Beyond the Screen:
Embedded Interfaces as Retail Wayfinding Tools

A thesis submitted to the College of Communication and Information of Kent State University in partial fulfillment of the requirements for the degree of
Master of Fine Arts

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Beyond the Screen:
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Abstract

This paper aims to widen the discourse on experience as an economic entity, which exists within retail settings that are deliberately designed and carefully controlled by service providers to elicit desired consumer behaviors. This body of research aims to underscore the importance of in-store wayfinding within the specific context of grocery shopping in large supermarkets by investigating the current state of affairs in the art of consumer experience design and the differentiation of consumer experience through wayfinding in retail spaces.

To design retail experiences, we must first understand the elements that comprise and produce them; however, the subject of experience is complex and extensive. In an effort to expand the discussion surrounding the careful creation of consumer experiences, this paper aims to deconstruct the underlying components that contribute to our formation of experiences; examine the ways in which retail experiences are differentiated through wayfinding; and assess the overall effect of wayfinding on consumers’ perception of grocery shopping experiences, as well as their subsequent choices and behaviors.

Technology has become a ubiquitous presence in the space we occupy and pervasive force throughout our lives. We exist as part of a complex global society in which we are dynamically interconnected in a continuous exchange of information and experience. This paper suggests ways in which cutting edge and emerging technologies can be embedded into the
underlying physical structure of retail environments—effectively infusing the store environment with highly targeted, personalized and anticipatory communication, with specific regard to the improvement of wayfinding in large grocery retail stores.

Additionally, this paper aims to advance the discussion surrounding the use of emerging technologies not only as tools in the production of final artifacts destined three-dimensional environments; but also, as moldable media that can reorient our way of thinking and improve problem solving within existing modes of interaction, communication, cognition and representation.

The potential of computing has not yet been fully realized and may always exist as an evolving entity within our lives. Despite its ambiguity and uncertainty, our current technological landscape demonstrates great potential in the generation of new conceptual and practical approaches, theory and methodologies, which transcend the current understanding and purpose of computing and foster the development of intuitive, relevant experiences in interacting with digital media.

**Keywords:** Retail, grocery, supermarket, superstore, Consumer Experience (CX), Experiential Graphic Design (XGD), experience economy, User Experience Design (UXD) wayfinding, ubiquitous computing, pervasive computing, embedded interface, distributed cognition, Human-Computer Interaction (HCI), Virtual Reality (VR), Virtual Environment (VE), Augmented Reality (AR), prototyping methods.
Chapter I

Introduction

There has been a paradigm shift in post-modern consumer preferences from large retail superstores to smaller convenience stores as a result of our economic evolution towards commoditization of experiences as economic goods. Consumers place a heavier emphasis on fulfilling their niche needs based on convenience; while retailers have begun to differentiate themselves through the production of highly-designed shopping experiences as a way to solidify the top spot in the consumer’s preference hierarchy.

Consumers are bombarded with a surplus of information inside of a retail supermarkets—especially so in even the most successful “big box superstores,” such as Walmart, Target and Costco (Kantar Retail, 2014). Steering around other people, glancing at a shopping list, the smell of the candle aisle, the taste of a food sample, or the wobble of the cart from a bummed wheel only describes a small fraction of the multi-modal deluge that can overwhelm a shopper—all of which culminate to produce their shopping experience.

Sometimes shoppers visit a store only to peruse the aisles, people watch or window shop on a Sunday morning, but grocery shopping can be seen as quite different because it is a need-based activity—something we have to do. Because of this, grocery shoppers in particular, want to be quick; to go in the store, get what they need and get out, without having to ask for help or spend more time shopping than planned.

When a shopper is trying to locate a grocery item in large and complex retail supermarkets, visible and understandable wayfinding tools become crucial, especially if they’re searching for an item they don’t purchase on a regular basis or are new to the store. Even if the shopper is familiar with layout and product placement, the limit of our sensory perception and
cognitive abilities means that signage and other navigation cues still remain important tools that are required to negotiate the store.

It is critical those cues are visible, straightforward and simple. In retail superstores, wayfinding tools are often unavailable or inadequate because of inconsistency, substandard placement and poor visibility. Furthermore, many large retail stores are designed to include a certain amount of disorientation in an effort to encourage consumers to stay in the store longer and increase the likelihood they will purchase more items. As a result, shoppers spend more time inside the store than anticipated, become frustrated and sometimes leave without purchasing anything.

Store design tactics and retail wayfinding tools should empower shoppers with useful information, rather than incapacitate them with too much or not enough of it. This empowerment can have a dramatic effect on a customer’s shopping experience, behavior and overall perception of the retail brand (Aust, 2006), which has direct and measurable effects on a supermarket’s profitability, success or failure.

As our technological capabilities continue to grow in leaps and bounds, computing has and will continue to become ubiquitous in our lives. As such, computer interfaces are increasingly engrained into the spaces around us in ways that often make it difficult to discern the difference between interface and environment. Embedded interfaces are improving environments and brand experiences by making them more responsive to shopper behaviors, wants, needs and limitations.

These interfaces are more dynamic than traditional signage and encourage shoppers to stay and interact with products longer (McConnell, 2014) in ways that evoke positive emotions and outcomes, instead of frustration. As shoppers traverse a store, the act of navigation is a
constantly evolving background task that can be improved through embedded interfaces. A ubiquitous system of embedded interfaces can provide more intuitive, context-appropriate and reliable direction through more passive and even subconscious forms of interaction that require little augmentation to existing objects.

Information can be infused with the store’s physical space and objects within it—floors, carts, baskets, clothing racks and lighting, just to name a few. Context-aware interfaces embedded within these items can sense the environment around them and use that information to engage shoppers in a way that is more consistent with natural human behavior (Abowd, 2002). “It’s the idea of an experience going on in the background without a direct customer interface or touch to a control. There is an initial exchange of information about you as you enter the space and that information might inform other parts of the experience” (McConnell, 2014).

Research shows that the most effective wayfinding tools should enhance shopper understanding, awareness and locatedness; allow shoppers to quickly decide which aisle they need; and help shoppers find items once they’re in the aisle. With regard to navigating, embedded interface designs should satisfy all the previous requirements, while also encouraging the development of or by actually providing new and different way of thinking and interacting with the store space. As such, a ubiquitous system of context-aware interfaces embedded in store environments could help shoppers better navigate the store; in ways that are more intuitive, anticipatory and satisfying than traditional, non-digital wayfinding systems.

There is currently a lack of understanding and means to develop these types of ubiquitous systems with regard to retail wayfinding; evaluating these areas of consideration will also require new metrics and mediums. The concepts explored within this thesis has given rise to insights that were used to form a set of recommendations for consideration in the conceptualization, design
and evaluation of embedded interfaces in general, and for use as wayfinding tools in retail superstores.

These recommendations are meant to serve as a foundation for exploration, understanding and discussion, as well as an aid in defining heuristics and techniques to measure and evaluate an embedded interface’s effectiveness. However, wayfinding is just one among a plethora of applications for this type of interaction and experience design. The initial objectives of this study were not to drive sales or target consumers with ambient communication outside of the store, but expansion into those areas seems like an appropriate next step its progression.

As these practices and technology evolve, their implementation has great potential for adaptation beyond wayfinding that includes pre- and post-store communication. Elegant context-aware embedded interface solutions can be expanded into more specialized applications aimed at driving sales; producing highly-targeted marketing and advertising; inducing, understanding and even anticipating consumer behaviors, wants and needs—ultimately creating very rich and uniquely individualized digitized shopping experiences. Additionally, the concepts, methods and recommendations discussed in this paper may serve as an evolving model for consideration in fields beyond the retail and consumer experience sectors, such as environmental design, industrial design and human-computer interaction, just to name a few.

**Chapter II**

**Understanding the Current Retail Climate**

Throughout history, manufacturing and technological advances have repeatedly changed the landscape of store-consumer interaction. Recent consumer trends show that we are again undergoing a significant shift in the attitudes, behaviors, preferences and expectations of
consumers. In response to the changing consumer climate, the practices and strategies of major retail superstores are also evolving.

A discussion of the historical evolution of the manufacturing industry will help develop an understanding of the factors that have contributed to the current trends of post-modern consumer society. Situating their interpretation within a larger landscape of social, technological and economic contexts can provide clarity in understanding how consumer society evolved to its current state of an “experience economy” and what that might mean for any fields related to retail design.

**A Brief History of Consumerism**

Great advances in science, technology and energy production brought dramatic and generally positive changes to the agricultural and manufacturing industries in the early nineteenth century. The resulting mechanization and globalization of the manufacturing industry made it possible to produce higher quantities of products in many locations, but often at a lesser quality. A new “consumer democracy” was formed on the basis that style, symbols and views of the upper class could be re-created and made available to those who are less affluent. This was accomplished though low-cost, mass produced products that resemble possessions of the wealthy, however poor their materials or construction (Davis, 2012).

Unlike the times when a single artisan controlled the design and hand production of a product from the beginning to the end, modern manufacturing requires collaboration between often large groups of people over vast distances, many of which only possess knowledge to complete the small part of the process they distinct to their environment (Davis, 2012). The geographic fragmentation of manufacturing across large distances also breaks the connection that the product-producers have with the product itself.
Compounding this issue is an increase in automated processes, which take the human hand almost, if not entirely out of the manufacturing process. Often pieces of products are machine-aided manufactured in different locations as separate portions of a larger whole before being shipped to another location to be assembled. Products are again shipped to yet another location for sale, which may be completely disconnected geographically, culturally, and socially from the community or communities the product was created in.

Figure 1: An image of the globalized supply chain of a laptop from Sourcemap, an open-source web tool that allows users to track the journey of a product from raw material to end use. The high, and possibly even excessive quantity of goods in production was not isolated to making just many of the same thing. Brands began to differentiate their products from the other guys’, as well as diversify the product offerings within their own brand—each serving the same basic purpose, but tailored to suit a specific preference through slight differentiation in color, flavor, material, and so-on.

A flood of low-quality products that were hyper-specialized in their differentiating attributes created a specific need for brands to be able to speak to consumers through a steady thread of advertisements encouraging them to buy their brands and their products—most often
because of an intangible “value” that often has little to do with the actual make-up of a product or the purpose it serves.

Instead, brands attempt to ascribe intangible values to their products or entire brand identity such as a perceived social status or an aspiration to purchase items that are just outside of their means to complete a “set”. Brand names are used to identify, label or symbolize abstract values such as quality, status, or reputation and are a means for differentiating one product, service, manufacturer or retailer from another (Hollenbeck & Zinkahn, 2006).

The culmination of these events bore a new consumer society—one that exists as a social and economic system that is sustained through the creation of desire in advertising and behavioral and social codes through consumption; a society that lives to consume, rather than consuming to live, as in centuries past.

**The Experience Economy**

During the Industrial Revolution of the nineteenth and twentieth centuries, the industrial and manufacturing industries were automated and globalized, allowing brands to produce many products for little cost and distribute them across a wide area (Davis, 2012). The flood of inexpensively produced goods created a consumer society, in which retailers sustain themselves by developing a desire for shoppers to purchase their goods and services in increasing amounts (Davis, 2012). As more retailers began to carry the same types and amounts of products and services, the need to differentiate themselves in other ways grew more important.

Now, in the twenty-first century, retailers have begun to create intangible experiences in addition to providing goods and services, as a way to separate themselves from other stores and gain consumer preference and loyalty (Gilmore and Pine, 1998). Within a historical context, the evolution of consumerism has reached a critical point. Leading up to the current time in
consumer history, the entities that provide economic value for retailers have progressed from providing goods and services to also include the creation of memorable experiences (Gilmore and Pine, 1998).

Current trends show that consumers are no longer interested in traversing a large and often confusing store space to sift through a multitude of products in the interest of being able to “find everything under one roof.” Nor do they place a higher emphasis on intangible brand benefits and experiences than they do satisfying their own immediate shopping needs. Today’s post-modern consumer is a product of niche marketing, in which the consumer seeks to satisfy a product selection and shopping experience that is hyper-specific to their personal needs and preferences, rather than what is preferred by “the masses.”

At the most basic level, retailers’ lifeblood is the revenue gained through consumer relationships and patronage. This revenue can be increased by cultivating relationships with new customers, encouraging current customers to spend more time and money in their store and by extending the duration of the relationship—seeking customers for life (Babin and Attaway, 2000).

Experiences have emerged as the next step in the progression of economic value that will solidify consumer relationships with retailers (Figure 2) (Gilmore and Pine, 1998). This advancement of value shows that customizing goods turns them into services; customizing services progresses into an experience; and those customized experiences can be transformative for consumers and retailers alike (Pine & Gilmore, 2000). Brands and retailers must create both economic value, by supplying goods and services, as well as experiential value, by providing the consumer with a meaningful and memorable experience to maintain their loyalty.
The progression of our consumer society into one that expects a certain level of experience can be described through metaphor; consider the evolution of the traditional birthday cake:

“During a time before the economy became industrialized, mothers made birthday cakes from scratch, combining farm commodities such as flour, sugar, butter, and eggs that together cost mere dimes. As the industrial economy advanced, moms paid a few dollars for premixed cake ingredients from brands, such as Betty Crocker or Sara Lee. As the goods-based economy progressed into one that focused on services, busy parents began to order cakes from a bakery or grocery store for $10 or $15 (or even more depending on size and complexity)—a price more than ten times the cost of the packaged ingredients.
Now, even services such as baking and decorating a cake have become commoditized as the economy progresses into one based on experiences. As parents become more and more pressed for time, they neither make the birthday cake nor throw the party. Instead, they sometimes spend several hundred dollars to “outsource” the entire event to destinations such as Chuck E. Cheese’s or the Discovery Zone that stages a memorable event for kids (Gilmore and Pine, 1998).

This analogy illustrates the importance of consumer experience. Many retailers place a high value on the creation and quality of the shopping experience within their stores. Other retailers, most often smaller in store size and product selection, ignore the element of experience in lieu of serving their basic economic function of providing goods and services. However, merely making products and services available to consumers will no longer suffice for large corporate grocery stores such as Walmart, Target and Costco. Our existence within an economy of experience continues to evolve consumer expectations into increasingly niche and stringent requirements.
Small convenience stores, for example, place less emphasis on creating a themed experience and more emphasis on making it easy for consumers to get what they need and get on their way. In fact, being convenient and quick are part of what contributes to building a favorable experience for small stores such as 7-11, Circle K or local mom-and-pop stores. These stores usually serve a small, local customer base and rely heavily upon each customer’s return to keep their business afloat. Little time and effort is spent infusing the store’s brand name with abstract qualities and values that have relatively short-lived, tangible or perceivable benefits for the consumer. Instead, the brand places their efforts into serving its customer.
The consumer experience trend has gained traction in stores, such as Giant Eagle Market District, which provides live music and in-store cooking demonstrations as a way to create a more engaging shopping experience—one that goes beyond just making goods and services available to shoppers (Figure 4). In an increasingly competitive environment, the potential for experiential value is still yet to be fully exploited in the grocery sector. Stores that can properly balance providing tangible goods and services with creating personal and memorable experiences for consumers will outperform their competitors in the race to gain consumer loyalty.

Figure 4: Store exterior and interior of Freshway, a small locally owned convenience store in Akron, Ohio. The store uses a minimal level of design and carries a narrow product selection.

Figure 5: LEFT: A local band plays live music outside of a Giant Eagle Market District in Columbus, Ohio (Lenz, 2004). RIGHT: Shoppers watch and engage with professional chefs during an in-store cooking demonstration and tasting event (Friends of Mediterranean Meat, 2014).
Many large retailers, such as Target, have taken a more consumer-centric approach to their store environment and experience—laboring tirelessly to create a highly-designed and branded shopper experience both inside and outside of their stores, and at each step in between. Other retailers, such as Walmart, Safeway, Whole Foods and Giant Eagle attempt to construct more intimate and pleasant shopping experiences by creating what have been affectionately dubbed the groceraunt. In these stores, special areas of the store are carved out for small bars, pubs, specialty cafes and eat-in or take-out food (Barclay, 2015)—all in addition to the basic products and services found in a grocery store (Figure 5).

However, it behooves designers and retailers to question if additional services and highly-designed experiences that extend beyond basic grocery store product offerings are the answer to creating a pleasant shopping trip? These tactics may be futile in the effort to gain and solidify consumer loyalty and repeat patronage because there are a multitude of factors (beyond frilly branding or store demonstrations) that can affect how we form, perceive and classify a shopping experience as good or bad.

Despite the emerging experience practices from grocery stores, the concept of consumer experience is still quite vague. Designers and retailers currently lack a sound theoretical basis that helps us understand the cognitive and emotional origins of experiences and the contextual components that contribute to the formation and perception of an experience. Such an understanding is critical to explaining and exploiting the differences between goods, services and experiences, as well as forming approaches to experience design that will be successful (Fitzsimmons and Fitzsimmons, 1999).
**Bigger Isn’t Always Better**

There is some merit in asking if the frills of a meticulously well-designed brand name, store and shopping experience are getting in the way of what consumers are actually trying to do: buy products that serve specific, tangible purposes. Instead, the retailer is placing a larger amount of design efforts into serving the niche needs of their customers. Traditional grocers are increasingly losing market share—some 15% in the past 10 years—to competitors like smaller markets, convenience stores, farmers markets and even dollar stores (Barclay, 2015).

"In the 1990s and the beginning years of this century, the greatest threat to supermarkets and grocery stores came from supersized 'one-stop shopping' venues like supercenters and warehouse clubs. Today the threat is spread out among all retail channels, including drugstores, dollar stores, limited assortment chains, and—the elephant in the room—e-commerce (Peterson, 2014)."

A 2014 Consumer Reports survey revealed that one-third of respondents reported that on average, they shop at five different types of stores to fulfill their grocery needs. Examples of store types include supermarkets like Kroger and Safeway; supercenters, such as Wal-Mart; discount clubs like BJ’s and Sam’s Club; and online stores (Peterson, 2014).

If consumers have the option to get everything they need under one roof, as with many superstores, then what drives them to visit multiple stores? Some shoppers may simply be overwhelmed by the paradox of choice (Schwartz, 2004). The trend could also be a result of few stores offering the precise mix of value, quality, and private label brands that consumers are looking for (Peterson, 2014).
The modernization of our manufacturing industry has allowed for the expansion of niche markets and a flood of products with slightly differentiated attributes, each to fit the preferences of a very specific and ever-shrinking target audience. The highly personalized and precise approach to shopping reported by consumers is a direct result of the ideals created by niche products and markets that were spurred by the advancements in manufacturing and technology discussed in Chapter 2.

In response to the growing threat from smaller grocery retailers, recent trends show that average grocery stores have started to follow suit; Store sizes have begun a downward slope in square footage since 2006, and currently average about 45,000 square feet (as opposed to the 260,000 square feet of a Walmart superstore (Ausick, 2014) (Figure 6). This shift to smaller store sizes is the first one of its kind for contemporary consumerism, after years of increasing store sizes through the 1990s and early 2000s. (Barclay, 2015). Again, the pendulum is swinging back toward smaller businesses as it was before manufacturing modernization.

![Retail store size comparison](Figure 6: Retail store size comparison. Since 2006, the average size of retail stores has shrunk from 260,000 to 45,000 square feet—more than 5 times smaller than before.)

Grocery retailers have shown an interest in creating stores where the typical customer makes short visits several times a week, as opposed to a long-haul, once-a-week shopping visit.
Walmart, a pinnacle retail superstore, has expanded their efforts to develop its small store formats, such as Walmart Express (Ausick, 2014), especially in urban neighborhoods, to compete not only with local grocers but dollar stores as well. This trend is also being replicated with several other large grocery retailers such as Publix, Hy-vee, and Kroger (Tuttle, 2014).

Dramatically smaller stores do require some compromises as Tim Stupka, Assistant Vice President of Operations for Hy-Vee’s northern district, explained in a 2015 Time article:

“In one of [the larger] stores, we may have 40 kinds of Hamburger Helper, [in the smaller stores] we have ten, or, instead of having four different types and styles of bananas, we have two. We have pretty much everything those stores have, but we don’t have as many varieties (Tuttle, 2015).”

Although smaller stores often translate to a smaller product selection, they do offer a less time-consuming and more convenient option for consumers that do not wish to spend more time than necessary navigating long, multidirectional aisles, or waiting in long check-out lines. A growing majority of consumers do not actually want to have to make a purchasing decision between many brands of the same product, which may not actually be of distinct quality, flavor, price, and so on. A less overwhelming product selection may not actually be such a bad thing, since consumers are rejecting the paradox of choice in lieu of less choices between products with more distinct and differentiated attributes.

Aside from being easy to navigate and providing a more streamlined shopping experience, small store spaces also create a more intimate connection between the shopper and store employees. Employees are more visible and available to shoppers for help finding an item, or to answer questions about a product or brand, for example.

Consumers may sometimes prefer smaller stores with fewer choices because they are
simply more convenient. This type of store structure and environment design place a heavier emphasis on their core purpose: acting as a middleman between the manufacturer and consumers to make products and services available for purchase. Many small markets and convenience stores often create very little brand materials and place less focus on their store experience and more of a focus on the customer and what they need.

The upswing in consumer traffic at small convenience stores suggests that the consumer may place less emphasis on the apex and all-encompassing shopping experience than many retailers had anticipated. It may also suggest that certain brand-ascribed, intangible values, such as “Living better” (as Walmart’s slogan touts) or shopping somewhere to be considered trendy, are less important to the consumer than other more direct benefits, such as time and location convenience, product selection and ease of shopping.

The current shift in consumer behavior from periodic long shopping trips at large retail superstores to visiting multiple small convenience stores several times a week, points to a need in the consumer market that is currently not being met by any one store or brand. Many grocery chains have sought to offset this change through creating smaller stores or beefing up their brand experience within the store, however, it behooves us to ask if building more stores of smaller size is really the solution.

There is some merit in understanding how the physical store space and the arrangement of products within it could be contributing to shifting shopper behaviors. Large retail store layouts are often designed to keep the shopper in the store longer and purchase more. Common trends in product placement within large retail spaces force the shopper to walk past as many products as possible to find the most commonly purchased items—there’s a reason that milk and eggs are usually located in the back of the store; and that’s just part of the store’s intended
experience. However, today’s consumers are looking for a streamlined shopping trip; experiences that purposely force a shopper through a maze of products with little direction, may cross the line into frustration; and that is likely not the type of experience the retailer intended.

As goods, services and experiences become commoditized across grocery retailers, it may become increasingly important for stores to leverage their customers’ unique individual needs and behaviors to create positive and memorable experiences. The uniqueness that is inherent to all experiences is perhaps the most promising area with which richer experiences can be created. Current technology has yet to be leveraged to its full benefit within the larger retail superstores that already exist. One blaring question still remains: how can we better consumer experience in superstores by streamlining a shopper’s store visit to better meet their unique needs and expectations.

Products and services are external to the consumer, while an experience is inherently internal, and thus, personal—it exists only within the mind of an individual. No two experiences will ever be exactly the same because each experience derives from the interaction between the store environment and the individual’s current state of mind (Gilmore and Pine, 1998). Likewise, no two individuals will perceive the same experience in exactly the same way. It would not be feasible to expect all shoppers to interact with the store environment in an identical manner. Furthermore, the varying personal needs, wants, goals and constraints of each individual shopper can be leveraged to design favorable experiences through more useful interactions and personal connections to the store environment (Pine & Gilmore, 2000).
Chapter III
Understanding Experience

Experiences are intangible; however, they are not structureless or indeterminate—they evoke deep emotions, create lasting memories, affect behavior and produce contextual outcomes just as much as the consumption of any product or service. A well-designed experience can gain and solidify consumer preference, while inciting emotions and behaviors that are fulfilling for both the retailer and the shopper. However, we must first understand the cognitive, contextual and emotional elements that define an experience, before we can begin to design them.

What is an experience?

Experience is a broad term that refers to any sensation or knowledge acquisition that is a result of a person’s participation in his or her daily activities. As human beings, we experience things all the time, no matter what we do. Merriam Webster’s Dictionary defines experience as the fact or state of having been affected by or gained knowledge through direct observation or participation; something personally encountered, undergone, or lived through; and the act or process of directly perceiving events or reality.

Shopping experiences, like goods and services, have their own distinct qualities and characteristics (Figure 7). Experience economy researchers suggest that a shopping experience occurs when a retailer intentionally uses services as a stage and goods as props, to engage individual customers in a way that creates a memorable event. Experiences, like goods and services, must meet a customer need; they have to work; and they must be deliverable and memorable (Gilmore and Pine, 1998).
The philosopher John Dewey suggested that there are certain conditions that qualify an experience as distinct from other events in life. The experience must have a beginning and an end. We can mark a beginning and an end to experiences in ways we cannot demarcate other passages of time. A conversation, for example, can be ended so that its close is what Dewey called a *consummation and not a cessation* (Davis, 2012). In other words, an experience can be “wrapped-up” or “finalized” instead of just abruptly ending or stretching on forever. For example, a grocery shopping experience may begin with a shopper searching items on the store’s website and end after the shopper has visited and then exited the store.

An experience must also be made up of several distinct parts that flow together to form the entire experience (Davis, 2012). A shopper may remember getting a cart, stopping at the deli and checking out as separate parts that made up a shopping experience. Dewey’s third criteria for experience is that it must be described in terms that are dictated by the individual, so that the
experience is recalled as distinct from all other experiences (Davis, 2012). Shoppers may refer to “that horrible time I had shopping” or “the best shopping trip I’ve ever had” as distinct events from all other shopping trips.

Lastly, Dewey suggested that experiences must involve a structure that alternates between doing and undergoing. Doing is the physical or sensory interaction that we associate with experience. Undergoing is the mental reflection and emotion necessary to interpret what is being done (Davis, 2012). For example, a shopper will search for a product they need (doing) and once the product is found, feel as if they have satisfied one of their shopping tasks (undergoing).

The Components of Experience

As part of an active, dynamic world, humans are continually observing, analyzing, and acting upon the environment. A person’s actions are closely tied to their perceptions and overall experience—each sensory system adding to the general picture of the environment. The overall experience is formed from all the information impinging upon the sense organs, spanning from prior experience and knowledge, to the interpretation of the current state of what’s around them (Norman, 1992). Understanding how we form experiences requires a breadth of knowledge that encompasses human emotion, physiology, psychology, behavior, cognition and perception—among many other subject areas.

Context and cognition. Context and cognition are particularly important when considering the components of an experience. When talking about a grocery store, context stands for the physical setting, selection and arrangement of products, other objects and people in the environment, and the rules and procedures that govern social interactions with others shoppers
and store employees (Fitzsimmons and Fitzsimmons, 1999). Cognition is the mental action or process of acquiring knowledge and understanding through thought, experience and the senses.

Context and cognition are tightly intertwined, generating and transforming each other in a dialectical relationship. The Situated Action Framework describes cognition as a process that is integrated into a person, their actions and the environment (Fitzsimmons and Fitzsimmons, 1999). In other words, cognition is inseparable from one’s ongoing activities—humans cannot simply stop thinking and that constant stream of thought, experience and sensation shapes an individual’s perceptions and behavior.

More specific to grocery shopping experiences, the Situated Action Framework best describes how choices are formulated and decisions are made in relation to purchasing behavior, based on the mutual relationship between store context and shopper cognition. The context physical and social circumstances of the environment affect the shopper’s experience in the store. Store environments can vary widely across retailers and any change in these circumstances will modify the shopper’s interpretation of their surroundings, and thus, their behavior and experience.

Within a given store environment, each individual shopper will form his or her own unique use of the environment based on activities and thought processes previously experienced in that setting (Fitzsimmons and Fitzsimmons, 1999). These unique uses of the environment also help to form the social and physical contexts within a grocery store. This cycle of situated action (store context affects shopper cognition, while shopper cognition affects store context) shows that consumer preferences are not static, but are unique and dynamic—constantly evolving according to the context surrounding an individual shopper. As such, the framework used to analyze an experience should include contextual areas, such as social interaction, organized
activities, and store culture, as well as a shopper’s emotional state and cognitive tasks (Norman, 1993).

Grocery retailers should be particularly interested in understanding how context—or environment—and cognition are connected with emotion in the construction of an experience, as patronage frequency, shopping duration and purchase outcomes all may hinge on the emotional impact a store has on its shoppers. A better understanding of these connections could help stores to design their environments in ways that elicit desired emotional and behavioral shopping outcomes for the retailer and consumer.

Interaction over time. The interactions a shopper has with a store over time shape a shopper’s context, cognition, schema, expectations, and ultimately, his or her experience. Grocery retailers must understand how the interactions of shoppers with parts of the store environment shape their perception and thinking in order to design successful experiences (Fitzsimmons and Fitzsimmons, 1999).

Figure 8: LEFT: The bar at the Hard Rock Café in Baltimore, Maryland (Vacations Made Easy, 2015). RIGHT: Customers enjoy a show at the Disneyland House of Blues in Anaheim, California (Disney, 2015). Both venues provide engaging and highly designed and themed experiences; however, customers are only intended to consume the experience, rather than actively participate in how the shows, events and environment evolves to form their experience.
Shopper interactions can be divided between passive interactions, in which customers do not affect the events that make up the experience at all, and active interaction, in which customers play a role in how the experiential events unfold. Most experiences, in restaurants such as Hard Rock Café or House of Blues for example, are designed to be unidirectional—the customer is meant to be influenced by the environment and events within it, while they are assumed not to participate in the creation of those contexts (Figure 8). This strategy inevitably fails to create a rich and memorable experience that is enhanced over time with repeated interactions because they do not account for the unique role of customer participation plays in shaping their own environment and experience (Gilmore and Pine, 1998).

Shoppers who are interested in purchasing an experience value what a retailer reveals over a duration of time (Gilmore and Pine, 1998). More specifically, an experience involves learning over a period of time, during which customers interact with various elements of the context created by the retailer (Fitzsimmons and Fitzsimmons, 1999). Over the course of these interactions, the activities of the consumer and the context created by the retailer reinforce each other, as the shopper’s mental activity (cognition) and environment (context) fuse in the production of a unique and memorable context-specific shopping experience (Fitzsimmons and Fitzsimmons, 1999).

**Perceived value.** What can boost the consumer’s perception of a retailer from just being consistent and reliable could be a more concerted effort to use current technology to their advantage to provide tools that aid the shopper in completing their goals, rather than focusing on fancy cooking demonstrations or the like to create an enjoyable experience.

In essence, the large retail chains should focus first on covering the basics needs of a shopper before moving on to more complex, emotional wants. Being able to find what you’re
looking for may go much further in creating customer loyalty than having a band play in the store, for example. You may sit and watch the band for a moment and feel a sense of enjoyment from that, but how gratifying is the overall experience if after listening to the band, you had to traipse around the store for an hour looking for sugar?

![The Consumer Experience Pyramid](image)

**Figure 9:** The Consumer Experience Pyramid shows that at the very least, consumers expect to have their needs met. Beyond merely meeting needs, consumers also want their interactions with retailers to be easy and if possible, enjoyable (Sanders, 1992).

Shopper interviews done in the primary phases of this study show that grocery shoppers are less concerned with all the frills of an over-branded shopping experience (Appendix B). Instead, they view grocery shopping as a basic task and are more satisfied with just getting what they need and moving on with their day.

Shoppers seek a reliably consistent experience that satisfies their immediate needs of purchasing what they need, and doing it in a timely manner. While this notion seems rather simple, it satisfies all three levels of the Consumer Experience Pyramid (Figure 9). Customers
form a need and an end goal to find and purchase an item. If the consumer can accomplish their
goal without having to work hard to do so, on a consistent basis, they can feel a sense of
enjoyment that they were able to reach their goal and feel confident it will happen again in the
future when visiting that particular store. This degree of confidence and reliability can serve as
the core of their brand loyalty to that retailer.

The importance of the shopper easily making intended purchases cannot be overlooked,
as it provides both utilitarian and hedonic shopping value for the shopper (Babin and Babin,
1999). Furthermore, the overall perception of value of a shopping trip is an assessment of both
tangible and hedonic consequences (Babin and Attaway, 2000). Utilitarian value reflects task-
related worth (having food to eat), and hedonic value reflects worth found in the shopping
experience itself, such as window shopping (Babin and Attaway, 2000).

From a task-oriented standpoint, shopping can be valuable because a consumer finds an
intended item, receives an intended service or gathers useful information. From a hedonic
standpoint, shopping can also provide experiential value in the form of immediate personal
gratification (Babin and Attaway, 2000). As shoppers satisfy each of their shopping goals, they
feel a sense of personal accomplishment that increases the probability that they will shop longer
to continue the gratification (Babin and Babin, 1999).

It is important to remember that experiential value is just one side of a dichotomy; at the
other end is economic value—tangible values that have noticeable and measurable outcomes.
The basic purpose of a grocery store is to act as an intermediary between brands and consumers
by making goods, services, (and now) experiences available for purchase and consumption.

That is not to say that experiential value is less important than economic value. The
expectation of a good experience can have a heavy influence on shoppers’ store patronage and
purchasing behavior (Gilmore and Pine, 1998). A desirable grocery store experience can often be a result of satisfying functional, need-based expectations. Grocery shoppers in particular do not necessarily visit the grocery store because they are in need of an experience. Instead, the experience is a byproduct of the shopping trip—the shopper found and purchased what they needed quickly and easily. That experience builds a schema—or memory, perceptions and expectations for the next shopping trip to that location.

**Schemas.** A schema is a mental structure we use to organize and simplify our knowledge of the world around us. We have schemas about ourselves, other people, places we visit or have never been to—almost everything. They are cognitive structures based on past experience that are specific to a certain context (Abelson, 1976), helping organize our spatial and temporal knowledge about objects, events and places (Mandler, 1984). Schemas affect what we notice, how we interpret things how we behave and make decisions. They act as filters, accentuating and downplaying various elements of objects and situations. We use them to classify things, such as when we ‘pigeon-hole’ or pre-judge people. They also help us forecast, predicting what will happen. We even remember and recall things via schemas, using them to provide a mental framework for understanding and remembering information, or encoding memories (Mandler, 1984).

The schema theory was developed from studies of memory in which subjects recalled details of stories that were not actually there. For example, the experiments of Bransford & Franks (1971) involved showing people pictures and asking them questions about what the story depicted; people would remember different details depending upon the nature of the picture. Schemas help us fill in the gaps. When we observe something and process that information, a schema will tell us much about its meaning and behavior, enabling threat assessment and other
forecasting. They act as a sort-of cognitive short-cut to understanding the world. Without schemas, we might spend much of our cognitive energy evaluating and re-evaluating everything about the world.

Schemas are the basis for how shoppers form specific expectations for a grocery shopping experience. These expectations help guide shoppers’ store choice, define how they will interact with the store environment, and influence their emotions and purchasing behavior (Block and Morwitz, 1999). Since grocery shopping is a repeated and utilitarian task, shoppers may develop particularly fixed schema that affect their expectations, emotions, behavior and thus, their overall shopping experience.

For example, consumers may have schemas for shopping at familiar grocery stores, in which they know the store layout and have a mental map of where items are located (Block and Morwitz, 1999). Consumers may have schemas for groups or categories of items. The schema for salad might include lettuce, tomatoes, cucumbers and carrots, while a Thanksgiving dinner schema might include turkey, cranberry sauce, sweet potatoes and apple cider (Block and Morwitz, 1999).

Since grocery shopping is a need-oriented activity, or something we have to do, shoppers tend to form rather simple perceptual schemas of grocery stores (Uusitalo, 2001). These schemas are constructed based on the consumer’s own shopping goals and constraints, as well as the physical and functional features of the store (Uusitalo, 2001). Store size, prices, product range, store location and journey time are some of the most important functional features that help to define these categories (Uusitalo, 2001). Product or service needs, time limitations and past shopping experiences also define the shoppers’ perceptual categories, and ultimately, their store
choice based on which store will best meet their needs (Uusitalo, 2001). For example, if a shopper is running short on time, they may opt to visit a smaller grocery store or one that is less crowded in an effort to expedite their trip.

The feelings experienced while interacting within an environment are stored in memory, and over time, create a schema that can alter a shopper’s cognitive and emotional reactions (Babin and Attaway, 2000). Again, the importance of interaction over a period time is underscored, as the structures of a shopper’s grocery store schemas are influenced by his or her past experiences in similar situations and are constantly evolving by being reconstructed throughout each experience. Each time a shopper uses their schema to make purchase decisions, they develop expectations that become either reconstructed or reinforced over extended periods of time. Put succinctly, a shopper’s previous experiences build schemas that evoke emotions, these emotions help determine value, and that value determines the shopper’s decision to patronize a given store.

**Emotion.** Emotion has been shown to play a key role in the formation of shopping experiences and schema. A shopper’s emotional state can be used to explain certain behaviors and decisions, such as store choice and consumer–environment interactions and reactions (Babin and Babin, 1999). Each aspect within the store environment will affect shoppers’ emotional state, and thus, influence their experience within the store (Babin and Babin, 1999). Each element, such as a store’s employees, prices, lighting, scents, product assortment, background music, and crowdedness are all crucial to how the shopper will perceive the store. The store elements also influence their shopping intentions, spending, quality perceptions, satisfaction and value (Babin and Babin, 1999).
Many of the emotions shoppers feel as a reaction to the grocery store context are a result of subconscious visceral responses. Humans have developed an amazing amount of subconscious visceral behavior because of evolutionary biology (Norman, 2009). Humans dislike bitter tastes, loud sounds, scolding voices, overly hot or cold temperatures—all because we have been biologically trained through evolutionary experiences (Norman, 2009).

Researchers agree that the first visceral emotional response to a context or environment generally guides an individual’s subsequent relations with that context (Machleit and Eroglu, 2000), pointing to the importance of a shopper’s visceral responses to a store’s environment in shaping their experience. A study published by Machleit and Eroglu in 2000 found that shoppers feel a range of emotions from joy and surprise to anger and frustration, based on the store qualities or environment and the shopping tasks involved.

In grocery stores, these visceral responses can be evoked in a number of ways: using red to signify a discounted item or a font choice that reflects handwriting for an organic produce section (Figure 10). Even subtle changes can change a shopper’s emotion in one store versus another (Babin and Babin, 1999). Situational and atmospheric aspects of the grocery store context, such as time constraints, routineness of the purchase, bright lights, loud music or crowding can enhance or inhibit the different types of emotions experienced by shoppers (Machleit and Eroglu, 2000).
Schemas should be remarkably important to grocery retailers, as research shows that shoppers respond quite negatively to deviations in their grocery shopping schema and grocery shopping experiences are particularly vulnerable to negative emotional responses (Babin and Attaway, 2000). Stores that provide less than satisfactory experiences by making it difficult for shoppers to build and maintain reliable store or brand schemas could be in trouble. Negative experiences evoke negative emotions, which has been shown to cause shoppers to perceive the store as having less value, making those stores less likely to meet expectations and be patronized (Babin and Attaway, 2000). In contrast, positive emotions are associated with expectations that have been met or exceeded, resulting in a higher perceived value and an increase in repeat visits and purchases (Babin and Attaway, 2000).

Research also shows that shoppers feel not only negative, but the strongest negative emotions when the store context does not match their constructed schema and expectations. Since grocery shopping is primarily a routine, functional goal-driven task, as opposed to recreational “window shopping,” discrepancies that occur between the store context and the
shopper’s expectations are easy to identify and have been shown to be met with adverse emotions, such as disgust (Machleit and Eroglu, 2000). When a store is similar to the shopper’s schema, they feel more familiar with the store context and that increased familiarity helps the shopper to make his or her desired purchases (Babin and Babin, 1999).

**Summary of Experience**

The evolution of our consumer economy to one of experience proves that the experiential value of a grocery store or a shopping trip cannot be underestimated. There is currently a lack of theoretical understanding behind the various cognitive, contextual and emotional components that contribute to forming an experience and one’s perception of that experience. However, the experience economy can only grow through this type of understanding that allows for relevant and successful innovations in creating grocery shopping experiences (Gilmore and Pine, 1998).

Experience is a complex entity that is produced and comprised of many different components over extended periods of time. Our sensory experience & history of interactions with of things, decides how we understand them ever after. As we interact with the world, we physically simulate outcomes that shape our internal expectations of how things may turn out in the future, which in turn affect our future actions, perceptions and expectations (Kirsh, 2013). Experience is affected by each part of human consciousness—distributed from the shopper’s internal mental and emotional states, to their external actions, contexts and environment. Their experiences are situated and constantly in flux, changing with each previous and future thought, emotion and experience they have.
Chapter IV

Wayfinding Shapes Experiences

We live in and perceive the world through our body and its movement through space and time (Lefebvre, 1974). As we move through built environments, we consciously and subconsciously notice visual attributes of the space such as nodes, landmarks, paths, edges or boundaries that affect our ability to find our way through the space (Lynch, 1960). We glean even more subtle cues and information about the environment through our senses, including hearing, smell, taste, touch, temperature, humidity, breeze and even social interaction (Whyte, 2002).

The term wayfinding was first introduced in an architectural context and defined as the consistent organization of sensory cues in the external environment (Lynch, 1960). In the 1980s, the definition was expanded to encompass a combination of sensory elements including visual representations, tactile surfaces and audible communications (Romedi, 1984).

Understanding Spatial Knowledge

The way that adults use representations to learn about and make their way through the environment is not yet well understood. Theories of spatial understanding have been built through knowledge of how children first understand space. Research shows that children first build their understanding hierarchically, through a sequence of stages at which different elements of spatial knowledge are learnt. First, we acquire landmark knowledge, in which only patterns and characteristic that identify key places are recognized and remembered. At this stage, they can identify key locations, but cannot navigate with confidence between them.

Next, they gain procedural knowledge; This includes an understanding of routes and procedures for navigating between landmarks within the environment. However, they do not
know how the separate routes are related and cannot find shortcuts between arbitrary points along the routes. The highest level of spatial understanding in wayfinding is *configurational knowledge*. This is when a person knows the environment fully, to the extent that they can draw a map and understand the direction and distance of any location and their relationships to each other (Siegel and White, 1975).

The hierarchical theory of spatial understanding has been widely applied to describe how adults learning about space (Siegel and White, 1975, however there is little evidence to support that this how adults gain spatial knowledge about unfamiliar places (Whyte, 2002). Adult cognitive processes are different from children, in that they already possess spatial skills and knowledge. For example, consider an adult studying a map of a store layout. They may be able to gain survey knowledge from the map that gives them an overall understanding of the environment from a 10,000-foot view. However, once they’re in the environment they may not have knowledge of any landmarks or familiarity of routes in the store.

This example underscores that it’s questionable whether or not these adults can be described as having gained the “highest form” of spatial knowledge. As such, when describing adults, it may be more beneficial to consider the three types of spatial knowledge at the same level of importance rather than in a hierarchy, as each has an equal, but distinct role in wayfinding. The three elements—landmark, procedural and configurational knowledge provide a useful way of breaking spatial knowledge into separate components for design and measurement.

**Retail Wayfinding Through Experience and Store Design**

Shopping is often regarded as a cognitive and psychological science in which buyer outcomes can be improved by successfully manipulating the physical environment through the
planning of stores, placement of displays and use of signs. These ideas have evolved into an entire field of study surrounding experience design (Signage Foundation, Inc., 2016).

Experiential Graphic Design (XGD) involves the coordination of typography, color, imagery, form, technology, and especially content to create environments that communicate (Dixon, n.d.). These environments include many parts that work together as a cohesive system to create themed or branded spaces. In a grocery store, some of the elements include wayfinding systems, architectural design and graphics, signage, advertising and retail design. To that end, the field involves a wide range of disciplines including graphic, interaction and user experience design; as well as architectural, interior, landscape and industrial design.

Branded environments shape experiences that orient, inform, educate and sometimes even delight users. Built spaces such as retail stores, theme parks, hotels, casinos, sports venues and shopping malls are using the tools and story-telling approaches of XGD to create engaging and meaningful interactions with their customers.

Wayfinding in experiential design, particularly through signs, has grown as a field dramatically over the last three decades. Experiential Graphic Design practitioners have set some design standards, tactics and best practices for wayfinding systems in spaces such as airports, subway stations, hospitals, museums or city streets and highways. Retail wayfinding, however, has defied being channeled into a specific discipline. Instead the field has been treated as component of multiple retail disciplines that include long-practiced fields like visual merchandising, newer disciplines like experience design, and technology-driven adaptations like digital and mobile innovations.

Retail wayfinding can be seen as unique from other wayfinding initiatives because it has an underlying effect on profits and bottom lines, causing it to be heavily driven by measurement,
analysis and best practices. Profitable stores tend to be meticulous record takers and are constantly experimenting with approaches that will attract customers. Store planning and wayfinding design are still areas deeply rooted in tradition and there is still an adherence to long-established practices.

Supermarkets and departments stores have used similar planning formulas for decades. Signs also have closely conformed to practices honed over years of experience. The racetrack and grid plans developed by retailers 1950s and the sign practices used to support them are still in use with small modifications. The current shift in consumer trends have forced retail design practitioners to consider the complexity of customer experience; and how satisfying increasingly specific niche needs and expectations of consumers contributes to improving those experiences.

While hierarchical signage systems and grid pattern aisles do provide persistent referents for wayfinding and help to create and define spaces within an environment, design and placement of wayfinding tools can be problematic in large retail stores. It can be expected that the larger and more complex the store, the more difficult planning a navigational system will be. As store complexity and size increase, it becomes harder to build mental schema of entire store to facilitate travel from one extreme of the store to the other and locate specific areas along the way. Additionally, as stores evolve through day-to-day business activities, the original plan for the original wayfinding system may break down. Constantly shifting products, displays and shopper movement throughout a store can render signage and other navigational cues less visible, creating less defined areas in the environment.

The space around us is always present and it is an invaluable resource for problem solving. Wayfinding design solutions could create and use space within the retail environment more efficiently by accounting for the dynamic and evolving environments within large
supermarkets. There are areas for wayfinding tools that have been commonly overlooked in supermarket environments, such as the store infrastructure that includes the shopper’s periphery areas like the floor and ceiling. These areas have become elements for design consideration in smaller retail settings.

**Three Case Studies in Retail Wayfinding**

**Shake Shack.** In 2000, Shake Shack began as a temporary food stand in Madison Square; it was so popular, it became a fully designed and branded permanent restaurant four years later (Signage Foundation, Inc., 2016). Since the restaurant grew out of a single iconic food stand turned restaurant, most of the branding and customer service practices are developed to reflect the core of the customer experience that started in Madison Square. The management team maintains strong control over the design of the overall customer experience at all the store locations, using signs as the central part of their exterior and interior design strategy. The Pentagram brand design team worked closely with the architect to design type, color and logo elements that could integrate into a variety of exterior and interior architectural approaches, materials and illumination techniques (Figure 11).
Figure 11: Shake Shack began as a food truck in Madison Square. It became so popular that they opened a permanent store space. Their brand places a heavy emphasis on the impacts of store design and wayfinding cues on consumer experiences. Signs are well integrated into the material architecture both outside and inside, creating a sense of place and division of space between service and dining areas through visual cues. The graphic palette on the signs closely extends to print menus and packaging which in turn plays a prominent display role in the space (Signage Foundation, Inc., 2016).

**Walgreens.** Walgreens focuses heavily on using illumination for signage legibility and placemaking. Most major interior signs are double illuminated using both projection and internal illumination to create a sense of place around each sign. Their Flagship stores are designed as a series of pavilions that stand off from the background architecture allowing for a respectful
separation between the floor, ceiling and architecture (Figure 12).

![Image](image_url)

**Figure 12:** Walgreens Flagship store interior. Their store design leverages vertical space to create clear separation between store architecture, fixtures and wayfinding elements.

Walgreens stores use vertical separation of store space and wayfinding elements. There is a clear separation between floor fixtures and signs highlighting each area, as well as a rigorous consistency of sign heights. Signs mounted on wall surfaces are also designed to contrast with a variety of materials and printed surfaces found in the stores (Signage Foundation, Inc., 2016).

**Walmart Supercenter.** Walmart reinvented the design of their retail environments in an effort to improve customers’ in-store experience with a more consistent and less cluttered brand expression in the store, through an emphasis on signage, graphics, colors, and store fixtures. Two major objectives of the new store layout are to clearly delineate grocery from general merchandise and to establish strong sightlines into key departments. The new store environment is also visually cleaner, faster, and friendlier for customers to shop due to wider aisles and the
removal of in-aisle palette displays. Wayfinding cues in the store are supported through color. The addition of color to the walls, the yellow, green, and orange on the grocery side of the store signals freshness and indicates food credentials. Blue delineates general merchandise from grocery and reinforces the brand.

A complete signage and graphics system aids in wayfinding through all points on the shopping journey. Departments are identified by a combination of large signage components and lifestyle imagery representative of the merchandise and Walmart customers. Smaller overhead signs identify subcategories within departments.

Figure 13: LEFT: Walmart Supercenter Grocery “Action Alley” (primary store aisle that spans the entire length of the store). TOP RIGHT: Walmart Supercenter Produce. The design of cornice fixtures creates a sense of place within the produce section while also communicating the store department. BOTTOM RIGHT: Walmart Supercenter Main Navigation Sign. Located at the front of the store, this sign provides the general direction of several different departments in the store.
Graphics, information, and price identification signage are used at the fixture level to merchandise products and communicate with the customer. A cornice element over key departments creates a sense of place and provides a flexible communications system that can be tailored to merchandise, promotional displays, and seasonal campaigns. This flexible kit-of-parts changes out quickly and easily to make communications relevant and up-to-date (Society for Experiential Graphic Design, n.d.) (Figure 13).

**Technology’s Role in Wayfinding**

Our current technological abilities offer new possibilities of physical, natural, context-aware interfaces—ones that can be embedded and integrated into the existing features and architecture environment. There is so much benefit from using the real world in which humans have evolved and constructed—consideration should be given to designing artifacts that are part of and aware of those environments. Since making digital artifacts have the appearance of being real is difficult, interfaces that integrate physical and digital worlds, while leaving the physical world unchanged as much as possible may be a better solution (Klemmer, Bjorn & Takayama, 2006). Most often, successful supermarkets employ a combination of traditional and innovative wayfinding approaches that are intended to enhance their consumer experience, but current wayfinding solutions in large retail stores are not enough of a departure from the status quo.

The most successful retailers often have a firm hand on both traditional practices and new innovations like digital technology and new production processes (International Sign Association, 2016). The majority of retail wayfinding tools in large supermarkets are static signage or systems, which do not necessarily facilitate or encourage human interaction (both mediated and unmediated) with the store environment and the objects in it. More and more, these systems involve the use of digital technologies that present and collect dynamic content through
ambient interfaces that are embedded in the environment—creating rich interactions between users, the content being provided to them and the context of the space in which the interaction takes place.

Some stores are already collecting a vast amount of data on their shoppers using consumer-tracking technology throughout brick-and-mortar stores to augment their consumer experience design. Using cameras and sensors, the Department-store chain Gordmans tracked movements of 29,000 shoppers over three weeks. The footage was turned into heat maps, revealing which parts of the store were popular with customers and which ones were ignored. Based on that data, Gordmans tweaked the layout of their stores and their conversion rate—the share of shoppers who make purchases—increased by more than 3% (Kharif, 2014).

Small retailers have begun integrating prominent interactive digital displays into the architectural elements throughout their stores. Wegmans has developed a reputation for creating a lively and varied shopping experience that mimics traditional European outdoor markets. The Clifton Market location has some of the most advanced supermarket digital signs in the country. Built around a mobile app that highlights specific promotions while the customer is walking the store, the store also uses digital screens in select locations to announce promotions and highlight new products.

In addition, there are interactive kiosks to educate customers on specialty items and services. With a store plan focused on reducing clutter and focusing on digital content, the displays are minimal and high quality with natural accents that highlight the products, while non-digital signs have a minimal presence in the space (Signage Foundation, Inc., 2016).
Beyond the Screen: Embedded Interfaces as Retail Wayfinding Tools

Figure 14: The Whole Foods Clifton Market store interior is meticulously designed to simulate the experience of shopping at an outdoor market. The Clifton Market location features digital signs built to interact with a mobile app that highlights specific promotions and new products while the customer is walking the store.

Digital signage such as these give structure the environment, while also infusing it with context-appropriate information—saving shoppers physical and mental execution by reducing the complexity of wayfinding, while offering the benefits of communicating through a dynamic and aware medium (Figure 14).

Additionally, the data collected from the cameras, sensors and data from store apps and interfaces that make up the digital signage system can be used to evaluate in-store wayfinding. Tracking consumer paths around store and behavior in areas that are navigational decision making points could be helpful in revealing areas of the store that are confusing or need more structure, as well as gleaning insights from areas where navigation is clear and easy.
Chapter V

Human-Computer Interaction & Retail Wayfinding

The mind is a unique thing, which exists both internally and externally, in the past, present and future and we must begin to think and design artifacts within those terms. Design solutions must be understood in the context of their relationship to a physical body interacting with the environment. Distributed cognition theories can provide new ideas about interaction and new principles for better wayfinding tactics and designs. However, we first need a more modern understanding of the interdependent nature of our cognitive processes, bodies and environment as they interact and alter each other over time.

Cognition Is Distributed

Perception, action and thought should be understood as inextricably integrated. The theory of distributed cognition states that the mind is not contained only within the boundaries of the skull, but is involved in a coupled and ongoing relationship with the space around it (Victor, 2011). It considers cognition and the context, or environment a two-way interaction that can be seen as a (Clark and Chalmers, 1998). It regards cognition as an open system—continually receiving input from the environment, which affects its function and produces output that has further consequences on the environment’s impact on the system itself (Wilson, 2002).

Simply stated, the theory proposes that our knowledge lies not only within the mind, but is also distributed out into the physical environment around us; the environment constantly affects us, as we are simultaneously affecting the environment, and so-on (Wilson, 2002). This relationship has an active role in how our cognitive processes unfold. Environmental aids, objects and tools within the environment can be seen as extensions of the mind itself, and can function as a part of the mind (Clark and Chalmers, 1998).
In addition to being distributed from our mind out into the space around us, our thought can be distributed through time. Cognitive processes can be rooted in the past and present in such a way that the products of earlier events can shape expectations and affect outcomes of related future events (Hutchins, 2009). For example, if you have a negative shopping experience at a specific store, you will be less likely to patron that store in the future (Babin and Attaway, 2000). These mechanisms are so strong that even when decoupled, or removed from a particular environment, the activity of the mind remains grounded in mechanisms that evolved from interaction with the physical environment (Wilson, 2002).

**Tools Are Things to Think With**

Our development of language and use of tools, even if those tools are our hands, are what separates us from other mammals. Humans communicate with and use their environment to their advantage. Humans use the environment around them to simplify internal computation. In other words, we make changes to the environment to save doing computations in the head. As modern retail stores grow in size and product selection, it’s critical for in-store wayfinding tools to be visible and useful more than ever before. As technology becomes increasingly complex, it’s critical for designers to provide visual wayfinding tools that account for the wants, needs, abilities and limitations of the shopper and represent information appropriately.

Interacting with tools and the environment changes the way we think, perceive and build schemas. Tools, when manipulated, are soon absorbed into the body schema, and this absorption leads to fundamental changes in the way we perceive and conceive of our environment. Tools become an extension of us—we absorb them as part of our body. They change the way we perceive the world and can reshape our way of thinking. With a tool in our hands we selectively see what is tool relevant; we see tool-dependent affordances and limitations (Kirsh, 2013).
Successful wayfinding tools reduce complexity of choice by eliminating the amount of decision making that’s needed, resulting in simplifying wayfinding tasks. They reduce the amount of perceived actions at decision points or eliminate them altogether, allowing shoppers to consider only the navigational actions that are important at the time. Wayfinding cues should make feasible navigational choices obvious by constraining the available choices and highlighting the most opportunistic paths (Kirsh, 1993). Complementary tools that satisfy these requirements can help reorient a shopper’s perception of not only themselves, but the environment (Kirsh, 1997).

**Persistent Referents**

Since the dawn of man, humans have evolved using our bodies and the environment around us to get what we need. The use of external representational vehicles—also referred to as *persistent referents*—points to the idea that our cognition, or way of thinking is distributed out into the environment around us. This idea gives a strong foundation for the theory of distributed cognition.

Creating external representations that serve as persistent referents enables us to do mental and/or physical computations outside of the body that could not be realized inside the mind (Kirsh, 2010). Good visual representations can reduce the amount of effort required to solve problems by acting as external memory. Our short-term or working memory holds the information that we’re currently using. When we need to remember a lot of things to perform a task, we attempt to overfill our short-term memory, making it difficult to remember things that are task-relevant (Johnson, 1998).

At some point, the cost of mental projection becomes prohibitive to thought and those projections must be externally represented to push further than what we can compute in the mind.
alone. As a result of these noetic limitations, humans have evolved to be resourceful and opportunistic. We exploit resources outside of the mind—our bodies, the environment and objects found within it—to simplify our cognitive tasks.

We exploit the environment to reduce our cognitive work-load; It is necessary to off-load some of our cognitive tasks onto the environment because of limits on our attention span and memory. We’ve learned to (even sometimes subconsciously) make the environment hold or even manipulate information for us and we harvest that information on a need-to-know basis to make our lives easier (Wilson, 2002). External representations reduce the amount of information that we have to remember, and thus, make thinking about a task or completing a series of tasks easier.

For example, consider a person trying to solve a math problem in their head; They may use gestures, such as or counting on their fingers or pretending to write the equation on their hand as if it were paper and their finger was a pen. These gestures help create persistent referents, or external visualizations that reduce the amount of information that has to be stored in the mind, making the problem easier to conceptualize, visualize, and solve. We make use of physical resources to help draw conclusions and solve problems, rather than preforming abstract, symbolic computations in our head (Kirsh, 1993).

In built spaces, persistent directional features in the environment can help drive wayfinding processes (Clark and Chalmers, 1998). Rarely do shoppers have an entire store layout memorized down to the contents of each aisle. Even if they have the highest level of configurational knowledge, it could be rendered inadequate if the store layout or product placements are changed, which happens frequently in the dynamic environment of a supermarket.
Instead, shoppers rely on store maps, directional signs and aisle markers to find their way around the store and locate the items they need, rather than committing each aisles’ contents to memory. By creating these persistent referents in grocery stores, we are able to dedicate our cognitive activity to shopping, instead of trying to memorize the store while shopping.

External objects or representations also serve as a shareable object of thought—a persistent referent that allows us to communicate with oneself and others with a common focus. For example, store signs with aisle numbers allow shoppers to communicate with other shoppers or store employees about the information the sign displays. They create a common element that can be measured, identified and re-identified. Additionally, the physical representation doesn’t degrade the way memory does and can be changed or added to (Kirsh, 2010).

The representation of a problem can affect its solvability. The best representation makes the solution transparent and highly visible (Klemmer, Bjorn & Takayama, 2006). This can also be applied to how people use representations of an environment to navigate around the space. Different types of representations make explicit different information about the environment or object in question and it can be expected that they have various strengths and weakness when used for different tasks (Whyte, 2002).

Passive wayfinding systems, such as static department or aisle signs in grocery stores, only maintain one unchanging surface representation. For example, a two-dimensional map of a store layout may be more useful for discerning the direction a specific department is in or the best route to take to get there. It would not, however, be useful in navigating to a store shelf to find a specific product. Additionally, the signs are often obstructed by an ever-evolving store environment, in which the height products are stacked on shelving and the placement and
orientation of the signs themselves do not necessarily provide the most visible wayfinding cues (Figure 15).

![Image of Walmart Supercenter](image)

**Figure 15:** Department signage in Walmart Supercenters. The signs are mounted on main interior walls. Their placement combined with high product shelving decreases the signs visibility and usefulness.

Active systems maintain dynamic representations within a memory that can be manipulated, transformed or modified in real-time. For example, current computer systems maintain both active internal representations of encoded data in the form of ones, zeros and various scripting, while visual representations are maintained at the surface level through graphics. Both internal data and external representations can be modified according to the operations requested by the user. These systems require an interface and input devices such as a mouse, keyboard, touchpad, screen (Norman, 1992), and sensors—some way of changing the internal representation into a visual, aural or haptic representation that is maintained at the visible surface of the device so that we can engage in mediated interaction with the computer.
Consumer (and all human) behaviors are complex. Shoppers don’t always have a specific goal completely formulated. Humans are inherently opportunistic beings—they pursue possibilities as they emerge, even if they weren’t anticipated. We use possibilities and resources found in the environment to shape thoughts and goals they didn’t originally set out to attain (Kirsh, 1993). These truths are especially applicable to the act of shopping. Think about how many times you’ve purchased items that you didn’t plan to, or do not even need because they were a “good deal” or looked desirable to you at the time…

There is a distinct parallel between opportunistic behavior in shopping and interactive computing. Like grocery shoppers, interactive computing is also an iterative process of discovery, in which original goals can change mid-process, causing new goals to be formed. Developing navigational features that include active systems, which function through mediated or unmediated interaction with the user, such as embedded context-aware interfaces, could better help direct people around a store while supporting this type of shopper inquisition and goal forming (Kirsh, 1997).

**Chapter VI**

**Prototyping & Testing These Designs**

Increasingly, design professions emphasize researching user needs and behaviors within a constructed environment through evidence-based design. In environmental and experiential graphic design, this research often takes the form of prototyping and user-testing of systems or communications, such as signage, to determine their effectiveness in helping people navigate spaces. Most often, research and testing of signage and wayfinding systems in built environments have focused on legibility, nomenclature, mapping, use of symbols, use of multiple
languages, sign location, and other factors affecting the effectiveness (Society for Experiential Graphic Design, n.d.).

As computing continues to become increasingly ubiquitous throughout our lives and seamlessly embedded into our environment, interface design solutions will require technologies that can be prohibitively expensive and time-consuming to produce and maintain—underscoring the importance of low-cost and rapid prototyping methods. Designers may experience difficulty in communicating their ideas for designs of three-dimensional spaces to others—never mind mocking up and testing them. Using mere words, hand gestures or two-dimensional mockups to communicate a designer’s ‘vision’ to other designers, engineers, stakeholders and users can be challenging. If an idea is not conveyed properly in the early stages of a project, it can spell the end for that design solution.

What’s more, accurate prototyping, testing and evaluation is critical to the success of the final design and they not as expensive or elaborate. Some people think that prototyping is very costly and complex and that user tests should be reserved only for projects with huge budgets and lavish time schedules. Usability experts have found that this is false. Elaborate prototyping and testing methods can be a waste of resources because the best results come from testing no more than 5 users and running as many small tests as you can afford throughout the project.

“The most striking truth of the curve is that zero users give zero insights. As soon as you collect data from a single test user, your insights shoot up and you have already learned almost a third of all there is to know about the usability of the design. The difference between zero and even a little bit of data is astounding.

When you test the second user, you will discover that this person does some of the same things as the first user, so there is some overlap in what you learn. People are definitely
different, so there will also be something new that the second user does that you did not observe with the first user. So, the second user adds some amount of new insight, but not nearly as much as the first user did.

The third user will do many things that you already observed with the first user or with the second user and even some things that you have already seen twice. Plus, of course, the third user will generate a small amount of new data, even if not as much as the first and the second user did.

As you add more and more users, you learn less and less because you will keep seeing the same things again and again. There is no real need to keep observing the same thing multiple times, and you will be very motivated to go back to the drawing board and redesign the site to eliminate the usability problems.

After the fifth user, you are wasting your time by observing the same findings repeatedly but not learning much new (Neilson, 2000).”

This methodology underscores the importance of modifiable prototypes when attempting to gain insight through iterative rounds of testing and redesigning. Virtual environment simulations are becoming easier to produce, alter and maintain (as compared to the assembly, adaptation and maintenance of actual environments) and can be an invaluable tool in prototyping and testing.

They can more accurately recreate a user’s time-based sensory experience on location (Singh, Ha, Kuang, Oliver, Kray, Blythe and James, 2006); and that is particularly important when considering embedded interfaces, as they require an understanding and evaluation of how the interface functions when it is part of a dynamic three-dimensional space. In addition to space, evaluation of such designs require accounting for human cognition and perception as they are
distributed across the interface, environment and through time. By capturing video (imagery and sound) at the intended site of deployment of an embedded interface, designers can create a highly-controlled, contextually dynamic, virtual representations for rapid phases of testing and designing.

**Immersive Prototyping Methods**

A number of ubiquitous systems have been built to support a variety of tasks and scenarios, including medical, workplace, and leisure-related applications. Users interact with these systems via implicit or explicit means, by moving around an environment or using a device. At the same time, they deploy sensors to gather information about the context in which those interactions take place, and system behavior can change depending on contextual factors. Together, these factors add up to a fairly complex situation, which poses new challenges for prototyping and evaluating design ideas—pushing the boundaries of traditional evaluation methods and opening up opportunities for novel approaches (Kray, Larsen, Olivier, Biemans, van Bunningen, Fetter, Jay, Khan, Leitner, Mulder, Muller, Plotz, & de Vallejo, 2007).

Cognition is situated—thinking takes place in the context of a real-world environment and it inherently involves both perception and action. Cognition is also time-pressured and must be understood in terms of how it functions under the pressures of real-time interaction with the environment (Wilson, 2002). Embedded interfaces should account for these factors, and thus, so should the methodologies and procedures used to test those interfaces. Currently, there is a lack of means to deal with the context-sensitive and dynamic research settings that those types of pervasive technology present. The more integrated a system is into an environment and the more complex its behavior can be, the more difficult it is to evaluate the system as more data sources may have to be taken into account during the evaluation.
We will need new ways to measure the effectiveness of these cognitive tools as part of the environment, considering that the mind arises in a physical system that’s distributed across the environment and through time. Testing designs that are embedded in the environment require the environment to be part of the testing. Investigations of environments and artifacts within them should be heavily influenced by the consideration of scale, and the activation of space through placemaking and physical engagement with the environment.

Immersive prototyping methods such as field studies, provide a more accurate representation of scale and how human factors distribute themselves across space and time. An awareness of how these elements work together is vital, not only in a practical sense of “how big will this be?”—but also in how the artifact will look and perform in a space, how accessible it is and how it will be integral to the larger ecosystem while still working on its own (Molloy, 2014).

To this end, immersive prototyping and evaluation techniques, such as full-scale field studies can provide more accurate testing situations and evaluation of three-dimensional artifacts and spaces. In spite of the benefits of testing in a more accurate context, these methods can be passed by because they are often expensive, time consuming and difficult to deploy. When applying these traditional immersive prototyping techniques to test and evaluate ambient, ubiquitous and embedded systems, specifically, their shortcomings become even more evident. While field studies offer a testing environment that is more authentic to the actual user experience in context, it affords little control over the environment itself and what’s going on in it.

In contrast, lab studies provide a highly-controlled environment for testing, but lack an immersive and interactive context for the user; thereby overlooking potentially important influences of distributed cognition and contextual interaction—both of which should heavily
influence the design and implementation of embedded interfaces (Hühn, Khan, Lucero, Ketelaar, 2012). This dilemma indicates the need for a new approach to early and rapid prototyping, testing and evaluating for ambient embedded interfaces. The ideal methodology would provide both a controlled setting and a rich context that users can relate to and interact with, while keeping costs, time and effort as low as possible.

Prototyping methods in ubiquitous computing must to tackle a broad spectrum of opportunities and challenges, including the ability to simulate existing devices and their function, with regard to the environment, and other devices, objects and people within it; without cost and large teams needed building and deploying them; to observe how users might react to new devices and interactions before we can fully realize them (Barton and Vijayaraghavan, 2002). Simulating ubiquitous systems and their functions in realistic, but controlled environments for is not impossible, especially as the limits of computing are expanded and technology continues to evolve. Emerging tools for design visualization are changing the practice of design itself—making it possible to create virtual and immersive prototypes that model attributes and simulate performance characteristics without having to build full-scale mock-ups.

Virtual reality, augmented reality and 360° media can be used as tools, rather than finished products themselves. It is the link between the representation in the simulated environment and reality that make the technique useful for design conceptualization and prototyping. Research shows that when organizations cannot cost-effectively marry their models to reality they waste time, effort and money (Schrage, 1999).

Augmented reality, virtual environments, location-based services or a combination of these, are contextual approaches that relate more closely with ever-changing retail store environments and the cognitive and behavioral processes of shoppers. Additionally, low-fidelity
virtual and augmented environments can save on project costs by providing more accurate, meaningful insights in a medium that is relatively easy to maintain and update for future testing. While the theory and technology to define and measure heuristics in these media are accessible, research is limited in the evaluation of embedded systems and interfaces, especially from a standpoint that accounts for the relationship between the user, interface and environment.

With regard to ubiquitous systems and embedded interfaces, the media, method and measurements should account for the users’ focus and cognitive efforts as they are internally ongoing and distributed across the design artifact in question and the virtual environment as a three-part system—user-interface-environment relationships. Immersive virtual environments can be useful in ideation and testing of designs for three-dimensional spaces because they provide consideration for such relationships—capturing more accurate context and sensory data about the experience users will be exposed to in the final, real-world design implementation. In comparison to actual, real-world environments, virtual environments can provide an easier, less-costly, and at times, more accurate method for documenting user responses and behaviors.

Not only do virtual approaches improve control over the testing environment (Leichtenstern, André and Rehm, 2010), they also give the researcher the possibility to test location and context-dependent concepts that are hard to deploy in the real world (Barton and Vijayaraghavan, 2002). Furthermore, the opportunities regarding measurement will improve when conducting studies with the use of virtual environments. Tracking individual persons in public spaces is challenging; although it is possible to accurately track their movement using Radio Frequency Identification (RFID) or other technologies, it is technically difficult and it raises privacy concerns when gathering data in public spaces.
In constructed virtual environments, tracking specialized metrics like (Wilson, 2002) (Woolley, 1993) psychophysiological measurements and behaviors, such as user gaze, gait and position are easier to record and measure because the researcher is given a stable setting that simplifies the placement of measuring equipment. These additional metrics could be critical in the exploration of wayfinding and search behavior, mental representation and schema construction of three-dimensional spaces (Valls, Redondo, Fonseca, Garcia-Almirall & Subirós, 2016).

**Challenges of Immersive Prototyping**

Experiential design research on ubiquitous and embedded technologies face considerable challenges regarding mobile context-sensitive evaluation and implementation. Physical spaces, particularly branded environments and the artifacts embedded within them, must manifest themselves in a specific way. The way that we visualize spaces and objects within them, how they work and how they might be used has a strong bearing on how we conceptualize and design the form and attributes of environments and their component parts. Prototyping and evaluating those designs presents complications that are not encountered when prototyping for two-dimensions, such as software applications or print designs.

A key issue in embedded and ambient interface design is the cost and effort required to prototype and evaluate the metrics of experience building and its impact on wayfinding. Evaluative field studies lack control and lab studies do not capture user-interface interaction within a dynamic context. Traditional methodologies, such as paper prototypes, scale models or mental walkthroughs have severe inadequacies when applied to three-dimensional spaces or ubiquitous settings, as they do not account for human factors or provide an accurate contextual representation of how the designs will work within the environment.
The human experience—our physiology, psychology and how we interact with each other and our environment—is essential in assessing and measuring an experience’s impact and effectiveness. To make sense of how experiences are built and can evolve in the future, designers must continually connect their design concepts with cognition, perception, action and experience building. Since the underlying purpose of ubiquitous technology is to be weaved invisibly into the users' life (Weiser, 1991), both the users' task and their interactions with a system are defined less clearly than in traditional settings. For this reason, it is not always straightforward to apply familiar methods based on task performance (i.e. metrics like task completion time and error rate) for ubiquitous systems (Kray, Larsen, Olivier, Biemans, van Bunningen, Fetter, Jay, Khan, Leitner, Mulder, Muller, Plotz, & de Vallejo, 2007).

Although all components of a ubiquitous system should be evaluated separately (Weiser, 1991), these singular analyses fall short of providing insights into the effectiveness of the overall system, which includes the design artifact being evaluated, as well as the user and environment around them. Oftentimes, there is an absence—or at best, a deficiency—of standard quality measures that can numerically evaluate the factors involved in human interaction with ubiquitous systems. Consequently, a combination of quantitative and qualitative measures allows us to form a more holistic understanding of the systems’ impact, effectiveness and areas for improvement.

Understanding how human factors, space and time are inextricably connected may require a new perspective on research and testing that goes far beyond mere observation. Qualitative metrics about the user and their environment, including the degree of communication and interaction, tangible and shared memorable experiences, modifications in the participant’s behavior, thoughts, and experienced emotions, must be defined and evaluated in some way.
Common qualitative research methods such as interviews and focus groups can provide a basis for deciding which metrics should be captured and asked for during experience sampling. Qualitative methods can also provide additional information after measurements have been taken, such as clarifications of specific experience sampling data, behaviors or contexts in which certain behaviors appeared (Kray, Larsen, Olivier, Biemans, van Bunningen, Fetter, Jay, Khan, Leitner, Mulder, Muller, Plotz, & de Vallejo, 2007).

Measuring against heuristics that account for the user as part of the context and space around them could help us evaluate ambient embedded interface designs more objectively and realistically, helping to reveal how they could be improved or evolved. Both the wayfinding tool that is being tested and the environment it is being tested within are crucial in understanding how the tool itself will be perceived and used by the user. As such, it is critical to test how the design and the user function as part of this environment.

**Understanding Virtual Representations and Their Implications**

*Virtual Reality (VR)* means different things to different people and its definition has evolved as the medium becomes more widely used. In the late 1990s, simple VR systems included video games that use three-dimensional graphics displays, sound and are controlled by a user through an input device, such as a controller or keyboard. More sophisticated systems at that time included driving and flying simulators used in pilot training. Today, VR has evolved to encompass any medium that is interactive, spatial and real-time. Real-time interaction with a responsive three-dimensional environment is the defining characteristic of VR and is what differentiates it from other mediums (Whyte, 2002).

The difference between VR and an immersive experience of 360° video can be compared to the traditional concept of playing video games versus watching a TV show. Fully immersive
virtual environments are generated live and are responsive to the user’s interactions, like a video game. This level of interaction requires an interface that facilitates real-time simulation and interaction with spatial data through multiple sensorial channels, like vision, sound, touch, smell and even taste. In contrast, 360° video can offer the same sense of presence in a virtual environment using a 360° sphere of video around the viewer. However, interaction with the 360° environment is limited; users may look where they like in any direction, but that’s the limit of their interaction with it—just like watching a movie (Smith, 2016).

All virtual reality visualizations are not and should not be created equally. Different project priorities and constraints can dictate the extent of interaction, response capabilities, quality and intricacy of the virtual environment being rendered. The degree to which a user is immersed in the environment and can interact with it can vary.

*Immersive systems* use head-mounted displays or large displays that surround the user, providing them an unmediated experience of the environment. *Non-immersive systems*, provide interaction with the environment through a smaller screen, such as a computer or mobile device (sometimes referred to as “window-on-a-world” systems). *Augmented reality* overlays virtual and real-world imagery, allowing the user to interact with data from both (Whyte, 2002). It is important to prioritize the needs of the project and balance those needs with the capabilities of each type of system and their varying levels of immersion and refinement (Figure 16).
Many major retailers across the globe have been experimenting with virtual reality for the last two decades. Supermarkets have enlisted the help of VR specialists to create three-dimensional interactive virtual environments, in which users could explore the store space and interact with products on display. Humans learn about the world and its properties by interacting with it (Klemmer, Bjorn & Takayama, 2006) and physical interaction in the world, including simulated physical interaction in virtual spaces can be indispensable in facilitating cognitive development and insights about the environment in question.

Nonetheless, actual or simulated physical interaction aren’t a stringent requirement for acquiring knowledge about our surroundings (although physical interaction does provide more innate understandings of the environment). Increasingly, we learn much about the world through a combination of visual and physical interaction with media in particular. Many people may have first experienced London or Los Angeles driving a stolen car in a PlayStation game. They bring
that experience with them and it molds their expectations, should they visit the real city in the future (Whyte, 2002).

Alternatively, just viewing a world and what’s happening in it allows people to learn about it. By passively viewing the dynamic movement of the world, or a representation of that world through a frame (immersive or not), people not only learn about using the medium itself, but also learn about the world they’re viewing.

Thirty years ago, an entire generation of suburban America could have formed their knowledge of what a city is like based on television shows like Sesame Street (Whyte, 2002). These ideas lend some validity to prototyping approaches that account for our interaction with the environment, while also pointing out that actual physical interaction isn’t a prerequisite for learning about and perceiving the space around us. Much could be learned from users viewing design concepts in new ways and from a new perspective, such as a virtual 360° space.

The way we understand space in two-dimensional representations is quite different from that of the physical world. The medium used to acquire spatial knowledge can affect the spatial knowledge that’s achieved. People have widely divergent spatial and technological capabilities. The levels of experience with a particular technology is a key factor that affects the extent to which someone will find a medium useful (Whyte, 2002).

Those differences in experience level with a particular medium can affect their use and perceptions of a prototype and thus, any outcomes of testing. For example, novice users of virtual systems are often subject to distraction by the system itself. Differences between the real and virtual environment affect their performance on simple wayfinding tasks, causing them to become lost or bump into virtual objects. Because of the difficulty faced in maintaining their
orientation, users may devote more attention to that instead of the design specific task-objectives (Whyte, 2002).

Experimenting and testing can be seen as a process of scanning through alternative options (Whyte, 2002); virtual models can reduce the cost and time required for experimentation, and can significantly increase the amount that can be learned through increased number and type of experimentations (Thomke, 1998). Because of the fundamental differences in individual humans, testing with virtual environments, hardware and software should and can include a range of users, from technological novices to experts, in addition to people who are familiar with the existing environment and those who are not.

While head-mounted systems, such as the Samsung Gear VR, are less widely used than predicted in the late 1980s (Whyte, 2002), interactive, spatial, and even real-time capabilities of immersive virtual prototypes are becoming better understood and more frequently implemented by designers across disciplines like architecture, interior design, industrial engineering and product design. However, many other industries have not or are only beginning to integrate virtual prototypes into the concept and design phases of projects for three-dimensional spaces.

Real-time virtual environments cannot be rendered to the same degree of visual realism or fidelity as animations, video or still images, as the latter do not require rendering in real time. Immersive 360° video can act as a virtual environment (VE) with which the user can interact with prototypes and the environment as much or as little as project and budget constraints permit. The range of virtual interaction can vary from just looking around to interactively modifying a context-aware environment depending on how much time, effort and polishing is dedicated to building the prototype.
There is an inherent benefit in the control we have over the virtual environments and how we design them affect our conceptualization and creativity: the abstract and partial nature of virtual representations (that have counterparts in reality) is precisely what makes them useful in thinking, conceptualizing and problem solving. Adults can still understand abstract forms in an environment (Whyte, 2002), abstract visual representations can aid in the creative design process because they offer a less developed and specific manifestation of the design concept and its attributes, allowing for more exploration in the early design phases. The differences between the virtual and actual environments can help illuminate hidden structures or attributes of the environment, ultimately changing the way we see, think about and interact with the space and objects within it.

It has been said that “...however real the physical world is...the virtual world is exactly as real and achieves the same status, but at the same time it also has this infinity of possibility” (Lanier, quoted in Woolley, 1993). This quote underscores that virtual environments are in fact different from reality and to leverage their potential, we must regard them as abstractions; designers should understand virtual artifacts as representation of reality, not replications.

By understanding the design prototype within the context of representations and how to capture relevant information about the environment, we can better understand how to use and make changes to it more effectively (Whyte, 2002). Not only could it help to find faults in a design concept earlier, when it’s less costly to correct, but we can also use virtual reality media to explore completely new solutions.

For activities such as design, where the problem and solution are not or cannot be clearly defined, we need prototyping methods that support visual representations that allow for movement between focused reasoning and free association (McCollough, 1998). The specific
nature of a representation affects our perception of the object or environment in question and constrains the inferences we can make about it, focusing our attention on particular areas or attributes (Scaife and Rogers, 1996). Ambiguity in representations may aid creative thought and moving between representations may help us see different aspects of design problems, giving rise to innovative solutions.

**Barriers in Using 360° Video for Immersive Prototyping**

Taking and playing 360° video, especially in VR headsets, hit the consumer market largely as a hobby or social activity; however, 360° video and virtual prototyping methods akin to these have been used in the architecture, engineering, gaming and interior design industries for decades (Whyte, 2002). The realistic environments modern videogame engines are capable of producing have been used to explore the decision-making processes in landscape planning for urban environments, for example (Valls, Redondo, Fonseca, Garcia-Almirall & Subirós, 2016).

To start, not all devices or the images they capture and display are created equally—and when discussing VR their differences become critical. Some applications recreate the virtual experience using computer generated environments and a real-time engine, such as Unity or Unreal, and some others use 360° photo or video spheres. Despite the prevalence and availability of technology for designing and rendering content for gaming consoles, that type of extensive real-time interaction may not be necessary to evaluate concepts and designs during their early phases.

While true full virtual reality, like that of gaming systems, can provide the highest level of user-interaction with the environment and designs in question, production and upkeep of such systems can be costly, time-consuming and require highly-specialized skill-sets, software and hardware. As described in the previous section, the trouble of developing a fully realized virtual
reality prototype isn’t always necessary because there is much to be learned from less defined immersive graphic simulations—especially in comparison to methods that are unresponsive and contextually disconnected. Even so, using immersive virtual graphics and environments to prototype and concept is not widely used in general. The understanding of how and why we use this media and what it can be used for are still a bit removed from what people are actually doing with 360° video and VR; but our understanding and contexts of use are not done evolving.

VR is a newly emerging medium; If the general expectations of how we anticipate true virtual reality will be are based on its dotted appearances throughout popular culture over the past 30 years or so, it may be a disappointing first experience for someone to think they are trying virtual reality, when all they are really doing is “looking at something through some weird goggles.” The disconnect in user expectations could prove to be a setback for 360° video, especially when it’s being used as a low-level entry point to immersive augmented and virtual environment technology.

The present-day predicament with 360° video and virtual graphics is that they are inherently limited by the viewing devices’ capabilities, and that issue is further exacerbated by ancillary limitations of phone-based platforms like Google Cardboard and Samsung’s Gear VR. Even on more capable and sophisticated desktop platforms that support higher resolutions, frame rates and positional tracking, users still won’t be able to get up and walk around in a 360° video. The cameras just can’t capture the data required to afford that level of interaction (Smith, 2015).

On the other hand, how we edit and produce virtual reality representations has an infinite amount of possibilities, not all of which result in favorable outcomes. Because VR is tightly integrated with your sense of vision, bad experiences have a real, physical impact on users. Unlike a web page, where breaking design rules results in long load times or a page that’s
difficult to navigate, breaking the rules in VR can induce nausea and even vomiting. And when bad design can make users physically ill, it’s less than an inconvenience—it’s a threat to the growth of VR itself. A lack in well-defined standards, practices and training could compound this issue.

There is a clear lack of a collective source that provides training, how-to guides and best practices for producing and using VR as a medium. This could be largely due to the fact that capturing, uploading and viewing immersive 360° video has been made increasingly easier, while actually developing, editing and rendering custom 360° video still requires a certain degree of planning and specialized skillsets, software and hardware. Our abilities to produce how outpaced our understanding of what we’re producing, how it might be used and what the outcomes may be.

Designers should be aware of the barriers that exist in expanding our use of 360° video as customized virtual representations for prototyping and evaluating real-life design solutions at various levels of virtual immersion. A lack in understanding of the requirements and limitations in format, resolution and graphics production for 360° footage can result in a poor virtual representation, while a lack in computing power or software capability can make producing and rendering content literally impossible.

Areas for Consideration in 360° Productions

During an exploration of using custom 360° video as a prototype in evaluating wayfinding design solutions related to this thesis, there are three areas that stood out as fundamental areas for considerations in understanding how to successfully produce this media: capturing, editing, rendering and viewing.
**Viewing platforms and devices.** There is a limit on the platforms and devices that are currently available to play even what we could consider the most basic forms of immersive virtual graphics—standard definition (SD) 360° still images and videos. Specific mobile devices like the Samsung Galaxy S7 have been built with consideration for 360° video playback, while other machines like Apple, LG and Windows devices have not—stunting 360° video’s emergence within the industry at the least.

If we consider that 360° video cameras have developed the ability to shoot a range of resolutions, which at the highest degree (4K Ultra HD), displays four-times the level of detail as our current standard of “high-definition,” we can see the immersive potential that these graphics can offer. As such, it could be inferred that the more specialized and advanced the virtual graphics, the more advanced the display system is required to be.

There are numerous head mounted displays (HMD) available to buy for a wide variety of budgets and technological partners. Ranging from the most advanced (and expensive) systems like the PlayStation VR headset or the Oculus Rift, which was the first to incorporate audio and video, and designed for ‘Full VR’ computer games and experiences. Others HMDs that require the insertion of a mobile device into the headset, such as Samsung’s Gear VR and Google Cardboard, are geared more towards VR Video and provide a lower price point, but also a less advanced visual experience. This is primarily aimed at 360/VR video viewers although you can of course play games and enjoy stereoscopic three-dimensional on it, just to the level of the performance of a mobile phone vs a powerful gaming console or computer with the Oculus Rift or PlayStation VR.

VR uses an array of sensors to track the movement of your head. The computer then maps your head’s real-world movement onto your view of a virtual world. If you turn your head
to the left in the real world, the computer mimics your exact movement in the rendered world. When executed flawlessly, VR tricks your brain into thinking that what you see is real, on conscious and subconscious levels (Smith, 2015).

While this concept sounds simple, perfecting the execution has proven to be difficult. Humans can be highly sensitive to the slightest dissonance between the movement detected by their inner ear and the motion that they see with their eyes—and this sensitivity can even develop below the level of conscious perception. If VR graphics consistently show frames of animation that are off by just a few milliseconds, users can feel ill and even grievous effects, such as headache, dizziness, nausea and vomiting (Smith, 2015).

There’s still plenty of work to be done on HMD hardware—headset ergonomics can be improved, pixel density increased, and tethers (like headphones) removed, but there’s no need for motion sickness in modern VR. The newest high-end headsets have solved the motion sickness problem for most people. They can track your head’s orientation and position in space more precisely (than low-end systems) and their displays give the software meticulous control over the timing for display of individual frames.

Users only see each frame of animation when the image it contains accurately reflects their head’s position. Unfortunately, phone-based headsets, including the Google Cardboard, lack these refinements, at least for now. They can only track the head’s orientation, not its position, and most lack fine control over display timing (Smith, 2015).

Aside from head mounted display systems, 360° videos can also be viewed in a “tethered” experience via apps and browsers on mobile and desktop devices. Google, Facebook, Vimeo and YouTube have released and continue to develop services that allow users to upload and play 360° videos through their websites.
Facebook has made a concerted effort to create an entire subdivision dedicated to this emerging immersive media, Facebook 360°. It is of interest specifically, as it places a special emphasis on how viewers interact with the video and audio—increasing the level of immersion and creating presence from their point of view, which can be of particular importance when considering design and prototyping activities. In addition to offering tools that add in graphic points of interest to help lead users through 360° videos and heat maps of user traffic in 360° videos that show what areas are being looked at most frequently, Facebook also offers an audio workstation that allows users to add spatial audio to their 360° productions.

While these sites support a varying and evolving range of depths, resolutions, frame rates, codecs, and the list goes on, they are still at the mercy of bandwidth limits and hardware and software capabilities. These sites and others have been successful in creating a community of enthusiasts with a developing library of media and growing pool of resources, but there still exists a formidable learning curve in understanding how to use this type of media in a productivity-based capacity.

**Capturing Footage.** There are dozens of 360° cameras available and new models with a wide range of capability and price are hitting the market all the time. Some of the most affordable options on the market vary in their basic areas like the field of view and stitching processes and understanding those differences is vital in choosing the right equipment for the task at hand.

Let us consider the differences between just two in a growing number of 360° cameras that are currently available: The 360Fly and the Ricoh S Theta. The 360Fly’s uses a single lens that captures a 290° spherical field of view, which isn’t big enough to accommodate a
comfortable VR experience in a headset or to test prototypes for designs that are on the floor, for example. Because the 360Fly’s lens points straight up, it can’t capture the space beneath it.

While the side-to-side and overhead footage does give the viewer a sense of place within the virtual environment, an inevitable vast black zone exists just below the horizon. This area can be distracting and omits a distinctly critical area within the user’s field of view for conceptualizing, prototyping and evaluating designs for built environments.

Almost all 360° recording systems have a footprint like this of some size. At the least, it’s a round black spot positioned relative to where your feet would be. There are more advanced VR systems that use several cameras mounted together or multiple lenses positioned within one camera to shoot various points of view simultaneously.

However, the technological difficulties caused by this setup are vast and include the need to join together those separate points of view into one seamless sphere. Some camera systems process the footage to omit the camera as the video is being rendered for output—a process known as stitching. Collectively, the footage from each camera perspective is stitched together to form a 360° sphere around the viewer, while removing the camera’s footprint from the final footage altogether.

The Ricoh Theta S operates in this way using a dual lens construction—one on both the front and back sides of the camera. The two 180° spheres of footage are stitched together to create a full 360° field of view. The Theta’s internal stitching process crops the camera out of the field of view, so that it’s omitted from the final footage, as if it were never there. The end result is equirectangular footage—or something like what you would get if you took a spherical globe and unfolded it to lay it out flat, like a poster of the map on a wall. The final 360° footage offers
the viewer the ability to sense and view items in their peripheral fields of view (including the floor beneath them) through a head-mounted display or mobile app.

**Editing Footage.** Industry-standard animating software like Adobe After Effects and Premier now include stereoscopic 360° video interpolation capability. More sophisticated plugins and encoders are also becoming available, allowing us to edit and render 360° videos for all of the various formats and platforms. Even so, it’s not an easy task to create true stereo vision, and there are many technical limitations to capture the real world in three-dimensional stereoscopic 360° images or videos. In addition to technical barriers, there is a steep learning curve involved in the production of such media.

For example, understanding the implications and limitations of how devices and rendering engines will process and display the large and complex amounts of data in 360° footage is critical in the planning and production of custom videos. Most VR video is shot at 4K resolution (4096 pixels x 2048 pixels), resulting in an effective viewing resolution of 720p field of view through the head mounted display. So, the device and software used to edit and rendering the 360° footage needs the horsepower for 4K, but we only get to see 720p at any one time.

To edit 360° video, designers must be able to reformat footage that spans a range of immersion created by monoscopic and stereoscopic visuals, so that it can be viewed and altered within a format that our brains can interpret on a two-dimensional screen. Plugins for Adobe software, like Mettle’s SkyBox Studio, allow us to view the three-dimensional space around the camera as six faces of a cube laid out flat (Figure 17). This view is particularly helpful because it provides an intuitive way to view and edit equirectangular 360° video as if it were six separate
“normal” two-dimensional videos of the camera’s view: (1) in front, (2) above, (3) below, (4) left, (5) right and (6) behind the camera.

Due to how rendering engines currently interpret and render three-dimensional space as 360° video data, some areas of the video just aren’t editable. Editing areas or placing graphics into areas that cross over a “seam” in the camera’s view, or moving from one face of the cube to another is just not an option; current camera tracking software experiences great difficulty in interpreting this specific type visual data because the footage becomes quite distorted as it crosses the seam.

**Rendering Footage.** Rendering footage for the growing number of systems and devices used to display the virtual representations requires an understanding of the format requirements, which can vary from device to device. The standard support for resolution, frame rate and
bitrates differ widely for the various codecs for different systems. Desktop platforms like Oculus Rift, HTC Vive; iOS and Android device-dependent platforms like Gear VR, Daydream, and Cardboard devices; and online platforms like Facebook, YouTube and Google all have widely divergent requirements in the formats that they support. The highest quality format, H.265, can be rendered, but is currently not playable because there aren’t yet any devices that support it. Understanding the implications of the various encoding settings, such as device support, file size, output and playback quality is critical is producing usable footage.

**Looking Toward the Future**

At the present time, immersive virtual technology has a long way to go before it can be considered an industry-wide means for conceptualizing, developing and prototyping design solutions. Even though most of the basic hardware, such as mobile devices, 360° cameras and VR headsets have become widely affordable and available, industry resources, skill, standards and software have quite a bit of catching up to do. We must consider that our current ability to collect 360° data currently far surpasses our ability to output that data in useful ways through planning, editing and rendering it into custom 360° visualization to be used for ideation, planning and prototyping to obtain measurable results and uncover new insights.

“In the short term, 360° video offers a relatively cheap bridge to the new medium. It’s fast. You can draft off of the many existing player infrastructures and creating 360° video adds just a few steps to the existing toolchain for video production. It’s easy. Because you can swipe your finger on the screen to explore a 360° video, your potential audience isn’t limited to owners of VR goggles.

It isn’t really good, though. This is just the latest example of content creators shoehorning old formats into new technologies. Like magazines and encyclopedia delivered on
CD-ROM or mobile apps that were nothing more than wrappers for websites, 360° video ultimately will be supplanted by native VR content that embraces the medium and delivers new experiences impossible to recreate outside of VR. And they won’t make you feel like you’re going to throw up (Smith, 2015).”

Pervasive use immersive and virtual graphics as learning tool and productivity resource across industries that involve consideration of human-computer-environment relationships could have extremely beneficial results. Immersive virtual prototyping could be used as a tool to perform experiments at lower costs with more control over the simulated experience—affording the ability to manipulate various aspects of the environment, like lighting intensity, simulating disabilities or placing the user in crowded situations using artificially intelligent avatars (Valls, Redondo, Fonseca, Garcia-Almirall & Subirós, 2016). They provide us the ability to user-test design concepts in more accurate space constructs with consideration for unavoidable elements of contextual experience and time, which may generate more successful, intuitive and innovative solutions.

As a spatial and temporal medium, 360° video, virtual and augmented reality simulations should be considered as useful representations for problem solving. Though they’re often advocated as models for reality, some of the most successful uses of these media are those in which they are used alongside representations in other media. Understanding these relationships can help evolve how we use virtual reality graphics by providing more meaningful knowledge and insightful explorations of human interaction with the environment and interfaces embedded within it.
Chapter VII

Design & Evaluation Recommendations

There is currently a lack of understanding and means to develop and evaluate these types of ubiquitous systems with regard to retail wayfinding. The concepts explored within this thesis have given rise to insights that were used to form a set of six recommendations for consideration in the conceptualization, design and evaluation of embedded interfaces for use as wayfinding tools in retail superstores (Appendix A).

It should be made clear that these recommendations have been built upon that ideas and insights that were aggregated from in-depth reviews of literature and existing research in several disciplines that are either directly or tangentially related to the design an evaluation of ubiquitous systems as navigational tools. However, wayfinding is just one among a plethora of applications for this type of interaction and experience design. The initial objectives of this study were not to drive sales or target consumers with ambient communication outside of the store, but expansion into those areas seems like an appropriate next step its progression.

The recommendations are meant to serve as a foundation for exploration, understanding, evaluation and discussion of embedded interfaces and part of ubiquitous computing systems, both in general and with regard to retail wayfinding. They should be understood within the contexts of the growing and evolving body of knowledge in the field of ubiquitous computing; and their contributions should be regarded only as an initial step towards the development of a proven, industry-wide set of design and evaluation standards and best practices.
Chapter VIII

Conclusion

Leading up to the current time in consumer history, the entities that provide economic value for retailers have progressed from providing goods and services to also include the creation of memorable experiences (Gilmore and Pine, 1998). During the Industrial Revolution of the 19th and 20th centuries, the industrial and manufacturing industries were automated and globalized, allowing brands to produce many products for little cost and distribute them across a wide area (Davis, 2012).

The flood of inexpensively produced goods created a consumer society, in which retailers sustain themselves by developing a desire for shoppers to purchase their goods and services in increasing amounts (Davis, 2012). As more retailers began to carry the same types and amounts of products and services, the need to differentiate themselves in other ways grew more important. Now, in the 21st century, retailers have begun to create intangible experiences in addition to providing goods and services, as a way to separate themselves from other stores and gain consumer preference and loyalty (Gilmore and Pine, 1998).

Grocery retailers should be particularly interested in understanding how context and cognition are connected with emotion in the construction of an experience, as patronage frequency, shopping duration and purchase outcomes all may hinge on the emotional impact a store has on its shoppers. A better understanding of these connections could help stores to design their environments in ways that elicit desired emotional and behavioral shopping outcomes for the retailer and consumer.

As consumerism further evolves into an experience economy, it is critical for grocery retailers to form approaches to experience design that will be successful. There is an ongoing
effort to understand the logic of experience economies, but the concept of consumer experience is still vague and lacks a sound theoretical basis to help us understand the cognitive and emotional origins of experiences, in addition to the contextual components that contribute to the formation and perception of an experience.

Wayfinding can be seen a vital component in how we form grocery shopping experiences and should be considered as one area that can have monumental effects on our classification of an experience as good or bad, when attempting to complete need-based, task-oriented activities like grocery shopping. Stores that make it easy for shoppers navigate quickly and efficiently to find what they need, without having to ask for assistance strikes a balance between the basic purpose of retail stores: providing goods and services; and their approach to how that purpose is fulfilled: by creating experiences. Retail designs that fail to balance these two areas can ultimately experience a decrease in customer loyalty.

After all these years of computing history, research and technological advances, expecting shoppers navigate increasingly larger stores using static signs, store apps or a smart cart is the best we can do? Probably not. Wayfinding in large retail spaces is an area that’s deeply rooted in traditional practices established for store layouts, signage design and placement; and these practices have only begun the ascent to incorporating the vast possibilities offered through our current computing capabilities.

We have reached a time in our history in which technology has become engrained throughout all parts of our lives. The lines between the real and the computed are often blurred as interfaces are designed to integrate seamlessly into our environment. Integrating dynamic and context-aware technologies into retail spaces can change and augment how shoppers navigate grocery stores with respect to their individual needs; having a profound effect on the perceived
value that’s derived from their overall shopping experience; ultimately resulting in symbiotically beneficial outcomes for retailers and consumers.

Furthermore, insights gained from research and implementation context-aware embedded interfaces in the retail sector can have far-reaching effects in areas well beyond wayfinding—improving everything from how consumers complete a purchase to how retailers advertise a sale; and providing a basis for understanding, discussion, implementation and evaluation that permeates all fields relevant to human-computer interaction and the design industry at large.

As technology evolves into pervasive media, engineering successful interactions with ubiquitous systems embedded in retail spaces, for wayfinding applications and beyond, will require a holistic understanding of who and what “we” are as humans and how we’ve evolved both as individuals and as a consumer society. A vast amount of knowledge, skill-sets and multi-disciplinary approaches that situates designing technology within a larger context of human emotion, physiology, psychology and behavior are needed to inform and evaluate the design of more intuitive, anticipatory interfaces.

Context and cognition are inextricably connected and we must begin to think and design in those terms. We should remember that our minds, bodies and the space around us are unavoidable, always present and should be seen as an invaluable resource for understanding, conceptualizing and problem solving. For designers acting as pioneers in the field of ubiquitous computing, it will become increasingly essential to have a fundamental understanding of that dialectical relationship and its effect to how humans perceive and use the space in their environment to gain knowledge by interacting with both real and virtual representations; and the vital role that past, present and future interactions play in the formation and production of human emotion, perception, behavior and experience.
Prototyping techniques and evaluation methods of ubiquitous system designs should also be based on the same ideas; providing opportunities to explore a range of representation and measure metrics that are related to how the interface preforms as part of a cognitive system, linked together through complex and dynamic human interaction with the interface and the context of space it’s embedded within. Immersive virtual approaches offer a modifiable, low-cost and rapid means to prototype and evaluate interface designs in a more realistic simulation of the context in which they are intended to be used.

Additionally, virtual representations can be used as tools for design and conceptualization, rather than as a final product itself. Representations are among the principal tools we have for exploring, manipulating, and conjuring possibilities (Tufte, 1997; Groak, 2001); and can play a vital role in problem solving. Treating virtual environments as a new form of inhabitable space can shrink the gap between the signifiers and signified, viewer and viewed, real and representation (Dyson, 1998), leading to new ways of discovery, thinking and innovating.

Currently, there is a lack of understanding and means to develop and evaluate these types of ubiquitous systems. This paper has put forth a set recommendations for consideration in the conceptualization, design and evaluation of embedded interfaces in general, and for use as wayfinding tools in retail superstores; that can serve as a foundation for exploration, understanding, evaluation and discussion of embedded interfaces and part of ubiquitous computing systems, both in general and with regard to retail wayfinding. However, the proposed guidelines are only an initial step toward the development of a proven, industry-wide set of design and evaluation standards and best practices; there is a significant amount of investigation
left for us to do in understanding ourselves, the technology we create and the implications each has on the other.

How and why computers are involved in our lives and the benefits provided by existing and to-be-developed technologies are not complete in their evolution, nor they fully understood…yet; and they may never be fully evolved or completely understood, as humans, technology and the relationship between them are a complex and moving target all of which are continually developing and in constant flux. The technological advances we make are often born from our needs or needs we must satisfy, but they also depend on our understanding of ourselves, and of technology.

New hardware drives the design of ubiquitous computing systems. The concept of ubiquity for computing arose from the potential for inexpensive and tiny computers embedded in or connected to our environment. Currently the ubiquitous computing community is driven by the rapid advance of technological solutions. The mechanics of these technological solutions are becoming accessible and inexpensive, enabling easier and faster experimentation and data collection through prototypes. However, the goals for research in ubiquitous computing lie beyond the hardware itself. The unique aspects of ubiquitous computing arise through combinations of technology available to us—or forced upon us—by ubiquity.

Ubiquitous computing systems cannot be developed without suitable hardware; and the design of that hardware depends upon our understanding how it can fit into the system and our lives (Barton and Vijayaraghavan, 2002). This cycle of dependency limits our progress in the production and betterment of ubiquitous systems. We must begin to reconsider how and why we interact with machines before we can develop communication and interaction scripts and schemas for human-computer relationships that are synergistic and symbiotic.
While these truths are becoming ever-more apparent to scholars and practitioners, we are still struggling with the same barriers in human-computer interaction as we were more than thirty years ago. We have reached a plateau in how we design for computing. Rapid advances in technological and computing capabilities have outpaced our understanding of how and why we use them and what they can be used for. This lack of understanding has slowed our ability to innovate beyond our current horizons to create new understanding and purpose.

It can be assumed that we are only in the infancy of ubiquitous computing and that there are profound insights to be gained as we continue to research, experiment and implement embedded computing systems across different applications and environments. But to uncover those insights, there must be a fundamental shift in what we regard as interfaces and how we conceive them to work. A definition of computing that speaks only of virtual representations under glass or inside of our devices seems as if it’s no longer sufficient. We should reconsider how we see computers and how they see us to fundamentally reshape the ways in which we expect to interact with them and how the technology interacts with us.
Appendix A

Guidelines for Embedded Interfaces as Wayfinding Tools in Retail Superstores
Guidelines for Embedded Interfaces as Wayfinding Tools in Retail Superstores

By Katie Barnes Evans, 2017

Embedded interfaces within ubiquitous systems should:

1. **Complement human abilities, not duplicate them.**
   
   Our understanding of designing embedded interfaces for ubiquitous systems should be situated within a larger framework of human emotion, physiology, psychology and behavior; and the role they play in forming experience.

   Embedded interfaces should either provide or encourage the development of new and different way of thinking about and interacting with the space around us.

2. **Consider the effects of context and cognition.**

   Embedded interfaces should be designed as one component of a three-part system comprised of dynamic and complex interactions between human-interface-environment; in which space is always present; and the contexts associated with that space are inextricably integrated with cognition and perception.

3. **Not be intrusive** (Gross, 2003).

   The way in which the embedded interface provides information should empower shoppers with useful information, rather than incapacitate them with too much or not enough of it. The interface should be able to exist in the peripheral attention, but seamlessly move to the center of attention when required, and back to the periphery again (Weiser and Brown, 1996), allowing the information to be available if it is needed, but is easily ignored when it is not.
Embedded interfaces should be integrated into the environment in ways that require as little augmentation to existing objects as possible; may or may not have a direct or apparent user-interface; and have the ability to collect and process both controlled and unmediated input data.

4. **Be context-aware.**

Can access existing data and collect contextual data through changes the environment around them; and use that information to self-alter its own processes and behaviors accordingly.

5. **Be intuitive.**

Embedded interfaces should engage interaction in ways that are consistent with natural human behaviors by facilitating multiple forms of interaction at varying level of consciousness, though active representations. These representations should be visible, straightforward and simple; and visualize information in ways that are consistent with natural human cognition to support and augment inquisition, understanding, and problem-solving processes.

6. **Be evaluated with respect to these areas.**

Evaluation methods should be derived from and abide by the same principals guiding the design of the interface. Qualitative and quantitative approaches should be used to evaluate the design; using heuristics for measurement that define success and failure with regard to function as individual parts and as a complete system of human-interface-environment.
Appendix B

Walmart Shopper Interview
Walmart Shopper Interview

Conducted by Katie Barnes Evans

On Sunday, Sept. 22, 2014

Participant Screening Criteria

The type of person that I’m looking to interview is someone who shops at Walmart Supercenter on a regular basis, and is attempting to make a quick trip to the store for just a few items, some of which they may not purchase on a regular basis.

Part 1: Demographic and Background Information

1. **Name:** Erica H.
2. **Gender:** Female
3. **Age:** 33
4. **City you reside in, or address:** 1459A Timber Trail, Akron, OH 44313
5. **Tell me a little about your family?** My family consists of me, my mom and two sisters. My mom and sisters don’t live with me, though.
6. **Do you have children or pets?** No.
7. **What’s your occupation?** A supervisor at a large commercial corporation.
Part 2: Walmart Patronage and Shopping Information

8. Who are you shopping for? (Ex. yourself, children, dinner for family)
   Just myself.

9. How many times a week do you visit Walmart on average?
   More than I want…[laughter]…Probably 1 to 2 times a week.

10. Why do you shop at this store?
    Because it’s close to where I live and it usually has the items that I need for lower prices than other stores, like the CVS right by my house.

11. Do you shop at any other grocery stores?
    Giant Eagle and Marcs, occasionally.

12. Did you make a shopping list for your grocery store trip today?
    No, no list.
    a. Did you stick to that list?
       N/A; No shopping list.

13. Which departments of the store did you visit? (Ex: Grocery, Health & Beauty, Garden)
    Produce, deli, frozen aisle, alcoholic beverages and home supplies.
14. How long did you plan on spending in the store today?

15 minutes…tops. In and out…

15. How long did you actually spend in the store?

At least an hour or more.

16. What do think contributed to making your trip so long?

They [Walmart] never have what I need, so I end up buying other things I don’t need. I feel buyer’s remorse a lot, and it causes me to spend a lot of time in aisles contemplating purchasing items I wouldn’t otherwise buy.

17. Did you find what you were looking for? What was it?

Umm…this time yes. It was meatballs, rolls and cheese.

a. On a scale of 1 to 10, how easy was it to find? (1 = easy; 10 = hard)

2. Pretty easy to find.

b. Where was the item located in the store? Is that where you thought it would be?

The deli had cheese, the “bread nook” had the rolls and the meatballs were in the meat case by the deli. I found the cheese and rolls without a problem. But the frozen meatballs were in the meat case instead of the frozen aisles. I thought it was weird. It took me a minute to find them.
18. On a scale of 1–10, how easy is it to find assistance when you need it?

10. Every time I need someone’s help, it’s like no one works there. But when I don’t need help with anything, it seems like there’s employees all over the place.

19. Tell me about a time when you couldn't find an item you really needed.

One day, I went to get a humidifier filter. The humidifier is only sold at Walmart. They’re also advertised online at walmart.com and the website said that they were available in the store. So, I went to the store and looked where all the filters were. After looking for a while, I found them by the humidifiers.

There were 4 varieties of filters, but none were mine. I asked the employee if they had them in the back and he said that “If they weren’t out on the floor, we don’t have any.” I know that statement wasn’t totally true and that’s annoying.

20. Do you remember noticing any signs in the store? Can you explain to me what they looked like?

I remember seeing white rollback signs with the Walmart “smiley face” on them. There was a “Was” price and then a big “Sale” price below it. I remember signs for contacts and the eye center. I remember signs for new release DVD and Blu-Ray movies. They were blue and had pictures of the movie covers on them.
21. Tell me a story about the worst trip you've ever had to that particular store.

[Long pause]

…I don’t know. They’re all pretty bad.

[Long pause]

22. Tell me about the best trip you've ever had to that particular store.

I was in the contraceptives aisle and a guy walks up and his phone starts ringing…he looked at it and then grabbed a pregnancy test and then just ran away. It was the funniest thing ever! Weird, but funny. [Laughter]

23. If you had to use one word to explain your store visit today, what would it be? Why?

Average. It’s never above my expectations and I expect it to be a mediocre experience.

24. How does shopping at Walmart make you feel? Why?

Pissed. It makes me angry. They never have what you need. You go there for something specific because it’s cheaper there than anywhere else. Then when you get there, you can’t find it and you end up buying other things that you don’t need because they were on sale.

25. Do you experience this at any other places?

No, just there.
26. Please fill in the blank: I wish Walmart was ______________. Why?

Nonexistent.

They’re the reason why our economy is spiraling downward because they’re taking away from smaller, local businesses. They’re so big and they sell everything so cheap, it’s hard for the small businesses to survive.

Findings

This Walmart shopper seems to be more concerned about price, than their shopping experience. She even admits to expecting a “mediocre experience” when visiting the store. The shopper is concerned that the store is damaging to small business; However, she patronizes the store 1 or 2 times a week on average.

The shopper has also expressed that items can be hard to find and that she often spends more time in the store than desired. Often, this is because she has become distracted by other product while looking for a particular item and begins contemplating making purchases that she had not previously allotted for. The shopper has also expressed that it can be difficult to find help when she needs it. In one instance, once she had found help, she felt as if they were not actually doing what they could to help.

This experience admittedly leaves her with buyer’s remorse and feeling frustrated, creating an overall negative experience. It’s important to point out that despite this shopper’s negative experiences and feelings toward Walmart, she continues to shop there because it’s the most affordable option for her.
Appendix C

Walmart In-Store Shopper Interview
Walmart In-Store Shopper Interview

Conducted by Katie Barnes Evans

Saturday, Sept. 21, 2013

Location: Walmart Supercenter, Stow, Ohio.

Time: 10:00a – 1:00p

Weather: 60-65°F, Rain – Heavy at times.

Store Traffic: Low to moderate.

Position of Observer: The middle of the store, directly in front of the electronics counter at the intersection of “Action Alley” and the main walkway through the entrance.

Shopper Interaction Observations

10:30a

Two young men appearing to be friends, mid-20’s, both wearing t-shirts, cargo shorts and tennis shoes. One is wearing an orange shirt and has tattoos, while the other is wearing a green shirt. The pair walks toward an endcap with video games at the front of the electronics department.

“We were here for the panda,” one in an orange shirt says to the other. “Yeah, we kinda gravitated towards the video games,” the other said as they laughed and quickly turned away from the games and immediately proceeded to their right, towards the grocery department, walking quickly.

About 30 seconds pass and the young men have turned around and are now silently walking back the other direction, towards the toy department, walking at an even faster pace.
10:30-10:40a

An older woman, late 50’s or early 60’s is pushing an even older woman, possibly in her 90s, in a wheelchair. Walking slowly past the crafts and fabrics, the two women proceed looking left and right, but not speaking. As they approach the fabrics service desk, the woman pushing the wheelchair asks the clerk “Where are the index cards?” The woman paused briefly before continuing, “Am I going the right direction?” “I think so,” the clerk replied. “They should be over to your right..”

The woman pushing the wheelchairs smiles and says “Thank You.” To the clerk and leans to the elderly woman in the wheelchair and says “It’s right over here somewhere.” The woman proceeds to push the wheelchair into the next aisle and pauses while the women examine the shelves. “Here they are. I found them,” the woman in the wheelchair exclaimed. The clerk came from the next aisle over and said “Oh, where?” The woman in the wheelchair pointed to the lowest shelf as the clerk said “Ohhmmm.”

The woman pushing the wheelchair picked up a white package of index cards and a pink package and showed them to the woman in the wheelchair. “Which one do you want?” she asked. “These ones are cheaper,” the clerk interjected while pointing to the white package. “I’ll take these.” The woman in the wheelchair said quietly as she placed the white index cards in the basket of the wheelchair.

11:15a

A man in his 30’s, wearing blue jeans and a light jacket, walking with his child, age 5 or 6, holding his hand. The man walks quickly down the aisle looking left and then right, while the child appears to struggle to keep up. The pair proceed past 3 more aisles before stopping abruptly
and turning around. They walk back 2 aisles and the man mutters “There,” as they move quickly
down the aisle. The child remains silent.

The man releases the child’s hand and steps back from the shelf to examine it. He reaches
toward the bottom shelf, and shuffles through product before retrieving a box of envelopes. The
child begins to play with items on the bottom shelf as the man says “Ok, let’s go,” and resumes
holding the child’s hand while proceeding to the checkout.

12:25p

A woman in her late 40s, wearing a flower print t-shirt and loose fitting jean shorts is pushing an
empty cart. She proceeds toward a store employee who is walking through the store as asks “Do
you know where kids posters are?”

“Did you check electronics?” The employee replied. “Yeah, someone else already
checked there.” The employee quickly said “What about crafts?” “I checked there too,” the
woman said. The woman began to walk away as she said “I guess I’ll check Toys.” The
employee said “Ok. Sorry.” And proceeded to resume walking the other direction.

Ten minutes pass and the woman reemerges, walking in the opposite direction of Toys,
now accompanied by a young woman, high school age, wearing a high school t-shirt, tight jean
shorts, and brown UGG boots. “Where would the posters be?” The woman said to the girl as the
proceeded back through the arts and crafts department. “Here?” The girl asked as she walked
into one of the aisles.

Three more minutes pass before the pair walks past again still pushing an empty cart, this
time heading down the main aisle, towards the exit of the store. The pair is not speaking and
looking side to side as they work their way down the aisle, out of view.
12:40pm

A man, in his early 40s, wearing a collared t-shirt and blue jeans, is pushing an empty cart and approaches a manager who is standing in Action Alley having a conversation with an employee. The manager is wearing a royal blue, button down shirt, tucked in khaki pants. An earpiece in in his ear and the cord extends down and is clipped to his shirt. The employee is a woman, late 40s, wearing a navy blue polo shirt and loose fitting khaki pants.

“Are you the store manager?” The man asked. “Yes!” The manager replied in a friendly tone. “I was going to buy a phone but I asked for help fifteen minutes ago and no one’s helped me…still,” the man said sternly.

The employee walked away without saying anything and the manager began to walk toward the man. The manager began to say “Let me…” as the man interrupted saying “I’m just going to buy it somewhere else,” while walking away, towards the exit of the store. The manager stood in place silently as the man walked away, before shrugging his shoulder and returning to working.

12:45p

A woman wearing a ponytail, glasses, jeans, tennis shoes and a hooded sweatshirt is pushing a cart with her daughter riding on the end. The girl is 4 or 5 years old, wearing a pink dress and shoes, with short, light blonde hair and bangs.

The woman approaches an employee at the electronics counter and asks “Do you know where the ice packs are?” “What type of ice pack?” the employee replied. “For your lunch?”

The little girl begins chattering and lifts up her bangs to reveal her forehead. “I fell down last night,” she says as the mother interrupts and says “She fell down the steps last night.” The
child continued inaudible chattering about her injury to the store employee as the mother and employee continue the discussion.

“Oh, you’ve got a boo boo!” The employee said excitedly. “Ice packs are in the pharmacy,” the employee continued. “I looked there. I didn’t see them,” the woman said. “I guess I’ll look again.” She muttered as she walked away. “They’re in the second aisle from the Pharmacy,” the employee said as the woman pushed the cart and child towards the Pharmacy department.

**Purpose & Goals of In-Store Shopper Observation**

Repeat Walmart shoppers can easily find products that they shop for on a regular basis, with little use of in-store signage because they are already familiar with the item’s location in the store. Customers seem to have the most difficulty when attempting to find an item that they shop for infrequently, or have never shopped for at all.

When a shopper is trying to find this infrequently purchased item, they become much more dependent on signage and other navigational cues to help them find what they’re looking for, proving the importance of clear, concise and well-placed signage. This proves particularly true in stores as large as Walmart. Often, the proper navigational tools are not available, causing shoppers to spend more time than anticipated inside the store, become frustrated and possibly leave without purchasing the item. This negative shopping experience can be damaging to the store’s sales, as well as their brand image.

My goal is to identify where these navigational barriers exist throughout the store, research the points of difficulty and develop possible solutions to improve shopper way-finding and ultimately enhance their shopping experience.
Summary of Observations:

**Macro vs. micro.** The navigational issue for Walmart begins at a macro level, in that departmental signage (Ex. Automotive, Electronics, Toys) is mounted very high on exterior walls, which are often far away and blocked by high product shelving (Image 1). The inability to see department signage from one side of the store to the other causes shoppers to have difficulty navigating to the part of the store they actually need to be in.

There is also smaller directional department signage placed at major “intersections” in the store, but they only exacerbate the issue. These signs are small, positioned high and off-center from the customer’s viewpoint and does not immediately show the direction of all departments, but rather just a few (Image. 2). The customer must walk around or under the sign to read the entirety of its content. Because of the size and position of these signs, they could often be overlooked and even if they’re not, they may not give the customer the information they needed.

Often, shoppers approach these intersections without clear direction, pause, do not see the sign and seem to randomly or instinctively choose a direction and proceed. In most cases, this led to shoppers moving in the wrong direction and having to retrace their steps back through the store, which can prove to be frustrating (especially if you’re in a hurry).

At a micro level, more specific navigational problems present themselves. Once the shopper has made it to the department in the store that they believe they need, there is still an apparent difficulty in finding the item they’re looking for. There were several “problem areas” of the store that quickly stood out: Toys, Arts & Crafts, Home and Office Supplies.
In these departments, aisles do not have numbers or signs at the end that tell the shopper what type of product is in that aisle (Image 3). Rather, there are in-aisle signs that show one or two overarching category names for the type of products in that particular aisle. These signs are small, mounted above eye level at the top of the shelves and is sometimes missing from an aisle. The in-aisle category signs are also mounted perpendicular to the product shelving, making them only viewable from either end of the aisle, rather than being viewable as you’re looking at product (Image 4).

Without clear signage at the end of aisles, shoppers are unable to effectively assess which aisle they need to be in and often tend to shop in a non-linear fashion, bouncing place to place, or skipping several aisles at a time. Aisles in these departments can also change direction, making linear navigation difficult and causing customers to feel like they’re in a “maze” of product.

Once in the aisle, shoppers can be met with messy shelves of disorganized product that can seem overwhelming to look through. Often, shoppers may look right past the item that they’re looking for because of shelf disorganization (Image 5). Other times, the product is not located in the department that “makes sense” to the shopper and they find themselves having to repeat this navigation process over again. During my research, I found an example of this phenomenon: Walmart currently stocks their exercise videos in the Sporting Goods department, however shoppers instinctively search for them in the electronics, with the rest of the DVDs (Image 6).

**What’s working in grocery?** While examining the Grocery Department, it became apparent that there are less navigational barriers between the shopper and their item. Each grocery aisle has a designated number, as well as signage at the end of the aisle that tells the shopper what type of products can be found within. Once within the aisle, there is smaller,
aisle category signage to help delineate between products. Items are also more organized than other parts of the store, making it easier for shoppers to look through (Image 7).

The product and shelving placement allow shoppers to navigate the store in a linear fashion (up an aisle and then down the next, in order). All the shelves run the same direction, giving a clear path to the shopper, while products are placed where they “seem” they should be. For example, sugar and flour are located in close proximity to muffin cups and icing kits. Lastly, the shelving is lower, allowing customers to better gauge where they are in the store and where they need to get to.

After positioning myself in the grocery department for 30 minutes, I did not visibly or audibly notice anyone having trouble navigating the department or finding product. Rather than spending time locating a product, shoppers spend more time examining the product and brand at-shelf. This is quite the contrast to the Home/Pharmacy side of the store.

...And other departments. There is a distinct type of signage in very specific departments in Walmart, which prove to be interesting. Both the Electronics, Greeting Cards and Hardware departments feature unique product category signage that is not present in other parts of the store (Images 8, 9 and 10).

The signs feature a short description of the product (Ex. Smartphone Accessories or XBox), are mounted at the top of the shelves, above all product, and are parallel or spatially inline with the products beneath them. The signs have effectively created visual “buckets” that products can sit in, helping shoppers to narrow down which part of an aisle their item will be located in and ultimately find that item faster and easier.
Proposed Solutions for Improvement of In-Store Wayfinding

1. Borrow signage practices that are working well in other parts of the store and apply those ideas consistently store-wide.
   - Add “aisle contents” signage at the end of all aisles (as in Grocery) to help shoppers discern which aisle they actually need.
   - Use in-aisle category signage with products to create a clear visual delineation between different types of products within an aisle. This could be done by manipulating existing shelf hardware to serve as navigational tools using shelf headers, as done in Electronics, or using shelf strips, etc. as signage.

2. Keep product as organized as possible, so that it’s easy to look through.
   - Keep product and shelving heights low enough that shoppers can see almost (if not all the way) across the store, making them more able to gauge where they are and how to get to where they want to go.

3. Have all shelving in a particular department run the same direction. This will help to cut back on the “maze” feeling that shoppers experience, while allowing them to navigate form aisle to aisle more easily.

4. Decrease visual clutter around the hanging signage by finishing the ceilings within the stores. The exposed scaffolding and piping could be distracting when looking for signage.
5. Consider placing one or two “Store Directories” in key places throughout the store, similar to what we see in shopping malls, to help shoppers navigate across large portions of the store.
Images

Image 1
Image 2
Image 3
Image 6
Image 7
Beyond the Screen: Embedded Interfaces as Retail Wayfinding Tools

Image 8

Image 9
Image 10
REFERENCES


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