DESIGNING TO LEVERAGE SPATIAL INTELLIGENCE TECHNOLOGY TO IMPROVE THE GROCERY SHOPPING EXPERIENCE

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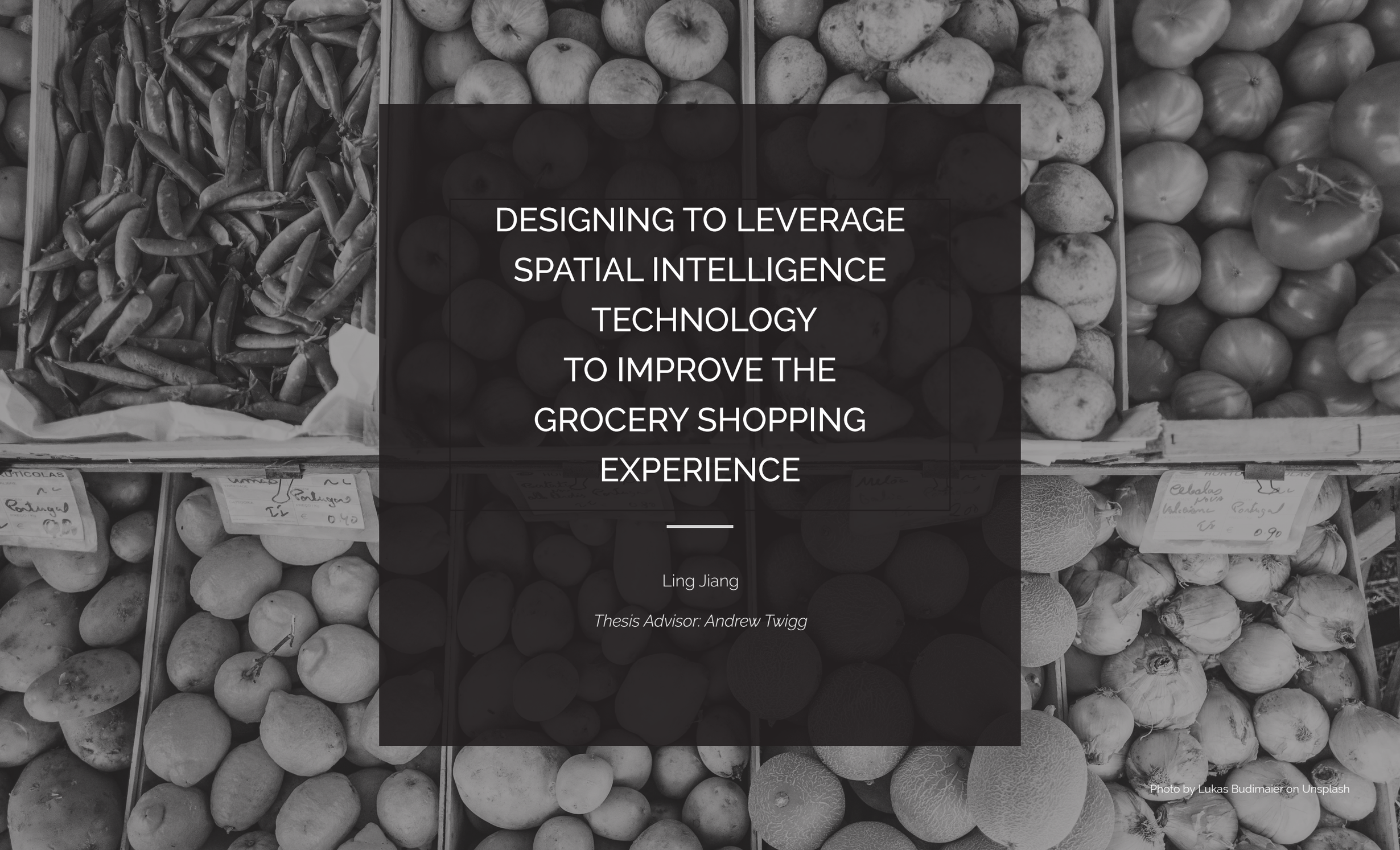

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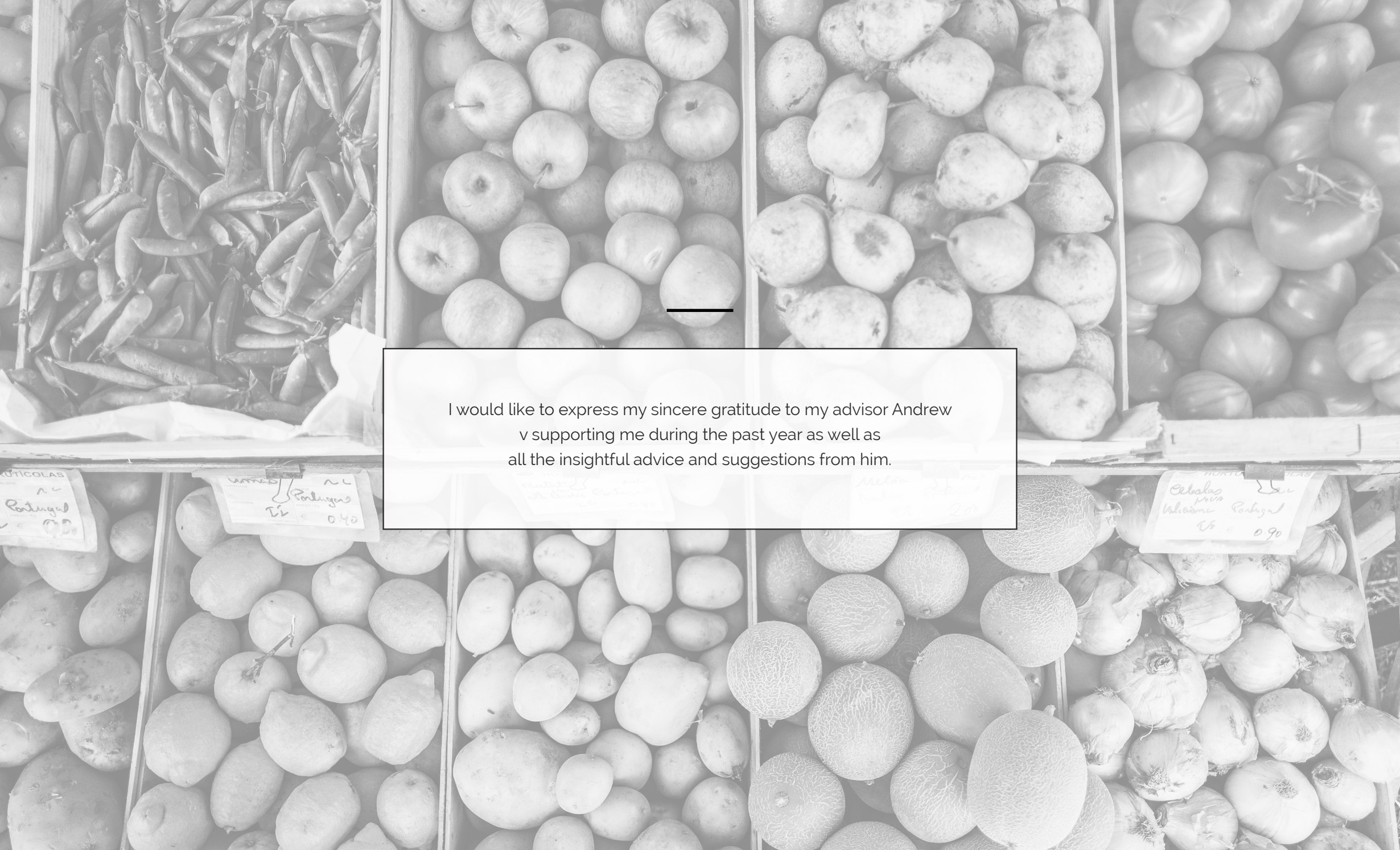

I would like to express my sincere gratitude to my advisor Andrew
v supporting me during the past year as well as
all the insightful advice and suggestions from him.

DESIGNING TO LEVERAGE SPATIAL INTELLIGENCE TECHNOLOGY TO IMPROVE THE GROCERY SHOPPING EXPERIENCE

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ABSTRACT

Facing the challenge of e-commerce, people assume that brick and mortar retail is in trouble. However, unlike other sectors, the grocery industry is booming.[1] Even though more shopping channels are available, more than 95% of people still purchase groceries in physical stores.[2] While new trends of grocery shopping are emerging-- such as the transition of household shopping from a matriarchal to a democratic process, and customers' inclination in emphasizing experience over price—shoppers' needs are changing and cannot be simply satisfied within a traditional retail context.

Using mobile and sensor data, retailers have been shaping their business models while learning customers' preference and Behavior patterns. As spatial intelligence technology multiplies, the power of the data goes beyond site planning.[3] It demonstrates its ability of radically changing the food shopping industry. With the context of advanced spatial analytics, this thesis explores the potential of spatial intelligence application in improving grocery store shopping experience.[4] Based on the design opportunities I defined from a series of research, the design solution I present is a shopping service platform. This platform helps retailers to better engage with their customers while adopting spatial analysis and artificial intelligence to provide personalized and holistic shopping experience.

[1] Skrovan, S. (2017, January 11). The state of the grocery shopper in 2017. Retrieved May 15, 2018, from https://www.retaildive.com/news/the-state-of-the-grocery-shopper-in-2017/433815/

[2] "How Do You Normally Purchase Groceries?" © Statista 2018. June 2017. https://www.statista.com/statistics/292933/us-shoppers--primary-food-shopping-locations-by-type/.

[3] Micek, B. (2017, August 02). Why The Future of Food Depends on Location Intelligence. Retrieved from https://carto.com/blog/why-future-of-food-depends-on-location-intelligence/

[4] Torre, J. D. (2017, December 20). How Location Data Can Revolutionize Retail. Retrieved from http://www.mytotalretail.com/article/how-location-data-can-revolutionize-retail/

PROJECT GOALS & SCOPE

1.1 Introduction

In this digital age, customers are unprecedentedly empowered by advanced technology and abundant information. Simply providing merchandise is not enough for retail customers. What they are seeking is a smart, tailored, high-quality shopping experience.[5] Facing emerging opportunities and challenges, the retail industry is undergoing enormous changes.[6] Enlarging the investment in spatial intelligence, innovative retailors try to create new business model while deeply understanding their customers.[7]

Although the increasing number of online shoppers implies an obsolescence of brick-and-mortar retailing, the fact is the opposite.Research indicates that the booming of online shopping does not eliminate customers' desire to shop in physical stores.[8] Retails are not pitting one business format against the other. Instead, they unify them all in a new format called brick-and-click.

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[5] Evans, D. S., & Schmalensee, R. (2016, May 30). The Best Retailers Combine Bricks and Clicks. Retrieved from https://hbr.org/2016/05/the-best-retailers-combine-bricks-and-clicks/ Harvard Business Revi

[6] Elliott, C. (2018, February 06). Location Intelligence, Personalization And The Changing Face Of Retail Success. Retrieved from https://www.forbes.com/sites/esri/2018/02/06/location-intelligence-personalization-and-the-changing-face-of-retail-success/

[7] Columbus, L. (2018, February 12). What's New In Location Intelligence For 2018? Retrieved from https://www.forbes.com/sites/louiscolumbus/2018/02/11/what-new-in-location-intelligence-for-2018/#cbfd02a14b5e

[8] Zaczkiewicz, A. (2016, November 4). How Using Geospatial Data Can Drive Retail Sales. Retrieved from http://wwd.com/business-news/business-features/pitney-bowes-bid-data-joe-francica-10699228/

Online shopping experience changed the customers' expectation for retailors in all dimensions.[9] For example, based on shopping history, Amazon provides real-time recommendations for online shoppers. This feature did not exist until online stores started to analyze customers' shopping behavior using big data. But now, customers expect the same level of personalized shopping service within offline stores. In this scenario, spatial intelligence is inevitable for business to achieve this goal. Revealing the relationship between customers' in-store locations, operational data and their purchase behavior, retailors can provide the right information at the right spot.[10]

"The retail sector is going through a fundamental change as companies find new ways to use data and intelligence, Artificial intelligence is now a part of the fabric, and we're seeing faster adoption of new technology than ever before." [11]

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[9] The Top Trends in Supermarkets for 2017 | Imperial ... (n.d.). Retrieved from https://www.bing.com/cr?IG=98502D815F484F3098590155CCC60672&CID=233CF82104C76F0A0E00F3D005686ED8&rd=1&h=FnXTG6DqILWnwOEw8iHuJLxheQxsPdlDH5gdr6DlYOo&v=1&r=https://www.imperialdist.com/top_trends_supermarket_2017/&p=DevEx.LB.1,5070.1

[10] How Digital and Location Intelligence are Remaking Retail. (n.d.). Retrieved from https://www.esri.com/about/newsroom/podcast/how-digital-and-location-intelligence-are-remaking-retail/

[11] Bhattarai, Abha. "5 Ways the Future of Retail Is Already Here." The Washington Post. January 16, 2018. Accessed May 01, 2018. https://www.washingtonpost.com/news/

1.2 Design Scope

IThis thesis attempts to investigate how spatial analysis technology can benefit grocery shoppers through providing holistic shopping experience. To understand grocery shoppers' demands and pain points, I conducted a series of research explorations, which includes research survey, interviews, user shadowing, observation, user-testing and prototyping. Through synthesizing the main learnings, I found four main design opportunities in this area:

- Making grocery shopping more efficient;
- Ameliorating shoppers' mental load;
- Integrating fragmented online and offline information;
- Exploring more intuitive communication method.

The solution I present here is a shopping assistant platform called LUMI. It provides a consistent food shopping experience for users while connecting the pre-shopping, in-store and after shopping scenarios. For the pre-shopping preparation, an AI assistant enables users to easily create shopping lists. While shopping in a store, real-time AR display and filter tools enable shoppers of better decision-makings. After leaving the store, people can share their reviews and recipes with their friends. Also, they can get grocery delivery from their neighbors by using LUMI. With LUMI, online and offline shopping will be more seamlessly merged and customers can better enjoy their grocery shopping.

EXPLORATORY RESEARCH

Interested in retailing, I began exploratory research with online secondary reviews about this industry. The retail sector plays a vital role in U.S. consumer-driven economy. The amount of profit generated by retail industry proximately equals to 5.9 percent of the nation's gross domestic product.[12] As both the digital and physical shopping channels increasing, the retail landscape is shifting and transforming dramatically. Meanwhile, emerging and innovative technologies also bring new opportunities and possibilities to this area. With the rapid growth of Internet of Things (IoT) technology, spatial intelligence shows its potential in providing business insights and personalized customer experience which were not feasible in the past.

[12] Amadeo, Kimberly. "The Retail Industry and Its Impact on the Economy." Balance. February 26, 2018. https://www.thebalance.com/what-is-retailing-why-it-s-important-to-the-economy-3305718.

2.1 Online Survey and Secondary Review

Attempting to gain a fundamental understanding of today's grocery shopping, I created an online survey. The fist purpose of this research survey was to confirm the assumption that the majority of consumers still prefer shopping for groceries in brick-and-mortar stores. Secondly, I planned to narrow down the target audience based on the participants' demographic information.

According to the survey results, 82.22% of people shop for groceries online less than once a season. In other words, they showed an obvious inclination to shopping for groceries in physical retailors. This data was consistent with my learning from online secondary research. The statistical data I found on Statista also supported this conclusion.

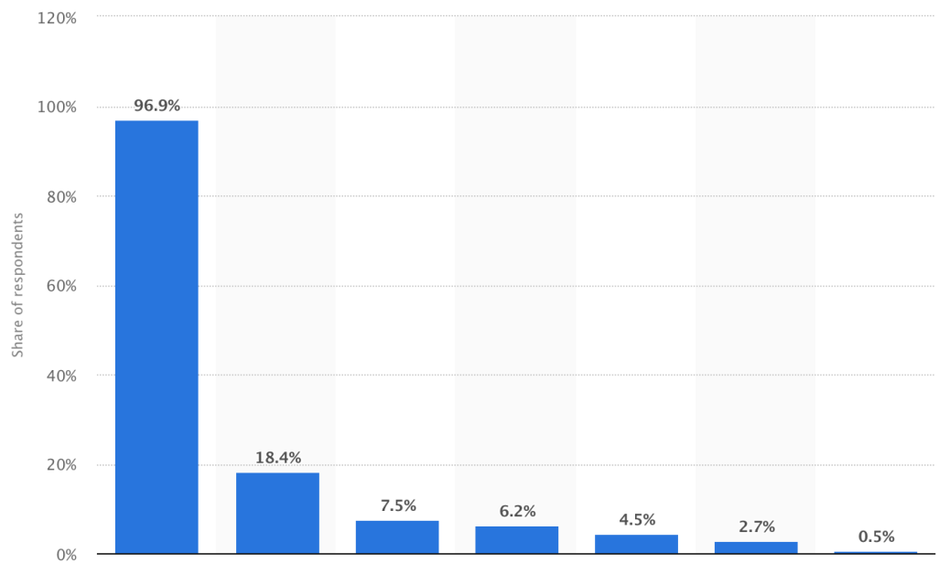


Figure 2.1.1
Statistic Diagram | "How do you normally purchase groceries?"[13]

[13] "How Do You Normally Purchase Groceries?" © Statista 2018. June 2017. https://www.statista.com/statistics/292933/us-shoppers--primary-food-shopping-locations-by-type/.

Moreover, among the 46 participants, I noticed that most of the questionnaire participants were relatively young—between 18 to 44 years old. Many of them were only in charge of their own grocery shopping. Many of them were only in charge of their own grocery shopping. The major types of products they purchased in store were foods, while there were multiple factors that could influence their shopping decisions. Thus, I scoped down the design territory to focus on food shopping within grocery stores. Also, I defined the target audience

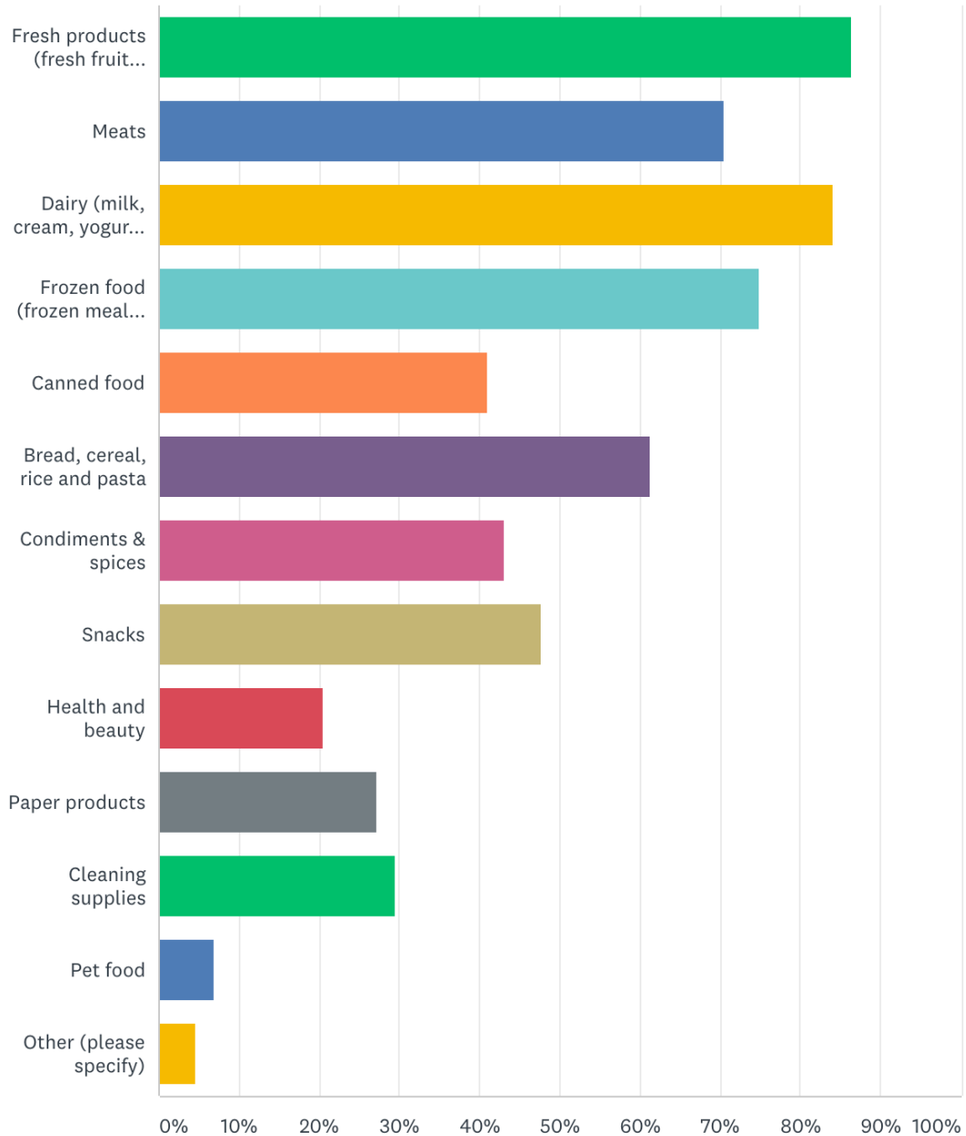


Figure2.1.2
Survey Summary Diagram | "The Products You Usually Purchase in Physical Retailers."

2.2 User Interview and Observation

Aiming to understand grocery shoppers' needs and expectations within brick-and-mortar stores, I started user interviews and observations.
There were three major goals during this research stage: First, understand how customers are different from others and how can I group them to create representative personas; Second, understand their shopping and decision-making process, and pinpoint how can spatial intelligence facilitate better shopping experience; Last but not the least, target the pain points for shoppers and identify the design opportunities for innovative technology.

3.2.1 User Interview

I recruited and interviewed 12 grocery store customers. They were asked to recall their challenges and happy moments they had in grocery stores. The shoppers I interviewed had different background and shopping habits. The major information I gathered in this stage was their general thoughts about grocery shopping as well as their shopping habits and preference.
The main takeaway from these interviews formed the design principles and implications I would follow later in design:

1. Customers have an intimate relationship with products while grocery shopping, which should not be eliminated. From my point of view, it was also the reason that people stick to shopping for food in physical stores. As an interviewee shared with me:" Food is something I have a relationship to, I want to be connected to my food."

2. Instead of creating something new to replace the current business model, we should use technology to bridge the gap between online and offline shopping experience; in other words, between digital information and physical context. To quotes a participant's words: "I enjoy online shopping, and I would love to experience the same level of service in stores." The design solution should be a brick-to-click type of service.

3. Everyone is shopping but everyone has different expectations. Different from the old days, in today's grocery stores, a lot more factors impact shopping. Beyond price, taste and convenience, shoppers are seeking to shop their values. "It's this type of values-oriented shopping that will play an important role in years to come, propelling retailers to improve their offerings."[14]

4. The retailers need to do more curating. They should help consumers make the best choices. Give them guidance. Make that visit to their stores more memorable, not just functional. Shoppers also want to feel a connection to their stores, and have it reflective of their community.

[14] Skrovan, Sandy. "The State of the Grocery Shopper in 2017." Retail Dive. January 11, 2017. Accessed May 15, 2018. https://www.retaildive.com/news/the-state-of-the-grocery-shopper-in-2017/433815/.

2.2.2 User Observation

While learning a lot of high-level thoughts and ideas from interviewees, I found it was hard for people to recall the details of a previous shopping experience sitting in a design studio. Thus, I shadowed research participants in physical stores in order to better observe and understand their shopping behaviors. I took notes to document the key learnings through observation, and created a user journey map of the shoppers' behavior.

Walking through the whole shopping process, despite of all the small pain points, I notice that something is missing in current shopping scenarios. The existing grocery shopping is separated from the holistic food experience. Although there are developed business models to support customers to accomplish various tasks, such as online shopping, offline shopping, making comments and sharing recipes, the gaps between these service need to be bridged to enable customers enjoying a better shopping experience.

Even though shopping can be individual activity, social factors still plays a vital role while shoppers making buying decisions. Decision-making is complicated, and social-based information can benefit shoppers to shop more efficiently and correctly. This information can come in the form of recommendations from families, a dish shared with friends in the past, or even a YouTube cooking video the shopper watched online.

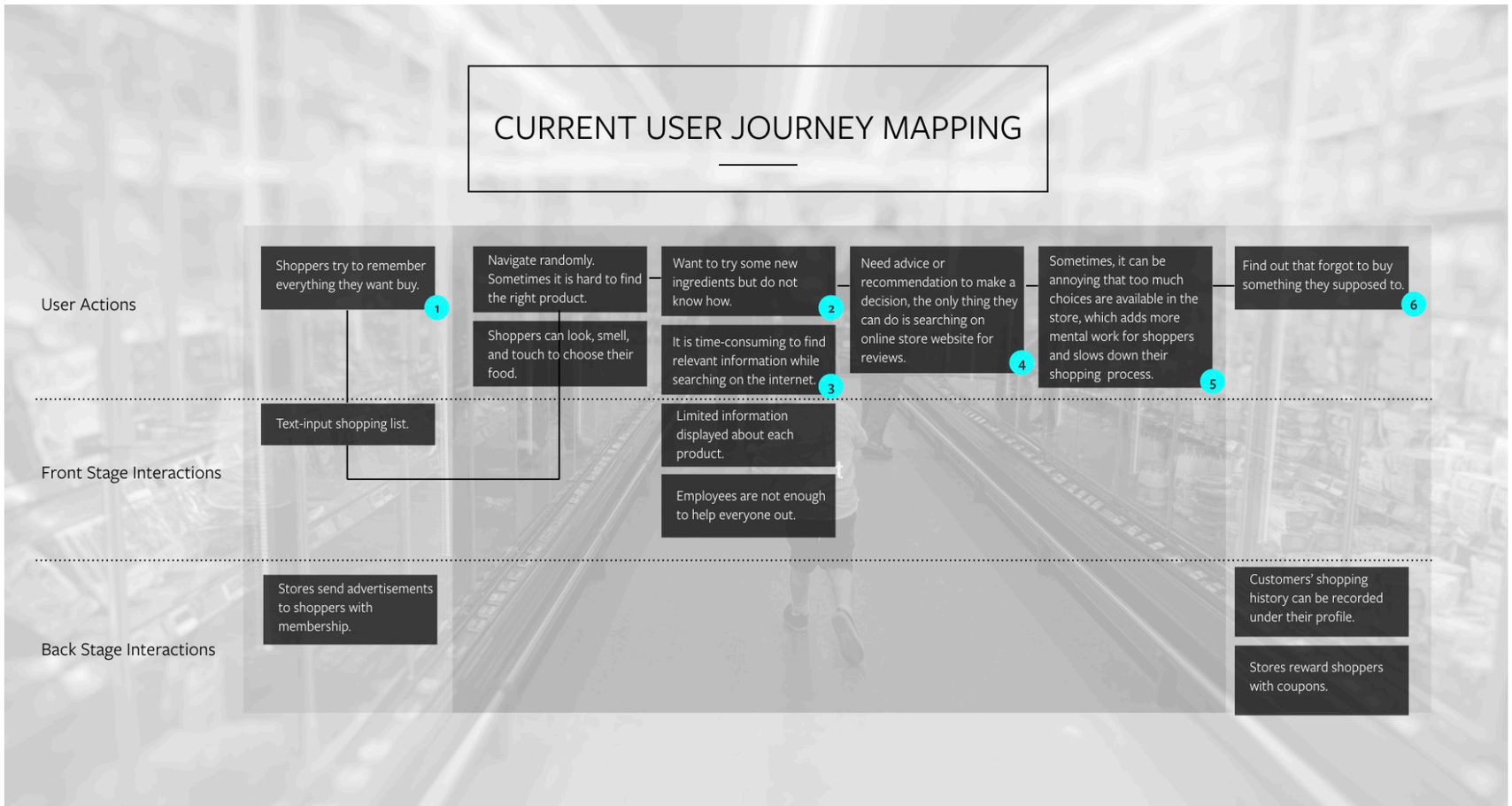


Figure 2.2.1
Grocery Shoppers' User Journey Map

2.3 Personas

One important fact I learned from interviews was that although I narrowed the target audience to be young professionals and students, there are still various types of shoppers. Even for one individual, he/she has different shopping demands and pain points based on the variety of his/her schedule, budgets, diet plans, social life from time to time. Thus, instead of diving deep into a small group of customers, I find it necessary to understand diverse shoppers. Based on their shopping behavior patterns, I categorized them into four main personas.

Also, I analyzed the shoppers I interviewed and observed. Based on their needs, habits, and shopping behavior patterns, I categorized them into several main personas. These personas not only enabled me to better understand and prioritize the insights I learned, they also laid a solid foundation for screening participants for later user testing.

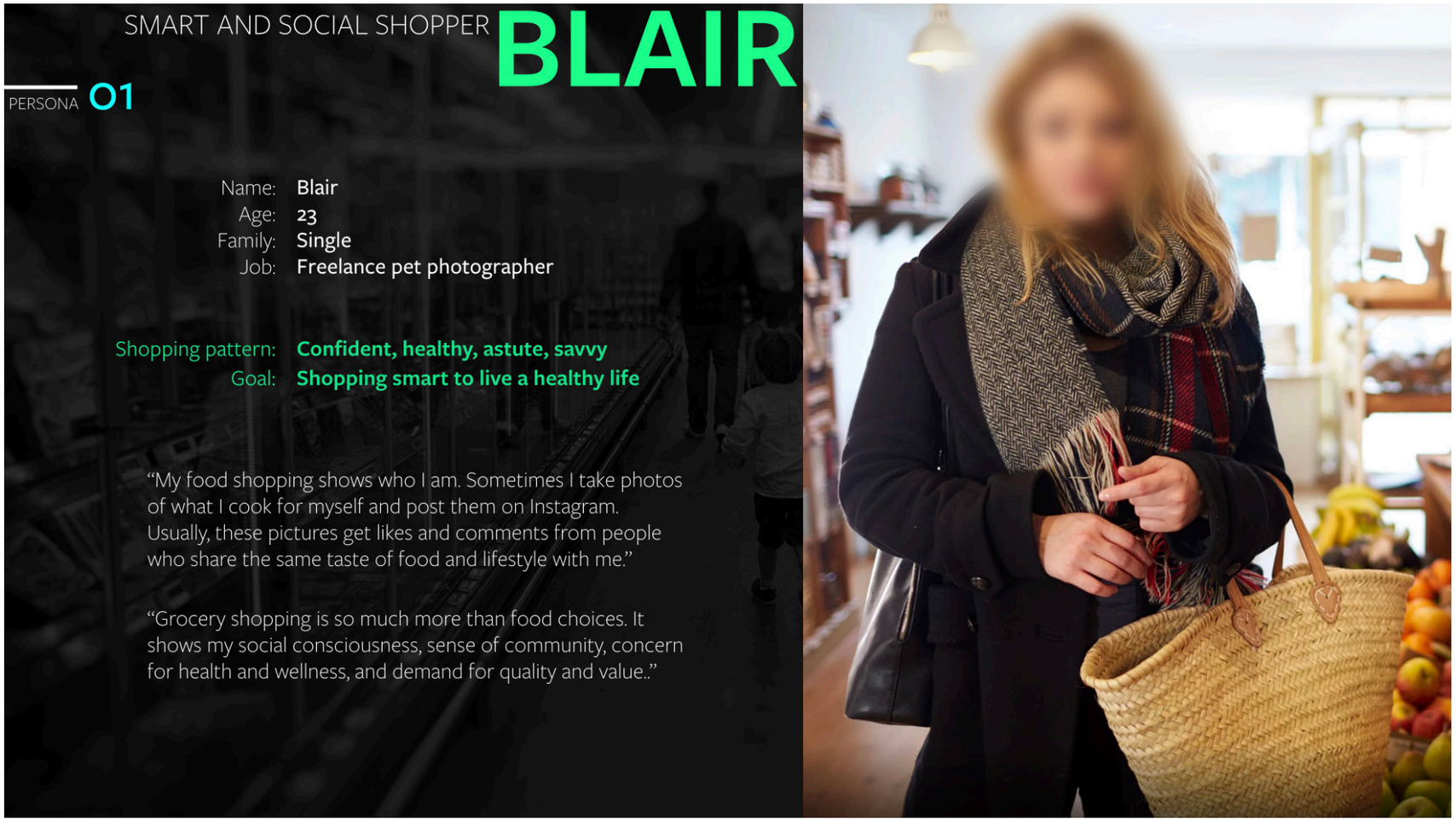
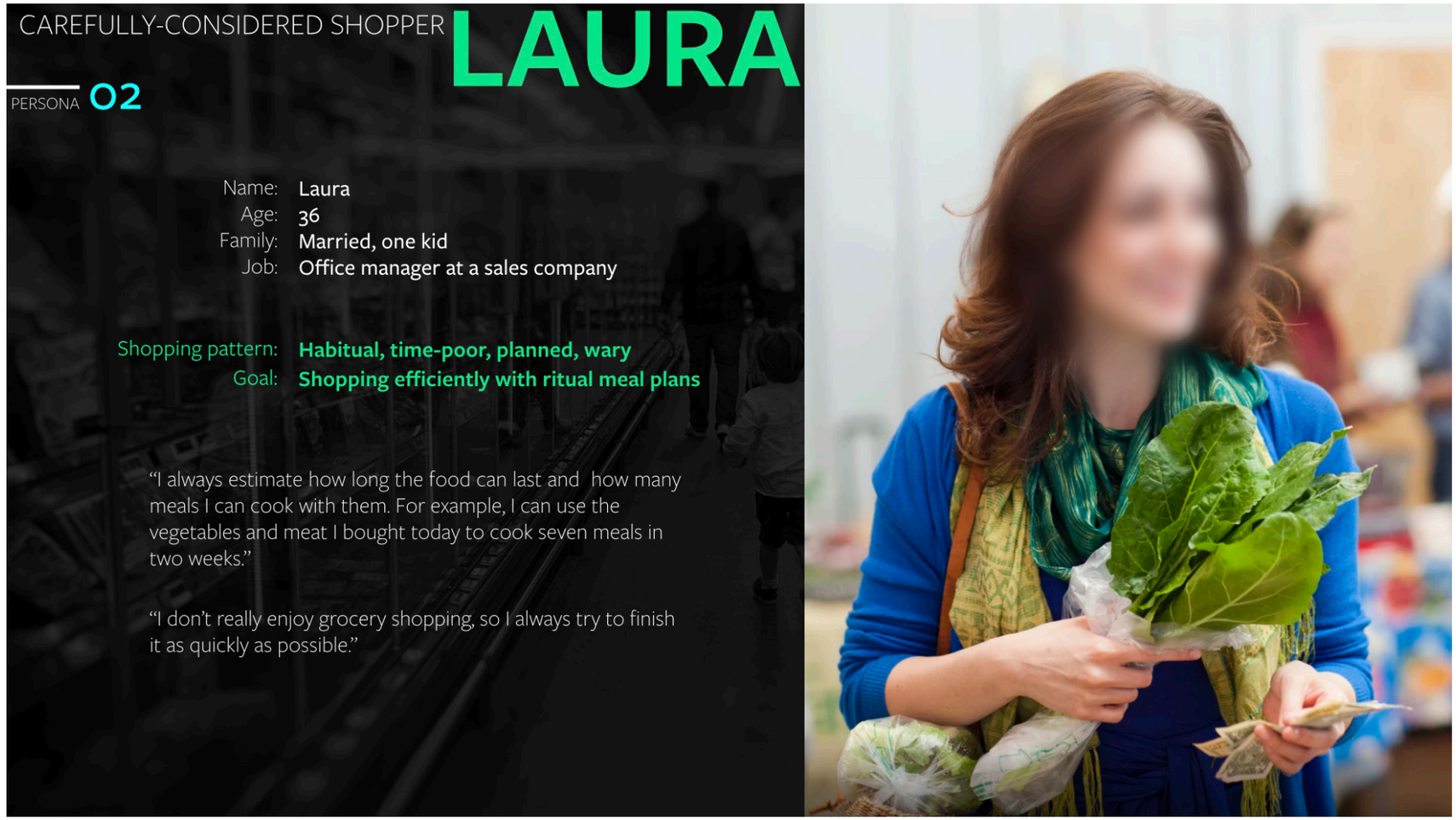


Figure 2.3.1
Personas | Smart and Social Shopper

1. Smart and social shoppers are a group of customers who already have certain knowledge of food, health and related shopping. They have relatively high standard about grocery shopping and feel confident about it. Besides, most of them are into cooking and tend to keep updating their knowledge.

Figure 2.3.2
Personas | Carefully-considered Shopper



2. Carefully-considered shoppers are habitual ones. They are also experienced customers and usually shop for ritual meal plans. Because of the limited amount of time they can spend on cooking, they are conservative and barely explore new foods.

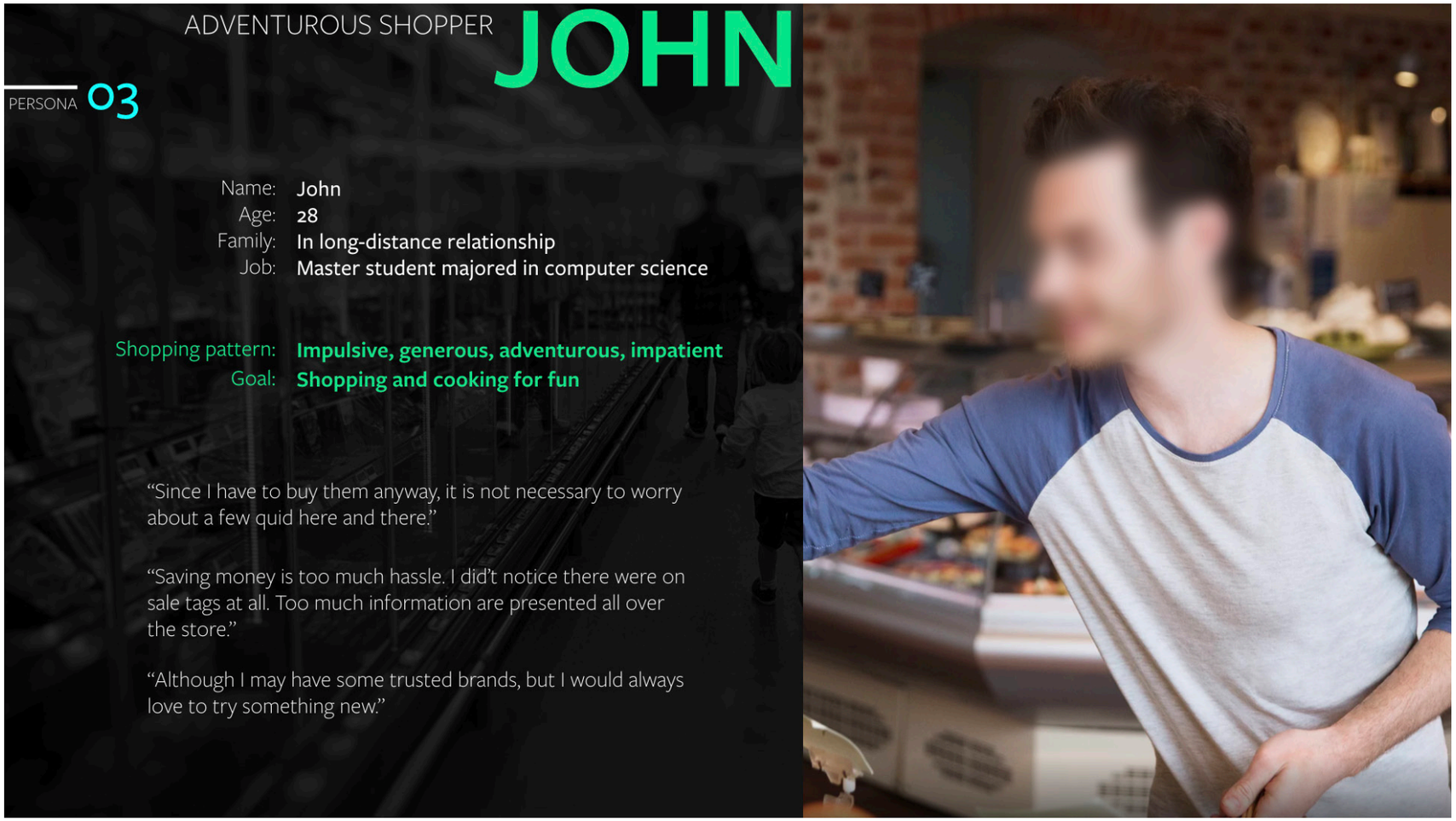
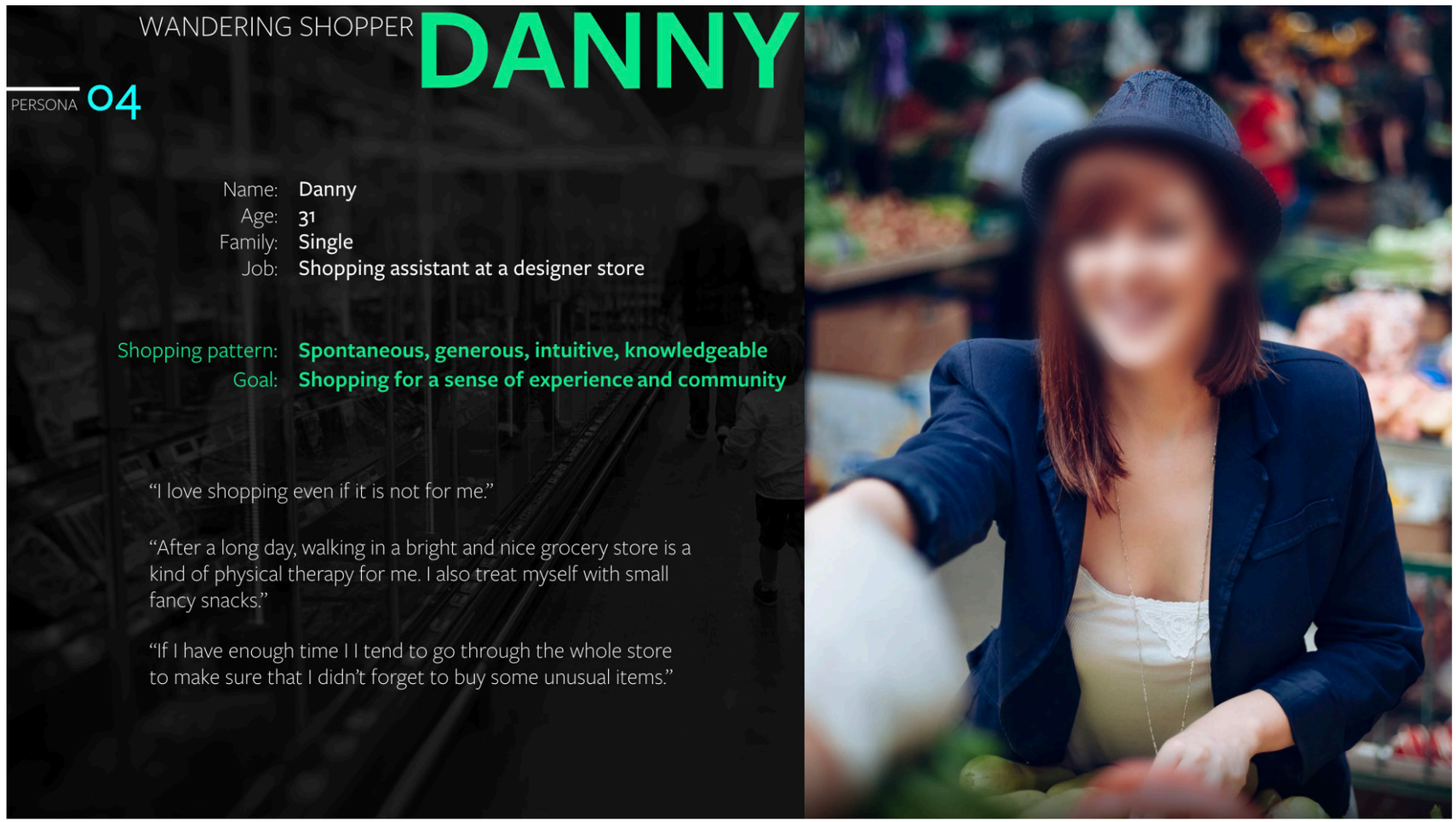


Figure 2.3.3
Personas | Adventurous Shopper

3. Most of adventurous shoppers are inexperienced. They do not have a lot of knowledge about food or cooking, and they barely plan for shopping. But they are always willing to be creative and try new things.

Figure 2.3.4
Personas | Wandering Shopper



4. Wandering shoppers are people who really love food shopping and cooking. They would like to spend extra time in grocery stores exploring new products and ingredients. Furthermore, they are seeking for values beyond shopping, such as personalized shopping service or a connection with the store and the community.

SYNTHESIS

With all the insights that I collected from the primary and secondary research phases, I started to synthesize them into main pain points. The goal of this stage is to reframe the design question to be more concrete ones and narrow down the design scope into specific directions. The design methods I used included rose, bud and thorn, affinity mapping and persona creation.
Rose, bud and thorn diagramming helped me to categorize the data I collected. Using this method, I was able to have a better understanding of the valuable touch points which should be maintained and the catchy ones which needed to be solved.
Through affinity mapping, I summarized these pain points faced by grocery shoppers into main problematic scenarios. Later, I transformed these scenarios to be design opportunities for spatial intelligence to make impact.

3.1 Main Pain Points

Although for the food lovers and experienced shoppers, the ideal shopping scenario may be wondering around in grocery stores while planning meals. However, because of the fast-tempo modern lifestyle, they usually have limited time for shopping. Thus, efficiency becomes a concern shared by most of the interviewees from my research. Even though grocery shopping is a day-to-day activity, it is not as simple and easy as it could be. Navigating in an unfamiliar large store while looking for some specific products is one of the worst scenarios. Additionally, comparing similar products can be annoying, which means scanning product details printed in extremely little font size one feature after another.

There is a lot of information and calculation for customers to keep in mind. Although most of previous user interviewees agrees that a shopping list is useful, they rarely use one. During shopping, shoppers try to recall from memory all the items they want to purchase. Based on the location of these items, they plan a routine while navigating in a store. To save some money, they must pay attention to all the discount tags. Also, calculating and comparing similar products is troublesome. Shoppers must scan, search, and compare for products one by one in an overwhelming environment loaded with information. Shopping is mentally exhausting.

Decision-making is complicated. Even though the financial risk of trying new products is relatively low, most people don't like the idea of being adventurous. To make a right decision, shoppers need relative background knowledge, recommendations from friends or families, or even a recipe from a YouTuber they follow. With all the information displayed in a store and the attendance of shop assistants, shoppers cannot take advantage of integrated data and knowledge.

There were some international students among my interviewees. They brought up the topic of multicultural needs, which overlaps with one of the top trends in supermarkets for 2017— A recent Nielsen study projects that the buying power from the Hispanic, Asian and African-American populations will be 17% of a $4.2 trillion market.[15] One thing the international students complained about was the poor-translation of food. According to their words it can be hard to describe an exotic food ingredient in words, which is frustrating. From my point of view, the first step is to eliminate the barriers in translation. Maybe it is about to find a better way to search products without calling its name.

3.2 Design Opportunities

The future grocery store will need to be a place that not only provides high quality food but also, the better customer shopping experience. It is a place that enables people to enjoy easy and mindful food shopping while merging the gap between online shopping and offline shopping. The insights from research shows that tailoring food relevant information for customers will be the one of the keys to help shoppers to make better decisions. In this area, spatial intelligence show its potential to connect people, physical space and objects to provide a holistic shopping service.
The design opportunities for this study:

How might we improve the efficiency for grocery shopping?

How might we ameliorate shoppers' mental load?

How might we integrate fragmented information to support better decision-making?

How might we provide an intuitive communication method to replace poor translation?

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[15] The Top Trends in Supermarkets for 2017 | Imperial ... (n.d.). Retrieved from https://www.bing.com/cr?IG=98502D815F484F3098590155CCC60672&CID=233CF82104C76F0A0E00F3D005686ED8&rd=1&h=FnXTG6DqILWnwOEw8iHuJLxheQxsPdlDH5gdr6DlYOo&v=1&r=https://www.imperialdist.com/top_trends_supermarket_2017/&p=DevEx.LB.1,5070.1

IDEATION

With the defined design opportunities as the basis for exploration, I began brainstorming ideas in storyboard and physical form, bucketing the ideas that emerged into the larger opportunity areas I'd defined through research. These ideas went wide----from in-store navigation system, to schedule-based meal planning assistant, to shopping and pick-up community. After brainstorm with post-it notes, I grouped them for patterns that might point towards a definition of future grocery shopping within the context of 21st century. Rather than a single tool or technology, my synthesis revealed the need for a system-level solution that will likely involve several different technologies working together to support shopping activities.

4.1 Initial concepts and speed-dating

Based on the main pain points I summarized before, I started to generate initial concepts with sticky-notes. Comparing to build a magic sci-fi future, I would rather to create a design solution which can be implemented within a short-term future. After discussing with my advisor, I narrowed down these ideas and focused on the most practical ones. To better iterate these scenarios and concepts, I created a series of storyboards. Each of them started from a concrete problematic scenario and ended being solved in a creative way.

With the frame of previous personas, I recruited four types of grocery shoppers as the participants of concept speed-dating. I conducted the speed-dating in four steps:

- Illustrated a pain point and a problematic scenario;
- Explained a possible way to ameliorate it;
- Asked participants for both positive and negative comments on the idea;
- Invited them to share their ideally magic solution with me.

Shaped by the findings from the speed dating, the design opportunities were reframed to be more concrete and accurate:

- Findings necessitate a shopping-list assistant
- Recommendations and suggestions from acquaintance plays an important role while the shopper makes decisions;
- Object-triggered search has the potential to empower grocery store customers to expand their choices and enjoy a full-range nutrition intake;
- Being overwhelmed by the information displayed in physical stores, shoppers need a new way to search and screen data;

Based on feedback from speed dating, I synthesized the key features of the final solution to be:

- An AI shopping assistant;
- Social-based shopping recommendation system;
- Object-triggered recipe and nutrition plans;
- AR irrelevant information blocking.

Figure 4.1.1
Storyboards for Speed Dating

4.2 Prototyping

Breaking down the food shopping into pre-shopping and in-store shopping activities, I created different mock-ups for the refined concepts based on different user interactions. Since I plan to provide design solution for short-term future with in five years, personal cell phones will probably still be the most ubiquitous and convenient mobile hardware by then. A screen-based product was necessary to integrate the holistic experience. However, within the context of a physical store, to merge the gap between physical context and digital data, more intuitive interactions such as AR display and haptic interaction would play the key roles.

4.2.1 Screen-based UI mock-up for AI assistant and AR display

From exploratory research, I learned from the shoppers that the moments they wanted to update shopping lists ware fragmented, which was the reason that creating a list was troublesome. To ameliorate this situation, I planned to provide various input methods for shoppers to achieve their goals. For example, a user can simply share a YouTube cooking video with the AI assistant to add all the items from the recipe to his/her shopping list. AI assistants are already a mature concept users are familiar with and have no obstacles to accept or use. Using sketch and InVision, I created functional mock-up for screen-based user-testing. During the speed dating, most participants liked the idea of generating shopping list with multiple-channel information. Moreover, some of them suggested that the AI assistant could be capable of more tasks. It could even become the system itself.

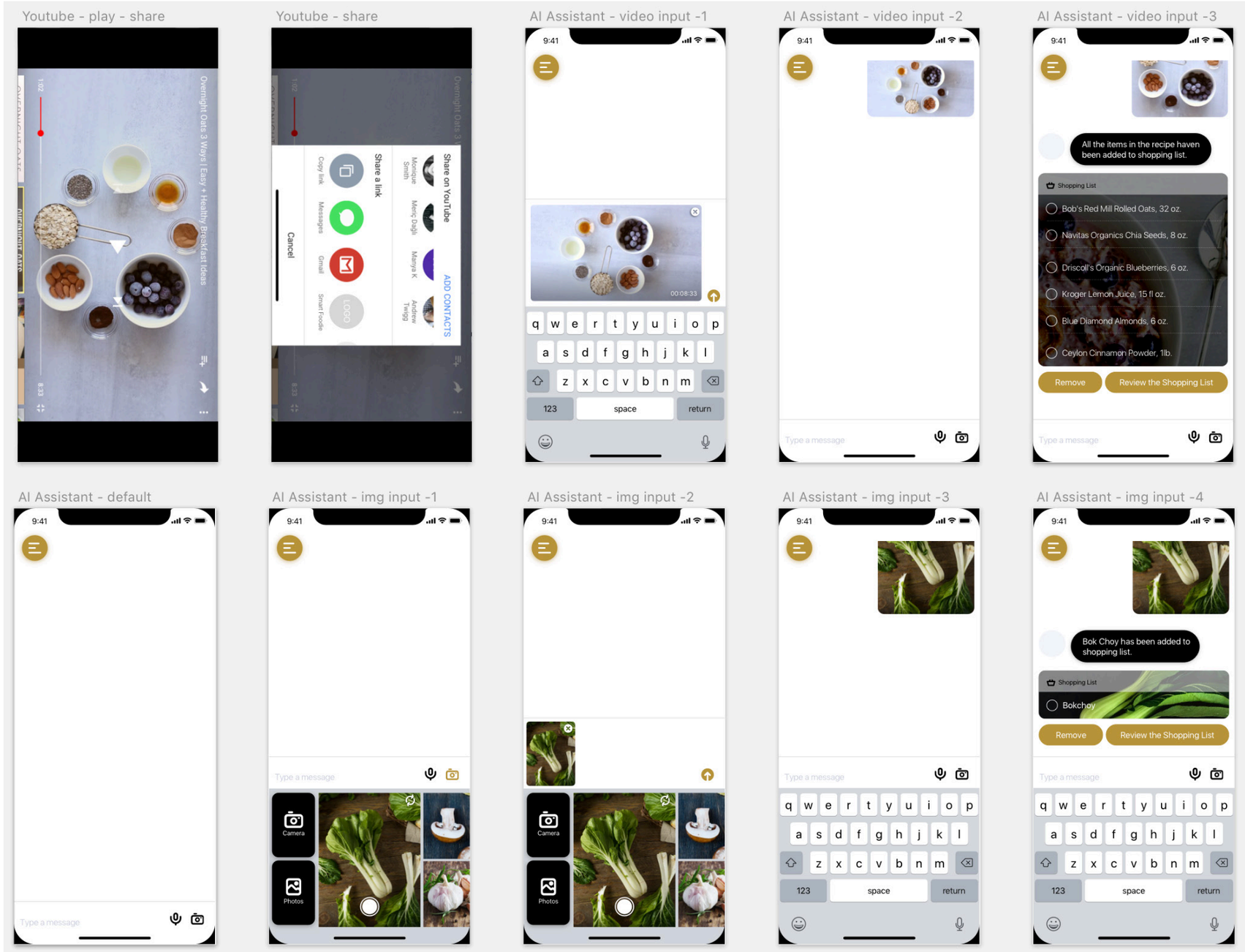


Figure 4.2.1
Low-fi Prototype UI Design

4.2.2 Body storming for AR display

Utilizing large monitors, this body storming activity simulated the grocery store environment and enabled participants to experience a AR-like information display and interactions. I tested features such as blocking irrelevant information and displaying social-based recommendations using this method.
I learned from these tests that information blocking is attractive to users; all users told me they would love to use this tool in their daily shopping routine. Also, most of them liked the idea of reading comments from friends and families. Meanwhile, although the users wanted to have access to online reviews, they hoped this mode would only be activated when they needed it.

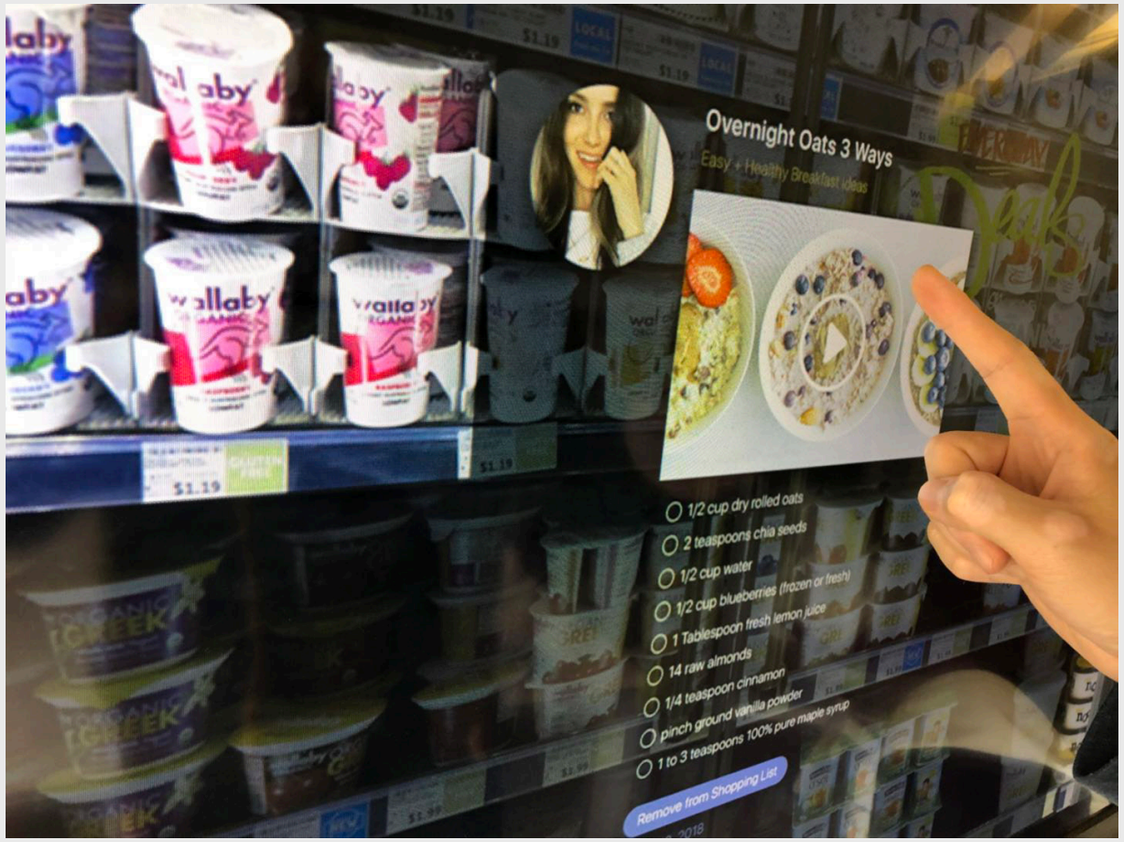


Figure 4.2.2
Body-storming for AR-like Information Display
User-testing

4.2.3 Haptic interaction on wearables

Although the haptic interaction only exists in limited user scenarios, it is important and inevitable. As one of the most intuitive and direct way of interaction, it is special because it can convey information extremely efficiently and effectively. The feature I tested was vibration alert when choosing a problematic item. For example, when a shopper picks a drink which contained an ingredient he/her was allergic to, he/she will be informed by a vibration.
In the testing, participants showed their passion about this feature. To support personalized shopping experience, they also suggested a feature for users to input personal preference and food shopping inclination.

Figure 4.2.3
Body-storming for Haptic Interaction User-testing

DESIGN SOLUTION

The question that has guided me through this project over the past several months is how might we design to leverage spatial intelligence technology to improve the grocery shopping experience? I like this question because it not only acknowledges the enduring need for offline shopping in grocery stores; but it also speak s to the need for the communication among humans, objects, and the physical environment.
The learning from the previous research shows the design direction. I realize that grocery shopping is integrated to daily food experience and social life, and thus it could not be simply addressed by one creative idea. With this in mind I started creating a service system which provides a holistic user experience while covering existing shopping methods.

5.1 System Map

Based on one participants' feedback from user-testing, an AI assistant becomes the core concept of this system. I named both the assistant and the whole system as LUMI, derived from illuminating better choices for grocery shoppers. As a bridge between the physical world and digital data, LUMI is mainly responsible for two functions—creating shopping lists from multiple information resources and searching and filtering information within a real-life context.
There are multiple ways to activate and communicate with LUMI, such as video Input, text input, voice input, and image input. Like existing AI assistants, users can communicate with LUMI through a chat bot. While adding new items to their shopping lists, shoppers can simply text the name of the item or speak it aloud with LUMI. Besides that, LUMI can also understand information embedded in images and videos. For example, a habitual shopper can take a picture of a food ingredient he/she always buy and send it to LUMI. LUMI will add it to a shopping list for his/her next visit to the grocery store. For people who are really into cooking, after sharing a YouTube cooking video with LUMI, the assistant will extract the recipe from the video and add all ingredients to a shopping list to help the shopper be prepared for next grocery shopping.

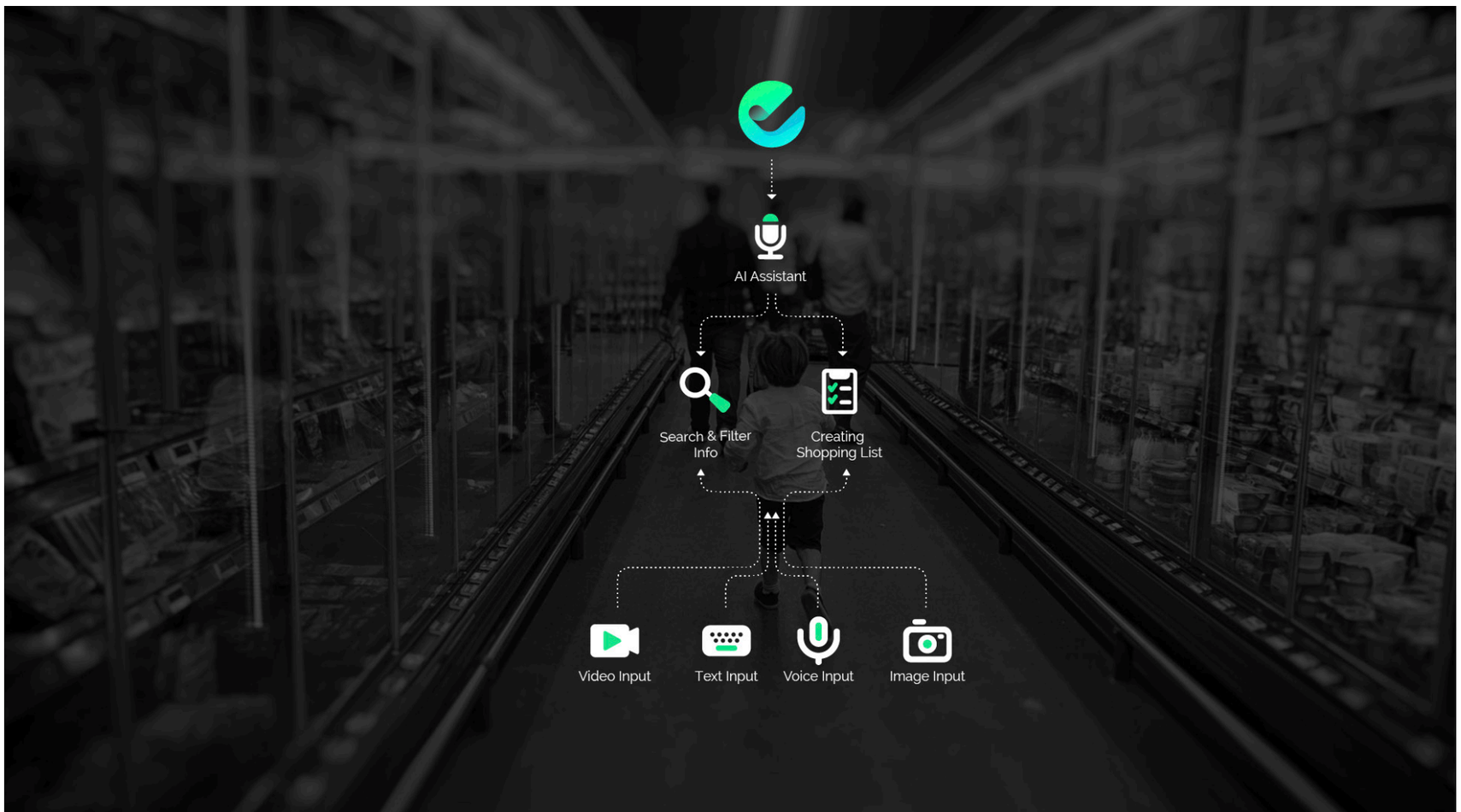


Figure 5.1.1
System Map | Part 1.

While visiting a grocery store, LUMI can display necessary information using Augmented Reality for shoppers to support better decision-making. Moreover, it can block irrelevant information for users to avoid them to be overwhelmed by abundant data. After a shopper enters a store, , LUMI will remain activated at the back-end and send passive notifications. Customers can choose to open the app to enjoy the full range of AR services. The system provides four major categories of AR information display/ filter: 1. Shopping list AR display; 2. Display of online reviews and acquaintance's comments; 3. Searching for relevant recipes and meal plans; 4. Irrelevant information blocking.

For the shoppers who have digital wearables, they can also enjoy haptic notification service. The system supports them to review shopping list, navigate in a store or get alerts while picking an inappropriate item from the wearable device.

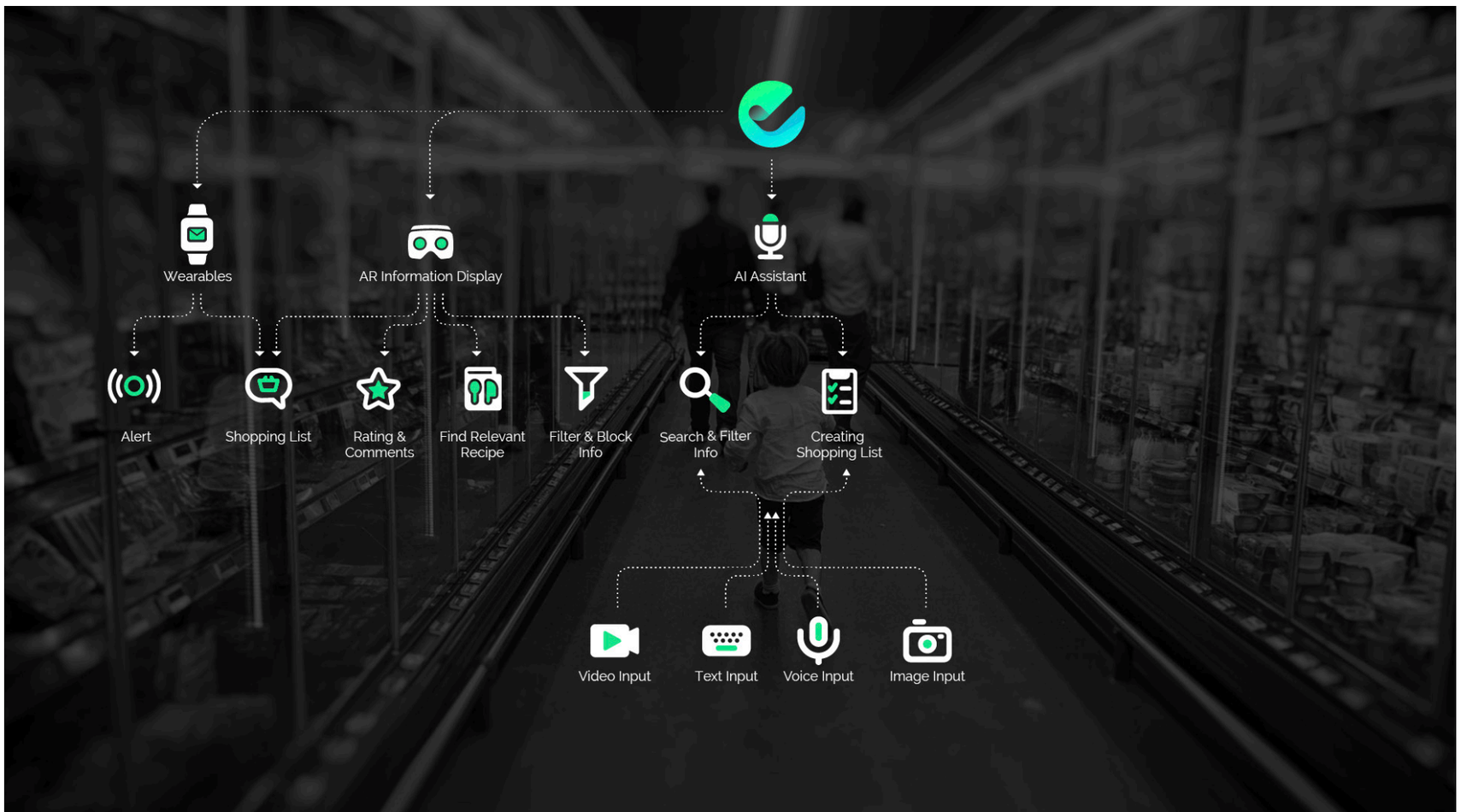


Figure 5.1.2
System Map | Part 2.

After cooking and having the food they bought, customers can comment on the commodity they had as well as share their original recipes on an online social community. Since there are already a lot of existing online review websites and recipe sharing social media, I didn't delve deeper into this direction, although it is still an important element of the LUMI system.

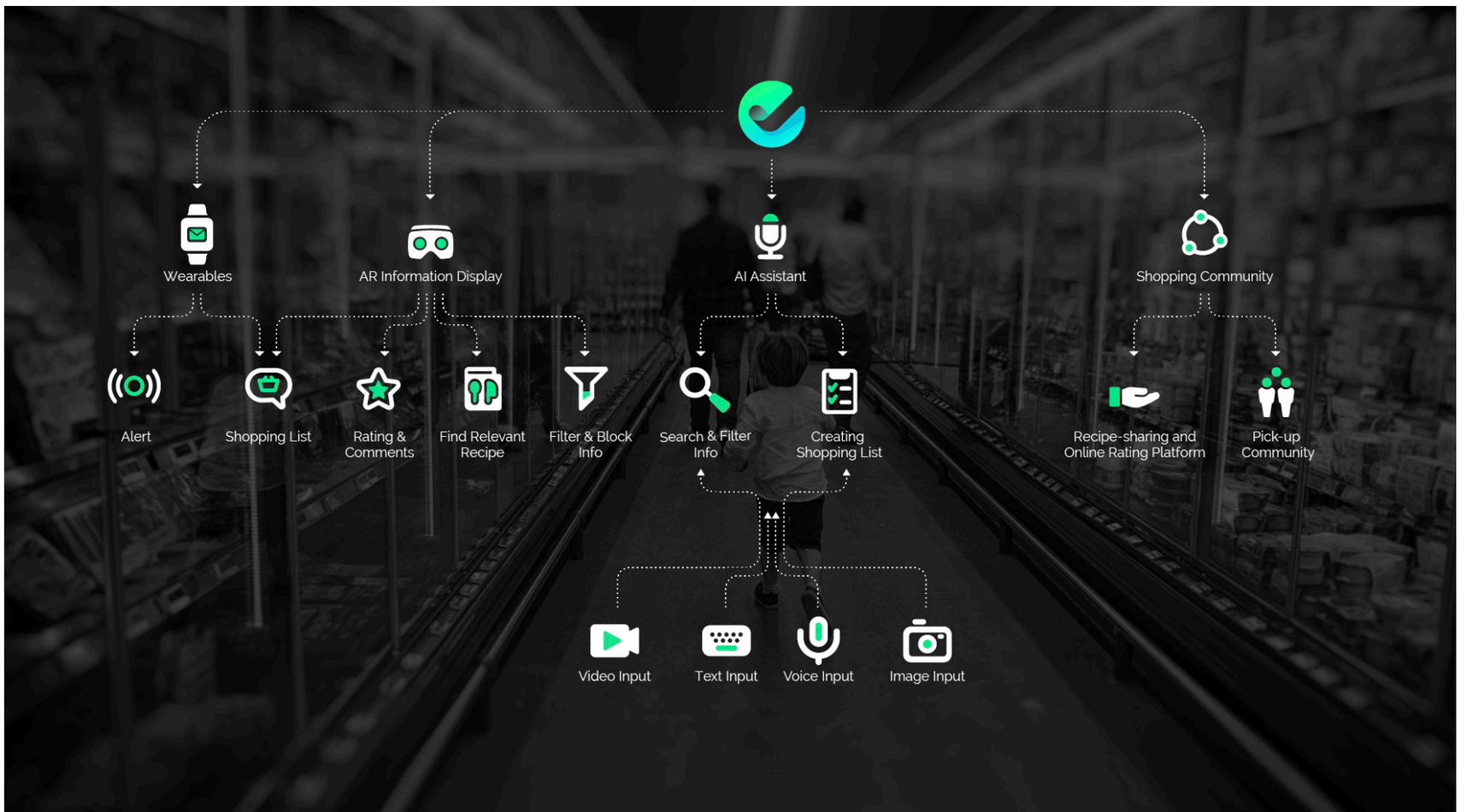


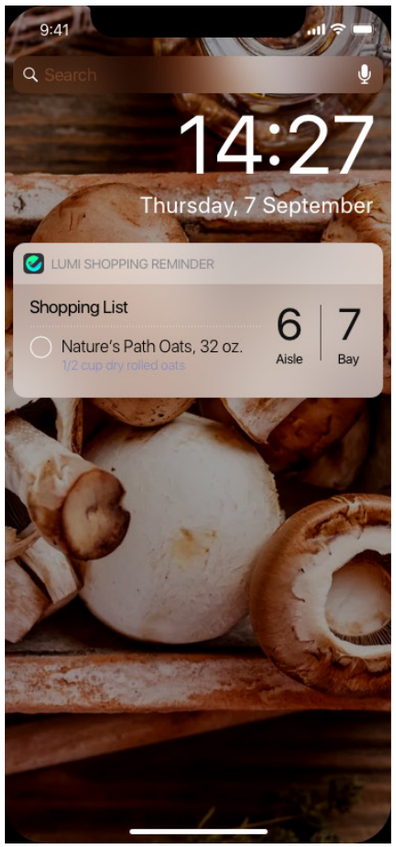
Figure 5.1.3
System Map | Part 3.

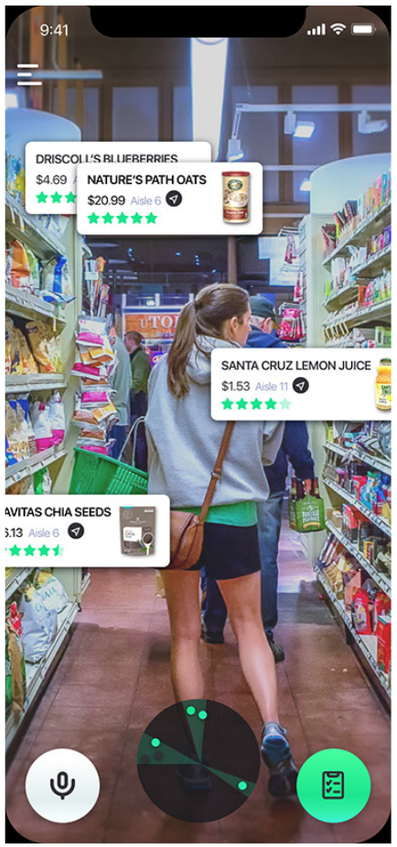
5.2 Main Features

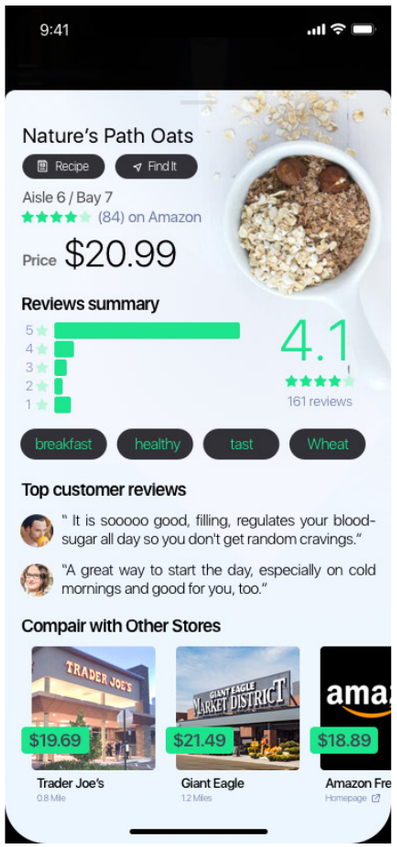
I defined the main features of LUMI based on the pain points and design opportunities I synthesized from previous research. For the following of this subchapter, I will iterate how LUMI solve or ameliorate these problematic scenarios.

5.2.1 Shopping Efficiency

LUMI improves the shopping efficiency from two aspects. First, real-time notification and alerts remind shoppers of imperative information. Realizing missing something on the shopping list after arriving at home is frustrated for shoppers. Through connecting to the grocery store IoT management system, LUMI can prevent this trouble for users. For those who tend to finish shopping as soon as possible and have no interests in wondering around, the in-store navigation feature can help them to reach the goal.







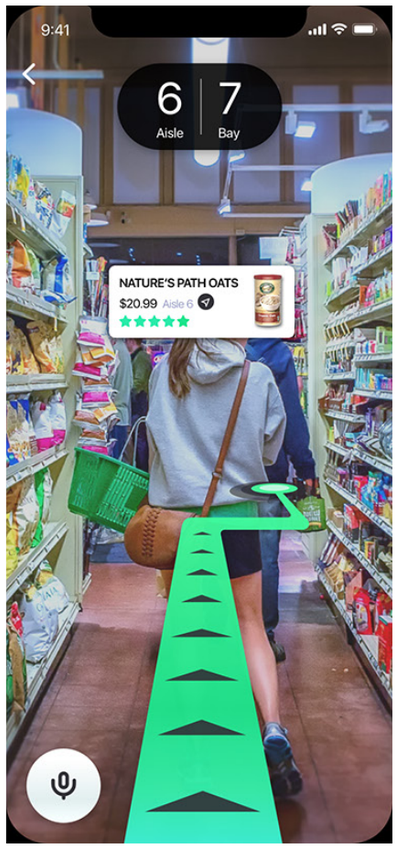


Figure 5.2.2
Features | Notification Screen; AR Shopping List View;

5.2.2 Mental Load

According to psychology study, being overwhelmed by too much options can lead to decision-making paralysis and unhappiness.[16] It is also one of the insights I learned from exploratory research. Shoppers complained about being overwhelmed by the abundant products and information in grocery stores. There is no doubt that each piece of information is useful for a certain group of people, however, they can also be annoying for the rest. For some retailers, their solution is to cut down the options they offer. It is part of the reason that Trader Joe's stores are smaller than average and Costco's only provide a narrow range of product options. But can we fix this problem in a smarter way?

Thus, to help people making better purchase decisions, instead of consistently providing additional knowledge of products, I choose to reduce the information that customers are exposed to. Using the filter tool of LUMI, grocery shoppers can search for a certain type of products without reading all the labels and detailed product information one by one. Different from the way search results are usually displayed, LUMI lessens the visibility of the irrelevant products while keeping the right ones visible. In this scenario, the shopping efficiency is also increased because customers only need to choose among limited but accurate options.

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[16] "10 Factors That Influence Your Purchase Decisions." Psychology Today. Accessed May 14, 2018. https://www.psychologytoday.com/us/blog/science-choice/201712/10-factors-influence-your-purchase-decisions.

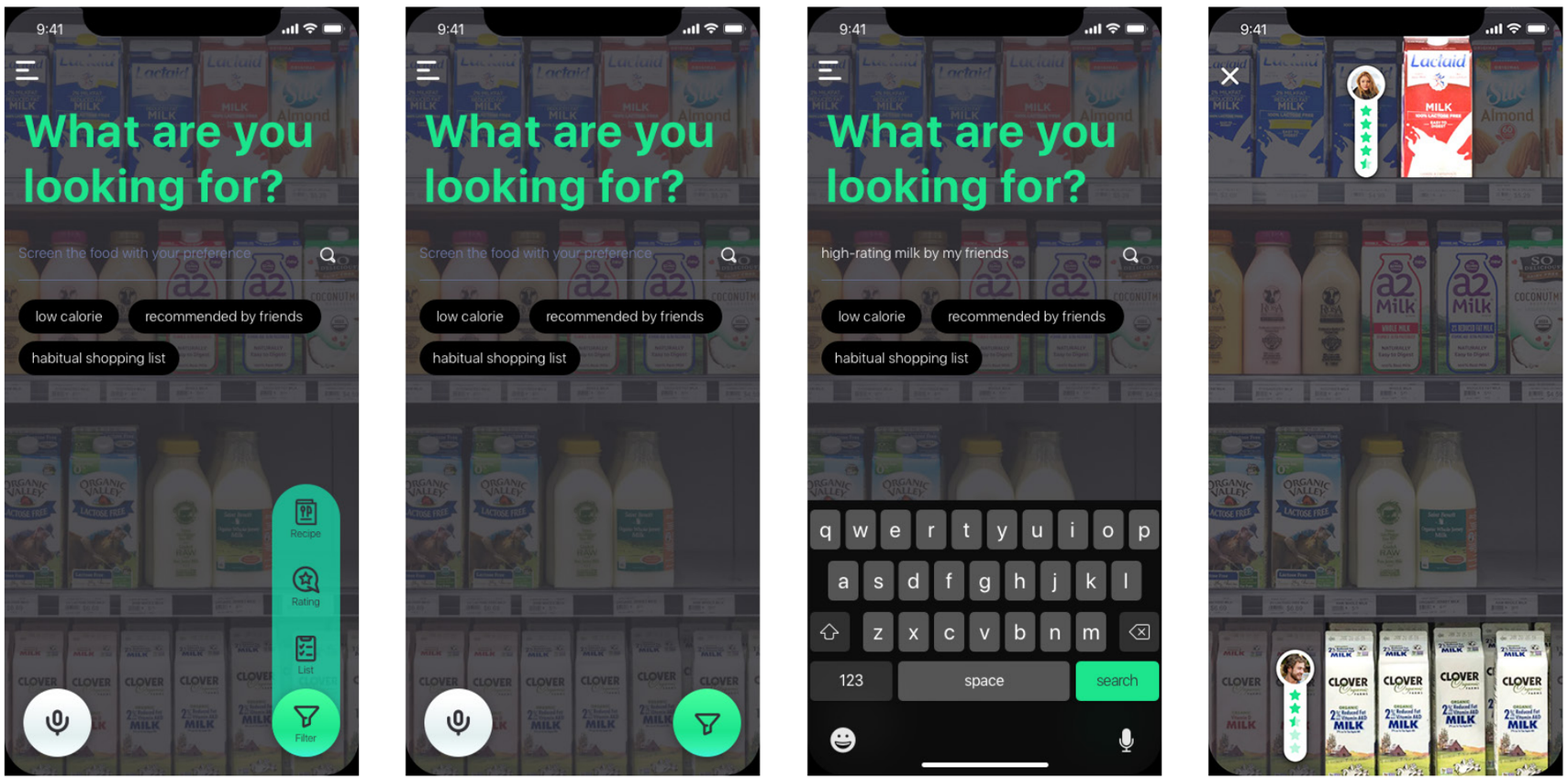

Figure 5.2.2
Features | Mental Load

5.2.3 Integrated Information Display

Psychology research also suggests that while people are making decisions they tend to look at people around them.[17] Those people are called as reference groups.[18] Reference groups are typically formed by people who individuals compare themselves with. They can be an individual's friends, families, neighbors, colleagues, etc. Among them, recommendations from close friends and family members are especially influential for shoppers. However, except for calling or messaging friends and families, there is no accessibility of reference groups' suggestions for individual shoppers. Even though they might have discussions or gotten opinions from people around before shopping, sometimes memory can be tricky and hard to recall. It is where LUMI intervenes and makes changes. After sharing reviews on LUMI, ratings and remarks will be attached to the specific products and become readable for reviewers' contacts. In this case, social based recommendations become and only become approachable when shoppers need them. .

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[17] "10 Factors That Influence Your Purchase Decisions." Psychology Today. Accessed May 14, 2018. https://www.psychologytoday.com/us/blog/science-choice/201712/10-factors-influence-your-purchase-decisions.

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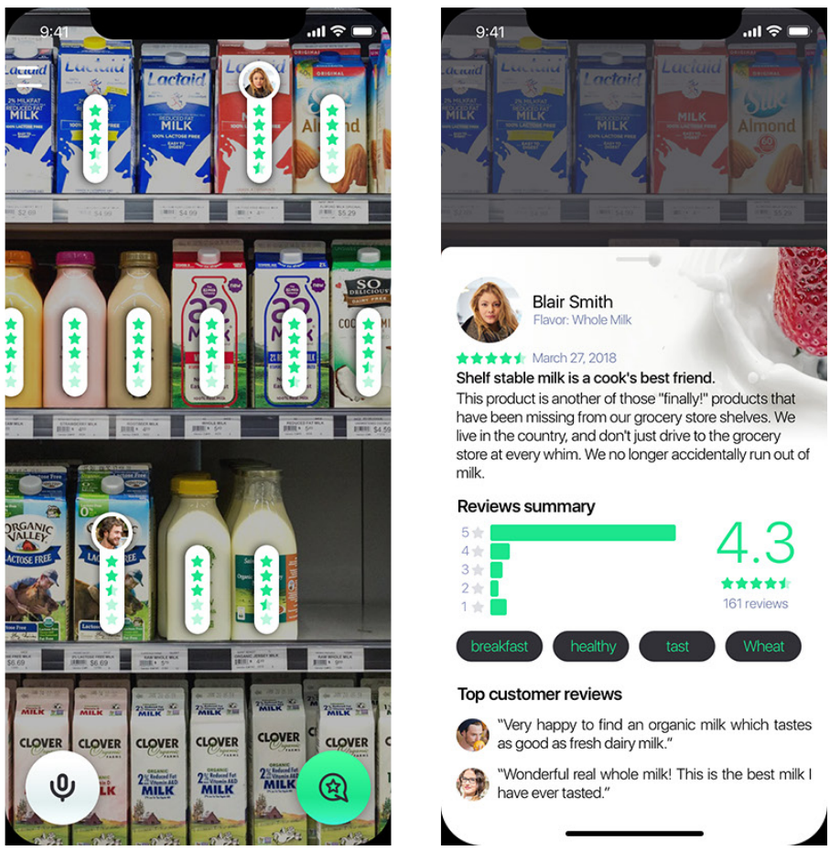


Figure 5.2.3
Features | Social-based Recommendation System

During user observations, I noticed that people try new foods from time to time, but they usually do not have the knowledge of how to prepare them. Thus, even adventurous shoppers may become conservative and habitual ones. Shopping for the same food ingredients repetitively limits the nutrition customers take in, and can limit the food experience they might enjoy. While the easiest and simplest solution seems to be searching on a cell phone for a relevant recipe, LUMI makes the process to be even easier and simpler. Through scanning the ingredient using camera, LUMI's recipe feature helps customers to find the most popular recipe and naturally updated the shopping list. Except for providing an integrated and consecutive experience, LUMI makes the interaction more intuitive since it is triggered by a real object.

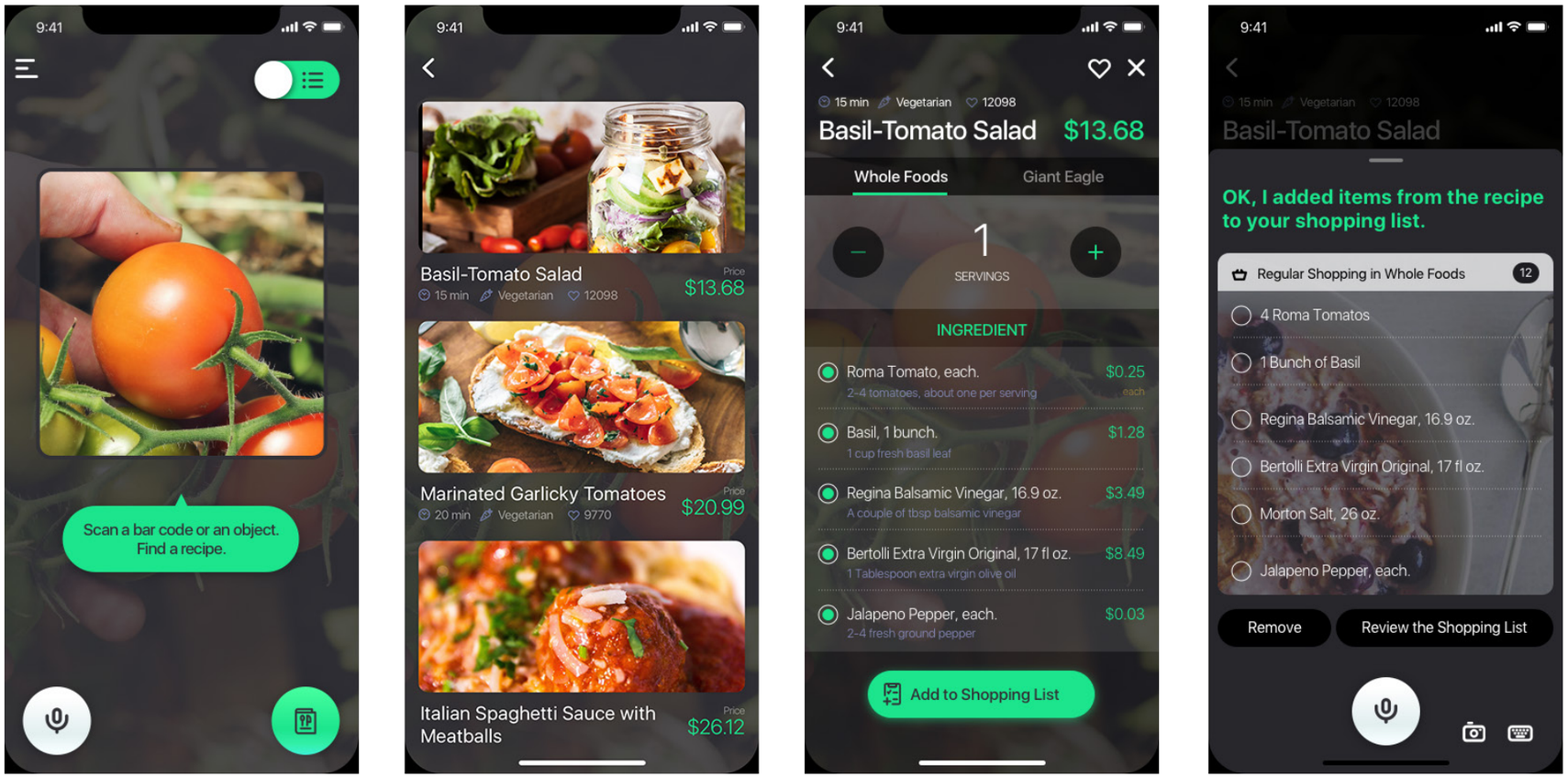


Figure 5.2.4
Features | Integrated Information

5.2.3 Integrated Information Display

One thing has been discussed a lot during user interviews was the necessity and inconvenience of creating shopping lists. Thus, in addition to traditional information input methods, such as text and voice input, as an AI assistant, LUMI is capable to understand more complicated data. Taking a picture of an ingredient can both update the shopping list and search for relevant recipes. For cooking lovers, sharing cooking videos with LUMI is also a new way to update shopping list.

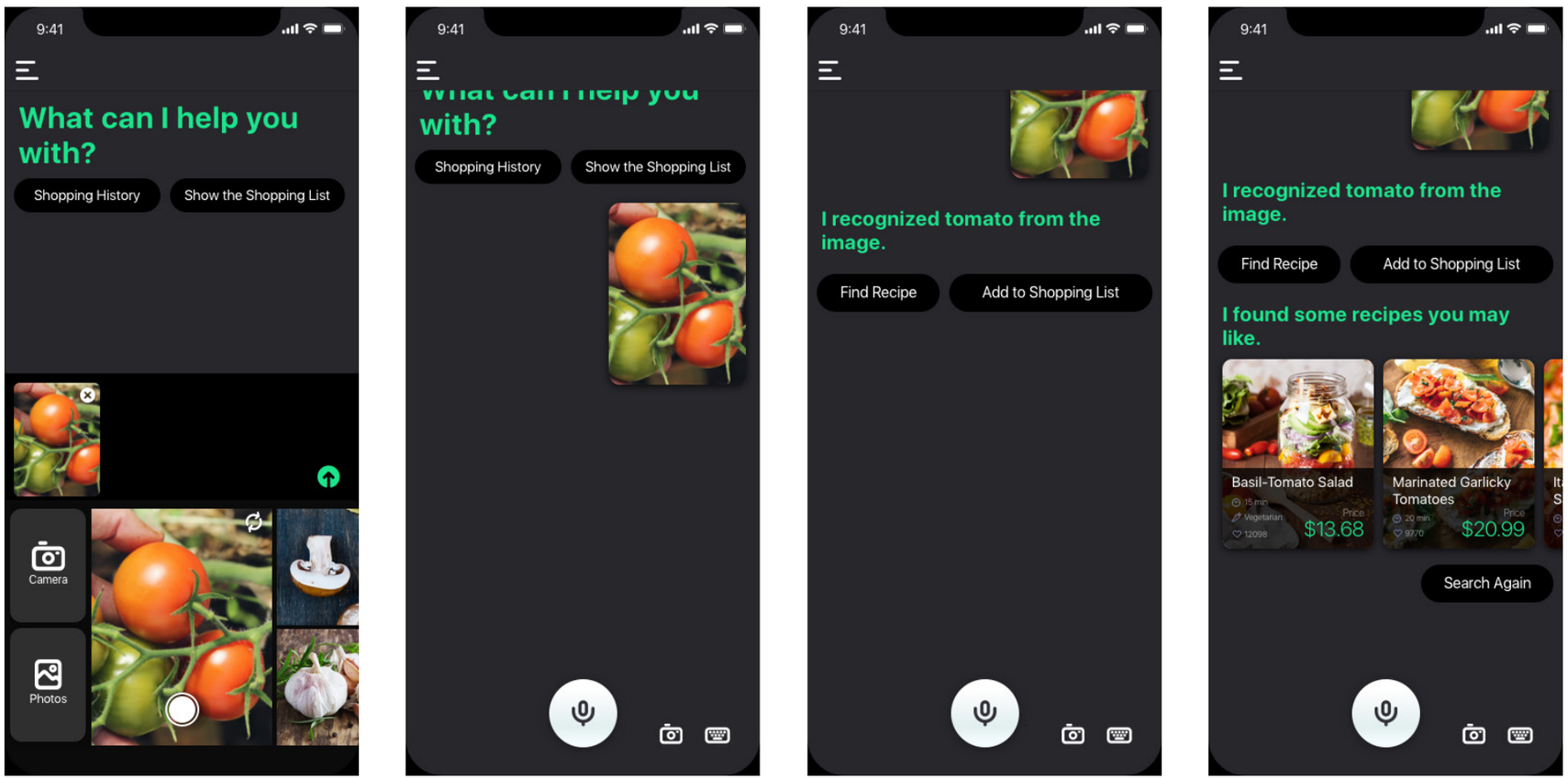
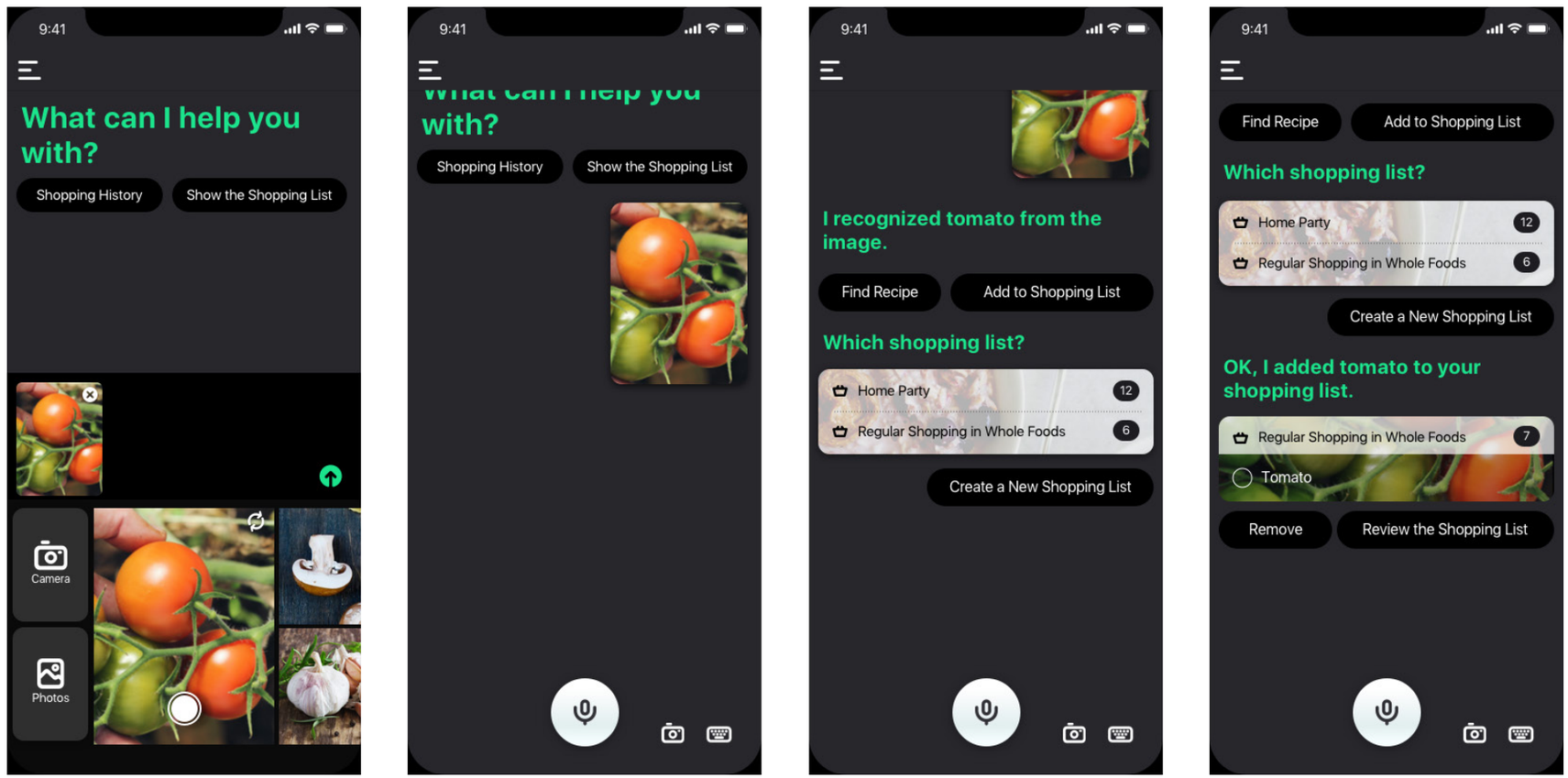


Figure 5.2.5
Features | Image Input to Update Shopping List

Figure 5.2.6
Features | Image Input to Search for Recipes



5.3 Final Design

With the established structure of the system, I defined the time frame of this design solution to be short-term future—a future will happen within five years. From the technology perspective, although I believe that one day highly advanced devices will be invented for people to read digital data with naked eyes, for the short-term future, the personal cell phone will still be the best choice for individual shoppers to review AR information. I chose an IoT technology equipped grocery store—just like Amazon Go—to be the ideal context for this conceptual design solution, in which an overall system is already capable of knowing and managing all the items and products' location and information.

5.3.1 User Scenario

There is a story of a target user—Ellen. This story is made of a series of major user scenarios. Ellen is a graduate student living in Pittsburgh. She is a confident grocery shopper who values healthy life a lot. One of her major shopping goals is shopping smart to live a healthy life. Since she has a very intense schedule because of her academic life, sometimes she needs to cut down the amount of her grocery shopping time and cook very efficiently. However, when she has some enough spare time, she enjoys exploring grocery stores and even shops adventurously and spontaneously.

After installing LUMI on her cell phone, Ellen sets up her personal preference. She inputs information such as the food she is allergic to and the types of protein she would love to take. This information will be later used to filter shopping options for her while shopping in a real store.

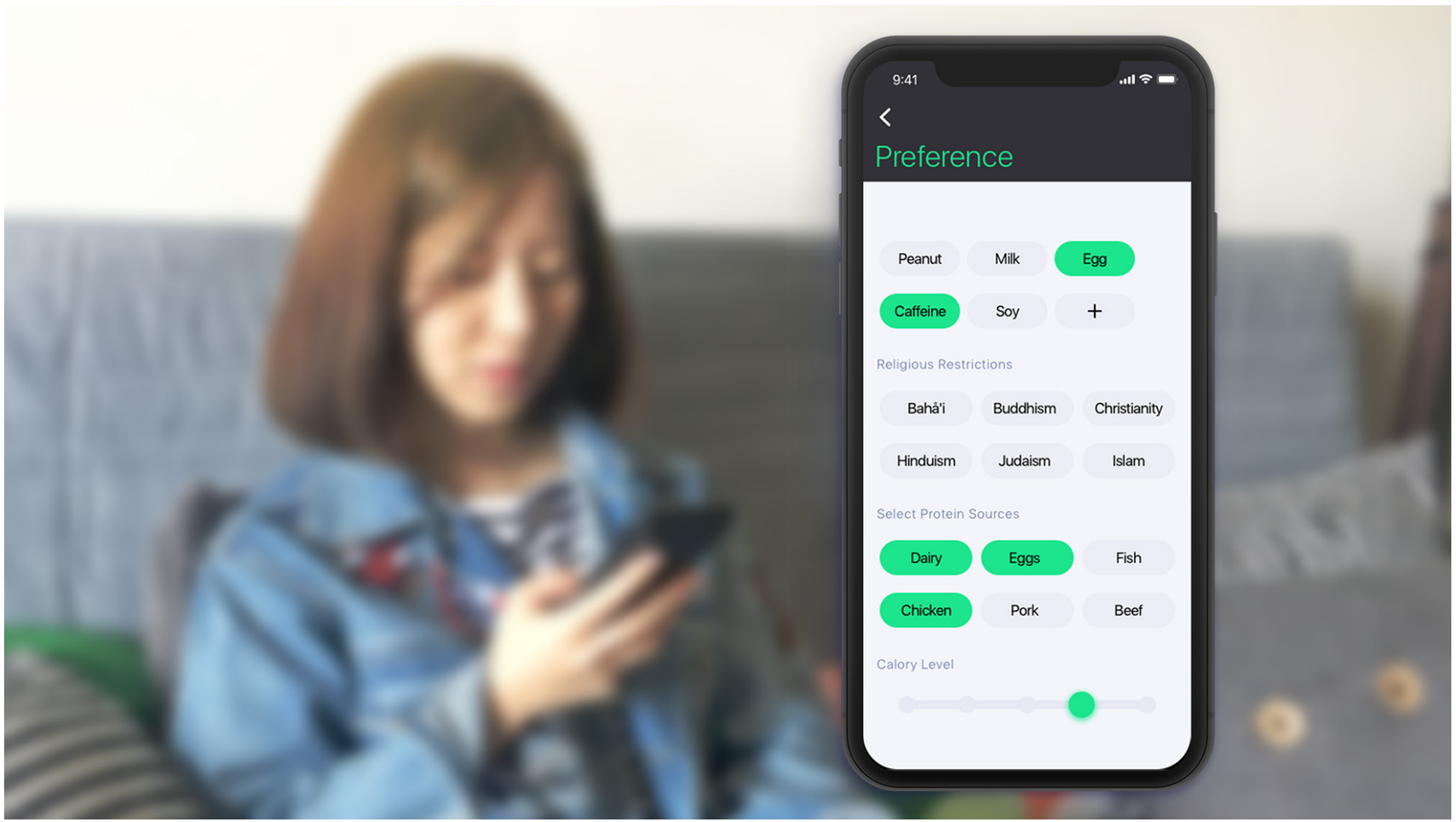


Figure 5.3.1
Setting up Personal Shopping Preference

One day, Ellen wants to explore some new healthy breakfasts, so she scans several cooking videos from a YouTuber she subscribed to. Interested in one video, she shares it to LUMI. LUMI automatically extracts the recipe from the video and helps her to add all the items to a specific shopping list. Also, she can save this recipe in LUMI for later revisit. Whenever she wants to cook, she can easily find the recipe and follow the video to prepare herself the dish.

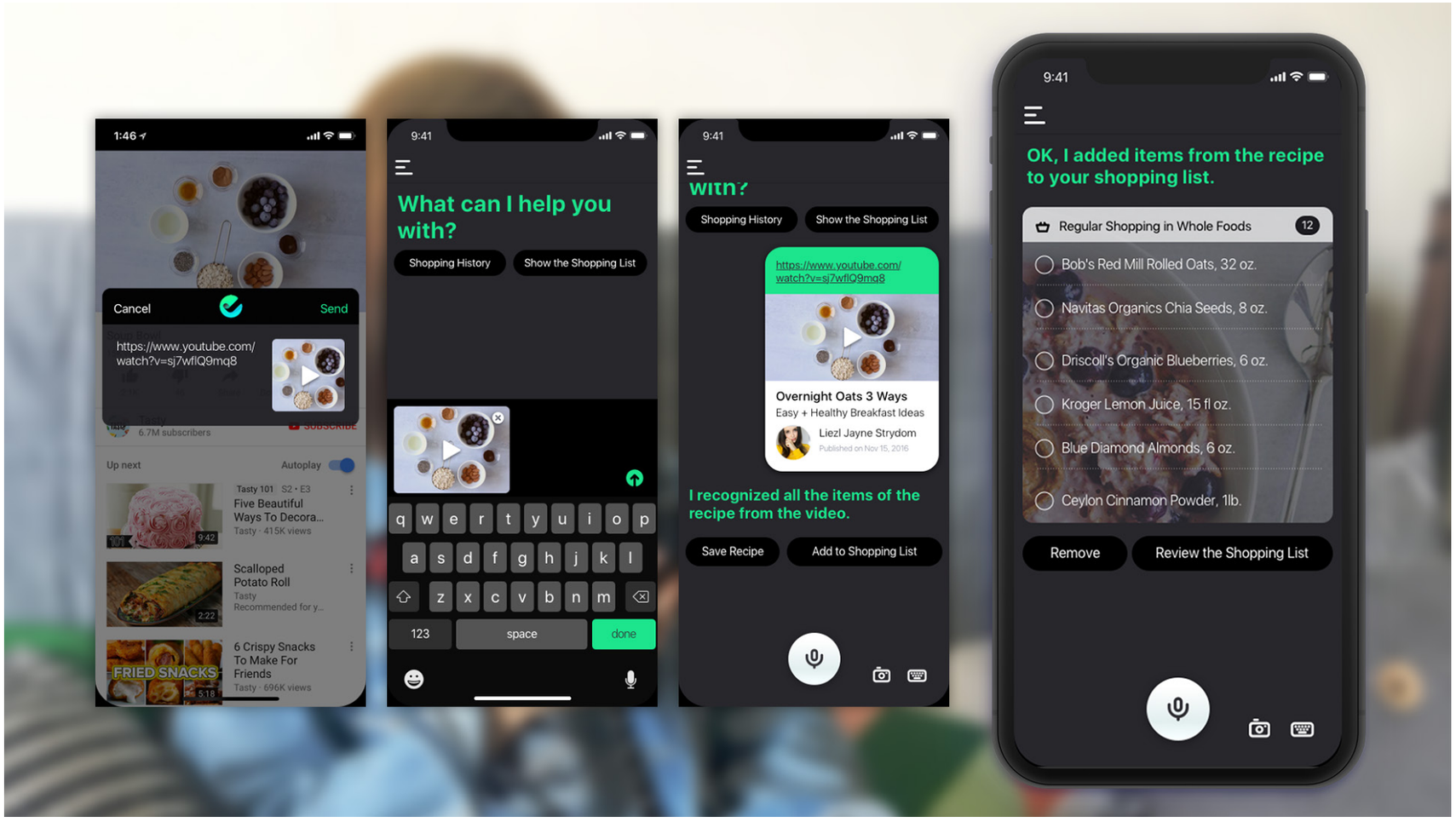


Figure 5.3.2
Sending YouTube Video to LUMI to Update Shopping

After Ellen enters a grocery store, LUMI connects to the store's IoT system. In this way, LUMI can locate both Ellen and items on her shopping list. While she is passing by the Nature's Path Oats which she planned to buy, LUMI notices that she forgets to buy the product. The system informs her by sending a notification. The notification also shows the oats' location on her cellphone, by which Ellen can easily spot the product.

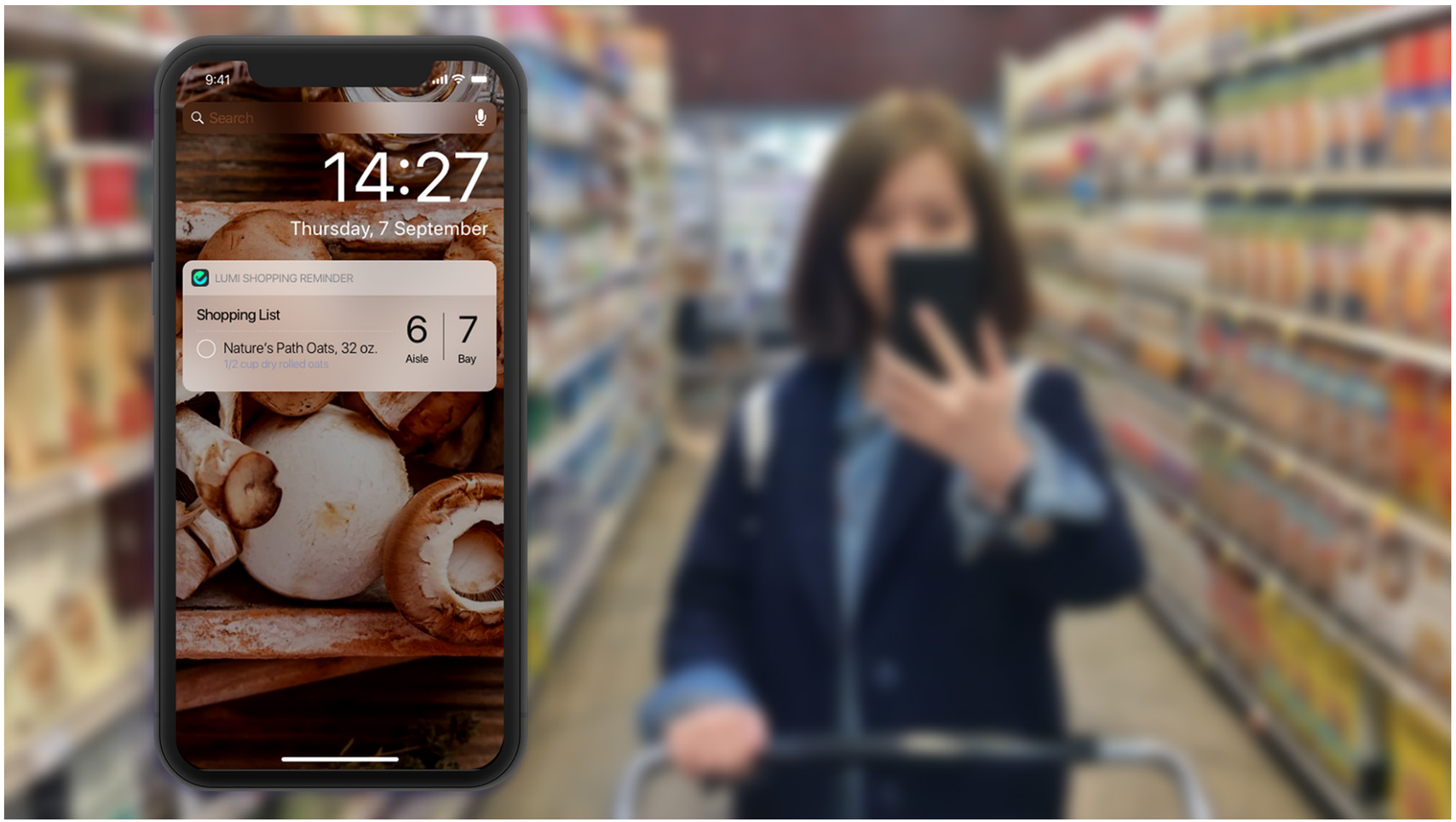


Figure 5.3.3
Notification for Missing an Item on Shopping List

Since Ellen also installed LUMI on her Apple watch, she can also get access to the item's information from the wearable. To spot one item, she can switch between information mode and navigation mode. In the individual navigation mode, there is a large arrow displayed on the screen which points to the location of the closest product on the shopping list. This mode can not only make the shopping activity more efficiently but also more entertaining.

Figure 5.3.4
Wearable Notification and Navigation Display

Ellen chooses to open LUMI on her cellphone. LUMI shows the items she planned to purchase in this visit. The abstract circular map on the bottom center of the screen implies the directions of all the items. The floating tags are the items nearby. Simply pressing on one tag-- for example, the Nature's Path Oats' tag-- more detailed information of this product shows on the screen. First, it shows the overall online review. Also, the key features and comments of this product are presented as labels as well as synthesized remarks. For the shoppers who have limited budgets, they can compare price from the current store with other stores nearby or online shops.

From previous interviews, shoppers told me that an accurate navigation tool was not always wanted, but it might be useful under extreme circumstances. Therefore, while providing this navigation function, I "hide" it within the product information screen, which can only be activated when users seriously want it.

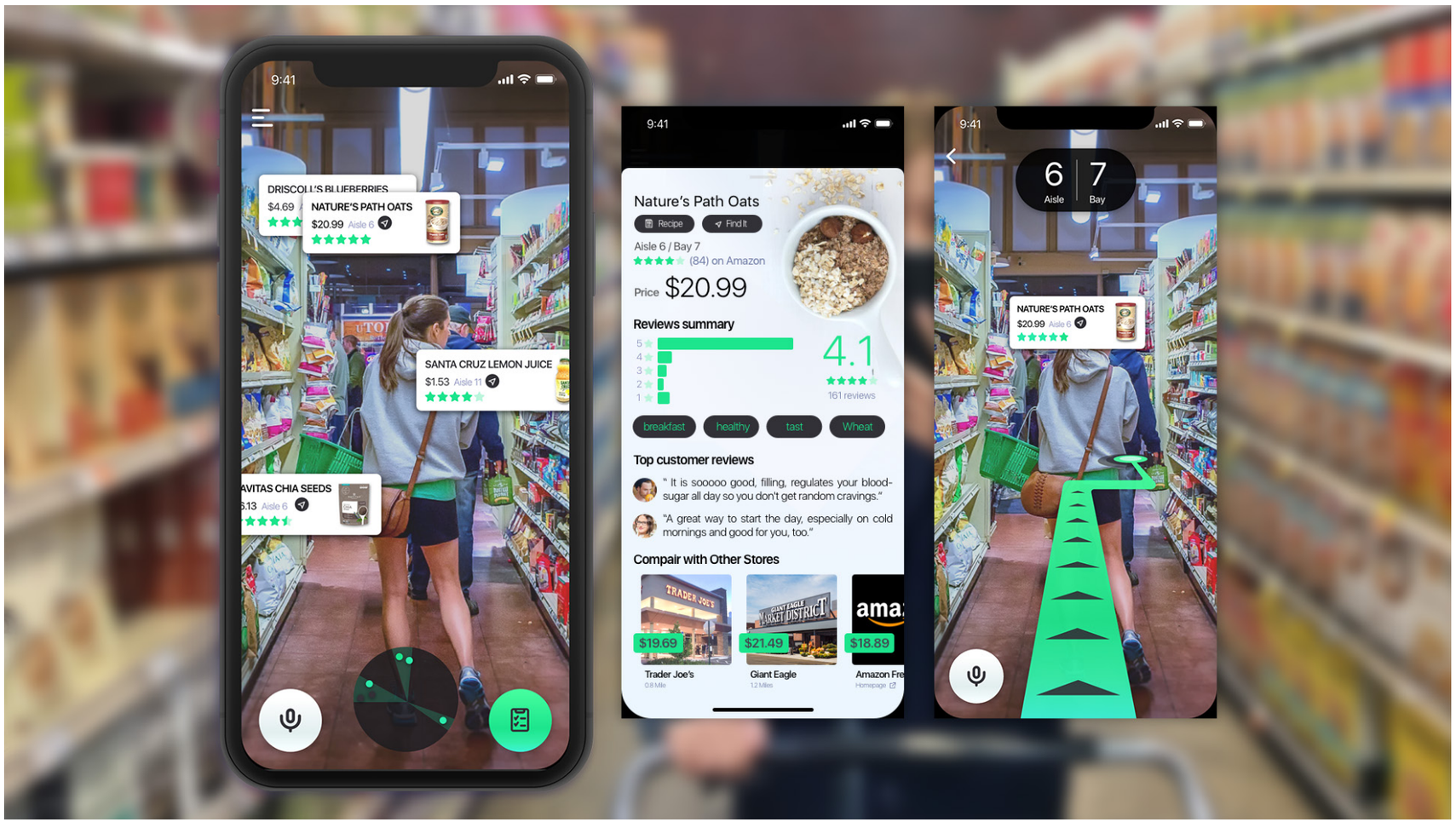


Figure 5.3.5
AR Shopping List, Product Information, Navigation

Moving to dairy section, Ellen finds out the milk brand she usually buys is sold out, so she must try something new. She turns to LUMI for help. While reviewing the general online ratings she notices that her friends Blair made some comments on one product here. She presses on Blair's rating and reads her remark. Since she knows Blair so well and both of them share similar taste about food, she trusts Blair's choice and picks the same type of milk.

During user interview research, although most people found online view useful, some shoppers shared their concerns with me. According to their words, people have different inclinations about food, and thus sometimes the online review might not be accurate enough to help them to make the right buying decision. It is the reason that I emphasize acquaintance's reviews in this feature. Human are social animals, it may not be reasonable but friends and families' opinions are influential to us when we are shopping.

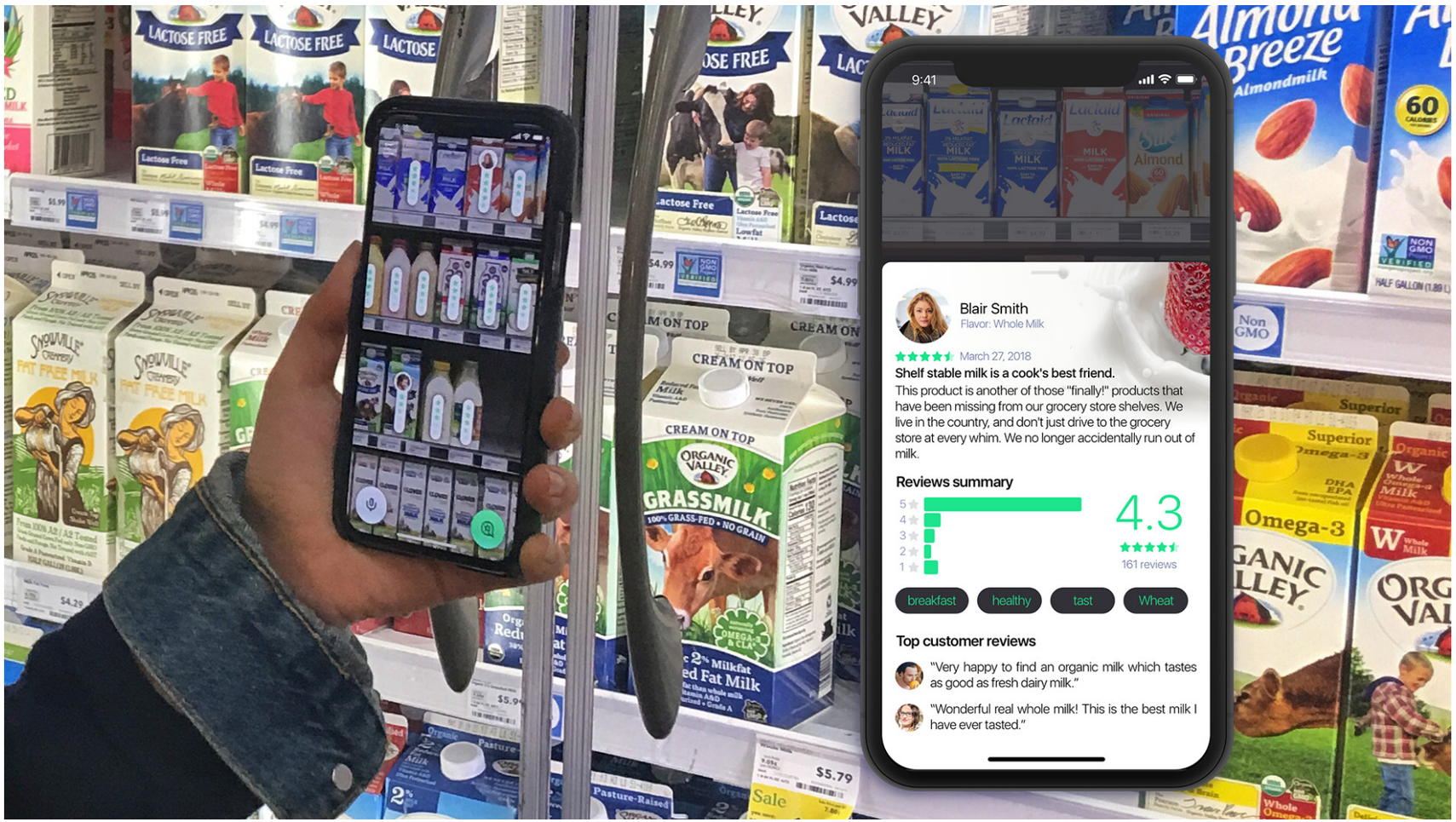


Figure 5.3.6
AR Online Reviews and Social-based Recommenda-

According to the feedback I collected from user testing, comment display is useful for some shoppers, but may be too much for others. For those who feel overwhelmed by too much information, LUMI can help them to filter shopping options. For example, in this scenario, Ellen can also use the search feature of LUMI to achieve the same goal by asking the system for the products most highly rated by her friends. The AR view blocks irrelevant products based on the search result. It saves Ellen an amount of time on scanning each item on the shelf and struggling between them.

The information blocking feature is activated by the search engine embedded in LUMI, so it can be used in many other scenarios. For example, in previous user interviews, vegetarians complained about the challenge of screening all the food every time they shop, which is time-consuming and exhausting. But with LUMI, simply asking a question of "what are the food for vegetarians?", they can easily pinpoint the suitable ingredients and products. For shoppers with limited budgets, they can choose to only review the items on sale.

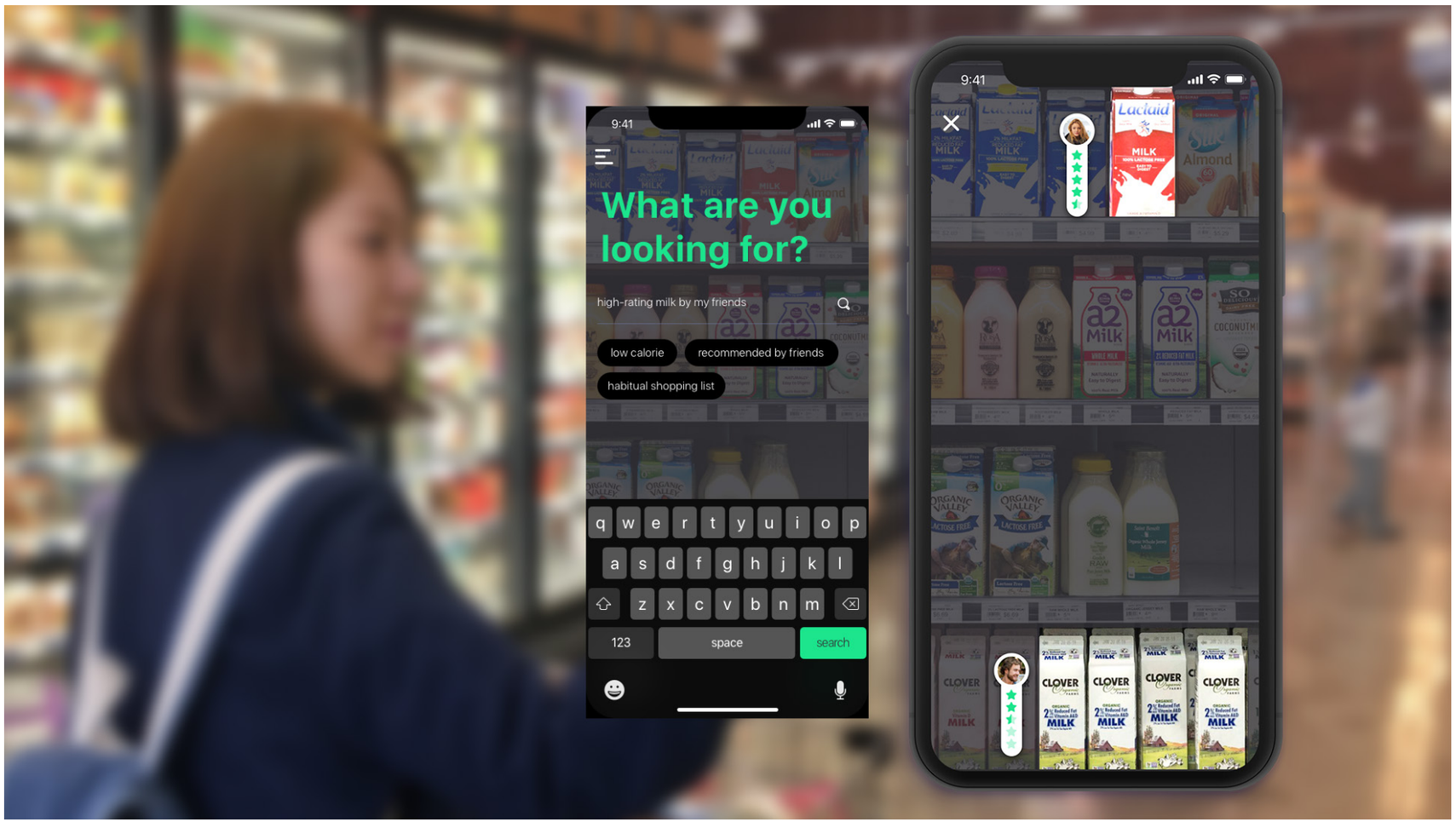


Figure 5.3.7
AR Irrelevant Information Filter View

Tomatoes are one of Ellen's favorite ingredients. She buys them a lot but always prepares them the same way. With the help of LUMI, exploring new recipes becomes simple. First, she takes a picture of a tomato with LUMI.

Figure 5.3.8
Real Ingredient-based Recipe | Scan View

After identifying the ingredient, LUMI provides a list of relevant recipes. These recipes ask for different amounts of time and budgets. Since Ellen is still a student who wants to shop economically and she is also busy with school, she chooses the cheapest dish which can be done with 15 minutes. After she reviewing the recipe, LUMI adds all the ingredients to her shopping list.

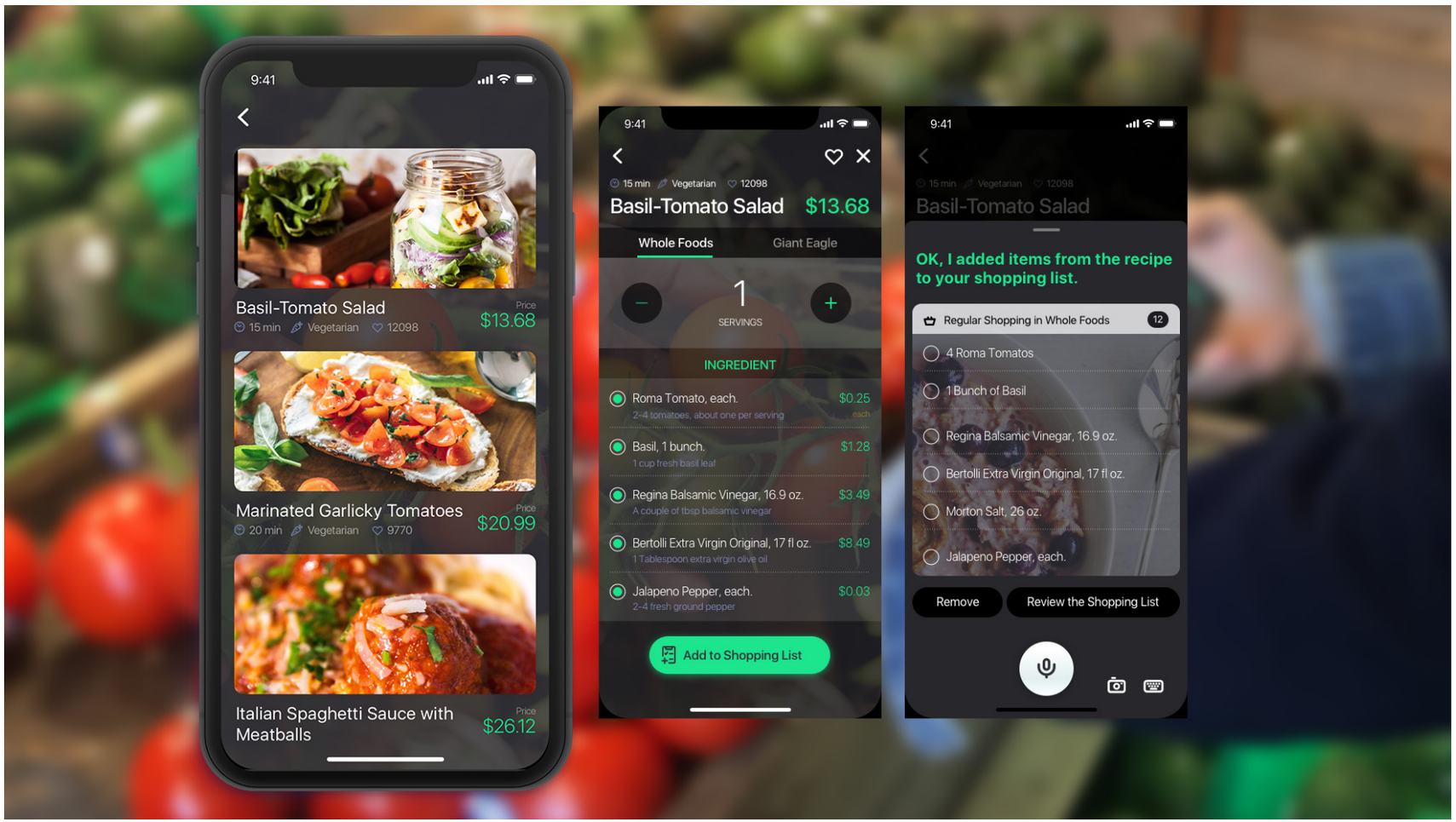


Figure 5.3.9
Real Ingredient-based Recipe List, AI Assistant View

Even though most people who have food allergies are knowledgeable of the products which are specifically hazardous for them, there is always potential danger. However, LUMI can help to eliminate this chance. With her personal information set up, LUMI knows food or drink containing caffeine may cause issues for Ellen. When she picks up a can of Red Bull, the wearable vibrates and informs her to reconsider the purchase.

Figure 5.3.10
Wearable Allergic Food Alert

5.3.1 Hi-fi User Interface Design

As part of the design validation, I used Sketch and Principle to create a high-fidelity prototype both for mobile phones and wearables as back-end device. I tested it based on different user scenarios with shoppers and optimized the final design based on their feedback.

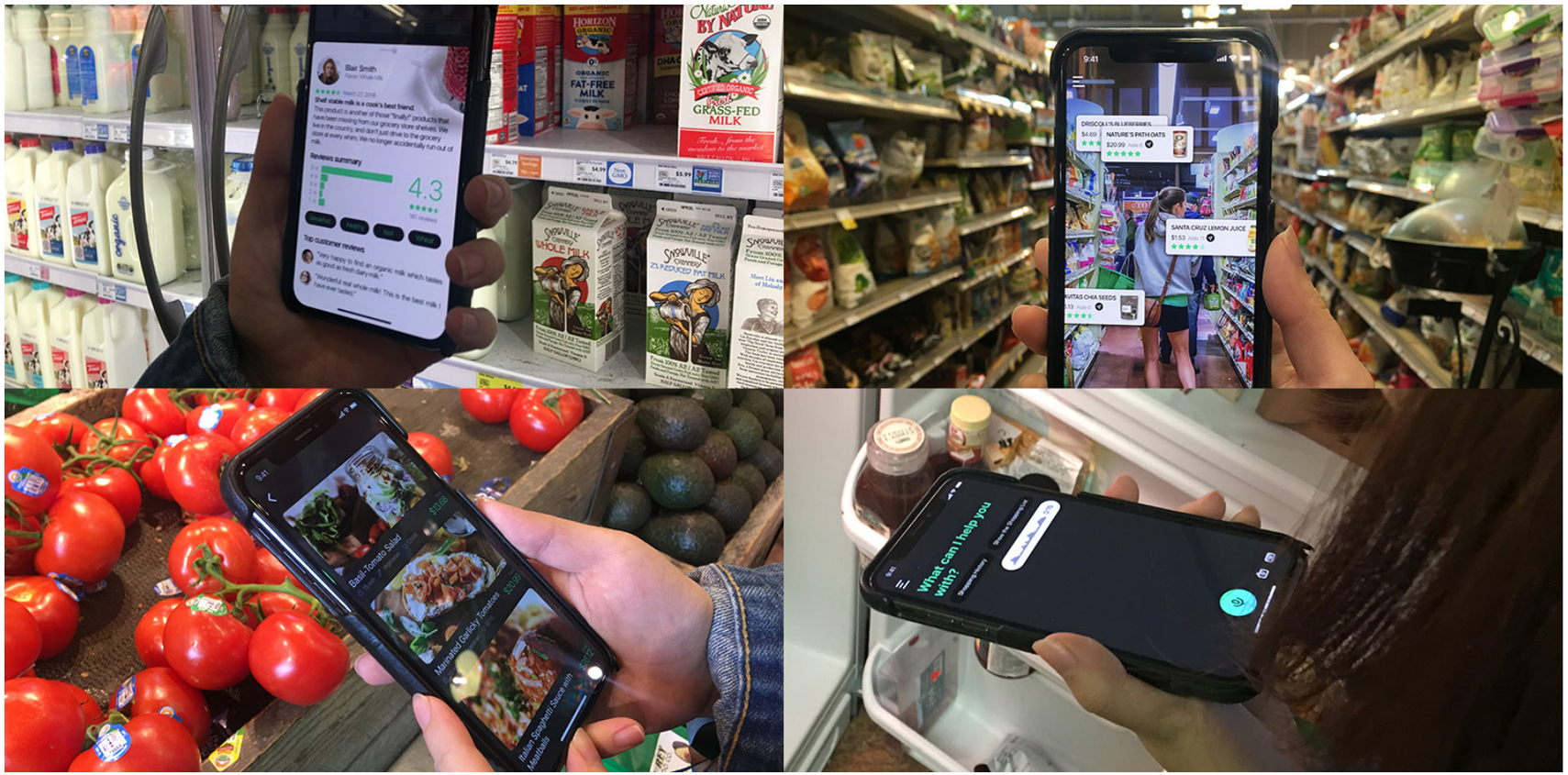
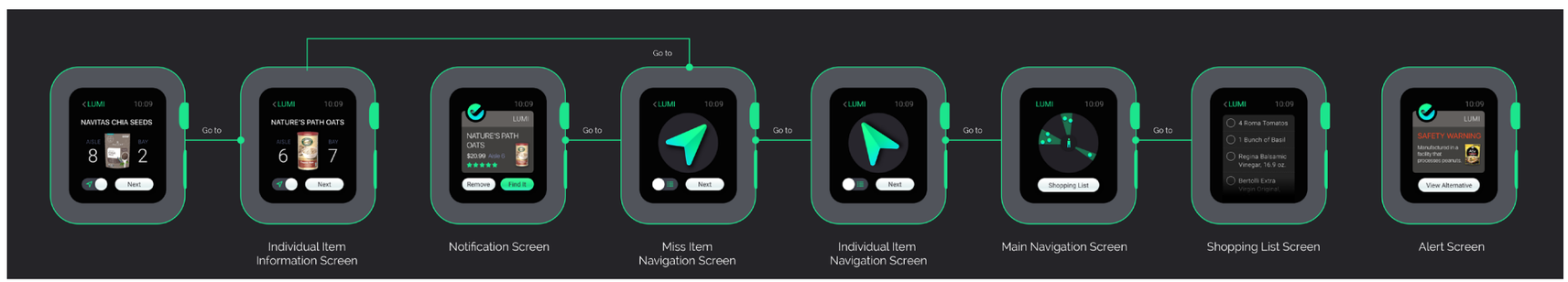


Figure 5.3.11
Final User-testing with Hi-fi Prototype

Figure 6.3.12
Wearable UI Design



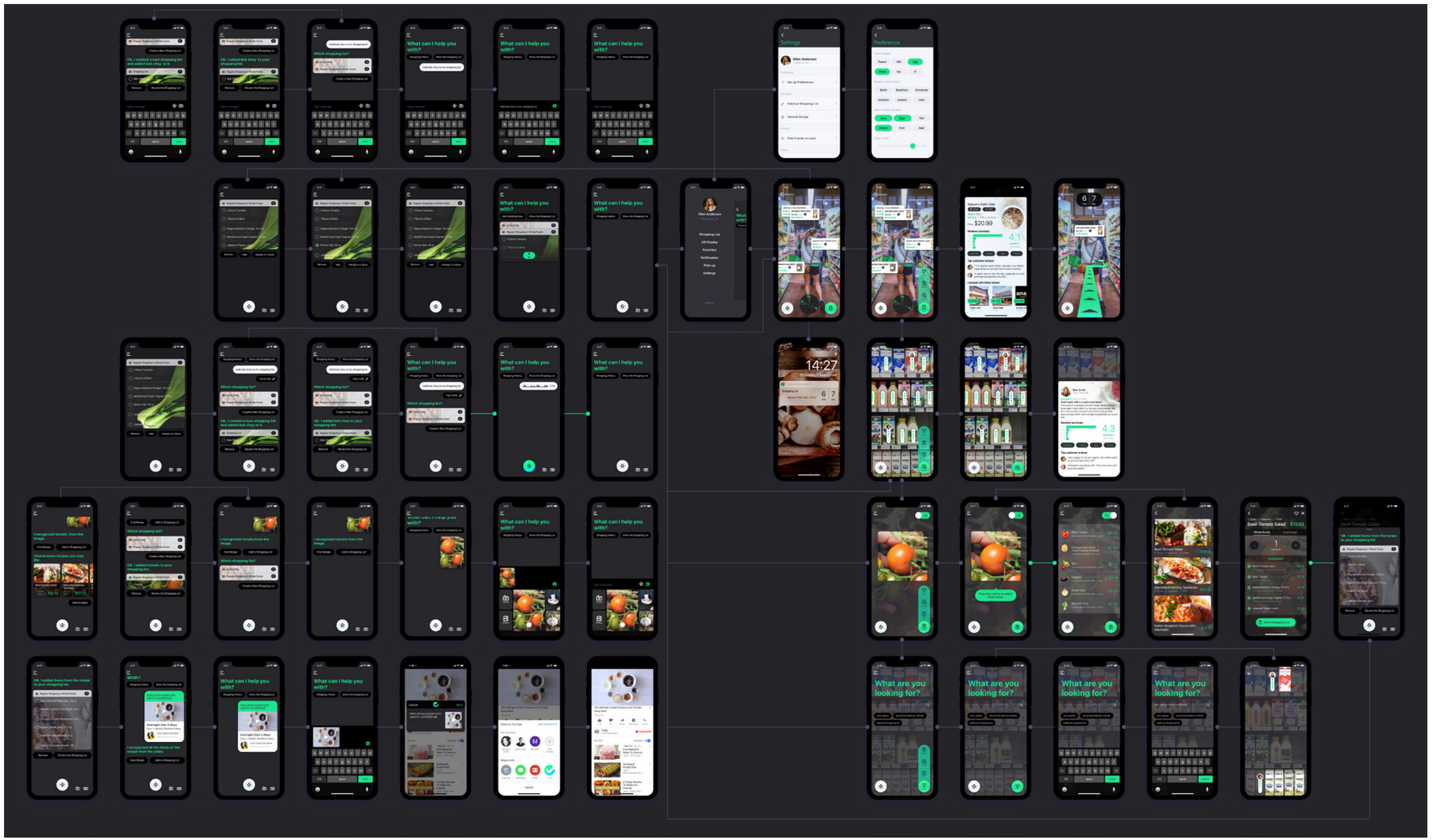


Figure 6.3.13
Mobile Phone UI Design

REFLECTION

Attempting to inspect the design solution, I return to the original design question for this paper: how might we design to leverage spatial intelligence technology to improve the grocery shopping experience? Based on previous research and analysis, it becomes clear that spatial intelligence is a powerful tool to reveal the relationship between segment customers, operational data and geographic information. Thus, it can provide business insights for retailers while supporting shoppers' purchase decision-making.

Grocery retail industry is getting reinvented. A likely future of this reinvention is a transformation from a traditional brick-and-mortar business model to an innovative one called "brick-and-click." Providing context of "where", spatial intelligence supports hyper-local targeting, by which retailers can understand customers' real-time demands and provide the right information, at the right location, at the right time.

The design solution I proposed in this paper is a comprehensive food shopping platform named as LUMI. LUMI can understand multiple types of information and help food shoppers to easily create shopping lists before entering stores. Within a grocery retail setting, customers can manage real-time information displayed through Augmented Reality by LUMI. With object-triggered integrated information, shoppers can make better buying decisions; using LUMI as a filter to screen information and products, shoppers can reduce mental load. After shopping, the reviews and recipes shared by shoppers will become part of the system database to support future shopping activities.

There is still more ground for LUMI to cover: to achieve better food experience, there are more possibilities for spatial intelligence and IoT technology to explore. What other information can be provided to users to support decision-making? For example, is it possible to measure the freshness of a peach and provide the real-time data for customers in the future? As IoT technology develops, more types of data will be available to platforms like LUMI. Also, there is a close relation between food and health: to enable people to shop for a healthy life, grocery shopping, exercise and physical condition should all be considered holistically.

Eventually, systems such as LUMI can be applied not only in retail industry but in many other scenarios. When the technology is advanced enough to truly merge online and offline, digital data and physical context, it might become the new way for people to interact with the world.

CONCLUSION

This paper explores the opportunities of leveraging spatial intelligence to improve the grocery shopping experience for consumers. This topic is built on two assumptions which were verified during primary and secondary researches:

- Brick-and-click business model will become the frame of future grocery retail.
- Spatial intelligence technology has the potential to reveal the relation between segments of customers, operational data, and in-store geography.

Synthesizing the key insights I learned from exploratory research, I summarized the key pain points and identified the main design opportunities to be:

- Make grocery shopping more efficient;
- Ameliorate shoppers' mental load;
- Integrate fragmented online and offline information;
- Explore more intuitive communication method.

Before delving into ideation, I set up the time frame to be a short-term future that will happen in five years. By then, the most ubiquitous personal mobile hardware will still be cell phones. Additionally, I defined the possible technology context for this design exploration to be an IoT technology-equipped grocery store, in which there is an overall system managing the data of every single object as well as the physical environment.

The final solution I demonstrated is a comprehensive shopping platform which in the form of an AI assistant called LUMI. Integrating three key user scenarios: pre-shopping, in-store and after shopping, LUMI provides a consistent and holistic food shopping experience:

- While preparing for shopping, LUMI enables shoppers to create shopping list through multiple types of information.
- Within the store, LUMI can adjust the amount of real-time information shoppers are exposed to. Customers can make better buying decisions with more integrated data displayed through AR. Meanwhile, they can shop more efficiently while screening abundant information and products using LUMI as a filter.
- After shopping, users can share information, such as reviews and recipes on an online community, by which LUMI can support and improve shopping activities for more.

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