USING WEB AUGMENTED REALITY TO ADD VISUAL INTERACTIONS TO CONTACTLESS RESTAURANT MENUS IN RESPONSE TO COVID-19

by

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USING WEB AUGMENTED REALITY TO ADD VISUAL INTERACTIONS TO CONTACTLESS RESTAURANT MENUS IN RESPONSE TO COVID-19

Master of Digital Media, 2020
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Abstract

Businesses that are slow to adapt to the digital world risk getting left behind. This research project explores how restaurants can adopt emerging technologies such as web-based augmented reality (WebAR) to improve the customer's ordering experience during the reopening phases of the economy from COVID-19 and beyond. Many restaurants that were permitted to reopen had to limit their menu offerings, adopted single-use paper menus, or asked customers to scan a QR code to view their digital menus. Standard menus are often engineered to influence customer purchases through clever content placement, visuals and other psychological tactics that increases a restaurant's profitability. This project demonstrates how WebAR can be used in three different ways to enhance contactless menus to reestablish trust and build purchase confidence for customers. The overall goal was to illustrate how WebAR can reduce the barriers for restaurants to create augmented brand experiences through integration with their existing digital presence and the ease of access to these experiences for their target customers without the need to download apps.

Keywords: augmented reality, WebAR, extended reality, contactless menu, touchless technology, restaurants, digital media, menu engineering, photogrammetry, COVID-19

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Preface

In the beginning, I approached my supervisor with the idea of utilizing projection mapping for my research project after being inspired by large-scale exhibitions and watching videos of Le Petit Chef, an immersive culinary experience with 3D visuals[1]. Our conversations led me to look at using mobile augmented reality to enhance restaurant experiences. First, I started with the idea to create augmented menus that had dynamic features such as promotional pricing based on a restaurant's stock quantity to mitigate food waste. Another idea was using WebAR, machine learning and computer vision technology such as optical character recognition (OCR) to dynamically filter out menu options based on personal food preferences and dietary restrictions. Idealistic at best. and technically too complex to be done for the current landscape of web-based applications on the mobile browser.

When COVID-19 forced the world into lockdowns, one of the hardest-hit industries was hospitality as travelling and sharing common spaces (such as restaurants) came to a halt. I decided to pivot my idea in response to the pandemic while trying to salvage my research and desire to introduce augmented reality in restaurant settings. As patios began to open up, I noticed the resurgence of QR codes to access online menus to minimize the use of disposable menus and pre-COVID menus. At this point in my research, I was already looking into how WebAR can provide value for customers while increasing sales and repeat customers for restaurants. The usage of QR codes made it easy for customers to engage with WebAR content since both processes use the camera to scan an image target. The pandemic has disrupted our lives, but the silver lining was that it expanded the world's innovative capacity. This project would not have been possible if this pivotal creative energy had not fuelled me. For that, I give thanks.

[1] For more details, please refer to https://lepetitchef.com/

1. Introduction

The COVID-19 pandemic has undoubtedly affected everyone around the world, with some of the most severe impacts affecting the hospitality and tourism industry, specifically restaurants and their workers as seen in Figure 1 (Gössling et al., 2020; Lund et al., 2020). By late March 2020, restaurant sit-ins had declined to over 90% in North America and remained at near 100% for the next two months (OpenTable, 2020). While some restaurants quickly adopted other modes of services such as delivery, curbside pickup, or takeout options, small independent restaurants such as cafes would not find those options feasible which resulted in permanent closures (Dube et al., 2020). At the time of writing, certain regions of North America were able to reopen their patios and some areas also allowed customers to dine inside whilst still following strict social distancing protocols. It is imperative that restaurants make customers feel safe when they are dining out again in order to help the industry recover and improve the global economy.

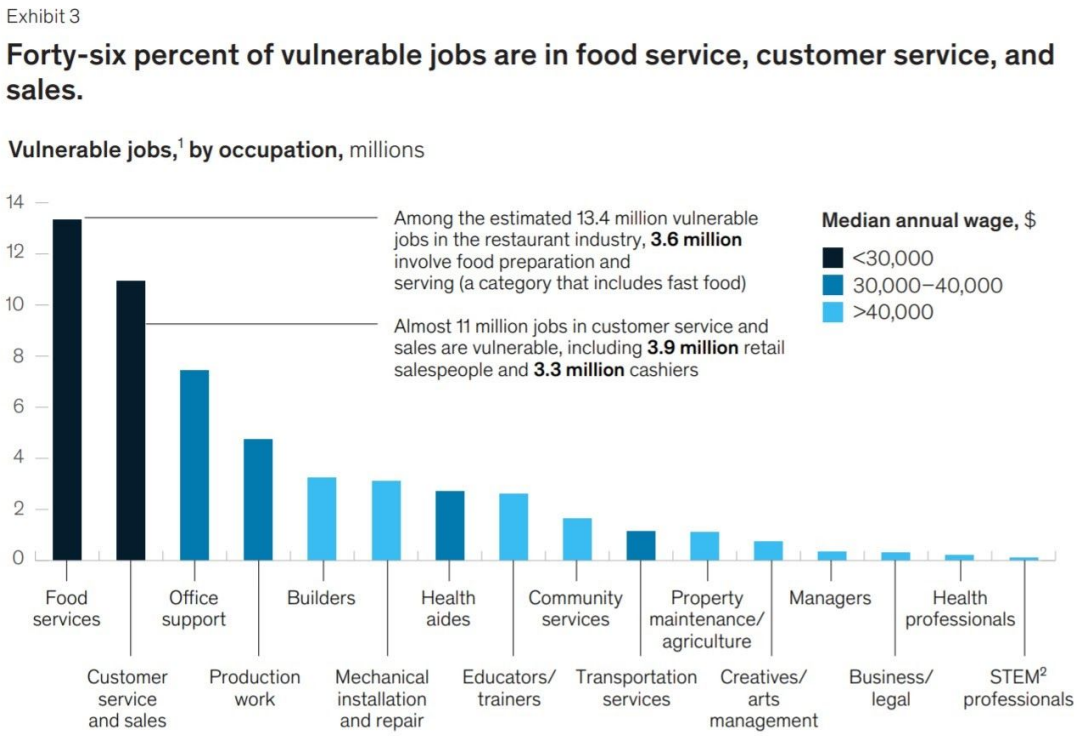


Figure 1. Vulnerable Jobs by Occupation. Source: LaborCube; McKinsey Global Institute (2020)

To facilitate the transition of making customers feel safe again when dining out, many restaurants updated their operational structure according to government regulations and food safety recommendations. The concept of "contactless menus" was introduced in the forms of scanning QR codes to access digital menus or single-use paper menus that are recycled after each group of customers. These contactless menus often lack visually appealing food imagery and strategies of menu design to influence favourable perceptions of products that would affect purchasing decisions. There are numerous studies that discussed how augmented reality (AR) is used in retail to affect the customer's purchasing decisions, brand and product perceptions, but very few studies have explored how AR can be used to influence restaurant customers. This project will question whether AR combined with menu design can be used to influence restaurant customers in their purchasing decisions and whether observations from technological adoptions can predict user behaviour and trends in the industry for the next few years.

This paper begins with reviewing existing literature and identifying gaps in the field that can be filled through the development of this research project. To understand how dining in restaurants have changed since the pandemic, field research was conducted to strengthen the significance of this project. The subsequent section will introduce the layout and overarching methodologies used throughout the entire project before diving into the detailed processes of three different WebAR experiences. The first example explored how to use a coaster to augment a drink menu, second example enhanced a bakery menu with realistic 3D models, and lastly, how to use AR with marketing collaterals to create a narrative experience to earn brand incentives. The paper will conclude by discussing the overall results and future research opportunities based on industry trends in relation to the dining experience, extended reality and related technologies.

2. Literature Review

2.1 Augmented Reality and Related Technologies

Augmented Reality (AR) is broadly defined as any technology that blends digital information with the real world in a meaningful way (Klopfer, 2008). Often associated with AR, Virtual Reality (VR) is defined as the full immersion in the digital world commonly used with VR headsets. Advanced technology had created the need to expand the definitions to include Mixed Reality (which includes elements of both AR/VR) under the umbrella term of Extended Reality (Figure 2). According to eMarketer, they anticipated that in the US, 42.9 million people will use VR and 68.7 million will use AR at least once per month in 2019 (Petrock, 2019). This represented 13.0% and 20.8% of the population, respectively. Worldwide spending for AR/VR was expected to reach 18.8 billion in 2020 (IDC, 2019). Consumer usage of AR/VR was already growing at a rapid pace and has accelerated due to COVID-19 increasing usage in areas such as virtual retail, government training and group collaborations (Walk-Morris, 2020; Castro, 2020).

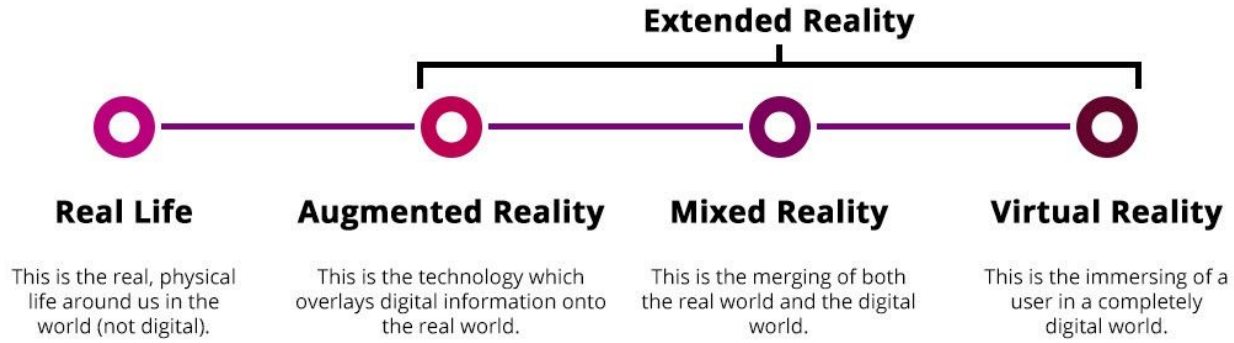


Figure 2. Spectrum of Extended Reality. From The Ultimate Extended Reality (XR) Glossary by TVRLP (n.d.)

In early 2020, the beta version of Chrome 81 was released which was significant because it enabled support for AR through the WebXR Device API on the most popular browser on the

internet (Chromium Blog, 2020). While this technology is relatively new, it is gaining momentum and the barrier to create and use AR will significantly decrease while the business adoption rate will significantly increase (Thykier, 2020). WebAR has many potentials since it is highly accessible, lightweight through deploying to the web and works cross-platform (Qiao et al., 2019). With the emergence of 5G technology, Qiao and colleagues also noted that it will enhance the efficiency of mobile computing with the web-based approach of AR.

The development of extended reality (XR) applications is heavily used in selective industries such as gaming entertainment, education, manufacturing, and retail (Morvan et al., 2019). The hospitality industry has not been quick to adopt, but it is starting to catch up with more hotels and restaurants seeking to use immersive technologies to enhance the customer experience (Revfine, 2019; Richards, 2018). Even within existing use cases in the industry, the applications developed for AR/VR tend to lean towards educational, marketing or employee training but not towards creating an immersive experience for customers (Clark et al., 2018; Yung & Khoo-Lattimore, 2017).

2.2 Technological Usage in Restaurants

When going to an unfamiliar restaurant with minimal visual representations on the menu, one of the primary concerns is ordering something that differs from initial expectations. Many companies have attempted to enhance the restaurant menus by creating 3D models of food items or augmenting individual ingredients in a salad bowl or recommend food pairings (Grigonis, 2018; Upcoming Media Inc., 2019). In 2019, Google Lens updated its image recognition technology with a dining feature that allowed users to scan restaurant menus and augment highlights of popular dishes, see reviews and relevant photos directly from Google's search

results (Chennapragada, 2019). In recent years, Japanese buffet restaurants have popularized the usage of the iPad ordering system and TGI Fridays have also used the iPad as a virtual bartender where customers can get a personalized drink based on virtual quiz results (Richards, 2018). To take that one step further, a sushi restaurant in Toronto has robot servers that will greet guests and deliver food to their table after placing the order on an iPad (Sagan, 2019). Many of these examples are seen as entertainment that has low perceived usefulness, which does not help to increase purchasing decisions or user satisfaction with food choices. Despite the emergence of technologies in the restaurant marketplace, they are for the most part seen as a novelty as opposed to a key operational medium to consistently increase restaurant revenue.

2.3 Augmented Reality for Branded Experiences

When brands create a memorable experience for their customers, they will likely attribute positive feelings to the brand and may want to share this experience with their friends. Kumar et al. (2014) performed four studies that demonstrated how people gained more happiness from waiting for an experience than waiting for material goods. People are often impatient when waiting for an item but excited when waiting for an experience. Also, companies that lead in brand experiences have 25% higher customer loyalty (Jack Morton, 2018). In restaurant settings, the augmented experiences would act as a priming activity that precedes the anticipation of receiving the food order and the wait time is significantly shorter waiting for food than waiting to receive a package in the mail.

AR apps that are highly interactive and also highly vivid (clear, detailed representations) positively influenced brand engagement and also increased the user's perception of the app's ease of use and usefulness (Mclean & Wilson, 2019). According to a consumer report by

Interactions Consumer Experience Marketing, Inc. (2016), 71% of shoppers would shop more at a retailer if there's AR and 61% prefer to shop at stores that offer AR over retailers who do not offer AR. In addition to that, 41% of consumers like to use AR to find deals and promotions and 72% have made unplanned purchases due to the influences of AR.

2.4 Consumer Expectations and Satisfaction with Augmented Reality

The use of augmented reality can positively influence the overall user experience such as increasing user satisfaction with the product choice and the user's willingness to make a purchase (Poushneh & Vasquez-Parraga, 2017b). By visualizing the products in AR, it can enhance the user's perception of reality in addition to providing high-level details of product information and endless interactions. Huang and Hsu-Liu (2014) noted that visual quality and interactions of 3D assets are important aspects of AR interactive technology, but retailers should also integrate a narrative aspect to shape a persuasive experience to affect consumer behaviour.

When there is a high discrepancy between the user's expected experience with the actual experience using AR, the lower the level of satisfaction. In a comparison study of different applications with varying levels of AR capabilities, the top attributes that generated the highest level of satisfaction were the rich quality of augmentation, an elevated level of informativeness and interactivity in addition to other attributes shown in Figure 3 (Poushneh & Vasquez-Parraga, 2017a). In a study conducted by McLean and Wilson (2019), a new set of AR attributes (e.g. novelty, interactivity, vivideness) was introduced to see how it can affect technology acceptance attributes (e.g. ease of use, usefulness, enjoyment) which in turn can positively affect user satisfaction with the app and repeated usage of the app in the future.

Summary Of AR Expected Consumer AR Attributes In Entertainment And Shopping Contetxs

Expected consumer AR attributes	**Description**
Quality of augmentation: Realistic view of virtual objects	Feeling of receiving realistic view of the augmented objects (size and dimensions) so that the virtual objects are inserted into the place where they belong.
High level of informativeness	Receiving sufficient amount of information regarding the virtual objects.
High level of interactivity	Being able to interact with virtual objects provided by AR (e.g., zoom in and out, change the content of augmentation).
Utilities: Search features	Being able to search for information about the objects within AR application
Ease of learning	Requirement of the AR application to educate consumers on using the AR application
Narrative	Receiving audio instruction (narrator) on using the AR application.
Quick response	Receiving output (virtual objects) in a quickly manner.
Need for touch	Being able to virtually touch the virtual objects.
Control	Feeling of having control over the virtual objects
Connectivity	Felling of being connected with other consumers
Fun and pleasure	Feeling of having fun and being entertained while using AR
Telepresence	Feeling of being immersed in the environment

Figure 3. Expected Consumer AR Attributes. (Poushneh & Vasquez-Parraga, 2017a)

2.5 Influences of 3D Models in Retail Purchase Decisions

Displaying and interacting with 3D models in real-time environments is one of the most popular ways to experience augmented reality. IKEA Place, an AR application is a successful example of a practical way of using this technology, visualizing realistic furniture in real-time with up to 98% accuracy (IKEA, 2017). At the height of COVID-19 in March 2020, Shopify, an e-commerce platform, announced its built-in system for uploading 3D models and videos to product pages. The "Shopify AR" feature was already available since 2018 powered by third-party apps, where the utilization of 3D models in AR had shown to increase conversion rates by up to 250% on Shopify's product pages (Wade, 2020).

A case study for the brand Rebecca Minkoff indicated that since implementing 3D models and AR functionality on its product pages in Fall 2019, shoppers were 44% more likely to add an item to their cart and 27% more likely to place an order after interacting with the 3D model (Shopify Plus, 2020). Furthermore, when visitors viewed the 3D model in AR, they became 65% more likely to make a purchase. According to Uri Minkoff, the CEO of Rebecca Minkoff, 3D media makes for a much more interactive shopping experience allowing the customers to view the products from various angles and creates a sense of intimacy with the products. This behaviour encouraged a deeper connection with the products which also resulted in a deeper commitment by shoppers to complete the transaction. This resonated with the study done by Brengman et al. (2018), where there was an increase of perceived ownership when users were able to virtually touch and interact with products versus non-touch screens such as laptops. When there were feelings of perceived ownership, the users also have a positive attitude towards the product and reaffirm purchase intentions.

2.6 Menu Engineering

Effective menu design can influence a customer's behaviour and their perception of value which could help restaurants generate more revenue. Menu engineering (also known as menu psychology) is the study of profitability and popularity of menu items and how their placements can influence sales and increase profit (Rapp, 2013). Wansink and Love (2014) did a study on how restaurants can engineer their menus so that it can focus on healthy yet profitable options to help reduce the rising obesity rate while helping customers choose healthier options by improving the perception of taste and value of their menu. Feldman et al. (2014) wanted to see if menu design can encourage university students to make healthier choices and found that nutrition labelling did not make a difference but a bounding box around the healthier choices was 2.75 times more likely to be chosen compared to the control group.

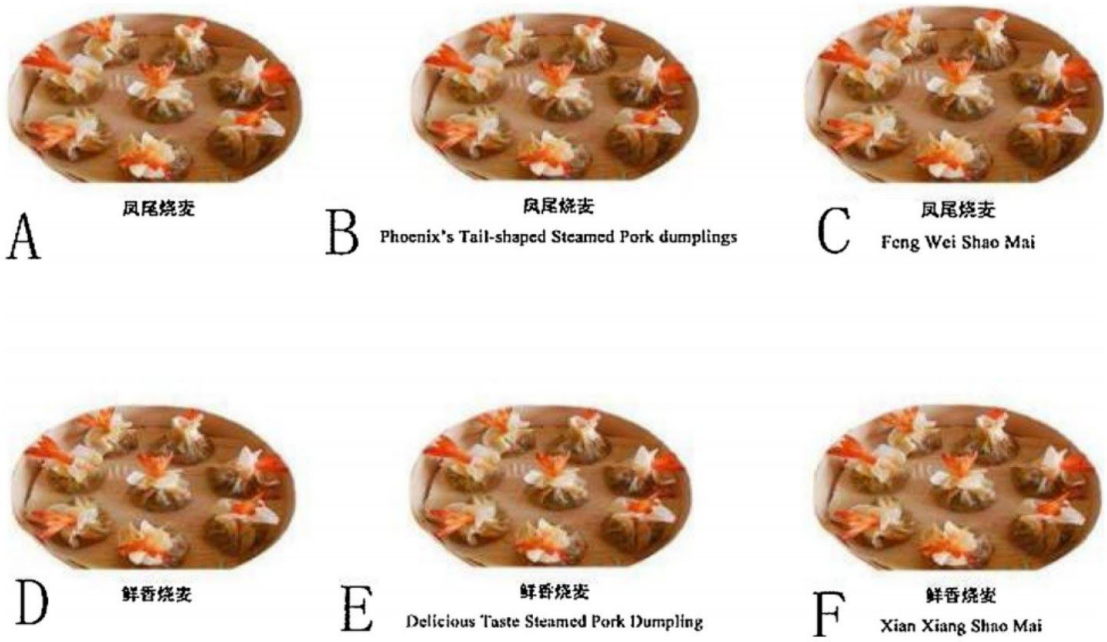
Healthy restaurants have become more popular in recent years in addition to food chains adding healthier menu options. To gain a competitive edge, a handwritten typeface can convey a human touch which positively influences the consumer's perception towards the menu, perceived healthiness of the brand and higher social engagement (Liu et al., 2019). The text associated with the name, descriptions, and price of food can also affect the customer's decision-making process. While the price presentation did not appear to affect consumer spending in fine-dining restaurants, when monetary cues such as the word "dollars" or "$" sign were used, spending total significantly decreased (Yang et al., 2009). Wansink et al. (2005) studied how descriptive food names can encourage selection and increase perceived taste while Mathe-Soulek (2016) explored how product descriptions in menus can affect the consumer's perception depending on the types of words used. Mathe-Soulek discovered that adjectives could affect expectations of quality and

taste while nouns only resonate with quality. Furthermore, a higher value is perceived when complex descriptions are used. Healthier options are often described as less exciting than standard menu items, which made it less appealing for consumers to order it (Turnwald et al., 2017). If restaurants truly want to promote healthy eating, their menu needs to incorporate more appealing themes and descriptive words to boost the attraction of nutritious food.

It is important to note that text should be used sparingly to highlight featured items or high margin items as text-heavy menus may not be helpful with decision making for food. Townsend & Kahn (2013) reviewed the "visual preference heuristic" that showed people preferred images over text when shopping online because images are processed quicker in our brains and it is more memorable. However, if images are overused and users are presented with too many options, it would still be overwhelming and cause consumers to be dissatisfied and delay decision making. There is no singular solution to satisfy the needs of all customers; different types of restaurants will affect how the menu is designed to serve their target clientele.

Xu & Huang (2019) studied how certain information cues can influence the diner's expectations which is dependent on the diner's need for cognition (NFC). The results showed that including more information increases the expectations for high-NFC individuals, whereas images of the environment increase low-NFC individuals' expectations. Marketing approaches can be set up differently for both types of individuals or include the cues that can elevate expectations and interest for both groups. For example, fast food restaurants can incorporate more images to trigger impulsive buying behaviours, whereas fine-dining restaurants can use more text in their menu to influence the perceived value and quality of food.

A recent study by Chen et al. (2020) used eye-tracking to determine the appeal of Chinese menus that had variations of Chinese and English translations accompanied by the same image. The eyes were always initially drawn to the visual element since it positively influences the consumer's expectations. The metaphorical names for both Chinese and English text were the most appealing menu design as seen in Figure 4's Option B. By using creative terminologies such as "Phoenix's Tail" in association with the food, this abstract concept appears to help with the decision making process. While a properly designed menu should always aim to guide users to items that have a high profit and low cost, it is important to remember marketing tools cannot completely control consumer decisions, but it can be directed by smart implementations (Chen et al., 2020).



Picture 1. Post-test for memory and desire.

Figure 4. Chinese Menu with Metaphorical vs Metonymic Names. (Chen et al., 2020)

2.7 Multi-Sensory Experiences with Food

Batat et al. (2019) introduced the concept of experiential pleasures of food (EPF) where cognitive and emotional benefits can be derived from food through multisensory, communal and cultural food experiences. Healthy living often seems like a sacrifice of decadent food in which food pleasure seems like a negative choice; alternatively, greater awareness of what we put in our body and being confident in our choices can yield positive results on our well-being. Having a colourful plate can also increase the intake of healthier food options, such as choosing more vegetables and fewer sugary food (König & Renner, 2018). Businesses can make use of this concept of food well-being to encourage food sensory, sociocultural appreciation and food sharing, and also the creation of food storytelling (Batat et al., 2019).

The visual imagery of food is very compelling, especially when simply imagining it can already set off intense cravings. In a study of food cravings' phenomenology, the intensity of cravings is related to the vividness of food imagery and other visual sensory modalities followed by taste and smell (Tiggemann & Kemps, 2005). The perception of food palatability can be influenced by the phenomenology of social-psychological effects such as conversations at the table where the majority opinion can change taste perception or eating with other people increased the palatability of food compared to eating alone (Sakai, 2014). The perception of taste and overall dining experiences can be augmented through multi-sensory technology designs, including visual, auditory, and haptic elements (Velasco et al., 2018). The authors noted that this emerging field of human-food interaction design can help encourage healthier eating behaviours, facilitate food choices before purchasing and make dining more entertaining.

2.8 Food and Social Media

Even though there are numerous food ordering apps, it does not replace the fact that younger generations also prefer to dine out and digitally document their lifestyles with social gatherings, aesthetically pleasing environments and Instagram-worthy food (Zimnowski, 2018; Richards, 2018; Lintao, 2017). Food marketers are also aware of this fact and would use images with high levels of visual complexity and endorsement by celebrities to generate more pleasure and arousal and impact consumer purchase intentions (Kusumasondjaja & Tjiptono, 2019). Popular food brands are also using social media to frequently deliver curated content to influence consumer emotions, generate engagement to create a memorable experience and foster a connection with the brand (Vassallo et al., 2018; Zimmerman & Brown-Schmidt, 2020).

User-generated content (UGC) can also be very influential to affect consumers' behaviours and their willingness to try new experiences. When searching for restaurants online, 80% of participants reported that it was important to see UGC of food and restaurant space as a sign of social proof (Oliveira & Casais, 2019). Furthermore, 70% of the participants reported that they preferred seeing images on independent platforms compared to restaurant managed platforms as it suggests there is a higher likelihood of authenticity, which promotes trust. According to a Market Force report, 81% of respondents admitted that social posts from friends and family directly influenced their purchase decisions (Olenski, 2012). Though UGC from strangers also have some influence on buying decisions for 84% of millennials (Pemberton, 2016). Many people are on high alert when it comes to disclosed sponsored posts or brand posts. However, covert advertisements such as user-generated brand content are still influential in increasing the viewer's purchase intentions (Mayrhofer et al., 2019).

2.9 Literature Gaps and Research Opportunities

At the time of this research, technological adoptions such as AR were dominated by certain fields, but there were untapped opportunities within the hospitality industry. As evident by COVID-19, restaurants (as well as other businesses) were able to adapt very quickly to the changing climate in order to stay afloat. How companies respond to this pandemic will demonstrate their resiliency and through crisis sparks innovation (Fretty, 2020). Technology was essential in the transition phase, whether it be telecommunications apps seeing five times the downloads, or physical storefronts rapidly converting into digital stores through the Shopify platform (Rana & McLymore, 2020; Syed et al., 2020).

At the beginning of the recovery efforts, restaurants increased their usage of third party delivery apps (e.g. Uber Eats, SkipTheDishes, Doordash) or provided takeout options such as curbside pickup. In Figure 5, research showed that customers were also more akin to ordering food and groceries online through their smartphones, with 53% of younger adults in the U.S having ordered from their local restaurant during the peak of COVID-19 (Vogels, 2020). While the initial solution was great for restaurants, they quickly became disgruntled because ordering apps can charge upwards of 30% in commission resulting in some restaurants breaking even or operating at a loss (Owen, 2020). This prompted restaurants to create their own online ordering system or other web-based solutions and created unique collaborations with a network of local restaurants (Foran, 2020). The purpose of introducing WebAR solutions is so that restaurants do not need to rely on third-party companies and can simply upgrade their existing digital menus, similar to making any other update on their websites.

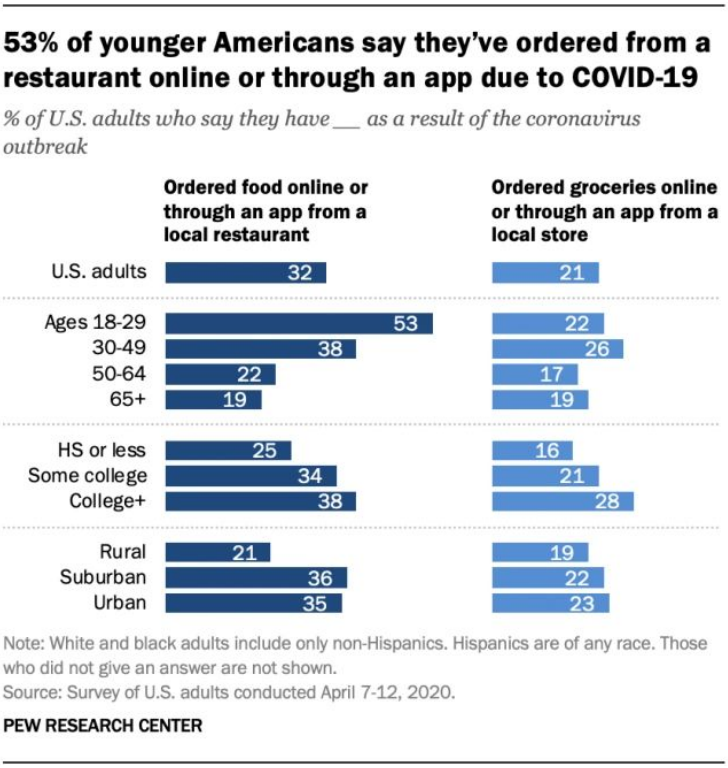


Figure 5. Online Food and Grocery Ordering Statistics. (Pew Research Center, 2020)

While there are numerous literatures for the retail industry and how AR affects the user's perception and purchasing decisions for products, there are very few studies done for restaurants. Restaurants are also a part of the food retail industry, and the trends found in traditional retail could also apply to restaurants when using AR to influence purchasing decisions. There is an abundance of research discussing how effective menu design can influence consumer behaviour and their perceptions of value, quality and willingness to spend. By combining the studies of menu design along with the studies of how retail businesses use AR to influence consumers and their purchasing habits, it created a sweet spot for this research project to fill in the gaps. The paper's findings can benefit restaurant marketers, large food corporations and anyone interested in designing and developing WebAR experiences. It is also a great opportunity for restaurants to redesign their menu, test out new products, and other service modes to reach new customers.

3. Field Research

Due to the ever-changing circumstances of COVID-19, it was difficult to predict when the world's situation would become "normal" again and even harder to predict how local authorities would react to the pandemic's aftermath. The original plan was to conduct field research in restaurants and collaborate with local food establishments interested in experimenting with emerging technology to attract new and recurring customers. While the pandemic limited the opportunities to do field research in the spring, the substitute solution was to use previous life experiences dining in restaurants accompanied by a comprehensive literature review to form the backbone of this project.

At the beginning of summer, the Ontario government's reopening phases began to progress to Stage 2 which meant outdoor seatings such as patios were allowed to open again. Suddenly there was a resurgence of QR codes being used to access digital menus. I visited several restaurants in the cities of Toronto and Ottawa and noted my observations in Appendix A. Ottawa, Canada's capital city, advanced to Stage 3 earlier than Toronto, so I observed how restaurants also adapted to in-restaurant dining protocols during COVID-19. There were some noticeable trends that emerged from the observation field notes. Restaurants will either adopt QR codes to digital menus (Figure 6) or single-use paper menus (Figure 7), but rarely both simultaneously except for bigger establishments. Interestingly, in places that offerred both options, the single-use menus and even the pre-COVID menus were automatically given out to customers without inquiring if they would prefer the digital version. For restaurants that cater to a younger clientele, they are usually equipped with QR codes because their target customers are typically more comfortable with this technology made famous by Snapchat's QR codes.

Figure 6. Restaurants with QR Code Menus. Top Left: THREE10 - Rec Room (Toronto). Bottom Left: Alchemy Food and Drinks (Toronto). Right: Copper Spirits and Sights (Ottawa). Photos were taken by Eileen Xue.

Figure 7. Restaurants with Single Use Paper Menus. Left: Milestones (Toronto). Top Right: Jack Astor's (Toronto). Bottom Right: Sunset Grill (Toronto). Photos were taken by Eileen Xue.

4. Project Overview

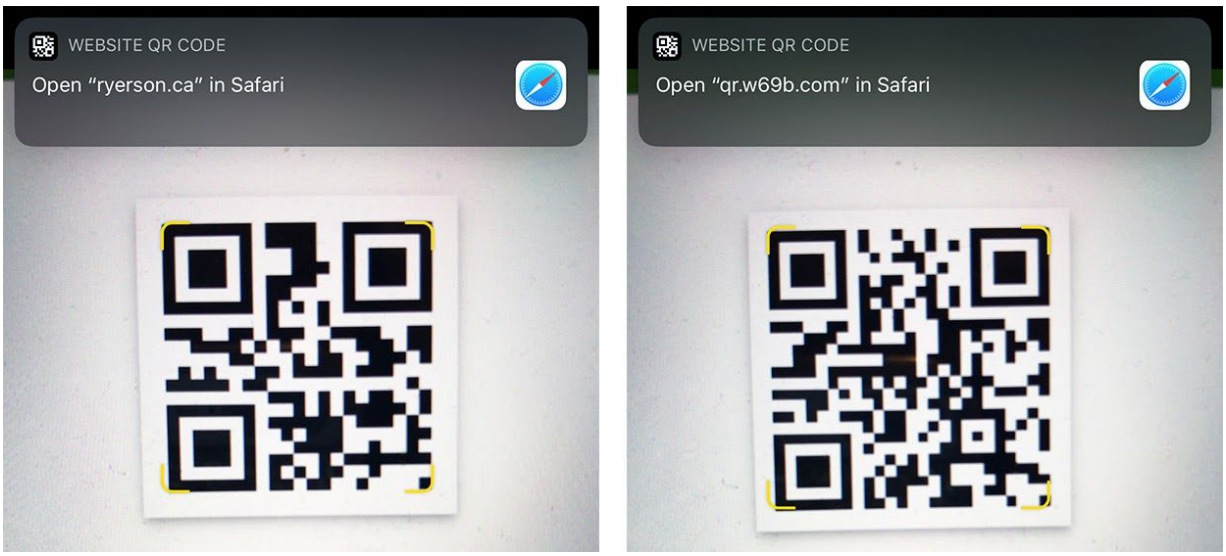
This project is made up of three thematically different experiences, but there were some general processes that were used throughout. The following section will outline the overarching software and tools used to create this project before discussing the process of each experience.

4.1 Presentation Format

Since this is primarily a web-based project, a centralized project page was created that housed all the required project files and digital versions of the physical assets. The best way to enjoy the experiences is by having a physical print out of the QR codes in the orientation that it was created for. For people unable to test out the experiences themselves, there are video demonstrations for each example. The main project page layout can be seen in Appendix B.

4.2 QR Codes

While it is not necessary to use QR codes to access any online menus or WebAR experiences as long as there is an URL link, it was implemented out of convenience for the end-users. It is a lot easier to ask customers to scan the code instead of asking them to type out a URL. Restaurants usually choose to use static or dynamic QR codes. The link for a static QR code cannot be changed once it has been generated, while a dynamic QR code can be modified afterwards through a redirection of the original link. For this project, static QR codes were implemented because the preview link would be the top-level domain of the URL linked to the QR code. It provided more trust and security than a random link generated by a third party company or a short URL generator (See Figure 8). If one has access to the management of the business' domains, URL redirection can be facilitated instead of relying on third parties.



Static QR Code **Dynamic QR Code**

Figure 8. Which QR Code Appears More Trustworthy? Same link, different URLs. Created with the QR Code Generator (https://www.the-qrcode-generator.com)

4.3 Design Methods

Several applications from Adobe Creative Cloud were used for the design process and for editing the demo videos. Adobe Photoshop was used for product mockups, photo adjustments, and for creating assets needed for superimposed effects. Adobe Illustrator was used for editing vector graphics and high fidelity layouts in earlier research examples, while Adobe XD was used for rapid prototyping with interactions. Adobe Premiere was used for simple video editing, while Adobe After Effects animated the superimposed effects. Adobe Media Encoder was used for video rendering and optimization. The digital assets were mostly from stock free sources such as Pixabay, Unsplash, and Freepik where I have a premium license which allowed me to use numerous assets without the need for attribution.

4.4 Development Methods

For quick deployment, the project and subsequent assets are hosted on GitHub and published through GitHub Pages under my personal domain eileenxue.com. One major reason this method was used was because GitHub Pages offered an option to enforce HTTPS (Hypertext Transfer Protocol Secure), which encrypts the connection and is mandatory for some of the WebAR functionalities to work. The project pages were all created with HTML/CSS/Javascript with the assistance of Bootstrap 4, a front-end design framework to create responsive websites.

There were two development tools that were used to display the WebAR experiences, AR.js with A-Frame and Google's model-viewer component. AR.js is a lightweight development library that makes it easy to get started with web-based augmented reality while supporting image tracking, location-based and marker-based tracking (AR.js, 2020). A-Frame, an open-source web framework commonly used for creating virtual reality experiences on the web,, will act as the base of the build to extend the features of AR.js. Google's model-viewer is a web component that allows 3D models to be rendered in the browser, and it can also work with the native AR Viewer on both iOS and Android devices (Google, 2018; Medley, 2019).

4.5 3D Models

All experiences in this project required 3D models which were freely sourced from Sketchfab and the built-in 3D Library from Windows 10. There are several considerations when incorporating 3D models onto a web-based project such as the size and format of the file, the fidelity of the models and how realistic the final result will be. Since this project was primarily about the mobile browser experience, it was important to reduce the file size and network requests when accessing the 3D files to improve overall performance and the page's load speed.

For people unfamiliar with 3D modelling and related tools, Sketchfab is a great website to find downloadable 3D models as long as the original creator allows for it to be repurposed and proper attributions are given. In addition to the original 3D file format uploaded to Sketchfab, one can also download the auto-converted glTF and USDZ file formats. It is important to note that auto-converted formats are not always usable, where textures may not show up or other settings that are simply not compatible with conversions to the newer 3D file formats.

When using 3D models in conjunction with the model-viewer component, the acceptable formats have to be glTF or GLB and the iOS format, USDZ. glTF (GL Transmission Format) is being touted as the "JPEG of 3D" a term made popular by Pierre-Antoine LaFayette (Android VR Engineer at Facebook) because the format minimizes 3D assets and has become a new standardized format for 3D publishing compatible across various platforms (droidcon SF, 2018; Khronos Group, 2013). The GLB format is simply the binary glTF where all the external files such as images referenced for the 3D model's textures are consolidated into one file. The benefit of GLB is that it is easier to transfer without losing relevant source files, but it becomes harder to modify unless the GLB file is unpacked (Khronos Group, 2013).

5. Experience One: From Coaster to Augmented Drink Menu

5.1 Overview

In this experience, a custom coaster was created for a fictional restaurant called Portal+ that also acts as the access point to the contactless menu, and interactive web augmented experience. The purpose of this experience was to display how seamless the transition can be from the physical world into the digital world while making the ordering process more engaging and memorable. The principles of menu psychology and the influential perceptions of using augmented reality and 3D models will be integrated and evaluated.

5.2 Background Research and Inspiration

I went on a solo trip to Washington, D.C. during my reading week in October 2019, and visited numerous Smithsonian museums, interactive exhibits and art galleries. One place, in particular, was called the ARTECHOUSE, an art space that merges art and technology together, which also formed the basis of their name (Art + Tech + House). The travelling exhibition at the time was called “Lucid Motion” by Rhizomatiks Research, and their ideas was to combine dance movements with dynamic wall projections where visitors can be the observers, the creators, and then use in-house iPads to look at augmented models dancing around inanimate objects (Figure 9). At the end of the exhibit, visitors could also download ARTECHOUSE’s mobile app to scan their bar coaster to get a randomized drink recommendation (Figure 10). While the experience was definitely novel for most visitors, some common criticisms regarding the AR experiences was that the iPad was heavy to hold after some time or the need to download their app for a one-time use AR experience. These concerns were noted and became some of the driving factors in how this project’s experiences were designed to overcome these challenges.

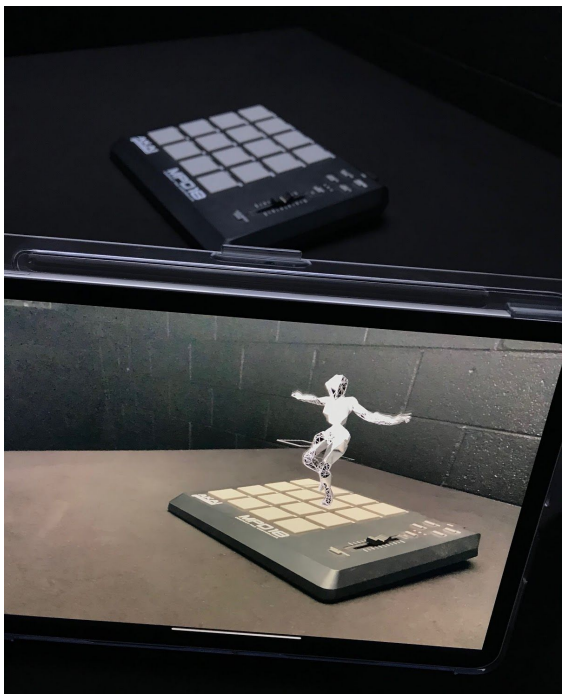


Figure 9. AR Dancer from "Lucid Motion" Exhibit. By Rhizomatiks Research seen at ARTECHOUSE, D.C in 2019.

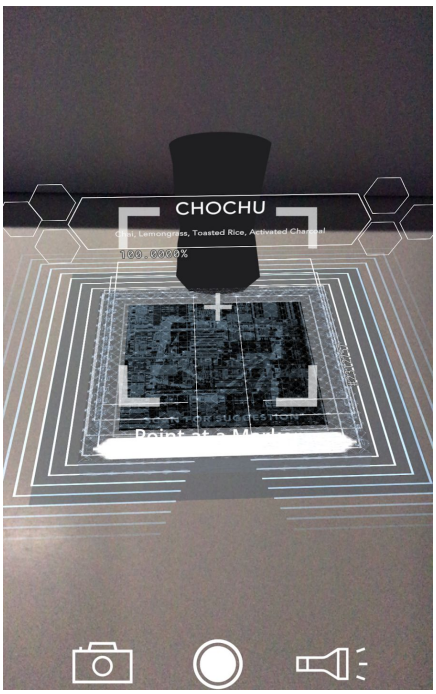


Figure 10. AR Drink with 2D Animation. From ARTECHOUSE, D.C in 2019.

As restaurants began to reopen for in-person dining, the initial phase started with only outdoor seatings such as patios because transmission risks are mitigated in outdoor spaces compared to indoor settings as recommended by the Public Health Agency of Canada (2020). Outdoor dining usually happens when the weather is warm, and this increases the likelihood that people would want to socialize and stay hydrated with a variety of drinks. Paper-based coasters are typically used for resting drinks on top of it to protect the table's surface and catch condensation from cold beverages. Coasters can also prevent the drinks from sliding off the edge due to condensation creating a slippery surface on certain table materials. In places that serve alcohol, it is common to see alcohol companies' advertisements on coasters, but some restaurants have self-branded coasters. Cardboard coasters are typically used once, so to extend the perceived usefulness of this object, it can also be used as a QR code menu.

5.3 Design and Development Process

For the first proof of concept, a low fidelity wireframe was created with Adobe XD to demonstrate the screen interactions and subsequently, a high fidelity prototype was created to illustrate the concept better (See Appendix C). Initially, the drink menu theme resembled an old fashioned bar with rustic colours and decorative fonts. However, a pivotal creative decision was made to convert the restaurant theme to a futuristic vibe inspired by neon lights and vaporwave aesthetics. When thinking about early adopters for restaurants who would implement emerging technologies and their clientele who are the end-users of the experience, I wanted to follow modern design trends to appeal to the younger generations who are more comfortable with technology.

For a seamless brand experience, the transition from the coaster to the web menu and finally to the interactive WebAR feature needed to look cohesive. The web menu was the first element that was completed and set the precedent for the other two parts. Using guiding principles for persuasive menu design, the cocktails section included descriptive names and information. The remaining drink menu adhered to the brand names of what is readily available on the market. The neon subheadings with blinking effects and the glowing call to action button were inspired by code on Codepen and not created as a gif animation. This allowed the content to be optimized for search engines and for web accessibility purposes.

As the entire coaster was to be used as an image target in addition to the QR code, it had to be designed to fulfill the criteria of being a suitable tracking object to trigger the augmented experience (see Figure 11). Generally speaking, images with various contrasting elements or high-resolution images such as photographs will have better tracking stabilization. With AR.js,

NFT (Natural Feature Tracking) technology is used to determine whether the image target has enough distinguishable points to be recognized for tracking. The image information is then stored as "image descriptors" files generated through the NFT Marker Creator (AR.js, 2020).

Figure 11. Portal+ Coaster Design. Created with Adobe Photoshop using assets from Freepik.

The last component of this experience was to investigate how to display multiple 3D objects on the scene and essentially create an interactive gallery of augmented drinks. During my code experiments, I spoke with a consultant from the Ryerson Library's Collaboratory, who helped me figure out a usable method of displaying and hiding the 3D models when they are not active on the scene. The final touches were adding instructional information (Figure 12), customizing the loading screen, and the user interface when the user initializes the experience (Figure 13). It is important to add instructional information and guiding prompts on top of the camera overlay that is also visible against the moving background. Once the coaster image target is detected, the instructions would disappear, and the 3D drinks would appear (Figure 14). If the tracking is lost, then the instructions would reappear again.

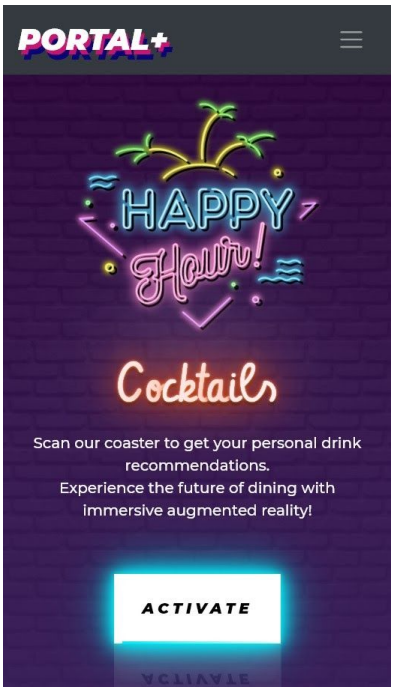


Figure 12. Portal+ Digital Drink Menu. Includes instructions for the WebAR experience..

Figure 13. Instructional UI for WebAR Drink Menu. It will appear if the image tracker is not present.

Figure 14. Augmented Blue Cocktail on Portal+ Coaster.

5.4 Results and Evaluation

The final result, assets and video demonstration can be referenced in Appendix D. The effectiveness of this experience was evaluated based on what is known in the literature and how the gaps were filled. For the drink menu, the cocktail section had affordance for a creative twist by renaming classic drinks such as Long Island Iced Tea to “Ice Ice Baby” or Caesar drink to “Julius Caesar” and adding descriptive information with adjectives which encourages selection and increase perceived tastes and quality (Chen et al., 2020; Wansink et al., 2005; Mathe-Soulek, 2016). The price display did not include any dollar indication, shortened without decimal values, and no leading dots from item name, to price which helps with higher perceived quality and increases average order value (Yang et al., 2019).

Ideally, the information from the digital menu would also be mirrored through the augmented experience, but due to limitations mentioned in the next section, the 3D models were chosen based on their software compatibility and then used to evaluate the effectiveness of how it can affect consumer behaviour. Visualizing and interacting with food products in 3D would create a stronger bond with the item through perceived ownership and can be further enhanced by how realistic and informative the experience is to reaffirm purchasing decisions (Brengman et al., 2018; Poushneh & Vasquez-Parraga, 2017a). As a result, this AR experience created a memorable time for customers, leading to higher brand engagement and loyalty (Mclean & Wilson, 2019; Jack Morton, 2018).

5.5 Limitations and Future Improvements

Web-based augmented reality and related technologies are still in the early stages of development. So, features and functionalities easily accomplished through a mobile AR app are difficult to achieve through WebAR. For instance, the functionality to take pictures was not implemented in this prototype. Taking pictures and easily sharable through social media can increase purchasing desires in online communities while generating brand awareness. Another limitation was that the display of 3D drinks was very jittery compared to the traditional app-based AR experiences. This is because web-based AR does not have the smoothest tracking yet due to limited processing power on the mobile browser.

With paper products, there is also a risk that the condensation from the drinks will affect the printed surface of the coaster which can affect the scanning of the QR code, the recognition of the coaster image target or both. Some solutions to this problem would be to have double-sided printing of the coasters to prolong the usage. Or print the website links in a shorten

URL format so customers can have access to the menu manually even if the coaster quality is compromised for camera scanning or accessed on another medium such as a computer.

For 3D drinks with clear stemware, it did not show up well in this experience as it looked too transparent against any background. Dim lighting in a restaurant can affect whether the camera can recognize the tracker features though newer phones are better at low light adjustments. If the environment is outdoors, there will be enough natural lighting during the day and sufficient ambient light at night, so the image target detection may not be an issue. The one issue that may occur if it is too sunny outside would be a glare on the phone screen, making it difficult to see and be immersed in the experience. If restaurants were to implement AR in their business strategy, they need to be aware of additional ambient lighting that would be useful for better image tracking.

For future developments, more information such as the name, ingredients, and price can be added onto the screen to change dynamically depending on which 3D drink is active and mirror the example from the digital menu. Instead of just cocktails, additional menu items can be added or integrated with other branding materials. More complex ideas such as creating customized cocktails through AR and subsequently sending the order through to the restaurant's point of sale system can be explored. Another idea would be an augmented avatar that can serve as a virtual bartender and converse with the customers through chatbot capabilities or guided through on-screen prompts to personalize a customer's drink recommendations.

6. Experience Two: Enhanced Digital Menu with 3D Food Models

6.1 Overview

In this experience, 3D models of dessert were integrated into an online menu for a fictional bakery called Major Sweets. This was done to demonstrate how interactive and realistic 3D models are and subsequently visualizing the desserts through augmented reality can improve customer's perception and reaffirm their purchasing decisions. Through the native AR viewers, users can take pictures of their augmented food and the option to create user-generated content for social media that would generate awareness for the brand.

6.2 Background Research and Inspiration

When deciding on the theme for this experience, an evaluation was done to determine what categories of food would benefit from this augmented treatment and which customers would become early adopters. With smartphones serving as a portable camera, it is reported that 69% of millennials will take a picture or video before eating (Maru/Matchbox, 2017). By sharing these experiences online and offline to large communities, consumers gain an elevated sense of pleasure and satisfaction from food consumption (Mendini et al., 2019). The food pictures that are shared are often curated to selectively show aesthetic appeal, gourmet meals or self-made dishes as a visual representation of oneself to gain social validation (360i, 2011). The digital marketing agency, 360i also found that consumers are more inclined to take and share photos of desserts than any other category because desserts are often colourful unique creations that are associated with special moments in life. Refer to Appendix E for additional charts of food trends in relation to the motivations of food sharing and the types of food that are shared.

One part of the research process was reviewing local restaurants' websites and investigating how their online menus are designed with images. The goal was to find restaurants that already have a menu hierarchy with pictures inserted in between different food items. The reason for this was to use a real-world example to show how simple it can be to upgrade existing menus with 3D models of food by replacing existing static images. I came across Fuwa Fuwa, a store known for Japanese soufflé pancakes, and their digital menu had the criteria and the assets that I was looking for. Appendix F shows the high fidelity mockup that was created for Fuwa Fuwa's redesigned menu along with early development experiments with USDZ formats of 3D models that can be accessed directly on the web page with iOS's Safari browser.

6.3 Design and Development

To ensure that the 3D models were the focal point of the menu, the website's design maintained a simple yet stylized aesthetic. The branding for this bakery made use of baby pink and blue colours along with a handwritten font which made it fun and inviting. The dessert models were sourced from Sketchfab which then dictated the appropriate background images used behind the 3D models to complement the menu's entire flow. For the header image located at the top of the digital menu, an enticing background with mouthwatering desserts was used while incorporating a stylized gradient that added to the overall branding.

The development of this WebAR experience is different from the other two experiences since it did not use AR.js but relied on Google's model-viewer web component which integrates with the native AR viewers for iOS and Android devices. With model-viewer, there are customizable options for displaying the 3D models on the web browser such as adding a background image or adding auto-rotation, determining the starting angles, or including cover

images before the 3D object is fully loaded. Once the AR feature is triggered through the native AR viewers, features were limited to built-in functionalities such as plane detection, and simple model manipulation including scaling, rotating and moving to another surface (Figure 15 & 16).

Figure 15. Truffle Cake 3D Model through iOS Quick Look.

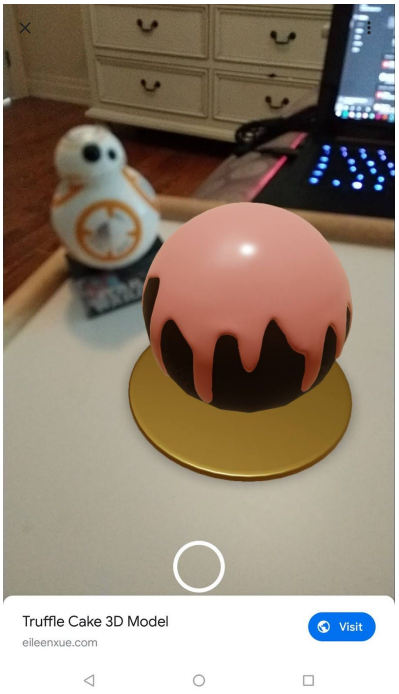


Figure 16. Truffle Cake 3D Model through Android's Scene Viewer. Taken by Michael Carter-Arlt.

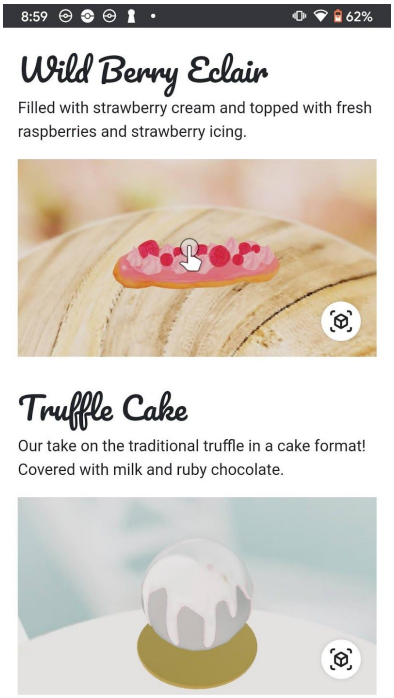


Figure 17. Missing textures on Truffle Cake 3D Model on Android's Chrome Browser.

Some of Sketchfab's auto-converted 3D files did not have realistic proportions after the files were downloaded. Therefore post-processing the 3D models were required to set the appropriate scale, optimize and reduce texture sizes. Since the 3D models are meant to be viewed on the phone which has a smaller screen size, reducing the file sizes would not be detrimental to model details. I am not familiar with 3D modelling tools such as Blender, so alternative web-based conversion tools were used to get the final 3D model renders with an appropriate scale to the environment. (See Appendix G).

6.4 Result and Evaluation

The final result of the WebAR bakery menu and video walkthrough can be referenced in Appendix H. Due to COVID-19 and time limitations of this project, no quantifiable data was collected to determine the effectiveness of this digital menu with 3D models vs. a regular digital menu. Despite this fact, by incorporating principles learned from existing literature and other research, the final result has a high likelihood of being effective. With contactless menus, especially for single-use paper menus, there is a lack of visual representation and menu design treatments that can be used to persuade customer choices. Not only did this experience use descriptive text and names to provide expectations of taste, but it included dessert 3D models that are interactable on the browser to foster a positive connection to the food product and reaffirms purchase intentions (Mathe-Soulek, 2016; Wansink et al., 2005; Brengman et al., 2018). The purchase intention is further amplified by the AR functionality to visualize the food product scaled to size to the local environment (Shopify Plus, 2020).

Through the AR viewer apps, there is a built-in functionality to take screenshots of the 3D objects in its environment and save them to the phone, which can then be shared online to social networks and other platforms. Especially useful for social influencers who may want to experiment with posing with the 3D models before going out to try the real thing with the ambient environment. User-generated content is very influential in affecting consumer behaviours where over 80% of people reported that posts from friends and family and even to some degree, posts from strangers could affect buying decisions and their willingness to try new things (Olenski, 2012; Pemberton, 2016). By sharing the experience with their communities, users would also derive a sense of pleasure and satisfaction towards the food and attribute

positive characteristics to the overall brand (Mendini et al., 2019). A positive brand awareness and social engagement can happen before customers have even stepped into a restaurant or ordered food.

As people become more comfortable with ordering food online, there will be more competition in the online space. To stand out from the crowd, a strong online presence is needed along with properly designed menus. Since this example was a bakery, a handwritten font was incorporated in the menu to convey a human touch to positively influence consumer's perception of the brand and increase social engagement (Liu et al., 2019). Also, by incorporating emerging technologies such as AR already makes a business 61% more preferable than their counterparts that do not have AR (Interactions Consumer Experience Marketing, Inc., 2016).

6.5 Limitations and Future Improvements

One of the challenges for this experience was getting the 3D models to accurately scale to the right proportions when it is augmented with the app viewers. Even after the scaling issue was resolved, there was an issue with some of the textures not showing on Android device's Chrome browser as seen in Figure 17, but displayed properly when the 3D model was viewed with Android's Scene Viewer as seen in Figure 16. Since this was a proof of concept, the texture issue was never resolved but this should be fixed in real-world applications to ensure the experience is usable and inclusive of all major platforms.

One limitation for restaurants wanting to adopt this enhanced menu would be obtaining and creating realistic 3D models of their food products. They can utilize photogrammetry tools which can provide high level detail of scanned food products, but the dense mesh would increase the overall file size that may not be suitable for web use. Alternatively, restaurant owners would

need to hire 3D modellers to recreate their products which can be costly and not suitable for smaller restaurants. For chains or restaurants with a higher budget, it may be worth the effort since there are other applications utilizing 3D models that can be used for additional branding and marketing efforts. For example, with SparkAR, brands can create Instagram or Facebook filters with the 3D food models for followers to engage with to build connections with the brand.

Another limitation was that including too many 3D models may delay the page load time due to overall download requests from the server or crash the page due to the limited processing power of mobile devices. The 3D model files are already large in size and more so for realistic texture files. With model-viewer, one model requires two times the bandwidth to include both glTF and USDZ formats which will be displayed accordingly to the user's mobile operating system. Further improvements should optimize how the files are loaded or make use of the user-agent to programmatically control what content is pulled from the server based on initial device detection.

To further extend the functionality of this type of menu, it can also be integrated into the restaurant's online ordering process. For restaurants that provide takeout or delivery services, this menu would benefit customers who are ordering from home to better visualize how the final food order would look like in their current environment. By envisioning the food in one's personal space, it can increase perceived ownership and attachment which increases the likelihood of making a purchase (Brengman et al., 2018).

7. Experience Three: Interactive Burger Promotion

7.1 Overview

A promotional ad was created for a fictional burger joint, Burger Lab, to attract new and returning customers into trying a new burger called the "Ultimate Canadian Burger" which is made with locally sourced ingredients. The attractive incentive of a free burger can only be obtained through the augmented experience. The purpose was to generate positive brand association through storytelling and provide useful information to influence perceived food quality which can help to justify premium pricing and association to brand prestige.

7.2 Background Research and Inspiration

Since the pandemic began, there has been a greater initiative to support local businesses because they are less likely to survive without consistent revenue. At the start of the pandemic, over half of Canadian businesses were already experiencing a loss and with a quarter of businesses reporting that they are unable to survive a month without half their income (CFIB, 2020). During this period, there was also a salmonella breakout in red onions from the U.S which further encouraged Canadians to buy onions grown from local farms (Connolly, 2020). There are many benefits to buying locally grown food such as reducing environmental impacts from air pollution and greenhouse gas emissions, higher food safety and quality (Arrowquip, 2017). Due to COVID-19, travel across borders had been more stringent which affected the delivery of goods ranging from food to household essentials. This situation encouraged Canadians to support local businesses for their immediate needs and discover new places in their neighbourhood. That is why the idea of incorporating local Canadian ingredients was factored into the marketing message in the creation of the Ultimate Canadian Burger.

For restaurants to make a profit off a food sale, the cost of their ingredients must be significantly lower than the selling price. As seen in Figure 18, hamburgers can have a high markup price while still perceived to be an affordable option when dining out. This makes it an ideal product to advertise because hamburgers are a high profit, low margin item for restaurants. Using the animated burger model found from Window 10's 3D Library, I researched the possibilities of where each ingredient can originate from in Canada including the condiments (See Appendix I).

Figure 18. Hamburgers, Deconstructed. The cost of ingredients in a typical hamburger. Sourced from PlateIQ.

According to Knexus (2016), the average consumer requires around six touchpoints before making a purchase and this can be spread out by different channels of marketing such as in-person interaction, mobile ads, or email newsletters. Baxendale et al. (2015) measured the impacts of different touchpoints and found that in-store communications were ranked the highest

in terms of brand positivity compared to retail ads, word-of-mouth, and PR. It is important to note that both frequency and positivity of touchpoints will affect brand consideration (Baxendale et al., 2015). This validated the decision to create one in-store communication through the table sign poster and the same ad to be used in a traditional bus shelter ad to demonstrate two channels of touchpoints.

7.3 Design and Development

To save time, a poster template with the burger image was used to reduce graphic design work needed for this marketing collateral. The focus was on how to implement the call to action text on the poster that would encourage the usage of the AR experience. Originally, the plan was to create two sides of the tabletop signs but decided to focus on one side (Figure 19) while using the same poster design as a large format display poster seen in bus shelters and other places of public transportation (Figure 20). The final poster design was turned into an image target using the NFT Marker Creator to create image descriptor files.

Figure 19. Burger Promotion on Tabletop Signs. (Version 1)

Figure 20. Burger Promotion on Bus Shelter Display. (Version 2)

For the first version of the burger promotion, the user would scan the QR code which would bring them to the main marketing page and then the user can choose to activate the WebAR experience. A customized loading screen with common burger ingredients was displayed as emojis which made it seem fun and helped to alleviate the wait time as the experience loads. Instructions were added to prompt the users of what to do in order to trigger the experience. When the camera detected the image target, it would display the animated burger model. The coupon button would only appear after the user had successfully scanned the image target at least once and it would not disappear unless the page was refreshed. The original idea was that the user can select individual pieces of the burger ingredients to learn about where it originate from in Canada and other interesting facts. Due to technical limitations, this concept was instead demonstrated through a superimposed video animation on After Effects (Figure 21).

Figure 21. Interactive Burger with Highlighted Ingredient. Version 1's superimposed effects.

Figure 22. Burger Promo with Featured Ingredient. A screenshot from version 2's animated video.

For the second version with the large display ad, the user would also scan the QR code but instead of the animated 3D model of the burger, a burger ad video was augmented on the original poster with the coupon appearing at the end of the video. The video ad was created by reusing layers from the original burger poster created in Photoshop and brought over to After Effects for animation (Figure 22). Due to time limitations, the final proof of concept was not developed through WebAR but demonstrated through the EyeJack application.

7.4 Results and Evaluation

The final results, assets and video demonstrations can be referenced in Appendix J. The effectiveness of this experience was evaluated based on what is known in the literature and how the gaps were filled. Both versions of this experience aimed to incorporate storytelling through learning about the origins of the locally sourced ingredients. This would invoke cognitive and emotional benefits due to receiving useful information that allowed customers to feel confident about their purchasing decisions, the brand they support, and what goes inside their bodies (Batat et al., 2019; Mclean & Wilson, 2019). In version 1, the animated burger was highly engaging with in-depth interactions with the 3D model along with stories from Canadians who grew or made the ingredients. With the additional narrative perspective, it would increase the experiential value of the AR experience to positively affect consumer behaviours (Huang & Hsu-Liu, 2014).

The overall experience was successful in demonstrating how the design assets could be used for multichannel marketing to increase touchpoints to affect positive brand awareness to lead to purchasing decisions (Baxendale et al., 2015). The same poster design was used to trigger two different augmented experiences that took into consideration where potential customers could be found and the environment they are in to enjoy the experience. In version 2, the video

ad that was augmented over the large display poster could easily be adapted to a TV commercial or a YouTube pre-roll ad to increase the frequency of brand exposure. Based on the statistics that 61% of consumers would choose a store that incorporates AR and 41% of consumers like to use AR to find deals, this created a competitive advantage for this brand in a highly competitive category of burger restaurants (Interactions Consumer Experience Marketing, Inc., 2016).

7.5 Limitations and Future Improvements

While the expanding animation of the burger to show the ingredients was engaging, I was unable to individually select ingredients from the animated 3D burger to trigger the information details. Since the 3D model was composed of a single GLB file, it is questionable whether the animation effect would work as smoothly if this model was stitched together by individual 3D ingredients or if that is even possible. Alternatively, anchor points could be added to each ingredient to trigger an action to open the information box or incorporated within the 3D model's animation sequence. To improve this aspect, more 3D modelling expertise would be required.

For both experiences in this proof of concept, the incentive was a static coupon that provided users with a free burger albeit with the clause that one must purchase a burger before they receive one for free, a common marketing tactic. With static coupons, it would be easy for one person to copy and share the coupon digitally without the need for other potential customers to access the WebAR experiences. This could be improved by having dynamic coupon codes that are uniquely generated every time the experience page is accessed by different devices. Another method would be to request users to fill in their contact details to receive the digital coupon through their email. This strategy would also allow the restaurant to share future promotional emails to generate more touchpoints in the customer journey.

8. Conclusion

8.1 Discussion

The pandemic had revealed that there is a huge "digital divide" between different demographic groups, especially for those who lost access to public services and community resources (Saba, 2020). A report by the Cybersecure Policy Exchange indicated that there are significant gaps with access to smartphones between income and age groups as seen in Figure 23 (Masoodi et al., 2020). This can be problematic because the groups with limited access to technology are also the most vulnerable groups and are now restricted from using certain services if they do not have access to smartphones or mobile data.

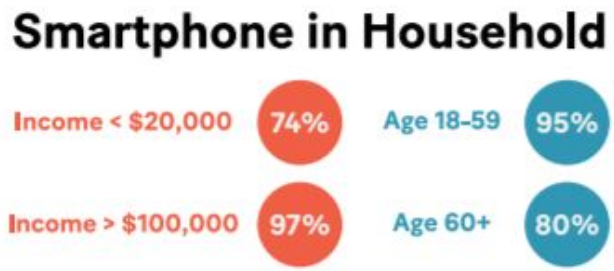


Figure 23. Smartphone in Household. (Masoodi et al., 2020)

In the efforts to minimize contact and increase the efficiency of service, some restaurants had to revise their offerings to a limited menu which could actually benefit the overall quality of their food. Luisa Ruocco, a food columnist, noted that while a variety of choices can be more inclusive of taste buds, restaurants would need to have a lot more ingredients in stock resulting in primarily frozen ingredients that are not fresh (Mitrokostas, 2019). Restaurants needed to plan strategically to only focus on their best selling products while using this as an opportunity to test new food items, procedures and use of technology. While restaurants were quick to adopt QR codes and other modes of going digital, there are other factors that needed to be considered in order to provide an inclusive customer experience.

When restaurants are considering incorporating digital menus, augmented experiences and online payment at the table, they also have to consider providing wifi or an alternative mode of menu and payment options if their customers are not equipped with a compatible smartphone. The experiences proposed in this project are meant to enhance the overall user experience and add persuasive elements to existing digital menus but do not intend to be an all-inclusive solution to contactless menus. Compared to a regular digital menu, WebAR experiences can require more bandwidth to use so it would be good etiquette to also provide complimentary wifi. Although it is worth mentioning that restaurants that have images or PDF files as their digital menu should also consider optimizing these files before uploading because I have experienced a PDF menu that required 30mb to download and took exceedingly long to load through data.

In relation to privacy and misuse of technology, restaurants may want to consider limiting wifi access to selective websites such as their own domain to prevent customers from abusing the wireless connectivity. Similar to how Cineplex Entertainment has implemented TimePlay, an interactive gaming experience before the movies, one has to connect to their network in order to participate. Aside from Cineplex's sites, the wifi speed is very slow to discourage users from taking advantage of free wifi for bandwidth-heavy activities. Although going digital is great for the initiative of performing contactless transactions, with more people and their devices connected to public networks, the higher the risks for cyber-attacks if users and companies are not protected. In the 2019 Data Breach Investigations Report, Verizon reported that 43% of the breaches involved small businesses (Verizon, 2019). It is a misconception that only larger companies get hacked, smaller companies are just as vulnerable and also less prepared. Not only do we need to feel safe while dining outside, but we also need to feel safe from cyber threats.

There are many factors to consider when restaurants and other small businesses are thinking about implementing AR into their business strategy. Appendix K outlined the pros and cons of various tools including both app-based and web-based AR. There is no one size fits all solution that would accommodate all restaurant types which is why this project showed three drastically different themes, categories of food, and WebAR use cases. The budget of chain restaurants would be drastically different than a local family-owned restaurant. One of the most important factors when determining the need for an augmented reality app is to identify what is the purpose and end goal of the experience. Just because it is currently trending, does not mean that it is the right solution for everyone. A few years ago, businesses were jumping on the trend of creating their own mobile apps when it did not offer any additional benefits compared to their mobile websites and now the industry is moving away from native apps due to app saturation and low usage rate after download (Patel, 2016).

Similarly, restaurants were quick to implement QR Code menus during the reopening stages but some have already reverted back to pre-COVID menus. In places that offered both digital and physical menus, many restaurants would automatically give out their physical menus without inquiring about the customer's preferences. For a sincere effort of minimizing contact, restaurants should default to their digital menus while inquiring about the needs of the customers as they sit down if they would prefer a physical menu. Even single-use paper menus are not truly "contactless" because these menus are still handled by the restaurant staff. Furthermore, digital menus are more environmentally friendly than single-use paper menus, which can positively improve the consumer's perceptions of the restaurant and their values.

8.2 Implications for Future Research

Since COVID-19 began, there has been exponential growth and adoption to using online food ordering services as well as online grocery services to access food (Powell, 2020). It has become more prevalent to see 3D models integrated on the web for retail, so it would not be surprising when online food ordering apps also start integrating 3D models as well. In order for that to happen, there needs to be a streamlined process to create and upload realistic 3D renders of food from restaurants. In recent years, it has become possible to use smartphones to do passive photogrammetry and utilize other 3D scanning methodologies to create 3D assets. For example, the Qlone app leverages AR technology and algorithms to convert 2D images into 3D models with built-in editing tools (Lievendag, 2018).

These software tools can only do so much and would also need to rely on the advancement of hardware tools to facilitate this process. LiDAR (Light Detection and Ranging) capabilities have already been integrated with iPad Pro in early 2020 and set to be included in iPhones releasing later this year. The technology is a game changer for consumer usage of AR because this method uses lasers to detect surface planes which means faster and more accurate placement of 3D objects and the depth information allows for virtual object occlusion which means 3D models can partially hide behind physical objects (Porter, 2020; Apple, 2020). Based on these trends, the WebAR experiences in this project will load faster and have a higher quality of immersiveness by blending in and reacting to the existing environment.

The arrival of 5G is imminent which will improve immersive experiences on the phone due to the faster data rates, lower latency (lag), increased bandwidth and data processing happening on the network to rely less on hardware (Qualcomm, 2020; Leidsens, 2019). With 5G

technology, this will support the infrastructure for web-based applications to incorporate processes that were once only accessible in native applications. For example, the power of computer vision and machine learning on the web can help improve WebAR experiences with dynamic changes and better recognition of physical objects. There is already a trend towards using progressive web applications (PWAs) which blends the best of both worlds of a responsive website and native application (Gazdecki, 2018). Many consumers are experiencing app fatigue and do not necessarily want to or have the need to download an app if the functionality exists on the web (Schippers, 2016). The prediction is that when 5G connectivity and compatible smartphones become more mainstream, the usage and development of web-based technologies are going to have a similar trajectory in growth. Restaurants should plan ahead and think about how they can utilize these emerging technologies into their marketing strategies.

Augmented reality has often been criticized for its gimmicky usage but this is due to the fact that most examples in the media were created for a novelty purpose or adopted by companies who just wanted to be on top of the latest trends. This becomes a disservice to AR which prevents consumers from taking it seriously. However, consumers will have to start taking notice in AR as many companies including Apple have been rapidly hiring AR/VR specialists in the race to develop the next generation of mixed reality headset (MacRumors, 2020). Right now is the interim phase between what will be possible when we can see augmented content without using our hands and phones. There are many learning opportunities and improvements for user experience and accessibility issues with extended reality (XR) to set the precedent and ease the transition towards the next stages of XR development. The future is exciting as we are one step closer to achieving the dream capabilities of AR popularized by mainstream media.

Appendix A – Field Research Observations

Restaurant	Menu Style	Stage	Dining Experience
THREE10 at The Rec Room (Toronto)	QR Code to Digital Menu Optional PDF Menu	2	● Reserved a spot online for patio seating ● There are hand sanitizers, contact tracing questions at the beginning before the host walks you to your table. Employees are compliant with mask rules. ● There are arrows inside the restaurant that leads you to the washroom, and it was set up so that there's a one-way flow for each direction.
Jack Astor's (Front)	Single-Use Paper Menus QR Code only at the front of the restaurant	2	● Patio seating with QR code at the front of the restaurant and asked contact tracing questions, but they'll give you single-use paper menus without asking if you need it. No QR code at the tables ● Hand sanitizers are there, and employees wore masks ● Only had one set of the menu (food and drink) shared between the group of 2
Sunset Grill (Toronto)	Single-Use Paper Menus	2	● It was a patio seating, and they did ask for contact tracing information from one person in the group ● Single-use menus printed on thin sheets with minimal colours. On brand with their original menus ● Extra condiments were given in a plastic bowl ● Coffee refills were provided with a fresh cup instead of poured from the pot
Jack Astor's (Dundas Square in Toronto)	Single-Use Paper Menus On the second visit, there was a QR code on the puck	2 3	● Patio setting with a view ● They asked us for contact tracing information and had sanitizer outside before you walk in. ● We got two paper food menus for two people and one drink menu, but no signs of QR code menus. ● There was also a green/red paddle thing, but I have no idea if it's for COVID-19 to indicate your preference of how you want to be served.
Starbucks (Ottawa)	QR Code to Digital App Menu	3	● Saw a Starbucks advertisement outside their store with a large QR code to prompt users to download their app to see the full menu and promote mobile ordering
Zak's Diner (Ottawa)	Pre-COVID Menu QR Code to Digital Menu was available	3	● In Ottawa, it was already in stage 3, so restaurants could open their dine-in spaces. ● Safety protocols were still in place where you need to wear masks inside, and they require contact tracing information. ● They had QR code, but they also gave us regular menus. The menu seems sticky, so not sure how often it gets wiped down after each guest.
El Furniture Warehouse (Ottawa)	QR Code to Digital Menu	3	● Took down our names/number and we received text messages when our table is ready ● They had QR codes stuck on each table but not that

	Reduced Offerings		securely. It led to a Wix site for their limited offering menu. The format is still on-brand but curious why it wasn't posted on their main site from the chain and didn't look polish to show that it's on Wix's subdomain. ● The vibe is loud and young, and they didn't mention anything about the QR code menu or ask if we needed other types of menu. They assumed we were okay with it because it seems to draw a younger crowd
El Furniture Warehouse Visit #2	QR Code to Digital Menu with Limited Menu	3	● Went to the upstairs patio area, a similar procedure as last time where we were asked contact tracing info and had an online waitlist
Blue Cactus (Ottawa)	Pre-COVID Menu QR Code Menu is available	3	● Sat near the outside area, and they had a specialized sticker with a QR code menu, but they gave us the regular menus anyways and never asked if we were okay with the QR code version
Copper Spirits and Sights at Andaz Hotel (Ottawa)	QR Code to Digital Menu	3	● They had their QR code menu near the front desk of the hotel lobby, and it's on a big plastic sign holder ● Service was excellent; made a huge display of cleaning the area and wiping down the service before we were allowed to sit down ● Told us about the QR code menu and asked if we were okay with it or they had single-use paper menus
Beavertails (Ottawa)	Food Stand Menu	3	● Traditionally already has no individual menu aside from huge boards for display menu ● Ordering aspects remain similar to before COVID as these are food trucks where you order from the cashier and just wait off to the side
Milestones at Yonge-Dundas	Single-Use Paper Menus	3	● Now that Toronto allows dine-in at restaurants, we chose to sit on the patio in the beginning. I don't think they asked us for contact tracing information because I reserved in advance on OpenTable, so they already have my data? ● They don't have QR code menus, but they have single-use menus with one for food and one for drinks. ● They have their own branded coasters and not from another drink brand
Artful Dodger	Pre-COVID Menu	3	● We wrote contact tracing information on a notebook ● We got regular menus (?) and ordered drinks
Toudou Ramen	QR Code Menu	3	● No dine-in allowed, only patio area. The menu was through QR code displayed on the table sign.
Alchemy Food and Drink	QR Code Menu with Wifi	3	● No dine-in was allowed, only patio area. QR code menu and also with a short link. They had wifi! ● Took down contact tracing information during dining time on a piece of paper

Appendix B – Main Project Page

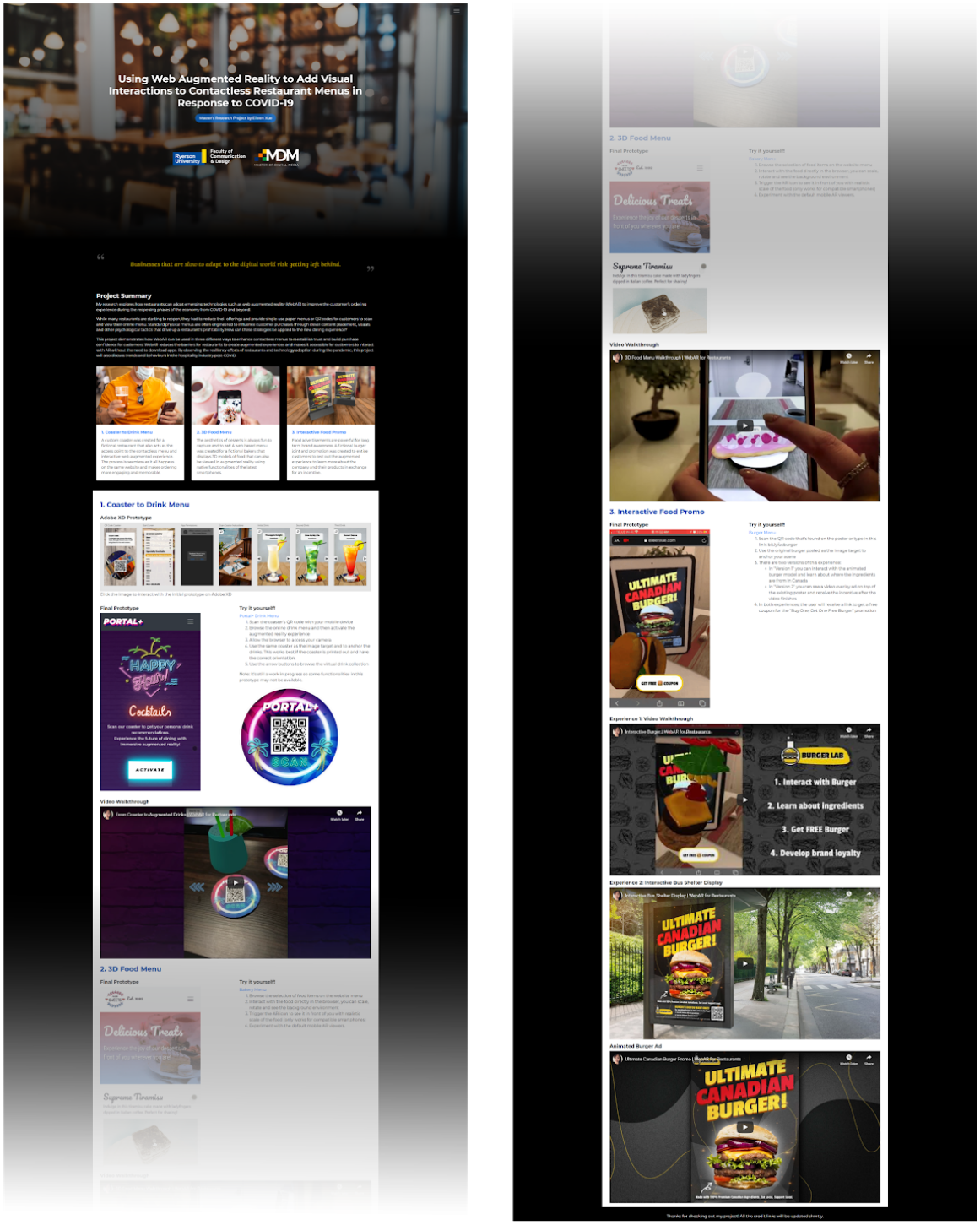


Figure B-1. Desktop Screenshot of Project Overview Page.
To see this in detail, please visit https://eileenxue.com/mrp

Appendix C – Prototypes for Experience One

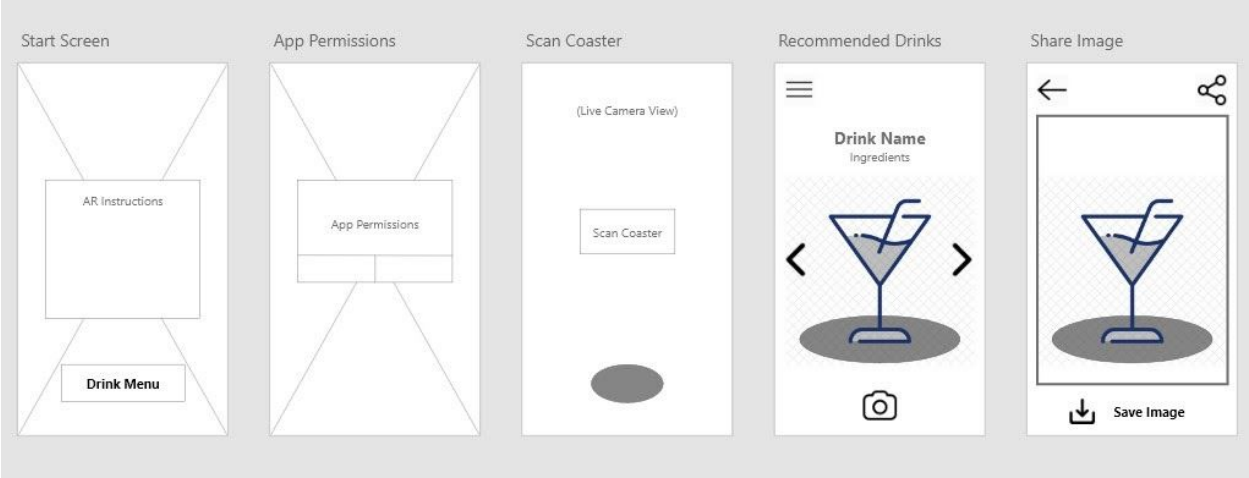


Figure C-1: Low Fidelity Wireframe of Coaster to Augmented Drink Menu

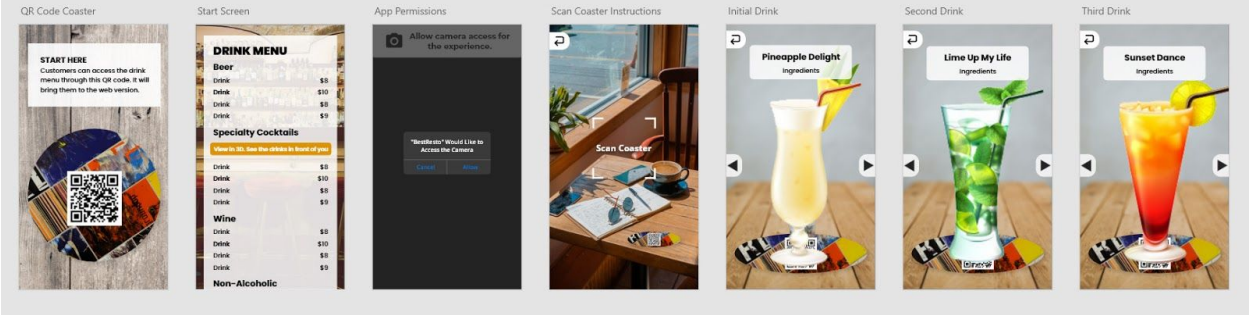


Figure C-2: High Fidelity Mockup with Interactions. Design assets were sourced from Unsplash and Freepik. Adobe XD Interactive Prototype: http://bit.ly/WebARcoastermenu

Appendix D – Final Demo for Experience One

Figure D-1. Mobile screenshot of the Portal+ Drink Menu. Graphic Assets from Freepik. View this online: https://eileenxue.com/mrp/drink-menu

Figure D-2. Arrangement of Portal+ Coasters.

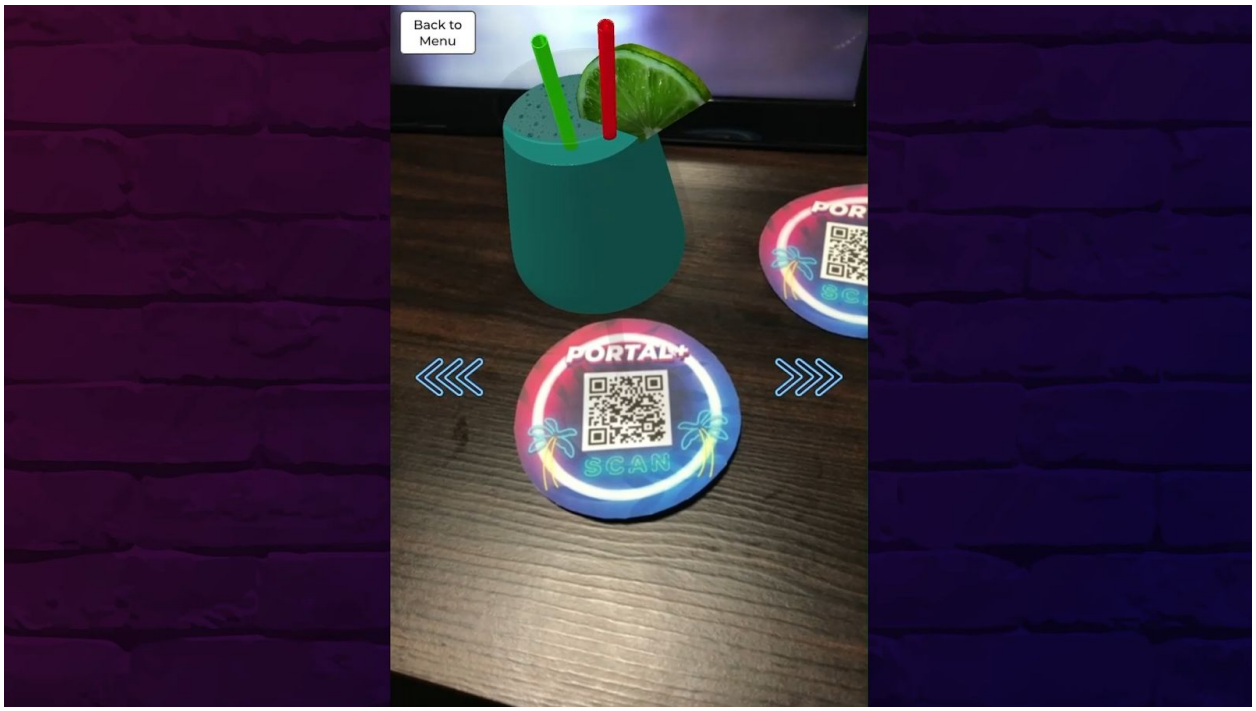


Figure D-3. Walkthrough Video of Portal+'s Coaster to Augmented Drink Menu
Watch here: https://youtu.be/NRon3GumWe4

All graphics, mockup templates and photos are sourced from Freepik with Premium License privileges.
The background video is from Pixabay. 3D Models are from Sketchfab with attributions below.
Summer Drink. From Broccoletto, 2019. Licensed under CC BY 4.0.
OJ Cocktail. From Canersoyer, 2019. Licensed under CC BY 4.0.
Cocktail (Martini). From Akiko.Tomiyoshi, 2019. Licensed under CC BY 4.0.

Appendix E – Online Food and Photo Sharing Trends

Why are consumers sharing food photos?

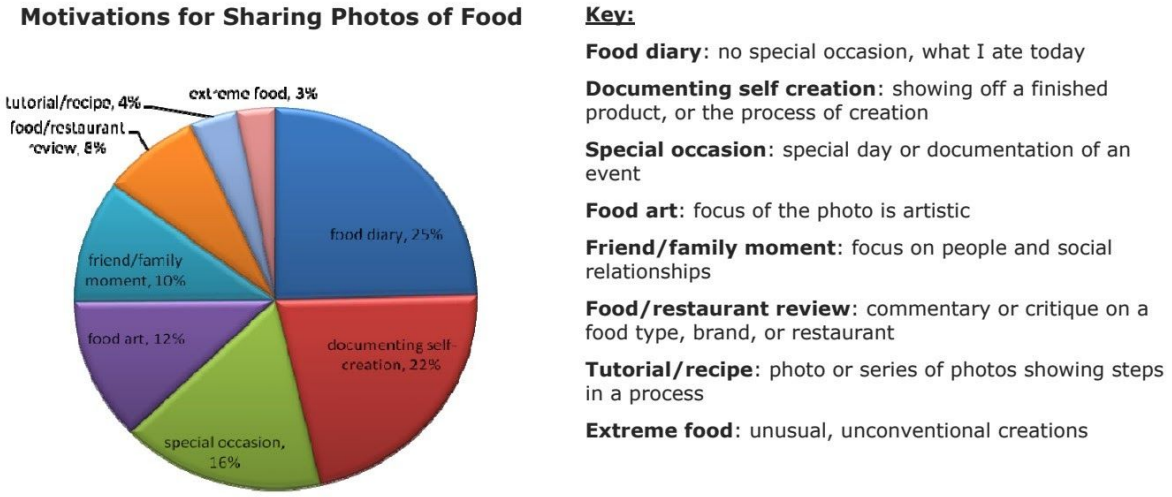


Figure E-1: Why are consumers sharing food photos? (360i, 2011)

What kinds of food do consumers share photos of?

Consumers are most inclined to take and share photos of desserts, followed by vegetable dishes and poultry.

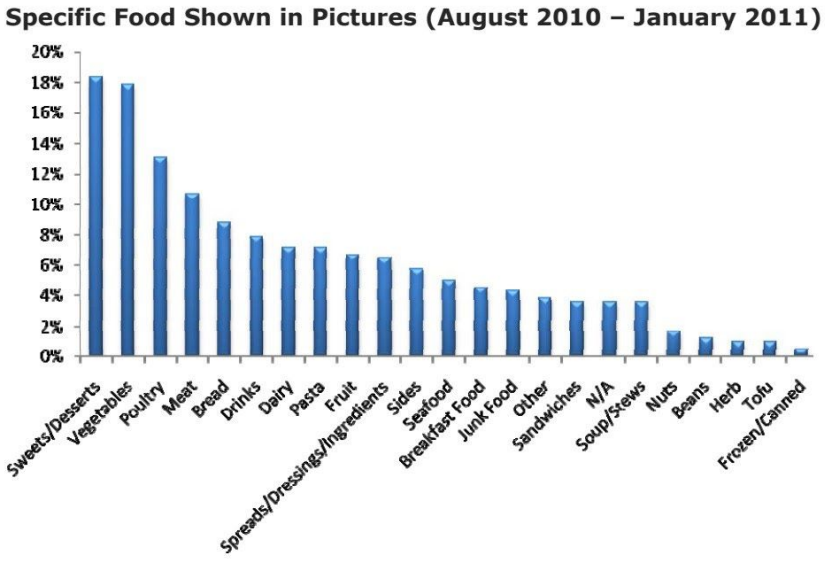


Figure E-2: What kinds of food do consumers share photos of? (360i, 2011)

Appendix F – Prototypes for Experience Two

Figure F-1: Redesigned Digital Menu for Fuwa Fuwa Pancakes with Augmented Food Experience.
Sourced from: https://www.fuwafuwapancakes.com/

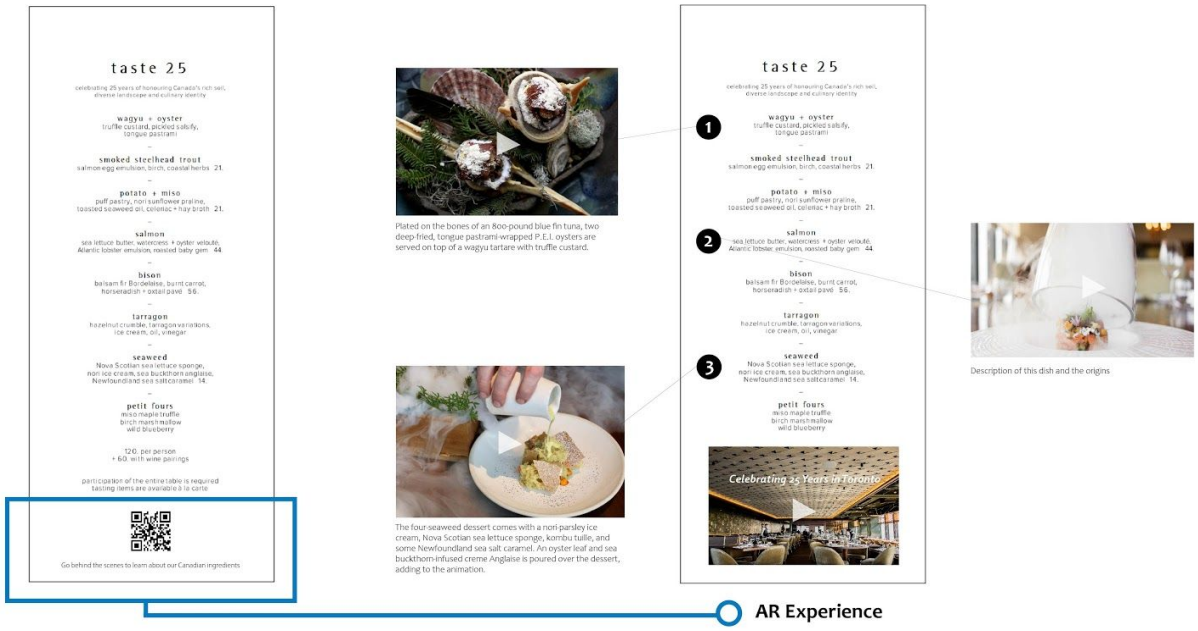


Figure F-2. Redesigned Canoe's 25th Anniversary Menu with AR Video Stories.
Sourced from: https://www.canoerestaurant.com/

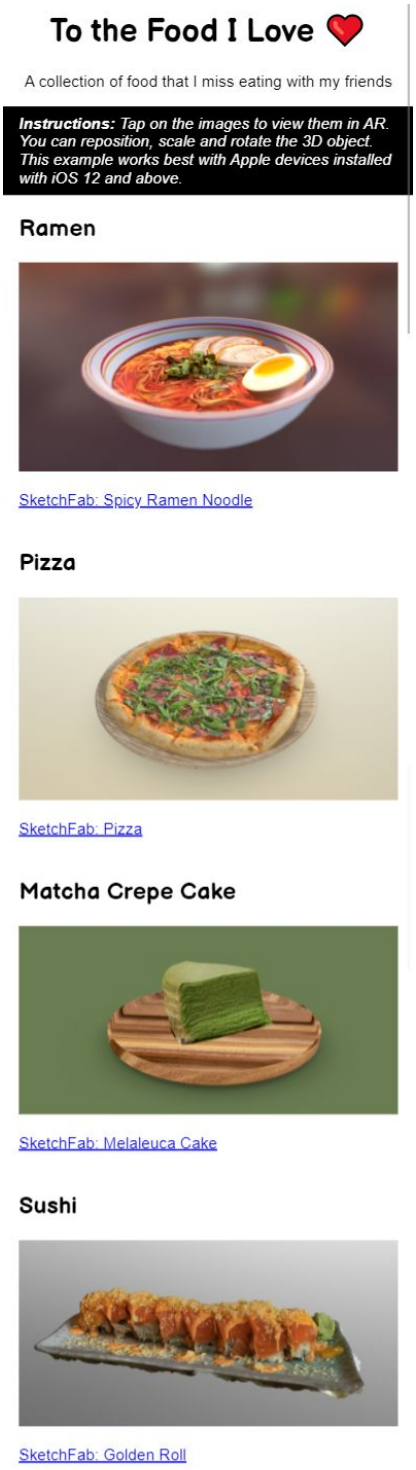


Figure F-3. Screenshot of digital menu incorporated with USDZ 3D models compatible with iOS 12 and above.

3D Models are from Sketchfab with attributions below.
Spicy Ramen Noodle. From JChing, 2018. Licensed under CC BY 4.0.
Pizza. From Rigsters, 2019. Licensed under CC BY 4.0.
Melaleuca Cake. From tutor3D, 2020. Licensed under CC BY 4.0.
Golden Roll. From Alban, 2017. Licensed under CC BY 4.0.

Appendix G – Alternative Methods of 3D Model Conversions

Tool Name/Source	Purpose
Adobe Photoshop	Reduce the size of textures to optimize file size
GLTF to GLB Packer https://glb-packer.glitch.me/	Upload the folder of glTF files and convert them into a single GLB file.
GLB Scale-O-Matic https://glb-scale-o-matic.glitch.me/	Upload the GLB file to resize to the desired dimensions. Download the resized GLB file.
Scapic's USDZ Converter https://scapic.com/create/usdz	Convert the resized version of the GLB file into USDZ format, which is required for iOS platforms.
glTF Viewer https://gltf-viewer.donmccurdy.com/	A useful tool to view how glTF or GLB files will render on the web. There's also file validation.

Appendix H – Final Demo for Experience Two

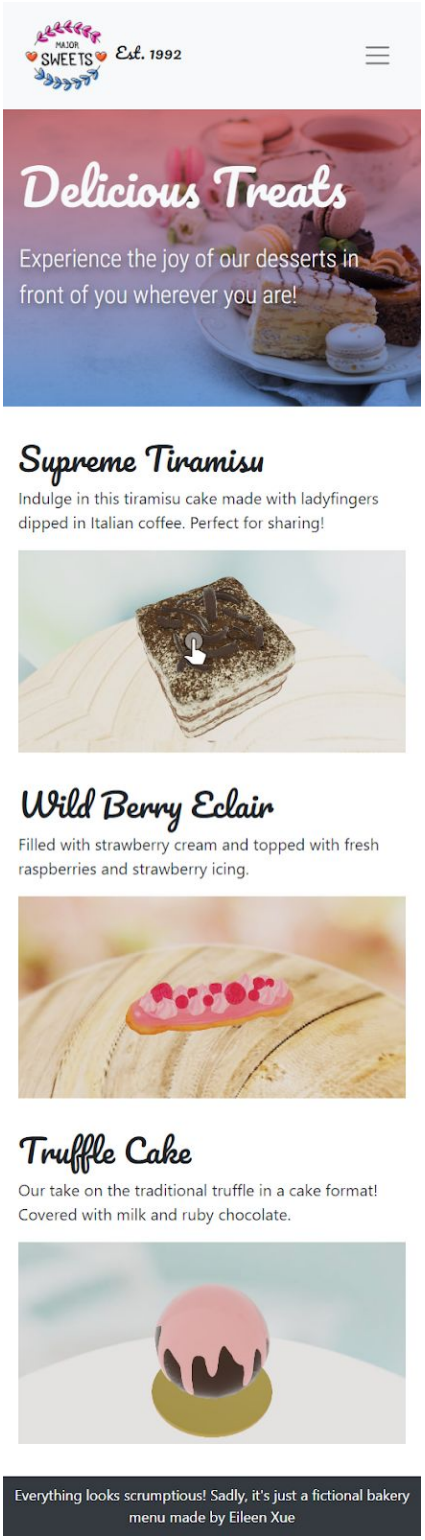


Figure H-1. Screenshot of Major Sweets Digital Menu with 3D Desserts.
View this online: https://eileenxue.com/mrp/bakery-menu

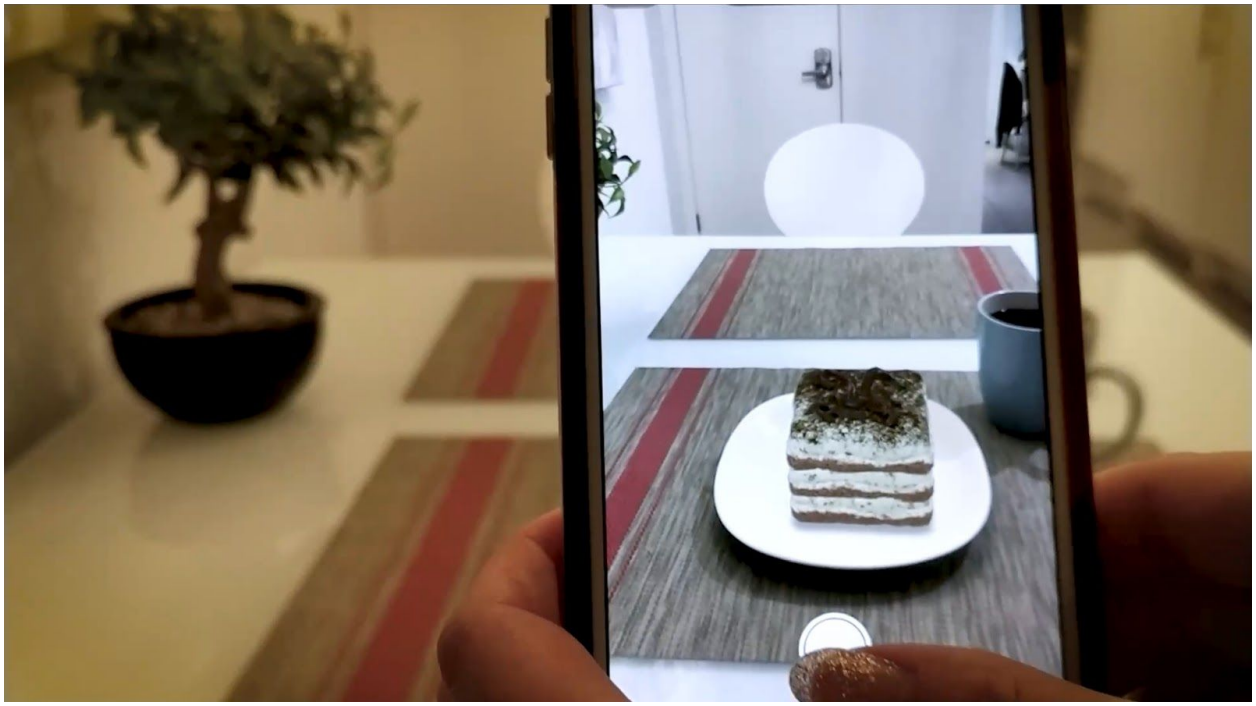


Figure H-2. Major Sweets Bakery Menu Walkthrough Video.
Watch here: https://youtu.be/24ib14DXWhg

All background images sourced from Freepik with Premium License privileges.
Tiramisu - Low Poly Challenge: Desserts. From Chuwakcz, 2019. Licensed under CC BY 4.0.
Fancy Eclair. From DeniseFelix, 2020. Licensed under CC BY 4.0.
Chocolate Truffle. From M.Reslan, 2019. Licensed under CC BY 4.0.

Appendix I – Burger Ingredients Research

Figure I-1. Expanded Version of the Animated 3D Cheeseburger. From Windows 10's 3D Library.

Ingredient	**Product Information/Description**	**Canadian Relevancy**
Bun	White or Whole Wheat	Dempster's is a Canadian brand; Bun made from scratch using other local ingredients
Red Onion	Sweet Red Onion	Grown locally in Ontario year-round
Pickles	Field cucumbers are grown from June-Oct. Also, greenhouse cucumbers.	Strub's Pickles made with mostly Canadian cucumbers. Facilities and packaging in Canada.
Tomatoes	Juicy Red Tomatoes	Grown in Ontario 10 months of the year due to Greenhouses
Lettuce	Fresh Romaine Lettuce; Adds crunch	Healthier than Iceberg with nutritious values
Mustard	Spicy Yellow Mustard; Tangy; Sweet;	Canada produces 90% of the world's mustard seed, and almost 80% are grown in Saskatchewan. Mustard brand from Canada = Kozlik's
Ketchup	Made from tomatoes, so can be homemade	French's Ketchup: 100% Canadian Product
Cheese	Processed Cheese; Aged Canadian Cheddar	Made from Canadian Cow's Milk
Beef Patty	Triple-A Beef; Prime; Never Frozen	Cattles are all around Canada, but mostly in Alberta

Figure I-2. Chart of Research Notes on Burger Ingredients.

Appendix J – Final Demo for Experience Three

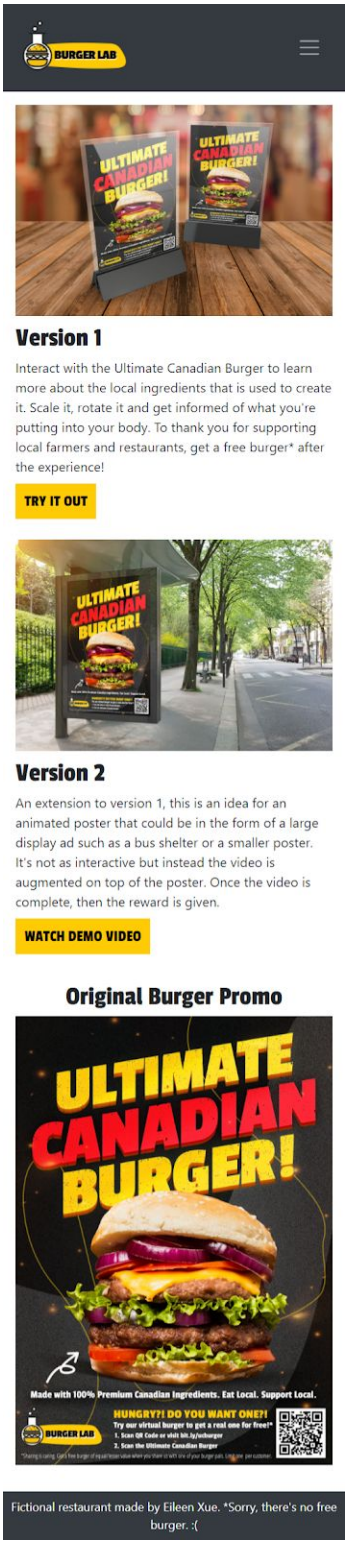


Figure J-1. Burger Lab's Menu Page.
View this online: https://eileenxue.com/mrp/burger-menu

Figure J-2. Ultimate Canadian Burger Poster Advertisement.

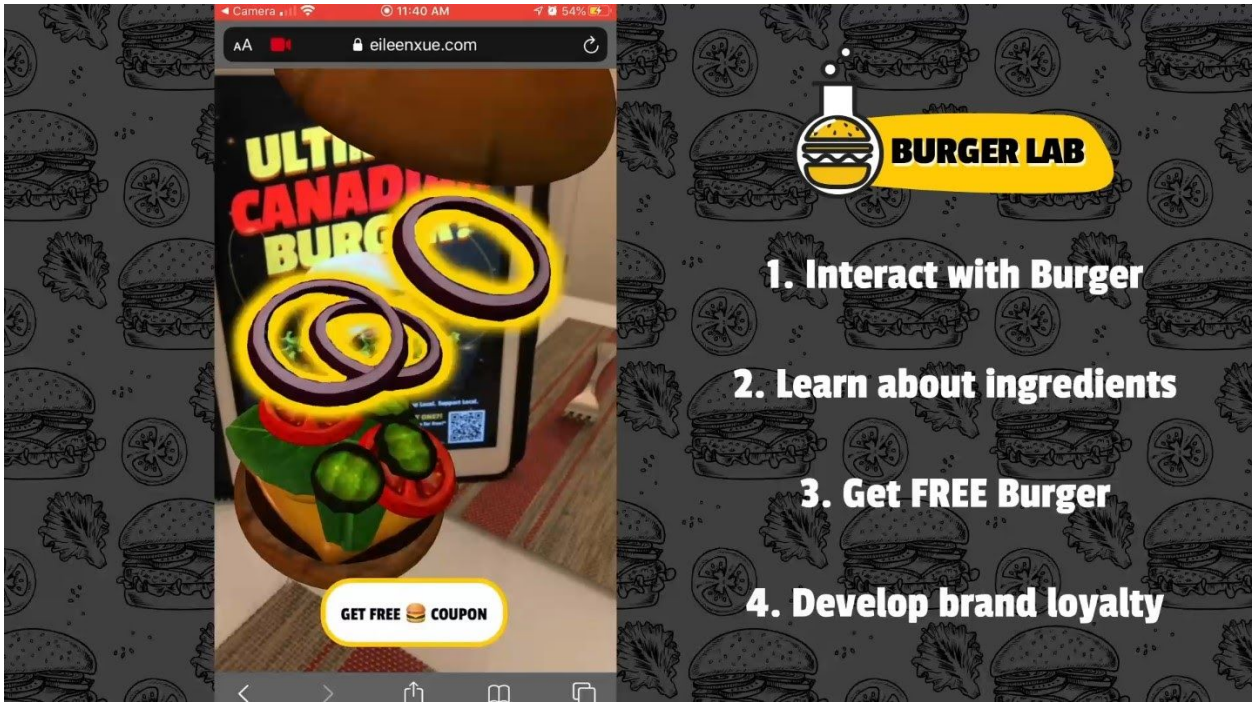


Figure J-3. Burger Lab's Interactive Burger Experience Demo Video.
Watch here: https://youtu.be/FrwvhkxXXvE

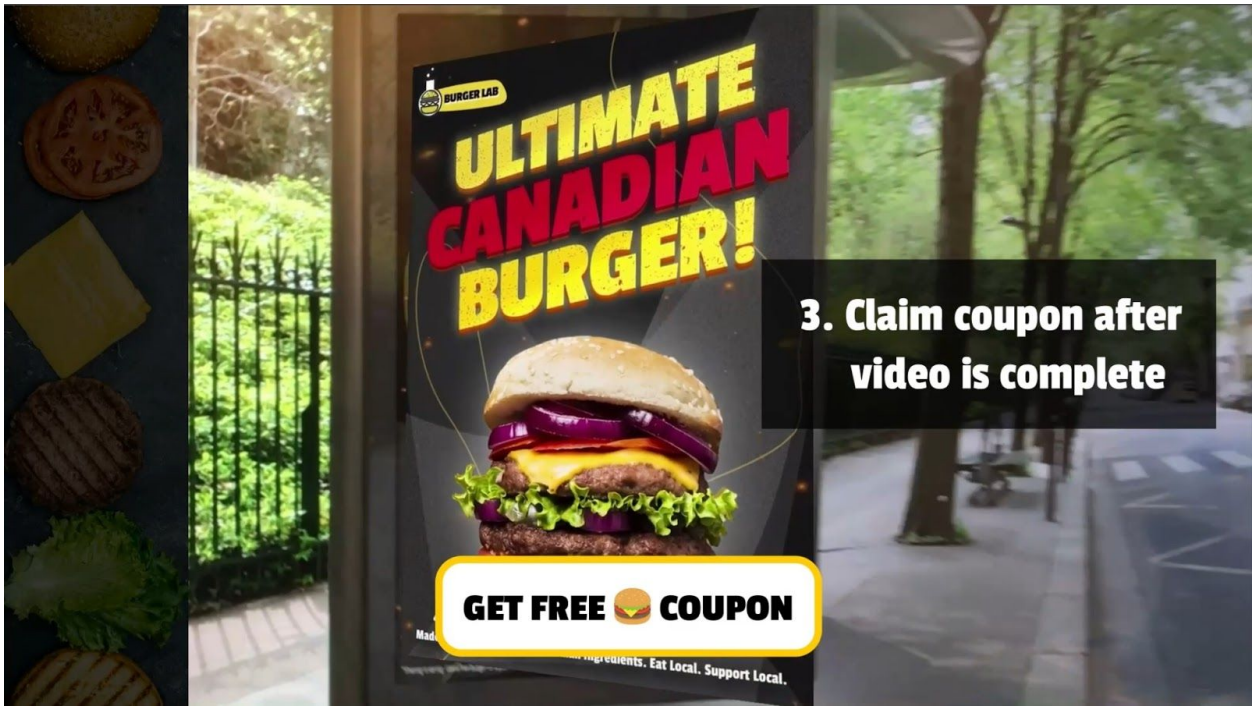


Figure J-4. Burger Lab's Interactive Bus Shelter Demo. The EyeJack App simulated the AR feature.
Watch here: https://youtu.be/8vxkgwoYDRk

Figure J-5. Promotional Video for the Ultimate Canadian Burger.
Watch here: https://youtu.be/ZIObt6KUxmo

All graphics, mockup templates and background images sourced from Freepik with Premium License privileges. Animated Cheeseburger is from WIndows 10's 3D Library.

Special thanks to Michael Carter-Arlt for doing the animation sequence from the poster layer assets in Figure J-5 and adding the superimposed effects such as the highlighted ingredients and information box in Figure J-3.

Appendix K – Comparison of AR Technologies for Businesses

	Pros	Cons
WebAR **(Hosted on the existing business website)**	● No app downloads required for users ● Easy to implement with the current business website ● Seamless branding and control of the experience, like every other part of the website ● Easy to update like editing any other website content and pages	● Need to rely on a web developer to implement ● If using managed hosting (Squarespace, Wix, Weebly, etc.) may be limited to adding custom code or modifications to the site ● Limited to the computing power of browser
Model-Viewer **(Hosted on the existing business website)**	● No app downloads required ● Seamless integration with existing website and works cross-platforms ● Maintained by Google with ongoing updated features ● Embed 3D models into the browser and interactable (not AR) ● For AR, can open up 3D model in Scene Viewer/iOS Quick Look with minimal customizations	● Limited functionalities within AR (or none since it opens in the default AR viewer of smartphones) ● Useful for only showing galleries of 3D objects in great details ● Interactions are limited to the 3D objects themselves
WebAR companies such as 8th Wall	● Currently, the industry's best tool at creating WebAR experiences with many custom features with their software tools and libraries ● Portfolio of many top companies around the world ● Lots of templates, documentation and support	● Extremely expensive plans. Pay per view is a base rate of $1000 and then $0.01/view ● Always need to show their branding ● Monopolized the market so they can set the prices ● Inaccessible to small businesses
Custom Native App	● Highly customizable to the capabilities of what is currently on the market ● Can use ARCore (Android) or ARKit (iOS) platforms ● Faster and more stable than WebAR ● Access to more native functionalities so more features ● Overall, user experience is better ● Able to handle more complex interactions	● Users need to download the app ● Development is very expensive since mobile app developers are needed and may need both iOS and Android expertise and upkeep ● Maintenance would be ongoing unless it's for a single purpose ● Inaccessible to most small businesses unless already in the app-based industries
Third-Party App Solutions **(eg. EyeJack, Overly, Adobe Aero)**	● Easy to create simple AR experiences and shareable ● Affordable options available ● An abundance of options out there for creator studio tools	● Users must download third-party apps to see experience ● Usually minimal features unless paying for additional features

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