CMSC 20370 GP2

Elizabeth Crowdus, Luke Giacalone, Lilly Hackworth, Jillian Ritchey

February 17, 2020

Project Description

Our project focuses on students with dietary restrictions and allergies at the University of Chicago. Currently, it can be difficult or unreliable to figure out how to comply with certain dietary restrictions, making the dining hall stressful to navigate for students with dietary restrictions. Menu information is currently available online, as well as on tablets in the dining halls, but not in easily searchable or accessible formats. Our project explores a better solution in this area, that will allow students at UChicago who are eating in the dining halls to better discover which foods they can and cannot eat at a given meal. Our system will support a wide array of dietary restrictions and any allergies, allowing students with these restrictions to find food they can eat. Non-exhaustive examples of students in this user group includes students following a vegetarian, vegan, or pescatarian diet, or students who cannot eat gluten or are allergic to other specific foods such as peanuts. A technological solution allowing students to view menus through the lens of specific allergies or dietary restrictions would allow them to see what their options for a specific meal are, allowing students to safely eat a wider variety of food without having to be concerned about eating something they should not because they were not sure about the ingredients.

Requirements Summary

- Support for dietary restrictions/allergies: Our system needs to support a broad range of dietary restrictions, as well as any allergens, not just a limited list of the most common allergies. Users should be able to enter their allergens or restrictions and have the menu options appropriately labeled or filtered by ingredient accordingly.
- Accuracy of food suggestions: In order to accommodate particularly severe allergies as well as strict dietary restrictions, and to ensure user trust, foods marked as appropriate for a user must fit in with their specified dietary restrictions, and any uncertainties or potential for cross-contamination be clearly expressed.
- Efficient and simple: Our system must be usable and practical for students on the go to quickly check which foods they can and cannot eat without having to put in significant time while checking or ahead of time to learn a system.
- Up-to-date info: Our system must reflect the most current info on the menu items being offered. Online menus are often out of date or otherwise do not reflect what is actually being served. Our system should take this into account, and accurately inform users as to the ingredients and allergen information of what is in the dining hall.
- Detail: Our system should go beyond just macro level labels of vegan, vegetarian, etc. to take into account specific ingredient allergies, for instance allergies to onion or dairy. It should be clear what restriction or allergy a food is being rejected for containing so that students can make an informed choice about whether they can eat the food anyway (severe vs mild restriction).

- All inclusive labeling: Our system should appropriately label all relevant items being served in the dining hall, not simply main entrees and their accompanying sides. This includes stations such as the salad bar, made to order pasta or stir-fry, and desserts.
- Detect mislabeling: Our system should appropriately handle the case of macro level labels not matching the actual ingredients, for instance a dish marked as vegan that actually contains cheese or eggs.
- Sides in dining hall: Our system should distinguish between the different dishes offered at a given station. Currently sides are grouped with their entree in the Bon Appetit filters, making it harder to find sides that conform with dietary restrictions even if the entree does not.
- Filtering: Our system should make it straightforward to filter by the dietary restriction or allergen, and readily surface the foods that can be eaten without having to manually read through all menu items.
- Best dining hall: Our system should help make it clear which of the dining halls has the best options for a given day so that users can choose accordingly.
- Enjoyable: Our system should provide a satisfying user experience that users wish to come back to and actually enjoy using.
- Accessible: Our system should meet a basic level of accessibility, and in particular should not require a high level of technical literacy.

User Research Summary

We created a survey using Google Forms for participants to fill out so that we could gauge the general level of satisfaction with the current dining hall systems. Additionally, we queried our participants as to how they currently act to navigate the dining halls and how they currently (or in the past, in the case of off-campus students) act in order to accommodate their dietary restriction.

We targeted a response rate of 10 to 15 people. In total, we received n=14 responses to our survey.

Respondents

Respondents were recruited by using multiple methods. First, we created and posted flyers asking people to fill out the survey. These flyers included a QR code for people to be able to easily reach our survey. Second, we posted a link to the survey in house-Facebook pages encouraging housemates to fill out the survey. Third, we engaged in snowball sampling where we asked respondents to have their friends also respond to the survey.

Analysis

For our analysis, we used both qualitative and quantitative methods. For certain questions, such as ranking and multiple choice, we used simple statistical analysis. For questions in which respondents gave a written response, we used data coding.

We were also able to take advantage of the analysis tools native to the Google Forms environment. For instance, we were able to review all responses to individual questions, and for multiple choice questions, we were able to view the responses in pie charts and bar charts.

P	Year	Living Situation	Restrictions[a]	Adherence (% of time)	Motivation[b]	Experienced mislabeled food in dining hall
1	Fourth	Off campus	Gf	100%	Sv	Yes
2	Second	On campus	Vn	100%	Ev	Yes
3	First	On campus	Df, Eg, Nu	100%	Sv	
4	Second	On campus	Gf	76-99%	He	No
5	Second	On campus	Lc	76-99%	He	No
6	Third	Off campus	Df	100%	Sv	Yes
7	Third	Off campus	Ve	76-99%	He, Ev	No
8	Third	On campus	Gf	100%	Sv	Yes
9	Fourth	On campus	Gf, Pk	100%	Re, Sv	Yes
10	Third	Off campus	Bf	100%	Ev	No
11	Fourth	On campus	Kr	100%	Re	Yes
12	Third	Off campus	Nu	100%	Mi	No
12	Third	On campus	Df, Kr	100%	Mi, Re	No
14	Fourth	Off campus	Nu	100%	Sv	Yes

[a] Restrictions key as follows: Bf=Beef free, Df=Dairy free, Eg=Egg allergy, Gf=Gluten free, Kr=Kosher, Lc=Low-cholesterol diet, Nu=One or many nut allergy, Pk=Pork free, Ve=Vegetarian, Vn=Vegan
[b] Motivations key as follows: Ev=Moral/ethical/environmental, He=Health/Lifestyle, Mi=Minor allergic reaction, Re=Religous, Sv=Severe allergic reaction

Results

Our results indicate an overall lack of satisfaction with Bon Appétit Management Company's handling of dietary restrictions at the University of Chicago. Depending on the severity of the restriction, this has led some respondents to struggling to eat in the dining halls, especially during their first-year, when undergraduate students are required to live on campus and purchase a meal plan—some (n=3) of our respondents reported arriving at a dining hall to find that there is no food that they can eat.

Our respondents took great care in making sure that they could truly eat the food that was being offered. Most (n=11) of our respondents looked at online menus before going to the dining hall, with n=8 of those using their mobile phone to browse the menus. Half (n=7) specifically chose a dining hall to go to based on the menu being offered. Menus are also posted in the dining hall by the food stations, and most (n=9) of our respondents gave the ease of use of these menus a three out of 5 or less.

The largest issue for our respondents was trust in the dining hall's labels. Specifically, there are labels on each dish that display whether it fits into certain categories, such as gluten-free or vegan. Most (n=10) of our respondents gave their trust in these labels a 3 out of 5 or less. No respondents gave it a 5 out of 5. Additionally, most (n=8) respondents reported experiencing mislabeled food in the dining hall. When asked about this, respondent P6 said:

> *Oh my god all the time. This was the worst thing about dining halls! I felt I could not trust anything I ate. And I was always anxious about reacting severely and getting sick. I basically never ventured beyond the salad bar and grilled chicken.*

Many respondents reported similar stories, such as lasagna made with real cheese labeled as vegan. A more egregious instance of mislabeling was P8's experience with a last-minute ingredient change:

> *There was a time when I got a stuffed bell pepper which was marked as containing sausage and being gluten free but when I cut into it, the filling was actually leftover thanksgiving stuffing which is made of bread, and the dining hall had decided to make the switch without noting it anywhere.*

Some of our respondents have also been in contact with Bon Appétit Management Company in regards to their dietary restrictions. All those who requested a change in the current system said that nothing ever changed, with one respondent referring to the dining hall managers as "extremely rude."

In summary, our respondents' largest problem with the current system is the lack of being able to easily identify food that is safe for them to eat. With ingredient lists being difficult to read and dishes being mislabeled as adhering to certain dietary restrictions, our respondents were dissatisfied with Bon Appétit Management Company's current practices.

Design Methodology

The first method we used when designing our prototypes was collecting things from existing systems. The dining hall currently has an existing menu system with both an in dining-hall and an online presence. They already offer attempts to provide support for students with dietary restrictions. We built off of some of these existing systems in our designs, taking into consideration the feedback we got from our user research. For example, the menus in dining halls are currently displayed on tablets directly above the station. We utilize this same physical space in some of our designs. Other things we have used in prototypes from the existing system include the ingredients lists and the ability to filter by certain dietary restrictions (though our prototypes expand on the options currently offered). We also looked at how users said they interact with the existing systems. The majority of users said they primarily use the existing online menus on their phones, so we brainstormed designs that utilized the mobile phone as the primary platform, since this was the most popular user interaction.

Another technique we used was collecting things that users said annoyed them about the current system and building off of these. The biggest grievance was that food was occasionally labeled with incorrect icons, such as "vegan" or "avoiding gluten" when it in fact contained non-compliant ingredients. Not being able to trust these icons, which, in an ideal scenario, would provide information about dishes with a quick glance, was a major problem for many users. They instead have to rely on closely reading ingredient lists, which is time consuming and intrusive. We brainstormed designs that would allow a user to quickly identify if a food complied with their dietary restrictions, without requiring extensive parsing or information processing.

Another source we took inspiration from in our brainstorming was prototypes and ideas we found in our research, such as sensors that can detect allergens in samples of food. We thought this was an innovative idea, and brainstormed ideas involving detecting dietary restriction compliance in real time, without relying on the dining hall system.

As we continue to develop our chosen prototype, we are planning to partake in action research and have users interact with our prototype while we collect feedback. We will then use this feedback to improve our prototype, and to inspire new features or help us refine the existing features.

Design Space

Our design space involves designing for users with a wide range of dietary restrictions and preferences, which are often not defined by a simple label (like vegan or gluten free), or restricted to a single common allergen. We also need to design within the space of the dining halls, which provide a fixed amount of information about dishes and limited interfaces for interacting with this information.

Difficult requirements

The most difficult requirement to realize is the need to present information about the available foods that is consistently accurate. When we cannot realize this requirement with 100% certainty, we need to make it clear to the user that this is the case. This requirement is difficult to realize because if we choose to rely on ingredient lists from the dining hall, we are limited by the accuracy of their information. As many users mentioned in the survey, foods are often mislabeled in the dining halls, or different ingredients will be used in the actual preparation compared to what was listed online. While we can use both the online ingredients lists and the provided dietary labels, we can also derive many of the labels (vegan, gluten-free) ourselves based on the ingredients list. We could also choose to not use the ingredient lists provided by the dining halls, and instead use some novel solution to detect ingredients ourselves, but this is also a difficult space to work in, and would require sophisticated technology.

Tradeoffs

One tradeoff we explored was the user's interaction with physical space in the dining hall. Some of our solutions require the user to use their phone to take a picture of the food being served, in contrast to other solutions that require them to scan a sign (which could be placed anywhere in the dining hall) or do not require them to physically be in the dining hall. Interacting with the food directly provides the advantage of having the latest information about what is being served, and what the user is about to be eating, however, also requires a physical interaction that may seem uncomfortable or intrusive to some people. Solutions that don't require the user to be in the dining hall offer the convenience of remote access, but sacrifice real-time information, and can suffer from changing dishes or ingredients between the time the information is accessed and when the user is dining. Another potential tradeoff we have to balance is between providing a high-level view of the dining halls and the total daily menu versus providing a dish-specific view. We have some requirements that involve providing a high-level view of the dining hall, such as presenting information like which dining hall would be the best for the user to eat in that day based on their restrictions, and surfacing

all available dishes that a user can eat in the dining hall. The dish-specific view accomplishes a different set of requirements, such as efficiency and simplicity so that the user can determine if they can eat a dish as they are presented with it and do not have to plan ahead, and providing the most accurate information, reflecting the most recent preparation of the dish as the user is about to eat.

Difficult and Easy Tasks

The most difficult tasks to support will again be those involving accuracy and ensuring users are shown correct information. It will also be more difficult to provide accurate real-time information to handle changing ingredients lists and preparations. Some of the tasks that will be easier to address will be supporting a variety of dietary restrictions, as we are designing with an awareness that dietary restrictions vary widely, and that our system should abstract away from specific allergens to make it widely applicable. We should also be able to easily support the task of letting users set their dietary preferences to be reused with each interaction with the system, so that they do not have to input preferences each time, or repeat actions involving providing information about their restrictions.

Modifications of requirements and usability criteria

Our design requirements and usability criteria remained mostly the same throughout the design process. We did refine requirements about accuracy and up to date information, as we realized that this was very important to users, and that our designs should emphasize accuracy. As we designed, we added the requirement for displaying complete information about side dishes, as we realized these are an equal part of the dining experience as entrees and should be treated with the same amount of importance. Likewise, foods at stations such as the salad bar and deli should be included in the system, since all foods in the dining hall contribute to the meals of users, and we should not limit the user's choices by limiting what stations our system covers.

Design Summary

There are a multitude of possible solutions to the problem that the dining halls present and, accordingly, we had many designs during our initial brainstorming session.

The first eliminations we made were based on technological limitations. For example, a design that we all agreed would be extremely useful is a type of scent detector which could be pointed at a dish and discern all the ingredients in the dish. This product would be really helpful in figuring out whether something is safe to eat or not. However, we quickly realized that scent-detection technology is not quite at a level where this would be even remotely possible.

Then we considered whether we should go with a physical or a digital design. Several reasons informed our choice to go with a digital design. First, we would have to manufacture a physical product. 3D printing would be the only option available to us, but none of us have much experience in this area. Second, we would have to come up with a way to connect sensors to computing engines (e.g. Raspberry Pi, Arduino) in a compact and efficient way. Third, there would still be extensive programming involved, which would only add to the first two challenges. Finally, and most importantly, our respondents already use their cell phones to access the UChicago Dining website to check menus. If we created a mobile friendly site, then it would be trivial for users to make a switch to our product, versus remembering to carry and use a physical device.

Restricting ourselves to purely mobile-based digital designs allowed us to eliminate many unfeasible alternatives. However, we again had to think about feasibility in our designs. We realized that we could not rely only on empirical data gathered from the prepared food in a dining hall. Therefore, we decided that we had to work with the menu data that Bon Appétit provides. Most of our survey respondents' issues with trust in the dining hall stemmed from the labels that they put on the food (eg "vegan") rather than the list of ingredients, which they instead found to be cumbersome and difficult to go through. Additionally, we took

an insight from the *Sound Awareness* paper we read which said that users would not use a system that gave a false positive; in our case, that false positive would be a food scanner reporting that a dish is safe to eat when in reality it is not. Accordingly we based our more realistic designs on finding a way to display to the user which food is okay for them to eat based on published menus.

The most difficult part of our design will likely be gathering this menu data and making sure that users can easily and accurately filter based on the menu data. We should be able to scrape the menus from UChicago Dining's website. Though we are going to have to make sure that we can categorize all possible ingredients (eg labeling butter as a dairy product) which could be difficult if Bon Appétit uses an extremely unusual ingredient or has a typo in their ingredient lists.

Since all of us have some level of experience in user-facing application development, we are expecting that this will not be a significant bottleneck for us. Making a web based application should be relatively trivial, though making an actual iOS or Android app would provide a greater challenge (and it would be near impossible for such an app to be approved onto Apple's App Store, limiting it's availability to users).

Designs

Scan food

Overview

This solution would utilize machine learning technology to identify foods based on scanning the food in question through a phone camera. The user would capture an image of the food at a given station, and the application would process the image to identify the food. This would be linked with the posted menus to scan for specific ingredients, and return a verdict back to the user based on a previously configured dietary restriction/allergen profile as to whether they can or cannot eat it, and why.

Illustrations

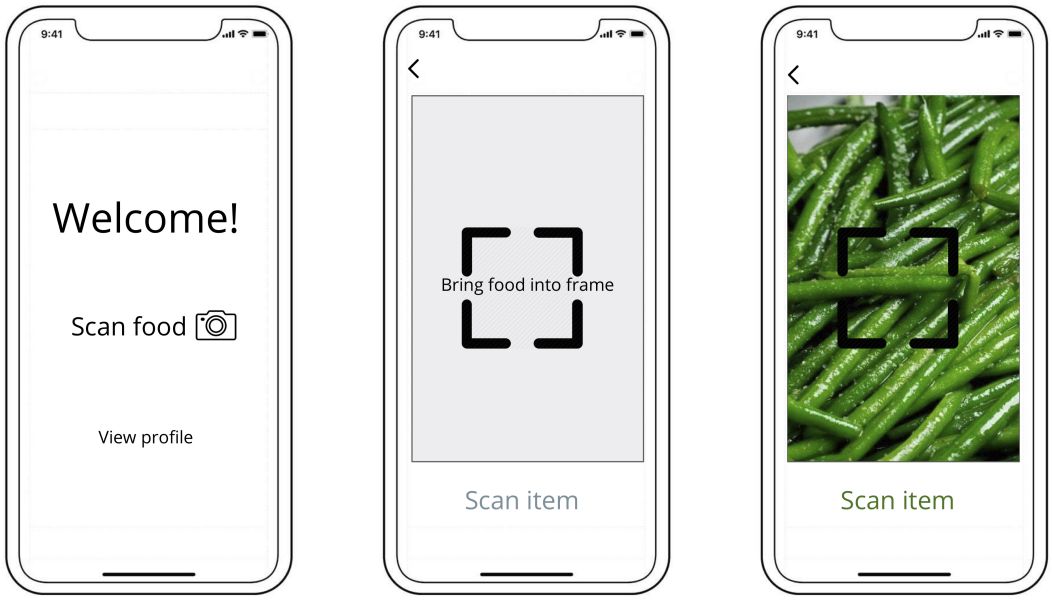

Figure 1: Home page and food scanning functionality

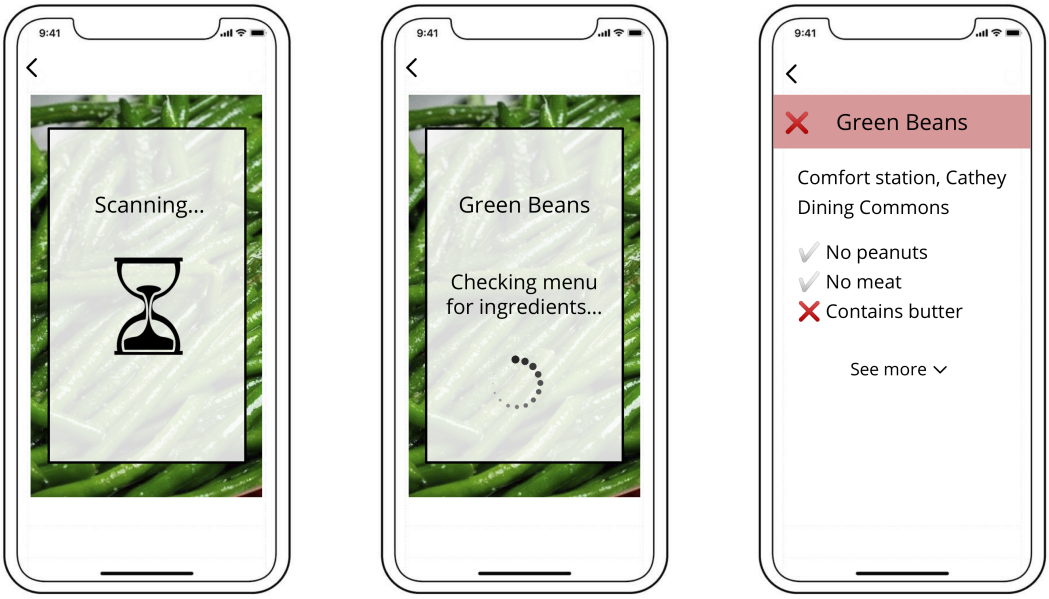

Figure 2: Processing, identification, and lookup of food item in menu. This food item is marked as not adhering to the dietary restrictions entered (such as dairy free or vegan) because it contains butter.

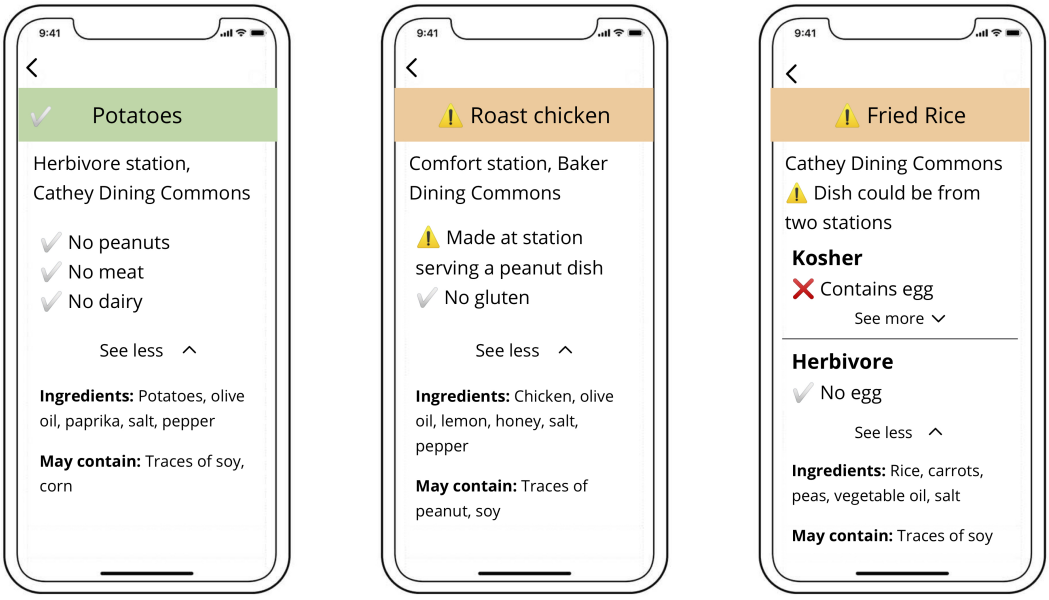

Figure 3: Results for various foods. Ambiguous foods or those that may contain trace amounts of an allergen are clearly identified. Having clicked to see more opens up full ingredient information.

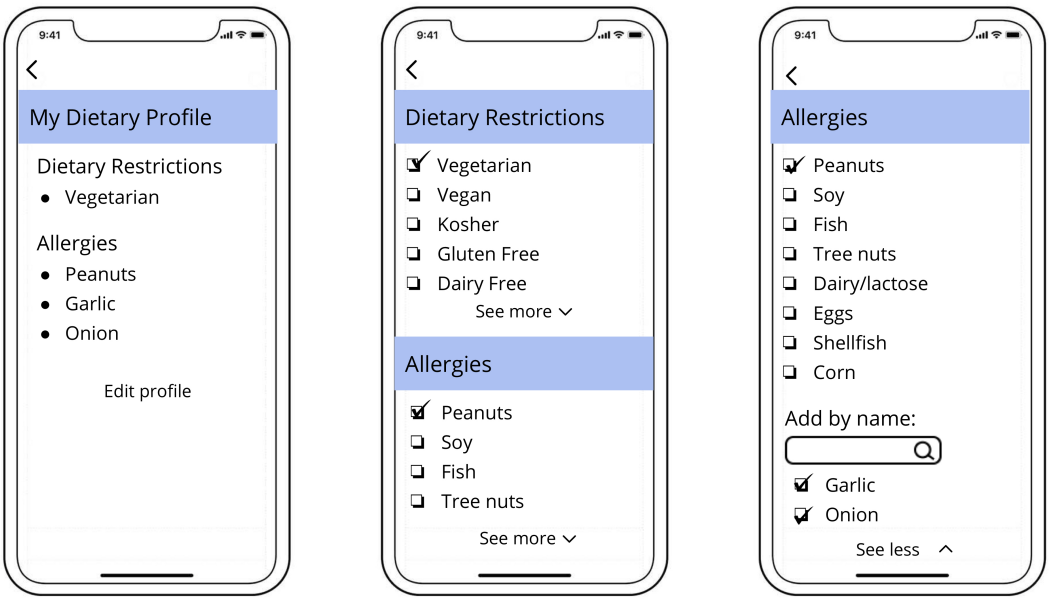

Figure 4: The dietary restriction/allergen profile set up; users can select from a list of allergens or dietary restrictions as well as add specific allergens by name.

Example Scenario

Imagine a user who is severely allergic to gluten, and is also vegetarian. Finding food in the dining hall can be a struggle for her, since the dedicated gluten-free station often serves meat. With this app, the user is able to enter in these dietary restrictions, gluten-free and vegetarian.

She goes into the dining hall for lunch one day, and thinks some of the options at the herbivore and Kosher stations look good, but is not sure if they meet her dietary restrictions. So she pulls out the app, and scans the entree at the herbivore station. It comes up mixed - the dish itself does not have gluten, but one of the sides being served does so there is a higher risk of contamination. Since she has had some health issues recently due to gluten, she decides not to risk it, and scans the food at Kosher instead. This comes up as both vegetarian and entirely gluten-free, so she has that for lunch. Instead of being limited to just the sides at the gluten-free station or ending up with an allergic reaction, she has better food options and stays healthy thanks to the app.

Assess the Design

This design's major advantage is that it simply requires users to essentially snap a photo of the food they are interested in, on a smartphone that they are probably already carrying around with them, and then it gives them the relevant allergen information. It does not require users to look up menus and search through them ahead of time, filter through all the various options, or read all of the ingredients. Like anyone else, they can go around the dining hall, see what looks good, and figure out easily using their phone whether they can eat that food. Both potential users asked about this design, who were simply shown the prototype and asked for their thoughts, whether they would use it, how they would use it, what they liked or could be improved, etc. and their answers transcribed, expressed that they liked an option that did not require them to look at menus ahead of time or carefully read through all the ingredients either in person or beforehand.

Additionally, beyond just the food identification, this design leverages the power of the menus to determine individual ingredients that might not be easily identified otherwise, as well as information about other

dishes at the station to determine cross-contamination risks. It avoids the assigned meta labels, which are often inaccurate, and instead goes directly to what was put in the food. One potential user particularly liked the level of detail in terms of identifying potential cross-contaminants.

However, there are some major disadvantages. For the purposes of this study, we would be able to use a Wizard-of-Oz technique to test this prototype. In order to be practical beyond that though, it depends on the further development of computer vision and/or deep learning research on food recognition. While some progress has been made in this area, identification is still not perfect.

Additionally, it can get more complicated when similar dishes are being served at multiple stations, forcing the user to look through potentially several options before finding the correct one. It also does still rely on the posted ingredient information, which can be potentially out of date or inaccurate, and it does not help if there are no ingredients listed, though it could flag that as a potentially risky choice. The major drawback both users identified was that they were still unsure that they would trust the app since the information still ultimately comes from Bon Appetit's menu, which they had bad experiences with in terms of misidentified ingredients.

With respect to our design requirements, this prototype does support all sorts of dietary restrictions and allergies, including allowing users to add the allergies by food name. Since it directly checks against the full ingredient lists for each food, as well as including trace contaminants, it is more accurate than the macro level labels and ingredient lists posted, though still limited in accuracy due to its reliance on Bon Appetit's menus. It is a simple interface to use, requiring users just to have a dietary profile ahead of time, and then scan the food in question. It is up to date, since it is based on the foods that are actually in the dining hall. This design is also quite detailed, going down even to the instance of ingredients being used at the same station that may contaminate the dish, and ignores macro labels and their inaccuracy entirely. All foods could be scanned, including individual side dishes.

However, beyond the simple food identification, this design would not be able to do anything more for labeling foods that do not have ingredient lists or menu items already (such as items at the salad bar) than is already provided with the menus. It also does not include any way to filter foods by the dietary profile since it focuses on checking whether an already selected food is good or not. With its focus on the in dining hall experience, it would also not be of much help in picking between dining halls ahead of time. One user expressed that while he liked the ability to check foods as he went throughout the dining hall, he would also want a way to know as he entered the dining hall where he could find good options, without scanning every dish at every station. Finally, it relies on intuitive actions that users are likely already familiar with - bringing an object into the frame and clicking a button to scan - and does not require high technical literacy to search through anything or enable options. With an effective and efficient back-end to do the food identification, it would provide an enjoyable and helpful user experience.

QR Codes at Stations

Overview

Each station in the dining hall (Herbivore, Kosher, Gluten-Free, Comfort, Halal, and other specialty stations like salad, taco, pizza, and pasta bars) has a tablet that displays that meal's menu. Currently, the tablet shows the dishes being served in the station and lists the ingredients for each of these dishes. This design would allow users to scan a QR code displayed on the tablet which would then take them to an app with their user preferences pre-established, telling them which dishes at the station they could and couldn't eat, and why.

Illustrations

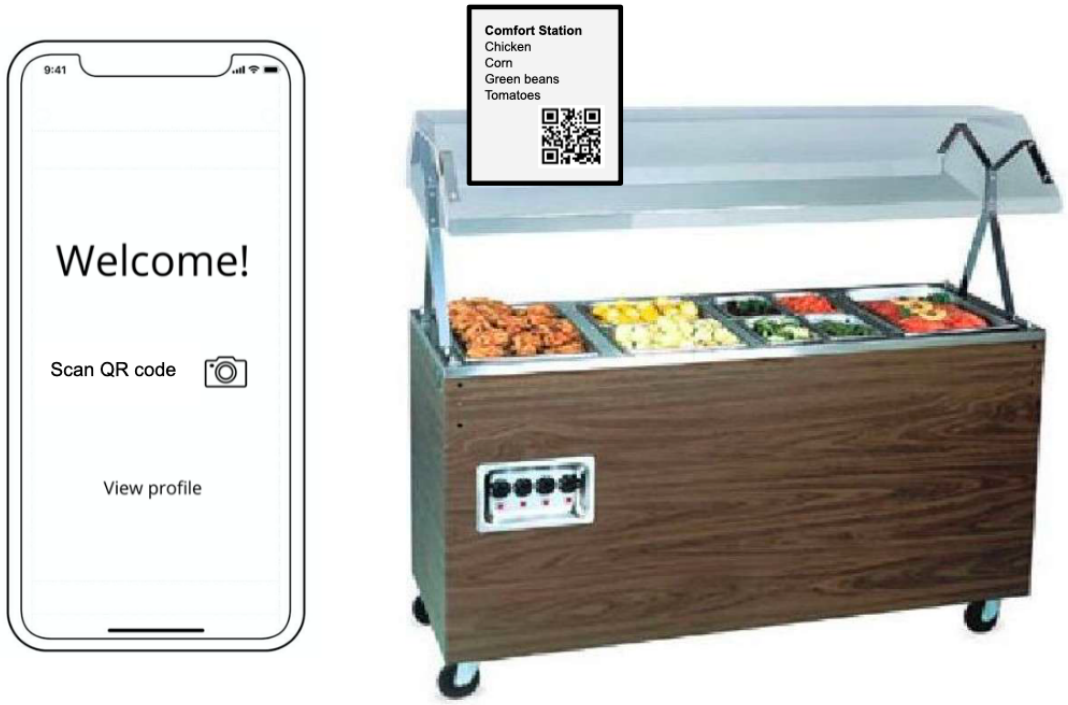

Figure 5: In-app QR code scanning of QR codes on food station menus

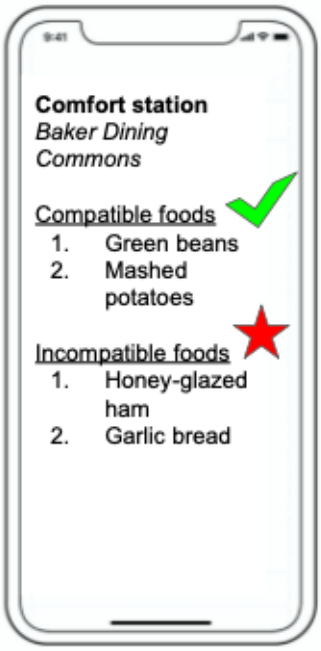

Figure 6: Overview of compatibility with different dishes at a scanned station

Note that the preferences set-up and food results would look similar to the design for the Food Scanner design.

Example Scenario

An example scenario would be if someone with a peanut allergy went up to one of the food stations in a UChicago dining hall. The user would open the app to take a picture of the QR code listed on the tablet display above the station. Once the photo was taken, the app would load the menu and show the user two lists: the first containing dishes at the station which are compatible with the user's uploaded dietary preferences, and the second containing dishes at the station which aren't compatible with the user's uploaded dietary preferences. Users can click on any of the listed dishes to see full ingredient lists. In the case of incompatible dishes, the ingredient list will also specify the ingredient(s) which made that dish incompatible.

Assess the Design

One weakness in this design is reliance on users to input their preferences beforehand. This could be a dangerous design flaw if a user with a severe allergy incorrectly inputed their dietary restrictions and thought that they could eat an dietarily incompatible food. Strengths of this design are that it allows users to personalize their dietary restrictions, and it allows them to access real-time information in the dining halls rather than being forced to rely upon researching menus before going to a dining hall.

The potential users thought that it would be valuable to evaluate food in real-time on mobile phones rather than having to do extensive research before arriving at a dining hall.

A potential drawback is if Bon Appetit publishes inaccurate ingredient or dish lists, which could lead to erosion of trust and potential confusion if what is on the app does not match the food at a station.

Otherwise, this design meets all of our requirements of users identifying the foods that they can and cannot eat in a timely manner. Our initial research suggested that some college students are hesitant to strike up

conversations about dietary concerns with dining staff. This real-time, mobile-based design could also help strengthen user confidence if they have a question about a dish: it might be easier to initiate a question about a dish if one is already holding information about the dish in their hand.

Web-based Filtration System

Overview

The web-based filtration system would be similar to our previous designs in that it will show users what they can and cannot eat based on a user profile. However, it would vary in the fact that it can be used before a user even decides which dining hall to enter, making it more versatile since a user can choose which dining hall to eat in based on their dietary restrictions.

The users would log on to a webpage which would contain the menus for the day at the various dining halls. Based on the user's profile and the ingredients in menu items for the meal, it would display which stations the user can and cannot eat at. The user would be able to explore into a certain station and the food it is offering to see which foods cannot be eaten and why.

Illustrations

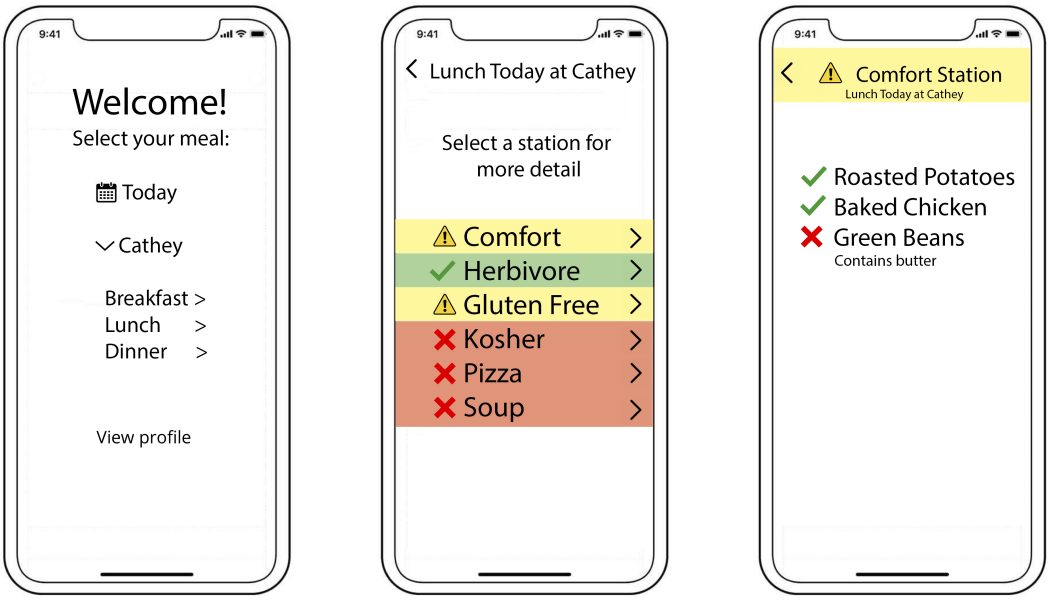

Figure 7: Home page and menu details. The user can select down into each station and the food which it is offering.

Note that the preferences set-up and food results would look similar to the design for the Food Scanner design.

Example Scenario

Imagine a user with a severe dairy allergy. Much of the food in the dining halls contains dairy, even if it is not visible, such as milk in mashed potatoes. With the website, the user is able to enter his dietary restrictions.

After the user's last class of the morning, he can open up the site and explore the dining halls. He can clearly see which dining halls have more options and more appealing options that can suit his needs. When, for example, looking at Cathey's lunch options for the day, he can see that he can eat no problem at the Herbivore station, there are some issues at Comfort and Gluten Free, and the user cannot eat anything at the Kosher, Pizza, and Soup stations. The user can then explore into the Comfort station to see that the only issue is the green beans, which are cooked with butter. If he chooses, he can further explore each of the options to see all the ingredients in each dish and why it might be a problem.

Assess the Design

A major advantage of this design is that the user can be anywhere when checking which food they can eat, and it is easily accessible on the smartphone that they already likely carry around everywhere. This will allow a user to choose which dining hall will be best for them at a particular meal. Therefore, the user does not have to waste time and meal swipes going to a dining hall only to find that they cannot eat anything being offered. This, like the other designs, avoids the inaccurate Bon Appétit assigned labels and instead looks at the ingredients in each dish, which was something that the potential users liked.

Additionally, since Bon Appétit publishes their menus days in advance, a user will be able to plan every meal for the coming few days and inform their friends as to which dining hall they should eat in for every meal. This would eliminate the anxiety the dilemma of showing up to a dining hall with food to eat but no friends or a dining hall with friends but no food to eat. The potential users liked this idea, but noted that college students are not always the best at planning in advance.

The only potential drawback is if Bon Appétit publishes ingredient lists that are inaccurate, or if there is a last minute menu change. This would render the site useless, but this should never happen in theory since it would make Bon Appétit's current dietary restriction system useless as well.

This design fits nearly all of the design requirements, the one issue being, again, a last minute menu change or inaccurate ingredient lists causing a lack of accuracy in the site. There is no technologically feasible way, however, to overcome this challenge. If Bon Appétit makes false statements about what is in their food, then no technology currently available on the market has the ability to detect that.