisible and sent through the air, and because the product could not rely on the antenna to communicate meaning due to it being internal, Lee had to devise a different archetype that would communicate the same function. Lee (2012) found the Wi-Fi icon used on computers and cellular devices to be the most recognizable archetype for this purpose (p. 25)

Figure 30: External Antenna Wi-Fi Routers. (Lee, 2012).

Lee (2012) then uses a process named “Iconize design process” where the archetype used is transformed into a simple icon and then incorporated into the design of the product (p. 26-27). This begins like the same process used for the categorization of product archetypes mentioned earlier, however, in this specific example, the archetype used was already an icon. Lee (2012) then uses the icon to develop the product and thus the archetype in transposed into its form (Figures 31-34) (p. 26-27).

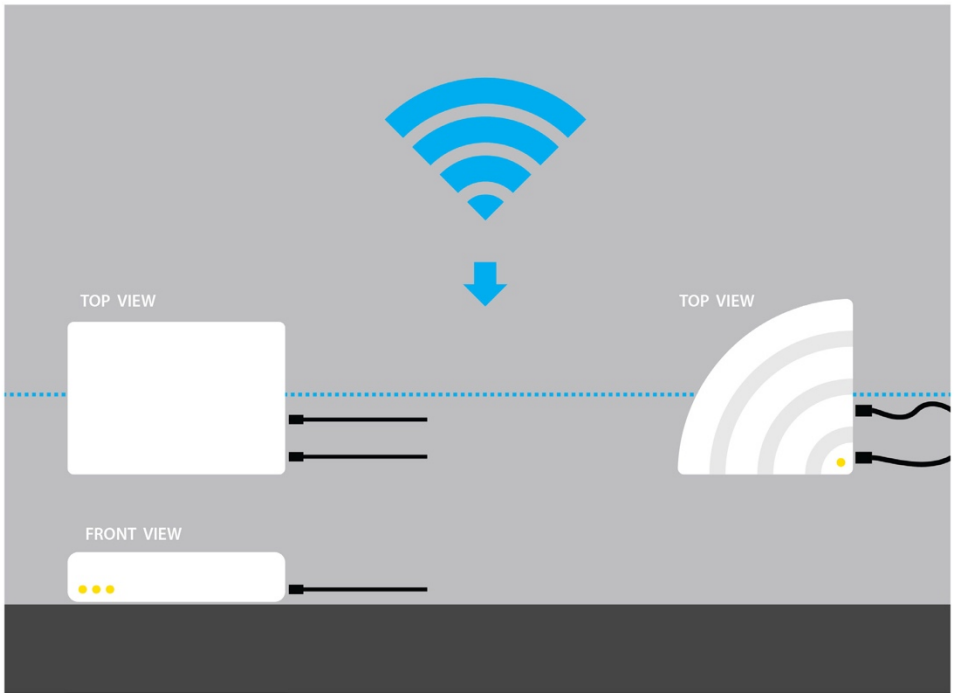

Figure 31: Iconize Design Process (Lee, 2012).

Figure 32: Wi-Fi Router – Top View (Lee, 2012).

Figure 33: Wi-fi Router – Perspective View (Lee, 2012).

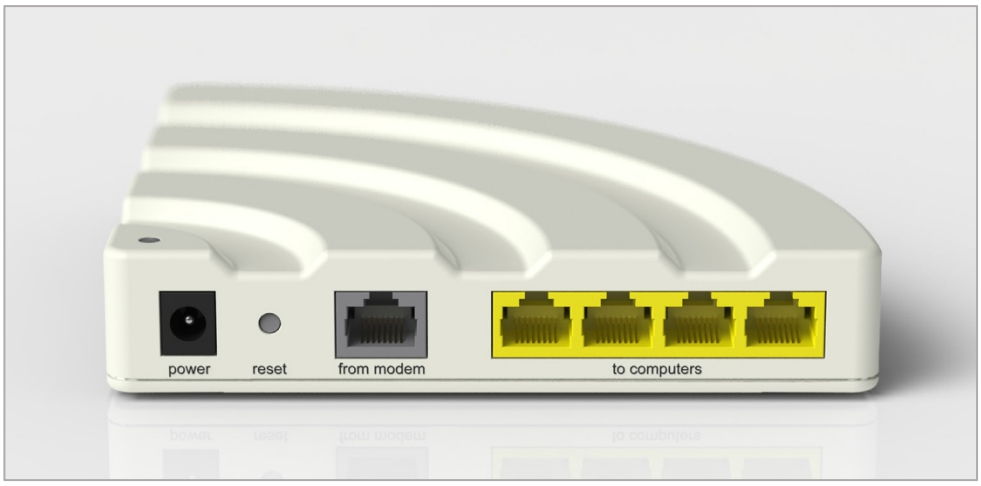

Figure 34: Wi-fi Router – Side View (Lee, 2012).

This iconize design process can be an effective tool to utilize product archetypes within the design process. While archetypes are an important concept and explain why we recognize the new as familiar, it is useless within the realm of product design unless they can be applied effectively. This process is a useful design tool that should be implemented in product semantics and links the current concept with an effective means of design application.

Maintaining trust.

Maintaining trust is a concept that Elaver (2012) discusses which relates to archetypes. Elaver (2012) states that there are two limiting factors to design innovation (p. 4). The first factor is that new things are never actually new, meaning that everything created is just a modification of something that already exists (Elaver, 2012, p. 4). For example, a 2017 Ferrari is just a byproduct of all of the years of car designs dating back to the Ford Model T, and the Model T was just a new form of transportation that evolved from the horse and buggy. The second limiting factor is that human beings are suspicious of anything unusual Elaver, 2012, p. 4). Elaver (2012) gives the example of a computer mouse and how users are accustomed to how it works, looks and feels (p. 4). He then states, "Any significant deviation from such a learned archetype will be viewed with skepticism, and it will require the user to recalibrate their interaction and expectations of the product (in form and function), as well as to build a new relationship with the product (emotion)" (Elaver, 2012, p. 4). It is important to note that Elaver distinguishes between the products form and function archetype as well as its emotional archetype. Humans are not only accustomed to how a product typically looks and functions, but also how we connect emotionally with the archetype. This emotional connection refers to how the product connects on a personal and cultural level. Often products are used because we feel it fits our own persona, that is, how we view ourselves and how well the traits of a certain product match up to that view. For example, a gold wristwatch, to some, may mean elegance, wealth, and class, while others may view the gold finish as gaudy, tacky, and unnecessary. Elaver (2012) says that there are two channels of communication which the designer must be aware of, internal and external (p. 5). Internal refers to how we view ourselves and external refers to how one views others. It is the designer's job to consider these and balance them to create desirable products that don't alienate the user. These two limiting factors of archetypes are what

constitutes trust between a user and the product. By paying attention to these two factors during the design process, designers can create products which remain understandable, relatable, and desirable to the user. This concept of maintaining trust is partially responsible for how humans form emotional relationships with an inanimate object (Elaver, 2012, p. 4).

2.12 Affordances

A paper from 2006, titled 'Applications of affordance and semantics in product design', states that it "aims to clarify the concept and elucidate the role of affordances in the interaction design for physical products by making a parallel comparison to product semantics." (You & Chen, 2006, p. 23) Though Affordance is often mentioned as a concept within the realm of product semantics, the paper argues that affordances and product semantics should be viewed as separate theories and that their purposes are different.

The history of affordance is explained in the paper. The term Affordance was first created by James Gibson in 1966 as part of his direct perception theory (You & Chen, 2006, p. 23). The term referred to the connection between an organism and its environment. (You & Chen, 2006, p. 24). You & Chen (2006) explain what the concept of affordance is: "if an object has a ridged, level, flat, and extended surface, and if it is about knee-high to the human observer, then it affords sitting-on" and "If there is optical information of the five properties, and if the information is detected, then the affordance of sit-ability can be perceived (p. 24). Unlike traditional psychological theory, which requires mental thought for meaning to be understood, Gibson's theory states that meaning is inherent in the system dynamic between organisms and their environment, in other words, the mental calculation is not required (You & Chen, 2006, p. 24). You and Chen (2006) explain that in design "…affordances are regarded as the potentiality of products that can support user action without requiring users' memory, inference, and further

interpretation" (p. 25). This statement places affordances as communicative properties of products that are realized and understood subconsciously, and without thought or mental calculation. You & Chen (2006) further elaborate that the concept is appealing to designers because it shifts focus away for user thought to user action (p. 25).

The concept affordance was actually introduced to the design world by Donald Norman's book *The Psychology of Everyday Things* rather than by Gibson (You & Chen, 2006, p. 26). You and Chen (2006) explain that Norman's understanding of affordances was far different from Gibson's ideas (p. 26). More precisely, Norman didn't retain Gibson's notion that affordances do not require mental thought, instead, he suggested that the perception of affordances in products occurred through mental interpretation and are based on previous experiences (You & Chen, 2006, p. 26). You & Chen (2006) point out that Norman's view of affordance has been accepted extensively by design society without regard to Gibson's view (p. 26). Krippendorff furthered this adoption when much of his thoughts on product semantics, with reference to affordance, focused on communicating meaning through "…cognitive models and perceivable features…" and focusing "on high-level cognitive processing in mind but not perceptual-motor level interactions." (You & Chen, 2006, p. 27). One of the main points within You & Chen's (2006) paper, is that the currently adopted definition of affordance should revert back to Gibson's view, and designers should use the new psychological viewpoint when designing products.

You & Chen (2006) call for affordances to be viewed as potential actions without a need for cognitive awareness, however, they further suggest that the concept of affordance should be separate from product semantics (p. 28). Specifically, "…affordances in product design are not meant to convey information for communication purpose, but are the groundwork for the necessary behavior in achieving a product's function." (You & Chen, 2006, p. 28). While the viewpoint of this paper largely aligns with You & Chen's ideas, it does not agree with the

separation of affordances from product semantics. While the concept of affordance might exist as a subconscious phenomenon, it is the position of this paper that it should remain in the field of product semantics. While affordance might not be communicative with regard to deep thinking or making sense of something, it is still a form of communication. Because designers can add or subtract affordances in products, communicative aspects, perhaps not directly related to deep thought, exist and therefore very much fit into the product semantic philosophy. Product semantics has evolved since its creation to encompass a large range of concepts that all share a common goal, to communicate or clarify meaning in products. While affordances might not be realized through cognitive reasoning, there is still information processing going on when a person senses an affordance within a product. Because of this fact, designers can control and communicate meaning through affordances much like any other product semantic concept. Therefore, this paper will include the concept of affordances, and explain its role in product semantics, within its proposed guidelines in chapter three.

2.13 The Challenge of Product Semantic

Evans and Sommerville (2007) wrote a paper, presented at an international engineering and product design education conference in the UK, which discusses an approach for "deconstructing product semantics" with the aim of improving its effectiveness in design education (p. 1). This is important because our paper has a similar aim, which is a simplification and organization of product semantics for improving design application.

Key concepts.

The paper summarizes key concepts for the application of product semantics, some of which have been discussed already in this paper. However, these summaries help clarify both, a

holistic view of what product semantics is, and individual concepts of product semantics. The first concept is *making sense.* We make sense of an object when we understand what it does in a specific context or situation (Evans & Sommerville, 2007, p. 2). Also, when we know why it's there, how we use it, and what it does, it makes sense to us (Evans & Sommerville, 2007, p. 2). The next concept is *meaning*. The meaning of something is the possible contexts in which a person can imagine it makes sense to them. (Evans & Sommerville, 2007, p. 2). Furthermore, meanings are specific to individuals and asking people what something is, usually creates a lot of different responses or meanings (Evans & Sommerville, 2007, p. 2). The third concept is *categories*. Humans view products as having a typical type, something that is expected or the norm with regard to the kind of product it is (Evans & Sommerville, 2007, p. 2). For instance, our idea of what a toaster is, what it does, what it looks like, are all combined into the category toaster and when we see an object that has some of those characteristics, we understand the object to be; a toaster. The ideal type is the sum of those characteristics and we call that ideal type an *archetype*. The next concept is called *interfaces*. People interact with objects by interfacing with them (Evans & Sommerville, 2007, p. 2). *Interfaces* are not only the controls on an object or just thoughts in a person's mind, they are the interaction between the two (Evans & Sommerville, 2007, p. 2). Designers are responsible for creating products that motivate human interaction with them (Evans & Sommerville, 2007, p. 2). Another concept mentioned is *affordances*. A car can allow us transportation, safety, exploration, the ability to sit inside, the ability to show off socially, the ability to accomplish a lot of errands. All of these examples and many more are affordances that objects can have. When designers align specific affordances with the intended function of a product the product will work better and become easier to operate (Evans & Sommerville, 2007, p. 2). *Motivation* is another concept discussed. Evans & Sommerville (2007) explain that people choose products that are relatable, easy to use, and

understandable (p. 2). There are two types of motivation that drive users to use or buy particular products (Evans & Sommerville, 2007, p. 2). *Extrinsic motivation* is a goal-centric motivation where we see an ability to accomplish something, reach it, and expect a reward or an escape from punishment in return (Evans & Sommerville, 2007, p. 2). *Intrinsic motivation* is an enjoyment in action itself, which is the pleasure of participation or the fun we have while doing something. (Evans & Sommerville, 2007, p. 2). The last concept mentioned is called *cognitive models*. Evans & Sommerville (2007) say these are the complex creation of meanings within mental thought (p. 2).

A selection of product semantic approaches.

Evans and Sommerville present an approach for product semantics within design education in their paper. This approach presents a selection of concepts and rules for application that also lends itself as a useful tool for designers. The following selection explains those design tools presented by Evans and Sommerville in their paper.

Signifiers.

Evans and Sommerville (2007) explain that *signifiers* are placed within objects by designers and they are both made and realized by the users of them (p. 3). The sense they make to users are the meanings that are conveyed by those signifiers (Evans & Sommerville, 2007, p. 3). Signifiers help users understand, recognize, and use products more easily. Organizing product semantics this way aids designers in implementing it in their own designs. The following paragraph discusses different types of signifiers and what they are.

Character Traits are signifiers that aid in an object's appearance, which are presented as adjectives "…fast, modern, expensive, high-tech…" or styles "…Bauhaus or Memphis…"

(Evans & Sommerville, 2007, p. 3). Evans and Sommerville (2007) state that putting these traits together create the overall expression of a product, which can align it to certain groups of users, classify it within a specific category, or serve as an outlet for judgments by its users (p. 3). It's important to mention that character traits do not communicate the function of artifacts or how to interface with them (Evans & Sommerville, 2007, p. 3). *Intrinsic Motivators* "invite users to attend to, observe, touch, listen to, play with them" (Evans & Sommerville, 2007, p. 3). Evans and Sommerville (2007) explain that these aspects of the product demand attention though lights, interesting shapes, or other aspects that draw the interest of users (p. 3). *Identifiers* are aspects of a product that communicates to the user what the product is, and these identifiers usually stem from archetypes (Evans & Sommerville, 2007, p. 4). Evans and Sommerville (2007) say *Distinguishers* separate aspects of a product by different meanings that express specific qualities (p. 4). Examples include what a person should and should not hold like the handle on a frying pan, or a disposable part distinguished from a part to keep, like on a surgical instrument (Evans & Sommerville, 2007, p. 4). *Expressives* are aspects of a product that express an ability to do something and also enable users to anticipate how to move forward. Evans and Sommerville (2007) give examples such as "…flexible, breakable, moveable, adjustable, untouchable, recyclable, disposable… …lightweight, fragile" (p. 4). Notice that these qualities are adjectives which could also contribute to an object's character traits, however, expressives are different from character traits because they communicate the function of the product to the user. *Pointers* draw user's attention to aspects of a product that are not themselves and "indicate where something came from, leads to, or belongs" (Evans & Sommerville, 2007, p. 4). Examples of pointers include analogies, icons, indices, pictographs, metaphors, and symbols (Evans & Sommerville, 2007, p. 4).

Metaphors.

Designers can use metaphors to incorporate meanings from one experience to the experience of a product. Evans and Sommerville (2007) explain that metaphors are "encouraged by certain visual or linguistic forms" (p. 4). The creation of metaphors can be broken down into three sequential elements. 1. A person must sense a commonality between something in a *source domain* (where the meaning comes from) something in a *target domain* (the product that the meaning is being placed in) (Evans & Sommerville, 2007, p. 4). 2. The meanings within the target domain are organized according to its context from the source domain, which changes a person's perception. (Evans & Sommerville, 2007, p. 4). 3. Meanings from the source domain are then transferred to the target domain and the cognitive connection is made. (Evans & Sommerville, 2007, p. 5).

Semantic dimensions.

Evans and Sommerville (2007) say that semantic dimensions can help define the character of products (p. 5). The first type of semantic dimension is based on polar opposite scales in which the characteristic is rated between the scales (figure 35) (Evans & Sommerville, 2007, p. 5). The second type of semantic dimension is based on a feature scale in which the amount an attribute is present is rated from non-existent to absolute presences (figure 36) (Evans & Sommerville, 2007, p. 5). These scales are design tools which are effective at utilizing semantic qualities within products.

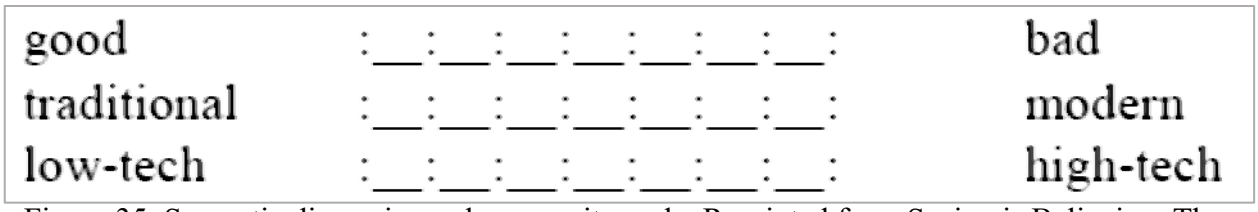

Figure 35: Semantic dimension polar opposite scale. Reprinted from Seeing is Believing: The Challenge of Product Semantics in the Curriculum (Evans & Sommerville, 2007, p. 5).

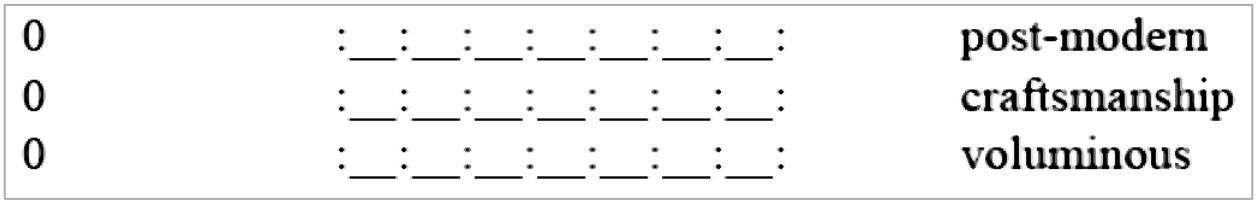

Figure 36: Semantics dimension feature scale. Reprinted from Seeing is Believing: The Challenge of Product Semantics in the Curriculum (Evans & Sommerville, 2007, p. 5).

2.14 Four Pleasures Framework

In the book, *Designing Pleasurable Products: An Introduction to the New Human Factors*, Patrick Jordan explains a new framework for product semantics based on product pleasures. These pleasures are created from the object or product being used or experienced and they are distinguishable by four different attributes. The first pleasure is *physio-pleasure* which is enjoyment received from sensory organs within the human body (Jordan, 2000, p. 13). Jordan (2000) says these include "touch, taste and smell, as well as feelings of sensual pleasure" (p. 13). *Socio-pleasure,* according to Jordan (2000), is the enjoyment gained from personal relationships with people, as well as social groups which can also contain issues such as social status and self-identity (p. 13). The way products can increase our social interaction, and in turn, the pleasure

created by it is how socio-pleasure affects us through product design. *Psycho-pleasures* are concerned with both the pleasure of people's cognitive functions and also their emotional responses (Jordan, 2000, p. 14). Jordan (2000) explains that improving and easing cognitive processes while increasing emotional satisfaction are the main pleasures within psycho-pleasure (p. 14). Finally, Jordan (2000) states that *ideo-pleasure*, is concerned with our personal values (p. 14) How our own values correlate with our perception of certain aspects or characteristics of a product is how products create ideo-pleasures (Jordan, 2000, p. 14).

This framework is the cornerstone of the book and the majority of the writing is focused on examples of pleasures from this framework. The important information from this book is that product semantics can focus on these four pleasures when taking a human-centered design approach. Also, Jordan (2000), explains that this framework should go hand in hand with understanding users holistically (p. 16). This is very similar to Krippendorff's notion of stakeholders, but rather than understanding each individual person's stake in the development of the product, Jordan's idea of holistic understanding focuses on the user and understanding "their hopes, fears, dreams, aspirations, principles and tastes" (Jordan, 2000, p. 59).

2.15 Case Studies

Making an object familiar can make it easier to be understood. Imagine you were born in the 1800's right after Alexander Graham Bell invented the telephone. If you were somehow transported from that point in time to today and someone handed you a smartphone do you think you would be able to easily discern it could serve the same function as the first landline telephone? Of course not, but what about if you grew up in the "flip-phone" era and the same thing happened? Perhaps it would be a much easier transition. Certainly, being familiar with existing technology plays a vital role in understanding an object's function**;** but what other

aspects of an object aids us in understanding its purpose or how it should be used?

Most people understand how to use a door because almost all door knobs rotate clockwise to open. Furthermore, almost all adults in modern society have used one and learned how this operation works. However, if we looked at a more localized and specialized example, such as flight controls on a Boeing 747, few would have the experience to know how to use it or what each control does. The use of product semantics can be very effective in product design, but the level of its effectiveness relies heavily on the user's realm of experiences. Through a handful of case studies, a point will be made that product semantics can focus on user experiences common to most, if not all people that will use and interact with the product. These common experiences can be drawn from the human condition we all share such as a heartbeat, a smile, or a handshake. It may not be immediately apparent how these experiences might be implemented into products or how they might improve the user experience, however, case studies on products that implement this approach will be studied and connections with relevant literature will be made.

Interfaces.

In 2001, while at IDEO, designer Naoto Fukasawa worked with Hitachi, Ltd., Design Division to create a vacuum cleaner prototype. The ABS prototype never reached production, however, the concepts unique interface and Naoto's vision for the vacuum cleaner remained (figure 37). Rather than having a traditional small LED to indicate when the device was full, Naoto opted to make the entire device the interface and have its semitransparent surface gradually glow red as it reached capacity. Fukasawa said, "I had an image of eating and eating until you were full" (Fukasawa, 2014, p. 53). He also stated, "I believe interactive design is designing the expression that comes from an object's entire body" (Fukasawa, 2014, p. 53). The

use of product semantics in this example takes the human experience of eating and getting full and translates it to the product in a symbolic yet abstract way. This interface and the vacuum's communication to the user is immediately and subconsciously clear to the user because it stems from a human experience everyone shares. Fukasawa and the Hitachi design team may not have fully understood this as a reason for implementing this interface into the design, but, whether by happenstance or through a deeper understanding of psychology and product semantics, the genius in its execution is evident.

Figure 37: Hitachi vacuum prototype. Reprinted from Naoto Fukasawa (Fukasawa & Morrison, 2014).

In 2002, Apple filed a patent titled “Breathing Status LED Indicator”. The patent was then featured in Apple’s next line of laptop computers. The feature was based on research of human breathing which averages between 12- 20 breaths per minute at rest. Apple stated that the human respiratory rhythm was “psychologically appealing” and Jonathan Ive and Steve Jobs gave the go ahead with the new interface. (Yun, S. 2011) The new indicator was implemented into laptops to show when the computer was in “Sleep mode”, a state at which the computer’s main functions are turned off but the machine is still on (figure 38) (Yun, S. 2011). This rhythmic breathing light, which may be considered by some a small feature, is a stark contrast to other blinking LED indicators. Apple took a traditional jarring indicator, far removed from humanity, and transformed it into something every human can relate to on an unconscious level. This is a small example of how mimicking aspects of humanity can improve the user experience of a product, by making it emotionally and psychologically relevant to us even if we don’t consciously recognize it.

Figure 38: MacBook sleep mode indicator. (Make, 2017).

Form.

Mimijumi is a new brand of baby bottle that seeks to imitate the female breast for nursing babies and their mothers (figure 39). The company's design philosophy "is based on the psychological dynamics of feeding/soothing items as transitional objects." (Mimijumi, 2011) The entire cap of the baby bottle is made of a flesh-colored, lifelike silicone and is set at an angle to the bottle to better emulate breastfeeding. While traditional baby bottles only mimic the human nipple in their designs, Mimijumi has sought to emulate the entire breast in its design while still remaining tasteful and maintaining the bottle archetype. The form of this bottle communicates its function even clearer than traditional baby bottles most parents are familiar with. While most people can recognize a baby bottle because they have seen or used one, all humans understand a breast as synonymous with nursing because we have all experienced that process in infancy. This novel feature in the Mimijumi bottle clearly communicates its function through product semantics and builds a better transparency between form and function. The product better simulates a very personal human interaction, nursing, and as such produces many emotional and psychological implications that can improve the user experience of the product (figure 40). While this product exemplifies the new area of product semantics discussed in the paper, it goes a step further in the design of its packaging.

Figure 39: Mimijumi bottle. (Mimijumi, 2017).

Figure 40: Mimijumi bottle in use. (Mimijumi, 2017).

Designed in collaboration with illustrator/designer, Dan Stiles, the product packaging for Mimijumi bottles are purposely shaped like a modern milk carton with graphics that feature a milk-like character that personifies happiness, youthfulness, and comfort (figure 41) (Mimijumi, 2011). This package design harmonizes with the product using product semantics to create a clear and communicative user experience, from the purchase of the product through its use.

Figure 41: Mimijumi packaging. (The Die Line, 2017).

In 1937, Isamu Noguchi designed a baby monitor coined the “Radio Nurse” (Victoria and Albert Museum) This early speaker and receiver was commissioned by Zenith Radio Corporation. It is thought to be produced in response to the kidnapping of aviator Charles Lindbergh’s two-year-old son in 1932. The radio itself resembles a nurse in an abstract form (figure 42). Its anthropomorphic nature seems to create an emotional response when you look at it and an argument can be made that the response is calming, nurturing, or simply familiar. This example emphasizes how a product can correlate with a common aspect of humanity while remaining true to itself. The radio doesn’t have eyes, a mouth, or any discernable features, however, its form is familiar to us and can create an emotional connection on a subconscious level. It is not a baby monitor that tries to be like a nurse, but rather, it is a product that causes us to think of one.

Figure 42: Radio nurse. (Flysfo, 2017).

Human imitation.

The previous case studies show the implications of using human imitation in design to make a product more understandable, relatable or emotionally appealing to the user. While it is disappointing that some products today don't feature this human imitation approach, it is also exciting that so many products have the opportunity to improve in this area. Hopefully more industrial designers will see the benefit of applying human imitation, as well as the other product semantics principles previously mentioned, into the design process. After surveying the literature, we will now attempt to convert this information into guidelines than can aid designers in applying product semantics to design.

Chapter 3: Product Semantic Guidelines

3.1 Introduction

As evident in chapter two, there is a lot of information and concepts in the field of product semantics today. The way people understand and see products and their associated meaning has largely been uncovered and certainly, the field has grown substantially since its creation. It is also an unfortunate reality that this information is not widely used within the design profession. Though some products today reflect the use of product semantics, many do not, and the reason for this is most likely its lack of order and limited means of application of its concepts. This chapter will seek to remedy this by organizing product semantics into a clear, understandable format. The objective of this chapter is to create a set of guidelines that will aid both designers and design educators to better understand and use the concepts within product semantics. The main focus of this endeavor will be to reorder concepts and present them in a way that makes sense holistically and framed within the design process. If these concepts have a clearer picture as to where they fit into the design process and how they might be used, the information as a whole will be better suited to design application and its concepts easier to use.

3.2 Organizing Literature

In order to place concepts correctly within the design process, we first must organize the concepts discussed in the literature review from chapter two. To make the organization clear the concepts will be organized based on their relationship to meaning. Meaning is the connection between the understanding of product semantics and its application. Therefore, the ideas within product semantics will be organized into guidelines that aid designers in expressing meaning in products.

Because there are so many concepts in design semantics, it is necessary to simplify and condense down this information. Combining concepts that relate to each other and grouping the information into similar categories should further simplify product semantics. These categories were developed by creating several iterations of mind maps (figure 43, 44, 45), which attempted to organize the concepts from chapter two based on their relationship to meaning and to each other. Mind mapping is a process where words and ideas are organized by their relationship to one another. The following guidelines, which will be presented shortly in chapter 3.3, consist of six categories developed through the mind mapping process.

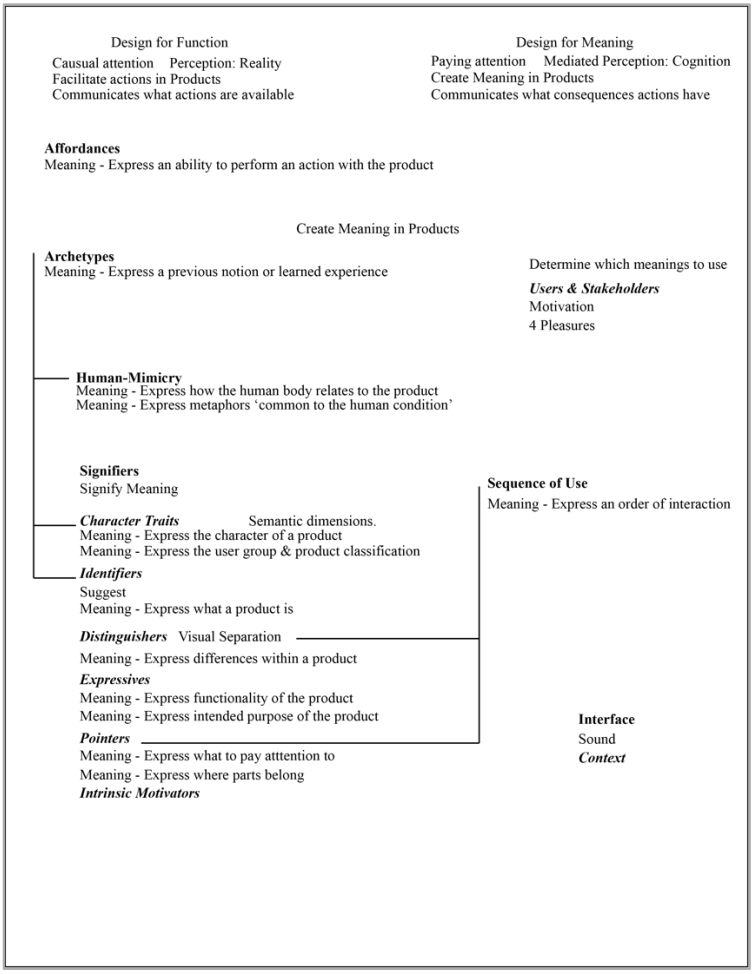

Figure 43: Mind map 1.

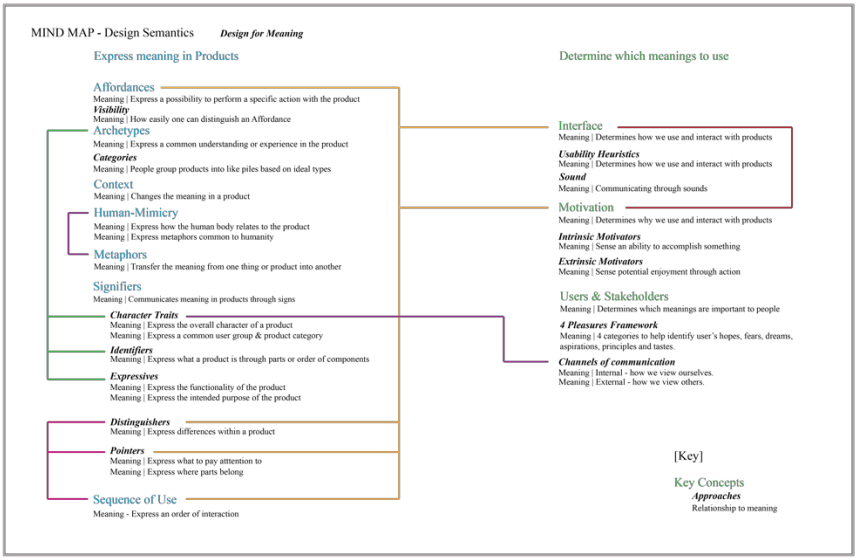

Figure 44: Mind map 2.

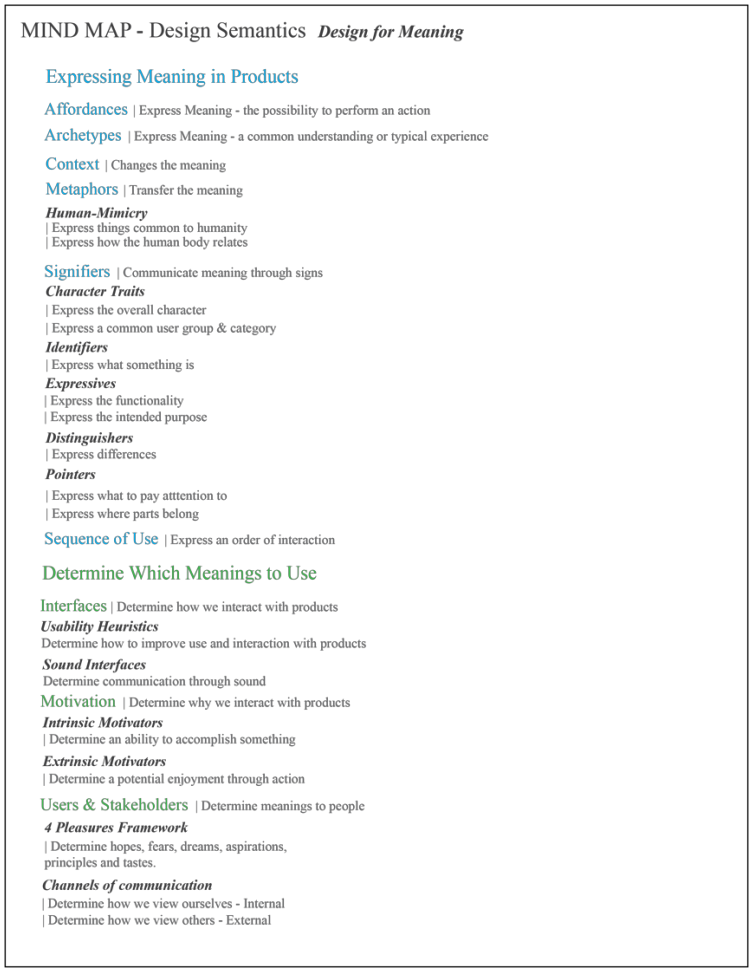

Figure 45: Mind map 3.

Meaning.

As discussed in chapter 2.5 (Meaning, sense, and context.), the first step to human understanding is through meaning. Krippendorff (2006) mentioned, “there is a move to human-centeredness, an acknowledgment that meaning in design matters” (p. 13). As we have seen in chapter 2, meanings can be transferred, re-used, sensed, and they exist in a person’s own understanding. Because of this fact, meaning in products can only be controlled to an extent because what something means to one person may not have the same meaning to another. How do product designers make design decisions based on meaning if this difference of understanding exists? The answer lies in understanding how meaning relates to products and how designers can control and create meaning through product semantic principles. Every concept and idea discussed in chapter two relates to meaning in some way; it is the singular concept that binds product semantics together. The aim of product semantics, which is to create products that are understandable, relatable, and easier to use, cannot be realized without the concept of meaning. Therefore, the concept of meaning is the best tool to organize product semantic principles into guidelines created in this chapter. In the following paragraphs, all of the major product semantic concepts and principles will be organized using meaning as a framework.

3.3 Guidelines

This section will focus on concepts discussed in chapter two that allow designers to express meaning in their products. These concepts will be simplified for clarity and guidelines for their application will be suggested based on how they relate to meaning and their role in industrial and product design.

3.3.1 Affordances.

The concept of affordances has an interesting history as discussed in chapter 2.12. Though the original idea is credited to James Gibson in 1966, the design profession adopted Donald Norman's definition from his book *The Psychology of Everyday Things***.** Both viewed the concept as an explanation for how we see an ability to perform an action with a product, however, Gibson believed to concept to be a subconscious process, while Norman saw it as a cognitive process. This paper will not take a position as to which definition belongs in product semantics, but the idea that products can afford action and those actions can be sensed (cognitively or subconsciously) and acted upon by their user will be a component of these guidelines.

Affordances express meaning in products and are in simple terms abilities. The concept was summarized as abilities that products allow by Evans and Sommerville (2007, pp. 2-3). The full summary can be found in chapter 2.13 (Key concepts.). A product can give us the ability to listen to music, to drive to work, to shine our shoes, or to write a paper. These are all functional affordances, which is an ability to physically accomplish something. Evans and Sommerville (2007) suggested that designers align specific affordances with the intended function of a product in order for the product to work better and become easier to operate (pp. 2-3). It is common in product design to add new functional affordances to existing products, a good example of this is smartphones. What used to be a device that had the affordance to talk to people in other locations now has many affordances, such as using the internet, navigating using GPS maps, and organizing daily life with a calendar or to-do lists. This example also highlights Donald Norman's concept of visibility discussed in chapter 2.7. All of those new affordances added to a cell phone may not be easily apparent, because nothing in the form of the object expresses that those affordances can be acted upon. The *visibility* in this example lies in the

communicative success of icons that express which applications do what. Regardless, smartphones are still widely successful, and what once was new affordances for this device are now expected.

In addition to functional affordances, there are also emotional affordances. The ability to feel useful because we have a product, or the ability to feel accepted or successful in a certain social group because we own a product. These are more intangible affordances that products can have and that designers need to be aware of. As mentioned in chapter 2.10 Donald Norman (2004) has said: "Our attachment is really not to the thing, it is to the relationship, to the meanings and feelings the thing represents" (p. 48). Though emotions are not specifically mentioned in the literature in regard to affordances, they do fit into the concept by association. Because humans often select and use products based on the feelings they provide, those products afford an emotional response. The *visibility* of those emotional affordances may not be apparent, and perhaps it exists completely subconsciously. However, designers need to be aware that those relationships exist. If designers can facilitate positive emotional affordances, products can become more useful, enjoyable, and desirable.

To summarize, affordances express meaning in products by representing the possibility to perform an action or the presence of an ability. These can be either functional or emotional affordances. Affordances are sensed based on their *visibility,* which is how easily distinguishable that affordance is detected by looking at the product's form or through using the product. Products can have affordances that designers may not have intended, as discussed in *Chapter 2.5 (Meaning in artifacts.*) the example of a chair being used as a step stool or using it for drying clothing. While it is improbable that designers can anticipate all affordances a product can have, they do have the ability to control affordances with their design decisions as well as improve the visibility of the intended affordances.

Based on reviewed literature, the concept of affordance is not given specific methods for its application in product design. However, one can create guidelines for affordances based on other concepts that relate, specifically*, users* & *stakeholders, context, and visibility.* Also, the two types of affordances will be used: *functional* and *emotional*. Users and stakeholders were both explained in chapter two (See chapter 2.14 Four Pleasures Framework and chapter 2.5 Stakeholders.). The four pleasures framework featured Jordan's idea of holistic understanding of the user and understanding "their hopes, fears, dreams, aspirations, principles and tastes" (Jordan, 2000, p. 59). Krippendorff's writing on stakeholders extended the idea of product users to include anyone who had an interest in the product or anyone who would be affected by its creation. These could be people often overlooked in the design for product users such as, people who recycle the product, or people who sell the product. Therefore, it is important to consider questioning all of these people during large design projects.

In order to align affordances with user and stakeholder desires one must first understand those desires. Krippendorff (2006) explained that the meanings of others, and how others sense things, cannot be understood without asking them open-ended questions and carefully considering their answers (p. 55). By adding people's desires to a product, meaning can be added in the form of those desired affordances to the product. Those products then have meaning specific to the people using them. The sensed potential to perform an action or use an ability of a product now aligns with the people using them.

The common design practice of constraints will be added such as making decisions based on project requirements (e.g. budgets, time, manufacturing, etc.). This will serve as a means to create real products that can actually be manufactured and sold. For these guidelines to be effective, they must fit into existing design processes and follow real world principles. The following are guidelines for using affordances in product design. See figure 46.

- Collect user & stakeholder feedback to develop a list of affordances that have specific meaning to them. See chapter 3 (*Users & Stakeholders.*).
- List functional & emotional affordances that align within the context of the product. See chapter 2.5 (*Context.*). Guidelines for different types of context are in chapter 3.3.4.
- Select affordances to use or not use based on the design constraints of the project. Examples can be found in figure 46.
- Identify and improve the visibility of the selected affordances. See chapter 2.7 (Communication through Form)

AFFORDANCES | Abilities of products

Guidelines

I. Align with user and stakeholder desires

Ask about opinions and desires from user & stakeholders.

Example: Q. What do you want to do with the product?
Q. What kind of feelings or emotions would you like to have while using the product?

II. Align with context of the product

List functional & emotional affordances based on the context of the product.

Example: functional affordances = transportability, durability.
Example: emotional affordances = the feeling of adventure, or exploration.
These examples align with the context of camping or hiking.

III. Select/modify based on design constraints

Choose affordances based on the constraints of the project.

Examples: Budget, time, manufacturing, marketability, etc...

IV. Improve visibility in the product

Identify and increase the visibility of the affordance in the product.

Example: the ability to turn on the product.
In this example, the "on" button or switch would be the visibility.
You could increase the visibility by making the switch stand out,
adding graphics to the button that says "on", or using archetypes or
metaphors for buttons, switches or the word "on".

Types of affordances

a. Functional:

E.e. collapsability, portability, timekeeping- ability, open-ability, etc.

b. Emotional:

E.g. ability to feel safe, adventurous, successful, smart, socially included, etc.

Figure 46: Guidelines for Affordances.

3.3.2 Archetypes.

Another type of meaning that products can have are archetypes. As discussed in chapter 2.11 an archetype is a common understanding or typical experience humans have based on past experience. Product archetypes evolve based on one's experience with similar products or product categories. For example, rotary telephones used to sit on a desk and had a speaker and microphone attached by a coiled wire and could dial a telephone number by rotating a circular dial with numeric symbols. That became the archetype of the time and though there were many different brands of telephones they all had the same general form and components. With the advancement of technology that archetype has changed dramatically. Today landline phones have been largely phased out and in many areas of the world, wireless cell phones are the norm. If you asked a young person today to draw a phone, it would most likely resemble a flat rectangle with a few buttons. This is not to say they do not know what a landline phone is, but it is what they have become accustomed to and likely use on a daily basis.

Archetypes can be a great tool for product designers because it allows them to create products that make sense to the user. Archetypes can help create products that have a clear purpose, function, and interaction with their users. As discussed in chapter 2.5 (Human-centered design methods.) Krippendorff uses the concept of archetypes in two of his design methods, the reformation of characters or traits of objects, and informing users of a product's identity and function. Both methods included aligning the product with an archetype, but neither method went into much detail or suggested how to accomplish this task. As discussed in chapter 2.11 (Applying archetypes.) a master's thesis project published in 2012 by Jungha Lee featured a

system of applying archetypes in the design process. The process used Krippendorff's idea of aligning products with archetypes but gave a clear and organized way to accomplish the task in product design. Lee's process for applying archetypes in the design process will be explained and outlined below as a component of the product semantic guidelines for applying archetypes. The following are guidelines for applying archetypes. See figure 47.

- Identify the type of archetype that will be used based on the meaning that needs to be expressed. For examples of types of archetypes see chapter 2.11 (Applying archetypes.)
- Use Lee's "Iconize design process" (Lee, 2012, p. 26-27)

ARCHETYPES | Common understanding or experience

Guidelines

I. Identify the type of archetype to use

II. Utilize the iconize design process

Types of archetypes

a. The form of similar products

Emulates the overall character of other products, which results in the new product's function and purpose being easier to recognize

b. Functional aspects of products

Emulates interactions that people are accustomed to by using commonly understood mechanisms, interfaces, or parts from other objects.

Iconize design process

Step 1. Develop a graphical icon

The icon should be simple in nature and reflect the aspects of the selected archetype that are crucial to its understanding. I.e. if using the archetype of a stapler, only omit aspects that do not aid in its identification as a stapler, such as branding, colors, texture, styling, etc.

Step 2. Use the icon as a blueprint

Incorporate the icon into the product's form, or other elements of the product. The success of the result relies on how well the specific meaning is transferred and represented.

Step 3. Test the result

Check to make sure the meaning of the archetype makes sense in the context of new product. This can be accomplished by asking product users what they think about it, what it means to them, and if they make the same connection that was intended.

Figure 47: Guidelines for Archetypes.

3.3.3 Metaphors.

Metaphors transfer meaning from one thing to another. In relation to products, metaphors simply take a specific meaning and make it realized in a new product. Metaphors in product design are a form of archetypes because they are an experience re-presented and experienced again by the product's user. There is almost no limit as to what kind of meanings can be placed in products through metaphors, but it's important to make sure those specific meanings fit the context of the new product. For example, applying the metaphor of "flight" to a cd player wouldn't fit the product's context. One could add wings to its form, make it appear aerodynamic, or even make it resemble an airplane or jet, but these metaphors wouldn't fit the context of what a cd player does or how it is used. This idea, of a product lying about what it is, was illustrated in Krippendorff and Butter's *four semantic infelicities* in chapter 2.3 (four semantic infelicities in design.). Therefore, selecting metaphors and aligning them with the purpose and identity of the product should be an important step in the process of adding metaphors.

In chapter 2.5 (Human-centered design methods.) we looked at a method proposed by Krippendorff for the creation of new or novel products. The first step of that method was to collect applicable metaphors by talking to clients, experts in tech-centered disciplines, and other people for their own ideas (Krippendorff, 2006, pp. 248-251). This is a good way to select metaphors for new products because, as discussed in chapter 2.5 *"*In perception, meaning arises in the awareness of the *possibility of different ways of seeing"* (Krippendorff, 2006, p. 52). Being able to understand other people's views and ideas enables designers to find new meanings to use as metaphors in products. Because designers are responsible for aligning metaphors to the context of a product, it is important for designers to not rely exclusively on their own understanding, but on what things mean to others as well.

In chapter 2.13 (*Metaphors.*) it was shown that Evans and Sommerville broke the

creation of metaphors down into three sequential elements. The first step was that a person senses a commonality between something in a source domain (where the meaning comes from) and something in a target domain (the product that the meaning is being placed in) (Evans & Sommerville, 2007, p. 4). The next step is the meanings in the target domain are organized according to its context from the source domain (changing the person's perception) (Evans & Sommerville, 2007, p. 4). The last step is meanings from the source domain are then transferred to the target domain and the cognitive connection is made (Evans & Sommerville, 2007, p. 5). This can be simplified and summarized as: a designer (or person) senses a commonality between a product that they are designing and something else, the designer (or person) organizes the meaning of something else within the product, and then the cognitive connection is made, and the meaning can be understood in the new product.

While the process of creating metaphors is sound, it is hard to suggest how to specifically incorporate different meanings using metaphors. Because so many meanings exist and because there are so many different ways metaphors can be used in products it would be impossible to suggest a clear order or specific steps to accomplish this. It is essentially the nature of creativity that is needed to sense commonalities between things in order to use metaphors in products. It can be suggested, however, that metaphors be used correctly based on the literature cited as well as suggestions as to what kind of metaphors might be applicable. The guidelines for using metaphors in product design are outlined below. See figure 48 for explanations.

- Collect applicable metaphors (Krippendorff, 2006, pp. 248-251)
- Align the metaphor with the context of the product. See Chapter 3.2 (Context.) Guidelines for different types of context are in chapter 3.3.4.
- Sense commonalties between things and the type of meaning you want to express See chapter 3.3 (Signifiers.) for different types of meaning in products

- Look at examples of other products that use metaphors to create new ideas. See chapter 2.11 (Applying archetypes.) and chapter 2.15 (Case Studies) for examples.
- Use Lee's Iconize Design Process to apply metaphors. See chapter 3.2 (Archetypes.)
- Use metaphors that express things common to humanity or how the human body relates to the product. See chapter 2.15 (Case Studies) for examples.

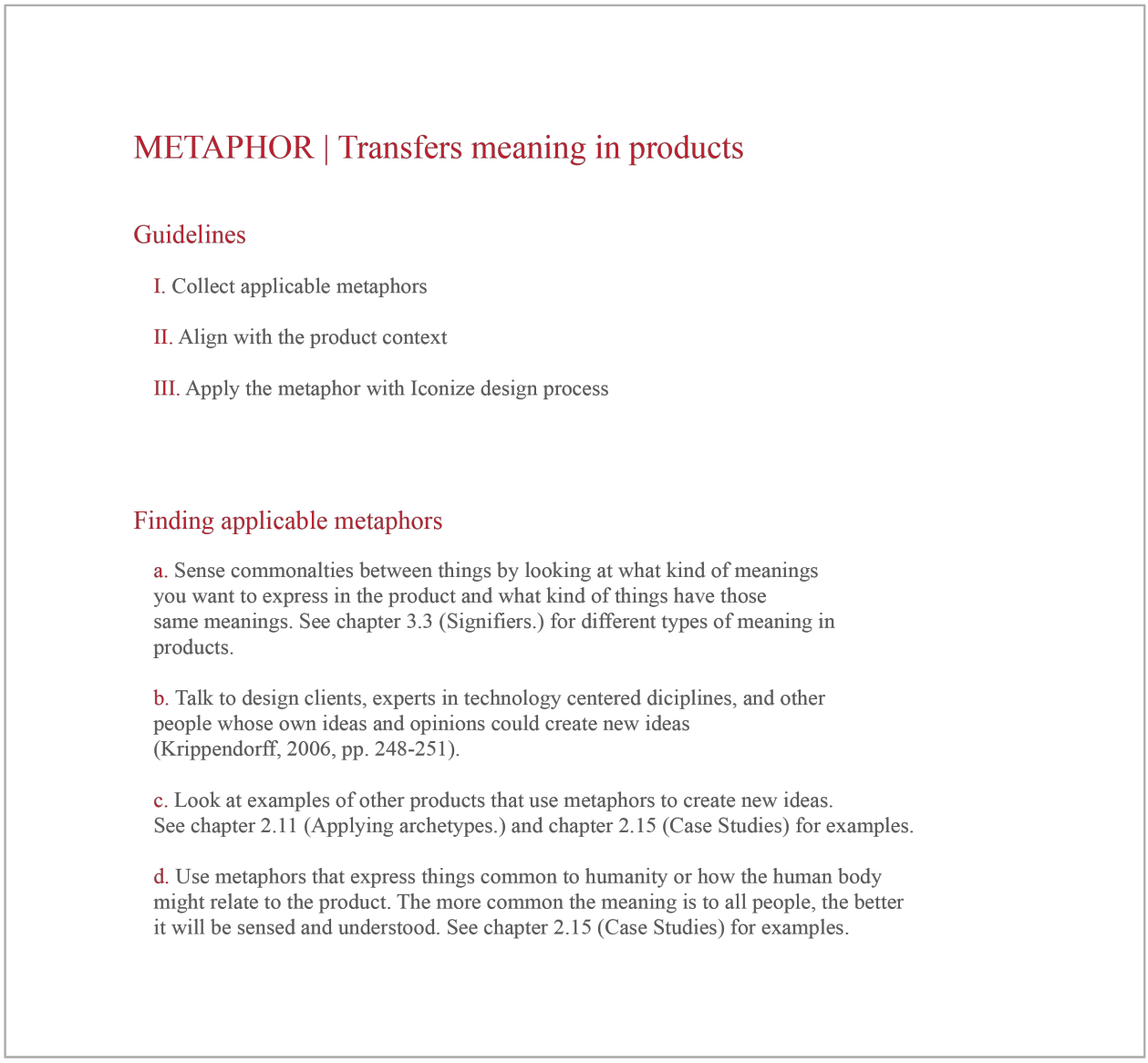

Figure 48: Guidelines for Metaphors.

3.3.4 Context.

The context of a product changes the meanings associated with it. Krippendorff explained this concept using a term he coined: *semantic contradictions* (in previous writing he referred to this as *semantic infelicities*). These semantic contradictions illustrate how context and products relate. The contradictions, which are lying relationships between a product and its context, are used to show the influence of product context. By showing the absurdity of products without context we can better realize its importance. Krippendorff and Butter (1984) discussed four types of semantic contradictions: products that are unable to be recognized by their user, products that are unable to be manipulated in ideal ways, the prevention of a user's ability to learn through the use of a product, and a products inability to work within its own context or symbolic environment (p. 6). See chapter 2.3 (Four semantic infelicities in design.) for examples. Krippendorff (2006) explains that products do what their context permits and gives the example of a dictionary including multiple meanings of a word which is useless without a context (p. 59). He further explains that context of products behave the same way, though they are physical (Krippendorff, 2006, p. 59).

If meaning in products are multiples much like words and if they are understood differently based on their context, how do designers ensure that the intended meanings are the ones being communicated? There are unfortunately not many suggestions on how to accomplish this in the literature. As mentioned in chapter 2.5 (Human-centered design methods.) Krippendorff uses context in one of his methods for informing users of a product's identity and function. In step three of the method he suggests exploring the context of use of the product to define limitations or requirements and gives examples such as a vacuum cleaner needing to fit

into small spaces or a humidifier's appearance complementing the décor of a room (Krippendorff, 2006, pp. 242-244). In step five of the method he suggests testing how easy it is to understand the product's context (in addition to testing other aspect of the product) (Krippendorff, 2006, pp. 242-244). These suggestions can be summarized as defining needs based on context and testing its effectiveness. These guidelines are important, but they don't take into account the type of context products can have which Krippendorff and Butter illustrated through *semantic contradictions*.

It appears obvious that guidelines for designing products using context should incorporate Krippendorff's methods discussed in the previous paragraph, but with the addition of the types of context products can have. The inverse of Krippendorff and Butter's four semantic contradictions will be used to develop four types of context. This will then be incorporated with the summary of Krippendorff's methods for context, which is defining needs and then testing its effectiveness. The following are guidelines for using context in product design.

- Define potential features of the product by context type,
- Take the potential features and select and incorporate them into the design of the product, or not, based on the design constraints of the project,
- Test the validity of the product within its own *context* (See figure 49).

CONTEXT | Transforms meaning in products

Guidelines

I. Define potential needs by context type
Make a list of all potential features the product could have for each context type.

II. Select features based on design constraints
Take the product features developed in each context type and select and incorporate them into the design of the product based on design constraints.
E.g. budget, time, manufacturing, marketability, etc...

III. Test validity of product
Test the validity of the product within its own context.
E.g. target users and stakeholder feedback, focus groups, questionnaires, interviews, product testing, small production trial runs, etc…

Product context types

a. Features that aid users in recognizing the *function* and *purpose* of the product

b. Features that aid the user in *interaction* and *operation* of the product

c. Features that encourage *use* and *learning* with the product

d. Features that enable the product to work in its own *social*, *technological*, or other relavent context

Examples of product context by type

a. *Function*: Does the feature allow the user to see that the product can record video?
Purpose: Does the feature enable the user to recognize that the product is a toaster?

b. *Interaction*: Does the feature allow users to see how much battery life remains?
Operation: Does the feature allow users to slide a switch down with minimal force?

c. *Use*: Does the feature make users want to hold or turn on the product?
Learning: Does the feature make users curious about whether the product can fold or collapse?).

d. *Social*: Does the feature enable the product to work in the context of a busy American family or consumers that live in rural Africa?
Technological: Does the feature enable the product to work in the extreme temperature climate of Dubai, or in an office in London that uses European wall outlets?

Figure 49: Guidelines for Context.

3.3.5. Signifiers.

Signifiers communicate meaning through signs. In chapter 2.13 (*Signifiers.*) we reviewed a piece of literature by Evans and Sommerville. Evans and Sommerville (2007) explain that signifiers are placed within objects by designers and that the sense they make to users are the meanings that are conveyed by them (p. 3). Signifiers are used as a system to organize the different types of meanings products can have. By studying and understanding this system, designers can better communicate meaning in products. Signifiers have the potential to be an excellent design tool in product semantics because it categorizes the types of meaning a product can have. If designers understand where they can add meaning in products, they can then effectively use product semantic guidelines to add meaning in products (See Affordances. Archetypes. Context. and Metaphors. in chapter 3.3 for information on how to add meaning to products.) For the purpose of creating product semantic guidelines, Evans and Sommerville's organization of signifiers are listed below with examples of each type of signifier.

Character traits.

Character traits express the overall character of an object. They make up the appearance of a product and can be used to align the product with a person's values or with a common group or product category (Evans & Sommerville, 2007, p. 3). Evans and Sommerville (2007) explain that character traits are presented as adjectives "…fast, modern, expensive, high-tech…" or styles "…Bauhaus or Memphis…" (p. 3). In linguistics, an adjective is a descriptive word. In adjective character traits, the object visually expresses the description. These adjective character traits look like the associated word, such as *smooth*, or *sturdy*, or *cheap*. A good example of this would be Lamborghini's Aventador supercar which effectively utilized the character trait "fast" (figure 50). Styles can be described as expressing a visual theme. A good example of this would be

streamlining, a popular style in the mid-twentieth century, known for its visual absence of edges (figure 51).

Figure 50: Aventador by Lamborghini (AutomobileMag, 2018).

Figure 51: Airflow fan by Robert Heller (Penccil, n.d.).

In character traits, these adjectives and styles have meaning. For a basic example, if a car looks “expensive” then that might carry a specific meaning to a certain person or even a group of people. If a group of people value or undervalue “modern” character traits, that will affect their emotional or cognitive reaction to the product based on what “modern” means to them. Character traits is a type of meaning in products which aligns the appearance of an object with a specific meaning.

Semantic dimensions.

Semantic dimensions are two methods that can be used to measure the presence and intensity of character traits within the form of a product. These methods are tests in which a person rates the presence or intensity of the character trait by looking at the product and rating the magnitude of the specific trait on a low to high scale e.g. 1-5, or 0-10, etc. As discussed in chapter 2.13 (*Semantic dimensions.*) these methods are performed by rating the character trait on a specific scale. While it may be obvious, it is important to note that these methods are subjective, as one person might rate the presence of a character trait differently than another person. A suggestion to overcome this would be to conduct multiple tests with different people in order to achieve a more accurate measurement of the specific trait.

The first type of *semantic dimension* is called a *feature scale* (See figure 10 in chapter 2.13 *Semantic dimensions.*). This scale rates the presence of a specific trait in a product. The feature scale is linear and starts at zero. This method rates the specific trait in a product from non-existent (zero), to absolutely present (the highest number on the scale). E.g. a feature scale for “rugged” is made with a scale from 0 to 10. A person looks at the product and then selects 7 on the scale based on their judgement. Based on that test, the product appears to be rugged and is rated as a 7 out of 10 on the feature scale.

The second type of *semantic dimension* is called a *polar opposite scale* (See figure 9 in chapter 2.13 *Semantic dimensions*.). This scale rates the intensity of a specific trait by placing opposite traits on each side of the scale. The polar opposite scale places conflicting traits on each side of the scale. E.g. A polar opposite scale is created with "cheap" on the left side of the scale and "expensive" on the right side of the scale. The scale is made with a range of 1-10. A person looks at the product and then selects 7 on the scale based on their judgement. According to that test, the product appears to be more expensive than cheap.

Semantic dimensions are good design tools for product semantics because they allow the designer to anticipate how a product will be received. Although designers are largely trained in critiquing the form and aesthetics of products, being able to gauge user feedback on the visual aspects of their designs is crucial to developing products that align with their vision and goals.

Identifiers.

As explained in chapter 2.13 (*Signifiers) identifiers* express what something is and are largely a component of archetypes (discussed in chapter 3.3 Archetypes.). Evans & Sommerville (2007) discussed that *identifiers* are aspects of a product that communicate to the user what a product is, and these identifiers usually stem from archetypes (p. 4). Based on this definition, we can surmise that *identifiers* are the building blocks of archetypes, much like the ones used to create the product icons produced in the iconize design process in chapter 2.11 (Applying archetypes.). E.g. if the archetype of a tea kettle consists of a spout, lid, liquid vessel, and handle, then each of those individual components are *identifiers* in regard to the tea kettle.

Looking back at chapter 2.11 (Applying archetypes.) one will see Lee's process for categorizing product archetypes through icons. While Lee uses this process to create simple icons for his iconize design process, it is also a good illustration of *identifiers*. Looking at the

images of highlighted icons (Figure 52) one will notice that each area highlighted not only has different functions, but they also are mostly *identifiers*. If the handle is removed, the grey area of the hairdryer, or the shape of the main body is changed, the white area of the clothing iron (figure 52), then those products would likely be unrecognizable. Therefore, it is important not to remove important identifiers from a product's archetype. It is also important for the designer to be careful when changing these areas on a new product, or else they risk changing the identifier too much.

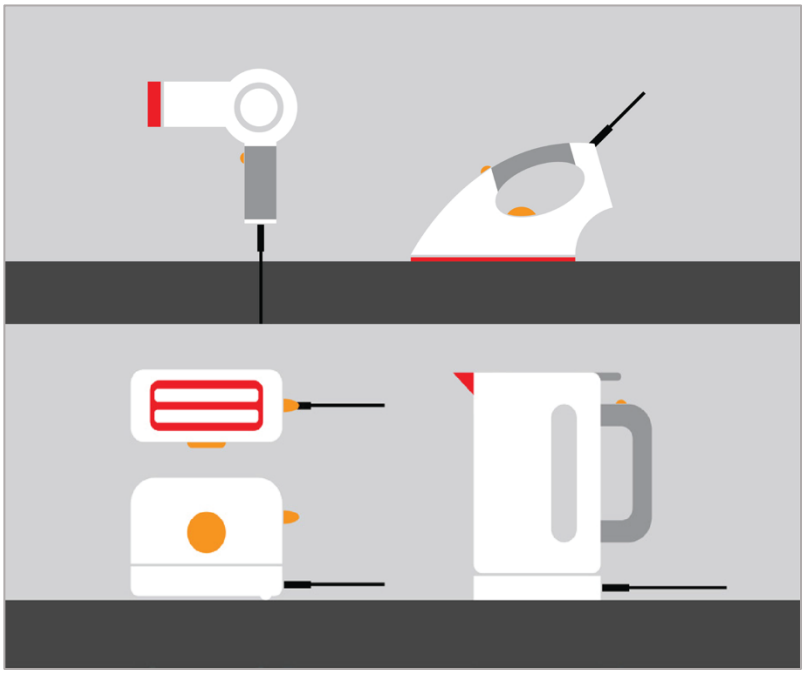

Figure 52: Electronic home appliances. (Lee, 2012).

Expressives.

These signifiers express both the functionality and the intended purpose of the product. As covered in chapter 2.11 (Signifiers.) Evans and Sommerville (2007) gave examples of expressives such as "…flexible, breakable, moveable, adjustable, untouchable, recyclable, disposable… …lightweight, fragile" (p. 4). Notice these examples are either functional abilities, or descriptions of a physical property. Expressives can be added to make a product appear to be what it actually is or look like what it can actually do. One example of using an expressive in a product could be the addition of tick marks added around a knob or dial to express that it is adjustable. Another example could be the use of a bendable looking hose on a vacuum to show that the part can flex. A third example might be designing a knob or lid with a 3D form which appears rotational. This could be used to express that that knob or lid can indeed rotate. The possibilities of expressive in product design are endless. The designer should focus on the intent of the meaning first, i.e. what motion or action should result from the expression.

Distinguishers.

These elements express differences within the product. Evans & Sommerville (2007) gave examples such as what a person should and should not hold like the handle on a frying pan, or a disposable part distinguished from a part to keep, like on a surgical instrument (p. 4). These signifiers are concerned with the meaning of how or why to use a product a certain way. Evans & Sommerville's definition of distinguishers include multiples, a part to keep, a part to dispose of; a part to hold, a part to not hold. From this we can conclude that distinguishers mean a separation of parts or functions. While expressives mean what a part does or does not, Distinguishers mean how or how not to use that part (in relation to other parts). If expressives are potential actions, then distinguishers can be considered potential interactions. While Evans &

Sommerville don't go into specifics other than a few examples, we can assume distinguishers cover a broad range of applications in product design. A simple parting line on a computer mouse could be considered a distinguisher, because it visually separates the button you press from the main body of the product you hold. A less subtle example would be a circular control knob on a stereo. In this example the distinguisher is created by simple adding the knob, the stark contrast in form between the circular shape of a control knob, and the rectangular form of a stereo creates a distinguisher without much help.

Pointers.

These signifiers express what to pay attention to and where parts belong. According to Evan's & Sommerville (2007), pointers draw user attention to aspects of a product that are not themselves and "indicate where something came from, leads to, or belongs" (p. 4). Examples are given including similarities, icons, indices, pictographs, metaphors, and symbols (Evans & Sommerville, 2007, p. 4). This is a very broad signifier according to this definition. Products that have moveable or removable parts have the most obvious examples of pointers. In these examples the form of a part often visually and physically "fits" with another (see figure 53). Another specific example would be a cd player, in which the slot communicates where the cd should go. It is important to not confuse pointers with identifiers. For example, a power button is an identifier and not a pointer. A power button communicates a function and draws user attention to itself. However, if a graphic were to be placed around, or visually leading to the power button, that would be considered a pointer.

Figure 53: 3D Printed Dyson to Shop-Vac Hose Adapter. (Li-Leger, n.d.).

Signifier summary.

In conclusion, the signifiers previously discussed are all aspects of products that carry significant meaning. Through this understanding of signifiers, designers can gain a holistic understanding of product semantics and better manipulate the meanings products can possess. Examples of each of these types of meanings have been discussed, but will be summarized below for reference as part of the product semantic guidelines of this paper (figure 54). In addition to the signifiers listed below, the use of semantic dimension methods just discussed in chapter 3.3 (*semantic dimensions.*) is also included in the signifier guidelines as a way to test and develop character traits in products.

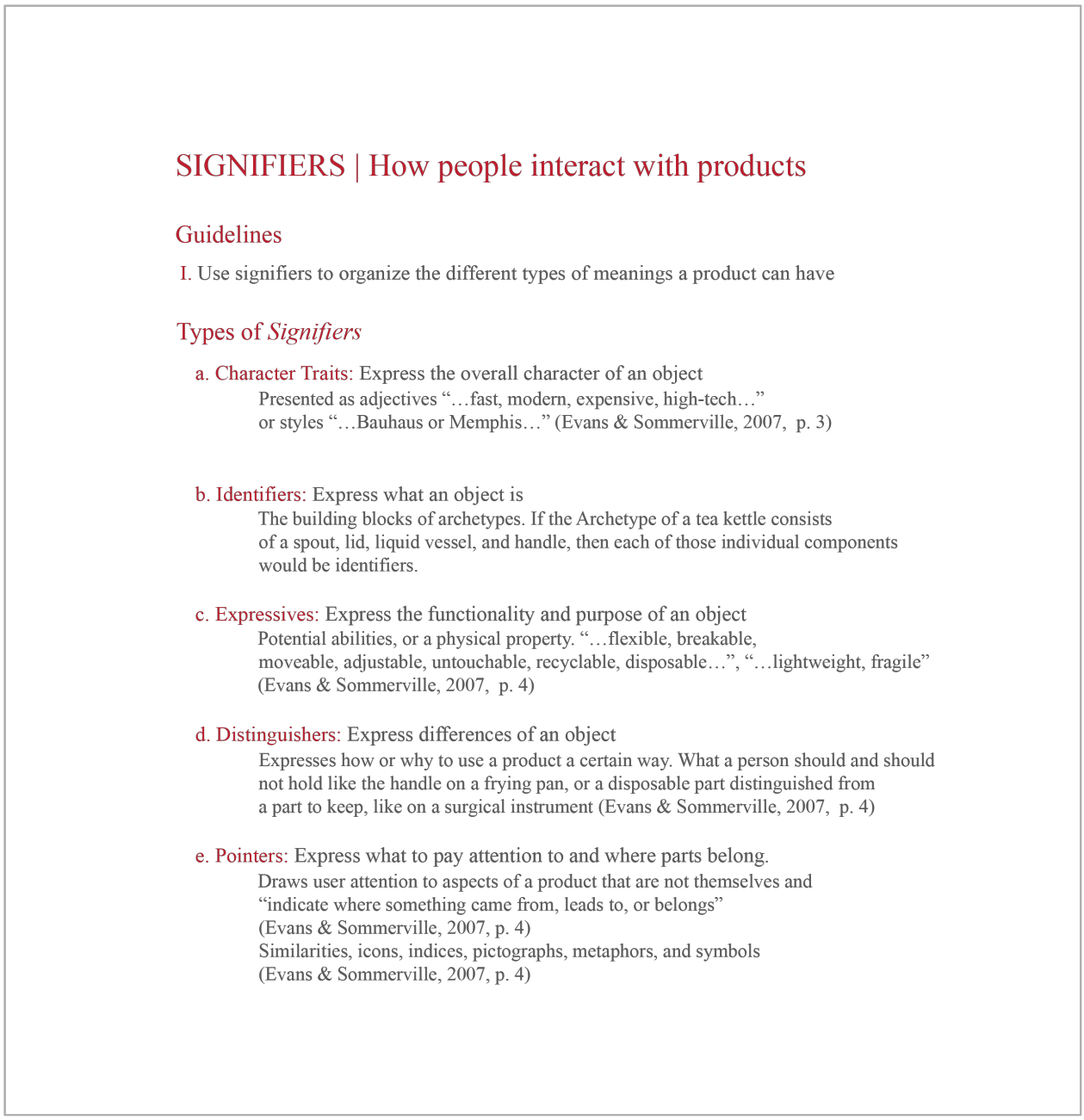

Figure 54: Guidelines for Signifiers.

3.3.6 Interfaces.

Interfaces determine how one interacts with products. As discussed in chapter 2.5 (Interfaces.) Krippendorff's definition of interfaces extends beyond personal computers and

technology and includes any object that humans touch, use, or communicate with (Krippendorff, 2006, p.78). He gives examples of electronic interfaces such as remote controls, aircraft controls, and telephones. (Krippendorff, 2006, p. 80). However, he also lists non-electronic interfaces like scissors, hand cranks, and stools (Krippendorff, 2006, p. 80). Evans & Sommerville (2007) explained the concept of interfaces in their summary of key concepts for the application of product semantics (p. 2). Evans & Sommerville (2007) said people interact with objects by interfacing with them and explained that interfaces are not only the controls on an object or thoughts in a person's mind, but they are the interaction between the two (p. 2). From these two definitions one can conclude that interfaces are both an action and a reaction when using any product. In other words, an interface is not only the action of using a product, but also how one reacts to *feedback* when performing the action.

Feedback is a concept that was discussed in chapter 2.7 (Communication through Form). Don Norman (1988), in his book *The Design of Everyday Things,* mentioned *feedback* as one of four elements necessary for effective communication of a product's functionality (pp.1-33). The four elements are *affordances*, *visibility*, *feedback*, and *mapping*. Elaver (2012) explained Norman's concept with the example of a light switch (p. 2). The example of the light switch, discussed in chapter 2.7, will be revisited for clarity. The *affordance* is the ability to turn a light on and off, the *visibility* is the switch which performs the ability, the *feedback* is seeing the light turn on and off while flipping the switch, and finally *mapping* is understanding the relationship between the switch and the light after receiving the *feedback*. The sequence of events in that example is a product interface if we compare it to Krippendorff and both Evans and Sommerville's definitions. These four elements help break down interfaces into their individual parts. By looking at each part individually we can better understand the interface as a whole, detect weaknesses that limit the interface, or devise ways to improve each area of the interface.

Because of this, we will include Don Norman's concept (four elements necessary for effective communication of a product's functionality) in our interface guidelines as four elements of product interfaces.

Krippendorff mentions a couple guidelines that relate to interfaces in his method for the creation of new or novel products. In step two of the method he says to use *narrative sequencing* which is creating a story about a hypothetical product and then using a scenario in the story (Krippendorff, 2006, pp. 248-251) Krippendorff (2006) suggests that this method could be used to create interfaces (pp. 248-251). In step three of the method, Krippendorff (2006) says to explore technical details that supplement narrative sequencing (pp. 248-251). These details should help support the creation of an interface that could work in real life. These two guidelines can be summarized as, illustrating a potential interface through storytelling, and supporting the probability of the interface working through engineering or manufacturing principles. Both of these guidelines will be included in the semantic guidelines of this paper. The first guideline should help support the creation of a well-illustrated product interface that relates to a user through story telling. The second guideline should help ground the proposed interface in the real-world principles of product design, engineering, and manufacturing requirements.

Usability heuristics.

As mentioned in chapter 2.8 (Usability Heuristics) Jakob Nielsen, is largely considered the father of usability heuristics (Nielsen, 1994, p. 1). Usability heuristic are used in the computer software field to help improve the usability of interfaces. While usability heuristics and this paper share the same goals, the later is concerned with the design of physical products, not software. However, if one takes a close look at the nine heuristics proposed by Nielsen, it can be observed how these might relate to product design and specifically product interfaces. The set of

heuristics focus more on effective communication with the user rather than the specifics of software or web design. It is the position of this paper that if Nielsen's nine rules are placed in the context of product design, then they will still make sense and fit into the field of product semantics. Therefore, Nielsen's nine usability heuristics will be a component of the product semantic guidelines of this paper.

The next step of creating these guidelines will be to look at each of Nielsen's usability heuristics and then attempting to relate them to product design with examples. The following are nine usability heuristics re-listed from Nielsen below

a) Visibility of system status;
b) Match between system and the real world;
c) User control and freedom;
d) Consistency and standards;
e) Error prevention;
f) Recognition rather than recall;
g) Flexibility and efficiency of use;
h) Aesthetic and minimalist design;
i) Help users recognize, diagnose, and recover from errors (Nielsen, 1995, p. 1).

Nielsen (1995) explains that the first heuristic, *visibility of system status*, should inform users about what is going on through feedback and do so in a reasonable time (p. 1). This heuristic already relates to product semantics through the concept of *feedback,* which was discussed in this chapter 3.4 (Interfaces.). One could take this to mean product interfaces should give feedback and do so in a timely manner. While a "reasonable time" is subjective, one could suggest that in product design, a reasonable time would be based on what the interface is and

whether the user needs to know what is going on instantly or causally while using the product. In summary, the product interface should give feedback to the user about what is happening while using the product. In addition, the feedback should be given in a short enough time, relative to the requirements of the interaction.

The second heuristic, *match between system and the real world*, suggests that "the system should speak the user's language, with words, phrases, and concepts familiar to the user" as well as "follow real-world conventions, making information appear in a natural and logical order" (Nielsen, 1995, p. 1). These principles will now be related to industrial design. Speaking a user's language is fairly obvious, at least in regard to familiar words and phrases. For example, products can have words or instructions on them such as graphics and embossed lettering, or electronic devices can speak to users through sound or electronic displays (smart phones or tablets). Whatever the case may be, these words and phrases should be in the native language of its user. Speaking a user's language through familiar concepts may be less apparent. In a product, this could be a functional archetype that the user is likely familiar with, such as the interface of a door where a door knob always rotates clockwise or counter-clockwise (depending on which side it's on) Another example could be a metaphor, like the power symbol on a keyboard key being synonymous with the on/off function. The final suggestion by Nielsen, which is following real-world conventions, is about using well established standards. Examples in product design would be using standard cable formats (e.g. USB, HDMI, etc.) when designing the ports of a laptop computer or designing a suitcase with correct sizing so that it will fit in the standardized overhead bin of an airplane.

User control and freedom, the third heuristic, is explained by Nielsen (1995) as "Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and

redo" (p. 1). While most products don't have the same complex dialogs that software programs typically have, there are products that have an ordered set of interactions or steps associated with their use. For example, most outdoor grills have gas knobs that can adjust the flame intensity for cooking. At the same time, some of those gas knobs can also create a spark to light the gas. If a user accidently bypassed the spark while turning the knob, the grill would just leak gas, thus causing a safety issue. In this known interface, the user can reverse the steps and start over by turning off the gas. In this example, the emergency exit that Nielsen refers to is intuitive, because by turning the knob backwards, it allows the user to exit the unwanted state. We can summarize this in relation to product design as allowing users to exit or reverse an interaction with a product and providing solutions for potential user errors.

The fourth heuristic is called *consistency and standards*. Nielsen (1955) says "Users should not have to wonder whether different words, situations, or actions mean the same thing" (p. 1) In software design this would apply to menus throughout multiple pages of a website, or navigating the user interface of a mobile app. In product design, interfaces are usually much simpler and have less choices when it comes to interaction. However, there are still opportunities to use consistency and standards in product interfaces. One example would be when creating a series of products. Companies that make multiple products in the same product category have elements of their interfaces that need to be consistent or standardized. Logitech for example, is a brand that has many different models of mouse devices and keyboards. While all of these devices look different and have different features, they have areas that feature consistency and standardization. Most of Logitech's wireless devices use a wireless USB dongle, which allows it to interface with a computer or laptop wirelessly. Logitech, across most of their wireless product models, has designed each device with a space to store these dongles in its battery compartment - (figure 55). Because of this standardization and consistency, a person who uses a wireless

Logitech product can expect to always find the needed USB dongle in the same area, regardless of which product they have. This heuristic can be summarized as using consistent design patterns or features, especially when designing a line of products.

Figure 55: USB dongle stored in Logitech mouse. (“Logitech USB Dongle.” n.d.).

The next usability heuristic is *error prevention.* “Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action” (Nielsen, 1995, p. 1) This can be summarized as, interfaces should use interactions that are unlikely to create errors or anticipate the errors and notify the user before they take place. Using interactions that are unlikely to create errors is fairly self-explanatory, products that have simple interfaces are likely less prone to errors. Anticipating

errors and notifying users in product design is often seen in electronic devices. For example, most smartphones today give auditory alerts and display messages notifying the user that the battery is about to die. This is an important heuristic because avoiding errors in product interfaces is crucial to products that are easy and enjoyable to use.

The sixth usability heuristic is *recognition rather than recall*. “Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.” (Nielsen, 1995, p. 1). This can be interpreted, in the context of product design, to mean potential interactions with a product should be self-evident and a sequence of use of the product should be obvious. A product which has a potential interaction that is self-evident could be an easily visible button that says ‘on’ or a simple knob that only rotates clockwise.

The next usability heuristic is *flexibility and efficiency of use*. “Accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.” (Nielsen, 1995, p. 1). This can be summarized for product design as: improve the user interface for expert users, not just novices. While simplified interfaces often help new product users, it is important to also take into account users that will become accustomed to the product and provide quicker or smarter interactions for them as well.

The final usability heuristic is *aesthetic and minimalist design.* “Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.” (Nielsen, 1995, p. 1). This can be summarized for product design as: simplify and limit

competing information. A more simplified interface or streamlined aesthetic can help prevent elements of the product from competing for user attention.

The previous information will be combined into a summary of the product semantic guidelines for interfaces (figure 56).

INTERFACES | Interacting with products

Guidelines

I. Use *narrative sequencing* to help develop the product's interface

Create a story about a fictional product and place the story into a scenario, which should illustrate how a person uses the interface

II. Use *usability heuristics* to improve the user interaction of the interface

A checklist for good usability practices that can be used when developing product interfaces

III. List technical details that support how the interface would work

Can the interface work in real life? Show how it works through engineering criteria, manufacturing details, or other real world principles

IV. List four elements of a product's interface

Areas of a product's interface which creates user understanding
These can be used to understand the interface as a working system. Improving these areas will improve the usabiltiy of the interface

Four elements of product interfaces

1. *Affordance* | The ability of a product (e.g. turning a light on);
2. *Visibility* | Discernability of the action (e.g. seeing the possiblity of flipping a light switch);
3. *Feedback* | Realizing the effect of the action (e.g. user flips the switch and sees the light turn on);
4. *Mapping* | Understanding through feedback (e.g. user understands the switch turns on the light)

Usability heuristics

a. Visibility of system status
   Provide timely feedback to the user, how quick is relative to the requirements of the interaction.

b. Match between system and the real world
   Feedback should be given in the native language of the user.
   Use familiar concepts like commonly understood mechanisms or symbols.
   Use established rules like technology formats or standardized sizing.

c. User control and freedom
   Design for the reversal or exit of an interaction and provide solutions for potential user error.

d. Consistency and standards
   Use consistent design patterns or features, especially when designing a line of products.

e. Error prevention
   Use interactions that are unlikely to create errors or anticipate the errors and notify the user before they take place.

f. Recognition rather than recall
   Potential interactions with a product should be self-evident and the sequence of use of the product should be obvious.

g. Flexibility and efficiency of use
   Improve the user interface for expert users, not just novices

h. Aesthetic and minimalist design
   Simplify and limit competing information

Figure 56: Guidelines for product interfaces.

3.4 Summary.

These guidelines are meant to help designers add meaning to their designs and better communicate the function and purpose of their products. The designer should select from and use the guidelines that are most applicable to the design. It is not suggested that the designer should use every guideline in every design project. Each set of the developed guidelines fit into the development phase of the design process, and as such, should be placed into the process based on the needs of the project. The following is a summary of the product semantic guidelines. Also included is a summary of purpose for each set of guidelines (See figure 57)

SUMMARY OF GUIDELINES

AFFORDANCES | How to add new abilities to products (3.3.1 pg. 79)

- Align them with user and stakeholder desires
- Align them with the context of the product
- Select or modify them based on design constraints
- Improve the *visibility* of them in the product

ARCHETYPES | How to make a product more familar and recognizable (3.3.2 pg. 84)

- Identify which type of archetype to express
  - The form of similar prodicts -
  - Function aspects of products -
- Use the iconize design process
  1. Create an icon
  2. Develop a product based on the icon
  3. Test it - Is the form/function familar?

METAPHORS | How to extract and transfer meaning into a product (3.3.3 pg. 87)

- Collect applicable metaphors
- Align the metaphor with the context of the product
- Apply the metaphor
  - The iconize design process can be used to apply metaphors

CONTEXT | How to design products that make sense in their environment (3.3.4 pg. 90)

- Define features that can improve four key areas of context:
  - Increase recognition of product *function* or *purpose*
  - Improve product *interaction* or *operation*
  - Encourage product *use* or *learning*
  - Enable product to work in its own *social* or *technological* context
- Select/Modify the features based on design constraints
- Test the validity of the product in its own context

SIGNIFIERS | Different meanings in a product that can be expressed through form (3.3.5 pg. 93)

- Use signifiers in products to express certain meanings
  - Character traits | Express the overall character of an object
  - Identifiers | Express what the product is (The building blocks of archetypes)
  - Expressivers | Express the functionality and the intended purpose of the product
  - Distinguishers | Express the differences within the product
  - Pointers | Express what a user should pay attention to or where parts belong

INTERFACES | How to create or improve a product's user interface (3.3.6 pg. 101)

- Use *narrative sequencing* to help develop the product's interface
- Use *usability heuristics* to improve user interaction of the interface
- List technical details that support how the interface might work
- List four essential elements of a product's interface:
  affordances, visibility, feedback, mapping.

Figure 57: Summary of guidelines.

Chapter 4: Design Project

4.1 Introduction

The goal of this chapter is to conduct a design project which uses the guidelines developed in chapter 3. The chapter will illustrate how these guidelines can be used in a design process to apply product semantic principles and embed meaning in a product. All design projects have different needs and goals. It is the designer's responsibility to organize and layout the design process in order to accomplish those goals. The guidelines used in this project are not intended as a substitute for a complete design process. They are also not meant as a complete design methodology. Each guideline is intended as an individual design tool. Each of these tools can be selected based on their purpose and then placed into the design process. All of these guidelines have a different purpose, but they are all intended as a way to embed meaning in products. We will now look at the design project which should explain how these guidelines can be used in a design process.

4.2 Design Project

For this project we chose to design an electric pencil sharpener. This specific product was chosen because it is believed that it will serve as a good example for the product semantic guidelines. Electric pencil sharpeners are commonly rectangular or circular shaped objects, with a flat base, a sharpening hole for the pencil, and a power cord or battery compartment. Electric pencil sharpeners are mostly automatic, meaning the user places a pencil into the device, and then the product sharpens the pencil. This differs from other pencil sharpeners where the user manually turns the pencil in the device. This product should serve as a good canvas for adding meaning to the product.

There are six sets of guidelines developed in chapter three. Affordances, archetypes, signifiers, context, interfaces, and metaphors. In this project we will take a look at each guideline and attempt to illustrate how they can be used in the process of designing an electric pencil sharpener. Some of the guidelines, such as signifiers and interfaces, contain many options. For example, signifiers are a collection of different meanings which can be expressed through a product's form. Also, guidelines for interfaces include usability heuristics which are a collection of good practices that can help improve a product's user interface. In these instances, we will not utilize every single option, but instead we shall select some of them to use in order to illustrate the process of applying them.

4.2.1 Adding affordances.

Affordances, in simple terms, are sensed abilities a product can have. We discussed and developed guidelines for this concept in the previous chapter (see chapter 3.3 Affordances.). In summary, people sense the potential to use these abilities by looking at the product, holding them, and using them. These abilities can include the physical means to do something, as well as the emotional ability to feel a certain way. Affordances by themselves are not semantic principles, but when they are aligned with user desires and with the product's context, they create meaning to the individuals who use them. In chapter three we developed guidelines for applying affordances in products. Those guidelines combined a concept from psychology with a human-centered design approach. In our design project we used those guidelines to help design our pencil sharper. That process is outlined below.

First, we aligned affordances with user and stakeholder desires. To accomplish this, questions and answers were made up for this project, in order to show the process a designer might use to collect affordances from people. By asking people what a product could mean to

them we can ascertain their desires. The affordances in the answers that were created were then highlighted (figure 58). Finally, we extracted the highlighted information and summarized it as a potential list of functional and emotional affordances (figure 59).

Q. What do you want to be able to do with the pencil sharpener?
A: I would like to sharpen different types of pencils with soft of hard lead without breaking. Maybe be easy to move from place to place wherever i'm working.
I like things on my desk to look well together, so maybe a color/shape that goes with other things i keep out all of the time.

Q: What kind of feelings or emotions would you like to have while using the product?
A: Would like to feel efficient, that my work will look professional and sharp.

Q. What do you want to be able to do with the pencil sharpener?
A: I would want it to be discreet and compact. Lightweight but sturdy.

Q: What kind of feelings or emotions would you like to have while using the product?
A: I would want it to be satisfying and reliable

Q: What do you want to be able to do with the pencil sharpener?
A: Sharpen a dull pencil and not weaken the lead tip.

Q: What kind of feelings or emotions would you like to have while using the product?
A: While using the sharpener, I would like to have a feeling of satisfaction from shaving a perfectly sharp point.

Q: What do you want to be able to do with the pencil sharpener?
A: Be able to easily sharpen the pencil while holding the sharpener.
I don't want to have something that is sitting or attached to a desk.

Q: What kind of feelings or emotions would you like to have while using the product?
I want a satisfied feeling when I remove the pencil and find it sharp.
Also want a useful feeling while sharpening like there is some feedback telling you the pencil is getting sharper.

Figure 58: Example for questions and answers.

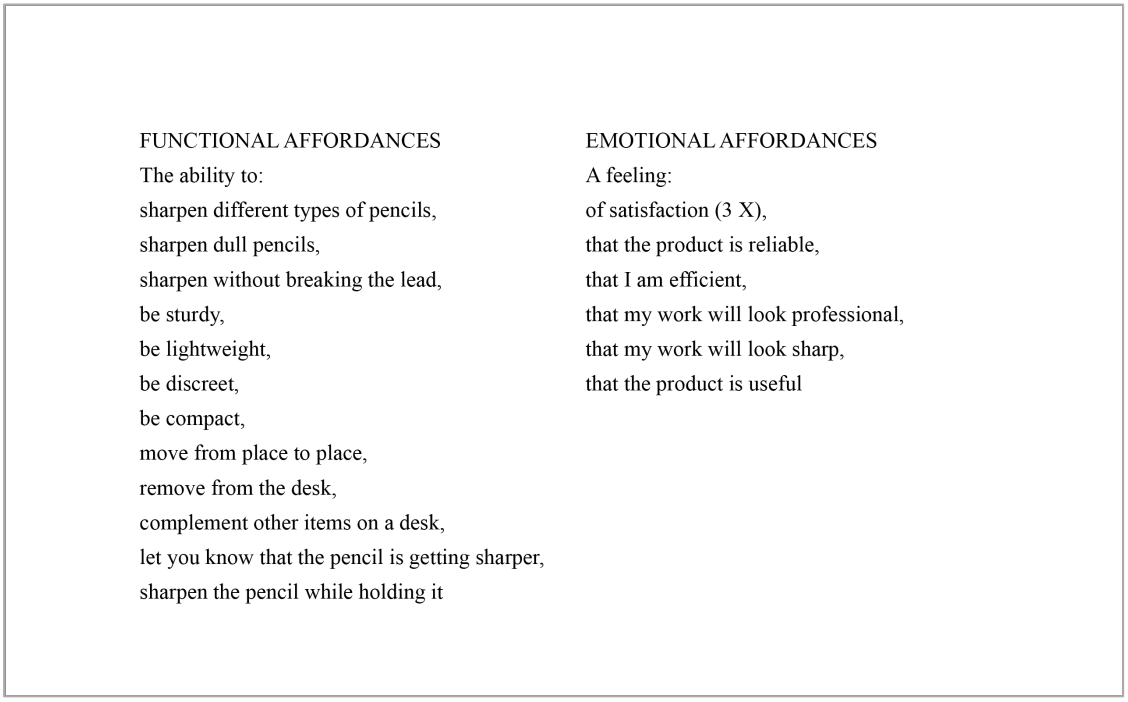

Figure 59: Summary of user and stakeholder desires.

Next, we aligned the affordances with the context of the product. To do this, we looked at the physical and social environment the product will be in during its use. A pencil sharpener will most commonly be found in an office or school setting. The social context of a pencil sharpener will likely include things such as work, stress, deadlines, peer collaboration, schedules, etc. We developed a list of affordances that could be useful or fit into those types of environments. We organized this list as both functional and emotional affordances just like we did with user and stakeholder desires (figure 60, figure 61).

FUNCTIONAL AFFORDANCES

The ability to:

sharpen a pencil
refill an ink pen
perform spellchecks
perform research
sit on a desk or flat surface
remove pencil shavings
clean a desk
look appealing in an office environment
keep it recharged (rechargable battery, replacable batteries, or power cord)
move the sharpener around
store unused pencils or pens with it
use as a stapler
use as a highlighter
use as a mistake corrector
use as an eraser
make scans or copies of a document
light up a work area
tell you when the pencil is sharpened
fix a broken pencil
clean a pair of glasses
clean a computer screen
notify you of an email or text message
notify you of an important due date
talk to a coworker
schedule a meeting
use as a calculator
mark mistakes red on a test
stamp a document with an address
store postage stamps
provide health reminders to take a break
keep track of timed work periods

Figure 60: List of functional affordances.

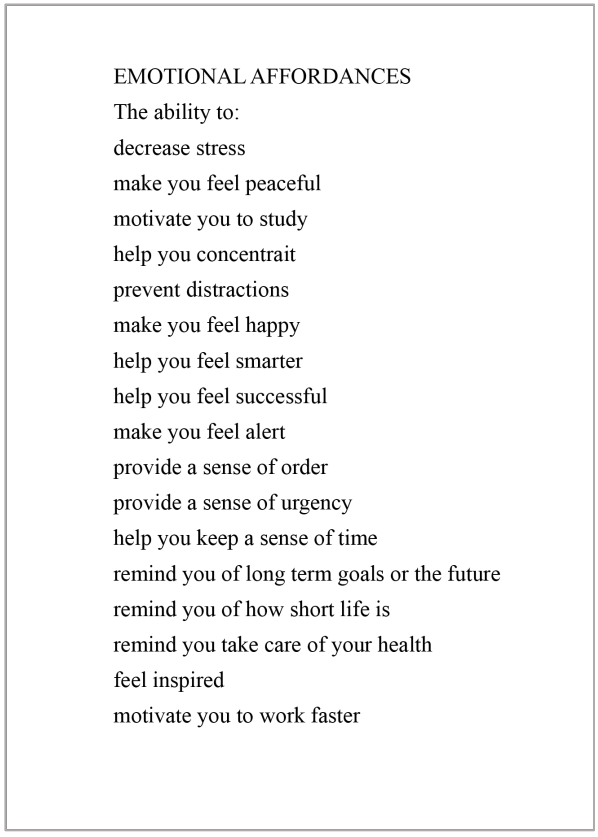

Figure 61: List of emotional affordances.

One way to choose from the lists of proposed affordances is to do so based on the design constraints of the project. Design constraints are often outlined in a brief before a project and are defined limitations used to control the process. While this product is not actually being designed through a real business chain, we can give some examples of typical design constraints in order to illustrate the process. Some common design constraints often seen in product design include the estimated cost of manufacturing the product, the deadline of a project, the complexity of the design, or the return on its investment. This is one way to narrow down a long list of affordances. In an actual project you may have the time and resources to compare every affordance to a set list of constraints. For example, you could estimate the cost or return on investment of each affordance in actual dollars and then eliminate affordances above a certain price point. For our

project we chose to select affordances based on how well they matched the context of the product. Below is the list of affordances we selected for this project (figure 62)

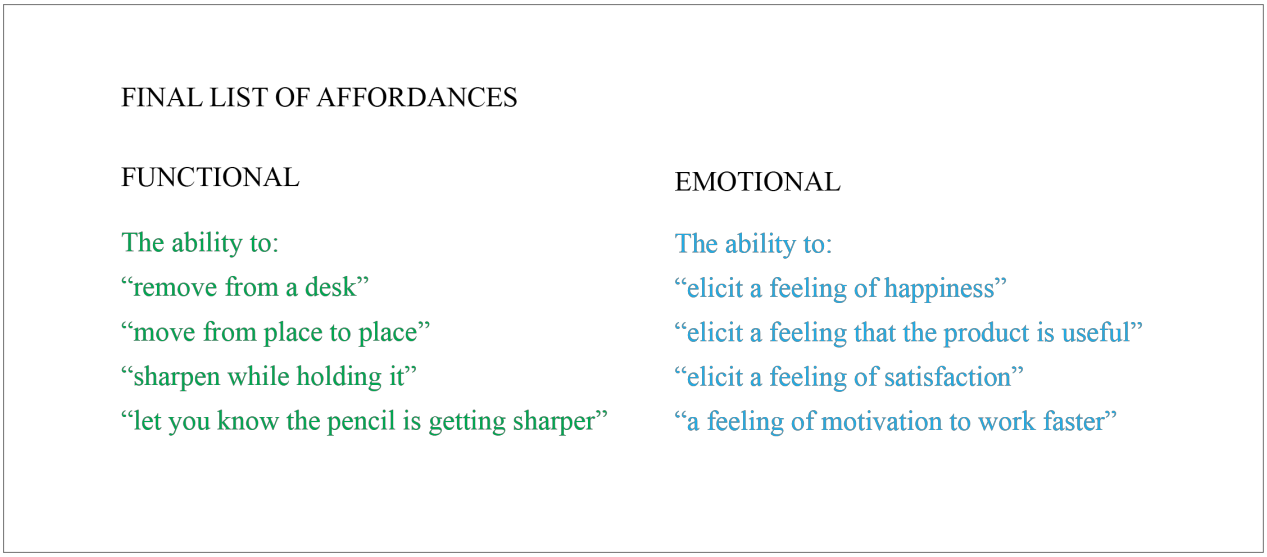

Figure 62: List of selected affordances.

Once choices have been made and the designer has a set list of affordances, they can then decide how to incorporate them into the design of the product. This can be accomplished in many ways. Developing ideas through sketching, brainstorming sessions, or looking at similar products, etc. In addition, some of the guidelines in this paper could be used. For example, if you wanted to add the emotional affordance of "an ability to feel that the product is fast" you could accomplish this by using 'fast' as a character trait (character traits will be discussed later in the project). In our project, we chose to use sketching in order to develop ideas on how to use the list of affordances (figures 63, 64).

Figure 63: Sketching development of functional affordances.

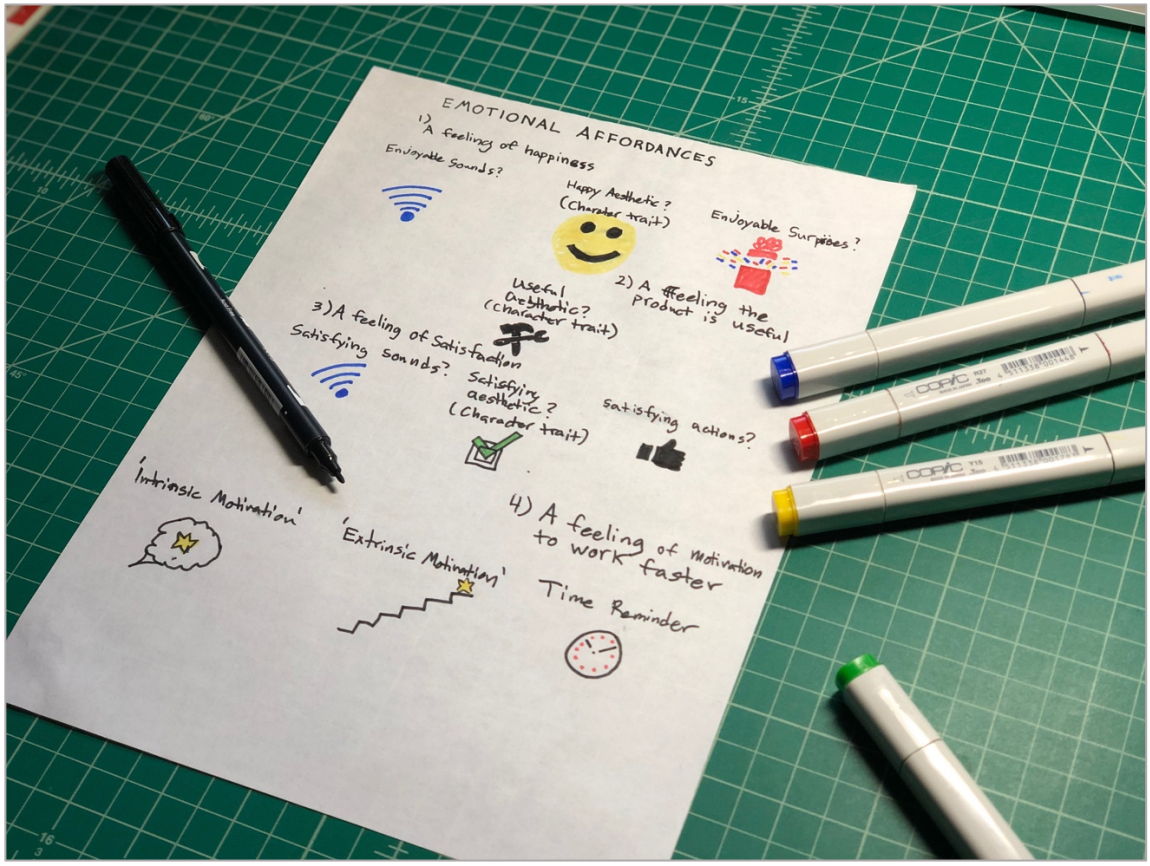

Figure 64: Sketching development of emotional affordances.

Finally, we attempted to improve the visibility of the affordances in our product. Visibility is how easily the potential action to use the affordance can be sensed. Visibility can be improved by making the action more physically visible, or by making the action more mentally apparent. In our project we developed ways to improve the visibility of several affordances from our final list. First, we thought of ways to improve the visibility of each affordance (figure 65). These ideas were left as broad categories in order to use them easily in development. For example, one of the affordances was “be able to sharpen a pencil while holding the device”, one of the ideas for the visibility of this was “it looks enjoyable or fun to hold”. This process was

conducted through brainstorming ideas and writing them down. After this, we used sketching to develop the ideas for visibility within the pencil sharpener (figure 66).

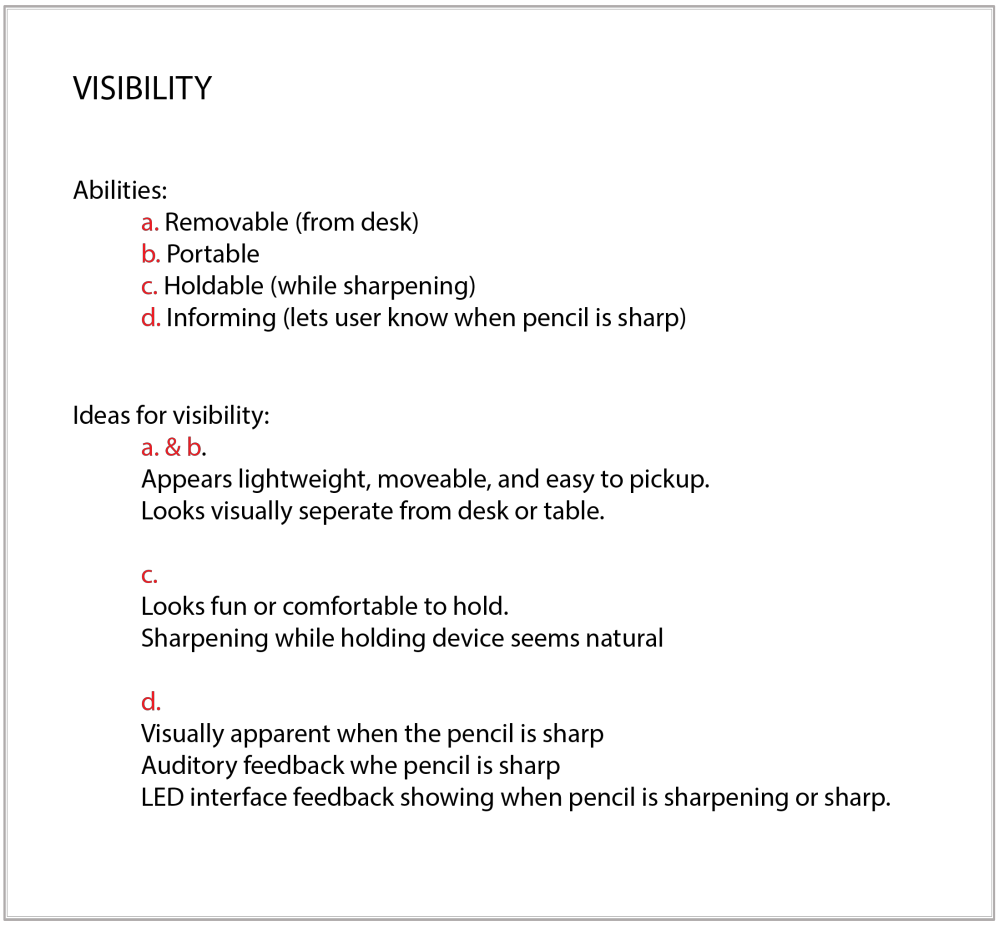

Figure 65: Ideas for visibility.

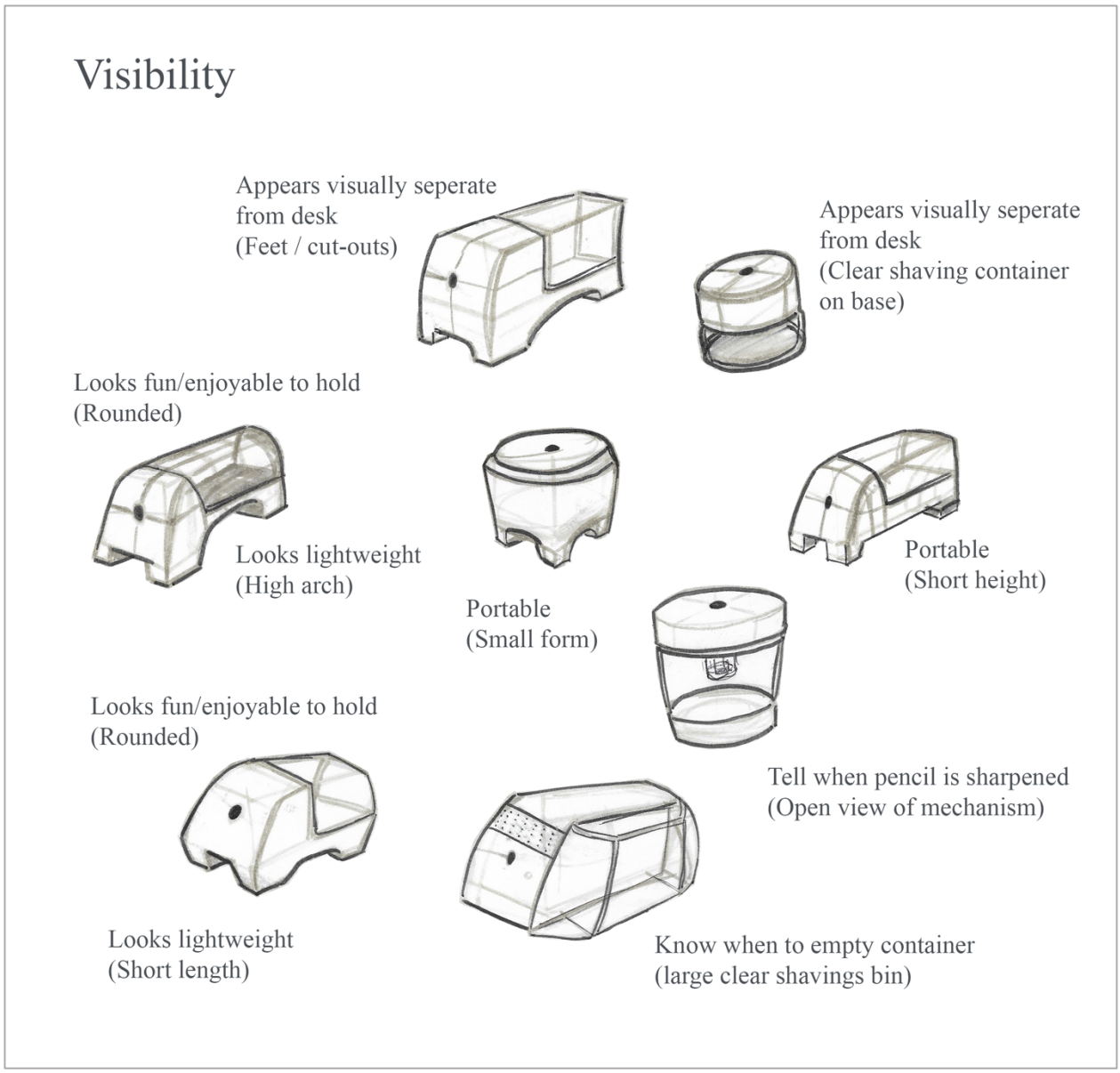

Figure 66: Sketching development of visibility.

4.2.2 Applying archetypes.

In this section, we used guidelines from chapter three for using archetypes in the design process (see chapter 3.3 Archetypes.). Archetypes are a human construct based on past experiences. They exist as a generalized idea, in a person's mind, of what something is and does. This psychological concept, framed within product design, helps explain how people understand and recognize new products based on their past experiences. The first type of archetype is the overall form or appearance of similar products. By mimicking this archetype, a designer can create a new product with a clear function and purpose. A person using the new product can then easily understand what it is. The next type of archetype is functional aspects of products. By mimicking this archetype, a designer can create a new product with an easily understood operation or process of how to use it.

In order to apply an archetype to our pencil sharpener, we first identified what type of archetype to express in our product. There are three types of archetypes, which include *the form of similar products*, *functional aspects of products*, and *metaphors of artifacts or nature*. We looked at each of these archetypes as a protentional in our project. We then used the guidelines for applying archetypes and metaphors in our project.

The form of similar electric pencil sharpeners features simple geometric forms with a flat base (figure 67, 68). The *identifiers* of electric pencil sharpeners include, the pencil hole, a removable pencil shavings bin/container, and a power cord for non-battery powered models (See chapter 3.3 Signifiers for information on identifiers). We chose to use this type of archetype in our product to keep the product recognizable. This was explored through sketching and applied using Lee's iconize process, a process outlined in the guidelines for applying archetypes in chapter three (figure 69).

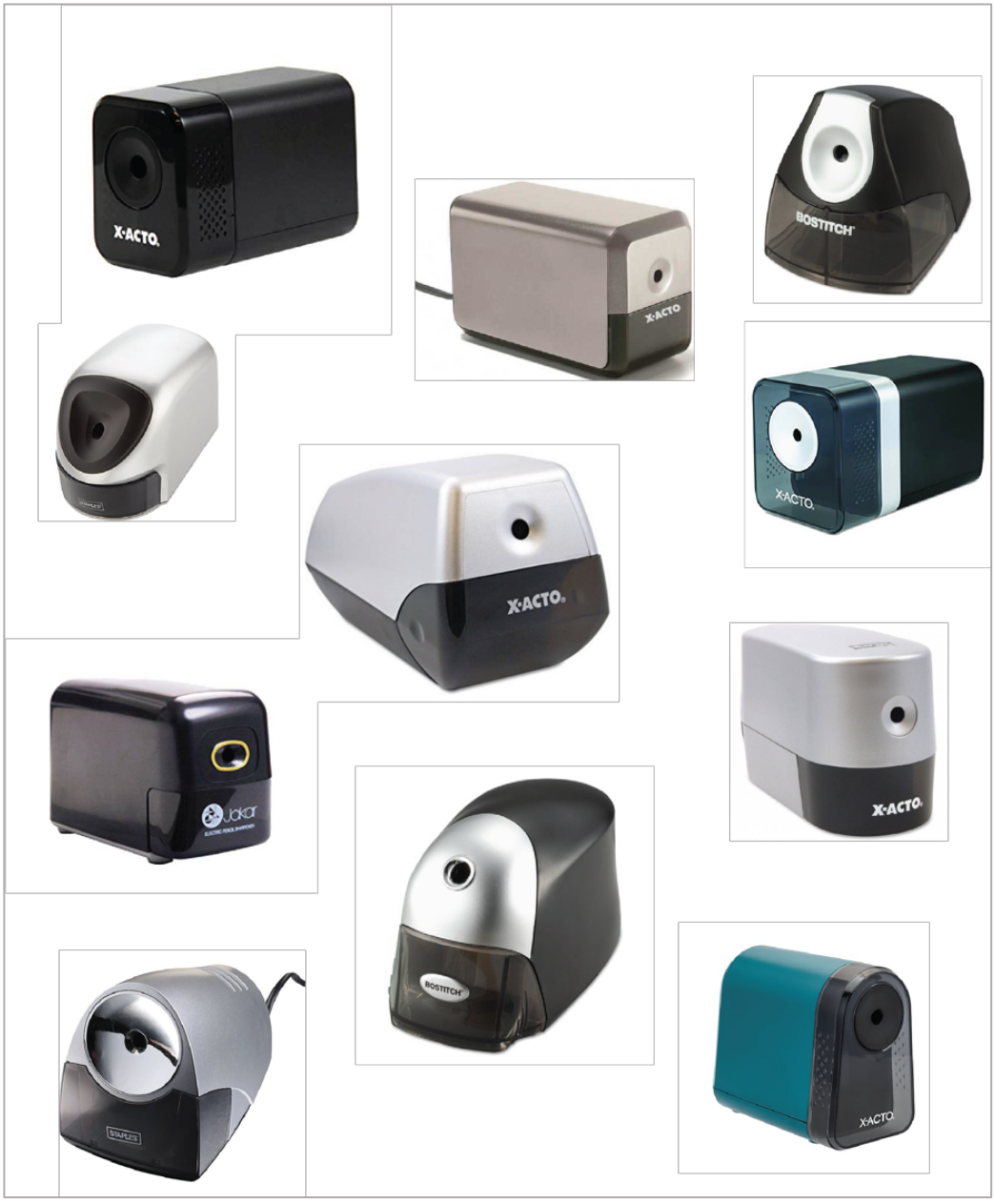

Figure 67: Horizontal electric pencil sharpeners. Google.com image search “electric pencil sharpeners”.

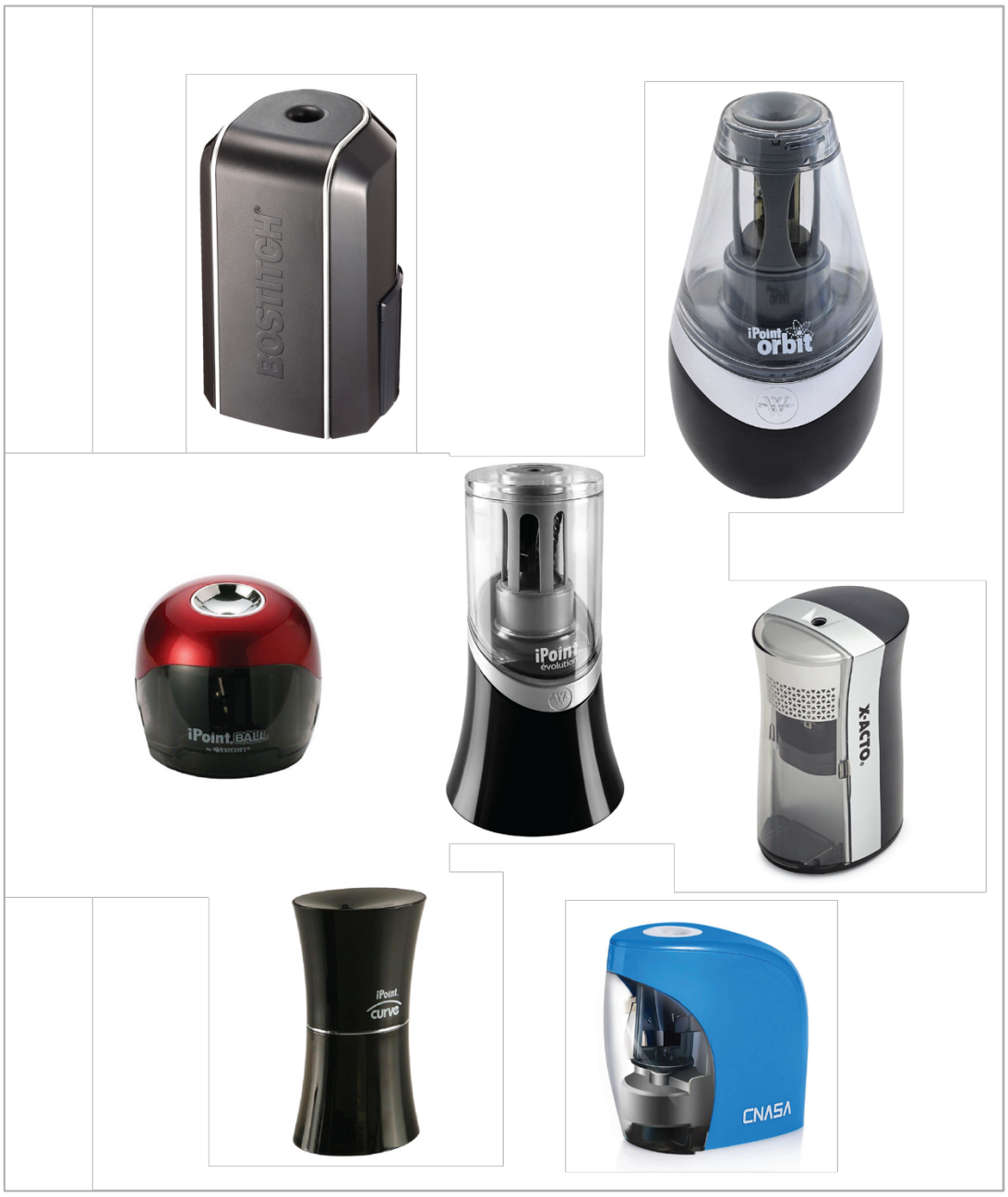

Figure 68: Vertical electric pencil sharpeners. Google.com image search “electric pencil sharpeners”.

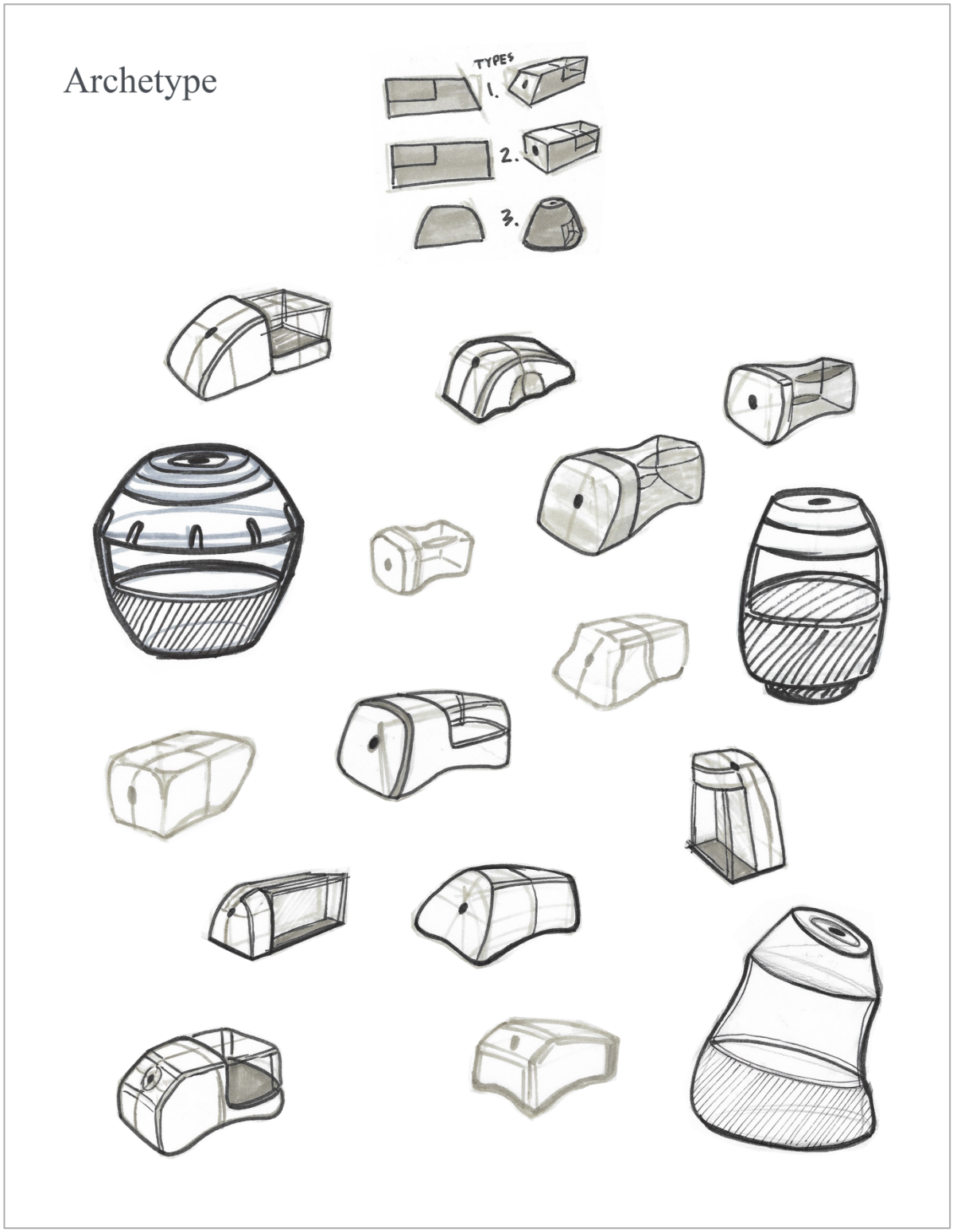

Figure 69: Sketching development of similar form archetype.

Functional aspects of products, in the case of a pencil sharpener, these would be the functions of emptying the shavings from the device, receiving the pencil to be sharpened, or plugging in the power cord or turning on the device if it is battery powered. None of these common functions appeared to be too difficult or in need of archetypes to improve their function or recognition in our project.

4.2.3 Using metaphors.

In this section, we used guidelines for using metaphors in the design process (see chapter 3.3 Metaphors.). Metaphors transfer meaning from something else into a product. Metaphors can express things such as nature, biology, or other aspects of the human condition (see chapter 2.14 Case Studies). Metaphors can be used in creative ways to better express meaning in a product. These archetypes can be used in product and industrial design to create objects which are easier to use, understand, and recognize. We developed guidelines to accomplish this in the previous chapter.

In the project, guidelines for collecting applicable metaphors was used, which helped determine a meaning to transfer into the product. One of the guidelines for collecting metaphors is to look at examples of similar products with metaphors to help create new ideas. Some similar existing products that use metaphors were found in our research and can be seen below (figures 70,71,72)

Figure 70: Wing Nut Pencil Sharpener by Suck Uk. (“Wing Nut Pencil Sharpener.” n.d.).

Figure 71: Pencil sharpener Kastor by Rodrigo Torres (Torres, n.d.).

Figure 72: Honest Boy by Kikkerland. (“Pinocchio Pencil Sharpener.” n.d.).

Another guideline for collecting metaphors is to sense commonalities between things by looking at what kind of meanings you want to express and what kind of things have those meanings. One of the meanings we tried to express in the product was created previously when using the guidelines for context: “A form that mimics a similar function to inserting a pencil”. While normally this would fall under a functional metaphor, there weren’t any products we could think of that had a similar function to inserting a form like a pencil, instead we looked at other things that could have a similar meaning. The meaning we came up with was a ‘target’ or ‘bullseye’ used in archery, darts, or firearm training (figure 73). The concept of putting the arrow or dart into the bullseye relates well to putting a pencil in the hole of a pencil sharpener. The next step was to develop ways to add this meaning in our product through sketching (figure 74).

Figure 73: Archery bullseye. (“Bullseye.” n.d.).

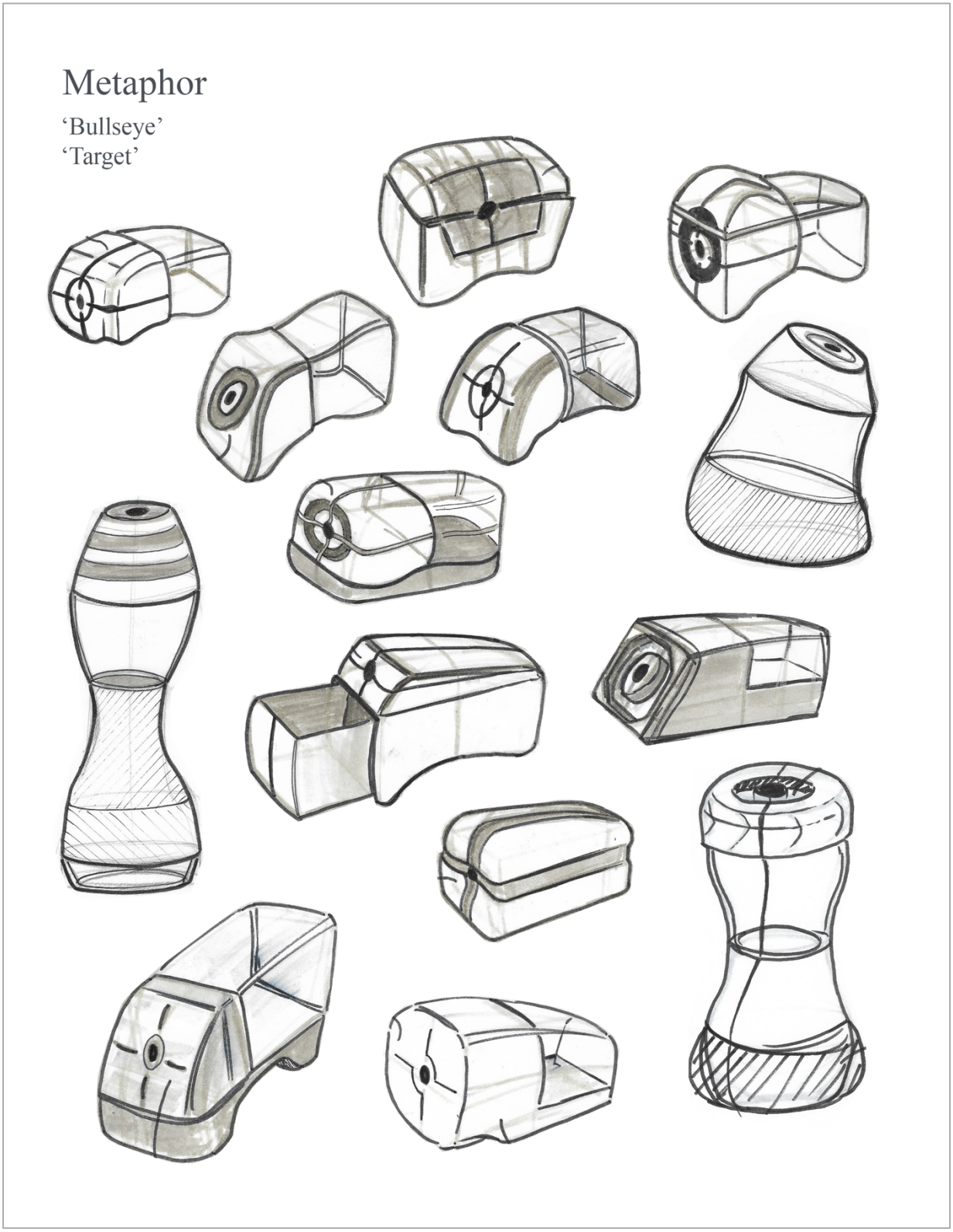

Figure 74: Metaphor sketching development

4.2.4 Aligning context.

The context of a product transforms what it means to people (see chapter 3.3 context.) Good product context is essentially how well the product matches the environment it is in. This environment can be in the physical sense, a technological sense, or also in a social sense. An example of physical context could be a laptop in an office being viewed as a tool, but when placed in a living room it might be viewed as an entertainment device. A bad technological context might be a laptop sold in Alaska not working in the cold climate because the product's battery isn't designed for extreme temperatures. An example of good social context might be a gold colored laptop being sold successfully in Dubai because of the social status and positive view of gold held by consumers in that region. Product context is complex, and it is based on many external factors in the world, but designers can use context as a tool to develop products which make more sense in their own environment.

To help align a product with its context we developed guidelines to help match a product's features with its environmental needs. These guidelines were developed by using the inverse of a concept presented by authors Krippendorff and Butter called semantic infelicities. Infelicities of products are lying relationships of context (see chapter 2.3 Four semantic infelicities in design.). Because they lie about what they are, they are easy to recognize in a product. These infelicities can make an object perform poorly in many ways. Products with the infelicities have features that are: less functional, have a limited purpose, feature poor user interaction, are undesirable to use, are uneasy to learn about, and don't make sense in their own physical, social or technological environments. By using the inverse of this framework, we were able to create a list of qualities that product features can have which can improve the overall context of a product. We used these guidelines in the development of our product below.

The first guideline for context is defining product needs based on different context types. This is accomplished by listing needs for the product in different context categories and then coming up with potential features that could help serve those needs. In our project we listed needs in every category in order to illustrate each type of product context (figure 75). Some of the affordances selected in the previous chapter were also added and organized within this list, because they were also based on the context of the product.

LIST OF CONTEXT FEATURES

FUNCTION & PURPOSE

Function (Users notice what it can do):

- Icons of a sharp pencil
- Form that mimics aspects of sharpening, or pencils.
- Form that mimics similar functions to inserting a pencil, emptying the shavings container, or charging or replacing batteries.

Purpose (Users can see what it is):

- Embossing or Graphic with words "Pencil Sharpener"
- pencil hole
- removable container for pencil shavings
- battery compartment / power cord
- form / shape / elements resembling other pencil sharpeners

USE & LEARNING

Use (Users want to use it):

- A shape that promotes a natural gesture when sharpening, regardless if the product is being held or sitting on a surface.
- Shape or form that invites users to pick it up
- A way to see the pencil being sharpened

Learning (Users are curious about it):

- A latch or button that releases the shavings container
- LED lights that show the status of the battery
- LED lights or sound that express the pencil is being sharpened

INTERACTION & OPERATION

Interaction (Users understand how to use it):

- Recognizible shavings collector with an obvious removal and empty process
- A hole with a form that makes sense it is meant for the pencil
- Feedback on when to empty the shavings container (sound, LED, screen, transparency, fill line)
- Feedback on when to change the battery (sound, LED, screen, mechanical indicator)
- Graphics on product that show how to use it (sharpen the pencil, how to empty the shaving container, how to replace the battery)

Operation (actions are simple and easy):

- Comfortable to hold
- Light and compact enough to carry or move
- Pencil slides in and out of product easily
- Simple and quick processes (to change batteries, charge batteries, plug in power cable, empty shavings)

SOCIAL & TECHNOLOGICAL

Social (Environment based on people):

- An aesthetic that is desirable to teachers, students, engineers, office workers, designers, or artists.

Technological (Environment based on technology):

- Works with common battery types (AA, aaa)
- Charges with common U.S. cables (USB, USB C)
- Can withstand drops from standard desk height

Figure 75: List of context features.

The next guideline for context is selecting from the list of features based on design constraints. This is the same guideline we used for affordances and can be used in the same way. You can narrow down a long list of potential features by eliminating features which don't fall within your project's design constraints. For our project we chose to select from the list of context features based on their sensed potential in the product. We used similar selection methods to design constraints by choosing features that sounded plausible based on potential cost, complexity, manufacturability, etc. The selected features which made sense in the electric pencil sharpener were then outlined below (figure 76).

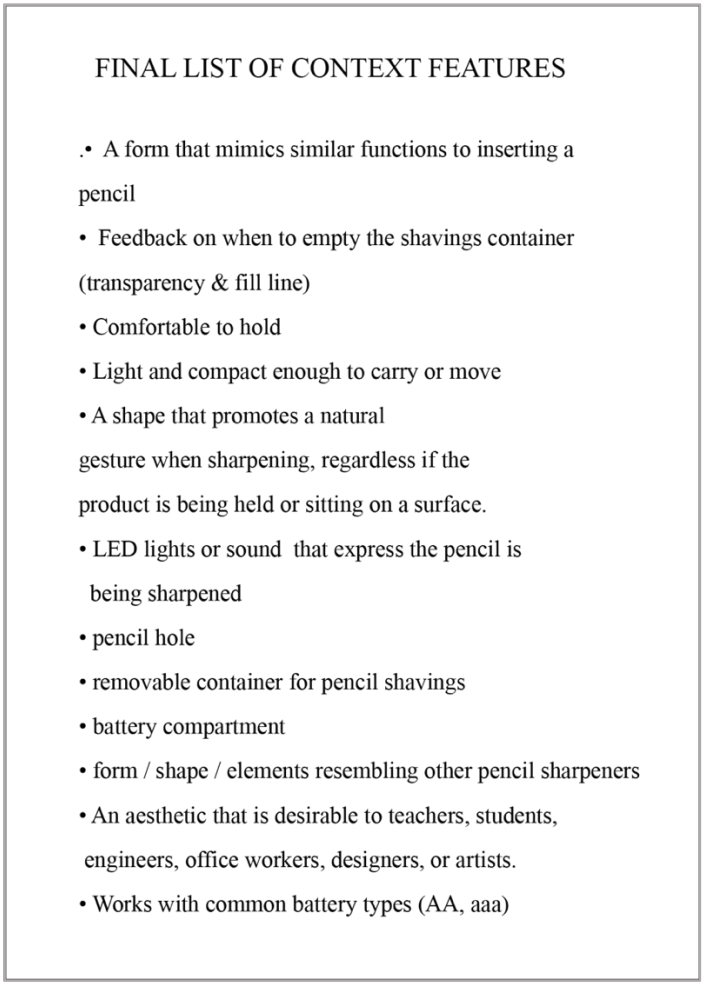

Figure 76: Final list of context features.

After we selected features to use, we chose to place them into the product through sketching development. We sketched ideas on how these features might look or work within the pencil sharpener (figure 77).

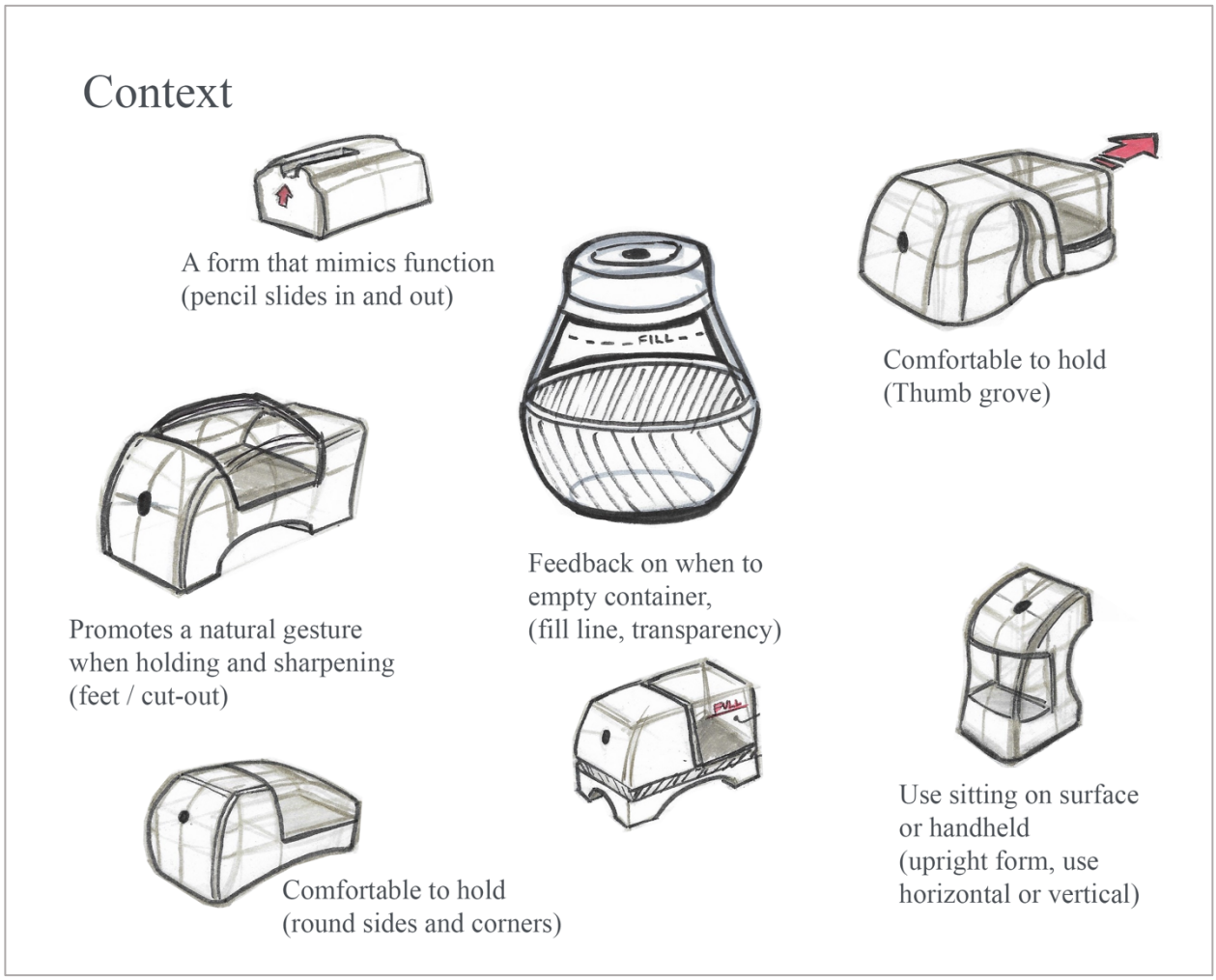

Figure 77: Sketching development of context.

The next guideline for context is testing the validity of the product in its own context. This can be performed at the end of product development to make sure the product makes sense in context

before it gets manufactured. The validity of context can also be tested throughout the product's development, helping the designer make better design decisions. The validity of a product's context can be tested by finding out what people think and feel about it. This can be accomplished by prototyping the product and letting people use it in context. You could also show images or drawings of the product being used in context and ask people what they think. If the product, in its future context, makes sense to them than it is likely valid. Getting feedback from these users and stakeholders can be accomplish in many ways, including focus groups, questionnaires, interviews, etc. After reviewing the developed context features, we added them in during the final development stages of the product. The final development stage will be shown near the end of the project. For this project we will present the final CAD design at the end of the process with the final context features. The reader can then make up their own mind if the product makes sense in its context.

4.2.5 Using signifiers.

Guidelines for signifiers provide the designer a way to organize and use different kinds of meanings in their products (see chapter 2.13 *Signifiers.*). These different meanings are all expressed in the form or appearance of the product. The different types of signifiers include character traits, identifiers, expressives, distinguishers, and pointers. Each of these meanings can accomplish different things. In summary, character traits can visually express words or styles in the object, thus making the product reflect those same meanings. Identifiers can help express what an object is, thereby making the overall identity of the object clear. Expressives can express what the object can do, which makes the purpose or purposes of the object known. Distinguishers can express distinct differences in the object, thus clarifying which areas of the object are different and what those differences are. Lastly, pointers can express which areas of

the object a person should pay attention to, thereby highlighting important features or abilities of the object.

The concept of signifiers can be used by designers in different ways. First, they can be used to look at the current state of a design, to make sure meanings and their associated forms are being expressed as intended. After this the designer can correct problem areas as needed. For example, most of the sketches thus far featured a shavings bin collector which was visually separate from the rest of the product. This is a distinguisher because it uses a product form to separate two or more parts of the product. Another way signifiers can be used is to let them drive specific development of a product. In our project we chose to use character traits to develop the overall appearance of our product. For this, we used the adjectives given by potential users during development using context guidelines. Like the other guidelines, we chose to use sketching to help develop and incorporate those character traits into the pencil sharpener (figure 78).

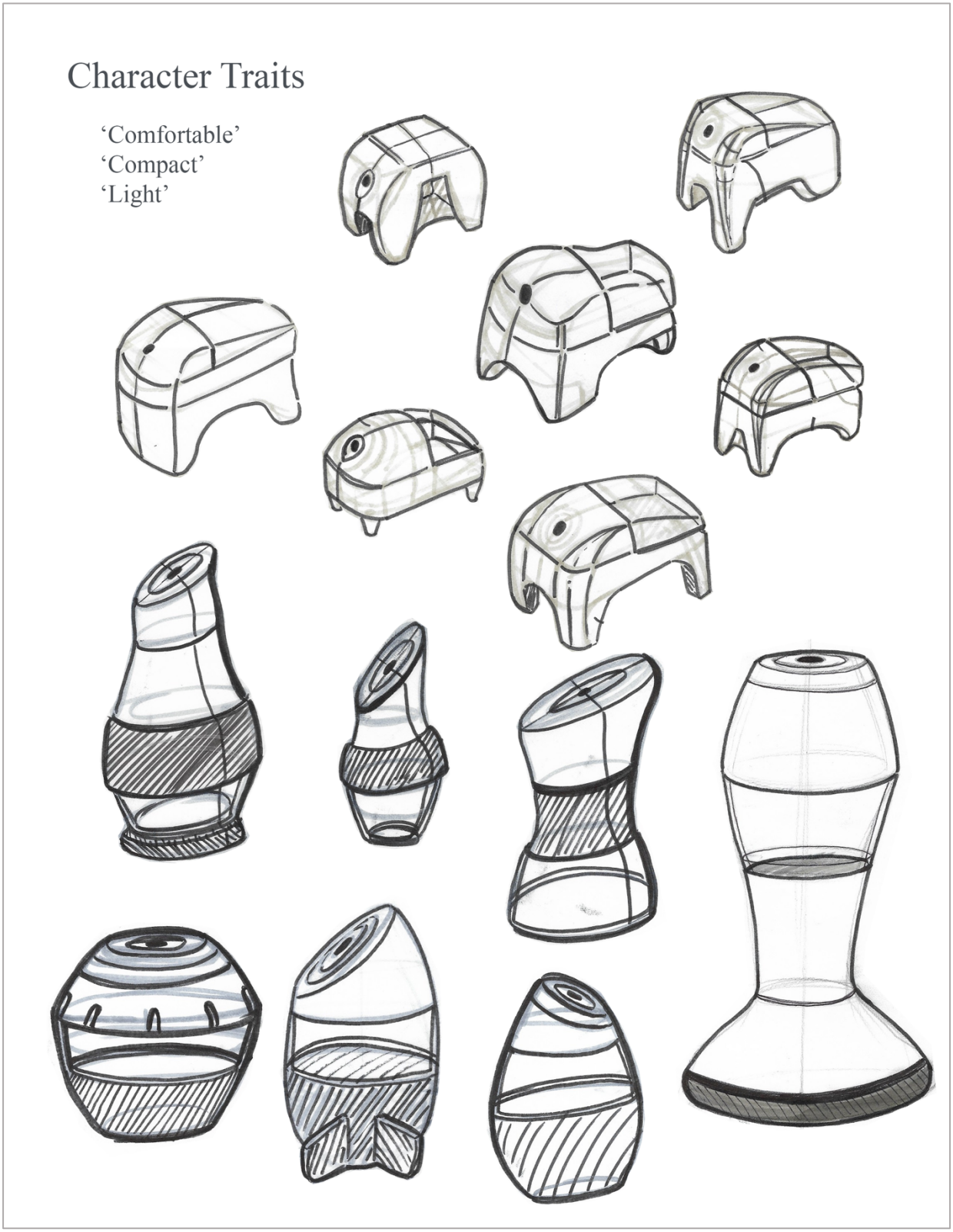

Figure 78: Character trait sketching development

4.2.6 Improving interfaces.

Guidelines for interfaces (see chapter 3.3 Interfaces.) can help a designer develop or improve the interaction between a product and its user. These guidelines include: *narrative sequencing,* which can be used to develop or improve the product's interface by telling a story of how a person might interact with the product; *usability heuristics* which is a general checklist for good usability practices; listing *technical details* which can help support the probability of the interface working in real life; and outlining and improving the *four essential elements* of a product's interface which can help improve a user's understanding of it. In our project we used narrative sequencing to come up with ideas for the interface of our product. We developed several short stories explaining the sequence of the potential interface (figure 79). For this guideline, we chose to focus on developing interfaces which provide *a way for users to sense that the pencil is being sharpened*. This idea was developed previously when we used guidelines for context. Next, we developed the interface based on the ideas created during narrative sequencing. We chose to sketch iterations of this interface (figure 80). Finally, we chose to use the guideline of adding supporting technical details. Again, we used sketching development to show these details (figure 80).

NARRATIVE SEQUENCING

Greg was writing in his journal on the train when his pencil suddenly snapped. He reached into his briefcase and removed his new pencil shapener his wife bought him for Christmas. He grasped the smooth edges of the shapener around the middle and inserted his broken pencil. The front of the sharpener suddenly glowed with a bright red hue. Greg noticed that the light slowly shrunk towards the middle as the pencil was being sharpened. When the light was reduced to a single ring around the pencil hole he removed his pencil to notice it was sharp again and ready to be used.

Sarah was taking her final exam in american history when she noticed all of her pencils were dull. The exam had just begun so she quickly removed her pencil sharpener from her backpack and placed it on her desk in front of her. She inserted her pencil into the device and was plesently surprised at how quiet it was and that not many students noticed what she was doing. The sharpener suddenly glowed red and noticing this she removed her pencil. The pencil was sharp and she continued with her exam.

Caleb was writing notes for his engineering project that needed to be turned in at the end of the week. His blue pencil which he always used was too dull to write legibly. He wheeled his desk chair over to his pencil sharpener and grabbed it off of his desk. He inserted his blue pencil and the sharpener turned on. A light then appeared on the surface of the sharpener. The light was in the form of the number 5. It then began to count down “4, 3, 2, 1.”. The lighted counter reached zero and Caleb removed his pencil to realize it had been sharpened.

Figure 79: Narrative sequencing for pencil sharpener.

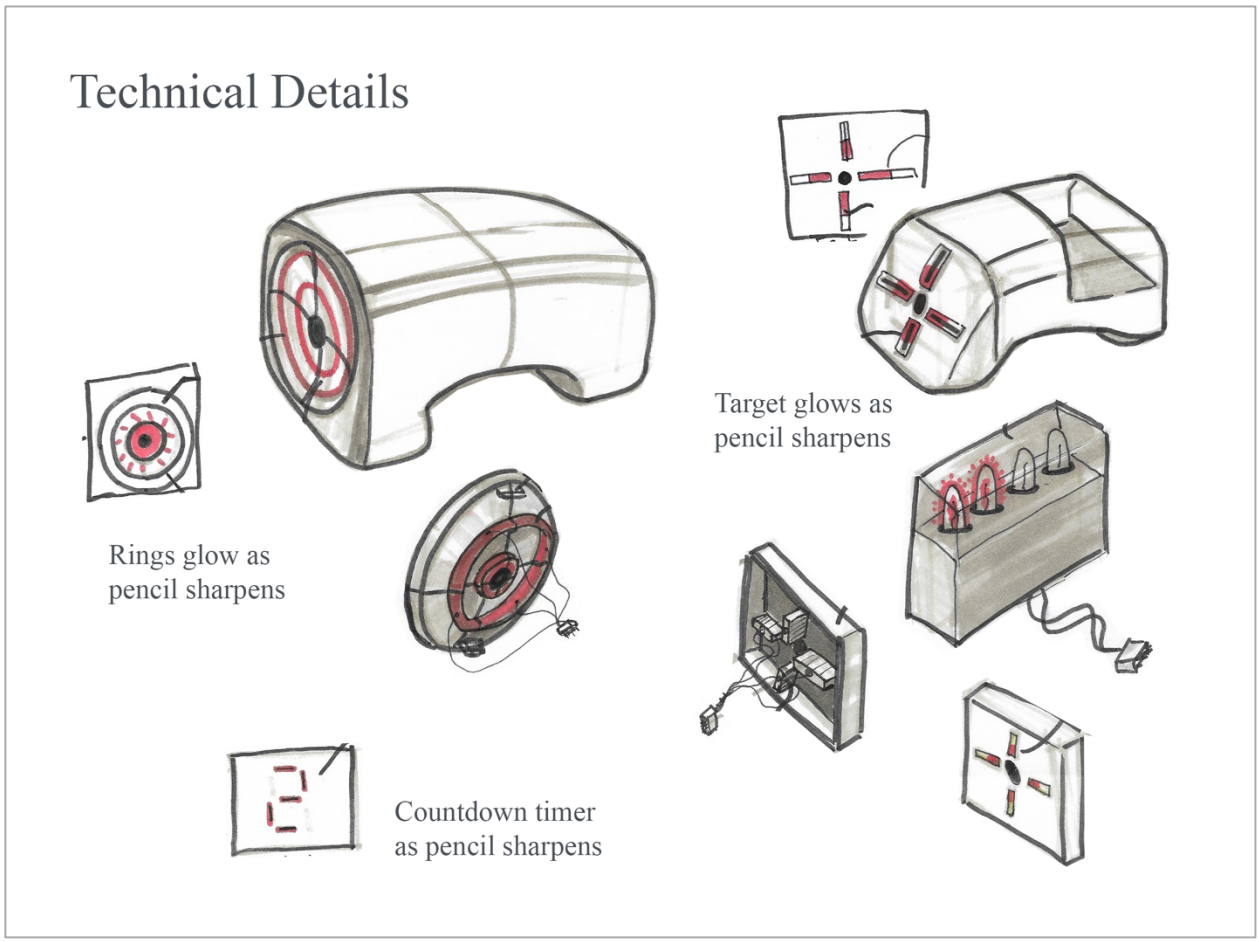

Figure 80: Interface sketching development.

4.3 Final development.

The last step in the design process was to take all of the product development produced from each set of guidelines and synthesis and combine them into a final product. We continued to use sketching development as the medium for this (figure 81). The goal of this process was to create a believable and polished product which could reflect the majority of the meanings we developed throughout the project. After completing this phase, we selected a sketch idea to go forward with the final development (figure 82).

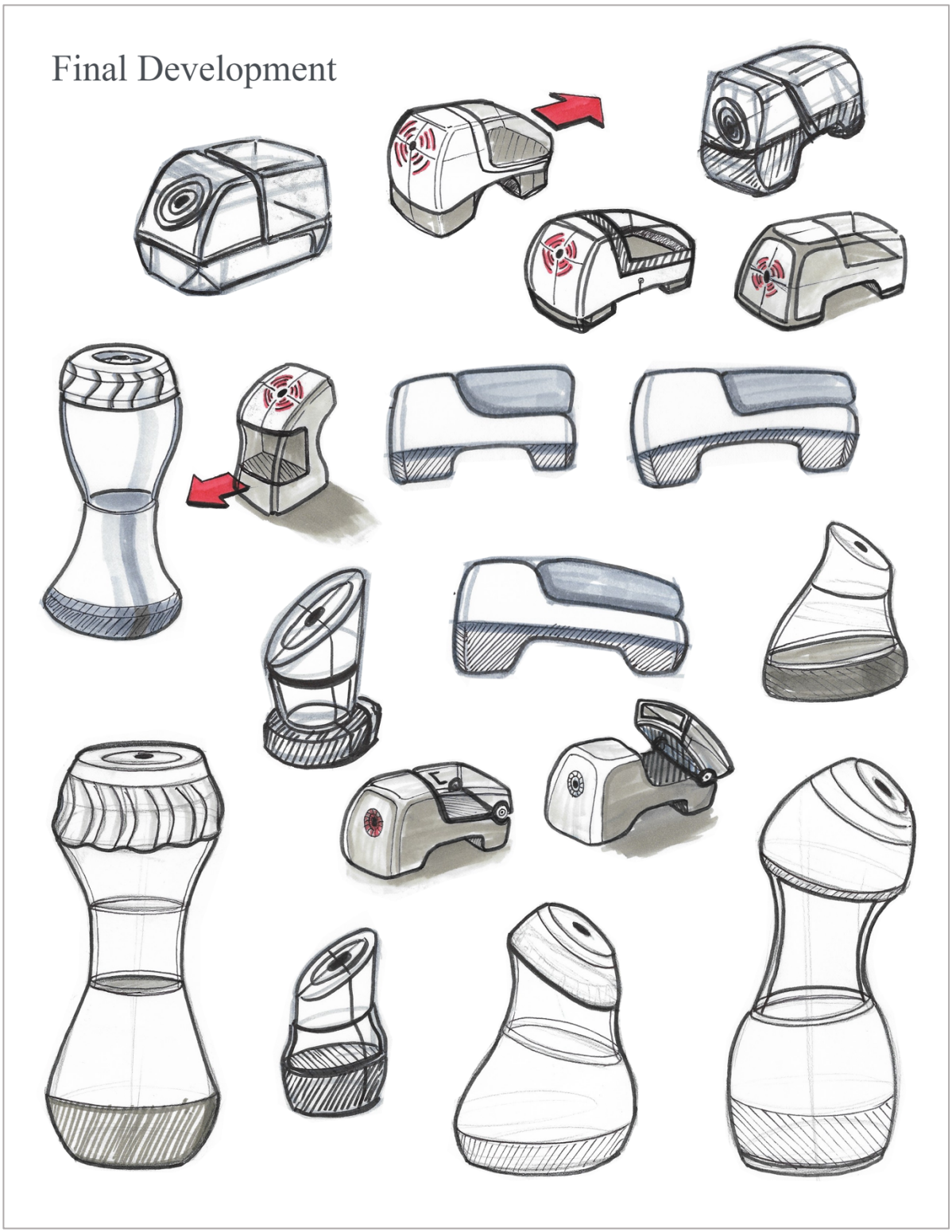

Figure 81: Final sketching development

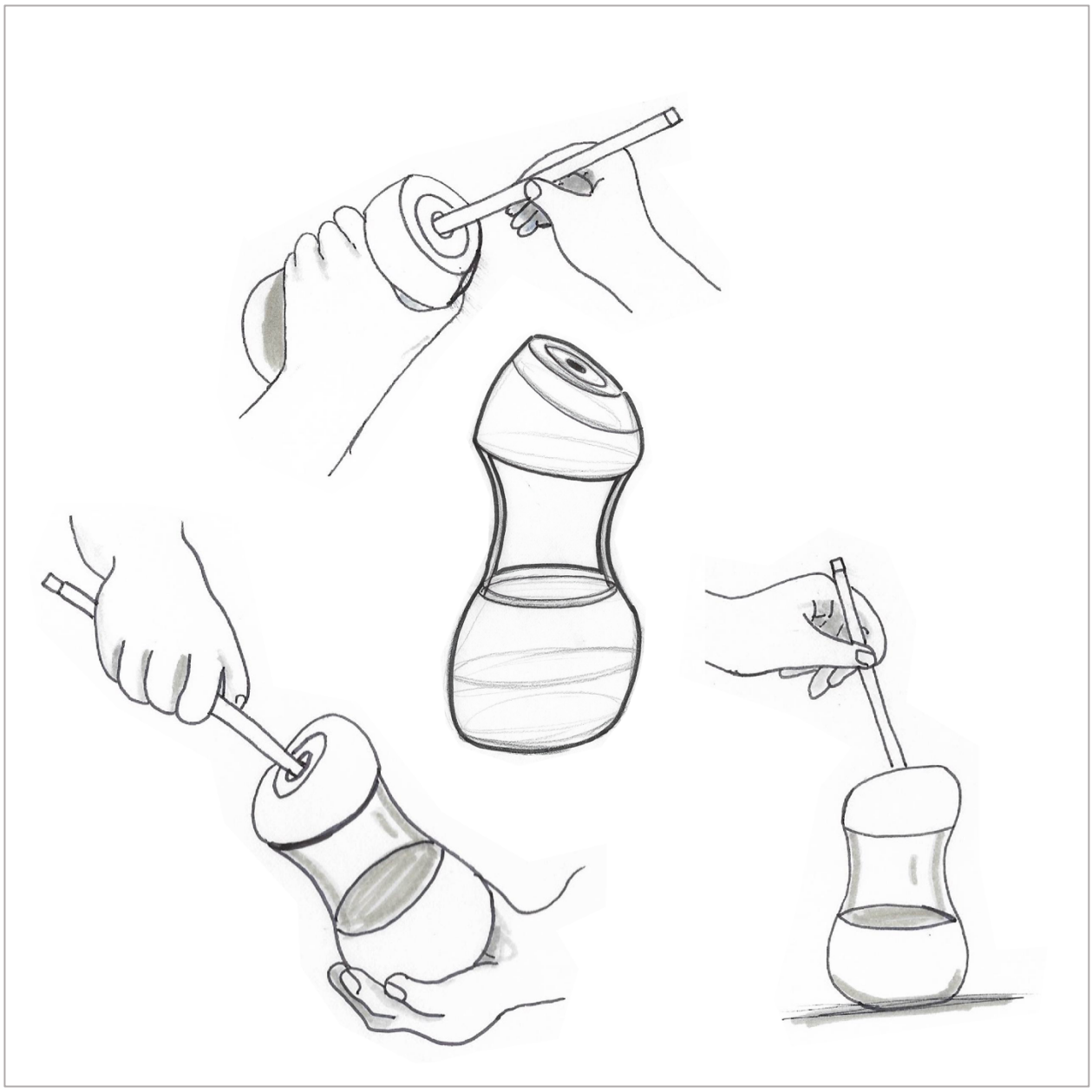

Figure 82: Final sketch idea

4.4 Final product.

As part of this project we developed a CAD model using the final sketches of our pencil sharpener as a blueprint. During the 3D modeling process 3D printing was used to study

ergonomics and proportion (figure 83). This 3D model should help illustrate the final results of using product semantic guidelines for application within a design process (figure 84, 85, 86, 87, 88, 89). In the images we used “callouts” to show details of the product. These specific details are the meanings that are expressed in the product. We also listed which category of guidelines were used to apply them so that the details can be traced back to their origin in the design process.

Figure 83: 3D printed model

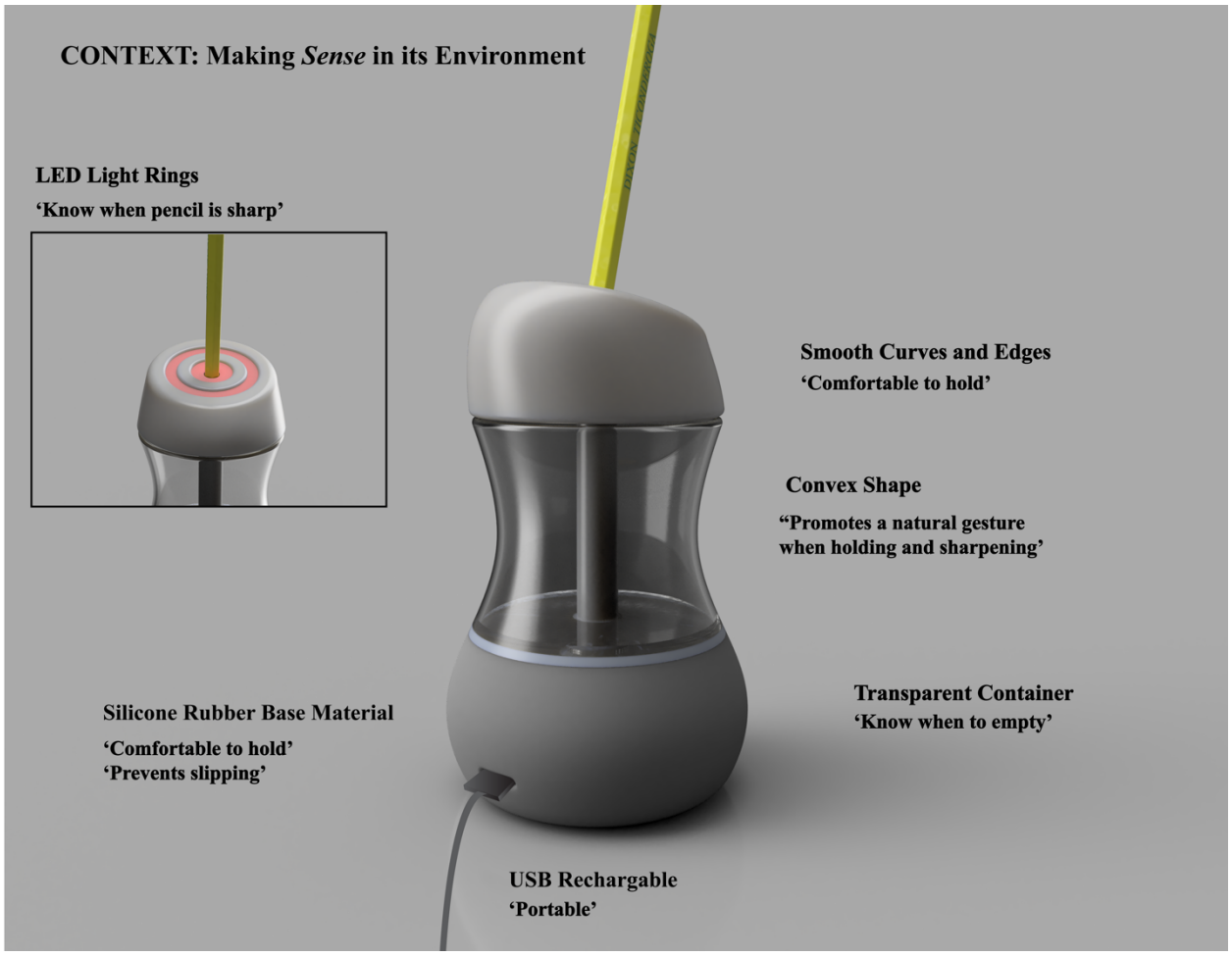

Figure 84: CAD Model (Context)

Figure 85: CAD Model (Archetype)

Figure 86: CAD Model (Affordances)

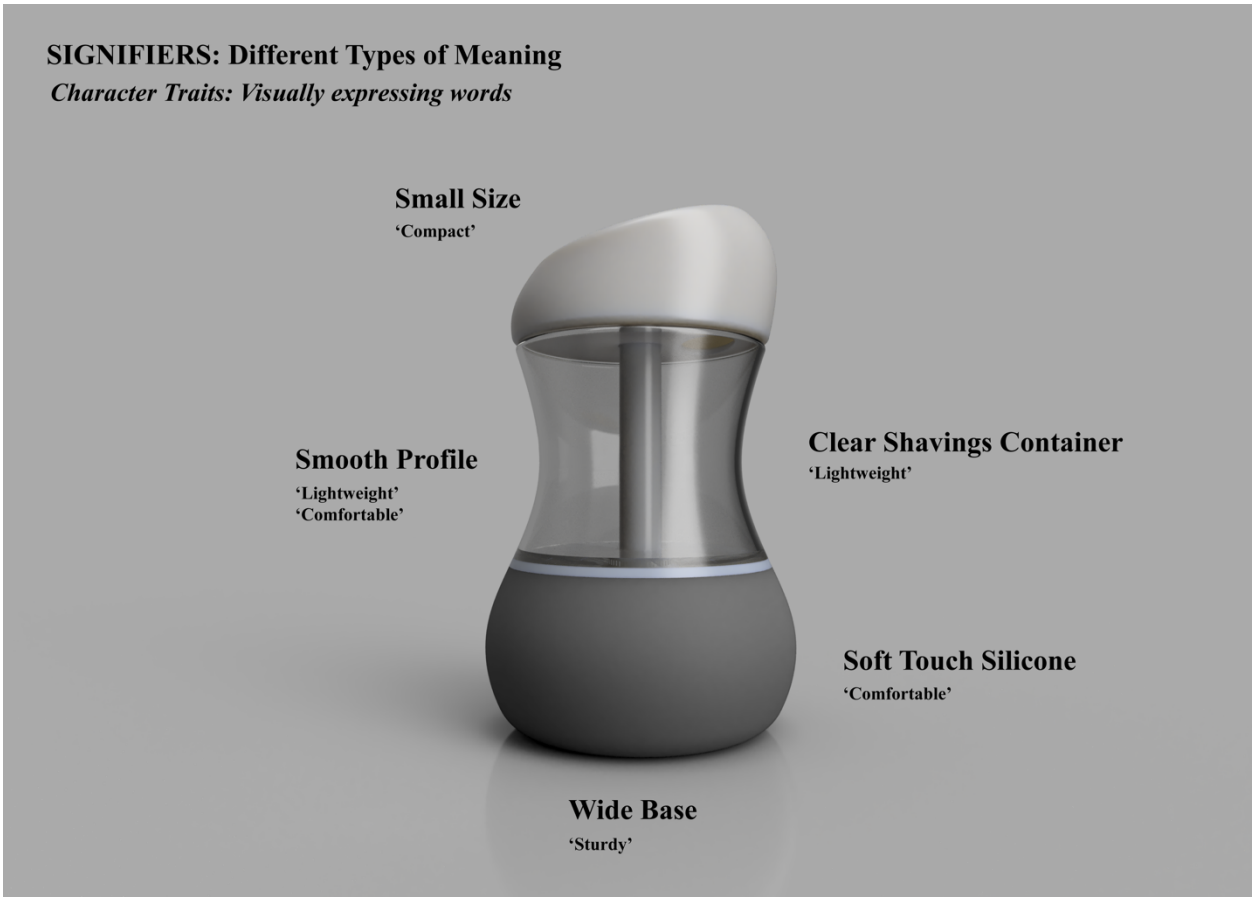

Figure 87: CAD Model (Signifiers)

Figure 88: CAD Model (Metaphor)

Figure 89: CAD Model (Interface)

4.5 Conclusion

This study was an aimed at highlighting the importance of product semantic in industrial design. The product produced in this study should showcase how product semantic can be used to drive a design process and create products with deeper meaning. Placing meaning at the forefront of the design process can create products which are more familiar, more enjoyable to use, and more useful. It is the hope of this study that product semantics as a whole will become a larger focus in industrial design, in both practice and academia. This study should show that product semantics is a field which has great potential in creating more meaningful products of tomorrow.

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