TYPE2U: A CUSTOMIZED SERVICE DESIGN FOR PEOPLE WITH TYPE 2 DIABETES THAT SUPPORTS MAKING HEALTHY FOOD CHOICES

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Department of Graphic and Industrial Design
College of Design
North Carolina State University
May 9, 2018

Submitted in partial fulfillment for the degree of
Master of Graphic Design

Deborah Littlejohn, PhD
Derek Ham, PhD
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ACKNOWLEDGMENTS

Thank you to my committee members, Deborah Littlejohn, Derek Ham, and Scott Townsend for your time and guidance.

Thank you to my cohort for your feedback and for challenging me to improve my skill sets and my knowledge.

Most of all, thank you to my family for your unwavering support, faith, and love.

ABSTRACT

When medical professionals diagnose patients with type 2 diabetes, they typically recommend websites, mobile applications, and information sources that provide nutrition plans with broad food categories, rather than a list of specific brands that an individual can consume to remain compliant with the recommended daily calories and food groups. Not every person diagnosed with type 2 diabetes is the same; therefore, directionally appropriate content, delivered with static information design and content through digital health services are not sufficient tools to help people adapt to a life-changing health condition. Each person diagnosed with type 2 diabetes has different pre-existing health conditions and glucose levels that vary throughout the day, creating the need for customization — one that food and beverage companies are only just beginning to address. As Gray suggests, appropriate nutritional information cannot simply be delivered by giving a patient a diet sheet in a one-size-fits-all approach (Gray 1). Individuals, particularly those diagnosed with chronic diseases such as type 2 diabetes, want control and they want to feel "heard," especially if it is clear that the doctors and dietitians do not have the time to customize dietary regimens to fit their individual needs (Ball et al. 490). The purpose of this investigation is to understand how the design of a customizable food shopping application can support dietary adherence in adults newly diagnosed with type 2 diabetes by assisting and integrating their food purchasing decisions related to food selection, food substitution, and food combination. I conducted discussions with medical professionals that confirmed the types of appropriate nutrition plans and the socioeconomic barriers to living with type 2 diabetes.

Based on the lists of doctor-recommended mobile applications and websites, I conducted a comparative analysis that identifies gaps in food shopping services, both in-store and online, for people with type 2 diabetes. The project that emerged from my research suggests ideas for interface design approaches that could help people adapt long-term strategies for type 2 diabetes management with greater ease by providing enhanced knowledge of appropriate and desirable food choices than they would obtain with a "one-size-fits-all" nutrition plan. With more specific and applicable knowledge at a patient's fingertips, it is likely that greater dietary compliance will result with fewer daily swings in blood glucose levels. Ultimately, the result could be a longer and greater quality of life for those with type 2 diabetes. The food shopping application, named TYPE2U, focuses on three phases during the first few weeks of a person living with type 2 diabetes, which include: 1) making food choices for the first time since the diagnosis; 2) making lifestyle adjustments according to blood glucose level testing; and 3) making mistakes that lead to meal planning as a method of increasing control over food choices.

PROBLEM STATEMENT

FOOD PURCHASING DECISIONS

How the users choose to consume food, which can include buying and simply selecting whether they may be in a store or at an event.

DIETARY ADHERENCE

The act of holding fast or sticking by a nutrition or diet plan or regimen ("Adherence"); people diagnosed with type 2 diabetes complying with medical nutrition plans through their food purchasing decisions (Savoca and Miller 224).

ASSISTING

Taking care of the users; facilitating suggestions, navigation, information, and accuracy; increasing sources of knowledge and supporting users in moments of confusion (Knijnenburg).

INTEGRATING

Consistency across devices

Human longevity is directly impacted by an individual's health-related decisions and food choices. Type 2 diabetes is a chronic disease that is a growing problem among American adults, primarily due to unhealthy food consumption (Hepler). According to the 2017 National Diabetes Statistics Report, over thirty million people in the United States have diabetes, and as much as ninety-five percent of those cases are type 2 diabetes ("National Diabetes Statistics Report"). *Food purchasing decisions* can influence a person's ability to manage their disease because what a person eats raises blood glucose levels, which increases diabetic risks and creates cardiovascular issues (Savoca et al. 225). People newly diagnosed with type 2 diabetes face many barriers when attempting to adhere to their doctor's new dietary regimen. Not only do they have to follow a new treatment and medication plan, they also must change ingrained habits related to past food choice, the leading cause of their disease (Sami et al. 3). Changing a habit that has developed over the course of a lifetime is challenging, especially when the change involves educating oneself on topics that range from nutrition to physical exercise (Savoca et al. 228). The purpose of this study is to understand how the design of a food shopping mobile application can support *dietary adherence* in adults newly diagnosed with type 2 diabetes in two ways: 1] by *assisting* them with making adherent food choices; and 2] through customizable tools for *integrating* their routines and preferences.

Design is the bridge between people and action, providing ways to intervene or influence new behaviors. Designers create the tools people use to achieve goals and accomplish tasks; mobile applications and websites, such as Netflix, Hulu, and Amazon Prime allow us to watch television from any device, or enable us to order groceries for delivery to the front door (Instacart, Postmates). When designers create websites and mobile services for a large number of people, there is a risk of dismissing specific information or details that are important to people. Generic design templates do little to help designers create customized health services. While using doctor-recommended websites and mobile applications for food and nutrition decisions, people with type 2 diabetes often experience the following pain points in the design of the typical user interface: information overload; lack of motivation, monotonous tasks; and difficulty changing habits (Nagelkerk et al.; Savoca et al.), among others. Of all these pain points, information overload is the most problematic; it results from having too many nutritional resources to choose from, as well as each resource containing large amounts of generalized information about diet, exercise, and medicine (Nagelkerk et al.; Savoca et al.).

NAVIGATION

Purposefully moving from point A to point B in a digital interface.

When information is designed in such a way that it appears overwhelming, users are less willing to interact with the material, which can lead to other pain points such as lack of motivation. In his "Navigating Large Bodies of Text", David Small explained his approach to designing overwhelming amounts of information in a succinct statement: simplify to help the user focus and to increase engagement. He used "multidimensional interfaces": to make Shakespeare's written works easy to understand (Small 516). Small organized information by using layers and direction, having the most relevant information in the foreground and the rest in the background; or *navigational* or factual details such as page numbers or footnotes angled on a z-axis (third dimension), so the user would have to rotate the screen to access that information. The users' motivation to perform tasks through a device depends on their engagement with the interface, which is a result of thoughtful and engaging design. Tero Hakala, Juha Lehikoinen, and Antti Aaltonen explained in their article, "Spatial Interactive Visualization on Small Screen," (Hakala et al. 137) that a simple, two-dimensional list of text (i.e., the typical approach to designing textual content in mobile applications) does not provide users with the most complete understanding of the information. Their research suggested that designing multidimensional information was more informative and engaging for the user. The Weather Cube is an example of a mobile application that embraces multidimensional information to create a more engaging user experience (see Fig. 1-2).

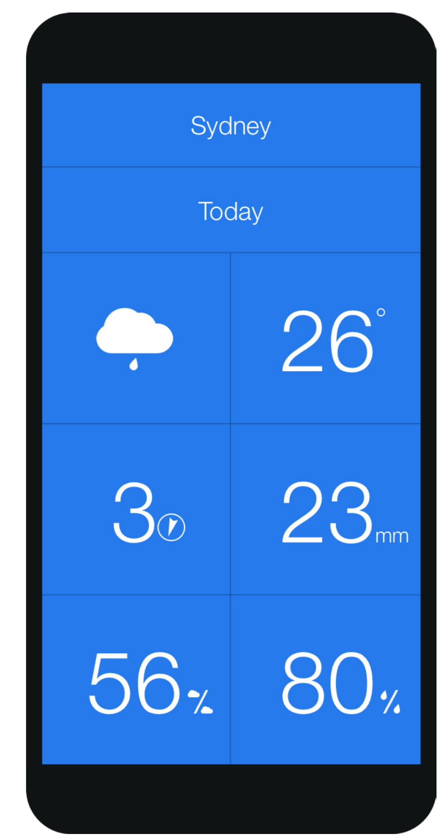

Fig. 1 The application, Weathercube, is an example of a multidimensional interface. ("Weathercube - The Revolutionary Gestural Weather App.").

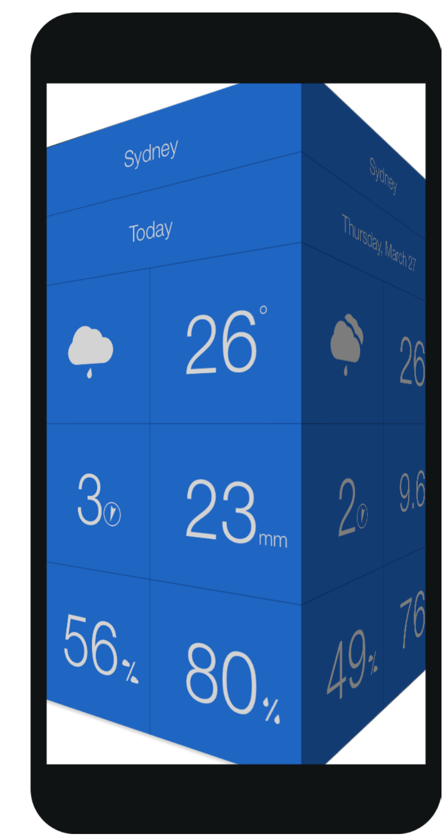

Fig. 2 This shows how the interface rotates to access more detailed information about the weather. I use this interface interaction in my application, TYPE2U, to access detailed information about the food products that the users could buy, such as nutrition ("Weathercube - The Revolutionary Gestural Weather App.")

Generic, two-dimensional, flat designs often found in websites and mobile applications cannot resolve these user experience issues because the problems associated with lack of motivation or engagement vary depending on the individual user. Doctor-recommend websites such as The American Diabetes Association that provide generic nutrition plans with broad food categories rather than lists of specific brands that an individual user can buy in a store (see Fig. 3). Not every person diagnosed with type 2 diabetes is the same. Each person has different pre-existing health conditions and glucose levels that vary throughout the day, creating the need for customization — one that food and beverage companies are only just beginning to address. “It cannot simply be delivered by giving a patient a diet sheet in a one-size-fits-all approach” (Gray 1). Individuals, particularly those diagnosed with chronic diseases such as type 2 diabetes, want control, and they want to feel “heard,” especially if it is clear that the doctors and dietitians do not have the time to customize dietary regimens to fit their individual needs (Ball et al. 490). Investigative research and innovative user experiences are essential for the design of an intervention tool for people to successfully manage their type 2 diabetes.

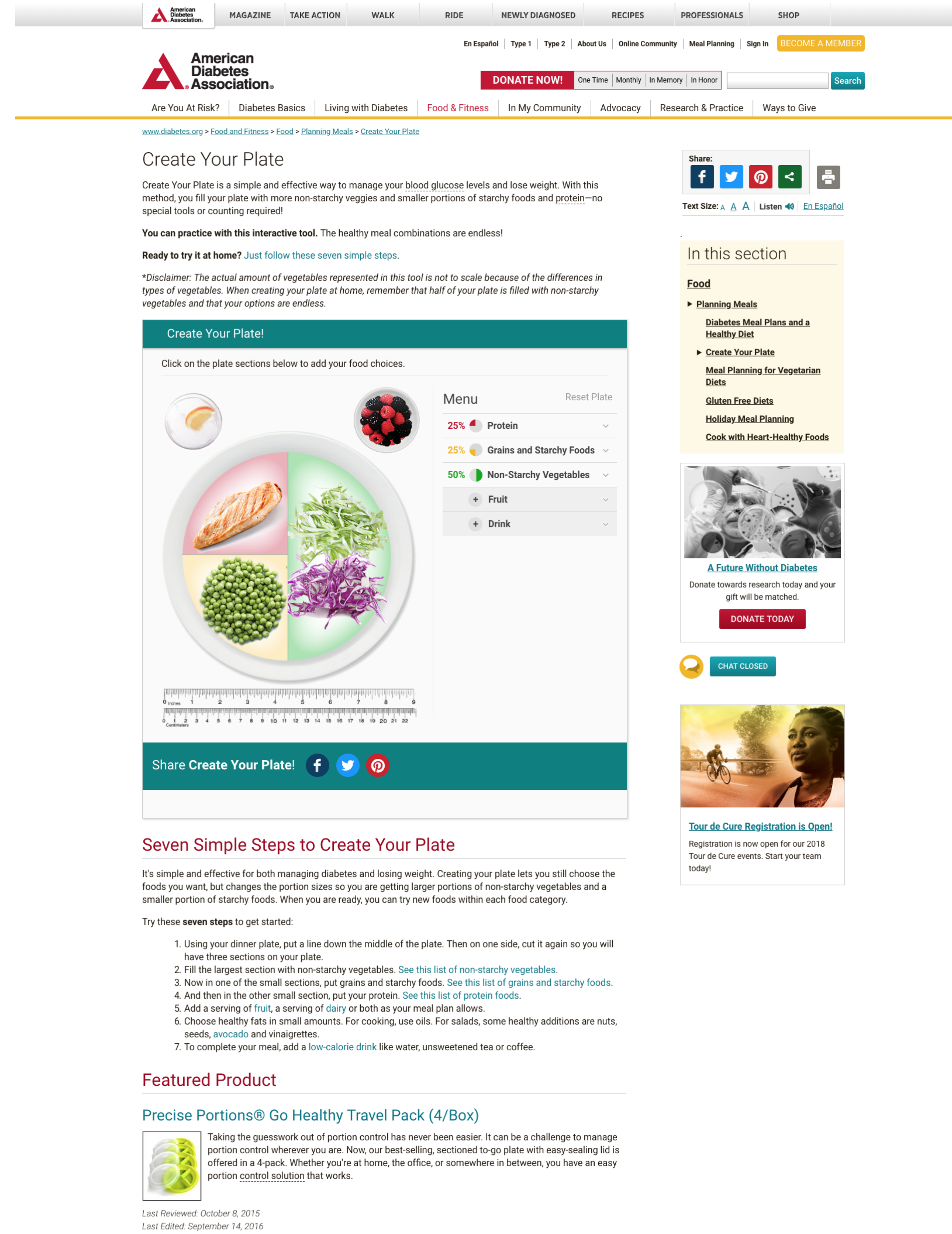

Fig. 3 Here is the ADA Meal Plate tool, this seems like a great example of a customization tool to make users feel like they are getting a specific plan for them. Let’s walk through it. You see the plate and select one or two items within each food category listed on the right-hand panel. As you select the food you see it placed on the plate to give users an idea of portion size. This tool neglects to direct people towards specific brands, and that is a deeper level of information that is missing from these website designs and mobile applications that are supposed to be directing people towards what food they should by consuming. When designing general informative services for a majority of people rather than the individual, these types of issues can be missed in the task flow process.

JUSTIFICATION

CUSTOMIZABLE INTERFACE

The ability to change a digital experience based on personal preference or necessity.

MOBILE DEVICES

Portable communication technology; tablet, phone, watch, wearables.

The Center for Disease Control recently reported that ninety to ninety-five percent of diabetes cases in the United States are type 2 diagnosis ("National Diabetes Statistics Report, 2017" 1). Designing a food shopping application with custom features for diabetics that can integrate into large food and beverage company websites and applications will enable designers to tackle more complex, interdisciplinary problems. Designers should be undertaking interdisciplinary problems by utilizing cross-disciplinary collaboration, such as if a designer is trying to resolve an issue in law or medicine with a service or product, that designer needs to research and work with people in law or medicine to understand their perspectives and experiences with that problem. I had several discussions with medical professionals who specialize in type 2 diabetes in order to support my user experience ideas and to make more informed decisions. Based on my research, there is an opportunity for designers to create an experience that targets a wide audience, while also allowing for user customization to individual needs and desires. Each person diagnosed with type 2 diabetes has different pre-existing health conditions, bodily reactions, and glucose levels, creating singular needs that food shopping systems should address, whether in store or online. The widely adopted design conventions (e.g., templated designs via wire framing, user interactions, and task flows) in the field's current approach to user experience, such as the style of buttons, menus, navigation, and page transitions, serves to control our approach to mobile application interface designs. As users continue to become more technologically adept, these design conventions should be reinvented to accommodate more sophisticated contexts of use and encourage deeper user engagement. A new approach to designing *customizable interfaces* is necessary not only to address problems associated with breaking unhealthy habits, but also creating an experience that people want to continue using long-term—just as managing type 2 diabetes is a lifelong effort. Therefore, there is an opportunity for innovation in researching design applications that provide customized and instantaneous responses for each user. Designers need to remain updated on innovations in the design field because health services are rapidly evolving to become more accessible through *mobile devices*.

Confronting the unexpected situation can cause confusion for mobile application users, especially when they need to make food selection decisions in settings that are not within their typical environment. For example, when they grocery shop somewhere other than their regular grocery store,, if they attend a social event and there is catered food that is not compliant with their dietary regimen. If available options contradict their doctor's instructions, there should be a tool that helps people know how to proceed while still adhering to their prescribed dietary regimen (even if the alternatives the system presents are not ideal, but simply better). There are several studies focused on the self-management of diabetes through design and public health innovations. In 2016, News & Media Research Centre of University of Canberra, for example, published research aimed at empowering people with type 2 diabetes using digital tools. Their research found that food management systems need to be intentionally placed into the patient's regular routines to increase participation (Park et al. 7).

Investigative research and intentional placement are essential for the design of an intervention tool for people with type 2 diabetes, because each type of device has distinct affordances for users, such as the readability based on screen size and wearability. Mobile devices are the

INTERACTIONS

How users behave with technological interfaces and physical environments; how the devices behave towards the users in different food consumption contexts.

most commonly used technology today. Smartphones have a screen size and well-developed system that allow for a wide range of available interactions with information while going through daily routines or tasks. The device requires a person to sit down or interrupt a behavior while consuming or interacting with information on the screen. Including many (but intuitive) gesture *interaction* options that give users a way to understand and view complex data by zooming in, turning it around, and seeing it from several angles rather than just one. The smartwatch is perfect for instantaneous interactions with information; rather than tapping through a phone to read a notification or search for an answer, the smartwatch allows users to address notifications on the spot with voice control or quick responses in one gesture. Certain user interactions and behaviors are better for the smartwatch than the smartphone, and vice versa. For example, if a person is in a meeting and their phone is not with them, that person can still receive notifications of other important emails sent to their phone with a subtle vibration that only the person will notice. The smartphone is ideal for interactions that take more than a minute to perform, such as scrolling through and reading a lot of information. Therefore, the mobile devices would be ideal technologies for assisting and integrating the food purchasing decisions of someone newly diagnosed with type 2 diabetes.

RESEARCH QUESTION

How can the design of a food shopping application support **dietary adherence** in adults newly diagnosed with type 2 diabetes by **assisting** and **integrating** their **food purchasing decisions** related to **Food Selection**, **Food Substitution**, and **Food Combination**?

SUBQUESTIONS

How can the interface design provide opportunities for users to control interface customization related to the assistance and integration of food purchasing decisions across multiple devices?

How can the customizable interface design use audio feedback to deliver 'just-in-time' messages to assist and integrate food purchasing decisions?

How can the customizable interface design integrate existing in-house grocery store services to support adults newly diagnosed with type 2 diabetes?

ASSISTING

Taking care of the users; facilitating suggestions, navigation, information, accuracy; increasing sources of knowledge and supporting users in confusing moments (Knijnenburg).

AUDIO FEEDBACK

An artificial voice response through a mobile device that answers questions and provides users with information; the user can customize the voice depending on user preferences.

DIETARY ADHERENCE

The act of holding fast or sticking by a nutrition or diet plan or regimen ("Adherence"); people diagnosed with type 2 diabetes complying with medical nutrition plans through their food purchasing decisions (Savoca and Miller 224).

CUSTOMIZABLE INTERFACE

The ability to change a digital experience based on personal preference or necessity.

INTEGRATING

Consistency across devices.

FOOD SELECTION

Choosing among available food products for purchase in a store; knowledge of available products in unfamiliar and familiar locations (Furst et al.).

FOOD SUBSTITUTION

Swap; having other choices; having food options that can be alternatives to the users' routine, unhealthy food consumption patterns.

FOOD COMBINATION

Recipes; allergies; food preferences; assigned dietary regimen that may need changes to fit individual needs and desires; integrating information from other health applications to thoroughly inform the users' food purchasing decisions.

FOOD PURCHASING DECISIONS

How the users choose to consume food products, which can include buying and simply selecting whether they may be in a store or at an event.

'JUST-IN-TIME' MESSAGES

How the users choose to consume food products, which can include buying and simply selecting whether they may be in a store or at an event.

MOBILE DEVICES

Portable forms of communication technology; smart devices: tablet, phone, watch, wearables.

NAVIGATION

Purposefully moving from point A to point B in a digital interface.

ASSUMPTIONS

GLANCES

"brief, 5-second sessions where individuals check ongoing activity levels with no further interaction" (Gouveia et al. 144).

My research is grounded in the following theories and conceptual frameworks: Furst's Food Choice Model (Furst et al. 251); Gouveia's *Glanceability Principles* (Gouveia et al. 144); Hakala's Interactive Visualization for Small Screens Guidelines (Hakala et al.); and David Small's Information Landscape Methodology (Small 516).

The Food Choice Model (see Fig. 4) explains how certain external influences affect personal internal values that lead to the development of food choice strategies (Furst et al. 251). The external influences are ideals, personal factors, resources, social framework, and food context. The personal internal values include value negotiations and strategies, which inform a person's methods of determining food choice. Based on the Food Choice Model and the audience targeted in this project, I divided users into two groups: 1] those who do, and 2] do not know how their food choices increase the risks of type 2 diabetes. This project focuses on users who do not know the effects of their food choices and who, in the past, buy unhealthy food as a result of their lack of knowledge.

For my interface designs, I explored Gouveia's Glanceability Principles, which include: 1] integrating with existing activities; 2] supporting comparisons between targets and norms; 3] being actionable; 4] checking habits; and 5] acting as a proxy to further engagement (Gouveia et al. 144). Incorporation of these qualities in the user experience will allow for multiple devices to communicate information to each other, helping users make food purchasing decisions depending on the specific context.

David Small emphasized the importance of creating 'Information Landscapes' when designing an interface with many layers of knowledge and contexts. According to Professor Muriel Cooper, founder of the Visible Language Workshop at the MIT Media Laboratory, an information landscape is "where information 'hangs' like constellations and the reader 'flies' from place to place, exploring yet maintaining context while moving so that the journey itself can be as meaningful as the final destination" (Small 516). Based on Cooper's definition of information landscape, Small aimed to create a continuous, multidimensional digital interface that used interaction tools to enhance user engagement and information architecture. I use David Small's work to develop a continuously smooth, multidimensional interface that allows people with type 2 diabetes to make food purchase decisions more easily.

A heuristic assumption for my work is that people with type 2 diabetes want to manage their food shopping decisions through technology. Several studies have already proven this assumption to be true (Hofman et al.; Peterson et al.; Park et al.) through the research and creation of self-management technology intended for the facilitation of medical treatments, appointments, and protocol for people with type 1 and type 2 diabetes. The target user group's ages range in years include those who are in their thirties to early forties—users who are typically comfortable using technology than, for example, an older demographic.

My design studies focus on the following specific contexts, listed below, of food shopping and consumption that involve Food Selection, Food Substitution, and Food Combination (see Fig. 5). The information will be delivered in the form of a mobile application and online service that will allow users to engage in a more informed food shopping experience at retail.

Food Selection is the context where a consumer obtains knowledge of available products in familiar and unfamiliar food environments. Currently, doctors and dietitians tell people newly diagnosed with type 2 diabetes that they need to learn detailed nutrition facts and food product categories to confirm that each product selection aligns with the approved nutrition plan. Notably, reading nutrition labels takes time and effort, which potentially creates a difficult barrier, thereby making dietary adherence less achievable. Currently, consumers obtain information from other mobile health applications specific to diabetes patients that inform them of food products that they should or should not buy.

Food Substitution introduces a context that is necessary when diabetic consumers' eating patterns hurt their health and increase diabetic side effects. The users of the new mobile service contemplated in this study need to know what food products and brands are better alternatives to their typical food choices.

The Food Combination context arise when, over time, users gain knowledge of how designed food shopping systems improve their shopping experience, and they become better equipped to select appropriate food combinations. They login to a mobile application to input their food preferences, medical documents, and nutrition plans, as well as other pre-existing allergies and medical conditions. The personal nutrition and health information incorporated into the system change how the food shopping application informs users in-store while making food purchasing decisions. Appropriate options, alternatives, and combinations surface in an easy to navigate, frictionless customer experience. All changes for in-store and digital information are tailored to each individual user's health status. The user can access new meal plans and recipes as a result of their stored and updated nutrition and health information.

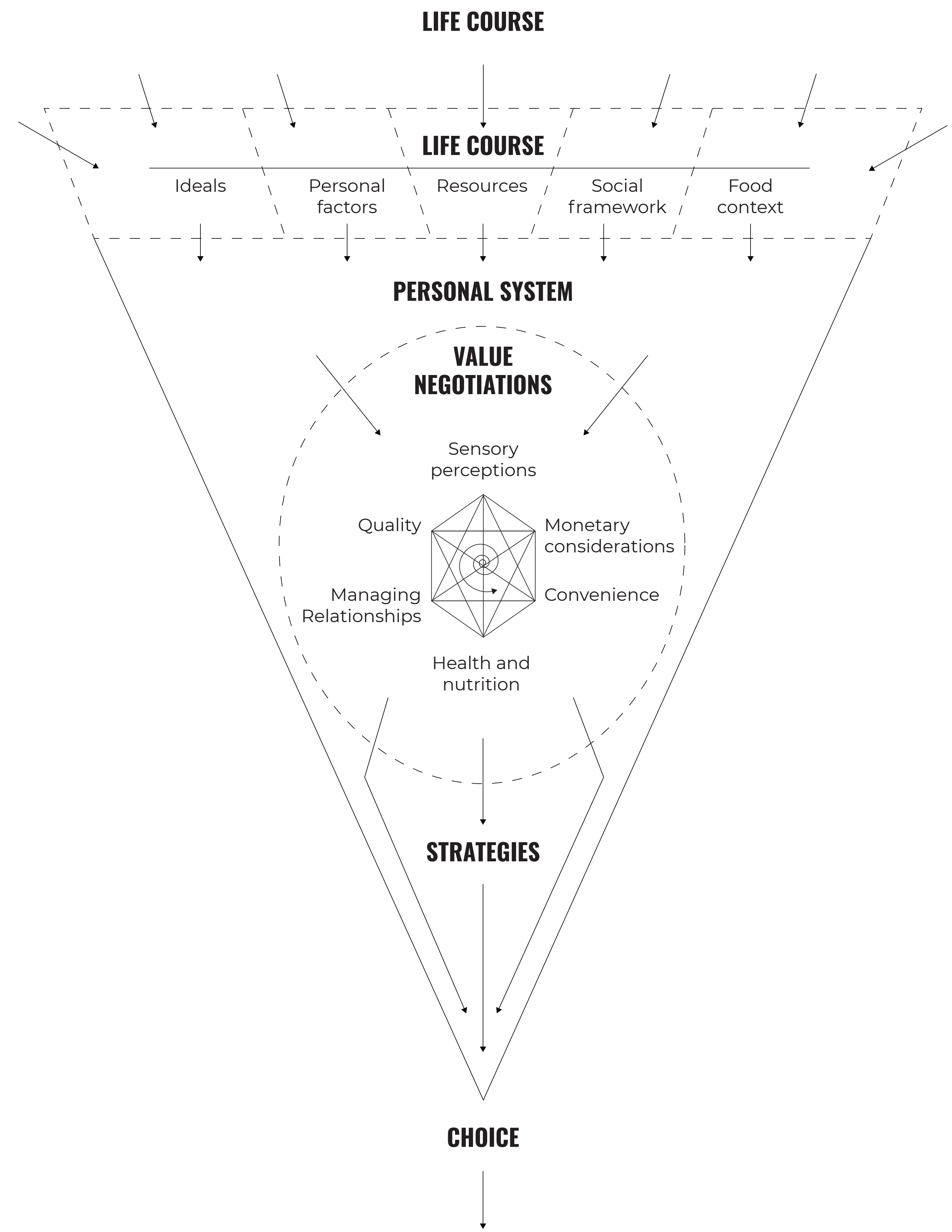

Fig. 4 The Food Choice Model explains how we make food choices, beginning with our life course and external influences, leading to our personal systems of decision-making, involving value negotiations and strategies, and ending with making the food choice (Furst et al. 251).

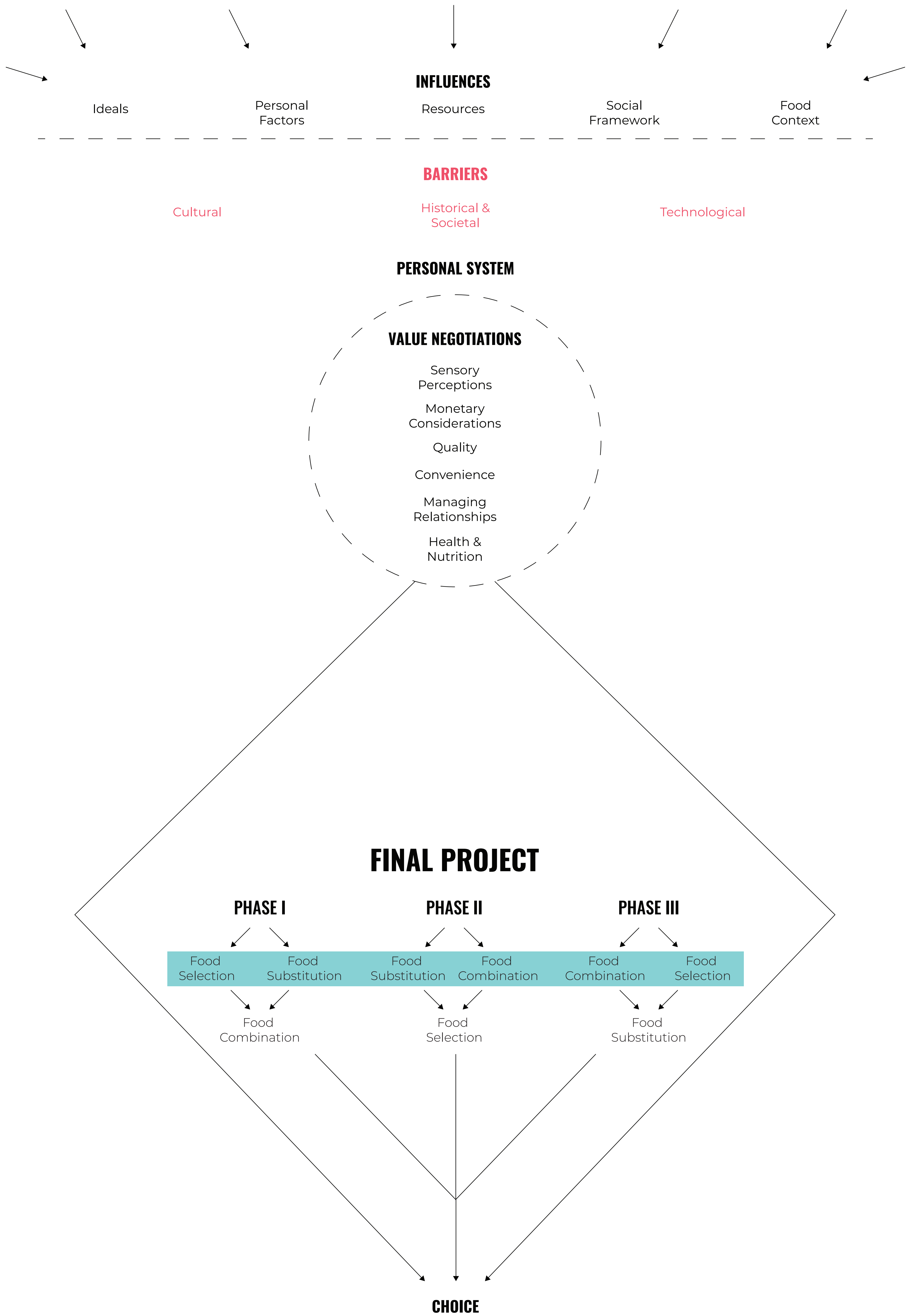

Fig. 5 My design framework integrates the barriers to type 2 diabetes management and the three areas of my final project, Food Selection, Substitution, and Combination within the Food Choice Model.

LIMITATIONS

The purpose of my investigation is to create a hypothetical, customizable mobile application that supports people newly diagnosed with type 2 diabetes, by consistently presenting tools, information, and feedback to users across multiple mobile devices to assist and integrate their food choices (related to food selection, substitution, and combination). While keeping the purpose of my investigation in mind, it is also important to acknowledge the project's limitations.

This project is not an engineered mobile application. If I were to continue working on this research, I would collaborate with an engineer to develop my work into a fully functioning application that people could download and use regularly. I would also research the design of an information integration feature that allows users to share information in the mobile application with other popular digital food delivery and retail shopping accounts, indicating which options and combinations from those websites would be most appropriate for the user. Integrating information from existing services and applications would enhance the overall design experience for people by providing more detailed data and feedback that relates directly to what the users already do in their normal food shopping routines. To make this a functioning feature, I would need to collaborate with other developers to create an API integration that other food services could use to integrate the customized user data and health information collected in my designed service into their own shopping experiences, or vice versa.

According to the CDC's National Diabetes Statistics Report of 2017, Hispanics and African Americans are the two most likely populations to have type 2 diabetes and to also not have access to health insurance ("National Diabetes Statistics Report" 5). The hypothetical customization and adaptability of the interface for my work intend to address diverse demographics and retail locations, but my research does not resolve socio- economic issues and barriers to successful type 2 diabetes management, such as lack of affordable health care, food deserts, varying belief systems, language, and technological knowledge/access (Jang et al. 14). The implication would be that I work with politicians and healthcare professionals to establish new regulations that could help eliminate these socioeconomic barriers to type 2 diabetes management. One method of doing so would be to allow people to subsidize healthcare for technology to lower the prices of devices required for checking blood glucose levels ("Financial Help for Diabetes Care - NIDDK" 1).

Some diabetics download non-diabetic applications, such as Lose It!, MyFitnessPal, or Lifesum, to help manage their food intake and exercise. However, my research is not for fitness tracking or calorie counting — two functions that exist for services targeted at all users whether or not they have type 2 diabetes. My project is specifically for people who are newly diagnosed with type 2 diabetes who need support while purchasing food. My project aims to support people while in food retail environments, who are making food purchase decisions. I cannot guarantee that my research will prevent the progression of type 2 diabetes, because I am not a medical professional. If someone has type 2 diabetes, it is critical that he or she visit a medical professional regularly to help manage this condition.

METHODS

My methods included: a literature review of the most relevant sources; medical discussions through emails and phone calls with Dr. Diana McNeill at the Duke University Medical Center; comparative analysis of existing mobile applications for type 2 diabetes management; user research from published articles and online type 2 diabetes community forums; visual studies that informed the process leading to final prototypes; and video documentation of the final prototypes showing how they could work in action.

Literature Review

Medical Discussions

Comparative Analysis

Case Studies

Visual Studies

User Research

Prototypes

Video Documentation

LITERATURE REVIEW

DESIGN

Lisa Strausfeld's video ("Lisa Strausfeld: Keynote, 2011") gives a talk about her life's work, explaining her transition from history and computer science to information design and data visualization. A few projects that are particularly relevant to this thesis research are One Laptop Per Child, LITL, and Diller & Scofidio Renfro. Strausfeld emphasizes the use of a continuous task flow within a user's experience. I use a continuous flow in the user's experience of TYPE2U to create an interface that adapts to the user's routine and that progresses with the user as they learn how to manage type 2 diabetes.

The article,"Food Choice: A Conceptual Model of the Process," (Furst et al., 1996) explained a food choice model that diagrams the process of how people make certain food choice decisions based on influential factors. The modeled process includes a person's life course, influences, personal system of value negotiations and strategies, and choice. I use the Food Choice Model as the foundation for my conceptual framework.

David Small's research (Small) explains how we have been treating text on a screen as if it were a printed page, and he discusses how he aimed to change that, thinking about text with multiple dimensions and gesture-based interactions. Small performed a series of trials, which tested the success of different human-to-text interactions prompted by various tools and text-layout designs. He developed ways to read information without becoming overwhelmed by the amount of text and while also maintain user engagement. I use David Small's work to develop a continuously smooth, multidimensional interface that allows people with type 2 diabetes to make food purchase decisions more easily.

Ziemkiewicz et al. researched visualizations and human-computer interaction to determine how individual differences could influence the use of visualization (Ziemkiewicz et al.). There was a discussion about how their research could progress towards adaptive interface design, explaining that the interface should learn from the user's actions and behaviors and adjust to fit the user's preferred experience. This discussion supports why my work should include a customizable interface that collects medical data about my users over time.

HEALTH

In Ball's article ("The Nutrition Care Needs of Patients Newly Diagnosed with Type 2 Diabetes: Informing Dietetic Practice"), he discusses how he collected patients' history of interactions with dietitians and medical professionals in regards to type 2 diabetes diagnosis and treatment to understand what the patients were not receiving in their past experiences that could be delivered in future interactions. Ball's research clarifies that there is a need for a service that allows patients to personalize their nutrition plans.

There are discussion forums published on this website (https://www.diabetes.co.uk/forum/threads) such as the forum discussion, "Diabetes, Life and All That", that provide primary sources of information for people with prediabetes or type 1 and type 2 diabetes, consisting of information for medications, plans, nutrition, daily living, as well as blogs and forums where people post questions and answers regularly. Thousands of people use this website internationally, bringing people together, bonding over common problems and experiences. The user experiences found on the type 2 diabetes forums of this website composed a majority of the user research for my project.

This Website forum discussion ("Diagnosed Yesterday with Type 2 Diabetes. No Idea Where I Go from Here") is an example of many discussions on Reddit that are questions from people newly diagnosed with type 2 diabetes. They are often confused and need help from other people who experience the same issues. Reddit provides the space for people to communicate about anything, whether they want to complain, to find answers or advice, or to just talk about their lives as a digital journal. This site was used for user research, exploring what types of people seek advice on Reddit for managing nutrition plans while living with type 2 diabetes. Reddit research also involved exploring user reviews of mobile applications and digital services that already exist for type 2 diabetes management. My comparative analysis includes several of the mobile applications mentioned in the Reddit user reviews, creating a matrix of what services those applications provide and of gaps where those applications do not support.

Hofman explored the effectiveness of internet-based self-management interventions on adults with type 2 diabetes (Hofmann et al.). Results showed that the intervention increased patient knowledge and awareness of their own health; increased patients' self-efficacy and support; improved patients' stress management and negative moods; and changed patients' eating and exercise habits. I use this research to justify my final project.

In the article, "Mobile Health Application and E-Health Literacy: Opportunities and Concerns for Cancer Patients and Caregivers", Hyunmin et al. explain how a mobile application and E-Health service have supported cancer patients and their families throughout their diagnoses and treatment plans (Hyunmin et al.). Although this research focused on cancer patients, the health literacy and technology access concerns align with the concerns of healthcare professionals researching patients with type 2 diabetes. Kim et al. explained that "low health literacy is associated with low adherence to medications, poor health status, and increased health care costs" (Kim et al., 1). Caregivers' low health literacy can also negatively impact a patient's success in medical plan adherence. According to their research, more interactive technology could increase patient engagement in treatment and adherence to medical plans, especially devices that utilize touch and hand gestures. The conclusions of this article support my use of multiple mobile devices for chronic disease management in my investigation.

In the article, "Perceived Barriers and Effective Strategies to Diabetes Self-Management," the research discussed the participants' perceived barriers to diabetes self-management and explored which strategies would be effective in dealing with these barriers. The most commonly reported barrier was lack of knowledge and understanding of diet plans, regardless of having the support of dietitians. One of the patients in the study expressed an interest in guidelines for the doctor's' diet plans, to explain the reasoning behind each food choice. My project's limitations discuss the barriers explained in this article.

HEALTH

Oldenburg et al. explain how the use of technology for health care treatments and self-management has the potential of increasing patient adherence and decreasing the negative effects of chronic diseases (Oldenburg et al.). However, patients and health care professionals do not take advantage of this potential as much as they could because of three reasons according to Oldenburg et al., "(a) poor program design and implementation of many of the program innovations using new technologies; (b) poor user interface with these programs and/or a lack of perceived benefit from users, including poor integration with users' daily [routines]; and (c) inadequate study design and measurement methods for evaluating the implementation of technology innovations in real time" (Oldenburg et al., 485). Further research in design approaches to self-management of chronic diseases through technology could increase patient care effectiveness if the research explores methods of increasing user engagement and adherence reinforcement and methods of integrating the technology programs into patient lifestyles and routines.

Park et al.'s article has two of the objectives: to identify barriers to type 2 diabetes patients' increased medical plan adherence; and to increase digital engagement for health professionals and patients through mHealth (Park et al.).. The mHealth experiment consisted of four management categories: food intake and diet; journaling; exercise; and communication. Park et al. found that food management systems need to be intentionally placed into the patient's regular routines to increase participation, and their research informs how TYPE2U adapts to a person's routine to increase their engagement with the mobile application.

Petersen and Hempler developed a mobile application for diabetes self-management using design thinking strategies, which were essential in creating value and incentive for the users (Peterson et al.). Focusing on using a human-centered approach, Peterson and Hempler had users involved in all stages of the application's research and development. Petersen and Hempler's strategies of creating value and incentive for users informed how I designed TYPE2U for my users.

MEDICAL DISCUSSIONS

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Duke University
Medical Center

I spoke with Dr. McNeill at Duke University to learn more about the barriers for adults when they are diagnosed with type 2 diabetes that prevent them from making adherent food purchasing decisions. Dr. McNeill treats two contrasting demographics, one in Brier Creek that consists of patients over the age of sixty and are financially stable, and the other in Durham at the Lincoln Community Health Center consisting of people that are homeless and without health insurance. Depression is another barrier for people with type 2 diabetes. McNeill said that a majority of people are depressed for a period of time while trying to manage their chronic condition because of the tedious, time-consuming, and seemingly futile nature of type 2 diabetes management.

Dr. McNeill explained that regardless of age or economic status, all of her patients own smart devices. Of the websites and mobile applications that exist, McNeill tells her patients to use the American Diabetes Association's website and the American Association of Clinical Endocrinologists' website as essential resources for type 2 diabetes nutrition. McNeill prefers giving her patients printed handouts for nutrition and medication planning rather than recommending mobile applications; but, as Apple Health continues to develop, McNeill believes that the nature of medical support for diabetes will change. Towards the end of our conversation, McNeill also gave me some nutrition tips for my users: 1] juices and soft drinks are deadly; 2] soft drinks stimulate our hunger centers, leading us to eat more even when we are not hungry.

My conversation with Dr. McNeill informed the limitations to my final project and confirmed that there is a need for mobile food shopping services that support adults newly diagnosed with type 2 diabetes when making food purchasing decisions.

COMPARATIVE ANALYSIS

The medical professionals gave me lists of applications that they recommend to their patients. I collected data on user reviews of applications intended type 2 diabetes and general nutrition management. Based on a list of intended purposes for the applications, I analyzed whether or not the applications performed their intended purposes (“Reddit.Com: Search Results - Type 2 Diabetes Mobile Applications.”; “Type 2 Diabetes.”; “ITunes.”). My analysis confirmed the need (see Fig. 6) for digital products that help people, specifically those who have type 2 diabetes, with their food purchasing decisions online and in stores.

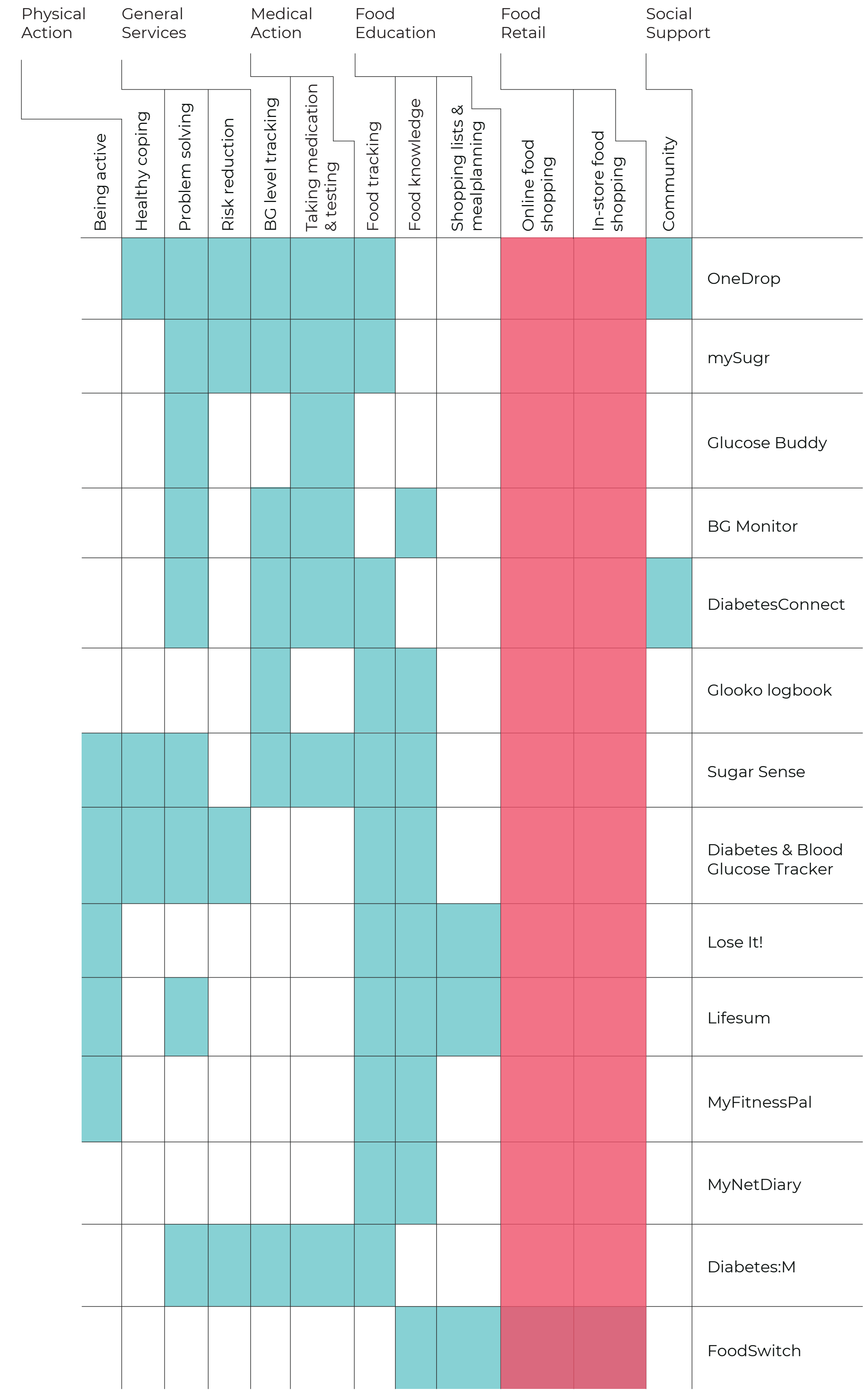


Fig. 6 Each of the applications in the top horizontal row have functions for managing type 2 diabetes that are listed in the far left column. The functions of each application are highlighted in blue. A design gap occurs when there is a maximum of one application that possesses a function. The red highlights the design gap for type 2 diabetes management in mobile applications.

CASE STUDIES

MORAL SUPPORT: DIABETES.CO.UK

The Online Global Diabetes Community is a global hub for thousands of people to seek help for prediabetes, type 1 diabetes, and type 2 diabetes. The website provides research, news, and other learning materials as well as popular community forums that the members use regularly, seeking advice and support from other members. There are hundreds of discussions for everyone, those who are newly diagnosed and those who have been living with a form of diabetes for many years. There is one discussion in the type 2 diabetes forum that people have been updating everyday since it was made several years ago specifically for sharing what they ate. The members feel compelled to share the food they ate everyday, whether or not the food was bad or good for them, they share it, because these members give each other validation and support regardless of their progress made in type 2 diabetes management. I am choosing not to provide a picture of this forum to respect the privacy of the community forum members.

SETTING GOALS: APPLE ACTIVITY

Apple Activity is a smartphone and smartwatch mobile application that tracks a user's physical activity, and allows users to share activity updates with other friends who use the application. Users also receive periodic badges and acknowledgement for reaching their daily and weekly goals (see Fig. 7-8).

Fig. 7 These are progress report screens in the smartphone view of Apple's Activity application, which inform my visuals for data visualization in TYPE2U, which inform my visuals for data visualization in TYPE2U. (Apple, "Apple's Activity App Could Be Removable in IOS 11."; "Apple Watch Gets Social Features, Breathing App, Emergency Services at WWDC | MobiHealthNews.")

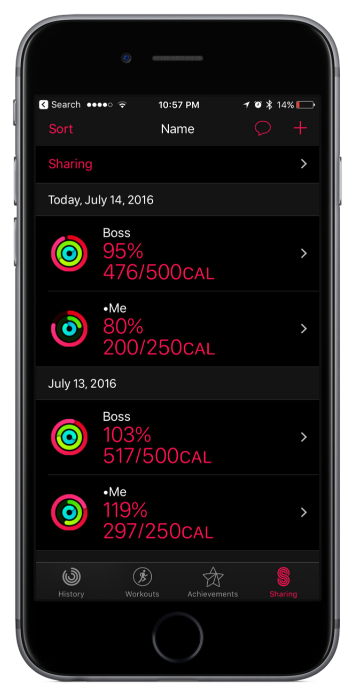


Fig. 8 These are progress report screens in the smartphone view of Apple's Activity application, which inform my visuals for data visualization in TYPE2U, which inform my visuals for data visualization in TYPE2U These are progress report screens in Apple's Activity application (Apple, "Apple's Activity App Could Be Removable in IOS 11.")

FOOD SHOPPING: FOODSWITCH

FoodSwitch provides users with a food shopping mobile experience that shows the nutrient quantities in each product and has shopping filters that eliminate product options that contain sugar, gluten, fat, or carbs at any store location. The application provides a barcode scanner and nutrition information. This is not specifically for type 2 diabetes management. For thorough type 2 diabetes management, a user needs all nutrient quantities for every product scanned or searched in the application (see Fig. 9).

FOOD SHOPPING: INSTACART

Instacart is a mobile food shopping service that allows users to select their preferred grocery stores and have food delivered to their homes or ready for pickup at the store locations. This is a form of user customization in a food shopping service (see Fig. 10).

Fig. 9 FoodSwitch is a mobile application for a general user group that has a barcode scanner to identify products and a view of product details, showing the user whether or not products align with particular diets, such as "no sugar", "no carbs" or "no glucose." These tools influence how my application identifies products and accesses customized product information for each user ("FoodSwitch USA.").

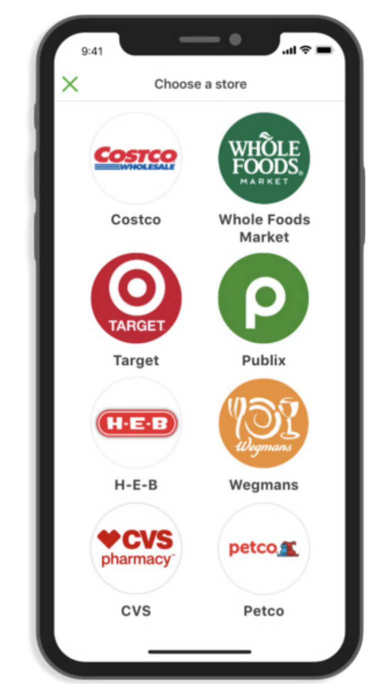


Fig. 10 Instacart is an example of a mobile application that integrates grocery store delivery services. This influenced my choice to include in-house grocery store mobile delivery services into TYPE2U ("Instacart Anytime: A Data Science Paradigm – Tech-at-Instacart.").

FOOD & MEDICATION TRACKING: MYSUGAR

The mySugr application provides users with a detailed progress report of their data tracking for blood glucose levels, medication, food, and exercise. Google Play has one inclusive application called mySugr, but there are three applications for the iOS version of mySugr, which are mySugr: Scanner, mySugr: Diabetes Training, and mySugr: Diabetes Tracker Log. Of the three applications, the training and scanning functions are the most unique. Unlike other mobile application scanners, mySugr Scanner allows users to scan medical devices to sync blood glucose level data. Let's say that the user owns an insulin pump and the user decides to download mySugr Scanner and wants to sync the data from their insulin pump to their mySugr application. The user just taps on the scanner and takes a picture of their device screen each time there is a blood glucose level update. The mySugr: Training application focuses on teaching users about type 2 diabetes, what they need to remember and how they need to behave. Another unique feature of mySugr provides users with a smart search for places, meals and activities that can support successful diabetes management (see Fig. 11).

Fig. 11 MySugr is a mobile application that ican sync data from blood glucose monitors by scanning the screens of the monitor devices. This tool influenced my decision to integrate blood glucose level testing into TYPE2U and how that data influences the products for future food shopping trips ("MySugr.Com.").

FOOD & MEDICATION TRACKING: ONEDROP

Apple Health collaborates with OneDrop so that Apple users with diabetes can sync their blood glucose information with their regular health data stored on their smart devices. This mobile application works with OneDrop insulin pump devices to collect accurate blood glucose information. The OneDrop features that users find the most helpful are food tracking (logging what was eaten), medication tracking (reminders for taking medications and going to appointments), and blood glucose level tracking. Users also believe that OneDrop reduces their health risks as well as solves problems and suggests coping mechanisms related to medication tracking. There is also a timeline that shows users their blood glucose levels and carbohydrate intake each day, but this timeline does not provide suggestions for improving and it does not include other nutrients besides carbohydrates (see Fig. 12).

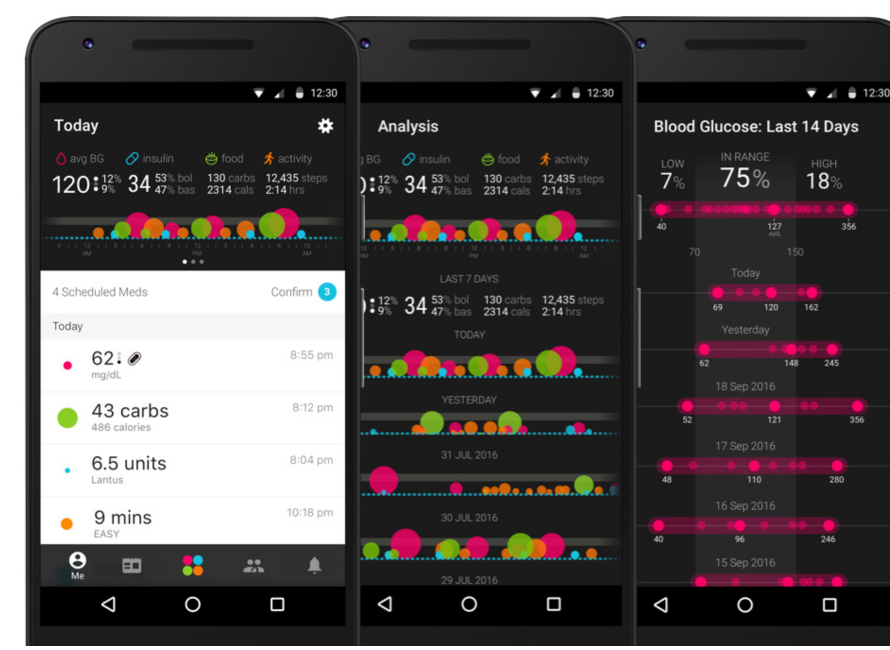


Fig. 12 OneDrop is a mobile application for diabetes management. The image above shows screens of OneDrop's progress reports for the users based on their blood glucose levels and fitness and food logs. These data visualizations influence how I design the TYPE2U progress reports for my users ("One Drop.").

FOOD & MEDICATION TRACKING:SNAPIT! BY LOSEIT!

The mobile application, LoseIt!, is not an application for diabetes management, however people who have type 2 diabetes use LoseIt! to track nutrient intake. When the user takes a picture of their meal using Snap It!, the app identifies each ingredient of the meal from the picture and has a list of the identified ingredients below the image (see Fig. 13).

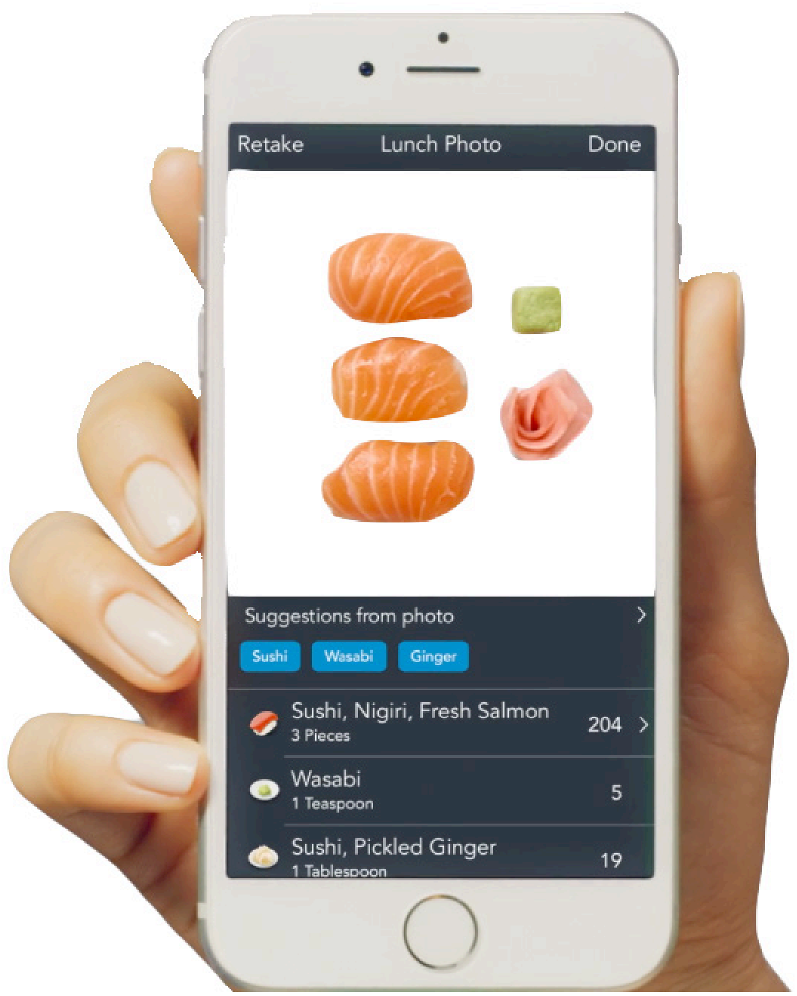


Fig. 13 When the user takes a picture of their meal using Snap It!, the appIdentifies each ingredient of the meal from the picture and has a list of the identified ingredients below the image ("Food Recognition Technology | SRI International."; "Snap It™-Lose It!")

VISUAL STUDIES

USER INTERACTIONS

These mini studies consist of hand and touch gestures for mobile devices, as well as animated transitions to create engaging user experiences. I referenced the article “To Use or Not To Use: Touch Gesture Controls For Mobile Interfaces”for the gesture studies. I collected the animated transition studies from design and presentation software programs, Adobe After Effects, Keynote, and Microsoft PowerPoint. The animations are ways for users to interact with information throughout a user experience (see Fig. 14-15).

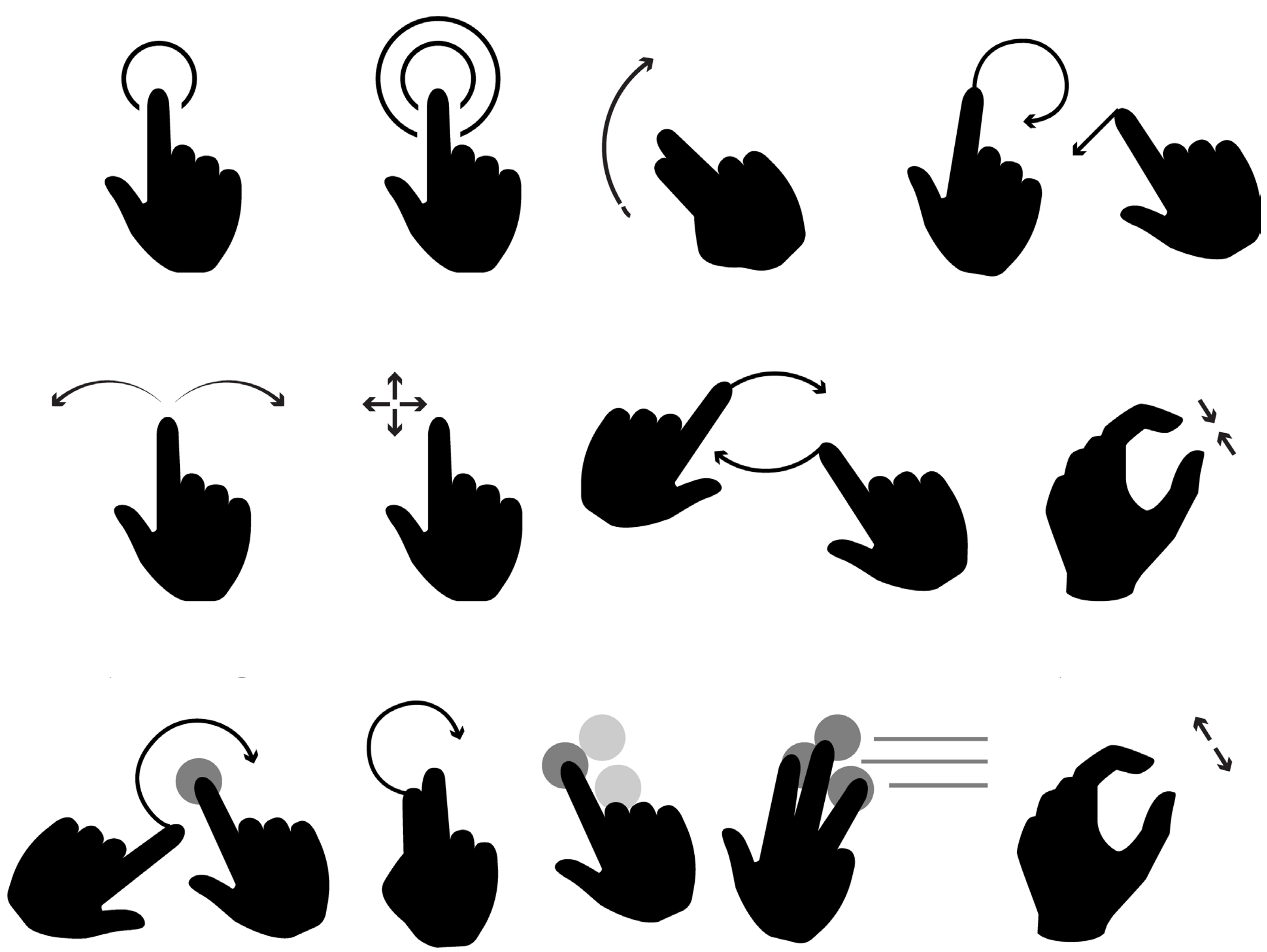


Fig. 14 These gestures are from the article, “To Use Or Not To Use: Touch Gesture Controls For Mobile Interfaces”, with some modifications based on the direction of my final project.

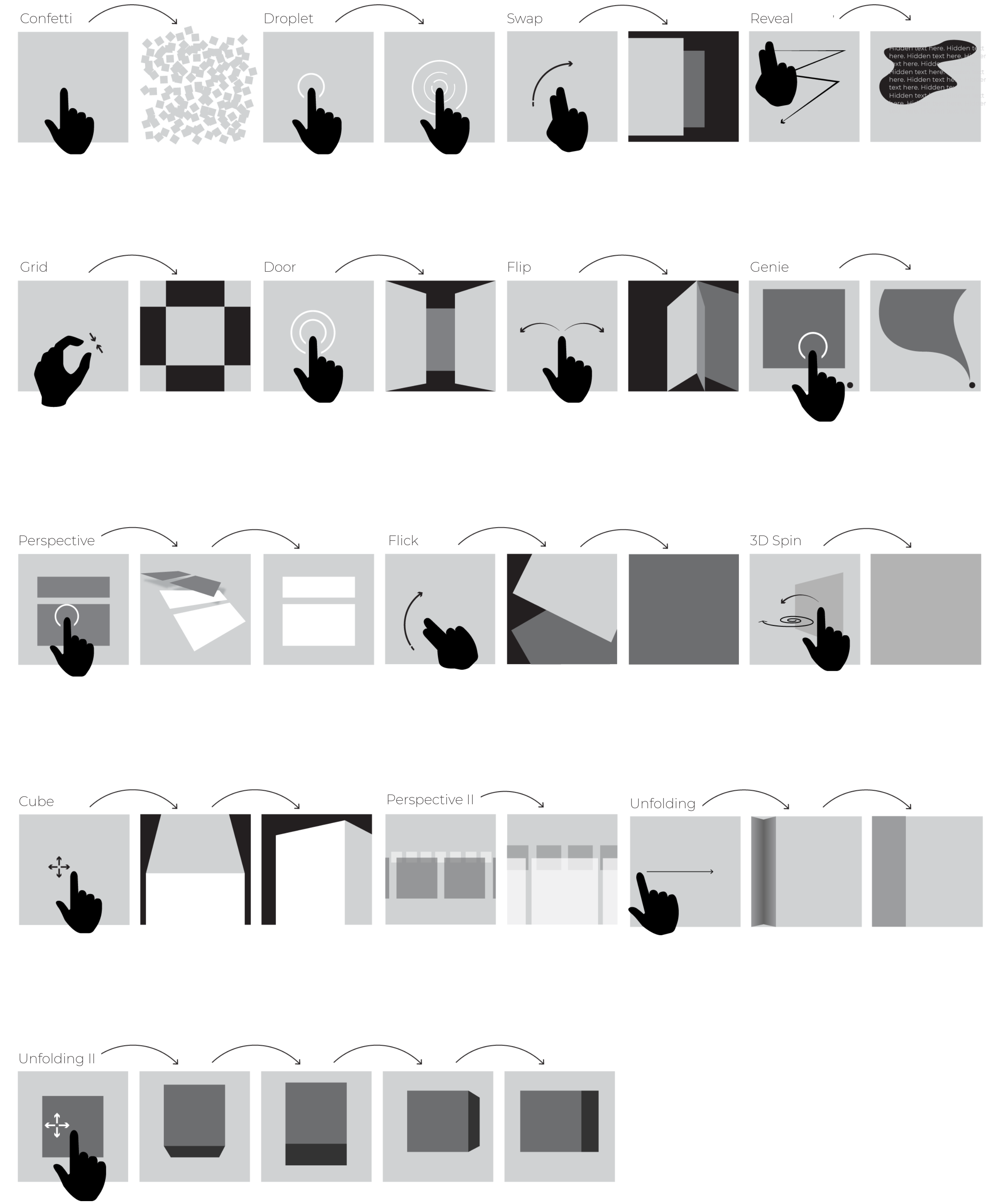


Fig. 15 This table is a series of animated effects from Microsoft PowerPoint, Adobe After Effects, and Keynote. Each animation above is paired possible user interactions and hand gestures (see Fig. 17).

MORAL SUPPORT

I explored how advice or words of encouragement could intervene during food shopping experiences through audio or haptic feedback based on Apple's user experience guidelines. One of the studies shows how a live chat could exist in the application to provide help from online community forums when a user is confused or discouraged while trying to adopt the new dietary regimen for type 2 diabetes. The third study shows a pop-up reminder about a food item to avoid buying or an online type 2 diabetes nutrition tip that appears in the mobile application interface while a user is shopping for food (see Fig. 16-17).

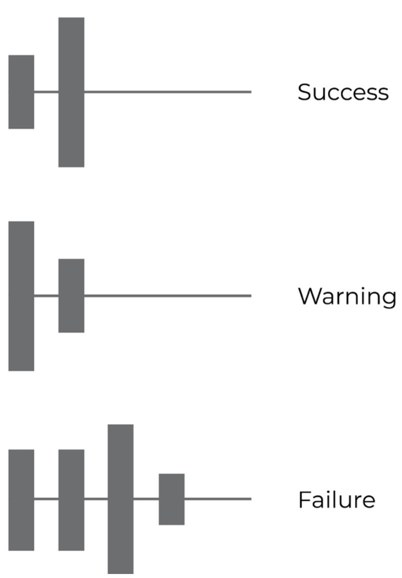


Fig. 16 Haptic feedback is also known as the vibrations that replace ringtones for notifications if your devices are on "Silent" (Apple). These variations of haptic feedback led me to using audio and voice feedback in TYPE2U.

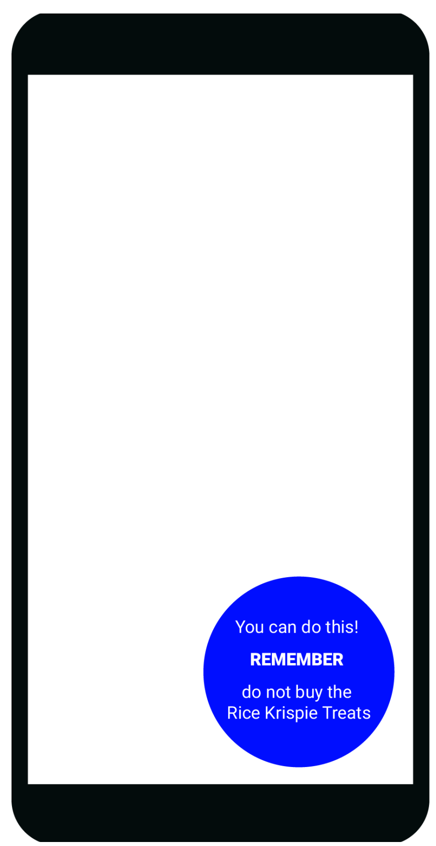


Fig. 17 Pop-up reminder that syncs tips from online community forums so that the user can receive the tips without logging onto the online community forum and sifting through weeks of discussions to find the useful tip.

SETTING GOALS

Based on the glanceable interface qualities (Gouveia et al.) and Apple Activity, I designed several smartwatch interface studies for the user to glance at throughout their day as motivation to buy more adherent food products. The visual studies represent these design qualities: abstract; integrating with existing activities; and checking habits (see Fig. 18-19).

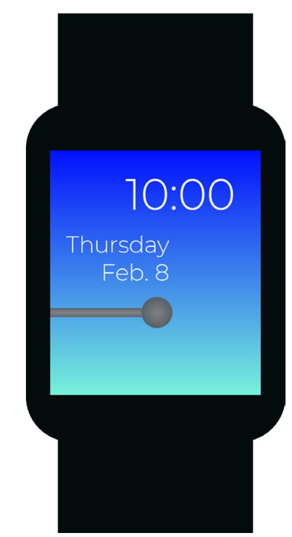


Fig. 18 When glancing at the smartwatch, a user will see a gradient scale that helps the user understand how food affects their daily blood glucose levels.

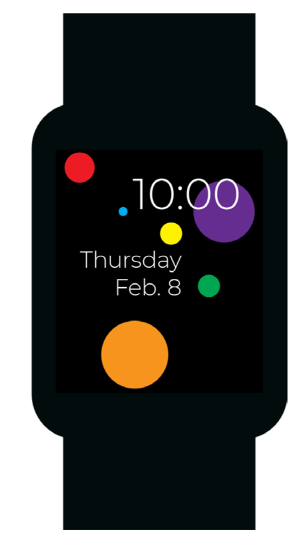
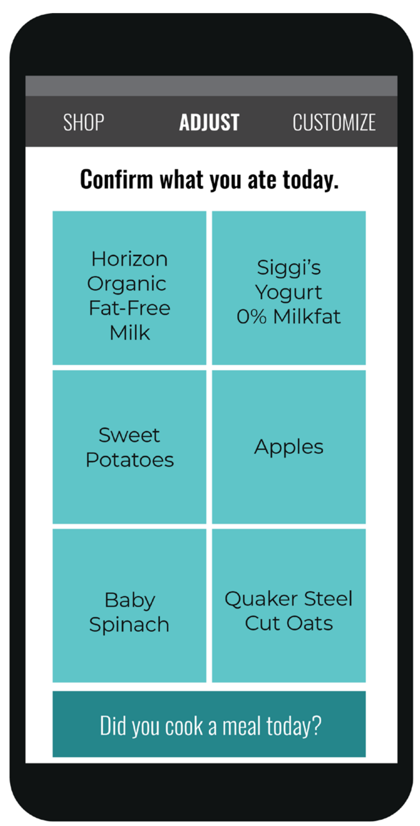


Fig. 19 While the user is shopping, they can glance at their smartwatch to see circles that represent different nutrients (carbs, protein... etc.), circle size is based on necessity.

FOOD & MEDICATION TRACKING

For the food and medication tracking, I explored how smart devices can support people newly diagnosed with diabetes while calculating how their blood glucose levels would change based on Food Selection. These studies involved product identification, food shopping, and blood glucose level tracking (see Fig. 20-21).



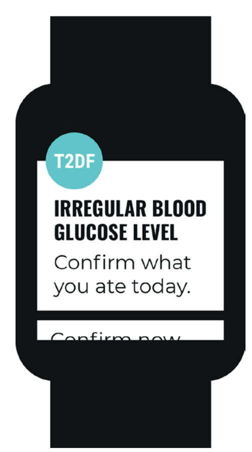


Fig. 20 If my application could sync with automatic insulin pumps and other medical devices, this could be a useful notification for users so that they can change their shopping lists if what they ate had a negative impact on their blood glucose levels.

Fig. 21 This is a premade shopping list based on doctor-approved nutrition plans and user dietary preferences. When the user receives a blood glucose update, it is important in the early stages of their diagnosis to record what they ate before their blood glucose level was tested so that they learn which food products help them the most effectively.

USER RESEARCH

My persona is based on information and user-generated content gathered from type 2 diabetes online community forums, Reddit.com and Diabetes.co.uk (also referred to as The Global Diabetes Community Forum). User comments consistently indicated that a person newly diagnosed with type 2 diabetes needs to:

Have easy access to food selection knowledge and tips.

Enjoy sharing what they eat with other people with type 2 diabetes, because doing so increases a sense of accountability and also provides sources of support and advice.

Test blood glucose levels after every food item and meal eaten (to determine food choice impact throughout the day) ascertain what works for them in terms of food products and time of day.

Have ways of customizing nutrition plans to include specific needs and desires. People newly diagnosed with type 2 diabetes have complained about nutrition plans lacking individual lifestyle preferences.

Feel supported when they make non-adherent food choices.

Sam is a 42-year-old female who was diagnosed with type 2 diabetes a few days ago. She does not want her health to worsen, so she is eager to start changing her diet following the nutrition plan that her doctor provided.

PROTOTYPE FRAMEWORK

The system for this project demonstrates the impact of specific design resources on the three prototype phases of my final project (see Fig. 22). Each of the three prototype phases represents the user's progression through the stages of type 2 diabetes, while beginning to manage their food choices after their initial diagnosis with type 2 diabetes. This is a story about the user's progression with making adherent food choices while using my designed tool. The story begins with phase 1, the initial diagnosis, moving to phase 2, when the user adjusts their thinking and their food choices to become increasingly compliant, and landing finally in phase 3, when the user is making mistakes and adjusting to get back on an adherent track. Food selection, food substitution, and food combination play important roles in these three phases.

David Small's "Navigating Large Bodies of Text" focused on designing overwhelming amounts of information, simplifying to help the user focus and increase engagement. He used "multidimensional interfaces" to make Shakespeare's written works easier to understand. I want to use this tactic in my work, because newly presented nutritional information and demands can be overwhelming to newly diagnosed type 2 diabetics. Small's work influences my prototypes for the first two phases most obviously, as the user moves from their initial diagnosis into making adjustments in their food choices. I have reviewed "Exploring the Design Space of Glanceable Feedback for Physical Activity Trackers", an article focusing on the impact of glanceable feedback, delivered via smart watch, on user motivations. The article outlines five qualities of glanceable feedback for digital interfaces: integrating with existing activities; supporting comparisons between targets and norms; being actionable; checking habits; and acting as a proxy to further engagement (Gouveia et al. 1). These qualities influence the digital interface design for moments when users need to check a quick notification, or progress while performing routine behaviors such as cooking in the kitchen, working at the office, or shopping in a store. "Spatial Visualization on Small Screens" emphasized how to use dimensions to provide the user with the greatest volume of necessary information, while increasing user engagement. The article influences the final two phases of my work, particularly in the third phase, where the user is actively learning, adjusting and improving food choice.

After the initial diagnosis, users are often frightened, as they lack knowledge and are overwhelmed with information from doctors, digital sources and pharmaceutical companies. Food Selection is the primary emphasis in the first phase of my prototypes. The phase 1 food selection prototype intends to help users develop good habits related to reading and assessing nutritional facts, building awareness of appropriate personal dietary choices, while helping them to make good food selections. Food Combination will be a secondary focus in the prototype, iterating how the user can customize food product suggestions.
Food Substitution is the primary focus of phase 2, because this is when the user is making adjustments to their choices, as they learn more about the impact of food choice on their blood glucose levels. The phase 2 food substitution prototype gives the user automatic updates on irregular blood glucose levels, by collecting data that is sent from the user's blood glucose monitor that automatically sends reports to smartphones via SMS messages. The prototype also intends to help the user identify food product consumption that leads to irregular glucose levels, so that the application can make substitution recommendations that will lead to more stable and managed blood glucose levels throughout the day. Food Combination is the primary focus of phase 3, because this is the stage of the user education where food choice mistakes are made, and new combinations should be introduced into their diet to drive more compliant behavior. This prototype will give the user an interactive data visualization that identifies the days when there were irregular blood glucose updates, providing cause related information and alternative food choice to alleviate the issue.

	I RECEIVING INITIAL DIAGNOSIS	II MAKING LIFESTYLE ADJUSTMENTS	III MAKING MISTAKES & MOVING FORWARD
FOOD SELECTION	Learning about food that the users can eat. Developing the habits of reading nutrition facts and the awareness of how nutrients affect the users' health.	System automatically adjusts for the user based on data input from tasks in food substitution.	Digital mama steps in to help the user get back on track with food selection tasks after the user makes a few mistakes.
FOOD SUBSTITUTION	Breaking old habits by using food and product recognition technology.	System automatically updates the user on irregular blood glucose levels. Confirming the food products eaten that day of the blood glucose level update.	Provides user with more creative ways to substitute food, with recipes and food rewards.
FOOD COMBINATION	Figuring out how personal preferences and needs can adapt to new dietary regimen.	Introducing how the user can share data with their doctors to inform the doctors during appointments and to increase the user's understanding of their health.	Provides the user with goal-setting options and data visualizations of progress that the user can share with a medical professional to discuss during appointments.

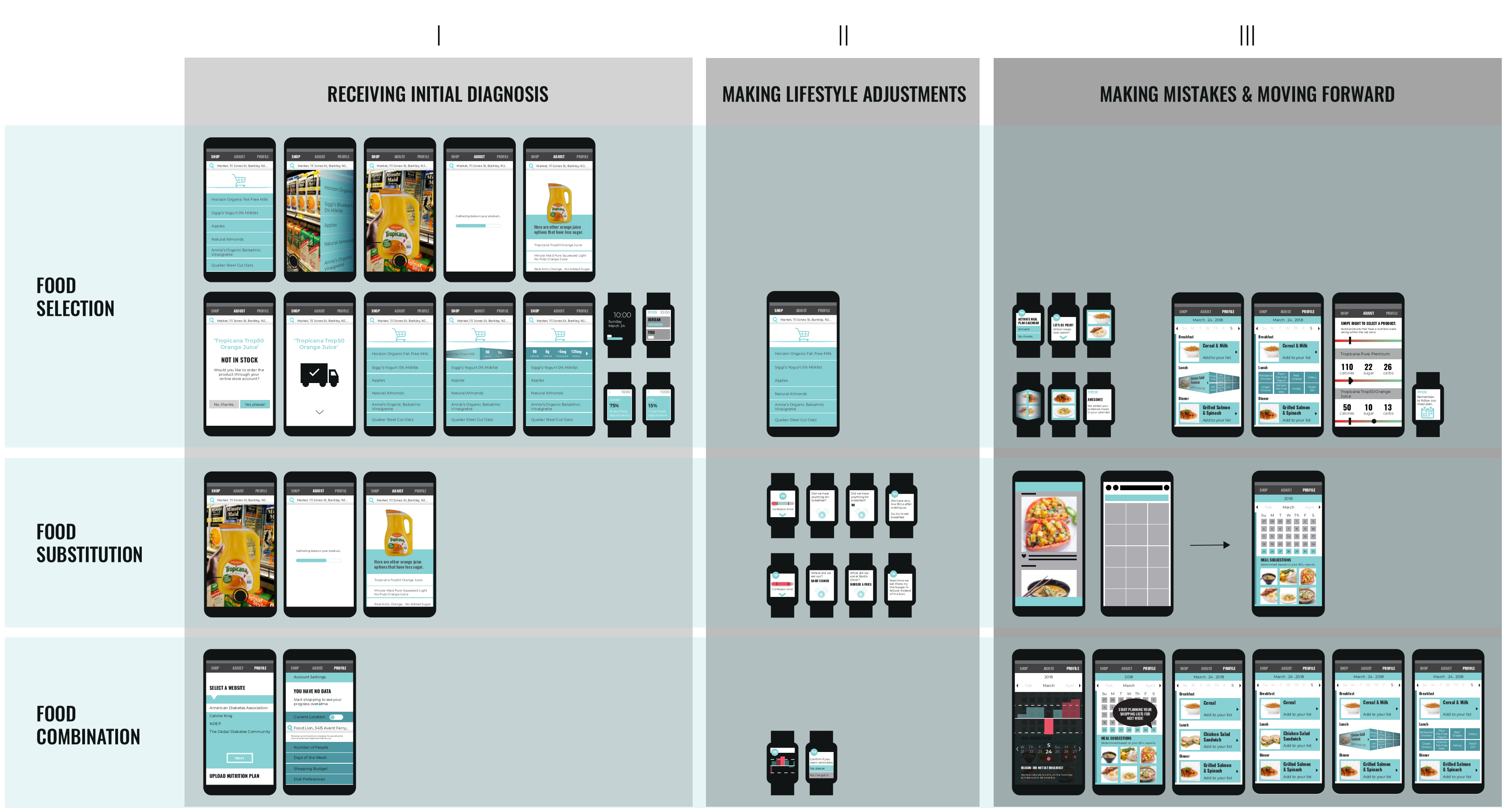


Fig. 22 The framework for the prototype system. The first half of the framework show the descriptions for each phase of prototypes. The second half of the framework shows the entire visual system (Small; Gouveia et al.; Hakala et al.).

PHASE I: INITIAL DIAGNOSIS

SUBQUESTIONS

How can the design of a customizable interface integrate in-house grocery store services to support adults newly diagnosed with type 2 diabetes?

FOOD BUCKETS

Food Selection
Food Substitution

PROTOTYPE SCENARIO

The doctor diagnoses Sam with type 2 diabetes, and she is shocked. Sam knows that her eating habits are not healthy, but she never thought that her choices would lead to type 2 diabetes. Although she is in a state of shock, Sam wants to improve her health and learn to adapt to a life with type 2 diabetes. Sam's doctor gives her a nutrition plan handout that seems simple - so simple that her doctor admits that the handout is a standard, "one size fits all" plan that every patient receives after their diagnosis. Hearing that the nutrition plan is not specific to her lifestyle makes Sam feel as if she is not a priority. For example, she can already see that nuts are a food category on the list, but Sam is allergic to nuts. However, the doctor also recommends that Sam download a food shopping application, TYPE2U, for people newly diagnosed with type 2 diabetes. The application helps patients like Sam create a customized shopping experience and nutrition plan, without seeming repetitive or boring, by enhancing the physician recommended information to include specific products and brands. When Sam returns home from the doctor's office, she immediately downloads the TYPE2U application, hoping that this will help her create a regular shopping and nutrition plan that will be compatible with her nut allergy. TYPE2U prompts Sam to upload the nutrition plan and enter important physical characteristics and necessary health information. After uploading her nutrition plan, Sam has the opportunity to customize the plan by specifying food allergies, dietary restrictions or preferences (vegan, vegetarian, low-carb, gluten-free), total number of people in household, and preferred grocery stores and delivery services such as Amazon Fresh, Prime Now or Walmart. Sam is looking forward to her next food shopping trip knowing that her food preferences are integrated into the doctor's nutrition plan and she's carrying all of the information that she needs on her smartphone.

A few days after her diagnosis, Sam wants to go food shopping, and she arrives at the store and opens TYPE2U on her smartphone. The app opens to the "SHOP" tab, which is the main screen used for food shopping in stores. TYPE2U generated a shopping list for Sam that adjusts based on her current location. Sam notices that none of the items on the list seem to include nuts. As Sam begins shopping, she wonders if she can still buy her favorite brand of orange juice. TYPE2U allows Sam to scan her desired product, so that the application can determine if the chosen product is adherent to Sam's dietary regimen. Two things can happen: The application may indicate that the product is appropriate for Sam, or it may suggest alternative products that are more appropriate for her physical characteristics and nutrition plan. After taking a picture of her orange juice, Sam watches the application interface as it decides whether or not the orange juice brand is compliant with her dietary regimen. After a few seconds, TYPE2U tells Sam that her preferred orange juice brand has too much sugar for her needs, and the application suggests several other orange juice options with lower sugar content that are more appropriate for Sam. The application indicates if the alternative options are available in this store, another nearby grocery chain, or it provides options to immediately order through the application, for delivery. Sam selects an orange juice brand that is not available in her current grocery store, but TYPE2U tells her that she can order it through the grocery store's online website. The application integrates the website's API, giving Sam access to purchase the product from the store's website without having to leave the application's interface (see Fig. 23-34).

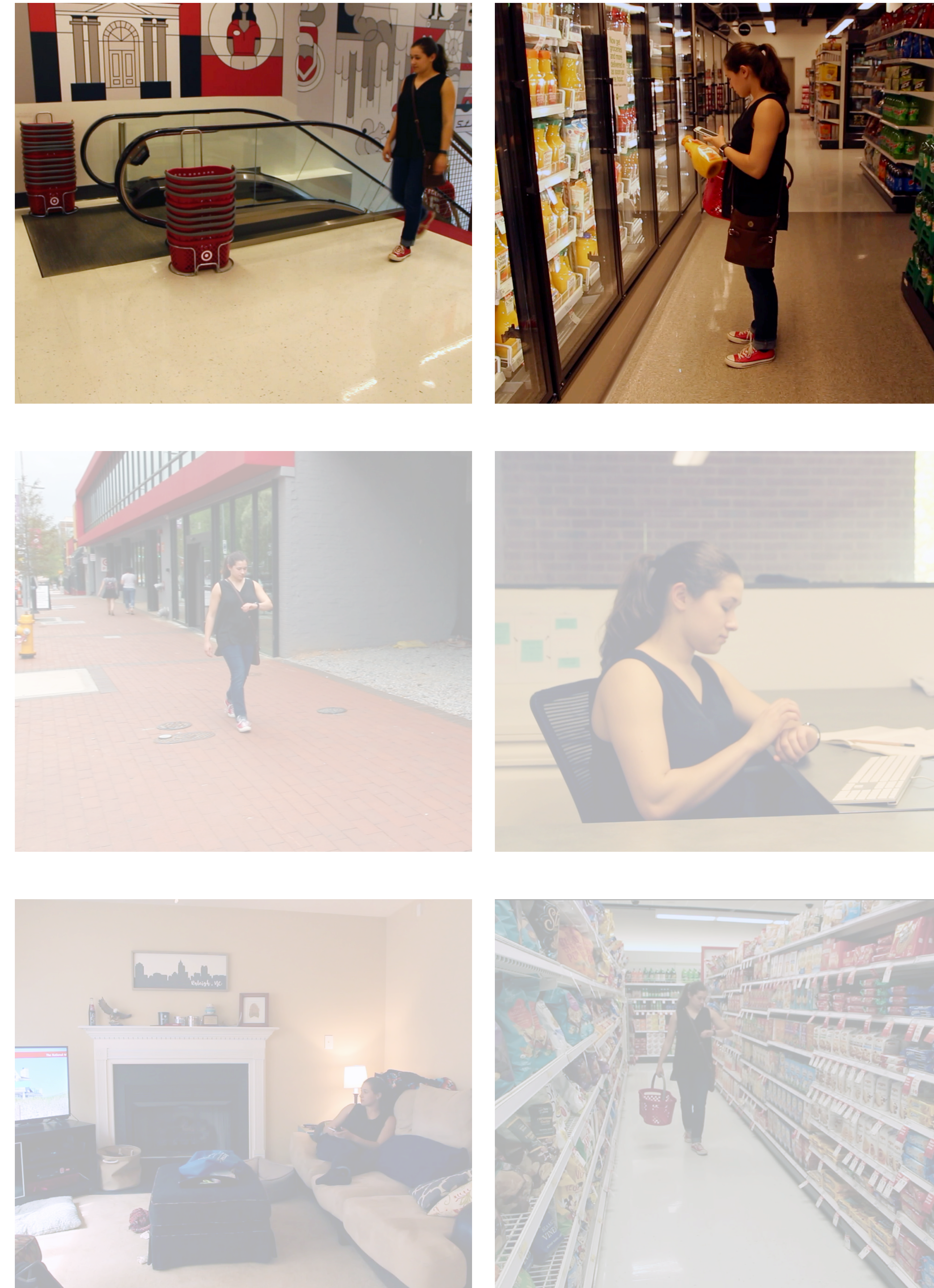
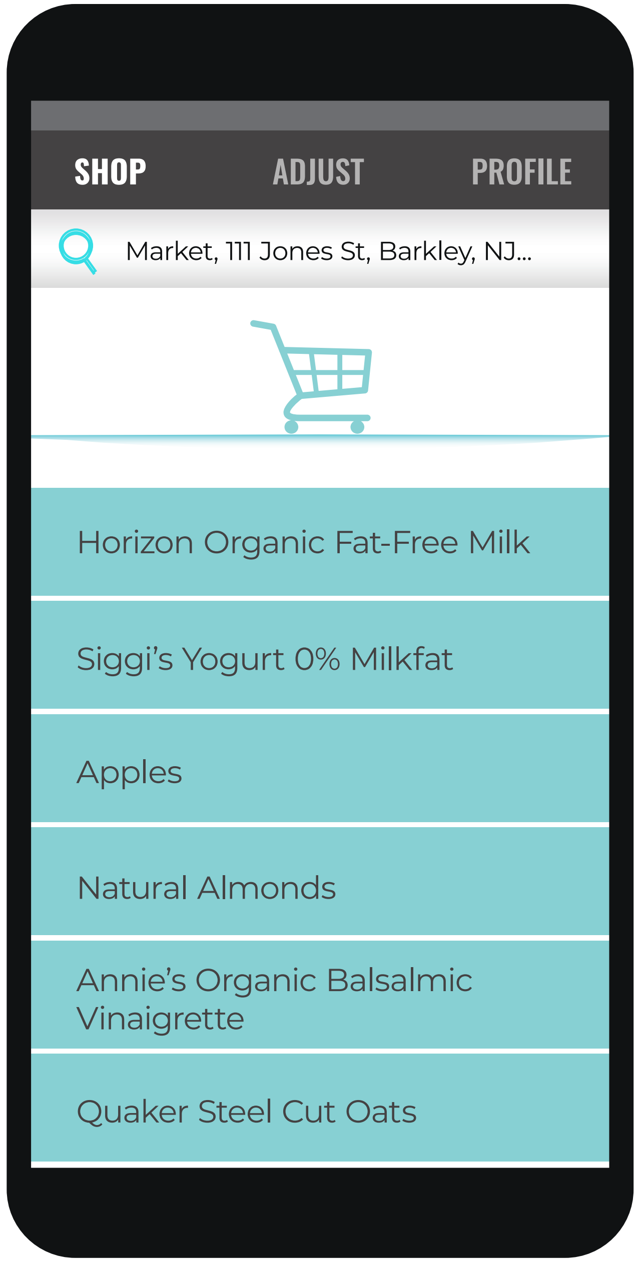


Fig. 23 Here is a video frame grid of each scene for the prototype phases. The row of images for the correlating phase is highlighted above (the top row). Sam is entering the grocery store and searching for the items on her shopping list.



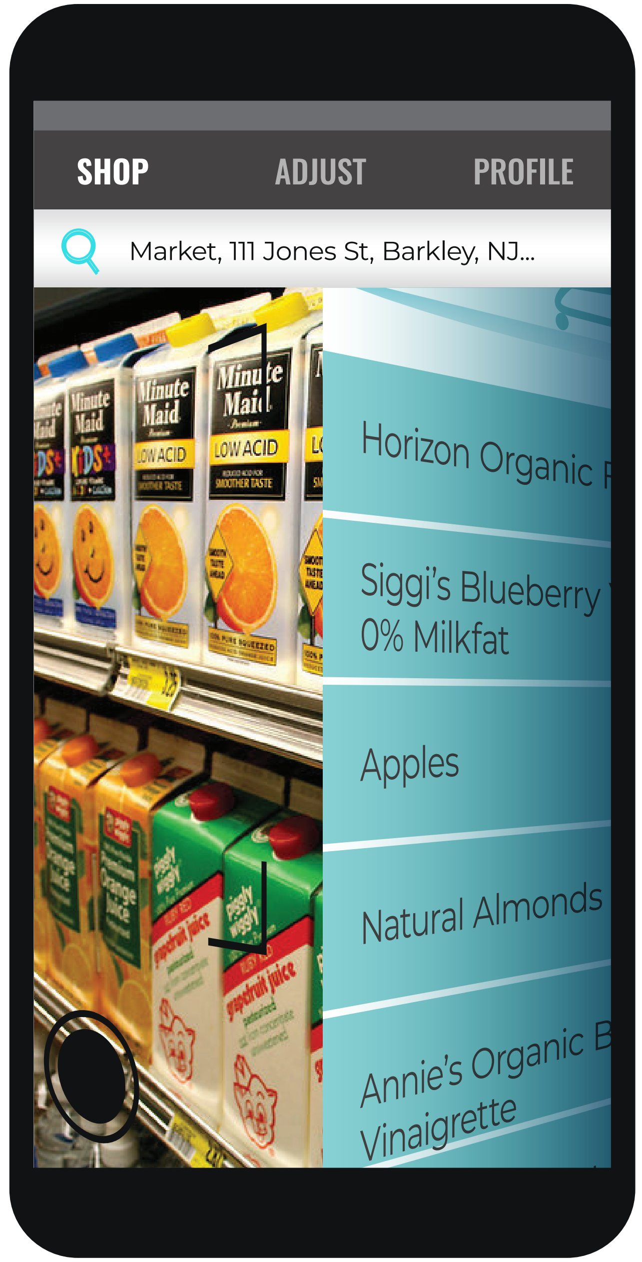


Fig. 24 This is the main screen of the "SHOP" tab in the application. The user taps on the tab and sees a pre-made shopping list based on their initial preferences that they customized.
https://college.design.ncsu.edu/thenfinally/foca/phase-one.mp4

Fig. 25 If the user wants to know if a product that is not on the list could adhere to their dietary regimen, the user can rotate the screen by swiping from left to right to access the application's camera.

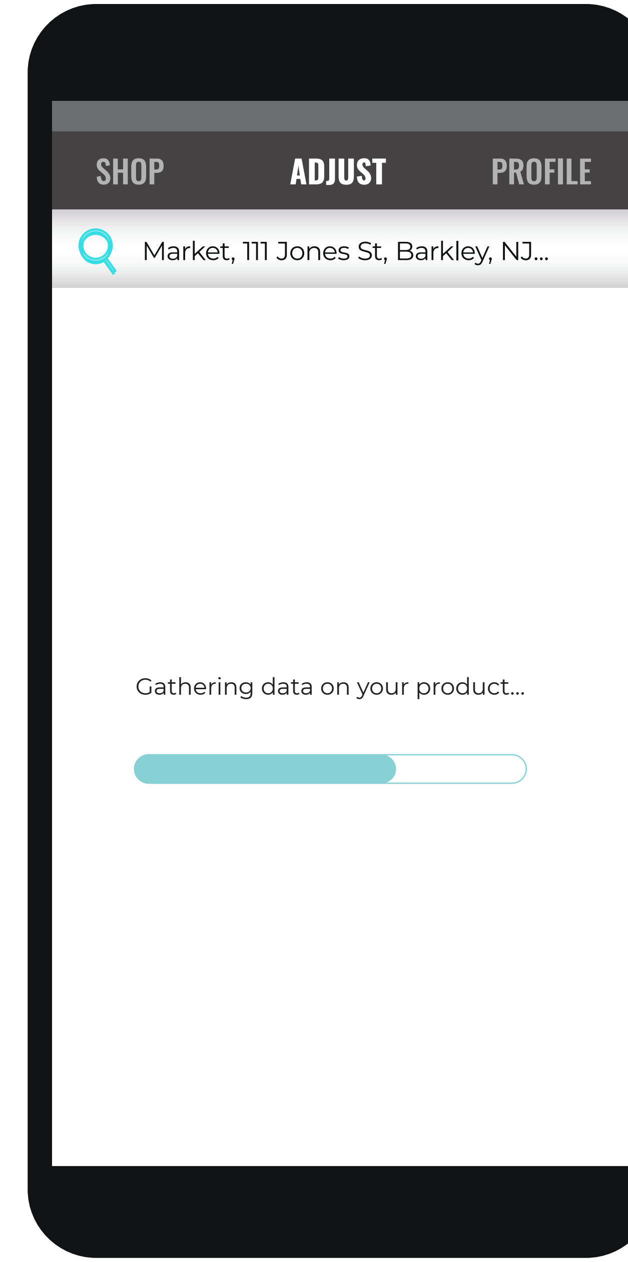


Fig. 26 This is the application's camera screen that allows the user to take a picture of a product so that the application can assess whether or not the product adheres to the user's dietary regimen.

Fig. 27 After the user takes a picture of the product, the application assesses the product and pulls data from the FDA to find other products that may have higher quality of nutrients.

Fig. 28 When the application finishes the product assessment, the screen reveals an isolated image of the identified product.

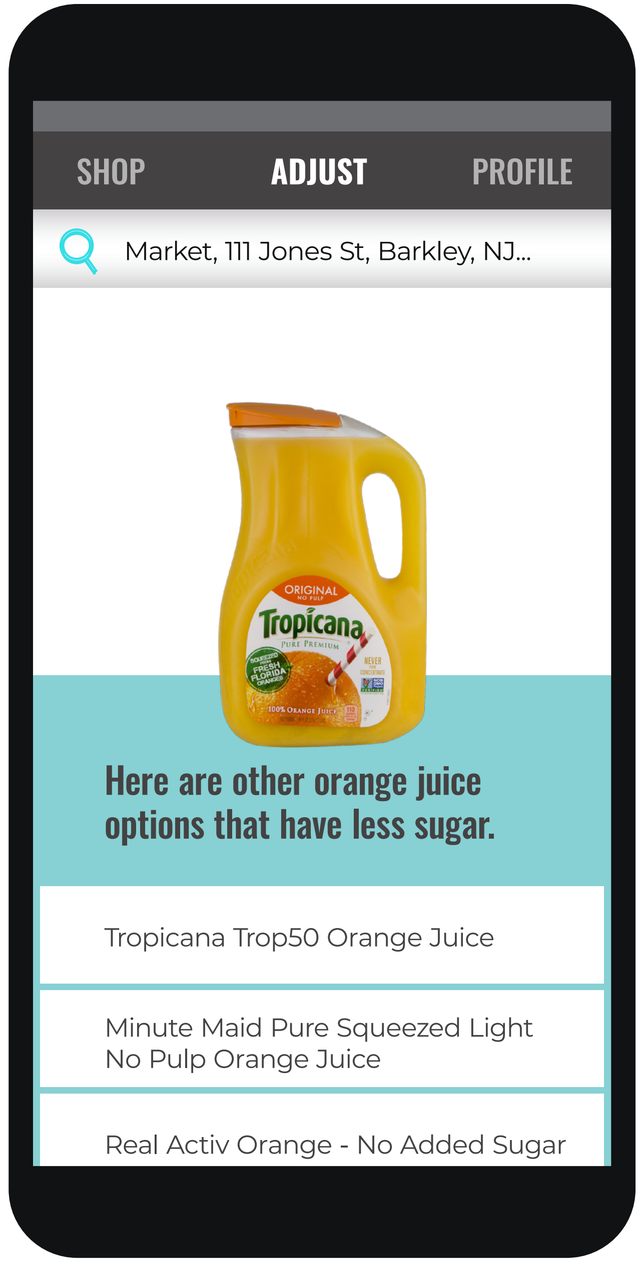


Fig. 29 If the product is not aligned with the user's dietary regimen, a menu of alternative products slides from the bottom of the screen into the user's view. The user can select from the alternative orange juice options with less sugar.

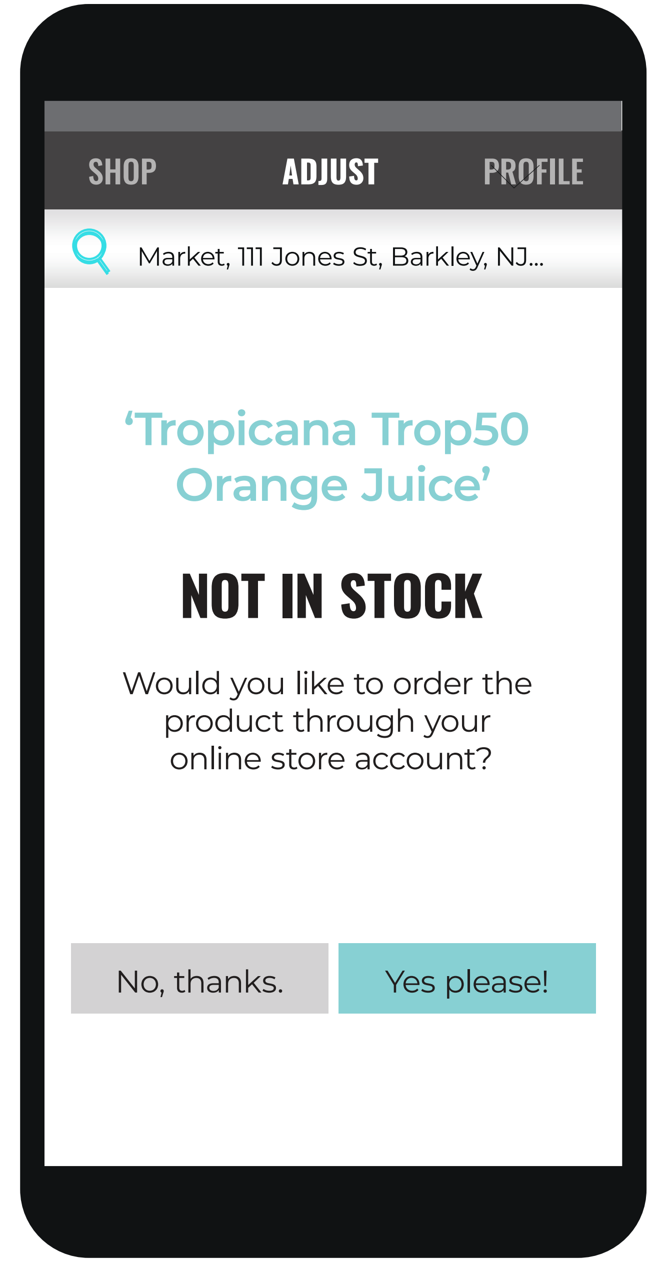


Fig. 30 If the user selects an alternative option that is not available in the store, the user has the option to order the product with any connected online or mobile food shopping service.

Fig. 31 If the user decides to order the product through their online or mobile food shopping service, the application confirms that the product is on its way. The arrow pointing downwards shows the user that they can scroll down to return to their shopping list.

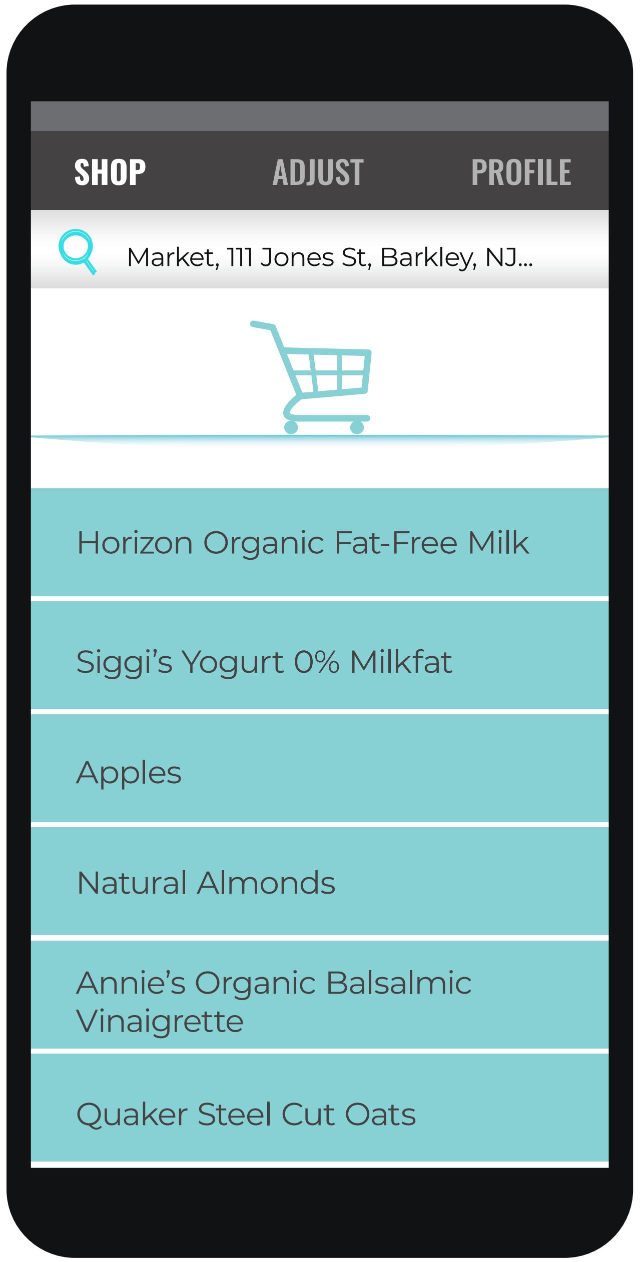


Fig. 32 The user returns to their initial food shopping list screen.

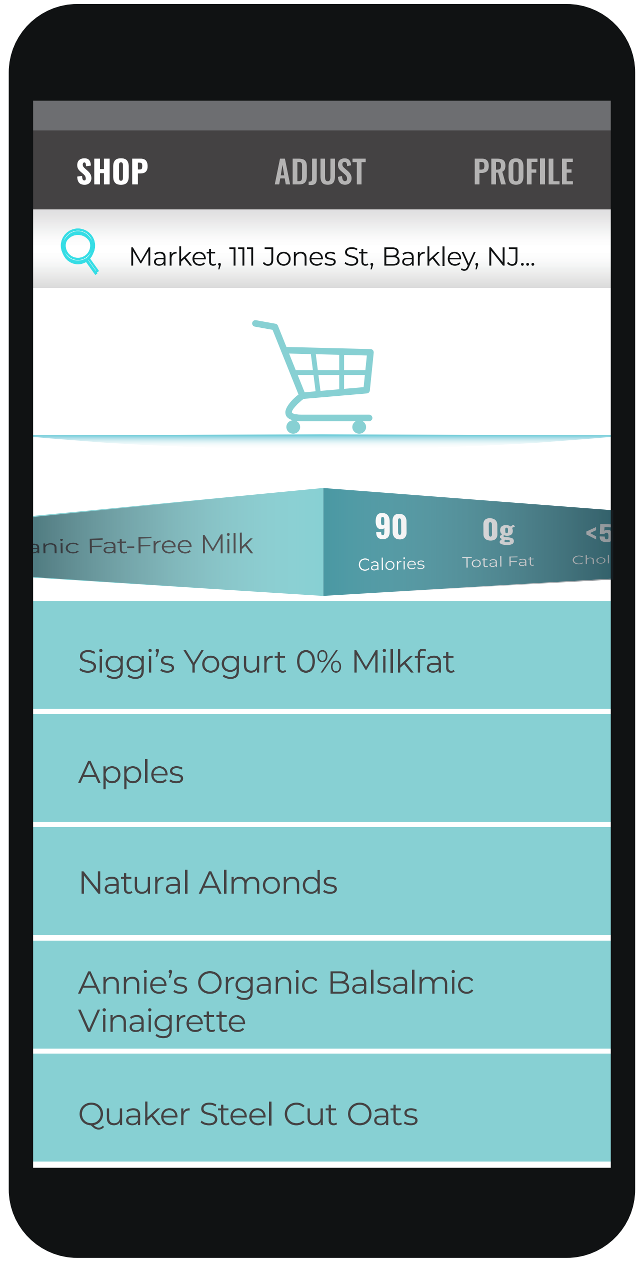


Fig. 33 The user can rotate each product from right to left, which leads to a cube animation that reveals more detailed nutrition fact information about the product.

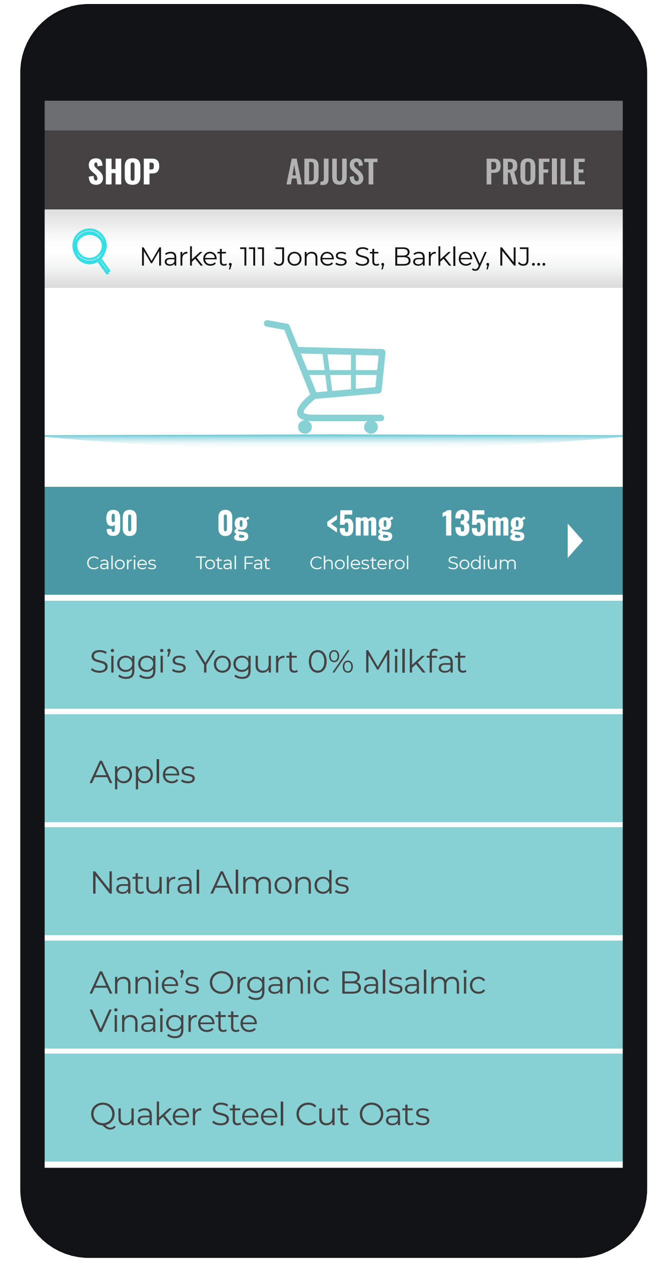


Fig. 34 This is a simple view of the nutrition facts that each product has on the back of its packaging. The nutrition fact information is more legible and isolated so that the user will not be overwhelmed by the FDA's standard format for nutrition labels.

PHASE II: MAKING LIFESTYLE ADJUSTMENTS

PROTOTYPE SCENARIO

SUBQUESTIONS

How can the design of a customizable interface use audio feedback to deliver 'just-in-time' messages to assist and integrate food purchasing decisions?

How can the design of the interface provide opportunities for users to control interface customization related to the integration and assistance of food purchasing decisions across multiple devices?

FOOD BUCKETS

Food Substitution
Food Combination

Sam's doctor told her that people newly diagnosed with type 2 diabetes have to test their blood glucose levels after every item eaten to determine the food products and time of day that best lead to manageable glucose levels. The most accessible items that people buy to test themselves are a blood glucose monitor, lancet device, lancet drum, and testing strips. If Sam's blood glucose level is too high, she could become hyperglycemic; and if her level is too low, she could become hypoglycemic. Conveniently, the external blood glucose monitor can send updates to a smartphone via SMS if a person wants to store that data for their doctor or for themselves. TYPE2U collects the data from the blood glucose monitor to generate customized food shopping lists. Food choices directly affect blood glucose levels, because the food nutrients move to the bloodstream after digestion.

The morning after her food shopping trip, Sam wakes up early to make herself coffee before work. She always tests her blood glucose level before eating in the morning. As Sam is walking to her office building, her smartwatch sends her an alert, informing her that she has a low blood glucose level and queries as to whether she ate breakfast. Sam taps on the microphone icon and responds with, "No," to which the interface responds with a recommendation to eat breakfast, because people with type 2 diabetes have naturally low blood glucose levels in the morning (making morning eating important). After a long day of work and eating out with her coworkers, Sam walks into her home at 9pm. Her smartwatch sends her another notification, telling her that she has a high blood glucose level. The TYPE2U application delivers a question as to what Same ate for dinner? Sam taps on the microphone and states that she ate at Barb's Diner and had a ¼ pound burger and fries. TYPE2U responds by suggesting that Same order burgers from Barb's Diner with a lettuce wrap, rather than a bun (see Fig. 35-43).

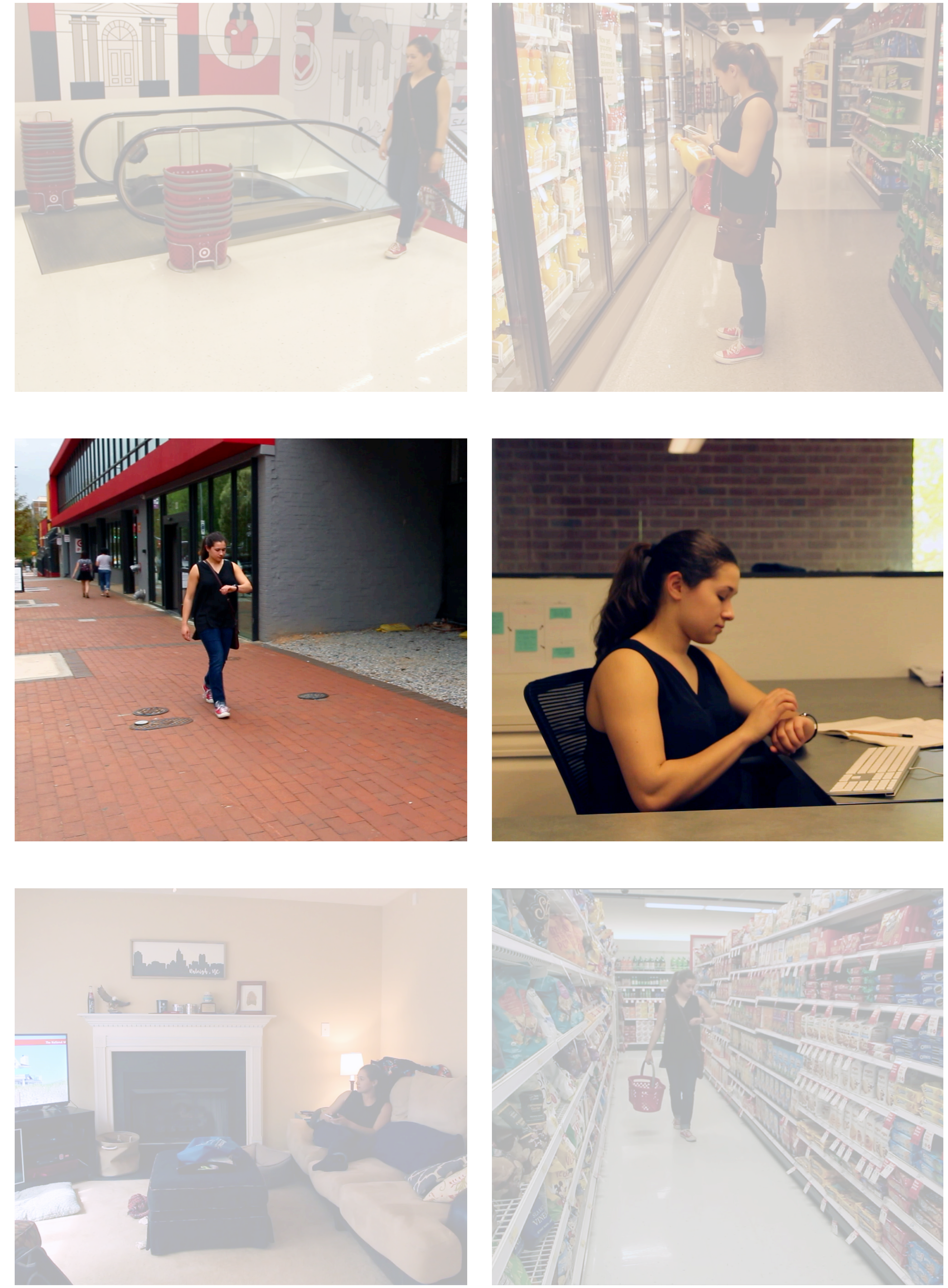


Fig. 35 Here is a video frame grid of each scene for the prototype phases. The row of images for the correlating phase is highlighted above (the middle row). Sam is commuting to her office and working at her desk when she receives TYPE2U notifications.

Fig. 36 If the user tests their blood glucose level and the level is irregular, they receive a notification on their smartwatch device. The user receives a notification on their smartwatch from TYPE2U (abbreviated to T2U for smartwatches) informing the user that they have a low blood glucose level and that they need to confess why it happened.

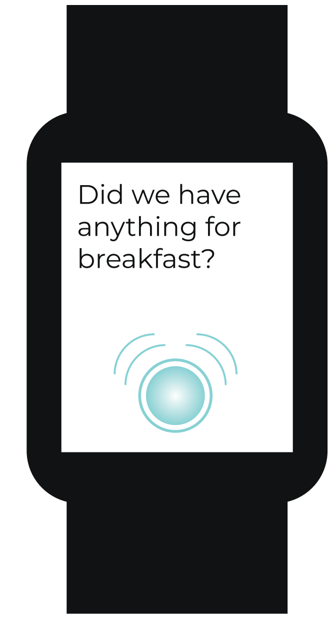


Fig. 37 TYPE2U predicts what the possible causes of the irregular blood glucose levels could be based on the time of day and type 2 diabetes medical information about symptoms and risks. Since the time of day is before noon, TYPE2U asks the user if they ate breakfast.

Fig. 38 The user realizes that they were in such a rush to get to work on time that they forgot to eat breakfast.

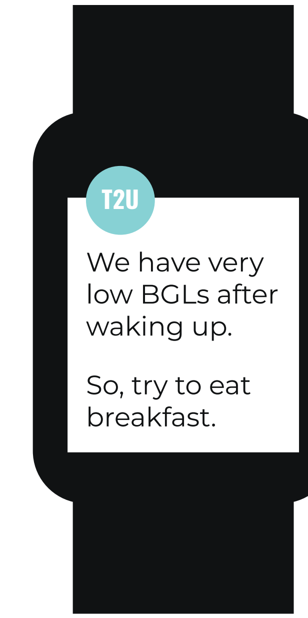


Fig. 39 After the user confesses, TYPE2U gives the user a fact about why they should change the confessed behavior, in this case, the behavior is not eating breakfast.

Fig. 40 This screen shows how the user receives a notification in the afternoon about a high blood glucose level.

Fig. 41 The user frequently searches places for lunch on their smartphone and TYPE2U predicts that they went out for lunch.

Fig. 42 The user did go out to lunch and confesses that they went to Barb's Diner and ate burgers and fries.

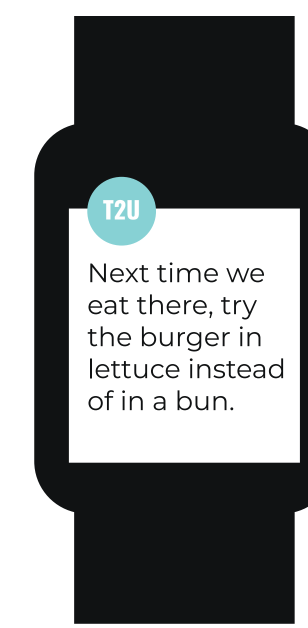


Fig. 43 TYPE2U recommends that the user substitute a bun for a lettuce wrap next time the user wishes to eat at Barb's Diner.

https://college.design.ncsu.edu/thenfinally/foca/phase-two.mp4

PHASE III: MAKING MISTAKES & TAKING CONTROL

SUBQUESTIONS

How can the design of a customizable interface use audio feedback to deliver 'just-in-time' messages to assist and integrate food purchasing decisions?

How can the design of the interface provide opportunities for users to control interface customization related to the integration and assistance of food purchasing decisions across multiple devices?

FOOD BUCKETS

Food Substitution
Food Combination

PROTOTYPE SCENARIO

TYPE2U gives Sam a weekly report that outlines how her food choices correlate with her blood glucose levels each day. Unfortunately, Sam made some food consumption "mistakes" at the end of the week that led to high blood glucose levels. She is unsure of how to consistently make food choices that help her manage her blood glucose levels throughout the day, because she has a weakness for periodic junk food snacks. TYPE2U suggests that Sam activate the meal plan calendar, which allows her to organize the food that she will buy for each day based on meals that will satisfy her cravings, while managing her blood glucose levels more evenly. Sam chooses to activate her meal plan calendar. Later in the day, TYPE2U prompts Sam to play a quick round of "Let's be picky!" on her smartwatch, which is a "game" from TYPE2U that asks users to choose the "tastier" of two meal options, with a simple tap. The images of the meal choices are within the same meal category, so the user can choose between two breakfast images, two lunch images, and two dinner images. The meal choices are part of a large database of meals that TYPE2U accesses, and the image options that are presented are specifically chosen to help Sam adhere to her physical needs and nutrition plan. Sam's input, through playing the game, helps TYPE2U collect data on Sam's meal preferences to autofill her meal plan calendar with meals that she would enjoy eating. The game is just one of several data collection techniques that TYPE2U uses to better inform meal suggestions.

On Saturday afternoon, Sam is watching television and thinking about her grocery list for the next week. She opens TYPE2U and taps on the "PROFILE" tab to browse her meal plan calendar. The screen opens to a view of the entire month, highlighting next week. Sam zooms into the highlighted week to select the meals she wants to eat. Now she sees a daily view for the week, organized by breakfast, lunch, and dinner, containing images of meals that are similar to the ones she selected during "Let's be picky!". When Sam selects a meal to add to her shopping list, TYPE2U generates an ingredient list with recommendations for specific product brands. To select meals, Sam taps on the plus sign next to each meal option, and if she wants to remove one from the list, she can tap on the minus sign in each meal. If Sam would like to see the ingredient details in a meal, she can rotate the meal from right to left to see the meal ingredients, ingredient amounts necessary, with specific brands that are adherent to her dietary regimen (see Fig. 44-56).

Fig. 44 Here is a video frame grid of each scene for the prototype phases. The row of images for the correlating phase is highlighted above (the bottom row). Sam is at home, thinking about what she wants to buy at the store, and Sam goes to the store and receives reminders about what food to avoid buying.

Fig. 45 This interface shows how the user can activate the meal plan calendar after they adjusted to the new dietary regimen.

Fig. 46 Here is the beginning of a game the user plays to inform the application of what meals they think are appealing.

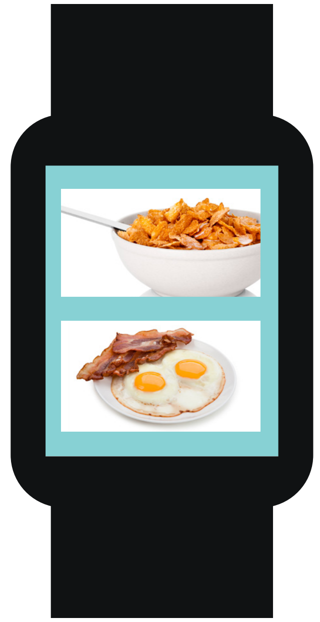


Fig. 47 The user taps on the meal that looks tastier. Here are two breakfast options to choose from.

Fig. 48 This is how the screens transition on a smartwatch. The transition is a cube rotation, because TYPE2U explores the multifaceted preferences of the user.

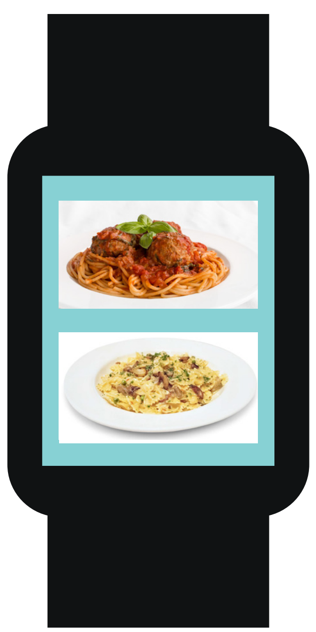


Fig. 49 Here are two dinner options to choose from.

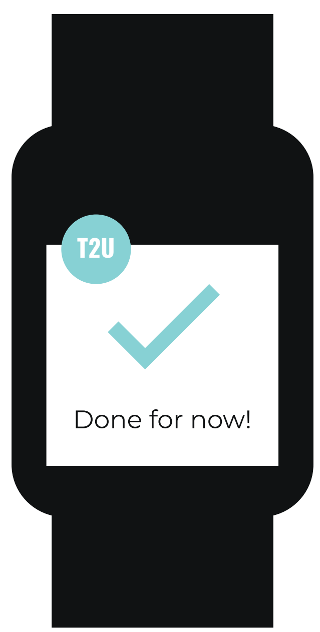


Fig. 50 TYPE2U confirms that the user has completed the task to help inform the meal plan calendar.

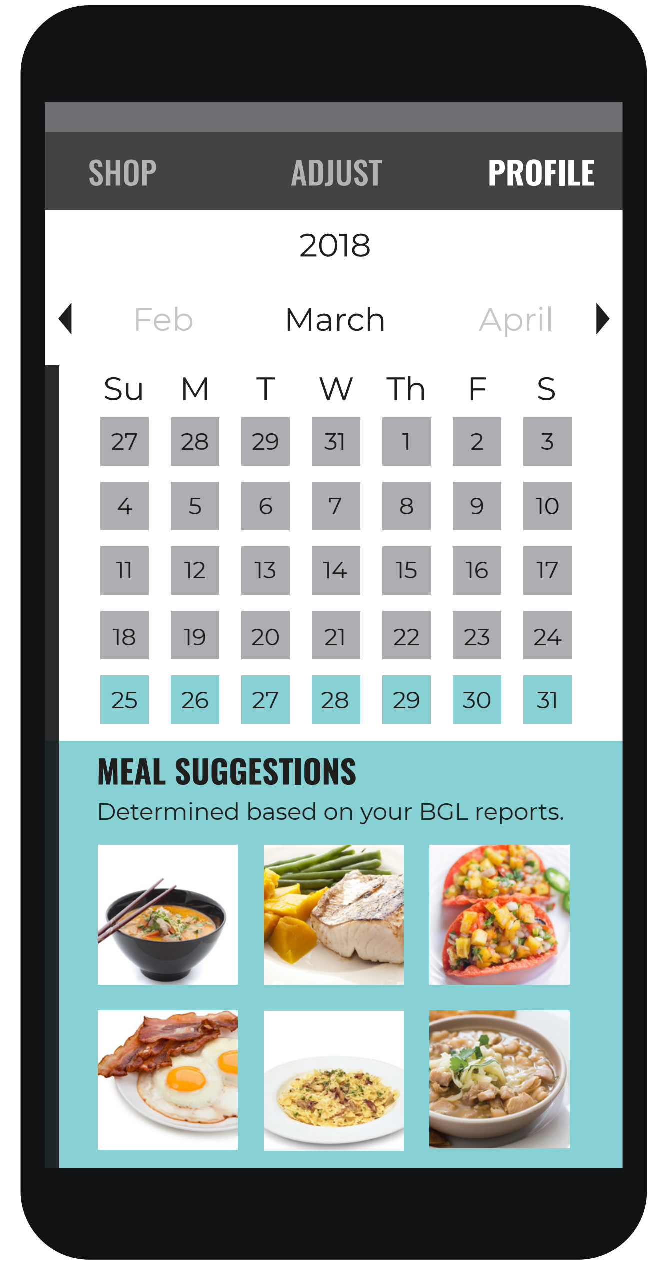


Fig. 51 If the user activated the meal plan calendar, they will see this screen when they tap on their profile tab. The calendar highlights the next week that the user will shop for. There are meal suggestions generated from the user's social media and online browsing.
https://college.design.ncsu.edu/thenfinally/foca/phase-three.mp4

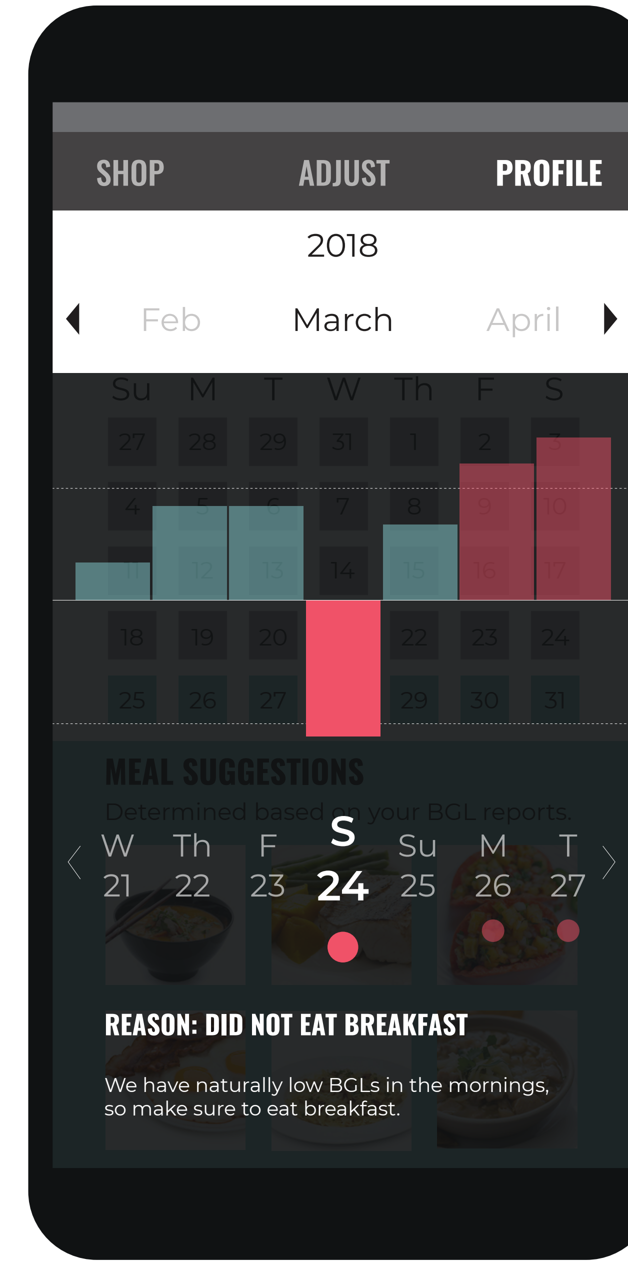


Fig. 52 The user can drag out the black tab from the left side of the calendar screen to view the blood glucose level report. TYPE2U shows the user their blood glucose level reports each day and suggests the causes of different blood glucose levels based on the user's food choices.

Fig. 53 There is a pop-up that indicates when the user can begin planning what food to buy for the next week. To see a daily view of the week, the user can zoom into a particular week of meals by spreading two fingers horizontally outwards across the highlighted week.

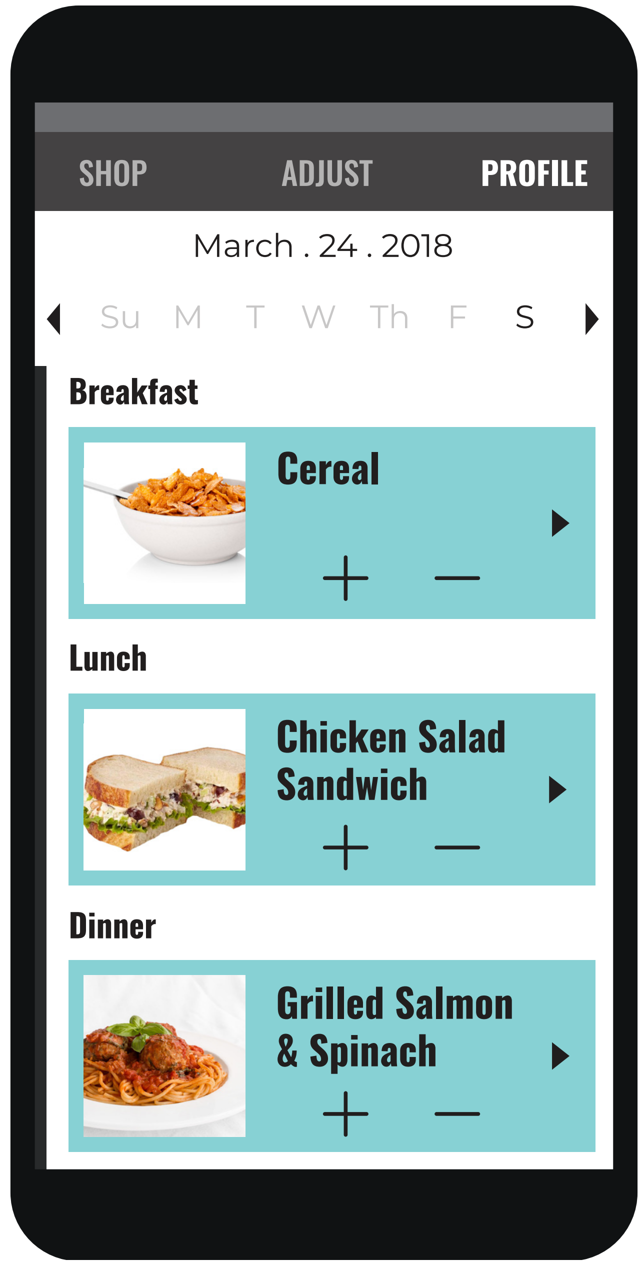


Fig. 54 Once the user zooms into a week, they can view each day of meals and select which meals they would like to buy ingredients for.

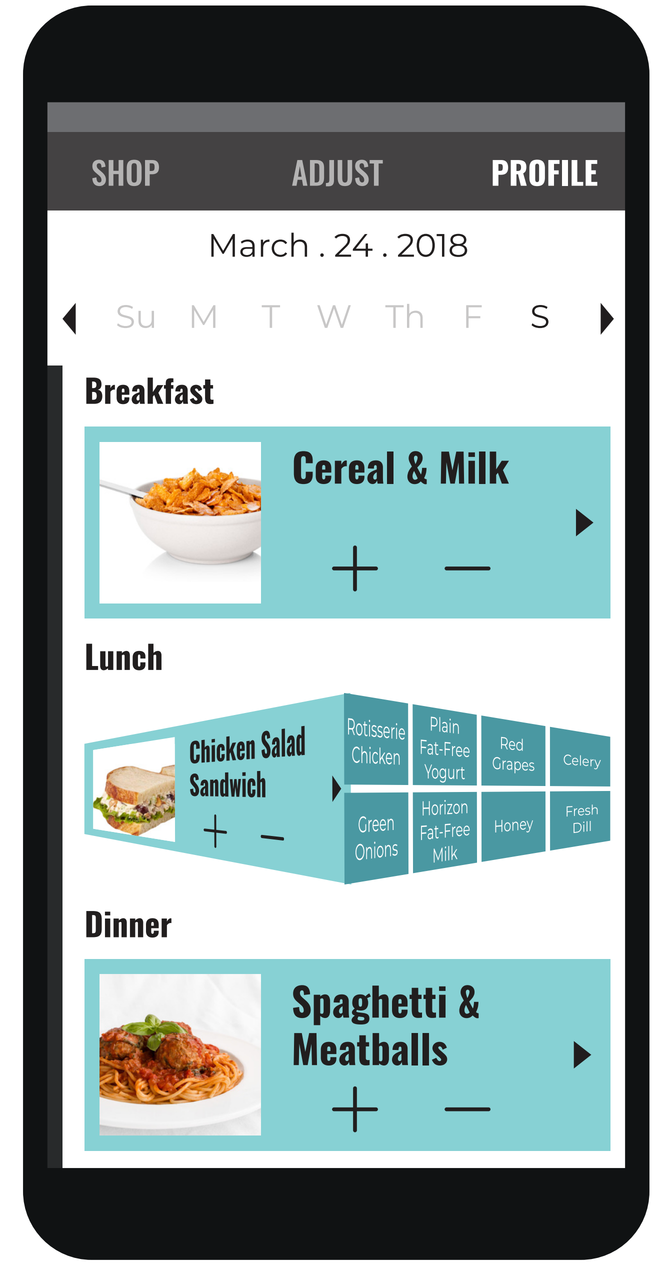


Fig. 55 The meals rotate horizontally to reveal the products to buy.

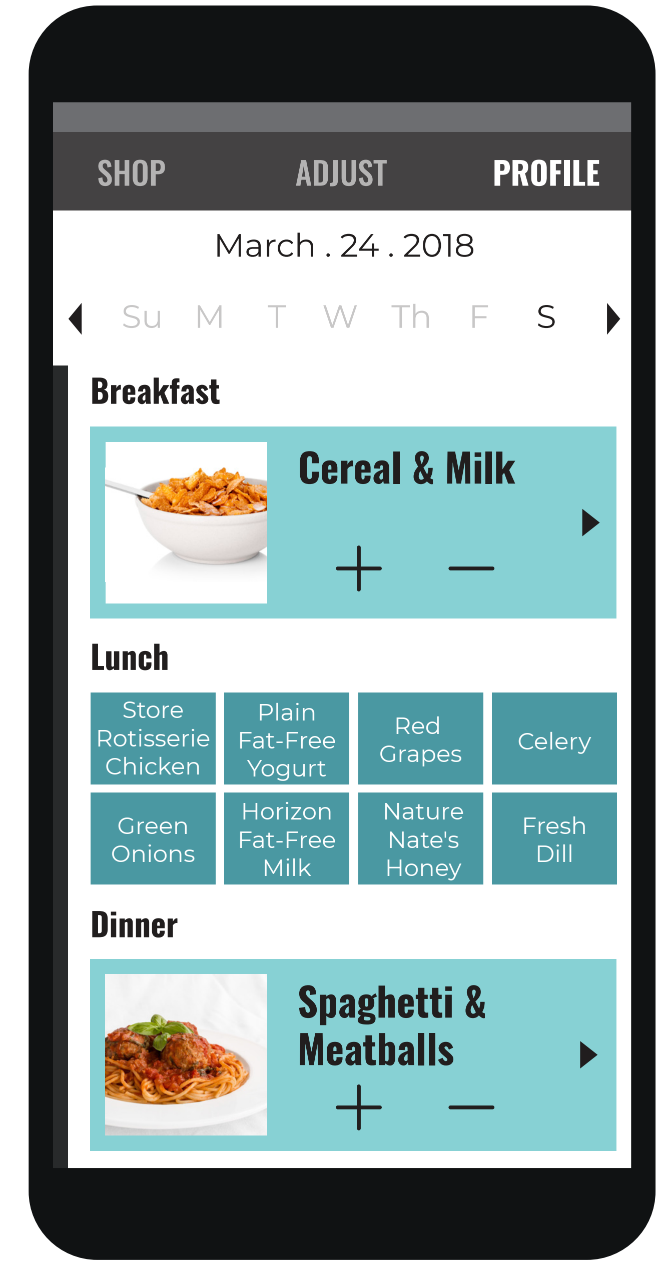


Fig. 56 Here are the products to make a chicken salad sandwich.

CONCLUSION

Throughout the research process, I discovered the importance of interdisciplinary resources for creating thoughtfully designed user experiences, such as gathering information on the medical procedures and the socioeconomic barriers of type 2 diabetes management. I would need to collaborate with food retail services, in-store and online, to integrate TYPE2U into the physical environment and into existing e-commerce websites, which would create a more engaging experience that could consistently support people for a lifetime.

The investigation emphasizes designing a food shopping application that supports dietary adherence in adults newly diagnosed with type 2 diabetes by assisting and integrating their food purchasing decisions related to Food Selection, Food Substitution, and Food Combination. Mobile device services for people with type 2 diabetes need user customization options to fit individual lifestyles, rather than using generic design templates. People newly diagnosed with type 2 diabetes are complaining that the nutrition plans are not specific to their situations, such as budgets, allergies, family sizes, or location. A new, customizable interface is necessary not only to address problems associated with breaking unhealthy habits, but also to create an experience that people want to continue using long-term—just as managing type 2 diabetes is a long-term (if not lifetime) effort. The future implications of this investigation would include: more informed food choices of people newly diagnosed with type 2 diabetes; and customizable user interfaces for all health-related services. My research has the potential of affecting more users not exclusive to people newly diagnosed with type 2 diabetes by creating customizable interface designs that can guide the food shopping experiences of people who need support while managing any health concern.

GLOSSARY

ASSISTING

Taking care of the user by: offering suggestions, facilitating navigation information delivery, and accuracy; increasing knowledge and supporting users in moments of confusion (Knijnenburg).

AUDIO FEEDBACK

An artificial voice response through a mobile device that answers questions and provides information; the user can customize the voice depending on user preferences.

CUSTOMIZABLE INTERFACE

The ability to change a digital experience based on personal preference or necessity.

DIETARY ADHERENCE

The act of holding fast or sticking by a nutrition or diet plan or regimen ("Adherence"); people diagnosed with type 2 diabetes complying with medical nutrition plans through their food purchasing decisions (Savoca and Miller 224).

FOOD COMBINATION

Recipes; food preferences; allergies; assigned dietary regimen that may need changes to fit individual needs and/or desires; integrating information from other health applications to thoroughly inform the users' food purchasing decisions.

FOOD PURCHASING DECISIONS

How the users choose to consume food products, including buying and selecting, whether shopping in a store or at an event.

FOOD SELECTION

Choosing among available food products for purchase in a store or when multiple offerings are possible; learning about available products in unfamiliar and familiar locations is a common context where Food Selection occurs (Furst et al.).

FOOD SUBSTITUTION

Swapping; having other choices; having food options that can be alternatives to the users' routine, unhealthy food consumption patterns.

GLANCES

"brief, 5-second sessions where individuals check ongoing activity levels with no further interaction" (Gouveia et al. 144).

INTEGRATING

Consistency across devices.

INTERACTIONS

How users behave with technological interfaces and physical environments; how the devices behave towards the users in different food consumption contexts.

INTERFACE DESIGN

The visual and interactive nature of a digital tool and/or device in a food consumption location that may be in a store, event, or Online.

'JUST-IN-TIME' MESSAGES

Quick, conversational moments between the user and device that provides the user with support or information through text and audio.

MOBILE DEVICES

Portable communication technology; tablet, phone, watch, wearables.

MNEMONICS

Memory; how we remember devices.

NAVIGATION

Purposefully moving from point A to point B in a digital interface.

PERSONALIZING

User's diabetic and heart medical information personalizing the shopping experience; combining design, ecommerce, and chronic disease into an action influencer (Knijnenburg).

PRODUCT IDENTIFICATION

Methods used in inventory, such as barcodes, QR codes, PLU codes, and RFIDs; system recognition of item organization.

PROGRESSION

Improving; becoming better; increasing; strengthening; data visualizations that increase awareness of positive shopping patterns and where to make more improvements.

USER CUSTOMIZATION

When people using the system have control over information that can personalize what the system gives them, such as a list of clothing items specifically selected based on a person's body measurements and style preferences that the person gives the system; meal plans or recipes created as a product of the user's profile input and specific health diagnosis and assigned medical protocol.

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