

Smart kitchen - The Amazon Home Refrigerator. A voice based UX integrated with Amazon Alexa. Kent State University - Master's Project Spring 2018
Michael Clingerman, Graduate Candidate 2018

Smart Kitchen

The Amazon Home Refrigerator. A voice based UX integrated with Amazon Alexa.



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Masters Project website and case study
<http://www.mcdesignthinking.com/ksu-masters-project>

“ The set of plausible sounding startup ideas is many times larger than the set of good ones, and many of the good ones don't even sound that plausible. So if all you know about a startup idea is that it sounds plausible, you have to assume it's bad.”

~ Paul Grahams Co Founder, YCombinator

PREPARED FOR

Kent State University - Graduate Studies Department
User Experience Design and Research
Professor Woods - Graduate Studies Advisor

PREPARED BY

Michael Cingerman - Graduate candidate
User Experience Design and Research Kent State University
E: artonthemind@gmail.com
M: 001-408-838-2848

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Forward

“Alexa, I’m hungry for Indian food tonight.”

In this Master's Project, I hope to explore the possibility of and ideate prototyping for a smart kitchen (VUI) voice user interface experience infused with Amazon Alexa in a kitchen home appliance. What if where possible to walk in your kitchen a simply speak aloud “*Alexa, I’m hungry for Indian food tonight.*”

What is a Smart Kitchen? Is it a refrigerator that speaks to you, teaches you to cook, stocks itself, suggests/orders products you've never ordered before, stocks existing products you use daily, entertains family members queries while in the kitchen. This may have seemed implausible years ago. Is it though?

Does a Smart Kitchen leverage voice-activated software applications? Is the goal to further our convenience in lifestyle utilizing technology? A clear business trend is rising from large companies like Samsung, Amazon, and Apple computer. Each of these companies is trying to increase consumer adoption via convenience utilizing voice UX. One example is the Alexa project from Amazon.

How can these types of user experience design applications be integrated into different parts of our homes and lifestyle? The kitchen is fast becoming one of the least used areas of homes today because most families and working professionals simply do not have the time or energy by the end of the workday to source, prepare, cook, and clean nightly. Another interesting trend has happened in food-based startups. The food industry brought to your home is one of the biggest businesses for startups today. To name a few, blueapron.com, plated.com, thegoodkitchen.com, and hellofresh.com. If Alexa was to take over where these new food startups have stopped what might this become? Can a smart refrigerator compete with hellofresh.com? How might Alexa bring you back into your kitchen and go a step further to expose you to a Smart Experiences of foods and preparation techniques and products you've never experienced? Let’s find out!

Executive Summary

The Amazon Home Refrigerator. A voice based UX integrated with Amazon Alexa.

Background

Over the course of The Graduate study program (12 weeks) I've explored the current business landscape of The Whole Foods delivery service, meal kit Subscription Service, smart home appliances, and voice user interface in home Technologies. The result is a Synergy of all four of these independent businesses and business models combined in a single consumer product/appliance. The refrigerator.

Goals

Goals of this project are:

1. Understand the power Amazon has to ultimately vertically-integrated all four of these different business segments.
2. Research and lean VUI design and prototyping
3. Prototyping of a voice infused Alexa home refrigerator VUI, UX, and UI experience might look like.
4. UX research that confirms the need and interest in a VUI appliance
5. Design thinking methodology for prototyping
6. User research that confirms the UX that is prototyped.

Results to Achieve

The results were trying to achieve are as follows. We want to understand can the existing foundation of Amazon's business play into the creation of a smart kitchen experience for users? Will Amazon's powerful distribution solution, already in play, place them in the front of the competitive pack of other small businesses and ultimately set them up for a winning experience for users in the kitchen?

Why do we want to make a change? Simple. **Time is a commodity.** People are saturated with work and no time to shop for, prepared, and cook foods, and clean for their households. There's ample evidence in online as well as startups leveraging billions of dollars who have already bet the bank that this trend will continue if not grow tremendously in the coming years.

Benefits

The benefits are potentially massive for Amazon and can ealy stretch into the Billions. The use

of a home appliance to vertically integrate all of Amazon's services including distribution from the now acquired Whole Foods Marketplace is a powerful tool to embed in the kitchen of targeted users capable of affording a \$3,500 refrigerator.

Challenges

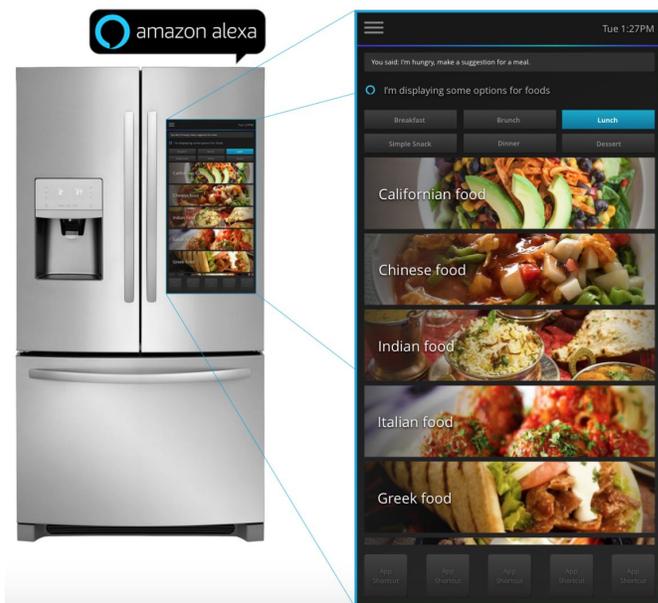
One large internal challenge standing in the way of understanding the power of voice user interface design or VUI is that VUI is the cutting-edge of user experience design today. Google, Amazon, and companies like Samsung have developed their own methodologies, systems, and applications as well as artificial intelligence solutions for dealing with VUI. Because of this challenge, I have recruited an internal Amazon employee familiar with DUI and the foods services. His name is Brad G. Brad has Open the floodgates to understanding and internal perspective as to how Amazon might approach and Incredibly difficult and time-consuming project such as an Amazon Alexa infused refrigerator.

External challenges such as product development, product and Appliance partnership with companies like LG, are also challenges that require relationship and road map planning for success. The Masters project challenges specific to this project however are quickly ramping up on the foundation's to voice user interface design, its challenges, and complications of dovetailing easily and seamlessly into scream based user experience design.

Business Problems & Value Proposition

One business problem for Amazon is how do we sell more food? How do we deliver better experiences that happened Upstream from the grocery store? How do we remove obstacles and make the entire food experience pleasurable for the user from their home? In essence, if this problem can be solved, the value proposition is a joyful holistic food experience that starts in the home and ends in at home.

Masters Project website and case study



<http://www.mcdesignthinking.com/ksu-masters-project>

The Masters Project

1. The Business Problem & Problem Statement

Vision

We want our Prime Members to be exposed to healthy culturally unique foods, access ingredients and food recipes, all brought to their doorsteps with the added bonus of monitoring all the ingredients via a consumer appliance refrigerator armed with the Alexa AI Platform.

(Vision)

Problem Statement

How to source and expose healthy culturally unique foods and food recipes to users. Monitor the use of food quantities, and provide instructional guidance of recipes, via a merger of artificial intelligence (AI) software and consumer appliances to users with little working knowledge of cooking.

Issue Statement

Today, competition existed in the Home-foods delivery service and the Meal-kit subscription service sectors that we can easily compete with and provide deeper customer experiences than competitors like [Blue Apron](#), [Uber Eats](#), and [GrubHub](#). Our recent purchase of whole foods and our vast distribution network will allow us to expand our foods services. However, a missing component to the user experience in americas kitchens is exposure to fresh food ideas and preparation instruction in the kitchen.



Consumer's problem statement

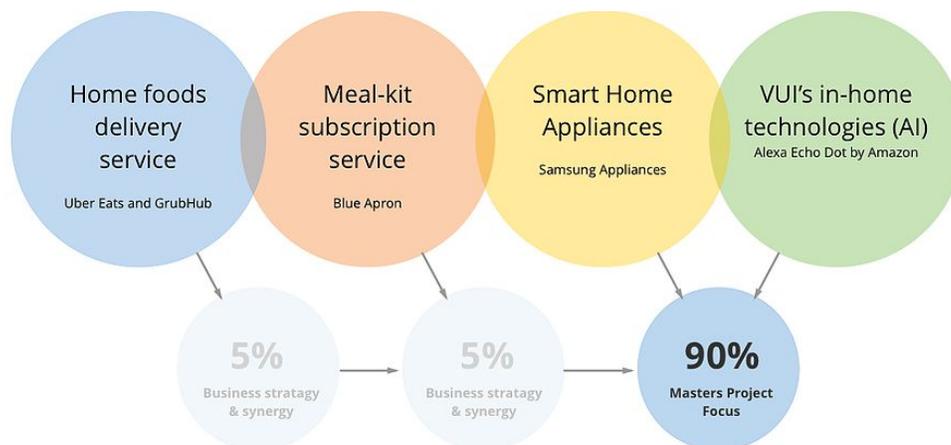
We don't know what we want to eat, where to buy the ingredients, or how to make the recipe, nor do we have the time to figure it out on our own. Therefore I stick to what I know which is boring and predictable. My friends have spent hundreds of dollars on cooking classes. How can I bring that into my kitchen?

Method

From a Amazon Project management position: We will use the Kaizen Method to evaluate, advance, and deploy the new services in a timely manner.

2. Masters project focus in detail

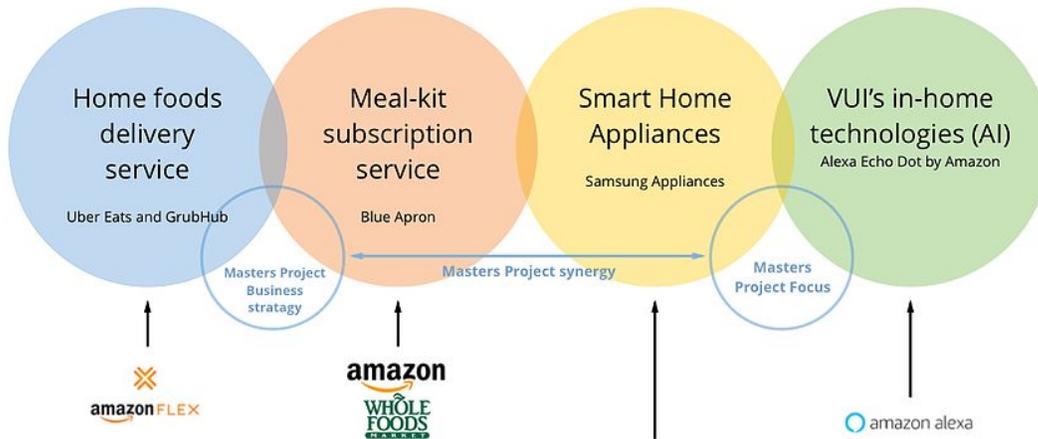
1. 5% of the project time Will be spent understanding the existing business strategies but home food delivery service sector currently supports and how to synergize Amazons existing food services to compete in the home food delivery genre
2. 5% of the project time will be spent understanding and synthesizing a new foot forward for Amazon in the mail kit subscription service. Can Amazon, with their existing food services, compete in the mail Kent subscription sector against other publicly traded companies like blue apron and hello fresh? If so, how?
3. 90% of the project will be spent synthesizing the business strategy and the smart home appliances and the UI/HR technology into an Amazon consumer product tentatively been called a SMART-Amazon Fresh refrigerator with Meal-Kit subscription services by Whole Foods.



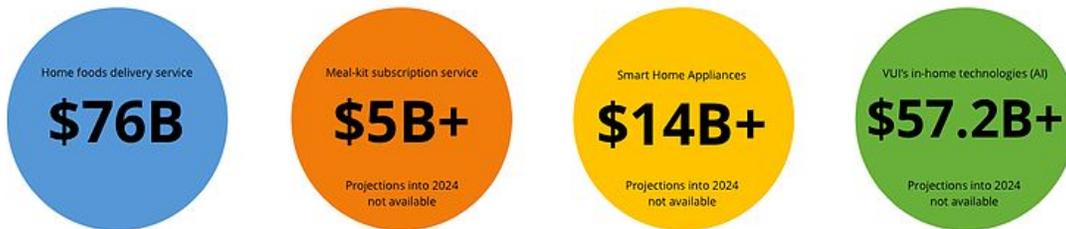
3. Business Sector Overview and Project Synergy

1. Amazon Delivery Services is already set up to deliver meals and meal boxes on a subscription basis. [Flex.amazon.com](https://flex.amazon.com)
2. Amazon, with its vast market share in Amazon Fresh and distribution (Amazon Flex) in the US can compete with Home Foods Delivery Services easily. Amazon will need Content recipes to sell as subscriptions and fulfill from Fresh and Wholefoods.
3. Amazon can easily move into the appliance sector and infuse it's VUI Alexa platform into new home SMART appliances and compete with companies like Samsung.

- Amazon's VUI Alexa platform is a dominant solution in the VUI consumer home sector. Leveraging this strength combined with a SMART Home Appliance like a refrigerator make s for a compelling story.



4. Business potential in revenues - Four areas of focus



Industry Analysis - Home foods delivery service - \$76 billion

The venture capital investment firm [Cowen](#) predicts a 79 percent surge in the total U.S. food delivery market by 2022, from \$43 billion to \$76 billion. Additionally, Cowen upgraded GrubHub.com following results from a recent survey that showed that 34 percent of respondents use their services. Online delivery currently represents 43 percent of all delivery orders.

Industry Analysis - Meal-kit subscription - \$5 billion

The meal-kit subscription sector, which has mushroomed to \$5 billion in sales. This number, as reported in [Meal Kits Delivery Services in the U.S., 2nd Edition](#), a new research report by Packaged Facts, shows an incredible potential for growth. The meal-kit subscription sector is doing so well that Walmart has entered the market and plans to push its meal-kit business out to 2,000 stores this year alone. The company has already rolled out meal kits services to 250 stores with 2,000 stores expected this year (2018). The move comes as big-box stores and grocers push food e-commerce with the hopes of large rewards in revenues.

Industry Analysis - Smart Home Appliances Sector - \$14 Billion+

Fact: 10 percent of households will be smart by 2025

The smart Appliance and Smart Home Market began a run at new revenues in 2010 with fewer than **0.5%** of homes in the United States connected. Of these connected devices, thermostats, lighting, security and entertainment systems were some of the first. Source: [IHS Markit smart home intelligence service](#) By 2017, **7%** of households in the United States will be connected. On average, American Homes will have six devices/home connected to the internet and accessible via mobile apps and cellular devices like cell phones and tablets. By 2025, it's expected that **10%** of households will be wired as Smart Homes.

Fact: Smart home device revenue will exceed \$14 billion in 2017

- The global market for smart home was worth \$14.7 billion in 2017, with the Americas region representing **48%** of global revenues.
- In 2021, the EMEA region will represent the largest portion of device revenue with a 42% global share.
- When excluding large ticket items, such as major appliances, the global market size for smart home devices is forecast to be worth \$3.3 billion by the end of 2017, reaching \$9.4 billion in 2021.
- Although the EMEA and Americas regions are expected to represent more than 70 percent of revenues for smart devices over the next five years, Asia is expected to dominate in terms of unit shipments. In 2021, the Asia region is expected to represent

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about 46 percent of unit shipments. Leading the unit shipments in Asia in 2021 will include light bulbs, air quality sensors, and video cameras.

Source: technology.ihs.com August 14, 2017 "[Global Smart Home Market to Exceed \\$14 Billion in 2017](#)"

Industry Analysis - VUI's in-home technologies - \$55.17 Billion

"As speech recognition accuracy goes from 95% to 99%, all of us in the room will go from barely using it today to using it all the time. Most people underestimate the difference between 95% and 99% accuracy. 99% is a game changer."

~ ANDREW NG, CHIEF SCIENTIST AT BAIDU

The voice user interface and global voice recognition Market size is valued at 55.17 billion dollars in 2016. This Market size is expected to grow by approximately 11% moving into 2024. High growth rates have been witnessed by Rising popularity voice-activated devices and appliances many of which are found in homes, hotels, and businesses. Some of these devices include lights, thermostats, appliances, and voice-enabled devices. The software segment of this Market is projected to become the fastest growing segment expanding at 17.4% into mm and 24. The component segment, Has witnessed two significant growth specifically in the voice recognition Solutions area. This includes automatic speech recognition or (ASR), speaker verification, and audio mining.

Source

Grandviewresearch.com Published Date: Jul, 2017 "[Artificial Intelligence Market Analysis By Solution \(Hardware, Software, Services\), By Technology \(Deep Learning, Machine Learning, Natural Language Processing, Machine Vision\), By End-use, By Region, and Segment Forecasts, 2014 - 2025](#)"

Grandviewresearch.com Published Date: Feb, 2018 "[Voice Recognition Market Size, Share & Trends Analysis Report By Component, By Application \(Artificial Intelligence, Non-Artificial Intelligence\), By Vertical, By Regions, And Segment Forecasts, 2014 - 2024](#)"

5. Smart Kitchen Product Research

After looking at over 50 different refrigerators at Best Buy, a local store for consumers at the mid-market level to purchase from, I finally settled on a Model I thought most appropriate based on it price point, style and appeal, and features and functionality. The model light shows was the LG LFXC24726S At a price point of \$2,400, This refrigerator seems to be at the right price with the right features in to suit an early adopter target audience seeking a smart refrigerator fully stocked with Alexa connections to your Amazon Prime and Amazon Fresh accounts. **See example below.**



6. Sample Dialogues - Research highlights

1. Avoid cognitive overload by creating rich VUI experiences. Using both voice commands and visual Solutions at the same time during voice journeys. It's important to build the voice commands as well as the mobile app at the same time. The number of interactions in a user has with a VUI is known as a “**turn**”. Most user interactions are a single turn.

2. **Conversational design** - conversational designs include multiple turns Beyond one and as many as four or five. Most conversational Design Systems are not capable of holding conversations Beyond two or three turns. Example, Figure 2 - 4 Page 19

Note: Completing a conversational design to the user can be an endorphin rush and prompt the user to continue forward down the path.

3. **Unnecessary verbiage** - Design with breadth in mind Example P.20 It's not always necessary to give a confirmation to a user during a conversational turn.

Note: Don't forget the corresponding task. If you can set an alarm to make sure you designed for being able to cancel the alarm.

4. Leverage in common vocabulary or terminology can be valuable in certain instances like taking a picture. Example: P. 21 “1,2,3... Cheese!”

Sources

Design for voice user interfaces, Principles of conversational experiences. By Cathy Pearl

<https://medium.com/@ironsexpert/smart-kitchen-reality-internet-of-things-ee914bde8ad6><https://www.wareable.com/features/best-smart-kitchen-devices>

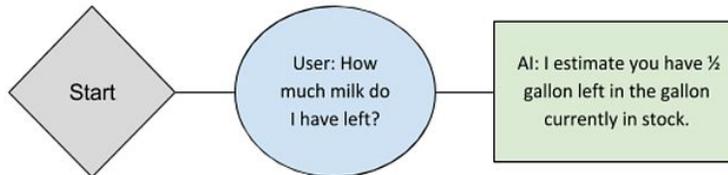
<https://www.oreilly.com/ideas/basic-principles-for-designing-voice-user-interfaces>

Example Sample Dialogues

1. Check the quantity of a product - 1 turn

User: How much milk do I have left?

AI: I estimate you have ½ gallon left in the gallon currently in stock.



2. Replacing the Milk - 3 turns

User: It looks like I'm almost out of milk. Please replace the milk.

AI: No problem. Would you like the same item replaced?

User: Yes

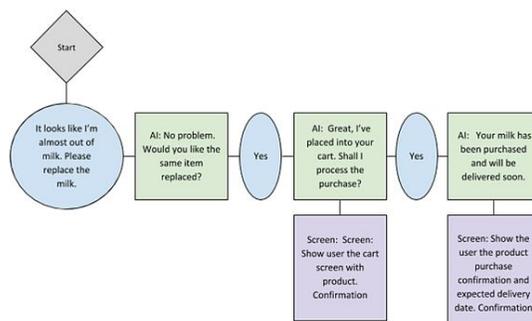
AI: Great, I've placed into your cart. Shall I process the purchase? (Screen: Show the user the cart screen with product. Confirmation)

User: Yes

AI: Your milk has been purchased and will be delivered soon. (Screen: Show the user the product purchase confirmation and expected a delivery date. Confirmation)

7. Sample Dialogue wires - Discover and Purchase Journey

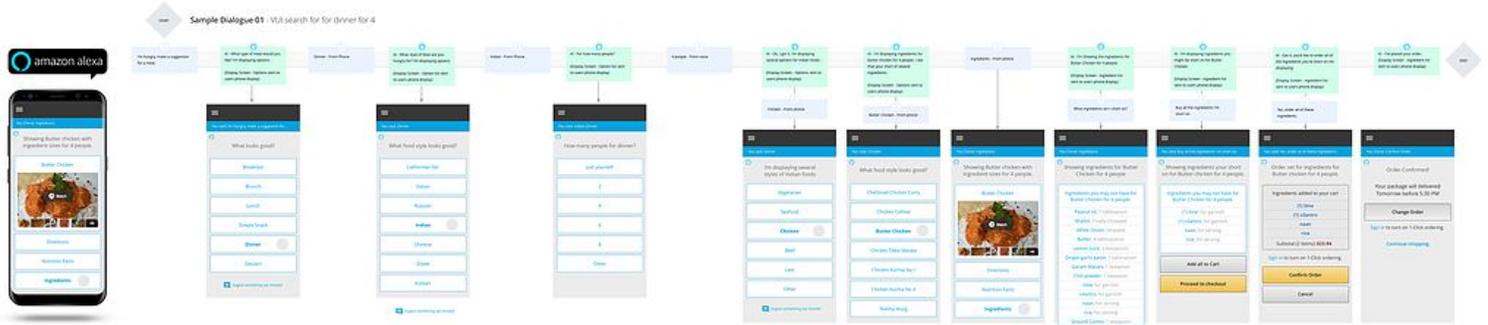
The following are examples of High Fidelity sample dialogues focused specifically on the ability of the user to discover and purchase food recipes and Food Supplies in the ability to



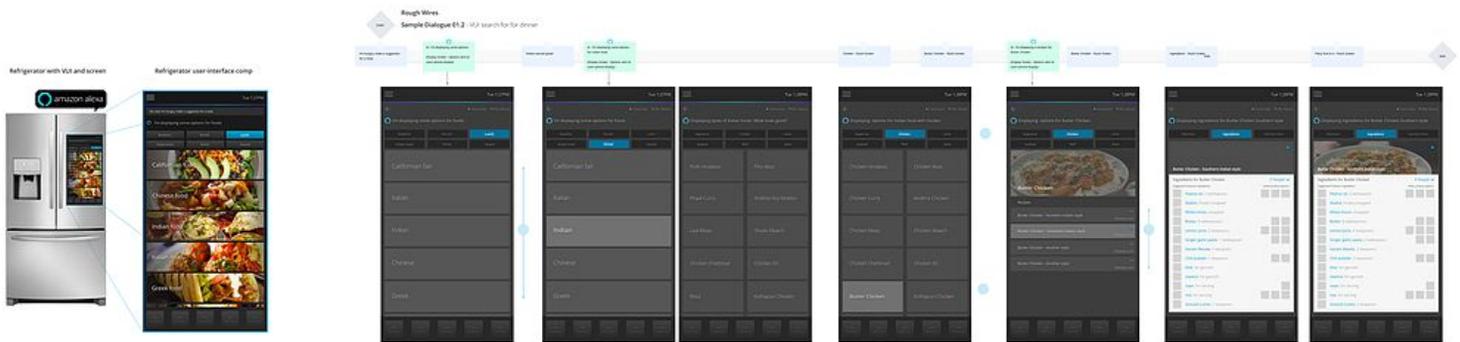
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purchase Foods. The first example was performed in a mobile environment.

Note: My Amazon advisor and I both agree that a mobile environment might be too complicated and at that point we switched to a large screen I would then be embedded into a refrigerator.



Sample Dialogue 01 - In the example below, a user is utilizing a voice-activated search for solving for dinner for 4. Solution shows the users voice commands to Alexa, as well as visual prompts to the users cell phone.



Sample Dialogue - Discover Butter Chicken and the required ingredients **Sample Sample Dialogue** - Revised Week 3

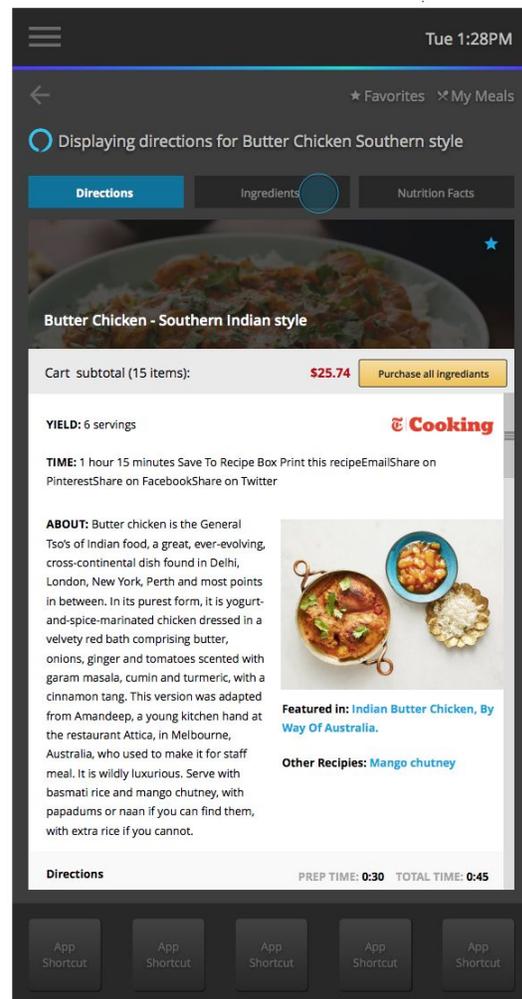
What was learned?

A mobile environment might be too complicated for the user

- In association to the product, the refrigerator in this instance, is important, therefore a screen embedded in the refrigerator door was decided upon as a viewport
- Most of the Dialogs required to complete a journey are VERY long and may fail.
- Most of the Dialogs required to complete a journey may stretch the AI (Alexa) to it's limits and or failure due to the many turns required.
- There's a very high level of detail associated with each of the screens there for prototyping might be better in a fully modded chromatic environment.

Sample Screen - Displayed to the right is a sample screen for a recipe for butter chicken Southern Indian style. if a user word to make a selection from a search result listing, this is the page that user would land upon that would provide them with information such as:

1. sponsor information
2. Preparation time
3. Photography
4. Direction affordance
5. High-level navigation affordance
6. Amazon Alexa visual confirmation
7. Favorites, and my meals.



8. Qualifying users and their needs

UX Research

Recruit 3-5 participants for a short recorded moderated Q&A interview. Interviews to be recorded via MP3 (See Website)

Qualified User Dimensions

A series of qualified Dimensions that a user may fall into work to find and explored. Ultimately it was decided that previous food delivery, the use of Alexa as an artificial intelligence whether online or on a mobile device was important. Additionally, users that were considered culinary explorers was the third qualifier.

| | | | |
|--------------------------|------------------|-------------------|---------------|
| Historical food delivery | AI or Alexa user | Culinary explorer | Not qualified |
|--------------------------|------------------|-------------------|---------------|

Participants that were interviewed

The following represents three of the many different participants that were interviewed. Recordings of these interviews can be sampled on the website. Additionally, findings from each of the interviews are associated with each of the users on the website as well.

Note: Please refer to the website for findings

Interviews & Findings



Interview 01 - Janaca J. April 22, 2018 - The participant was vegan.



- Income - Less than \$120K
- Loves cooking regularly.
- Never had foods delivered
- Familiar with AI
- Has owned a property in the past.



Interview 02 - Rob April 26, 2018 - The participant was vegan.



- Income was not asked due to respect for my neighbor (Estimate at \$140K)
- love to share with friends and Loves cooking regularly sailor style
- Never had foods delivered
- Familiar with AI (Alexa)
- Has owned a property in the past.
- Is very conservative with food leftovers
- doesn't like spicy foods



Interview 03 - Evelyn April 26, 2018 - She was driving during the interview



Note: Evelyn was driving during this interview and the reception was spotty at times. The participant had problems hearing the conversation time to time.

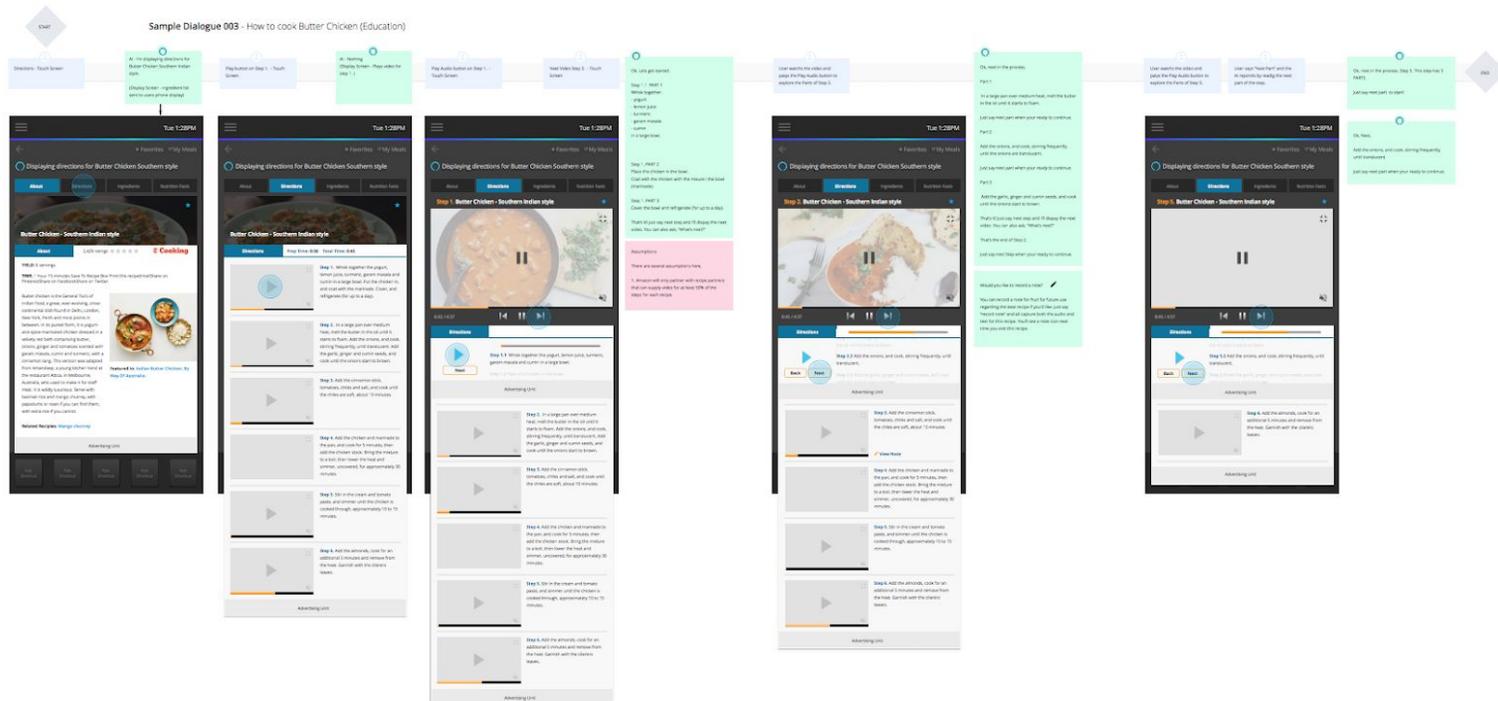
- Income - Greater than \$120K
- Loves cooking regularly.
- Never had foods delivered but picks up food weekly
- Familiar with AI and Amazon Alexa
- Has owned a property in the past.

9. Wireframing - Mid-resolution sample dialogue, VUI turn examples, and UI design examples.

Sample Dialogue - How to cook Butter Chicken (Education)

The following is an example of a voice user interface design call and response to the Alexa artificial intelligence how a user interacts with by touch the screen on the refrigerator.

Note: Please refer to the website for PDF



10. Mental Model and user research confirmation

Mental Model Topics of focus

The following areas of focus have been defined as a hypothesis of what I believe to be the most important in the journey of discovering new foods and new food recipes in the SMART kitchen experience.

1. Searching for foods
2. Finding recipes
3. Acquiring the ingredients

- Learning how to cook the recipes
- Sharing your experiences - Ideas, comments, notes, issues, photos, food creations, stories, etc.

Moderated Interview questions for participants

Note: Please refer to the website for details

Mental Model Deliverable

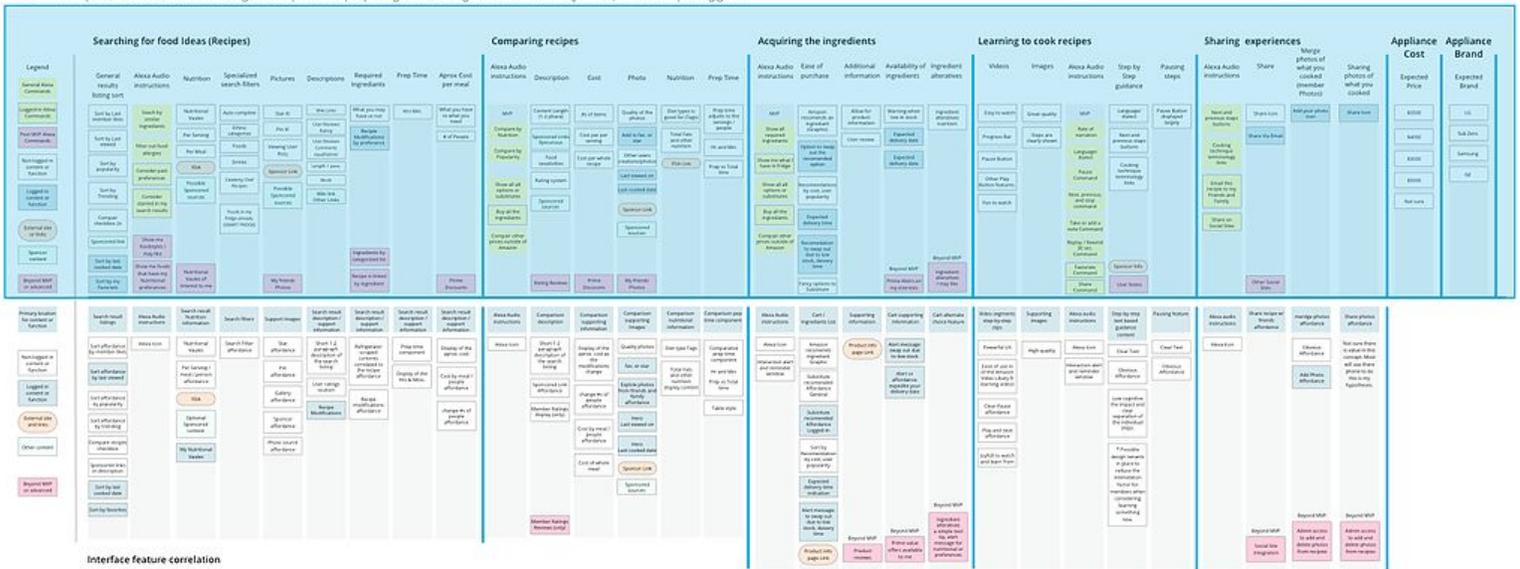
Customer expectations are shown in blue highlight.

Between three and five people were interviewed a crossed the different quadrants of the model. They were obviously many overlaps in terms of general expectations. I tried to keep the interview focused on general expectations in terms of the user interface design the user might expect to see and the kinds of affording says and services they might expect to experience.

The model is displayed below in blue highlight

Mental Model - Smart Kitchen

Understanding the Users expectations of an Alexa connected refrigerator and its 5 major areas of focus. This model represents the states of mind and general expectations people might have during these areas of focus (journeys) while accomplishing goals.



Platform recommendations by feature and facet in blue highlight specific to the customer expectations.

Recommendations specific to the five different dimensions of focus for the mental model are correlated column by column specific to the customer recommendations. The platform

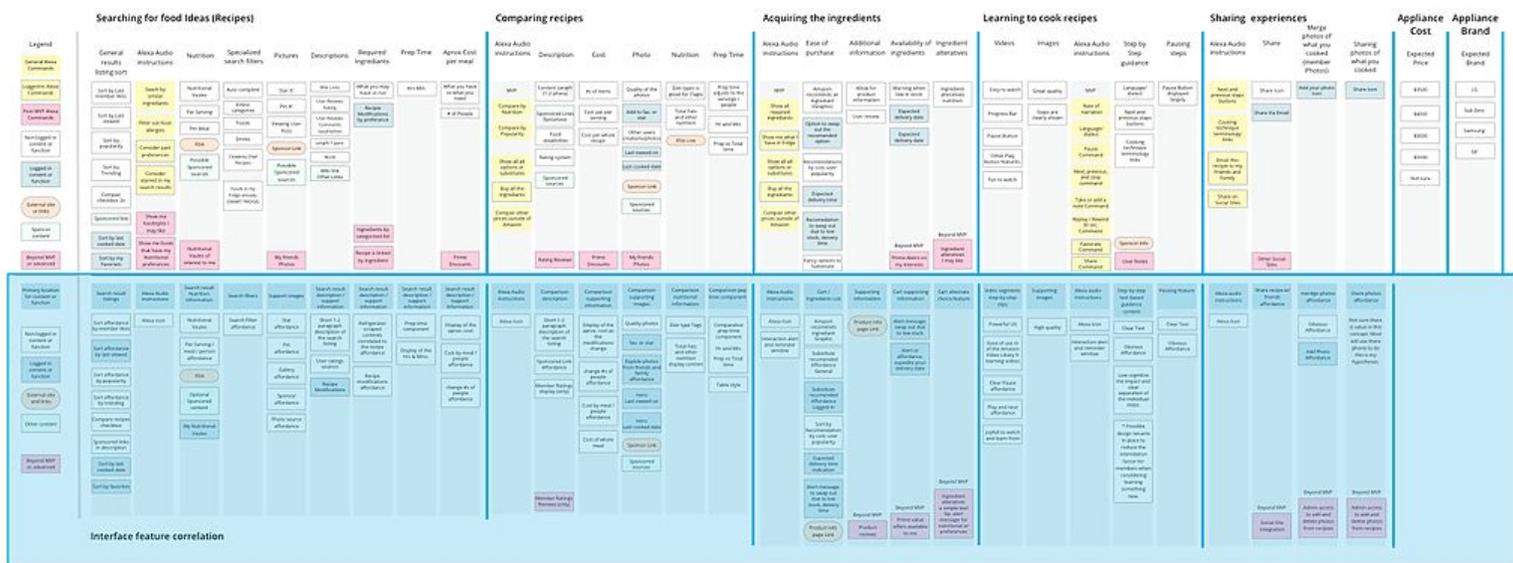
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recommendations reflect an interpretation of how specific features might react given users expectations of how the SMART Alexa infused refrigerator show operate day to day.

Platform recommendations feature by feature displayed below in blue highlight.

Mental Model - Smart Kitchen

Understanding the Users expectations of an Alexa connected refrigerator and its 5 major areas of focus. This model represents the states of mind and general expectations people might have during these areas of focus.



11. Amazon Skills - Skill examples and solutions

Amazon skills where explored for further understanding of the breadth of the the Amazon solutions and how VUI UI can solve users problems leveraging artificial intelligence. A total of 7 skills were explored and examples of the Kitchen application of the skills can be seen on the [website](#).

Skill Example: Do One Thing Really Well

An example of a skill that does one thing really well is a skill called Games Back . The sole purpose of this skill is to tell you how many games back from a first place your favorite baseball team currently is. It doesn't have live game scoring, and it doesn't even tell you if your team won their last game. It only tells you the current standings for your selected team.

Link: <https://developer.amazon.com/designing-for-voice/design-process/>

SMART Refrigerator Skill: What's Expired

Skill Concept

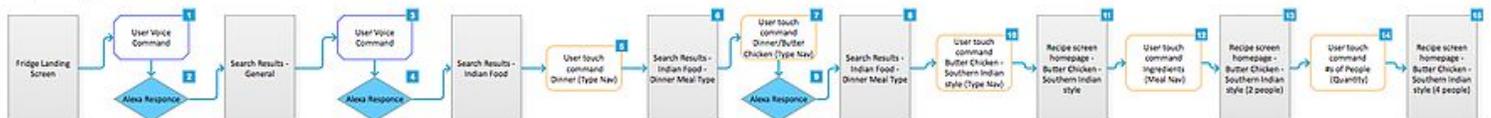
The skill is pretty much what you would expect to experience when asking Alexa in front of your refrigerator, what's expired? The user asks Alexa while standing in the kitchen, what's expired. Alexa responds with just one minute while I check. Alexa then displays a list of previous purchases that she's familiar with that most likely are inside of your refrigerator and have an expiration date that is either expired or close to expiring. These two different categories are shown in a stack ranked priority in terms of their expiration date or close to expiration date.

Additionally, for items purchased for cooking such as spices, not stored in the refrigerator, Alexa can use an artificial intelligence that can determine the possibility for needing to reorder as well as depletion rates in an algorithm to more accurately determine the potential for expiration across its entire member base.

12. Updated Final Sample Dialog Masters Project Example

Revised Sample Dialogue - User VUI and touch screen "Search for dinner"

Sample Dialogue 1 - User VUI and touch screen - Search for dinner



A Revised Sample dialogue for the "search for dinner" solution was created using Axure RP. I added a number of dimensions into the flowchart that helps to describe the user's voice commands, Alexis response, as well as the user, touch commands associated with the user interface.

Link: <https://bub7wi.axshare.com/prototype/login/bub7wi#c=2>

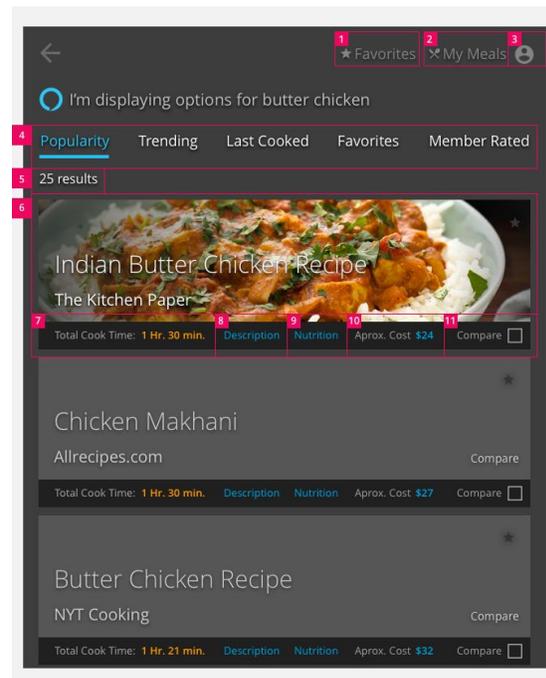
Password: kentstate

13. Final wireframes and interactive prototype - Search results navigation

Navigation and filters in the UID of the touch screen - search for dinner

Below and to the right I've pulled from the Mental Model the expected filters and features users have discussed.

1. Users Favorites
2. Users past meals
3. Profile logged-in icon
4. Filter search results bar
5. Results total delivered
6. Result Hero
7. Cook and prep time in Hr's and Min.
8. Result description affordance
9. Results Nutrition affordance
10. Cost affordance
11. Compare affordance



Explorer the interactive click through.

Note: A prototype of the comparison segment of the screen interaction was designed in InVision and wireframed using Sketch, a dynamic vector based application popular today in crafting digital applications.

Comparing meals with a VUI enabled appliance

VUI Command to compare by highest Protein in four different meals.

VUI Commands allow users to ask Alexa to gather meals for comparison by nutritional values.

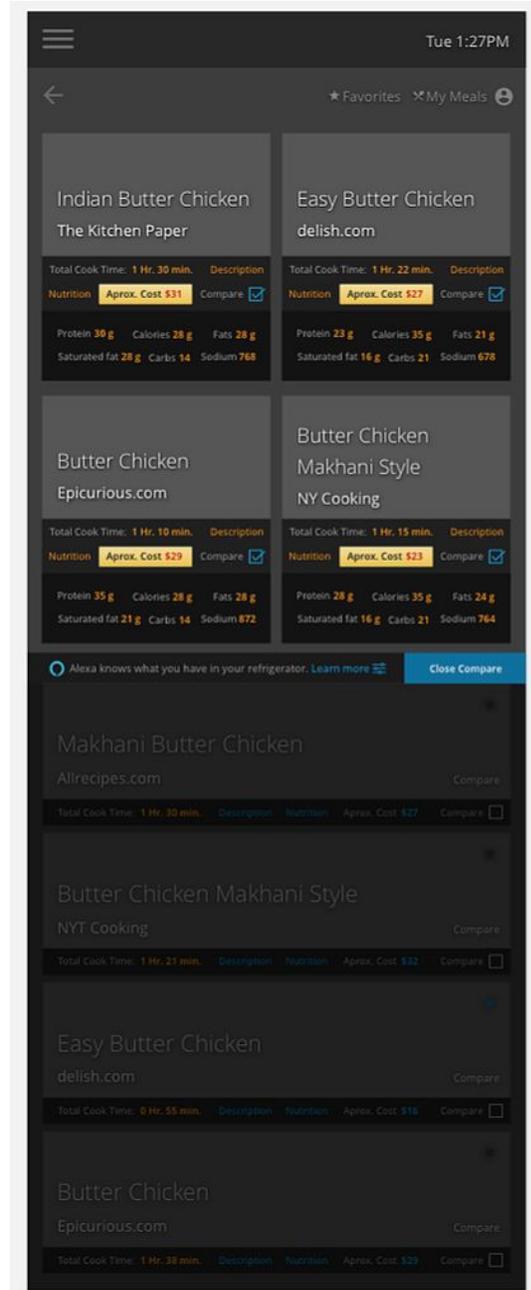
Shown to the right, a card style UI format has been used to display lots of information that users have asked for to easily compare various meals at one time.

User Command to Alexa:

"Alexa, show me 4 options for Butter Chicken organized by highest protein."

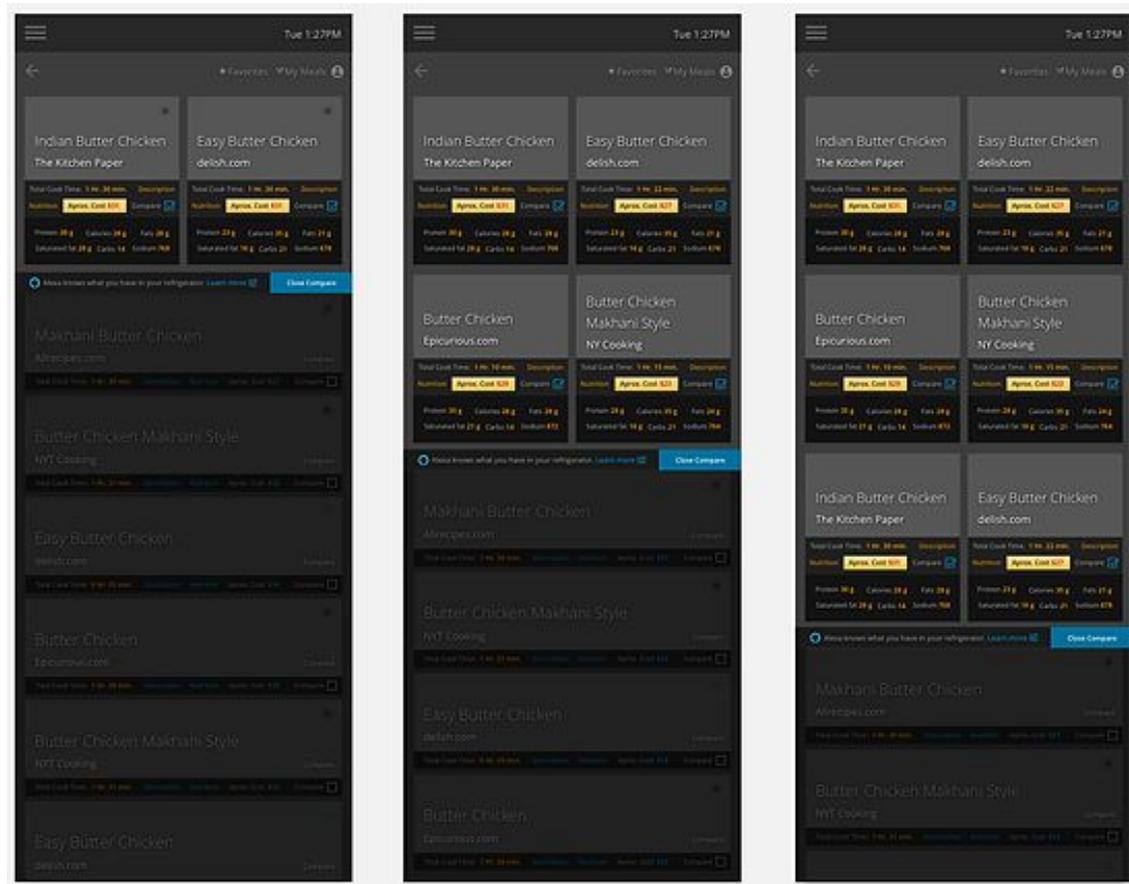
1. Alexa displaying her response to the user asking to show 4 options for butter chicken organized by highest protein.
2. Card style meal UI
3. The highest protein value is shown in the top left position.
4. The lowest protein value is shown in the bottom right position.
5. Close Compare affordance

Explorer the interactive click through.



User command - For the screen below.

"Alexa, show me 4 options for Butter Chicken organized by highest protein."



Explorer the interactive click through.

Thank you for exploring this incredible design and business sector!

Thank you to all who helped me learn along the journey.