AdaptivePassage in a Shopping Mall:

Calling to Drive Customers into Stores and Encourage Shopping

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Abstract

Passage, the glass-roofed marble-paneled corridors extending through buildings, acted as the center of commerce and the invention of industrial luxury in 19th century Paris. It elegantly stood as one of the most suitable places for the middle-class Parisians to spend their time; with tempting odors, music, and lights colorfully shining the shop windows and its articles. The prosperous atmosphere still exists today and attracts people to spare their leisure time drinking coffee, browsing boutiques, or enjoying just strolling around the place and its history.

This dissertation addresses *AdaptivePassage* Model, a model driving customers in shopping malls and encourages their shopping by creating an environment calling to their senses. The environment full of sounds, smells, and sights can be designed by adding a layer of ubiquitous computing technologies on top of the current brick and mortar retail architecture. This model is fruitful for renovating the existing static functional-style shopping mall into a dynamic architecture providing customers the enjoyable experience of shopping. In this paper, I set three components to design retail architecture and provide three methods to realize the adaptive experience with this model.

AdaptivePassage Model was developed and implemented through a collaboration project aiming to design prosperity in a shopping mall, conducted with the owner company of the mall. In this project, I created an adaptive sound environment calling to the customers to shop. This paper describes the design of AdaptivePassage Model implemented in a real shopping mall, and states that sensuous environments created with an additional layer of ubiquitous computing technologies is effectual for a new shopping mall design.

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Introduction

1.1 Calling to me

One step outside Tenma Station in Osaka, *Tenjinbashi-suji Shotengai* greets visitors with medley of various of stores on both sides of the roofed block. Appetizing odor of food-vendors and fresh brewed coffee tempt pedestrians to have a stop. Energetic voices of the grocery store owners and the garish neon lights notify the price discount of the groceries on the left side of the street. Over on the right hand, the laughter of residents around the area fill the space as they enjoy their street-corner conversations in front of some delicatessens. Walking forward, some rusty smell of iron and rhythmical sounds of hammers striking in the factories welded ironware. This vigorous street full of enchantment, one prosperous example of the traditional Japanese shopping arcades and one of the longest arcades in Osaka with over 600 local shops[1], provide citizens the integrated sensation of sight, hearing, and olfaction when purchasing daily goods in their everyday life.

Shopping malls, the typical commercial architecture style, have been struggling to prosper like Tenjinbashi does. The typical shopping mall architecture that exists all around the world today arose in the 1920's when the motorization took over the United States. Sears Roeback and Co.[2], originating as a mail-order catalog company targeting farmers, branched their retail store complex for the American citizens. Robert E. Wood, the vice president of the

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[1]Osaka Shopping Guide http://www.japan-guide.com/e/e4013.html
[2]Sears http://www.sears.com

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Sears, pioneered in launching their department stores in the low-density area for the citizens with automobiles.[3] Until then, the only way to purchase goods for citizens in the suburban and rural area was by catalog ordering or to go to department stores in the metropolitan area. Citizens living in the country drove their automobiles with their families to shop what they wanted, thus was a great trend as they were no longer limited to shopping by catalogs.[4] The strategy Wood decided to take made great success; the sales of stores in the suburban area were larger compared to those of their metropolitan markets.[5]

The Sears store that opened in 1934 in Englewood, Chicago, was designed as the first fully-enclosed windowless retail architecture, which style still remains as the central tenet of United States retail space design today.[6] As the "America's First Store without windows"[7] or "The World's Most Modern Store"[8], it exemplified the Chicago World Expo 1933[9] on American architecture, eliminating all natural light and using artificial light to create illuminations within architecture.[10] The windowless department store structure was completely air conditioned, lent itself to climate control, and provided roomy retail space to place its goods. Instead of using windows just to bring light into the building, the windows were used for a promotional display for the customers, where they enjoyed seeking for what they wanted with their own feet and were serviced to buy goods across the counters.[11] Creating windowless fully-enclosed architecture was the most frontier method to design a different experience of purchasing using illuminations with artificial lights and shop windows for display.

As had the department store Sears took the country-side strategy, other large-scale retailing also began shifting to the uncultivated as well. One of the first influential automobile-oriented shopping center, Kansas City's *Country Club Plaza*[12] which opened in 1923, was designed by J.C. Nichols, the

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[3]Jackson (1987) *Crabgrass Frontier: The Suburbanization of the United States* pp.257-258

[4]Sears Archives: Sears History 1925 http://www.searsarchives.com/history/history1925.htm

[5]Sears Archives: Sears History 1930s.http://www.searsarchives.com/history/history1930s.htm

[6]Sears Archives: Store History http://www.searsarchives.com/stores/history_chicago_first.htm

[7]Chicago Daily News article in 1934 hailed the Englewood Sears store so.

[8]Sears took out a full page ad in the Chicago Daily Tribune on November 21, 1934.

[9]Chicago's second World's Fair: A Century of Progress Expo. Chicago previously hosted the World's Columbian Exposition in 1893.

[10]Chicago History Museum *Chicago History* Fall 2000 Vol.29 No.2. pp.26. http://www.chicagohs.org/documents/chicago-history-magazine/ChicagoHistory_Vol29No2_Eskilson.pdf

[11]Chicago History Fall 2000 pp.41

[12]Country Club Plaza http://www.countryclubplaza.com

Kansas-native developer. He turned the swampy little valley of Kansas City into an European-like one-of-a-kind shopping center which stood in organic harmony with the prairie surroundings of the mid-western America.[13] Nichols created the idea of the planned regional shopping center, and was the first person to use leasing policy which he put together the concentration of retail stores and gave rental charges that included a maintenance fee to insure that the property was adequately cared for during the term of the lease.[14] With more than thirty bronze statues, tile mosaics, or various Spanish architectural reproductions such as the half-sized Giralda Tower of Seveille, Country Club Plaza surprise visitors to find these magnificent European-like works of art in the heart of Midwest America. Country Club Plaza provide visitors to walk around its pedestrian oriented outdoor-type shopping center of more than 100 retail stores.[15]

Although the concept of the regional shopping center was recognized as the best method of serving the growing market of customers with automobiles by the mid 1930's, the Great Depression and World War II gave a chilling effect its constructions, therefore were only several of them throughout the entire United States as of 1946.[16] It was only after the post-war period which accelerated the developments of shopping malls. *Northgate*[17], an open-air shopping center in suburban Seattle, was constructed by the architect John Graham Jr. in 1950. Within the mall, he designed a long, open-air pedestrian way lined with a number of small specialty shops and ending with a department store. Such design was the beginning of "anchoring" facility that attract people who would then shop their way to their destinations.[18]

Reflecting on Graham's design, Victor Gruen was the architect that introduced an enclosed, climate-controlled indoor mall with pedestrian decks and anchor tenants by designing *Southdale Center*[19] in 1956, located in suburban Minneapolis. Gruen designed the fully-covered air-conditioned malls to let

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[13]Worley (1993) *J.C. Nichols and the Shaping of Kansas City: Innovation in Planned Residential Communities* pp.10-28

[14]Jackson (1987) pp.258-259

[15]Country Club Plaza: Art&History http://countryclubplaza.com/art-history

[16]Jackson (1996)

[17]Northgate Mall http://www.simon.com/mall/northgate-mall

[18]Jackson (1996)

[19]Southdale Shopping Center http://www.simon.com/mall/southdale-center

all activities to be held inside, regarding the fierce climate of Minneapolis—snowy winters, hot summers, rainy springs and falls. As an Austrian-native, he had been inspired by Milan's *Galleria* where people pause to rest and sip aperitifs between visits to other shops.[20] He wanted to design a building that would be a communal gathering place, where people would shop, drink coffee, and socialize, just like those European arcades.[21] His main focus on design was on efficiency, safety, comfort and cleanliness.[22] Gruen therefore designed a climate-controlled public space in the center of the architecture, with two anchoring department stores diagonally opposite each other across it and a pedestrian deck with tenant-store blocks in-between.[23] In addition to this method, he also used artificial lights, giant show windows, and fancy facades for his stores, while he created grand water fountains, twirling sculptures, and rose gardens for the public central space; for the visitors to enjoy their time at Southdale.[24]

Gruen's method on designing an enclosed-type shopping malls proved wildly popular, and demonstrated that climate-controlled shopping arcades were likely to be more profitable than open-air shopping centers.[25] Various malls followed and located their stores on outlying highways that attracted shoppers from trading areas all over the country. This perfect scientific placement of stores inside met the visitor's diverse needs and maximized the store owners' profits. For example, *Garden State Plaza*[26] and *Bergen Mall*[27]—which both opened in 1957 near the intersection of Routes 4, 17, and the Garden State Parkway in Paramus, New Jersey—provided good models for how shopping centers of the 1950's followed Gruen's prescription and became more than just a miscellaneous collection of stores.[28] Gruen's method of scientific location—placing several anchor department stores opposite each other and creating pedestrian decks with numerous retail store blocks between—were based on Reilly's law of retail gravitation[29], applying the gravity model to

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[20]Gruen (1973) *Centers of the Urban Environment*

[21]Article by *The Economist*:"Birth, death and shopping. The rise and fall of the shopping mall". Dec.19, 2007. http://www.economist.com/node/10278717

[22]Southworth (2005)

[23]Wall (2005) *Victor Gruen: From Urban Shop to New City* pp.92-96

[24]Hardwick (2010) *Mall Maker: Victor Gruen, Architect of an American Dream* pp.4

[25]Jackson (1996)

[26]Garden State Plaza http://www.westfield.com/gardenstateplaza

[27]Now known as The Outlets at Bergen Town Center http://www.bergentowncenter.com

[28]Cohen (1996)

[29]Reilly (1931) *The Law of Retail Gravitation*

measure retail trade between two cities.[30] By 1960, each shopping center had two to three department stores as anchors, surrounded by fifty to seventy smaller stores, attracting half a million patrons a week.[31]

Malls indeed provided a fulfilling national pastime for the American citizens for a long period of time. The industry's peak was in 1978, where sales per square foot of retail space averaged to $197 a year, however, the number of constructed shopping centers started to decline in 1988.[32] Kenneth T. Jackson, the chair of the department of history at Columbia University, notes in his papers that "perhaps the Americans have finally started to become boarded with the same malls or tired of the effort it takes to navigate them". The typical malls—with pedestrian decks and anchoring stores—have become too popular that it became too homogenized and predictable for the customers and started to lose much of the entertainment value. By the early 1980's, malls that have been designed in the same old-fashioned scientific style for three decades started to lose its customers.[33]

Around that time, the Californian-native architect Jon Jerde noticed that although the shopping malls remained the meeting point for citizens living and working in the area, the retail industry itself had only focused on functionality and rationality. He felt the standard formula of shopping mall design that had spread widely across the entire United States were completely outdated, which lacked the rich experience it had when it originally were planned over decades ago. He believed that the mall could again be a communal setting by fabricating the experience visitors spend in the space.[34] In 1985, Jerde's first shopping mall *Horton Plaza*[35] opened in downtown San Diego, which totally revolutionized the mall typology with architectural tricks and odd spatial rhythms.[36] This groundbreaking mall has mismatched levels and diagonal links that induce visitors for a feeling of exploration.[37] The architectural tricks with long one-way ramps, sudden dropoffs, and bright colors facades were something

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[30]Fujita, Krugman and Venables (2001) *The Spatial Economy* pp.97-99.
[31]Cohen (1996)
[32]Schwanke, Lassar and Beyard (1994) *Remaking the Shopping Center*
[33]Jackson (1996)
[34]Jerde (1998) *The Jerde Partnership International: Visceral Reality* pp.9
[35]Horton Plaza http://www.westfield.com/hortonplaza
[36]Richard W. Crawford, *The Journal of San Diego History.* Summer 1995, 41(3). https://www.sandiegohistory.org/journal/95summer/chapter22.htm
[37]Jerde (1998) pp.19

that citizens had never seen before. The multi-level double-curved diagonal street acts as an axis and connects the downtown area with the waterfront of the city. This remarkable shopping complex is not just a building but a urban environment covering a huge territory of 1.5 million squares, attracting over 25 million people within the first year.

The most significant point of the malls by Jon Jerde and his firm Jerde Partnership[38] is that the architecture itself provides the experience of exploring something as if getting lost and finding something unexpected. Another example of their works, *Canal City Hakata*[39] opened in April 1996 in Fukuoka, Japan. This large-scale shopping district consists of various colorful buildings with distinctive styles that stand along a canal running throughout its site. With many curving sculptures and fountains, it creates an oasis atmosphere in the center of the city of Fukuoka. The shopping complex comprises various business and leisure facilities including movie theaters, amusement facilities, two hotels, showrooms and corporate offices, which aims to create a sense of a "city theatre".[40] Young teenagers, families, businessmen, are drawn to Canal City Hakata which provides a manageable, interesting, comfortable place to spend time, and experience a sense of community.[41] For Hakata, the Jerde Partnership produced an one-of-a-kind mall with 5 different zones of curvy buildings and walkways for visitors to explore. When walking through the zones, visitors feel the nature and enjoy a variety of scenes as if they are walking through the universe.[42] Canal City Hakata injected new urban life by integrating many aspects that still attract many people from all over the places as of today.

Such architectural approach is a great challenge to the general shopping mall design that has been carried on since Sears had back in the 1920's. "Half the fun of travel is the aesthetics of lostness", the science fiction writer Ray Bradbury wrote in his essays.[43] Jerde's architecture with winding walkways and mazed-like mismatched levels creates moments of surprise and excitement. This design arose from their focus on communality and experiential

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[38] Jerde Partnership http://www.jerde.com

[39] Canal City Hakata http://www.canalcity.co.jp/eg

[40] Canal City Hakata's concept. http://www.canalcity.co.jp/eg/concept

[41] Gandel (2000) *Jon Jerde in Japan: Designing the Spaces Between* pp.11

[42] Jerde (1998) pp.63

[43] Weller (2006) *The Bradbury Chronicles: The Life of Ray Bradbury* pp.292

Figure 1.1: Canal City Hakata designed by Jerde Partnership

placemaking, in comparison to the focus on object making like the traditional conventional architecture. The retail industry architecture's style of function and rationality in the United States lacked of the communal setting of commercial architecture which the standard simple design of shopping centers had had.[44]

Mall of America[45], the largest enclosed shopping and entertainment facility in the United States opened in suburban Minneapolis in 1992, is perhaps the most well known masterpiece of Jerde Partnership. In its territory of 78 acres and four levels, the mall consists of not just 520 stores but also a theme park, aquarium, miniature golf course, entertainment district, and even its own transit station. A dreamhouse of collectivity, Mall of America was the model case in the retail industry to mix retail and entertainment attractions.[46] Mall of America still attracts more than 40 million visitors—more than those of the Disneyland[47], Grand Canyon[48] and Elvis Presley Graceland[49] combined— from all over the world each year, which generates nearly $2 billion each year in economic impact for the state of Minnesota.[50]

Co-creativity, the practice of bringing together remarkable people of diverse talents, is their method of creating the experiential one-of-a-kind architecture. Starting with Bradbury, Jerde Partnership has involved the film director Speilberg and George Lucas, and celebrated artists and architects. This style of

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[44]Jerde (1998) pp.9

[45]Mall of America http://www.mallofamerica.com

[46]Goss (1999)

[47]Disneyland Resort https://disneyland.disney.go.com/

[48]Grand Canyon National Park http://www.nps.gov/grca/index.htm

[49]Graceland http://www.elvis.com/graceland

[50]Mall of America: History http://www.mallofamerica.com/about/moa/history

co-creativity enabled the retail projects to expand and elaborate beyond themselves and into the city fabric, and create a communal setting that renewed a public life of richness and complexity. With this method, the firm creates curvy roads, sudden dropoffs, colorful facades, or mismatched floors for bringing civility, continuity, and related-ness to the retail architecture. They revolutionized the typical enclosed-type shopping mall as the enchanting experiential urban retail environment.[51]

The experience of enchanting moments of surprise and excitement refers to Walter Benjamin's unfinished research project *Das Passagen-Werk*[52], *The Arcades Project* in English. Passagen-Werk is a series of notes in which the German philosopher Benjamin wrote reflecting on the ephemeral quality of the world and life of Paris in the 19th century. He received his inspiration of the work by reading Louis Aragon's Surrealist novel *Le Paysan de Paris*[53], which centers one of the Parisian passages *Passage de L'Opera* just before the material space itself disappeared due to Haussmann's reorganization of Paris.[54] Passage de L'Opera was one of the most gorgeous passages that captivated various Parisians at the time of its grand-opening in 1821, with modern cafes, prestigious boutiques, ballrooms, theaters, and beautiful restrooms, until it was torn down in 1925. Benjamin felt his heartbeat strongly when reading the book mentioning the ephemerality of the material space the Passages provided.[55] He considered the Parisian Passages of the nineteenth century were the precise material replica of the external physical experience and internal consciousness of the dreaming collective.[56]

The oldest existing Passage, *Passage des Panoramas* opened in the year 1800, during the age for epic transformation soon after the French Revolution, by some Parisian affluents that remarked on the unpaved muddy roads.[57] (See Figure1.2) The idea of creating a pass-through with roofs connecting from one

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[51]Jerde (1998) pp.98-99

[52]Benjamin (2002) *The Arcades Project.* I will be referring to the English translation by H. Eiland and K. McLaughlin

[53]Aragon (1998) *Le Paysan de Paris.* Original version printed in 1926

[54]Buck-Morss (1991) *The Dialectics of Seeing: Walter Benjamin and the Arcades Project* pp.33

[55]Buck-Morss (1991) pp.33 Written in his letter to his friend Theodor W. Adorno, May 31, 1935. Referring to *Briefe*, 1978, Vol.2, pp.662-663

[56]Buck-Morss (1991) pp.33-40

[57]Geist (1982) *Arcades: The History of a Building Type* pp.464-475

Figure 1.2: Passage Panoramas, the oldest existing Parisian Passage

marketplace to another came to their minds. Affluents purchased various territories near the marketplaces, and created an alley with parallel three-story-high commercial buildings covered them with glassed roofs. The landowners did the best efforts to provide citizens the most luxurious atmosphere at that time, placing the large circular tableaux *panorama*[58] in front of either sides of its entranceway.[59] With the lights from glass ceilings and the panoramas, the illumination of the endless string of flaring candlelights or colorful scenery projected by panoramas emblazed the decorated floor patterns, facade designs with marble walls, and various venus sculptures that greeted the passerby.[60]

Many of the Parisians favored to walk through these covered passages to get to the marketplace, which lead numerous stores from prestigious to counterfeit

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[58]Benjamin (2002) pp.1043-1044. Large circular views to be placed in the center of a rotunda displaying scenes of battles or cities painted in trompe l'oeil. Pictures were painted on cloth transparencies. Introduced in France in 1799 by American engineer Robert Fulton. Their installation burned down in 1839.

[59]Benjamin (2002) pp.51. Quote of Paul d'Ariste, *La Vie et le monde du bouleard 1830-1879*, 1930, pp.14

[60]Benjamin (2002) pp.533

located within the passage to attract the passerby and thrive their business.[61] "Nana loved the Passage des Panoramas." French naturalist novelist Emile Zola[62] writes in his famous novel *Nana*[63] and continues, "Ever since her girlhood she had had a passion for the glitter of articles de Paris, counterfeit jewelry, gilded zinc, and imitation leather. Whenever she passed through it she could not drag herself away from the shops".[64] Identical to the high-class prostitute Nana in the novel, ladies and gentlemen of young and elder felt attracted to the shop windows in such passages that sold dresses, hats, shoes, bags, books, perfume, or accessories.[65] These counterfeit products called *articles de Paris* were somethings that they could not possess before this epic transformation era.

In his work Passagen-Werk, Benjamin convolutes a collection of short notes on 36 topics, for example fashion, iron construction, Haussmannization, interior, and in particular, Baudelaire. Benjamin saw Charles Baudelaire's melancholic poetry as the gaze of the alienated man, or the gaze of the *flaneur*.[66] Flaneur, or strollers in English, was the name of which the middle-class Parisians strolling in the streets of Paris called themselves.[67] The *Illustrated Guide to Paris*, the complete picture guide of Paris and its environment published in 1852, notes the iron constructed glass-roofed passages called *Passages couverts de Paris* appeared as "a recent invention of industrial luxury...whose owners have joined together for such enterprises" and that the elegant shops in "the passage is a city, a world in miniature."[68] These passages were something between a street and the indoors, which served as a dwelling place for the flaneurs. The shiny enameled shop sign in the passage is a good wall ornament for a flaneur, just as an oil painting in the living room is for a bourgeois.[69] Baudelaire mentions the crowds created by the flaneurs in the passages as

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[61]Benjamin (2002) pp.31

[62]One of the most important writers of French naturalism. Most of his novels focused on describing various Parisian citizens during the Second French Empire.

[63]Published in 1880. *Nana* is the ninth book of the *Rougon-Macquart Series*, a series of 20 novels about the members of a family in the Second French Empire era.

[64]Zola (1941) *Nana* Excerpt from Chapter 7. Published in English by Pocket Books Inc. in 1941. pp.174-180

[65]Benjamin (2002) pp.37

[66]Benjamin (2006) *The Writer of Modern Life: Essays on Charles Baudelaire* "Paris, the Capital of the Nineteenth Century" pp.40

[67]Benjamin (2002) pp.416-417

[68]Benjamin (2002) pp.31. Quote of *Illustrated Guide to Paris*, 1852.

[69]Benjamin (2006) "Paris of the Second Empire in Baudelaire" pp.68

"anyone who is capable of being bored in a crowd is a blockhead."[70] The crowd formed in the passages by numerous flaneurs served as the veil through the familiar city of Paris beckons as *Phantasmagoria*.[71]

Phantasmagoria, originally a magic lantern show hosted by a Belgian inventor Robertson[72] in 1798, attracted many Parisian citizens of the time with a theatre plunged with darkness and assailed with strange sounds. During the show, the dusky candle-light of the magic lanterns, images appeared like fantastic luminous shapes floating inexplicably in the air.[73] The passages, the marble-paneled corridors with gas-lamps lighting near the ceilings that extended through whole blocks of buildings, has been the most prosperous place to hang around and shop for the flaneurs. Benjamin saw the behaviors of people in the Passages, felt various economically and technologically based creations full of lights, sounds, odors, and excitement, and called the atmosphere Phantasmagoria.[74]

In this dissertation, I propose a model for driving customers into stores and encourage their shopping, driven by producing an environment calling out to human's senses into the ready-built shopping architecture. Typical commercial architecture style known as shopping malls have been facing difficulties for its prosperity. Throughout the past century, different models challenged to create the most exciting shopping architecture—Sears' country-side windowless architecture model, J.C. Nichols' planned regional shopping center like Kansas City, Graham's open-air pedestrian way, Gruen's model of enclosed-type scientific-location of anchoring tenants, Jerde's co-creativity method of creating odd spatial rhythms—but struggles still remain. The key to encourage shopping refers to the exciting atmosphere of the Parisian Passages back in the early 19th century, full of phantasmagoria. This research addresses that revitalizing the phantasmagoria environment into the current brick-and-mortar retail architecture will inspirit the customers to be driven into the stores of the shopping malls. This model driving and encouraging the shopping of customers by revitalizing environmental phantasmagoria, is called the *AdaptivePassage* Model.

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[70]Benjamin (2006) pp.68 Originally a quote of Baudelaire, *Oeuvres* Vol.2 pp.333: "Le Peinter de la vie moderne"
[71]Benjamin (2006) "Paris, the Capital of the Nineteenth Century" pp.40
[72]Stage name of Etienne-Gaspard Robert(1763-1837), a prominent stage magician.
[73]Castle (1988)
[74]Benjamin (2002) pp.14

1.2 AdaptivePassage Model

This dissertation addresses a model driving customers into retail stores and encourage their shopping by producing an environment calling out to the human's senses. The principle of the model is calling to customers with various senses of smell, sights, sounds, and feelings of the space. Calling to their senses will attract their attentions, pull them towards the stores, and produce crowdedness. This atmosphere is the key to encourage the shopping of the items in the stores, and turn existing commercial architecture to an environment full of prosperity. AdaptivePassage Model drives the customers of shopping malls into the stores and encourage the shopping of goods. (See Figure 1.3)

This model refers to the phantasmagoria of the Parisian Passages which Benjamin mentioned. The atmosphere underneath the long glass roof brightened by the reflection of the lamps existed the most fierce illumination. Endless string of colorful flames of gas lamps created lighted the row of shop windows on both sides. Sweet smells of confectioners, the merry music played from the organ grinders, and the laughters of Parisian flaneurs strolling around filled the air. This environment full of sensation and phantasmagoria tempted the citizens of Paris that the items sold in various shop windows—though most of them were counterfeit articles de Paris—looked so attractive to them.[75]

Environmental phantasmagoria also attracted the American citizens in the beginning of the 20th century. Coney Island[76], the capital of amusement resort that begun gaining its tremendous popularity from all over United States, developed as a city of festivity and play in southwestern Brooklyn of New York City. Until its decline of popularity after the second World War, Coney Island's attractions proliferated and crowds increased. John E. Kasson, a cultural historian and a professor of American Studies currently in the University of North Carolina at Chapel Hill, notes in his book *Amusing the Million* that as the visitors entered the amusement area, they encountered an environmental phantasmagoria. "We must try to imagine the smells of circus animals, the taste of hotdogs, beer, and seafood, the jostle of surrounding revelers, the speed and jolts of amusement rides," and continues, "and, what especially

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[75]Benjamin (2002)
[76]Coney Island USA http://www.coneyisland.com

Figure 1.3: Shopping mall revitalized with AdaptivePassage Model

impressed observers, the din of barkers, brass bands, roller coasters, merry-go-rounds, shooting galleries, and hundreds of other attraction—above all, the shouts and laughter of the crowd itself." Described by the journalists as "a carnival"[77], all of these essentials combined to create the amusing atmosphere of Coney Island, provided visitors the exciting experience which overturned conventional restraints and washed away everyday concerns.[78]

AdaptivePassage Model transforms the ordinary shopping mall into the environmental phantasmagoria driving customers into stores adaptively depending on the customer's presence. The environment adaptively provides customers the enchanted sensuous experience, as those of the Parisian Passages, by changing the retail architecture dynamically. This model, intended for shopping mall owners and commercial architecture designers that want to renovate their malls, can be applied to drive customers into stores and encourage their shopping. Most essential point to drive customers into stores and encouraging their shopping is to design the environmental phantasmagoria call-

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[77]Quote of Rollin Lynde Hartt, "The Amusement Park", *Atlantic Monthly*, 99(May 1907):668.
[78]Kasson (1978) *Amusing the Million* pp.47-50

ing to human's senses. Transforming an existing commercial architecture into an environment full of sensation and phantasmagoria will provide customers an enjoyable experience of shopping in the mall.

I approach this revitalization of existing shopping malls by adding an ubiquitous computing environment layer in addition to the brick-and-mortar ready-build retail architecture. *Ubiquitous Computing* was Mark Weiser's thoughts of which the computers could seamlessly integrated into the objects and activities of human's everyday life. When he wrote his essay "The Computer for the 21st Century"[79] in 1991, most information technology of general-purpose computers were in huge desktop displays, and its focus was on the computer itself rather than on the tasks that it was used to accomplish. Although they were far from being part of the environment at the time, he argued that technological developments in mobile and low-power devices would essentially disappear and weave themselves into the fabric of everyday life. It will become just like how writings have become ubiquitous in almost all industrialized countries that it appears not only in books or newspapers but even in street graffiti or candy wrappers. He claimed ubiquitous computers will also become as vanished and interconnected, in different sizes and places, that it can adapt its behavior in significant ways. The profound technology would be worn, carried, or embedded in the world around us in tables, fabric of clothes, or buildings in everyday life.[80]

Meanwhile around the entrance of the 21st century, the accumulation of various smart devices in our lives—personal gadgets, information appliances, smart tags, responsive rooms, monitors, and location-based services—are everywhere that it seems misguided and gives a sense of surveillance. Malcolm McCullough wrote in his book *Digital Ground* in 2004 that such digital networks are no longer separate from the physical environment, and it is the designers that must consider how embedded technology interacts with our environment and its influence within our own communities. His theoretical concept of "digital ground" expressed that knowing the environment and the context of a place ideally becomes the subject matter of interaction design compared to the current stream of anytime-anyplace sameness in computing. To design places completely as architecture, architects need to become more

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[79]Weiser (1991)
[80]Weiser (1993)

aware of the challenges and opportunities raised by ubiquitous computing, understand where technology is going.[81]

While information technology devices has become everywhere watching us for over a decade, there are some examples that technology has become common and invisible in our lives; we ride the car with EZ Passes in highways, we heat the house with a preheated thermostat before returning, or we wash your dishes with dishwashers instead of your own hands at your sink. Paul Dourish mentions in his book *Where the Action Is* that since the context of the digital task has extended beyond the desktop to world of work, play, travel, or dwelling in the 21st century, then the question is not whether this technological facility will be available to us, but it is how humans will be able to understand it, control it, interact with it, incorporate it into our lives.[82]

Design is the most important point for technologies to integrate further into our daily lives in real environments, but it is not an easy challenge. In 2009, Mark Shepard curated the exhibition *Toward Sentient City*[83] with the Architectural League of New York[84], critically exploring the evolving relationships between ubiquitous computing, architecture, and urban space, and considering how it influences human's experience the city and the choices made there. One example of the exhibit uses two networks of floating interactive tubes installed in the river of New York City was a public interface serving as interfaces connecting citizens to water quality and aquatic life of the urban rivers.[85] Shepard's concept of sentient cities include responsive buildings, infrastructure, transportation, and mobile devices. However, the main concern of integrating all of the mentioned should be focused on what kinds of interactions are wanted by the people.[86] Researchers are still challenging and struggling to design ubiquitous computing technologies into urban spaces and architecture, to integrate with our daily life.

AdaptivePassage Model renovates the existing functional-style shopping mall into an architecture driving the customers into stores and enhance their

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[81]McCullough (2004) *Digital Ground* pp.3-24

[82]Dourish (2004) *Where the Action Is* pp.193

[83]Exhibition Toward Sentient City http://www.sentientcity.net/exhibit

[84]Architectural League of New York http://archleague.org

[85]Shepard (2011) *Sentient City: Ubiquitous Computing, Architecture, and the Future of Urban Space* pp.48-63

[86]Shepard (2011) pp.16-37

shopping. Changing the current architecture into the environment full of dynamic sensation calling out to the senses at the perfect timings will provide them the enjoyable experience of shopping. The adaptive environment fulfilling the senses arises by weaving ubiquitous computing technologies into the architecture including ceilings, walls, floors, or even fixtures of the stores. Various sensors and actuators are fabricated into the architecture to sense people's movements and change their activities, all connecting with a computer integrating as one system.

In this dissertation, I set three components to designing retail architecture with AdaptivePassage Model; (1) sensing customer behaviors, (2) calculating its timings, and (3) actuating intangible information related to the articles. These three components are critical elements to design AdaptivePassage in a shopping mall driving customers into stores and encourage their shopping. To realize these components, I provide three methods giving customers the adaptive experience of enchantment. The methods are by (1) creating an actuating device calling out to their five senses, (2) creating a sensing device responding to the presence of customers, and (3) designing both the sensor and actuator to fit into the environment. These components and methods are found through the AdaptivePassage Project conducted in collaboration with a shopping mall from April 2012 to March 2013.

1.3 AdaptivePassage Project in a Shopping Mall

In 2012, I was commissioned to design prosperity in a shopping mall owned and operated by Daiwa House Industry Corporation[87], thus my research has started. *Heart Avenue*, a sub-stream passage located in the corner of a suburban shopping mall named *iiasTsukuba*[88], stands with a complete lack of exuberance. (See Figures1.4 and 1.5) Relatively loud background music is sonorously played throughout the street during the entire day. Clerks in each of the stores are busy with their own works inside their back-offices, having difficulty servicing some visitors. Posters displaying the recommendations of

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[87]Daiwa House Industry Corp. http://www.daiwahouse.co.jp
[88]iiasTsukuba shopping mall. http://tsukuba.iias.jp

Figure 1.4: iiasTsukuba

Figure 1.5: Heart Avenue, a serene passage in iiasTsukuba

each stores have been posted for quite a long period of time. Though some pedestrians use the passage as a way to walk from one place to another, those who purchase goods in Heart Avenue are seldom seen. It stands with a calm and serene atmosphere.

Since the time of the grand opening in 2008, citizens around the Tsukuba area were delighted to have such a spacious and luxurious mall in the neighborhood, where they drove their automobiles with their families or friends. Visitors spend their weekend hours at the cinema complex to watch any new movie, and browse at some new outfits the assorted fashion stores provide. Families have dinner together within the restaurants from all different cuisines around the world, and buy their daily commodities at the supermarket on their way back to the parking lot. The experience of hanging around and enjoying shopping in iiasTsukuba was something new to the citizens in the neighborhood.

The structure of iiasTsukuba follows the architecture style of scientifically locating anchoring stores. The three story-high fully-enclosed architecture style locates several anchoring stores such as the universal toy store

Toys "R" Us[89] or the stylish furniture store Francfranc[90] in the diagonal ends of the mall. Within this energetic mall, Heart Avenue locates its passage and its 11 specialized stores in the corner of the first floor. Though various visitors hang around and shop in the mall itself, only seldom does it occur in Heart Avenue. Compared to the vigorous activity of the main stream passage that has a three-story high ceiling with wide widths, Heart Avenue acts as just a simple walk-through passage.

This research practically challenged to turn the serene Heart Avenue into not just an environment full of prosperity, but also a passage driving customers into the stores and encourage their shopping. People that come to iiasTsukuba will be pulled to Heart Avenue, stroll around and explore the environment, and walk into the stores located along this small passage. AdaptivePassage in a shopping mall iiasTsukuba turns the serene sub-passage into a prosperous space full of enchantment and phantasmagoria by providing various sounds, lights, and odors. With this, it revitalizes the sub-stream passage in the modern shopping architecture and provide visitors an enchanting experience when promenading and shopping, and creates crowded prosperity.(See Figure1.6)

The environmental phantasmagoria drawing customers' footsteps toward the stores is revitalized by integrating ubiquitous computing technologies into the shopping mall design framework. Sensors and actuators are invisibly embedded into the architecture to sense people's movements and change their activities, all connecting with a computer integrating as one system. Just by adding an additional layer of ubiquitous computing technologies to the traditional brick-and-mortar architecture, it will transform into an environment driving customers to purchasing. I designed an interactive system using intangible materials and embedded it into the shopping mall, which adaptively plays various sounds according to the human's behaviors inside the architecture. The interactivity and adaptivity is demonstrated with intangible materials invisibly embedded into the architecture; technologies ubiquitously embedded into the backgrounds of our everyday world.

In the year 2012, Daiwa House and I collaborated to attract customers to Heart Avenue by applying sounds and a hint of sights. We decided to use

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[89]Toys-R-Us http://www.toysrus.com
[90]The only Francfranc retail store located in Ibaraki. http://www.francfranc.com

Figure 1.6: Image of AdaptivePassage in a Shopping Mall

intangible materials to call to the customers senses to already built architecture, rather than creating architectural tricks with materials actually creating doors, crashing the walls, or constructing winding pedestrian decks.It transforms the serene Heart Avenue into a prosperous passage offering customers the experience of being naturally called from the architecture itself. This passage full of sounds calls out adaptively responding to the people's behavior within the passage, its name is *Soundful AdaptivePassage*. (See Figure1.7)

Soundful AdaptivePassage plays sounds from all over the place to call customers into the stores and encourage them to shop. Responding to presence of customers, sounds dive towards them from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores, or show windows. When the sounds are delivered to their ears, they feel as if being called from the architecture itself and take an extra look inside. Customers notice the sounds, pulled into the store located along the passage, explore something new, and purchase items that they would not have. They enjoy talking with the shop clerks, and as a result purchasing goods that they would not planning in the beginning.

Soundful AdaptivePassage components with various sensors and actuators,

Figure 1.7: Image of Soundful AdaptivePassage in iiasTsukuba

invisibly embedded into the architecture to sense people's movements. The sets of sensors placed within the passage senses when the customers walk through the passage, and the speakers play sounds responding to them. Various sets of sensors and various actuators are implemented into the architecture; from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores, or show windows. These sets are all integrated and play a variety of sounds corresponding to the visitors behaviors within the space. The played sounds are assembled on certain themes to express a sense of unity, to harmonize the entire environment. These sound sets are synchronized and changes adaptively to various situations. By applying these ubiquitous computing technologies, the entire passage plays a variety of sounds corresponding to the visitors behaviors within the space.

In this dissertation, I address a novel model of *AdaptivePassage* that drive customers into the stores, and enhance their shopping. I also provide methods to transform an existing retail architecture into an environment full of sensation and phantasmagoria by incorporating ubiquitous computing technologies into the ready-built shopping malls Though most design methods of

commercial architecture has either created odd spatial rhythms with materials, scientifically located anchoring tenants, or regarded the location strategy of the store itself, AdaptivePassage uses ubiquitous computing layers that add on to the current brick-and-mortar commercial architecture. In this way, existing shopping malls can transform into a mall driving customers into stores, creating prosperity, and enhancing the shopping.

This dissertation consists of the following contents. Chapter 2 considers the value of AdaptivePassage by exploring the variety of challenges ubiquitous computing applying to retail environments, clarifying the irrational decision making behaviors of humans when shopping, and give an account of the various sensory approaches deployed in consumer behavior research. Chapter 3 presents the AdaptivePassage Model and the methods to realize it. The methods I propose derives from the collaboration project, an actual case embedded at Heart Avenue in iiasTsukuba. Chapter 4 reviews the pros and cons of the AdaptivePassage Model, states its effectiveness by discussing how I theorized the experiences and how I conceptualized the methods. Chapter 5 concludes the discussion regarding how AdaptivePassage Model may be applied in future use.

Chapter 2

Literature Review

AdaptivePassage Model is a system driving customers into retail stores and encourage their shopping by producing an environment calling out to the human's senses. I provide a set of methods creating the sensory environment which adds ubiquitous computing layer to the traditional brick and mortar architecture. These methods enable to design a shopping mall that encourages shoppers to purchase more in an enchanting environment. Applying ubiquitous computing technologies to retail has been considered, but hardly any has actually launched in the real shopping environment. The shopping malls have been designed based on scientific location of placing anchoring tenants, however this old-fashioned design cannot keep up with the rapid change of shopping behaviors. Behaviors of shoppers of the malls are more irrational than considered in classical economics; they have the tendency to purchase more when they feel like it, rather than its low pricing.

Shopping malls have been designed based on scientific location of placing anchoring tenants since it first appeared in the early 20th century. Now, in the 21st century, shopper's behaviors within the mall have become diverse that this rational old-fashioned design cannot keep up with such rapid change. Regarding the out-of-date architectural design, several design trials by the architect Jerde had approached some architectural tricks and odd spaces to give shoppers a surprise and enhance their shopping experiences. However, such architectural designs with playfulness only deal with materials; actually creating doors, crashing the walls, or constructing winding pedestrian decks. This is where ubiquitous computing technologies can become a new potential candidate to redesign the design strategy of shopping malls in this century.

In the field of ubiquitous computing, a great amount of research has been going on to sense human's behaviors and provide them some interactivity since the late Mark Weiser had first stated in his famous visionary paper "The computing for the 21st century" in 1991. His vision of ubiquitous computing expresses that small, inexpensive, robust networked processing computing devices that will be distributed at all scales and weave into everyday life.[1] Many researchers have enhanced various technologies and created digital architecture, but hardly any have yet actually realized in a real retail environment. In this emerging field of ubiquitous computing technologies, there are trials that can be done to naturally weave into the human environment.

In the field of retail and consuming behavior, the research focus was on the sales numbers with theoretical approaches based on functionality, rather than the actual behaviors of visitors at malls, for a vast period of time. For the past decades, shopping scientist Paco Underhill has observed shopping behaviors in malls to optimize the environment and increase the sales.[2] He claims that satisfying shopper's sensations and making them feel more pleasurable leads to more purchasing. However, his proposals are still small and material-oriented; to change where to place the signs can be more seen, or to change where to layout the items for more effective sales. This is also where ubiquitous computing technologies can become a powerful candidate to enhance shopping behaviors in a real shopping mall.

Shopper's decision making process have started to clarify in regards to Underhill's research. The behavior which shoppers take in retail environments not as rational as it has been thought in the long history of traditional economics. Dan Ariely focuses on human's irrational judgment process drawing back on both psychology and economics; this emerging field is called Behavioral Economics. His research has clarified various biases that lead consumers to purchase goods that are not rational decision. The base of behavioral economics arises from the *Prospect Theory*—Daniel Kahneman's research awarded the 2002 Nobel Prize in Economics—which is a theory describing the way humans make decisions among alternatives. The irrational behaviors of shoppers have slowly began to theorize, however the traditional brick-and-mortar architecture still based on the functionality and rationality.

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[1] Weiser (1991)
[2] Underhill (2008) *Why We Buy: The Science of Shopping*

AdaptivePassage Model drives the customers in malls into stores and enhance their shopping. This research provides a way to redesign shopping malls by creating intangible architecture that actuates sounds, lights, odors, or anything else and detects human's shopping behaviors that passes the information through a computer system. Let us explore the variety of challenges ubiquitous computing applying to retail environments, clarify the irrational decision making behaviors of humans when shopping, and give an account of the various sensory approaches deployed in consumer behavior research.

2.1 Ubiquitous Computing for Retailing

In the ACM Ubicomp 2013 conference[3], a workshop session called *PeTRE: Workshop on Pervasive Technologies in Retail Environments* considered the relationship between technologies and retail environments. The session challenged to explore how pervasive technologies can be integrated into today's "brick and mortar" retail environments to enhance the shopping experience.[4] Some research questions that were discussed were what are unique properties of retail environments that can be tackled by technologies, how can consumers be supported in their decision making process, or how can social media add to the retailer-consumer relationship. The vision of the session was that if integrated display networks and fully equipped sensing technologies weave into the retail environment, retailers will be able to analyze the customer flow and detect flaws in the shop design. A dozen research were shared among the researchers and industry partners which discussed to construct a roadmap for future integration of pervasive technologies and retailing to increase the effectiveness, productivity, and profits.

Li et al. from Computer Graphics and Multimedia Group of Germany presented ProFi, a mobile display device assisting product-finding in front of the destination shelf in a supermarket. Without requiring extra installation of sensing or marking equipment in the environment, the researchers assist the customer's browsing process by mounting ProFi on the shopping trolley. As the customer walk through the aisles, the display circles or spotlights the target

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[3]2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing http://www.ubicomp.org/ubicomp2013

[4]Löchtefeld, Nurmi, Michahelles, Magerkurth, Floréen and Krüger (2013b)

product in the shelf. The camera pointing towards the shelf extracts features from the captured images matches them with what you wanted. Their tests were carried out in a lab environment equipped with a large touch-enabled display wall displaying the photos of product shelves taken at real supermarkets.[5]

Pous, of UbiCA Lab at Universitat Pompeu Fabra in Barcelona[6], have proposed the concept of *cricking*, merging the online and the physical world by bringing the "clicking" in eCommerce into the "brick" and mortar retailers.[7] Online shopping experience enables customers to receive automatic feedback like recommendation or alternative options, whereas the real world only allows customers to obtain information by reading the product label, asking the salesperson, or searching online through a smartphone. Their approach is create the human-product interaction in a real store as if experiencing on eCommerce. For their first step, they created smart shelf, a traditional retail shelf enabled with RFID antennas, and assumed RFID tags attaching to every single product in a store for identification. Currently they are seeking for different interfaces to perform cricking by sensing customer's hand position, body gestures, and inputs from personal devices. Future insights are to providing instant reviews, extended product information, or tailored personal and collaborative recommendations through embedded tablet screens or wearable devices.

Also from the UbiCA Lab, Carreras approached the same question of filling the gap between online and offline retail by providing "store view", virtually navigating the store and its inventory without having to physically be there.[8] Among the various technological approaches, they chose to use robots integrated with RFID readers cooperating with the smart shelf which the Pous mentioned, rather than installing the RFID infrastructure or using phased arrays, They proposed a robot incorporating a camera for taking pictures of the items, RFID readers for knowing its inventories, and sensors required for its autonomous navigation with in the store. This ideal robot takes photos along the path into a 360 panoramic view, and synthetic vision techniques integrate

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[5]Li, Arning, Bremen, Sack, Ziefle and Kobbelt (2013)
[6]Ubiquitous Computing Applications Lab http://ubicalab.upf.edu
[7]Pous, Melià-Seguí, Carreras, Morenza-Cinos and Rashid (2013)
[8]Carreras, Morenza-Cinos, Pous, Melià-Seguí, Nur, Oliver and De (2013)

RFID information, which automatically generates the store view. Their initial prototype robot currently does not include a camera nor the autonomous navigation system, and their evaluations of the RFID based inventory is yet to be done.

On the other hand, Melia-Segui also from UbiCa Lab took a different approach by actually installing three types of interactive screens into an apparel retail store in Barcelona.[9] First, they created an interactive fitting room that automatically detects and shows photographs of the garments brought inside. Through the screen, customers can request for a different size or some extra accessories which is automatically sent to the handheld device of the salesperson. Second, they created a magic mirror that virtually shows 3D pictures of garments put on a certain rack next to the screen. Third, they installed an interactive shelf equipped with a vertical screen next to it which detects the garment is being examined by the customer and shows videos of a model wearing it. All of them work with their RFID-based system—every single product tagged by store staffs, handheld readers serving as inventories, reader embedded entrance floor mats, a POS system connecting all—which the store staffs salivate for its functionality and efficiency of sales increase. With this entire system installed, stores can obtain valuable information like the time spent in the fitting rooms or what combination they brought inside for a further customer understanding and modeling.

El Mawass et al. at Saudi Arabia deployed a pervasive system creating a "stress map" in a supermarket by measuring stress levels of customers, aiming to localize store design deficiencies.[10] They created a mobile application attached to a shopping trolley periodically taking pictures of the shelves of aisles, which receives signals from a wearable sensing device measuring emotions with Electrodermal activity sensors. In the initial test, they used Affectiva's Q-sensor, a wearable non-instrusive wrist band measuring emotional arousals via skin conductance.[11] Their first experiments were conducted in a Saudi Arabian hypermarket chain Danube[12], and had a volunteer wear the system and do their normal shopping in the store. The generated heat map showed that one customer's stress levels around three points in particular;

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[9]Melià-Seguí, Pous, Carreras, Morenza-Cinos, Parada, Liaghat and De (2013)
[10]El and Kanjo (2013)
[11]Q Sensor: Resources http://www.qsensortech.com/overview
[12]Danube Company Ltd. http://www.danubeco.com

canned goods aisle, waiting queue before the cashier, and moment of paying the bill. Their future plan to be used by a large number of customers will show places where most of the customers feel hesitant, confused, detached or frustrated. It should guide the store managers to change these zones into a better shopping environment.

Meneweger et al. of University of Salzburg are currently in the process of designing a counter-free store with a mobile sales-supporting consulting tool for the salespersons to fulfill their tasks anywhere inside the store.[13] They cleared the requirements to design their vision of a counter-free store by conducting two focus groups of telecommunication stores from both the salesperson and the customers point of view. Analysis showed that four issues need to be considered; sales process, spatial situation, tool mediated cooperation, and information transparency. Their ideal mobile tool visualizes customer needs prior to their arrival to provide a pre-selection of best fitting products for them. It will enable flexibility in conducting sales conversation anywhere inside the store, without having to run back to the counter to check for additional information. The tool should be used to raise customer's trust in the salesperson, therefore it needs a presentation mode and the database mode. Last but not least, it will make the pricing of the product transparent to visualize why it is priced as it is. In general, the mobile sales-supporting tool needs to consider the high situatedness of the sales situation; no customer is the same, and they cannot be stereotyped. The design of this tool is yet to come.

Lochtefeld et al at German Research Centre for Artificial Intelligence (DFKI)[14] aimed to bring together the advantage of physical leaflets and information the digital world can provide.[15] They created two types of concepts enhancing experience of searching for products on a leaflet using mobile AR technologies. GuerrillAR, a mobile application for augmenting single pages with advertising contents, allow users to easily compare products of different retails with transparent price or quality comparison. By pointing their smartphone to the leaflet, users will see a personal adapted overlay on his mobile device, showing different prices, comparable products, or special bundle offers. On the other hand, PageAR is an application for guiding their findings when

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[13]Meneweger, Wilfinger, Aslan, Zachhuber and Tscheligi (2013)
[14]German Research Center for Artificial Intelligence http://www.dfki.de
[15]Löchtefeld, Böhmer, Daiber and Gehring (2013a)

browsing through multi-paged advertising leaflets. They created different pro-
totypes on visual guidance notifying the customer how many pages to turn
in which direction to find out the target product, to find out which among
the three is most efficient. Based on an analysis of 16 German paper-based
leaflets in mail-boxes that have an average of 7 products printed on each page,
the three prototypes provided three different visual guidance—visualizing all
pages between the current and target page as layers with depth/height, indi-
cating pages by showing the current page position and providing hints until
the target page, and showing simple arrows coordinating with how many pages
the customer should turn in which direction. Though they have conducted a
preliminary usability study among 12 participants in the twenties, extended
user studies in real situations are for the future.

Kahl, also a member of DFKI, presented a framework to automatically con-
trol displays in supermarkets known as electronic shelf labels (ESL).[16] Different
types of electronic displays are already integrated into various supermarkets
displaying advertisement or acting as price tags. The proposed framework,
called ACES (Application and Controlling Framework for Electronic Shelf La-
bels), automatically generates contents and transmits data to several kinds
of display types with a plugin approach. Consisting of a controller, display
manager, application manager, and datasource manager, ACES facilitates the
integration of changes gathered by sensors in an instrumented retail environ-
ment and outputting a variety of applications through different displays. He
assumes that the framework will reduce the problem of wrong pricing informa-
tion with a software for content creation and transmission, and the hardware
acting as a electronic point-of-purchase (epops). Employees do not have to
replace the price label every time it changes, and customers can have a clearer
overview of the prices that are synchronized with the merchandise system.
Some applications including dynamic pricing, navigation functionality, and a
game for price reduction have been installed in their laboratory set up like a
supermarket, the *Innovative Retail Laboratory*.

Innovative Retail Laboratory (IRL)[17] is a retail research environment oper-
ated by DFKI in collaboration with a German retail chain Globus[18]. Opened

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[16]Kahl (2013)

[17]Innovative Retail Laboratory http://www.innovative-retail.de

[18]GLOBUS SB-Warenhaus Holding http://www.globus.de

in 2007, IRL created a simulated shopping environment and implemented various technologies into their retail environment itself to explore the possibilities. It seeks for different types of interaction and interfaces by prototyping various applications using intelligent technologies of near field communication—optical markers, radio technology, multi-touch surfaces, sensors, e-paper, or depth cameras—embedding them in objects and architecture of the retail laboratory store.[19] Products, shelves, and shopping carts in IRL are equipped with RFID labels and antennas. The laboratory approaches the shopping experience starting and ending at the customer's home—shopping starts with an individual shopping preparation, shopping assistance in the supermarket, and information about purchased products and their use—and creates a wide variety of prototypes supporting their shopping experience in the retail environment.[20]

Their entire shopping cycle starts from thinking about what to buy, at home. Writing down on *SmartSL*, a system that takes a written shopping list and transforms into a digital data.[21] SmartSL is located on *Smart Fridge* in the home environment, which can be managed by several persons, and gives an overview of the products inside the fridge and the corresponding best-before dates.[22] In the supermarket, the list is connected to the *IRL SmartCart*, an instrumented shopping cart that acts to support shopping process by recognizing products that are put in the basket of the car, and determines the position of the cart in an instrumented shopping environment.[23] Show the *ShelfTorch-Light* to a supermarket shelf and the products it holds are augmented with context-aware content by using a camera projector unit.[24] When you want to know more about the product's information, *ProductLens* is a mobile application that can be installed in the smartphone, showing additional information of the package's content just by looking at it through the camera.[25] *Productfinder* gives customers the exact location of a desired article in a fast and

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[19]Innovative Retail Laboratory Brochure in English pp.20 http://www.innovative-retail.de/fileadmin/irl_redakteure/bilder/IRL-Overview_English_web.pdf

[20]Spassova, Schöning, Kahl and Krüger (2009)

[21]Liwicki, Thieme, Kahl and Dengel (2011)

[22]IRL Research Topics: Smart Fridge
http://www.innovative-retail.de/index.php?id=47&L=1

[23]Kahl, Spassova, Schöning, Gehring and Krüger (2011)

[24]Löchtefeld, Gehring, Schöning and Krüger (2010)

[25]IRL Research Topics: Mobile Product Magnefier
http://www.innovative-retail.de/index.php?id=54&L=1

easy way with its multi-touch-screen, showing the form of the shelf number it is located. What they put inside the cart can be easily checked out with mobile payment.[26]

The concerns of these striving research are how to integrate cutting edge technologies into the retail field and influence a shopping experience. Li's product finding ProFi uses cameras and large displays, but has only had a chance to test in their laboratory with photos of the retail environment. Meneweger conducted prior research on a real salesperson of stores but their design is yet decided. Among the Barcelona's UbiCa Lab researches using RFIDs into the stores, Melia-Segui's interactive screen in a fitting room of an apparel shop is the only one that actually gave a trial in real space. El Mawass' stress map in Saudi Arabia has tried in an actual hypermarket but it needs a wearable wrist band for every single customer, therefore only tested with one person. The series of DFKI's research trying to produce the entire shopping cycle have actually created their own IRL, a retail research environment set up like a supermarket where they can easily test and embed their prototypes. There are many difficulties which these research must overcome for actually weaving into a real daily shopping environment.

It was in 2009 when Black et al. challenged to research focusing on how a context-aware system could influence the shopping experience in a real supermarket environment.[27] In their research they created a context-aware shopping trolley directing customers through a real supermarket supporting finding products from their shopping list by outlining product placement in the store. As their prototype, the set of bluetooth headset and the pocket PC device notifies contextual information about the shopper's location as map of the store with the store layout and the current position, and providing a dynamic ordering list of the products for what best suits the customer's current context both visually and aurally. This design roots from the contextual study of 7 shoppers in a supermarket in Denmark, the research team remarked on the difficulty of locating and finding the desired products, the difficulty to move around the store, and that the shoppers list the shopping list in some order which is easy for them to find out. Their evaluation with 18 shoppers took

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[26] Kahl and Paradowski (2013)
[27] Black, Clemmensen and Skov (2009)

the Wizard-of-Oz approach; manually entering the position and product information into the system without any subjectiveness of the users, provided a shopping list with 23 daily goods, and supposed a shopping scenario. The study showed that their prototype did make shoppers easier to locate products in supermarkets, however it caused slower walking and stopping completely to check product location.

Like this research of the shopping trolley, studies rooting from the real environment and actually using the created design back in the real environment, are known as "in-the-wild" studies. Featured as a key issue of ACM's *Journal of Transactions on Computer-Human Interaction* in Summer 2013[28], in-the-wild studies are becoming a popular concern in the field of human computer interaction(HCI). Crabtree, the editor of this issue, discusses that since so much of the technology is now embedded into our everyday lives already, HCI researchers started to move out of their usability labs and move into the wild to sample, probe, and understand experiences of people on the streets and shape new technology interventions.[29] In-the-wild approaches create and evaluate new technologies and experiences in situ rather than in a lab setting with an experimenter giving instructions; researchers need to understand what people do by their own volition when approaching the same design when placed in a real-world setting such as a public place.[30] It is necessary for researchers and designers to ground their work in the open environment of everyday realities in order to explore how people may approach a technology, find it beneficial, appropriate it in the context of routine activity, and use it in a sustained way over time.[31] This special issue discusses a diverse of perspectives on studies in-the-wild as methodological frameworks[32], pros and cons of longterm sustainable in-the-wild projects[33], or practical usage of mobile apps by children[34].

Yvonne Rogers is a leading researcher in studies in-the wild. She created an ambient installation in a school building to playfully and subtly push peo-

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[28]*ACM Transactions on Computer-Human Interaction* July, 2013. Vol.20, No.3. Special Issue of "Turn to the Wild"

[29]Crabtree, Chamberlain, Grinter, Jones, Rodden and Rogers (2013)

[30]Marshall, Morris, Rogers, Kreitmayer and Davies (2011)

[31]Rogers, Connelly, Tedesco, Hazlewood, Kurtz, Hall, Hursey and Toscos (2007)

[32]Benford, Greenhalgh, Crabtree, Flintham, Walker, Marshall, Koleva, Rennick Egglestone, Giannachi, Adams, Tandavanitj and Row Farr (2013)

[33]Carroll and Rosson (2013)

[34]Bonsignore (2011)

ple to take the stairs rather than the elevator. Their concern was about how to nudge and change a community's behavior through situating various forms of ambient displays in their workplace. The ambient distributed installation consists of three interlinked displays; a set of twinkly white lights embedded on the floor leading to the stairs, a group of colorful spheres hung in the central atrium showing the number of people taking the stairs and the elevator, and a large vertical public display showing visualized historical trend of the ratio of people. Their steps of realizing the installations started from an initial survey asking 30 people why they ride the elevator, then a series of initial low-tech prototyping studies actually installing in the targeted space and interviewing 6 participants how they felt, following a three-part installation built and situated in the building based on the feedbacks, and finally an in-the-wild study observing how people that workers and visitors of the building react and respond in both qualitative and quantitative ways. Throughout their eight-week in-the-wild study, they decided to use a mix of data collection methods including observations, interviews, surveys, actual logged data of stairway and elevator usage, and counting the total number of people passing. Findings from this study showed that the distributed installation did elicit much intrigue and triggered much playful behavior, however visualized displayed data were overlooked. It also showed conflicts between the awareness of people and their actual behaviors; the distributed installation elicited much curiosity but said it hardly changed their behavior, however the logged data showed a statistically significant increase of usage. Embedding playful ambient displays that lure and intrigue can induce positive attitudes and a level of behavioral change, but there are more considerations about whether the change in behavior will persist over time.[35]

Kalnikaite, a member of Rogers' research group, introduced a minimal mobile lambent display that clips onto any shopping trolley handle that can be easily used for a weekly shopping at a local supermarket in 2011.[36] This lambent shopping handle using simple ubiquitous computing technologies provide information about food products in a supermarket with LEDs and a display showing a three-level emoticon. When the lambent device scans the barcode, it shows 4 different information of a food product—how far away the food

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[35]Rogers, Hazlewood, Marshall, Dalton and Hertrich (2010)

[36]Kalnikaite, Rogers, Bird, Villar, Bachour, Payne, Todd, Schöning, Krüger and Kreitmayer (2011)

product has travelled, the average distance of the all items chosen, whether the product is organic or not, and comparison of the average distance against a social norm—which were selected from their pilot observation of 11 shoppers making decisions based on the food's origin, if its organic or not, and the price. How shopper's everyday decisions can be nudged to choosing what to purchase in supermarkets realtime using simple lambent technologies was their key concern, therefore they conducted an in-the-wild user study with 18 shoppers in a supermarket in the UK with their shopping handle device. Their research concludes that gentle devices with salient nudges do provide better decisions, but there are more considerations about what exact information are helpful for the right choices. With this device, they have shown their further challenge to a fast and frugal shopping experience.[37]

Bird et al. developed a mobile application that shows supermarket shoppers the nutritional balance of their shopping trolley.[38] Deriving from the previous study together with Kalnikaite[39], their two month study in a organic supermarket in the UK showed the significant changes in participant's shopping habits and an improvement in the nutritional balance of their diets. Their challenge was to overcome some limitations of the previous study and enabled shoppers to get nutritional information of the 3000 food products being sold at Planet Organic, an organic supermarket in the UK for health conscious shoppers.[40] They also made the program run on any mobile device rather than changing the trolley itself. The mobile application, designed for single people doing a weekly shop, displays a plate representation of the proportion of the four main food types in a balanced diet—meat and alternatives, milk and alternatives, fruit and vegetables, and grains—and also treats. They had a longitudinal study with 7 participants lasting for two months each, with a month of recording participants' baseline shopping data following with a month of participants using the device while doing their weekly shop.

Research in the field of HCI are currently seeking for possibilities to apply their cutting-edge technologies into the retail environment, but are still struggling to have it actually launch in a real shopping environment. Some

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[37]Bachour, Bird, Kalnikaite, Rogers, Villar and Kreitmayer (2012)
[38]Bird, Fozzati, Harrison and Marshall (2013)
[39]Kalnikaite, Bird and Rogers (2013)
[40]Planet Organic http://www.planetorganic.com

are focusing on creating systems and using them real environments in-the-wild, but the way they look at the environments are still a semblance. My research uses simple ubiquitous computing technologies and embed into a real retail architecture, with thousands of customers coming from the neighborhood everyday. Moreover, it is created based on an in-depth research of shopping behaviors in commercial spaces, unlike the scientific assumptions arousing from the laboratories. In the following section, I would like to review research about shopper's behaviors in retail environments, especially focusing on the irrationality of humans, emerging field of behavioral economics.

2.2 Shoppers' Irrational Behaviors in Retailing Spaces

One afternoon inside the gorgeous *Galerie Vivienne* of Paris, the sweet smell of chocolate from the tea salon tempted the visitors to have their extra snack. They just enjoyed a fulfilling lunch course with a glass of wine in the bistro restaurant near the entrance of this Parisian passage, thus they certainly do have a full stomach. They have already purchased some extra perfume at the fragrance shop next door, those that were beautifully displayed in the decorative show windows in the front of the store, so their purse is beginning to get lighter. However, the scones with jam and hot chocolate which other couples are enjoying under the warm sunshine from the glassed ceiling looks so delicious. They could not resist the temptation and decided to have an extra teatime in the salon; with a cup of hot chocolate and double scones with strawberry jam and vanilla ice cream topping.

Irrational decision making of humans had been a keen interest for the Israeli-American psychologist Daniel Kahneman and his late research-mate Amos Tversky since the 1970's. Their research clarified the simplifying short-cuts of intuitive thinking, explaining the biases as manifestations of the heuristics and human's decision making.[41] Based on this research they developed a psychological theory of how people make decisions, a theory of choice intuitive preferences that consistently violated the rules of rational choice. This

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[41]Tversky and Kahneman (1974)

Figure 2.1: Shoppers in Galerie Vivienne, Paris

theory, called Prospect Theory, was awarded the 2002 Nobel Memorial Prize in Economics, and is one of the foundations of Behavioral Economics.[42]

Standard theory of rational choice, based on value maximization, assumes that all humans always have a complete preference order and they always choose the one with the highest rank. Compared to this, Tversky claimed that humans do not have a global preference, and they use the context for the most attractive option at that certain time. This context-dependent model of choice, called the componential context model, values every option with a combination of the following two components; a contingent weighting process and a binary comparison process. Undergoing this process, the choice possibilities are effected by irrelevant alternatives, while the standard theory principle deals with its independence. Human preferences are generally ill defined and incomplete, but when the time for decision making comes, they construct their preferences influenced by the environmental factors.[43]

Tversky's research on preference construction in decision making influenced various researches in human behavior, including Dan Ariely, the leading researcher in the field of Behavioral Economics. During his PhD on Psychology in University of North Carolina at Chapel Hill, Ariely focused on the standard conventional decision making making process that assume that humans compute the value of all options as we always think.[44] Behavioral economics, as opposed to that, focuses on the actual irrationality of human's judgement and decision making, which aims to understand the way humans really operate and figure out the hidden forces that shape our irrational decisions.[45]

In 2006, Leonard Lee and Dan Ariely proposed the two-stage framework combining the increasing concreteness of consumers' goals during shopping process and sensitivity of these goals to contextual influence.[46] The *Shopping Goals Theory*, integrates general ideas from the construal level theory, mind-set theory, and the preference construction rooting on Tversky's research. Construal Level theory refers to customers think about the future objects and their actions in superordinate terms, while they translate them into a more

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[42]Kahneman and Tversky (1979)
[43]Tversky and Simonson (1993)
[44]Ariely and Wallsten (1995)
[45]Ariely (2010) *Upside of Irrationality* pp.9-11
[46]Lee and Ariely (2006)

concrete subordinate action when it becomes more near.[47] Mind Set Theory discusses the two phases of customers, phase one when they are uncertain about their goals, they are openminded and have a deliberative mind set. When it's phase two, they switch to an implemented mind set where they have a well defined established goals.[48] Preference construction suggests that although consumers preferences are generally ill defined and incomplete, they construct their preferences based on their internal likes and dislikes, and environmental cues available at the time, when it is time for them to decide.[49]

In his first book *Predictably Irrational*, Ariely has conducted numerous experiments within his laboratory on various biases that lead consumers–why costs of goods do not exactly match the supply and demand[50], why humans are happy to do things for free rather than some small income[51], why expensive medicine seems to work more than cheaper medicine[52]—and to make irrational decisions.[53]

Even more irrational decisions are made by shoppers in real shopping spaces than those inside the laboratory. Shopping scientist Paco Underhill and his consulting firm Envirosell[54] specializes in researching in situ shopping behavior in shopping environments all across the world, aiming to support retailers to do more business in the same space or location. In his first book *Why We Buy: The Science of Shopping*, he mentions how shoppers make buying decisions in the store at the moment with impressions and information they acquire on the spot, rather than the brand-name loyalty or TV advertising influence that were the main factors of decision making several decades ago. They make their decisions on what to buy with their instincts and urge them for impulse purchasing.[55] Some interesting facts they found about in-store irrational human behaviors are full of obscurity; 8 percent shoppers in a mall housewares store use shopping baskets and among that 75 percent actually buy something while only 34 percent buy without using the baskets[56], or that

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[47]Trope and Liberman (2003)
[48]Gollwitzer and Bayer (1999)
[49]Tversky and Simonson (1993)
[50]Ariely, Loewenstein and Prelec (2003)
[51]Shampanier, Mazar and Ariely (2007)
[52]Shiv, Carmon and Ariely (2005)
[53]Ariely (2009) *Predictably Irrational*
[54]Environsell http://www.envirosell.com
[55]Underhill (2008) *Why We Buy: The Science of Shopping* pp.25
[56]Underhill (2008) pp.50-60

65 percent of males who take jeans into the fitting room will buy them while only 25 percent of females will[57].

Underhill and his crew researched and understood the irrational and obscure shopper behavior by observing and measuring nearly a thousand different aspects of shopper-store interactions in the entire world for over 30 years.[58] Their method of researching tracks down every moment of shoppers movements simultaneously with an array of video equipment, store maps, customer-profile sheets, and writes down everything they notice from the shopper's smallest eye movements to their way of walking. Above all, the most important point is to research all of this without being noticed by the shoppers themselves. When they work on placing signs in stores, for example, first they measure how many people actually looked at it, then they discreetly position themselves behind the sign it self and watch shopper's smallest eye movements while simultaneously keeping track of the stopwatch to say that the target focused on the sign for a couple of seconds enough to read what is written there, and then if the target shifted the eye to see something else.[59] Through this research, they propose ways to optimize the environment of shopping—where and what signs to place with what information, where to place shopping baskets within stores, or when exactly the clerks say their hearty "Can I help you?"—to provide shoppers a pleasurable shopping experience and also increase of sales.

Underhill argues in his book specializing in shopping malls *Call of the Mall*, that the more pleasurable the shoppers feel, the more unplanned purchasing occurs.[60] What is most interesting is the usage of sensation during the process of decision making. This is because experience is provided through sensation. Most planned or even impulse buying occurs when the sensations are satisfied by probation. Such unplanned buying is a result of touching, hearing, smelling, or tasting something on the premises of the store.[61] For example, the average of 6 people touch a towel before it is sold to someone. Other than towels, goods that people clad in are touched and tried before its purchase. Bed sheets, underwear, shirts, sweaters, or any other clothing are usually tried before the purchase.[62] Another example, a drugstore selling vitamins in a

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[57]Underhill (2008) pp.102-120

[58]Underhill (2008) pp.8

[59]Underhill (2008) pp.62

[60]Underhill (2004) *Call of the Mall* pp.210

[61]Underhill (2008) pp.158

[62]Underhill (2008) pp.172

department store has a bakery on the same floor. The smell of fresh baked bread tempts the visitors of the floor to go to the bakery before realizing it. The smell of coffee beans grounded by coffee shops let visitors to drink an extra cup of coffee.[63] The more sensation visitors experience, the more shopping is stimulated.

Unique aspects of an in-store environment such as music, signage, lighting, and layouts, does affect the consumer's decision process. Other aspects that are effective include mirrors, talking, recognition, bargains, and discovery. Layouts of the mall speak to the love of browsing, exploring, and window shopping, but for the discovery to come true, we need satisfying emotional content to the shopping experience. Underhill states in his book *Why We Buy: The Science of Shopping* that the percentage of customers that has some interaction with the sales clerk is important for retail stores. While many retail stores tend to cost-reduct the number of staffs, he states that if customers have time to talk or interact with the clerks, the average sales will raise. His research shows that if clerks have some kind of a contact with customers, it is likely for the customers to buy some goods in the store. If clerks have a nice talk with the customers, the more likely the customers buy the goods. The importance of touching or trying things on has been rising the sales. Before, staffs were in stores for guiding customers to let what goods are good for them. Now, the goods are displayed and the customers are free to touch, take in hand, try them on. Clerks are no longer in need to guide the customers to the goods, however they are still an important aspect of sales. The combinations of the sales clerks and how they display the goods encourage customers motivations of shopping through various senses.

The video equipped direct observation method derives from William H. Whyte, Underhill's former professor. Whyte, an pioneering American urbanist that researched how public spaces are used by humans, deeply observed how streets, parks, plazas, benches, fountains, shrubs, or anything else were used based on hidden direct observation.[64] His method of researching was mostly based on just watching people on the street unobtrusively and tracked down everything that was going on minute by minute in their notebooks. They also used time-lapse photography with wielding still and movie cameras from five

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[63]Underhill (2008) pp.174

[64]Whyte (1988) *City: Rediscovering the Center* pp.3

feet high to track pedestrian flows, street corner encounters, or daily lives on the newsstand. In this way, for example, they located that street conversation starts in the middle of the main pedestrian flow which concentrates at corner or outside the entrance, at Saks Fifth Avenue and 50th Street in Manhattan, by recording the activity from the corners for two weeks.[65]

One example, they found the lack of crowding in many parks and playgrounds of New York, which more were nearer empty than full. Children play in the street not because of the lack of playgrounds but because they like to, for example 101st Street in East Harlem. This block had the basic elements of a successful urban space; adjoining stoops, fire escapes for mothers to view their children. Such places were more attractive than most playgrounds and plazas that were zoned and created by the city.[66]

This innovative way of researching human behavior in urban spaces arouse from his own urban design plan. In 1969, Whyte created a comprehensive design plan of New York City to support the growth and workability as a member of the New York City Planning Commission[67]. He designed intensive zoning to provide parks and plazas, but he did not have a chance to know how the new spaces he designed were actually working after they were developed. Although he was a native to the city of New York, he did not know how his rationally created parks and plazas were working or not. Until then, observational studies were about far-off peoples and far-off places but his questions was: we think we know where we spend our everyday lives, but do we really know exactly what is going on? This leading research project aiming to turn made-public spaces better and useful later became *Project for Public Spaces*[68] in 1974, a nonprofit planning, design, and educational organization contributing to preserve good health of urban landscapes and build stronger communities.[69]

Observing human behaviors in shopping environments have clarified the human's irrational and emotional decision making process. Theories of decision making process from the emerging field of behavioral economics and

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[65]Whyte (1988) pp.8
[66]Whyte (1980) *The Social Life of Small Urban Spaces* pp.10-15
[67]NYC Department of City Planning http://www.nyc.gov/html/dcp/html/about/plancom.shtml
[68]Project for Public Spaces http://www.pps.org
[69]Whyte (1988) *City: Rediscovering the Center* pp.3

methods of researching actual behaviors of humans in our everyday environments have given insights for how to make our current environment better. My research reflects upon these theories and methods of researching shopper's behaviors in retail environments, and actually prototyped a design focusing on the sense of hearing. In the following section, I would like to emphasize the originality of my design by reviewing current sensory approaches for consumer behavior research in the retail environment.

2.3 Sensory Approaches for Retail Behavior Research

Figure 2.2: Omotesando Hills

Omotesando Hills[70], a popular shopping complex located in the center of the high-class area in Tokyo, has the most obsessed space design in the area. Its six story high atmosphere has a spiral slope going around the six stories with high-class luxurious tenants located on the sides. A grand stairway stands in the center of the atmosphere where visitors can walk from basement to the grand floor. In this great architecture designed by Tadao Ando, there are projectors, directional speakers, and poll-shaped speakers installed to produce the luxurious space design. The sound installation, created by sound designer

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[70]Omotesando Hills http://www.omotesandohills.com/english

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Hiroaki Ide[71], changes every moment with serendipity. The design senses the movements of the Zelkova trees planted by the roadside of Omotesando boulevard, and create real-time sounds based on them, played from the poll-shaped speakers placed on the sides of the grand stairway. As visitors walk through the spiral slopes, they hear bird chirps from the directional speakers.[72]

Human's sense of sound, sight, smell, and touch have a powerful effect. Research aiming to improve the shopper experience and change behavior beyond consciousness has been emerging.[73] Retailers are revisiting the principles and practices of in-store consumer engagement and leverage the sales optimization, customer satisfaction, and sustainable profitability. Visual noise and clutter has become too infiltrated, static posters and product displays do not have the same impact as they used to have. Retails are facing the needs to understand the multi-channel retail mix and also to determine how the physical store environment can be fine-tuned. The way to do it is to offer the greatest brand experience through sensation, feelings, perceptions, and behavioral responses. Researchers have proposed the sensory engagement process, a strategy to provide a holistic brand engagement by taking sensory strategies and provide the experience and impact customers; sight, sound, touch, scent and taste to shape the propensity to purchasing. [74]

Harrods, the department store of London, themed their store lifts to the senses—with sound, sight, smells, taste, touch, and the special "6th sense"—for a captivating, inspiring, soothing and invigorating shopping experience in 2008.[75] Sound lift played a special musical composition by Michael Nyman. Sight lift sculptured light installations with Swarovski crystals produced by Chris Levine. Taste lift provided a competition of the your ultimate flavor of ice-cream and have a chance to eat it in support with Morelli's ice cream[76]. Touch lift displayed tactile hands for vision impaired by Royal National Institute of Blind People[77]. Smell lift installed buttons for bursting fragrances of new cars, laundry, or pomegranate by the Aroma Company[78]. Last but not

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[71]El Produce http://elproduce.com

[72]Ide (2009) *Mienai-Design* (Written in Japanese)

[73]Soars (2009)

[74]Stephen Ogden-Barnes "Store Sense: Reclaiming the four walls with sensory engagement. http://www.deakin.edu.au/buslaw/gsb/retail/docs/storesense.pdf

[75]Senses at Harrods. http://www.sitestaging.net/senses

[76]Morelli's Ice Cream. http://www.morellisicecream.com

[77]Royal National Institute of Blind People http://www.rnib.org.uk

[78]Aroma Company. http://www.aromaco.co.uk

least, the "6th sense" lift had its chance of cosmic ordering; writing down your wishes and hoping they would come true. All six of these lifts aimed to engage the customers with the stores at Harrods.

The Aroma Company, working on the smell lift of Harrods, introduction of aroma is a belief that the sense of smell is emotionally powerful, affecting humans up to 75% more than other senses such as sight and sound. Positioning a variety of scents provoke memories and encourage customers to feel positive about the buying experience.[79] They are working with Brand Sense Agency[80], a sensory branding company directed by Martin Lindstrom.

Another firm specializing in scents for retailers is ScentAir[81], providing affordable and effective scent delivery solutions. They created SonyStyle electronics departments, a mix of full-bodied orange, vanilla, and a dash of cedar wood. On the other hand, Samsung has a signature scent of green melon. Hotels brand their images with scents. The scent of air in Four Point hotel chain is "America's favorite pie". Sheraton hotels has adopted their welcoming scent with a blend of fig, bergamot and jasmine. Omni hotel chain uses lemongrass and green tea. The Westin chain uses white tea. Phoenician design hotel in Arizona uses seduction, a spicy citrus blend. [82]

Martin Lindstrom[83] writes in his book *Buyology* that the effects of brands, logos, and commercials are not the way they are intended to after three years of neuromarketing study on 2,081 people.[84] He challenged to identify the factors that influence various buyers' decisions in a world cluttered with messages such advertisements, slogans, jingle and celebrity endorsements. In his latter book *Brandsense*, he indicates that connecting the five senses of human beings emotionally beyond what humans see with their eyes for marketing. As our feelings, emotions, values are all stored in our brains that are able to interact among another, emotion attracts our attention through our five senses, which

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[79]UTalk Marketing: Harrods introduces scent marketing.
http://www.utalkmarketing.com/Pages/Article.aspx?ArticleID=4492
[80]Brand Sense http://www.brandsense.com
[81]ScentAir http://www.scentair.com
[82]UTalk Marketing: Scent Marketing
http://www.utalkmarketing.com/pages/article.aspx?articleid=1211&title=scent_marketing
[83]recognized as "The World's 100 Most Influential People" of the *TIME* magazine in 2009.
TIME Magazine Top 100 of year http://www.time.com/time/time100
List of 2009 here. http://www.time.com/time/specials/packages/0,28757,1894410,00.html
[84]Lindstrom (2008)

influences our decision making processes drastically.[85] Advertising by incorporation of the five senses has spectacularly worked well in connecting people emotionally, especially on visual advertisement all around the area in urban places.

Lindstrom's research on neuromarketing buying behavior influences Julian Treasure, chairman of The Sound Agency[86] specializing in sound in the marketing field. Treasure vigorously mentions in the 2009 TED conference[87] that sound has its potential power to affect individuals emotionally, cognitively, and behaviorally. Treasure approaches practically to make the soundscape optional, appropriate, valuable, and to test it over and over; as the four Golden Rules of sound in the commercial environment.[88]

Treasure states that sound has been practically used in public spaces over a century ago. Since Muzak[89], the world's longest-standing provider of piped music into commercial spaces founded in the 1920's, has had a vested interest and executed a series of experiments to prove that music can create business benefits. Though under rigorous controlled experimentation by Muzak, results conspicuously show that music does effect in behavior; for example, decrease of errors in the accounts payable section of a business office, increase in productivity at an electric utility company, or a decrease in nonessential conversation among telephone company employees.[90] One example of using sound as its company's branding, Nokia[91] uses the famous ringtone for their cellular phones; as they say it is one of the most recognizable melody from the phone switching on to calls and messages that come in.[92] These give a crystal clear indication of the powerful influence music can effect human behaviors. Providing specific music to the specific place may enable them to change their behaviors within their daily lives.

Meanwhile, the sound surrounding us is mainly produced accidentally by objects making noise just because of what they do. Much of it is unpleasant,

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[85]Lindstrom (2010)

[86]The Sound Agency http://www.thesoundagency.com

[87]TED Global Conference http://www.ted.com
Treasure's talks are here. http://www.thesoundagency.com/what/julians-ted-talks

[88]Treasure (2011) *Sound Business*

[89]Muzak Corporation http://www.muzak.com

[90]Hodges (1996)

[91]Nokia http://www.nokia.com

[92]The winning tune http://brandbook.nokia.com/blog/view/item66319

inappropriate and counterproductive as the elements of the sound environment is often unintentional and undesigned.[93] This unfortunate environment that most organizations are blissfully unaware is very upsetting, where there have been several studies bringing the effects together to shift our psychological state, whereas musical texture can change attitudes to willing to volunteer[94], willing to wait longer[95], with pleasant music.

Sound effects shopping behaviors in retail environments in various ways. In a supermarket displaying both French and German wines with equal emphasis, the playing of French music cause French wine sales to raise whereas playing German music caused German wine sales to raise.[96] Areni et al researched the effects of the music genres played in a wineshop.[97] They compared the customer's behaviors, duration in the store, and the purchase when playing the top 40 billboard pop music and classical music. As a result, the sales of the wine increased more when playing classical music. This was because when playing classical music, the wine bottles the customers tend to choose became more expensive compared to when playing billboard top 40. However, there were no effects in particular to the duration of stay. Yalch et al researched the difference of duration in a store when playing music which people know or not.[98] They played Billboard top 40 and some healing music in a supermarket and researched the duration. The average time of stay was 7 minutes when playing the top 40, while it was 10 minutes when playing some healing music. The research team interprets this result that customers feel more provocative when listening to unknown music than what they know.

Milliman et al researched the effects of background music provide the supermarket shopping behaviors.[99] They researched the effects of the music tempo gives to the behaviors of shoppers in an American supermarket. Their result was that when they played slow tempo music, the speed of the visitors walking through the store became slower and the average duration in the store became longer. While when they played fast tempo music, the speed became faster and the average duration in the store became shorter. Not only did

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[93]Treasure (2011)
[94]North, Tarrant and Hargreaves (2004)
[95]North, Hargreaves and McKendrick (1999)
[96]North, Hargreaves and McKendrick (1997)
[97]Areni and Kim (1993)
[98]Yalch and Spangenberg (2000)
[99]Milliman (1986)

the tempo affect the duration and the walking speed, but slow tempo music encouraged to spend more money than fast tempo music, the average sales per person increased about 38%. They concluded their research that the slower the music is, the slower customers walk and have time to browse around the store and find something that they want.

Sullivan et al researched effects of music volume in a restaurant.[100]The result of their research showed that calm and quiet music linked to a longer stay of the customers and spent more money. Gueguen et al researched the effects of music volumes played in a bar.[101] Their result was that calmer music encouraged visitors to order more drinks than louder music.

In the field of retailing and consumer behavior, the study of customer's impulse buying behavior has been a keen interest since more than half a century ago. In more recent years, Kacen et al found that individuals who are more independent engage in greater impulse-purchase behavior than those who are not independent in self-concept.[102] Ramanathan et al states a point-of-purchase sign encouraging touch exploration may increase the salience of touch information motivating individuals to touch and impulsively purchase the display product, impulsive behavior occurred for both impulsives and non-impulsives when a hedonic goal was primed.[103] Peck et al. suggests that both individual and environmental touch related factors increase impulse purchasing.[104] Silvera et al studied the impact of emotions and inferred that impulse buying is influenced by the affect or emotions of the consumer.[105] Chang et al observed that the positive emotional responses of consumer to the retail environment result in impulsive purchases.[106] In this field, the research is almost only done by interview sheets and comparing sales data.

These research in neuromarketing and retail behavior research field have given the powerful influence that sounds or other senses attracts our emotions and behaviors. My research goes further in depth and captured the exciting experiences the shoppers are expecting, and designed a prototype which

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[100]Guéguen, Jacob, Le, Morineau and Lourel (2008)
[101]Guéguen, Hélène and Jacob (2004)
[102]Kacen and Lee (2002)
[103]Ramanathan and Menon (2006)
[104]Peck and Childers (2006)
[105]Silvera, Lavack and Kropp (2008)
[106]Chang, Eckman and Yan (2011)

adaptively responds to the presence and behaviors. In the next section, I will extend the discussion to a way to design places by applying models of physics, regarding humans as self-driven particles and not statistic atoms.

2.4 From Atoms to Self-driven Particles, Applying Physics to Urban Design

All long-distance drivers in the Tokyo area of Japan know the last tunnel coming back to Tokyo on Tomei Expressway, the Yamato Tunnel. This tunnel, only 280 meters long, is one of the most frequent places where traffic jams sprout from nowhere.[107] The irritating traffic jam which the short tunnel induces unfortunately has no particular cause—no accidents, no lanes closed for construction—but for some strange reason, cars are stuck in the traffic for countless hours. The main reason why this jam occurs before this tunnel there is a slight sag, a gradual downhill followed by a gradual uphill.[108] In a long downhill, drivers are aware of the speeds to not get fast caused by the gravity. They unintentionally slow down their speed with engine brakes. When the downhill ends and suddenly becomes an uphill, the drivers are still hitting the brake too hard. The uphill slows down their speed even more. Cars following them get too close to another car in heavy traffic, therefore slows their speed down to keep the safe distance from the car in front of them. This is how the bunching traffic jam is born, naturally and spontaneously.

These self-sustaining traffic jams amplified by the drivers' small disturbances are called "phantom traffic jams" by the researchers of MIT's Department of Mathematics. Key to the study is the realization that the mathematics of such jams, which the researchers call jamitons, are strikingly similar to the equations that describe detonation waves produced by explosions, says Aslan Kasimov, one of the lecturer in MIT's Department of Mathematics. The equations, similar to those used to describe fluid mechanics, model traffic jams as a self-sustaining wave. Variables such as traffic speed and traffic density are used to calculate the conditions under which a jamiton will form and how fast

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[107]Nexco: National Traffic Jam Forecast during Golden Week 2013.
http://www.e-nexco.co.jp/pressroom/press_release/head_office/h25/0329/pdfs/pdf.pdf
[108]Nexco: Why jams occur in sags.
http://www.driveplaza.com/traffic/jyutai/jyutai_hassei/jyutai1-1.html

it will spread. A team of MIT mathematicians has developed a model that describes how and under what conditions such jams form, which could help road designers minimize the odds of their formation.[109]

Applying these models of physics and mathematics to road design, financial design, and pedestrian behavior design has become a common concern. For example, research on using a model of pedestrian behavior[110] investigating mechanisms of panic and jamming by uncoordinated motion in crowds.[111] The phenomena of human jamming has been considered by modeling humans as self-driven particles[112], theory for pedestrian outflow through an exit[113], or anticipation effects in pedestrian dynamics[114]. These models and theories on physics resembling human behavior

Bayesian Networks, consisting of a graphical structure and a probabilistic description of the relationships among the variables in a system, can be effective for modeling human behavior and phenomena.[115] The variables represented as nodes can be connected by links of the network representing the properties of conditional on the configuration of its conditioning parent variables. Bayesian Networks has become a popular artificial intelligence representation for reasoning under uncertainty for its effectiveness in describing dynamics.[116]

Behavioral Economics deals with human's irrational behaviors and their decision making. In the field of modeling and simulation, researchers have started to regard humans as self-driven particles with dynamical features. The combination of the two may have great potential to actually design an urban place that control these irrational behaviors of humans. Utilizing Bayesian Networks as subjective probability modeling network, may give a great work to design the probabilistic of the irrational decision making and also the human jamming.

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[109]Flynn, Kasimov, Nave, Rosales and Seibold (2009)

[110]Helbing, Farkas and Vicsek (2000)

[111]Helbing (2001)

[112]Nishinari, Sugawara, Kazama, Schadschneider and Chowdhury (2006)

[113]Yanagisawa and Nishinari (2007)

[114]Suma, Yanagisawa and Nishinari (2012)

[115]Pearl (1988)

[116]Koller and Pfeffer (1997)

My research of driving customers into stores of shopping malls and encouraging them for an extra shopping challenged to expand some possibilities in this emerged field by creating the networked interactive sound system inside the shopping mall. I have created a simple input of sensing the presence of customers, a simple calculation for the timings or selecting the contents, and outputting the actuations into the architecture to pull the customers into the stores. Although the calculation part is still a very simple function, the input and output of sensing and actuating is a novel experiment field of this research field.

2.5 AdaptivePassage, A Concept for Retail Architecture Design

HCI researchers have challenged to apply the cutting-edge ubiquitous computing technologies into the retail environment, but there still seems as there are many leftover agenda for crossing the threshold to the side of the retail stores. Theories of human's decision making process and methods of researching actual behaviors of humans in our everyday environments have given insights for how to make our current environment better, however the design proposals to make a better shopping environment are still small and material-oriented. In neuromarketing and retail behavior research field, we have started to notice that sounds or senses attracts our emotions and clearly indicates that sounds to have a powerful influence towards behaviors, but the sensory designs in some shopping malls have either only decorated the architecture itself or has only regarded the static selection of music, which not had actually captured the exciting experiences of the shoppers. The movements of applying the self-driven particles of the field of Physics to the field of Urban Design has started to be considered, however going beyond the computer-simulations and actually design a real urban environment is next on their agenda.

AdaptivePassage, a novel concept adaptively creating the phantasmagoria environment in retail environments, encourages customer's shopping and drives them into the stores. With the three components of sensing, calculating the timing, and actuating, AdaptivePassage Model built methods using simple ubiquitous computing technologies in addition to the brick-and-mortar

architecture layer. These methods, adopted from a real case of embedding in a real shopping mall with thousands of customers coming from the neighborhood everyday, are based on an in-depth research of shopping behaviors in the mall rather than the scientific assumptions arousing from the laboratories.

In the next chapter, I describe the AdaptivePassage Model and its methods to realize it. This model is intended for retail architecture designers and shopping mall owners who want to make their mall better, or to design prosperity from scratch.

Chapter 3

Design

This chapter presents the *AdaptivePassage* Model, a model driving customers into stores and encouraging their shopping in current shopping malls by creating a sensuous environment. The environment full of various sounds, smells, and sights can designed by adding an extra layer of ubiquitous computing technologies on top of the current brick and mortar retail architecture. This model is fruitful for renovating the existing static shopping mall into a dynamic architecture providing customers the enjoyable experience of shopping. Mall owners can apply this model to change their current mall, as well as mall designers making a new mall from scratch. Adding the ubiquitous computing technology layer into built environments influences human's behaviors in a variety of ways. It can encourage customers in shopping malls to shop the displayed articles.

First, I propose the AdaptivePassage Model, its three components, and its three methods to realize it in the shopping mall. Next, I describe in detail why the three components of the model were developed, through the AdaptivePassage Project 2012 taking place in the shopping mall iiasTsukuba, in collaboration with Daiwa House. This project initially roots from the year 2010, when we held discussions and primary testings of the effects of sounds calling pedestrians to develop our initial concept. After the project launch in 2012, we created an early interactive sound prototype in the sub-stream passage of iiasTsukuba to call customers. The sound prototype attracted a variety of customers in the sub-stream passage, where we received hints to update our concept. We tested various types of sounds and timings that attract

customers browsing. We also conducted ethnography research on both customers and salespersons, and also a focus group session with the salespersons to understand what is actually happening when shopping. As a design based on these processes, I created the Soundful AdaptivePassage, an integrated system playing sounds from all over the place responding to the customer's presence to drive customers inside and encourage their shopping. Finally, I describe this passage comprehending small sensing and speaker devices embedded into the architecture; from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores or show windows.

3.1 AdaptivePassage Model

Since the early 20th century, when shopping malls have appeared in the scenes of American countrysides, mall designers have challenged to create the most exciting shopping architecture they could think of at their times. In the 1920's, the Sears department stores were designed in the country-side as a windowless architecture; creating the luxurious environment with air conditioners and artificial lights which were a sign of fortune at the time.[1] Also in the same era, Kansas City's Country Club Plaza concentrated dozens of retail stores all in the settlement of European-like architecture as a planned outdoor-type regional shopping center, and provided the mid-western citizens the hint of magnificent European-like works of art.[2] After the chilling era of the Great Depression and World War II, Seattle's Northgate Mall was designed with a long open-air pedestrian way with anchoring department stores on the ends, lined with a number of small speciality shops on the sides of the walkway for the pedestrians to hop inside.[3] From the mid 1950's, Victor Gruen efficiently designed the fully-enclosed climate-controlled indoor mall with a public space in the center of the architecture and anchoring department stores diagonally opposite each other; for it would be a communal gathering place for the people.[4] Gruen's way of designing the enclosed-type shopping mall with scientific locations of anchoring tenant stores served as a great role model which spread out widely

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[1] Chicago History Fall 2000 pp.41
[2] Jackson (1987) pp.258-259
[3] Jackson (1996)
[4] Wall (2005) pp.92-96

throughout the entire United States for over two decades.[5] However, shopping malls with pedestrian decks and anchoring stores on both ends had become so popular that all malls looked so homogenized, which started to lose the customer's interests from the early 1980's.[6]

To fracture this typical functional design method, the architect Jerde creates odd spatial rhythms in malls such as Horton Plaza, Mall of America, or Canal City Hakata. His approach of creating some architectural tricks of curvy roads and sudden drop-offs surprise the visitors and make them wander around in the unpredictable space. Like Bradbury's words of "Half the fun of travel is the aesthetics of lostness"[7], Jerde's architecture with winding walkways and mazed-like mismatched levels create moments of surprise and excitement. Jerde recognized the retail industry architecture's style of function and rationality focused on object-making and lacked communal setting, therefore he directed his design to create an experiential placemaking, where visitors of the mall could feel the sense of place, of purpose.[8]

Jerde's approach shows signs of effectiveness when creating brand-new architecture, however it faces difficulties when renovating a ready-built architecture. Transforming a long hallway into a curvy winding road needs to override a multitude of issues dealing with time, cost, and flexibility. It is not the cleverest idea for the mall owners to reform their big streets into a maze-like architecture. Malls will need to completely shut down their shutters for months to change the building frame itself, which means the mall will not be able to yield profit during the time. Mall owners are more than likely to not choose that choice, where large renovation frequently occurs within shopping malls every several years.

AdaptivePassage Model, a model driving customers into stores and encourage their shopping, is fruitful for renovating the existing functional-style shopping mall into an prosperous architecture. The model's principle is to call out to human's senses with sights, sounds, or smells at the perfect timings. With this model, places in the mall that are not-as-popular compared to those that are considered as main streets generated from its scientific location, will

[5]Cohen (1996)
[6]Jackson (1996)
[7]Weller (2006) pp.292
[8]Jerde (1998) pp.9-11

turn into a place full of prosperity. Changing the current architecture into the environment full of dynamic sensation will drive customers into stores and provide them the enjoyable experience of shopping.

The environment full of sensation and phantasmagoria refers to those of the Parisian Passages in the 19th century. Walter Benjamin's unfinished set of notes *Das Passagen-Werk* comprehends 36 topics reflecting on the ephemeral quality of the life in Paris. *Passages couverts de Paris*, the centering subject throughout the project, stood as a center of commerce and a recent invention of industrial luxury in the 19th century.[9] The glass-roofed, marble-paneled passages extending through blocks of buildings were the most suitable place to dwell for the *flaneurs*—the middle-class Parisians strolling—in the crowd-edness. The smell of confectioners, sounds of organ grinders, string of lights colorfully shining anything glittering shown in the shop windows tempted the flaneurs to stroll day after day. The atmosphere in the passages created a veil to see their familiar city into the fantastic phantasmagoria.[10]

AdaptivePassage Model transforms the ordinary shopping mall into the environmental phantasmagoria adaptively depending on the customer's presence. This environment can be realized by adding an ubiquitous computing environment layer in addition to the brick-and-mortar ready-build retail architecture. The adaptive environment fulfilling the senses arises by weaving ubiquitous computing technologies into the architecture including ceilings, walls, floors, or even fixtures of the stores. Various sensors and actuators are fabricated into the architecture to sense people's movements and change their activities, all connecting with a computer integrating as one system. In this way, the environment adaptively provides customers the enchanted sensuous experience adaptively by changing the retail architecture dynamically.

Designing architecture with AdaptivePassage Model requires (1) sensing customer behaviors, (2) calculating its timings, and (3) actuating intangible information related to the articles. These three components are critical elements to design AdaptivePassage in a shopping mall driving customers into stores and encourage their shopping.

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[9]Benjamin (2002)
[10]Benjamin (2006)

Sensing requires to understand which direction the customers are walking towards, and how far away they are from the stores. Timing requires to calculate the customers have arrived about 2 meters away from the articles and connect to the actuation. Actuating requires to provide intangible information related to the stores and articles. AdaptivePassage in a shopping mall senses the customers behaviors, calculates the perfect timings, and actuates sounds and lights, to call customers into the stores and enhance their shopping.

First component of sensing customer behaviors comes from the researches of the ubiquitous computing field, where various research have tried to implement sensing technologies to create a better environment. McCullough claimed that such digital networks of smart devices are no longer separate from the physical environment to understand the context of place.[11] Shepard explored the relationships between ubiquitous computing, architecture, and urban spaces, and considered how the integration effects human's experiences and choices in the places.[12] Sensing the behaviors of customers critically stands as one component of designing shopping malls driving customers for shopping.

Second component of timing roots from the researches of human's irrational decision making process and behavioral economics. Tversky and Kahneman's research on irrational choice and decision making have focused on the intuitive preferences consistently changing the choice.[13] Componential context model of Tversky shows the human's contingent weighting and binary comparison processes are always going on.[14] Ariely's research of shopping goals claimed that there are plural phases of shopper's minds; openminded when they are uncertain about what to buy, and implemented when they have defined what to buy.[15] The first phase when still openminded are the exact times to call and give information, while the second phase when implemented are too late.

The third component of actuating intangible information related to the articles arose from the various sensory approaches for retail behavior research. Lindstrom indicated to connect the fives senses enables our feelings, emotions,

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[11]McCullough (2004) pp.3-24
[12]Shepard (2011) pp.16-37
[13]Kahneman and Tversky (1979)
[14]Tversky and Simonson (1993)
[15]Lee and Ariely (2006)

values to interact among another which influences our decision making processes drastically.[16] Human's sense of sound, sight, smell, and touch have a powerful effect, and research has been aiming to improve the shopper experience and change behavior beyond consciousness.[17] Providing intangible information calling to the senses is the critical element to effectively drive customers for an extra shopping.

This component also evokes from the challenges of the researchers in the field of ubiquitous computing. The field considers the relationship between cutting edge computing technologies and brick and mortar retail environments to enhance the shopping experience, where most of them challenges to integrate display networks into the architecture.[18] Through the display, they have challenged to provide additional information about the articles sold at the stores[19], images of how the articles fit to the customer[20], or advertisements of related items[21]. Integrating the technologies into the environment ubiquitously and providing information via display or speakers are becoming a hot topic in the recent field of retail and ubiquitous computing.

AdaptivePassage model can be utilized by shopping mall owners and commercial architecture designers that want to renovate their malls and change the current situation. Mall owners can apply this model when they realize in-equal distribution is happening in their mall. They can use it when they want to attract the customers to a certain spot. They can use it when are hosting events at the central court. They can adaptively change the flows of customers and their create crowdedness. This theory enables to change the fixed commercial architecture into an adaptive environment by implementing various sensing-actuating devices into and within the architecture.

This model can also be applied by shopping mall designers that are making a new mall from scratch. Mall designers can integrate ubiquitous computing technologies on top of their current design of built architecture, and change their design adaptively. The adaptive environment full of sensation calling to the human's senses are also useful for new malls. Integrating the ubiquitous

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[16]Lindstrom (2010)
[17]Soars (2009)
[18]Löchtefeld et al. (2013b)
[19]Pous et al. (2013)
[20]Melià-Seguí et al. (2013)
[21]Kahl (2013)

computing technologies into the shopping mall design framework will enable both already-built and brand-new malls to become an adaptive sensuous environment driving customers to stores and encouraging to shop.

To realize AdaptivePassage Model, I provide three methods to create the environment full of sensation and the prosperous atmosphere encouraging customers to shop. The methods are by (1) creating an actuating device calling out to their five senses (2) creating a sensing device responding to the presence of customers (3) designing both the sensor and actuator to fit into the environment.

The first method is to create actuating devices calling out to the customer's sensory aspects. These actuating devices can call to any of the five senses of sights, touch, smell, tastes, or hearing. Colors, lights, images, videos, can be shown as signs, stickers, posters, or digital displays. Sounds relating to the stores or its items can be played from various types of speakers—directional, flat panels, woofers, or anything else. These devices talk to the customers either consciously or unconsciously, pleasurably encourage them want to walk into the stores, and shop some goods.

In his book *Why We Buy: The Science of Shopping*, the shopping scientist Paco Underhill states that calling to the humans' emotions is the best way of encouraging them feel like they want to buy something. Deciding what to buy is an emotional and spiritual moment, not a necessarily a technical and rational one. The shopping process involves a human experience using the sensory aspects—sight, touch, smell, taste, hearing—and deciding to take it or reject it. "We'll believe it when we see/smell/touch/hear/taste/try it," he claims in his book with various examples of sensing items before buying; touching towels for its smoothness, tasting the new brand of ketchup for its flavor, smelling the bread for its palatability, seeing the clothing and trying them on if the color really is good on yourself, or listening to the salesperson's talks for more information. The more sensation visitors experience, the more shopping is encouraged.[22]

Salespersons do their best efforts to attract the customers by appealing to their five senses. They create point-of-purchases(POP) that describe some extra information, more than just the name of the item and its price. They call

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[22]Underhill (2008) pp.171-183

out with their best voices to notice the customers that they are having a special sale. They put posters of new products on the walls, with a beautiful model promoting it. When customers are wondering around in the fashion store, the clerks kindly say "Feel free to try it on," and guide them to the fitting room. Creating devices that actuate sounds, odors, images, or anything that calls to the senses, will attract the customers more than it is at the current moment.

The second method is to create sensing devices that respond to the customer's presence. The sensing devices can use a variety of sensors—light, infrared, distance, motion, vibration, or cameras—that can notice the activity of customers. For noticing the activities further than the presence of the customers, such as their slowly seeking, taking something in their hands, or even the act of pondering, a further line up of sensors—accelerometers, radars, ultrasonic, piezo, or anything else—are necessary. Creating sensing devices responding to the presence of customers enables the environmental phantasmagoria to become adaptive and dynamic.

Anthropologist Lucy Suchman argued that the planning model which most machines run the interactions does not take sufficient account of human's daily lives. Her argument of situated actions discusses the human actions are constantly reconstructed from dynamic interactions with the material and social worlds.[23] First step requires to overcome the common thought that built architecture is something fixed and static.

In retail stores, salespersons react and change their routines depending what is going on at the moment. Salespersons ask their hearty "May I help you?" when there is a customer inside their store. When they notice the customers are slowly seeking for some items, that is the exact time to start talking to them. When the customer is holding some goods in their hands, it is the perfect time to press on and give some extra information that move their hearts. When there is no customer in the store, they dust up the fixtures or shelves displaying their goods, for a better look to attract the passerby. Salespersons' way of service changes depending on the situation and responding to the customer's behaviors.

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[23]Suchman (1987) *Plans and Situated Actions: The Problem of Human-Machine Communication*

Sensing devices responding to various behaviors of customers enables the actuations to become interactive. The actuators designed by the first method is connected with the sensing devices either physically or wirelessly through networks. The sensing devices give signs to the actuators when exactly to either show images, play sounds, or burst odors. Depending on what kind of interactions to provide in the architecture, the way of connecting the sensors and actuators differ. For example, showing images of the items being used should be shown at the exact time the customer takes the item in hand, therefore the sensors should sense when and what items have been taken, while actuators should show images of the items at the spot. In this case, the sensor and the display should be put in the same place, either integrated as one content or connected via wires for the immediate timings. Another example, playing sounds noticing the items in stores to the customers walking along the street should be played before they pass away the area, therefore the sensors should detect the customer passing a while before they come to that certain point, while actuators play the sounds from ahead. In this case, the sensors and actuators should not be placed together, therefore they should be wirelessly connected and communicating via networks; bluetooth, zigbee, or the internet. Connecting the sensors to the actuators enable the adaptive interactions of the environment.

The third method is to well design the sensing devices and actuating devices to naturally fit inside the retail environment. Without losing its technical aspects, the sensing device and actuating device should be implemented into the architecture so it will not be notable from the customers. Some sensors and actuators may be embedded into the architecture itself; into the ceilings, the walls, the post-and-beams, or the floor. Some may be placed into the stores; hiding them into the shelves, underneath the tables, or placing on top of the fixtures. If the items of the stores are large enough, the devices may be placed behind the item itself. If there are foliage or signage in the middle of the street, hide the devices there. If there are couches for the customers' short break, place the devices underneath the couch.

"The most profound technologies are those that disappear." Mark Weiser begins his paper "The Computer for the 21st Century" with this strong assertion, "They weave themselves into the fabric of everyday life until they

are indistinguishable from it."[24] Technologies supporting our everyday lives should transform itself from it "desktop" appearance and naturally fit into the human environment. Nobody ever thinks about the electric motors when riding their automobiles, because it has become so cheap, small, and efficient during the past century. Technologies should disappear into our environments, without disturbing the current livings, but effectively placed and functioning for an added value of living.

In addition to the placements of the devices, the designing of the device itself from the product design point of view is important as well. Design of things, refers to the methodologies of anthropology in the burgeoning area of Design Anthropology.[25] Contemporary design is starting to become diverse in the past decade, it is much about the spaces, interactions, and meanings between things and people than just itself. Giving the devices a modern design of both aesthetics and functionality will enhance its fitting in the retail architecture. It is also a way to package both the sensor and the actuator together as one simple device.

The three methods mentioned were found throughout the AdaptivePassage Project conducted in 2012, a research project in collaboration with a shopping mall owned and operated by Daiwa House. The mission of the project was to attract customers to the sub-stream passage Heart Avenue, where the quiet atmosphere squarely sat compared to other areas of the mall of iiasTsukuba. This mall is very popular among the neighborhood of Tsukuba since its opening in 2008, however it is currently struggling with in-equal distribution of customers. It is designed in this typical way of scientifically locating anchor stores. The broadway serving as the main pedestrian deck attracts many visitors, while narrow streets are not-as-popular compared to it. The rational locating unfortunately leads the in-equal distribution.

In the year 2012, Daiwa House and I decided to focus on the usage of sounds to create the crowded atmosphere and encourage the customer's shopping. I created *Soundful AdaptivePassage*, an adaptive sound system playing various sounds responding to the customer's presence from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores or show windows. Heart Avenue with Soundful AdaptivePassage attracts the customers' attentions and

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[24]Weiser (1991)

[25]Clarke (2011) *Design Anthropology: Object Culture in the 21st Century* pp.9-13

provide fulsome experience of strolling, as if it were phantasmagoria. When the customers walk through the passage, the set of sounds produced are delivered to their ears seem as if they are being called from the architecture itself. As if the architecture itself is tempting, the strollers actually walk into the stores to find out what items are there. I created ubiquitous computing technology devices—consisting of sensors, speakers, and micro-computers—and implemented them into the retail architecture to call customers to shop at the stores in Heart Avenue.

Figure 3.1: Image of Soundful AdaptivePassage in iiasTsukuba

The process of creating Soundful AdaptivePassage through the project was not a simple linear route but a complex combination of various aspects. Starting for the primary testing of the effects of sounds, I planned and created the early prototype and the networked foundation of the ubiquitous computing layer. Observation of the interactions between sounds and shoppers with the prototype was done in depth through a series of tests with different sounds and interactions. Learning from the first trial, a series of research was conducted to understand current shopping behavior of both salespersons and shoppers. Finally, I created small speaker-embedded sensing devices which fit into the store appearances from items, fixtures to couches. All of the phases repeated from

hardware sketching, software sketching, and user tests.[26] From the following section, I describe in detail how Soundful AdaptivePassage was developed, through the AdaptivePassage Project 2012 taking place and working together with the shopping mall iiasTsukuba.

3.2 Initial Sound Experiments and Concept

3.2.1 Initial Discussion Sessions

It all started from one simple message I sent to the iiasTsukuba shopping mall customer service via its website one day in 2010. In the message, I wrote that our research team is studying the usage of sounds in commercial spaces and that we wanted to hear some opinions from the mall side. The general manager responded immediately to our message, "Please come to our mall and discuss some ideas". It was September 2010 when our design team went all the way from Yokohama to Tsukuba, a three hour train ride.

The mall iiasTsukuba opened in 2008 as a flagship shopping mall of a Japanese house-making company Daiwa House at the corner of Kenkyu-gakuen, a well-known suburban research town in Tsukuba-city with over 300 research institutes. iiasTsukuba holds a tagline of "shopping center for families of all ages". Due to the opening of the Tsukuba Express Line[27] in 2005, the huge territory in front of the Kenkyu-gakuen station had been widely concerned and many shopping center operating companies were strongly eager to locate their malls. Daiwa House was the company that acquired the land and opened the spacious and luxurious mall in the territory of nearly 150,000 square meters.[28]

Stores located in iias Mall, the main-stream passage between the anchoring stores are prospering, however Heart Avenue on the corner of the first floor has a quiet atmosphere. (See Figure 3.3) This sub-stream passage located in the corner of iiasTsukuba stands with a complete lack of exuberance. Though some pedestrians use the passage as a way to walk from one place to another,

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[26]Buxton (2007)*Sketching User Experiences*

[27]Railyway line connecting Akihabara and Tsukuba area powered by Metropolitan Intercity Railway Company, a joint private-public venture. http://www.mir.co.jp/en/

[28]Daiwa House Press Release http://www.daiwahouse.co.jp/release/20080829115007.html

Figure 3.2: Map of iiasTsukuba (as of Autumn 2010) (Courtesy to the handout map of iiasTsukuba)

those who purchase goods in Heart Avenue are seldom seen. It stands with a calm and serene atmosphere. Since their opening, Daiwa House had been challenging everything they could think of to attract customers to go to the not-as-crowded places—placing signage noticing its existence, holding price reducing events, or handing out coupons—nevertheless they were struggling to do so. It is the architectural design which determines the in-equal distribution of customers among the sections of the mall, creating crowded main-stream passages and not-as-crowded sub-stream passages.
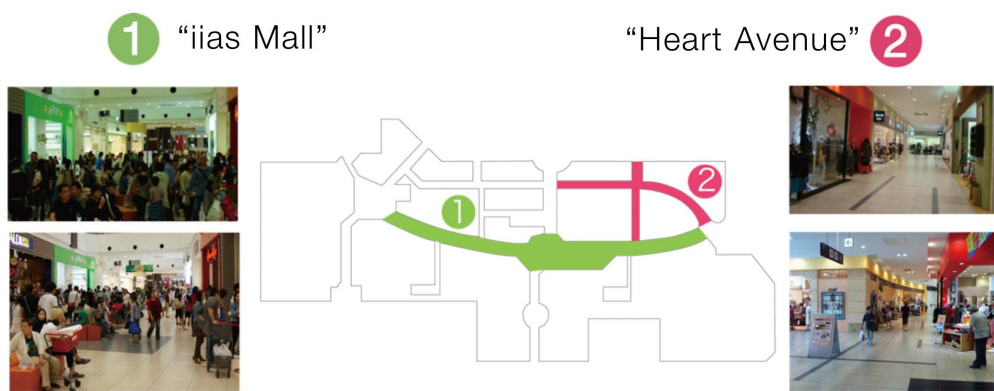

Figure 3.3: Current Situation of iiasTsukuba

As Daiwa House started to operate the mall, they noticed that the architecture of the mall does not function as initially planned. They have been facing the problem of in-equal distribution of customers among the immense architecture where more customers are attracted in main passages and the sub-stream passages have less. They have tried out almost anything they could think of for attracting the customers; placing visual signage, changing flooring materials, and hosting various events in the center of the mall. Daiwa House team were seeking for other possibilities to attract customers, and gave us the mission to increase the number of customers and the sales of the shops within the branched sub-road Heart Avenue.

We had a very fruitful discussion with the managers of Daiwa House; head general manager Mr. Sasaki, vice general manager Mr. Murata, and the head of sales division Mr. Suzuki. We presented our initial ideas to provide something more than background music for a larger retail profit. They listened to our ideas seriously and nodded earnestly. "This mall is one challenging experiment for our company, Daiwa House," Mr. Sasaki told us with shining

eyes, "Our company is a house-making company, but we wanted to expand our business to something new. Shopping malls is a new challenge for us, and we want to develop our own way of building and operating them. We want to challenge anything we can think of to make this place better, anything that other shopping malls have not yet tried." Mr. Suzuki added, "Shopping malls are supposed to act as the communal space for the neighborhood. We want to create a mall that can call out to the visitors from all around the neighborhood. I am sure that sounds can take a great role in this."
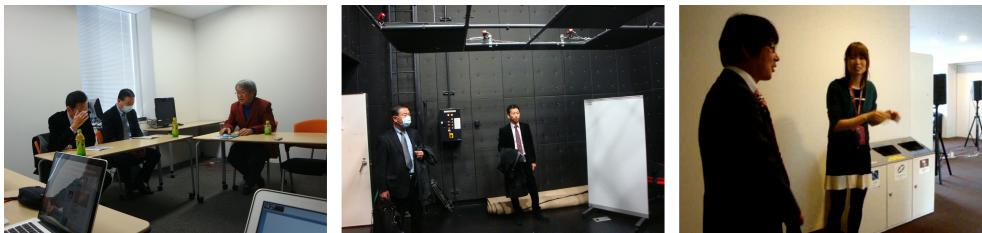

Figure 3.4: Discussions with Daiwa House crew before project launching

Our design team brainstormed some ideas to use sounds effectively in the mall. We had a discussion with the Daiwa House crew every couple of months, aiming to develop a plan that effectively uses speakers to navigate customers unconsciously. We showed them a simple prototype using speakers in our studio at the university. They liked our ideas, and decided to create a sound architecture with speakers embedded in the ceiling, that pulls and navigates customers to encourage to stay more at the mall. We were planning to start our project from the new academic year of 2011, aiming to create a sound environment that navigates customers according to the mall owner's intentions. However, it was an unfulfilled plan.

March 11, 2011 is a day all Japanese shall never forget. Although not as much as the northern Tohoku area, Tsukuba area had a great damage as well. The earthquake destroyed the architecture of the mall, and could not operate for more than a month. When they restarted their mall just before Golden Week 2011, the government gave a notification letter to deal with the issue of low electricity. "We are having a hard time," Mr. Murata gave me an email on one day in May 2011. "Generally, shopping malls are places for entertainment. But the planned electricity outages, which swayed us and the tenant stores, have began to so weary. However, we must do our best to make this shopping

mall a further communal gathering place," and concluded the message "Let's discuss what we can do for a greater shopping mall."

We started having discussions with the Daiwa House crew again, from June 2011. This time we decided to launch the project from April 2012, but with a more powerful plan. We needed to come up with a stronger plan which provides customers an enchanting experience of their shopping at the mall. The design team and I decided to run several sound experiments in public space, rather than the experiment laboratories we had been conducting in the studio of our university.

3.2.2 Primary testing of sounds calling pedestrians

In September 2011, the design team and I tested the potential power of sounds provide towards humans. We conducted a 3 day experiment in Dokuritsu-kan of Keio University, a 7 story-high building which has large classrooms, computer rooms, and study halls which are free for the students to use when class is not going on. (See Figure3.6) Before and after classes, the bachelor students pass through this building as a passageway. In this primary test, we examined the behaviors that people take when they hear some music being played in the environment.

The sound environment we created in Dokuritsu-kan consisted of two speakers. From these speakers, we played environmental music that keeps repeating the same phrase simultaneously. This music was originally created by the team member. This Dokuritsu-kan usually does not have any background music played, so it usually has no sounds at all. We wanted to see how humans will react to sounds where there are usually no sounds. This test was held during lunchtime hours (45 minutes long) where nearly 1000 students passed by, for 3 consecutive days in September 2011.

In Day 1, there were 1469 students that walked through the building, and among that there were 102 students that took a look at the installation. On Day 2, there were 85 students that took a look at the installation 1268 students walking through the building. There were 958 students walking on day 3 and 126 of them took at look at the installation. Most of the students seemed to notice that there were music being played in the atmosphere, and noticed the

Figure 3.5: Initial testing location and implementation

Figure 3.6: Students looking at speakers

difference. Some of the students were talking among each other "Is there an event going on?" While others checked with their eyes what was going on, but as soon as they figured out that there were big speakers being placed, they lost their attention and started walking again.

From this primary test, we learned that music being played simultaneously sometimes attract people's attentions, but they get used to it easily. Also we learned that people do want to know why the music is deriving. The behavior of checking the speakers and losing their attention gave us a hint that there must be something that is attractive other than speakers that do something more that eye catching. We need something more attractive where their eye sights go, in order to change their activities to walk towards a different way. For our next testing, we decided to add sounds in reaction to the people's behavior on top of the music being played simultaneously.

3.2.3 Adaptive Sound Design, a Surround Sound System

To attract the pedestrians walking within our university, we created a sound design playing sounds responding to the behaviors on top of consecutive music. This sound design, called Adaptive Sound Design(ASD), plays both music and sounds with surround sound system consisting of four speakers. The four speakers simultaneously play original music created by university students majoring music. Once it detects movements of people with a camera, it sends the data to a computer system to play sounds through the four speakers as a surround system. (See Figure 3.7)
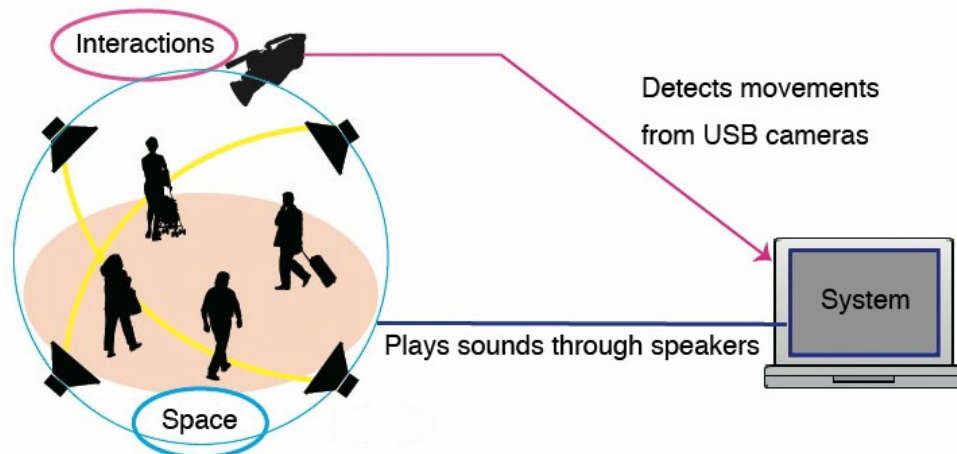

Figure 3.7: Adaptive Sound Design System

Our aim of ASD was to see what kind of behaviors pedestrians will take if short sounds are played into the environment according to their actions. This time, we embedded ASD in 2nd floor basement of Dokuritsukan during lunchtime hours (45 minutes long) for two days in December, 2011. The four speakers and the camera is set into the space as the figures 3.8 and 3.9. The current flow of students in Dokuritsukan are shown as blue arrows in this figure. We wanted to attract these students into the orange area shown in this figure.

Among the 100+ students that walked through the environment, most of them took a look towards the sound area when a sound was played. (See Figure 3.15) When the camera detected their facing, sounds were played again. The students double looked at the area. But as soon as they realized that there
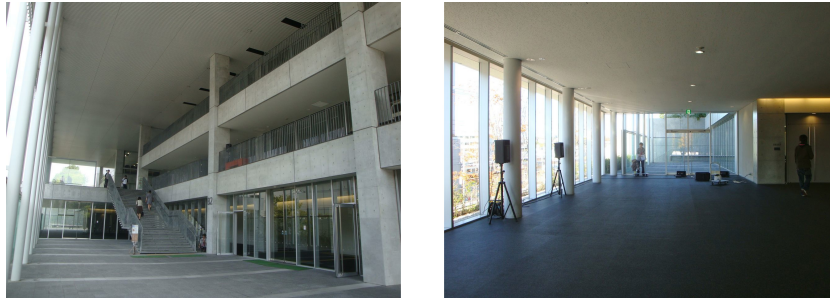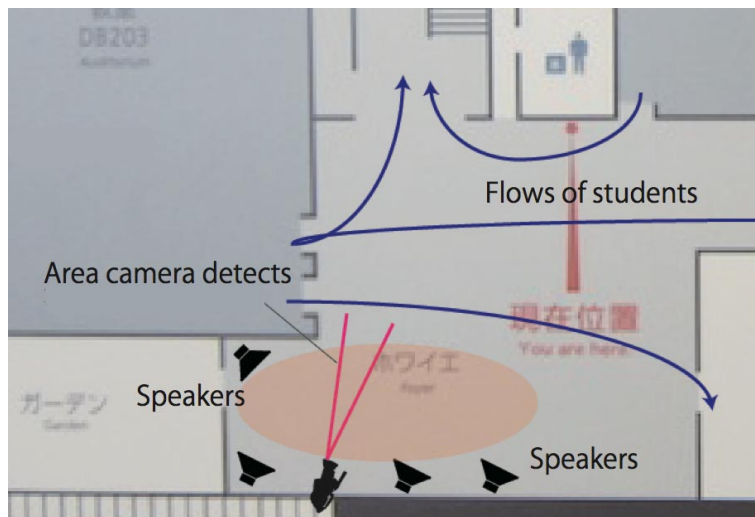
Figure 3.8: Initial Experiment at Dokuritsukan

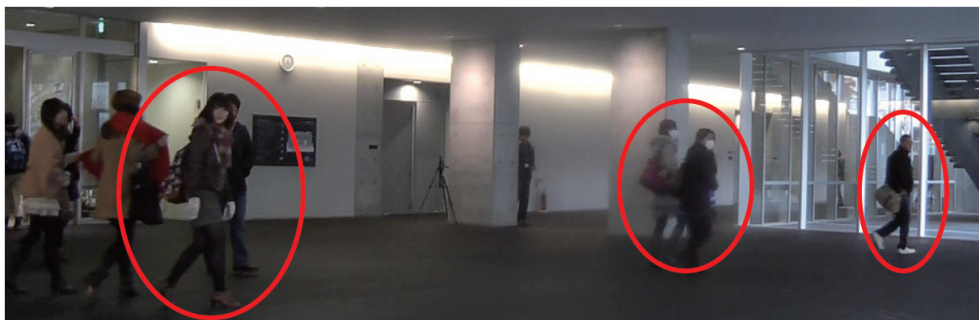Figure 3.9: Setting of ASD in Dokuritsukan of Keio University

Figure 3.10: Behaviors of Students passing

are only speakers placed in the area, they started walking again. From this experiment, we figured that we may need to put something visual other than speakers to actually change their behaviors and pull them towards the area.

3.2.4 Initial Concept: Sound Street for Heart Avenue

After sharing our findings from the initial experiment with the Daiwa House crew, they pointed some points such as "We want something to see when customers notice the sounds and turn their faces towards it." and "Something to see may be some visual signs or signage which we currently already place in the middle of roads. We can raise the possibility to pull customers with the collaboration of visual signs and sounds." We decided to create a system with sets of signs and sounds that attract visitors that walk passed the entrance and pull them inside.
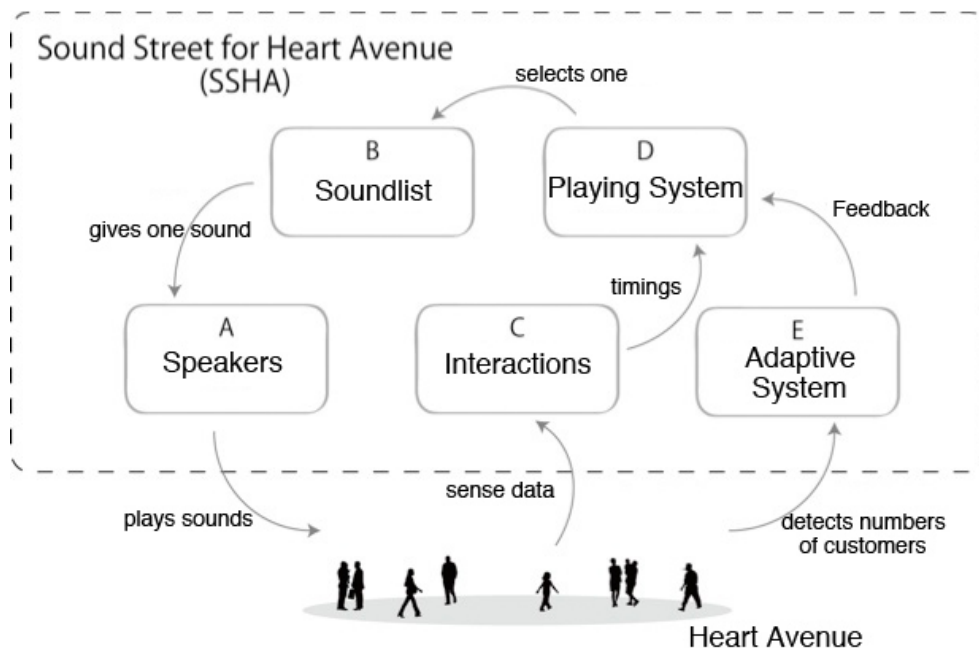
Figure 3.11: Initial Concept: Sound Street for Heart Avenue

The initial concept before the project launch was called *Sound Street for Heart Avenue.* (See Figure3.11) The behaviors of customers in Heart Avenue are sensed by the signs and provide them Interactions(Figure3.11-C). At the certain timings of the behaviors, the Playing System(Figure3.11-D) selects one sound from the Soundlist database(Figure3.11-B). The selected sound from

the Soundlist are played through the Speakers(Figure3.11-A) and provided to the customers in Heart Avenue. The changed behaviors of customers and its numbers are detected to the Adaptive System(Figure3.11-E) and provides feedback to update the Playing System.

3.3   Setting: Heart Avenue of iiasTsukuba

The stores are located in Heart Avenue, along both sides of the narrow passage of nearly 100 meters long, have no divided partitions between the store and the passage. Therefore it is easy for any visitors to come in and out. Fixtures located on the boundary of the store's territory displays highly recommended items of the store. Couches and foliage are placed in the center of the narrow passage for pedestrians to sit down and have a short break. Signage are positioned at the intersection of the passage, providing information of what is new or recommended in the area. All of these components have been placed since the opening of the mall, however they are a part of the phantasmagoria environment as well. These components of the passage all together plays sounds to call customers within the mall.
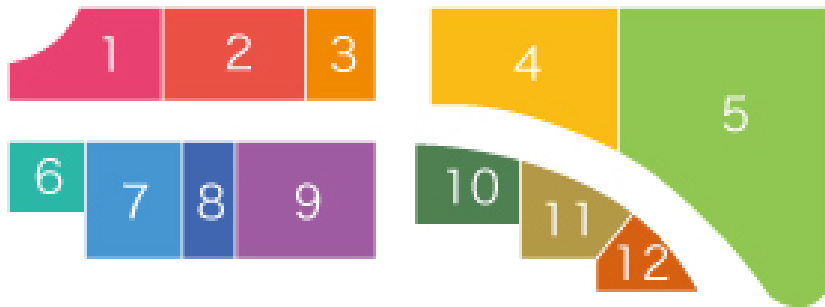
Figure 3.12: Heart Avenue Shop Map

There are 12 stores selling their original goods; used-car store *Kawashima Auto*[29] (Figure3.12-1), outdoor goods store *Namche Bazar*[30] (Figure3.12-2), children's and pet goods store *Mother Garden*[31] (Figure3.12-3), handcraft goods store *Craf*[32] (Figure3.12-4), old-fashioned department store branch

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[29]Kawashima Auto http://www.kawashima-auto.com

[30]Namche Bazar http://www.namchebazar.co.jp

[31]Mother Garden Pet Paradise http://www.creativeyoko.co.jp

[32]Craf http://www.e-craf.com

Mitsukoshi[33] (Figure3.12-5), clock and watch store *Cloccal*[34] (Figure3.12-6), kimono store *Hanagoromo*[35] (Figure3.12-7), traditional Japanese goods store *Kichijituya-Fukuemon*[36] (Figure3.12-8), Japanese pottery store *Oribe*[37] (Figure3.12-9), women's fashions store *Fashion Village*[38] (Figure3.12-10), glasses store *Paris Miki*[39] (Figure3.12-11), and tea store *Lupicia*[40] (Figure3.12-12).

Figure 3.13: Entrances of Heart Avenue

Heart Avenue has two entrances. Entrance 1 (Left of Figure3.13) is on the left side coming from the parking area, with Kawashima Auto and Cloccal welcoming. On the right side there are restaurants, and walking straight takes you to the center court where various events are held. In center court, many concerts and performances are held on the weekends. Since the road from the entrance of the parking lot is straight and easy to understand, it leads many visitors walk directly to the center court. During lunchtime and dinnertime hours (approximately from 12pm to 2pm, and from 5pm to 7pm) The entrance towards the restaurant avenue gets crowded. Since Heart Avenue is located in such area, many visitors walk through Heart Avenue as a walk-through passage to get from the supermarket to the restaurants. Entrance 2 (Right of Figure3.13) is the road that branches to the right from the main entrance, with Mitsukoshi on the right side and Lupicia on the left. When walking straight, it takes you to the Main Mall, with various store selling grocery goods. On

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[33]Mitsukoshi http://www.mitsukoshi.co.jp

[34]Cloccal http://timetime.jp

[35]Hanagoromo http://www.k-futabaya.co.jp/hanagoromo

[36]Mutoh Corporation http://www.glass-kumiai.jp/mutoh-corp

[37]Oribe https://www.oribe-minoyaki.com

[38]Fashion Village http://www.fashion-village.co.jp

[39]Paris Miki http://www.paris-miki.co.jp

[40]Lupicia http://www.lupicia.com

the left side, there is a big grocery supermarket which is very crowded almost all the time. Heart Avenue exists on the right side. In the Main Mall, many visitors were taking a brief rest at the orange sofas located as islands in the middle of the wide road.

3.4 First Prototype: Sound Entrance in Heart Avenue

To create the basic environment, first I implemented sound architecture itself utilizing speakers and sensors connected to a computer system as soon as the project launched in April 2012. It took several nights of construction to actually exploit the speakers, cables, sensors, cameras, and computers into the architecture of iiasTsukuba. Also since there was no network environment within the mall, and linked the backyard of Heart Avenue with internet. Moreover, there were no electric power supplies in the backyard and in the ceiling, and supplied electricity for the sound architecture. I created sensors with infrared LEDs and its light detectors on my own to put into the ceilings of the mall, wirelessly connecting to the computer system placed in the backyard. Furthermore, I decided to implement cameras at both entrances of the road, to inspect how the customers are actually behaving within the shopping center. It was May 2012 when the speakers were put into the wall, sensors in the ceiling, cameras in the ceiling of the entrances, internet and electricity environment were built into Heart Avenue.

When the project launched in April 2012, we first decided to set the goal of to attract customers in the entrance of Heart Avenue. We created "Sound Entrance", an entrance which plays sounds when people step over visual signs placed on the floor. (See Figure3.14) It was created to attract visitors that walk passed the entrance and pull them inside. The played sounds serve as triggers for the visitor's attentions to go towards the place where they usually walk pass. We decided to set a visual sign that attracts them in front of the entrance of Heart Avenue. If the person step over the sign, sensors detect the data and make the speakers play sounds. The sensors and speakers are both implemented into the ceiling.
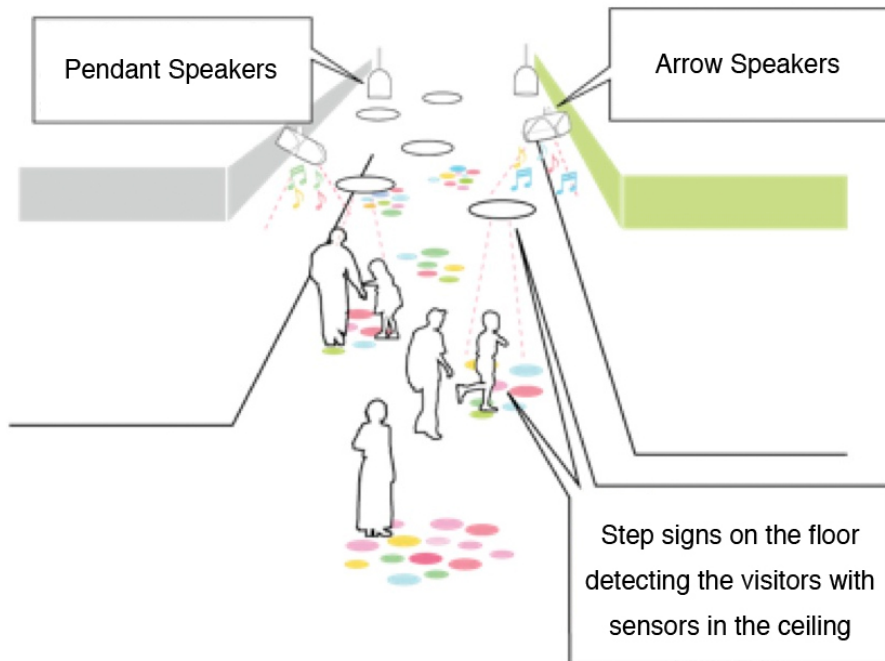
Figure 3.14: Sound Entrance Concept

In the two entrances of Heart Avenue, we implemented four speakers each, summing to eight speakers in the ceilings. The speakers were implemented on the along the sides of the avenue, and the sensors were on the in the middle. See Figure3.15 for details. Underneath the sensors, a visual design using stickers were put on the floor. There were two different types of speakers. Towards the outer entrance, we put two arrow speakers facing outwards, on both sides. The two speakers implemented inside were pendant speakers. The arrow speakers have a directional way of playing sounds, while the pendant speakers had no

Figure 3.15: Implementation Map

direction.

When visitors step over the first set of stickers from the entrance, the two arrow speakers play sounds towards them. The two speakers are alternately playing sounds about 0.1 seconds long, and provide a surrounding atmosphere. One sou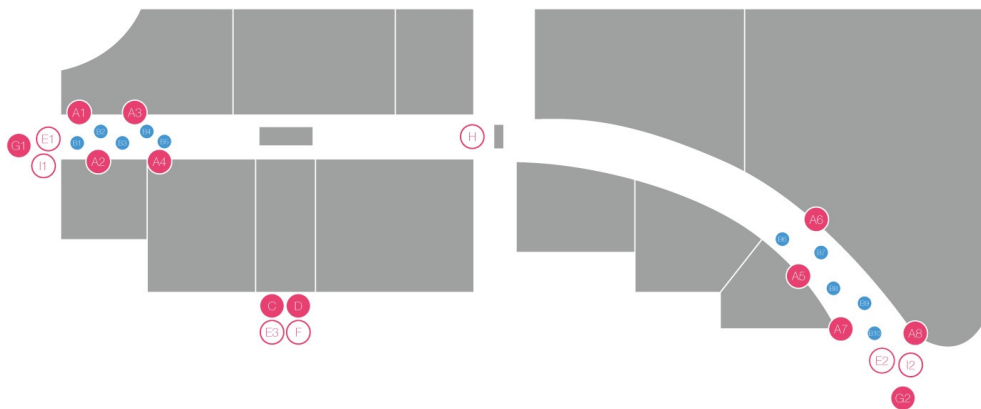nd lasts for about 1 to 2 seconds long. The sounds are delivered to the visitor's ears and therefore take a look inside Heart Avenue. Then they see a series of sticker sets in the road. When stepping on the second set, different sounds are played again from two different speakers. So then customers start to understand that if stepping over the sticker sets, sounds will be played. If stepping over the third set, the two pendant speakers play sounds alternately. The five sets of stickers all play different sounds from the four speakers in the ceiling. The visitors are called into Heart Avenue without noticing so much about it, and when they have stepped over five stickers, they see that there are many stores that they have not noticed before.

The sounds that are played from the speakers are like sound effects, all lasting about 1 to 3 seconds long. The reason why we chose rather short sounds is to emphasize them from the background music played in the entire shopping mall. The sounds we played are short sounds made from instruments; harp, glockenspiel, drums, marimba, and shakers. Suppose the five sticker sets from the outer side are named A, B, C, D, E; the two arrow speakers are named W, X, and the two pendant speakers are named Y, Z. Stepping over sticker-A will play harp sounds from speaker-W and speaker-X alternately. Stepping over sticker-B will play glockenspiel sounds from speaker-W and speaker-X alternately. Stepping over sticker-C plays sounds of drums from speaker-X and speaker-Y. Stepping over sticker-D plays marimba sounds from speaker-Y and speaker-Z. Last but not least, stepping over sticker-E plays sounds of shakers from speaker-Y and speaker-Z. This system works for the other entrance as well.

By playing sounds to them when they pass by the entrance, we approach them with visual signs and audio sounds to spend time walking and browsing in Heart Avenue. With Sound Entrance of Heart Avenue, visitors of iiasTsukuba that passes by the entrance of Heart Avenue notices the played sounds. Their sights head toward inside Heart Avenue, trying to figure out where the sound came from. They find some visual signs sticked on the floor of the entrance.

Other visitors already walking in Heart Avenue are making sounds as they step over the stickers. The visitors are pulled inside to step over the stickers as well. Each sticker plays a different sound. They follow the stickers that are placed in a row, and before they notice it, they are completely inside Heart Avenue. This is the ideal scenario of shoppers with Sound Entrance.

As customers walk pass the entrance of Heart Avenue, they notice five sets of colorful stickers on the floor located in the entrance of the passage. As they step over the first set of stickers, the two speakers on the front side on both sides of the entrance give sounds of the marimba alternately. When stepping over the second set of stickers, the same two speakers on both sides give sounds of the maraca, also alternately. Stepping over the third set of stickers provides sounds of the drums from the two speakers switching among each other. The fourth set of stickers offers sound of the harp from the two speakers located in the back side of the entrance. The fifth and final set of stickers issues sounds of bells from the set of speakers in the back side taking turns. These originally created set of sounds are designed upon my figuration that may suit the atmosphere of the passage as well as the fact that the sound may easily be heard to human's ears.

The instrumental sound effects we designed—harp, glockenspiel, drums, marimba, and shakers—-were designed in the order to provide an original experience. Harp sounds were selected to design the feeling of wanting to start running. Glockenspiels were for the feeling of floating in the air. Drums were for waking up. Marimbas were for facing in several directions. Finally, the shakers were for designing the feeling of rolling around.

The sensors embedded into the ceiling were created by our design team as well. These sensor kits included a handmade infrared LED set, a photo-transistor that detects the amount of light, an Arduino Uno[41] calculating the data the phototransistor detects, and a Xbee[42] that wirelessly connects to the computer located in the backyard delivering the data every tenth of a second. (See Left of Figure3.17) Five sets of sensor kits are embedded into both entrances of Heart Avenue, summing up to ten implemented sensor kits. The sensors are connected to the AC above the ceiling. The infrared sensors shine

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[41]Arduino http://www.arduino.cc

[42]Digi Xbee Wireless Modules http://www.digi.com/xbee

Figure 3.16: Sensor system of Sound Entrance

infrared light that is not visible to human eyes but can be seen through camera lens. (See Right of Figure3.17) Below these ceiling sensors, we put stickers of colorful dots using reflective papers to shine back the infrared light.

Also since there was no network environment within the mall, and linked the backyard of Heart Avenue with internet. Moreover, there were no electric power supplies in the backyard and in the ceiling, and supplied electricity for the sound architecture. So we had Kandenko[43] create extra electricity supply.

I created sensors with infrared LEDs and its light detectors on my own to put into the ceilings of the mall, wirelessly connecting to the computer system placed in the backyard. Furthermore, I decided to implement cameras at both entrances of the road, to inspect how the customers are actually behaving within the shopping center. It was May 2012 when the speakers were put into the wall, sensors in the ceiling, cameras in the ceiling of the entrances, internet and electricity environment were built into Heart Avenue.

To create the basic ubiquitous computing environment, I implemented the entire sound architecture itself as soon as the project launched in April 2012.

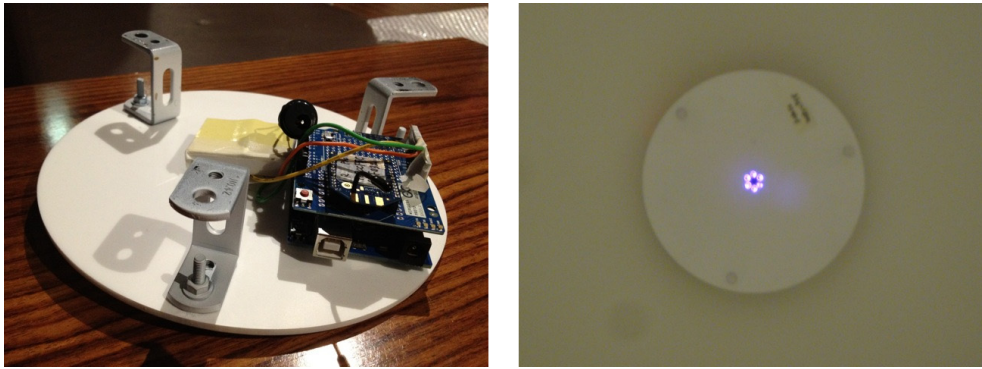[43]Kandenko http://www.kandenko.co.jp

Figure 3.17: Sound Entrance Sensor Kit
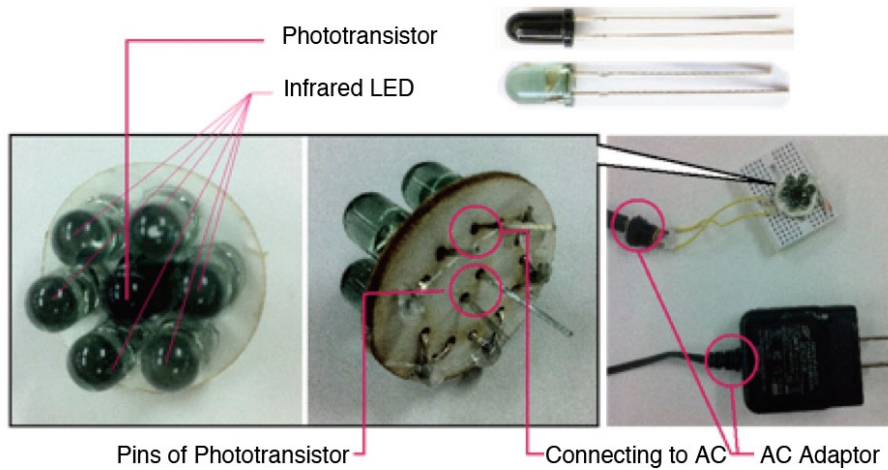
Figure 3.18: Basic system of Sound Entrance Sensors

Regards to the collaboration with Xebec[44], it took several nights of construction to actually exploit the speakers, cables, sensors, cameras, and computers into the architecture of iiasTsukuba. The speakers and cameras are connected by wires to the mother computer placed in the backyard of Heart Avenue. These wires are all linked over the ceiling, some as long as 120 meters long. The implementation took place in midnight of April 16 to 18, 2012.

Step signs, the signs on the floor for attracting customer's eyesights, were designed on the floor with stickers. When visitors step over the stickers, the speakers in the ceilings play the instrumental sound effects. To realize this interaction, we decided to use a variety of colors and create a series of dots, as if playing hopscotch. We put six sets of series of dot stickers in each entrance, all coordinated to a particular sound, except for the first set of stickers that do

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[44]Xebec Co. http://www.xebec.co.jp

Figure 3.19: Implementing Sound Entrance into Heart Avenue

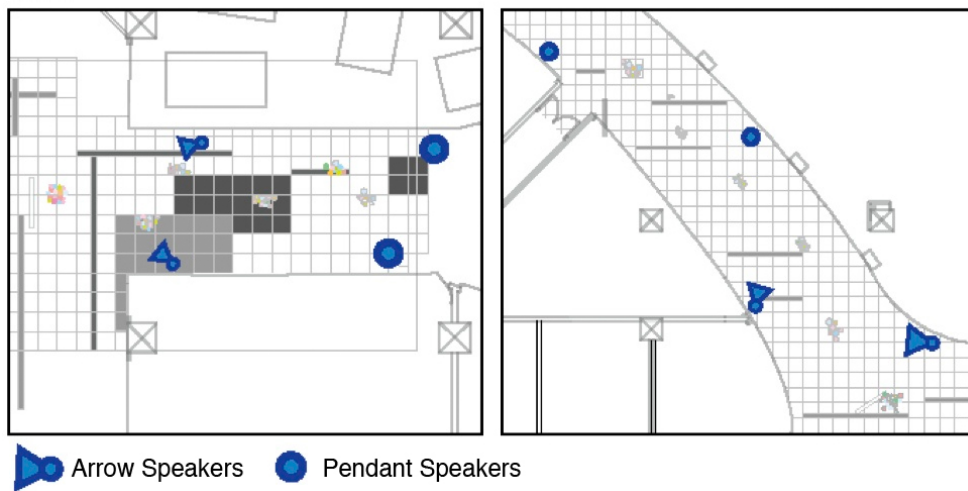Figure 3.20: Map of Sound Entrance

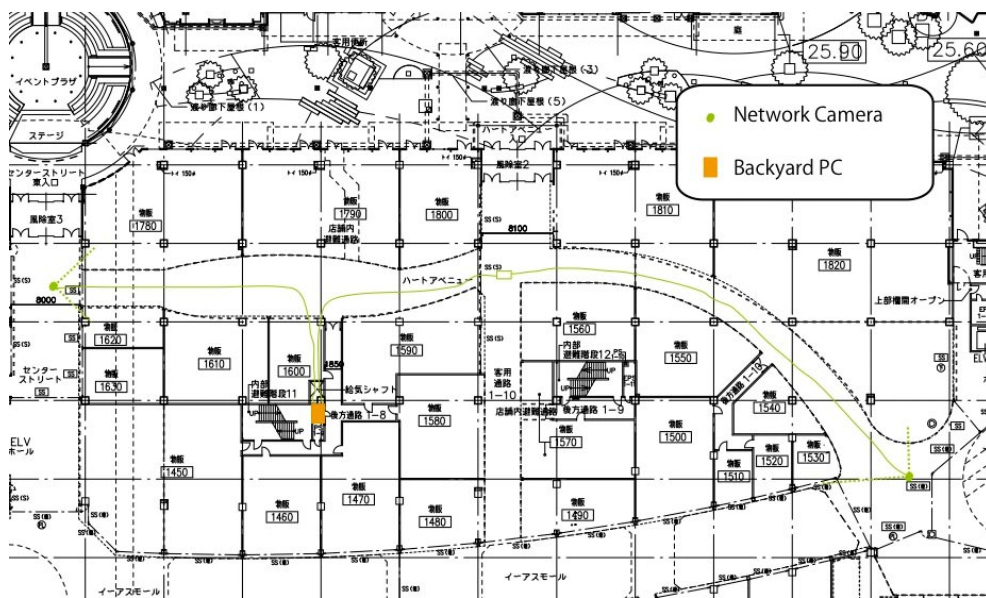Figure 3.21: Camera Implementation Map

Figure 3.22: Speakers, Step Signs, and Sensors embedded

not make any sound even if somebody steps over it. The colorful stickers were printed on label sheets. The white stickers were created with retroreflective paper, to reflect the infrared light shining from the sensors in the ceiling.

3.5 Influences of Sound Entrance

Sound Entrance, first prototype aiming to gather the customers within the entrance of the Heart Avenue, ran for 3 weeks in May. It ran from May 5 to May 28, from 10 o'clock in the morning to 9 o'clock in the evening. In this section, some interesting behaviors of the customers with Sound Entrance are described, as well as the comparison of the customer numbers that came into Heart Avenue with and without Sound Entrance for its overlook.

Young girls dancing

On a Saturday afternoon, May 12, a mother with two girls came into Heart Avenue from Entrance 1.(See Figure 3.23) Saturday afternoon is the one of the most crowded hours at iiasTsukuba, especially from 2pm. The girls are siblings, the elder one in her early elementary years, and the younger one around age four. Their mother was inside Clockal, a clock store near Entrance 1 of Heart Avenue. The sisters were sparing their time, and they accidentally stepped over the set of colorful stickers on the floor. The sounds of the glockenspiels rang in the entrance. The elder sister took one step over another set of stickers. The sounds of the harp rang. She realized that the stickers were some switch for the sounds to ring in the entrance, and started to hop on them. The younger sister saw her elder sister hop on the stickers,

Figure 3.23: Young girls dancing with Sound Entrance

and started to do the same with another set of stickers. The sounds of the drums rang. However, she moved to another set of stickers, and hopped on them again. The sounds of the marimba rang. The younger sister decided to step on that set of stickers that rang the marimba, rather than the ones that the drums rang. It seemed like she did not like the sounds of the drums, and liked the marimba better. Two girls were stepping over the stickers, and they looked as if they were dancing. After about 5 minutes, their mother came out Clockal, and so the family went off to their next destination.

After about an hour, the family came back to have their early dinner in the Restaurant Avenue, which is right next to the Entrance 1 of Heart Avenue. "Look, mom! We dance on these signs, and sounds play!" The girls started hopping on the stickers once again, while the mother was standing in the corner of the entrance, watching at her girls having fun. While she was standing in the corner, the mother started looking at the showcases of Clockal once again. This time, it was the mother who was sparing her time, and started to browse at the items being displayed in the showcase.

The girls were dancing again for a couple of minutes. The elder sister then started wondering why the sounds were reacting to their dancing. She looked above the stickers, and realized that there were white sensors on top of them. She jumped with her face facing above, and took at look if the sensors react. She kept jumping for a couple of times. She did notice the sensors, but seemed like she did not understand what the sensors were sensing. "It's time for dinner!" The mother called to the girls. The girls responded and walked away towards Restaurant Avenue to have their dinner.

Boy playing by himself

Just before lunch time on Saturday, May 12, a boy around the age of eleven walked alone into Entrance 2 of Heart Avenue. (See Figure 3.24) He was wearing a red jacket and a red baseball cap. His parents were shopping at Mitsukoshi department, right next to Entrance 2. Since the Mitsukoshi department store is quite huge, his mother and father were shopping around for quite a long period of time. The boy was extremely bored.

He noticed the set of stickers in the entrance, and stepped above one of them. The sounds of harp rang in the entrance. He looked around, and found

Figure 3.24: Boy playing alone with Sound Entrance

speakers embedded in the ceiling. He stepped out of the stickers for a second, and stepped on them again. The sounds of harp rang again. He stepped out again for a second, and stepped on again. He repeated this action for over a dozen times, and then moved on to the next set of stickers. The sounds of the glockenspiel came out. Once again, he repeated stepping over and stepping out of the stickers again and again. He moved to the next set of stickers. This time it was the sound of the drums. He stepped on and off again. He spent about 3 minutes each on the stickers. Next he went to the set which the sound of marimbas came out. He seemed to like the sound of the marimba, and spent even more time on them. Finally, he went on the final set of stickers, where the sound of shakers came out. All together, he spent over 20 minutes playing alone, sparing his time.

After his solid time of playing alone with Sound Entrance, his parents came out from Mitsukoshi. However, his mother decided to go to Paris Miki, a glasses store located inward in Entrance 2. Therefore, the boy was again sparing his time. So he started again playing with Sound Entrance, this time starting from the sounds of the shakers, and going back in order, for about 2 minutes each. At the end of this second session, he seemed to master how to ring the sounds of Sound Entrance completely, and totally have fun with it. In total, he spent time playing at Sound Entrance for over 30 minutes. Finally, it was time for his lunch, so he walked away with his parents.

Grandfather and grandson dancing together

On a Sunday afternoon, May 13, a young family consisting of a father, mother, son about 2 years old, and the grandfather, came shopping to iiasT-sukuba. While the father and mother were browsing for their new car at Kawashima Auto, the grandfather was taking care of the grandson. The grandfather loves his grandson so much, that he was hugging the grandson on his shoulder. (See Figure 3.25)

At first, the grandfather holding the grandson inside Kawashima Auto, but after a while, they stepped outside the store. Grandfather noticed the colorful stickers on the floor. "Look, there are some stickers!" The grandfather talked to the grandson, and walked towards the stickers. Then the sound of marimba filled the entrance. "Did you hear the sounds??" the grandfather talked to the grandson. The grandson was laughing. The grandfather stamped his foots

Figure 3.25: Shoppers playing with Sound Entrance

again and again on the stickers. The sounds of marimba was ringing again and again. Then the grandson pointed his arms and fingers towards the next set of stickers on the floor. The grandfather tiptoed to the stickers which the grandson pointed to. The sounds of drums were played. The grandson was laughing, while the grandfather kept tip-toeing over the set of stickers. The grandson pointed towards the next set. The grandfather again tip-toed towards the next set of stickers, where the sounds of glockenspiels were played. The grandfather and grandson looked as if they were dancing together in Sound Entrance.

Then the grandfather noticed the speakers set on the ceiling, and the sounds being played from there. The grandfather pointed his fingers towards the speakers. "See the speakers set in the ceiling, that's where these sounds come from!" he talked to the grandson. The grandson was smiling. The grandfather was certainly enjoying playing with his grandson in Sound Entrance. After about 5 minutes, the father and mother came out of Kawashima Auto. They walked towards the grandson and grandfather, and started walking inside Heart Avenue.

Salespersons playing during their spare time

Some salespersons from the upper level floors come down to the first floor and hand out advertising tissues or leaflets. This entrance, right next to Entrance 1 of Heart Avenue, is the entrance near the main parking space. Every once in a while, stores with less customers passing by their stores come near this entrance and advertise their stores. They stand in front of the entrance for hours, trying to let the customers notice their shops.

It was the evening of Saturday, May 20. A salesperson wearing a black shirt was standing in front of the entrance of iiasTsukuba, handing out his advertising tissues of the sports goods store in the third floor. (See Figure 3.26) While he had been standing there for nearly an hour, he noticed the customers that were stepping over the signs on the floor, and some sounds were being played responding to it. The time was almost 8pm, one hour before closing time. Since there were hardly any customers walking in the area at that time, he decided to take a break, and test what was going on in Heart Avenue.

Figure 3.26: Salespersons playing with Sound Entrance

First, he stepped on the set of stickers in the most rear end of Sound Entrance. He was standing still while the sound of shakers rang. Next he moved to the next set of stickers, where the sounds of marimba rang. Again, he was standing still on the stickers while the sound was ringing for about 3 seconds. After the marimba sound stopped, he moved to the next set. The sound of drums rang in the air. He looked above him, and realized the white sensors in the ceiling.

It was then when he moved onto the next set of stickers, another salesperson came to join him. They were stepping on the same stickers, and listened to the sound of glockenspiel ringing. The newcomer salesperson asked what is going on, and he replied what he had been trying in the passed couple of minutes. Then he asked the newcomer salesperson to stay standing where he was, while he went over to the first set of stickers and stepped on them. They wanted to figure out what would happen if two stickers were stepped over at the same time. In the mean time, some customers were passing through Heart Avenue, so some other sounds were ringing. They kept trying to figure out how the system was working, by waving their hands towards the ceiling sensors, or looking at the stickers, for a total of about 10 to 15 minutes.

Comparison of customer numbers in Heart Avenue

In addition to the customer's detailed behaviors in a microscopic view, we also tried to clear the customer's flows in a macroscopic view. With the cameras embedded into each of the entrances of Heart Avenue, we counted the number of customers that walk through Heart Avenue. We compared two entire days in the weekends, one when Sound Entrance is working, and another when it is not working. May 20, Saturday, was a day with the system, while Sunday June 2 was a day without the system.

Figure 3.27 shows the numbers of customers that went inside and outside both entrances. On the top is Sunday, May 20, when Sound Entrance was running. On the bottoms is Saturday, June 2, when it was not running. This mall, according to the chief manager of iiasTsukuba, usually has more customers at the end and beginning of the month, while the middle of the month has less customers. They think this happens because Japanese companies give salaries at around the 25th of each month. Also, this mall usually has more customers on Saturday compared to Sunday. They think think this happens

TIME	2012/05/20(SUN) (With Sound Entrance)						TOTAL
	Entrance 1			Entrance 2			
	IN	OUT	TOTAL	IN	OUT	TOTAL	
10:00-10:30	74	80	154	110	123	233	387
10:30-11:00	148	171	319	201	155	356	675
11:00-11:30	146	249	395	242	173	415	810
11:30-12:00	164	291	485	254	181	435	920
12:00-12:30	108	241	349	261	200	461	810
12:30-13:00	247	347	594	370	231	601	1195
13:00-13:30	238	363	601	328	206	534	1135
13:30-14:00	231	331	562	263	195	458	1020
14:00-14:30	279	313	592	317	231	548	1140
14:30-15:00	205	328	553	313	187	500	1053
15:00-15:30	220	340	560	304	218	522	1082
15:30-16:00	217	315	532	320	220	540	1072
16:00-16:30	195	299	484	337	223	560	1044
16:30-17:00	159	304	463	281	167	448	911
17:00-17:30	200	241	441	248	181	427	868
17:30-18:00	183	246	429	252	171	423	852
18:00-18:30	173	242	415	234	148	382	797
18:30-19:00	133	202	335	167	133	330	665
19:00-19:30	151	224	375	180	139	319	694
19:30-20:00	138	167	305	143	110	253	558
20:00-20:30	82	101	183	96	69	165	348
20:30-21:00	63	94	157	105	59	164	321
TOTAL	3754	5489	9283	5326	3720	9074	18357

(1) Customer numbers that walked in/out of Heart Avenue with Sound Entrance

TIME	2012/06/2(SAT) (Without Sound Entrance)						TOTAL
	Entrance 1			Entrance 2			
	IN	OUT	TOTAL	IN	OUT	TOTAL	
10:00-10:30	79	52	131	54	67	121	252
10:30-11:00	99	114	213	92	107	199	412
11:00-11:30	90	163	253	164	118	282	535
11:30-12:00	122	188	310	198	108	306	616
12:00-12:30	160	180	339	208	165	373	712
12:30-13:00	174	259	433	237	138	375	808
13:00-13:30	154	231	385	212	210	422	807
13:30-14:00	205	218	423	280	152	432	855
14:00-14:30	191	248	439	238	210	448	887
14:30-15:00	154	290	494	213	154	367	861
15:00-15:30	233	281	514	267	206	473	987
15:30-16:00	200	243	443	273	194	467	910
16:00-16:30	160	253	413	271	184	455	868
16:30-17:00	145	237	382	232	184	416	798
17:00-17:30	168	237	405	264	160	424	829
17:30-18:00	155	283	428	270	160	430	858
18:00-18:30	125	281	406	240	132	372	778
18:30-19:00	160	228	388	217	146	363	751
19:00-19:30	152	270	422	226	125	351	773
19:30-20:00	146	222	368	238	127	365	733
20:00-20:30	149	184	343	155	90	245	588
20:30-21:00	100	179	279	125	73	198	472
TOTAL	3321	4841	8211	4674	3210	7884	16095

(2) Customer numbers that walked in/out of Heart Avenue without Sound Entrance

Figure 3.27: Comparison of customer numbers

because most of the customers that come to the mall on weekends are families, and they like to spend their time out on the first day but like to spend their dinner hours relaxed at their homes and getting ready for the coming weekdays.

Regarding these facts, the numbers shown in Figure 3.27 show a great effect of Sound Entrance. Generally, Sundays are less than Saturdays, and the middle of the month has less than the end and beginning of the month. However, May 20 with system involved 18,357 customers in total, while June 2 without system involved 16,095 customers in total. Focusing on the number of customers that walked inside to Heart Avenue, Entrance 1 with system had 3,754 customers while Entrance 1 without system had 3,321 customers. Entrance 2 with system had 5,326 customers while Entrance 2 without system only had 4,674.
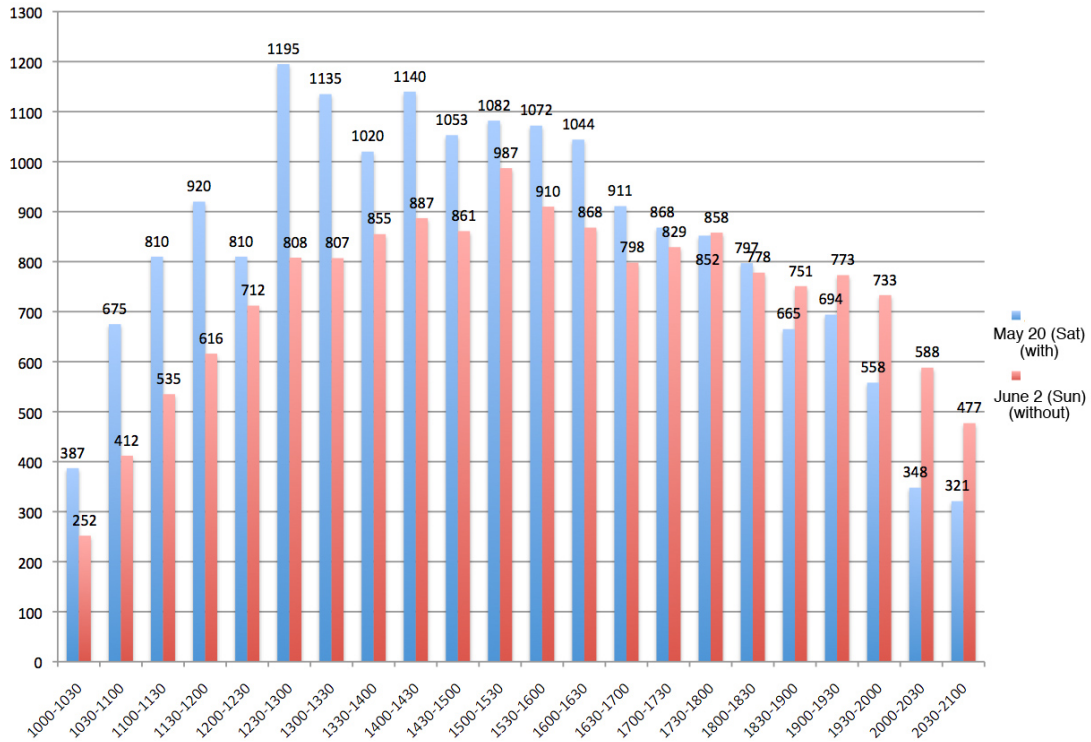

Figure 3.28: Comparison of customer numbers

Figure 3.28 shows the graph of comparison numbers of customers that came into Heart Avenue, dividing the time charts each in 30 minutes. Blue shows the number of customers with the system on May 20, while red shows the number of customers without the system on June 2. This comparison graph easily

shows the effects of Sound Entrance, especially during the morning hours, until about 2pm. Some reasons why this may have happened is that Sound Entrance near Entrance 2 could pull the customers that finished shopping at the grocery store, near Entrance 2. Usually, morning hours at the mall is rather quite, as compared to the afternoon hours. Customers were perhaps able to notice the stickers and its sounds of the Sound Entrance, and were pulled towards that place to have an extra look. When we showed this graph to the Daiwa House crew, they thought that there definitely were an effect. They said there was nearly a 10 percent increase of customers compared to the time not installed. The customers did actually stay longer in the entrance of the sub-stream passage.

Reflections of Sound Entrance

Many interesting behaviors among both customers and shop clerks. Two young girls had fun stepping on the stickers as if playing hopscotch, jumping together between the two sticker sets for about 10 minutes in total. These girls were looking up to the ceiling where the sensors where embedded, trying to find what actions make the sounds. A grandfather holding his grandson had fun chasing the stickers; when the grandson points the sticker sets the grandfather walks over to the sets and step over them to make sounds. One boy spent about 30 minutes alone playing with the system, without being bored. Moreover, the shop clerks of different shops stepped over the sticker sets finding out what stickers make what sounds, searching for the speakers that make these sounds.

These behaviors were something very interesting indeed, and showed that interactive sound system can effect behaviors of customers in shopping malls. However, the customers with Sound Entrance only played with the system itself in the passage, and did not step into the stores located along it. For the next step, I decided to focus on bringing these customer's attention towards the stores, and actually encourage them to walk inside and browse around.

It was not only positive effects that could be seen with Sound Entrance. On the second week of testing, the clerks at Hanagoromo gave the office a telephone call. "The sounds ringing in the system are too loud," they claimed, "it is starting to annoy us." I immediately ran to Tsukuba and turned the system off. It was morning hours, and the preset sound level was too loud for

a serene morning of Heart Avenue. I apologized to them, and restarted the system again with a smaller volume.

This was not the only time Sound Entrance annoyed them. On the third week of testing, Hanagoromo clerks gave the office a telephone call again. "It is too loud again, and this time we are starting to get annoyed with the same sounds ringing throughout the entire day." I went and apologized to the clerks again.

From these points, I realized that I did not understand the fact that salespersons spend hours at the same store everyday. Although customers pass through Sound Entrance for small moments of their entire stay at iiasTsukuba, salespersons are at their own stores spending hours from 10am to 9pm. If customers do not like Sound Entrance, they can walk away from it quickly. If they like it, they can stay and play with it until they get bored with it. However, the salespersons cannot get away from it if they do not like it. I realized that the design of Sound Entrance did not think about the stores located along the street and its salespersons. For the next step, I decided to research how the salespersons are working, and what the characteristics of each stores are.

3.6 Study of Sounds and Interaction in Heart Avenue

Reflecting on the Sound Entrance, we figured that sounds are effective to attract the customers attentions, but we needed more than that. We decided we need to try more types of sounds and interactions that what we had assumed. We hosted a study of sounds and interaction to explore its possibilities in July 2012.

Our first study of sounds and interaction were hosted on the weekend of July 14 and 15. First we wanted to figure out what sounds and timings are suitable for customers in Heart Avenue to make them want to go into the shops. Our team designed 80 types of sounds relating to the shops of Heart Avenue and those relating to the environment. We focused on Entrance1, where the used car store Kawashima Auto and clock store Clockal are located. We also created an iphone application for inputting the exact timing we want

to have the sound heard according to the customers behavior. With this application, we would be able to play sounds whenever we press the buttons on the screen. We experimented all 80 sounds using the 4 speakers embedded near the entrance with the used-car shop and a clock shop. The basic system flow is shown on Figure 3.29.
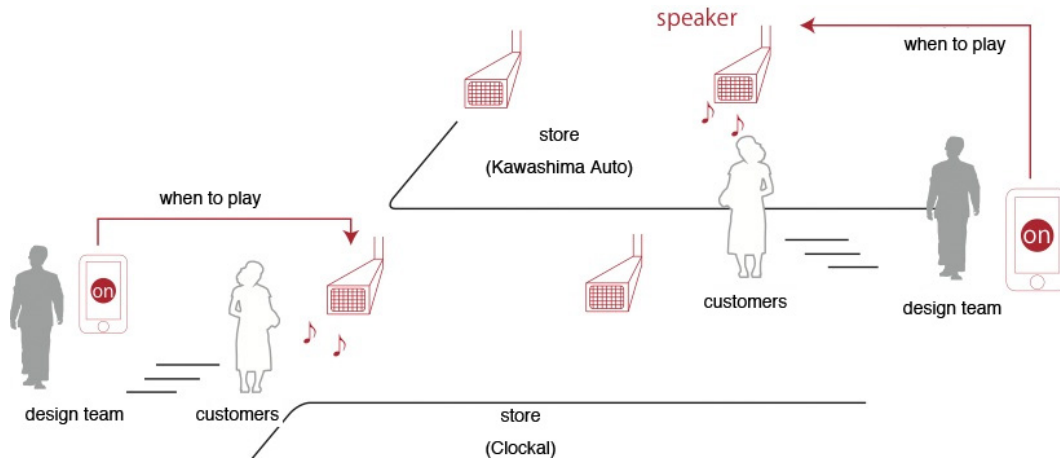

Figure 3.29: System of Sound Test

The sound sets range a variety, regarding all possibilities that we could think of; automobile engine sounds and clock's second hand sounds which are the sounds related to the what the shops sell, voices of people saying "Welcome" which is quite usual for shop clerks to say when customers pass by their shops, sounds of variety of animals ranging from dogs to elephants, environmental sounds such as water, birds, and fireworks, and also sounds of instruments such as bells.

The design team pressed the buttons on the iphone screen when we wanted to play the sounds from the system; especially when customers were walking by the stores. (See Figure 3.30) Shop related sounds gave a feeling of a wider shop area, and attracted some customers to actually look towards the shops. (See Figure 3.31) When we played the sounds of the car engines towards customers going into Heart Avenue, customers realized the store selling cars and looked toward it. The same happened when we played sounds of the clock ticking towards customers going into Heart Avenue, they just realized the clock store's existance. Towards the customers going out of Heart Avenue, the car engine sounds attracted them quite effectively as they were searching for where the sounds were playing from. But when they realized that there were speakers

Figure 3.30: Sound Test

Figure 3.31: Customer Behaviors of Sound Test

in the ceiling, they perhaps felt relieved and started walking again. Clock ticking sounds were effective for the customers going out as well, however, they thought that the large display standing in front of the Clockal store was the one which was playing the sounds. What was quite astonishing was the fact that the calling sounds of animals were efficient for attracting people's attentions. Customers walking from both sides were searching for the audio source of the animals when walking down the street, or perhaps searching for real animals that may be somewhere.

It seemed like there were three key effective aspects; 1) where sounds are played from, 2) who to attract walking in which direction, and 3) what sounds to play. When customers hear sounds, they search for where the sounds come from. As soon as they find speakers or displays that may have speakers embedded, they get satisfied and keep on walking. We also noticed that the directions of walking may have some correlation to attracting them. It appeared that those walking in a slower speed walking out of Heart Avenue are easier to catch attentions. Most of all, the sounds of animals were more effective than the sounds of cars or clocks, which are those of what they sell. Perhaps the sounds of cars and clocks were too direct, it is easy to think that cars make car engine sounds and clocks make ticking sounds. Perhaps some sounds that may be a little indirect, but related to the stores and its articles may pull customers attentions more. Next we decided to explore the effects of directions the customers are walking, and which timings may be suitable and the most effective to call customers inside the stores of Clockal and Kawashima Auto.

On the weekend of July 28 and 29, we gave another trial of sounds and interaction, setting our short-term goal to figure out the timings to provide sound to let the customers' walk inside shops according to which direction they are walking. Our assumption of providing sounds at different timings depending on which direction they are walking towards. Depending on the direction of walking, what they have in their sights are different even if they are at the same exact place. We used the same system of inputting the desired timings of playing sounds with the iphone application.

Places to play sounds differs according to which direction they are walking; either walking into Heart Avenue or walking out of it. Figure 3.32 shows the detailed spots to play sounds for pulling them into Heart Avenue. Spot 1, a

For Clockal
① Walking into Heart Avenue
② Walking out of Heart Avenue

For Kawashima Auto
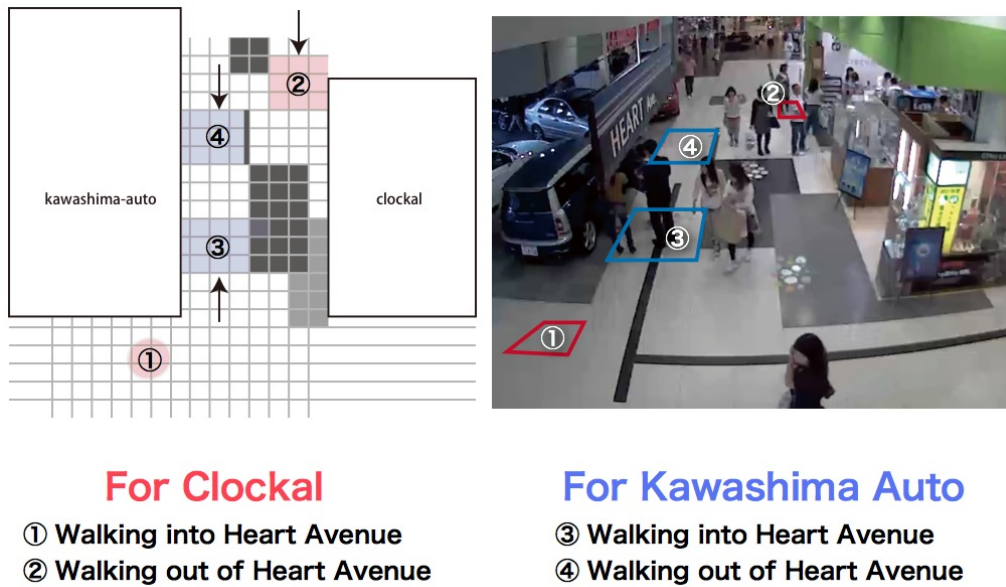③ Walking into Heart Avenue
④ Walking out of Heart Avenue

Figure 3.32: Spots to attract Customers depending on Directions

pin pointed spot outside Heart Avenue just next to Kawashima Auto, was the effective spot to attract customers into Clockal towards customers walking into Heart Avenue. Spot 2, a place next to the display which Clockal displays still images of their items, was the most effective spot to attract customers walking out of Heart Avenue, especially at a rather slow speed. Spot 3, a place near the entrance of Heart Avenue, was the place to pull customers walking into Heart Avenue inside Kawashima Auto. Spot 4, a place near Kawashima Auto, was the place to call customers walking out of Heart Avenue into Kawashima Auto.

From this study, I decided to classify customers upon walking directions. Figure 3.33 shows the difference of customer's perceptions depending on directions of walking. When customers are walking into Heart Avenue, the eye sights of the customers are facing straight forward into the street itself. There are too many stores to look at, and too much information in general. On the other hand, when customers are walking out of Heart Avenue, their eye sights are facing towards the stores only before the intersection. If they are before the intersections, their attentions face towards either of the two stores located before the passage ends. The way customers look towards the stores and the passage itself depends on which direction they are walking towards.

Walking into Heart Avenue

Customers eye sights face straight forward
Too many stores to look at
Too much information in general

Walking out of Heart Avenue

Eyes look at stores before the intersection
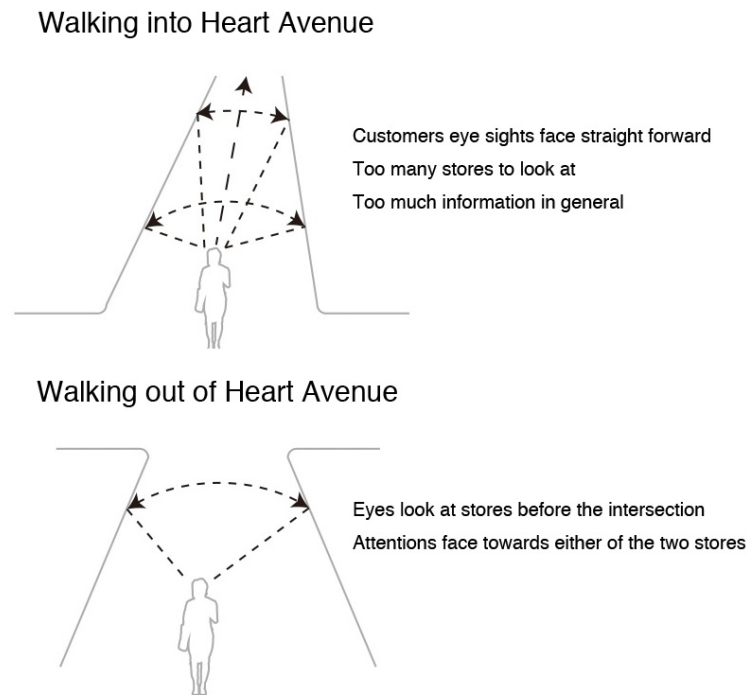Attentions face towards either of the two stores

Figure 3.33: Characteristics of Customers Walking Directions

From these two studies, I decided that to call out sounds in relation to the articles in stores, and to attract the right customer's attentions at the perfect timings are two important factors to design the next prototype. I figured it would be important to set sensors that react to the exact timings the sounds should come out, and also that sounds related to the shops, but not too directional, may be useful. Also it would be necessary think about where to play sounds from, perhaps not only from the speakers embedded in the ceilings, but also from places inside the stores. This is because when customers noticed the speakers, they got satisfied and walked away. If customers kept on trying to find where the speakers are, they may walk into the store and see the goods as well.

3.7 Research on Customers and Salespersons

Learning from the prototype of Sound Entrance which did not really think in depth about the stakeholders of Heart Avenue, I decided to research how the salespersons are working, and what the characteristics of each stores are.

I also decided to observe how customers are behaving in the mall in detail. I approached this research in several approaches, all based on ethnography. Ethnography, a form of participatory research as the art and science of describing a human group,[45] Ethnography in system design is a form of writing and a way in which a cultural understanding is inscribed as a literary form.[46] It is not mere acts of writing up user reactions or focus group discussions or transcribing interviews, but they are representations of the world that the ethnographer encounters.[47]

Below, I describe the observation of customer's behaviors, a focus group session of the salespersons about how they are trying to attract the customers, and an ethnography research on how the salespersons are currently doing their services.

3.7.1 Observing Customer's Daily Behaviors in the Mall

Sales is only organized when there is a person that purchases the goods. We researched the activity of shoppers within the mall for days. For understanding shoppers, I chose to use direct observation method to watch people interact with their usage environment reveals physical clues about the tasks they perform and the problems they may be having.[48]

We conducted ethnography research on shoppers in Heart Avenue. We observed and chased after a dozen of shoppers in their regular shopping routines with a camera and notebook in hand, tracking down what exactly the target shoppers were doing in detail. The sets of visitors varied as the following; group of high school boys, group of high school girls, a married couple in the late 50's, group of male university students, twosome of women in the 50's, a high school girl and her mother, a girl around 8 years old and her mother, a high school couple on a date, a man in the 30's alone, a married couple in the late 60's, and a family of four with two toddlers.

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[45]Angrosino (2007)
[46]Anderson (1994)
[47]Dourish and Bell (2011) pp.67-70
[48]Goodwin (2009) pp.56-57

The most popular visitors of weekends were young families. The next common set of visitors were married couples of ages around 40 to 50. The following was two-or-threesome of ladies of ages around 40 to 50. On the other hand, there were more customers coming alone or younger twosomes on the weekdays. Below describes some highlighted customer behaviors that were significant.

Businessman in a rush with his destination

Figure 3.34: A businessman in a rush

It was around 6pm on Tuesday, June 5, 2012. A gentleman wearing his business suit came out of his light-vehicle, and walked directly inside the east entrance of iiasTsukuba mall. This man in his mid 30's was walking in a fast speed, looked kind of in a rush. He quickly walked up the escalators to the third floor, and walked directly into the restroom near a sporting goods store. After he came out of the restroom, he walked directly to the center court, again at a rather fast speed. He slowed down a little bit to take a look at his cellular phone and checked some updates, but after he finished, his speed became faster again where he arrived to ABC Mart, the shoes store.

In ABC Mart, he walked directly into the leather shoes corner, and started browsing at all of the gentlemen's leather shoes lined up on the wall. After about 5 minutes, he called one of the salespersons around the area and asked for fitting. The salesperson brought 3 types of black leather shoes of his requested size. The gentleman tried all 3 types on, and asked the salesperson which of the shoes had the most casual outfit. The salesperson pointed to the one he was wearing at the moment, and he decided to take them.

As soon as he bought the shoes, he walked straight back the roads he walked when he was coming. He walked back to the first floor and headed towards the parking lot where his car was parked. Suddenly, the juice stand stood in front of him. This juice stand serving fresh brewed fruit juice had its grand-opening just a couple of weeks ago, and it seemed new to him. The smell of the fresh juice tempted him to stop his hurrying footsteps. After a couple of seconds, he decided to buy kiwi and banana juice. With his right hand, he walked out of iiasTsukuba, walked towards his car, and rode away. (See Figure 3.34)

The duration of his stay at iiasTsukuba was only about 20 minutes long. During his stay, he went to the restroom, tried several shoes and bought one, and bought an extra drink at the juice stand on his way back to the parking lot. He knew where the restroom was, he knew what to buy, and he knew that he was thirsty. His walking speed was very fast and straight forward. He had his own destination, and knew exactly what to do.
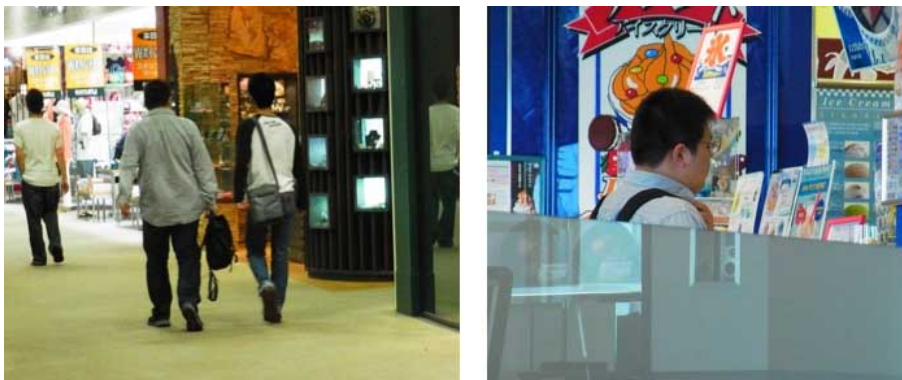
Two University Boys hanging around

Figure 3.35: Boys hanging around

On the afternoon of Wednesday, June 6, 2012, two boys in the late teens came into iiasTsukuba from the bicycle parking lot. One of the boy had a computer bag in his hand, they must have rode their bicycles from Tsukuba University after they had finished their class. As soon as they came inside the mall, they rode the escalator up to the third floor. They seemed to be having fun talking about the TV anime that were on last night. At a rather steady speed of walking, they arrived to Village Vanguard, a bookstore selling general items together.

Village Vanguard had many customers browsing at the items they sell there. The two boys went inside and started to hang around. One boy pointed at a comic book and they started talking about it. After a couple of minutes of chatting, they moved on to the next shelf. They spent about 30 minutes inside the store and came out without buying anything. Their minds seemed to be set on the TV anime and the comic book, and they enjoyed their stay there. (See Figure 3.35)

Next they headed towards the food court on the same floor. The food court has about 15 different stores selling fast food or snacks, and the customers are free to take seats at any open tables. One boy went to buy ice-cream at Hobson's Ice Cream, while another went to Pepper Lunch to buy a steak plate. They sat near the entrance of the food court, and quickly ate their food. The steak plate perhaps was his late lunch, while the boy with ice-cream was having his extra snack. After they finished their meal, they immediately stood up and left the food court. They only stayed for about 10 minutes.

Then they went down to the first floor with the escalator, and arrived to the entrance of Heart Avenue, where Lupicia is located. Lupicia was handing out small cups of tea for tasting in front of the store. The boys were walking slowly, but suddenly they could taste some tea for free about a couple of meters away from the store, and headed towards Lupicia. The salesperson at Lupicia handed each of the boys a cup of tea. While the boys were enjoying the cup of tea, they were browsing at the variety of tea leaves the store sells. After they finished their cup, the left Lupicia without buying anything and slowly walked inside Heart Avenue. They walked slowly and checked what kind of articles the stores sell. The boys stopped their footsteps at Oribe, the Japanese pottery store. They looked at the huge clay pot displayed in front of the store, and took them in their hand. They talked to each other and discussed that they want a big clay pot in the winter to enjoy dinner with their friends. They left the store soon after the discussion, and still walked slowly. When they arrived at the intersection, the end of Heart Avenue, they looked around the street and decided to go out of the mall from there. As they were walking out of the mall, they took a look at the Mini cooper which was displayed at Kawashima Auto.

Their stay at iiasTsukuba was about a hour and a half. They had their destination to go to Village Vanguard and have a meal at the food court, but

that was their only plan at iiasTsukuba. After their missions were completed, they had no destination and started to hang around. Before their mission, their walking speed was faster and more steady compared to that after their mission was completed. When they started to hang around, they were called into Heart Avenue with the cup of tea for tasting. They walked and browsed around the stores of Heart Avenue and took some items in their hands. They browse around the stores once their mission is completed.

Wrap up

Based on our research, we divided the visitors into two groups; visitors with a destination, and visitors without a destination. The visitors with a destination basically walk on a fast speed and face their eyes straight ahead. For example, the gentleman wearing the business suit walked straight ahead without looking at anything on the side, towards the restroom, the shoes store, and to the parking lot.

On the other hand, the visitors without a destination were walking rather slowly compared to those that walk straight. If they are more than a twosome, they had conversations while walking therefore they sometimes were looking at each other's faces. These types of visitors took a look at the stores located on both sides as they slowly walked, and started talking about what the saw with their companion. They also stopped their footsteps to touch items when they seemed to find something that attracted them. For example, the two university students walked slowly into Heart Avenue looking at stores on both sides of the street, starting with Lupicia's cup of tea for tasting. Searching for a store to spend his spare time, he looked at the displays in front of each store. When he arrived at the intersection, he looked at the streets left, right, and straight, and decided to go right where there was an exit to the outside mall. These visitors that are spending their spare time are walking as they feel like at the moment, as if talking a random walk.

For our next prototype, we decided to target visitors without a destination, to pull these random walks into the stores and spend time there. The system needs to understand the customers if their time is currently under mission or dismissed. It needs to attract the customers that are walking rather near the stores, at a rather slow speed.

3.7.2 Focus Group Session with Salespersons in Heart Avenue

The first design of Sound Entrance did not regard so much about the stores located along Heart Avenue and its salespersons. I decided I need to research how the salespersons are working and how they are thinking about sales. I conducted a focus group session on salespersons to share my goal and challenge of gathering customers in Heart Avenue. In the session, the Daiwa House crew created a interview sheet about what store clerks are confident about servicing their customers, and asked the clerks to fill out before attending the session. This was conducted with the help of our project client Daiwa House, and had the chance to have the salespersons understand who I am and what my challenge is. Then I did a series of ethnography research based on master-apprenticeship model introduced by Beyer[49], and observed how the clerks actually do their servicing on a regular basis. The ethnography research requires steps starting from selecting groups to study, choosing a form of participation, making initial contact, building relationships within the group, iterative data collection and analysis, and reporting the results.[50] I also researched the customers in iiasTsukuba and Heart Avenue and observed how they walk or look around and enjoy shopping based on ethnography research. In this case, I chased after many customers without being realized by them, and saw how they behave in the mall.

For all of these research, I wrote down thick description[51] soon after the research was done and analyzed it with five work models of Beyer's *Contextual Design*[52]; flow, sequence, artifact, physical, and cultural. This understanding generates "mental model", the internal representations[53] humans use to understand, predict events in the world, act, and to react.[54]

Daiwa House crew and I hosted a focus group session, a group discussion or interviews of purposive selective participants on a focused given topic[55], with the shop clerks that locate their stores in Heart Avenue and understand

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[49]Beyer and Holtzblatt (1997) *Contextual Design: Defining Customer-Centered Systems*
[50]Lazar, Feng and Hochheiser (2010) pp.218-224
[51]Geertz (1977)*The Interpretation Of Cultures*
[52]Beyer and Holtzblatt (1997)
[53]Craik (1967) *The Nature of Explanation*
[54]Goodwin (2009) *Designing for the Digital Age* pp.128
[55]Rabiee (2004)

Figure 3.36: Focus Group Session

their thoughts about sales to design a system calling customers to the stores. The session was held on a afternoon on August 10, 2012, for 90 minutes. Members of the session involved total of 8 clerks from the Kawashima Auto, Namche Bazar, Clockal, Oribe, Kichijitsuya-Fukuemon, Craf, Fashion Village, and Paris Miki. Clerks from Hanagoromo, Mother Garden, and Lupicia were absent from the session due to duties. In addition to the shop clerks, vice manager and the head of promotions at iiasTsukuba attended as observers.

Though some suggest that focus groups should be held between eight to twelve people[56] or groups of five to seven[57], I chose to divide the participants into two groups of four members each for a more in-depth conversation and establishing rapport. Since most of the clerks in Heart Avenue are very friendly among each other, I considered group discussions would support interactivity, with participants ideally balancing each other and encouraging each other to speak up. In each of the groups, two members from the design team attended to manage and facilitate the discussion. Basically, I followed the notes written in Lazar et.al's book *Research Methods in Human-Computer Interaction* about hosting the focus group.[58]

Mr. Watanabe, the head of promotions at iiasTsukuba mall, created an interview sheet and handed out to each stores at Heart Avenue in advance. He collected the filled in interview sheets from the stores that were absent from the session. The interview sheet was A4 size and included the three questions and a blank box following each questions.(See Figure3.37) The three questions

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[56]Robson (2011) *Real World Research*
[57]Krueger and Casey (2008) *Focus Groups: A Practical Guide for Applied Research*
[58]Lazar et al. (2010) *Research Methods in Human-Computer Interaction* pp.192-213

were discussed in advance among Mr. Watanabe and I, to start the discussion with easy questions that they will like to talk about.[59] They are listed below.

- What are some points about your store that you are proud of?

- Are there any original ways to attract customers to your store?

- What kind of customers do you target and who mainly come?

In the interview session, first I introduced myself and the goal of my research project to encourage customers to buy goods in the stores of Heart Avenue with an interactive sound system, to all attendees for about 10 minutes. Next, I had all 8 clerks to give a brief talk about their own store sales situation one by one, including the three questions from the interview sheet. The original plan was 2 minutes each per talk, however they all seemed to want to talk more which extended each talk to about 5 minutes each. Further, I held a 30 minute open discussion regarding the usual sales and their ideal situation. In the discussion, I divided the group into two groups because I considered a single group of 8 people was difficult to facilitate and the smaller the group the more depth the conversation would become. Group A included Namche Bazar, Kichijitsuya-Fukuemon, Clockal, and Kawashima Auto. Group B included Paris Miki, Craf, Oribe, and Fashion Village. Also in this discussion, salespersons were guided to discuss about using sounds to call customers into the stores. Finally, I concluded the session that I will research each stores one by one to further understand the sales at Heart Avenue, and will design something enchanting for the entire Heart Avenue. This entire 90 minute session was audio-recorded and video-recorded by two video cameras, photos were taken by still-cameras, and the team took down notes about anything we have noticed in our own notebooks. At the end of the session, we collected the filled interview sheets of each stores and did not forget to thank the clerks for their precious time.[60]

The following are abstracted voices from each stores based on the interview sheet and the 30 minute discussion. I will describe the information of the stores and the thoughts of salespersons in order.

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[59]Lazar et al. (2010) pp.201
[60]Robson (2011)

Figure 3.37: Example of the filled Interview Sheet (Courtesy to iiasTsukuba and Mother Garden)

Namche Bazar

Figure 3.38: Staff of Namche Bazar

Namche Bazar is a top-ranking official dealer of outdoor brands, for example The North Face or Patagonia. It sells a wide variety of items for mountain trekking, from outfits, shoes, or water bottles. They host mountain trekking tours once a month, limiting to about 20 persons per tour. The list is always full of members that want to attend. Their tours climb mountains starting with the Tsukuba-mountain and other mountains in Ibaraki prefecture. Pictures of the tour are posted in the 40 inch screen embedded in the wall of their store.

Since there are only three staffs belonging to the store, basically only one staff have to work alone and take care of the store on their own. To call customers inside the store, they place a wagon near the entrance of the store displaying items that they highly recommend, and change it every two weeks. They especially place items for women near the entrance for customers that come from the main street of the mall to notice the store. Although they have a big screen embedded in the wall of their store, they only turn it on during the weekends when there are many passengers that pass by. They change the style of mannequins frequently to appeal to the elder ages.

The most common type of customers that come to this store are young families in the 30's and 40's that want to go trekking. During weekdays, mainly housewives come in the afternoon while younger ladies come in the evening after their work.

Kichijitsuya-Fukuemon

Kichijitsuya-Fukuemon is a small store selling lacquered ware, pottery, and glassworks from all over Japan. These traditional goods can be used for both

Figure 3.39: Staff of Kichijitsuya-Fukuemon

gifts and for own usage. All the staffs can explain about the items in detail, and recommend the characteristics. They display items that encourage customers the seasonal sense.

Since more than 70% of the customers that come to Kichijitsuya-Fukuemon do not have any particular item that they actually want, the clerks do their best efforts to have a talk about the wide variety of items. Even if the customers do not buy at the time, most of them come back again. They created their own stamp cards for the store, to encourage customers to come back again. The most common customers are those in their 50's and 60's.

Staffs at Kichijitsuya commented that it would be nice to have a system that grandparents and little children can have fun playing together and come into stores.

Clockal

Figure 3.40: Staff of Clockal

Clockal, a watch store, is located on the corner near the entrance of Heart Avenue, which is also near the entrance from the parking lot. Many visitors walk into the mall itself from this entrance from the parking lot, therefore

the goods can be displayed in a very effective way. In additional to selling brand-new watches, they also take care of repairing the watches.

Near the entrance of the store, the store has their original display for showing some advertisements related to their goods. They hold their own sales and write their own point-of-purchases to increase the number of customers. They select the recommended item of the month and appeal to customers walking by with posters and pictures. Both men and women from the 20's to the 40's come to the store to either buy a new watch or to repair their own.

Kawashima Auto

Figure 3.41: Staff of Kawashima Auto

Kawashima Auto sells imported used cars. The most unique point about this store is that it locates its store inside a shopping mall, where most car selling stores locate their stores on the roadsides. The store's concept is a touchable car store. Aftercares of the cars are their most strong points.

Paris Miki

Figure 3.42: Staff of Paris Miki

Paris Miki is a store selling eye-glasses focusing of both fashionability and functionality. Their optometers and fitting equipments are high ends, so it is

fast and easy to customize each glasses for the customers. All of the staffs working at the store are trained to service in a friendly manner. This store has about three clerks working at the same time.

Although their store location is not so good, they have creatively done their best to attract customers from the main street. They asked special permission to the mall to put their original stand-light which their store logo is designed, so the passengers in the main street will notice the store existence. The staffs create many banners and POPs for each shelf, trying to express the characteristics of each items. They also changed the color of the wall to red to pull pedestrian's eyesights, although their store is basic tone all white colored.

In the weekends, families from 30's to 50's are the most common customers. Morning hours on weekdays attract 60's to 70's, while in the late afternoon there are more younger ladies that come after their work. The customers that come to Paris Miki tend to buy eyeglasses from certain staffs because they like the way they service. The staffs do their best efforts to tell the various characteristics of the items in their own way.

Clerks at Paris Miki mentioned they wanted a trigger to start their talks with customers. If they can start their conversations, they have the confidence to sell their items.

Craf

Figure 3.43: Staff of Craf

Craf is a selected craftwork shop, deals brands like their original Souleiado, or normal crafting materials, to unique imported materials. The item line-up of the store has its own originality compared to those big-brand craftwork shops. inside the store, they handout some easy how-to recipes to create crafts so it

is easy for beginners to start. The staffs try to talk to the customers so it is easier for them to ask questions about some troubles they are having.

They frequently change the display of the goods towards the entrance of the store, where many passengers take a look. The clerks do their best to bow to passerby to pull them inside.

Oribe

Figure 3.44: Staff of Oribe

Oribe has their headquarters in Tajima-city, Gifu, where the famous pottery Mino ware localize. This store specialize in selling a wide variety of Mino ware directly from the pottery factory at a reasonable pricing. New products are immediately sold in the stores of Oribe, about 8000 items at the headquarter in Tajima and more than 7000 items in the store of iiasTsukuba. Not only do they sell Mino ware but also original craftwork by artists and craftsmen from all over Japan. The main concept of the store is "Artful Life", as they manage their best to design the four seasons in the store.

Some ways the crew worked out attract customers is that they change their displays and product line ups very frequently. This is because they always want the customers to enjoy the store and find something fresh every time they come. They also do their best to provide customers a welcoming smile to encourage their return to the store, because they feel customers would not want to come to stores that have a bad impression.

Customers range from young to elder, ladies or gentlemen. In particular, mothers with their young children are most common customers in the weekdays, or a group of women in their 40's to 50's. Since the location of the mall is in the research town Tsukuba, many foreign students or visitors from overseas come to buy some traditional Japanese goods for their souvenirs to their

hometowns. Young couples that are starting their new life come to prepare their daily commodities.

Clerks at Oribe thought it would be nice if there is a system that pull children inside so it will automatically pull their mothers as well. If there are people inside the store, the clerks will be more than happy to have a sales-talk with them.

Fashion Village

Figure 3.45: Staff of Fashion Village

Fashion Village is a women's fashion store targeting elder women in their 50's and above. The fascia of the store is Italian red, the image of their store. The items they sell are basically originally designed by the company members, therefore outfits are sometimes designed based on customer's demands. The music they play inside the store is basically classical music, so the customers can have a pleasurable time browsing at the items in the store.

The clerks at Fashion Village update the store's internet blog everyday, and they frequently send direct mails to their customers. They started their own membership cards from last June, which encouraged more customers to come back to the store again. Customers come to the store and ask for certain clerks that they were serviced that last time they arrived.

Staffs at Fashion Village noted that they want some small opportunity to start talking with their customers. The more they talk with the customers, the more likely the customers will purchase the goods and they will come back again.

Wrap up

Storeclerks mentioned that they do their best to display the items of the store, as some have to manage their stores only on their own. But if there are chances to start talking with the customers, they are confident enough to sell their goods.

When we presented our idea of creating the sound design calling customers to the salespersons, 4 stores among the 8 clerks that attended the session insisted that we can utilize their store territory to play the sound from, and provide pedestrians the experience of being called from the store itself. In order to actually implement sounds inside the stores, I thought it is necessary to understand what exactly is going on in stores, in depth.

3.7.3 Ethnography Research of Salespersons in Heart Avenue

Soon after the focus group session, our design team and I conducted a series of ethnography research of salespersons in the 11 shops located in Heart Avenue, all stores excluding Mitsukoshi. This time we wanted to understand more than just simply asking about their daily practices, precisely the implicit practices that have not been stated in the session. In this case, I followed Beyer's *Contextual Design* process, a process supporting to find out how people work.[61] Among the process, I utilized *Contextual Inquiry* techniques—went to where the person work, observed them working, and talked to them about their work—specifically designed to uncover implicit knowledge focusing on specific details about various work processes.[62] When observing, the design team and I used the master-apprentice model, learning the salesperson's work as if an apprentice learns a skill from a master building a respectful relationship.[63] This is because experts are usually unaware of how they are working but can talk about it as it unfolds. We asked each and every store if we could disguise ourselves as members of the store and observe their jobs of servicing for a duration of about 60 minutes in three divided days; on July 7, August 18, and August 23, 2012.

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[61]Beyer and Holtzblatt (1997)
[62]Lazar et al. (2010) pp.209
[63]Beyer and Holtzblatt (1997) pp.42-46

Throughout the observation, we took pictures with our camera and audio recorded the entire research, and most importantly took down took notes on whatever we realized throughout the process. Then we created a variety of *work models* that describe the work graphically to understand their work as a concrete representation.[64] We saw the works from five unique perspectives— flow models for sharing information among individuals in the workplace, sequence models to outline steps for completing the task in order, artifact models to point out by-products of the work process, physical models describing logistical and physical constraints, and cultural models describing the backgrounds and assumptions of the context of the job[65]—to analyze the large set of notes to understand the work process in detail.[66]

In order to design a system that calls strollers to go into the stores, I abstracted the salesperson's *mental models.* In his book *The Nature of Explanation*, Kenneth Craik posited the that humans use their own internal representations to understand and predict events in the world, and people act and react based on these mental models.[67] Kim Goodwin notes in her book *Designing for the Digital Age* that it is a necessity for designers to understand a user's mental model of the acquired data for designing a system generally easy and natural to use. Designers must design the conceptual structure and behavior of a system that matches their mental model; for example meaningful object types, how are they related in their mind, or the current implementation model of those objects.[68]

In this section I describe the observation data of the works of salesperson at 11 stores. A mental model of the salespersons concludes this section, deriving from both the focus group session and the master-apprenticeship observation research.

Kawashima Auto

We researched Kawashima Auto(Figure3.12-1) on Saturday, August 18 for one hour in the early afternoon. Kawashima Auto is a car dealer which sells imported cars. This store deals imported cars on a high quality on their own

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[64]Beyer and Holtzblatt (1997) pp.81-87
[65]Beyer and Holtzblatt (1997) pp.89-123
[66]Lazar et al. (2010) pp.210
[67]Craik (1967) *The Nature of Explanation*
[68]Goodwin (2009) *Designing for the Digital Age* pp.128-130

Figure 3.46: Kawashima Auto store and its service

original way. The originality of the store is the fact that they locate their store inside a shopping mall, whereas usually car dealers locate their stores on the roadsides. Kawashima Auto main targets gentlemen that have a yearn to imported cars after their retirement age.

We observed Mr.F, who has been working at Kawashima Auto for over two years. Kawashima Auto usually operates the store with only one staff working at a time. Mr.F's basic position was at the desk in the rear of the store, where he can have a holistic view. Several visitors slowly walk to take a look at what kind of cars are in stock today, but Mr.F stayed at his work desk. When a married couple in the 40's entered the store and had walked around the black car, Mr.F stood up and slowly walked toward the couple. He gently asked the couple "Would you want to have a look inside the car?", and they said "Yes please." Mr.F walked back towards his desk and took out the car key from his desk shelf. He returned to the car to open the key and said "Feel free to sit on the driver's seat and experience how it feels". The husband had his wife sit inside the car, and asked how it is. "It's very nice, I like it" she said, and came out of the car. Next the husband sat in the driver's seat. While the husband was in the driver's seat, Mr.F started talking to the wife about the handy maintenance system of the car. The wife listened carefully to what Mr.F was saying, and was nodding and smiling. The husband came out of the car with a smile on his face. The couple seemed to be thinking about changing their car, but were thinking about other candidates as well. Mr.F gave the couple his name card, and told them "Please come back again" with a smile on his face.
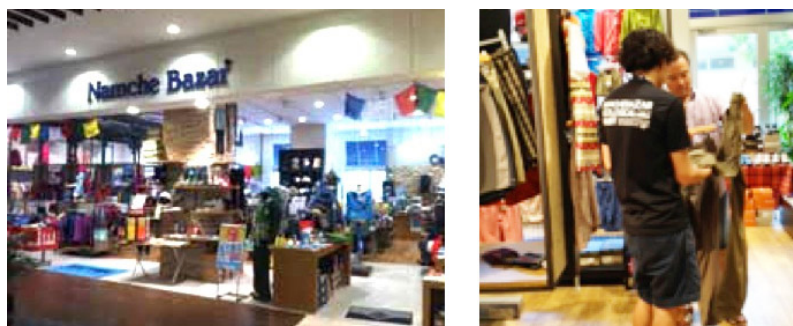
Namche Bazar

Figure 3.47: Namche Bazar store and its service

For one hour on a late Saturday afternoon on August 18, we researched Namche Bazar(Figure3.12-2), a store selling various items for outdoor activities. This store is a rather spacious store among the stores in Heart Avenue, selling various outdoor goods for mountain-climbing or camping from shoes, backpacks, fashion brands such as The North Face or Patagonia. Young women in their 20's to 30's are the main customers on the weekdays, while on the weekends more families come to find some outdoor goods for their family camp. Their store have a wide entrance, with a screen displaying pictures of the mountain-climbing tour that the store hosts every month.

We focused on Mr.K, one of the staffs working for Namche over three years. "Although this store is rather commodious, the store has to be operated alone on myself," he said with a bitter smile on his face. "I work here 6 days a week. Our store does not have many staffs so I must work a lot." He was standing in front of the store calling "Irasshaimase", the Japanese word for "Welcome to my store", when there were no customers inside the store. Several minutes later, a gentleman in the 40's walked inside the store wandering with shifty eyes. Mr.K noticed the gentleman did not seem to understand what was displayed where in the store, and walked towards him. "Are you looking for something?" The gentleman answered, "Yes, I'm looking for pants to wear for mountain climbing." Mr.K guided the gentleman to the corner where clothing by The North Face was displayed. "Well, since it's summer, I think the lighter pants are better," Mr.K chose two pants from the display and showed them to the gentleman. "Please try them on and see for yourself," he said and guided the man to the fitting room at the rear of the store. The gentleman tried two pants on, and came out of the fitting room with a smile on his face. Mr.K

explained to him the easy ways to wash this with a washing machine, and then he decided to take it. "I'll go mountain climbing to Tsukuba-mountain next weekend with this pants on," He said with a big smile on his face. Mr.K answered "Please come again and show us pictures of you and the mountain."

Mother Garden

Figure 3.48: Mother Garden store and its service

We researched Mother Garden(Figure3.12-3) on Saturday, August 18 for one hour around noon. Mother Garden is a general store that sell miscellaneous pets and toddler goods. Its main eye-catcher is the original character *Shirotan*, the white seal. It targets ladies in their 30's to 40's with children in the young elementaries.

We observed how the store manager Ms.M does her work to sell goods. Ms.M has been the store manager of this store since its opening in 2008. During the research, Ms.M was the only person to operate the store, because this store Mother Garden usually has only one staff working in the store at the same time. Her basic position was to stand in the cashier in the rearer part of the store. A lady in the 30's came into the store with her child, as she was looking at the goods for sale displayed in the storefront. Ms.M realized that the lady had been there for more than a couple of minutes, and walked near her. The lady had a glass in her hand, so Ms.M said "I highly recommend this glass." "This glass is cheap and cute," the lady answered back immediately, and took a look at her daughter who was looking at the shelf with Shirotan goods. Ms.M noticed the lady with a questioning face, and quickly started explaining what kind of character Shirotan is and that it is very popular recently among young girls. "Since it has been crazy hot this summer, the Shirotan paper fan is very popular among girls," she said to the

lady. The lady decided to purchase the Shirotan paper fan for her daughter, and the glass for herself. Ms.M went to the rear office of the store to take the new box of the glass, and walked to the cashier for payment.

Craf

Figure 3.49: Craf store and its service

Craf(Figure3.12-5) is a store that sells various crafting items, and we researched the store during the early afternoon of August 23. This store sells various arts and crafts goods imported from all over the world, from a variety of small beads to sewing machines. In the spacious store, they have a table for customers to try some easy arts and crafts. The store targets from younger to elder, from beginners to experts of crafting. The staffs in the store create easy original How-to-make recipes for beginners to start crafting. Some of their displays such as aprons or lunch-bags were created by the staffs working in the store. The store is full of ladies from the 30's to 60's all looking for something new.

Ms.I, a lady working at Craf for over three years was our main observing target. During the research, there were two staffs working in the store. One person was near the cashier, and Ms.I was towards the front of the store, taking care of the displayed items. There were several sets of customers inside the store, all looking at the items displayed. A lady in the 70's and 40's, very possibly to be a mother and child relationship, walked towards Ms.I with a recipe in their hand. They asked Ms.I, "Where can I find materials to create this recipe?" Ms.I answered "They are over on that shelf," and guided them towards the area with a smile on her face. The two ladies put all the materials at the guided shelf inside their shopping basket. "We're making this for my granddaughter," the lady in the 70's said. "That is very sweet. I'm sure

your granddaughter will love it. There are many other customers that make crafts for their grandchildren as well." Ms.I replied, while guiding them to the cashier, "Would you want to make a stamp card for this store? Collect 10 stamps and you will receive a 500 yen off." Then the ladies replied, "Yes, we'd love to. We'll come again to check a different recipe."

Clockal

Figure 3.50: Clockal store and its service

On Saturday morning on August 18, we researched Clockal(Figure3.12-6), the clock store for one hour. They sell a variety of watches from expensive brands to young fashionable types, alarm clocks, wall clocks, or even cuckoo clocks. They also take care of repairing and changing the batteries, which also is very popular. Many young customers from the late teens to the 40's come to either purchase new watches, change the batteries, or change the watch-belts.

Our research focused on Ms.N, who has been working at Clockal for over three years. Ms.N basically stays outside their small store to call pedestrians and inform their store is here. A married couple in the 70's and a lady in the 50's came near by the display in front of their store. This display had many watches of the Citizen brand, and the couple were standing in front of it for about 30 seconds. Ms.N noticed and talked to them "What kind of item are you searching for?" The husband answered, "I want a conspicuous watch that runs long with the battery." The family was looking for a watch for the father. Ms.N decided to take out three watches inside the display of Citizen brand, and one watch of the Seiko brand. All four of the watches were atomic radio-controlled watches with large dial plates. The father tried all four of them on, and he said "I like them all, what do you think?" to his wife and his daughter. "Well, I like watches of Citizen so I prefer that," the daughter said

started looking at the price of the three Citizen watches. The pricing of three watches were around 35,000 yen, 41,000 yen, and 53,000 yen. The wife and the daughter started discussing about the price and design of each of the watches, and the wife said "Let's choose the one in the middle, the one that's around 40,000 yen" and told Ms.N that they would choose it. Ms.N then placed the other three watches inside the display back again, and took the chosen Citizen watch to the cashier. "Let's fix the size of the wrist-band for you," she said and checked the wrist size of the father and fixed the size. Then she put the watch on him and said "You can wear this from now and If you feel the size of the band is a little bit loose while you are shopping at the other stores, come back again and we can fix it for you again." The family had a smile on their face and left to the restaurant area.

Hanagoromo
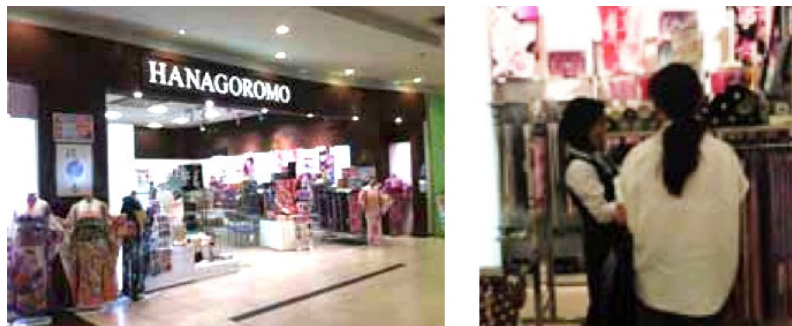
Figure 3.51: Hanagoromo store and its service

During the morning of Thursday, August 23, we researched the kimono store Hanagoromo(Figure3.12-7). Hanagoromo has a variety of kimono with reasonable pricing targeting younger generations to elderly. Their main focus is on kimono, however they sell yukata during the summer time as well. Hanagoromo basically operates with two staffs working together at the same time.

We observed Ms.Y, a lady working for Hanagoromo for over ten years. Since there were no customers inside the store, Ms.Y was standing outside the store in the walkway, taking a look at the passengers with a smile on her face. A woman in her 40's walked slowly inside the store, taking a look kimono that the mannequin was dressed. Ms.Y walked toward her and asked "Are you searching for something?" "Yes, I want a kimono that's blackish," the woman

answered back. "I can show you some of our black kimonos. Let me choose some for you. Please have a seat while I go to choose some." Ms.Y guided the woman to a chair inside the store, and brought three different kimonos from various places inside the store. She broadened out all three kimonos to let the woman have a look at the different print designs the black kimonos had. "Oh, I like all of them, they are all so nice," she said and started considering which of the three to choose from. Ms.Y started explaining the characteristics of all three types. "This one with the silver flowers was made in Kamakura area, it is nice and sedate design. The second one with the blue and yellow flowers is rather popular to a younger generation, some girls have chosen this type for their coming-of-age ceremony. The third one is very simple with a beautiful bird printed, quite popular for mothers to wear for their child's weddings." The women was listening to Ms.Y's explanation very carefully, and decided to take the one with silver flowers. "Please keep the one with silver flowers. I'll come back again during the weekend with my husband." she said very delightfully, and left the store.

Kichijitsuya-Fukuemon

Figure 3.52: Kichijitsuya-Fukuemon store and its service

We researched Kichijitsuya Fukuemon(Figure3.12-8) in the afternoon on Saturday, August 18 for one hour. This store sells Japanese traditional pottery and glassworks from Hokkaido to Kyushu area of Japan. Inside the small store, various pottery and glassworks are displayed everywhere. Their main targets are men and women over their 50's, and most of them are repeaters.

Ms.A, a salesperson working for Kichijitsuya for over two years, was our observation target. This store is basically operated by one salesperson at a time, thus Ms.A was always checking at all the shelves within the store, saw

how the items were displayed, and sometimes used the duster to keep them nice and clean. She noticed a lady in the 40's standing in from of the items on sale displayed in front of the store. Ms.A talked to the lady, "All of these items are 50% off the price on the tag." The lady took one lunchbox from the shelf, and asked "Can I use this lunchbox in the microwave?" Ms.A answered, "Yes, all the lunch boxes we have here can be used in the microwave. This lunchbox was made in Kanazawa area of Japan," and explained the characteristics of this item. "Okay, I'll take it," the lady decided, and Ms.A went to the cashier to wrap the lunchbox.

Oribe
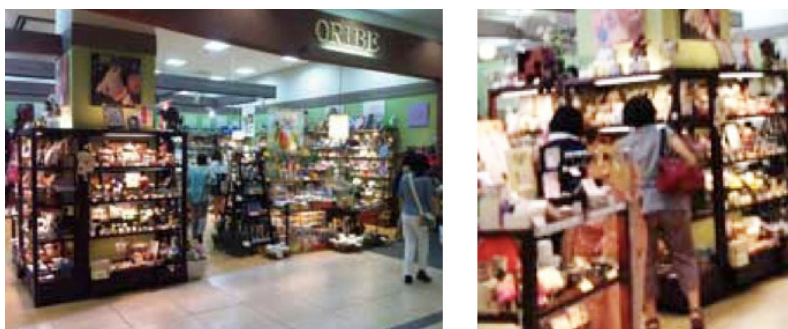
Figure 3.53: Oribe store and its service

Research on Oribe(Figure3.12-9) was conducted in the afternoon on Thursday, August 23. Like Kichijitsuya-Fukuemon next door, Oribe also sells Japanese pottery, but also more reasonable traditional goods in general of about 7000 different items. Many groups of women from young to elder come to check what is new in this store.

We focused on Ms.K, the store manager of Oribe. She has been the store manager for over three years. Since this store is rather spacious compared to the other stores, it is operated with more than two staffs at the same time. One staff was working in the backyard of the store, while Ms.K was checking at the lightings of each shelves. A couple in the 30's were checking at the pottery near the entrance. Ms.K noticed their long stay in front of the shelf and walked towards them. "Do you need some help?" She asked them softly. The couple looked at each others face and answered, "We're looking for a wedding favor. Do you have any catalogues we can have a view of?" "Sure, I'll be right back," Ms.K went to the cashier and brought five different gift catalogues. "This one

ranges from the price of about 10,000 yen to 20,000 yen. Its main focus is on Japanese chinaware, very simple but for daily use. The design is somewhat pop and cute. And this one..." Ms.K explained the different characteristics of each catalogues very suavely, one by one. The couple listened to Ms.K's explanation and took a look at each and every one very carefully. They decided to chose one catalogue of the five. "We're having our wedding in a couple of months. Thank you so much." The couple went out of the store with a contented smile on their faces.

Fashion Village

Figure 3.54: Fashion Village store and its service

Around Thursday noontime on August 23, we researched a women's fashion store Fashion Village(Figure3.12-10). It is located in the intersection of Heart Avenue. The store stands with an Italian red color signage, with many displays of mannequins wearing fashionable outwears. Their outfits are reasonable pricing for its European-taste design targeting ladies in their 50's and 60's. This store is usually operated by two staffs at a time, one in the cashier and the other near the outside.

Our focus was on Ms.S, the salesperson working at Fashion Village for over five years. Ms.S was dusting the shelves near the entrance of the store, and refolding some shirts. One woman in the 60's came inside the store, checking at the displays near the entrance. "Are you looking for something?" Ms.S talked to her. She replied, "Yes, I want some clothes which I can hide my body proportion, I have gone out of shape so much," with a troubled face. "I have some nice shirts that are loose-fitting," Ms.S took out a tunic style shirt. "Please try this on." Ms.S guided the woman to the fitting room. The woman tried the tunic on and decided that she will take it. Ms.S suggested, "Would

you want to make the members card? You can use this in the entire mall and can use the collected points for discount." The woman decided to make the members card, and left the store with a fulfilled smile.

Paris Miki

Figure 3.55: Paris Miki store and its service

Research on Paris Miki(Figure3.12-11) was conducted on a Saturday afternoon on July 7, for one hour. Paris Miki sell both fashionable and functional eye glasses, from reasonable pricing to valuable high brands. Ladies from their 20's to their 40's are the main customers on the weekdays, while on the weekends the store is full of families from 30's to their 50's.

We observed Ms.M, the store manager of Paris Miki. Ms.M has been working at Paris Miki for over 10 years, and served as the store manager of the shop at iiasTsukuba since its opening. Unlike the other stores of Heart Avenue, this store has more than 3 staffs working at the same time. Ms.M flexibly moved around the store and observed various visitors that were taking a look at the displayed glasses. Suddenly, she focused on a married couple in the 60's that took one of the glasses in their hands, and walked towards them. "Are you looking for some glasses?" she talked to them with a smile. "Yes, we're searching for a tough light-weighted glasses for my husband," the wife answered taking a look at various glasses, "since our dog ate my husband's glasses the other day." Ms.M quickly replied, "What a cute doggy, it must have wanted to play with you! We have the perfect glasses that are strong and light. For example..." and picked out 5 different types of glasses and lined them in a row in front of the couple. The husband picked out 2 from the 5 choices, and were thinking about which among them to buy. Then Ms.M started explaining about the characteristics of both of the glasses with her own

unique words. "This silver glasses just came out this week, and uses the most lightest materials, the mechanism in the folding point is very tough and you don't have to worry about your glasses even if you accidentally have a nap with your glasses on," The couple started laughing and talked that the dog came and ate his glasses when he was lying down and watching TV. Ms.M continued, "and this black glasses, I actually have the same type, for women. Even if I keep this glasses on for a long time, it doesn't bother me because it is very light," The husband began to think again about which of the glasses to buy, but could not decide among which. "Honey, I can't decide, I want both of them," he talked to his wife and started to discuss about the price. After about a couple minutes of discussion, the couple decided to buy both of the glasses. Ms.M had the best smile on her face and guided the couple to the eye-sight measuring equipment to create his own glasses.

Lupicia

Figure 3.56: Lupicia store and its service

On Thursday, August 23, we researched Lupicia(Figure3.12-12) during the morning for a hour. This store sells hundreds of different assortments of tea from all over the world; red tea, green tea, Oolong tea, flavored tea, spice tea, and etc. They have a tasting corner in front of the store with different types of tea everyday. Many customers come to try and taste the tea, from children to elderly.

We researched Ms.B, a lady working at Lupicia for more than three years. This store usually has two to three staffs working together, however Ms.B was the only person operating the store since it was a morning on a weekday. Ms.B was setting up the tasting corner with a pot full of hot water and tea leaves. Today's selected tea was corn tea. "The corn tea is a popular selection for

the summer, you can drink this both hot and cold." she told us as she was brewing the tea. Then a lady in the 30's came towards the tasting corner. "Please have a taste," Ms.B gave the lady a small cup of tea to try. The lady had one sip, and she entered the store as she was drinking the rest of the cup. She was looking at the wide variety of over hundred samples of tea leaves, and took one package in her hand. She opened the package and tried to smell it. Ms.B came up to her and said "This red tea with vanilla flavor is very popular in this store," and then continued, "If you like this one, you may also like this red tea with rose flowers. This is the number one popular blend tea we sell here." The lady tried the smell of the rose flower blend, and said "Oh, I like this one better. I'll take this." and decided to purchase.

Mental Model of Salespersons

Mr.F at Kawashima Auto started talking to the customer when he saw that the married couple walked around the black car after staring at it for a long time. At Paris Miki, Ms.M started talking as soon as she noticed that the married couple took one of the glasses in their hands. Ms.M at Paris Miki picked out five different types of glasses depending on the customer's wants and situation, that he wants tough glasses because his dog ate his previous one. Ms.M talked to the customer with her own unique words about each of the glasses she picked out. Ms.B at Lupicia suggested another type of tea similar to the one which the customer had in hand.

We realized that different customers come with different combinations. Different lay outs of products are necessary for different line ups of items. However, the way of servicing is basically the same, even if they are dealing different products; from glasses to automobiles. Basically, almost all service clerks within Heart Avenue had the same mental model; they like to talk more about items themselves adore compared to items that they do not have so much interest in. Another mental model is that the clerks can sell their products based on their sales talk however, that only happens when customers are already inside the store looking around for goods. From the research of the salespersons at 11 stores, I assumed that the mental model of salespersons when servicing the customers is that "They seek for the perfect timing—whether the customers are stop and stand in front of a certain place for a period of time or when the customer takes an item in their hands—to start talking to customers about information they know about the items."

3.8 Soundful AdaptivePassage: A Calling Passage Design

The initial sound experiments, initial prototype of Sound Entrance, the study of sounds and interaction, and the research of customers and salespersons, gave me a wide input of sound environment and customer relationship in a shopping mall. Based on these researches, I decided the three components to construct a design AdaptivePassage in a shopping mall; (1) sensing customer behaviors, (2) calculating its timings, and (3) actuating intangible information related to the stores and its articles. First component of sensing understands which direction the customers are walking towards, and how far away they are from the stores. Second component of timing calculates the customers have arrived about 2 meters away from the articles and connect to the actuation. The third component of actuating provides intangible information related to the stores and articles into the atmosphere. AdaptivePassage in a shopping mall senses the customers behaviors, calculates the perfect timings, and actuates sounds and lights, to call customers into the stores and enhance their shopping. To integrate the components as a prototype, I decided to create a sound design which calls out to the customers unconscious senses, calls out actuations in relation to the articles in stores, and attracts the customer's attentions at the perfect timings.

Soundful AdaptivePassage, a passage playing sounds adaptively according to the presence of customers, calls out to the customers to drive them into the stores. Responding to presence of visitors, Soundful AdaptivePassage plays sounds from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores, or show windows. When the sounds are delivered to the customers' ears, they feel as if being called from the architecture itself. Customers notice the sounds, pulled into the store located along the passage, explore something new, and purchase items that they would not have. They enjoy talking with the shop clerks, and as a result purchasing goods that they would not planning in the beginning.

Soundful AdaptivePassage component with various sensors and actuators are invisibly and ubiquitously embedded into the architecture to sense people's movements. The sets of sensors placed within the passage senses when the visitors walk through the passage, and the speakers play sounds responding

to the visitors. These sets are all integrated and play a variety of sounds corresponding to the visitors behaviors within the space. Fixtures located on the boundary of the store's territory displays highly recommended items of the store. Couches and foliage are placed in the center of the narrow passage for pedestrians to sit down and have a short break. Signage are positioned at the intersection of the passage, providing information of what is new or recommended in the area. Soundful AdaptivePassage weave various sets of sensor and actuators into all of these fundamentals that have been placed since the opening of the mall. This passage all together plays sounds in relation to customer's behaviors.

Figure 3.57: Image of Soundful AdaptivePassage

Heart Avenue with Soundful AdaptivePassage plays sounds to drive visitor's footsteps into the stores located along the passage and encourage them to purchase goods within the stores. This passage using sounds provide customers the experience as if they were exploring the architecture. Throughout the entire passage of nearly 100 meters long consisting 12 stores, different sounds are played in each of the stores. With this layer of sounds, the ordinary passage turns into a special passage that enlightens the visitors daily visits to the mall.

Figure 3.58: Sequencial Experience of Customers

The played sounds reaches the visitor's ears and attracts their attention as visitors walk by the various spots inside the passage. When visitors come into the entrance of the passage, they hear sounds from inside. Various sounds related to the shop itself are played as they proceed strolling. Then they take a look at the shop and walk towards the shops to check where the sounds come from. Sounds are played again, trying to notify that there are more items inside the store. Visitors walk inside the stores to check what is going on, and realizes that there are some charming items displayed. They reach out and take one of the goods in their hands, wondering if the sounds are generated from them. As they keep having the goods in their hands, they feel the goods are somewhat captivating, and decide to take it. In this way, visitors walking in the mall notice the sounds, pulled into the store located along the passage, explore something new, and purchase items that they would not have. (Refer Figure3.58 for the visual images of this sequential experience.)
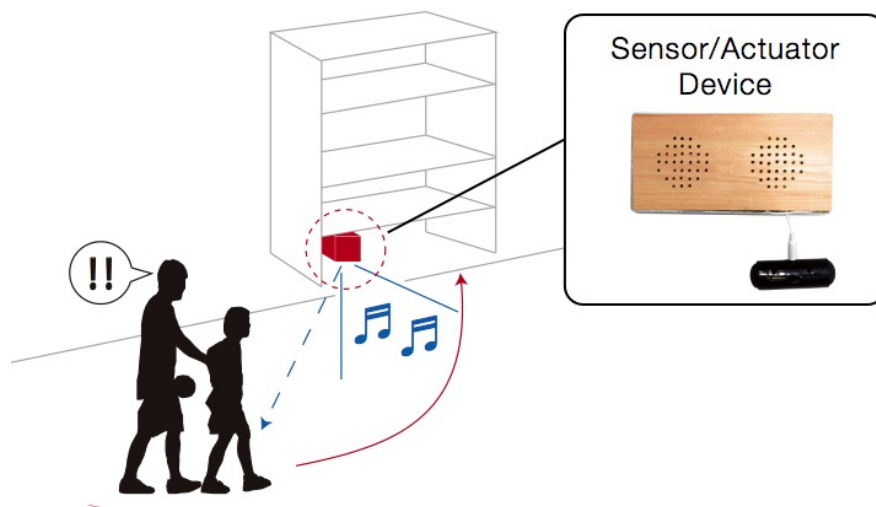
Figure 3.59: Basic Interaction

Figure3.59 shows the basic interaction of the Soundful AdaptivePassage. Speaker sets are implemented into the items, fixtures, or shelves of the stores invisibly. When customers walk close to the certain spot, the sensor detects the customers, and calls out sounds to attract them. They notice the sounds calling, and take a look towards the direction which the sounds were being played from. Then they notice that there are items of the stores, and they are pulled into the store to check for more details.
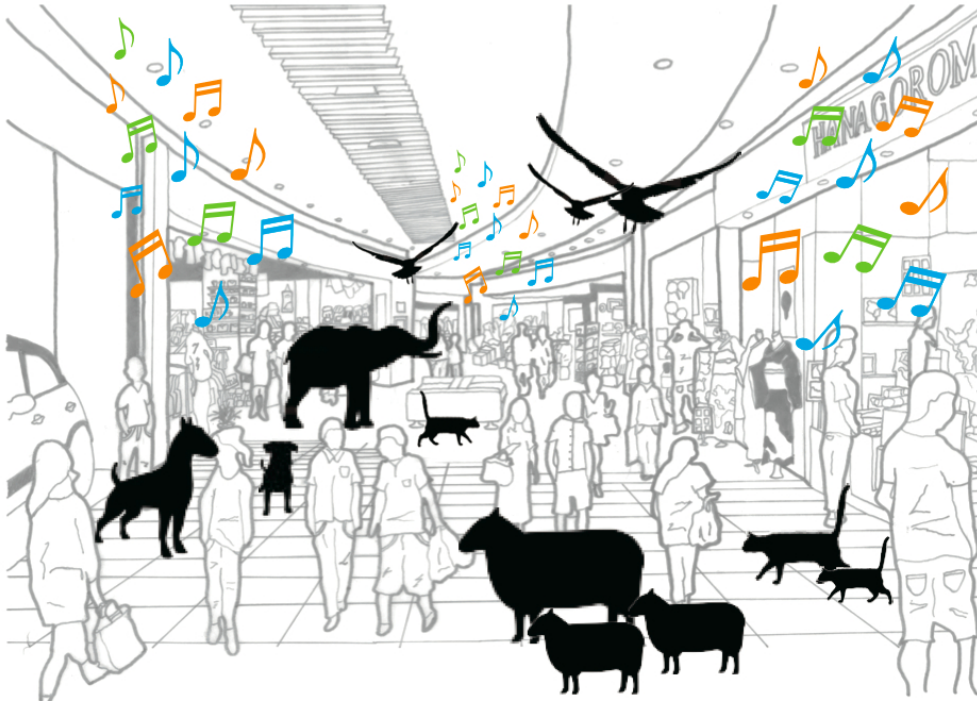
Figure 3.60: Image of the first Soundful AdaptivePassage with calls of animals
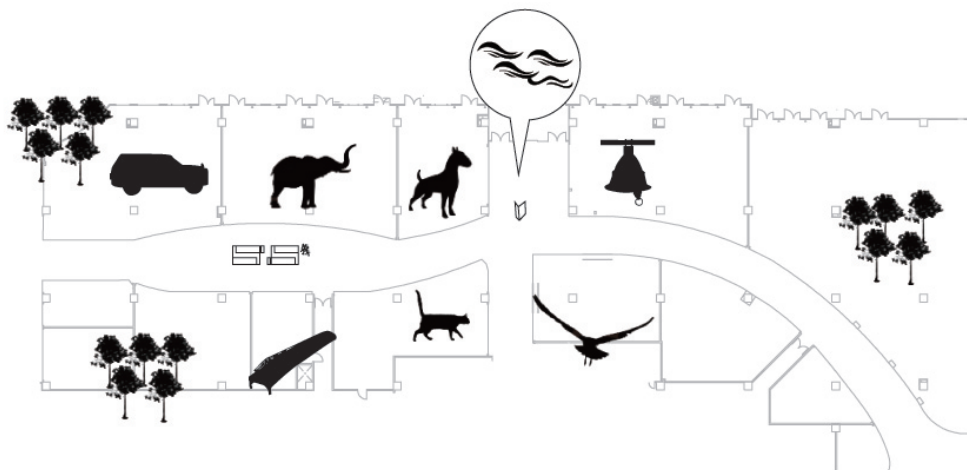
Figure 3.61: Map of Zoo-like Soundful AdaptivePassage

To express a sense of unity as the entire passage, sounds played in Soundful AdaptivePassage are packaged based on certain themes. Examples of themes are seasonal issues like the holidays, relaxation, computer games, musical instruments, or seasonal environments. Every store within the passage plays sounds based on one theme to harmonize the entire environment. These sound sets are synchronized and can be easily changed depending on the days of the week, times of the day, or the outside weather. Sounds are selected throughout iterative consideration to pull pedestrians toward the stores. After an iterative consideration process of deciding what sounds to use, I settled to utilize calls of various animals as the first sound set of Soundful AdaptivePassage and create a zoo-like environment for the first exemplification. (See Figure3.61 for the image)
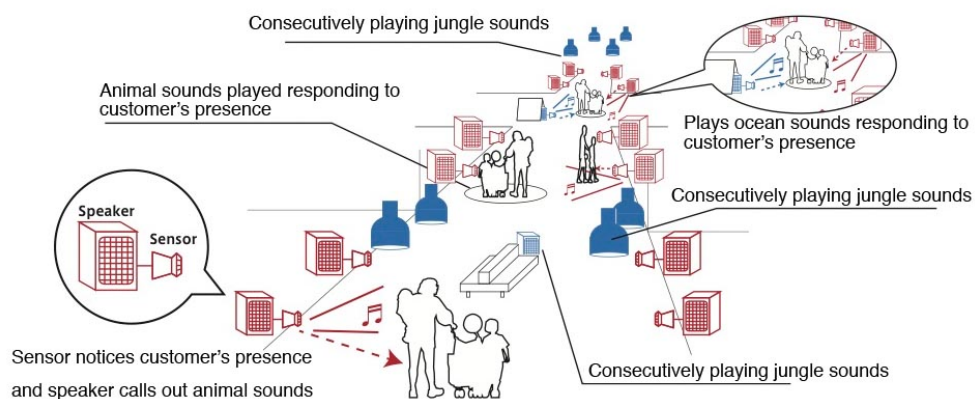
Figure 3.62: Experience flow of Zoo-like Soundful AdaptivePassage

The zoo-like version of Soundful AdaptivePassage gives customers the experience as if they are walking in a zoo and encountering various animals. Visitors experience gives the feeling of walking in a forest environment, and meet various animals in order; for example elephants, sheep, birds, dogs, cats, or giraffes. In between some animals, there are waterfronts for some animals to rest. Sometimes there are sounds of bells our simple instruments that bond together the environment. Each sounds of animals were allocated to each stores—outdoor goods store plays that of elephants, women's fashion store plays the call of birds, Japanese pottery store plays the call of cats, children's and pet goods store plays the calls of dogs—while sometimes the sounds of the bells were for the crafting store, and the sound of the harps were for the traditional Japanese goods store. The entire sound environment derives its sounds
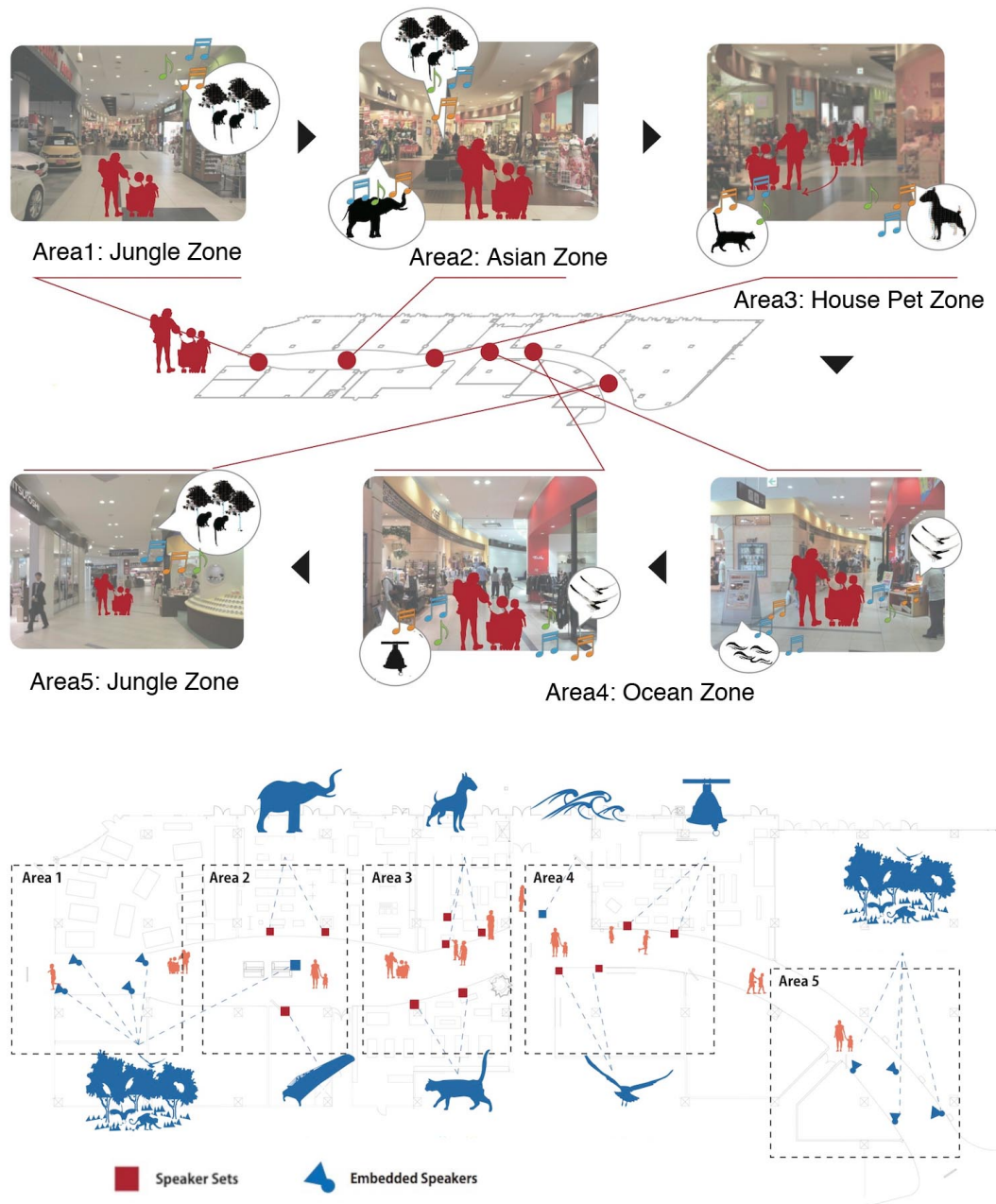
Figure 3.63: Zoning for Zoo-like experience

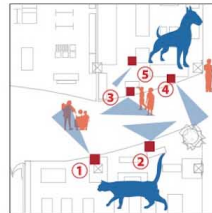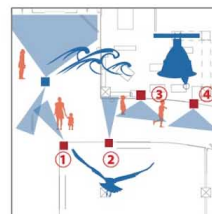Area1: Jungle Zone

Area2: Asian Zone
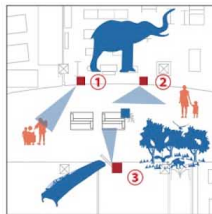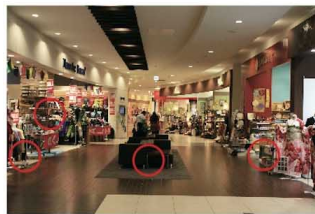
Area3: House Pet Zone

Area4: Ocean Zone

Area5: Jungle Zone
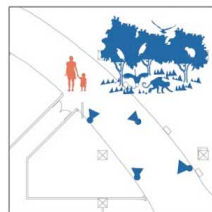
Figure 3.64: Placements of Speakers for Zones

Figure 3.65: Detail Placements of Speakers for Zones

from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores or show windows.

Soundful AdaptivePassage currently has 8 ceiling-implemented speakers in the entrances of the road and also 12 portable networked-speakers to be positioned near the entrance of the shops located along the avenue. All of the portable speakers also consist of a sensor which detects whether there are customers that are near by. In addition to the ceiling implemented speakers, we created a set of speakers and sensors. The speaker sets include motion sensors, Arduino micro computer, MP3 music shield, SD card, audio amplifier, and a portable speaker available off-the-shelf.(See Figure3.66)

The passage has speakers implemented all over the place within Heart
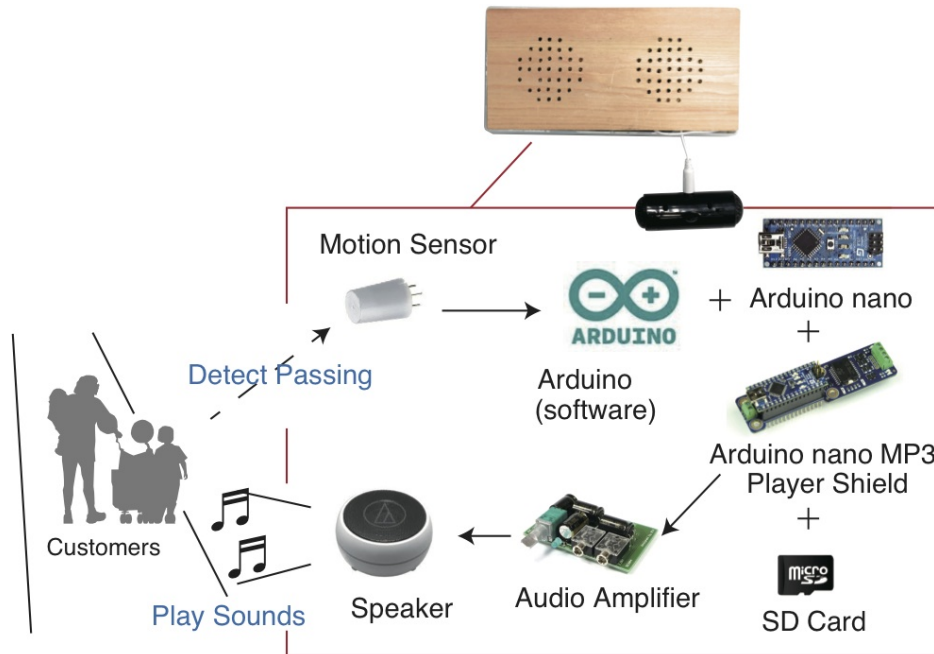
Figure 3.66: Architecture of a set of speaker and sensors
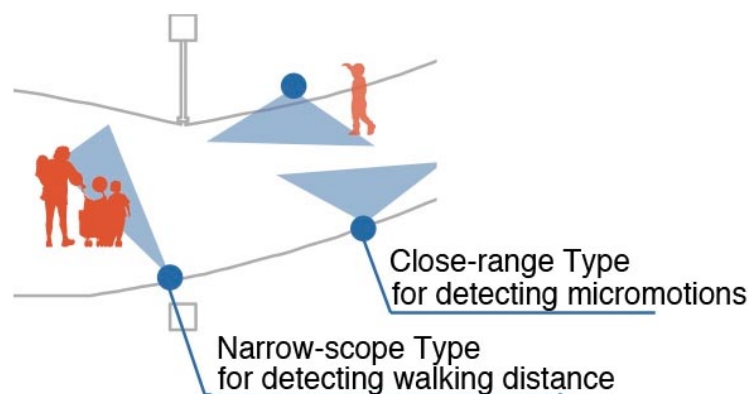
Figure 3.67: 2 sensor types for detecting presence
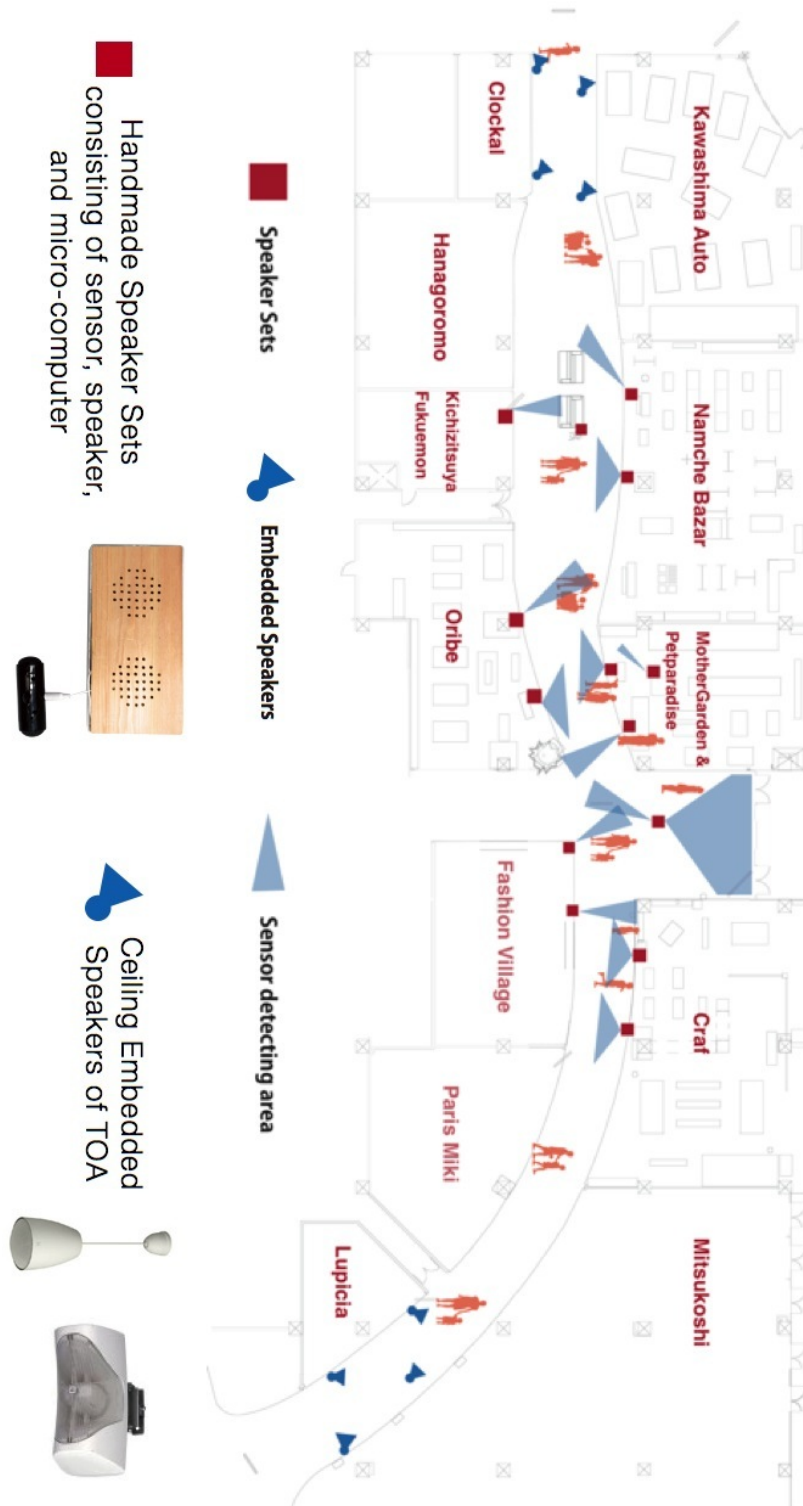
Figure 3.68: Soundful AdaptivePassage's Implementation

Figure 3.69: Embedding speaker set into fixtures

Avenue. It has plural ceiling-implemented speakers and numerous portable networked-speakers positioned near the entrance of the shops located along the avenue. All of these speakers are controlled by a master computer system located in the backyard of the shopping center, also consisting of sensors networked to detect whether there are customers that are near by and providing the selected sounds at the prompt timings. The portable speakers are placed near the entrance of stores, into the fixtures that display various items of the shops. These speakers are set into places that are difficult to see from customer's viewing locations.

Speakers are set into each of the stores with different fixtures. For example, for a fixture that place stuffed animals in three columns, the sensor was set under all columns, but the speaker was placed in the rear of the second column as both were connected with a long wire. Another example, for a fixture that placed china-ware in five columns, both sensor and the speaker were placed under all columns, however the sound seemed as if the china-ware was calling. Among the stores we have collaborated, the challenge was that stores were selling items with various sizes, which leads to using many types of fixtures, from flat table displays of rows of glasses to boxes of overlapping plates, from clothing racks with hangers to doll houses located directly on the ground. There are even automobiles that are parked in the indoor territory of the mall itself, each car close to one another. The speaker set was implemented into almost any kind of fixture that existed within the passage, into places that are difficult to be seen.

With this implementation system, Soundful AdaptivePassage becomes a passage full of sounds plays sounds adaptively according to the people's behavior. It responds to presence of visitors and plays sounds from ceilings, walls, floors, couches, signage, foliage, fixtures of the stores, or show windows. Customers feel as if being called from the architecture itself, become pulled into the store located along the passage, explore something new, and purchase items that they would not have.

3.9 AdaptivePassage Model

I proposed Daiwa House the AdaptivePassage Model—a model driving customers into stores and encourages their shopping—by adding intangible materials like sounds or lights onto the current brick and mortar retail architecture. This model can renovate the existing static shopping mall into a dynamic architecture full of various sounds, smells, and sights. Creating a sensuous environment with an extra layer of ubiquitous computing technologies on top of the current brick and mortar retail architecture enables a novel structure to design new shopping malls driving customers into stores and encouraging their shopping.

To design the concept of AdaptivePassage in a shopping mall, I went through ethnography research, system testing, and user studies that were conducted through the AdaptivePassage project. Based on those researches, I presented three components to construct a design in a shopping mall; sensing, actuating, and its timing. Sensing requires to understand which direction the customers are walking towards, and how far away they are from the stores. Timing requires to calculate the customers have arrived about 2 meters away from the articles and connect to the actuation. Actuating requires to provide intangible information related to the stores and articles. AdaptivePassage in a shopping mall senses the customers behaviors, calculates the perfect timings, and actuates sounds and lights, to call customers into the stores and enhance their shopping.

First component to sense customer behaviors of direction and distance derived mostly from the study of sounds and interaction and ethnography research on the customer's behavior. The ethnography research showed that the customer without a destination are those that are likely to be pulled into the stores and spend time there. These customers either dismissed from their mission or without any from the beginning are walking rather near the stores, at a rather slow speed. Also the study of sounds and interaction showed that the way customers look towards the stores and the passage itself depends on which direction they are walking towards. These two elements seemed critical to call the customers inside, therefore I created a system which senses both direction and distance from the stores where the customers are walking.

Second component to calculate the perfect timings is perhaps the most complex component. The study of sounds in general seemed to be effective to attract customers walking out towards the main street, rather than to call customers walking from the main street. The ethnography research on the salespersons showed that the salesperson started talking as soon as she noticed that the customer took one of the articles in their hands. Successful salespersons know the exact timing to start talking to, and they know who to talk to as well. It is important to provide information before the customers walk passed the stores, and to call beforehand.

The final component to actuate intangible information in relation to the articles of the stores, derived from the series of prototype testings. The initial sound testings at Keio University showed that sounds have the power to attract people's eyesights, however it did not change their current behaviors if there are nothing interesting beyond their eyesights. Sound Entrance in Heart Avenue attracted the customers to play and stay in the walkway with its interaction, however the sounds of instruments we designed—harp, glockenspiel, drums, marimba, and shakers—-served out for the function of attracting attentions, but could not have enough power to create meanings to walk attracting them into the stores. Among the 80 types of sounds we prepared during the sound study, the most effective sounds were those of the animals calling, and those related to the articles sold. Perhaps the sounds of cars and clocks were too direct, since it is easy to think that cars make car engine sounds and clocks make ticking sounds. Playing sounds related to stores but not too directional, would have power to pull customers towards stores rather than sounds not related at all.

Realizing these components integrated in the shopping mall requires undergoing the three methods I provided; (1) creating an actuating device calling out to their five senses, (2) creating a sensing device responding to the presence of customers, and (3) designing both the sensor and actuator to fit into the environment. These methods derived from the AdaptivePassage project in 2012, a collaborative project with a mall aiming to create prosperity within a not-so-popular passage. Actuating devices calling out the ones senses—sights, hearing, smells, taste, or tactile—are the most effective way to talk to the customers either consciously or unconsciously and have a pleasurable experience. Sensing devices responding to various behaviors of customers enable

these actuations to become interactive, dynamic, and adaptive; like all living things always are. Designs of both sensors and actuators shall fit into the built environment and woven into the mall without and incongruity.

AdaptivePassage implemented in a shopping mall was constructed with the three components of sensing customers behaviors, calculate the perfect timings when they are about to pass by the store, and call out the actuations to pull them inside the store and shop. This system was built upon the three methods of creating the actuating device calling out to the five senses, creating the sensing device responding to the presence of customers, and designing both of them to naturally weave into the retail environment. This system in Heart Avenue of iiasTsukuba is called Soundful AdaptivePassage, an interactive sound environment playing sounds to call customers into the sub-stream passage drive them for extra shopping. Adaptively responding to the customer's behaviors and presence, Soundful AdaptivePassage plays sounds from all over the architecture; ceilings, walls, floors, couches, signage, foliage, fixtures of the stores, or show windows. These sounds, evoking the stores and the articles being sold, tempt the customers to walk inside and explore what is there. Inside the stores, customers would encounter something they would not have been planning in the beginning, and perhaps purchase those articles.

The following chapter tries to prove the effectiveness of the concept of AdaptivePassage through research conducted in Heart Avenue of iiasTsukuba. I will illustrate how the system of AdaptivePassage effected the behaviors of customers in Heart Avenue, and actually did drive the customers into stores and encouraged their shopping. The implementation of Soundful AdaptivePassage ran for about 3 weeks from September, 2012. During this time, there were some days we did not run the system. In addition, we ran the system for 2 extra days in Sunday, January 13, 2013 and Monday, January 15, 2013, and deeply observed three sets of customers.

Chapter 4

Proof of Concept

In autumn of 2012, the design team and I had conducted a series of user studies with AdaptivePassage in a shopping mall. This interactive sound system for Heart Avenue called Soundful AdaptivePassage was designed as the example of AdaptivePassage Model, a model driving customers into stores and encourage their shopping by calling. From September 18 until October 7, 2012 and also two days in January 2013, this design of AdaptivePassage in a shopping mall was proven to call customers into the stores and encouraged to shop. During this time, we ran the system almost everyday and recorded the behaviors of various customers that walked through Heart Avenue with plural video cameras set through the passage. We also took down notes in our own notebook on anything we noticed during the session.

AdaptivePassage model, using the three components (1) to sense customer behaviors, (2) calculate its timings, and (3) actuate intangible information related to the stores and its articles, as a key because these derive from the previous researches and studies I conducted throughout the project. Sensing derived from ethnography research on customers insight that those without destinations walking slowly are likely to be pulled in, and also the study of sounds showed the importance of walking directions. Timing calculation came from ethnography research on salespersons where they knew the exact timing to start talking to the customers for a good sales, and also the sound study which spotted certain places within the street that is effective. Actuating the intangible information comes from the initial experiments and prototype of Sound Entrance, that did not have enough power to create good enough

Figure 4.1: Customers attracted to stores with Soundful AdaptivePassage

meaning to walk towards the stores from the attracting. Therefore this model uses these three components and proves they are effective for calling customers.

To implement and realize these three components into Heart Avenue of iiasTsukuba, I used the three methods—(1) creating an actuating device calling out to their five senses, (2) creating a sensing device responding to the presence of customers, and (3) designing both the sensor and actuator to fit into the environment—and designed Soundful AdaptivePassage, the interactive sound system playing sounds to pull customers into stores and shop. In this chapter, I provide detailed experiences of customer behaviors that were driven into stores and actually shopped, and state that sensuous environments created with an additional layer of ubiquitous computing technologies is effectual for a new shopping mall design.

4.1 Setting

Soundful AdaptivePassage was implemented from Tuesday, September 18, until Sunday, October 7. During this time, there were some days we did not

run the system. In addition, we ran the system for 2 extra days in Sunday, January 13, and Monday, January 15, 2013, and deeply observed three sets of customers. These three sets of customers were their first time to come to iiasTsukuba, and were scouted in advance by our design team.

To see how the customers are behaving with Soundful AdaptivePassage, I used video cameras and kept them running during the entire time it was being tested. Figure 4.2 shows how the cameras were set and what areas the cameras were filming. The top of Figure 4.2 are the cameras that we implemented into the ceiling in the beginning of the project, which were used to count the number of customers that come and out of Heart Avenue for a macroscopic view. The bottom of Figure 4.2 are cameras we put on the floor inside Heart Avenue, which filmed the microscopic behaviors of customers with Soundful AdaptivePassage.

In addition to the implementation from September to October on 2012, we recruited three sets of customers to browse and shop around Heart Avenue. These three sets of customers that lived around the Tsukuba Express Line that was their first visit to iiasTsukuba. One of them were a set of mother and daughter around the age 3. The second set was a mother and her son with his friend both around age 5. The final set was a set of two women in their 50's. We asked them to wear a hat with a small video camera attached to it, and also an IC recorder to record their conversation. (See Figure 4.3) We chased after these customers with a video camera and a still camera, and also took down notes in our notebook. (See Figure 4.4) We gave them a simple map of Heart Avenue, and asked them to freely browse around Heart Avenue for 30 minutes. We told them that they were free to buy any goods if they wanted to, and if not just browse around. We did not tell them in advance that we had implemented the interactive sound system inside Heart Avenue. After the 30 minute shopping time, we held an interview session regarding their activity. Based on the notes that we took down as we were chasing, we asked the targets what they were thinking at the certain time, as we shared with them the video we took. Each interview session took about 20 minutes long.

During this additional user study in January, the camera setting was set as the same as mentioned in figure 4.2. This way, we found some interesting

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Cameras in the ceiling
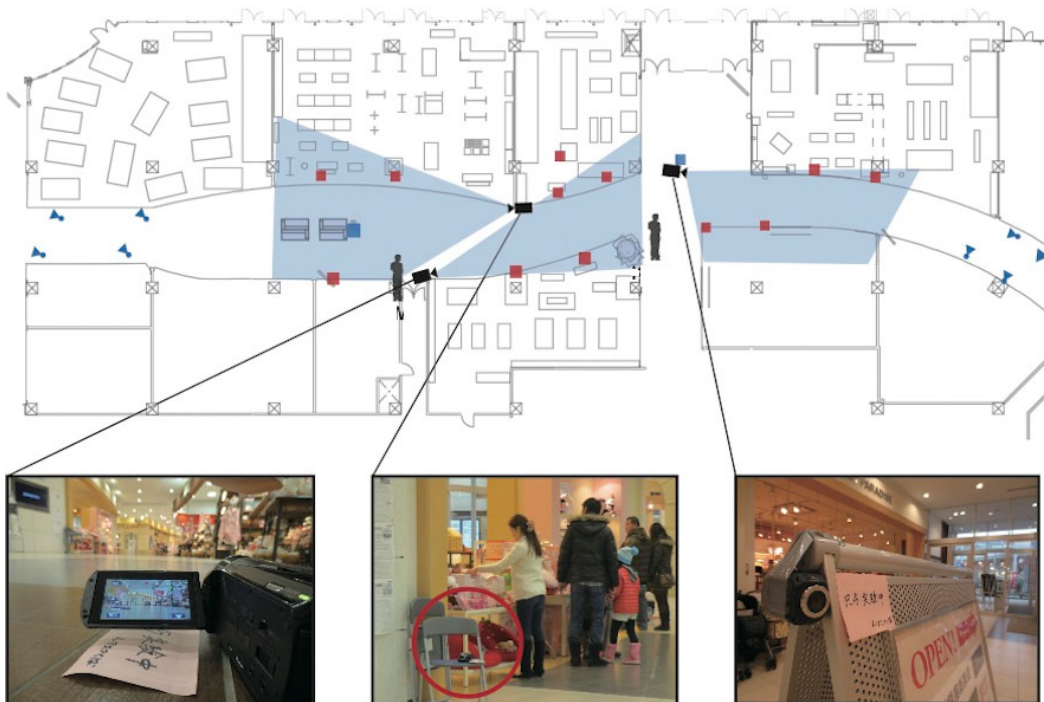
Cameras on the floor

Figure 4.2: Camera Setting Map

Figure 4.3: Asking to wear a camera and recorder during their shopping

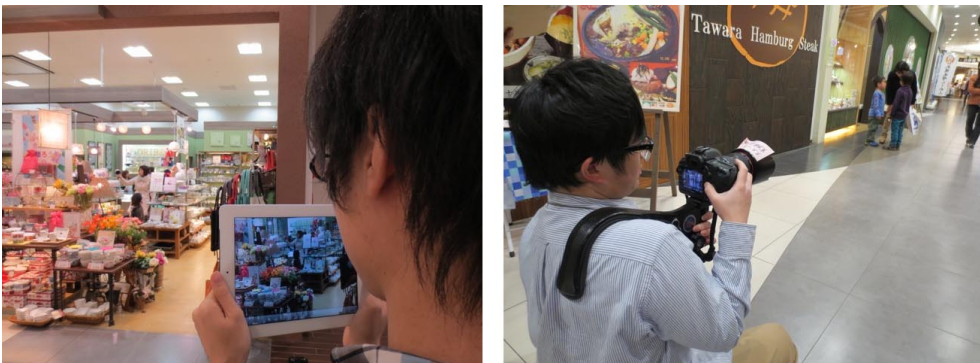Figure 4.4: Chasing after customers

Figure 4.5: Interviewing after their shopping

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behaviors of customers that were not recruited by us, that came to iiasTsukuba as their daily routine. With this setting, I will prove how effective the three components of AdaptivePassage was, by illustrating out the behaviors of customers clearly.

4.2 Three Components of AdaptivePassage and customer behaviors in Heart Avenue

The three components of sensing, calculating, and actuating are all integrated as one system to drive the customers into the stores and encourage the shopping. The effectiveness of these components will be proven by describing the highlighted behaviors of customer in Heart Avenue with Soundful AdaptivePassage, seeing if they were called into the stores and were encouraged for shopping. This section illustrates that intangible information actuated at the perfect timings due to sensing the customer's presence will pull the customers into the retail stores and shop.

Two women called into Oribe and shopped items

It was almost evening of Tuesday, September 25, 2012. Two women around the 40's came from Entrance 2 of Heart Avenue. (See Figure 4.6) They were walking very slowly, and looking at the items lined in each stores. One of them already had a paper shopping bag in her hand, so they perhaps have already completed their mission at iiasTsukuba and have no destination any more.

When they came near the intersection where the store of Oribe, the sensor detected their walking near the store. The sounds of cats calling was played towards them. The two women noticed the sounds of cats, and searched a little towards the direction which the sounds came from for about two seconds. Then they realized that there was a large shelf about a meter away from them. They walked towards the shelf and stopped their footsteps in front of it. The sounds of cats called again. The women figured that the cat sounds come from this shelf, which displays many articles that have a cat motif. They started taking a look at the items on the shelf from the top to the bottom.

Then the woman which did not have the paper shopping bag noticed the item on the bottom of the shelf, and squatted down to see it more carefully. It
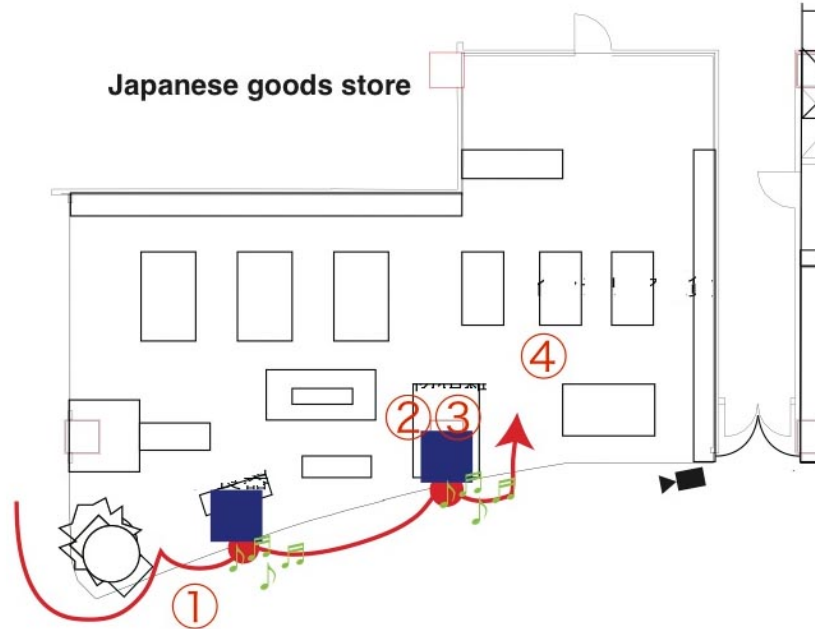
Figure 4.6: Women shopping items at Oribe

was a set of chopstick stands designed with cute little cats. The woman took them in her hands and started discussing how cute it was to the other woman. They squatted down to take a look at the other series of chopstick stands with different designs of cats.

After a couple of minutes of discussing which of the chopstick stands were the most attractive, the woman without the paper shopping bag took the white box with several chopstick stands inside and walked inside the store. She handed the box to the salesperson of Oribe standing near the shelf. The salesperson guided them to the cashier in the rear of the store with a smile. The two women came out of the store slowly, with paper shopping bags in both of their hands.

The sensor located inside two different shelves detected the women's walking near the store. The motion sensor detected the two women walking slowly towards Oribe, about a meter away from the store end. The microcomputer connected to the sensor understood that there were customers about a meter or two away from the targeted shelf. It sent the data to play sounds of cats at that direct time. The speaker played the sounds of cats in random order. The sounds played by the speakers pulled the two women towards the items on the shelf with cat motifs. Then another sensor inside that shelf noticed that there are customers really near the shelf. The microcomputer attached to that sensor understood that it was the time to play sounds again. The speaker inside the shelf played another voice of cats calling. This time the two women started to squat down and take the items in hand for a closer look.

Boy finding sounds and father walking into Mother Garden

In the afternoon of Wednesday, September 26, 2012, a boy with his mother and father came to Heart Avenue. (See Figure 4.7) The boy's age is around 4 years old. The family perhaps picked up the boy from his nursery and directly came to iiasTsukuba. They seemed to be hanging around in the mall, spending their spare time together.

First, the boy and his mother were in front of Oribe, the Japanese pottery store located in front of Mother Garden. They were walking slowly together in front of the shelf of Oribe. The sensor detected their walking, and played cat sounds. The mother and the boy noticed the cat sounds, and were wondering
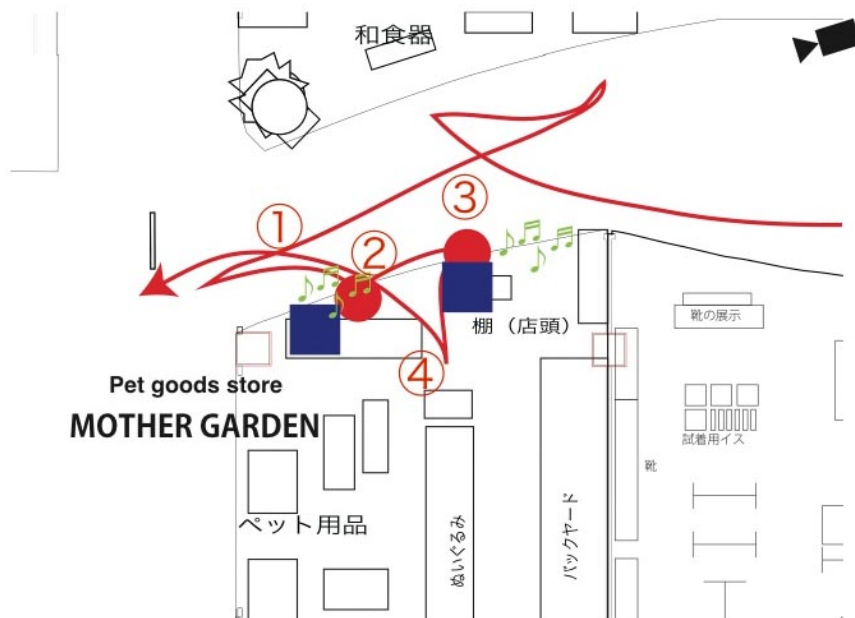
Figure 4.7: Boy finding sounds at Mother Garden

where the sounds came from. They walked back to where they thought the sounds came from, but they were not sure.

Meanwhile, the father were in front of Mother Garden, and the sensor detected his existence. The sounds of dogs were played into the air. The father pointed his fingers towards the direction which the sound came from. "There are sounds of dogs calling from somewhere!" The father called to his son and his wife. The boy looked towards the shelf in the corner of the store of Mother Garden. This shelf had many stuffed animals displayed. "Maybe it's this one!" The boy pointed towards the big stuffed animal of "Shirotan". Then his held his father's led hand, and looked at the Shirotan stuffed animal together.

The father hugged the boy and carried him in his arms. This time, the boy's eyesights became higher and could see more items displayed on the shelfs. The sensor detected their presence in front of the shelf, and played the sounds of dogs again. The boy had a smile on his face. The father noticed his boy being happy, and took a look at other articles being displayed inside the store other than this shelf. He walked into the store with his son in his arms.

The speaker set in the shelf of Oribe first noticed the mother's existence and detected their slow walking. The microcomputer told the speaker that it was the timing to send out cat sounds into the air. When the cat sounds were played from that speaker implemented inside the shelf, the mother and his son noticed and tried to find out where it was. Meanwhile, the father was in front of Mother Garden, where another speaker set was hidden in that shelf. The motion sensor here detected the father's slow speed, which the microcomputer told the speaker to play dog sounds now. The father noticed and went closer to the shelf with his son, where the sensor again noticed their existence and played another dog sounds. This combination lead the father and his son to walk into the store of Mother Garden to explore more inside the store.

Couple pulled into Mother Garden

At the same afternoon of Wednesday, September 28, 2012, a young married couple were enjoying their time together at iiasTsukuba. Perhaps they had finished their works early today and they were enjoying their off time together. They were slowly walking and chatting in Heart Avenue. They came from the
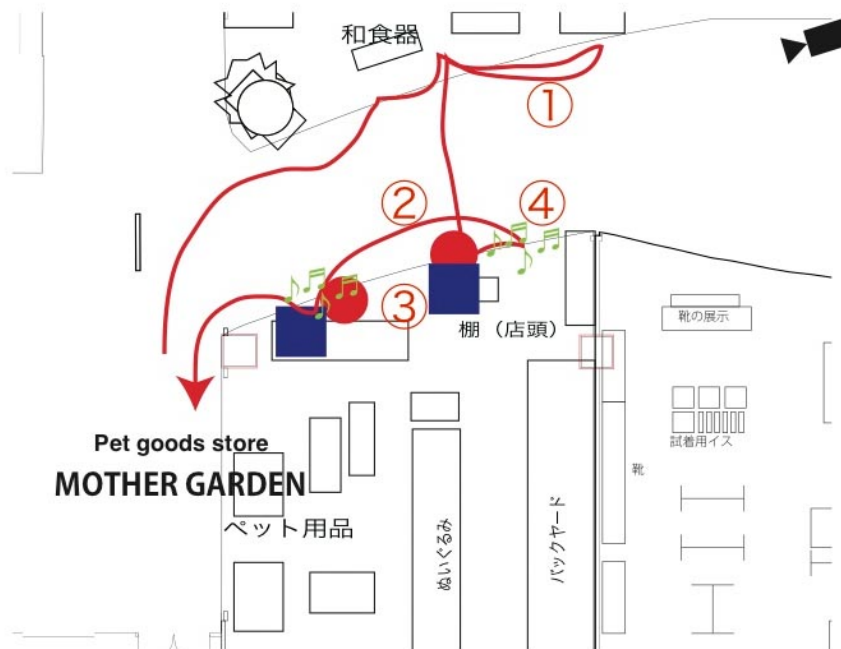
Figure 4.8: Married couple pulled into Mother Garden from Oribe

direction of entrance 2 of Heart Avenue. At around the intersection, they walked towards Oribe. They may have been searching for some new tableware for their house. Pointing to some of the items displayed on the tables of Oribe, they were having fun chatting.

It was then when the sensors implemented in Mother Garden noticed a set of girls walking by in front of Mother Garden, and played the sounds of dogs calling into the street. These sounds did not attract the two girls, but it reached the ears of the married couple taking a look at the articles in front of Oribe. The husband looked towards the direction where the sounds of dogs came from, started walking towards the direction. The wife followed after him. The two girls were slowly walking by Mother Garden, but they were into their own conversation and did not realize sounds that were played in reaction to their behavior. Another set of sensor detected the two girls that kept walking, and the speakers corresponding to it played a different sound of dogs. The husband noticed that the sounds were coming from the store of Mother Garden, and walked towards the shelf. He then noticed a stuffed animal being displayed. The wife walked towards a different shelf of Mother Garden, which another speaker set is implemented, and looked towards a toy displayed on top of it.

After taking a look at what else is displayed on the shelf, the husband walked towards where his wife was standing. He pointed towards an item displayed inside the store, and started talking to her. Perhaps it was some items for dogs, they seemed relieved at seeing what was there. The husband walked inside the store to see the item, and the wife followed him inside.

The sensors in the shelf of Mother Garden detected the movements of the two girls walking by the store. The microcomputer attached to it told the speaker to play the sounds at that time and speaker played the sounds. The sounds of dogs that were played did not attract the girls, however it attracted the couple in front of Oribe, the store facing it. The other set of sensors and speakers that were placed detected the girls walking again, and it played the sounds of different dogs. With these two sets of sounds, the couple understood that the sounds were coming from the store behind them, Mother Garden. Although the speaker sets detected the presence of one set of customers, it attracted another set of customers quite near the place.

Family walking into both Fashion Village and Craf

October 7, 2012 was a busy Sunday. It was a nice and sunny day, just perfect to go out and enjoy your day off with your family. So it was with the family of 8; 4 children, a mother and a father, and the grandparents. This family seemed to come and spare their time together at iiasTsukuba on this Sunday afternoon. Perhaps they woke up a little late, and were enjoying their late lunch at Restaurant Avenue of iiasTsukuba, which is just next to Heart Avenue. The youngest child was riding a baby carriage, which one of the daughters was pushing it forward. What a big family in this era of falling birth rate.

This big family was walking slowly from entrance 1 of Heart Avenue. (See Figure 4.9) The eight-some was as a crowd, all walking to get towards Mitsukoshi department store. When they reached the intersection in Heart Avenue, the sensor in the shelf of Fashion Village detected their slow walking. The sounds of the seagulls called out to the space. The grandmother looked towards the direction of the sounds, and found a women's fashion store just perfect for her. She touched one of the dresses that was displayed on the table. But she realized that the family kept on walking, so she had to leave and started walking again. She was walking along Fashion Village, with her eyes towards the show window. Then another sensor set inside the show window detected her slow walking, and played another sound of birds. She looked into Fashion Village again, and stopped her footsteps.

Then, one of the daughters came up to her and held her hands. "Grandma, there are sounds calling from this store," she pointed her fingers towards Craf, the store facing Fashion Village, "let's go and see, grandma" the girl pulled her arm to walk towards Craf. The sensor embedded underneath the table located in front of Craf detected their coming, and played the sounds of the bells. "See, there's sounds of bells!" The girl and the grandma was taking a look at where the sounds were coming from. The grandmother's concern shifted and started to take a look at what items are displayed in front of the store of Craf. But the other members of the family kept on walking, and they needed to catch up with them. After a couple of seconds, they left the store to meet the crew.
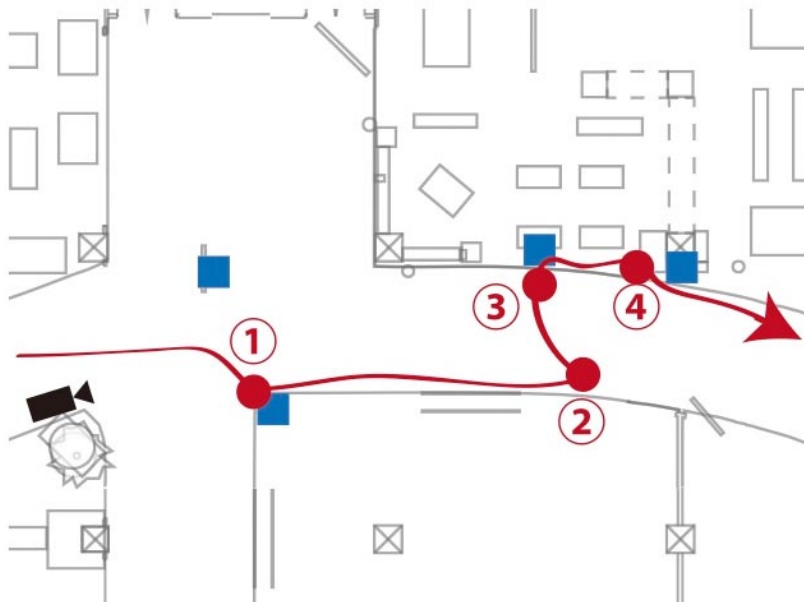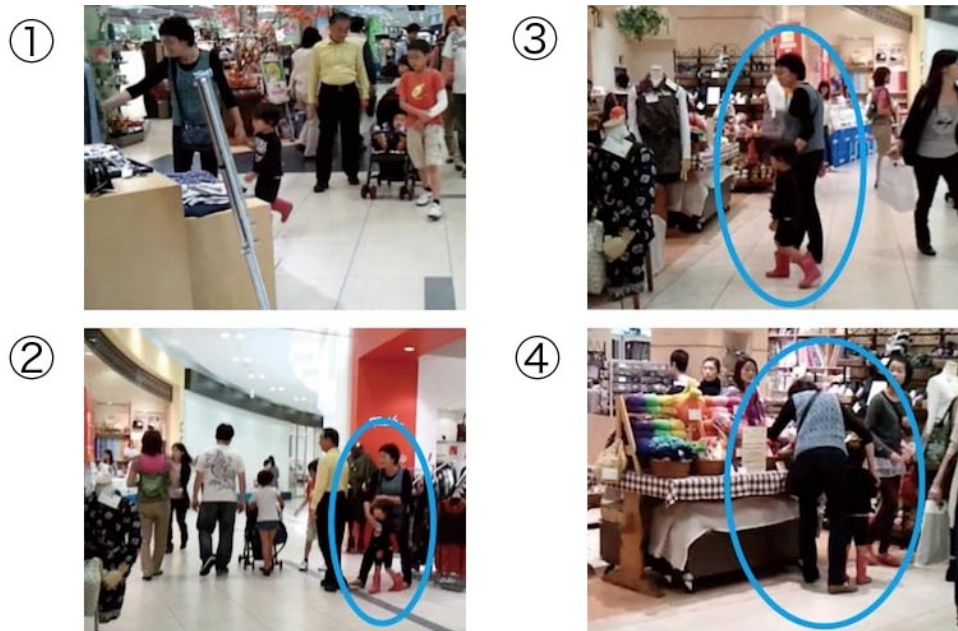
Figure 4.9: Family pulled into Fashion Village and Craf

The sensors inside Fashion Village detected the slow walking of the grandmother, which the microcomputer sent the data to the speaker to play sounds of seagulls. It attracted the grandmother's attention, and took one of the dresses displayed in her hands. When she started walking again, the sensor located in another fixture detected again and the speaker attached to it played different sounds of birds. While, one of the daughters was walking along Craf, which the sensor located in one of the shelves detected her presence and played out the sounds of bells. The daughter called the grandmother, and asked her to come towards Craf and search where the sounds were coming from. Then, the other set of speakers detected their coming and played the sounds of bells again. As the grandmother was searching for where the sounds were coming from, she started to take a look at the items displayed on the table of Craf. The sensors in Fashion Village and those in Craf detected different person's behavior, but could encourage communication between the different people.

Siblings going from Oribe to Mother Garden finding sounds

It was January of 2013. Sunday, January 13 was a nice sunny day, in the middle of a three day weekend. A family of four walked into Heart Avenue at around 1pm. They perhaps finished their lunch, and were browsing around very slowly. (See Figure 4.10) The father of the family stopped by at Namche Bazar, at the shelf where there were many knitted hats. The mother stopped with him, but the girl wearing the light blue jacket and her brother kept on walking. Since their father stopped for a browse, the siblings had some time to spare.

Some customer walked passed the shelf of Oribe, and the sounds of cats were played. The sister noticed some sounds of cats calling from somewhere. She walked over towards the direction of Oribe, trying to find out where the sound came from. She stood in front of the big shelf where the speaker set was implemented, and was taking a look. The brother realized his sister's actions, and came towards her. Then the mother realized that her children were not in the area, and came towards them. The sounds of cats were played again. The three of them discussed that the sounds of cats were ringing from somewhere in this shelf, but still could not find out where it came from. The sister started taking a look behind the shelf, and the mother took some items in her hands figuring what items may be the ones playing sounds. While, she started taking
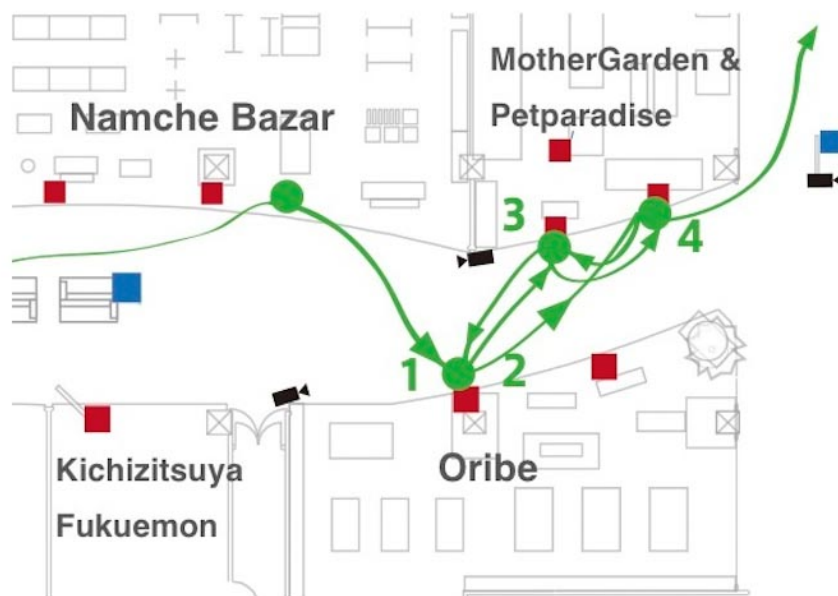
Figure 4.10: Sisters going between stores finding sounds

a look at the other items displayed on the shelf, which were some items of the cat motifs.

Some other customer walked by Mother Garden, and the sounds of dogs were played. The sounds reached the sister's ears. She left the shelf of Oribe, and walked towards the direction of Mother Garden. The sensors in the shelf of Mother Garden detected her walking towards, and played a different sound of dogs again. Once she was convinced that the dog sounds were being played from this store, she walked back to Oribe, where her mother and her brother was still searching for where the sound of cats were being played from. "Hey, there's dogs calling from that side!" She talked to her brother as pointed her fingers towards the direction of Mother Garden.

The siblings ran towards Mother Garden. The sensor detected their coming, and played the sounds of the dogs again. They tried to search for which of the items were making the dog sounds. They started examining the items on the shelf one by one. The mother realized their children had shifted to the store behind where she was, so she walked towards them. The three of them again started trying to find out where the sounds were coming from, picking up every item at a time.

The father, which finished his browsing at Namche Bazar, came over to join the three of them in front of Mother Garden. Sensors located in the other shelf in Mother Garden detected his coming, and played dog sounds again. "Dad, there's dog sounds calling from here," The sister talked to her father as soon as she saw him, "and there's cat sounds calling from that store!" she pointed her fingers toward Oribe. The father listened to his children with a smile, and noticed that it was time for them to go somewhere else. They left Heart Avenue from the exit of the intersection going outside, while talking about the sound of cats and dogs calling from the stores. The duration of their total time playing with the system was about 5 minutes.

The sensors in Oribe first detected some other customer besides the siblings, and played out cat sounds. The sounds attracted the siblings that were sparing their time waiting for their father's shopping. While the children was standing in front of the shelf which the speaker set was implemented, the sensor detected the mother's coming towards them, and played the sounds of cats again. They started searching for where the sounds were coming from,

which the mother took some items in her hands and had some interest in them. While, another customer's passing by Mother Garden was detected by a sensor implemented in Mother Garden, and played out sounds of dogs. This dog sounds attracted the sister's attention, which lead her to walk towards Mother Garden and find out what was going on. The sensor in the shelf of Mother Garden detected her walking, and played out a different dog sounds. She walked back to her family to let them know that there were dog sounds calling from the store next door, in addition to the cat sounds in the store. The sensor in Mother Garden detected the siblings running towards the store, and immediately played the sounds of dogs again. The family started to find out what items were the ones that were playing the sounds, and took each of the items in their hands one by one. When the father came towards them after he had finished his shopping at Namche Bazar, the sensors inside another shelf of Mother Garden detected his coming and played out sounds again. The sounds of dogs again were played, which lead the conversation of the children to talk about the different sounds coming from different stores. Although the sensors were detecting different customers presence than the siblings, their ears received the sounds and were attracted to both Oribe and Mother Garden, and were enjoying finding out where the sounds were coming from with their family.

Family going back and forth exploring the sounds

On the same day of Sunday, January 13, 2013, a family of 5 were spending their afternoon together at iiasTsukuba. This family, consisting of a young girl, her parents, and her grandparents, were walking slowly inside Heart Avenue. (See Figure 4.11) They came from Entrance 2 of Heart Avenue, and slowly walked the curvy road. The girl was in her father's arms, having fun walking together.

When they came near the intersection in Heart Avenue, the sensor in the fixture in front of Fashion Village detected them and called out sounds of the birds. The sound caught the mother's attention, and started looking at the clothing displayed in the show window or Fashion Village. The mother and the grandmother decided to take a look at what was there, perhaps something may be good for them. The father, the child, and the grandfather decided to keep walking and spare their time inside Heart Avenue.
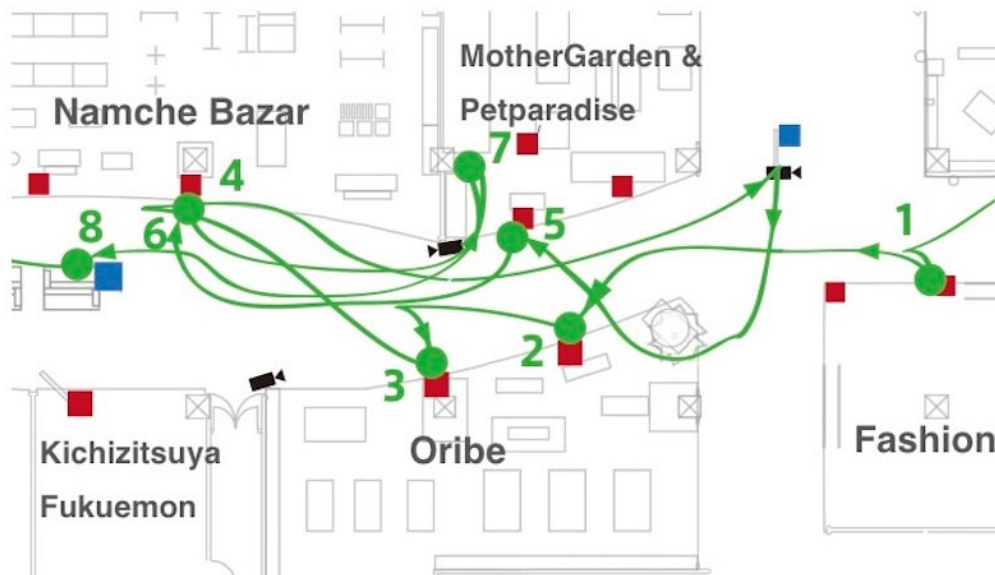
Figure 4.11: Family exploring sounds in plural stores

The father, child, and the grandfather slowly started walking, the sensors in Oribe detected them and played the cat sounds. From the direction they heard sounds, they saw that there was a cute store displaying small items, and decided to take a look what they were displaying. Standing in front of the shelf with the speaker set embedded, they were having a conversation about the cat sounds. They slowly walked by the front of Oribe, which the sensors in the shelf next to that detected their slow walking. The sounds of cats were played again. The father and the child walked backwards to check where the sounds were coming from. The girl noticed that there were cat motif items displayed in that shelf, and thought that the cat sounds come from there.

The father and the child kept walking. They walked in front of Namche Bazar, where two sets of speaker sets were implemented. One sensor detected their walking, and played elephant sounds. Now they noticed that there are several animals hiding inside this street. The father decided to go back to where the mother and grandmother were taking a look at clothing in Fashion Village. Walking back to the intersection, he noticed that they were still inside Fashion Village, so he decided to go back to other stores. The grandfather was standing in the intersection, near Oribe during the entire time.

The girl decided to get off the father's arms and walk to find out the sounds in the stores. She walked towards Mother Garden to see if there were any sounds from this shop. The sensor implemented in the table of Mother Garden detected her existence and played out dog sounds. The grandfather came towards the girl, and asked her what she was doing. "There's a dog calling somewhere from here," she said, and pointed towards the stuffed animals displayed in the shelf.

In the meantime, the father walked towards Namche Bazar again, to see what items are displayed in that area. While the mother and the grandmother finished taking a look at Fashion Village and walked towards the girl. The sensor detected their walking towards the store and played dog sounds again. "Mommy, there's dogs and cats singing from stores," She said and pointed to the items displayed at Mother Garden. She must have liked the doll houses and stuffed animals that were displayed in Mother Garden, her age was just the perfect target of this store. She pulled her mother's arms to see the items inside.

After about 5 minutes, the father came out of Namche Bazar and walked towards where the rest of the family was, in Mother Garden. The girl seemed to want to look more at the items, but it was time for them to go. The family slowly walked out of Mother Garden, and walked towards Entrance 1 of Heart Avenue. The duration of their entire stay was a little longer than 20 minutes.

The sensors and actuators in plural stores worked a good deal to call the members of the family into the stores. The speaker set in Fashion Village played the sounds of birds and attracted the mother and the grandmother of the family to walk inside and see the clothing. In Oribe, the sensor detected the walking of the father and the girl twice, which even pulled them to come back to take a look at the store. The speaker set in Namche Bazar played elephant sounds in reaction to their walking, which let them notice that there were plural sounds of animals in every store of this area. It pulled the father to come back and see the items inside the store later. The sensors in Mother Garden detected the little girl walking slowly towards the shelf of the store, where she explored the items displayed there and wanted to see more. Every time the member of the family came towards the girl, the sensors in Mother Garden detected it and played the dog sounds. The entire passage with plural stores integrated into one theme encouraged the family to explore the stores on their own interests; the mother and grandmother to Fashion Village, the father to Namche Bazar, and the girl to Mother Garden. This system encouraged them to stay in Heart Avenue for more than 20 minutes long.
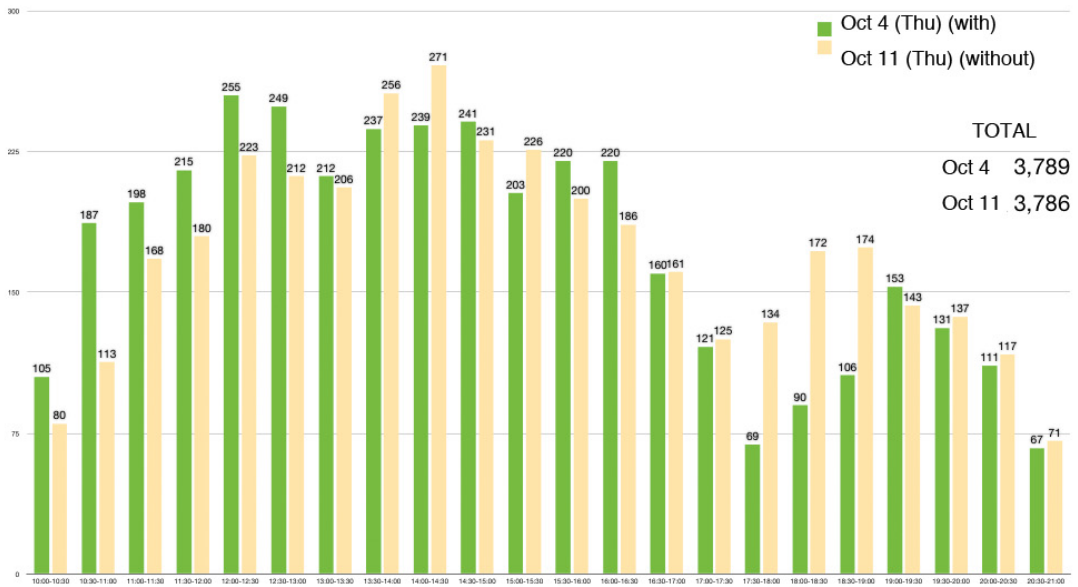
Comparison of customer numbers in Heart Avenue

In addition to the microscopic behaviors of the customers with the system, As we did in the previous prototype, we also tried to clear the customer's flows in a macroscopic view. With the cameras embedded into each of the entrances of Heart Avenue, we counted the number of customers that walk through Heart Avenue. This time, we compared two entire days on both weekdays and weekends, one when Soundful AdaptivePassage is working, and one when not working.

Figure 4.12 shows the numbers of customers that walked through both of the entrances of Heart Avenue. Top of the figure shows the comparison of the number of customers on the same Thursday weekdays, while the bottom shows the comparison of those on the weekends.

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(1) Weekday Comparison

(2) Weekend Comparison
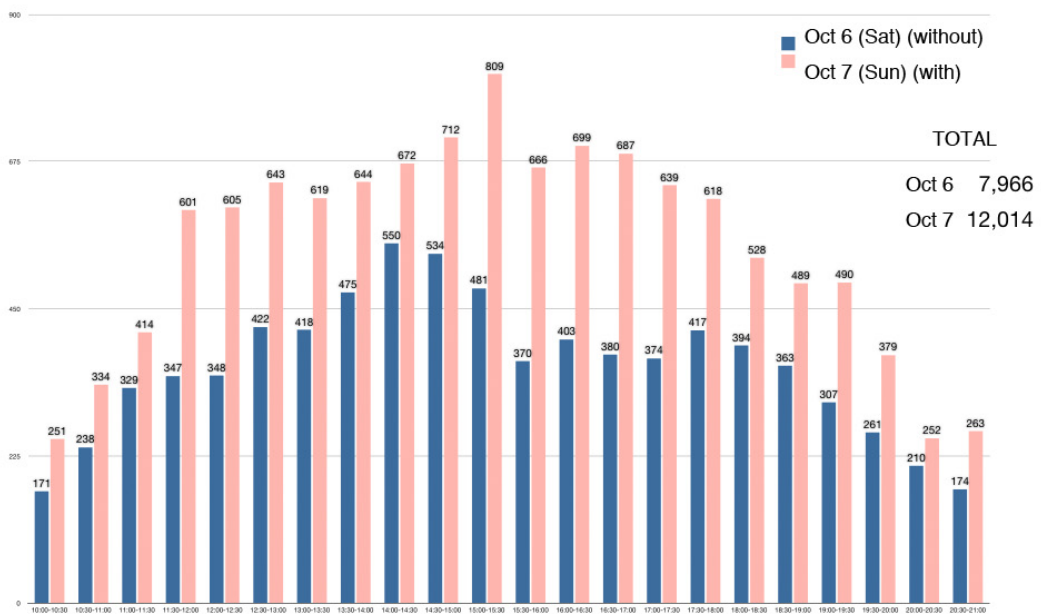
Figure 4.12: Comparison of customer numbers

Thursday, October 4 was the day with the system which had a total of 3,789 customers come and go out of Heart Avenue during the entire day. While October 11 was the day without the system, where there were 3,786 customers came and went out. Surprisingly, it was almost the same number of customers. The noteworthy point of this comparison is that the days when the system was running could attract more customers in the morning time. This was actually the similar to what happened in the first prototype of Sound Entrance; more customers came in from morning hours at the mall is rather quite, as compared to the afternoon hours. Again, Customers were perhaps would spend a slower time at Heart Avenue, noticing the sounds calling from all over the place of the passage.

4.3 Proving AdaptivePassage and its components

The three components to construct AdaptivePassage in a shopping mall— sensing, actuating, and its timing—and its integration are the key principles to call customers, drive them into stores, and encourage their shopping. Sensing requires to understand which direction the customers are walking towards, and how far away they are from the stores. Timing requires to calculate the customers have arrived about 2 meters away from the articles and connect to the actuation. Actuating requires to provide intangible information related to the stores and articles. AdaptivePassage in a shopping mall senses the customers behaviors, calculates the perfect timings, and actuates sounds and lights.

These components were proven as effective from the various behaviors of customers; women that heard the cat sounds and purchased items at Oribe, boy and his father finding sounds that play when the move and walked into Mother Garden, a young married couple pulled into Mother Garden from Oribe with the dog sounds played by some other customer, family taking a look at items in Fashion Village and Craf as they were walking, siblings that hear cat sounds from Oribe and dog sounds from Mother Garden which were played by some other customer's walking but walked to the stores to find out what

was going on, or a family walking back and forth to explore the plural animal sounds calling from plural stores as they walked by.

As the two women were drawn into Oribe and shopped chopstick holders in Figure 4.6, the integration of sensing, its timing, and its actuating was effective. The sensor located inside two different shelves detected the women's walking near the store. The motion sensor detected the two women walking slowly towards Oribe, about a meter away from the store end. The microcomputer connected to the sensor understood that there were customers about a meter or two away from the targeted shelf. It sent the data to play sounds of cats at that direct time. The speaker played the sounds of cats in random order. The sounds played by the speakers pulled the two women towards the items on the shelf with cat motifs.

In the situation of the boy and his father finding sounds and walked into Mother Garden in Figure 4.7, the combination of the two walking towards the store in different timings enabled to play different sounds. First the speaker set in the shelf of Oribe first noticed the mother's existence and detected their slow walking. The father noticed and went closer to the shelf with his son, where the sensor again noticed their existence and played another dog sounds. This lead the father and his son to walk into the store of Mother Garden to explore more inside the store.

AdaptivePassage Model, a model driving customers into stores and encourages their shopping, adds intangible materials on top of the current brick and mortar architecture and create a sensuous environment with the extra layer of ubiquitous computing technologies. The shopping mall design with sensuous environments of intangible materials is effectual for a new shopping mall design driving customers for an extra shopping.

From the user study testing, it showed that sensing customer behaviors with sensors embedded into the architecture, calculating the exact timing to call out to which customers, and calling actuations with intangible information related to the articles of stores, do drive customers inside the stores and shop. This model and its system design is effectual for a new shopping mall design.

Chapter 5

Conclusion

5.1 Conclusion

Shopping, one of the most compelling and enjoyable experiences for people
living today, was first designed as an architecture in the Parisian Passages of
19th century. In his research notes Passagen-Werk, Walter Benjamin wrote
that the glass-roofed, marble-paneled corridors with stores displaying their ar-
ticles in the show windows enabled the ephemeral life quality of middle-class
Parisians strolling in the Passages. This enchanting environment full of sensa-
tion and phantasmagoria gave impact to the United States since the beginning
of the 20th century, where the American citizens rode their automobiles with
the families to spend their time at the windowless department stores, like the
Sears. As decades passed by, mall designers have been challenging to design
the most exciting retail architecture they could think of, however it has not
evolved since the fully-enclosed type mall with scientific locations of anchoring
tenant stores by Gruen in the 1950's. This functional design was very popular,
however it has started to lose customer's interests as early as the 1980's.

To design a new mall from the traditional scientific mall design, Jon Jerde
creates malls with odd spatial rhythms with curvy roads and sudden drop-
offs. One of his masterpiece, Canal City Hakata, attracts many customers
to come and explore the unexpected in the unpredictable space. However
this approach of creating physically odd spaces faces many difficulties with
time, money, and flexibility. Common shopping malls in Japan today have
followed the traditional method of scientific design, which unfortunately leads

various problems as compared to the initial plan. Similar to Heart Avenue of iiasTsukuba, where the research was conducted in this dissertation, there are any places within the shopping mall where there are less people coming in as compared to the other parts of the mall. Renovating this area with methods of physically creating odd spaces with sudden walls or winding roads, is not the cleverest idea for shopping mall owners.

This dissertation presented AdaptivePassage model, a model driving customers into stores and encourage their shopping with intangible materials, and applied it to a ready-built retail architecture. Creating the wondrous atmosphere calling to their senses attracts their attentions, pulls them towards the stores, and produces a crowded mall. This model turns the existing commercial architecture adaptively into an environment full of prosperity by calling out to customers with various senses of smell, sights, sounds, and feelings of the space.

Based on a series of research, the key components of designing architecture with AdaptivePassage Model to drive the customers for shopping are (1) to sense customer behaviors, (2) to calculate its timings, and (3) to actuate intangible information related to the stores and its articles. From the user study testings in Heart Avenue of iiasTsukuba, it showed that sensing customer behaviors with sensors embedded into the architecture, calculating the exact timing to call out to which customers, and calling actuations with intangible information related to the articles of stores, do drive customers inside the stores and shop. This model and its system design can adaptively provide intangible information and also the wondrous experience as there were in the Parisian Passages. In this dissertation, I designed the most fundamental elements of designing retail architecture with intangible materials. Adding on the extra layer of ubiquitous computing technologies to the traditional brick and mortar layer of retail architecture is effectual for a new shopping mall design.

Almost all shopping malls face the renovation period. Some evolve, while some unfortunately devolve. Mr. Sasaki, the head general manager of iiasTsukuba, informed me an interesting story on a day in March 2013. "Our mall opened in October 2008. Most of the tenants that locate their stores in this mall have signed the contract of a 5 year rent. Sometimes there are tenants with 3 years, sometimes with 7 years, but most of the times it is a 5 year contract. Among the 220 tenants we have here in iiasTsukuba, 60 to 70 percent

of them have a 5 year contract. That means this year, in 2013, more than 100 stores are moving out of this mall. But of course, we cannot close the entire mall itself for the renovation, so we must have this huge store replacement movements little by little. Most shopping malls face this reshuffling period every 5 years in general, so we can evolve into a fresh new shopping mall once again." Figure 5.1 shows the complex situation of the renovation period of iiasTsukuba, with many new opening stores or vacant spots under renovation.

AdaptivePassage Model, intended for shopping mall owners or commercial architecture designers, is fruitful for renovating the existing static functional-style shopping mall into a dynamic architecture providing customers the enjoyable experience of shopping. With this model, the not-as-popular sub-stream passages which are created from the scientific location, will turn into a passage full of prosperity. In this research I also provided three methods to realize this environment in a shopping mall; (1) creating a sensing device responding to the presence of customers (2) creating an actuating device calling out to their five senses (3) designing both the sensor and actuator to fit into the environment. These three methods enable to create an additional layer of ubiquitous computing technologies that fits over the existing commercial brick-and-mortar architecture.

No mall stays the same forever. Malls owners are always strategically thinking about what stores are the trend-conscious, what stores can have the most benefits, what stores can attract visitors. They are conscious about what stores to have contracts with in the future, ones that they can create a good relationship both financially and aesthetically. Their malls need to attract the visitors that are loyal followers of popular trends and can easily feel enough of one thing. There must be something enchanting for them, every time they arrive to the mall.

AdaptivePassage can take part in this renovation era of shopping malls; for example, by putting the sensors and actuators into the entrances of the street of the store, it calls out to the customers passing by and attract them to come in towards them. Basically any type of retail store that is located in the area where there are not so many customers can utilize this model to call customers in. Several steps are required to call customers towards stores where there are renovation going on. First, it is necessary to research the store

Figure 5.1: iiasTsukuba under renovation period (as of Autumn 2013) (Courtesy to the iiasTsukuba website)

on what items are sold and what kind of customers are their main customers. Next, research what stores are located near and along the street it is located in. Then, choose the suitable theme for actuating intangible information for the entire street; either sounds, odors, or lights. From here, realizing the three key components of sensing customer behaviors, calculating the timings, and actuating those intangible information based on the three methods of creating the sensing device, creating the actuating device, and designing both of them to fit into the architecture, can create a calling passage.
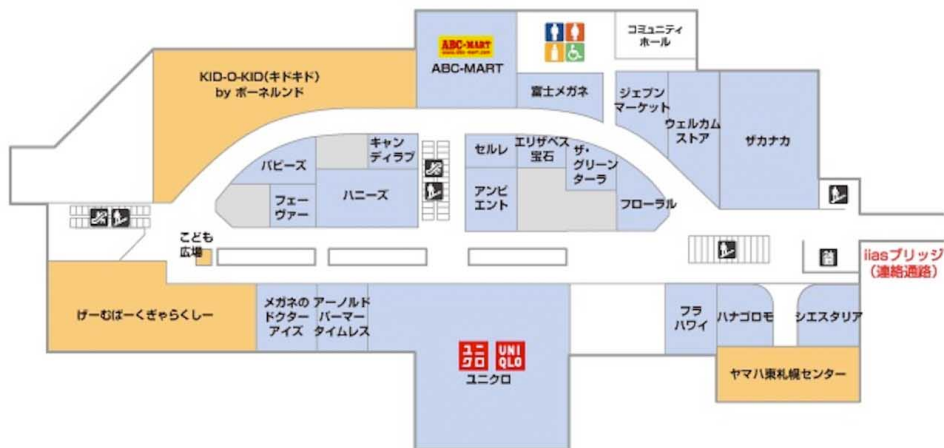

Figure 5.2: iiasSapporo shopping mall (as of Autumn 2013) (Courtesy to the iiasSapporo website)

This model can also be applied to a mall where there are hardly any customers at all. Daiwa House's shopping mall at Sapporo, called *iiasSapporo*[1] can become another example of the mall with this model implemented. "To be honest, our second mall iiasSapporo, has been facing more difficulties than iiasTsukuba," Mr. Murata, the general manager of iiasTsukuba had told me

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[1]iiasSapporo shopping mall. http://sapporo.iias.jp

his story working double as the general manager of iiasSapporo on top of that. "In Sapporo, there are less visitors in general. The architecture itself is smaller, and the location of the mall is a bit off the center of Sapporo city. If this project's work proceeds, we will definitely want to apply it to iiasSapporo as well." His ardent desire to call customers to the passages of iiasSapporo in general can become realized with AdaptivePassage model.

For example, first I would find out which of the places within the mall attract the most customers among the mall, which the possibilities are the restaurant zone, the grocery store, or the entrance near the parking lot or the station. In this case, perhaps it would be the food court placed near the iiasBridge in the right hand of the map of Figure 5.2. Next I would research the retail stores located around the area, which hardly attracts the customers. Then I would choose a theme that would make the space a merrier and entertaining place, and design the intangible information for the stores. From here on, the steps are the same as written above with the mall under renovation.

AdaptivePassage model, calling to the customer's senses to drive them into the stores and encourage shopping, can be realized by an additional layer of ubiquitous computing technologies on top of the current brick-and-mortar architecture. The three components of the model will weave into the architecture and naturally call the customers into the stores. AdaptivePassage model contributed to prove that using intangible materials as key components of designing architecture is effective for a new shopping mall design.

5.2 Further Discussion

This research has been taking place in a shopping mall and has actually implemented the integrated system inside the retail architecture. For future developments, these sensors and actuators implemented throughout the entire passage architecture would be connected into one network, to provide a more detailed interaction. Regarding the stream of thinking humans as self-driven particles rather than atoms, the sensors sensing customer's presence at each of the places can undergo an even more dynamic process of actuating intangible information into the place. This way, more complex interaction can be

designed and a more fulfilling shopping experience can be provided. The way of applying the models of physics and mathematics can effect a new way for urban design.

Irrational behaviors of humans and human behaviors in crowds are some next steps to challenge. This concern has been simulated as a theory and within a computer, but has not yet launched in a real human field. In the future, I would like to analyze human behaviors in more detail, and create a design regarding probability calculation to enhance not just the purchasing behavior but also more complex shopping.

Figure 5.3: Renovated Passages of Paris lacking Phantasmagoria

This model may perhaps transform the unfortunate Passages of Paris. Today in 21st century Paris, around a dozen of the passages still exist and are active, but it is not that all are preserved. Some has been renovated and turned into a completely different atmosphere, without the phantasmagoria. Passage du Havre (Left of Fig5.3) and Galerie Colbert (Right of Fig5.3) and two of the renovated Passages that unfortunately have no more phantasmagoria, and is no longer a place for strollers enjoyed their browsing and dwelling in the 19th century.

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Appendix A

Behind the Scenes

This is a narrative report on how this dissertation was developed, through the AdaptivePassage project which roots back in April 2010, where we first made the team concerning music in general.

A.1 July 2010, Initial Attacking Period

The project's thoughts back in the early years were to use music in a different way other than packaged CDs (it was still the main approach to sell music) and provide a new field for composers and players. The team members and I tried approaching various companies that we could think of by sending emails to the customer services. We approached companies on a variety of fields; those that operate hospitals or nursery homes, or at kindergartens or nurseries, train stations, airports, retail stores, shopping mall developers, theme parks, toy makers, or show rooms.

Among the 20 companies that we approached, three companies responded to our email in a positive attitude. One was a mobile telecommunication company, which were interested in a new way of distributing music over their communication platform. Another was a general trading company, which owned a small shopping center. Finally, Daiwa House replied to our email.

A.2 September 2010, Discussions with Companies

Our initial discussion among all three companies that gave us replies took place in this month. First we had a chance to talk with a mobile telecommunication company which were interested in music distribution. They seemed to want to create their own distribution platform to their mobile phone users, however it was not exactly what our team could provide. After this once and only talk, we could not have a chance to talk with them for the second time.

Then, we had a chance to discuss with a general trading company which owned a small shopping center near Daikanyama station. At that shopping center, they were struggling to attract customers to the complex itself. We had some discussion with the members of the trading company, and tried to figure out some ways to extend the visitors stay at the complex. Figure A.1 shows that location which we were targeting to design our sound installation.

In this shopping center, we focused on a water-fountain which existed in the basement floor. This floor had several cafes and a small rental studio. The water-fountain was placed in the center of the floor, which several visitors sat along the edge to have a brief rest. (See Figure A.2) We provided some sound installation plans to encourage their duration time to extend, with selected healing music being played according to the time of the day. These healing music will be played through a surround acoustic system with four different speakers surrounding the water-fountain.

Unfortunately, although we had about three sessions of discussions, this plan was not accepted by other members of the trading company and could not be realized. However, we learned that there may be some chances to provide shopping malls a sound installation that can attract customers to places where there are hardly any people currently.

Figure A.1: Shopping Center of our initially target at Daikanyama

Figure A.2: Place initially targeting to design our sound installation

A.3 September 2010, Discussions with Daiwa House

As written in Chapter 3, the AdaptivePassage project started from the simple message I sent to iiasTsukuba's customer service. Our first discussion session with the Daiwa House members took place on a day in September, 2010. They were interested in our idea to use music and sound installations to attract customers in the shopping mall. At this time, Daiwa House members gave us the out-mall of iiasTsukuba, called *Katsuragi Road*, which were struggling to have customers come to the area. (See Figure A.3) The owner, Mr. Sasaki, told us the story that they created this out-mall so it would become a walkway for the citizens in Tsukuba area, which did not have any shotengai or any walkways in general. So first, we decided to research and design a sound installation for Katsuragi Road to become a place of relief. (See Figure A.5)

Figure A.3: The out-mall which was our initial target place in iiasTsukuba

Figure A.4: Map of iiasTsukuba out-mall, *Katsuragi Road* (Photo of the signage placed at Katsuragi Road)

Figure A.5: Initial Installation plan at Katsuragi Road (Drawn into hand-out map of iiasTsukuba 2010)

A.4 February 2011, Experiments on Sound Installations at KMD

Daiwa House liked our plan of making Katsuragi Road into a place of relief, and were planning to kick off the project from April 2011. Before the launch of the project, we need to select what kind of speakers we will be using for the installation plan at Katsuragi Road. It required several types of speakers, including directional and parametric speakers. To decide which speakers to buy and install into Katsuragi Road, we had discussions with the HSS, TOA, Electri, and Totsu, the company which sold Bose speakers. We had the chance to test out which of the speakers were the most suitable for our design.
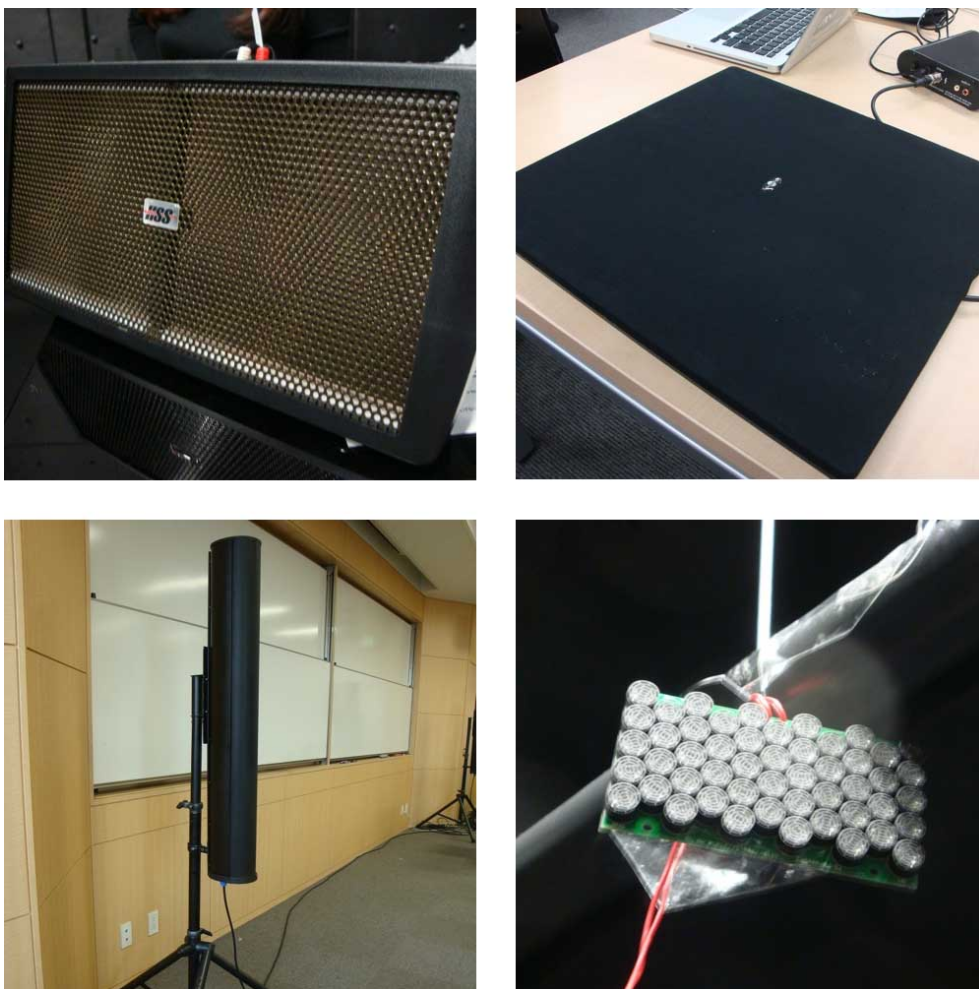
Figure A.6: Various types of speakers we borrowed and tested

Figure A.7: Testing effects of various types of speakers

A.5 March 11 2011, Earthquake

We were getting ready to launch the project from April 2011, but this day of the earthquake came and damaged everything completely. iiasTsukuba could not give us any response after this earthquake for nearly 2 months. They said they had to shut down the entire mall for more than a month, to get things fixed back in order. At this time, I thought that we would not be able to continue on the project with them.

Figure A.8: 3.11 Earthquake

A.6 June 2011, iiasTsukuba after the Earthquake

We received email from them two months after the earthquake. They said they were having a hard time with the low electricity, which was the government's objective. But they decided to continue the research project with us, so we had several discussions together about how to realize the project in such an intense situation. We also conducted some ethnography research in the mall with low electricity.

Figure A.9: Low electricity at iiasTsukuba

A.7 August 2011, Asking for Sound Experiments in Kyoseikan

Before actually putting the sound system into Katsuragi Road, the superiors of Daiwa House told us to show some prior examples that could be evidential to start the project. We decided to test some acoustic environments within our university. First, we wanted to test how sounds effect pedestrians at Kyoseikan, so we made plans to negotiate with the Keio Office.(See Figure A.10) Unfortunately the office said no.
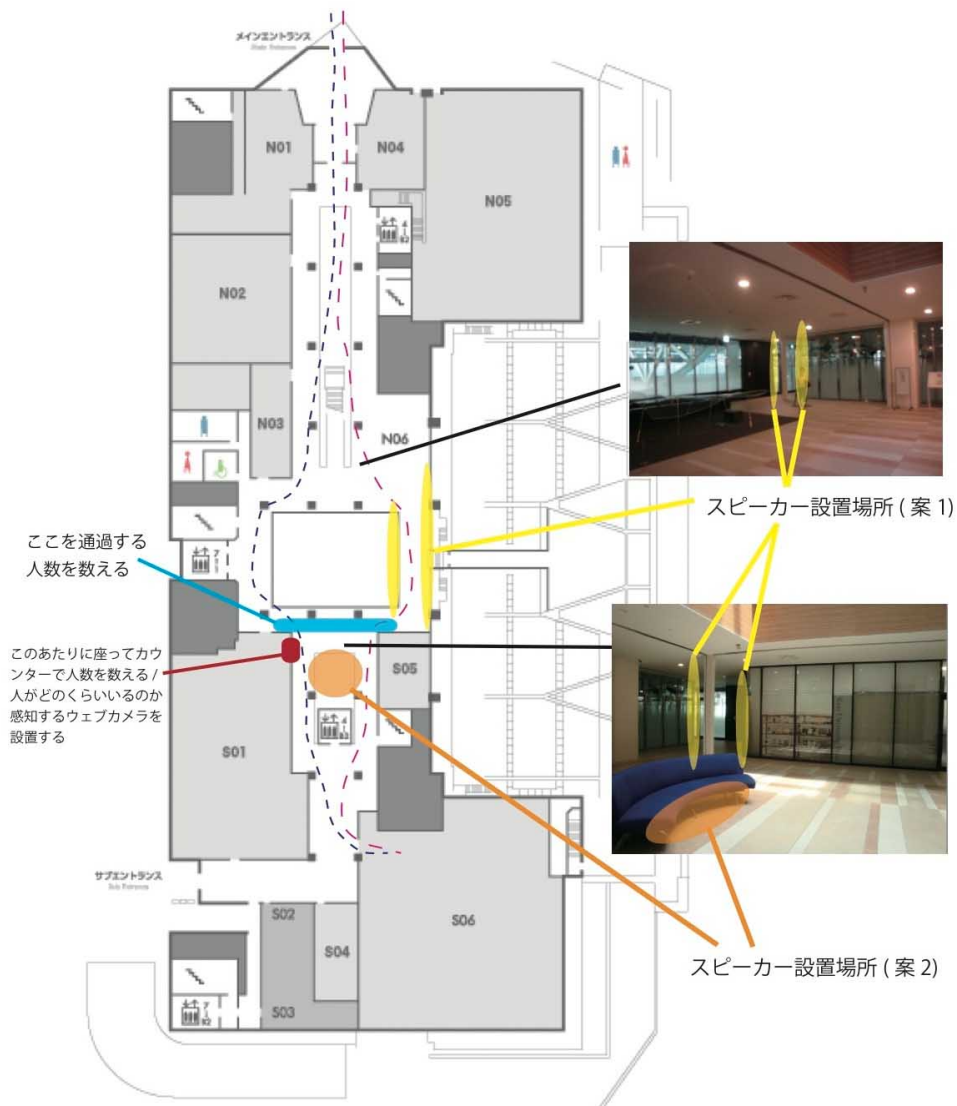
Figure A.10: Plans for Sound Experiments in Kyoseikan

A.8 September 2011, Initial Sound Experiments

Next we made a different plan using another building at our university. This time the office said yes, so we could conduct the experiment. It follows in Chapter 3.
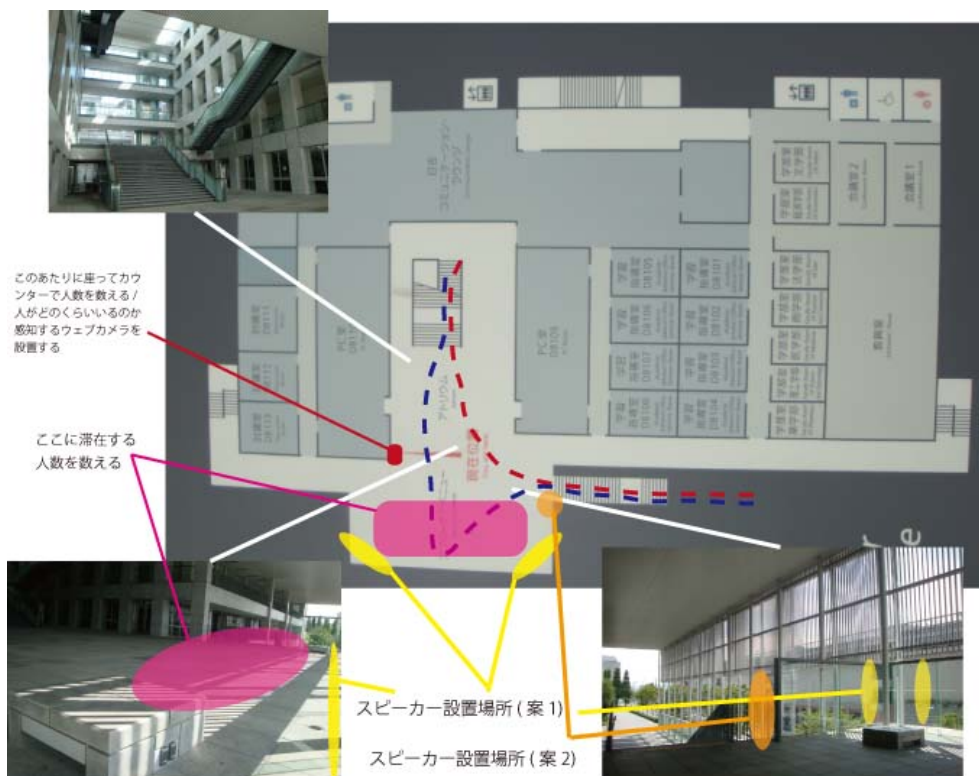
Figure A.11: Plans for Sound Experiments in Dokuritsukan

A.9 September 2011, Change from Katsuragi Road to Heart Avenue

One day in September 2011, we went to Tsukuba to have a discussion with Daiwa House members. They told us the surprising story that they wanted to change the field of sound installation from Katsuragi Road to Heart Avenue.

Figure A.12: Manager guiding us to Heart Avenue for the first time

A.10 March 2012, Concluding Contract

After a long discussion period, the project had finally started. We decided to install the plan as shown in Figure A.13.

Figure A.13: Heart Avenue Installation Plan
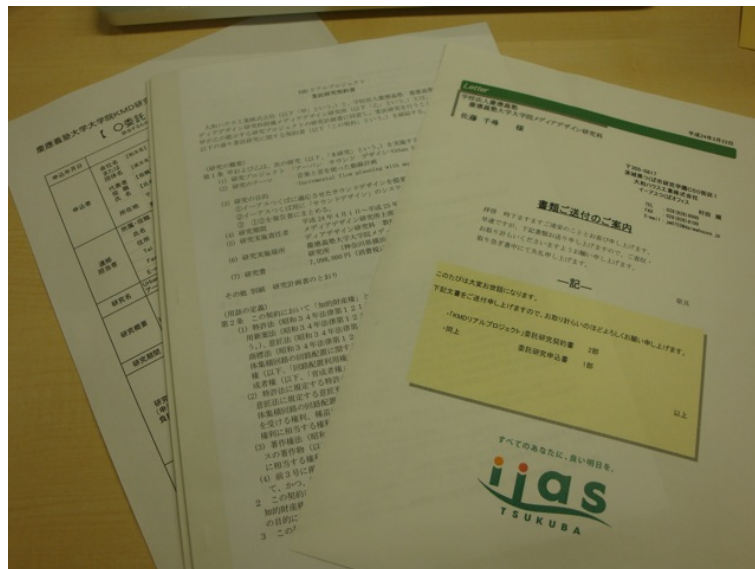
Figure A.14: Contract concluded

A.11   March 2012, Deciding Technology

Realizing our system required the iterative process of testing the technologies. We decided to put infrared LED sensors in the ceiling and reflective paper on the floor, but we needed to test how far away it can actually work in a real building environment. We had done several tests within our university to find the suitable plan.
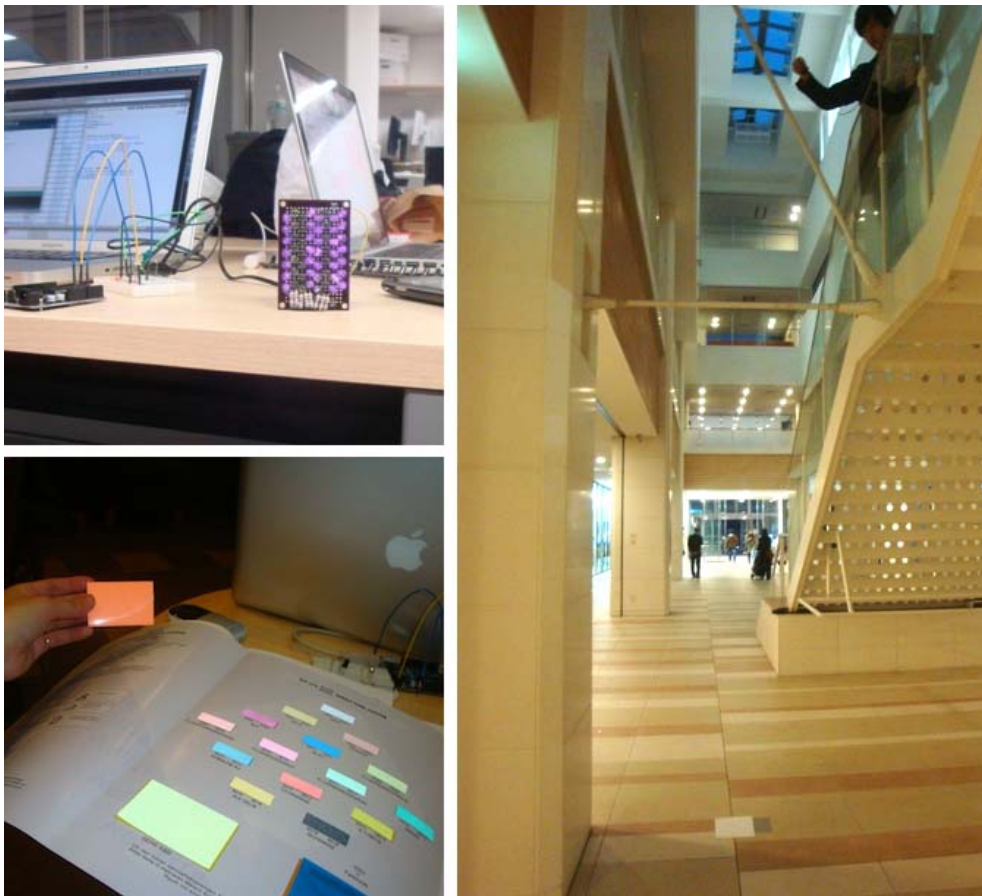

Figure A.15: Testing Infrared Sensors with Reflective Paper

A.12 April 5 2012, Deciding Design patterns

As soon as the project actually started, iiasTsukuba members and us discussed what kind of design to create on the floor in detail.
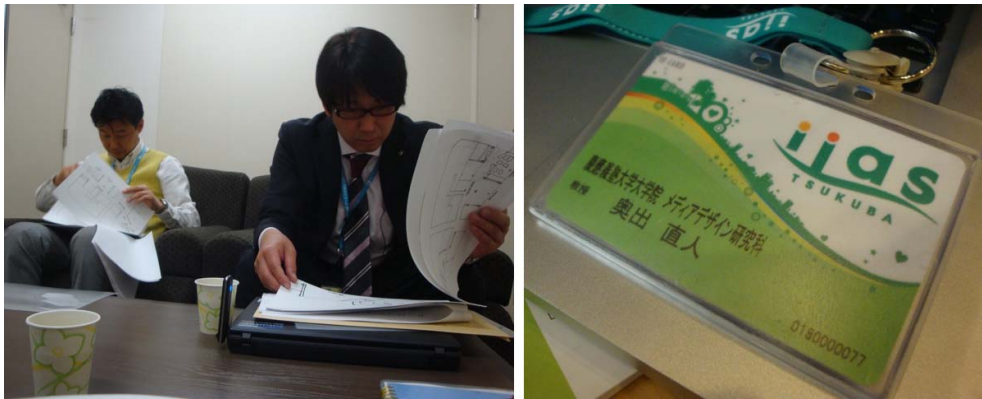

Figure A.16: Kick off meeting with Daiwa House Members

Figure A.17: Heart Avenue Implementation Plan

Figure A.18: Design plan patterns

A.13   April 16-17 2012, Construction

The days of construction started, which went on for 2 nights.

Figure A.19: Managing with the members of the construction

Figure A.20: Construction Process

Figure A.21: Putting Backyard Computer

Figure A.22: Putting Speakers in Ceiling
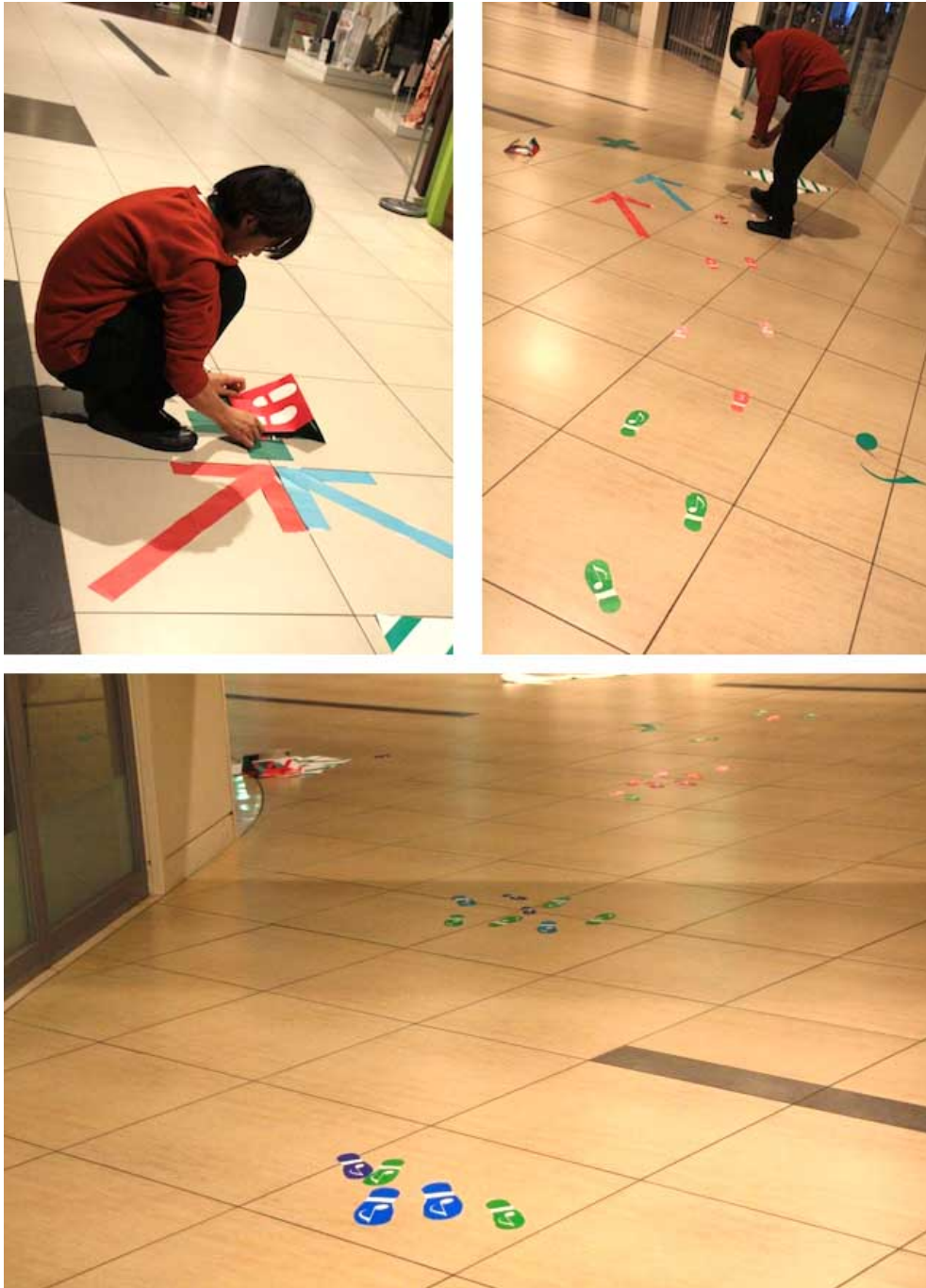

Figure A.23: Checking Inside the Ceiling

Figure A.24: Testing Floor Patterns

A.14 May 6 2012, Twister and Blackout

Unfortunately, the twister hit the Ibaraki area on the second day of the experiment. The mall went blackout for over 10 hours. We learned how important electricity and safety is to the shopping mall.

Figure A.25: Blackout at iiasTsukuba