

Sense-It!: Insights into Multisensory Design

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Introduction

Product designers recognize the importance of designing products that people enjoy and may even grow to love. Products designed with multisensory features can create emotional and meaningful interactions between people and the products they use. The more designers become familiar with the sensory aspects of design, the better they will apply sensory interactions in their products; products that include features with sensory, emotional, and cognitive qualities as well as the traditional product design qualities of form and colour.

In *Sense-It!: Insights into Multisensory Design* you will gain insights into a range of multisensory concepts that contribute to the product design process and ultimately improve user experiences. We believe that the potential for innovation through multisensory interactions exists when sensory considerations are integrated into a design project from the beginning. The chapters that follow present a step-by-step discussion of design principles for each sensory theme that comes together in a final multisensory design chapter. These applied principles integrate traditional approaches to product form and colour with recent research on multisensory design. They provide a sensory lens for informing user-centred approaches to product design, research, and development. Many considerations that we address in this resource are useful for exploring multisensory design variations in the initial stages of design development and for evaluating the effectiveness of design concepts that enhance user experiences.

The primary objective of this resource is to introduce sensory aspects of design to industrial design (ID) students and professionals, as well as those in related design disciplines. It provides foundational knowledge about multisensory principles for designing products that engage users. Interactive learning activities are interspersed throughout and enable you to reflect on the sensory concepts discussed along the way. These interactive activities are unique to this resource, offering you the opportunity to explore foundational knowledge about multisensory design and to guide others, as appropriate. It strives to be interactive, AODA compliant, and culturally diverse, although we think that there is still room for improvement in these areas!

Learning Outcomes

The key objective of this *Sense-It!: Insights into Multisensory Design* resource is to provide a basic introduction to the multisensory aspects of design by translating research from key figures in the field of sensory design into more understandable content for a wider audience. We have compiled this information as a straightforward resource for novices – both novice designers and design researchers. As a result, illustrations, interactive examples, and evaluations that complement academic learning and design practice are integrated into each chapter. While we do not delve into multisensory academic design research data

or statistics, the principles and theories described are informative and compatible with current design frameworks. Indeed, many traditional “form and colour” foundation studio design principles are reframed here as visual design guidelines according to our learning objectives below.

In reading and interacting with this resource, you will learn to:

- Identify the sensory, emotional, and cognitive qualities that contribute to human-product interactions.
- Understand how designers can integrate sensory and emotional attributes into designed products.
- Reflect on the variety of multisensory experiences that affect the design of products, services, and environments.
- Apply sensory design concepts through interactive simulations or related assessment activities.
- Qualitatively evaluate a product’s sensory design factors and how they contribute to emotional and meaningful responses.



Multisensory Design Factors

Contextual Information and Definitions

While developing this resource we identified and categorized many professional terms that are relevant to this topic. These terms are addressed here in the following categories: Industrial (Product) Design, Product Experience, Multisensory Design, and Product Aesthetics.

Industrial (Product) Design is a profession that focuses on the design of concepts for physical products, devices, and related services that have interactive, utilitarian, and functional uses (Association of Industrial Designers of Ontario (ACIDO), Carleton University School of Industrial Design (CUSID), Industrial Designers Society of America (IDSA), & The World Design Organization (WDO)). Designers develop the physical appearance, functional properties, and manufacturing specifications for products and related services. On the product side of the design process, this resource focuses in part on a product's *physical appearance* – its compositional, interactive, structural, and surface properties – that a user interacts with to accomplish their goals.

Design problem, problem space, design challenge, or challenge are used in this resource to refer to the context within which a product is to be used or experienced. These problems or challenges present a desired goal of product use. The *design brief* is a formal document that defines the client's expectations with regard to the design problem and solution, the deliverables, limitations, and parameters for accomplishing the design task, along with timelines and costs. We also use the word *value* to refer to a quality of experience rather than a financial cost, where a user values one product or feature more than another. In addition, the design skill of creating coherent and attractive compositions is called "*styling*", which was once considered to be the main strength designers brought to the design team (Hekkert and Schifferstein, 2009, p. 1-4).

Iterative design development refers to the ongoing process of concept development through continual variations of design concepts. Initial concepts may evolve through iterative stages with milestones for refinement before settling on a final concept. Designers refer to theoretical *principles and guidelines*, sometimes called *tools* and may be compiled into a *toolkit* or *toolbox* of approaches to consider when designing. *Usability* is also an important concept for product design; a product must be easy to understand and use, and perform its task effectively and efficiently. This is true whether the function is purely utilitarian or has features that engage one's sensory perceptions and emotional responses.

Design research refers to the process in which designers, marketers, psychologists, anthropologists, and other researchers collect data about users' goals, activities, and practices with products in specific contexts.

Product Experience is the term coined by Schifferstein and Hekkert in their seminal book about multisensory design entitled *Product Experience* (2009). They describe it as "awareness of the *psychological effects* elicited by the *interaction with a product*, including the degree to which all our senses are stimulated, the meanings and values we attach to the product, and the feelings and emotions that are elicited" (Hekkert & Schifferstein, 2009, p. 2). This resource was deeply influenced by their work on *product experience design*; it inspired us to simplify some of the material discussed to make it easy for novice learners to understand.

The term *user experience* is relevant across design fields and is the name of a field of its own. It refers to the experience a user has with a product, from first contact to post-use. User experience acknowledges that the perspective of the user must inform the perspective of the designer in developing new products and in improving existing products. For example, Cyril wants to design meaningful and appropriate experiences for

young users who are new to bicycling, so they will focus on learning about the perspectives of parents and their children in all the stages of product interaction – from considering bicycle options to buying, adjusting, using, maintaining, and finally discarding their bicycles. The term *user-centred design* has long been relevant to industrial design and is discussed here because it addresses the importance of designing products that people can use in ways that centre on their needs, not only on the capabilities of the product. In other words, the design should fit the user, the user should not have to adjust to fit the design. If someone must have three hands and arms to use a drill press properly, it would be better to redesign the drill press to accommodate the tactile capabilities of existing users, rather than to add a mechanical third arm.

We also use terms – that emphasize the perspective of the person experiencing the activity – derived from other fields. The term *experiential*, coming from the field of education, is important in design because it focuses on the nature of the experience a person is having. For example, if we refer to Kai's experiential development as a driver, we are discussing how, over time, Kai has developed driving skills by gaining practical experience on the road. Designers can use *experiential knowledge*, especially from firsthand observation or studies, to develop features for new products that contribute to improved experiences.

The term *worldview* is another important term borrowed from academia, specifically, the social sciences, and refers to the perspective that guides an individual's understanding of the world. For example, your worldview may be that anyone can do anything with the right tools (a worldview that emphasizes the importance of design), whereas my worldview might be that anyone can do anything with enough training (a worldview that emphasizes the importance of education). Consideration of a user's worldview can inform product design in context. For example, in an organization that emphasizes its workers' health to the degree that it has a standing-only office, it does not make sense to improve the multisensory features of chairs, but it does support the opportunity to design footrests that provide comfort to a person standing for several hours.

The phrase *sensory practices* is also derived from the social sciences, in which anthropologists study patterns of sensory practices within cultures to learn about the sociocultural meanings associated with them (Classen 1997, p. 401; Howes 1991, p. 3). In this resource, we discuss *sensory practices* as part of peoples' experiences – the how, what, why, when, and where of sensorially engaging with products to achieve a desired goal. We sometimes also refer to *product interactions* when we mean multisensory and sensory practices with products.

Multisensory Design refers to the design of multiple sensory features that contribute to *layers of sensory experiences* at the same time or in stages. These are experienced through the different *sensory channels* or *modes* of hearing, seeing, touching, tasting, and smelling. These sensory properties are referred to as *multisensory* or *multimodal*, in which more than one sense is involved when a person interacts with a product, service, or environment. Sometimes the adjective sensorial or multisensorial is used to describe a feature that specifically engages or appeals to one or more senses. *Product interaction* is inherently multisensory; every time a person uses or interacts with a product to complete a task, more than one sense is involved.

Product Aesthetics is a term that is associated with the appearance of artworks, to which we traditionally assign the term aesthetics. The term product aesthetics goes beyond the concept of *styling* that relates only to refining a product's visual appearance. In this resource we follow Hekkert and Leder's lead in broadening the term to include "sensory pleasantness in general, things can be aesthetic or pleasant to listen to, to

touch, smell, or taste. Aesthetic pleasure is not an emotion... it is the response limited to the gratification that comes from the sensory perception of an object” (Hekkert & Leder, 2009, p. 260).

In the chapters that follow, we address sensory design, whether we are discussing a *product, thing, property, feature, form factor*, or related *attributes*. We often use words like *design features, design elements*, and *design qualities* to describe the properties/factors that can be designed into a product, service, or environment, to improve the opportunities for people to engage with them in multisensory ways. These terms may be used interchangeably since they all apply to properties that can be designed into the user experience of a product with physical and/or digital attributes.

The Chapters

This book follows Schifferstein and Hekkert’s (2009) approach by presenting the senses individually. It discusses the many ways each sense can contribute to Design and people’s experiences and perceptions while engaging with designed products, environments, and services. The chapters lead to a final discussion of multisensory design where it becomes clear that people rarely experience products through one sense at a time and that there are many rich sensory layers that support product interactions.



Introduction

Here we describe what this book is about and what to expect in each chapter. We provide definitions of terms used throughout the book that are organized into these four categories: Industrial (Product) Design, Product Experience, Multisensory Design, and Product Aesthetics. We also explain how this resource is organized and provide samples of the interactive assessment activities. Lastly, we introduce the 3Ts (Thoughts, Tips, and Tools) at the end of each of the content chapters, in which readers can enter their key takeaways to print out or save.



1. Design for Emotion and Meaning

The topics in this chapter introduce the concepts of pleasure and design attraction, the importance of emotional and sensory impressions and other emotional responses to product experiences. We explain the ideas of product attachment, rituals and routines. We discuss people's positive and negative emotional responses to product qualities and the effectiveness of emotional design elements such as affordances and semantic qualities.



2. Design for Visual Perception

This chapter presents traditional design principles that are mostly oriented toward visual perception. We include a review of visual compositions for form-giving in both two and three dimensions, and a discussion about rectilinear, curvilinear, and organic form factors. We also explore Gestalt Perceptual Principles of composition such as closure, emphasis, continuity, symmetry, figure-ground, proximity, and similarity. In addition, our discussion about visual harmony explains the principles of unity and variety, rhythm, and connectedness. Finally, we explore relationships and hierarchies within compositions, describing how proportions and surface transitions contribute to the overall perception of the product.



3. Design for Visual Perception of Colour and Light

The topics in this chapter are also fundamental to design studies and are considered important to visual perception and design. We address basic colour theories such as colour mixing and discussions about hue, value, and saturation. We briefly introduce the concept of colour wheels and the types of perceived colour relationships or colour schemes that can be derived from various colour systems. Light is also discussed as a compositional element that is perceived as transparency, translucency, or opacity. In addition, we touch on colour specification systems and applications for design (Morris, 2006). Lastly, we introduce the psychology of colour in terms of the psychological, cultural, and emotional significance of colours.



4. Design for Tactile Product Experience

This chapter focuses on touch experiences that contribute to the tactile aesthetics of products. We include a discussion about how people perceive different kinds of touch (such as active and passive touch) and explain the difference between instrumental and non-instrumental touch experiences. We provide insight into how substance, hardness, elasticity, and plasticity are perceived and how people react to the temperature, weight, and balance of products. We explore the tactile qualities of surfaces, addressing themes of textures, surface structures, surface aesthetics, and surface imperfections (Pedgley, O., 2014). We also focus on meanings associated with material sensations and end with a brief discussion of tactile affordances (Karana, E., 2010).



5. Design for Auditory Experiences

This chapter explores how sound adds information to peoples' experiences with products. We introduce the properties of sound that convey auditory information such as pitch and frequency, timbre, loudness, duration, envelope, and diffusion. We discuss how people experience sounds, whether ambient, localized, or as part of larger soundscapes and explore how foreground, middle ground, and background layers of sounds convey different auditory information. We address how sounds can be tied to the passing of time.

The chapter also highlights the nature of wanted and unwanted sounds, especially those in hospitals and other noisy environments (Case & Day, 2019, Kristenson et al, 2016). How sounds can contribute to the emotional attachments people form with products and services are described. We present auditory principles for contributing to emotional connections, sonic branding, and anthropomorphism. We describe the seminal studies of consequential and inconsequential product sounds derived from Langeveld et al (2013) and go on to discuss additive and subtractive sounds as derived from Case and Day (2019). Lastly, we suggest ways for designers to become sensitized to sounds.



6. Design for Smell and Taste Experiences

This chapter addresses taste and smell and the relationship between these two senses. It begins with a discussion about smell – what it is from a biophysical perspective and its link to memory. We introduce terms for discussing the characteristics of smells. We note that some smells can be ephemeral while others can last for a long time and that the qualities of smell semantics can trigger emotional responses. We describe the layers of smell compositions derived from the top, middle, and base layers used in the perfume industry while introducing the history of fragrance wheels and exploring the idea of smellscape or scentscape. Lastly, we discuss the olfactory design principles of authenticity, intensity, quality, and suitability and how they can be applied to design.

The chapter then explores the concept of taste, which is the least applied sense in most product design experiences. We position the five tastes as flavours that engage the senses in ways that are like smell – as they can be both lasting and fleeting. Taste practices in the food industry are explored with a view to understanding how the principles of layering taste compositions may apply to product design. The taste of edible products and product packaging are a part of this discussion. Lastly, we touch on the relevance of design for the food industry.



7. Design for Multisensory and Kinetic Experiences

This chapter integrates information about the senses and sensory perceptions from previous chapters into a discussion about multisensory product experiences. We begin by exploring how people process multisensory experiences relevant to design. We describe the concept of sensory dominance developed by Fenko and Schifferstein (2008) and Ludden et al (2007) in which specific sensory modalities dominate people's experiences at different stages of product use and change over time. We introduce the concept of multisensory delight, as derived from Park and Alderman (2018), which contributes to pleasant product experiences.

We explore multisensory design principles for improved multisensory product experiences by applying four principles derived from Park and Alderman (2018). Multisensory design applications are discussed that target different sensory abilities and unique multimodal design combinations of senses, either for crossmodal support or sensory surprise (Ludden et al, 2007 and 2008). Lastly, we explore the dynamics of multisensory movement, presenting the seven attributes of kinetic movement that are integral in the choreographed dynamics of interacting with multisensory products, environments, and services.



Conclusion

This chapter offers a brief conclusion and suggestions for further study. We explain how this resource came

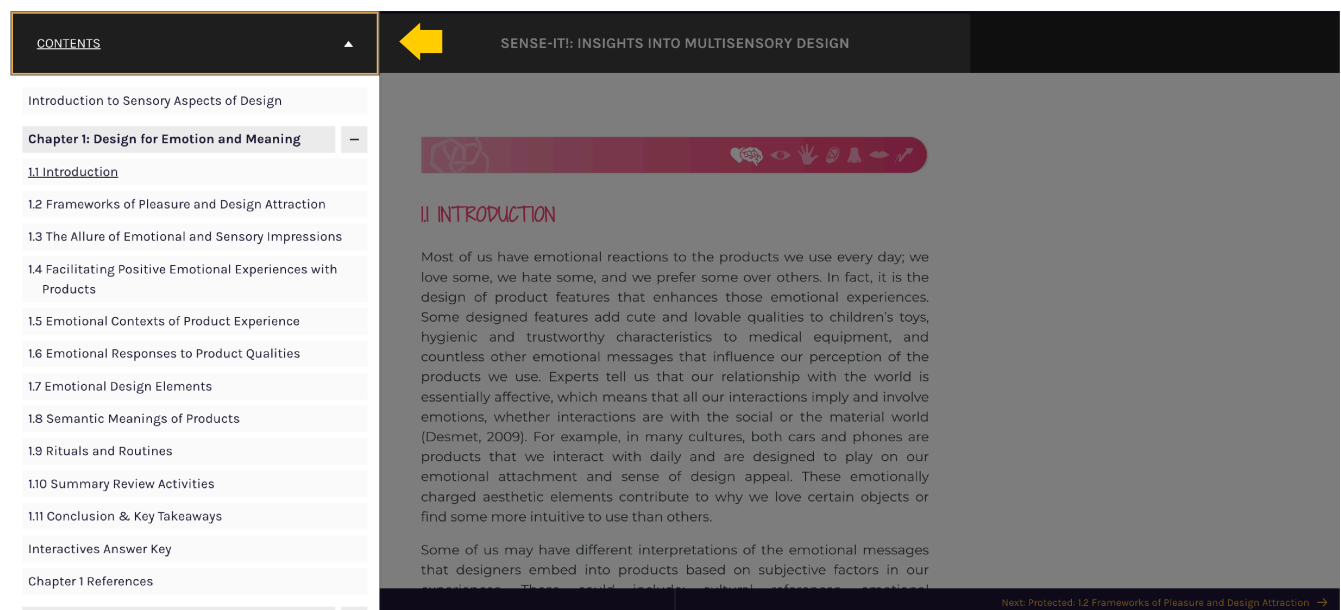
to be, the scholars who influenced its development, and recognize the team that contributed to designing it. We acknowledge the funding and support for the Sense-It! Project since it began in 2016.

Glossary

The Glossary provides definitions for terms frequently used in the professional practice of design that are mentioned throughout the book.

How to use this book

This resource is designed to enable you to use it in several ways. It can be read from the beginning to the end, in chapters, or in numbered segments within each chapter. You can use the left-side menu to navigate within chapters and from chapter to chapter.



The navigation menu is on the left



The navigation tabs between sections are always located at the bottom of the page

Each chapter contains textual information accompanied by illustrations, and in some cases, animations (gifs), and videos. Interactive assessment activities called “Activity Time” are interspersed throughout to provide the opportunity for fun, practice, and reflection. Some of the interactive activities are illustrations with hotspots like the one pictured here:



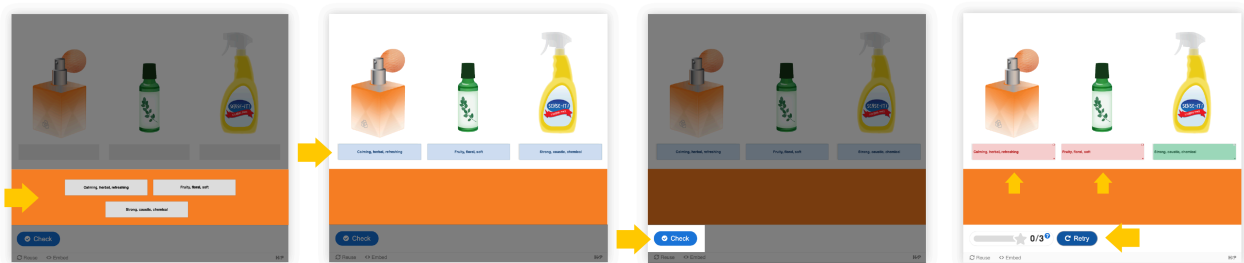
Steps for how to navigate an interactive image with **hotspots**. Clicking on each icon will provide the reader with more information to reflect on. It's important to check within the text to understand why these statements are here.



An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2123#h5p-62>

Example of an interactive Image with green **hotspot** icons.

You will come across another “Activity Time” interactive format that involves dragging and dropping answers into place. You can check (see check tab) how accurate your answers are and retry until you are satisfied. An example of a *Drag and drop* activity is pictured here:



Steps for how to navigate a **Drag and drop** activity. The labels with text descriptions can be dragged to match the product they correspond with. Readers can use the check button to determine the accuracy of the matches. Once checked, The labels will indicate which matches are correct (in green) and which are not (in red).



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2123#h5p-125>

Example of an interactive **Drag and drop** activity.

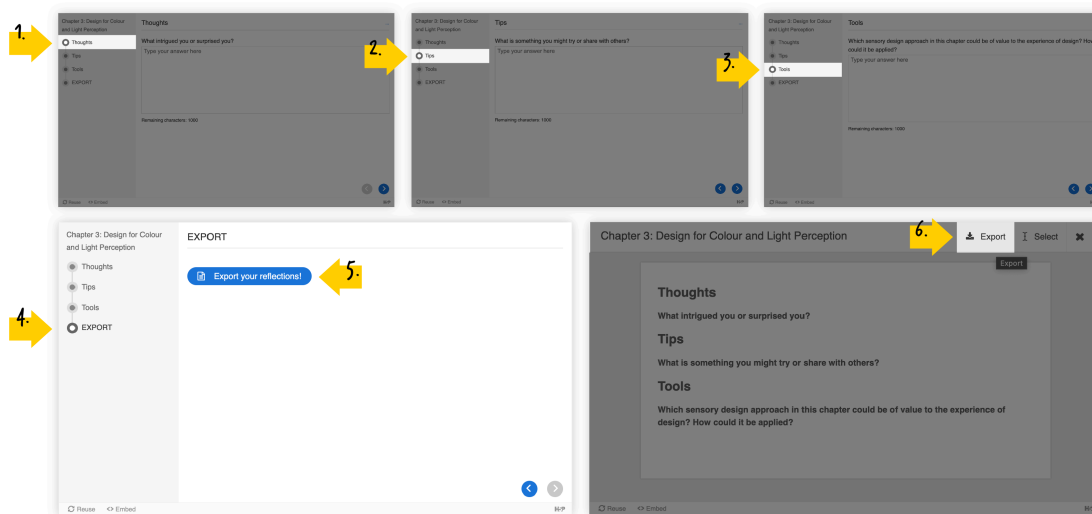
Throughout the chapters, we provide these and other activities that are fun and helpful for assessing how much of the content you grasp. Look out for mini Image Sliders and Memory Games to fine-tune your awareness along the way. In each chapter, the answers for the interactive activities can be found in the left navigation menu under the title “Interactives Answer Key”.

Reflection Time!

At the end of each chapter, you will have the opportunity to review the key points that you found significant. *Reflection Time!* encourages you to recall key concepts, principles, and guidelines to take away from each sensory theme. You will be prompted with the 3Ts:

- *Thoughts*: your ideas and opinions about the chapter.
- *Tips*: something you might try or share with others.
- *Tools*: concepts or frameworks that could have future applications.

Fill in the form by clicking through the three pages. When you are done, click “Export” to find the download icon to save or download your reflections document. This allows you to recall the key ideas from each chapter at a later date and to refer to them in future design situations.



Steps for how to navigate a **Reflection Time!** activity. Steps 1-3: Navigate through the Thoughts, Tips, and Tools sections in the navigation menu on the left and complete each section. Steps 4-6: Export your reflections.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2123#h5p-45>

Example of an interactive **reflection Time!** activity.

Conclusion

Sense-It!: Insights into Multisensory Design provides an easy-to-read and instructive overview for design students, design instructors, and practicing designers. It is for people who want to learn more about the significance of recognizing key sensory features and interactions in the early stages of design development. It is also for professionals in related fields such as applied social sciences and marketing, who want to understand the multisensory design issues that influence people's everyday experiences with products. We hope you find it useful and enjoyable!

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Begin reading: Chapter 1: Design for Emotion & Meaning

CHAPTER 1: DESIGN FOR EMOTION AND MEANING



Next section: 1.1 Introduction



1.1 Introduction

Most of us have emotional reactions to the products we use every day; we love some, we hate some, and we prefer some over others. In fact, it is the design of product features that enhances those emotional experiences. Some designed features add cute and lovable qualities to children's toys, hygienic and trustworthy characteristics to medical equipment, and countless other emotional messages that influence our perception of the products we use. Experts tell us that our relationship with the world is essentially affective, which means that all our interactions imply and involve emotions, whether interactions are with the social or the material world (Desmet, 2009). For example, in many cultures, both cars and phones are products that we interact with daily and are designed to play on our emotional attachment and sense of design appeal. These emotionally charged aesthetic elements contribute to why we love certain objects or find some more intuitive to use than others.

Some of us may have different interpretations of the emotional messages that designers embed into products based on subjective factors in our experiences. These could include: cultural references, emotional connections, familiar contexts of use, favoured design elements, metaphors, past experiences with a similar product, psychological interpretations, and sensory attributes. In order for designers to develop artefacts that are perceived as beautiful and functional, it helps to have insights into a wide range of rituals, emotions, memories, and meanings that involve product interactions. These contribute to understanding how we interact with products in different contexts and how that influences product attachment.

Many everyday products expose us to suggestive and symbolic messages because of the designer's choices of features such as surface treatments, colour combinations, and product shapes or forms. Design features may symbolically communicate subtle messages that are encoded within products, whether intentional or not, that affect our relationships with those products. This chapter discusses key concepts related to design, emotion, meaning, and ritual that are fundamental for designers to understand, beginning with the theory behind our emotional interactions with products.

Further, this chapter introduces principles that designers can draw from to enhance emotional experiences with products. You will learn:

- How designers and marketers interpret and classify people's behaviours towards products.
- The kinds of product roles that give rise to emotional responses.
- The value of long-term emotional attachment to products and how designers can support this.
- How products enhance daily routines and rituals.
- A range of multisensory emotional design approaches and elements for designing emotionally influenced product experiences.
- How to use a product semantics approach to apply emotional meaning to product design features.

Next section: 1.2 Frameworks of Pleasure and Design Attraction



1.2 Frameworks of Pleasure and Design Attraction

Pleasure: “A feeling of satisfaction or joy: sensuous enjoyment as an object of life” – Concise Oxford Dictionary

Let’s look at the kinds of interactive experiences or behaviours that motivate us to use some products and not others. Patrick Jordan, a human factors specialist, applies Lionel Tiger’s 1992 model to the pleasurable aspects of our interactions with products (Jordan, 1999). His 4-pleasures framework is described here:

1. **Physio-pleasure**— Jordan explains this as bodily pleasure connected to sensory experiences, such as touch, taste, and smell. For example, a physio-pleasure many of us experience occurs when the smell of brewing coffee lures us out of bed and into the kitchen for an energetic yet soothing start to the day.
2. **Psycho-pleasure** — This refers to our reactive psychological state while using products. For example, we often experience psycho-pleasure when we can complete a simple task, like using a remote device to lower and raise a screen, instead of experiencing frustration when struggling with the mechanical mechanism.
3. **Ideo-pleasure** — The aesthetics and embodied values in some products align with our values and personal aspirations creating a sense of pleasure related to our attitudes. For example, Lina Bonapace, a human factors specialist, explains that using products with biodegradable materials aligns with the values and personal aspirations of people with strong concerns about environmental issues (Bonapace, 2002). This results in ideo-pleasure.
4. **Socio-pleasure** — This refers to the enjoyment of being in the company of others. Many products can play a social role, either on purpose by design or accident, by being a part of everyday rituals that support our social interactions. This can include a skipping rope that brings children together or a water cooler that supports casual office conversations. Of course, all communication technologies play important social roles and effective product design contributes to our ubiquitous use of cellphones and remote technologies. In addition, some serendipitous uses of designed products, like being able to listen to music by sharing one earbud set between two people, provide socio-pleasure.



SOCIO-PLEASURE: IN BOTH IMAGES THE MAIN PRODUCT BRINGS PEOPLE TOGETHER

Activity Time!

Look at the following images. Can you identify product experiences that align with each of the categories of the 4-Pleasures Framework? Click on the pink icons to see some examples.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=766#h5p-14>

PATRICK JORDAN'S 4-PLEASURES FRAMEWORK

Similar to Jordan's 4-pleasures framework, cognitive scientist and design theorist, Donald Norman, presents a concept of an emotional design approach with three levels of design appeal that describe how users respond, interact, and experience products. These three levels of design appeal are described below:

1. **Visceral design**— This level of design appeal refers to a 'wired-in' response based on an individual's initial reaction to how a product looks, feels, or sounds. This visceral reaction influences whether we like or don't like the product at the onset. For example, even though you have a perfectly good skateboard, when you set your eyes on a next generation skateboard that was motorized, you became excited. That is a visceral design response!
2. **Behavioural design**— This level of response is based on how well a product functions. An easy-to-use product, such as a can opener that opens cans with a simple twist of the handle, is effective and pleasurable to use. That's a behavioural experience.
3. **Reflective design**— At this level, Norman describes how messages, meanings, and cultural symbols are embedded into the design of the product to influence our reflections about it. For example, when having a particular cell phone adds to our positive self-image, it falls into the reflective category of design.

Activity Time!

Look at the following images. Take some time to consider what kind of responses would be appropriate for each of the 3 levels of design appeal. Then click on the pink icons to see if you've got the idea!



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DONALD NORMAN'S THREE LEVELS OF DESIGN APPEAL

Norman's three levels of design appeal and Jordan's 4-Pleasures Framework relate to one another as follows:

- Physio-pleasure is compatible with and contributes to Visceral Design experiences because they are both bodily responses.
- Psycho-pleasure results from a good Behavioural design experience because they are both responses to the ability to successfully achieve a task with a product.
- Ideo- and Socio-pleasure are closely related to the Reflective design model, where product interactions support subjective points of view because each one is influenced by attitudes related to values, culture, society, or other meaningful experiences.

Activity Time!

Reflect on and compare Norman's and Jordan's Frameworks discussed above. See if you can match the design appeal scenarios to the types of pleasures.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=766#h5p-4>

COMPARING NORMAN'S LEVELS OF DESIGN APPEAL TO JORDAN'S 4-PLEASURES FRAMEWORK

Back to previous section: 1.1 Introduction

Next section: 1.3 The Allure of Emotional and Sensory Impressions



1.3 The allure of emotional and sensory impressions

It is common knowledge that marketers believe that design can help seduce consumers into purchasing “cool” products. As we just learned, consumers may respond to the messages behind products with visceral, behavioural, and reflective responses. A toothbrush that looks like a dragon may be appealing to kids because it seems fun and playful, while a baseball cap with your favourite team logo may draw upon deeper childhood memories. Designers may play upon the concept of ideo-pleasure to design sustainable products such as sun hats made of upcycled plastics to seduce environmentally conscious consumers. An emotional design approach may also contribute to designing assistive devices like canes or even eyeglasses that fit into fashionable trends to make them seem cool. In these cases, the emotional appeal comes from the added qualities that resemble meaningful and familiar products from the past (Schütte et al, 2009). Have you ever experienced strong emotional bonds with your favourite or special possessions, whereas other products are insignificant to you?

Did you know that people often strive to take better care of products that they are attached to, and they even exhibit protective behaviours towards them (Schütte, et al, 2009)? Just think about how you feel about sharing your favourite coffee mug or even your cell phone! That feeling of “it’s mine” is referred to as product attachment. Imagine how important it is for companies like Apple, Sony, or BMW to have their customers attached to their products and services. In a study on the value of understanding people’s emotions as drivers for product design, marketers identified the importance of learning about emotional reactions to existing products as a way of identifying the design aspects that can be enhanced with “additional positive emotional impact” (Yoon et al, 2014).

Designers may be tasked with adding features that contribute to the kinds of product appeal concepts discussed earlier that could contribute to product attachment:

1. **Pleasure**, where a product provides you with physio-pleasure (such as a car, stereo, or ski equipment).
2. **Self-expression**, where a product provides ideo-pleasure by expressing your unique identity (clothing, shoes, or vehicles).
3. **Group affiliation**, where a product provides socio-pleasure by displaying your belonging to a group (wedding ring, university sweatshirt, or a Harley Davidson).
4. **Evoking memories**, where a product provides reflective stimulation by reminding you of the past (leather jacket, heirloom, or tea cup) (Schütte, et al, 2009).

Activity Time!

Look at the following image. Can you identify any product attachment concepts that could be associated with each of the items? What could the owner of each of these items be thinking about them? Click on the pink icons to check.



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PRODUCTS may be APPEALING FOR DIFFERENT REASONS

The potential for product attachment is often considered in the early stages of product development. In the twentieth century, the Mazda Motor Corporation developed a design research method they called Kansei Engineering to improve the emotional appeal of their car design features. A Kansei quality refers to “the [sensory] impressions somebody gets from a certain artefact, environment, or situation using all her or his senses of vision, hearing, feeling, smell, and taste, as well as her or his cognition” (Schütte et al, 2009, p. 477-496). The Kansei approach is based on the belief that positive impressions contribute to better emotional responses that may promote product attachment.

Mazda’s approach uses design research that measures and analyses users’ subjective psychological or physiological reactions to the design qualities of a particular thing – the interior of the Mazda Miata car, for example – for the purposes of designing better qualities. This kind of design research has proven useful for appealing to people’s preferences by differentiating mature products from newer competitive products that may be similar in function, price point, and performance, especially in the design of vehicles. Some design theorists call this a *lifestyle-design approach*.

Back to previous section: 1.2 Frameworks of Pleasure and Design Attraction

Next section: 1.4 Facilitating Positive Emotional Experiences with Products



1.4 Facilitating Positive Emotional Experiences with Products

In a lifestyle-design approach, a key factor in the design process includes considering the kind of positive interactions we could have with products and services that we own or use. A lifestyle-design approach focuses on how to immediately trigger visceral appeal through pleasurable emotional interactions when we first engage with a product. Three different product roles that contribute to creating positive emotional product experiences, derived from Desmet (2018), can be categorized as:

1. A **pleasurable object** is something that stimulates pleasant emotional responses. The product may have features that connect to personal or cultural meanings through its look and feel, sound, smell, or even taste. For example, the sounds of a lawnmower, wind chimes, or the ice cream truck bell may remind you of pleasant summers.
2. An **instrument** is an object that makes you feel good about completing a task. For example, you may feel pleasure as a result of stapling a large pile of notes with a stapler that was strong enough for the job. Your sense of satisfaction comes from using the right instrument for the task. You may also feel a pleasurable emotion of success when cutting high branches from a tree with a long-handled set of trimming shears rather than balancing on a ladder with a pair of short-handled garden shears.
3. An **enabler** is a product that simply brings you joy or delight while you are using it. For example, you could be delighted with your bicycle while enjoying cycling along a beautiful riverside path or loving how your sneakers provide cushioning for the uneven terrain of the hilly path you are running on.

Activity Time!

Look at the following products. Can you come up with some reasons why each of these items fits into the roles described here? Click on the pink icons to see if you've got the idea!



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THREE PRODUCT ROLES

In the field of design for emotion, psychological design researchers have developed tools to help designers identify the types of experiences, interactions, contexts of use, and features that contribute to a positive interaction with the designed object (Yoon et al, 2020). They believe that positive emotions experienced while interacting with a product may contribute to an improved sense of well-being over time. For example, over time you might experience positive emotions because you are contributing to the well-being of the planet as you use eco-friendly storage containers.

Back to previous section: 1.3 The Allure of Emotional and Sensory Impressions

Next section: 1.5 Emotional Contexts of Product Experience



1.5 Emotional Contexts of Product Experience

Professor Jonathan Chapman (2015) promotes a more nuanced lifestyle-design approach that relates to incorporating sustainable values in product design. In his opinion, we develop relationships with “green” products for emotional and behavioural reasons. He credits human beings with wanting meaning in their lives, yet, he warns that our socially mediated and status-seeking culture has set us up to disregard the authentic meaning of objects in favour of the latest upgrade as we quickly become dissatisfied with the status quo – from cell phones to snowplows to digital applications. He adds that products that are complicated to use affect the emotional product-person relationship on a behavioural or psycho-pleasure level; where more complexity can lead to less pleasure and more purchasing of the next best thing. In addition, that dissatisfied *fear of missing out* (FOMO) also leads to rampant consumerism and consequently, heaps of discarded products. These behaviours induce more meaningless consumption and jeopardize the sustainable future of the planet.

Emotionally durable design that is connected to sustainability also contributes to the potential to create emotional bonds between people and their products. Chapman believes that designers can encourage *affective* attachment to products using appealing aesthetic, behavioural, cognitive, sensory, and symbolic design elements. Based on this premise, could it be that designs that encourage stronger emotional experiences support our willingness to keep products longer? If so, this means designers may hold the keys to supporting our ability to be psychologically and emotionally connected to our products; that connection could increase the timeline during which we perceive value in keeping our products. If we are attached to our products, we will not want to abandon them or the meaning they bring to our lives. And this limits what we throw out! For example, feeling an emotional connection with family heirlooms provides a sense of socio-pleasure and reflective connection.



AN EMOTIONALLY DURABLE FAMILY HEIRLOOM ADDS VALUE

We are not usually conscious of how we interact with products until they don't work! As the title of Industrial Design Professor Brian Burns' (2012) book says, "People want toast not toasters". He means the product is the means for completing a task and when it has complex functions or is difficult to use, it can create frustration for the user. For example, a multi-use tool that offers numerous functions might be initially appealing yet, ultimately lead to dissatisfaction as it may be perceived as too complex to operate easily. This often results in discarding the item. Have you ever discarded an item for this reason? If so, what could you do differently next time?



PEOPLE WANT TOAST, NOT PROBLEMS

Design researchers warn us that we need to take an ethical approach to designing for emotions (Yoon et al, 2020). The marketing approach of commoditizing positive emotions focuses on our desire "to have" a product, which may lead to short-lived product attachment. Whereas a *design for emotion approach* is oriented toward meaningful and long-term product engagement (Hassenzahl, 2010). This is where emotionally durable design may lead to more fulfilling product experiences that could have better effects on our well-being, the environment, and the economy.

The impacts of emotionally durable design can be seen with vintage car collectors. The collector is likely fond of cars in general, but what makes them invest time and money into their rare car? Their attachment may arise from the collector's perceived value of the car's uniqueness (ideo-pleasure) or it may be associated with childhood dreams or memories of positive and rewarding emotional experiences (evoking memories). For example, my grandpa had a Thunderbird and I remember him taking me for a ride on my birthday. Owning a similarly special car helps me feel closer to him. This is an example of emotionally durable design that provides socio-pleasure and reflective stimulation.



EXPERIENCING PRODUCT ATTACHMENT

Back to previous section: 1.4 Facilitating Positive Emotional Experiences with Products

Next section: 1.6 Emotional Responses to Product Qualities



1.6 Emotional Responses to Product Qualities

Product features can contribute to both positive and negative emotional responses. Our perceptions of strong product quality are often influenced by positive responses. For example, if you end up with a sharp pencil each time you use your pencil sharpener, you will likely think it is a well-made pencil sharpener. If you sometimes end up with a broken pencil, you will decide it is a poorly made *instrument*. Likewise, a well-designed product can have product features designed to trigger a negative emotional response to reinforce appropriate behaviours. For example, a jar may be designed to be difficult to open to prevent children from unsupervised access.

Negative emotional responses may also contribute to richly nuanced user experiences. For example, your loud morning alarm is likely an unpleasant disturbance, but it is an instrument that achieves the goal of waking you up. Hopefully, it also serves as an *enabler* that leads to a feeling of satisfaction at starting your day as planned. In this case, according to Fokkinga and Desmet (2012), a negative reaction to a disturbing alarm helps a person, ultimately, transform their perception of and attitude toward certain situations. Although we are initially annoyed by the loud alarm, we end up appreciating the on-time wake-up call to start our day.

Although that negative reaction to the alarm may lead to a positive user experience, designers are usually not hoping for a negative association or frustration while using a product. If a potato peeler doesn't peel potatoes the user will want to discard it. If a computer doesn't work, few of us will destroy it, but we welcome enhancements that make it easier for us to do our desired tasks or make a different brand choice when we need a new one.

Gif of a person working at a computer and becoming frustrated when the computer encounters an error.

EMOTIONAL RESPONSES TO PRODUCT QUALITIES

Activity Time!

Select the best answer to the question below.

—



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Physical pleasure or discomfort toward a product can come from the actual feeling of materials – a cozy blanket, a sharp knife, a scratchy clothing label, or a slimy object’s surface. Touching something cold like an ice pack can make you shiver, touching something ancient and rusted like a rusty tool can make you feel dirty, or touching something soft like a blanket can make you feel cozy and secure.

Affection is often associated with the meaning we perceive of products – I love my teddy bear, my delicate fishing lures, my freshly washed and polished car, or conversely, I really don’t like this camera my father gave me, but it was a special gift from him, so I keep using it.

A product’s visual qualities and your emotional responses to them can seduce you to select and cherish it or avoid it. For example, a beautiful hand-crafted wooden picture frame with a family photo in it may bring back good memories for you, whereas a dented car fender that reminds you of an unpleasant experience does not bring back good memories. These emotional responses to products are often subjective and differ among people. You could be thrilled with your new coffee maker because it makes amazing espresso, whereas I might be disappointed with its complicated features and shiny black surfaces that require a lot of cleaning to remove fingerprints.

Pieter Desmet (2009) notes that “seeing, touching, hearing, and smelling an object can be a strong emotional stimulus” (p. 390) before and during product use. In other words, specific sensory design features contribute to how the product is perceived, used, and enjoyed. Qualities discussed in the following chapters such as appearance, colour, composition, surface textures, sounds, and smells are sensory elements in the overall design of the product that can contribute to and sometimes elicit emotional responses.

Back to previous section: 1.5 Emotional Contexts of Product Experience

Next section: 1.7 Emotional Design Elements



1.7 Emotional Design Elements

The term *affordance* is used by psychologists who study how people perceive situations and things. The concept of an affordance was coined by psychologist James J. Gibson in his seminal book, *The Senses Considered as Perceptual Systems* (1966). The concept was introduced to the Human Computer Interaction (HCI) community by Donald Norman in his book, *The Design of Everyday Things* (1988, 2013). Norman argued that instructions and labels are unnecessary if people understand how to engage with and use a product by interpreting the product's affordances. Norman described the affordances or elements of the designed object or service that communicate its purpose and operation as *signifiers*. The features of well-designed objects communicate or signify to a user what it can be used for (or what uses it affords); hence a door handle is considered an affordance. For example, if you see a light switch, it acts as a signifier to indicate that by toggling it, the light will go on.

Design Affordances

Affordances provide clues about how an object should be used, typically provided by the object itself or its context. Even if you've never seen a coffee mug before, the handle intuitively signifies its intended use. It is shaped for easy grasping and other elements in the design act as *signifiers*, similar to how the large opening at the top of a bottle with an empty well inside communicates that this is a volume waiting to be filled with liquid. Of course, these affordances depend on previous cultural experiences. Affordances are a specific case of product semantics, which we discuss next.

Activity Time!

Click on the pink icons to see examples of product affordances.

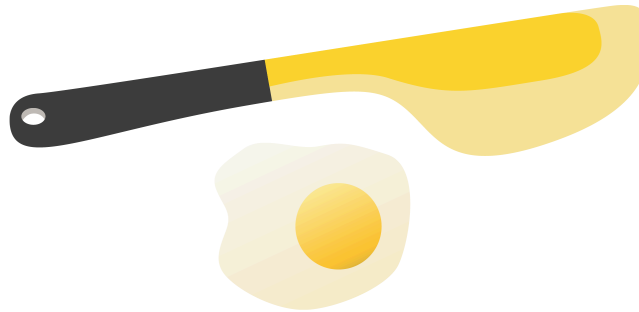


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Product affordances on a game controller

Product Semantics

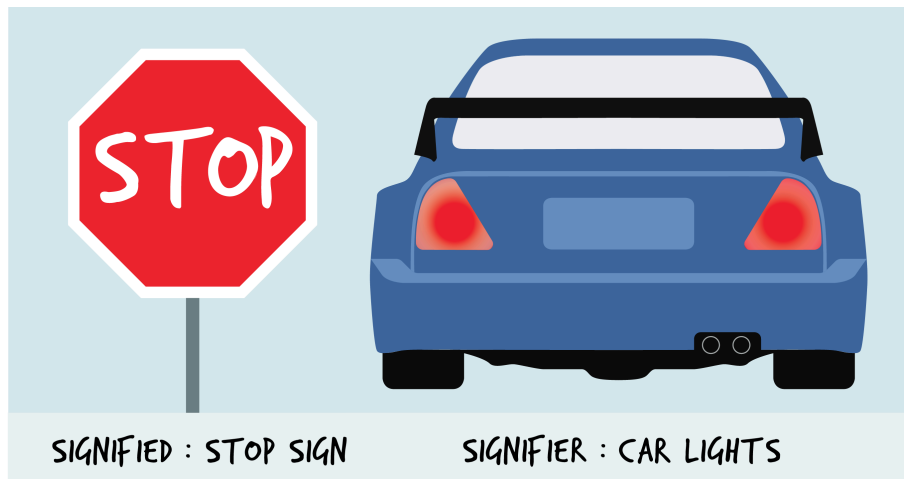
The term **product semantics** was coined by Krippendorf and Butter in 1984 to describe the study of the communicative properties of manufactured objects; what they signify to users about their operation and appropriate social contexts. In industrial design, the term *product semantics* usually refers to the ability of a form, surface texture, pattern, material, or colour to convey the intended purpose of a product or the environment in which it is used. Symbolic properties of form can express meaning when we have prior knowledge that enables us to interpret the code or message designed into the product.



THIS SPATULA USES AN EGG METAPHOR

Krippendorf (2006) notes that meanings can be designed into and derived from products in a range of ways. While using a product, we may associate similar ways to use it with other products, visual metaphors, and conceptual models we already have, or we may associate it with familiar affordances and use scenarios. For example, a kitchen chair can be used as a perfect step ladder to reach pots and pans stored on higher shelves, not just to sit on. We also share cultural ideas about aesthetics, group identity, institutional qualities, common metaphors, and narratives. For example, if someone told you that they have a stupid pencil sharpener or a nasty screwdriver, you'd likely interpret both of those descriptions as negative.

Product semantics are symbolic properties that convey meanings that play upon the users' prior knowledge. Since the designer is not there when you are interacting with the product, the use of the object must be self-explanatory, which is also known as a *self-sign*. Self-explanatory products send a message to you through signs and clues encoded into the product, expressed through features such as form, surface texture, pattern, material, or colour. These design clues reinforce your perception of what that product is communicating. Design clues are called signifiers because, like Norman's definition, they are associated with known experience and product interaction. For example, red car brake lights are signifiers of a red stop sign or red stop light; they say STOP. How do you think traffic lights get across the message that it's okay to start driving? What traffic light features are signifiers that send you the message to stop, to go, to slow down?



THE CAR LIGHTS SEND THE MESSAGE– **STOP**

Krippendorf (2006) asserts that interpreting design clues is dependent on the appeal of one of three modes of our attention, as users:

1. **Recognition**: our ability to identify the clue and how it can be used.
2. **Exploration**: our ability to figure out how to operate something, how it works, and what to do to achieve desired outcomes.
3. **Reliance**: our ability to intuitively recognize the clues without having to pay close attention to how to use the product.

Activity Time!

Click on the pink icons to see examples of product clues.



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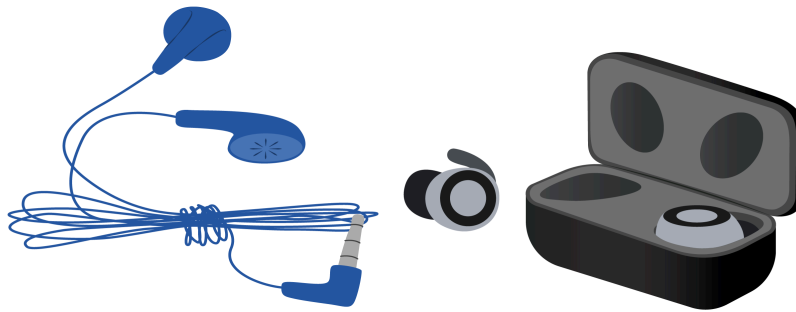
3 MODES OF USER ATTENTION

Theorists like Krippendorf and Vihma (2003) say that you can perceive product semantics through design elements that consciously rely on *form factors* (this is a design expression to describe formal or 3-dimensional product features) that remind you of another familiar emotional response such as:

- Imitating the form of a tough hammer to impart the spirit, character, feel, or emotional memory of a rugged product.
- Borrowing a form factor from another product to indicate that this product works similarly, like a game remote that looks like a boat steering wheel.
- Using form factors that are already in the environment where the product will be used, such as in an office or a workshop.

Not only does the concept of product semantics refer to the encoded clues in the product design features, but it also refers to the quality of the relationship between you and an artefact. Did you know that the ability to apply product semantic elements in design differentiates designers from other professionals involved in product development? Our ability as designers is to observe users, understand their conceptual frameworks, and incorporate design elements. These elements communicate unspoken messages that enable us to figure out how to interact with products, services, or environments in familiar ways, even if the product is new or unfamiliar.

In fact, product semantic design elements that carry over from an earlier model of a product can contribute to our acceptance of the new version of that product. This is a design strategy that plays on familiarity with the initial product, making it easier for us to decode the meaning, accept, and interact with the more advanced product. While it can also be considered manipulative, by encouraging us to buy the newer product, it can also be considered supportive by making it easier to transition to the newer product.



SIMILAR OVAL FORM FACTORS CARRIED OVER TO NEW WIRELESS EARBUDS

Back to previous section: 1.6 Emotional Responses to Product Qualities

Next section: 1.8 Semantic Meanings of Products



1.8 Semantic Meanings of Products

Krippendorff and Butter (1984) introduce us to four *semantic functions* of products: expressing, describing, triggering (which Krippendorff calls exhorting), and identifying. These semantic functions provide more insight into ways to interpret the meaning and attributes of one thing (the signifier) and apply them to communicate the meaning and attributes of another (the signified). Let's look more closely at them:

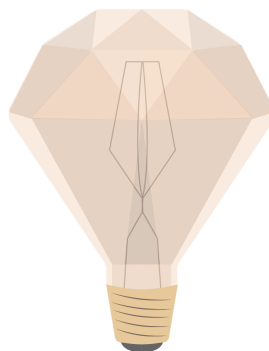
Expressing

A product's overall aesthetic can include features that express the values, qualities, and properties of the product. Product semantic elements may convey stability, softness, heaviness, or lightness. For example, the power bank below uses design clues that incorporate form factors from rugged tires and an orange and black colour palette that signifies that it is a working tool resistant to all sorts of factors from shocks, vibration, dust, or solar radiation to extreme temperatures, low pressure, rain, fog, and humidity.



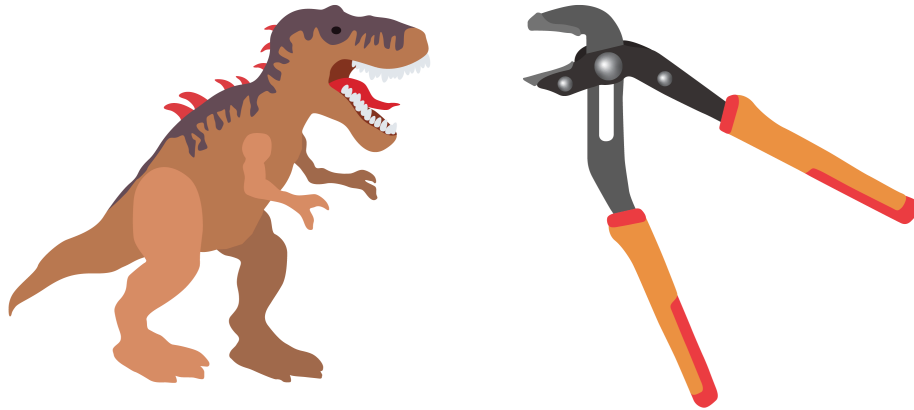
THE SEMANTICS OF THIS POWER BANK EXPRESS RUGGED USE

Another example of expressive product semantic elements can be found in this lightbulb, designed to imitate the form of a diamond, with sharp faceted edges that communicate extreme durability, clarity, and long-lasting use by symbolic association with a diamond.



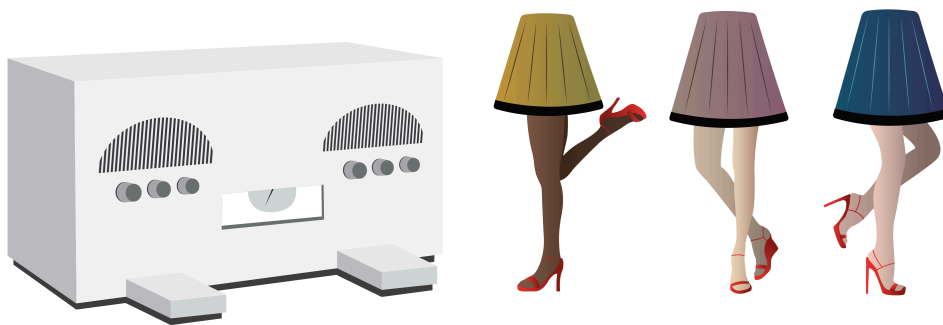
THIS LIGHTBULB DESIGN EXPRESSES A DIAMOND METAPHOR

In the next example, the meaning and attributes of one thing could be compared to the meaning and attributes of another. Imagine that you start to make your own semantic associations for certain products – can you relate the overall form and stance of the pliers below to a tenacious and strong T-Rex dinosaur? Sometimes we perceive metaphors that designers did not initially intend, hence as designers, it is good to find out how users perceive the metaphors we embed into products.

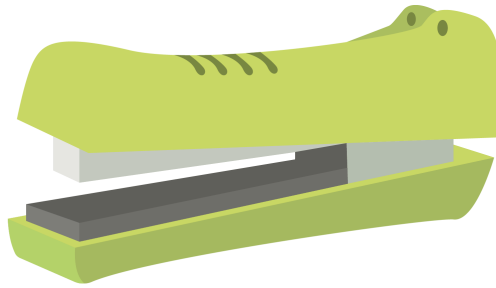


THESE PLIERS EXPRESS A DINOSAUR JAW METAPHOR

An important aspect of expressing semantic meanings relates to anthropomorphizing a product's design features to inspire users to view the product as human-like. Anthropomorphizing refers to attributing human traits, emotions, or intentions to non-human entities. It embeds simple or sophisticated elements and traits into a product's appearance that inspire users to behave as if the artefact has human qualities. These anthropomorphic elements can be intentionally designed or user-attributed (like naming a car) and may result in our becoming more attached to a product. In the images below, we can see examples of products that are intentionally designed to imitate human-like features.



2 KINDS OF PRODUCTS WITH ANTHROPOMORPHIC FEATURES



SOME PRODUCTS SIGNIFY ANIMAL ATTRIBUTES TOO

Describing

Product semantic elements can be used to describe the purpose and function of a product. For instance, a round door knob provides a descriptive clue for the user to grasp it whereas a door knob with a handle provides a descriptive clue for the user to push it down. The metaphor of a traffic light – green, amber, and red – is applied to the mobile payment device below. We may associate ingrained cultural and societal cues to direct, identify or link elements in an object. The machine incorporates the universal green for go, yellow to yield, and red to stop, which is a familiar societal reference. In this case, the signifiers are the three coloured machine feedback buttons that signify the same message as a stop light (go, prepare to stop, stop).



THIS PAYMENT DEVICE USES A STOPLIGHT METAPHOR TO DESCRIBE POSSIBLE ACTIONS

Triggering

The design of a product may play on product semantic messages that trigger a visceral response for the user – for example, to be careful or to be precise. Triggering clues can also be very specific in providing you with a message about how to operate a product. For example, if you grasp a hairdryer on the handle close to where the buttons are located, you will avoid covering the air intake and causing overheating. In this case, the cues that instinctively direct you to hold the handle implicitly direct you to avoid the danger zone at the air intake end!



SOME CLUES TRIGGER APPROPRIATE ACTIONS: THE HANDLE INVITES HOLDING

Identifying

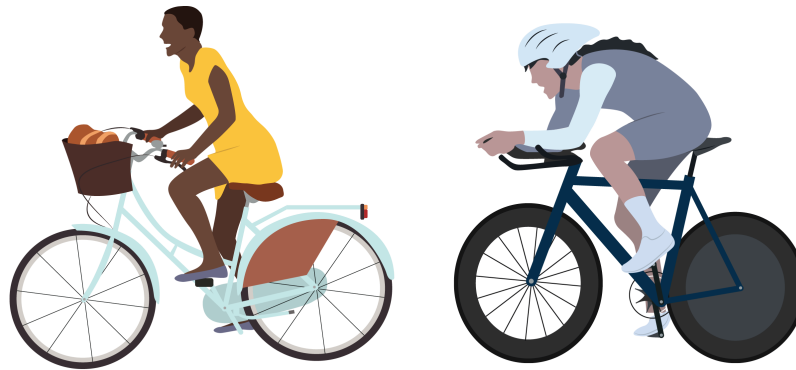
A product's semantic message identifies key attributes about it and in certain cases also about the human being who owns it. We often extend product attributes to product owners, which help locate people in the complex societal map of roles, groups, subcultures, age, and gender. For example, you may identify the owner of an iPhone as being cool and affluent whereas you identify the owner of an Android as being practical and less current. In addition to product semantic messages contributing to our human identity, iconic symbols of products can be associated with specific references, areas, cultures, or eras.

Social status can also be identified through product semantic messages, which address the commercial trend to own designer goods. Many people go out of their way to own designer luggage, which in the example below communicates a message of wealth, luxury, and elevated status.

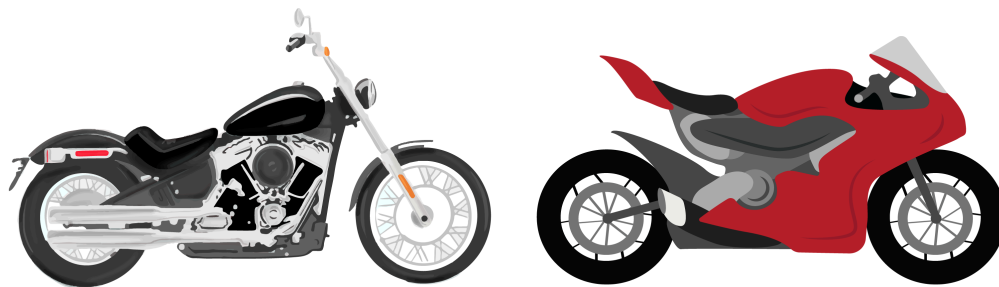


SEMANTIC MESSAGES IDENTIFY LUXURY PRODUCTS & SEND STATUS MESSAGES

Owning a particular type of motorcycle, for example, may associate you with a specific subculture or age group. Owning a cruiser bike, a street bike, or a touring bike might also offer clues to the age or status of the cyclist. Sporting goods products depend on qualities like form, material, and colour to target specific gender and age groups.



BICYCLE SEMANTICS DIFFER ACCORDING TO THE CATEGORY OF CYCLISTS



MOTORCYCLE SEMANTICS TARGET DIFFERENT SUBCULTURES

Ideo- and socio-pleasures can also be related to branding decisions. In Yoon et al's (2014) study of the Nuances of Emotion in Product Development, designers and marketers expressed an interest in aligning the impact of a product with the positive emotions that best represent its brand. For example, the Nike swoosh logo and the iconic Coca-Cola curves are considered cultural icons associated with leisure and recreation and are recognized worldwide. Can you bring them to mind as you read this?

Many well-designed products or objects contain encoded messages that communicate a purpose or meaning, both for the designer and the user. We are all exposed to product semantic messaging in our everyday product interactions. Have a look at the product semantic messages encoded into the razors depicted below: What population demographic do you think is being targeted for each one?



TRADITIONAL "GENDERED" DESIGN

These products are not gender neutral; design theorists call them gendered products because they are designed with cultural codes embedded into their features. *Gendered products* assume the target market for a product. As seen in the examples above, designers often associate a product's design features with cultural codes through colours, forms, shapes, and materials connected with stereotypes. Some of these codes are associated with gender roles. Marketers and designers use these cultural codes to create and tailor products to be interpreted as suitable for specific genders.

Gender branding of products is not a modern concept; it is a centuries-old practice (Forty, 1986). However, it is a growing topic of interest among designers as we become increasingly aware of the impacts of product semantic messaging such as those above. Designers have taken an active role in perpetuating the gender-branding of products through the product semantics of form and colour. In this current time of gender questioning, is it necessary to design and create a variety of subtle and overt gender-branded products that only increase product waste in landfill sites? Perhaps the solution is not to design gender and culturally-neutral products, but rather, the designer is informed about who is using the products and how they are used, and avoids embedding products with semantic interpretations based on our own cultural assumptions (Powers, 2017). Understanding the kinds of use-behaviours people have with products, instead of relying on a bias toward design that supports specific gender identification, can strongly influence a designer's choice of semantic or aesthetic features.

Many of these design semantic approaches are suitable for enhancing daily rituals and routines.

Back to previous section: 1.7 Emotional Design Elements

Next section: 1.9 Rituals and Routines



1.9 Rituals and Routines

Designers come into the initial product development process by adopting a *human-centred* approach to design. This means they take the time to systematically understand user behaviours, rituals or routines, and subjective views. This knowledge can contribute to designing better sensory experiences that enable you to perform your tasks well.

Think about some of the mini routines or rituals that are familiar, easy to follow, and an important part of your everyday experiences. How do they involve interacting with products, services, or environments? How can you determine if they are rituals or routines? One of a designer's roles is to recognize the differences between rituals and routines in order to design the artefacts that can best contribute to those activities. Routines and rituals differ in some ways. Routines deliver efficient results (having a 'wake-up' cup of coffee or arriving at the workplace punctually), whereas rituals focus on deep beliefs that are associated with the steps of your activities, as we will discuss later.

Routines that are part of everyday experiences often take place within a whirlwind of activity, like boiling eggs, making bacon and toast, feeding kids, cleaning sticky spills, and drinking coffee. You may be able to relate to the ways some of these simultaneous routines create distractions, where your attention can be jumping among activities. Can you recall a time when you were rushing through a daily routine to the point of feeling like you were not really paying attention to what you were doing? Researchers Lévy and Hengeveld (2016) remind us that sometimes we perform these everyday routines automatically; they are mostly functional rather than meaningful. *Functional rituals* can be somewhat adjustable in their sequence or timing, like charging your cell phone or heating a frozen meal. These kinds of everyday interactions are more appropriately called *routines* and are focused more on performing an action without any deep meaning or emotions attached to it, like reheating that meal.

Over time, routine processes may evolve into deeply *personal rituals*, like tying your shoes in a certain pattern and then continuing to use that pattern each time you play soccer because you think it may contribute to a successful game. Reflect on special rituals that you find meaningful and the steps involved in doing them. The same rituals can happen both daily and ceremonially, and, therefore, it is the context of use that plays an important role in determining the nature of the design elements. For example, your daily teacup could be a functional insulated metal mug with a lid designed to hold a lot of liquid and to travel without spilling, whereas your ceremonial tea bowl could be a delicate porcelain vessel that fits into the palm of your hand, hot to the touch, and designed for slow and gentle interactions.

Meaningful behavioural cues can be designed into ritual artefacts to keep participants focused on the experience. For example, the Japanese tea ceremony is a well-known ritual that follows a sequence of multisensory events, using ritual objects such as a tea caddy, a tea whisk, tea bowls, a tea kettle, and a brazier. According to Pierre Lévy (2015) and Ger Bruens (2011), ritual sequences are often structured into a series of culturally significant actions that enhance personal values and meaning over time. These actions

can be either simple or complex and are structured into three phases: a preparatory phase, an experiencing phase, and an ending or closing phase.

By way of further distinguishing between routines and rituals, Lévy and Hengeveld (2016) identify the key experiential qualities of rituals as:

- incorporating cultural values that affect people's perceptions.
- requiring active and significant multisensory participation.
- separating from daily life in some way that frames them as special.
- positively affecting the performer in ways that ripple out into their other activities, adding to a sense of well-being.

To further help us recognize the differences between rituals and routines and to better design for them, we turn to anthropologist Grant McCracken's insights on daily, exchange, expropriation, possession, and self-made rituals (as cited in Bruens, 2011):

Daily rituals or routines offer a way to balance, energize, and connect us to our world. They can be simple routines like having a morning coffee or a hot shower at the end of the day. Or they can be deeper rituals like meditating early in the morning. These daily rituals and routines provide meaning, comfort, authenticity, and connection to our day. They may provide reflective appeal.

Exchange rituals can be somewhat more special. They involve giving and receiving presents that highlight singular events like holidays, birthdays, celebrations, or life transitions. They often lead to symbolic attachments to the gifts (my best friend gave me this keychain) or product-related (we always use our family birthday knife to cut the cake) rituals that offer meaning to either the recipient or gift giver or both. They relate to ideo- and socio-pleasure.

Expropriation rituals include disposing of, disassociating with, or giving away an object, either by choice or not. Given that different objects may hold encoded meanings for each of us, we may feel a loss when it is no longer ours. For example, it may be emotionally difficult to give away old books or childhood toys that we no longer use. Sometimes a meaningful ritual can help with the transition to letting go. These rituals may respond to behavioural appeal as well as socio- and ideo-pleasures.

Possession rituals refer to the desire to possess and accumulate products for personal gratification or status. The purchase of the latest car, phone, or home can be both personally significant and contribute to your perceived social status. This is strongly connected to ideo- and socio-pleasure.

Self-made rituals are ways to adapt a practice from an existing ritual so that it fits one's needs and context. For example, a couple might blow bubbles, which children commonly do for daily fun, or release sky lanterns at their wedding to honour a lost family member, hence personalizing their ceremony to reflect their values. This is an example of reflective appeal and ideo-pleasure.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=780#h5p-6>

RITUALS CAN MAKE EVERYDAY EXPERIENCES SEEM SPECIAL

Activity Time!

Click on the boxes to view types and examples of rituals. Match the ritual example to the type of ritual!



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RITUALS AND THEIR MEANINGS

In most cases, we perform rituals in specific ways to achieve a goal, honour cultural customs, or provide pleasure and satisfaction. The objects we interact with during rituals may embody meaning or transmit encoded messages or symbolism that varies for different users. For example, a pair of mittens given to you by your favourite aunt might be meaningful to you because they were a gift from your aunt and enable you to be warm and comfortable on a winter's day. Whereas your friend may have the same pair of mittens that they regard as practical for warmth but not special in any way. Similarly, a designer might understand the purpose and function of a product but not the type of attachment a user might form with it. This is the unknown human variable that all designers face.

Designers may gain meaningful information to contribute to the quality of a design by observing and studying how people relate to the products in various contexts of rituals and/or routines. The goal of a successful design is to develop a functional, emotionally connected, and meaningful object that users will want, use, and cherish.

Video: Rituals and Routines

Press play on the video below to view an example of a ritual and a routine.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=780#oembed-1>

Back to previous section: 1.8 Semantic Meanings of Products

Next section: 1.10 Summary Review Activities

1.10 Summary Review Activities

Activity #1

Activity Time!

Drag each type of product appeal to the mug that you think it best corresponds to based on the semantic messages it communicates.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=782#h5p-7>

OBJECTS CAN COMMUNICATE PRODUCT ATTACHMENT MESSAGES

Activity #2

Activity Time!

Recall the different roles described earlier. Can you identify how the French Press may act as either of them at different times?



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=782#h5p-22>

Objects may embody multiple roles

Activity #3

Activity Time!

Take a moment to think about the affordances that each of the products below may have. Drag the affordance and the action descriptions on the left into the appropriate boxes for each product.

Hint: Some may correspond to more than one of the products!



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=782#h5p-23>

Products have many affordances that send subconscious messages to users

Activity #4

Activity Time!

Think back on each of the product-interaction moments in the previous video. First, see if you can order them appropriately. Then, imagine yourself in that moment. What kind of pleasure do you think is most likely to be experienced in each of those moments?



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=782#h5p-21>

Product Rituals and Routines may be pleasurable in many ways

Back to previous section: 1.9 Rituals and Routines

Next section: 1.11 Conclusion & Key Takeaways



1.11 Conclusion

Through understanding the concepts of emotional design, from the theoretical to the practical, this chapter provides insight into the potential for designing from a human-centered perspective. The concepts presented here shed light on the importance of understanding our desired goals, frustrations, and pleasures when we interact with products in specific contexts. The kinds of emotions that arise can run the gamut from positive to negative, and influence how we respond to, think about, and use products. This information contributes to making insightful decisions about designing products for the people who use them.

Key Takeaways

The key takeaways from this chapter include:

- Understanding the range of theoretical discussions about people's behaviours toward products including the frameworks of product pleasure and appeal, Kansei engineering, and emotionally durable design.
- Knowledge of the kinds of product roles and features that may give rise to emotional responses and a sense of meaning in product interactions.
- Recognition of the long-term value of designing for emotional attachment to products.
- Exposure to a range of multisensory emotional design approaches and elements for designing positive and negative emotionally influenced (also called affective) product experiences.
- Perception of the value of product semantics as a design tool for applying emotional meaning to product design features: for expressing ideas, describing actions, triggering responses, identifying with familiar concepts, and enhancing product meaning.
- Awareness of how products are integrated into daily routines and rituals, and the variety of experiences that provide an opportunity for meaningful stages of product use.



Chapter 1: Design for Emotion & Meaning

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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The next chapter provides a more detailed approach to identifying design elements.

Key Words: Emotions, Emotional Durability, Affordances, Semantics, Emotional attachment, Design appeal, Routines and rituals, Affective product experiences, Product semantics

Back to previous section: 1.10 Summary Review Activities

Next section: Chapter 1 References



Interactives Answer Key

Section 1.2: Form Factors of Compositions

Comparing Norman's Levels of Design Appeal to Jordan's 4-Pleasures Framework

3 Levels of Design Appeal & 4 Pleasures Framework

Visceral: **"It's so cool, I want it!"** & **Physio Pleasure**

Behavioural: **"I can master it, it is a great tool!"** & **Psycho Pleasure**

Reflective: **"It means so much to me and it shows my personality!"** & **Ideo & Socio Pleasure**



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1014#h5p-28>

Section 1.6: Emotional Responses to Product Qualities

Multiple Choice: How could you design a product that evokes positive emotional responses?

Identify the features that people find frustrating to use and improve them.

Section 1.9: Rituals and Routines

Memory Game

Daily Rituals & "Meditating during your morning commute to work"

Exchange Rituals & "Gifts on holidays"

Expropriation Rituals & "Passing along old textbooks to a younger sibling"

Possession Rituals & "Adding to your collection of comic books"

Self-made Rituals & "Personalized anniversary traditions"

Section 1.10: Summary Review Activities

Objects can communicate product attachment messages

Mug with letter "M": "Self-expression"

Glass tumbler mug: "Pleasure"

Mug with travel graphics: "Memories"

Mug with university logo: "Group affiliation"



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Section 1.10: Summary Review Activities

Objects may embody individual roles

In the video above, the French Press acts as a/an:

- A) pleasurable object when **you remember the pleasant morning smell of coffee brewing as a child**
- B) instrument when **you easily prepare the perfect cup of coffee**
- C) enabler when **you are delighted that you can prepare such a great cup of coffee at home**

Section 1.10: Summary Review Activities

Products have many affordances that send subconscious messages to users

French press

Corresponding affordances: Open Cavity, Handle, Spout, Plunger, Rim

Actions they prompt: Pushing, Filling, Pulling, Gripping, Pouring, Aligning

Mug

Corresponding affordances: Handle, Rim, Open Cavity

Actions they prompt: Gripping, Drinking, Filling

Alarm

Corresponding affordances: Buttons, Numbers, Feet, Beep Noise

Actions they prompt: Stabilizing, Alerting, Pushing, Informing



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1014#h5p-31>

Section 1.10: Summary Review Activities

Product rituals and routines may be pleasurable in many ways

Ritual

Preparatory Phase: French press and mug image & “Psycho-pleasure”

Experiencing Phase: Two mugs clinking together & “Socio-pleasure”

Closing Phase: Clean mug with cloth & “Physio-pleasure”

Routine

Preparatory Phase: Alarm clock & “Psycho-pleasure”

Experiencing Phase: Coffee machine dispensing coffee in travel mug & “Physio-pleasure”

Closing Phase: Empty coffee pods & “Ideo-pleasure”



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1014#h5p-30>

Back to previous section: 1.11 Conclusion & Key Takeaways

Next section: Chapter 1 References

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Back to previous section: 1.11 Conclusion & Key Takeaways

Next chapter: Chapter 2: Design and Visual Perception

CHAPTER 2: DESIGN AND VISUAL PERCEPTION



Next section: 2.1 Introduction



2.1 Introduction

When you are at your local hardware store selecting a new vacuum cleaner, electric drill, or kettle, you may not realize that those products are communicating with you through their form, composition, and element combinations. Every well-designed product you use is sending you a message in this way.

Let's imagine that all the electric drills are lined up on two shelves and that you have some idea of what you want. Your requirements may include ideas like cordless, easy to hold, storage for extra drill bits, strong carrying case, and so on. Based on your requirements, you will expect the product *housing* to provide you with a clue about where the battery is – perhaps one unit has a different colour and a visible parting line to indicate separation. The product may clearly communicate where the grip is and that it is strong and fits your hand, or the grip is a different colour and made of a softer material, like silicone, that prevents slipping. You will also want clues about where you can store your extra drill bits – perhaps the handle end has an elongated section that clearly opens and has a locking mechanism so none of the drill bits can fall out. As well, you will want to be convinced that the carrying case is right for you – perhaps it is very compact, and you know it will fit with your other workshop tools, or it may have a large handle and two closing tabs that snap firmly shut. As you may know from other shopping experiences, not every electric drill on the store shelf will meet your requirements – you will be considering tradeoffs and prices. Given these few overlapping requirements, and others not yet expressed, the principles in this section offer the means to embed a visual language into the formal composition of those electric drills to help you choose the best one for you. These principles apply to any other products we design from baby strollers to car dashboards.

In this chapter, we are going to explore how designers embed messages that communicate with users to impart emotion, meaning, and function into the visual language of products. This chapter explores a designer's foundational knowledge by providing principles for developing product shapes and forms, often referred to as “the look and feel” of the product. In this chapter, you will learn:

- What a composition is.
- How overall form can be organized to communicate messages about how to perceive it.
- The Gestalt principles of visual organization that contribute to the perceived aesthetics, functionality, and user-friendliness of a product.
- How to systematically organize the elements within a composition to perceive them as a unified whole, where the whole is greater than the sum of its separate parts.
- The kinds of relationships and hierarchies among the sub-elements of a composition that indicate a *hierarchy of perception* – from most information-rich to least.
- How proportions, orientation of axes, and formal transitions between elements contribute to a perceptual hierarchy and unify an overall composition.

Next section: 2.2 Form Factors of Compositions



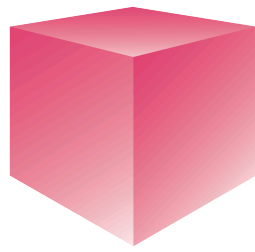
2.2 Form Factors of Compositions

Overall Perception

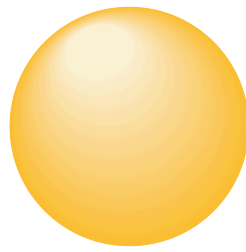
A composition is a structure, arrangement, or organization of design elements into a perceived whole. Compositions can be *two-dimensional*, such as an artist's painting or a poster, where we convert the visual elements into a meaningful story to help us interpret what we see. Compositions can also be *three-dimensional* and, similarly, the sub-elements are arranged so that we can easily perceive them as part of a coherent object. For example, the housing or outer surface of your hairdryer is made of several elements. When considered as a whole object, it may look a bit like a gun with a handle in one place and a blower in another. When you think of a hairdryer, do you think of it as an object with a handle unit, a cylinder containing the mechanical components, with an air intake unit and an air output unit? Or would it be just a hairdryer with all these sub-elements harmonized into an overall composition?

The essence of developing a form that communicates information-rich messages is to determine the overall *formal composition* of the product. It may have many elements or parts, but nevertheless, there is often an overriding *formal organization*. Formal organization is a design term that refers to how the sub-elements in a composition are arranged so that they are perceived as one overall composition. Many designers sketch several formal compositions, with sub-elements that have different sizes, forms, and features that address the goals or requirements for a future product. We refer to this early stage in product design as the *iterative stage* because we are designing iterations or possible solutions to the criteria within the *design brief*; the document that specifies the product requirements. The requirements may specify function, target market, maintenance, and cost factors.

In the early stages of a design project, designers explore different arrangements of sub-elements, by integrating their forms, or *form factors*, into a whole composition. For example, you are tasked with designing a new type of bicycle pump that, when displayed for sale in a store, must stand out from its competitors. Form factors communicate messages that range from ease of understanding how to use the product and where it belongs to how attractive it looks; the cool factor often matters. The overall physical geometry of the form, which we call the *typology*, refers to the shape that people initially perceive – is it rectangular, round, or organic? These categories for classifying the *formal properties* of a composition are referred to as: rectilinear, curvilinear, and organic. Some compositions may be complex and have a mix of typologies. We discuss each separately in this chapter.



RECTILINEAR



CURVILINEAR

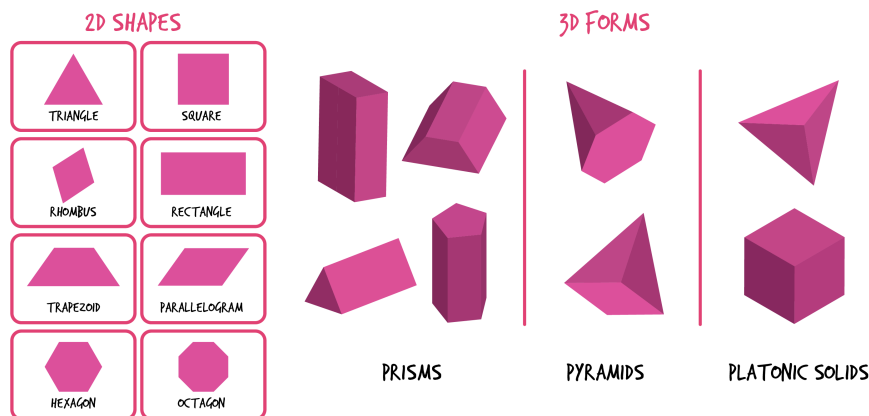


ORGANIC

Formal Typologies

Rectilinear Compositions

Rectilinear shapes or forms can be identified by their borders, which have straight lines, parallel or straight edges, and measurable angles. We call geometric rectilinear two-dimensional shapes squares, rectangles, triangles, pentagons, hexagons, octagons, etc. We call rectilinear *geometric* three-dimensional forms platonic solids (cubes, tetrahedrons, etc.), prisms (triangular prisms, hexagonal prisms, etc.), and/or pyramids (square base pyramids, triangular base pyramids, etc.). Human-made or manufactured products often have rectilinear shapes and forms with a sharp, clean, and angular appearance. Our overall perception of these compositions is that they are rectilinear. The rectilinear shape corresponds to the shape of the boxes that the products are tightly fitted and shipped in. Can you think of any of the products in your house that are rectilinear?

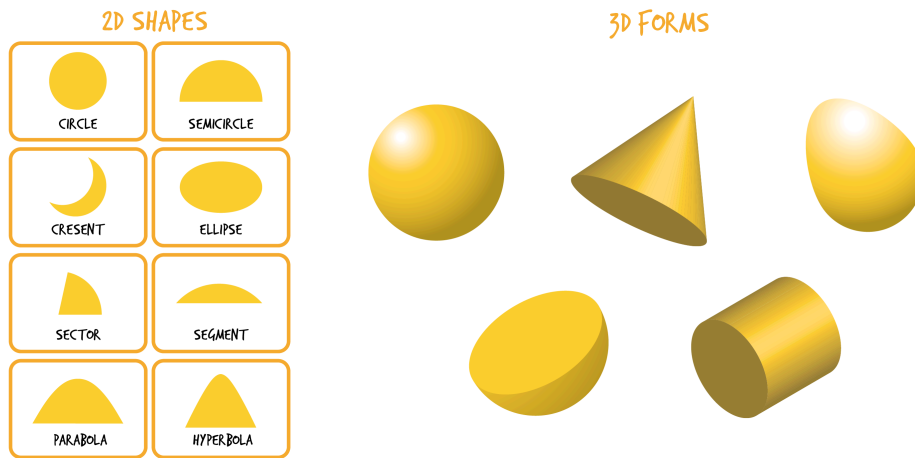


Rectilinear Geometric Shapes & Platonic Solids

Curvilinear Compositions

When we consider **curvilinear** shapes or forms, their boundaries usually have a curving line or edge. In curvilinear compositions, we find two-dimensional elements such as circles, crescents, ovals, ellipses, and three-dimensional volumes such as spheres, hemispheres, cones, and cylinders. Given the curving nature of the surface of curvilinear forms, we can perceive the composition by looking all

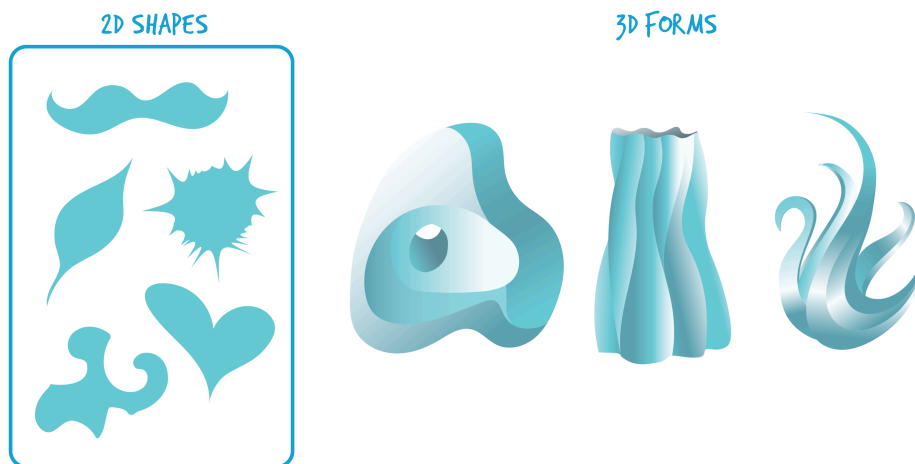
around the three-hundred and sixty degrees of the surface. Curvilinear compositions can be simple, like a beach ball or ice cream cone, or more complex, like a seashell, trombone, or submarine.



Curvilinear Shapes & Forms

Organic Compositions

The third formal typology includes **organic** shapes and forms that often have irregular curving borders and may remind us of shapes found in nature. We may, at first, think of them as curvilinear, but they are usually irregular and often asymmetrical. For example, organic forms can be found in the design of bottles, light fixtures, and high-end household items, like bathtubs. They are sometimes referred to as biomorphic shapes or *biologically-influenced design*. These are generally inspired by natural shapes such as vines, leaves, water, and clouds, and can even reference animal forms. A good example of an organic composition is a propeller for a boat, helicopter, or airplane. What are the design elements of a propeller that could be derived from a maple tree?



Organic Shapes & Forms

Variations and Combinations of Formal Typologies

Everyday products rarely have only one *formal typology* or one type of form, usually they are composed of variations and combinations of design elements. Our perceptions of the overall form factors of objects as being rectilinear, curvilinear, or organic are supported by the way the composition is designed. We approach design by systematically organizing elements within the composition. In the early stages of concept development, designers develop a series of concept development iterations by mixing and matching typologies. There could be multiple ways to organize sub-elements to enable users to perceive them as a fully integrated formal composition. Our goal is to achieve an overall perception of a balanced composition that may also be perceived as having an overall typological form factor.



Variations and Combinations of Formal Typologies in Iterative Concept Development

Back to previous section: 2.1 Introduction

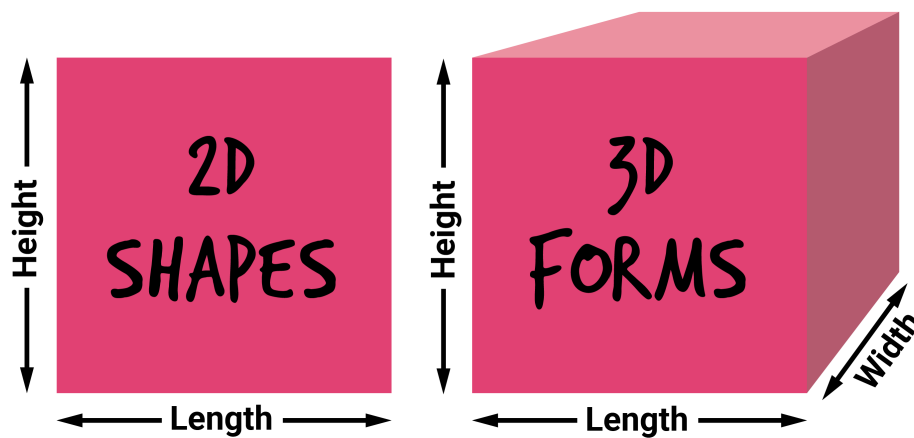
Next section: 2.3 Elements of Visual Compositions



2.3 Elements of Visual Compositions

Designers are known for their versatile and iterative approach to generating formal compositions; we do this by drawing on design composition principles. These principles are key components of our visual organization discussion.

To begin with, product designers adapt the principles of two-dimensional composition into three dimensions. You may recall from previous studies that a two-dimensional overall flat shape has only two measurements: length and height. The square, triangle, and circle are examples of two-dimensional shapes. They differ from three-dimensional forms that have three measurements: length, width, and height. A cube, pyramid, and sphere are examples of three-dimensional overall forms. Three-dimensional forms have volume, whereas two-dimensional shapes do not.



A FORM HAS MORE DIMENSIONS THAN A SHAPE

These complex two-dimensional forms made of many smaller and colourful rectilinear elements evolve into a three-dimensional rotating form that contains the same elements, which are seen from different angles as the animation rotates.

Three Dimensions add interest to a Composition from many perspectives

Nonetheless, both two- and three- dimensional forms have the same overall compositional factors: a *frame of reference* relating to the perceived shape in its entirety (format shape & size), a negative, white, or void space either around it or within certain areas, and a positive, main body or figure as illustrated below. These compositional factors include the outside borders of the product that define the *overall typology* (rectilinear,

curvilinear, organic) and the combinations of *positive spaces* (the volumes that the sub-elements occupy in the composition) and the *negative spaces* (white space or air around the internal elements and the whole boundary). In the example below of an iron, the frame of reference or the overall border of the iron is curvilinear and it both defines the positive volumes of the object and provides room for the curvilinear negative space that tells us exactly where to place our hand. Through its form alone, we perceive that this iron has a flat plane that could be placed on a surface, that it has a negative space that acts like a grip for us to place one hand through, that the positive space contains the iron's working components, and that the small negative circular shapes on the flat plane are openings to the interior of the iron.

Activity Time!

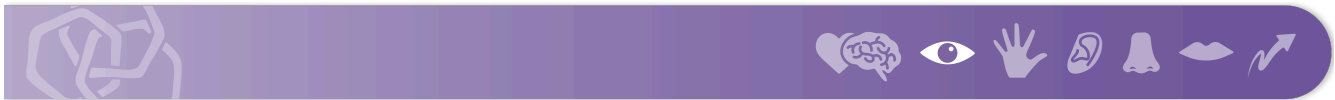
Click on the purple icons to see examples of how compositional factors appear in both two-dimensional and three-dimensional artefacts.



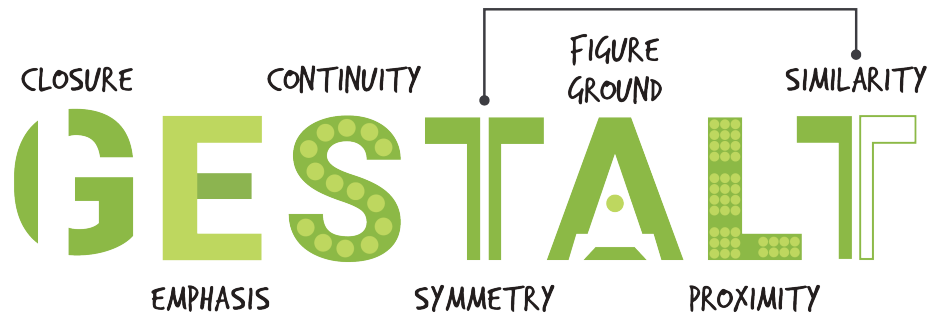
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OVERALL COMPOSITIONAL FACTORS (TWO-DIMENSIONAL & Three-dimensional)

Back to previous section: 2.2 Form Factors of Compositions
Next section: 2.4 Gestalt Principles of Perceptual Organization



2.4 Gestalt Principles of Perceptual Organization



GESTALT PRINCIPLES OF PERCEPTUAL ORGANIZATION

We not only design simple objects (with one main formal element) like a pencil sharpener, a comb, or a screwdriver but also products with a range of complex volumes that contain internal components and a variety of *affordances* like buttons and switches with specific functions. How then, do we design complex compositions that make it easy for the user to visually understand how to use the product and its parts?

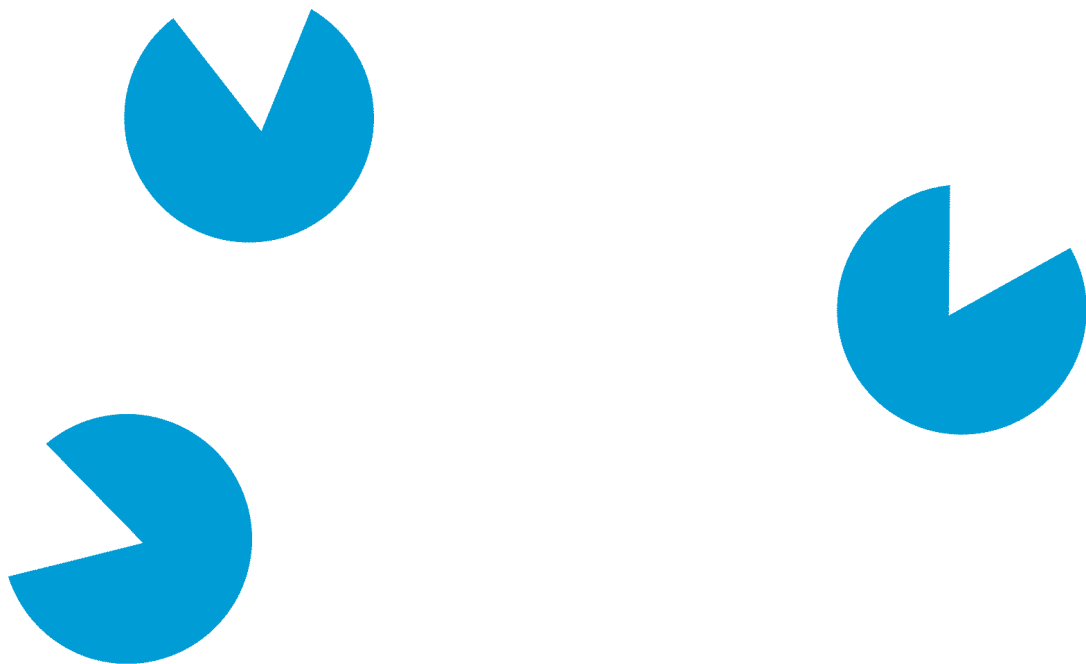
For guidance, we turn to the Gestalt principles of perceptual organization developed by psychologists Max Wertheimer, Kurt Koffka, and Wolfgang Kohler in the early twentieth century, to explore how we perceive each object around us as a unified whole. The word *gestalt* means “something that is made of many parts and yet is somehow more than or different from the combination of its parts” (Merriam-Webster, n.d.). The artists and designers at the Bauhaus, an experimental early twentieth century German art school, explored these principles in their teaching and personal projects. Since then designers have been referring to Gestalt principles or Guidelines to organize elements by grouping similar elements, recognizing patterns, and simplifying complex images. Gestalt Principles provide *visual guidelines* that help designers and artists create understandable, communicative, and rich compositions.

Designers apply these visual guidelines in their formal compositions to improve the perceived aesthetics, functionality, and user-friendliness of a product. For example, when you see a handle, a spout, an interior volume, and a flat bottom, your cognitive processes register that set of elements as a vessel for containing and pouring liquid, like a pitcher or a measuring cup. You have a simplified perception of the parts that come together as a single object – this is an example of the Gestalt principle of *closure*, where we perceive these elements as a complete and familiar thing. It is human nature to cognitively simplify what we are seeing when we perceive complex visual components that are grouped together, so that, in this case, we recognize the object as a pitcher. By grouping elements in a design composition together into compositional areas, the message of what we are looking at becomes simplified enough to make it easier to grasp the essence of the product. Gestalt principles provide insights into how people perceive organization within vague or unclear visual compositions.

Gestalt principles have been around for at least a century and have evolved as strategies to guide the appearance of unity within the whole and the ways elements are “assembled” within a composition. These guidelines may have different names or categories, depending on which source you consult, but the categories listed below are common to most theorists. These key categories are: closure, focal point, continuity, symmetry, similarity, figure/ground, proximity, and similarity. To those, we add harmony, which is the overall goal of a composition. This includes the principles of unity and variety, rhythm, and connectedness.

Closure

Our minds have the tendency to complete a form or figure so that it is perceived as a complete and unified whole. This tendency occurs in situations where an image appears to be incomplete, when other visual information is missing, or when parts of the whole composition are hidden by other objects. Knowing this, designers want to combine the parts of a product or composition into a simple and complete whole pattern to make a strong unified impression on the person perceiving it. What do you see in the example below? Did you visually complete the triangle whose edges are defined by the blue circles?



Closure

Emphasis or Focal Point

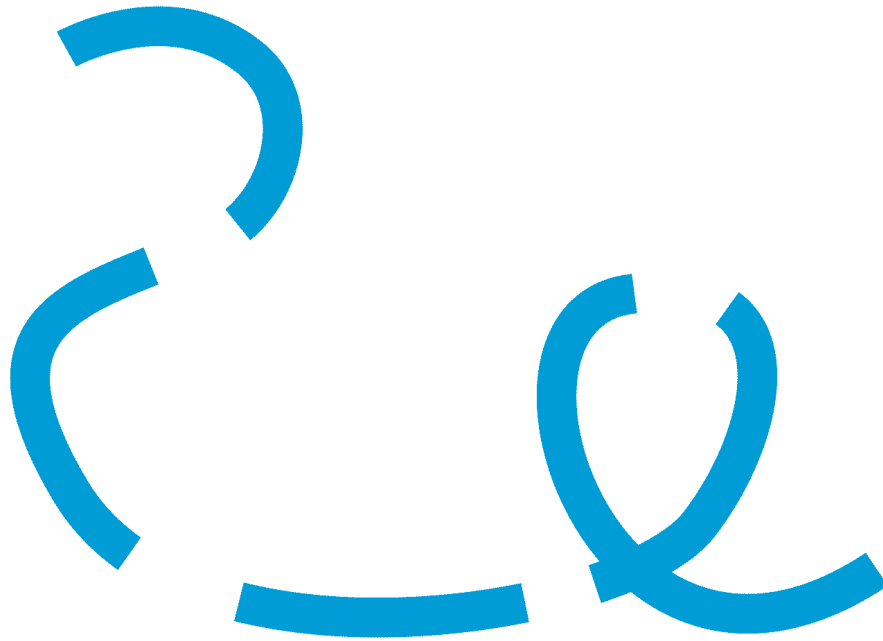
Drawing our attention to a focal point requires design skills and many concept iterations. Designers may choose to emphasize a particular element through colour, scale, value, or contrast to catch a viewer’s eye.



Emphasis or Focal Point

Continuity or Continuation

We tend to visually follow straight and curved lines until they are interrupted in some way. It is easier to follow lines that seem to flow in a uniform direction than angular lines with sharp or abrupt changes in direction. It is important to design two- and three-dimensional patterns that have a continuous vertical or horizontal flow across a surface to ease perception. This visual flow guides us through a composition, such as packages, web sites, instructional pages, or aesthetically pleasing artwork.



Continuity or Continuation

Designers can be obsessed with a subset of the guideline of continuity called **alignment**. We like to line up elements in a composition so that the eye flows smoothly from one to another and as soon as one element is out of place, we rework the visual connections between elements! How do we align the elements? We use a grid! Think about a time when you may have used a grid on your computer desktop to align the icons; if you have ever seen the instruction “snap to grid” then you are familiar with the concept of alignment. We often prefer to manually align elements with one another so that we can be sure to line up the items that belong near each other.

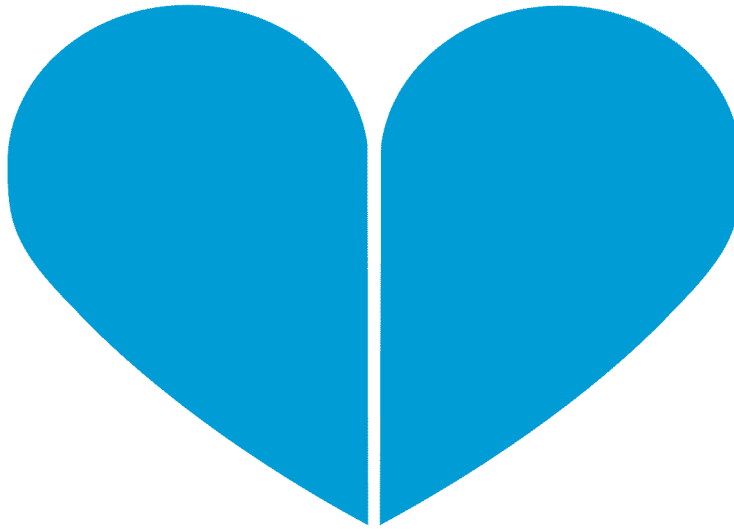


ALIGNMENT

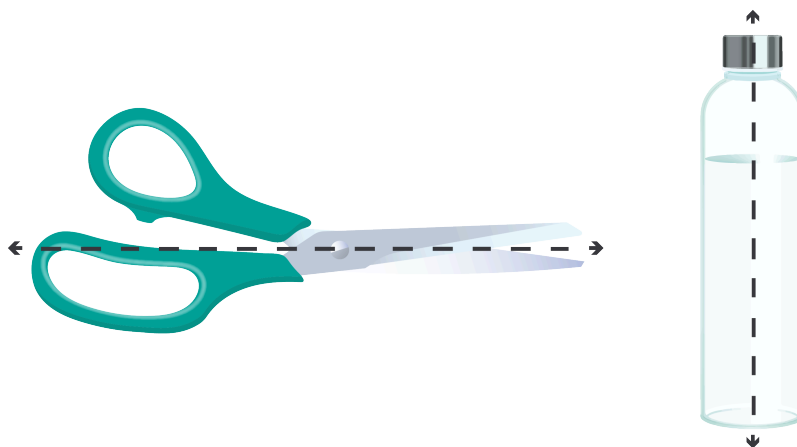
Alignment

Symmetry and Order

This principle focuses on the factors that support us in perceiving compositional balance. Designers can achieve this by creating symmetry or order among the positive elements and the negative spaces of any composition. Symmetry can be achieved by placing sub-elements that are perceived as having identical visual weight in a balanced composition on either side of one or more axes. An axis is an imaginary line in a composition and can be vertical or horizontal; it indicates the centre of the design distribution and helps to organize elements.

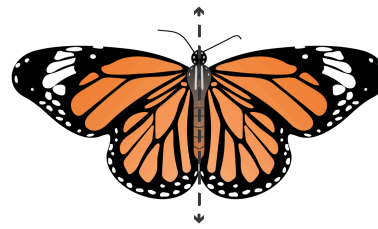
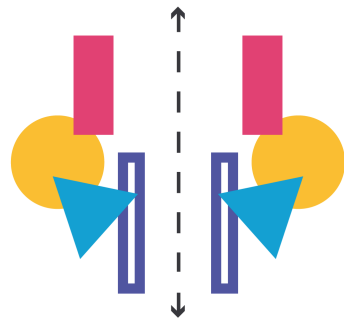


Symmetry

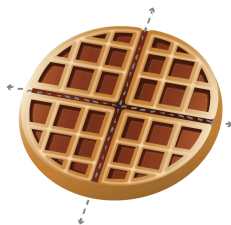
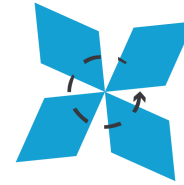
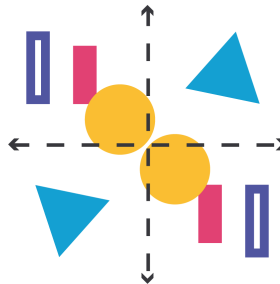
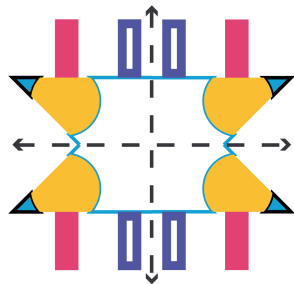


Symmetry on either side of an axis

We usually perceive symmetrical or balanced compositions as stable and generally aesthetically pleasing. In symmetrical compositions, the elements on both sides of an axis appear to be equal in size, shape, and value. There are three types of symmetry: biaxial mirror symmetry (symmetry on either side of two axes, vertical & horizontal), near symmetry (symmetry on either side of a central axis where two halves may be only slightly different), and radial symmetry (symmetry around a central point).



SYMMETRY



BIAxIAL SYMMETRY



NEAR SYMMETRY



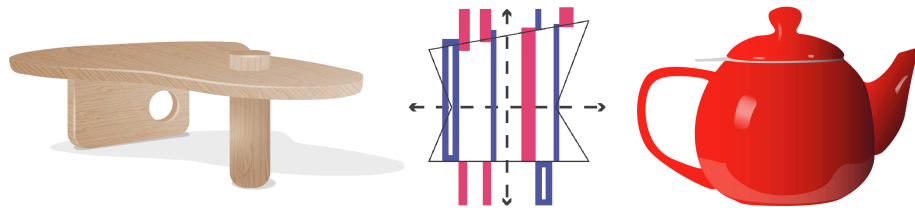
RADIAL SYMMETRY

Examples of types of symmetry

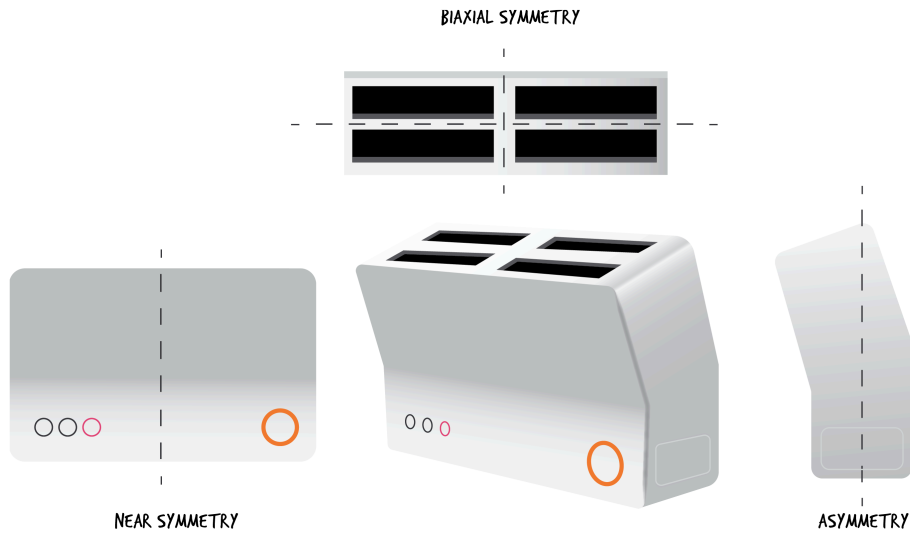
In all of these types of symmetry, some of the sub-elements might be focal points and attract your eye, however, no single area of the composition draws your eye so much that you can't see the other areas.

Asymmetry

You may perceive a composition as unsettling or tense because it is not symmetrically balanced. Some people may consider asymmetrical compositions as dynamic and interesting, especially in the art world. Designers may choose to place sub-elements unevenly around an unseen compositional axis, which leads to an unbalanced composition. This strategy may work well when exploring where to place one-of-a-kind sub-elements to attract a user's attention, as the asymmetrical focal point in the table illustrated below. However, some products may appear asymmetrical from one point of view and symmetrical from another, like the teapot depicted from its asymmetrical perspective below.



Asymmetry



multiple types of symmetry within a product

Figure/Ground

You may be familiar with the image of two heads facing one another that contains a space between them that looks like a goblet. This image illustrates the figure/ground principle – are you seeing the figure or the ground? Much like the principle of closure, this guideline depends on cognitive processing capabilities. Typically, the objects in the foreground are the focal points or main figures (like the faces) and the background provides a negative space behind the focal points. While we rarely come across two competing focal points like in this example, designers use this principle to clearly indicate which elements to focus on.

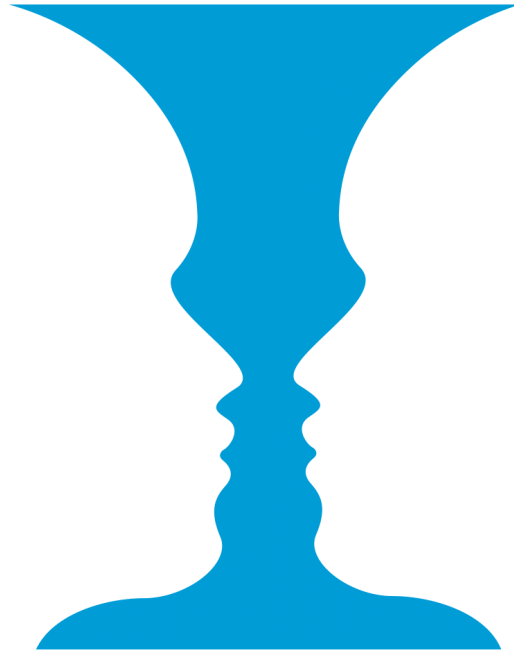


Figure /Ground

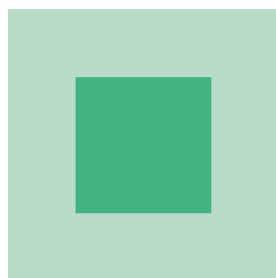
Designers should be aware of the different types of figure/ground relationships:

Stable: In this relationship, we can easily differentiate between the figure and the ground. The composition is designed to highlight one or the other.

Reversible: In this relationship, we see repetitive patterns in which the figure and ground reverse, leading to a dynamic tension in perceiving the composition.

Ambiguous: In this relationship, which we have already seen in the faces and goblet example, we are attracted to both figure and ground simultaneously, which may cause confusion.

TYPES OF FIGURE/GROUND



STABLE



REVERSIBLE

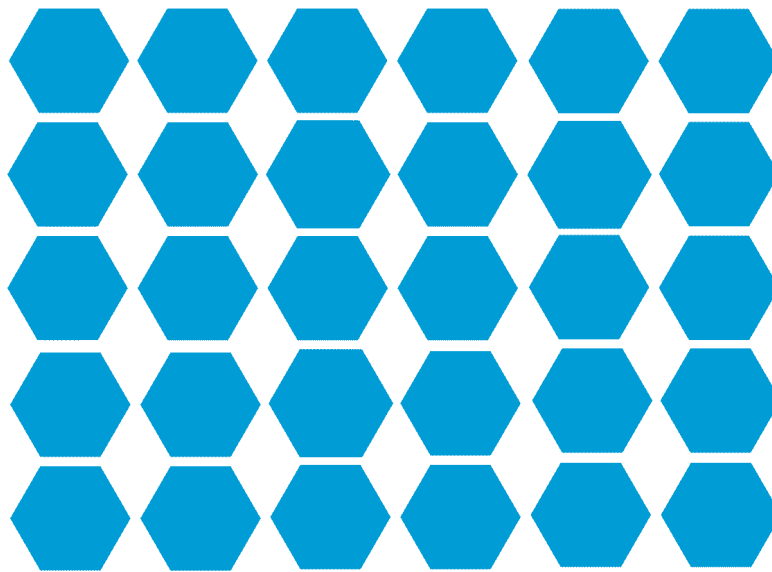


AMBIGUOUS

Types of Figure/Ground

Proximity

We perceive objects or shapes that are close to one another as belonging to one group of elements. Even if the shapes, sizes, and objects are radically different, they may appear as a group if they are close to one another. This principle is useful for designers working with sets of elements of different sizes and shapes: elements that are grouped in proximity to one another appear to be related to the others in that group.



ELEMENTS GROUPED IN PROXIMITY SEEM TO BE RELATED
& SEPARATE FROM ELEMENTS IN ANOTHER GROUPING

Designers intentionally try to unify compositions by combining a group of different elements within a unifying larger element, or by placing smaller elements inside larger ones as in the image below:

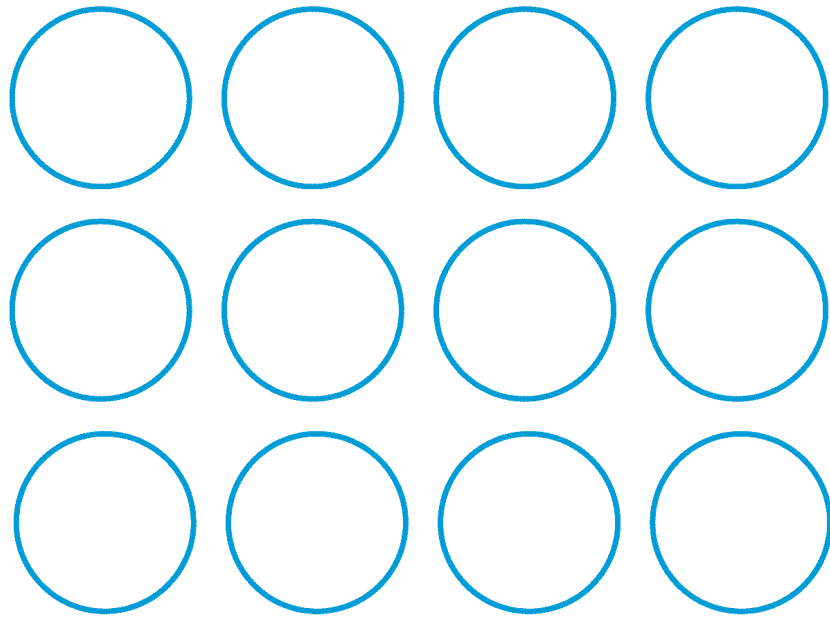


ALTHOUGH THE SHAPE AND SIZE OF THESE ELEMENTS VARY, similar buttons are grouped together by proximity

Proximity and similarity often work together and are perceived as a visual hierarchy. Either can dominate the other, depending on how they are combined and applied. In the image above, the function buttons are similar to one another and are arranged in separate groupings of sub-elements that are in proximity to one another. Sub-element groupings are organized within the composition using the principle of proximity and the following principle of similarity to provide strategies for simplifying complex design features.

Similarity

When we see objects or shapes that physically or visually resemble each other we perceive them as being part of the same composition. This principle is useful for designers who want to provide visual cues to help people interact with the important features of a composition.



Similarity

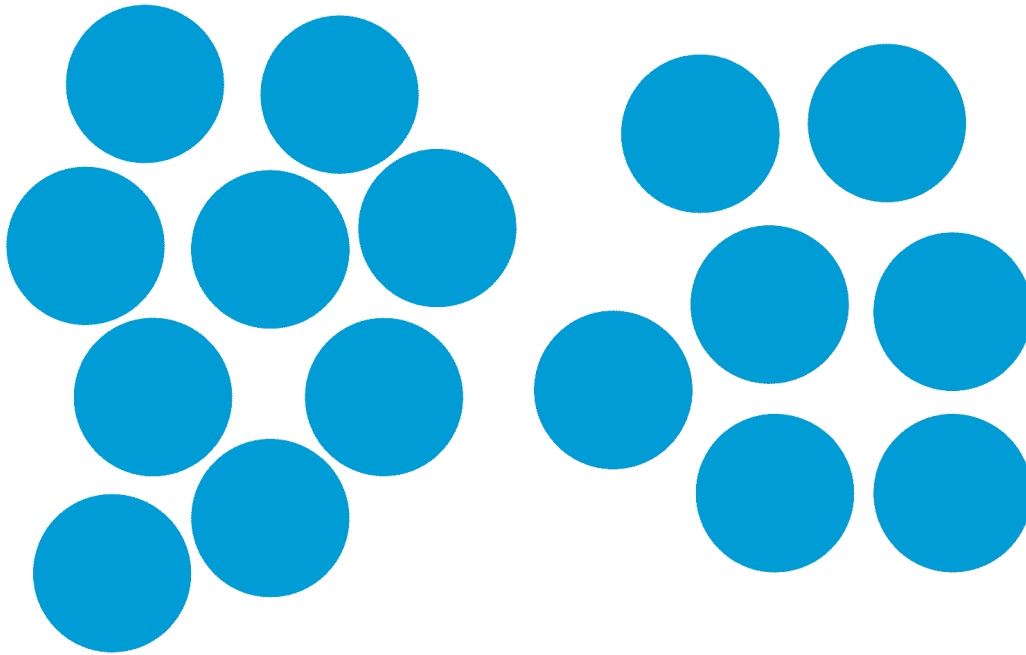
Harmony

The Gestalt principles are applied to compositions to achieve a sense of balance or harmony, especially in three dimensions. Designer Del Coates (2003), who coined the term *objective concinnity* (or what we call harmony), said the goal of every designer is to achieve a perception of overall harmony, simplicity, aesthetic unity, good form, or formal elegance. To these seven Gestalt principles for achieving a well-balanced composition, we add three more: unity and variety, rhythm, and connectedness.

Unity and Variety

Ultimately each of the Gestalt principles contributes to the overriding goal of combining all the elements of a composition to help the viewer perceive the composition as unified, or complete.

Variety is the complement to unity and is needed to create visual interest. Often designers depend on the variety of sub-elements to make a composition visually stimulating and engaging, without being confusing.



Unity & Variety

Rhythm

Rhythm refers to the recurrence or organized movement of elements through space and time. We perceive the experience of rhythms through a sequence of repeated elements. The perceived visual movements of shape, colour, or lines could be interpreted as rhythmically moving waves of water that provide visual interest through repetition.

You may determine very different messages when the rhythms are regular as compared to irregular. Regular rhythms are sequential arrangements of a repeated pattern of identical elements that build a uniform and consistent pattern. They seem to be calming or stabilizing. On the other hand, irregular rhythms are sequences arranged in irregular or unequal spacing or in dynamic patterns. They seem to be erratic or destabilizing.



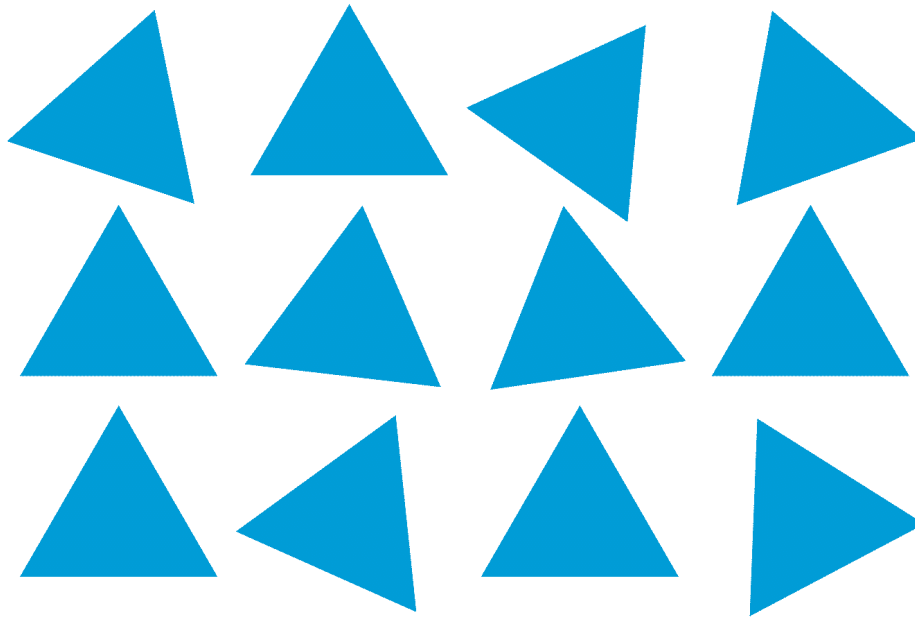
EXAMPLES OF Repetition and RHYTHM USING similar ELEMENTS



REGULAR (left) AND IRREGULAR (right) RHYTHM THROUGH REPETITION AND DYNAMIC VARIATION

Connectedness

When people see that elements are connected, they perceive them as a single unit. This guideline is related to the Gestalt principle of proximity because it includes a connecting line that brings the elements into proximity with one another. Despite the difference in physical attributes (size, shape, colour), the object is seen as part of the same group. This principle also includes physically connecting through touching, overlapping, and combining.



LINES CONNECT ELEMENTS TO ONE ANOTHER



Touching

overlapping

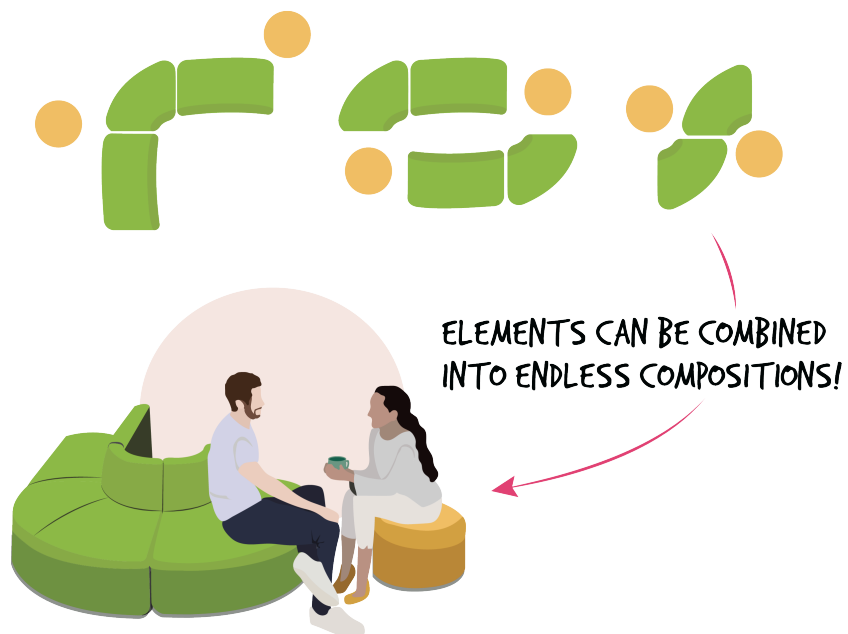
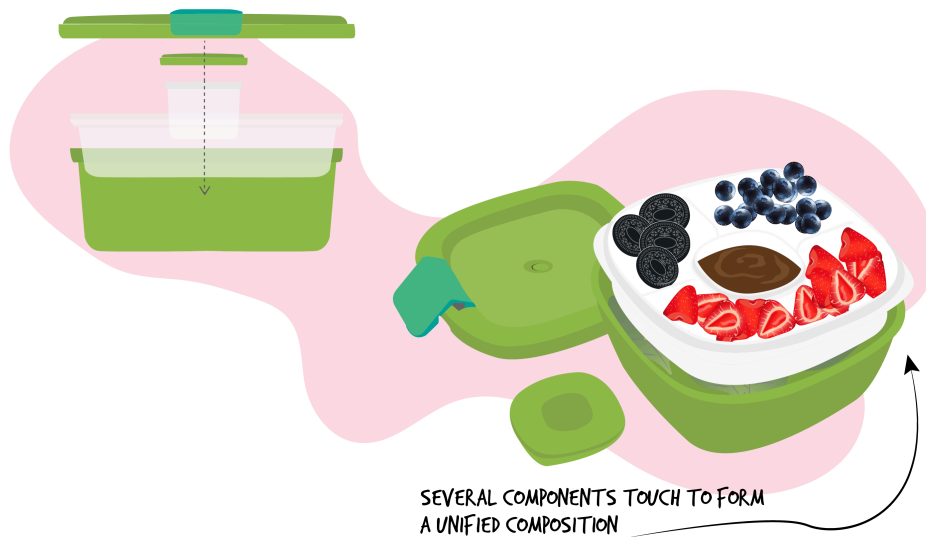
In three-dimensional products, unity can also be created via physical connections that touch one another. Common examples of connections between physical elements include cradling, in which one element acts like a cradle for another element (like a diamond set in a ring), wedging, in which one element has an opening that the other element fits into (like a dock for devices), and piercing, in which one element passes all the way through a hole in the other element (like a pierced earring passes completely through the ear lobe).



EXAMPLES OF CONNECTIONS BETWEEN PHYSICAL ELEMENTS

In addition, three-dimensional objects and products overlap and combine elements to create harmonious compositions. This approach incorporates the principle of similarity. It is often used to design modular components that can be combined to form a variety of configurations. Clients

can mix and match related units to form office workspaces, living room furniture, and even storage containers.



THE PRINCIPLE OF SIMILARITY IS APPLIED TO COMBINING SIMILAR ELEMENTS INTO MODULAR COMBINATIONS

Activity Time!

Consider the product below. Can you identify some of the Gestalt principles used to achieve harmony in the design of this device? Before you click on the icons below, review the principles above to see which ones you can find in this formal composition.



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instances of gestalt principles applied within a single product

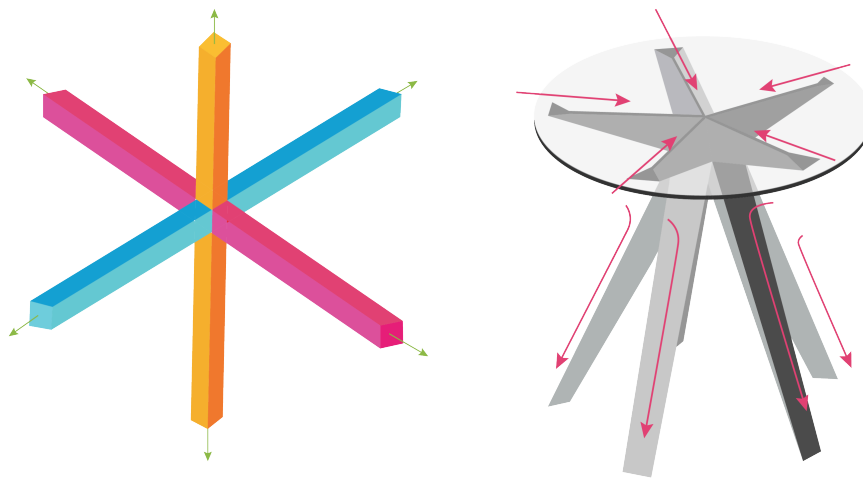
Back to previous section: 2.3 Elements of Visual Compositions

Next section: 2.5 Relationships and Hierarchies Within Compositions



2.5 Relationships and hierarchies within compositions

Form giving is an evolving process, requiring reflection and experimentation. Designers continually ask themselves, does the design look good? Is it interesting from all sides, and at eye level or from the top? Three-dimensional compositions should appear to have balanced directional forces from every viewpoint (360 degrees) around the whole structure or product, whether it is symmetrical or asymmetrical.



Examples of balanced directional forces from every viewpoint

Clearly, it doesn't make sense to emphasize every element equally. If designers were to do that, all the design elements would compete for attention, and nothing would stand out. Certain elements in any composition should draw the viewer's eye and lead it to other sub-elements for the sake of aesthetics as well as function. We do this by creating *visual hierarchies* of sub-elements, where at least one main element stands out, another serves as the background for the main element, and others support the main compositional elements.

According to Rowena Reed Kostellow (Hannah, 2002), we can control the participant's attention by applying principles of composition to organizing contrasting shapes and forms. She encouraged her students at Pratt Institute to apply features that provide *emphasis* to develop a *hierarchy of visual importance* in their compositions. She would challenge them to make iterative models of compositions with the following three main components:

The **dominant** element: This element is the most dramatic in character.

The **subdominant** element: This one contrasts and complements the dominant element and adds another directional axis.

The **subordinate** element: The role of this element is to add three-dimensionality and to complete the unity of the composition from every viewpoint.

Activity Time!

See if you can identify each of the hierarchical elements in the products below. Drag the labels into their appropriate positions.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=980#h5p-19>

Hierarchy of Visual Importance

Back to previous section: 2.4 Gestalt Principles of Perceptual Organization

Next section: 2.6 Proportions and Transitions



2.6 Proportions and Transitions

By now it may be clear that in every composition we are striving to make the object or artefact look simple and harmonious, no matter how many sub-elements are included. Designers iteratively adjust the visual scale of sub-elements using the principles of composition until the whole composition seems to work as a complete entity. Just as with our faces, where our eyes, nose, and mouth have different sizes and shapes, yet seem to belong together, so too can the elements in a composition be varied and still perceived as a cohesive composition.

When we iterate concepts to develop a design solution, we are exploring the objective concinnity or harmony of our composition. For example, what exactly is the designer adjusting in the image of the four separate bottle concepts below? They are tweaking the proportions of several sub-elements in each bottle: the overall bottle size and shape; the position, size and shape of the top; the position of the cavity and overall proportions of the bottle. They are also focusing on how the elements are joined together through minute details and proportions. Let's investigate proportions next.

Relative Proportions, Scale, and Size

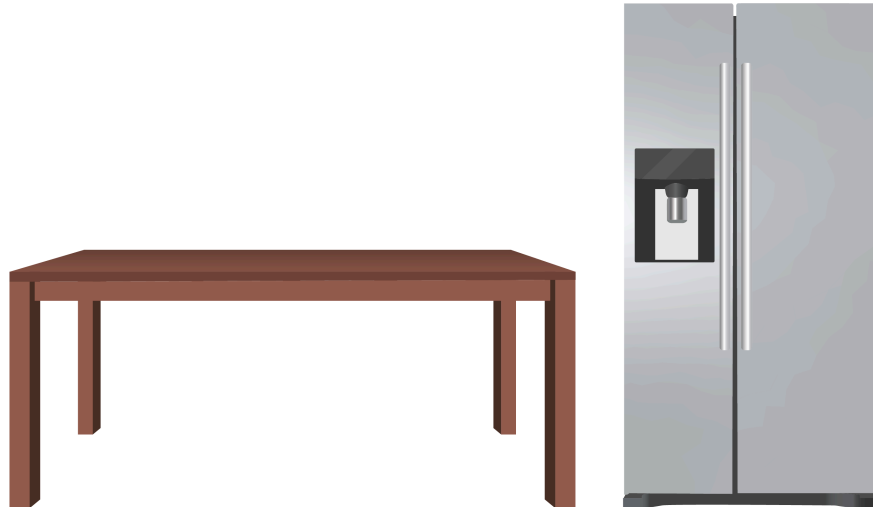
Notice all the sub-elements that are different from one concept to the next.



ITERATIVE DESIGN DEVELOPMENT INVOLVES ADJUSTING THE PROPORTIONS AND ORIENTATION OF THE SUB-ELEMENTS IN A COMPOSITION

Proportion refers to the relationships between elements or groups of elements in an object with respect to their comparative size, quantity, or scale. Three types of proportions are commonly found in compositions:

1. **Overall proportions** describe the character or overall configuration of a group of elements; the relationship of the parts to the whole. In the examples below, we see that these products have either a horizontal or vertical overall proportion.



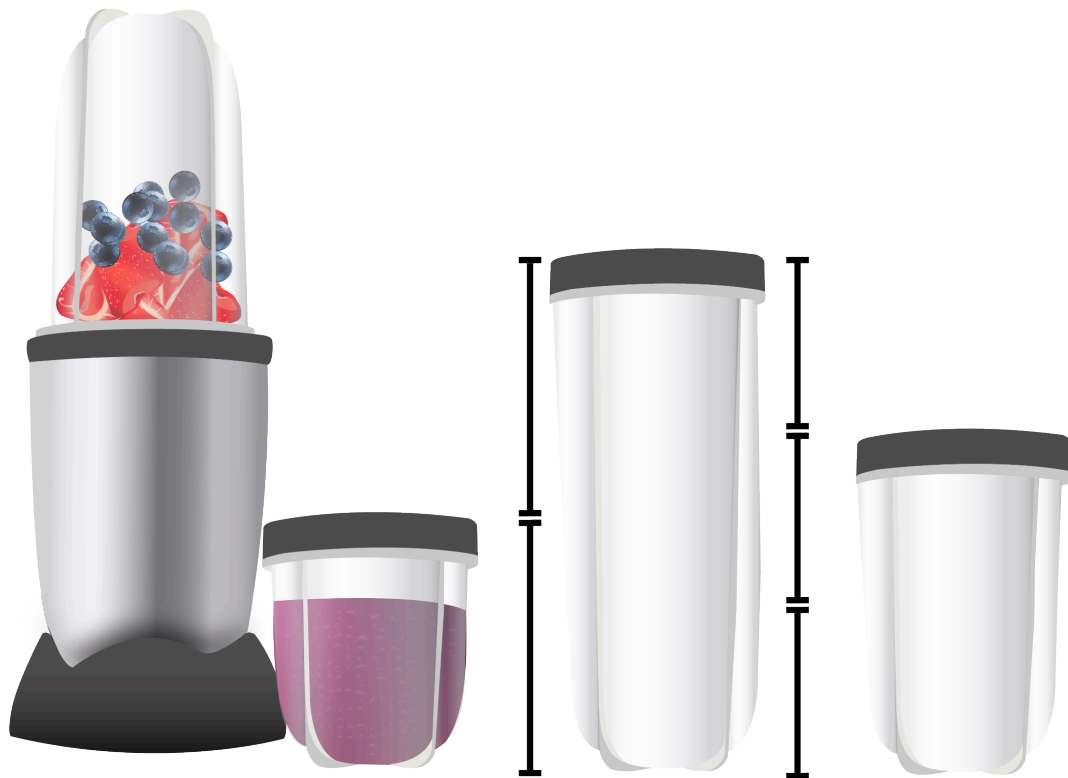
OVERALL PROPORTIONS CAN BE EITHER HORIZONTAL OR VERTICAL

2. **Inherent proportions** describe the spatial organization of elements within a formal group with respect to length, width, and thickness. In the example below we see within a family of products that each separate product may have similar elements, like conical forms. However, each separate product has a different set of inherent proportions relative to the other products in the family. This creates variety across the line of products. Nonetheless, they are clearly related by materials, colour, and function.



INHERENT PROPORTIONS OF SIMILAR ELEMENTS CAN VARY ACROSS A PRODUCT LINE

3. **Comparative proportions** describe how the sub-elements within a single product composition relate to one another in terms of the whole composition (e.g. large or small, many or few). In the example below the individual modular elements resemble one another and vary by size within the overall composition. Notice that the materials, colours, and rounded corners are consistent throughout the product.



COMPARATIVE PROPORTIONS: THIS PRODUCT'S SUB-ELEMENTS RESEMBLE ONE ANOTHER AND HAVE VARYING SIZES

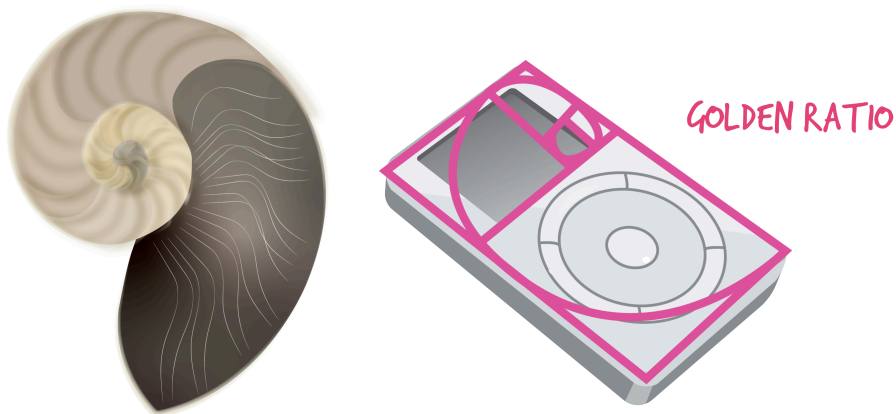
Proportion Systems

As we have learned, Gestalt principles clearly enable designers to contribute to an overall perception of harmony within a composition. Mathematical systems of proportion also contribute to developing a perception of compositional harmony. Historically, artists, architects, and designers have applied mathematical measures to the inherent and relative proportions within compositions to provide harmonious visual relationships. The Golden Ratio is one well-known approach to creating aesthetic balance in architectural, artistic, and design compositions. It is based on the relationship between two or more elements of a composition that have a ratio of 1 to 1.618 in proportion to one another, which is considered aesthetically pleasing to the eye.



THE GOLDEN RATIO APPLIED TO THE ELEMENTS OF A CORKSCREW

You may have learned that you should place the focal point of any composition about one-third of the way in the composition, rather than at the halfway mark or centre. This is a simplified application of the Golden Ratio in which the optimal placement of an important feature is close to the division point between one-third and two-thirds as in the images below.

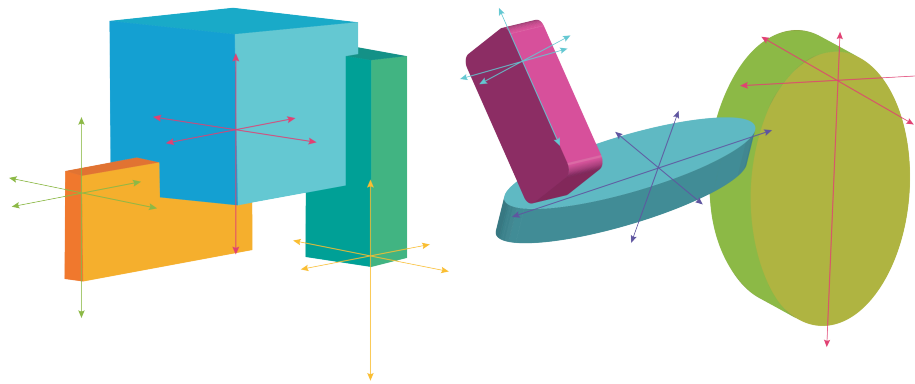


THE FOCAL POINT IN THESE IMAGES IS AT THE ONE-THIRD/TWO-THIRDS POINT

You may think that you would be unlikely to use these systems of proportion, however as noted earlier many artists, architects, and industrial designers have used them for centuries while they, along with graphic and web designers, continue to use them today.

Orientation of Axes

The axis is the imaginary line down the centre of the longest dimension of the object. It defines the strongest perceived movement of the formal composition. There are two categories of axes: static and dynamic. We perceive objects with a static axis as having a vertical and/or horizontal orientation of sub-elements, and orthogonal (right angle) relationships between elements. A camera is a typical example of an object with 2 static axes – horizontal and vertical. We perceive these objects as stable and with no indication of movement.



The Orientation of the axes determines whether the composition is static or dynamic

On the contrary, we perceive objects with dynamic axes as off-kilter and indicating movement, either implied or actual. In certain objects, the dynamic axes are asymmetrical and may unbalance the perception of compositional harmony. While harmony is certainly a key factor in product design compositions, there are many two- and three-dimensional compositions in which a dynamic-axes design strategy is key to making the composition appear to be more interesting. In some cultures, such as Japan, asymmetrical harmony is key to a dynamically balanced aesthetic. How do you think the diagonal axis adds compositional interest and a sense of movement to the lamp below? By comparison, what message do you get from the static horizontal and vertical axes in the camera below?



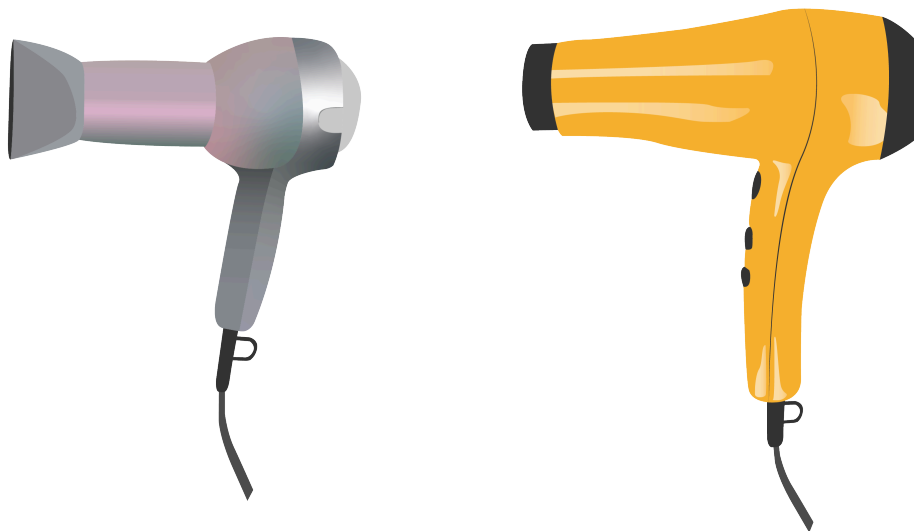
Static and Dynamic product axes communicate different messages about product use

Formal transitions between elements: FLUID Surfaces

In product design, a key point is that the user first sees or senses the whole object before noticing or being distracted by the individual sub-elements. Since any three-dimensional product is made of separate elements (e.g. a handle and a cylinder), the design team wants you to perceive it as a harmonious whole (with objective concinnity). One way to do this is to join the sub-elements of the composition together so their surfaces appear to flow into one another. Designers must decide not only when surfaces should flow together, but also when they should appear to be separate. Once again, this is an excellent opportunity for iterative design concept development, by sketching many variations.

Don't forget that how surfaces are designed to flow into one another is not only a compositional decision, it is based on the types of manufacturing processes, materials, or production costs involved. There is no perfect design; all designs involve compromises or trade-offs among the various requirements of the product brief. In the examples below the designer may have tried to make the blower end apparent because it is an important functional affordance. For example, these two compositions show that there are different ways to design how the product's sub-elements go together. On the left, we see chunky sub-elements with abrupt connections that do not seem unified into one whole formal composition. On the right we see sub-elements that blend or flow into one another, creating the perception of a unified product composition. Having FLUID surface transitions can simplify how you perceive the object – is it a conglomeration of a bunch of separate sub-elements stuck together or a synthesis of forms into one unified whole?

Let's examine how the acronym FLUID can help designers unify compositions:



THE FORMAL TRANSITIONS BETWEEN SUB-ELEMENTS DIFFER FOR EACH OF THESE HAIRDRYERS

FLUID is an acronym that describes how elements within a composition can be unified:

F– flowing

L– links

U– unify

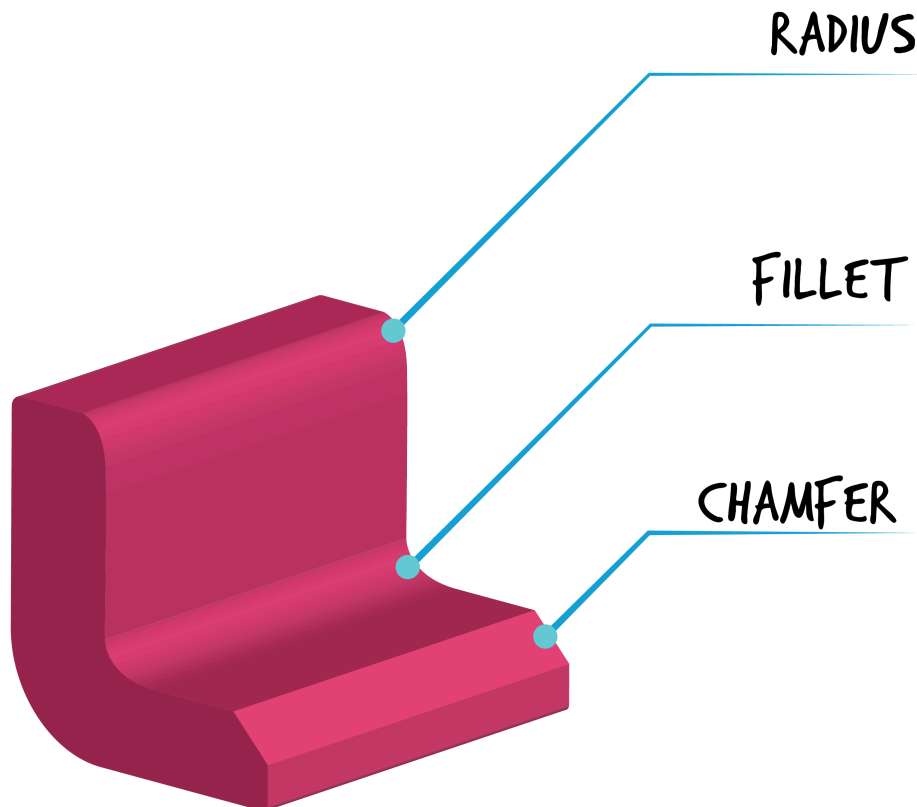
I– individual

D– details

In other words, we can combine sub-elements so that they are perceived as a unified part of a whole composition. The techniques for creating a sense of FLUIDity, where each individual element flows into the next, are technical, where the geometry – the mathematical relationships and properties of the surfaces, angles, and lines – between sub-elements plays a key role.

Surface Continuities

Designers use the term surface continuities to describe the appearance of the edge between surfaces, this is also referred to as the *formal transitions* between surfaces. These transitions depend on the size and geometric values of radii, fillets, and/or chamfers to reduce the perceived complexity of the overall composition. For example, in the image below, each of these transitional edge treatments – radii, fillets, and chamfers – occurs at the edge where two surfaces meet. If you look at your mobile phone, you may notice that it has rounded or chamfered edges. If the edge has a convex curve a radius was applied to it. If the edge has a concave curve, a fillet was applied to it. If the edge has a bevelled 45° angle a chamfer was applied to it.



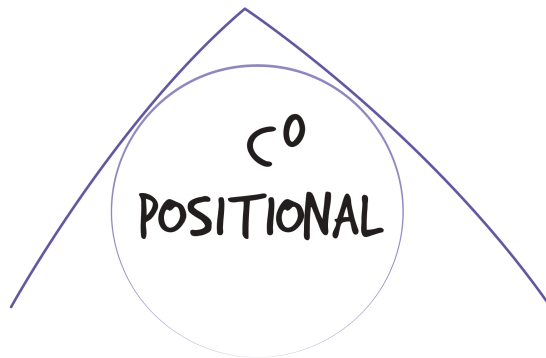
Surface Continuities: Radii, Fillets, and Chamfers

Surface continuities allow surfaces to appear to flow into each other instead of having them appear to be chunks or units of volumes simply stuck together.

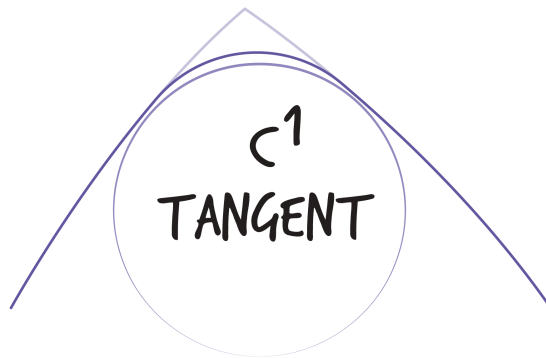
The perceptual goals for considering the kind of surface continuities that join sub-elements of a product may include diverting the user's eye by drawing their attention toward or away from that element, indicating action areas, or simply creating an overall unified impression of the product.

Continuities across surfaces: Surface Transitions

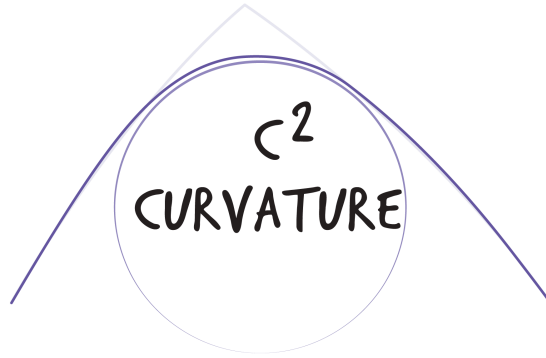
Designers use three kinds of edge-to-edge radii for surface transitions, which are visible under a light source that highlights the edges:



C0 or **positional continuity** appears as abrupt and sharp edges at the intersection of two surfaces. These edges are composed of straight lines that are perpendicular to each other and are not joined at all. In this case, there is no curvature at the edge, hence it is called C0 (curvature zero).

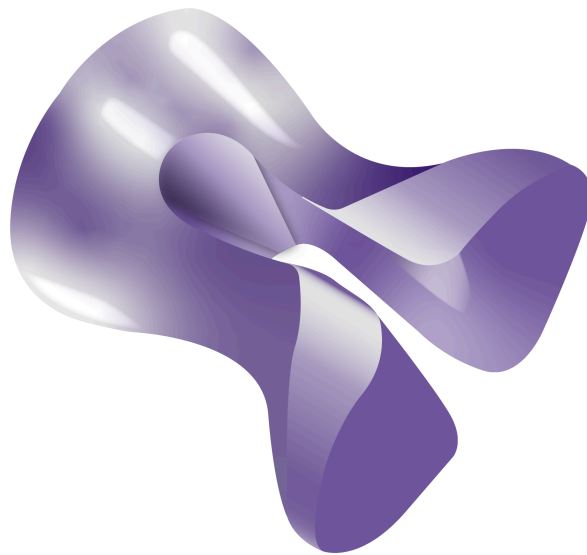


C1 or **tangential continuity** appears when two circular segments of different radii are joined with the same tangent. This curvature seems to be instantaneously changing where the radii join.



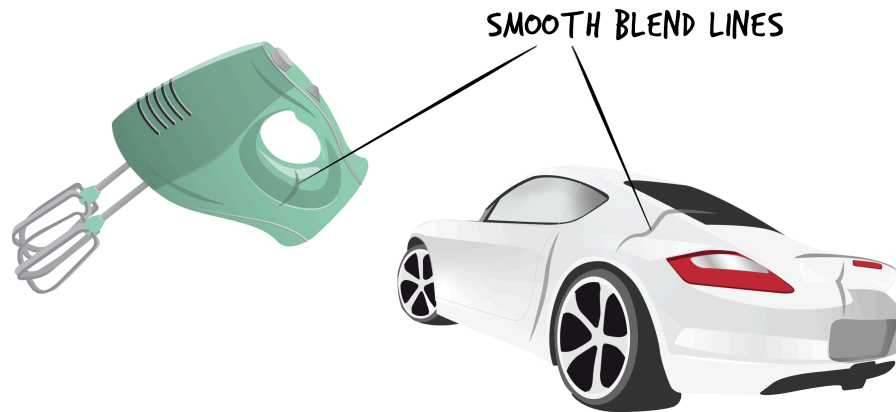
C2 or **curvature** continuity appears when the tangent and curvature at the edges are the same. In this case, the edges seem to flow together; it is impossible to tell where one curve ends and the other begins.

If you begin to look at the things you use, you should be able to identify the formal treatment of the edges between adjoining surfaces. Check out your mobile phone, computer, extension outlets, or your desktop.



Surface Transitions

Visual contrast can also be created through exaggerated and sharp blend lines at the point where two surfaces meet; these may indicate action areas. Blend lines are sharp curving transitions between two surfaces that emphasize the form of the overall object. They are similar to sharp C0 edges, but may not be straight lines. In the examples below you can see blend lines in a small appliance and a much larger car. They are often used in car design. Products can use FLUID continuity, contrasting blend lines, and even abrupt blend lines to highlight design features.



BLEND LINES SMOOTH OUT SURFACE TRANSITIONS & EMPHASIZE FORMAL DETAILS

Activity Time!

Click on the purple icons to see examples of different surface transitions within a product.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=982#h5p-24>

Surface Transitions

In this section, you have been introduced to a range of approaches that can be applied to unifying sub-elements so they are perceived as belonging together in any composition – art, architecture, or design. Whether by manipulating proportions of sub-elements or focusing on the transitions between surfaces, or both, a designer can tweak the overall composition so that it is perceived holistically and communicates its formal details clearly. Remember that thoughtfully designed formal features can also communicate important semantic messages.

As noted earlier, we interpret these messages and other characteristics by paying attention to the three dimensions of a product, not just what we see from a single viewing point, like the front. Some products may have unique components on one side or the other, on the top, or even on the bottom. Consequently, visual compositions achieve perceived coherence and provide interest from different viewing angles when they incorporate many of the foundational principles discussed in this chapter.

Back to previous section: 2.5 Relationships and Hierarchies Within Compositions

Next section: 2.7 Summary Review Activity

2.7 Summary Review Activity

Activity Time!

Practice your visualization skills by matching each of the 3-dimensional compositions below to its distinctive top, front, and side views.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2839#h5p-26>

Back to previous section: 2.6 Proportions and Transitions

Next section: 2.8 Conclusion & Key Takeaways



2.8 Conclusion

Through a detailed breakdown of design considerations for visual perception, this chapter explores the visual principles for designing compositions that communicate with viewers through their formal details and compositions. These contribute to a designer's foundational knowledge. They are not prescriptive rules that you "must" do because there can be endless variations in rectilinear, curvilinear, and organic 3D compositions. It rests with each designer to explore the range of possibilities through attention to the overall composition and to the guiding principles for organizing the sub-elements within it. This is the challenge and the pleasure of designing products: there is no correct solution.

There can, however, be compositions that are more easily understood than others. In some cases it may mean that when you interact with a product you can easily identify where the controls are, which controls are most important, or which parts are to be ignored. At first, these principles may seem daunting since there are so many of them. Over time and with practice, they become automatically integrated into the ideation phase of product concept generation. These principles help designers develop varied and unique results that can be tested with users to see which compositions communicate the concept most effectively. Believe it or not, all of these considerations are only part of what a designer has to take into account when designing for manufacturing and consumer use. Other constraints, such as choice of materials and manufacturing processes, human factors considerations, and costs also influence the design elements and features of the final product. Each of those design decisions impacts the overall composition.

Key Takeaways

The key takeaways from this chapter include:

- An overview of the visual languages associated with different typologies of compositions, ranging through rectilinear, curvilinear, organic, and combinations of these.
- Knowledge of the Gestalt principles for creating a unified perceptual interpretation of a composition including closure, focal point, continuity, symmetry, figure/ground, proximity, similarity, as well as unity and variety, rhythm, and connectedness
- An awareness of the importance of perceiving an object composed of many sub-elements as a unified visual whole.
- An understanding of the strategies for manipulating proportions, axes, and formal transitions between sub-elements and surfaces to create the perception of a unified composition.



Chapter 2: Design & Visual Perception

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=984#h5p-44>

The next chapter introduces colour and light relationships and associations in the visual perception of products.

Key Words: Composition, Typology, Form factors, Form giving, Principles of Composition, Gestalt principles of perceptual organization, Visual relationships, Visual language, Hierarchy of elements, Creating unity through composition, Proportions, Proportion systems, Orientation of axes, FLUID surface transitions

Back to previous section: 2.7 Summary Review Activity

Next section: Chapter 2 References



Interactives Answer Key

Section 2.5: Relationships and Hierarchies within Compositions

Drag and Drop, Overall Compositional Factors

Lighter

Red clicker: **subordinate**

Silver metal top front piece: **subdominant**

Red lighter body: **dominant**

Chair

Purple decorative cushion: **subordinate**

Green seat cushion: **dominant**

Wooden frame: **subdominant**

Wheelbarrow

Metal bucket: **dominant**

Wheel: **subdominant**

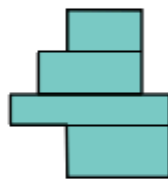
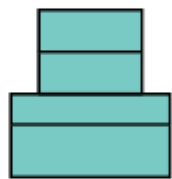
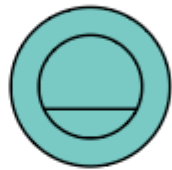
Metal support frame: **subordinate**



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1011#h5p-32>

Section 2.7: Summary Review Activity

Drag and Drop, 2D & 3D Matching



Back to previous section: 2.8 Conclusion & Key Takeaways

Next section: Chapter 2 References

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Back to previous section: 2.7 Conclusion

Next chapter: Chapter 3: Design for Colour and Light Perception

CHAPTER 3: DESIGN FOR COLOUR AND LIGHT PERCEPTION



Next section: 3.1 Introduction



3.1 Introduction

Colours provide a great deal of visual information. Many designers believe that colour can make or break a design and its accurate application is vital to the success of any product. However, the appeal of colours is subjective and open to individual interpretation. You might not be willing to purchase a product with a colour palette you don't like, even if the product is suitable for the task. Since people have varied opinions on what is or isn't attractive, the psychology and theory of colour come into play as sensory design elements. Furthermore, as with formal compositions, there are principles for applying colour to products or environments.

In the early design stages of your product, environment, or online service it's important to consider colours. Which ones are appropriate for your design? Should the colours be on trend for this year or should they last for many years? Will they be exposed to ultraviolet light rays that will change the saturation of the colour over time? You may have already experienced how colours can fade on sneakers worn in the sun, where the initial overall green now appears to be several shades of green, some more yellowy, some more reddish, each affected by how the materials of the shoe are reacting to the environment. Fading with subsequent colour change is only one of the issues that matter when making colour decisions.

How do designers apply colours that appeal to different age groups, that are appropriate in different contexts of use, in different professional environments, and for different kinds of visual communication? How can the choice of colours stimulate emotional responses to products? If you can't answer these questions, this is the chapter for you!

In this chapter, we are going to explore the principles of colour theory that contribute to our foundational design knowledge. You will learn about:

- Colour theories that are important for designers.
- How people perceive relationships among colours.
- How light affects colour perception and influences product perception.
- The nature of light as a compositional element.
- Unique applications for colours in industrial and environmental design.
- Colour specifications and systems for managing colour outputs.
- Cultural associations that are attributed to different colours and how they may influence design decisions.

Next section: 3.2 Basic Colour Theory



3.2 Basic Colour Theory



We begin with a review of basic colour theory. Colour is a property of light and can be broken into a spectrum of six distinct colours: red, orange, yellow, green, blue, and violet. Red has the longest wavelength and violet has the shortest, which is why the visual spectrum of a rainbow is arranged from red to violet. Also, did you know that white reflects all the wavelengths of the colour spectrum, whereas black absorbs all the wavelengths of the colour spectrum?



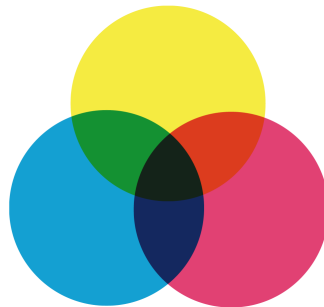
The Colour Spectrum is made visible when passing light through a prism

Did you know that the surfaces of objects have no colour of their own? They reflect specific wavelengths from the colour spectrum that result in the colours we perceive. Some wavelengths of light are absorbed and others are reflected by these surfaces. For example, the surface of a green stapler absorbs all the wavelengths of light but reflects green, so we recognize the stapler as green. These perceived colours are further modified by surface textures, surrounding colours, and lighting conditions.

Let's try a simple experiment. Pick up a nearby marker or highlighter with a similarly coloured barrel (e.g. the yellow body of the marker and yellow ink) and draw a wide stripe on a piece of white paper. Then, place the pen barrel (the body of the pen) on the paper beside the line. Are the paper ink line and the plastic barrel the exact same colour? You are comparing the reflected light of a similar colour pigment on two different materials – are the colours exactly the same? Try it outdoors under the sun too; colours can look different under different types of lighting.

Colour Mixing

How we perceive colour depends on whether the colour is generated from pigments or lights and their respective systems for mixing colours. There are two main systems of colour mixing: *subtractive* and *additive*. Subtractive refers to mixing the pigments of inks or dyes on physical surfaces like paintings or products and additive refers to mixing light sources in atmospheric lighting (like on stage theatrical lighting) or on displays with lighted screens. In general, the colours of physical products result from subtractive colour processes, whereas screen-based products that depend on light for activating their visual qualities use additive colour processes. We begin with subtractive processes.



Subtractive Colour Palette: Red, Yellow, Blue (RYB)

Subtractive Colour Mixing refers to the process of creating colours from pigments or dyes that we perceive as reflected to us from the printed page or coloured surface. The colour we see is the only colour wavelength reflected from the surface; the other colour wavelengths are subtracted or absorbed by the medium the pigment is on, as noted earlier. In other words, we identify the colour of something by perceiving the colour of the light reflected from its surface. For example, we perceive a fire truck as red because the only wavelengths we cognitively recognize are those reflected in our eyes; the others have been absorbed or subtracted from our visual experience. In *subtractive colour mixing*, the primary colours are red, blue, and yellow and through overlapping, create the secondary colours of violet, green, and orange as seen in the above diagram of a Subtractive Colour Palette.

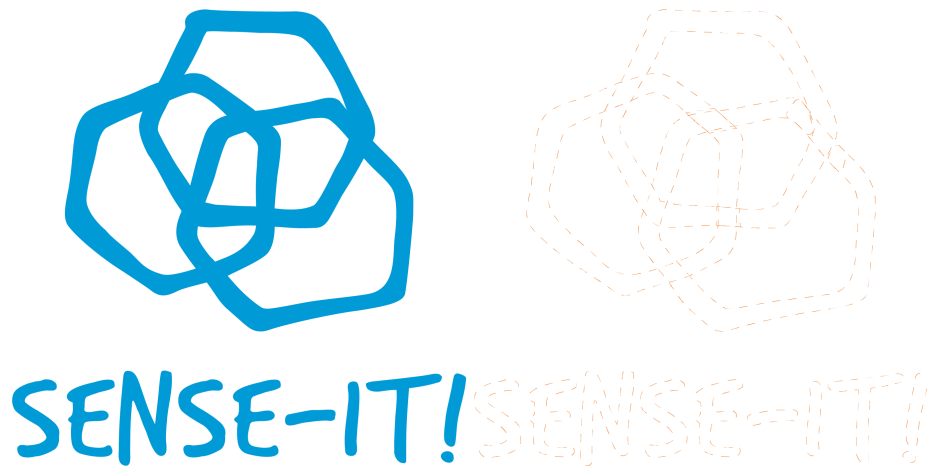


Additive Colour Palette: Red, Blue, Green (RGB)

Additive Colour Mixing refers to the process of creating colours from projected light that we perceive when viewing screen-based surfaces such as computers, cell phones, and televisions. We also experience additive-coloured lighting in computer art, photography, interior, and stage design.

In additive colour mixing coloured lights are combined to generate new or different colours. Our eyes blend and perceive the mixed hues of the red, blue, and green light sources as specific colours, depending on the strength of each of the coloured light beams. The lights are mixed when red, blue, or green filters are positioned in front of a projected ray of light. If the light is projected through all three of these coloured filters the result would be white light. In the additive system, the primary colours are red, blue, and green. The secondary colours of yellow, cyan, and magenta are created where the primary-coloured lights overlap as seen in the above diagram of an Additive Colour Palette. When you watch anything on a screen, this is the colour-mixing process that enables you to perceive the colours.

Lastly, if you have ever stared at a coloured object intensely and then shifted your gaze onto a white surface you may have noticed a coloured shape on the surface, similar to the object you were staring at, but different in colour. That *afterimage* is an optical reaction – if you look at a blue object you will likely see an orange afterimage. This is a physiological response to colour called **Partitive Colour Mixing**, where adjacent colours seem to mix and influence our understanding of colour relationships, as discussed later.



See for yourself! stare at the blue logo for 30 seconds, then look to the right for the afterimage

Hue, Value, and Saturation

A designer's job is to specify the exact *colour palettes* for specific elements in any product composition. To do so, it is important to understand the terminology and effects of the properties or dimensions of colour, which are: *hue*, *value*, and *saturation* (or *chroma*). Hue refers to the pure or true colour. Value refers to either tints (adding white), shades (adding black), or tones (adding grey) of the hue. Saturation (or chroma) expresses the strength or intensity of the hue. Altering one of these dimensions affects the others and adds nuances to the colours selected for every design.

Hue refers to a colour in its pure form that has not been mixed with white, black, or another colour pigment. The primary colours red, yellow and blue are pure hues. It does not refer to a colour's brightness or dullness.

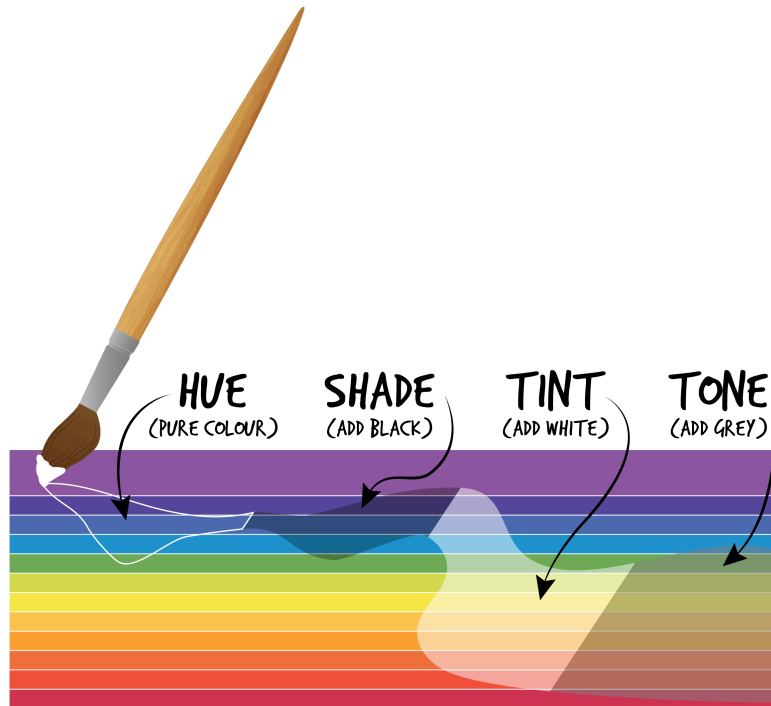
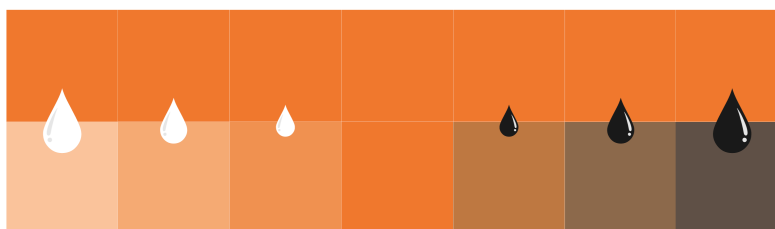


Diagram: How hues can be changed by adding black, white, or grey

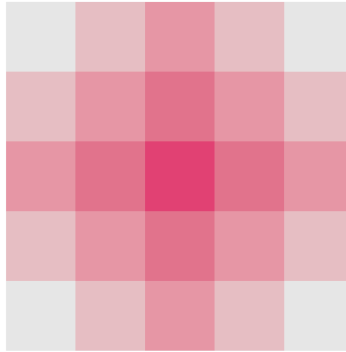
Value refers to the lightness or darkness of tint, shade, or tone, not to the quality of the colour. Have a look at the row of oranges in the Contrast of Colour Values table below. The middle cell is a pure orange hue. The cells arranged to its left illustrate different values of tints from the darkest tint (with a small amount of added white) which is immediately beside the pure hue, to the lightest orange (with a larger amount of added white) as your view moves toward the left side of the table. Moving to the right of the pure hue in the centre is the lightest value orange (with a small amount of added black) and the cells become darker (with larger amounts of added black) toward the right side of the table. These variations add contrast when used in colour applications. For example, you may wear an orange jacket with a scarf of a darker orange value (that you perceive as brown) to add a bit of subdued colour flare.



Contrast of Colour Values Table

Saturation refers to the degree of purity of a hue. Rather than mixing a hue with white or black, it can be diluted, such as when you add more water to watercolour pigment to reduce its intensity.

Saturation is described as pale or weak and pure or strong, rather than in terms of light and dark. In the table below you can see that the strongest saturation is in the middle cell. As the hue becomes less saturated in each direction – up and down, right and left – the hue appears more pale, weak, or strong depending on the layers of saturation. You can use the term saturation to explain the strength of the hue that you are looking at.



Colour Saturation Table: The pure hue is in the centre and the saturation values change in horizontal and vertical layers (Itten, 1970)

Achromatic Colours

The **achromatic** colours of white and black have lightness but no hue or saturation. They absorb (black) or reflect (white) all wavelengths of light evenly across the spectrum.



Achromatic colours: Black and White

Black and white provide the fundamentals of visual contrast. Indeed, we recognize the formal details of things by perceiving changes between light and dark (Morris, J. 2006). In a line of cells between black and white, there can be an infinite series of incremental changes in tints and shades, each progressively moving closer in value to one side (white) or to the other side (black). Where the average eye can perceive twenty incremental changes or steps, the trained eye may be able to distinguish between forty incremental changes or steps, where the steps are equal additions between each cell (Itten, 1970). Black and White can be used as achromatic colours or mixed with hues.



Black and White provide visual contrast that defines formal details

White: The human eye is sensitive to the slightest change in the purity of whites, which can be lightly tinted to produce thousands of warm or cool tones. Whites are reflective and have no distinctive hue.

Black: Blacks range from warm to cool and reddened to blued. They may vary in tone from pure pitch black to dark charcoal grey. Blacks are absorptive and have a perceived absence of reflected light.

Grey: The *contrast of value scale* (shown below) depicts a series of grey value contrasts between the poles of white and black (Itten, 1970). We tend to be better at distinguishing between lighter greys than darker ones.



Contrast of Value Scale: The centre figures have an identical grey value in each square

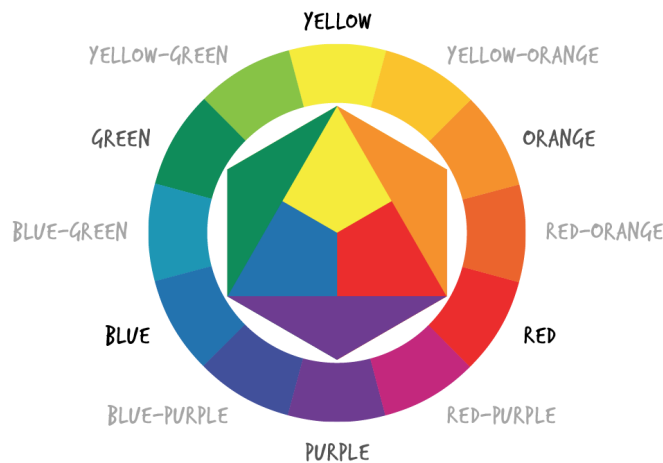
Back to previous section: 3.1 Introduction

Next section: 3.3 Colour Wheel and perceived Colour Relationships



3.3 Colour Wheel and perceived Colour Relationships

You may be familiar with the concept of a colour wheel, like the one seen in the image below, a model that illustrates a circular relationship between colours (Itten, 1970). In the 17th century (1666), Sir Isaac Newton developed the first colour wheel to represent a system for understanding how colours relate to one another. Since then, many colour systems have been based on this by organizing the spectral colours in a circular array, where red and violet are placed side by side, even though we actually see them at opposite ends of the spectrum.



Itten's RYB Subtractive Colour Wheel (1970)

Since then, other colour theorists have developed a range of models to demonstrate relationships among colours such as Goethe's colour wheel and colour triangle (19th century), Maxwell's colour triangle (19th century), Munsell's three-dimensional colour tree (early 20th century), Itten's colour wheel as seen above (early 20th century), and the Pantone Colour System, which is a current product design industry standard discussed later in this chapter. Colour theory is a vast area of study across disciplines that range from physics to design (Clay, 2009, Hope and Walch, 1990, Fiesner and Reed, 2104). In this section, we focus on applied colour theory that can bring products to life.

Itten's colour wheel is the most common way we visualize the relationships of the basic colours in design. In his subtractive RYB colour model, seen above, the primary colours are red, yellow, and blue, which we see in the triangular centre area. The three secondary colours, depicted in green, orange, and purple triangles adjacent to the centre, are created by mixing pairs of primary colours. Green is composed of blue and yellow, orange is composed of red and yellow, and purple is composed of red and blue. Six tertiary colours are created by mixing primary and secondary colours, as seen in the models below (Itten, 1970).



Primary, Secondary, and Tertiary Colour Models (adapted from Itten)

As you probably know, every designer should understand basic colour theory. Colour system schemes provide a foundation for designers to select appropriate product colour relationships that will enhance a user's product experience by communicating an aesthetic, emotional, or functional message. You can apply the following colour relationships or colour schemes in the design of products, environments, and interfaces. As you will see, we discuss relationships using an adaptation of Itten's colour wheel as our foundation.

Monochromatic Colour Schemes

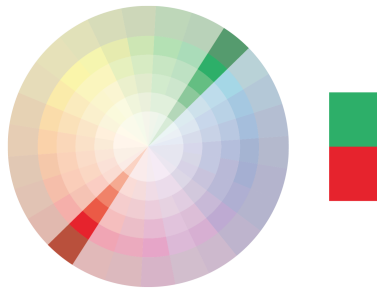
Monochromatic colour schemes are derived from a single base hue that is extended using its shades, tones, and tints. The hue never changes, but the value does. For example, in the image below, each segment depicts a monochromatic colour scheme, where the original hue is in the centre of the segment, the shade is above it and the tint is below it.



Monochromatic colour wheel

Complementary Colour Schemes

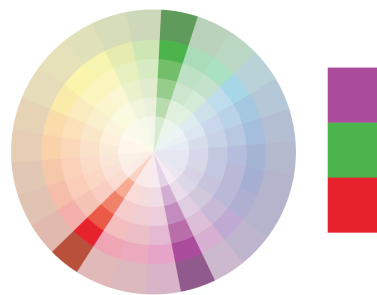
Complementary colours are positioned opposite one another on Itten's colour wheel: red and green, blue and orange, and yellow and purple. These are derived as a product of partitive colour mixing, where complementary opposites include: yellow and blue-violet, red and blue-green, green and red-violet, and violet and yellow-green (Munsell, 1946). These hue combinations intensify (contrast) each other and catch our eye, often expressing fun or excitement (Clay, 2009). Some key points about complementary colours are that placing two complementary colours side by side creates a brighter image. However, mixing two complementary colours together creates grey.



Complementary Colours

Split Complementary Colour Schemes

In addition to the base colour, **split complementary** colours include the two colours adjacent to the original colour's complement. This colour scheme has the same strong visual contrast as the complementary colour scheme, but less tension. This relationship is built with one hue plus two others equally spaced from its complement. In the diagram below the split complementary colours for green are orange/red and red/blue.



Split Complementary Colours

Analogous Colour Schemes

An **analogous** colour relationship includes a colour combination of three colours located adjacent to each other on a colour wheel. The analogous colours in the example below range from blue to indigo. Analogous colour schemes provide visual harmony.



Analogous Colours

Triad Colour Schemes

A **triad** colour combination includes three colours that are at an equal distance from each other on the colour wheel. They are perceived as stimulating and enhancing each other, as with the triad colour combination of green, violet, and orange below.



Triad Colour Combination

Discordant Colour Schemes

Discordant colours are widely separated on the colour wheel (but not complementary or triadic). Discordant colours can be eye-catching and/or visually disturbing. They deliberately break from harmonious schemes and can be said to clash or fight against each other. They are often used as attention-getting devices in advertising. For example, the red font on the violet magazine cover below is a discordant colour combination that has recently become rather fashionable.



An Example of a Discordant Colour Scheme

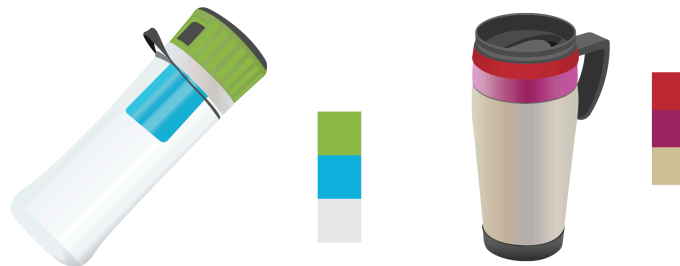
Warm/Cool Contrast Colour Schemes

Itten divides the colour wheel into **warm** and **cool hues**. He associates *warm colours* with the ability to conjure up vivid and energetic perceptions. They include violets to yellows and may send us a semantic message, reminding us of the summer, sun, or fire. On the other hand, he associates *cool colours* with communicating the message of calm, or soothing. They include greens to violets and may remind us of spring, ice, or water.



Warm red/yellow and Cool blue/green colour schemes

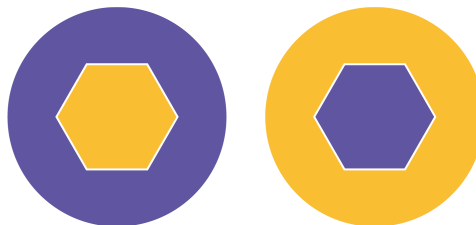
White, black, and grey are neutral. However, you can make colours (hues) ‘cooler’ or ‘warmer’ by playing with the vividness or colour saturation, as discussed earlier. For example, a warmer or cooler version of a blue may be manipulated by levels of saturation. There can also be warm or cool whites and greys depending on the variation of undertones mixed with the base hue. For example, a blue undertone contributes to a perception of coolness, whereas a yellow undertone contributes to a perception of warmth.



Cool Colour Palette (left) and Warm Colour Palette (right)

The first example above is a cool colour *scheme* or combination symbolizing refreshing cold water (blue = water) in the context of nature (green). By contrast, the second example is a warm colour scheme, with deep reds and violets symbolizing the comforting warmth of the hot drink inside.

Architects and interior designers depend on *colour relationships* to create a perception of depth in environments. Clay (2009) notes that warm colours (yellow, red, orange) tend to be perceived as enlarging areas or volumes whereas cool colours (blue, violet, green) reduce their perceived size, as seen in the images below. That is because warm colours generally appear to advance (to be closer to you) and cool colours appear to recede (appear to be farther away from you).

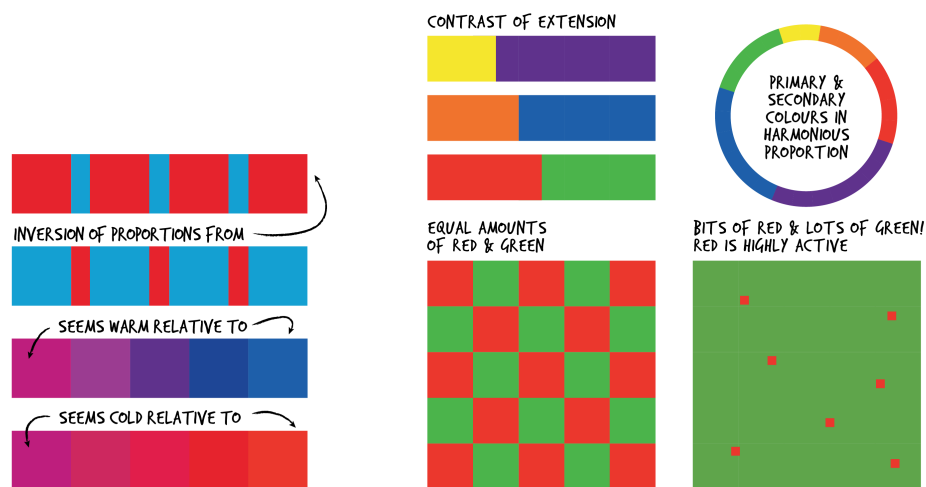


The centre shapes are the same size, but the warm yellow shapes appear larger in both cases: the warm yellow advances, the cool violet recedes

Colour contrast is often used to amplify the effects of coloured elements next to one another in a composition. For example, warm hues combined with cool ones or light tones next to dark tones may draw the viewer's eye to the place where the contrast is the greatest, as discussed below. Even a small area of strong colour contrast could have a positive impact on the overall appeal of the composition. Many effective colour schemes depend on an unequal proportional distribution of colour – a large area of one colour adjacent to a small area of a contrasting colour, like in the images above where the small centre colour is in the middle. Other proportional distribution colour schemes follow below.

Contrast of Extension Colour Scheme

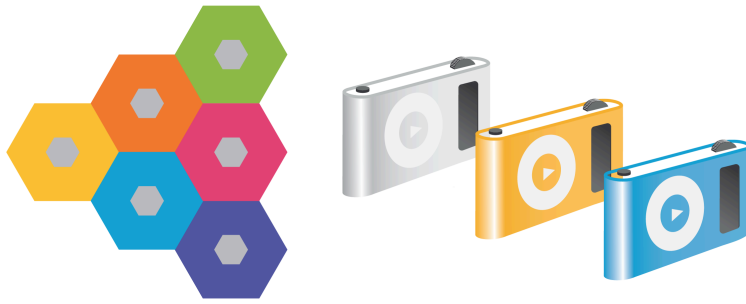
Combining warm and cool colours can also add to the contrast of the composition, creating the desired *colour accent*. For example, placing small areas of light colour on a dark background, or a small area of dark on a light background will create a colour accent. When you are exploring contrasting colour relationships, experiment with colour combinations as well as proportions to achieve a colour accent. For example, as you explore the ratio of areas of a warm colour to those of a cool colour you may achieve a suitable accent, as seen in some examples below. This colour principle is often applied in product design to highlight elements that users will interact with, like placing a strikingly red stop/start button against a less saturated green background, which minimizes the background or less important elements.



Examples of Contrast of Extension (Based on Itten)

Simultaneous Contrast Colour Scheme

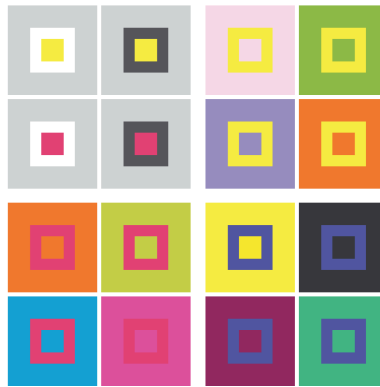
Simultaneous contrast can also be called colour modification because identical areas of hue or tones can be perceived differently relative to surrounding or adjacent colours, as we saw in the yellow/violet examples earlier. For example, if large areas of light hues are used, the whole area will appear light; if large areas of dark values are used, the whole area appears dark. Colours can also be modified by their neighbouring colours. For example, in the coloured hexagons below, the grey element can be perceived as a different value in relation to each of the different background colours (a neutral grey appears slightly green next to pink). On the music player below, the *value contrast* of the white is perceived differently in relation to each of the backgrounds. The contrast is more pronounced on the vibrant blue or yellow than on the silver device.



Simultaneous Contrast Colour Schemes affect overall perceptions

Zing Colour Scheme

Zing refers to a small patch of highly concentrated colour amidst less saturated colours or greys. It is often used to attract attention or feature important elements in a product.



The Zing of bright patches of colour attract the eye (Based on Itten)

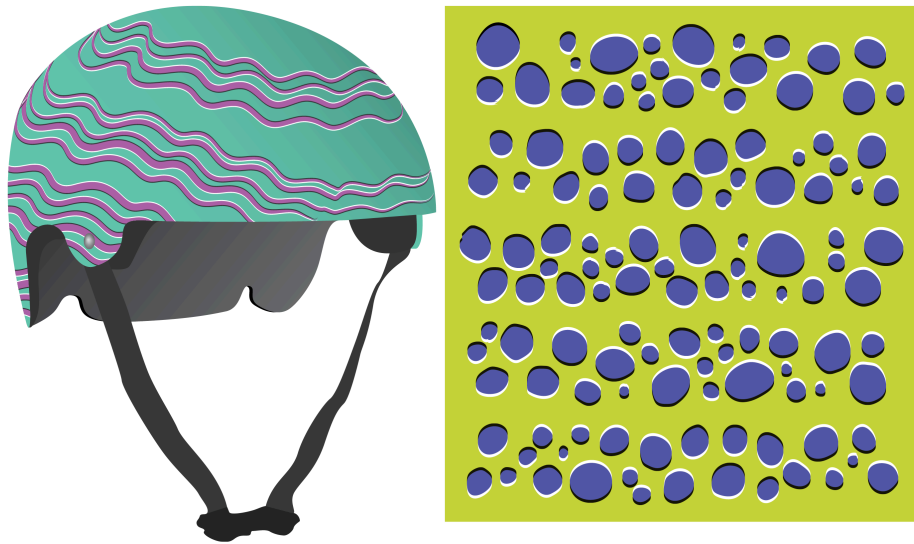


Zing attracts attention to product features

This is where more complexity can contribute to an interesting product *colour palette*, which we discuss later. To attract attention, a small amount of one colour, which could be an accent colour, can be applied to create contrast with a larger area of another background or surrounding colour.

Flicker effect

The **flicker effect** creates an illusion of independent movement, where two colours that are very similar in tone, but otherwise different in hues (colour) are placed beside or close to each other. This can create the optical illusion of movement or hovering.



The Flicker effect creates an illusion of movement

Activity Time!

Look at the following images. Take some time to reflect on the colour relationships applied to each sneaker below. See if you can match each colour scheme name to its appropriate sneaker.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1052#h5p-34>

THE SAME PRODUCT CAN APPEAL TO DIFFERENT USERS BY APPLYING VARIED COLOUR SCHEMES

Back to previous section: 3.2 Basic Colour Theory

Next section: 3.4 Light as a Compositional Element



3.4 Light as a Compositional Element

Not only do designers need to consider appropriate colour choices, but also the degree to which light is an element in either the composition or the perception of the product or both. Will the product elements be *transparent*, *translucent*, or *opaque* – and to what degree for each of the elements of the composition? How will the degree of transparency of product elements affect the colours? How will the different materials affect the perception of colours? Furthermore, how will the setting or environment that the product will be in influence the perceived colour, size, and composition of the product?

Transparent surfaces allow visible light to pass through them, as in the left toothbrush holder below. As the light meets transparent materials – such as plastics, glass, and resins – almost all the light travels directly through them. In this case, we clearly see whatever is on the other side of the transparent material.

Translucent surfaces such as frosted glass and some plastics allow some light to travel through them, as in the middle toothbrush holder below. In this case, some of that light becomes scattered so we may see a hazy version of whatever is on the other side, and sometimes we cannot even make out what is there.

Opaque surfaces of materials such as wood, stone, metal, and some plastics block light from travelling through them, as in the right toothbrush holder below. In this case, the light is either reflected or absorbed by the opaque material, and we only see the material surface's colour, pattern, and texture.



Transparent, translucent, and opaque materials support different degrees of transparency

Since objects and different materials vary in how they transmit and reflect light, we need to understand that material selection and treatment also contribute to how the overall product is visually perceived.

Activity Time!

Reflect on the value of different degrees of transparency for functional and semantic applications in design. Click on the purple icons to see some functional and semantic reasons for selecting different materials and levels of transparency for each of the jars below.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1056#h5p-35>

The same product can serve different purposes and be perceived differently depending on its level of transparency

We have seen that transparency, translucency, and opacity influence colour perception, but how do designers control the specific colours and colour schemes that guide our perceptions? They specify colour palettes for every product. Knowing how to choose suitable colour combinations and specify colours is key to designing a product where colours enhance the composition and communicate the product's functional uses. Designers also want to ensure that the colours they specify are available for manufacturing.

Back to previous section: 3.3 Colour Wheel and perceived Colour Relationships

Next section: 3.5 Colour Specification and Colour Systems



3.5 Colour Specification and Colour Systems

In design, most colour choices are specified numerically (according to specific colour systems) and standardized across product elements. A part of the designer's job is to clearly identify colours for specific product parts, specific interior areas, and/or specific interface features. This is important, especially since different parts may be manufactured or produced in different plants or even different countries. Colour systems provide a systematic way to standardize colour schemes across multiple versions of the same products or product lines.

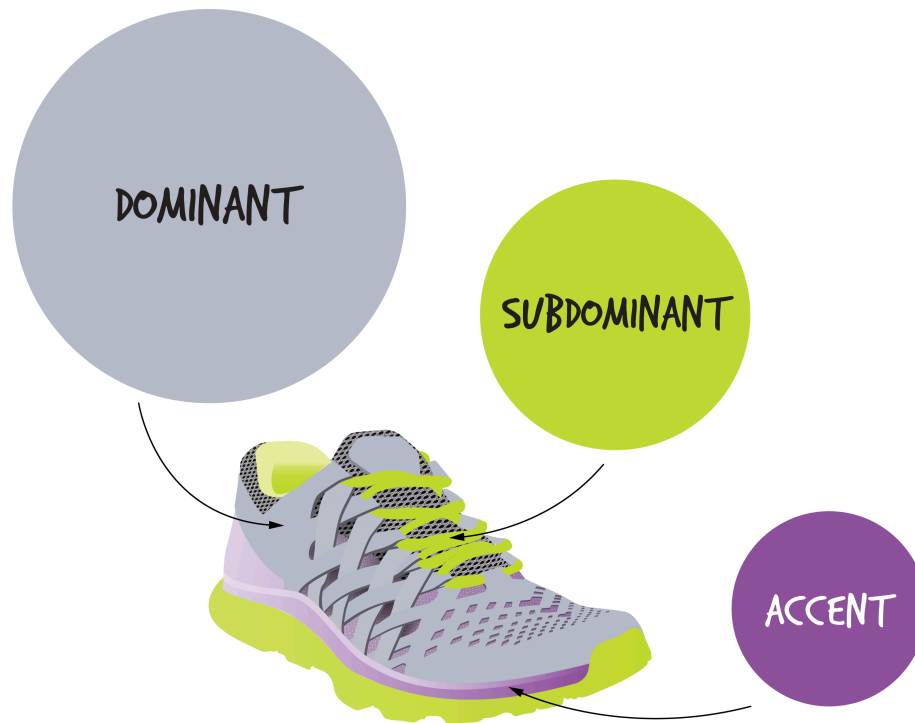
Colour specification is based on standard systems of colour like the Pantone Professional Color System (Pantone, n.d.), the Munsell Book of Color (Munsell, n.d.), or the Colorcurve System (Stanziola, 1992). When we work with manufacturers or work on different computer applications, we need to know which standardized colour system they use to be able to provide the specifications for each colour we identify for every product component. We can refer to that colour system's standard set of templates in books, binders, or material samples to make our colour choices. By specifying the colour codes that align with those your service provider uses, we can be assured that the end result will be the colours we have selected.



A generic example of templates for a colour specification system

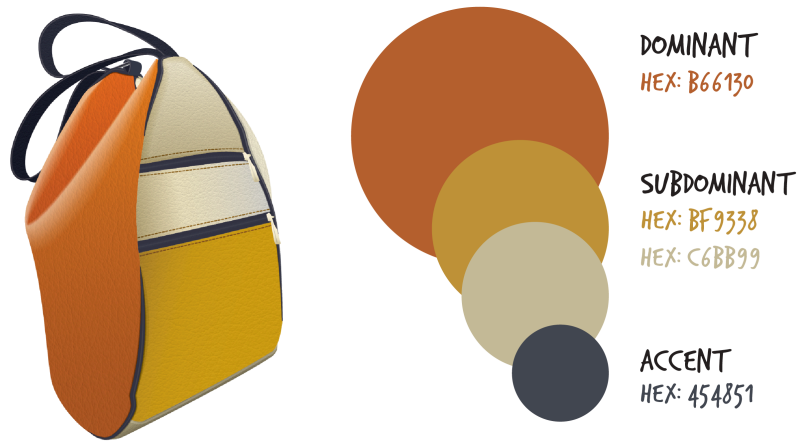
Product specifications

Since it is your job as a designer to specify the colour codes for each of the elements or components of your products, you can organize your colour palette while you make your choices. This would minimally include the main body colour, a secondary colour, and the accent colour. The background colour is usually the main or overall colour of the body of the product, like the main grey colour of the sneaker in the example below. The secondary colour may be used for trim details (such as the lime green soles in the sneaker example) or for functional affordances (like the lime green laces). The accent colour may be used to highlight important elements (like the charcoal grey separation between the sole and the body of the shoe). The proposed colour palette would include at least a dominant, subdominant, and accent colour, where dominant refers to the colour of the body or overall colour, subdominant refers to the secondary colour, and the accent colour refers to those used the least and that could be the brightest or strongest.



Product Colour Specifications: grey is dominant, lime green is subdominant, and charcoal grey adds a strong colour accent.

Today there are numerous applications and websites that you can use to select suitable colour palettes for products, logos, and web design. Try searching for colour selection tools or colour pickers, or online colour palette generators. You can easily experiment with their online colour combinations of different values, tints, shades and tones. You can also try to develop your colour palettes using the paper paint colour samples supplied in paint stores (however the colour codes may not match those of the colour system your manufacturer is working with). You can arrange the printed colours in a composition that represents the relative dominant, subdominant, and subordinate proportions you want based on the colour principles already discussed. Are the colour relationships complementary, split complementary, or even discordant? Are they warm or cool? Do the accent colours leverage the perceptions that principles like zing, simultaneous contrast, or contrast of extension support?



An example of a colour palette applied to product design

Back to previous section: 3.4 Light as a Compositional Element

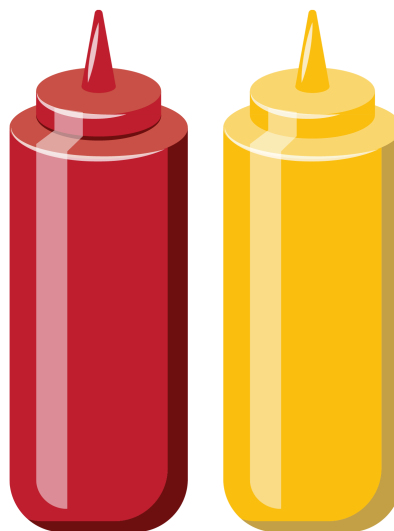
Next section: 3.6 From Colour Principles to Product Design Applications



3.6 From Colour Principles to Product Design Applications

In this chapter, it is apparent that the designer's task is to translate colour theory into colour applications that convey messages or have desired effects for consumers. Jason Morris (2006) explored ten categories of colour applications that designers can consider for applying colour principles to enhance users' perceptions. Let's look at them below:

Colour as association: In this category, we can apply colours with symbolic meanings that reflect cultural, locational, or generational influences. As we have seen, colour can communicate symbolic meanings through colour metaphors or combinations. Colours also add semantic meanings to products when we have prior knowledge that enables us to interpret the message encoded into the product. For example, we associate each of the bottles below with a specific condiment – mustard or ketchup – because of our prior use experiences. Reflect on some coloured products you associate with your family rituals.



Cultural memories from past experiences can influence colour choices

Colour as user interface: In this category, we can apply colours to a user interface that acts like an affordance. Colours can be strategically placed to provide clues about the function of the product, the order of tasks, or general high-touch spots. We revisit the game controller below on which the green button is associated with “go” or “confirm”, while the red button might mean “back” or “cancel”. The coloured buttons add bright accents on the neutral white background through contrast by extension to draw attention to their functions. They act as strong highlights that capture our attention against the less saturated background. Buttons that perform special actions can be coloured, while neutral-coloured buttons perform ordinary or common actions. What other coloured user interfaces provide information for you in your daily tasks?



Game controller buttons leverage contrast by extension

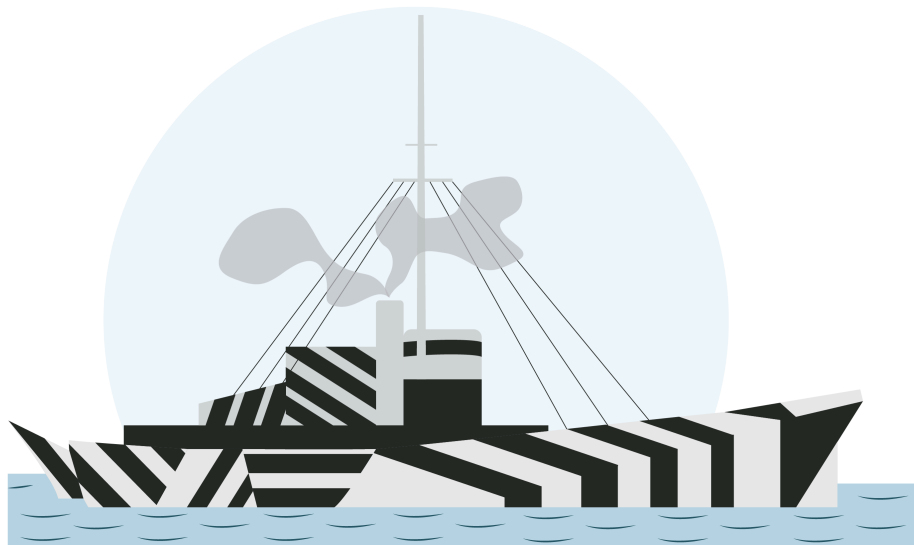
Colour as fashion: In this category, we can apply colours that are influenced by fashion colour palettes and colour trendsetters' forecasts. Colour trends are not random, they are the result of lengthy research and observation into global art practices, fashion and environmental design patterns, and cultural influences. This information is distilled into colour forecasts and colour trend palettes that influence designers to adopt similar colour palettes for the upcoming year, or within a given timeframe (Color Marketing Group, 2022).

Is there a colour that you no longer wear that you really liked several years ago? For many fashionable products, it may be important to follow the predominant colour trends, and there are cases where avoiding trendy palettes offers a unique alternative. For example, most of us have fridges that are likely to be white, stainless steel, or black. Very few of us have pink, yellow, or green fridges these days, so these product colours may stand out as cool or innovative.



Fashionable colour variations appeal to different trends

Colour as form alteration and to modify shape and proportion In this category, we can apply a colour or colour combination to alter how a three-dimensional form is perceived by concealing or disguising it. We can use this application to masquerade or de-emphasize a form. For example, the camouflage pattern applied to a military vehicle or helmet (see below) can minimize its visibility outdoors. This approach de-emphasizes the overall form, minimizing the ability to perceive the visual boundary of the product when seen among natural features in the surrounding environment. *Dazzle* painting was also a form of alteration technique introduced in the First World War as a way to mislead the enemy about a ship's range, speed, or direction.



Camouflage colouration & form Alteration

Form alteration is also useful to enable products to blend into our home or office environments, where they may not appear as different or as taking up too much space. Colour can also be used to de-emphasize certain elements in a composition, particularly black or dark greys, which make elements of products appear to recede into the background, as in the stroller design below. The seat is colourful, while the structural mechanism is dark enough to avoid attracting attention.



The colourful seats of these strollers attract more attention than their dark structural elements

Of course, the old tenet that black makes a person look thinner can also apply to a product! On the other hand, brighter, contrasting colours, or white could draw attention to certain form factors. Have you ever noticed people around you applying this trend?



Black and white are not only fashionable – they can also modify perceptions of shape and proportion

Colour as form emphasis: In this category, we apply colour to emphasize form. Colours can accentuate various surfaces and offer a variation in perceiving three-dimensional visual details. The three factors that influence form emphasis in colour application are: the value, pigments, and the graphical application of colour. For example, applying light colours (high in value) juxtaposed with darker colours (lower in value) can create heightened contrast. Through the contrast of colour applied to different areas, some elements of a composition or overall form can be enhanced or diminished (see helmet below). To emphasize the form further, metallic pigments can be used to reflect light or precise colour blocks or stripes can be applied to emphasize contours (as in the bicycle helmet below).



Juxtaposing light and dark colours emphasizes contours

Lastly, the perceived surface treatment of the colour application can influence how we perceive the details of the form. In the examples below, the glossier the pigments are on the product's surface, the more light is reflected, emphasizing the blend lines that communicate the product's contours.



Form emphasis through colour can also be enhanced or diminished by different surface treatments ranging from flat matte to reflective glossy

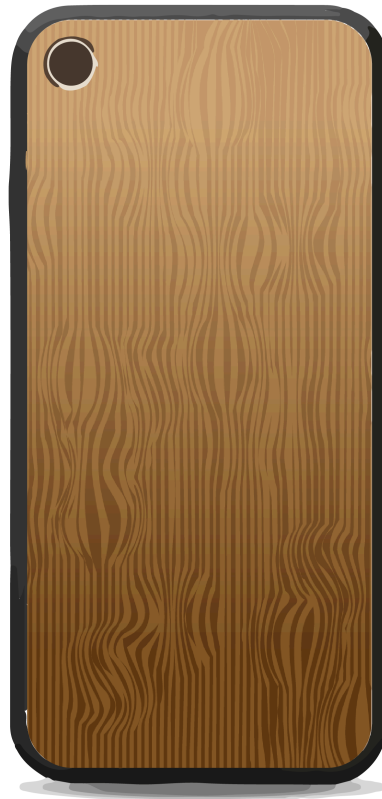
Colour as material emphasis: In this category, we apply colour to highlight material properties by emphasizing certain visual and tactile properties and surface textures. We often use this when products

have a combination of materials, which may even be associated with different ways of interacting with a product. For example, a can opener may have a colourful rubber handle in contrast with sharp silver metallic blades.



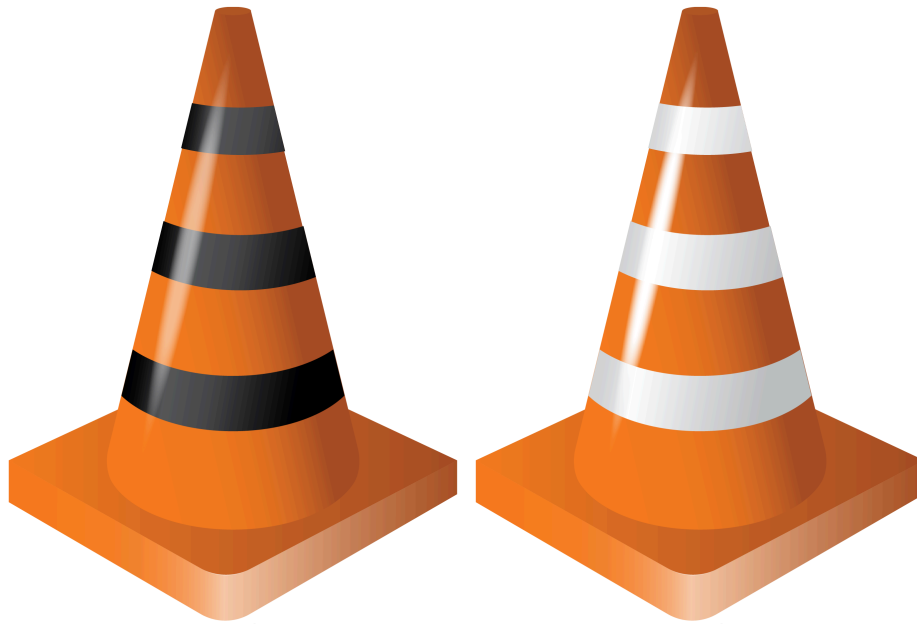
A Contrasting colour palette for different materials emphasizes affordances

Colour as material deception: In this category, we apply colour to deceive the user by making the material look like something other than it is. This is often applied when less expensive materials are used to simulate more costly ones, such as plastic standing in for marble, glass, or wood. Have you ever been surprised that a product you thought was made of a certain material was designed to hide the nature of the actual material it was made of?



This phone looks like it has a wood grain cover, but it is plastic

Colour as contrast: In this category, we apply colour to make a product stand out in an environment. Distinctions can be created by hue, saturation, or value. This approach is often used in the design of safety products (orange cones), to draw attention (yellow strip on stair edges), or to differentiate a product from its competitors. In the example below, we see orange and white traffic cones that stand out in contrast with the grey road environment to deter vehicles away from hazards.



Traffic cones use colour contrast to attract our attention and deter us from traffic hazards

Colour as harmony: In this category, we apply colour to make a design visually compatible with its environment. For example, it can be used to achieve a quiet, harmonious environment to reduce visual chaos. The blender in the image below has contemporary kitchen appliance colours of silver, black, and white so it can harmonize with the similarly coloured kitchen setting. How does the colour of the appliances in your kitchen harmonize with the overall environment, if at all?



A black blender blends nicely into a black-and-white kitchen

Colour as identity: In this category, we apply colour as a branding tool. Since many purchasing decisions are made in-store or online, it is important to use colour to effectively convey information that can boost sales. Did you know that a person may pay attention to a black-and-white image for less than two-thirds of a second, whereas they may pay attention to a coloured image for two seconds or more (White, 1997)? That points to the potential for success using colour branding, especially when strong, saturated, and primary or secondary colours are used.



The branding colours for each of these products are associated with different well-known companies

The video below summarizes these applications for colour in design.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1062#oembed-1>

Colour As: A video about applying colour in industrial design (adapted from Morris, 2006)

Activity Time!

Take a moment to think about how colour principles can be applied to product design as explained in the video. Click on the cards to flip them. Match each “Colour as...” phrase with its associated image.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1062#h5p-37>

Back to previous section: 3.5 Colour Specification and Colour Systems

Next section: 3.7 Psychology of Colour



3.7 Psychology of Colour



The psychology of colour is important in the design of many products

So far in this chapter, we have been discussing the principles of applying colour. Now, we turn to the psychological, cultural, and emotional importance of colours in the design process. For centuries, colours have been associated with different cultural contexts and a range of associated meanings (Ciotti, 2020). Singh (2006) found that we decide to purchase a product within 90 seconds of our initial interactions with it and that up to 90 per cent of this decision is based only on our response to the colour! As a result, marketers regard colours as persuasive factors in product design. The more we understand cultural colour references the more we can apply colours to positively influence consumers' responses to products.

Research on the psychology of colour focuses on the cognitive and emotional associations that affect those of us with sight living in western countries. Colours influence our perceptions and behaviours, although there is a great deal of subjectivity in this experience that is not generalizable. This is especially so since responses to colours may depend on past experiences, personal preferences, upbringing, and cultural influences (Kaiser, 1984). The challenge for designers is that there is no clear formula for making colour choices that link certain colours to specific perceptual or emotional responses. Let's review some of the attributes of colour commonly considered in the western world, keeping in mind that these associations differ among cultures.

The following attributes have been applied to colours in a North American context.



Colours communicate familiar messages

Red is connected to strong emotions, such as passion, anger, and danger. It is also associated with erotic desire in images of red lips and fingernails. Since it is so vibrant it is highly visible in the environment and a small amount of red can attract attention (applying contrast by extension). That could be why stop signs, stop lights, and fire engines are red. Add a bit of white and the high-arousal message of red changes to a gentle pink tint, often connected to romance, love, friendship, and relaxation.

Orange is perceived as less intense than red and has positive associations with creativity, happiness, joyfulness, play, and tropical countries. It is a warm colour and is second to red in terms of visibility. That also makes it useful for attention-getting highlights, as we saw in the traffic cones earlier. Since it is associated with healthy oranges and carrots, it could add semantic meanings to food product packaging and toy design.

Yellow is associated with sunshine, which is related to happiness, warmth, and action. It is pleasant and exciting, even spontaneous. Since it too attracts attention, it can be used for toys and leisure products. When paired with black, it signifies danger and is used in situations where the high contrast alerts people to beware, such as on the edges of stairs.

Green is closely connected with nature, healing, safety, and a sense of being emotionally balanced. It is also culturally linked to money. Due to its healthy and healing association, it is used in food and pharmaceutical packaging.

Blue is also associated with nature, especially the sky and water. It is perceived as calming, serene, and deeply refreshing. It can be associated with clean and cool things like cleaning products, drinks, and health, as noted in the earlier water bottle images above.

Purple has been associated with royalty and communicates power, luxury, and dignity. Tints of purple are perceived as childlike, playful, and relaxing, while shades of purple may seem dark, ominous, or sad.

Brown is another nature-related colour. Like tree trunks, it is associated with stability, timelessness, and usefulness. It sends a message of reliability and endurance, which is why briefcases and wallets are often brown.

Achromatic black is the darkest colour and is associated with darkness, depth, and evil. It is culturally connected to villains, fast cars, and designers (who often dress in black). It is considered dramatic, powerful, and sophisticated.

Achromatic white is associated with purity and goodness and is currently a popular colour for homes and offices. It communicates a message of cleanliness and sterility. It can be related to hospitals, electronic products, and clothing. North Americans consider white to be a hygienic colour. These days, most bathrooms have white appliances such as sinks, bathtubs, and toilets. However, coloured appliances were popular in the past and have changed as cultural ideas evolved.



Colour choices for appliances are culturally dependant

Colour Association and Culture



Global Colour Associations

Perceptions of colour differ across cultures with some notable differences as follows:

White is worn at weddings and is a symbol of cleanliness in North America, whereas it is a symbol of mourning in China. However, red is associated with joy and weddings in China and with caution and danger in other countries. Yellow is considered a warm and happy colour in North America, but not in Latin America where it is associated with sorrow and mourning. Green symbolizes eternal life in Japan, health and well-being in North America, and corruption in North Africa.



Wedding Dress Colours in different cultures

In North America, pink and blue have been associated with gender since the twentieth century, where pink is perceived as a feminine colour and blue as a masculine colour, as noted in the Design and Emotion chapter.

Given the strong relationship of colour to cultural messages, it is important for designers to become sensitive to the nuanced messages of colour that may be interpreted differently by different target markets. A well-designed and useful product with an inappropriate colour palette may not only fail in some cultural markets but could also be considered offensive and cause harm!

With all the variables in colour psychology, thinking critically about colour is necessary in product development. Reflecting upon all aspects of colours for product design including placement, references, branding, associations, and content is key to creating an informed product that appeals to your targeted audience.

Back to previous section: 3.6 From Colour Principles to Product Design Applications

Next section: 3.8 Conclusion & Key Takeaways

3.8 Summary Review Activity

Activity Time!

Select the answer or answers that best demonstrate some of the insights that you have gained in relation to this chapter's learning objectives.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2598#h5p-38>



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Back to previous section: 3.7 Psychology of Colour

Next section: 3.8 Summary Review Activity



3.9 Conclusion

This chapter reviews the basic principles of colour theory that are relevant to most creative fields, including design. It introduces colour theory and its application in product and environmental design, providing insights into making colour choices in design. It discusses ways to apply colour for communicating meaning, functionality, and creativity in product design. As in previous chapters, there are no prescriptive rules about how to use colour in this chapter, only principles for making informed colour choices. This is not to say that designers should make subjective colour choices, especially since our colour decisions have the potential to make or break the acceptability of the final product. Choosing colours depends on a wide range of variables that relate to product perceptions. What is the message the colours are to communicate? What is culturally in place already? What is the relationship between the colour selections of the product brand and its colour palette? How can colours perform a functional role that enables products to stand out or fit into specific environments? Ultimately, it is just as important to study how we respond to certain colour palettes as it is to study how well we can use a product.

Key Takeaways

The key takeaways from this chapter include:

- Principles for selecting colours in the context of how the colour is perceived, whether as mixed light (additive) or as coloured pigments on surfaces (subtractive).
- The effects of values such as tints, shades, tones, and the kind of light transparency to produce the “right” colour.
- The range of design colour schemes that leverage key colour relationships in products and environments to enhance their ability to communicate information.
- The importance of specifying the exact colours within specific colour systems to end up with the correct colour output.
- The unique principles of applying colour that are relevant to the industrial design of products.
- Approaches for translating colour theory into colour applications that convey messages relevant to industrial design consumers.
- Cultural associations that are attributed to different colours and how they may influence design decisions.



Chapter 3: Design for Colour and Light Perception

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts, Tips, and Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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The next chapter introduces the aesthetics of tactile design, tactile experiences, and meanings associated with material sensations.

Key Words: Colour theory, Colour relationships, Psychology of colour, Colour systems, Colour specifications

Back to previous section: 3.8 Summary Review Activity

Next section: Chapter 3 References



Interactives Answer Key

Section 3.3: Colour Wheel and Perceived Colour Relationships

Colour Relationships

Monochromatic: Orange shoe

Complementary: Red and green shoe

Split complementary: Green, purple, and pink shoe

Analogous: Blue, dark purple, and light purple shoe

Triad: Green, purple, and red shoe

Discordant: Red, dark purple, and light purple shoe



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1069#h5p-36>

Section 3.6: From Colour Principles to Product Design Applications

Colour As... Memory Game

Colour As Form Alteration: Woman in white and black dress

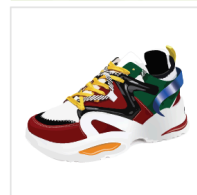
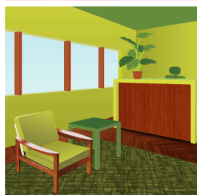
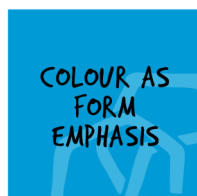
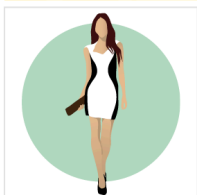
Colour As Form Emphasis: Yellow electric hand mixer

Colour As Harmony: Chair waiting room

Colour As Contrast: Road with orange traffic cones

Colour As Material Emphasis: Running shoe

Colour As Identity: Toy scooter



Section 3.8: Summary Review Activity

Multiple Choice Questions

1. **The symbolic meaning of colour is universal and is interpreted the same way by all users. True or false?**

False. Symbolic meanings of colour can be influenced by culture, location, and generations.

2. **The principle of using colour to confuse the ability to perceive the visual boundary of a three-dimensional product is known as:**

Colour as form alteration

3. **What are the perceived effects of a matte finish on the surface of an object?**

Formal details are diminished or under-emphasized because there is little play of light on the surface transitions and the whole area is easily perceived as flat.

4. **Gold-toned jewellery is an example of:**

Colour as fashion & Colour as material deception

Gold-toned jewellery is often considered fashionable, however, it can also be a gold patina applied as material deception when the underlying metal is not gold.

5. **Most brands use colours that are soft, muted, and subtle to help identify them. True or false?**

False. Colours used for brand identities are most successful when they are strong, saturated, and primary or secondary colours.

6. **What are the properties of a colour that can contribute to how an object contrasts with its environment?**

All of the above:

- Adding a strong difference between the colour values of an object and its background &
- Adding a strong difference between the hue of an object and its background &
- Adding a strong difference in the colour saturation of an object and its background

In order to stand out and contrast with its environment, colour can be critical. Whether it's an orange traffic cone or a yellow taxicab, colour is a powerful differentiator. Distinction from the environment can be enhanced through contrasting hue, saturation, or value. This application is important when safety is a concern.

Back to previous section: 3.8 Conclusion & Key Takeaways

Next section: Chapter 3 References

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Next chapter: Chapter 4: Design for Tactile Product Interactions

CHAPTER 4: DESIGN FOR TACTILE PRODUCT INTERACTIONS



Next section: 4.1 Introduction



4.1 Introduction

We use all kinds of products every day; many of them have been thoughtfully and systematically designed, but not all. The product development design process is not just focused on what a product looks like, it also includes tactile features that we interact with when using a product – pushing a button, holding a bottle, carrying a pack, opening a can, or accidentally scratching a shiny surface. Most of these activities involve the proximal (close) sense of touch. Our sense of touch supports and sometimes confirms what our distal (far) sense of sight has already taken in, and together these two sensory experiences guide us in operating the product. That is why the expression “seeing is believing” is not enough; it is actually “seeing is believing, but feeling’s the truth” (Paterson, M, 2007 in Teinaki, V. et al, 2012). For example, we may see a pattern on the surface of an electric razor, and when we feel the texture of that pattern, we realize that it is likely designed for us to grip the device at that point. In this case, vision and touch work together to provide a multisensory experience, which we discuss in detail in the following chapters. In this chapter, we explore the nuances of designing for tactile experiences.

When you think about touch, your hands might come to mind first. You touch piano keys to make music, toothbrushes to clean your teeth, and tennis rackets to hit the ball. What about your feet? Do you feel comfortable when wearing shoes, skates, or ski boots to engage in activities? Even wearing nothing on your feet gives rise to the tactile experience of surface textures – sand, concrete, carpet, wood, ceramic tiles, some which are designed to provide a sense of ambiance. The designer oversees the quality of these touch experiences so that you feel comfortable using products you purchase or work with. The manufacturer doesn’t want you to feel buttons sticking, glasses that are too heavy, floors that are slippery, or tools that slide around during a precise task.

Social scientists have even argued that some everyday objects feel so comfortable that they can be considered bodily extensions. Grandpa’s cane helps him feel so stable when walking on the street that he won’t go anywhere without it. Aunt Pia is such a wiz with a drill it’s like her hand has melded with the tool to make accurate holes when hanging pictures. Thank a designer for paying close attention to how we use the things we do our tasks with because they apply that knowledge to enhance the tactile features of a range of everyday products. However, Sonia wishes someone would design better bicycle handlebars for her so that her hands feel integrated with her bike, instead of initiating agonizing wrist cramps after a 45-minute ride on rough terrain! Not all tactile experiences are fun!

In this chapter, we explore the relationship between touch and design from four perspectives: tactile aesthetics, tactile experiences, material qualities, and meanings associated with material sensations. You will learn about:

- Tactile aesthetics of objects.
- How different skin sensations contribute to tactile experiences.
- Material characteristics that affect our sense of touch.

- How product surfaces contribute to tactile interactions.
- The nature of surface perfections and imperfections.
- Emotional and cognitive interpretations related to tactile memories and experiences.
- Tactile Affordances.

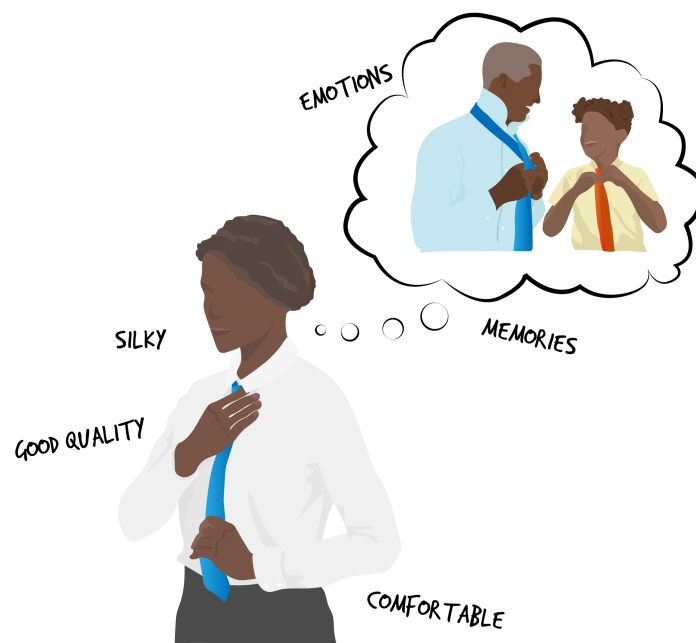
Next section: 4.2 Tactile Aesthetics and Experiences



4.2 Tactile Aesthetics and Experiences

Our tactile experiences contribute to the feelings and meanings we attribute to the things we touch and interact with. Many of these experiences contribute to our perception of the *tactile aesthetics* of a product – our sensory responses to how a product feels, how we interact with it, or our sensory responses to our physical contact with objects. Professor Stuart Walker (1995) includes surface texture and tactile delineation to describe our aesthetic interpretations of objects. Our appreciation of a product's tactile aesthetics arises in response to our experience of holding, using, and generally being in physical contact with the objects around us.

We experience a sense of pleasure or frustration through tactile interactions in three ways. First, when we use products as instruments, we get pleasure from our positive interactions to achieve our goals. Second, when we use the appropriate materials for product surfaces, we aspire to achieve our ideals at the non-instrumental level, contributing to our feelings of ideo-pleasure. This may involve making sustainable material choices, as we discuss later in this chapter. Lastly, we may gain pleasure from our emotional memories (socio-pleasure) of past tactile experiences with materials that contribute to our understanding of the material world around us. For example, the silky feel of tying a tie can bring back fond memories of the nuances of learning how to tie a tie.



Emotional meanings from past tactile experiences

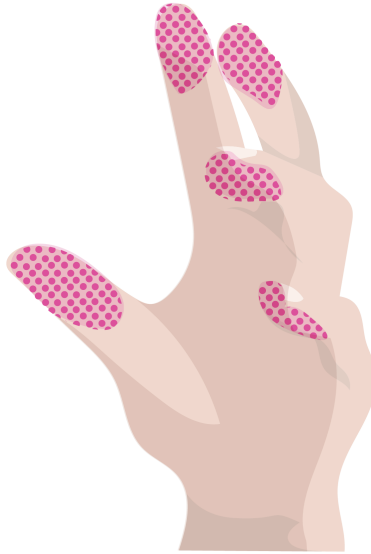
We discover tangible information about a product through our sense of touch. Touching things also allows us to discern where the edges of our bodies are – where does my spine touch the back of the chair? How is the lumbar support from this chair better than that one? We already mentioned how some people can feel that an object they are holding somehow extends the limits of their bodies, whether by holding assistive devices to support balance or grasping a working tool to get a job done. Touch also provides information about materiality – something may look like glass, but as soon as we touch it, we can tell that it is made of glass or plastic because of the different thermal properties of those materials. Our ability to form impressions about what we touch depends on our finely tuned tactile sensations. Many of these tactile experiences are described in this chapter.



Products that are designed for people's capabilities can improve their tactile experiences

Skin Sensations

We perceive touch through sensory receptors in our skin and muscles throughout our bodies. The sensory receptors in our fingertips and lips enable us to gather very detailed information about what we are touching. Mechanoreceptors send messages about pressure and vibration sensations. Thermoreceptors send messages about warm and cold sensations. Nociceptors send messages about pain. All of these receptors send tactile sensation messages to the brain, which interprets the intertwined sensations of pressure, resistance, and weight that contribute to our understanding of what we are touching. We even receive messages about how our body is moving during activities – that is *kinesthetic* information.



Mechanoreceptors in the fingertips gather tactile information

While most of us experience the feeling of touch all over our bodies, the quality of our perceptions varies in terms of sensitivity to detail, intensity, duration, and location of each tactile feeling. We experience different ways of touching; are we touching or being touched? All these sensations change over time or in relation to our health: older people and those with diseases like diabetes and multiple sclerosis experience decreased tactile sensitivity. From a sensory design perspective, good design depends on an awareness of the kind of tactile interactions a user could have with a product and designing features that would best facilitate those actions. We find two main types of touching play a part in demonstrating human-product interaction: *active* and *passive* (Sonneveld & Schifferstein, 2009).

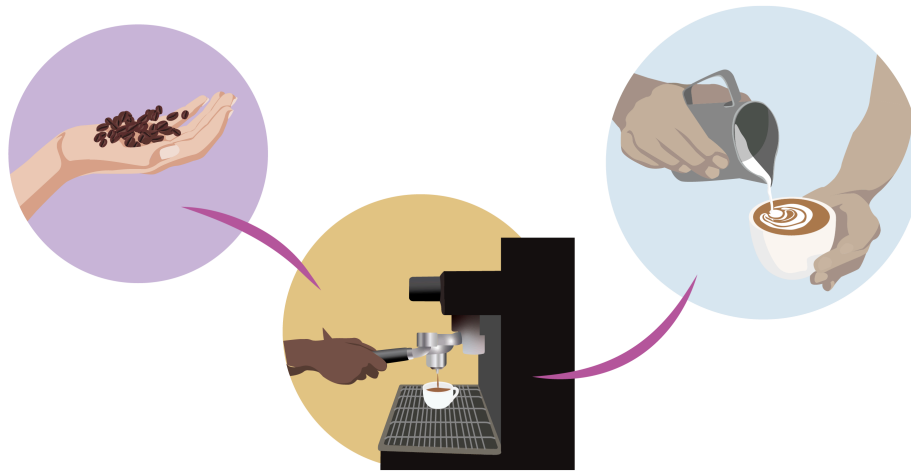
Let's begin with the concept of **active touch**, which refers to the activity of touching that we are most familiar with, although we may not call it that. We perform active touch all the time because we touch things, explore their physical properties, and get to know how they feel, work, and move. This tactile activity is also referred to as *dynamic touch*. We develop a tactile understanding of what each object is and does through actively touching it. Active touch refers to intentionally interacting with an object's properties, mostly using our hands or other parts of the body, depending on the task. We actively experience a range of tactile interactions, from small to large, as we accomplish different tasks during the day. Think about what you are able to touch right now; are the sensations of touch similar or different when you switch between objects?

Many of these interactions are for instrumental purposes, where we are using the object like an instrument to achieve a specific purpose. According to Sonneveld and Schifferstein (2009), these kinds of activities include:

- Practical and functional uses like hammering a nail or entering information on a computer.
- Playful uses like swinging a tennis racket or golf club, rolling marbles, or online gaming.
- Carrying uses like wearing a backpack or purse, putting something in our pocket, or pulling a suitcase along.
- Personal care uses like brushing our hair, feeding a baby, mending clothing, or making the bed.

When a designer starts a new project, it helps to clarify the end-users' goals and where they actively touch the objects that help them achieve those goals. Let's say you are the designer tasked with redesigning a coffee machine. You may observe baristas working at different coffee shops, with their permission, to learn about their tactile interactions involved in:

1. Grinding the coffee beans;
2. Preparing the coffee;
3. Adding the crema.



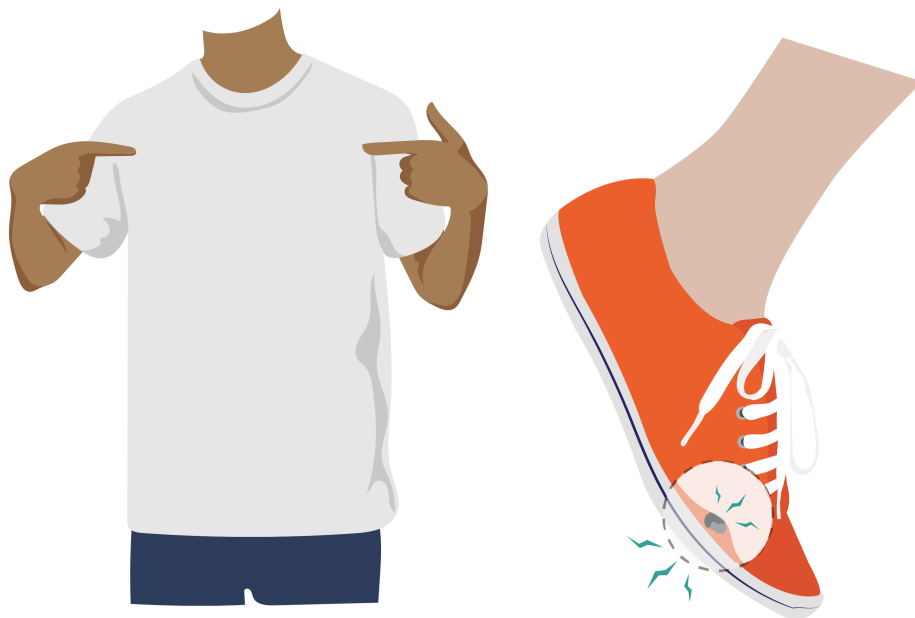
Active Touch: Tactile Interactions in espresso preparation

This kind of information is often so instinctual when someone has been doing the same job for a long time, that they may not be able to describe their interactions as clearly as when you observe the details yourself. Most of us process the tactile information we receive through our interactions with products, without consciously defining it. We learn how to interact with the things in our lives through hands-on experiences or active touch. In those cases we have what can be called *tacit knowledge*, knowledge that we just seem to know, but never describe. The beauty of design research is that it's possible to observe people in order to recognize what does and does not work, which informs possible design improvements or innovations.

Some of our experiences involve **passive touch**, where the object touches us. We may not even consciously register that something is touching us, unless it is uncomfortable, itchy, painful, or feels downright unpleasant. When we sit on a chair, in a car, boat, or truck, the seat and backrest provide passive tactile sensations. Canadians love the feeling of heated car seats in winter – the seats passively warm us up. Passive touch also includes the haptic or tactile vibrations we feel when our mobile phone or smart watch sends a notification. My smart watch regularly vibrates to get my attention for various notifications. Someone made design decisions about the nature of those vibratory messages – the speed, the intensity, and the variations in vibration patterns. In the car industry, haptic or tactile feedback provides an additional mode of interaction for drivers, so they are not wholly dependent on their visual perception. Let's look at the sensations involved in passive touch.

Sonneveld and Schifferstein (2009) note that the physical properties of objects can produce the following passive sensations of touch:

- A feeling of a *light touch* where no indentations or marks remain on your skin afterward; we all experience light touch when wearing clothing. Our awareness of this kind of touch dulls quickly because the sensors that detect light touch adapt rapidly.
- A feeling of *pressure* where indentations or marks remain on our skin afterward; the pressure is enough to feel deep and heavy sensations like when wearing a bathing cap for swimming. Our awareness of this kind of touch is maintained throughout the contact because pressure sensors adapt slowly.
- A feeling of *vibration* where *rhythmic stimulation* triggers rapidly adapting touch (high and low-frequency sensors). This occurs during a bouncy experience while riding in a motorboat over choppy waves or walking with a stone in our shoe. It also occurs when our smart phone vibrates in our pocket.
- A feeling of cold or warmth when touching anything with a temperature below 20 degrees Celsius (68 degrees Fahrenheit) or above 40 degrees Celsius (104 degrees Fahrenheit) like accidentally being touched by a hot iron or a cold icicle. Sensors rapidly adapt to mid-range temperatures, but not at these extremes.



Passive touch: The light touch of clothing or feeling stimulation from a stone in your shoe

The key thing to remember about passive touch is that design solutions may not be as simple as a good grip or a smooth surface texture. Designers may need to consider the whole environment or context in which an activity takes place. One example of how design can mediate passive tactile interactions is the use of shock absorbers in cars and bicycles to minimize vibrations from the uneven surfaces of the road or path.

Tactile experiences may also be *intra-active tactile sensations*, a combination of active and passive touch while doing an activity. For example, when using a hair straightener, as in the image below, we are actively moving one object over another static object, usually a part of your body – this is an intra-active tactile experience. You regularly have intra-active tactile experiences, for example when you put on a jacket or a hat, or brush your teeth.



Intra-active touch: the dynamic movement of the hair straightener actively moves over passive hair

Intra-active touch can also be perceived as different tactile sensations when interacting with the same product, as in the image below.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1588#h5p-63>

Intra-active (passive and active) touch can both be part of different tactile sensations in the same product

Pain and *pleasure*, as well as *tickle* and *itch* (mild stimulation across the skin when something is irritating), are also intra-active skin sensations responding to active and passive touch. Pain can occur at different levels, ranging from superficial (at your skin), to deep (in your muscles, bones & joints), and somatic (in your body). Imagine using a pair of scissors that painfully squeezed your fingers every time you cut something – this is an example of active touch when initiating the cutting motion, and passive touch when the scissor handles press against the fingers inside of them. Would you want to keep them? If a product is painful to use, it is unlikely that you will want to keep it, but if it is comfortable in your hand and works well you may enjoy its use for a long time. Perhaps you have experienced the fun of using a head massager like the one pictured below. This tactile activity is an intra-active *tactile sensation* that is pleasurable; it is a tactile physio-pleasure.



Enjoying the Physio-pleasure of a tactile tickle!

These tactile skin sensations enable us to understand and articulate how we experience the tactile properties of objects. They provide a context of tactile awareness for designers to work with to intentionally provide useful, comfortable, and appropriate tactile product experiences.

Back to previous section: 4.1 Introduction

Next section: 4.3 Material and Substance



4.3 Material and Substance

Designers must make granular choices about the *materials*, the *substance*, the *surfaces*, the *structures*, and the *moving parts* that are unique to each object they work on. While we mainly focus on the tactile qualities of materials and surfaces in this section, we recognize that materials affect other sensory experiences too. As an example of tactile aesthetics, we illustrate the skateboard image below to identify some qualities that contribute to tactile experiences: the elastic material that stretches a bit when flexed (substance), the textured surface used for grip (material), and the structure that provides a sense of balance and supports dynamic movement.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1591#h5p-132>

Tactile aesthetics include substance, surface sensations, structure, and moving parts

Since there are many different kinds of materials, it is best to select those with the most suitable characteristics for each product. Look at the **material** swatches below and try to describe their tactile features in comparison to one another. For example, does fabric have a similar temperature flow as glass? Do the same size pieces of wood and glass have similar weights?

Activity Time!

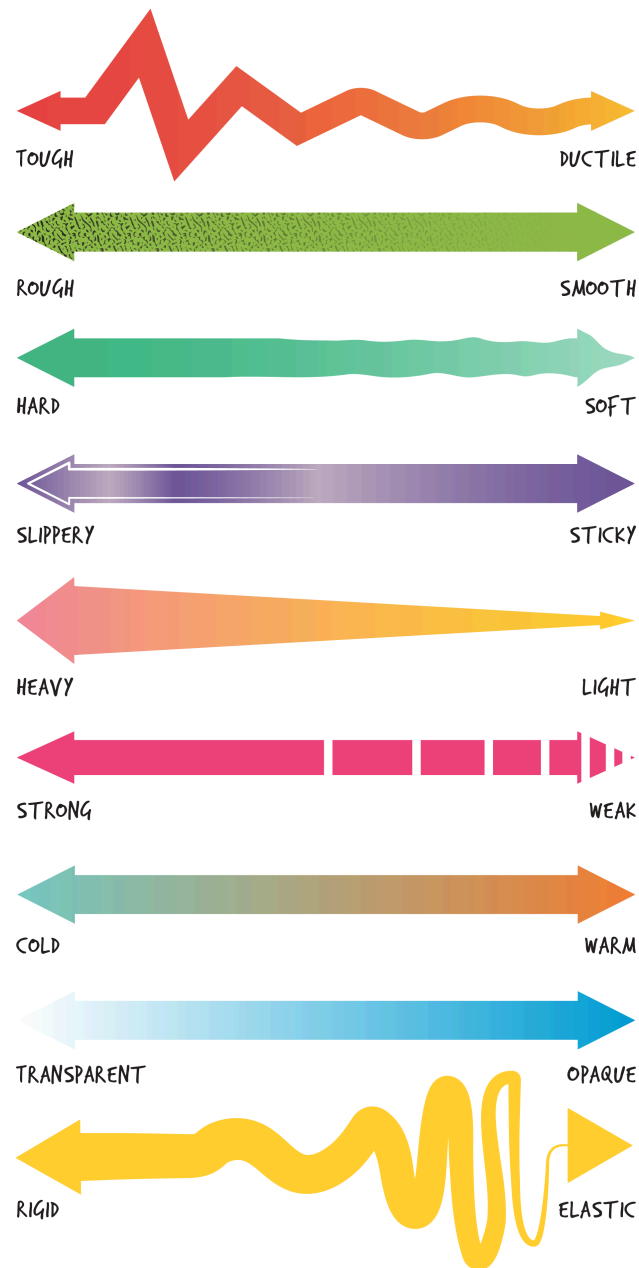
Drag each set of descriptors to the type of material that you think they best correspond to based on the material's temperature flow and surface quality.



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Each of these materials has different tactile qualities

Karana, Hekkert and Kandachar (2009) developed a sensorial scale for differentiating among material qualities. Their scale is arranged in pairs of semantic differentials (opposites) and we list those related to tactile surfaces here: hard-soft, smooth-rough, cold-warm, not elastic-elastic, tough-ductile, strong-weak, and light-heavy. These are the kinds of tactile perceptions of substances that we may be exposed to as designers and as users. To those terms, we can add sticky-slippery, bumpy-flat, and thin-thick. Can you think of any textures or patterns to add to our descriptive list of surface qualities?



Sensorial Properties used for attributing meanings to materials

The **substance** of an object can be described by what it feels like when a person manipulates it. Is it hard or soft, elastic or plastic, hot or cold, heavy or light? Schifferstein and Wastiel (2013) point out that these perceptions depend on the different material choices designers make.

Let's consider an object that could be hard or soft, or both. Have you ever tried to use a squeeze ball to strengthen your grip? As you exert pressure by squeezing the ball, the rubber material resists your efforts as you transform its shape by squeezing, pulling, pushing, or bending it. Ultimately this builds strength in your hand.



Exerting pressure on the ball reveals its substance and material resistance qualities

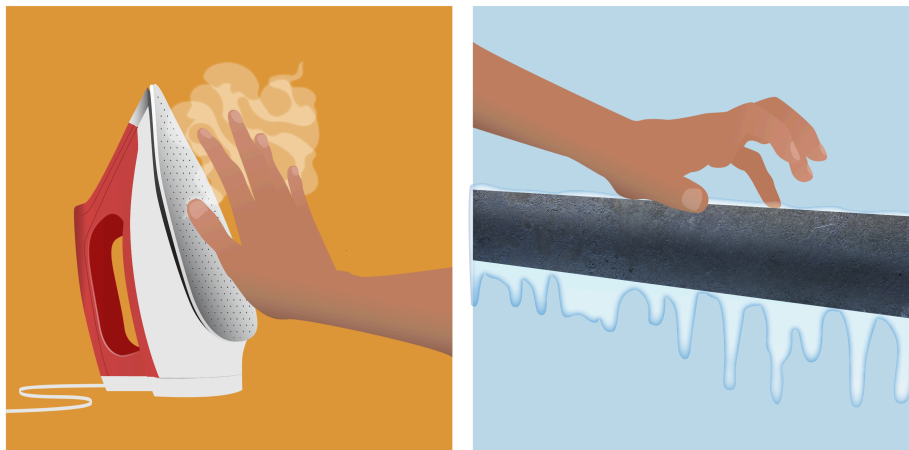
When you exert pressure on an object you are exploring its hardness or softness; when you bend or twist it, you are exploring its *stiffness* and *flexibility*. Can you think of objects you use every day that need a certain hardness to do the job – what about a pencil sharpener, a cooking preparation knife, or a hammer? Each of these objects are hard enough to resist the pressure you apply on it to get the task done – sharpening your pencil, dicing an onion, or hammering a nail into the wall.

Imagine if those same objects were elastic or plastic. *Elasticity* occurs when you stretch an object and it returns to its original shape after it has been transformed. *Plasticity* occurs when the object remains in its newly transformed shape. What would a pencil sharpener with elastic properties feel like when you are trying to sharpen your pencil? It might be difficult to hold and get the job done. On the other hand, a baby bottle top that compresses when squeezed by a suckling baby would feel perfectly natural and its elasticity would be a welcome affordance for feeding! Most of us have experienced plasticity as young children when making things out of playdoh – once we built that car, sailboat, or character, the only way it would return to its original shape was by squishing it – that's plasticity for you.



Degrees of elasticity

We discussed **temperature** earlier; how do you react to an object that is very hot or very cold? The only way to know is to actively touch something or to have it passively touch you. You will likely sense that the metal handles on your pot of boiling spaghetti as hot if you aren't wearing oven mitts.



We react to tactile temperature sensations: extreme heat and extreme cold

Let's say you accidentally touch that iron, the high-temperature flow between it and your skin makes you feel a hot or burning sensation at the point of contact. And if you are about to grab that ice-cold handrail it will feel cold at the point of contact because it is drawing heat from your skin. In both cases, materials like metal and glass have *low-temperature resistance* because the temperature flows quickly between your skin and

the surface you are touching. Materials with *high-temperature resistance*, like wood and plastic, feel warm or neutral because they do not draw away heat or cold and “generally feel warm even if their temperature is below body temperature” (Sonnefeld & Schifferstein: 2009).

Temperature flow refers to this transfer of warmth or coolness between your skin and the object it is holding. In some cases, it may be wonderful to experience temperature flow. For example, on a cold day, you may experience temperature flow when holding a hot ceramic cup of coffee that warms your hands.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1591#h5p-65>

Temperature flow in different materials

Another key property of the *substance* of any object is its **weight** – heavy or light? Having just carried 25 boxes of books down three flights of stairs, carrying the heavy boxes was definitely more of a challenge than the light ones! Although sometimes *heaviness* can be an important property, a heavy table can be perceived as sturdy. We often make decisions about which products to buy, or use, based on their weight. For example, a lightweight folding stool seems easier to carry in a backpack than a heavy one.

Balance is another factor related to weight – would you prefer to sit on a chair with a narrow central post on a wide foot or a conical post as shown in the images below? Which one is likely to feel more balanced when sitting on an uneven surface? Our perception of *balance* depends on *weight distribution*, which may change due to external factors.



Structural weight distribution contributes to a sense of balance

If the weight distribution of a product changes, its stability changes too and it can become unbalanced. This may be due to fluctuating internal or external influences. For example, high-end cameras used for videography can be difficult to hold steady while filming, resulting in shaky videos. Attaching a stabilizer to the camera counters the movements of the person holding the camera. This allows the filmmaker to move freely while the camera's orientation of axes remains the same at all times.



A stabilizer improves the tactile experience of capturing videos and contributes to a more pleasant visual outcome

In addition, the weight distribution of objects affects how they are set up and maintained. In the images below you can see two products that would tip over if not stabilized in an upright position. Imagine what kind of tactile interactions you would have with the lamp below if it didn't have a counterweight to balance it. The same is true when setting up and maintaining a buoy on the river.



Balancing weight distribution is an important factor when interacting with products

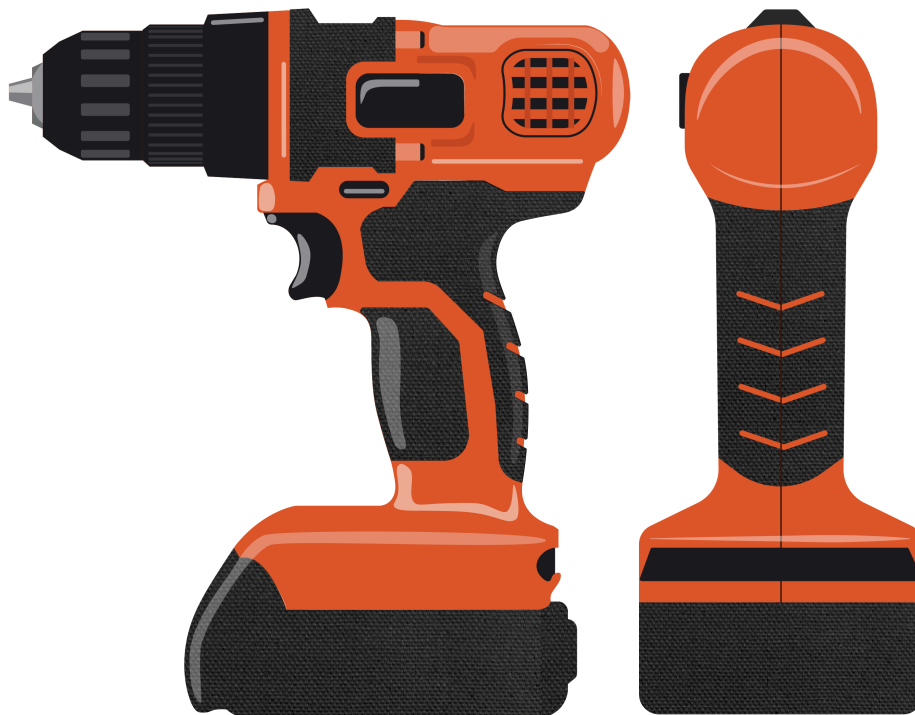
Back to previous section: 4.2 Tactile Aesthetics and Experiences

Next section: 4.4 Surfaces and Structures



4.4 Surfaces and Structures

Think about your tactile interactions with the products you use. How often do you hold the outer surface or shell of your phone or your hairdryer while using it? Every time, right? Compare that to how often you take apart either of those devices to get inside – likely rarely or never. For this reason, it is important for designers to focus on the details of the exterior shell that contains all the mechanical, electrical, and computational components. We traditionally refer to this shell as the product's *housing* or *formal envelope*; it is the main tactile interaction surface. The inside of a *plastic housing* is designed for structural stability, with a framework of elevated *ribs* and *bosses* (indentations for positioning and fastening parts together). The housing is usually made in 2 parts, like a clamshell; the line or seam where they join together is called the *parting line*. We can see the parting line on products like hair dryers and drills.



parting lines are often visible on product housing

Designers select the materials for product surfaces, whether they contain inner components or not. In many cases, the surface qualities of the materials contribute to our ability to perform an activity. For example, the sticky toes on climbing shoes make the tactile experience of climbing more efficient, similar to the slippery suede soles on good dancing shoes.



Sticky climbing shoes or slippery dancing shoes: Surface qualities contribute to our tactile experiences when using products

Professor Prasad Boradkar (2010, p.151) says that “designers tinker with the surface characteristics of form, contour, material, colour and texture to create the aesthetic experiences that users seek and desire”. After reviewing cell phone covers, referred to as *skins*, he developed a functional typology that differentiates them. We believe these descriptions apply to a wide range of product surfaces, as well as cell phones. Boradkar says:

- **Shielding skins** enclose the technical and mechanical inner components and protect them.
- **Green skins** are made of materials that are environmentally compatible such as biopolymers, biodegradable materials, or recycled plastics.
- **Faux skins** are imitations of natural materials seen when transparent plastics are used instead of glass or polyvinyl chloride is used instead of leather or suede.
- **Informational skins** communicate through their material, like providing the transparent ability to see the inner workings of the device or through the graphics on the surface.



Shielding and Informational product Skin

- **Technological** or **intelligent skins** depend on material properties that may be bulletproof, heat resistant, or shock resistant like bicycle helmets.
- **Responsive skins** are made of smart materials with changing properties that respond to stimuli. For example, skins that change colour or temperature in response to embedded thermochromic (temperature sensitive) sensors.



Example of heat-sensitive responsive skin

Since most of our contact with objects is through the material surfaces we touch, we receive a lot of tactile information every day. We experience what surfaces feel like and how or if they move, as well as the quality of the surface textures and finishes, and we notice differences as these surfaces change over time.

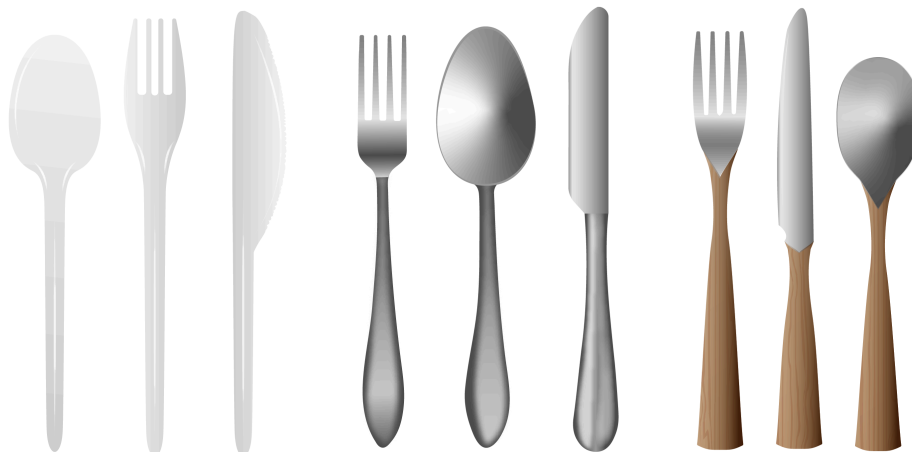
Designers study texture samples to specify textures and finishes that are appropriate for different parts of the same product. These material choices may make a difference to the longevity of a product – if the material does not match our expectations, memories, cultural ideals, or comfort levels we may not want to keep it.

Textures and finishes are often designed to support different kinds of user experiences. Some finishes may provide an overall impression of a product – a shiny kettle, a rugged boot, or a soft toy – that indicate a certain quality to the user. For example, I prefer to use a toothbrush with a slightly textured plastic handle rather than a smooth one so that my hand doesn't slip on the wet surface while I brush my teeth. How would you feel about using a leather toothbrush like the one below?



Product surface textures should suit the product task

On the other hand, if I can grasp a smooth handle with moulded indentations for my fingers, I would have a secure grasp of my toothbrush and not need a textured surface. In addition to your toothbrush, consider the different shapes, weights, and textures of the cutlery you use. There are many different cutlery designs on the market, each with a different tactile aesthetic due to weight, balance, surface treatments, and materials. Designers seem to like experimenting with the design of eating utensils. It may be fun to assess the qualities of their material choices and tactile aesthetics the next time you go out to eat – which ones provide pleasant and useful tactile affordances for you?



Plastic, steel, and wood all provide suitable tactile affordances for eating utensils

Not all surfaces are uniform – some may have unique **structural features**. If you run your fingers over the surface of an object you may perceive places where it is easy to slide over the surface and others where your fingers need to go around or interact with some of its structural features. Stuart Walker (2014) identifies the following three kinds of surface structures:

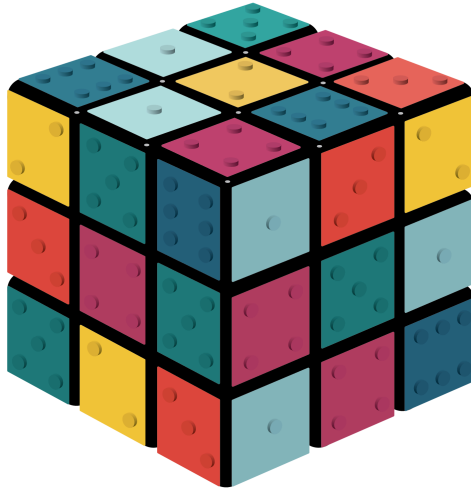
- Abrupt **surface discontinuities** like edges and holes. These may inform where you open and close your water bottle when filling it or may be buttons that enable you to operate a product by turning it on or off or changing its speed.
- Continuous three-dimensional **surface contours** like curved or flat surfaces. These may indicate the top and bottom surfaces, like the flat bottom of a vase indicates how to place it on a table, while the open top provides an affordance for filling it.
- Different **surface orientations** like horizontal, vertical, or slanted. These may also inform you where to grip or open an object, as in the slanted tops of waxed paper milk cartons.

The use of Braille is an example of the importance of surface structural features in the use of assistive products for vision-impaired people. In the example below, a visually impaired person is using the elevator button to open the doors.



Braille buttons take advantage of surface discontinuities to provide information

Since most of our tactile interaction is with a product's surface, a designer specifies the quality and function of those surfaces. They act as affordances for holding, grasping, opening, or sealing. They can also have *moving parts* that we physically interact with or that are purely decorative. For example, the raised surface discontinuities provide tactile feedback for solving the Rubik's cube puzzle below. This could be an innovative design solution to engage a visually impaired person in solving the Rubik's cube.



Rubik's cube with surface discontinuities and raised dotted surface details

Back to previous section: 4.3 Material and Substance

Next section: 4.5 Surface Imperfections



4.5 Surface Imperfections

When I close my laptop, I see the matte surface of my laptop lid. I can also see several little scrapes in different places that mar the surface. When I look at the glossy black door of our kitchen microwave, I see clouds of fingerprints and am tempted to clean it right away (which I often do). These are *surface imperfections* that have come about during everyday use. Should the designers have chosen more appropriate materials? Could they have chosen surface materials that would be 100% resistant to the wear and tear of being used? Most likely they had to make compromises, or at least, the best decisions possible given a set of parameters such as strength, cost, and context of use.

Imperfections go against the principle of mass production, a process fundamental to industrial design, where products with imperfections are weeded out of the manufacturing line and rejected or sold as second rate.



Surface imperfections on different product surfaces: A fridge, a cell phone, a boot

However, professor Owain Pedgley and his research team believe the *aesthetics of imperfection* plays a key role in addressing urgent cultural and environmental issues (Pedgley et al, 2018, Pedgley, 2014). What do they mean by the aesthetics of imperfection? We have learned that the idea of aesthetics is related to an emotional response to a product based on social and cultural ideas. For example, we repair the scratches on our cars to maintain their resale value and to reflect our responsible behaviour. We also repair and paint garage doors as we expect them to have a consistent, surface appearance (which is not so easy when someone backs into one!) to reflect not only our responsible behaviour but also our judgment of a pleasing appearance.

Pedgley and his team say that surface imperfections can originate in four different ways:

1. **Material sourcing.** This refers to naturally or mechanically occurring *surface disturbances* that seem to be part of the material. We see this in wood grain and textures, uneven surfaces of recycled plastic products, and intentionally distressed materials used in jeans.



LOOSE KNOTS AND
CRACKS IN WOOD

Surface disturbances from material sourcing

2. **Material Processing.** This refers to traces of the *production effects* such as ejection pin indentations on injection moulded plastics or other intentional or unintentional *surface irregularities* caused by the shaping and finishing.



PARTING LINES ON
INJECTION MOLDED
PLASTICS

Production effect from the manufacturing process

3. **Material changes over time.** This refers to how surfaces respond to *degrading material properties* such as becoming more brittle, maturing over time like worn leather or wood, or ageing over time where scratches and patinas develop on metal surfaces.



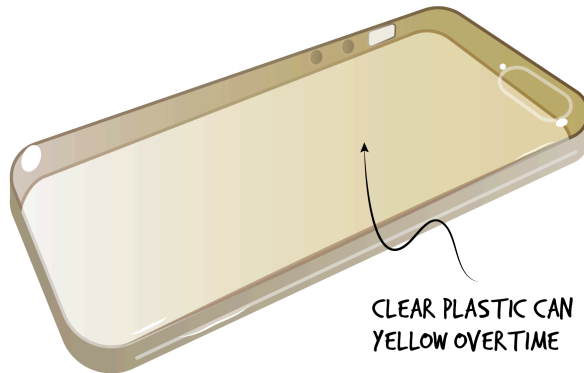
SCRATCHES AND
AGEING OF SOME
METALS

Degrading material properties

4. **Everyday wear-and-tear.** This refers to the different kinds of damage that result from ongoing interactions, either sudden or accumulative: impacts from dropping, chipping, abrasion, or dirt build-up.



SCRATCHES EASILY VISIBLE



CLEAR PLASTIC CAN
YELLOW OVERTIME

Everyday wear and tear on cell phone and accessory surfaces

	PERFECTION	VS	IMPERFECTION
MATERIAL SOURCING	Consistent Finished Synthetic Regular Structured		Disrupted Unfinished Natural Quirky Random
MATERIAL PROCESSING	Engineered Obedient Mass produced Controlled Predictable		Crafted Disobedient Handmade Out of control Unpredictable
MATERIAL AGEING	Ageless Lifeless Resilient Untouched Virgin		Aged Alive Deteriorated Tarnished Lived-in

Qualities of surface perfections and imperfections (adapted from Pedgley et al, 2018, Pedgley, 2014)

Pedgley and his team developed categories for four kinds of material surface imperfections based on their studies of people's responses to the nature of the surfaces:

1. **Negative Perfect.** Products in this category have 'perfect' surfaces (shiny, smooth, glossy, or uniform) however, study participants described them negatively as being too synthetic, too boring, or too sterile.
2. **Positive Perfect.** Products in this category have 'perfect' surfaces (mirror-like gloss or strikingly flat) and study participants described them positively as displaying superior engineering.
3. **Negative Imperfect.** Products in this category have 'imperfect' surfaces (unfinished appearance, worn out, or defective) and participants described them negatively as undesirable imperfections.
4. **Positive Imperfect.** Products in this category have 'imperfect' surfaces (handmade, smoothed over from ageing, natural organic textures, etc.) and participants described them as positively expressing value, uniqueness, or charm.

Activity Time!

Drag each item to the diagram quadrant that you think they best correspond to based on the item's material surface imperfections.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1596#h5p-66>

Material surface imperfection diagram adapted from Pedgley (2014)

Back to previous section: 4.4 Surfaces and Structures

Next section: 4.6 Meanings Associated with Material Sensations



4.6 Meanings Associated with Material Sensations

As you can see designers use materials to create sensory experiences that we interpret in meaningful ways. In this section, we acknowledge that some meanings related to materials are not only derived from touch, they are so closely aligned with the substance of materials that the discussion belongs here. Designers often consider using tactile responses to material sensations to evoke associations related to previous product interactions. Do you remember when boating paddles were only made of wood? We perceive wooden paddles as classic, warm, and comfortable to hold. We perceive plastic and metal paddles, which are now widely used, as less expensive and more durable than wooden ones, but less comfortable. Our perception of their value relates to the materials and care each kind of paddle requires. It is not that easy to separate sensory experiences from cognitive and emotional experiences. Some tactile sensations are translated into emotions and memories.



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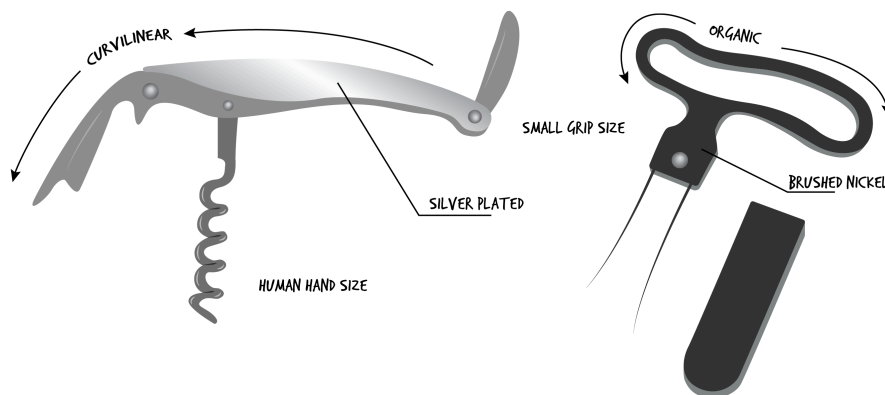
Materials associated with different memories of use may elicit positive responses

Tactile interactions contribute to the meanings that arise when we interact with products in certain contexts. Elvin Karana (2010) researched the meanings that people attach to the features of different materials. In one study, she analyzed the meanings people associate with waste baskets and lighters and discovered that participants associated different meanings with different materials and shapes. She found that metal products were perceived to be cozy, sexy, elegant, futuristic, and masculine, whereas plastic products were perceived to be toy-like.



Meanings attached to materials: elegant (on left) versus toylike (on right)

Taking this concept further, you may see how materials can be interpreted as imparting a personality to a product, not only through tactile interactions but also through visual perception. A corkscrew made from metal feels cold and sharp. It may be perceived as having an aggressive and efficient personality, possibly a semantic association with a knife. Whereas a corkscrew made of plastic could be associated with the feeling of everyday tools and linked with utility and simplicity.



Different materials and tactile interactions can be associated with different meanings

Design researchers Ashby and Johnson (2003) also compared materials used for similar purposes to perceptions about their value. Their work shows that participants consider a plastic coffin to be cheap as it is more likely associated with a wastebasket and, therefore, inappropriate for its dignified purpose. You may have had wine in an exquisite glass and associated that with an upscale, elegant experience or you may have had coffee in a dinged-up metal camping mug and associated that with a cheap and rugged experience. Essentially, they are both drinking vessels made of different materials and, as a result, they provide completely different experiences that originated from completely different contexts.

Ashby and Johnson provide insights into meanings that link to our general perceptions of materials:

- **Woods** are perceived as warmer than other materials and are associated with traditions of craftsmanship. We also perceive it as ageing well and acquiring additional character over time.
- **Metals** seem cold, clean, and precise, especially when polished to reflection. Machined metal looks and feels strong.
- **Polymers** are perceived as cheap and easily scratched.



Different material perceptions

Ultimately designers cannot rely on their own material associations for determining the best materials for the product. It is critical to understand how others use or will use the products you are designing. What kind of actions will people perform with the product? How will they perceive it during their interactions with it? In a 20th-century redesign of Ingersoll Rand's cyclone grinder (Peters, 1991, Frankel, 1994), designers observed that aircraft workers had built protective shields out of cardboard on their heavy metal grinders to protect their hands from sliding into the grinder while in operation. The workers also relied on their work gloves to insulate them from the heat of the grinder in action. Those observations inspired the industrial design team to develop concepts that incorporated lightweight and temperature-resistant polymers in the housing that could also be moulded into a "shield-like" formation that addressed workers' tactile safety concerns. At the time, having designers study workers in action was considered innovative. Now we take it for granted that the more we learn about how people perform their typical product tasks, and how they perceive their experiences, the better we can design products that feel right for them and provide appropriate tactile sensations.

Back to previous section: 4.5 Surface Imperfections

Next section: 4.7 Tactile Affordances



4.7 Tactile Affordances

Tactile sensations are often affordances, as described in Chapter 1, Design for Emotion and Meaning. Whether designed intentionally or not, products send us messages that inspire us to take action. This would include opening a drawer, turning off a light, or popping toast out of the toaster. This is not only a *tactile experience*, but it is also a multi-sensory experience, where layers of different sensory perceptions contribute to the overall experience of using the product. In familiar everyday scenarios, we first look at the handle or light switch or toaster button (visual), then we touch it (tactile) to achieve our respective goals. When the affordance is comfortable to hold or provides a distinct *haptic response*, we perceive it as being easy to use.

This is also true with haptic feedback in technology-enabled products, whether it's a smartwatch or a game controller or an automotive system. We can perceive informative tactile feedback from these devices — for example, anyone who uses a game controller recognizes the value of having different kinds of haptic feedback to enhance their gaming experience.



Example of haptic product experience

Future cars may commonly add *haptic vibration feedback* in addition to *auditory feedback* to keep their drivers informed about safety on the road and provide assistance (Gaffaray & Lécuyer, 2018). While we have a lot

more to learn about applications for haptic feedback, we know that tactile sensations can provide important and immediate feedback to drivers. Some areas where haptic sensations will be useful in cars include places where: our fingers are in contact with the steering wheel, our bodies are in contact with the seat belt, our foot is in contact with the pedal, and our back and legs are in contact with the seat. The concept of affordances is evolving as technology provides innovative new tactile opportunities for communicating with users.

Back to previous section: 4.6 Meanings Associated with Material Sensations

Next section: 4.8 Summary Review Activity

4.8 Summary Review Activity

Activity Time!

Match the sets of tactile characteristics to the objects below.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1607#h5p-68>

Tactile aesthetics of different products

Back to previous section: 4.7 Tactile Affordances

Next section: 4.9 Conclusion & Key Takeaways



4.9 Conclusion

The discussion in this chapter draws our attention to a variety of considerations about the quality of *tactile experiences* involved in product use. This is again, a human-centred perspective because no matter how wonderful a thing or the material it is made from is, it must be designed to provide an effective tactile experience for the human who is completing the task at hand. Often, we, as users, experience *tactile sensations* unconsciously and we acknowledge our *tactile experiences* when we say “it works”, or “I don’t like this”. Every aspect of designing for *tactile interactions* involves the creation of opportunities for human contact with something tangible that makes the task of using it possible and appropriate. This could be drinking a cup of coffee, working on a machine, or playing with toys.

This chapter provides insights into the ways we experience tactile sensations, and how materials and surface treatments influence those experiences. It isolates tactile design qualities that can enhance or detract from good user experiences. It offers a viewpoint and a vocabulary about tactile design qualities that provides critical knowledge for designing innovative products or incremental improvements to existing products. The product experience can be greatly enhanced when designers take the time to ask, “What does it feel like?” for the people who are doing the task or are going to do the task with the newly designed product.

Key Takeaways

The key takeaways from this chapter include:

- An introduction to tactile experiences starting with how we perceive touch sensations and continuing to the differences between active and passive touch in relation to kinds of product experiences from play to practical.
- Knowledge of the tactile aesthetics of objects that explores the tactile responses to different substances, whether they are hard or soft, elastic or plastic, hot or cold, heavy, or light among others.
- Exposure to the tactile aesthetic considerations of surfaces and skins, such as how surface finishes and surface structures can be experienced and the tangible applications for product skins.
- An exploration of surface imperfections that can affect users’ tactile and emotional perceptions of products, whether the imperfections come from material sourcing, production processes, material changes over time, or wear and tear.
- Awareness of meanings and emotional responses that users associate with the tactile aspects of sensory experience that influence whether they want to use certain products.
- Perception of the range of tactile design considerations that go into product design from the perspective

of user experience and material appropriateness.



Chapter 4: Design for Tactile Product Experience

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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The next chapter introduces the aesthetics of auditory design including the properties of sound, how we respond to them, and insights into the process of sound design.

Key Words: Touch, Active touch, Passive touch, Instrumental touch, Haptic feedback, Interactive touch, Tactile properties of objects, Material surfaces, Materials, Meanings

Back to previous section: 4.8 Summary Review Activity

Next section: Chapter 4 References



Interactives Answer Key

Section 4.3: Material and Substance

Drag and Drop, *Tactile Qualities*

Concrete: Hard & textured

Wood: Warm & porous

Leather: Warm & water-resistant

Glass: Cold & smooth

Metal: Cold & slippery

Fabric: Soft & flexible

Section 4.8: Summary Review Activity

Drag and Drop, *Tactile Aesthetics of Different Products*

Yoga mat: Sticky

Disposable gloves: Low temperature resistance & Elastic

Work gloves: High temperature resistance & Tough

Slide: Slippery

Tent: Light & Stable

Wheelbarrow: Heavy & Unstable

Back to previous section: 4.9 Conclusion & Key Takeaways

Next section: Chapter 4 References

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Back to previous section: 4.9 Conclusion & Key Takeaways

Next chapter: Chapter 5: Design for Auditory Experiences

CHAPTER 5: DESIGN FOR AUDITORY EXPERIENCES



Next section: 5.1 Introduction



5.1 Introduction

It wasn't that long ago when our products only talked to us through sounds: beeps, alarms, bells, and squeaks. These days, Siri, Alexa, and other digital assistants talk to us in whatever language we choose on our computers and in our cars. We have come to depend on these auditory exchanges, just as we do with sight and touch, to enrich our sensory experiences. Design decisions can determine what things sound like, such as Siri's voice or the microwave's beeps.

We know that sounds engage people's attention, whether as background in the environment or during specific product interactions. While you are reading this, what kind of sounds do you hear around you? Are some of those sounds closer to you and some farther away? These are all part of what is called the *soundscape* and many sounds that products emit are aimed to fit into the surrounding soundscape. However, many soundscapes are not harmonious: how many times has your focus been disturbed by an ambulance or fire truck siren? That persistently annoying and distinctive sound is very useful when emergency vehicles are weaving through traffic to answer an emergency call, but much less useful when it disturbs your quiet meditation practice at home! Have you ever been in a place where the ambient noise is so overwhelming that you can't hear the person across from you? Many people have that experience when they visit busy restaurants, and as you may imagine, some of these sounds are unwanted. In design, we focus on sounds that are wanted, even if they are not always appreciated at the time – like a very loud alarm waking you up from a deep sleep.

Most people would agree that the sounds of nature, like a babbling brook or birdsongs, are more soothing to the ear than the sounds of highway traffic and road construction. On the other hand, you may have heard people who live near highways compare the constant noise to the ocean's roar. This is a kind of *biophilic response* (Wilson, 1984; Kellert, 2018) in which we experience elements of our environments or objects as if they represent nature. However, many design elements do not provide for that biophilic response as designers prefer to incorporate *intentional sounds* into products that remind us of our prior sound associations and, therefore, leverage our abilities to interpret sound messages accurately. For example, designers generally do not design our toasters to croak like frogs when the toast is ready, or our keyboards to growl like angry bears when we hit a delete key, or our electric ovens to crackle like an open fire when we bake a cake. With these products, designers select sounds that are intentional, so that we hear our toasters "pop", our keyboards "tap", and our electric ovens "beep" when the cake is ready.

In this chapter, we will explore auditory experiences from three points of view: the properties of sounds, how people experience sound, and sound design. You will learn about:

- The properties of sounds that convey auditory information.
- The features of soundscapes that we interpret in meaningful ways.
- Applications for sound that are relevant to design.
- The emotional appeal of sounds.

- The categories of sound that correspond to different auditory messages.
- The process of sound design.

Next section: 5.2 Properties of Sounds

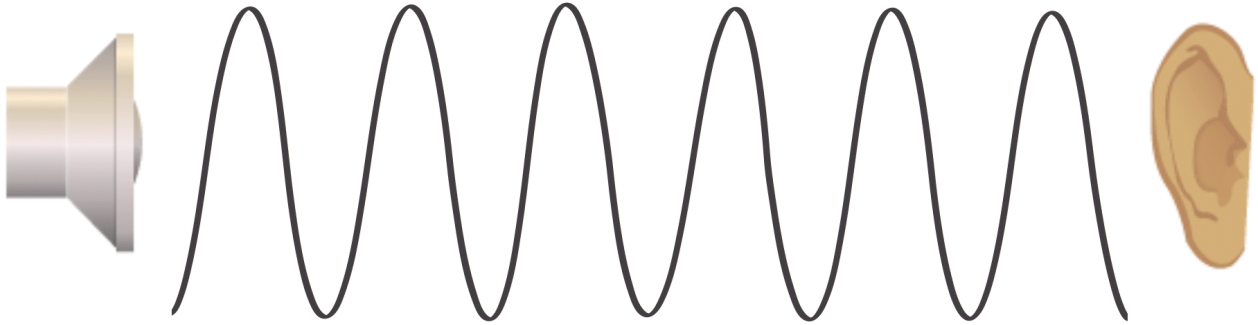


5.2 Properties of Sounds



SOUND PROPERTIES

Let's start with a brief introduction to the biophysics of hearing. Sounds occur as disturbances of molecules that take the form of waves travelling from the source of the sound to the human ear (Lupton, 2018). When the sound waves reach a person's eardrums, they cause vibrations that act like signals for the auditory nerve and the brain (Lupton, 2018). This is the process of *hearing*. The sounds are then interpreted as either important or not, depending on their source. Some sounds convey information, others add to *aesthetic appreciation*, and others stimulate memories. All of these enhance and impact people's experiences.

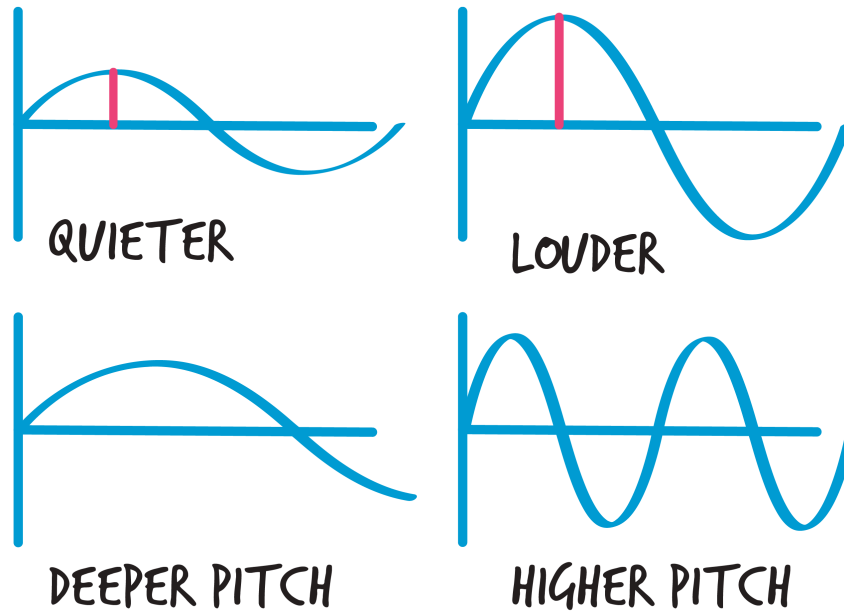


Soundwaves and the human ear

Each of us may hear sounds a little differently since hearing ranges are unique to individuals. Sounds are also modified by the way they are reflected or absorbed by environmental features such as terrain, surrounding objects, and the density of architectural or natural elements (Case & Day, 2019). The more designers know about the properties of designing with sound, the more appropriate the designed outcome may be for the context.

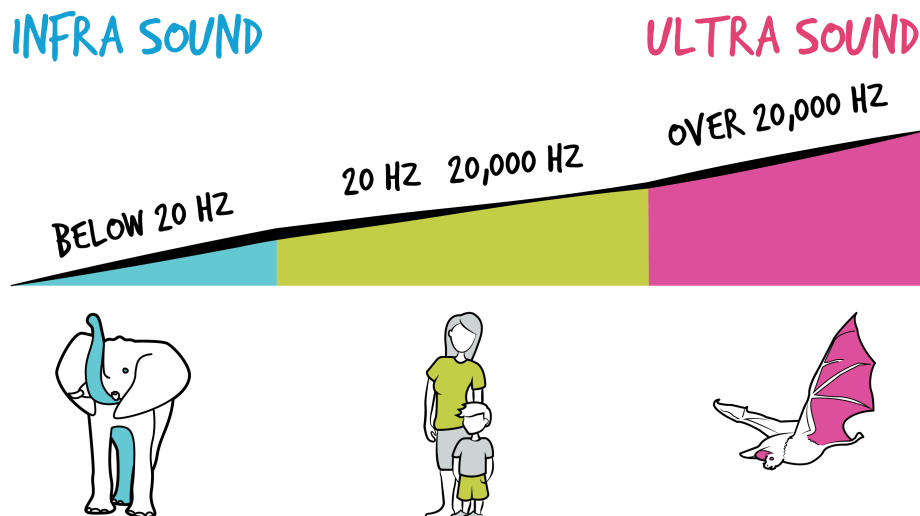
There are six properties of sound relevant to designing products, services, and environments. These include the following:

1. **Pitch and frequency** both relate to the length, height, and vibration of the soundwave. A higher or greater frequency of waves produces a higher *pitch* of sound and conversely, the lower or lesser the wave *frequency* the lower the pitch of the sound that we hear.



The perception of sound depends on the physical frequency of the soundwave

Frequency is measured in hertz (Hz). We can perceive sound waves with frequencies between 20 Hz and 20 kHz (kilohertz); this is our range of hearing. Within this range, the levels from 1,000 Hz to 5,000 Hz are the important working ranges for designers to consider because they are the levels of sound waves that are comfortable for most people. *High-frequency* sound waves include shrill sounds like whistles, whereas *low-frequency* sound waves may come from the humming of a car engine. The sound waves beyond our human hearing range are not relevant for most designs; they include infrasound with wave frequencies below 20 Hz and ultrasound, with wave frequencies above 20 kHz (Case & Day, 2018; Lupton, 2018).



Human hearing is in the range of 20Hz to 20,000 Hz

It is important to consider sound frequencies and their resultant pitch when designing sounds for communicating different messages, since the ability to hear loud or soft sounds varies with the *sound frequency*. For example, few people would wear earphones for any length of time if the sound was permanently set at a high pitch, but at a lower pitch, we might be comfortable wearing our earphones for hours.

2. **Timbre** refers to characteristic qualities or tones of sound that result from different sound frequencies grouped together or from different sources of sound production, like a metal clarinet versus a wood guitar. The frequency of each sound may be the same, but the source material is different for each one, resulting in our perception of the sounds as differing. It is important for designers to explore the types of sounds that are compatible with their products and make appropriate material choices to support the desired outcome.

Activity Time!

Throughout this chapter, you can click on the teal icons to hear sound samples.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1673#h5p-79>

The timbre of a sound varies according to source frequency as well as source material

3. **Loudness** is measured in decibels (dB) and refers to how high the volume of sound is. We can hear levels of sound between 0 and 140 dB, even though some sounds are lower than 0 dB or higher than 140 dB. Between 130 and 140 dB we can only endure 1 second of exposure before experiencing a damaged eardrum. However, we can easily endure 8 hours of exposure to 85 dB sounds, which are in the comfortable range for our ears, such as a computer at 40 dB or a dishwasher at 70 dB. However, a food processor at 95 dB or a jackhammer at 110 dB (Centre for Hearing and Communication, 2022) starts to be uncomfortable if the sound continues for too long. Standards for urban and institutional environments specify noise exposure limits; however, they often target reduced health risks and not necessarily pleasant environments or product interaction experiences.



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Loudness levels of the things around us

4. **Duration** refers to the length of time the sound occurs or is noticed, from start to finish. It may not actually reflect the exact time the sound began or ended, as much as it reflects the length of time a person can identify the sound and the pattern of its *rhythm* or *tempo*. In this case, a designer may want to consider the duration of one cycle of sound (period of sound) in relation to the continuous pattern (pulse) of the communication. For example, the sound cycles of washing machines, kitchen appliances, and lawnmowers have continuous patterns. The next time you use a blender, try to identify the duration of one cycle of sound before it repeats. Design teams can be involved in intentionally designing these sound patterns to ensure that they will blend into their surroundings.



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The duration of the sound produced depends on the duration of the pulse and the pattern of repetition of each pulse

5. **Envelope** refers to the pattern of the sound over its duration from the *attack* – just prior to reaching its steady state, to the *sustain* – the steady state at maximum intensity, and finally, to the *decay* – when the sound fades to silence (Case & Day, 2019). Doing your laundry exposes you to each of these phases of sound; the attack begins right after closing the lid when water pours into the machine. Once full, the sound pattern of the water and clothes swishing around reaches its steady or sustained state, and finally, the decay phase happens when the water drains out of the washer. Can you imagine the difference in the sound envelope when listening to a chiming crystal glass compared to listening to a lawnmower or chainsaw? Which one of these sound scenarios could easily become background noise and which one might evoke your emotions? The effects of these different patterns of sound on users are important in designing products.

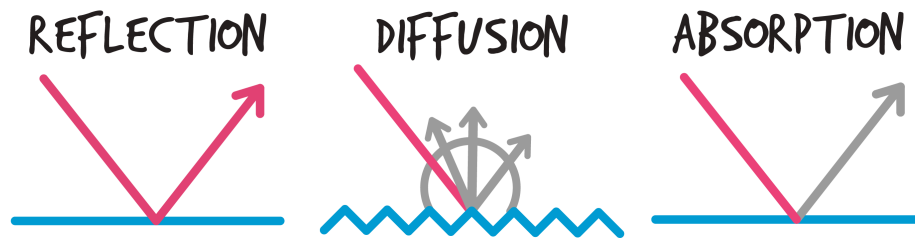


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The pattern of sound over its duration

6. **Diffusion** refers to how sound scatters when the sound waves hit different textured surfaces. Sound waves can be reflected into the environment, absorbed, or diffused. As you can see in the diagram below, *Reflection* is when the quality of the sound does not change because the same amount of sound bounces up after hitting a smooth surface. Whereas you can see that the impact on an irregular surface can break the sound vibration into smaller waves, which then travel in different directions or become *diffused*. When sound waves are *absorbed*, the sound dissipates and can no longer be heard. Waves can be deadened by cotton, wool, or foam rubber, or optimized by hitting

hard, smooth, and shiny surfaces (Lupton, 2018). Designers are aware of the challenges of too much noise in the environment and choose materials that absorb or disperse sound waves.



How sound travels when hitting different surfaces

These technical descriptions may be helpful to understand how sound can be manipulated by design. By changing any of the 6 sound variables, designers can experiment with different sounds for fit and comfort considerations. Designers can try out different sound qualities, at the same time as exploring different iterations of *product appearance* and *tactile qualities*, to develop a range of concepts that best optimize sensory product interactions.

Back to previous section: 5.1 Introduction

Next section: 5.3 How We Experience Sound



5.3 How we experience sound

This section introduces the kinds of sound experiences that we have and examines qualities of sound that can be enhanced to improve our experiences with products and places. When sound waves hit our eardrums, they vibrate in response and send signals to our brain, which interprets these signals as sound (Lupton, 2018). However, we do not all experience sounds the same way; some people only hear the sounds in their immediate vicinity, while others are sensitive to the sounds coming from all around them, and others experience diminished hearing. While hearing is a biophysical process, we also have affective (emotional) responses to sounds. If you have ever heard the sound of glass shattering on a hard floor, you may have experienced a visceral reaction of shock rippling through your body (van Egmond, 2009). We will touch on some emotional responses, such as fear (upon hearing sirens), pleasure (upon hearing soothing sounds from nature), or a sense of urgency (upon hearing beeping alarm sounds) in the following discussion.



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Emotional responses to sounds

Sound localization refers to how we can distinguish between sounds by locating their direction (Clarkson, 2009). Of course, this also engages our sense of sight – looking around to see where the noises of the children playing and the cars whizzing by are coming from! This kind of textured auditory information is valuable for us to distinguish between different soundscapes.

Soundscapes, as mentioned earlier, encompass the whole melody or composition of ambient sounds that we experience at any given time. We are constantly surrounded by sounds. Some everyday sounds include the noise of traffic in the morning, people talking, the humming of the lights in the office, music playing, or birds singing outside our window.

Given the ubiquitous experience of driving cars, you may be familiar with the experience of external traffic and environmental ambient sounds combined with the internal sounds of a radio or conversations with a passenger or on a hands-free call. This melange of noise can even interfere dangerously with the *intentional* sounds designed into the experience.

For a design team, considerable experimentation and concept iteration may also go into designing the sound quality of a restaurant's interior soundscape. By identifying the *multi-patterned* context of the *auditory experience*, it is possible to explore factors that modify the loudness and diffusion of noises to achieve an auditory balance. Since people must discriminate among competing noises to focus on the most important sounds in their vicinity, design teams can make it easier for them by considering ways to minimize hearing

demands caused by sound reflection and reverberation in larger spaces (Clarkson, 2009). If you are looking for an intimate dinner with a friend, you might choose a restaurant that has been designed to minimize distracting ambient sounds.



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The auditory spatial character of a place can be curated by design decisions

Layers refer to the categories of sound in a soundscape. In general, sounds can be divided into 3 main categories: Foreground, Middleground, and Background.



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Categories of sound: Foreground, Middleground, Background

1. **Foreground Sounds** or **Sound Signals** are familiar and intentional sounds that are designed to alert people about a product or environment. They may include beeps, sirens, or bells. They are proximate (close) sounds and can even be intermittent, to alert a person to something, such as an alarm clock. These are the key sounds that drive the user's experience and need to stand out appropriately from the other sounds around them.



Foreground Sound: An alarm clock ringing

2. **Middleground** or **Contextual Sounds** provide immediate contextual information. They communicate what is going on, informing people in the environment about the situation. For

example, contextual sounds like increased talking may inform the waiter that people are nearly finished eating or a teacher that students have completed their quiz. Sometimes these nearby sounds may be too loud and compete with the surrounding soundscape. For example, the noise of the coffee grinder or your partner's snoring may keep you awake and conflict with your quiet bedroom ambiance.



Middleground Sounds: Your partner snoring

3. **Keynote** or **Background Sounds** are the *ambient sounds* that we rarely pay attention to. They include the combined levels of background sounds at any specific location, considered both *spatial* and *textured*. Spatial sounds are directional and help define the extent of the spatial envelope (the surrounding soundscape) that we are in. The combination of these sounds contributes to our overall auditory perception of the experience, called the *sonic texture*. They may be birdsongs, ice cream truck bells, traffic noises, or overhead planes that are some distance from where we are (distal sounds). A design team may develop a gentle sonic texture for a product like a vacuum cleaner, but our impression may not be the same as that intended – we might interpret it as a disruptive ambient sound, especially if we are not the person who is vacuuming.



Background Sounds: Birdsongs

If the familiar traffic noises completely disappear you would likely register that absence of background sound as unusual. Or have you ever tried to study for an exam when people are talking in the background? For some of us, that can be extremely distracting, and we may choose to wear noise-cancelling headphones. Alternatively, others may find that background music or white noise supports concentration, and we fill our soundscape with music or white noise (Davis, 2015).

Have you ever experienced how ambient sound interferes with your hearing when you are calling someone from a busy location? In that case, the texture of the ambient sound disrupts the quality of your experience. According to Özcan, Cupchik and Schifferstein (2017), ambient sounds can have a significant effect on user experience and need to be carefully considered and moderated through design features in products, environments, and services. The man in the image below might be able to improve the quality of his call by relocating away from the main sources of ambient sound.



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The sonic texture of the ambient sound interferes with the quality of this phone call

Interestingly, ambient sounds are also an integral part of the *auditory spatial character* of places, such as restaurants, the dentist's office, the cafeteria, or the forest. Think about the kinds of sounds you recall from being in each of those environments – can you describe them? Designers should become sensitized to the contribution that our sonic product interactions make to our auditory experience of spaces and try to optimize them.

Activity Time!

Determine which sounds are **Foreground**, **Middleground**, and **Background** sounds in the three scenarios below.

Scenario 1: At a hockey game



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Scenario 2: An elevator



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Scenario 3: A cocktail party



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Layers of Sound in different contexts

Back to previous section: 5.2 Properties of Sounds

Next section: 5.4 Interpreting Time through Sound Interactions



5.4 Interpreting Time through Sound Interactions

The relationship between *soundscapes* and time is unique in comparison with the other senses. For example, visual feedback provides *spatial awareness*, but not necessarily distinctions related to time, whereas auditory feedback can provide information about the passage of time. Have you ever noticed that your perception of oncoming traffic changes over time? Think about riding your bicycle on a bike path – when another cyclist rings to let you know they want to pass, you can likely perceive that they are behind you and what side of you they are on. When they pass you hear their tires rolling by, and after they've passed the noise of their bike will diminish as they ride away. That kind of sound experience communicates the passing of time, not just that the rider is going faster than you. You may use this information to realign yourself on your bike – first by moving over to let the rider pass, then by staying in place until they pass, and lastly moving back into the path after they have passed. That is a *time-related auditory sequence*. Other types of auditory time-related information can be categorized according to the information you may perceive. For the most part, sounds that form sequences are related to steps in product use or in related use activities that indicate the passing of time:

Start and Stop sounds like those of an electric motor, an elevator moving from floor to floor, or a pencil sharpener communicate specific moments of product interaction.



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Start and stop scenario related to pencil sharpening

Transitional sounds like the opening and closing of doors or a car approaching and passing are experienced as communicating the passage of time, like the car driving away below.



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Transitional scenario of a car zooming into the distance

Adding or **subtracting** sounds like liquid being poured into or out of a container or rocks being added to or removed from a wheelbarrow indicate the time it takes to complete the task.



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Noting time passing through sounds of liquid pouring into a glass

Expanding and **contracting** sounds such as blowing up and deflating a balloon or breathing indicate a rhythmic activity that fills a specific timespan.



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Expanding and contracting sounds of blowing up a balloon

Back to previous section: 5.3 How We Experience Sound

Next section: 5.5 The Five Main Functions of Sound for User Experience



5.5 The Five Main Functions of Sound for User Experience

According to sound designer, Lucas Lacerda (2018), the 5 main functions of sound that relate to enhancing user experiences include sonic branding, anthropomorphism, emotion, conditioning, and feedback:

1. **Sonic** or **Sound Branding** refers to the use of specific sound patterns to create an identity or familiar auditory signal connected to a company and its product line. A 2016 study on long-term noise recognition found that even meaningless audio patterns were recognizable for up to four weeks after first hearing them, even if the listener only heard the sounds once (Spectrio, 2021). This research suggests that if you frequently hear a set of sounds organized in a particular sequence (sometimes called a sound sentence) in connection with a specific product brand, you will likely recall it. Indeed, you may experience this effect with websites as well as products or organizations, in a way that enables you to match sounds with specific product or service identities (Lindstrom, 2005). These specific sets of identifiable sounds or *audio logos* are commonly used in television and are also tied to distinct computer brands. Can you play the melody in your head of your computer's startup sound ("to imagine" a sound is called "to audiate")? These repeating sound patterns are designed to encourage user recognition and attachment.



Imagine the Sonic Brand related to this image

2. **Anthropomorphism** refers to a particular choice of human sound added to a product by adding a humanized sound that we find familiar and associate with specific memories. For example, in the movie "Wall-e", the robot was not only made to look human-like, but its sounds took on human intonations that increased the audience's empathy for it.



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Anthropomorphic sonic branding is recognizable: even vacuums need help!

3. **Emotional Connections** drive user experiences, and good sound design often relies on evoking emotional responses. Well-designed sounds have the potential to enhance comfortable and pleasurable experiences (physio pleasure) (Lacerda, 2018). If you play an instrument, you may recall moments of pleasurable immersion in your sound experience.



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Good auditory design contributes to a pleasurable experience

We also derive emotional comfort from the soothing sounds of our favourite playlist, a spa environment, or a water fountain. These sounds might motivate us to slow down and relax. What sounds inspire you to change your behaviours?



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Emotionally comforting sounds encourage relaxation

Sounds may be designed to trigger either positive or negative emotional responses; some leverage negative reactions as a way to communicate a sense of urgency. *Discordant sounds* give rise to negative emotional responses. For example, a piercing siren will suddenly alert people to danger to get them to act (this is an induced flight response), whereas a doll playing a melodious lullaby will put a baby to sleep (this is an induced comfort response). In general, negative or discordant sound patterns can affect how we viscerally relate to certain products. For example, the sound of a screeching device usually evokes a negative response that we can physically or viscerally feel.



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Poorly designed sounds may cause sensory confusion

It is important for designers to recognize that poorly designed sounds have the potential to negatively influence experiences with and judgments of a product (psycho-pleasure) and deter people from interacting with it.

Wanted and *unwanted sounds* are differentiated by who wants or does not want them. For example, in a hospital environment, there are good reasons for medical alarms to notify staff about patient conditions. These are considered wanted sounds. Hospital staff, however, suffer from *alarm fatigue*, given that there are so many potential alarms sounding during any given hour, and therefore may ignore the alarms that go off longer than necessary (Özcan et al, 2017; Van Egmond, 2009). These may be considered *unwanted sounds*. Moreover, ongoing sound disturbances have been shown to have negative effects on people's memory, attention, and mood, even to the point of causing PTSD (Post-traumatic Stress Disorder).



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Unwanted sounds are disturbing in the hospital



Innovative melodious sounds in the hospital may be 'wanted'

According to Case and Day (2019), most of us have some degree of sound sensitivity. The kinds of sounds we commonly find annoying include unwanted sounds with low frequencies like those of large trucks, high frequencies like chalk screeching on a chalkboard, unexpected 'noise pollution' like jackhammers outside the window, or repetitive sounds like the same audio playlist looping every twenty minutes over the entire workday. In recent years product development teams have begun to focus on designing quieter, more harmonious, or more silent product sounds rather than the beeps, dings, and alarms of earlier product versions (van Egmond, 2009). The term *sound quality* was first used to identify irritating environmental sounds that could be reduced or modified in some way to be less problematic. The term sound quality does

not, however, describe the emotional, semantic, and sensorial experiences related to sounds (van Egmond, 2009).

4. **Conditioning** plays a key role in sound design by using sounds to direct or change people's behaviours and encourage responses or attachment to products and environments. We respond to certain sounds that trigger ideo- and socio-pleasure through their ties to meaningful or cultural experiences in our lives, like sounds from our childhood, sounds tied to repeated sonic messages, and sounds that play on our imagination.

Designers and marketing professionals look for ways to influence our ability to experience *adaptive emotions* that “draw upon memories of a similar experience in the past and transfer those positive feelings to the new auditory experience” (Lindstrom, 2005). For example, purchasing patterns can be directly affected by music playing in stores, as familiar music may encourage you to stay longer. Once emotions are tied to positive sensory experiences, the potential for customers to become loyal to product brands increases (Lindstrom, 2005).

Soundmarks or *conceptual sounds* are designed to evoke positive emotional responses because they draw upon unique and rare sounds that are usually related to a specific cultural experience through languages, dialects, and music. Sometimes these keynote nature sounds are connected to a community experience. For example, the mechanical sounds of a tractor cutting grass in the countryside or the traffic sounds of the city. These could include the sounds of the ice cream truck bells, the Islamic call to prayer, or emergency sirens, which are unique to places and cultural activities.



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Ice cream truck bells are soundmarks that evoke cultural childhood memories

5. **Sound Communication** and **feedback** enables us to receive messages and information about the state of our products – “ding, ding” the door is open, “beep, beep, beep” the truck is backing up, “ping” the text was sent. These auditory signals alert, verify, or inform people during their product interactions.



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Sounds provide feedback and communicate messages

Auditory User Experience begins with awareness because we are not fully aware of the sounds around us. Often it is only when asked to recognize, remember, and/or identify them do we stop, listen, and make auditory associations (Lacerda, 2018). We need to be actively listening to be able to identify different sounds, discriminate between sounds within a multi-pattern context, and retain and interpret the sounds into a meaningful story.



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Active Listening contributes to discrimination within a multi-pattern context

When we interact with products, there is often an auditory message – whether it’s the sound of a hammer hitting a nail, fingers typing on a keyboard, a chainsaw slicing a tree, a swing during its back-and-forth motion in the park, a gas tank popping open, or a garden hose watering the flowers. These sounds, while part of the larger soundscape within which they occur, communicate with us about the nature and quality of our interactions – did the hammer hit the nail, are all the keyboard keys making contact, is the chainsaw slicing clearly through the tree, is the swing well oiled, is the gas tank top secure, is the water flowing through the hose? At this scale, there is a significant opportunity for designers to match sounds with the expectations and needs of the people who will be using those products.



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Auditory feedback should be easy to understand and differentiate

Activity Time!

Match the 5 functions of sound to their examples.



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5 functions of sound

Back to previous section: 5.4 Interpreting Time through Sound Interactions

Next section: 5.6 Categories of Sound



5.6 Categories of Sound

In certain product categories such as vehicles, electronics, and many domestic products, users perceive auditory cues to be as important as visual ones (Knöferle, 2012; Schifferstein, 2006). A product's sounds transfer information about its functioning, which can be categorized into two different kinds of sound categories, based on the sound's source of origin – consequential or intentional.

1. **Consequential sounds** result from the internal or external structure of a product, especially products with moving parts. Sounds are emitted by the product in relation to how they function, such as a lawnmower or washing machine. These products contain multiple sound-producing parts like running engines, rotating gears, fans, bouncing springs, pumping water, or blowing air. These mechanical sounds inform us about the product functioning cycles and listeners cannot intervene to change the sounds while they occur (Özcan & van Egmond, 2008; Langeveld et al, 2013).

2. **Intentional sounds** are the second kind of sounds – often used in product interfaces and controls. These are added, designed, implemented, and put into a product by a sound designer, like cell phone alerts, microwave oven finish bells, and oven setting feedback sounds. They are mostly digital and abstract, but listeners learn to attribute meaning to them since they convey messages. Listeners may feel obligated to attend to the message being communicated (Özcan & van Egmond, 2008; Langeveld et al, 2013). Perhaps that is why we almost always respond to our beeping phones, even when we are in the middle of other activities.



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Sounds can be the consequence of moving structural parts or intentionally designed

Semantic Descriptions of Sounds

Sounds are often expressed in descriptive terms because scientific terms are not widely known. In addition, the way we perceive the character of a sound can depend on both perceptual and cognitive factors (Özcan & van Egmond, 2005) and, as a result, sounds described in the categories below vary in their spectral-temporal composition, the material interactions that cause the sound and their conceptual associations. Through their research into how participants describe sound types, Özcan and van Egmond (2005) organized sounds into the following six perceptually distinguishable groups using semantic associations:

1. **Air** sounds were generally defined by location (where the sound takes place), action (the action causing the sound), and psycho-acoustical (physical properties of sound like pitch and tone). Examples of air sounds included vacuum cleaners, hair dryers, and vacuuming motors.
2. **Alarm** sounds were described through abstract meanings, source descriptions, and onomatopoeias. Examples of alarm sounds included bells, microwave button feedback, warnings, alarms, and other attention-getting sounds.
3. **Cyclic** sounds, which resembled air sounds, were identified by source, location, psycho-acoustical properties, and action descriptions. Examples of cyclic sounds included dryers, fans, monotones, and ventilator backgrounds.
4. **Liquid** sounds were described by action, sound source (the medium in which the sound was produced) and onomatopoeias. Examples of liquid sounds included coffee machines, boiling, pouring, and filling.
5. **Impact** sounds were described by temporal aspects (duration and constancy of sound), source properties, onomatopoeias (imitations of sounds), and materials (used in the product). Examples of impact sounds included doors, switches, banging, and opening.
6. **Mechanical** sounds were described by sources, action descriptions, emotional responses (how people feel in response to the sounds), onomatopoeias, and abstract meanings. Examples of mechanical sounds include shavers, rattling, buzzers, electro-motor, mechanical and high-pitched noises.



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Sound descriptions Categories

Activity Time!

Drag the **sound (onomatopoeia)** and **semantic description** under the columns *Consequential Sound* and/ or *Intentional Sound*.

Hint: some sections may remain empty.



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Consequential & Intentional Sounds

Back to previous section: 5.5 The Five Main Functions of Sound for User Experience

Next section: 5.7 Sound Design



5.7 Sound Design



Sound design is important in a variety of professions from design to the arts

Sound design refers to the practice of developing sounds by specifying, acquiring or creating auditory design elements using audio production processes. Sound design in products can range from non-existing sounds or silence (minimizing the sound of kitchen appliances) to consistent sounds (ongoing sounds of the car motor or the sewing machine), or aggressive sounds (alarm clocks and smoke detectors). As noted earlier, the sound must be well-matched to the product.

Products can be enhanced by sound design in two ways: additive and subtractive sound design. According to Case and Day (2019), additive sounds should aim to improve the user experience, augment a display, or enhance an environment. Whereas subtractive sounds should aim to produce quieter, better-sounding and more pleasant products or environments. These design principles are related to the user experience response to wanted and unwanted sounds, as discussed earlier.

General guidelines for designing *additive sounds* adapted from Case and Day (2019) include:

- Taking cues from familiar sounds in the natural world (Gaver, 1986).
- Selecting sounds that fit within their context of use or provide the opportunity for users to change the sounds to fit.
- Determining the appropriate timespan of sounds, for example by reducing the duration of frequent notifications.
- Considering the volume of sounds relative to each other, to their function, and to their interactions with other objects.
- Attempting to provide alternative feedback (such as visual or tactile) for people with very low hearing

ability and facilitate connections with auditory aids (Clarkson, 2009).



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Designing sounds for a car interior

General guidelines for designing *subtractive sounds* adapted from Case and Day (2019) include:

- Minimizing materials and components that create noise.
- Improving the quality of materials and components to ensure longer life and smoother fit.
- Coating surfaces with vibroacoustic materials to reduce friction and noise or insulating parts to minimize vibrations.
- Providing the opportunity for users to modify, minimize, or turn off notification sounds completely or for a specific time range.
- Reducing or eliminating spoken word product communications when appropriate.



Product innovations can reduce consequential sounds



Sound-dampening materials improve noisy environments

Process of Sound Design

The process of *designing sound* is similar to the process of product design in that it is divided into iterative phases from the initial concept to the final product. According to Özcan & van Egmond (2008), sound is an integral property of the product and the application of product sound is a part of the main product development process.

When it comes to the design of the sound, designers use a 4-stage model which consists of the *Problem Analysis Phase*, the *Conceptual Design Phase*, the *Embodiment Design Phase*, and the *Detailing Phase*.

The **Problem Analysis Phase** is responsible for identifying the nature of the sound challenge (i.e., products, materials, and parts). In this phase, designers analyze the *sound problem* and present it by auditory means, such as recordings of existing sounds.

The **Conceptual Design Phase** includes *sounding sketches* which are snippets of recordings. They are created to conceptualize ideas and find any object that has the potential to represent the desired sounds. This is like the iterative phase in a design project and sounds can range widely.

The **Embodiment Design Phase** is a specification phase. *Sounding Models* are produced that represent and roughly imitate how the product functions and sounds. The *sounding model* is an auditory representation of the designer's ideas that is used for discussion and consideration with other decision-makers.

In the **Detailing Phase** prototypes, actual sounds of the selected representations are developed to test the functionality of the product and the sound it produces, as well as the user's responses to them (Özcan & van Egmond 2008).

Back to previous section: 5.6 Categories of Sound

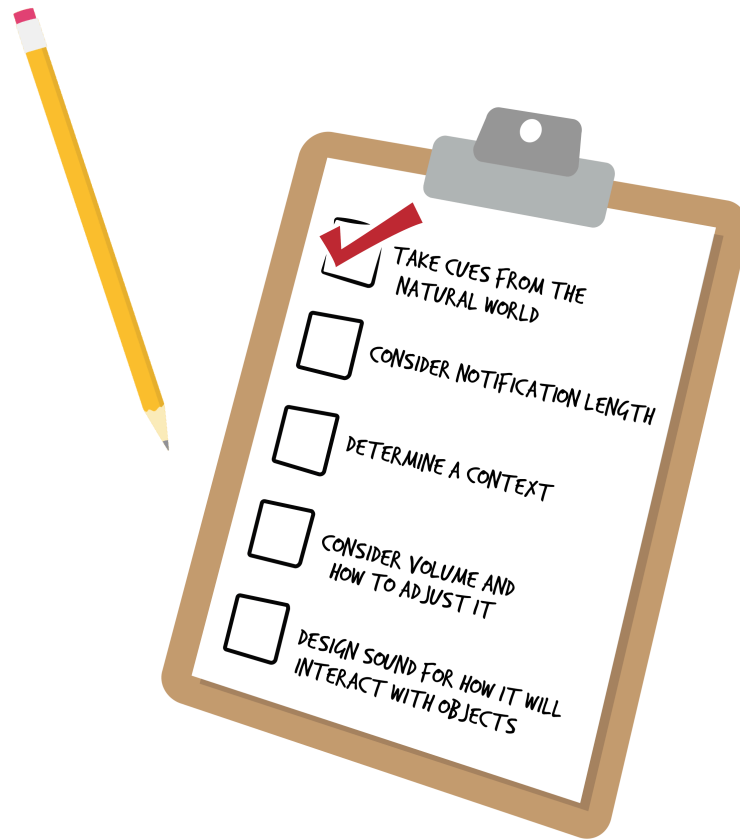
Next section: 5.8 Methods for Sound Sensitization



5.8 Methods for Sound Sensitization

Given that product designers are typically not sound designers it is useful to develop a sensitivity to the nuances of sounds, but it's not necessary to become skilled auditory designers. Some of the methods that are useful and fun to develop *auditory sensitivity* include:

- Imitating sounds associated with a place or an activity scenario using only your mouth and non-speech noises in a practice called *vocal sketching*. Try imitating the sounds of filling up with gas at your local gas station or taking an elevator up several floors.
- Producing samples of possible sounds which is a process called *audio prototyping*. Some sounds you might want to produce could be the sounds of an egg timer, a car starting, or a pressure cooker.
- Listening to and identifying the layers of sounds in your environment, which is an exercise called a *soundwalk*. Take a walk around a playground listening to the sounds of children playing on the swings and slides. Record the sounds and try to identify them later.
- Creating a map, picture, or chart of the different sounds that you hear while doing an activity, which is a process called *audio mapping*. Some of the activities you can consider are making breakfast, shovelling snow, or working on your computer.



Sound Design Checklist

You may enjoy trying out some of the activities above and, through playful experimentation, recognize how important sound can be in providing different kinds of information in many user scenarios. Sound design follows a similar process to other aspects of design; that is why it makes sense to take initial steps to develop an awareness of the nuances of sound that enhance a person's engagement with a product, place, or service before diving into designing sounds.

Back to previous section: 5.7 Sound Design

Next section: 5.9 Summary Review Activity

5.9 Summary Review Activity

Activity Time!

Select the best answer or answers to each question below that demonstrate some of the insights you have gained in relation to this chapter's learning objectives.

1. The properties of sounds that convey auditory information.

Question 1.1



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1698#h5p-94>

Question 1.2



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2. The features of soundscapes that we interpret in meaningful ways.



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Airport Soundscape

Question 2.1



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Question 2.2



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Question 2.3



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3. Applications for sound that are relevant to design.



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4. The emotional appeal of sounds.



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5. The categories of sound that correspond to different auditory messages.



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6. The process of sound design.



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Back to previous section: 5.8 Methods for Sound Sensitization

Next section: 5.10 Conclusion & Key Takeaways



5.10 Conclusion

Auditory design is not simple. It requires a sensitivity to how sounds can improve an existing environment or product interaction as well as knowledge and experience in working with sound. Since sound is an integral part of the aesthetics of our everyday interactions with people, places, and products it is a key feature in *sensory product aesthetics*. Are the sounds we hear useful? Are they appropriately pleasant or unpleasant, depending on the situation? What happens if we can't hear the sounds that are embedded into products or that are a part of the *auditory spatial character* of places? How do we perceive the important messages that sounds are designed to communicate? Consider these questions while paying attention to the sounds around you.

This chapter approaches sound from two perspectives: how people experience sounds and how design teams work with sound to create good and even better auditory experiences for product users.

Key Takeaways

The key takeaways from this chapter include:

- An introduction to the 6 properties of sound and how they affect the way sound is perceived across a range of products and environments.
- Knowledge about how the qualities of sounds and soundscapes communicate information that enhances our interactions, including the layers of sounds that compete for our attention.
- Awareness of the ways sound can provide contextual information about time passing, the changing states of our surroundings and the things in them, and how products are working.
- Exposure to some of the benefits and problems associated with sounds such as unwanted sounds, and negative effects of sounds that are serious enough to cause disorders. Design can improve the quality of these auditory issues.
- Perception of how sound can contribute to a product or brand's emotional appeal in enhancing sonic branding, recognizing anthropomorphic features, influencing behaviour, and providing informative feedback.
- Understanding the 6 categories of sounds, from air sounds to mechanical sounds and how to identify whether sounds are consequential or intentional.
- Explanation of the principles and processes for designing sound, how to become sensitized to the sounds around us, and guidelines for considering how to include sound in products.



Chapter 5: Design for Auditory Experiences

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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The next chapter introduces the senses of smell and taste, how we experience them, and their importance in enhancing our experiences with designed products and places.

Key Words: Sound Design, Properties of sound, Layers of sound, Functions of sounds for user experiences, Benefits and Challenges of sound feedback, Emotional value of product sounds, Categories of Sound, Sound design considerations

Back to previous section: 5.9 Summary Review Activity

Next section: Chapter 5 References



Interactives Answer Key

Section 5.3: How we experience sound

Drag and Drop Activity, Scenario 1: At a hockey game

Foreground sound: goal buzzer

Middleground sound: people shouting at each other & game commentators

Background sound: the puck on the ice & players' skates and sticks on the ice

Drag and Drop Activity, Scenario 2: At a hockey game

Foreground sound: dinging sound to announce arrival at floor

Middleground sound: elevator music

Background sound: the elevator's sounds of movement

Drag and Drop Activity, Scenario 3: A cocktail party

Foreground sound: a fork clinking on the side of the glass

Middleground sound: people talking

Background sound: music

Section 5.5: The five main functions of sound for user experience

Memory Game, 5 Functions of Sound

Sonic branding & Knock

Anthropomorphism & Robotic

Emotional & Car alarm

Conditioning & School bell

Feedback & Timer

Section 5.6: Categories of Sound

Drag and Drop, Consequential & Intentional Sounds

Sonar:

Intentional sound:

Onomatopoeia: **PINNG**

Semantic description: **Cyclical**

Electric toothbrush with timer:

Intentional sound:

Onomatopoeia: **TA-TING!**

Semantic description: **Alarm**

Consequential sound:

Onomatopoeia: **Brrrrrr**

Semantic description: **Mechanical**

Umbrella:

Consequential sound:

Onomatopoeia: **Rustle & Fwoop**

Semantic description: **Impact**

Section 5.9: Summary Review Activity

Question 1.1

Which of these properties of sound are relevant to designing products, services, and environment? Select all that apply.

- **Pitch & Frequency**
- **Timbre**
- **Loudness**
- **Duration**
- **Envelope**
- **Diffusion**

Question 1.2

Envelope can be described as the properties that seal a sound space.

True / False

Question 2.1

In this soundscape, what is the keynote sound?

Planes landing

Question 2.2

In this soundscape, what is the contextual sound?

Crowd and announcer chatter

Question 2.3

In this soundscape, what is the sound signal?

Boarding call

Question 3

The negative effects produced by ongoing unwanted sounds are called:

Alarm fatigue

Question 4

Define a soundmark.

A unique cultural sound tied to pleasant memories.

Question 5

What category of sound is subtractive sound design used to minimize?

Intentional / Consequential Sound

Question 6

What are the stages of sound design?

The Problem Analysis Phase, The Conceptual Design Phase, The Embodiment Design Phase, The Detailing Phase

Back to previous section: 5.10 Conclusion & Key Takeaways

Next section: Chapter 5 References

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Back to previous section: 5.10 Conclusion & Key Takeaways

Next chapter: Chapter 6: Design for Smell and Taste Experiences

CHAPTER 6: DESIGN FOR SMELL AND TASTE EXPERIENCES



Next section: 6.1 Introduction



6.1 Introduction

Designers often disregard smell, and even more so taste, as elements in product design. This attitude fits into historical and cultural approaches to the senses that still influence us today. Since the time of the Greeks, the distal (or distant) senses of sight and hearing have been considered more important than smell and taste in the western world. Greek philosophers believed that a person mainly perceived objective sensory information through sight and hearing, since they could determine a great deal of information, at less risk, while at a distance from the source of the stimulation (Synott, 1991). They also believed that touch, taste, and smell, the contact or proximal senses, put the perceiver in danger of being too close to make objective observations. Of these latter senses, smell has been ranked as the least informative as it is the sense most closely linked to emotional responses and subjective interpretation (Classen, 2005).

It may be hard to believe that smell is such an inferior sense when you walk into a mall flooded with food court smells or when you visit a real estate open house that is infused with the smell of chocolate brownies, baked only to associate the place with your fond memories. Today designers and marketers depend on these intimate and subjective olfactory (smell) perceptions to develop customer loyalty, another term for winning potential clients over and keeping them for the long term. The science of sensory marketing is a specialization in product branding where unique smells and tastes are designed and referred to as a product's signature smell or taste. Examples include a new car smell or the ambient smell of spas and restaurants (Derval, 2010). Sensory marketing is used as a strategic stimulus that connects products and places to people's emotional memories and preferences (Lindstrom, M. 2005).

Can you think of smells that you associate with certain product experiences?



Smell Memories connect us to the past

Have you ever been surprised by the artificially sweet scent of some kinds of toilet paper or kitchen garbage bags? Or have you ever noticed an absence of smell when you expected there to be one? You may also find it interesting to know that some common elements of our environments have smells you have never noticed, like the smell of the concrete in sidewalks, metal handrails on staircases, or fungus in your water bottle. That smell – the fungus or mildew smell – provides an important warning message and requires action. It is a call for maintenance, which is also an integral activity to consider when designing for product interactions.

Smell and taste often go together; sometimes we are drawn to the smell of certain foods before we eat them, and other times we perceive tastes and smells as an intertwined sensory experience. For example, if you reflect on memories of eating brownies or other chocolate baked goods, you may be able to distinguish between the smell of the chocolate and its taste. In this chapter, we acknowledge the sophistication of the food design industry in applying techniques to heighten gustatory (taste) sensations, but the focus is more on introducing ideas about designing for products that are enhanced with smell and taste features. We explore how they work together as well as how each of these intimate senses work on their own. We begin by discussing smell and follow by discussing taste because of their close relationship.

This chapter introduces some of the key concepts that designers should be familiar with when considering smell and taste as multi-modal layers in product design. In this chapter you will learn:

- Insights into the biophysics of smell (olfaction) and taste (gustation).
- Knowledge about the experiences of smelling and tasting, and how they interact with one another to create evocative memories.
- Awareness of the taxonomy for describing smells and tastes, and the limitations related to describing

and producing smells and tastes in product design.

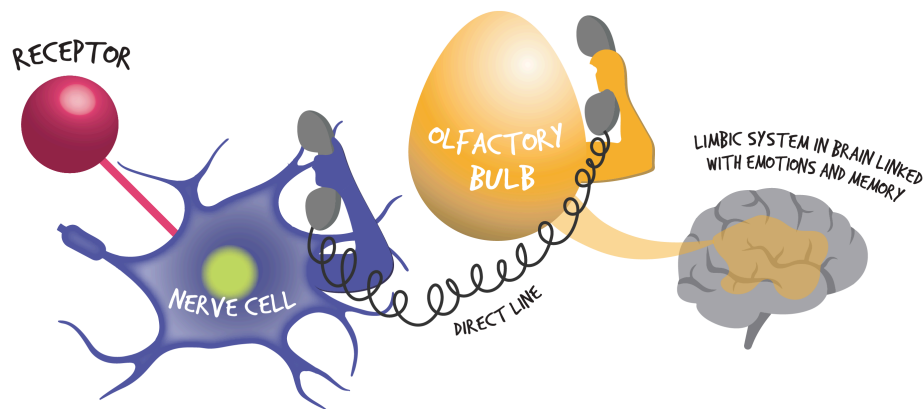
- How we are affected by smellscapes and scentscapes.
- Principles of olfactory and gustatory design.
- How the context within which we have smell and taste interactions influences our perceptions and experiences.

Next section: 6.2 Experiencing Smell



6.2 Experiencing Smell

The experience of olfaction begins as a chemical process in which receptors in the cilia in your nose capture and send smell signals to your olfactory sensory neurons. These signals are interpreted as an electric impulse that travels to your brain (Derval, 2010; Cardello and Wise, 2009). You experience this when you inhale airborne smell particles (called odourants) during interactions with products or places; these odourants are translated into messages of pleasure (the smell of morning coffee) or danger (spoiled food).

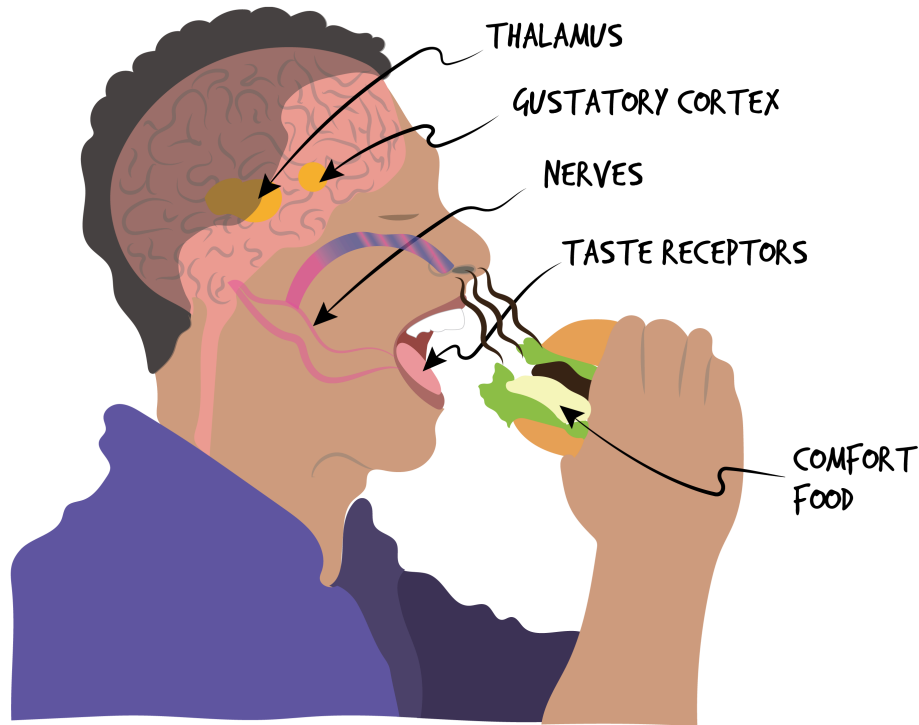


The path of smell: from receptors capturing odourants to your brain interpreting them

In fact, your smell receptors can detect “at least one trillion different aromas, which makes smell a discriminating sense” (Jasper & Wagner, 2018, p. 50). The eye and the ear each provide much less information; the eye can distinguish among several million colours and the ear can sense less than half a million tones (Lipps, 2018).

You have many more smell receptors than other types of sensory receptors combined

Think of the last time you ate a delicious meal. Do you remember what it smelled like? Do you remember what it tasted like? Can you separate the smell memory from the taste memory as you did with the earlier brownie example? Is your perception of one of those senses more memorable than the other? If you recall them as one overall perception, that is an example of how you perceive odours through two different pathways – the nose and the throat. When you sniff, smells enter through the front of your nose and that process is called *orthonasal olfaction*. When smells move into your nose from the back of the mouth while you are chewing or swallowing and breathing out that process is called *retronasal olfaction* and is related to your experience of taste (Auvray & Spence, 2008; Christodoulaki, E. 2016; Lipps, 2018). Your olfactory sense is thus considered a proximal (close) and dual sense because of its ability to sniff smelly molecules in the air and savour the scent of food. As well, smelling sometimes acts as a distal (distant) sense because it can also detect stimuli at a distance by means of their odours (Thavonekham, 2015).



Orthonasal Olfactory sensing when eating

Smell and Memory

Olfactory perception makes a substantial contribution to how people interpret their lived experiences through sensory links to smells, memories, emotions, things, and places. Smells have more power to immerse people in their surroundings through cultural and personal associations than any of the other senses.

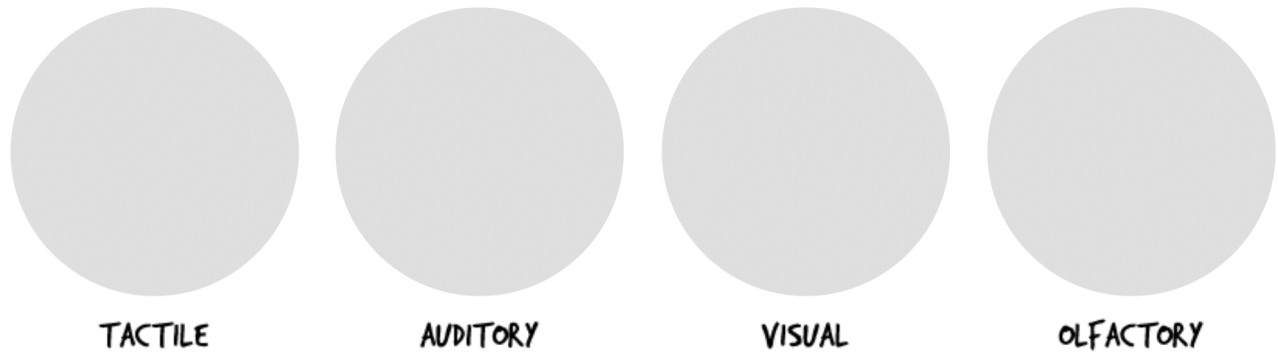


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Cultural Associations through taste and smell memories

According to the Auracell (a polymer scent product manufacturer) website (2020), “Research suggests that people *remember* 35% of what they smell, compared to just 5% of what they see, 2% of what they hear, and 1% of what they touch”. Even though scent is more connected to memory, people also look for additional information in the moment through sight, touch, and sound. The Auracell site also tells us that fragrances evoke moods and enhance brand recall. According to their site, that may be why the demand for fragrances that enhance products is growing. They argue that adding fragrance strengthens a customer’s perceptions of quality, leading to product brand loyalty. Are there certain products or places (e.g. soaps or coffee shops) that you prefer because of their fragrance?

% of what people remember from different sensory data



Percent of what people remember from different sensory data

This experience is sometimes called the “Proustian phenomenon”, and supports the idea that there is a strong emotional connection between smell and memory. It refers to the involuntary childhood memory that overcomes one of Proust’s characters in *À la Recherche Du Temps Perdu* when eating crumbs of a madeleine cake. In lay terms, it can be said that a *signature smell* evokes the emotional tone of the context in which it was originally experienced. This emotional smell can suddenly trigger specific memories from the past (Jones, V.E., 2017, p. 14).

Since you are now thinking about the power of your emotional attachments through scent, try to recall what happens when you smell coffee brewing. Do you experience attraction or aversion? What about the smell of welding? Or the smell of freshly cut wood or a newly mowed lawn? You may have originally experienced each of these smells while someone (maybe you) was using a product like a coffee maker, a welding iron, a hand saw, or a lawnmower; so your smell memories are connected to your product interactions. That means when encountering those products later, the smells may bring up old memories that you then attach to the new interactions.



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Your smell memories can become associated with specific product interactions

The Taxonomy of Smells

It may not be easy, however, to describe your smell memories. Jasper and Wagner (2018) tell us that there is a lack of a specific smell vocabulary and many smell descriptions are borrowed from those of other senses, where we might say that something smells sour (like the taste of a sour fruit) or that it smells heavy (like the tactile weight of a material).



Expressions we use that describe the character of smells

Our individual odour preferences may be learned over time and may also be culturally dependent. Since we interpret smells differently, similar smells may trigger varied emotional responses, depending on the original context of the smell experience. That means designers need to conduct user research to understand how people respond to the fragrances they plan to use to avoid designing a product with a negatively perceived scent. Before a product goes to market, user studies can predict the likely outcome of product acceptance due to smell alone. For example, Lindstrom (2005) believes that a popping corn (and butter) smell is so closely associated with the experience of going to the cinema that the scent alone can attract moviegoers. He recounts a story of a Chicago cinema owner who installed vents on the street outside his theatre to pipe the popcorn smell onto the street prior to starting the show. He found “that magically evocative smell helped him fill seats in a matter of minutes” (Lindstrom, 2005, p. 18). This is like the allure of the smell of baking bread for a bakery.



The aroma of baking bread draws people into the bakery's retail space

Not all of us appreciate the smells around us, perhaps for good historical reasons. Many cities have been characterized by their smells – of animal, human and industrial waste – in the urban environment, waterways, and industrial sectors. For example, the City of Peterborough, Ontario smells like oats from its Quaker Oats Factory and many small towns in Quebec had a smelly reputation until recently due to their pulp and paper mills. Sometimes pervasive and unpleasant odours need to be controlled. Odour management includes these three factors: separation, deodorization, and masking (Thompson et al, 2017). *Separation* involves isolating the smelly offender so that it can be contained. This occurs when you take out the smelly garbage. This is followed by a process of *deodorization*, often involving chemicals and air filtering devices that treat the source of the odours to neutralize or lessen their intensity. This occurs when you put an open box of baking soda in your fridge. Lastly, *masking* can be as simple as spraying air fresheners that provide a fragrant odour to distract visitors from unpleasant odours in the vicinity or as complex as applying harsh chemicals (Decottignies et al, 2007). Masking odorants usually mix the masker and the offending odour to reduce or cover up the unpleasant odour.



Garbage bags are often treated with a fragrant odourant to mask smells

Urban planners and environmental scientists use criteria for measuring smells so that they can provide data that help professionals to minimize or eliminate odours from environments (Bull, M. 2017). In the air quality and waste management industry, the characteristics of an odour can be measured and defined, using terms similar to those for sound quality: odour character, hedonic tone, odour intensity, duration, and frequency (McGinley, P. E. 2000). These are described below and are terms that can be applied to designing smells:

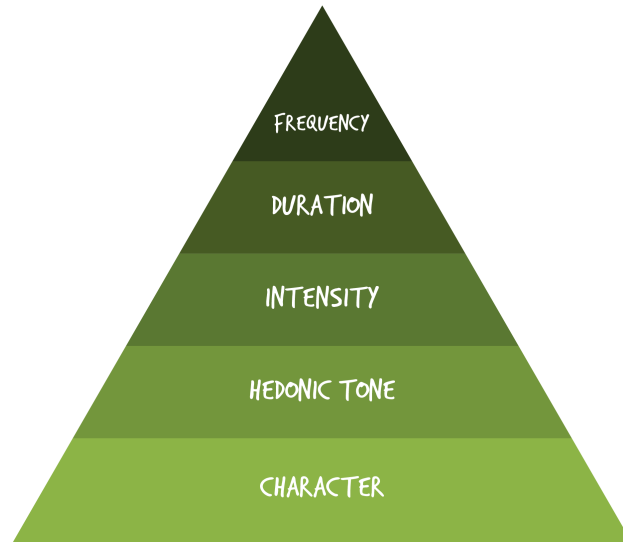
Odour Character refers to how we describe the smell of an odour, as bad, stinky, terrible, or offensive. This description is objective and selected from a standard measurement scale of odour quality. These odours warn us to stay away from the source of the smell.

Hedonic Tone refers to subjective descriptions of the quality of an odour, usually based on our life experiences and feelings. In this case, the description might include emotionally loaded words like scary, threatening, or unpleasant. These odours are connected to our emotions.

Odour Intensity refers to how strong we perceive the odour to be, whether pleasant or unpleasant. Think about when you encountered someone with a very strong perfume or cologne; you may recall something about its intensity. Our reactions to these odours vary depending on how sensitive we are to smells.

Duration refers to how much time it takes for us to continue perceiving the smell of an odourant; this is the amount of time we experience a single odour episode. For example, you may enter an elevator that a caretaker with a garbage cart has just vacated and the smell that remains behind does not even last for your entire ride up. That odour episode had a short duration.

Frequency refers to how often you perceive odour episodes. You may consider changing your route to work if you experience getting on the elevator at the same time as the caretaker with that smelly garbage cart every morning. The daily frequency of that smell episode could be affecting your quality of life.



This odour inspection pyramid begins with character and as the issue becomes more significant it moves to the top of the pyramid (adapted from McGinley, 2000)

The pyramid above is a useful tool for odour enforcement in urban environments so that the appropriate professionals can neutralize offensive odour situations. However, taking a more positive spin, it may be adapted into a helpful tool for characterizing the qualities of scents that designers hope to imbue in products and product experiences, which is the reason that the term *hedonic tone* is important in this list. For example, in bathrooms and kitchens, scents are often added to *mask* emerging odours from natural activities such as composting and storing garbage. We want to have pleasant smells in our kitchens to enhance our experiences preparing and serving food.

Back to previous section: 6.1 Introduction

Next section: 6.3 Categorizing Smells



6.3 Categorizing Smells

You can find smells everywhere you go, and in many cases, you may not consciously notice them. As you pay more attention to smells around you, you will also notice that they change as you move into other environments. Each of these scented spaces or places are called **smellscapes** or **scentscapes**. Some cities, similar to Peterborough's oat factory smells mentioned above, have a *signature smell* (a smell unique to that place or thing). Most places have a combination of smells and as you pay attention to them, you may become more closely attuned to the differences. In researching the nature of urban smells, participants went on guided *smell walks* in different cities and cityscapes (Guercia, Schifanella, Aiello, & McLean, 2015 and 2016). They were asked to find smells as they walked along and to name them. It turns out that finding smells can be challenging. "Smells are not neatly defined objects; they can travel large distances and appear seemingly unattached from their origin" (Feuer-Cotter, J. 2017). Dr. Kate Maclean (2019) developed a set of activities to help us attune our senses to ways of perceiving and describing smells. By experiencing a smell walk, designers can begin to appreciate the power and importance of smells in a variety of contexts through these three activities:

- **Smell catching** – breathing deeply to receive smell information.
- **Smell hunting** – locating the sources of smells closely connected to products or places.
- **Smell naming** – experimenting with names based on associations with familiar scents).



Become sensitized to smell by taking a smell walk

Given that smells swirl through the environment and dissipate, it is unlikely that the exact same set of smells would be experienced in the same sequence or in the same place repeatedly (Lipps, 2018). Nonetheless, perceptions of places and product interactions are built partially upon smell experiences. Why not take a smell walk to become sensitive to the smells in your neighbourhood?

Activity Time!

Place each of the four items that appear in the column on the right in its appropriate spot along each of the four Smell Spectrum continuums below. First choose the order for the top Smell Spectrum, Synthetic to Natural, then reorder the items appropriately in the next Smell Spectrum, Bold to Faint. Continue reordering for the following two Smell Spectrums, Aromatic to Stinky and Brief to Enduring.

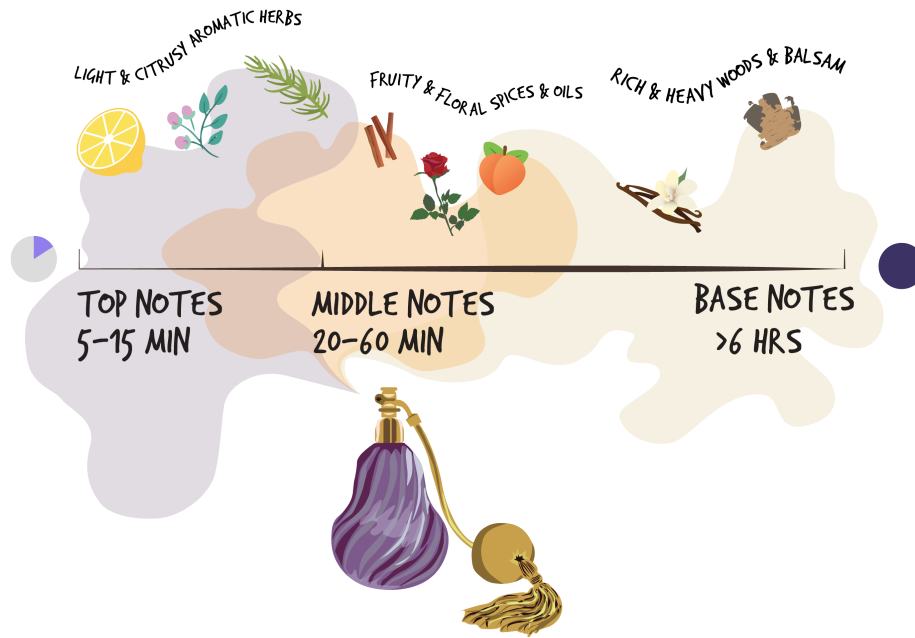


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Smell Spectrums

Characteristics of Smells

We refer to smells by a number of different names – odours (usually scientific), scents (cosmetic and environmental), and fragrances (cosmetic and alimentary). Let's consider some significant smell characteristics. Perfumers refer to the notes (or immediate scent you can distinguish) of a smell as top, middle, and base. They may be related to proximity, strength (intensity), or *duration* of the specific odours, which are terms we will define shortly. They can be combined in layers of different fragrances and active time spans that contribute to a longer-lasting and pleasant experience that we will want to repeat frequently. However, most smells do not last long. "The smell of violets (methyl ionone) is famous among perfumers for persisting for only about half the duration of an inhalation before it becomes imperceptible" (Jasper A., & Wagner, N. 2018, p. 52). This is the result of another common smell phenomenon called *olfactory fatigue*, in which we experience a rapid loss of perception over the duration of the smell event.



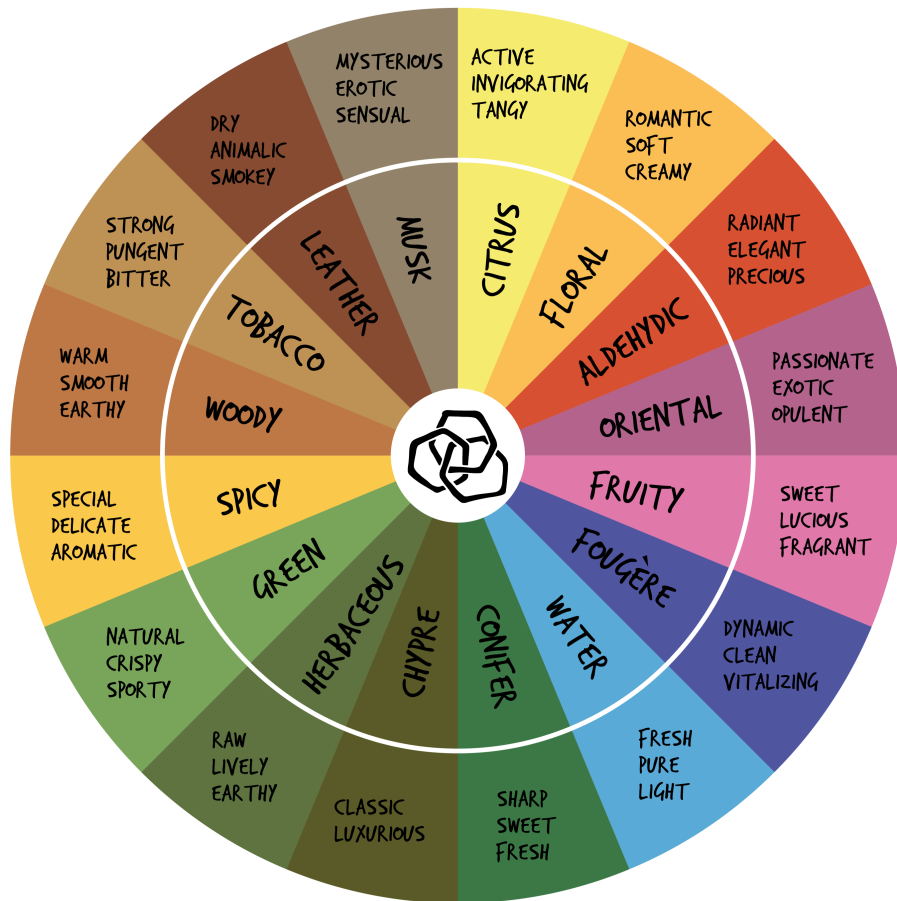
Duration & Layers of different fragrances

For a designer, the ephemeral character of smells means that care and consideration must go beyond the choice of smell. It should also consider the moment when the smell is most intense. Again, when buying a new car, you experience that “new car smell” the moment the door is opened. According to Martin Lindstrom, cars acquire their new car smell via an aerosol sprayed on at the end of the production line. “The smell generally lasts for about six weeks before it’s overtaken by the rough and tumble of dirty running shoes, old magazines, dry cleaning” odours of everyday life (Lindstrom, 2005, p. 15).

These complex considerations may be rather sophisticated for most product design teams, as designing scents is rarely a highly-developed design skill. However, scents are part of many product experiences and the more we are aware of their effect on product interactions, the better. For example, we could consider the scent of salmon, emerging from a tin as we pierce it with a can opener, to be an affordance that provides us with feedback that the opener is working. Or the smell of a toaster in action may send us a different message. It can alert us to how well done our toast is – lightly toasted, darkly toasted, or burnt. For the design team, a well-designed toaster would rarely produce burnt toast and would be adjustable to its users’ personal preferences. It is important to note that smells can also come from the products themselves, such as the materials or electronics, not only from interacting with them. Describing some smells may not be as easy as describing other sensory perceptions like colours, sounds, or shapes.

Fragrance Models

Smells can be organized into *scent categories* and displayed in two-dimensional models similar to colour wheels. One such model is the Drom Fragrance Wheel developed in 1911, in which scents are characterized in relation to specific smells like leather, floral, or herbaceous, and are assigned descriptive adjectives (as discussed in Jasper A., & Wagner, N. 2018).



Drom Fragrance Wheel (adapted from Jasper and Wagner, 2018)

An earlier scent model, developed in 1857, by George William Septimus Piesse, assigned musical chords, harmonies, notes, and progressions to describe melodies and compositions of scents as harmonies or disharmonies (Jasper A., & Wagner, N. 2018; Piesse, 2011). This musical association is a completely different and multisensory way of categorizing and organizing smells and is still used by the perfume industry today!

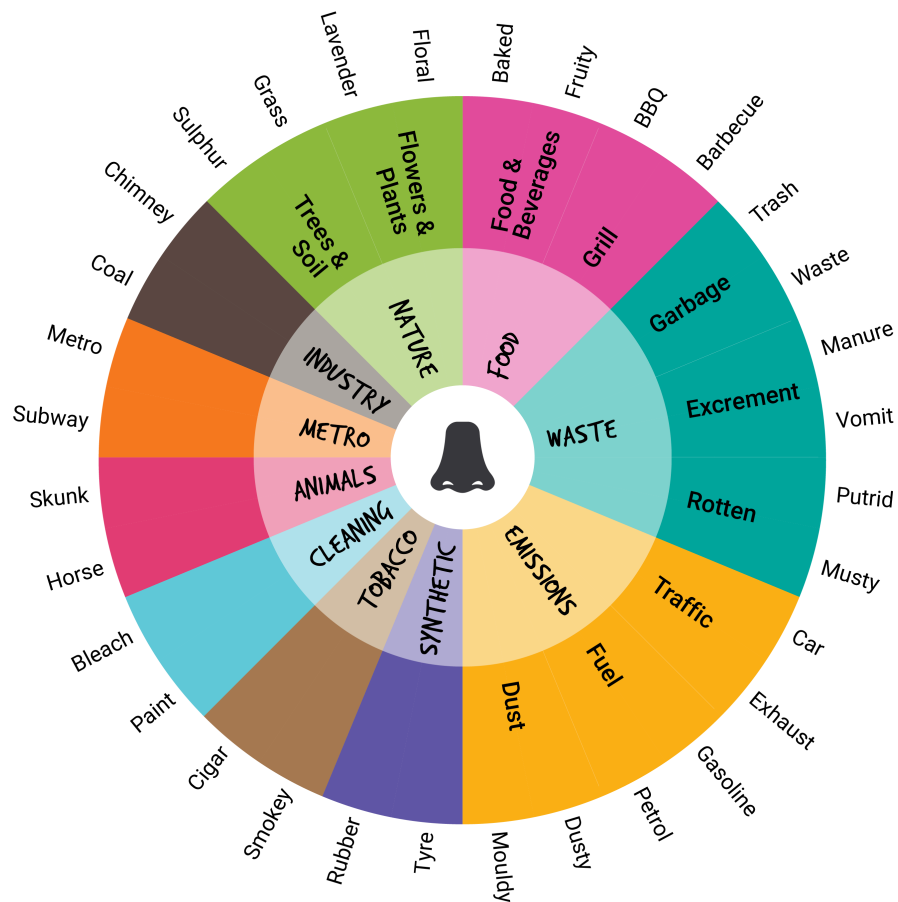


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Piesse's scale of scent taxonomies: scents are assigned different octaves
(Adapted from Piesse, 1857, 2011)

Nonetheless, the models for describing scents are still considered weak and less than ideal representations (Jasper A., & Wagner, N. 2018). In the search for suitable terminology for describing aromas, researchers Guercia, Schifanella, Aiello, and McLean, developed their Urban Smellscape Aroma Wheel to illustrate the ten key smell categories that their smell walk research participants described (2015, 2016). They organized the descriptive words generated by their participants into a hierarchy of urban smells as you can see below.

They found that the smell walkers used metaphors related to categories of the smells one finds in the environment. For example, flowers and plants as well as trees and soil fit under the category of “Nature”.



Urban Smellscape Aroma Wheel (adapted from Quercia et al, 2015, 2016)

Back to previous section: 6.2 Experiencing Smell

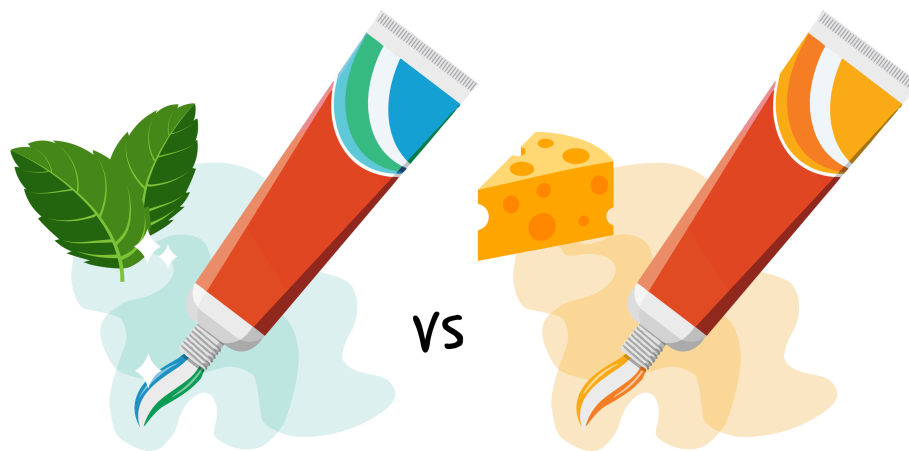
Next section: 6.4 Olfactory Design Principles



6.4 Olfactory Design Principles

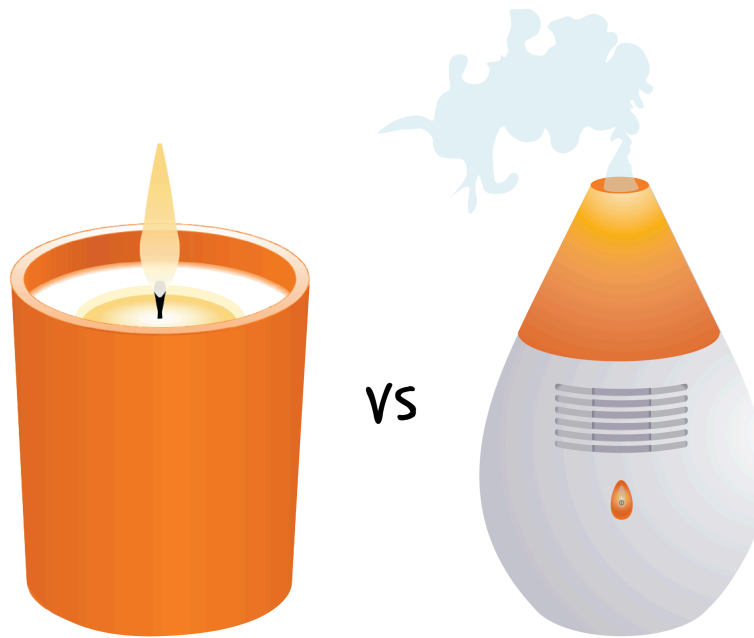
Instead of applying familiar scents, the car industry was one of the first to deliberately design and associate smells with their luxury brands. Rolls-Royce took the lead in 1965 and other car manufacturers followed in its footsteps (Thompson et al, 2017). From a brand perspective, design and marketing teams consider that scents can be unique product identifiers and try to closely match them to the product or space they are designed for. Thompson et al (2018), offer principles for designing appropriate smells:

Authenticity: Design accurate smells that fit the product or environment, like a chocolate smell in a chocolate retail space or a “clean” scent for hygienic spaces or products. Apple adds olfactory cues to its new products, which have been described as plastic, metal, silicon, printed cardboard, and other scents that seem authentic for electronic products.



Designing Authentic Smells

Intensity: This principle relates to how much a scent is diluted and how strong we perceive it to be, as noted earlier. Ambient scents can be diffused in air conditioning, electronic diffusers, or stand-alone scented products. The goal is to not be too intrusive or powerful and to provide a smell journey that includes “silences and crescendos (similar to the concept of the Piesse scale) in both time and space” (Thompson et al, p. 145).



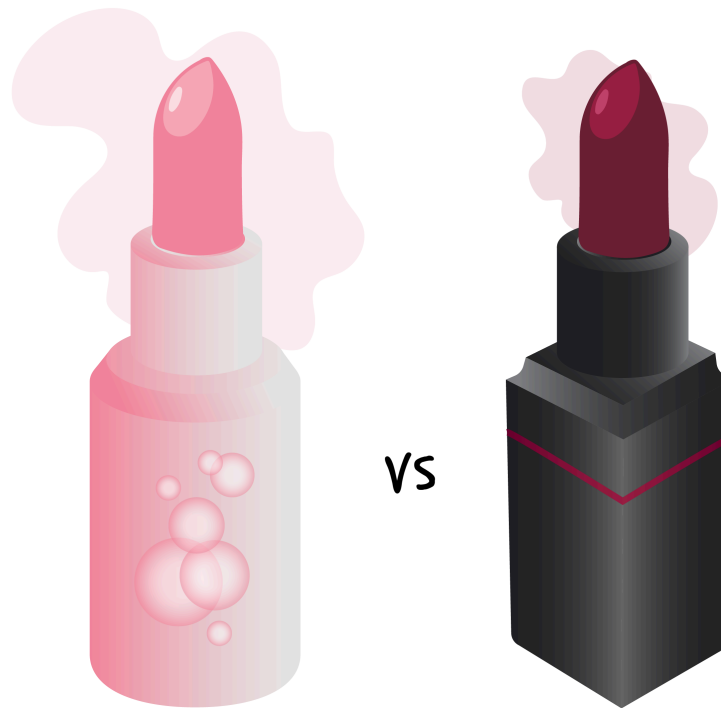
Designing Ambient Scents

Quality: While toiletries, cleaning and skincare products are the most scented consumer goods, their scents vary due to the formulas for constructing their odours and the quality of ingredients used. As consumers become used to the sophisticated nuances of their personal products, they develop sophisticated smell expectations that designers should be aware of.



Designing products with quality ingredients and materials

Suitability: Since smell perceptions vary based on age, demographics, culture and geographic region, it is important for designers to understand the target users in order to design scents that are suited to their past smell experiences.



Designing scents suitable for target users

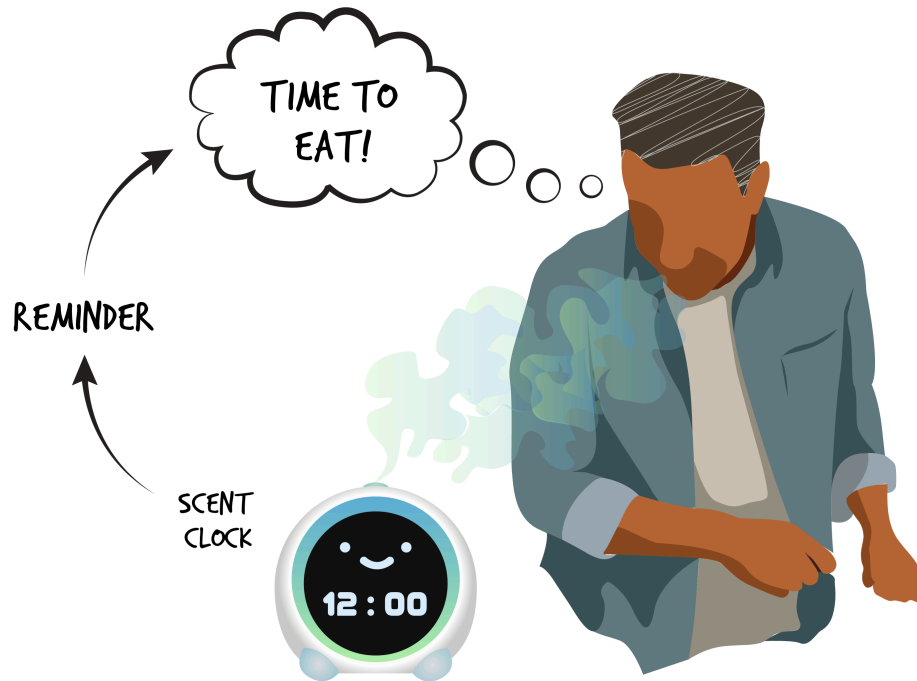
Design Applications

The benefits of selecting *suitable* odours as part of a product's multi-sensory features include the opportunity to contribute to positive associations in the culture for which the product is intended. For example, we already discussed the practices of wafting smells into retail environments – of baking bread, fresh lemons, and flowery fragrances – to entice us into that environment. In some places, walls can even be studded with smell-emitting pods or fragrances that are diffused to pleasantly manipulate our sensory perceptions.

Not all smell experiences, however, are marketing ploys. Interactions can instigate a smell alert. For example, if you burn rice on the stove or toast in the toaster, the result will be a burnt smell. If it's extreme your smoke alarm will sound off. It will also sound off if a fire breaks out while you are sleeping and smells are less likely to be processed (this is why smoke detectors are placed near bedrooms) (Lipps 2018). This smell alert may save your life or, at least, keep you safe!

A United Kingdom project that used design to encourage health and well-being in older adults with dementia led to the design of the ODE device, by Rodd Design. It acts like a clock and emits three different food-related fragrances, one for each meal of the day (breakfast, lunch, and dinner), selected from a menu of different odours, to stimulate patients' appetites by emitting smells they associate with meals (Springwise,

2022; Lipps, 2018; Shepherd, 2006). Jinsop Lee (2013) also describes designs for clocks that emit different smells when activated by the sun at specific times.



Product Scents may be used to remind or alert users to take action: a smell-emitting clock may encourage users to eat at mealtimes (adapted from ODE project, 2022)

Smells may also intentionally be embedded in products as preventative deterrents. For example, a bike lock designed by Skunklock releases a putrid gaseous smell when broken which becomes a crime deterrent, while alerting others to the broken lock (Lipps, 2018). Can you think of an innovative way to use smell in products? How about designing smell alarms into food storage containers to alert you when food stored in them is going bad? In these design concepts, the design team has leveraged the characteristics of smells to change people's behaviours and avoid a crisis.

Sensory perception involves multiple factors that compete for perceptual attention at once – smell is only one of them! It is wise to become sensitized to your *smell experiences* – the context of smells related to product use or the environmental odour ambiance – so that it is clear where, when and how many additional scents integrate or compete with one another and other sensory perceptions. As a designer, you may be thinking about why you would choose certain materials, as we discussed in Chapter 4. Imagine if you were to notice that the glossy material you selected for a new water bottle emitted an industrial smell – would you look for a material with a more neutral odour? This is the case with specifying materials in the design of many products for food, from spatulas to containers, to pots and pans. Not only can smell affect the perception of the food product, it can also directly affect the perceived taste experience. Since smell and taste are closely connected, we discuss taste next.

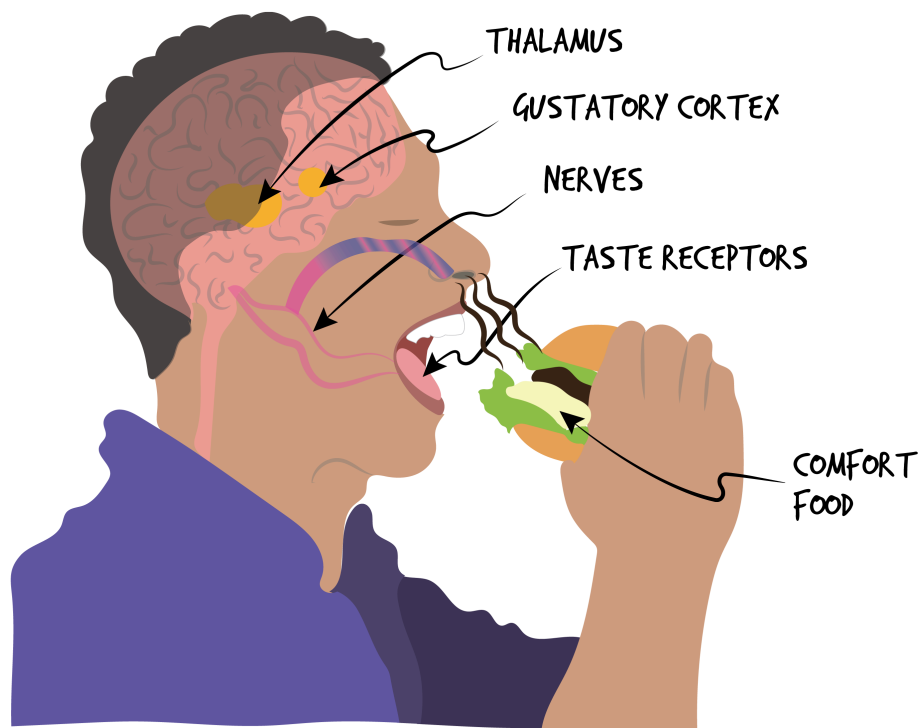
Back to previous section: 6.3 Categorizing Smells

Next section: 6.5 Experiencing Taste



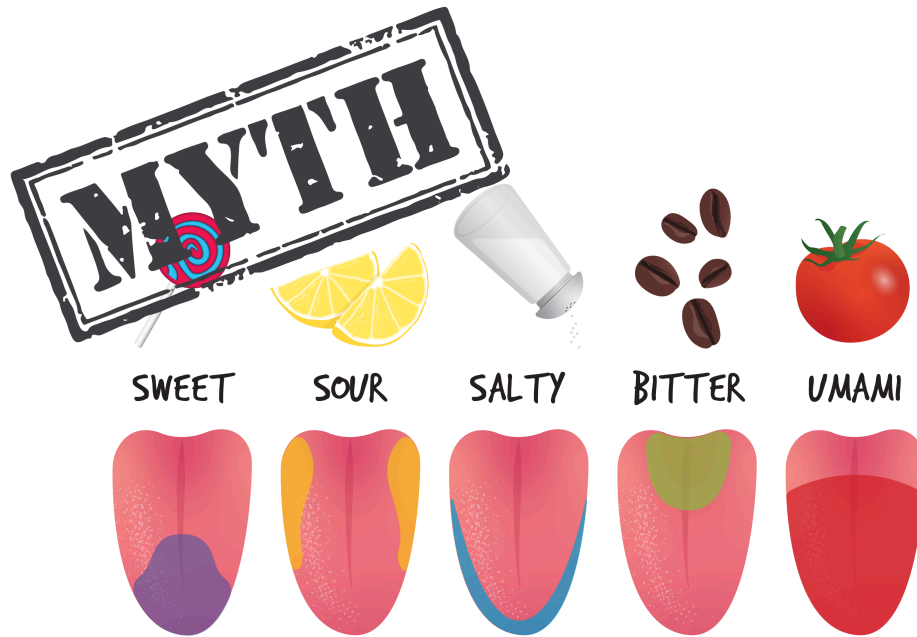
6.5 Experiencing Taste

The flavour of food, sometimes simply called the taste, includes the oral sensations of taste (sweet, salty, sour, bitter, and umami) and the nasal sensations of smell. As you learned earlier, the sensation of *orthonasal olfaction* results from smells entering the front of your nostrils, and the sensation of *retronasal olfaction* occurs when food vapours rise up the back of your throat as you chew and swallow your food (Cardello & Wise, 2008; Christodoulaki, 2020). These contribute to your experience of taste (Schifferstein et al, 2020), even though you may not be aware of the taste-smell interactions that affect your perception of taste (Burdach et al, 1984).



Retronasal Olfaction: food vapours rise up the back of your throat as you chew and swallow your food

You have thousands of taste buds in your mouth (along your tongue, the roof of your mouth, and the lining of your throat) that respond to the chemicals in food and drink. They distinguish the five taste qualities (sweet, salty, sour, bitter, and umami) that send separate signals to the brain, which identifies them as different tastes (Lupton 2018, National Institute on Deafness and other Communication Disorders, 2022, Schifferstein et al, 2020). Umami may be the least familiar taste sensation; it is a satisfying savoury flavour, most often associated with Japanese food and enhanced by monosodium glutamate (japan-taste.com).



The five tastes are experienced all over the tongue and were once believed to be at specific locations as shown above (adapted from Christodoulaki, 2020)

You perceive the five tastes as flavours through a combination of three kinds of sensations in the brain: 1. the five *taste qualities*; 2. the *chemical sensitivity* of your skin and mucous membranes in the oronasal cavities that recognize cool and burning properties of chemicals (these properties, such as mint or chilli peppers are perceived as pungency, irritation, or burning); and 3. your perceptions of the *tactile sensations* of heat, cold, and texture. You then acknowledge these taste signals as the flavours of what you are eating – pizza, apple pie, or a grape (atlas of science.org, 2023).

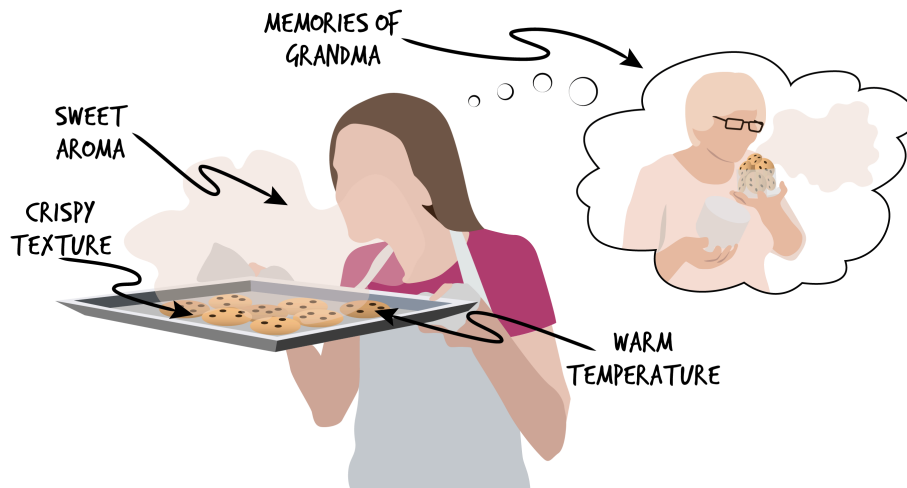
Your flavour perceptions can also be a fleeting sensory experience similar to your perception of smells. *Taste adaptation* is like olfactory fatigue in which the sense of taste grows weaker over time as its perceived intensity decreases (Cardello & Wise, 2008, Schifferstein et al, 2020). In other words, after about one minute, the sense of a unique taste disappears. For example, have you ever noticed that the first bite of a chocolate bar seems to have the most chocolatey flavour and subsequent bites are less flavourful? Try it. Another thing you can try to pay attention to is how the taste of one thing can influence what the next thing tastes like. What about when you eat something just after brushing your teeth? You may think that the taste of the toothpaste changed the taste of your apple, but research has found that the effects of the toothpaste actually changed your apple's perceived smell, leading you to sense that it tasted different (Cardello & Wise, 2008).

Taste is Multisensory

According to Lupton (2018, p. 66), flavour engages all the senses, "Texture (touch), aroma (smell) temperature (touch), and appearance (sight) as well as language and memory, [which] all contribute to the complex experience of flavour". She considers flavour as primal because the brainstem is involved in triggering our responses to tastes, which can be either attraction or repulsion. These primal reactions may

respond to sensory properties that protect you from poison or toxins, such as aversion to the smell of spoiling meat, the look of mouldy berries, or the feel of slimy vegetables (di Cicco et al, 2021).

Flavour compositions may also trigger emotional responses since they include tastes, smells, textures, and sounds connected to food that you may have experienced before. They are often associated with pleasant memories of preparing meals and dining with family and friends that are tied to social or cultural rituals. Here we recall Jordan's (1999) four pleasures: physio-pleasure, psycho-pleasure, ideo-pleasure, and socio-pleasure; each of these pleasures can be part of our eating experiences. For example, the smell of baking cookies may bring up happy, delicious, and emotional childhood memories as in the image below.



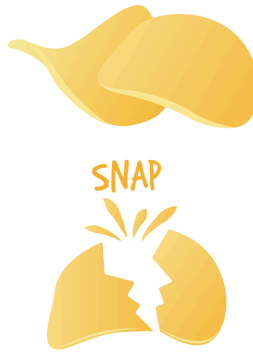
Flavour is a Multisensory experience

The tastes of food also depend on the contexts in which you experience them – a romantic restaurant, a busy snack bar, or a cold outdoor kiosk on the ice during Ottawa's Winterlude festivities. Visual cues like colour and composition, along with auditory cues like crunching, fizzing, and cracking also influence your perception of flavours. Researchers have experimented with manipulating the sounds of foods to influence consumers' ideas about freshness. For example, study participants perceived a louder crunch to imply fresher potato chips (Auvray and Spence, 2008; Lupton 2018). Listen to the sounds of your own chewing; depending on what you eat they could be crackly, crispy, sloshy, or slurpy (Schifferstein et al, 2020).

Flavour compositions are also extremely tactile because the texture of food materials changes while we are chewing; so, the tactile receptors in our mouths respond to and identify the unique physical qualities (texture and temperature) of different types of food. Pay attention to how food feels in your mouth; depending on what you are eating it could feel rough, smooth, sticky, hard, or elastic (Schifferstein et al, 2020). This diverse group of responses is referred to as *mouthfeel* or the mouth-sense of food (Lupton 2018). You experience mouthfeel when you bite, masticate, and swallow food.



MELTING
ON THE TONGUE



CRISPY &
CRUNCHY



FIZZY &
BUBBLING

Mouthfeel changes depending on the texture and temperature of different kinds of foods

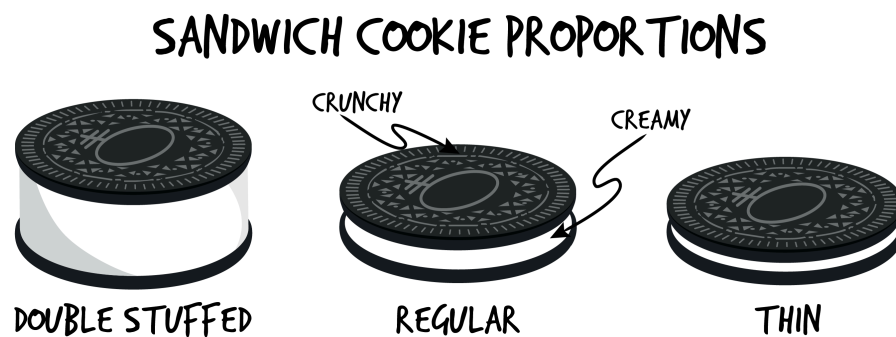
Back to previous section: 6.4 Olfactory Design Principles

Next section: 6.6 Design and Taste



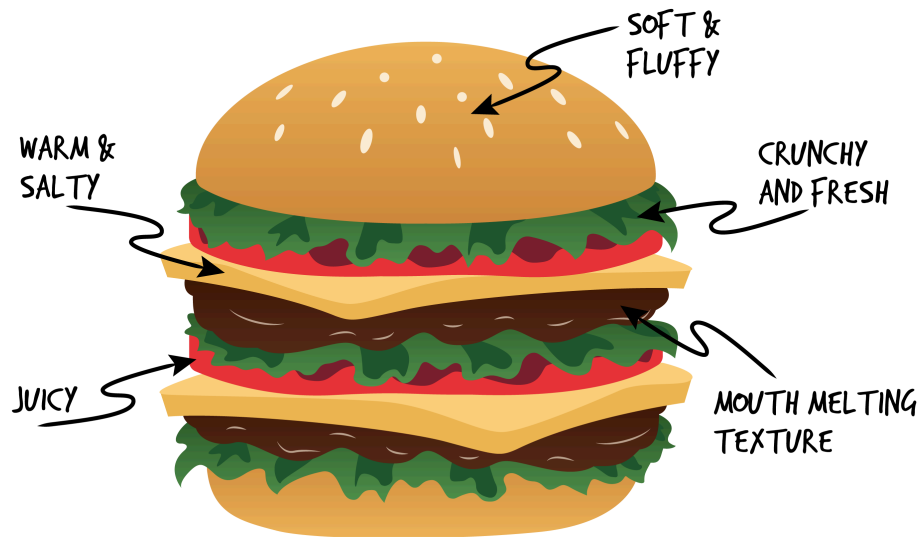
6.6 Design and Taste

The food industry leverages the concept of providing *sensory contrast* in a product as another way to maximize multisensory product impact, as the experience of eating Oreo cookies demonstrates. Kessler (2009) dissects the appealing components of the ubiquitous Oreo cookie texture and **mouthfeel**, and the unique combination of bitter and sweet. He says that these cookies are designed to stimulate our cravings for more. First, we experience the crumbly texture and bitter taste of the chocolate wafer. Next, the smooth texture and sweet taste of the interior icing melts in our mouth and leaves us longing for another sensory stimulus. Even the proportions of one element to another are intentional.



Every detail of your oreo cookie has been designed to enhance its appeal

Contrasts of mouthfeel and flavour combinations are called *dynamic novelty* in the food industry. "High levels of fat generate easy mouth-melt, and surface variations add a level of interest... Heightened complexity is the key to modern *food design*" (Kessler, D., 2009).



Your commercial hamburger ingredients are designed to provide stimulating dynamic novelty

For Kessler, the hedonic (pleasure-oriented) experience of modern food design should include the following factors:

- an emotional aspect that stimulates anticipation of the taste experience.
- a visually appealing appearance.
- a pleasing aroma.
- an interesting taste and flavour composition.
- a range of oral textures and mouthfeel.

As you may see food design is related to product design and can draw upon many industrial design skill sets such as determining form and colour properties, selecting materials, providing auditory feedback, and designing tactile features. Schifferstein (2021) is interested in how designers can enhance the aesthetic experience of consuming food by systematically engaging multimodal sensations. His description of a food experience journey compliments Kessler's above. The stages of interaction with food products starts with conjuring up thoughts or memories about a food's taste, engaging with it at a distance by seeing or smelling it, having closer interactions by touching it, and eventually eating the food. He believes that designers can support the quality of these experiences at each stage along the way.

Food and Design

In view of the stages of a food experience, we get an idea of the part design can play in this multisensory experience. From Schifferstein's perspective (2021, p. 115), "the physical food may function as the centrepiece, [and] ... several supporting elements may be recruited in shaping the intended consumer experience, involving considerations of how the food is prepared and presented (e.g., cooking utensils, packaging, spatial arrangement, tableware) and the context in which it is consumed (e.g., on the street, at a particular occasion, in a restaurant)".

Designers are already involved in the design of utensils, tools, containers, and cooking ware in which food is kept or processed. Even if these things do not have any intentional flavours, their materials, shapes, and temperature resistance may affect the taste of the foods they interact with. In addition, some utensils, containers and tableware may be designed to influence people's behaviours. For example, Canadian designer, Diane LeClair Bisson (2020) explored how tableware design could influence behaviour change for children in hospitals who experience a loss of appetite due to their illness. She found that by designing a set of playful mix-and-match bowls, the children's senses of taste were affected positively and they were more likely to eat.

As another example, lunch boxes can be designed to support Canada's Food Guide as a way to teach children the proper proportions of foods in a healthy diet. Lunch box size and materials also influence the ability to separate flavours and contain foods with different consistencies. This illustrates the value of design in influencing good eating behaviours, such as eating more healthy foods, reducing food waste, and supporting good food hygiene practices (Bordewijk & Schifferstein, 2020).



Lunchboxes can be designed as tools for learning about healthy eating

Food packaging designers have also been involved with the food industry for quite some time. Their task is to apply the visual design principles discussed in earlier chapters to communicate the sensory properties of the food inside. They do this through graphic design applications of form, colour, imagery, typography, and materials to attract or possibly even repel consumers (Maffei and Schifferstein, 2017, p. 143).



visual design principles are applied in food packaging design to communicate a message to consumers

Another area where design can contribute to an apparent change in perceived taste is in scented food packaging which is used to enhance the perceived flavour of the food. This is the process of *referred olfaction*, which means that the addition of a pleasant smell in the package can stimulate our olfactory sense in a way that increases our taste experiences. Referred olfaction played an unusual part in Jessie Thavonekham's (2015) Master's thesis in the School of Industrial Design at Carleton University. She invited participants to eat plain unflavoured yoghurt with fruit, from two different types of containers. One was a paper cup and the other was a gelatinous agar cup. In both cases, volunteers perceived a vanilla scent, although none was present. She concluded that the participants had assumed the yoghurt was vanilla-flavoured and due to *referred olfaction* transferred their expectations into perceptions of sweetness.

We know that many products that industrial designers develop are not meant to be eaten, such as vacuum cleaners, hairdryers, X-Ray Machines, car interiors, and portable drills. However, as we have already noted, designers have a wide range of skills that can be leveraged to enhance multimodal taste experiences. Thinking broadly, there are a number of products that people put into their mouths where taste can be affected by the choice of materials, textures, smells, and sounds. These include baby soothers and baby bottles, coffee cups, dental floss, flutes, snorkels, toothbrushes, and water bottles. Have you ever noticed if your water bottle always tastes the same? If not, how does your taste experience change over time and

what features contribute to that change – temperature, texture, smell, or appearance? What part does the water play, or what you put into the water, or what you ate before drinking?

You may not have realized how much attention to your sensory perception goes into the design of your food experiences. For designers interested in food, there are many opportunities for different types of design activities: “design about food, design with food, design for food, food space design, food product design and eating design” (Zampollo, 2015, p. 111). Many of these food design areas are inherently multisensory; layers of sensory stimulation determine the flavour of a good user experience.

Back to previous section: 6.5 Experiencing Taste

Next section: 6.7 Summary Review Activity

6.7 Summary Review Activity

Activity Time!

Select the answer or answers that best demonstrate some of the insights that you have gained in relation to this chapter's learning objectives.

1. Insights into the biophysics of smell (olfaction) and taste (gustation).



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2. Knowledge about the experiences of smelling and tasting, and how they interact with one another to create evocative memories.



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3. Awareness of the taxonomy for describing smells and tastes, and the limitations related to describing and producing smells and tastes in product design.



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4. How we are affected by smellscape and scentscape.



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5. Principles of olfactory and gustatory design.



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6. How the context within which we have smell and taste interactions influences our perceptions and experiences.



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Back to previous section: 6.6 Design and Taste

Next section: 6.8 Conclusion & Key Takeaways



6.8 Conclusion

This chapter introduces smell and taste as senses that play a part in design for user experiences. Today smell and taste are not commonly considered sensory elements of design, but they are clearly a part of our interactions and perceptions of products and places. They contribute to the multisensory aesthetics that trigger our deepest emotional responses to products. The concepts presented in this chapter provide insights into how we experience smell and taste and how this knowledge can be applied in design. Sometimes our experiences may become richer, through intentional smells that connect us with our memories. Other times they may become better, through product designs that encourage behaviour changes around smell and taste. The principles and insights presented in this chapter contribute to understanding the role of design for smell and taste.

Key Takeaways

The key takeaways from this chapter include:

- Understanding how the body interprets smell and taste signals into messages of pleasure or danger.
- Knowledge about the multimodal aspects of smell and taste that combine to enhance our overall experiences and memories.
- Awareness of the power of smell receptors to evoke emotional, cultural, and personal associations.
- Information about categorizing smell for describing the characteristics of smells.
- Understanding of the historical usefulness of scent models such as fragrance wheels for describing smells.
- Awareness of the value of smell and taste as a marketing tool for attracting consumers.
- Exposure to the principles of olfactory design and scent application.
- Insights into the concept of layering of smell and taste characteristics to be perceived at different times and for different lengths of time.
- Introduction to activities for perceiving and describing smells and scents.
- Knowledge about applications for product design that leverage taste and can be associated with food.



Chapter 6: Design for Smell and Taste Experiences

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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The next chapter acknowledges that we rarely experience products through one sensory channel. It builds on the multisensory theme addressed in this chapter and introduces principles of multisensory design and kinetics that tie all the senses together. It provides insight into practical approaches for integrating multisensory layers into design.

Key Words: Smell, Taste, Emotional qualities of smell and taste, Characteristics of smells and tastes, Taxonomy of smells, Qualities of smells and tastes, Olfactory design principles, Smellscapes, Food design

Back to previous section: 6.7 Summary Review Activity

Next section: Chapter 6 References



Interactives Answer Key

Section 6.3: Categorizing Smells

Drag and Drop, *Smell Spectrums*

Synthetic to Natural:

1. Tire
2. Boot
3. Oil diffuser
4. Espresso pot

Bold to Faint:

1. Espresso pot
2. Oil diffuser
3. Tire
4. Boot

Aromatic to Stinky:

1. Oil diffuser
2. Espresso pot
3. Tire
4. Boot

Brief to Enduring:

1. Espresso pot
2. Oil diffuser
3. Boot
4. Tire

Section 6.7: Summary Review Activity

Multiple Choice

Question 1.1

Humans have more smell receptors than other types of sensory receptors combined.

True

Question 1.2

The five tastes are experienced at specific locations on the tongue.

False

Question 2

What percentage of the smells that we encounter do we remember according to research?

35%

Question 3.1

Odour Character is objective and selected from a standard measurement scale, while Hedonic Tone is subjective and connected to our emotions.

True.

Question 3.2

The addition of a pleasant smell in food packaging that enhances our taste experiences, is known as:

Referred olfaction

Question 4.1

What is the correct order of scent types from shortest-lasting to longest-lasting?

(1) Light & citrusy aromatic herbs, (2) Fruit & floral spices & oils, (3) Rich & heavy woods & balsam

Question 4.2

Which of the following is an example of olfactory fatigue?

I can't get enough of that beautiful citrus scent.

Question 5

What olfactory design principle matches the following definition?

Since smell perceptions vary based on age, demographics, culture and geographic region, it is important for designers to understand the target users in order to design scents that are suited to their past smell experiences.

Suitability

Question 6

What is the purpose of designing a scentscape? Select all that apply.

Branding and marking

Preventative deterrents

Alerts and signals

Environmental odour ambiance

Back to previous section: 6.8 Conclusion & Key Takeaways

Next section: Chapter 6 References

CHAPTER 6 REFERENCES:

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Back to previous section: 6.6 Conclusion & Key Takeaways

Next chapter: Chapter 7: Design for Multisensory and Kinetic Experiences

CHAPTER 7: DESIGN FOR MULTISENSORY AND KINETIC EXPERIENCES



Next section: 7.1 Introduction



7.1 Introduction

Earlier chapters explore the application of sensory features to facilitate positive design outcomes. They provide you with foundational knowledge about the significance of designing for each of the senses and set the stage for the more complex multimodal (multiple sensory modes) interactions presented in this chapter. This chapter examines the sensory modalities we experience when using a product and how they can be integrated into a greater whole that contributes to our individual interactions with it. It also explores how our holistic and multimodal experience depends upon the synergy of our many senses interacting with products, environments, and services at the same time.



Multimodal/Multisensory synergies across senses

We perceive our surroundings and interactions as a combination of sensory interactions, not as separate sensory layers or modalities (Ludden, Schifferstein & Hekkert 2007; Fulkerson, 2013; Park & Alderman, 2018). For example, in previous chapters, we learned the importance of our sensory modality of vision for most activities, especially for orienting and scanning our surroundings. When our visual perception is combined with tactile coordination, we experience the familiar multisensory experience of hand-eye coordination, e.g. taking notes during a lecture, playing a musical instrument, hammering a nail, or sending a message on any electronic device. We perceive this as a fully integrated sensory experience rather than separate sensory visual and tactile layered experiences. In addition to visual and tactile sensory experiences, we may simultaneously depend on auditory and proprioceptive feedback (discussed later in this chapter) for locating our body position and navigating through environments (Park & Alderman, 2018). These multisensory abilities depend on integrating complex layers of sensory modalities that systematically support and enhance user experiences. In this chapter, we discuss approaches designers take to accommodate these complex layers and add new terms that describe them.

The designer's job is to determine the appropriate multisensory design features that best support a wide range of interaction contexts. Since each of us processes sensory feedback differently, we need to learn more about accommodating a range of perceptual variations through design. In many cases, it may not be possible to dissect some multisensory interactions into their individual sensory modalities. In these cases, our senses are so intertwined that we perceive them as truly blended multisensory interactions that we call crossmodal. For example, vision and touch often provide overlapping crossmodal information; people can see and feel the shape, size, or surface roughness of an object (Schifferstein & Spence, 2009).

In collaboration with other experts, designers determine the problem space and the design brief that defines the design variables. The combinations of multimodal, aesthetic, and manufacturing variables can be infinite, and how they work together determines the experiential value of the design solution. Given this daunting task, having an understanding of multimodal considerations could contribute to innovation, flexibility, and acceptance, and avoid a fixation on the visual modality — still dominant in design today (Schifferstein & Spence, 2006). In this chapter you will learn:

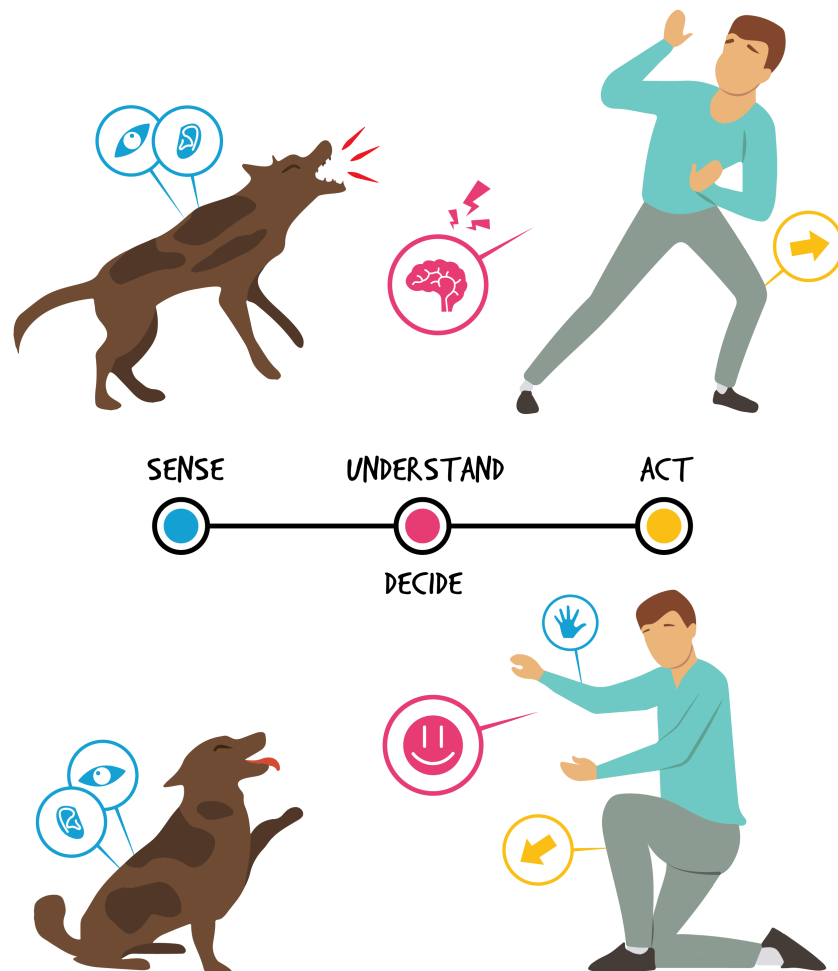
- How we process multisensory experiences from a perspective that is relevant to design.
- How multisensory layers can provide opportunities for design features that add value to product interactions.
- How sensory dominance affects the interactions people have with products at different phases of use.
- Why it is important to design features that contribute to a feeling of delight in product interactions.
- How multisensory design principles can support a variety of use scenarios that lead to positive outcomes.
- Unique applications for multisensory experiences that enable us to achieve tasks, given different sensory abilities and perceptions.
- How interpreting a synaesthetic approach can lead to richer design interactions.
- Awareness of the multisensory aesthetic properties of kinetic and collapsible design that add depth to our product experiences.

Next section: 7.2 Multisensory Awareness & Design



7.2 Multisensory Awareness and Design

We go through our days, moment by moment responding to different stimuli that keep our brains and nervous systems up-to-date. With every incoming sensory event, we automatically process the stimuli by interpreting, understanding, and deciding how or if we should respond in a particular way (Park & Alderman, 2018). This step-by-step processing of incoming sensory stimuli is part of everyday life. Would you react differently to a barking dog charging at you than to a gentle dog snuggling against your leg? You may either jump out of the way of the barking dog or enjoy petting the gentle dog. In either case, the dog's behaviour provides **multisensory stimulation**, as do most events in our surroundings, and each situation prompts a different response that requires us to assess it before taking action.



Responding to sensory stimulation

According to Park & Alderman (2018), the way we perceive all sensory stimulation can be organized into three categories:

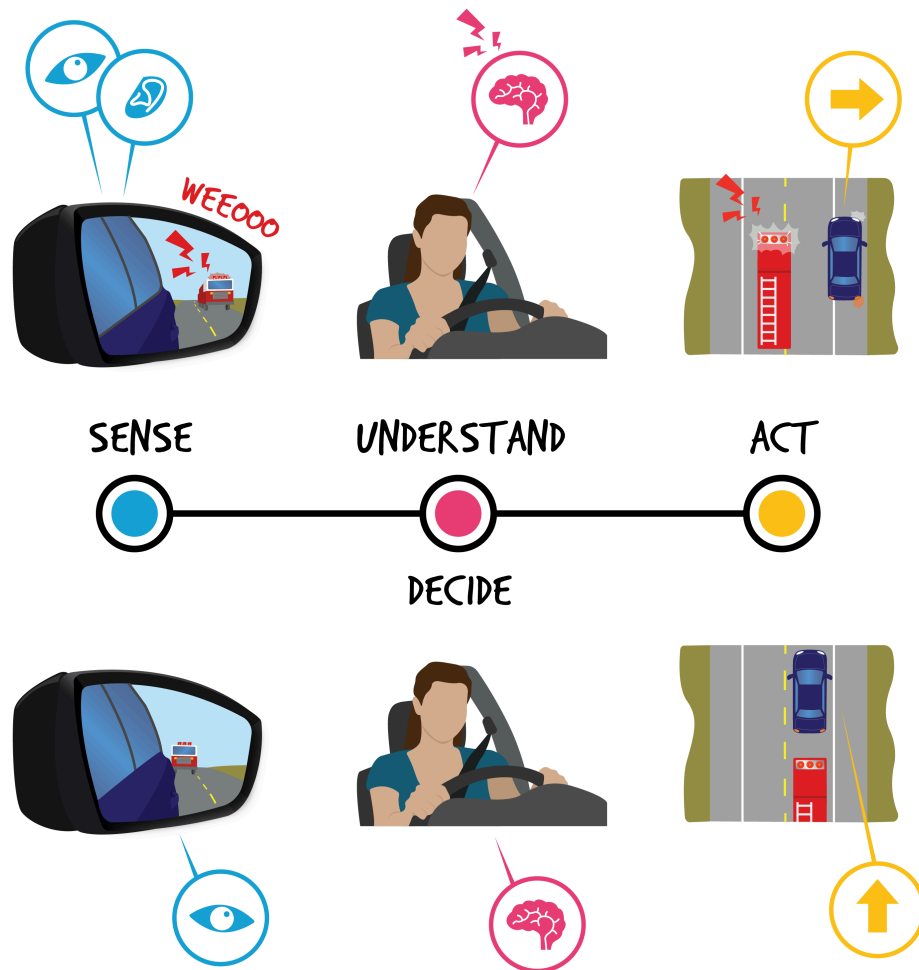
1. **Electromagnetic** stimulation that requires physiological reactions, such as pulling our hands out of the way when we see and feel heated electrical elements (relating to vision and touch).
2. **Mechanical** stimulation that involves tensile, compressive, or shearing interactions between physical things that require us to react, such as when we exert pressure to remain upright while windsurfing (relating to sound and touch).
3. **Chemical** stimulation that involves interactions among chemicals, such as when we use toothpaste to clean our teeth (relating to smell and taste).



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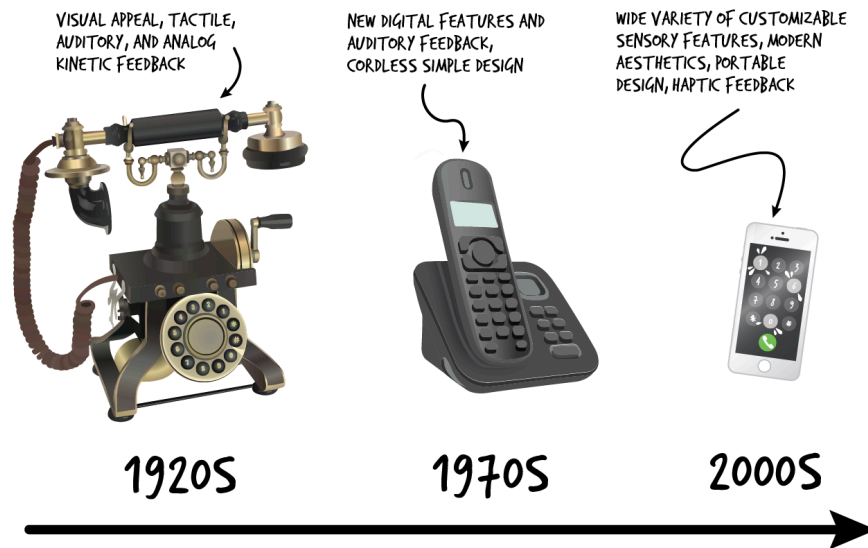
Categories of sensory stimulation

With this awareness, designers can integrate layers of multisensory design features into products, services, or environments that support our abilities to process and react to different kinds of stimuli (Schifferstein & Spence, 2009, Park & Alderman, 2018). For example, think about what happens when you are driving and hear a siren. While driving, you receive concurrent multisensory stimuli providing important information about your surroundings. Perhaps you look at the side and rear-view mirrors and see a fire engine approaching with lights flashing. Usually, this triggers your responsive processes into action. You may quickly pull over or stop to let the fire engine pass. The flashing lights on the firetruck and in the mirrors, the noisy siren, the positioning of the car windows, the rotating steering wheel, the moveable turn signals, the gas pedal, and the brake all support your ability to act appropriately and notify other drivers of your immediate intentions. These sensory electromagnetic (sirens, flashing lights) and mechanical (steering wheel and gas pedal resistance) stimuli are holistically designed to provide you with the opportunity to react appropriately to the context of the situation, as seen below.



Cognitive and MultiSensory Responses to Layers of Stimuli while driving

We are learning how to modify design properties to influence the perceived sensory messages that stimulate memories, sensory and motor skills, reflexes, and attention (Schifferstein & Hekkert, 2009, Schifferstein & Spence, 2009; Park & Alderman, 2018). As a result, our devices are changing quickly, with new or more suitable features to improve our quality of life. For example, phone designs continue to evolve by incorporating multisensory modifications into how the devices look, feel, sound, and function. Each upgraded version affects how you listen, hold, and carry the device, physically engage with its interactive features, and even where you can most comfortably use it (in the sun or shade, in noisy or quiet surroundings). All the sensory information we receive when interacting with our products affects our perception, cognition, experience, and behaviour. For example, today many persons with disabilities are experiencing newfound independence through a variety of multisensory and accessible features that were only a dream a decade ago!



Evolution of the phone

Did you know that phones also have a significant cultural impact on us? That they have changed how we live? As you know, our phones are no longer solely communication devices. They organize details about friends, family, and events that effectively replace our need to remember information – by capturing and storing text, images, music, and videos. Each of us can customize our phones to our personal sensory preferences, like ring tones or vibrations when a call or message arrives. Most of us, to various degrees, depend on these features. Indeed, we are even attached to our phones in multisensory ways that often define our personalities, by leveraging design and emotion concepts like ideo- and socio-pleasure, as discussed in Chapter 1.



PHONE = CAMERA

Changing cultural impacts: Capturing our experiences with our phones

Park & Alderman (2018) believe that people, places, and things become a part of our unique everyday worldview because of our sensory experiences with them – for many of us, seeing, touching, and interacting with something makes it real. In other words, physical evidence builds trust in products, brands, and relationships. That is why rich, multisensory experiences provide more opportunities for engagement.

From lipstick to bicycles, designers incorporate layers of sensory features that go well beyond how a product looks and feels. Consider how the auditory click of a deodorant stick opening and closing provides assuring feedback that the deodorant will remain inside a cleverly designed and easy-to-use container – rich in colour, form, and function. In the design of bicycles, design teams optimize materials and mechanical actions to maximize the gentle swishing sounds of smooth bicycle movements in the kinetic performance of the brakes, wheels, and gears, the tactile comfort of the seat, and the colourful surface finishes and to minimize the tactile vibrations through the handlebars (steel vibrates less than aluminum). All of these features contribute to a product's multisensory aesthetics.



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Layers of multisensory features across products

Back to previous section: 7.1 Introduction

Next section: 7.3 Multisensory Design Experiences



7.3 Multisensory Design Experiences

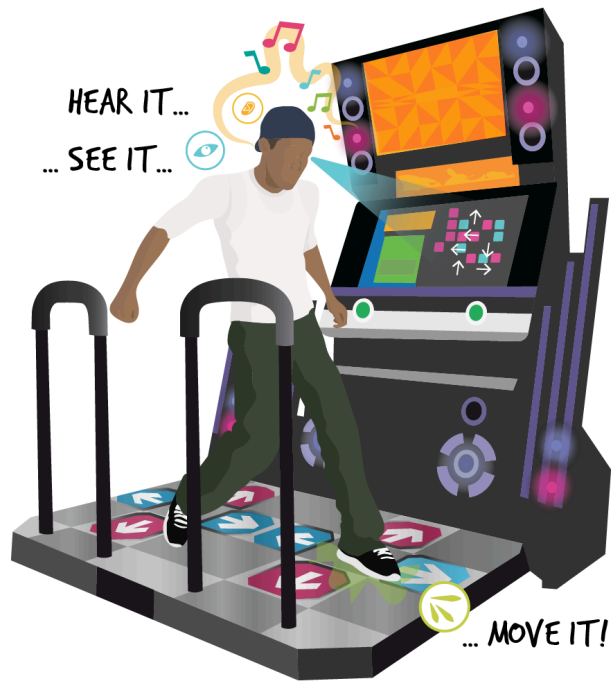
Interactive products that incorporate smart technologies depend on the integrated expertise of a range of design disciplines. The synergy of the design team provides important skills for developing enhanced sensory product interactions that make familiar products more complex. For example, interdisciplinary design teams develop watches that no longer only have the primary function of telling time; they can measure your heart rate (tactile), send messages to your friends (visual), alert you about key events (auditory), and even wind themselves with animated and rhythmic (kinetic) hand gestures (Park & Alderman, 2018). Watches may soon emit smells to trigger important memories or rituals. These days, do you have a watch or another device for telling time? Take a few minutes to reflect on your device's additional features, especially its multimodal and accessible features.



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enhanced multisensory and multi-layered product interactions

While video games provide even more complex multisensory experiences, the essence of multisensory layering in design is the same – to integrate patterns of sensory modalities or layers that stimulate multiple senses in a specific order over time or in synchronous clusters. In the example below, we see a participant player perceiving and interpreting the game's electromagnetic (light and sound) and mechanical (motion mapping and handrails) stimuli. In response, our player takes action by stepping on or across squares in reaction to the beat and to their own physical capabilities. This leads to an engaging pattern of further sensory stimulation and responses. A key concept that helps us understand how to design the order of sensory interactions is called *sensory dominance*, which we explain in the following section.



Player engaging with complex, active, and fun multisensory stimuli

Back to previous section: 7.2 Multisensory Awareness & Design

Next section: 7.4 Sensory Dominance



7.4 Sensory Dominance

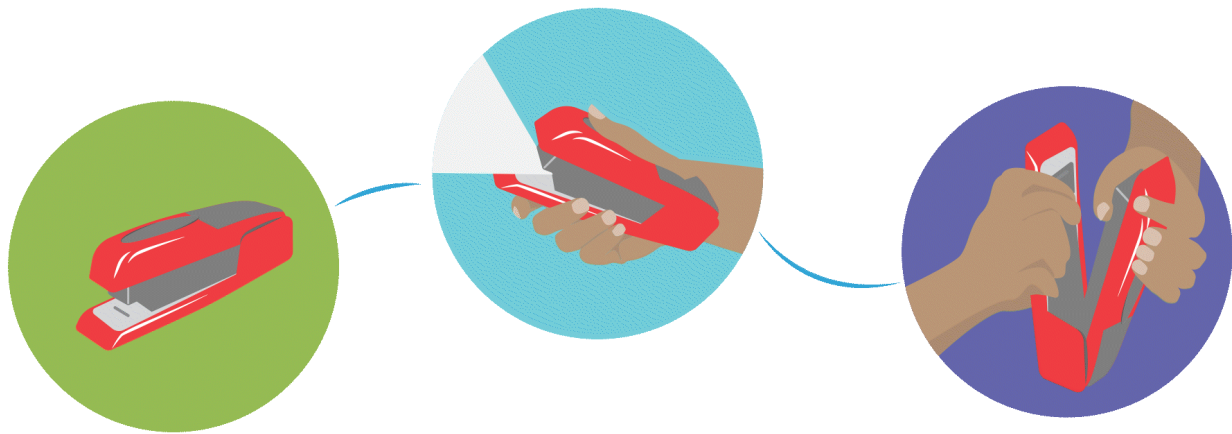
Industrial design decisions can influence the way we experience products by organizing the multiple sensory stimuli that may improve user-product interaction (MacDonald 2001; Rashid 2003). The senses can be divided into two distinct groups based on the physical distance we need to interact with an object: the distance (**distal**) senses of audition, vision, and olfaction and the proximity (**proximal**) senses of taste and touch (Ludden et al, 2007, 2008). Most of us see, hear, or smell an artefact before we touch or taste it – a sensory order that is dictated by the stages of our interaction with it. If they were near you, you would see and smell the muffins (below) before you could pick one up. This smelly enticement is used for marketing food worldwide; it appeals to your distal olfactory senses. Have you ever found yourself craving chocolate chip cookies or french fries in the vicinity of a food court? If so, you experienced an intentional multisensory ambush!



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Distal and proximal sensory order

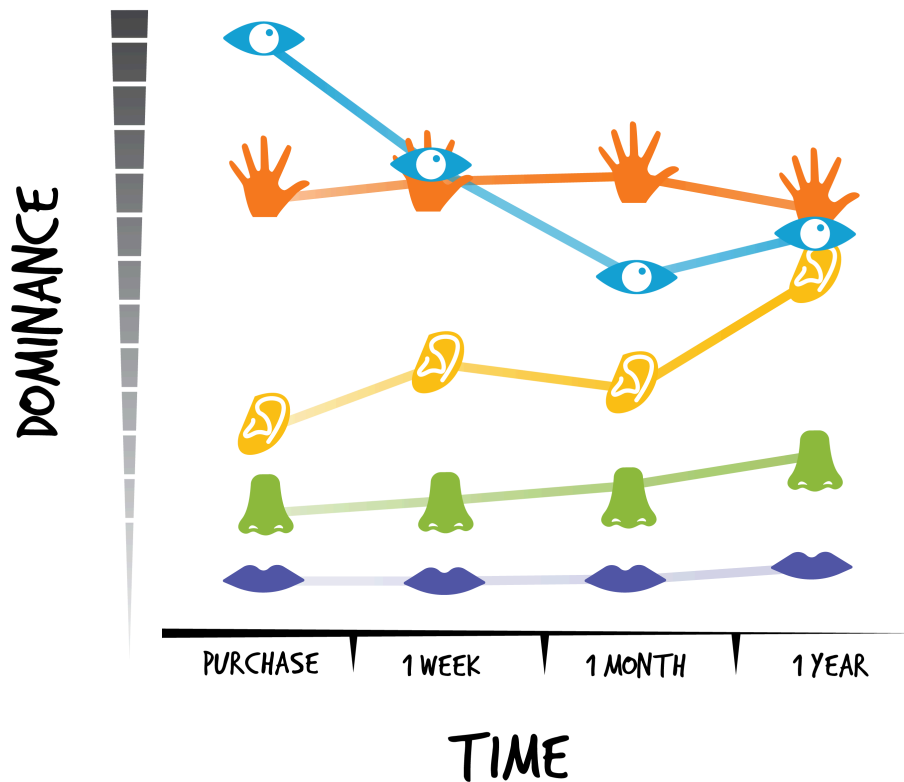
Most designers prefer to use multisensory or multimodal features to support users, not to ambush them! A key approach to multisensory product development is to identify which sensory modality dominates our experience at each stage of user-product interaction (Fenko, Schifferstein, & Hekkert, 2008). This is called **Sensory Dominance**. By establishing a *sensory hierarchy* (or step-by-step order) of use in the design of each product, service, or environment, designers can address the sense or combination of senses that are at play during each stage of use. The best way to collect this information is to observe others interacting with the things they use until their patterns of use become apparent. This information can provide insights for designers that contribute to improving products to best suit a wide range of multisensory interaction modes. In the example below, we first see the red stapler – using our eyes – then we use it, again using our eyes to align our hands to pick up and press, and our ears to hear the click of completion. We also perform maintenance, using our eyes and hands to open the stapler channel, grasp staples, and insert them before closing the arm, and our ears to listen for the final click. When you interact with a stapler with this kind of design composition, a similar pattern of multisensory interaction will take place every time you use it.



Sensory dominance at different stages of product use

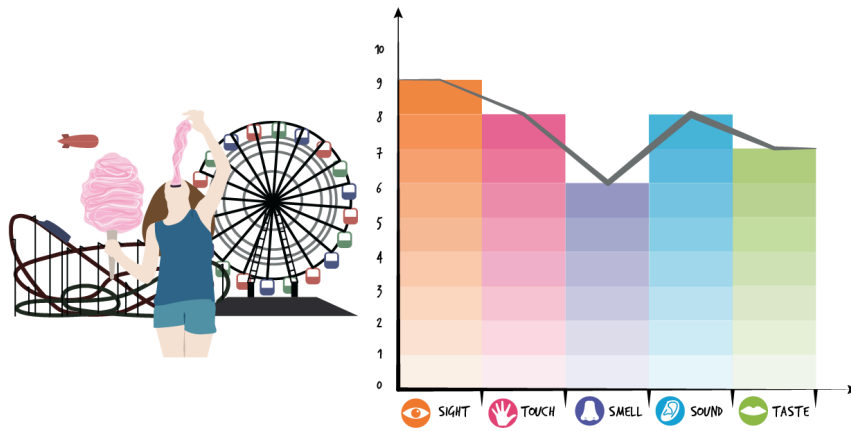
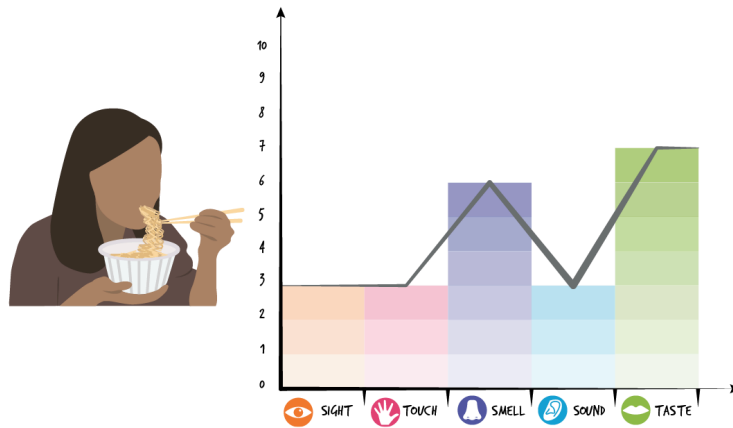
Fenko, Schifferstein, & Hekkert (2008) conducted a study with students using a range of products from electronics such as alarm clocks, mobile phones, and cameras to personal tools such as shavers, guitars, snowboards, and coffeemakers. They were studying whether individual stages of product use for all kinds of products depend on a similar order of sensory interactions or not. Most of the participants concluded that vision provides the most product information in the shortest time frame, and it is heightened at certain points during interactions with products. For example, at the point of purchase, visual experience is *dominant*, followed by touch, auditory, smell, and taste occurring in *sequential order*. We call this visually dominant.

However, after the first week of having a product, vision and touch provide equal stimulation, followed by the senses of hearing, smell, and taste. After the first month, the difference between touch and vision was significant – with touch in the lead – and the senses of hearing, smell, and taste were less influential. After the first year of use, vision, touch, and hearing were similar, smell was in second place, and taste was in last place (Fenko, Schifferstein, & Hekkert, 2008). Their findings suggest that the less significant sensory modalities may play a more influential role in the later stages of product interaction and affect the emotional experience associated with products (Schifferstein & Desmet, 2007).



An example of documenting changes in sensory dominance in the use of a single product over time

Of course, the role of each sense depends on the product, the frequency of use, and the importance attached to the activity performed (Schifferstein, 2006). Typically, as noted above, most of us initially react to the visual components of a product and other sensory modalities become more dominant with use. Over time we may no longer need to see (vision) the button on the alarm clock to turn it off in the early morning; simply hitting it (tactile) after hearing it (auditory) works just fine. In his TED talk, Jinsop Lee (2013) presents his 5-sense design theory in which he uses a 5-senses graph for measuring specific sensory experiences on a scale from 0 to 10, where 10 is the most intense experience. His idea is that if you run the senses across the bottom of the graph and an intensity scale up the vertical axis, a perfect experience would lead to a horizontal line running across the top! This is a great place to start to investigate how you experience your five senses while doing an activity you love; he chose to document his motorcycle ride, and we chose to document eating Pho and candy floss, as you can see below.



sensory dominance scales for different life experiences

Can you think of any objects in your daily life – your alarm clock, your phone, or the cutlery you eat with – that you barely look at before using them? If so, pay attention the next time you use them to reflect on which senses you engage with at each stage of use (you may need to take pictures along the way to determine what belongs in your own sensory map of use!).

Activity Time!

Match the product to the graph according to their sensory dominance over time.





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Changes in sensory dominance over time differ across products

Back to previous section: 7.3 Multisensory Design Experiences

Next section: 7.5 Multisensory Delight



7.5 Multisensory Delight

Some products, such as the alarm clock we have been discussing, are manufactured to engage with a dominant sense. An alarm clock needs to offer correct and accurate auditory feedback, or the product is only a time-telling decoration and at risk of becoming obsolete (Schifferstein, 2006). A watch might be visually appealing when purchased, but if it grates against our skin or no longer provides auditory feedback, it will lose its appeal. Have you ever owned a pair of boots that were fashionable yet hard to put on or uncomfortable to wear, or developed an unpleasant smell from the material used? We all want to enjoy using our things, which is why designers should be aware of the kinds of multisensory impacts – both frustrations and delight – we experience while we use them. This will encourage us to keep our things longer and avoid discarding them.



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Sensory frustration vs delight

According to positive psychology, if we experience product interactions as more enjoyable than frustrating, we may have engaging and delightful feelings (Pohlmeyer, Anna, 2012). Happiness and delight go together; they seem to influence the way sensory dominance changes over time. For example, if it is a pleasant experience to use your can opener, over time you may rely less on looking at it and more on listening to the auditory feedback it provides. This also relates to the following three levels of happiness or delight derived from Park & Alderman (2018): *i) immediate delight ii) delight through flow and iii) gratifying longer-term changes* that build on the concepts about design for emotion, discussed in Chapter 1.

1. **Immediate delight** is based on senses, aesthetics, or interest and is also connected to pleasant experiences. It can be designed into products and spaces through semantic or multisensory design product qualities that are enjoyable to use. These qualities can promote good feelings and trigger good memories. For example, re-experiencing enjoyable memories can lead to immediate delight (or physio-pleasure) (Jordan & Green, 2002). Many of us enjoy engaging in activities that draw upon comforting memories from childhood – foods (tastes and smells), blankets and stuffed toys (tactile), or seasonal changes (hot summers and cold winters).

Pleasant memories last for a long time, are easy to recall, and lead to the desire for similar experiences that can be found in other products that are satisfying to use (Park & Alderman, 2018). According to a study conducted by Özcan & Van Egmond (2009), visual context also has a positive effect on sound identification and that context can be regarded as a series of associations in the user's memory. For example, the multisensory swinging chair or seesaw seems to be a universal symbol of

delightful relaxation; perhaps because it brings back our tactile and kinetic memories of rocking as a child, along with the auditory memories connected to the creaking noises of moving mechanical parts, the visual memories of seeing a loved one rocking, or the positive sense of well-being through working together to keep the rocking movement going.



Multisensory Delight can be triggered by multisensory features connected to pleasant memories

2. **Delight through flow** is based on being deeply engaged in achieving a task or activity. It usually involves complete absorption in the task at hand. A photographer in the wild may be so focused on the birds that they are not aware of the camera in their hand while taking pictures. The designer's task is to make sure that the affordances of the camera – the weight, the placement of buttons, and the overall interface – provide a seamless experience for the user. If anything is out of sync, this kind of delightful experience will be disrupted. Over time and with practice using it, a well-designed product can become almost intuitive to use.

3. **Gratifying longer-term changes** are based on changing behaviours or developing good skills/habits. These may evolve as we develop the habits or skills that lead to fulfilling and delightful multisensory user experiences. These may align with ideo- and socio-pleasure (as discussed in Chapter 1) and contribute to new cultural ways of being comfortable about ourselves and others. We may perceive ourselves as trendy or fashionable when we have certain things that fit into our cultural or social worldviews. For example, the professional photographer may experience his camera as a multisensory (vision, touch, and sound) extension of his body while he continually repositions himself to take photos of his subjects. He just wants photos, not a cumbersome camera (this is the same principle as wanting toast, not toasters!); his hand-eye coordination becomes more gratifying as he integrates his camera into his work routine.



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Park & Alderman's 3 levels of Happiness

Back to previous section: 7.4 Sensory Dominance

Next section: 7.6 Multisensory Design Principles



7.6 Multisensory Design Principles

Layers of multisensory design interactions maximize engagement and minimize distraction if carefully considered in the early design phases. Good design can lead to clear perceptual feedback by applying the principles of flow, maintaining focus, managing demands on attention, and sequencing as discussed in the following sections adapted from Park & Alderman (2018):

1. Flow

Any designer who has lost themselves in drawing concepts has experienced flow, which is, “a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it” (Csikszentmihalyi, 1990). If you have experienced a state of flow, you will likely recognize some of the following qualities without even knowing that good design contributed to your immersive experience:

1. The ability to concentrate wholly on the task.
2. The ability to transcend time.
3. The ease and effortlessness of performance.
4. The ability to move beyond self-conscious evaluation.

These four qualities are the result of design features that minimize disruptive interactions. The next four qualities describe the user experiences of a state of flow.

5. Clarity of goals and immediate feedback.
6. Intrinsic reward from doing the activity.
7. The balance between challenges and skills.
8. A feeling of control.

Activity Time!

Select the answer or answers that best demonstrate some of the insights that you have gained in relation to this chapter's learning objectives.



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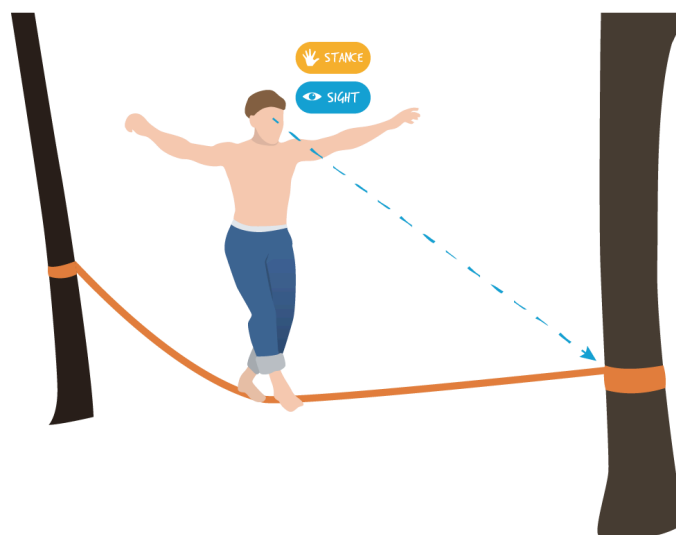
“Checklist” for Flow

A truly important user-centred goal for good design is to provide such a positive multisensory experience that the tools for achieving a user’s tasks are ultimately invisible to the user – or designed just right to support the experience of flow. In other words, as we already learned, Burns (2012) maintains, “people want toast, not toasters”, also noted earlier. Don’t we all simply want our tasks to flow well to achieve our immediate goals?

2. Maintaining Focus

Designers should look for ways to support our ability to deeply engage with a product at different stages of use, especially while other activities are demanding our attention concurrently. This design challenge is met by studying the phases we perform for each task, the steps we take to complete them, and the multisensory and physical interactions that we engage with – similar to a *human factors’ task analysis* – whether sharpening a pencil or driving a bus.

Good design can support our ability to focus without needless distractions. Designers can map the order of sensory dominance in performing each of the tasks at hand and design features that call for our attention at appropriate stages of use. Are there multisensory features that will help us focus on the task at hand – without distracting us from paying attention to crucial interactions? For example, the tightrope walker below has only one focus – to get to the other side. If the strap is sturdy, he will achieve his goals through multisensory engagement (visual, tactile, kinesthetic, and auditory). If the strap fails, he will be distracted and fall off, and he will not have maintained his focus or completed his goal.



Experiencing focus and filtering distractions

We have learned that distractions do not support flow, but they may actually be necessary in some cases. For example, if our tightrope walker falls off the strap enough times, he will have ample practice to learn how to maintain his balance and fall properly, as well as how to adjust his equipment to prevent frustration and maintain focus. However, another way to design for maintaining focus is to incorporate features that require a dominant sense that can direct a user's attention and skills onto a specific task and allow other senses to be on standby as necessary. Park and Alderman (2018) maintain that a designer can reduce the effects of interfering distractions with features that provide flexible options for secondary senses, which a user could bypass as necessary. For example, when monitoring a baby's sleep, not every parent wants to or can be awakened by loud sounds, some may prefer to have haptic or visual feedback through vibrations or lights, depending on their individual preferences.



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Maintaining focus and filtering distractions by offering customizable feedback features

It is sometimes difficult to sustain concentration on a specific task, which presents a wonderful design opportunity to develop product features that may help refocus a person's attention quickly. Have you ever noticed that you hunch over when using your computer? Have you ever considered using a posture support device to help you maintain good posture? It could help you refocus by giving you tactile or auditory feedback when you begin to slump. Something like a sound erupting during your silent activity is one way to provide enough contrast to your immediate sensory experiences and expectations and help refocus your attention on the new sensory stimulus. This is called neural adaptation. Neural adaptation is also key to resolving the alarm fatigue (auditory) issues mentioned in Chapter 5 because a sensory change can alert you to the initial alarm message.



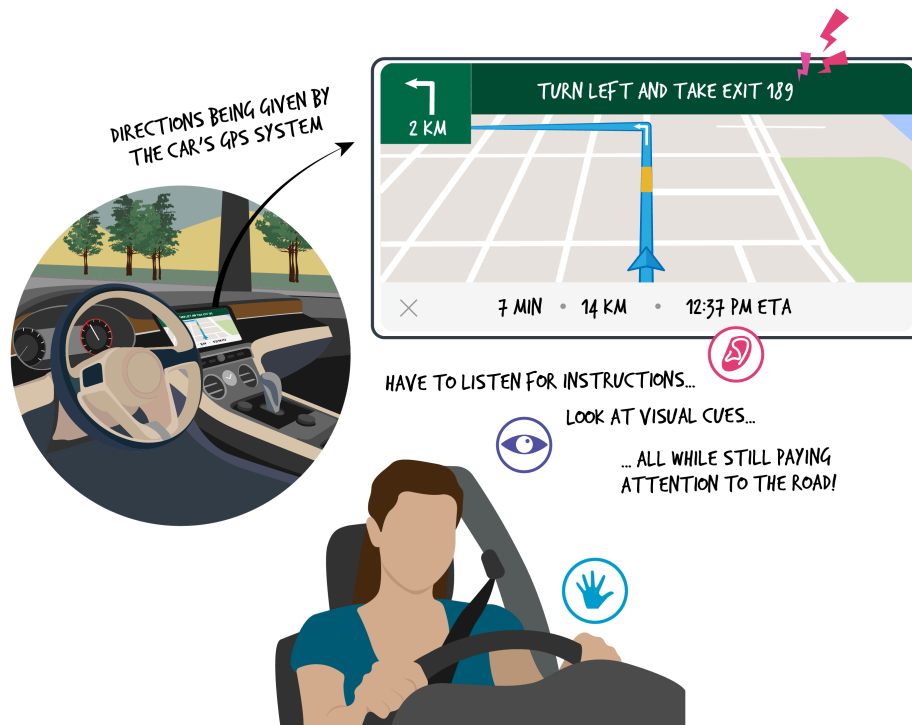
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Product features can help with refocusing attention

3. Managing Demands on Attention

As discussed earlier, some user scenarios are multimodal (multisensory) – such as driving a car, where we need to have awareness of what's going on inside and outside of the vehicle. In this case, there are overlapping multisensory and cognitive demands on our driving performance. From the point of view of our sensory engagement, driving is demanding. Our cognitive and sensory attention is simultaneously focused on steering, switching between the gas and brake pedals, engaging in conversation, and absorbing media updates and directional data. Our external attention also requires awareness of the car's position in relation to other vehicles and traffic control signage and lights, road markings, and pedestrians. These simultaneous and multimodal activities demand a lot of attention, even though some operate on an automatic level. In

addressing this user experience, the designer's job is to design sensory cues for quickly and safely switching attention as circumstances change – if a bike is about to cross the path of a car, the traffic light changes, or a tire goes flat.

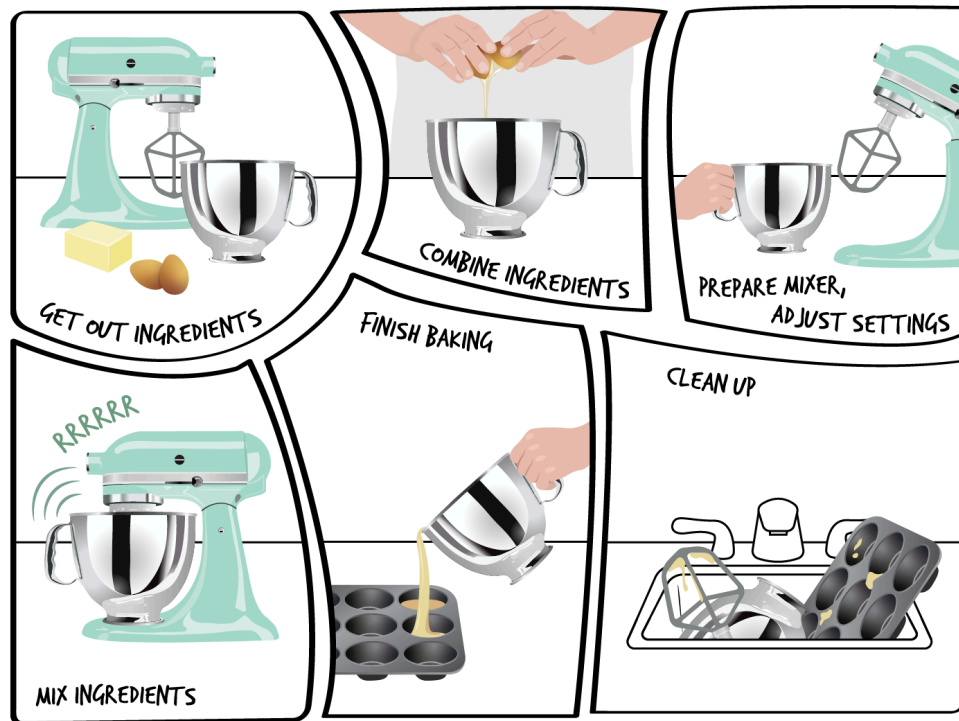


Simultaneous and multimodal activities demand a lot of attention when driving

Good design provides mechanisms for *selective attention* – which enable us to shift mentally or physically into and out of a sequence – to reduce *sensory overload*, which can lead to fatigue (Park & Alderman, 2018, Schifferstein & Spence, 2009). The design team can determine the qualities of the shifts that occur – is the transition smooth or is it unsettling? Many drivers can tell tales of troubling transitions when applying the brakes at high speeds and sliding across the road! The ability to put our phones on speaker mode while driving is a great example of design for selective attention that frees up our attention to visual and tactile interactions so that we can pay more attention to looking at the road (visual) and engaging in a remote conversation (auditory). Needless to say – as Park and Alderman (2018) point out – in some cases, the inability to pay attention can be fatal (as when not paying attention to a bicyclist suddenly appearing in your path when driving a car), whereas in others it can merely be an inconvenience (as in making a mistake typing an email)

4. Sequencing

Most of us perform tasks in an orderly progression of small sequential steps.



Orderly sequence of tasks

These may even be the same steps that have been designed into the experience to support *sensory dominance* within a hierarchy of events. Interactions with a kettle provide an example of how sensory modalities can be designed into the stages of use to set up a familiar hierarchy of events. As shown in the image below, 1) after seeing that the water level is low, the user picks up the kettle, 2) and opens it to prepare to fill it up, 3) they see, hear, and feel the weight of the water in the full kettle and place it back, and eventually 4) hear the sounds of the boiled water.



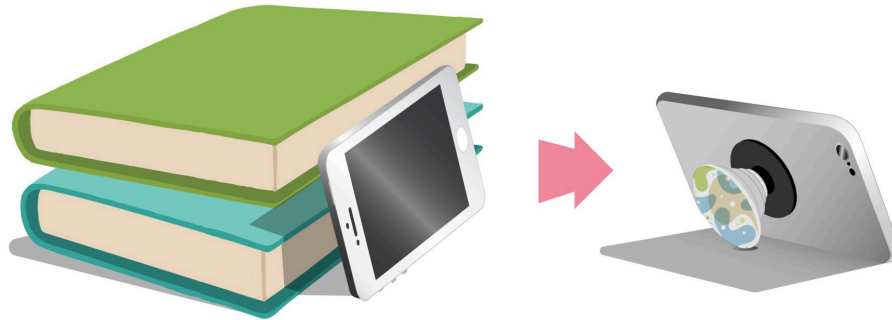
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Multisensory sequencing when boiling water in a kettle to make tea

These events occur in the same order every time, calling upon different senses or combinations of senses at distinct points in the sequence. This sequence of events usually fits into our mental framework of how we like to do things. Once designers understand our patterns, they have evidence about which sensory design features correspond to most of our *mental models* about the hierarchies of sensory dominance throughout the product *use-cycle*. Routines like these can become more engaging through intentional design considerations for each stage of interaction. As we previously learned, the kettle is only one product in a sequence of routine steps – the source of water and coffee, the cups and spoons, and the milk and sugar

form a part of the larger network or system that is designed for this routine. This means that many individual products are part of a larger system or context that influences how each of us goes about our activities.

Despite a designer's best efforts to support user experiences, some people may alter the designer's intended sequence. Some activities do not even follow a specific sequence, which could change the way multisensory layers of design features integrate into the artefact. In fact, many innovative products came about by changing the use sequence.



Product extensions to facilitate and enhance product use-cycles

For example, there is no stage in the sequence of cell phone use that includes repositioning the phone for different purposes. Some of us lean our phones against a stack of books. Given that a phone is such a multifunctional product, it is lacking the affordances for supporting it in a diverse range of user scenarios such as: reading recipes while cooking, watching a movie, or having face-to-face conversations. We think that phone holder mounts are a versatile option to those books! They adapt to different places of use – your car, your bed, or your desk.

Back to previous section: 7.5 Multisensory Delight

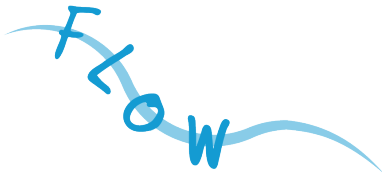
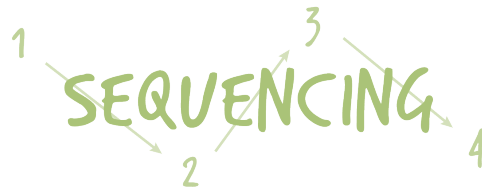
Next section: 7.7 Multisensory Novella



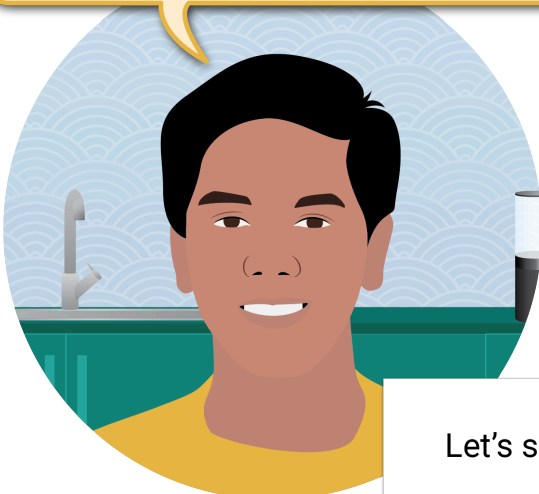
7.7 Multisensory Novella



Did you know that multisensory design principles support your daily routines in 4 ways?



I'm just about to make breakfast. Will these principles support this routine?"



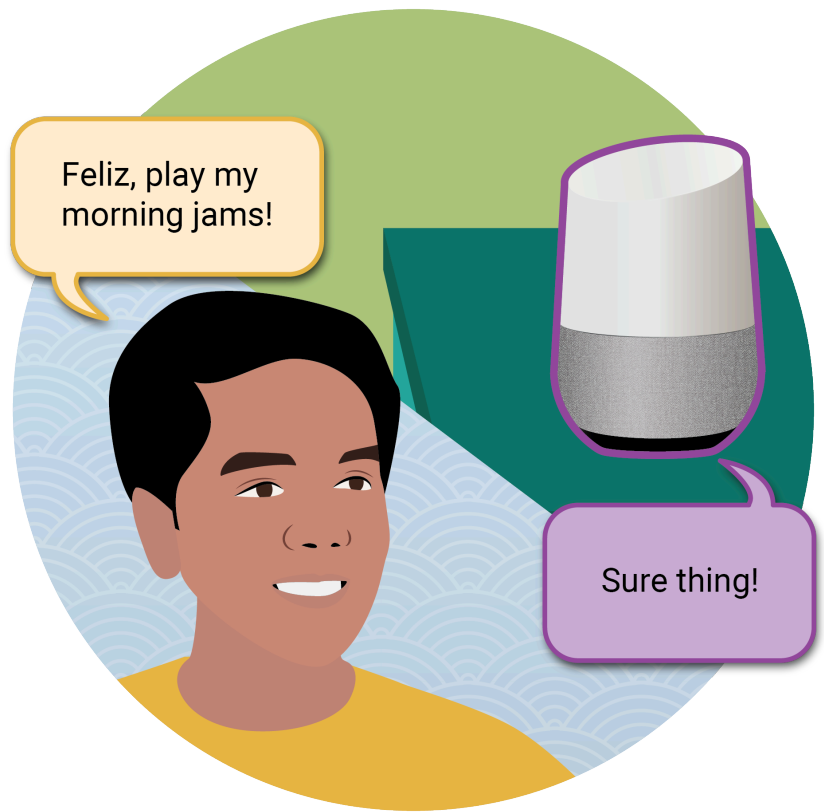
Let's see!

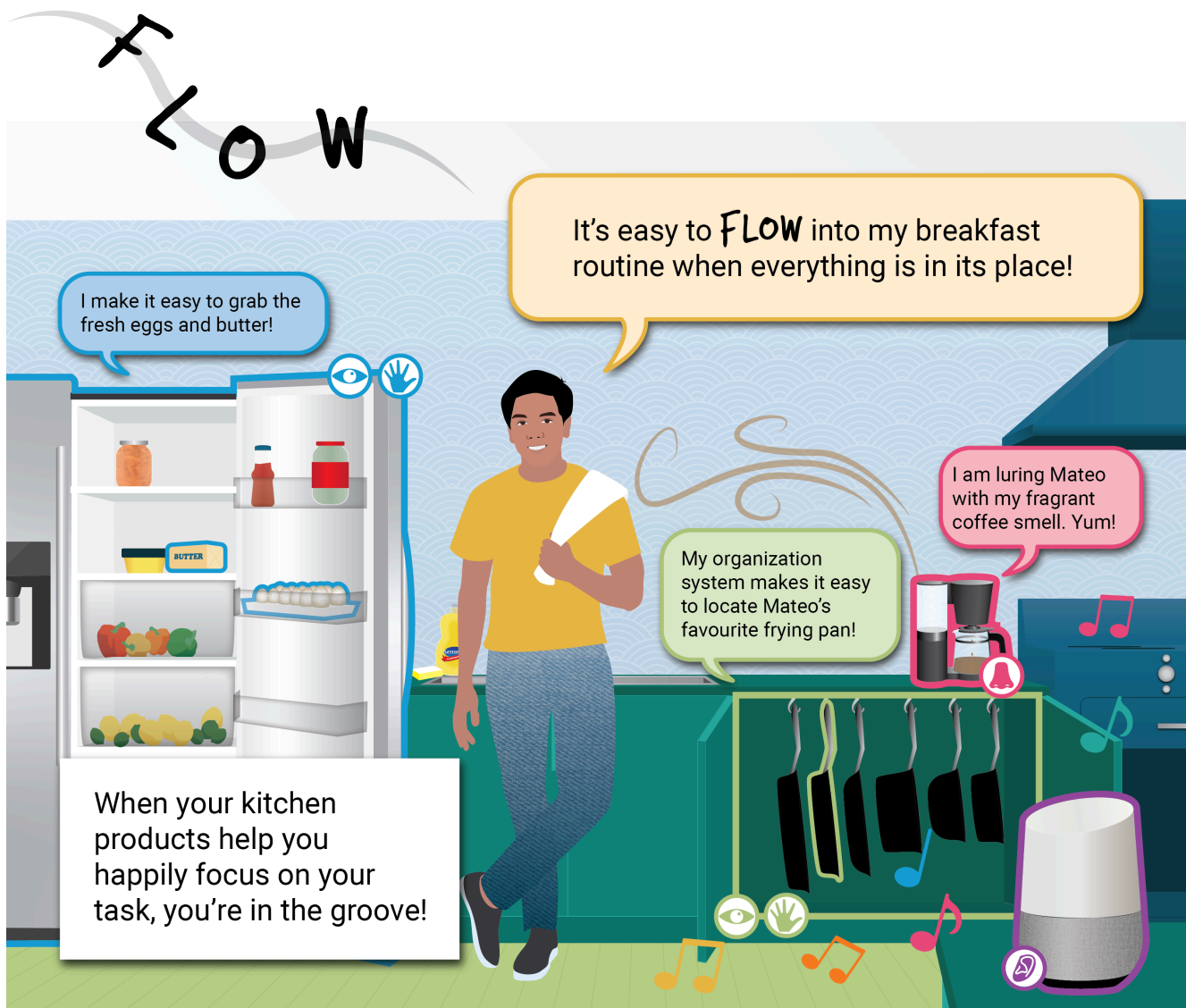
1 2 3 4 SEQUENCING

My coffee maker has already started brewing. I'll start with the tasks that will take the longest, so everything is ready at the same time.



I see you are planning a **SEQUENCE** for your routine. Your kitchen products can help you execute this plan!





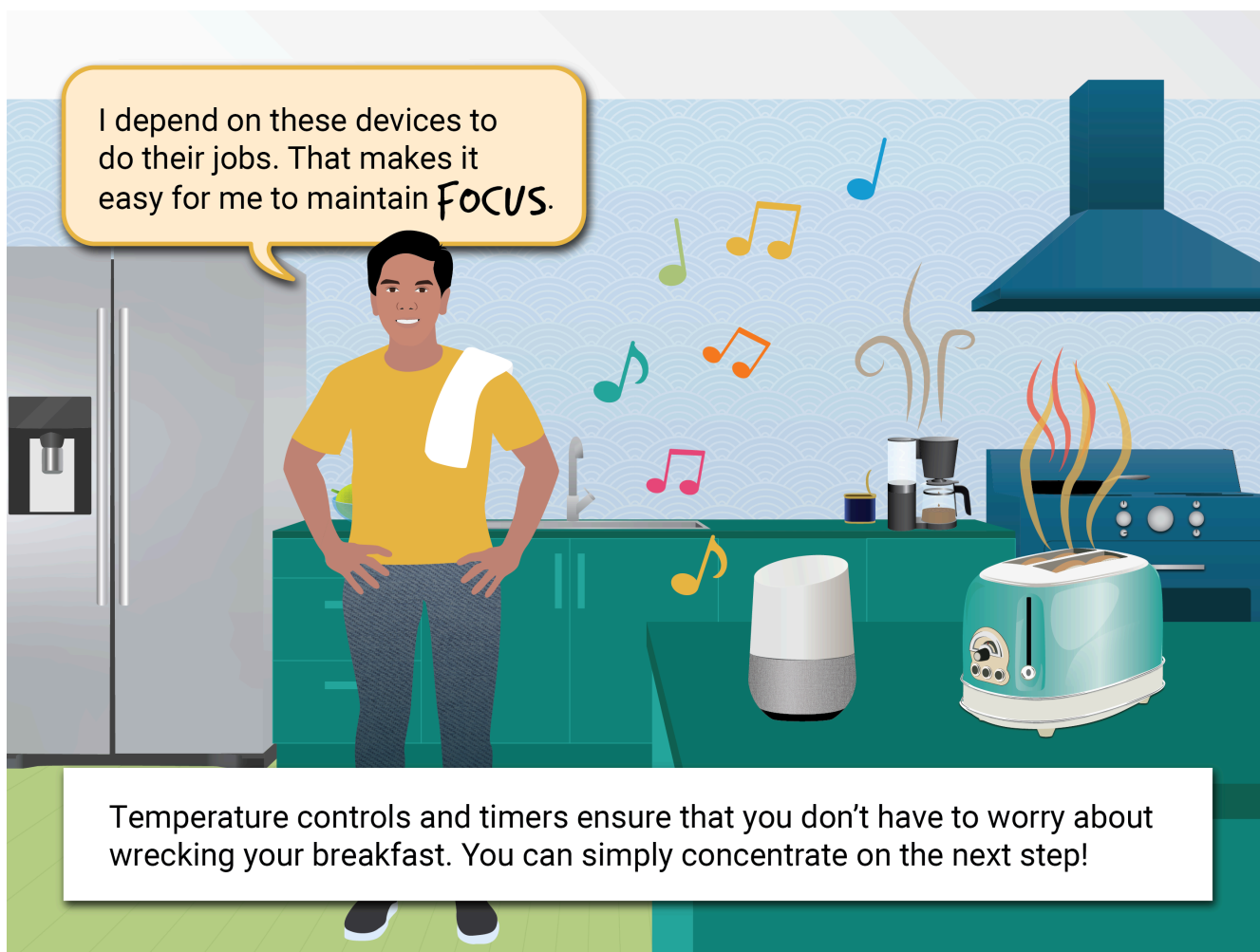
FOCUS

Feliz, set a timer for 5 minutes.

Will do!

I'm heating the stove top to the temperature Mateo sets, and I remind him I am turned on with my red coils.

I make it so easy to have perfect toast, see?



ATTENTION



HEY MATEO!

Your eggs are ready.

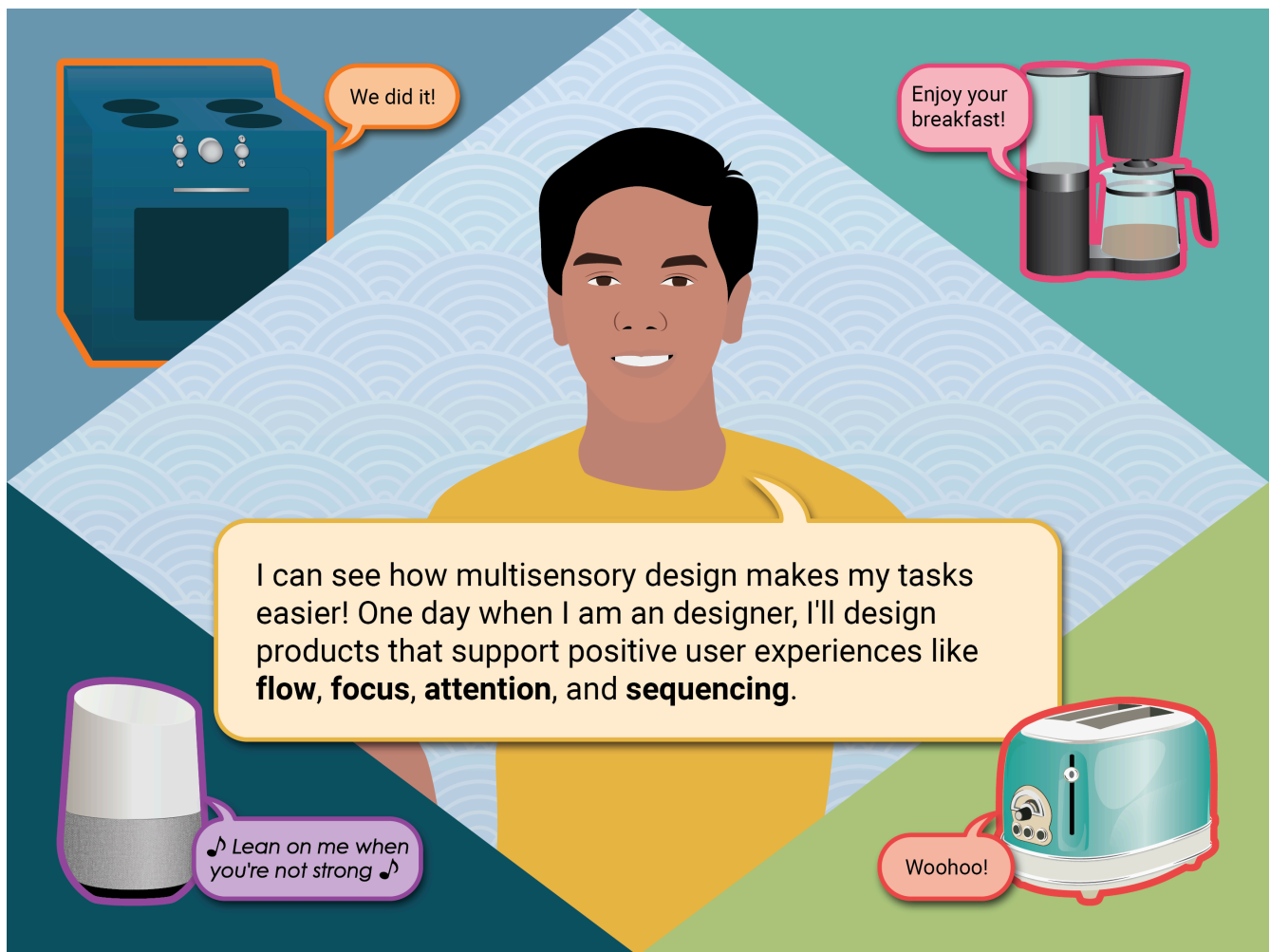


Phew, good thing Feliz got my **ATTENTION!** I wasn't thinking about my eggs at all.



Well-designed products provide feedback that supports attention-shifting.





Back to previous section: 7.6 Multisensory Design Principles

Next section: 7.8 Multisensory Design Applications



7.8 Multisensory Design Applications

Rich multisensory experiences with products, environments, and services are the norm; we do not break down design in terms of vision, smell, touch, hearing, taste, or perceptions of mobility. Good design immerses us in holistic interactions that stimulate us to achieve our goals through optimizing the principles of flow, maintaining focus, managing demands on attention, and sequencing as discussed in the previous section. This section focuses on design applications that target different multisensory abilities and unique multimodal design combinations such as *crossmodal and accessible* design, sensory congruency, multisensory integrations, synaesthetic influences, and the dynamics of movement.

Crossmodal and Accessible Design

Sensory experiences are not only multi-layered but also unique for each of us. One of the designer's roles is to design adaptable features that respond to an individual's sensory variations and capabilities. Sometimes we may find that the physiological operations of one sensory modality affect the physiological operations of another (Fulkerson, 2013). These multimodal experiences are called multimodally emergent (IBID, 2013). For example, when walking on snow and ice, you can both see and feel how slippery the surface is under your feet as you move along. Your perceptions about how you are going to adjust your efforts to the condition of the ice evolve in pace with multimodal visual and tactile emergent feedback as you skate along.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1359#h5p-138>

Crossmodal adjustments in response to slippery ice: adjusting poles with prongs for stability

Where some senses *complement* one another, like taste and smell, others may *compensate* for one another. Have you ever observed an older adult grab onto a handrail to determine their position on the stairs rather than relying on their sense of kinesthesia (the ability to detect body position)? Some elderly individuals or persons with disabilities will replace or reinforce a blocked or weak sense with a more suitable or accurate sense (Park & Alderman, 2018, Frankel, 2015). In this case, it makes a lot of sense to hold (tactile) the stair railing instead of risking a misstep due to the inability to see (visual) clearly, to judge (cognitive and proprioceptive) distance, or to lift (tactile and kinesthetic) a leg – all of which could lead to a fall. These kinds of compensations are called *crossmodal relationships* between senses. They relate to evolving sensory capabilities pertaining to ageing, illness, or disability, where one sense fills in (compensates) when the other sense is not working well or at all.

A disability may be permanent, situational, or temporary. Where a person could once dance the night away, they may now be swaying on an assistive device such as a cane in time with the music, no longer able to

bend fragile knees without it – but enjoying the dance anyway in an adjusted situational mode. In another situational and temporary activity, a mother may be working on her laptop with one arm while holding her young child in the other. These days, her temporary disability can be supported by voice recognition and voice control software. In any case, designers should be sensitive to how *crossmodal accommodations* could affect the design of a product, place, or interface.



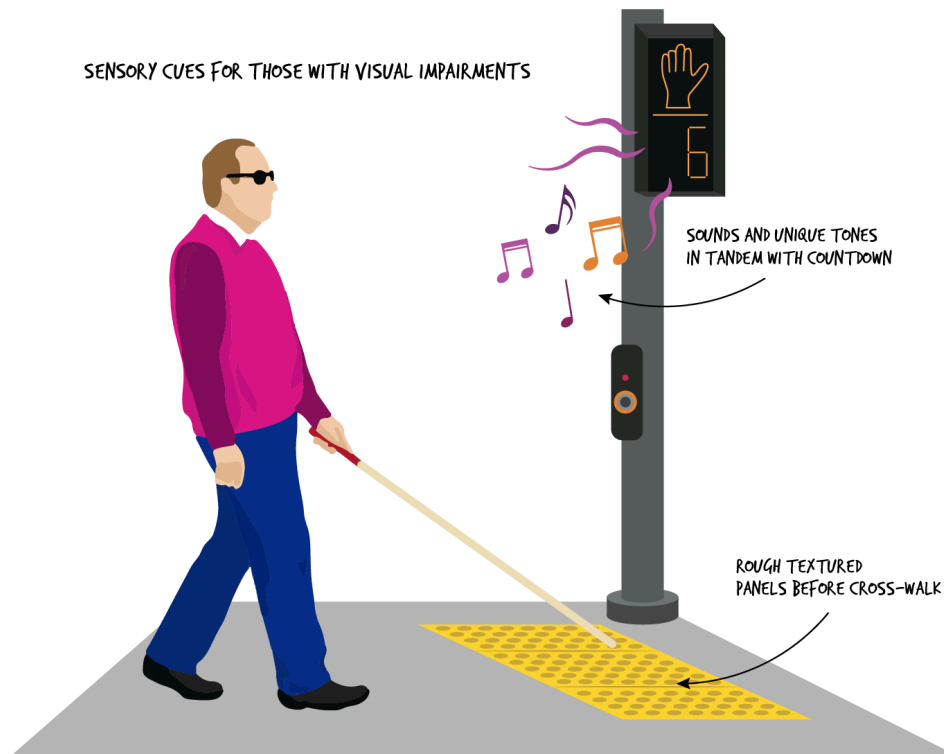
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Accommodating crossmodal and accessible needs with assistive devices and services in different scenarios

The designer's key task is to clarify goals for using a product, service, or environment before determining which senses should come into play (Park & Alderman, 2018). Many experiences can be well supported or enhanced through multimodal and accessible design using devices, services, or extra environmental features. Consider the scenario of watching a movie or an opera; the option to select (tactile) a specific language and read the close-captioned translation on a screen (visual) while listening to the scene (auditory) serves a wide audience of people with different sensory and cognitive needs. This *substitution strategy* addresses sensory and cognitive preferences, and in the end, may improve the experiences for everyone, even those without disabilities (Park & Alderman, 2018).



A close-captioning substitution strategy may improve everyone's experience



Accessible Design accommodates crossmodal sensory augmentation

Have you ever noticed a person walking on the sidewalk while tapping with a white cane or holding a seeing-eye dog on a leash? People with vision impairments often turn to other senses to replace or augment vision – feeling for the curb on the side of the road when crossing the street, listening to the sound of the traffic lights to know when and where to enter the intersection, or relying more heavily on their sense of smell to identify weather conditions, like rain. How often do you consider whether the rain will make the streets more slippery and affect your ability to cross when cars are coming? People with vision impairments may be more aware of the overall multisensory feedback in their surroundings than those without visual impairments. Since we all experience our environments differently, flexible and inclusive multimodal features should be designed to accommodate variations in our differing capabilities. Designers are trained to explore alternative ways of sensing and interacting with objects, services, and environments through *iterative design development processes*. By integrating crossmodal design features into everyday interactions with products, services, and environments, an *exploratory design approach* can contribute to a better experience for all.

Back to previous section: 7.7 Multisensory Novella

Next section: 7.9 Sensory Congruity and Multisensory Integration



7.9 Sensory Congruity and Multisensory Integration

From an ergonomic perspective, if we can understand how to use the multisensory features of a product, then our understanding is consistent with how it was designed to be used (Schifferstein & Spence, 2009). This consistent relationship is called **sensory congruence** and happens when the sensory message is aligned with the overall product interaction experience. A congruent message fits into our perceptual and cognitive understanding, whereas an incongruent message does not. Looking at a hammer, you would likely expect it to be heavy and if it is, upon picking it up, you will likely use it without thinking about it. However, if it feels light, you may wonder what is wrong with it and if it will work. That heavy feeling is providing a congruent message – it is what it seems to be and what you think it should be based on your familiarity with the product. In our example below, a thoughtfully designed product package can present a clear message to the user about the product, whereas a product package that conceals what is inside does not provide any message about its contents.

Activity Time!

Drag each smell attribute to the bottle that you think it best corresponds to.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1361#h5p-125>

Congruent visual messaging between product and package

Integrated multisensory experiences also provide a congruent perception through **sensory synthesis** (combining of senses). For example, *taste* and *smell* are experienced together as flavour; *audio* and *visual* effects are often combined to provide robust, immersive movie experiences; and the integration of our *visual vestibular system* in our inner ear contributes to our sense of balance. In these latter contexts, one sense helps the other focus and prepare for the next stimulus (Park & Alderman, 2018; Stein, 2012).

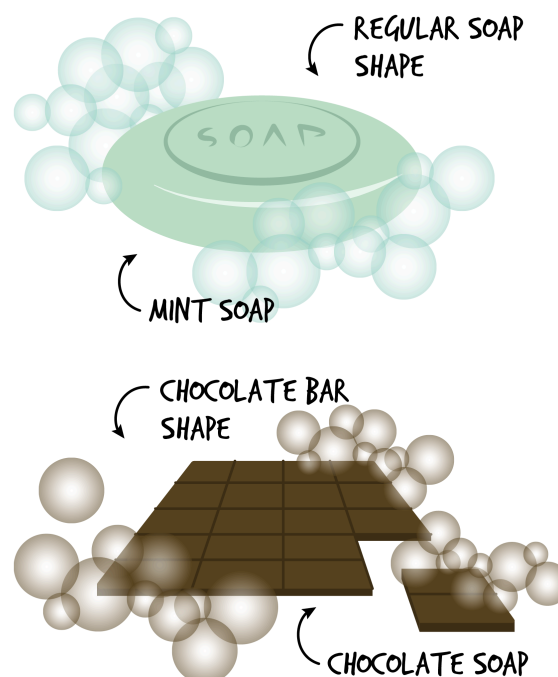
Sensory Incongruity and Novelties

In contrast to a congruence approach, some designers use the element of sensory surprise in their products to offer a more stimulating design. For example, you may expect a stool that looks like a sawed-off log to be hard like a log, yet it turns out to be a soft pillow that merely looks like a log (this was initially discussed in the section about colour as material deception, Chapter 3). When our expectations are different from the reality of the product or experience, this is called **sensory incongruity** (Ludden et al. 2007, 2008).



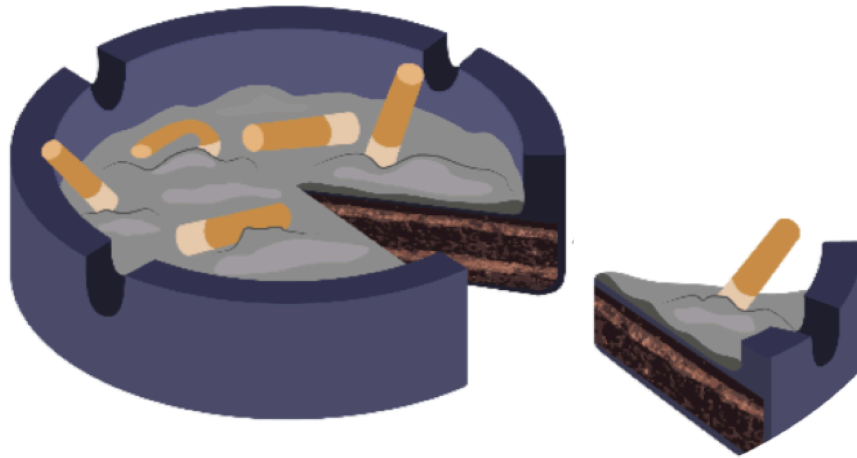
Visual-tactile sensory incongruence: it's a pillow!

Studies by Ludden, Schifferstein & Hekkert (2007, 2008) suggest that evoking the element of surprise or intrigue in a product can be seen as a uniquely pleasurable product experience. *Sensory incongruities* can be deliberately incorporated into a design to capture consumer attention or make a product unique and recognizable through associations with memories. However, designers should consider avoiding garish or kitschy incongruities to add meaning to a product – to avoid detracting from its long-term value (Ludden, Schifferstein & Hekkert, 2007). Designing novelties into products can be beneficial and fun or harmful and aggravating, depending on the context. Designers need to recognize and apply incongruities suitably to enhance an experience. Consider, for example, which bar of soap pictured below would you prefer to use.



How much sensory incongruity surprise is appropriate?

We can experience different types of sensory incongruities or **sensory novelties**. Hidden novelty is another type of sensory incongruity; it refers to products that look familiar at first sight yet have unexpected properties that may be shocking. The surprise arises when interacting closely with the product, offering an unexpected sensation, material, or output (Ludden et al. 2007, 2008). While the log pillow is a form of sensory incongruity and hidden novelty, there are some designers who take the concept of hidden novelty to the extreme. For example, Chef Ben Churchill (2020) and Tuba Geçkil (2021) are chefs who independently create desserts that challenge sensory perceptions. Churchill's sweet offerings (a dirty dish sponge, a decomposing orange, or a soiled ashtray, amongst others) initially look unappealing but taste delicious. Whereas Geçkil's hidden novelty cakes look like everyday objects (an iron, a toaster, a roll of toilet paper, a raw piece of chicken, for example), only to surprise viewers when they are sliced into, revealing pieces of deliciously layered cake.



Tasty hidden novelty!

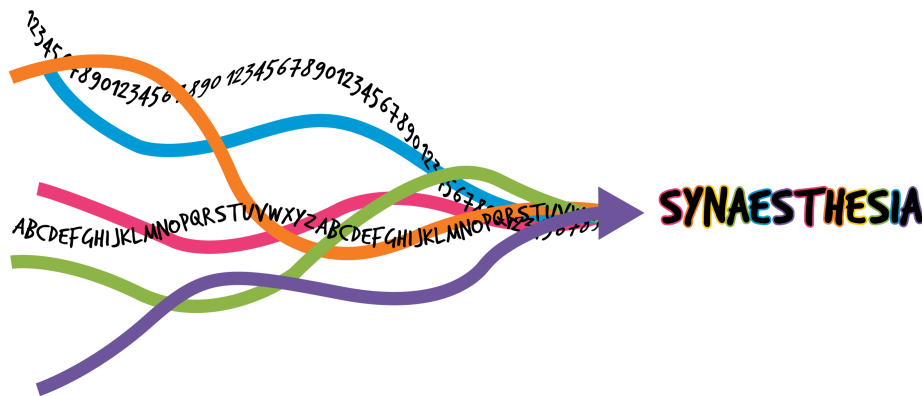
Another sensory novelty is a visible novelty, which occurs when an element looks unfamiliar and we have no former references or expectations to relate to (Ludden et al. 2007, 2008). For example, the image below captures the unusual novelty that Luigi Colani introduced to camera design in the 1980s (Colman, 2009). At the time, his camera was such a novel concept that it was unfamiliar to camera users who were used to holding small rectangular boxes to take photos. Today, Colani's once-novel tactile affordances have been interpreted into common curvilinear and ergonomic features of the camera's shell and no longer seem novel. In the case of visible novelty, we may experience a surprising reaction to its true nature. Some of us may try to make associations with other familiar elements or products but remain uncertain about its reality until exploring its surface and weight.



Visible Novelty

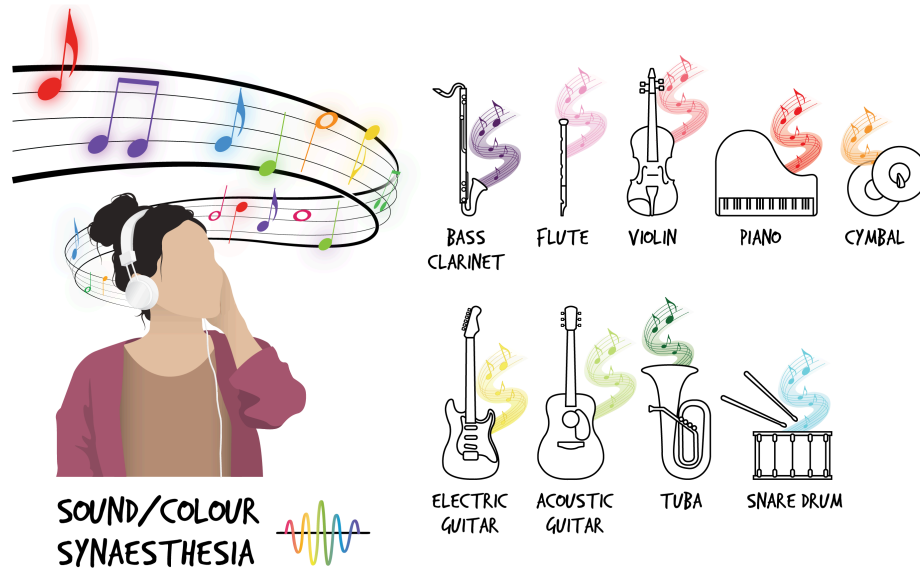
Ludden et al. (2007, 2008) found that both hidden and visible novelties evoke surprise. Their participants tended to be more reactive in their facial and vocal expressions to hidden novelties and more exploratory with visual novelties by investigating and interacting with the products (Ludden et al., 2007, 2008).

Synaesthetic Experiences



Different stimuli are perceived as crossmodal correspondences

As we have noted, most of us engage with products, environments and services as multimodal experiences, however, some individuals process sensory stimulation in unique ways, which we refer to as **synaesthesia**. *Synaesthesia* is a neurological condition where incoming information that is normally perceived by a particular sense stimulates other senses too; a person may experience stimuli from one sensory channel through a different sensory channel as a crossmodal correspondence. Wassily Kandinsky was well known for perceiving tones of sounds associated with particular colours – where a trumpet or bugle is yellow, and a flute, cello, or organ is blue (Kandinsky, 1910). However, synaesthesia is not limited to auditory and visual combinations; some people relate colours to letters of the alphabet, and others relate sound to pain levels in their bodies; the combinations of senses are diverse. These are involuntary experiences, typically involving two sensory modalities that inform one another, which vary among individuals but are consistent for any given person (Schifferstein & Spence, 2009).



Synaesthetic sound associations

True synaesthetic experiences are natural and cannot be induced, although designers can use synaesthesia as inspiration in designing *multisensorial products* (Hummels & Overbeeke, 2006). As an example, synaesthetic-like features can be experienced in the use of electric toothbrushes. In experiments using sound to enhance the toothbrushing experience, louder and higher sounds were related to roughness, whereas softer and lower sounds were related to gentleness. People also perceived fabrics as softer when imbued with pleasant scents (Schifferstein & Spence, 2009). Interestingly, most of us are usually unaware of these crossmodal effects (Schifferstein & Spence, 2009).



Crossmodal effects inspired by synaesthesia

The scope of the discussion about multisensory principles and applications in design would not be complete without considering the multisensory aesthetics of movement, which we discuss in the following section.

Back to previous section: 7.8 Multisensory Design Applications

Next section: 7.10 The Dynamics of Movement



7.10 The Dynamics of Movement

The dynamics of movement are another integral and multisensory part of a product's aesthetic and emotional expression; they can support interactions between users and products by communicating functional actions. Products with moving parts are inherently multimodal because they include a crossmodal aesthetic that engages *vision* and *kinetic* (produced by motion) *movement* through space, as well as *tactile* and *auditory* interactions. Kinetic product movements add multimodal depth to the user experience – whether responding to the graceful overhead opening door of a high-end vehicle, or that of a contemporary kitchen cabinet, as well as deleting unwanted emails with a simple sweeping gesture (Park & Alderman, 2018). Kinetic product actions can be both manual and automated, offering us a range of multisensory experiences. Consider the kinetic movement of a printer paper tray, the pop of an umbrella opening, or the stretch of a wound-up tape measure. Designer Ben Hopson asks us to, “imagine how much richer objects could be if they looked like how they moved” (Hopson, 2009). He goes so far as to say that, “once viewed through the lens of **Kinetic Design**, the world is revealed to be full of lifeless objects awaiting animation” (Hopson, 2009).



Imagine how this car door will move once the handle is activated

Moving Parts, Moving People

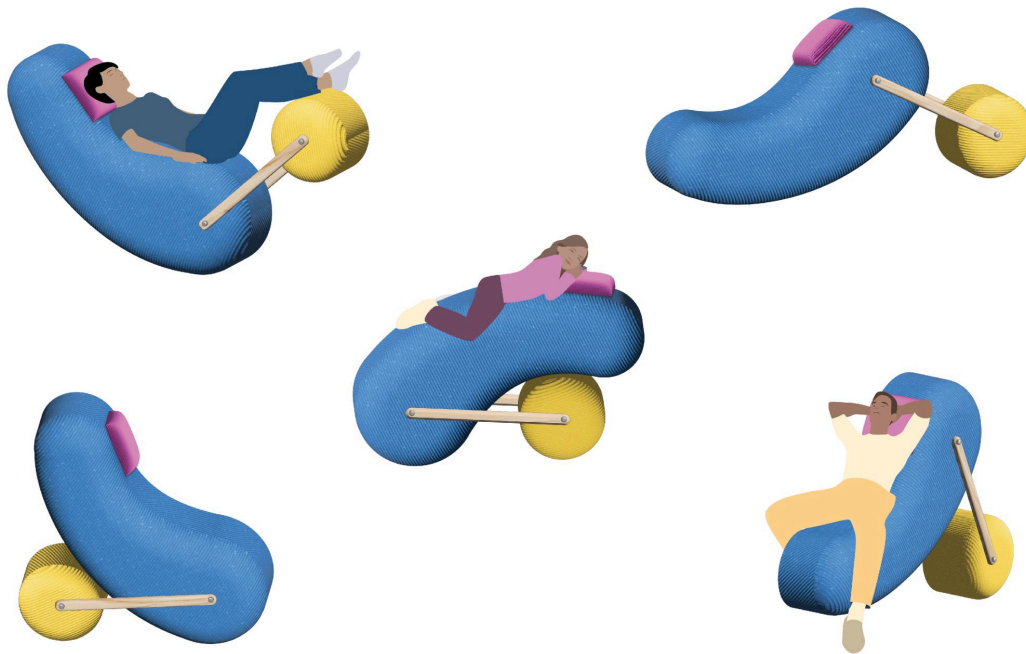
Moving parts are the different components within a product that move in relation to its other non-moving parts. This kinetic action can be choreographed by design to determine the appropriate physical movements and the invisible paths these movements take while dynamically changing position. In many cases, the movement is initiated by a person's interactions with a product. This tangible interaction often involves tactile engagement with the product's physical movements.

In fact, the choreography does not stop with the product alone, it often encompasses our “dance” when interacting with the product. This kind of responsive interaction engages us in different multisensory ways. Most of us don't even consider that shifting in our chair to find a comfortable position or moving our body,

laden with parcels, to navigate through a doorway is an interactive sensory response to how the object was designed. Design educator Heidi Overhill (2015) describes how different door knobs elicit a variety of different dances, “Some doors are fast to open; others are slow. Some are heavy, and some are light. If you are carrying two cups of coffee as you approach a door equipped with a crash bar, you can turn on your toes, push the bar with your hip and pirouette through, spinning”. Overhill informs her readers that the design of the door knob dictates the *kinaesthetic* movements required to open the door in a variety of circumstances.

Our kinaesthetic senses are intertwined with our other senses; watching how to do something enables us to interpret what we saw into muscle movement. This is how we learn to dance, tie shoelaces, handle a chainsaw, or paddle a canoe. Think of some actions you have observed in the past, then tried, practiced, and eventually mastered. If you can’t think of anything offhand, remember that as a baby you learned to walk by watching the people around you.

These interactions take place within the immediate space surrounding our bodies and are defined by their range of movement, which Laban (1980) named the *Kinesphere*. Laban also coined the term *movement literacy* to describe the importance of physically sensing differences in movement and being kinaesthetically aware of the body and its movements (Moen, 2006). Imagine that designers are choreographers, designing the whole interactive experience, ranging from the product’s affordances to our bodily responses. In other words, a good design considers Overhill’s (2015) idea that the user is in a multimodal dance with the product that changes depending on the external context of the situation. And, when there are parts that move, a good design incorporates an appropriate kinetic aesthetic of moving parts.



interactive multimodal & kinetic aesthetics

Hopson (2009) encourages designers to explore the aesthetics of motion by generating kinetic sketches using modelling materials (referred to as low-fidelity models). He advises designers to explore how parts can or will move before refining or prototyping models or even before figuring out the mechanisms for the movement. He is not alone in promoting choreographed movement in the ideation phase of product

development – Hummels and Overbeeke (2006) explored the use of full-body spatial movement sketches to express “rich movement-based interactions.” They believe that expressive gestures may become a valuable exploratory tool for developing kinetic design concepts. Why not try to use physical gestures to kinetically mimic how your printer paper tray opens or how your electric drill works?

Hubel and Lussow also provided guidelines for designing kinetic features to be aesthetically cohesive properties of a product, and, in their view, are of equal importance to the aesthetics of form, colour, or material (Hubel & Lussow, 1985). They described seven attributes of kinetic movement that clarify the kinds of movement Hopson promotes. Their attributes are organized by time, sequence, and patterns with recognizable forms listed below. Each of these movement forms adds unique dynamic and animated patterns in which parts of products and people can move (Hubel & Lussow, 1985). These patterns can be applied separately or in combinations to generate a variety of kinetic and potentially multisensory iterations. As an adaptation from Laban, we can call this design movement literacy, another foundational design principle for designers to work with.

Seven Attributes of Kinetic Movement (Hubel & Lussow, 1985)

Rate: The movement can be fast, slow, constant, irregular, or frequent.

Size: The expansion or collapse can be small, big, expanding, or constricting.

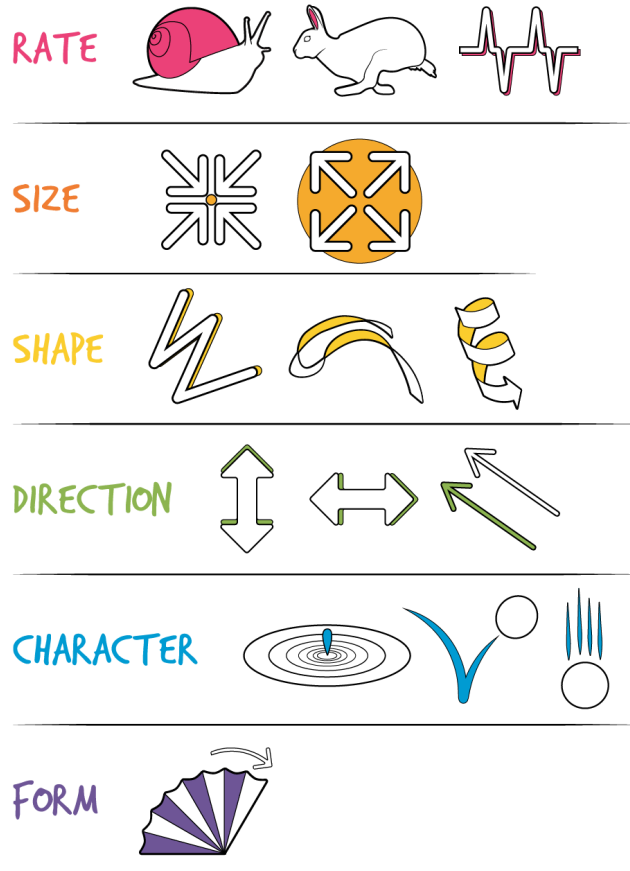
Shape: The shape of the movement can be straight, curved, zigzag, spiralling, or twisting.

Direction: The direction of the movement can be upward, downward, forward, backward, sideways, or parallel.

Character: The character or expression of the movement can be concentric, bouncing, thrusting, floating, sliding, or spiral.

Form: The characteristics of the movements, when organized in time, result in specific patterns that have a recognizable form.

Function: When the particular attributes of movement are selected and organized to perform a function, they fulfill a need.



Attributes of kinetic movement

Activity Time!

In each of the three scenarios below, match the six sensory tiles (in the column to the left) you believe best matches the movement and personality of the product on the right.

Hint: Each scenario matches with one sensory tile from each tile colour group in the column to the left.

Scenario 1



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1363#h5p-126>

Scenario 2



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Scenario 3



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Kinetic Actions

In his book *Collapsibles*, Per Mollerup (2001) also categorizes product movements into types of mechanical actions that enable a person to collapse and expand a product. Try to imagine how some of the concepts of kinetic movement identified below would engage you in a multisensory kinetic dance as you open, close or otherwise use them.



Collapsible and kinetic design

Movement is multisensory, involving tactile, visual, and auditory sensations that add yet another layer to a product's aesthetic. When we design a product, an environment, or a service the end result will rarely be static, especially if it is well-used and well-loved. It will become part of an interactive relationship that evolves with us over time. Sometimes our relationship will be intuitive and even automatic unless it does not result in achieving our objectives. At other times our relationship will be dynamic, engaging our senses at different stages of use, with dominant senses taking turns. Indeed, our capabilities may also evolve over time, with the need to interact in a variety of ways, depending on our immediate circumstances – holding a baby, carrying coffee, nursing a sprained ankle, or carrying a heavy backpack. Although environments do not move, the products we place in them need to be designed with the expectation that people will be moving around, in, and through them. Movement is not only complex, it also integrates the multisensory aesthetics of user experience. As you can see, the variations are endless; they are described here to provoke designers to explore dynamic design iterations that can delightfully engage us in multisensory product interactions.

Back to previous section: 7.9 Sensory Congruity and Multisensory Integration

Next section: 7.11 Summary Review Activity

7.11 Summary Review Activity

Activity Time!

Select the answer or answers that best demonstrate some of the insights that you have gained in relation to this chapter's learning objectives.

1. How we process multisensory experiences from a perspective that is relevant to design.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-115>

2. How multisensory layers can provide opportunities for design features that add value to product interactions.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-117>

3. How sensory dominance affects the interactions people have with products at different phases of use.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-118>

4. Why it is important to design features that contribute to a feeling of delight in product interactions.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-119>*

5. How multisensory design principles can support a variety of use-scenarios that lead to positive outcomes.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-120>*

6. Unique applications for multisensory experiences that enable us to achieve tasks, given different sensory abilities and perceptions.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-121>*

7. How interpreting a synaesthetic approach can lead to richer design interactions.



*An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-122>*

8. Awareness of the multisensory aesthetic properties of kinetic and collapsible design that add depth to our product experiences.



*An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=2289#h5p-123>*

Back to previous section: 7.10 The Dynamics of Movement

Next section: 7.12 Conclusion & Key Takeaways



7.12 Conclusion

We have seen that the senses work together in uniquely individual ways that support how we adjust and react to everything around us. Sensory experience is most often multimodal and shifts over time, space, and context. Design is a job that extends beyond the object – it includes identifying people’s multisensory patterns of adapting, adjusting, perceiving, and responding to the design features that support or distract them from accomplishing their goals. The more awareness a designer can have of the user’s journey while interacting with a product, service, or environment, the more its multisensory aesthetics can be adjusted and attuned to specific activities and interactions. This awareness is also informed by routines and rituals that engage different sensory interactions over time.

A key role for the designer is to integrate different multisensory qualities into a holistic set of sensory experiences in the design of products, services, and environments – while complimenting all of the other factors contributing to a well-rounded design solution. While there is no specific formula for balancing multisensory experiences, the most important considerations include awareness of the hierarchy, dominance, blend and juxtaposition of multisensory interactions and how they might engage and delight everyone.

Key Takeaways

The key takeaways from this chapter include:

- Understanding how people process their experiences through all of their senses by simultaneously interpreting layers of sensory stimulation and reacting to them.
- Knowledge about designing features that engage different senses during distinct phases of product use, where certain product interactions are the result of sensory dominance.
- Recognition of the importance of delightful product interactions and the various ways product design can support them and avoid frustrating product-use experiences.
- Awareness of the multisensory design principles of flow, maintaining focus, managing demands on attention shifting, and sequencing for determining product features that lead to positive interactions and outcomes.
- Appreciation of the importance of designing for a wide range of people’s different sensory abilities by applying unique multimodal design combinations that address crossmodal and accessible design.
- An overview of the multisensory dynamics of movement across moving parts and moving people in a variety of ways that add depth to design development, exploration, and responsive kinetic aesthetics.

- Acknowledgement that the senses are rarely, if ever, experienced in isolation; most interactions with products, environments, and services are multisensory and can be combined in infinite combinations as long as they make it possible for users to easily achieve their goals.



Chapter 7: DESIGN FOR MULTISENSORY EXPERIENCES & KINETICS

Reflection Time!

Instructions

1. Type your reflections for the 3Ts below: **Thoughts**, **Tips**, and **Tools**.
2. To download your reflections as a document, click **EXPORT** to open a summary preview, then click the export icon on the top right of the window.
3. Use your reflections to recall the key ideas later and to apply them in future situations.



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<https://ecampusontario.pressbooks.pub/sensoryaspectsofdesign/?p=1342#h5p-46>

Key Words: Multisensory awareness and design, Multimodal design experiences, Sensory dominance, Delight, Multisensory design principles, Crossmodal and inclusive design, Sensory incongruity, Synaesthetic experiences, Kinetic and Collapsible design

Back to previous section: 7.11 Summary Review Activity

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Interactives Answer Key

Section 7.4: Sensory Dominance

Drag and Drop, Sensory dominance over time

Graph 1: **Alarm clock**

Graph 2: **Espresso pot**

Graph 3: **Running shoe**

Section 7.6: Multisensory Design Principles

Drag and Drop, Checklist for Flow

1. Senses engaged: **The ability to concentrate wholly on the task.**
2. Sensory feedback: **Clarity of goals and immediate feedback.**
3. Senses ignored to reduce distraction: **Feeling of control.**
4. Perception of intrinsic reward: **Intrinsic reward for doing the activity.**
5. Skilled practices: **The ability to move beyond self-conscious evaluation.**
6. Senses when challenges arise: **The balance between challenges and skills.**
7. Interactions contributing to apparent ease: **The ease and effortlessness of performance.**
8. Responses that seem to flow: **The ability to transcend time.**

Section 7.8: Sensory Congruity and Multisensory Integration

Drag and Drop, Scent Attributes

Perfume bottle: **Fruity, floral, soft**

Essential oil bottle: **Calming, herbal, refreshing**

Cleaning spray bottle: **Strong, caustic, chemical**

Section 7.9: The Dynamics of Movement

Drag and Drop, Kinectic Actions

Scenario 1:

- Hinging
- Segmented
- Shiny

- Cool
- Functional
- Simple

Scenario 2:

- Symmetric
- Freeform
- Deformable
- Quiet
- Playful
- Organic

Scenario 3:

- Expanding
- Anticipatory
- Cylindrical
- Musical
- Colourful
- Balanced

Section 7.11: Summary Review Activity

Multiple Choice Assessment

Question 1:

According to Park & Alderman (2018), the way we perceive all sensory stimulation can be organized into which of the following categories. Select all that apply.

Electromagnetic

Mechanical

Chemical

Question 2:

True or False: A product must incorporate all five senses to have a multisensory aesthetic.

False

Question 3:

Which term **best** matches the following statement?

Consumer experience with products is always multisensory. Someone who perceives a product does not perceive all the information at one time, they often perceive sensory aspects in some order, where one sensory perception may lead to an expectation of the next. For example, when a phone rings, the expectation of the next sensory event is to touch the phone to stop the ringing. The senses can have different levels of importance at each stage of use.

Sensory Dominance

Question 4:

True or False: It is important to design features that contribute to a feeling of delight in product interactions so people will enjoy interacting with their products, leading to keeping them longer and avoiding discarding them.

True

Question 5:

What principle of multisensory design best matches the following definition: "A state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it" (Csikszentmihalyi, 1990).

Flow

Question 6:

A motorcycle that looks loud and powerful but has a horn that sounds soft and quiet is an example of:

Sensory incongruence

Question 7:

True or false: True synaesthetic experiences are natural and cannot be induced, although designers can use synaesthesia as inspiration in designing multisensorial products.

True

Question 8:

The following attributes best describe which category of kinetic movement:

- Straight
- Curved
- Zigzag
- Free Form
- Random
- Hugging
- Hovering
- Waving
- Spiralling
- Twisting
- Winding
- Rotating
- Encircling
- Rolling
- Fanning

Shape

Back to previous section: 7.12 Conclusion & Key Takeaways

Next section: Chapter 7 References

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Conclusion

Now that you've explored this resource, your ideas about multisensory product design will be more clear and you have new tools and knowledge to recognize that sensory, emotional, and cognitive design qualities contribute to people's interactions with products. Likewise, you've started to develop an understanding of how design decisions impact people's experience of using products, services, and environments. Clearly multisensory design features are important for supporting a user's holistic interactions with products. Lastly, given the variety of sensory factors and multisensory design combinations we have discussed, you now know that designers can choose among a wide range of features to create optimum product aesthetics and interactions.

By way of review, consider what you have learned:

- The differences among the sensory, emotional, and cognitive qualities that contribute to people's interactions with products.
- The integration of sensory and emotional attributes into products by design.
- The variety of multisensory experiences that affect the design of products, services, and environments.
- Sensory design concepts through the interactive simulations and related assessment activities in many of the chapters of this resource.
- The sensory design factors that may contribute to users' meanings and emotional responses derived from products.

This foundational information should make a significant difference to your understanding of multisensory design principles for your user-centred product design education and practice.

BACKGROUND

Did you know that sensory design education dates to the curriculum of the early twentieth-century German design school – The Bauhaus – from 1915 to 1933? Its instructors believed that, “the quality of concrete experience arising from multiple sensory sources was at the heart of their work” (Heywood, 2017; Harris et al., 2019). Later in the twentieth century Italian designers like Gaetano Pesce and Joe Columbo, explored the impact of sensory interactions in their designs in the 1980s, as did the design team at Philip's Design in the Netherlands with their 'new everyday' conceptual design explorations (Power, 2007; Power, 2017; Verbrucken 2003). In addition, an influential Sensory Turn in design was underway in the Faculty of Industrial Design Engineering at the Technical University of Delft between 2002 and 2007. It involved industrial design engineering researchers who were working on a project called the 'Multimodal Experience: Implications for Product Design' (Schifferstein & Ludden, 2002-2007; Sonneveld, Ludden & Schifferstein, 2008).

Following that project the book *Product Experience* (Schifferstein & Hekkert, 2009) was published; it was a seminal call to attention for product designers. It provided a comprehensive message to contemporary industrial designers that the design of traditional physical structures, materials, and manufacturing factors were part of a much larger approach to designing for people's experiences with products. Their book introduced the idea that product experiences are subjective and include the "awareness of the psychological effects elicited by the interaction with a product, including the degree to which all our senses are stimulated, the meanings and values we attach to a product, and the feelings and emotions that are elicited" (Hekkert & Schifferstein, 2009, p. 2). In the same book, Hekkert and Leder update the definition of aesthetics, explaining that a multisensory aesthetic is tied to sensory pleasure, through seeing, hearing, touching, smelling, and tasting (2009). This is a key premise behind our online resource.

By 2012, there was a wider disciplinary movement toward sensory awareness. Researchers in fields such as anthropology, architecture, design, engineering, psychology, neuroscience, sociology, and urban planning were also exploring sensory practices related to people's lived experiences (Frankel et al, 2021; Howes, 2019; Howes & Classen, 2013, Malnar & Vodvarka, 2004). In addition, the emphasis on multimodal design and sensory knowledge for designers was becoming more relevant given the growing complexity of people's interactions with networked products, spaces, and urban environments (Coulton, 2017, Heywood, 2017, Schifferstein & Wastiels, 2018).

This sensory focus in design was documented in the exciting 2018 Cooper Hewitt exhibit, "The Senses: Design Beyond Vision" (Lupton & Lipps, 2018), and in two recent publications, "Sensory Arts and Design" (Heywood, 2017) and "Senses and Sensation: Critical and Primary Sources Art and Design" (Howes, 2019).

Today, designers are increasingly venturing beyond the traditional emphasis on visual aesthetics; there is a need to understand, integrate, and synthesize the senses with design across all cognitive and sensory modalities (Bacci & Melcher, 2011; Núñez-Pacheco & Loke, 2018; Lupton & Lipps, 2018; Mau, B., 2018; Park & Alderman, 2018; Schifferstein & Desmet, 2006). As a result, we believe that design education will benefit from more foundational resources for integrating multisensory design approaches into the design curriculum, which is explained in the following section.

The Context of Design Education

Product design education has traditionally trained designers to determine the visual and three-dimensional attributes of products. In product design schools there is an emphasis on form-giving, according to fundamental principles governing visual and tangible properties (Frankel, 2014; Gilles, 1991; Pipes, 2009). Students also learn about user-centred issues in separate ergonomics or human factors courses and user-centred design projects (Courage & Baxter, 2005). There is often a separation in the design curriculum between learning creative design skills and human-oriented research skills, such as human factors and usability. In the former case, a good designer applies the rules of compositional unity and balance to achieve or disrupt a model of harmony (Jordan, 2002). In the latter case, user studies provide feedback for refining and adjusting a product's formal properties to meet user requirements (Kuniasvsky, 2003).

We take the approach that the visual and formal qualities of a product are part of the same domain or multisensory aesthetic as user-centred product elements, such as affordances (Norman, 2004). From that perspective, user-oriented design can benefit from a larger multisensory and cognitive set of perspectives that encompasses both compositional attributes and the broader range of design detailing for subjective multisensory product experiences.

Inspiration

While studying with Sensory Anthropologist Dr. David Howes I became aware of the growing emphasis and importance of multisensory design and user experience. As part of my PhD studies, I determined that the literature on the senses and design could be divided into four categories (Frankel, 2015):

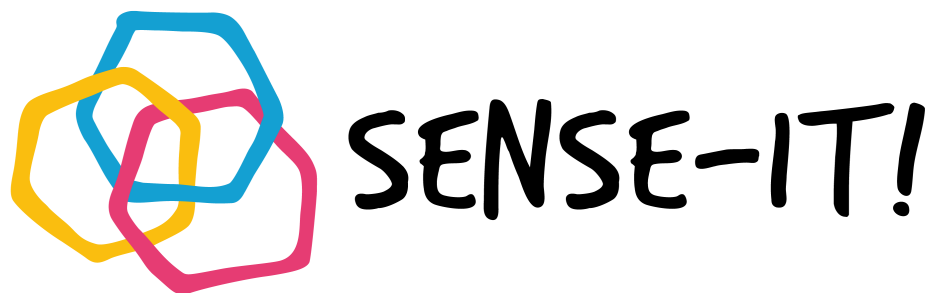
1. **Multisensory aesthetics** for product design that provide pleasurable experiences for users. This approach, which uses quantitative research methods based primarily in the field of psychology, focuses on creating an overall context for the user to engage their senses in the activities they are doing (Desmet & Hekkert 2007; Hekkert & Leder, 2009; Jordan 2000; Norman 2004; Overbeeke et al. 2003; Schifferstein & Hekkert 2008). Much of the information for this introductory online resource was extracted and simplified from this literature.
2. **Sensitizing designers** so that they will understand the multisensory nature of a user's interaction with a product. Such an integrated and coherent sensory approach is powerful for enriching the overall experience that one is designing for, as well as avoiding unwanted conflicting messages (Schifferstein 2011; Schifferstein & Desmet 2006; Sonneveld, Ludden & Schifferstein 2008). This online resource provides introductory information and simplifies information from the existing literature to fill a gap and sensitize aspiring designers to multisensory design.
3. **Sensory design detailing** provides information for designers so they can optimize the sensory features of products to enhance user experience. This realm of sensory design includes visual choices such as colour palettes and typography; sound elements, such as the background music in a shopping mall or the beep of a microwave oven; tactile qualities, like the textured handle of a power drill or the click of a button on a remote control, as well as smell and taste attributes (Garrett 2006: 39; Karana, Hekkert & Kandachar 2010; Kim & Boradkhar 2002). This resource compiles many of the principles and guidelines regarding sensory design detailing, making them easily accessible.
4. **User requirements** that specify the quality and kind of sensory feedback users need to operate a product. For example, when using a computer mouse, the tactile characteristics were reported to be the most important feedback for the user. When using a vacuum cleaner, it was the emanating sound. For a cleaning product, its smell was most important and for those drinking a soft drink, its taste was most important (Dore et al. 2007; Gibson 1966; Salvendy 2006; Schifferstein & Desmet 2007, p. 2027). This information is addressed by extensive literature in the area of human factors and ergonomics. Nonetheless, it is complementary to this qualitative introductory resource about the multisensory aspects of design and addressed where suitable.

As I became aware of these four categories, I also became inspired to include the study of more multisensory design features into the traditional designers' skill set to sensitize them about multisensory

aesthetics (Frankel, 2015; Frankel et al, 2021). I taught a Form and Colour Design Studio in the School of Industrial Design at Carleton University for close to two decades. In 2012, I began to convert that course into an applied theory lecture course, which the students named Sensory Aspects of Design. Since making a transition from studio to lecture required a big leap, I began to insert experiential modules in my lectures to keep our hands-on design students engaged. The course content was primarily adapted from information in the Product Experience book (Schifferstein & Hekkert, 2009), which was rather complex for second-year industrial design students. So, the content was simplified to become engaging, experiential, and alluring for junior undergraduate students.

To assist in this endeavour, I formed a design research group, which we ultimately named *The Sense-It! Team*. Our group consisted of undergraduate and graduate students, most of whom had taken the course Sensory Aspects of Design. We developed the experiential activities to appeal to second-year design students and expose them to the importance of sensory design as a key to enriching and mediating people's lived experiences. We conducted extensive usability testing to evaluate our learning resources and the students' ability to engage with these new ideas.

Our group has since developed a large range of educational resources for sensory design studies and presented them through papers and workshops at several conferences (Frankel, 2013, 2014, 2016, 2017, 2018, & 2021; Özcan et al, 2018). The Sense-It! team includes a design education specialist and Sensory Aspects of Design and User Experience Instructor, as well as industrial design and information technology undergraduate and graduate students. Given the synergy and playfulness of our imaginative and talented team of design research assistants and educational specialists, the modules blossomed into a set of exploratory in-class activities and related resources. Although we did not realize it at the time since we were immersed in experimentation, the work that we have been doing since 2016 contributed to the groundwork for this online resource.



Sense-It! Logo

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years. Her design research applies a sensory anthropology perspective across areas of design for ageing and disability, sensory aspects of design, and user experience. She was the sensory design editor for the Routledge Journal, *The Senses and Society* from 2015-2020. She can be contacted at lois.frankel@carleton.ca

The content for each chapter of *Sense-It!: Insights into Multisensory Design* evolved from Lois' initial course lectures and was later enhanced by Claudie St. Arnaud's subsequent lecture material. Lois, who was determined to develop this material into an easy-to-use educational resource for designers, refined the content, chapter by chapter. Her goals were to contribute to the field of design and to share the Sense-It! team's playful and novel approaches for engaging students in learning about the senses and design.

The Sense-It! Team members who are responsible for generating this online educational resource include Alanna Bamber, Dawson Clark, Kristine Hipolito, Amélie Houle, Matthew King, Lindsay McCauley, Cora Vasut, and Marta Wasiak. Only 3 are still in their undergraduate design studies, and the others are in different stages of their professional design careers. They reviewed each chapter, offering editorial suggestions and adding to the team's incredible graphics archive, developing new assets such as graphic images, animations, videos, and interactive activities, as well as publishing it all in Pressbooks. Their thoughtful creativity, enthusiasm, knowledge, and perseverance have infused this project with meaning and innovation.

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Audience

We hope that *Sense-It!: Insights into Multisensory Design* provides an easy-to-read, instructive, and interactive overview for design students, design instructors, and practicing designers who want to learn more about designing for optimal sensory interactions between people and the things that enrich their lives. It is also for those in related fields, such as applied social sciences and marketing, who want to understand the multisensory design issues that are important for people's everyday experiences with products.

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Glossary

Professional terms relevant to design:

Attributes: Properties that can be designed into a product, service, or environment to improve multisensory opportunities for people's engagement. Related to properties, factors, features, and qualities.

Design brief: A formal document that defines the client's expectations with a design problem and solution; the deliverables, limitations, and parameters for accomplishing the design task, along with timelines and costs.

Design problem: The question or considerations within which a product is to be used or experienced. Problems or challenges are the understood issues that help the designer create a desired goal for product use. Related to problem space, design challenge, and challenge.

Design research: The process in which designers, marketers, psychologists, anthropologists, and other researchers collect data about users' goals, activities, and practices with products in specific contexts.

Experiential: The nature of a personal experience. Related to experiential knowledge.

Industrial (Product) Design: A profession that focuses on the conceptual design of physical products, devices, and related services that have interactive, utilitarian, and functional uses.

Iterative design development: An ongoing development process through continual variations of design concepts. Initial concepts may evolve through iterative stages with milestones for refinement before settling on a final concept.

Modes: Sensory channels through which humans perceive their world, such as hearing, seeing, touching, tasting, and smelling.

Multisensory design: The design of multiple sensory features that contribute to layers of sensory experiences at the same time or in stages. Related to multimodal and multisensorial.

Physical appearance: A product's compositional, interactive, structural, and surface properties with which a user interacts.

Principles: Approaches to consider when designing. Related to guidelines and tools.

Product aesthetics: A term associated with the appearance of artwork, to which we traditionally assign the term aesthetics. The term product aesthetics goes beyond the concept of styling that

relates only to refining a product's visual appearance. Products can also be aesthetic or pleasant to listen to, touch, smell, or taste.

Product Experience: "Awareness of the psychological effects elicited by the interaction with a product, including the degree to which all our senses are stimulated, the meanings and values we attach to the product, and the feelings and emotions that are elicited" (Hekkert & Schifferstein, 2009, p. 2).

Sensory practices: The how, what, why, when, and where of sensorially engaging with products to achieve a desired goal. Related to product interactions.

Styling: The design skill of creating coherent and attractive compositions, which was once considered to be the main strength designers brought to the design team.

Usability: A product must be easy to understand and use, and perform its task effectively and efficiently.

User-centred design: Designing products that people can use in ways that centre on their needs, not only on the capabilities of the product. In other words, the design should fit the user; the user should not have to adjust to fit the design.

User experience: The experience a user has with a product, from first contact to post-use. User experience acknowledges that the perspective of the user must inform the perspective of the designer to develop new products and improve existing products.

Value: A quality of experience rather than a financial cost, where a user values one product or one feature more than another.

Worldview: The perspective that guides an individual's understanding of the world.