

Design Project User and Product Manual

Recycle Savvy

GNG 1103: Engineering Design

Submitted by:

Project Group C12

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Table of Contents

Table of Contents	i
List of Figures	iv
List of Tables	vi
1 Introduction	1
2 Overview	3
2.1 Background: Design Briefing	4
2.2 Comparison with Competition	7
2.3 Excellence: Unique, Practical and Entertaining	8
2.4 Cautions & Warnings	10
3 Getting Started	11
3.1 Introduction to the System	12
3.2 Set-up Considerations and Accessing the System	13
3.3 System Organization & Navigation	14
3.3.1 Subsystem: Game Component	15
3.4 User Access Considerations	17
3.5 Exiting the System	17
4 Using the System	18
4.1 Introduction to the Functions	20
4.2 Scanner	20
4.3 Game	21
4.4 Map	22

4.5	News.....	23
4.6	Profile	24
4.7	Settings	25
4.8	Characters.....	26
4.9	Rewards.....	27
4.10	Supplementary Information on the Functions.....	27
5	Troubleshooting & Support.....	28
5.1	Error Messages or Behaviour	29
5.2	Maintenance.....	29
5.3	Support.....	29
6	Product Documentation.....	30
6.1	Evolution of the Design	31
6.1.1	Camera Scene	32
6.1.2	Game Scene.....	33
6.1.3	Settings Scene & Profile Scene.....	34
6.1.4	Map Scene.....	35
6.2	Schedule.....	36
6.3	Risk & Contingency Plan	38
6.4	Replication: Subsystems of Design	39
6.4.1	Information Scene.....	39
6.4.2	Switching Scenes	40
6.4.3	Camera Scene	41
6.4.4	Game Scene.....	42

6.5	Testing & Validation	44
6.5.1	Feedback: Global Concepts	44
6.5.2	Feedback: Prototype I	45
6.5.3	Feedback: Prototype I ½	46
6.5.4	Feedback: Prototype II.....	47
6.5.5	Feedback: Prototype III	47
7	Conclusions and Recommendations for Future Work	48
8	References	50
9	Appendix I: Design Files	51

List of Figures

Figure 1. Other recycling apps.	7
Figure 2. Gameplay in Recycle Savvy.	8
Figure 3. Web of features in Recycle Savvy.	9
Figure 4. Web of the system: Features and their connecting network.	12
Figure 5. The opening of the app, dictated by the direction of the camera.	12
Figure 6. Equipment: (a) For a downloadable app; (a) to (d) For an unreleased app.	13
Figure 7. Web of the system, expanded: All features and their elaborate network.	14
Figure 8. Sequence of a game: Ready item, aim it, and miss or score; repeat, as needed....	15
Figure 9. A victorious game in four panels.	16
Figure 10. Significant features: The app represented in four panels.	16
Figure 11. Web of screens.	19
Figure 12. Camera scene: Scanning of items.	20
Figure 13. Game scene: Gameplay activation and completion.	21
Figure 14. Map scene: Locations of available recycling receptacles and facilities.	22
Figure 15. Information scene: Accessing topical news articles on recycling.	23
Figure 16. Profile scene: Personal account for the user.	24
Figure 17. Settings scene: Accessing the menu of general options and inquiries.	25
Figure 18. Characters scene: Unlocking and upgrading collectibles.	26
Figure 19. Rewards scene: Showcase of gameplay milestones for the user.	27
Figure 20. Standard setup of the Unity® project.	31
Figure 21. Camera Scene: From concept to result.	32

Figure 22. Game scene: From concept to preliminary result, to amended.	33
Figure 23. Settings scene: From earlier to later design.	34
Figure 24. Profile scene: From concept to design.	34
Figure 25. Map scene: From earlier to later design.	35
Figure 26. Gantt Chart: Deliverable D and the project dependencies.	37
Figure 27. Gantt Chart: Deliverable D by subtasks and assignees.	37
Figure 28. Gantt Chart: Design Day shown as a milestone.	37
Figure 29. Information scene: Code for accessing news articles.	39
Figure 30. All scenes: Code to switch from one scene to another, using the panel buttons. 40	
Figure 31. Congratulatory scene: Code for when the user is victorious in the game.	42
Figure 32. Game scene: Code to allow the user to throw the item.	43
Figure 33. Conceptual designs for a recycling app: Identifying items.	44
Figure 34. Design of prototype I: Game, map, and rewards.	45
Figure 35. Intermediate prototype between I and II: Profile, map, and settings.	46
Figure 36. Design of prototype II: Game.	47

List of Tables

Table 1. Implied or inferred needs from the client, ranked..... 4

Table 2. Needs considered in designing the app, described. 5

Table 3. Simplified significant features on Recycle Savvy..... 20

Table 4. Tasks and their corresponding owner, time frame and due date..... 36

Table 5. Risks that may affect the design project, paired with contingency plans. 38

Table 6. Information scene: Bill of materials. 39

Table 7. Information scene: Equipment. 39

Table 8. Switching scenes: Bill of materials..... 40

Table 9. Switching scenes: Equipment..... 40

Table 10. Camera scene: Bill of materials. 41

Table 11. Camera scene: Equipment. 41

Table 12. Game scene: Bill of materials..... 42

Table 13. Game scene: Equipment..... 42

Table 14. Prospects to improve the app..... 49

Table 15. Referenced Documents. 51

1 Introduction

Recycle Savvy

By Team RS

Via Unity® and Vuforia®
(payment-free 2019 versions)

This User and Product Manual (UPM) provides the information necessary for the layperson and the broader general user to effectively use the app **Recycle Savvy**, as developed in 2019.4.19f1 Unity® with Vuforia® Engine 9.8.5, and for prototype documentation.

The target audience is anyone wishing for—or in need of—assistance with the recycling procedure of consumer materials, as well as any individual who may wish to recreate the app.

The organization of this document relays into the description of the app, details of its use, the history of its development, and the means for its replication.

2 Overview

2.1 Background: Design Briefing

Recycling: Widely accepted environmental protection yet disorganized in its communal following

On January 26, 2020, the design project entered its infancy: An introductory meeting was held with the client, Mitch Bouchard of General Bearing Service, Inc. (GBS), in conjuncture with fourteen other design groups and the host, Professor Muslim Majeed. The client eloquently stated his seeking of an innovative way to guide and improve individuals' recycling etiquette. The company GBS supplies recycling plants and trucks with a broad assortment of bearings, so the client has a thorough understanding of the industry's struggles and needs—namely, the ill sorting of recycling goods by the general public. Items, if incorrectly denied recycling, are fated to occupy landfills; or worse, items, if wrongly recycled, can damage recycling machines and misallocate resources of labour and time. Even worse, if withheld any semblance of sorting, items can contribute to the littering of roads, landmarks, and oceans. Educating the public, in especially a simple and convenient manner, would address many of the client's frustrations.

Nearly two months of devoted work later, the designated Group C12* of three engineering students—Melissa Helm, Cole Schieman, and Scott Whittington—planned and designed the app **Recycle Savvy** to provide an entertaining solution for the problem outlined:

A need exists for a recyclable item identification application to enhance the public's knowledge and improve recycling on a global scale, while also remaining user-friendly, accurate and cost effective for the customer.

Table 1. Implied or inferred needs from the client, ranked.

Interpreted Need	Importance
User friendly interface with easy navigation of application	5
Accuracy of information accessible to user	5
Globalization of application	4
Item scanning feature	3
Location of local recycling facilities	3
Game format	2
Colour code for recyclable items	2
Incentives for users	2

5 - Need is critical; 4 - Highly desirable; 3 - Would be nice but not necessary;
2 - Not important; 1 - Undesired

*In tribute of the product, Group C12 shall be hereby called Team RS, or Team **Recycle Savvy**.

On the needs for the app, the client may favour functionality and universality and the user may favour entertainment and affordability. One focussed desire does not preclude both audiences from sharing that same desire, yet the assumption should hold that there will be a distinct hierarchy of demands to reflect different agencies. Like an advocate versus a participant, a sports player will likely seek criteria for gameplay that differ from a bystander; nevertheless, both parties want a good game.

Table 1 draws inspiration from the first meeting with the client, while **Table 2** stands as a compromising agglomeration of the expectations from the client and potential users. Needs are classified by the quality of functionality: whether the need affects the primary action of the app as a recycling tool—or not.

Table 2. Needs considered in designing the app, described.

Need	Design Criteria	Functional / Non-Functional
User-friendly interface with easy navigation of application	User friendliness and visual aesthetic	Non-Functional
Globalization of application	Accessible to everyone, everywhere, on various devices, in multiple languages	Non-Functional
Accuracy of information accessible to user	>95% accurate	Non-Functional
Affordability	Low financial demands on the user	Non-functional
Item scanning feature	Easy-to-use item identification feature	Functional
Colour code for recyclable items	Items are accurately colour coded based on how to recycle them	Functional
Location of local recycling facilities and receptacles	Shows where recycling facilities are located as well as what can be recycled there	Functional
Game format	Makes recycling entertaining	Functional
Incentives for users	Offers users rewards for constant recycling	Functional

Clarifications and Elaborations:

User friendliness and visual aesthetic:

Allows users to easily navigate the app while being pleasing to the eye

Geographically accessible to everyone, everywhere:

Can be used in any location and still have the full range of functionality

Available on various platforms:

Application is available on both IOS and Android, as well as a website with supplementary information

>95% accurate:

The information given is accurate and up to date by a standard of >95%

Easy to use item identification feature:

Users can take a picture of an item; the app will tell users exactly how to recycle it

Items are accurately colour coded based on how to recycle them:

Items that are recycled the same way are grouped together by colour

Makes recycling entertaining:

By using either a game or competition, the app keeps users interested and entertained

Identifies correct recycling bin:

Application can indicate with recycling or waste bin the item should be placed

Recycling facility locator:

Shows the location of where items can be recycled and what else can be recycled there

Provides information on recycling facilities:

Information, such as hours of operation and address, available for recycling facilities

Offers users rewards for constant recycling:

Rewards users for reaching recycling milestones and for winning competitions

Supplementary information for user:

Additional links, news articles or interesting information available for user

Cost of application:

Shows how much does the application cost the user; whether free or not

Thus, for Team RS, the app has been crafted to honour the wants and desires of the client and potential users. Functionality and enjoyment are what lead the app design. Ultimately, for the capacity of the **Recycle Savvy** app, its two main functions are to identify a material as recyclable and, subsequently, to locate its proper receptacle. The user will engage in a rewarding and free experience, fusing together information and entertainment, by fulfilling these functions in a vivid, interactive gameplay setting. Team RS strives for the app to emulate the best of both worlds: good content *in* a pretty package.

- Scans items and identifies them as recyclable or not
- Informs how and where to recycle items
- All while fun and free

2.2 Comparison with Competition

Underperforming: Costly or Just a Search Bar

Understandably, a recycle-assisting app is not a novel idea: There are other recycling applications for mobile device on the market, with a range of innovation. One example is **RecycleNation**. While that app has a large recycling database, the user must manually type into a search bar the name of the concerned item, in unison with the input of the current postal code. Thus, **RecycleNation** requires a cumbersome activity of the user, much more like engaging with a search engine than fully utilizing a mobile device. Most importantly, the app is limited by the vocabulary of the user—and further exclusive to only the English literate. If the user cannot articulately describe the item, nor even identify the item in question, then **RecycleNation** fails in its usefulness. Another recycling app includes **iRecycle**: Also search bar dependent but restrictive in its geographical scope—limited to the USA (and a few parts of Canada) [1]. The app **RecycleRight**, also reminiscent of a search engine, encloses an even smaller range: exclusive to Washington, USA, specifically Vancouver and Clark County [2]. Additionally, that app is quite muted in appearance, seemingly lackluster in a dichotomy of just white and blue. A user could tire of the uninspiring screen—or a potential user put off by it. A final example of a recycling app is **Eugene**. Again limited, its scope is of some European countries and only nutritional items; no information is provided on recycling facilities, whether for their locations, hours of operation, or materials accepted. Unlike the other apps mentioned, **Eugene** embraces the camera of a mobile device, permitting the user to scan items and receive relevant recycling details on them. However, a physical barcode scanner is required, priced at £79, for the successful operation of that scanning feature [3].



Figure 1. Other recycling apps.

In contrast, **Recycle Savvy** is free of any expected cost from the user, demonstrates a colourful appearance, acts as a locator for nearby recycling facilities and receptacles, and hosts a scanning feature to identify recyclable materials without requiring any additional device. The app would also strive to function regardless of geographical location.

2.3 Excellence: Unique, Practical and Entertaining

Where is the fun?

Seemingly absent in the forementioned recycling apps is the solidifying pursuit for enjoyment. None of the apps are formatted as a game—or grant the option thereof. User retention is key. For recycling, an audience willing to search for and use an assisting mobile app is the same sort who would be already knowledgeable and active in the practice. The other apps target that audience. The user retention would be diminishing: Once a few concerns are resolved, the user will carry poor engagement with the app—or none whatsoever, making it an inactive, deactivated, or deleted app. Rather, the target audience should be the persons poorly engaged or unengaged with the practice of recycling. The people in need of a recycling app are those who need encouragement. The **Recycle Savvy** app was designed with that type of user in mind. Entertainment is key. As shown in **Figure 2**, gameplay is a major component of this app, built on the premise of “play and learn” with a heavier reliance on visuals than language (vocabulary).

When the **Recycle Savvy** app has been opened, with the camera in view of a recyclable object, the user will be prompted by an optional screen (scene) to transport a virtual representation of that same object into the rightful receptacle. With a swipe of the finger from the user, the targeted object, as a caricature in the lower left corner, can be thrown into a bin in the upper right corner. Accuracy matters. Interest in the app may therefore stem from the creative design of the caricatural representations of the various recyclable materials, as well as from the capability of the user to level up these characters upon repeated collections and earn rewards by reaching milestones, like managing to “capture” 100 cans. The app embraces the gamer attributes of competitiveness and addictively collecting items.

Buttons and available options—the features of the **Recycle Savvy** app are outlined in **Figure 3**.



Figure 2. Gameplay in Recycle Savvy.

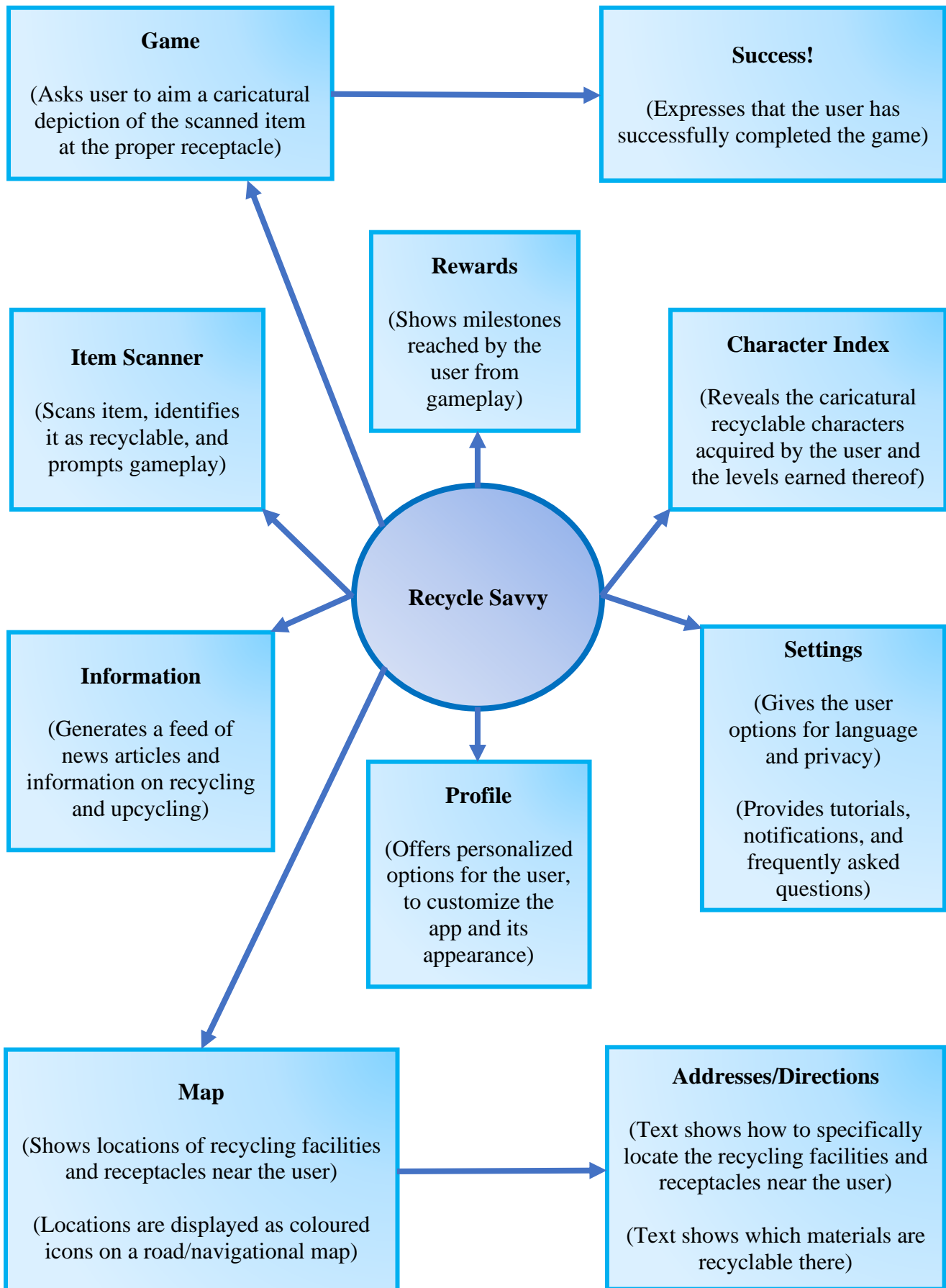
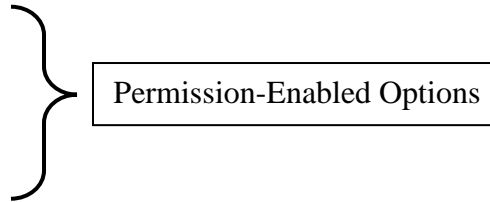


Figure 3. Web of features in Recycle Savvy.

2.4 Cautions & Warnings

You share only what you want, only when you want

- Camera Access
- Location Access
- Notifications
- Link to Personal Email Address
- Link to Social Media
- Memory Storage



For the app to properly function on a mobile device, the user must grant the app access to its camera, thereby giving permission for the scanning of nearby targetable items once the user selects the **camera scene**. The inability of the app to utilize this important scanning feature deprives the user of the **gameplay scene** and the subsequent cataloging of recyclable items in the **rewards scene** and **character collection scene**. The user would be therefore denied advancement in the game. For the app to further function as intended, the geographical location of the mobile device must be accessible. The use of the **map scene** requires permission to identify any proper recycling receptacles and facilities based on directional proximity. The access of location would also benefit the **information scene**, pertaining to more relevance in its material. In the creating of an account, a user may wish to connect it with a personal email address, securing the progress in the game for transfer to another device, if needed. The receiving of notifications—the unsolicited prompting of alerts for awarded content and other updates—will also require permission from the user. For the fullest experience with the app, the user can grant the sharing of content—the same as that shown in notifications—over a social media account. Permissions can be adjusted in the **settings scene**.

While the app will be small in its occupancy of storage space, the user should still consider the limited capacity of the mobile device for memory—and maintain enough room for updates. Furthermore, the memory size requirement of the app and the running of the app could slightly drain the mobile device of its processing speed.

Wherever a downloadable version of the app is found, the potential user ought to pause with concern for viruses and other unintentional attachments, whether originating from malice or incompetence. Please use only reputable app stores.

3 Getting Started

3.1 Introduction to the System

The beginning is the end is the beginning

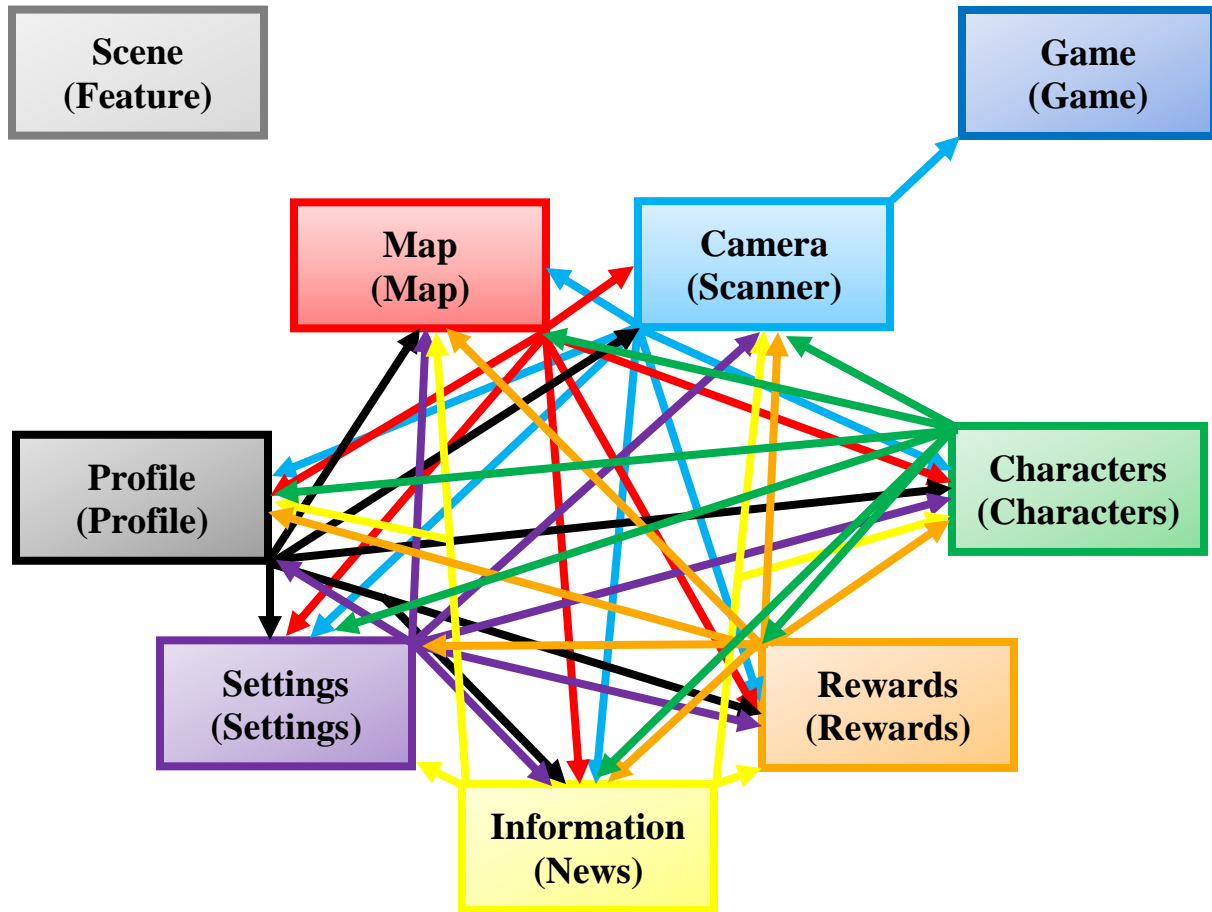


Figure 4. Web of the system: Features and their connecting network.

The app welcomes the user at the **camera scene**, as shown in **Figure 5**, with the app readily engaged to identify recyclable materials. Its other components are merely a click away: Like the colourful ball of yarn allusion in **Figure 4**, the many features of the app are interconnected and easily accessible from one to another—enabled reliably via an upper and lower panel of buttons.

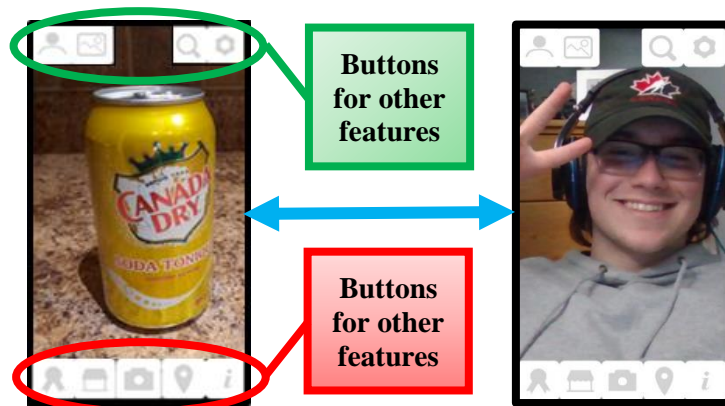


Figure 5. The opening of the app, dictated by the direction of the camera.

3.2 Set-up Considerations and Accessing the System

Modern needs, modern tools

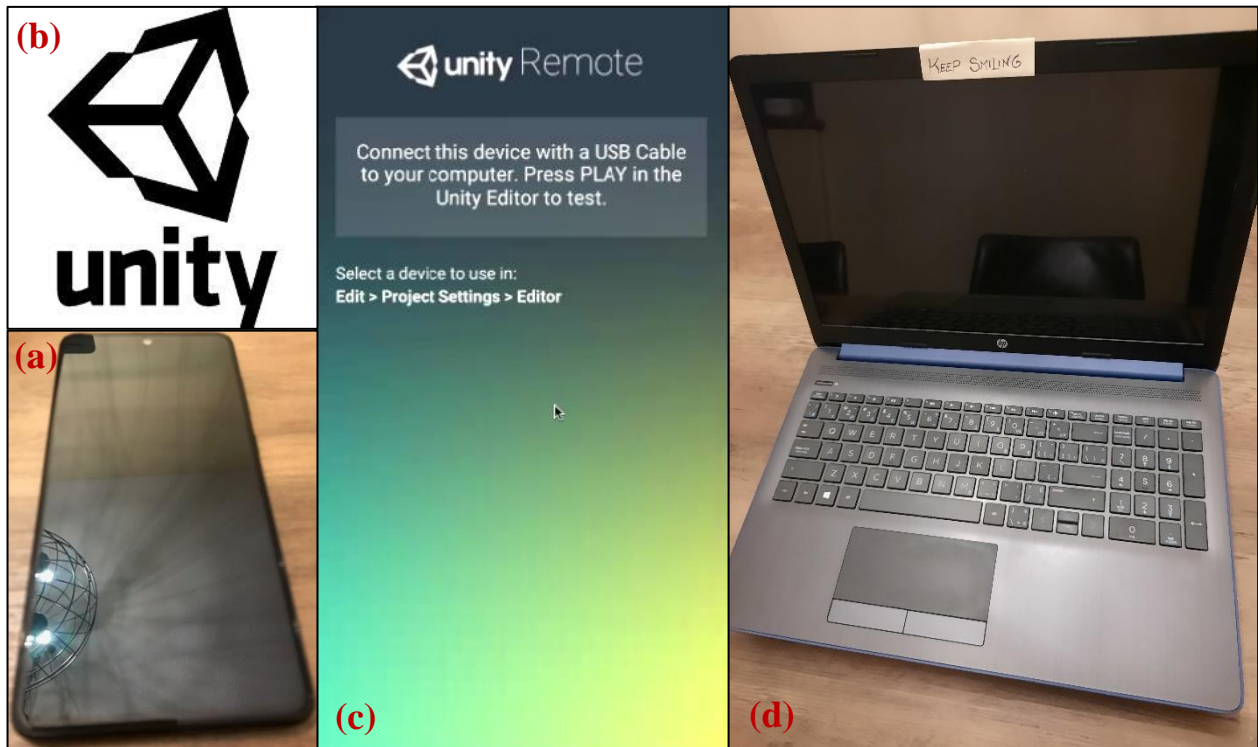


Figure 6. Equipment: (a) For a downloadable app; (a) to (d) For an unreleased app.

For the proper operation of the app, certain technological requirements are desiring of the users, as illustrated in **Figure 6**. In its rudimentary form, the app is stationed as a Unity® project. The access is therefore in request of a computer and a Unity® account. If connected to the computer, via a USB (Universal Serial Bus™) cable, a mobile device could be used—and be quite *useful* for the **camera scene** and the scanning of items. Unity Remote® allows for such a possibility. Furthermore, permission from the creators of the project—Team RS—would need to be granted to each user, notwithstanding a wider availability across public forums. Ideally, the app would be made accessible on many platforms and mediums, at the behest of Team RS. Otherwise, granting permission per user to the Unity® project makes for a tedious task; a public release is thus a better option. Note that, regarding Unity®, the access for a potential user would be to a copy of the project, not the original, lest troublemakers stay true to their name.

Once released, the app would be downloadable from an applicable store or website. The access would increase greatly for the public. The only equipment asked of the user would be a mobile device to host the app. Incredibly portable, light in weight, and unburdened by cords: a mobile device encourages exploration and convenience for the user—to actively search for recyclables or to find items serendipitously, with the app readily available.

No login necessary: Once opened on the mobile device, the app is ready for use. The app functions without requiring identification from the user. Nevertheless, connecting with an email address allows the transferable saving of game progress—and viewably shared on social media.

3.3 System Organization & Navigation

The end is the beginning is the end

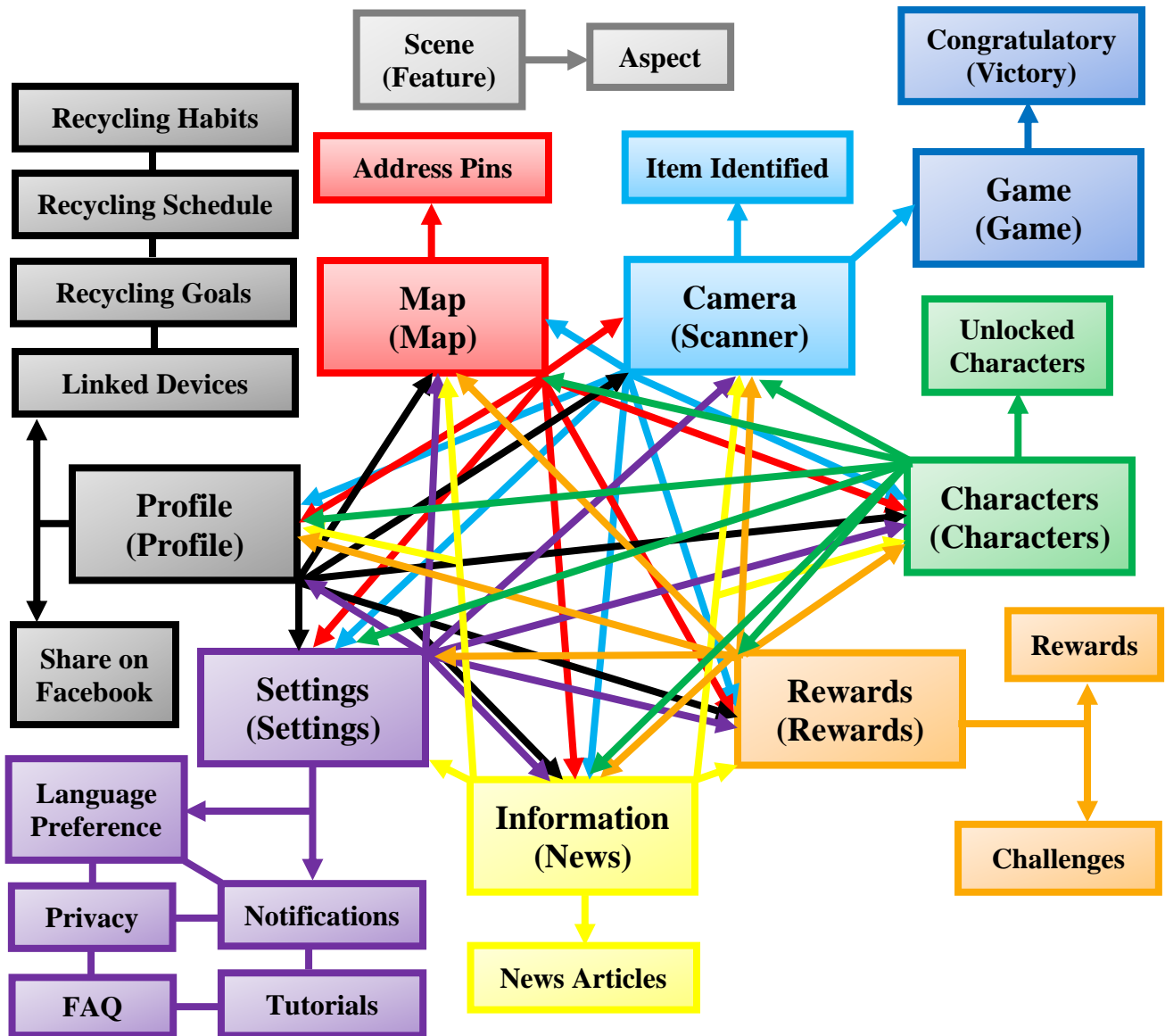


Figure 7. Web of the system, expanded: All features and their elaborate network.

The system of the app is arranged in scenes, each defined by a major feature. Aspects—options; minor features; functions—compile under the categories of each major feature. The resulting expansion of broad attributes passing into more specific ones is displayed in **Figure 7**. There, a scene is summarized by its main feature, which may share the same name as the corresponding scene; then branching out is one or more aspects. To clarify, a scene is essentially the screen of the mobile device as rendered in a distinct appearance with unique aspects. There are eight scenes, plus one escapable pop-up scene: **camera**, **map**, **information**, **characters**, **rewards**, **profile**, **rewards**, and **game**—plus a **congratulatory scene** at the completion of the game. The major feature is representative of what a scene provides, and the aspects feed into the description.

3.3.1 Subsystem: Game Component

Infotainment: learning whilst amused

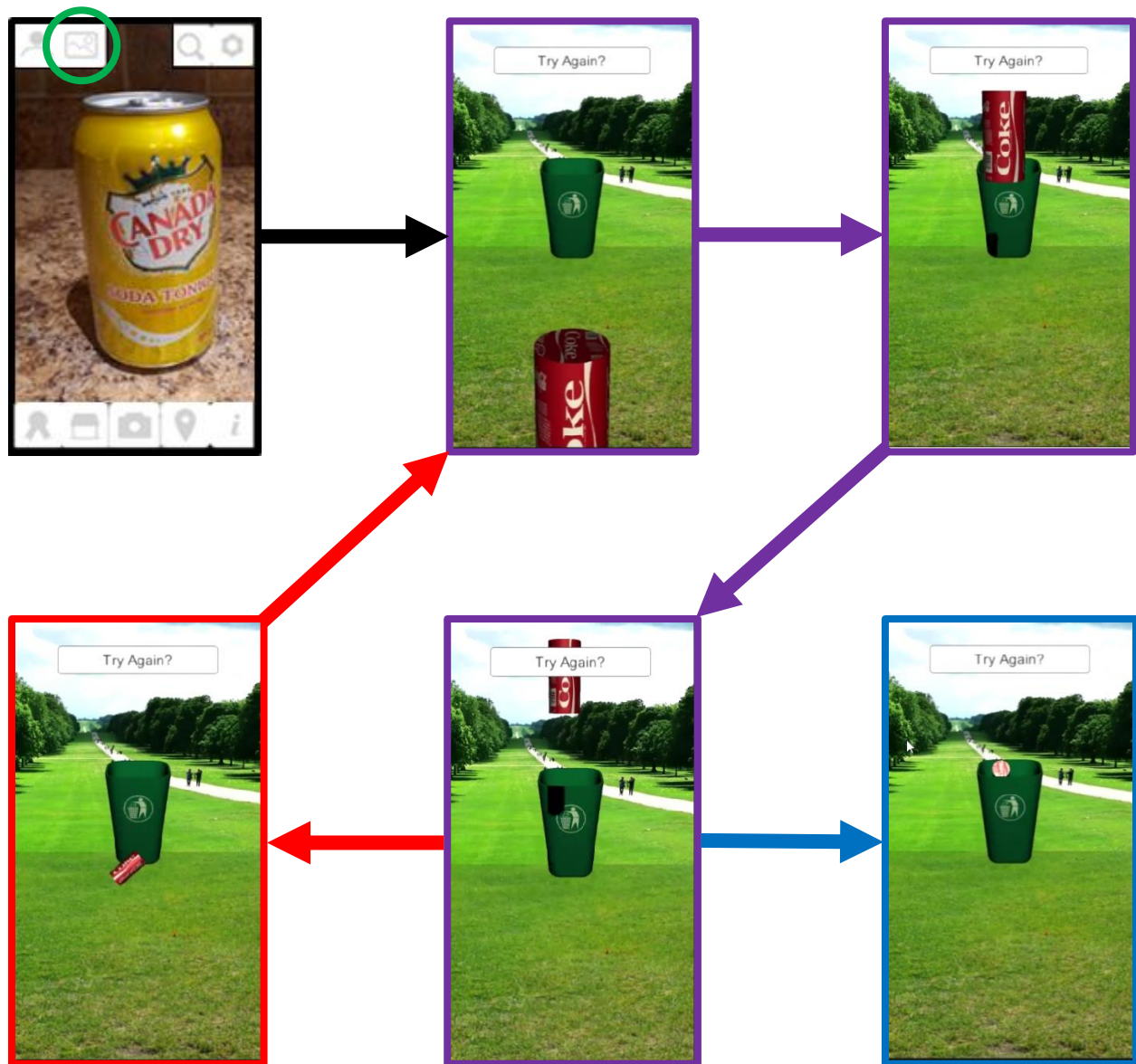


Figure 8. Sequence of a game: Ready an item, aim it, and miss or score; repeat, as needed.

A highlight of the **Recycle Savvy** app—the feature that stands it apart from other recycling apps—is its capacity for gameplay. Initiated from the **camera scene**, the button to enter the **game scene** is circled in green, as shown in **Figure 8**. The user scans an item whilst active in the **camera scene**, resulting in the readiness of the **game scene**. With a swipe of the finger or a stroke of a stylus, the user is pressed with a challenge on accuracy: Target the digital representation of the scanned item to land into a digital representation of the proper receptacle—namely, the correctly coloured recycling bin. Victory is captured in the blue-outlined panel, in **Figure 8**; the red-outlined panel demonstrates the opposite—and a need for another “throw.”



Figure 9. A victorious game in four panels.

Victory in the game is also marked with the **congratulatory scene**, as seen in **Figure 9**.

Below, a preview of the major features for the app is seen, courtesy of **Figure 10**, including the map for locating recycling bins, the game for virtual recycling, the identifying of recyclable items, and the rewards earnable through repeated gameplay.

A greater examination of all the scenes and their major features can be found in **Section 4**.

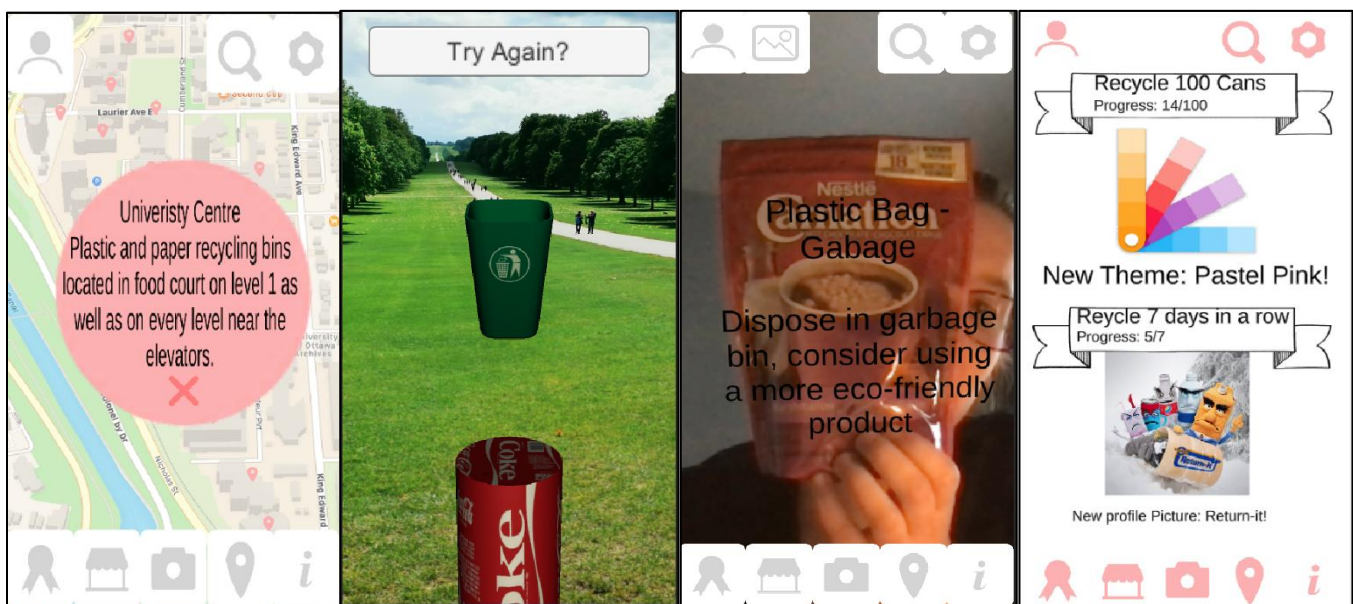


Figure 10. Significant features: The app represented in four panels.

3.4 User Access Considerations

Fun for the whole family

The intended user for the app is representative of the broadest appeal—ideally, interest will reside with persons in need of recycling assistance or encouragement. Most importantly, the targeted audience is not exclusive. Anyone can use the app—age, country or language should not discriminate. Technical updates of locational information (more address pins for added receptacles) and language preferences (more than English added) should make that possible.

Restrictions come mainly from the users themselves: Privacy absolutists—persons who are reasonably hesitant in sharing their personal information—will find limited functionality of the app, since the **map scene** and **camera scene** (and, by extension, the **game scene**) require permission to access the geographical location and camera of the mobile device, respectively.

In its form as an available Unity® project, the app is not for a computer of low processing power or low available storage memory. The interface may frustrate casual users. Eager designers, however, would embrace the format, affording them adjustments to the code as they please.

As a downloadable on a mobile device, the app would be as intended: portable and contained, requiring minimal technical knowledge from the user to operate.

3.5 Exiting the System

Goodbye for a future hello

For the app **Recycle Savvy**, the closing of the system is feasible for the user at any select opportunity, while on any scene—be it the **profile scene**, **game scene**, or otherwise. In its downloaded form on a mobile device, the app would turn off as indistinguishably from any other app: The user can swipe away the app to end its current run of activity. Alternatively, in its form as an accessible Unity® project, the app acts a window on a computer screen, so its escape follows the standard procedure: The user can click the “close” button, symbolized as like a multiplication sign. Further assurance of an exit can be accomplished by the users logging out of their Unity® account and ending that application.

4 Using the System

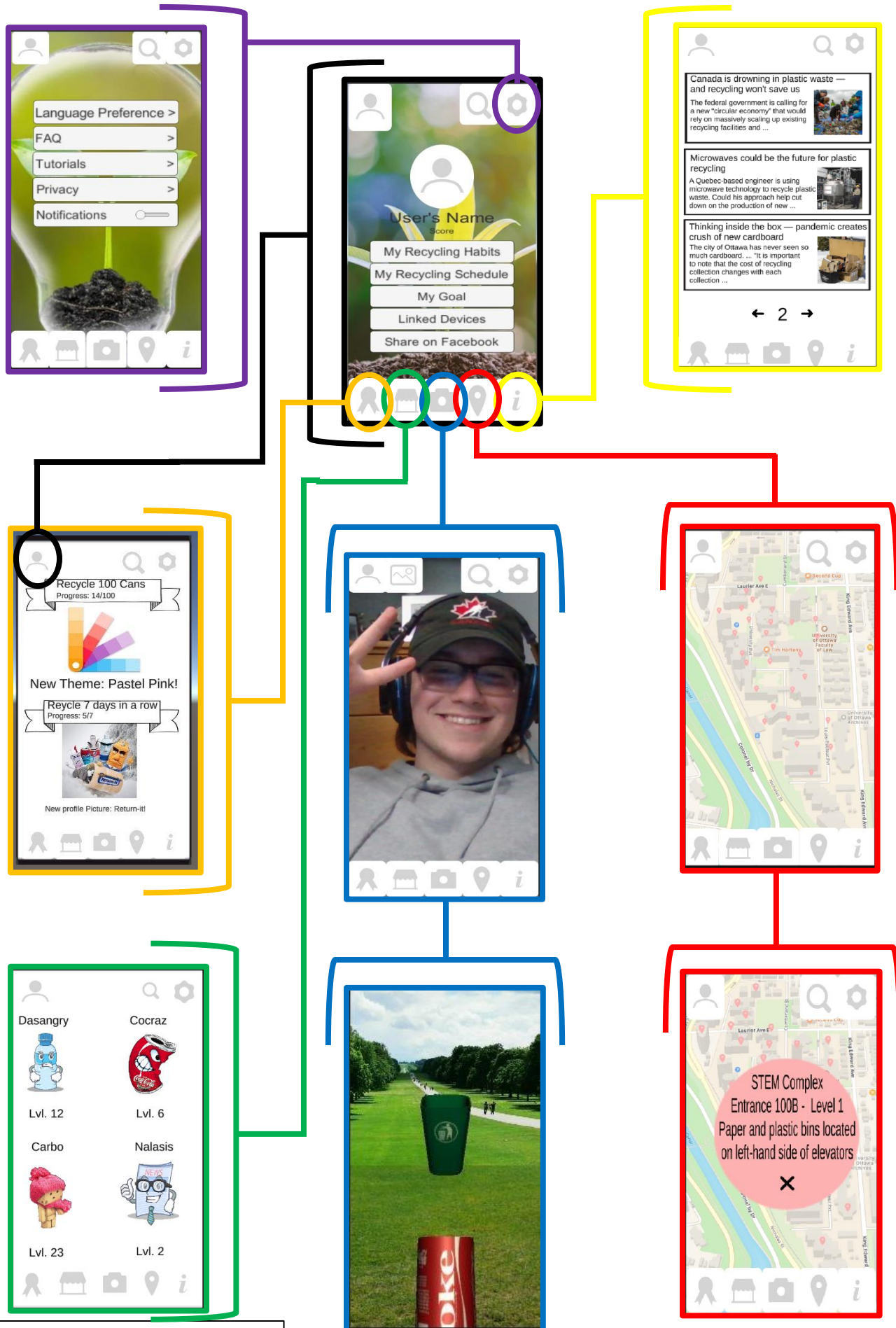


Figure 11. Web of screens.

4.1 Introduction to the Functions

Welcome to games, maps, and information

As illustrated in **Figure 11**, the app Recycle Savvy is bountiful of potential, encompassing an interactive domain of four main features, assisted by four major supplementary features that enhance the experience with the app. **Table 3** identifies these features.

Table 3. Simplified significant features on Recycle Savvy.

Main Features	Supplementary Features
Scanner	Profile
Game	Settings
Map	Characters
News	Rewards

4.2 Scanner

Found you, item!

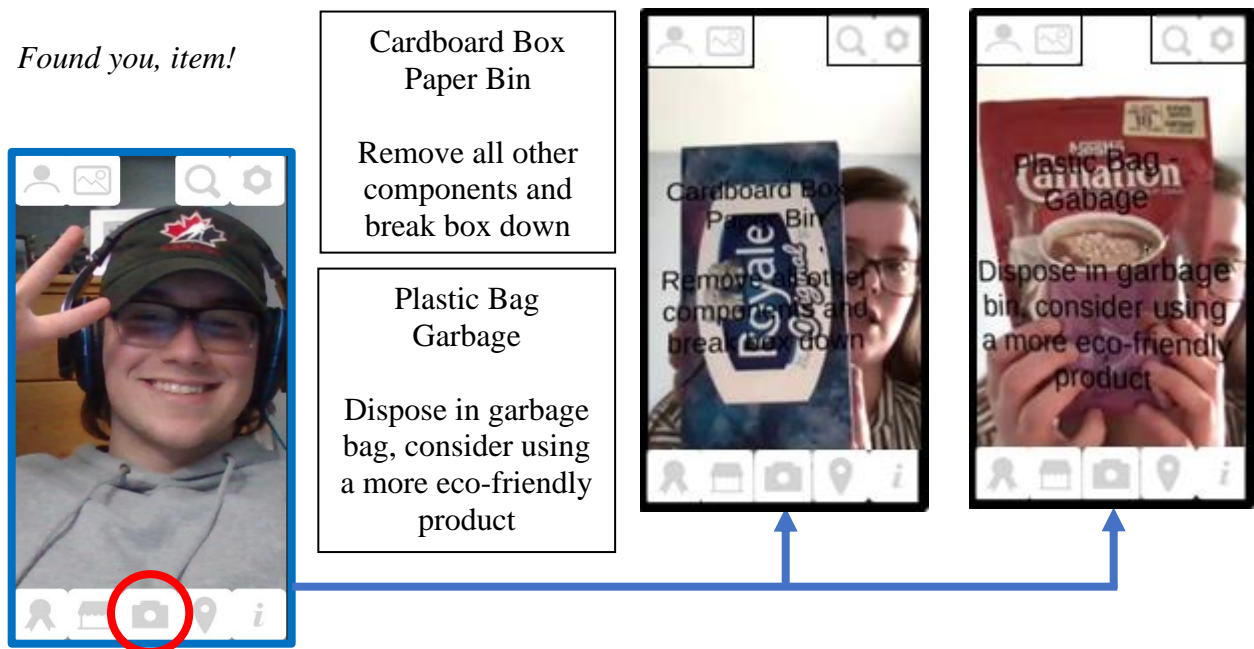


Figure 12. Camera scene: Scanning of items.

Press the middle button in the lower section of the screen, with the symbol of a disposable camera, to launch the **camera scene**—to launch the camera of the mobile device. The specified button is circled in red, in **Figure 12**. In the **camera scene**, enabled by Vuforia, an item in sight is identified and recognized by its material. The user is subsequently informed of the proper manner for recycling or disposing the item. The relevant information is relayed to the user with text appearing on the screen, superimposed upon the item—and slightly overlaying upon whatever (or whomever) else is in view near the item. On the technical front, the Vuforia database can be expanded with more items registered. Also, due to lighting issues or personal preference, a user may favour different fonts and colours for the screen text.

4.3 Game

A scan, a toss, and a win

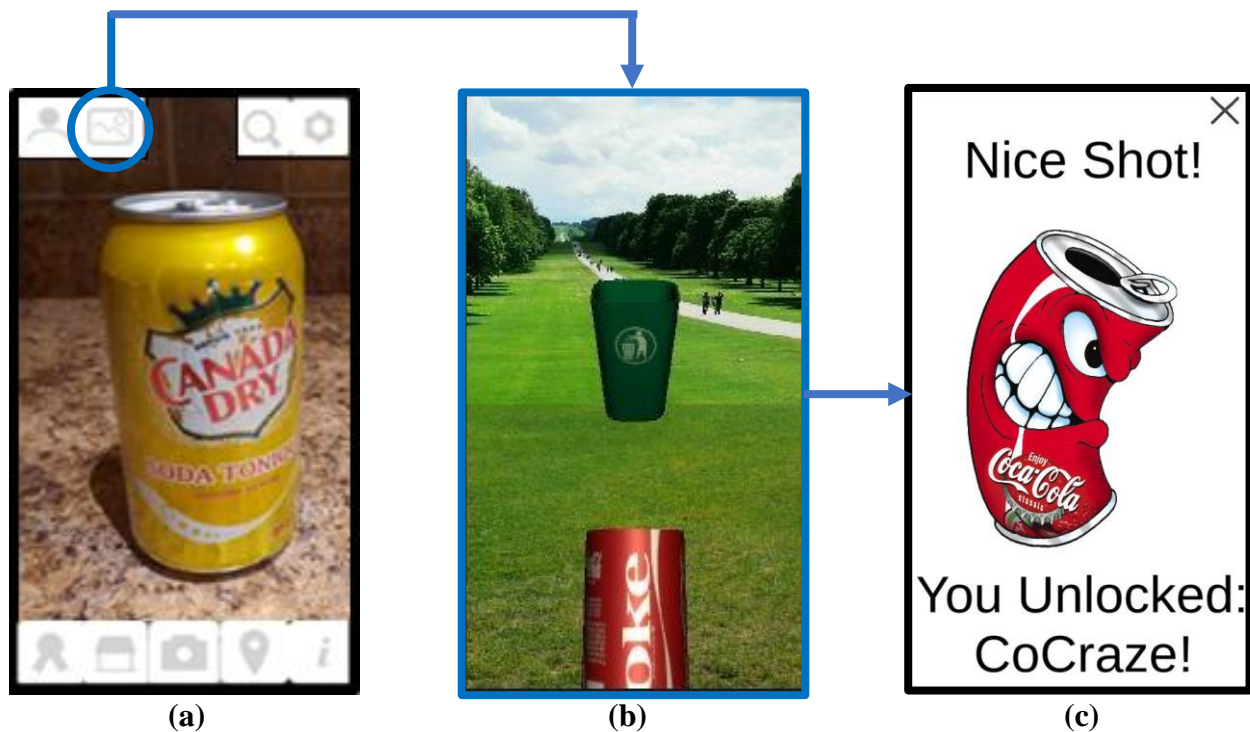


Figure 13. Game scene: Gameplay activation and completion.

Press the middle-left button in the upper section of the screen, with the symbol of scenery (a crude drawing of the Sun over a hill), to launch the **game scene**. The specified button is circled in blue, in **Figure 13 (a)**. Note that the button is only available if the user is already engaged with the **camera scene** (scanning feature). There is nevertheless reason for this choice of design: The scanning of an applicable item is the means to access the gameplay with a digital recreation of that item. Thus, absent the probe of scanning, no item would be represented in the game—hence no game would become available or possible. Cannot make a true apple pie without apples: Cannot launch a game without an item selected. The activation of the gameplay is demonstrated in the transition from **Figure 13 (a)** to **(b)**.

The **game scene** allows the users to take the item that they have scanned and figuratively “toss” it into a recycling bin. That is, a caricatural or literal display of the item, such as the Coca-Cola™ can in **Figure 13 (b)**, is transposable by a user’s finger(s) making a swiping motion upon the screen. The representative item is located at the bottom of the screen, and the objective of the game is in aiming and landing that item into the receptacle at the opposite end of the screen. Furthermore, the manipulation of the item is not restricted to just contact with a user’s touch, for a stylus should serve the same function—rather, the limitation is on the chosen mobile device.

Once the users succeed at tossing the item into the proper bin (receptacle), the game ends and a **congratulatory scene** is presented, revealing to the users what they have unlocked, as shown in **Figure 13 (c)**. The users can be rewarded with various icons, themes, and profile pictures.

4.4 Map

Found you, bin!

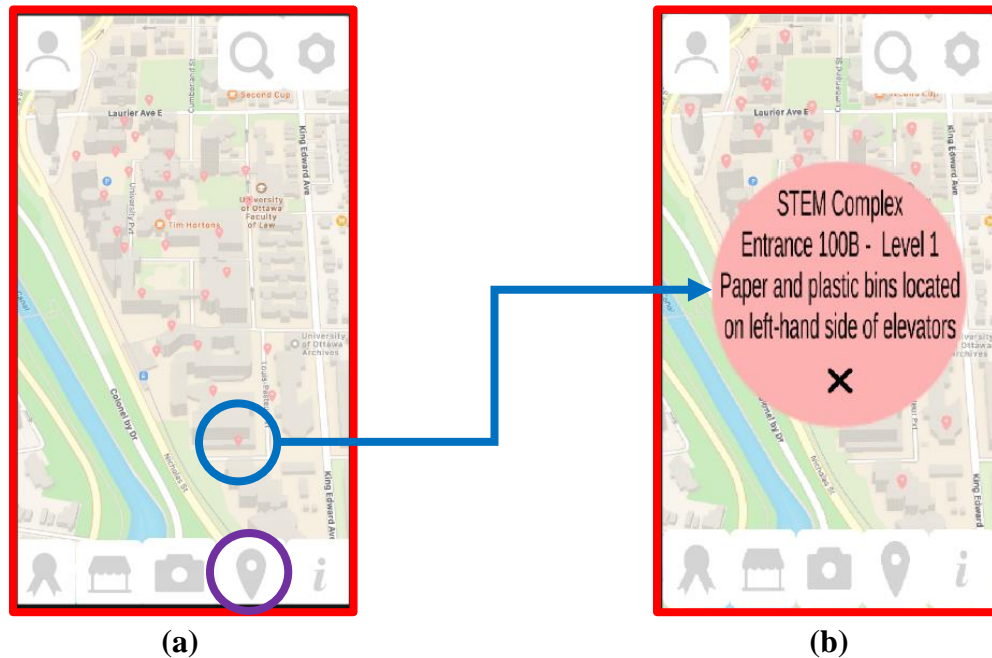


Figure 14. Map scene: Locations of available recycling receptacles and facilities.

Press the middle-right button in the lower section of the screen, with the symbol of a pin (appearing like a fat sewing needle), to launch the **map scene**. The specified button is circled in purple, in **Figure 14 (a)**. When granted permission to the geographical location of the mobile device, the map feature of the app displays any nearby recycling bins or facilities to the user. Visually, the points of interest are represented as clickable pink pins on a road/navigational map. A circular information panel is opened once a single pin is pressed like a button on the screen, prompting descriptions for a more precise location to the bin (i.e., if a building, the floor number) and for the acceptable materials (plastic, glass, paper, etc.) that can be deposited in that bin. The reveal of elaborated information for a specified receptacle is demonstrated in the transition from **Figure 14 (a)** to **(b)**. Also, for demonstration, most recycling bins on the University of Ottawa campus have been registered onto the app. Distinct for a recycling facility, its pink pin would relay its hours of operation as well as its accepted materials. Note that manipulation of the screen is available in the map feature: With the touch of the fingers, the user can search the area and increase the magnification to expose more pink pins—hence the difference in the number of pins between **Figure 14 (a)** and **(b)**, with the latter having a “zoomed in” view.

4.5 News

What is new in the world of recycling?

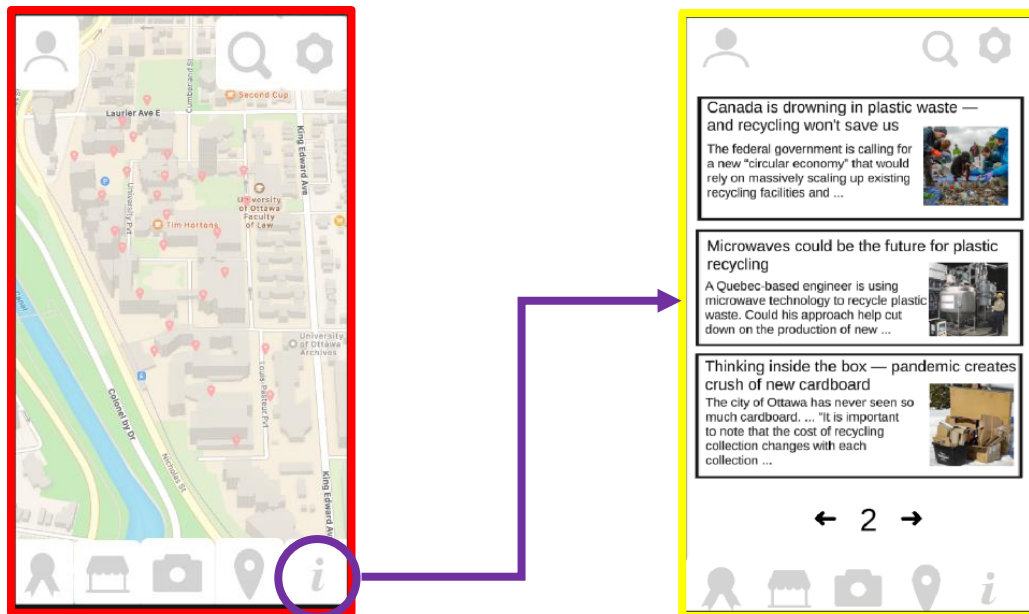


Figure 15. Information scene: Accessing topical news articles on recycling.

Press the far-right button in the lower section of the screen, with the symbol of an italicized lowercase “i,” to launch the **information scene**. The specified button is circled in purple, in **Figure 15**, expressing the easy transition from the previous **map scene**, just as an example, to the **information scene**. There, relevant news is displayed on recycling, with preference for the location of the user—or rather of the mobile device, to be pedantic. The scope of the location could be as specific as the current city, county, or region and as broad as the country, continent, or even worldwide. The subject of the news articles would be tailored to recycling advice, recent concerns, updates on procedure and protocol, and upcycling—the practice of repurposing materials that what would be otherwise discarded: a bucket, damaged with unintentional holes, turned into a planter, for instance. On the screen, the articles are arranged by the headline, with a few lines of the body readable. A click on an article preview will send the user to the actual article, to whatever its host site. Also, for the **information scene**, the user can click on a forward or reverse arrow to explore the next or previous page, respectively, on which other articles are presented. The index of news is organized into pages, rather than compiled into a single scroll.

4.6 Profile

Personalize, organize, and connect

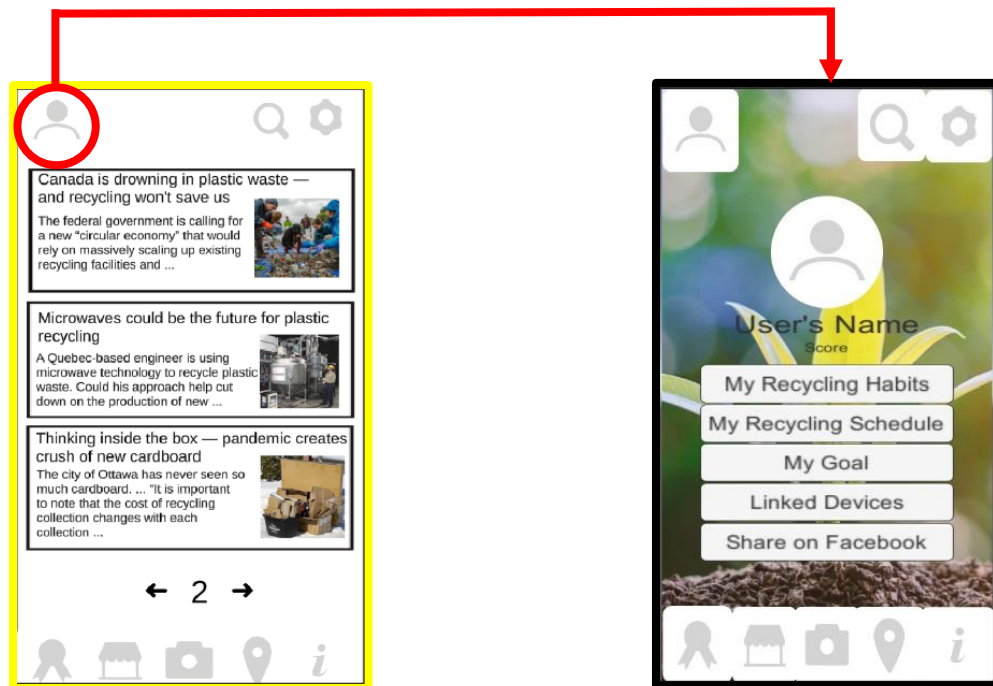


Figure 16. Profile scene: Personal account for the user.

Press the far-left button in the upper section of the screen, with the symbol of a person in outline (from the shoulders and up), to launch the **profile scene**. The specified button is circled in red, in **Figure 16**, whereby showing the transition from the previous **information scene**, just as an example, to the **profile scene**. There, the users can view and adjust their recycling habits and goals, connect through social media—namely, via the Facebook™ platform—and link devices. The social media option permits the sharing in news of achievements from a user’s gameplay progress, and the linking of devices secures that gameplay progress in the case of the mobile device becoming damaged or lost. The “My Recycling Schedule” button, once clicked, leads a user to the City of Ottawa disposal schedule, readily answering which materials are being retrieved, for a certain week, at the user’s selected address. Note that all the options displayed on the **profile scene** act as clickable buttons.

4.7 Settings

Comprenez vous?

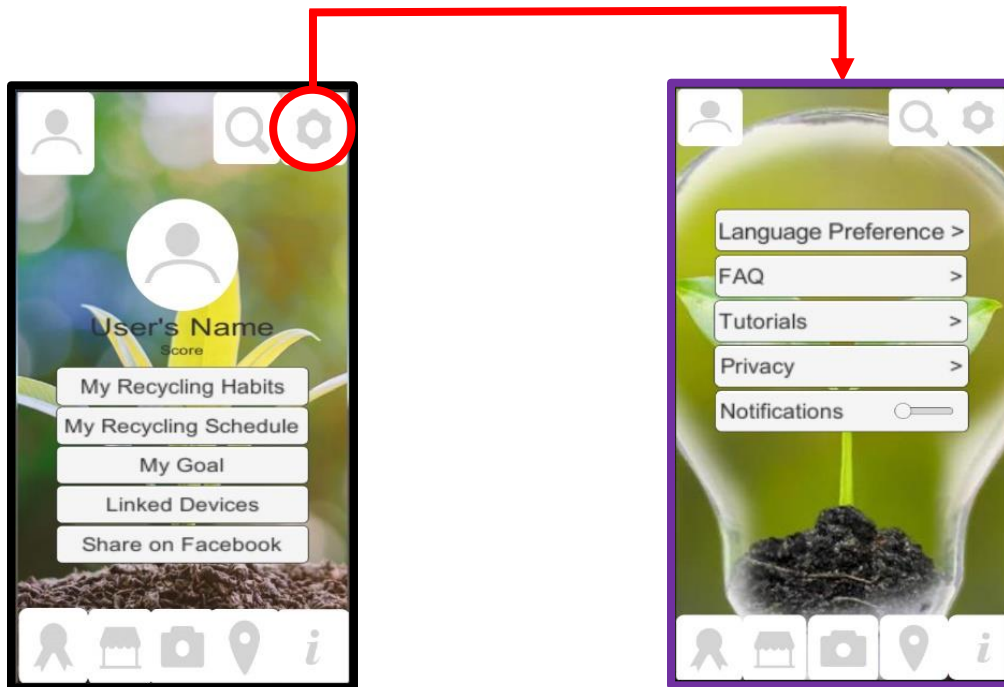


Figure 17. Settings scene: Accessing the menu of general options and inquiries.

Press the far-right button in the upper section of the screen, with the symbol of a gear, to launch the **settings scene**. The specified button is circled in red, in **Figure 17**, whereby showing the transition from a previous scene (**profile**, as an example) to the **settings scene**. There, the users can customize their experience with the app in terms of language, privacy, and notifications. Presently, only the English language is available. The privacy option pertains to permission: The user can grant the app access to the camera and geographical location of the mobile device. Such permission allows the app **Recycle Savvy** to function as intended. The receiving of notifications—the prompting of alerts for awarded content and other updates—is a binary decision: either slide right to allow or left to disallow. The tutorials and frequently asked questions (FAQ) sections would ideally resolve any ambiguity a user may harbour with the app and its features: “How does one play the game?”, “What rewards are possible?”, and “Will the app ever ask for money from the user?” (The answer to the last inquiry would be a negative.) Note that all the options displayed on the **settings scene** would act as clickable buttons.

4.8 Characters

Cute and creative: Recyclables as anthropomorphic cartoons

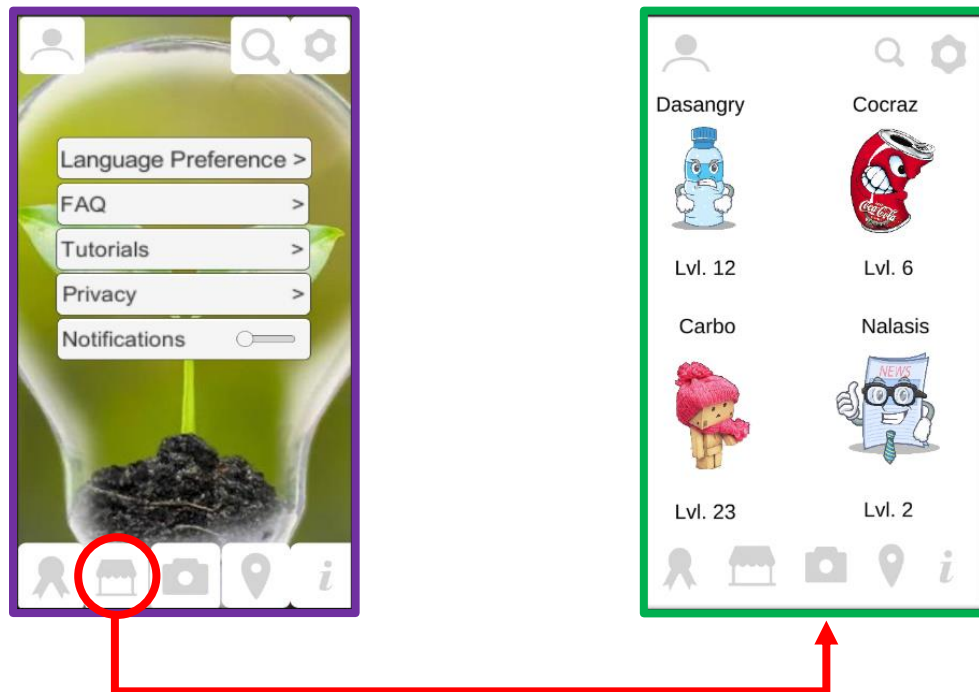


Figure 18. Characters scene: Unlocking and upgrading collectibles.

Press the middle-left button in the lower section of the screen, with the symbol of a canopy, to launch the **characters scene**. The specified button is circled in red, in **Figure 18**, showing then the transition from a previous scene (**settings**, as an example) to the **characters scene**. There, the users are presented with their “captured bounties”—the visualization of their progress in the game for acquiring collectibles. Through gameplay, the user scans an applicable item and claims victory by successfully launching a digital version of that item into the proper receptacle, made available on the screen—that item is then showcased in the **characters scene**. Notably, anthropomorphism and creativity are embraced in the character designs. As a user captures more of the *same* item, the relevant character will increase in its level. Alternatively, as a user captures more items of *different* materials, more characters will be distinctly revealed. With increased unlocking of characters, the user can swipe downward to view them on the **characters scene**. The index of characters is compiled into a single scroll, rather than organized into pages. Overall, on the **characters scene**, each character is identifiable by its caricature, name, and level. Note that the characters are not clickable buttons.

4.9 Rewards

Collectibles and user retention for the win!

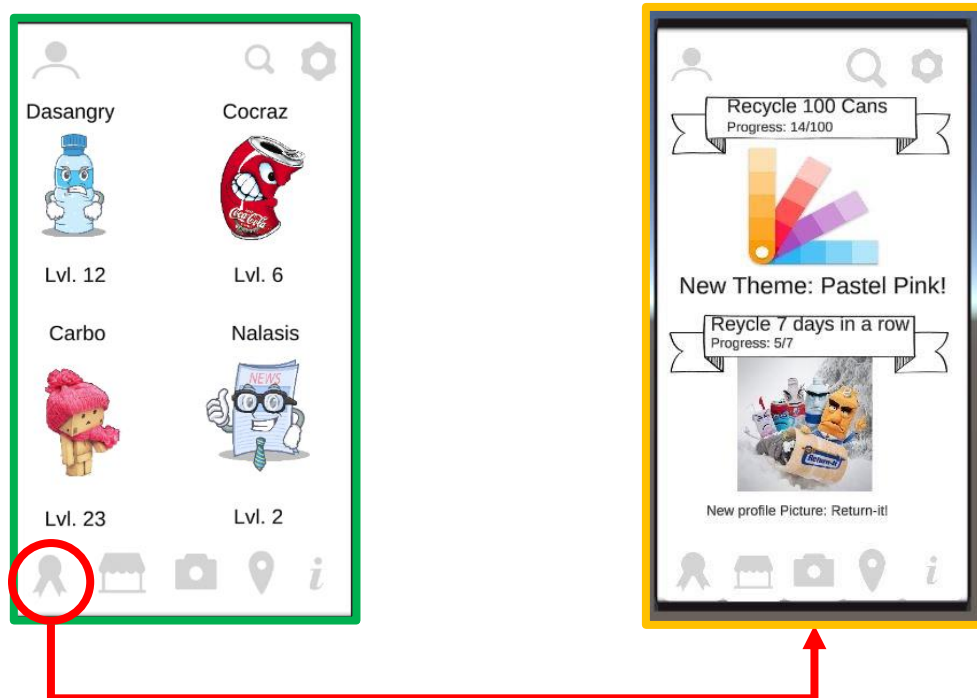


Figure 19. Rewards scene: Showcase of gameplay milestones for the user.

Press the far-left button in the lower section of the screen, with the symbol of a ribbon, to launch the **rewards scene**. The specified button is circled in red, in **Figure 19**, showing then the transition from a previous scene (**characters**, as an example) to the **rewards scene**. There, the users are presented with their “earned bounties”—the visualization of their progress in the game for acquiring collectibles and reaching milestones. Displayed are challenges and achievements for the users; upon their completion, the users are gifted with rewards—customization features such as new themes, icons, and special features. Note that the rewards are not clickable buttons.

4.10 Supplementary Information on the Functions

Barring one exception, all features are accessible on all scenes. The user can click from the **camera scene** to the **map scene**, to the **information scene**, to the **profile scene**, to the **settings scene**, to the **characters scene**, to the **rewards scene**, and in any order thereof. The **game scene** is only available through the **camera scene**; the reason for which is given in its **Section 4.3**—that is, the presence of a scannable item is required for the launching of the game.

Search scene: An additional feature is of future consideration for the purpose of locating content across the app. To access, the middle-right button in the upper section of the screen, with the symbol of a magnifying glass, would be pressed. A search bar would be presented, into which the user could type words and terms. Recommendations, with clickable links, would appear.

5 Troubleshooting & Support

5.1 Error Messages or Behaviour

The lynchpin to the fullest operation of the app is its database. Errors will arise for the user in the absence of identifiable items and addresses from the database. Features of the app will improperly or sub-optimally function in their absences—in their lack of registry within the app. Specifically, scannable items are required for the **camera scene** and **game scene**, while addresses for recycling facilities and receptacles are needed for the **map scene**. Thus, without these crucial details programmed into the app, a scan in the **camera scene** will yield no findings and the **map scene** will remain empty of clickable locations. The user could be standing immediately next to a recycling bin, yet the **map scene** would be barren. The user could be aiming the camera directly at a recyclable can, yet the **camera scene** would be blind.

Obscured view of the targeted item can also render issue with the performance of the app. The **camera scene** requires clearly visible items for scanning, hindered by neither physical blockage nor a dirty appearance. For a better resolution, isolate the item and wipe it if needed. Also, adjust the proximity to the item; greatly zooming in or out the magnification of the camera can blur the identifiability of the item.

5.2 Maintenance

The solution for the forementioned errors of absences is an updated database. New recycling facilities and receptacles are continuously being made, as are new recyclable items, just as their removals too are possible: The database requires constant revisions. A recycling bin can be newly placed or removed, and the app should reflect that change. New products of recyclable materials also need to be recognized by the app. Thus, for the success of the app, a team member would have to scan distinct items and input their identifies into the database, via the Vuforia® software. As more items are registered, the database expands in size. For the map, a team member would have to consistently program for locational changes—create new address pins or delete those that are no longer correct. Such tasks demand a larger and evolving workforce.

5.3 Support

For comments and concerns, Team RS can be contacted through recyclesavvy@gmail.com as the joint email address shared by all three members. Once a message is received, one team member will provide a response and proceed with care for further correspondence, if requested.

To avert the message from being incorrectly assigned as spam or junk mail, please summarize the main issue in the subject line.

Recipients: Cole Schieman, Melissa Helm, and Scott Whittington—Team **Recycle Savvy** (RS).

6 Product Documentation

6.1 Evolution of the Design

Inspiration, creativity, and determination—and trial and error

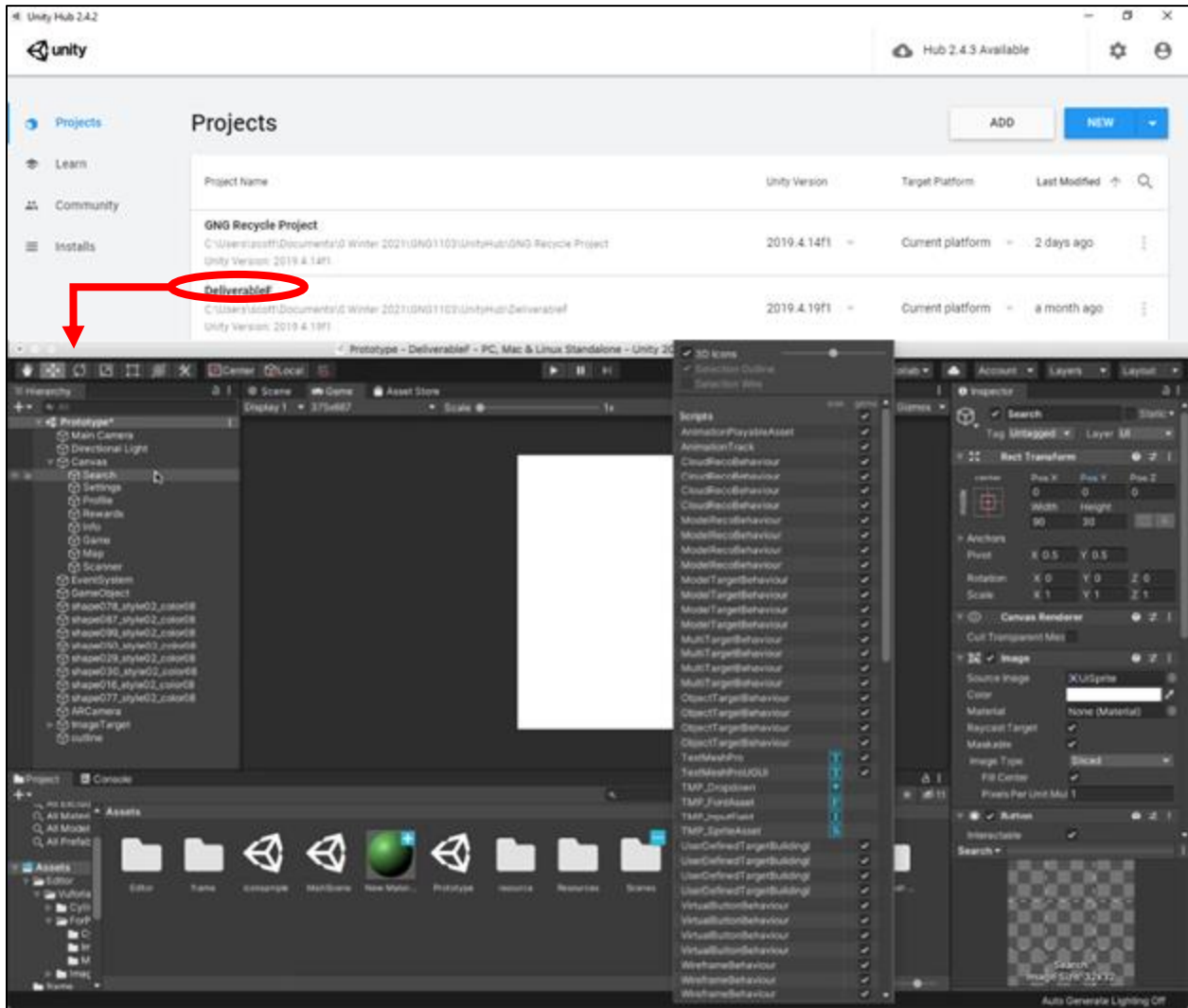


Figure 20. Standard setup of the Unity® project.

From brainstorming to benchmarking, to then prototyping, Team RS has configured an app to address the reluctant participation of the public with recycling. With the Unity® platform, in juncture with Vuforia® software, the app arose from coding script and spatial arrangements of scenes and aesthetics, as partially previewed in **Figure 20**.

The changes to the design of the app are documented, arranged into subsections by scenes.

6.1.1 Camera Scene

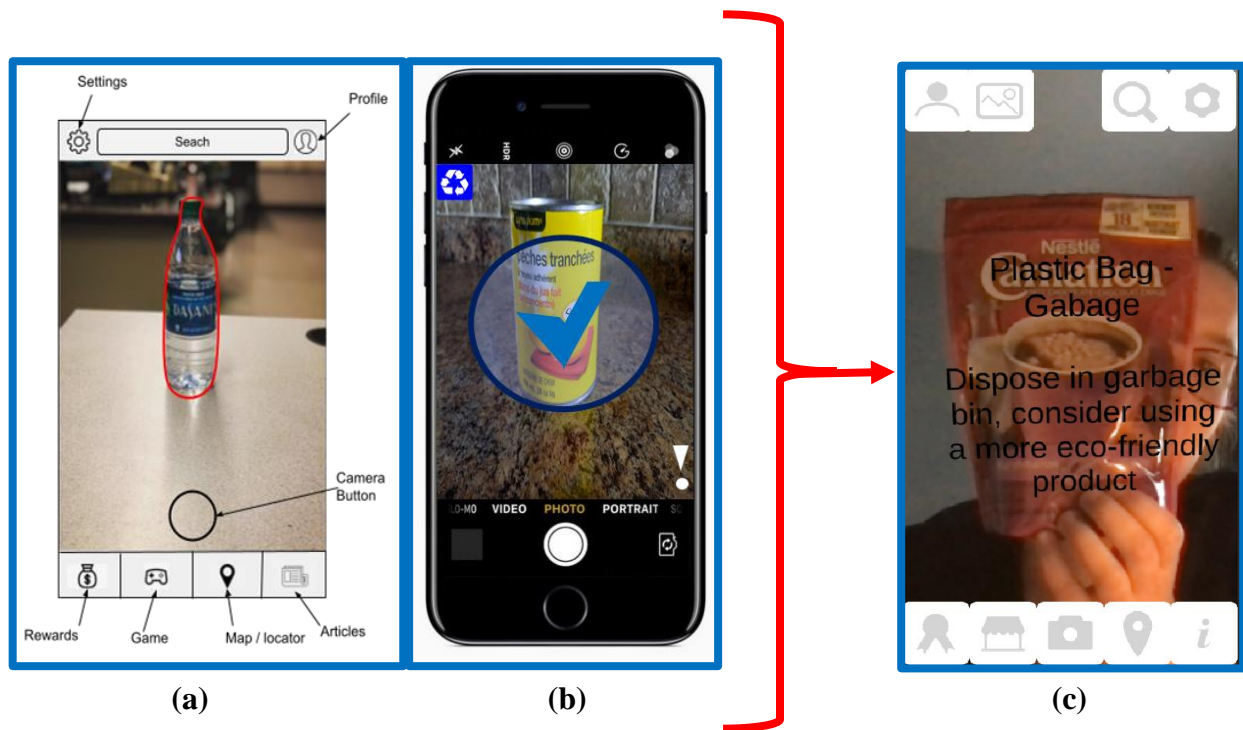


Figure 21. Camera Scene: From concept to result.

As shown in **Figure 21 (b)**, a suggested interface for the recycling app was as a button, as a pressable featured added to the camera of the mobile device. Once the app was downloaded, an icon would have appeared in the upper left corner of the screen whenever the camera function of the smartphone was selected. The button would have been of a most minor size, as though to be simultaneously noticeable yet undistracting. With the app as a fixed feature on the camera, the user would have a greater success in remembering the app.

Clearer technical feasibility made the scenario in **Figure 21 (a)** the preferred avenue to explore: An app open to itself, not as an extension—or *widget*—to the camera. Recyclable items would be identified in red outline. Panels would be a permanent fixture on the screen, linking to supplementary information. Improvements lead to **Figure 21 (c)**, the current version of the **camera scene**, where information about the recyclable item is displayed directly on the screen without a need of the user to press a button or click the item.

6.1.2 Game Scene

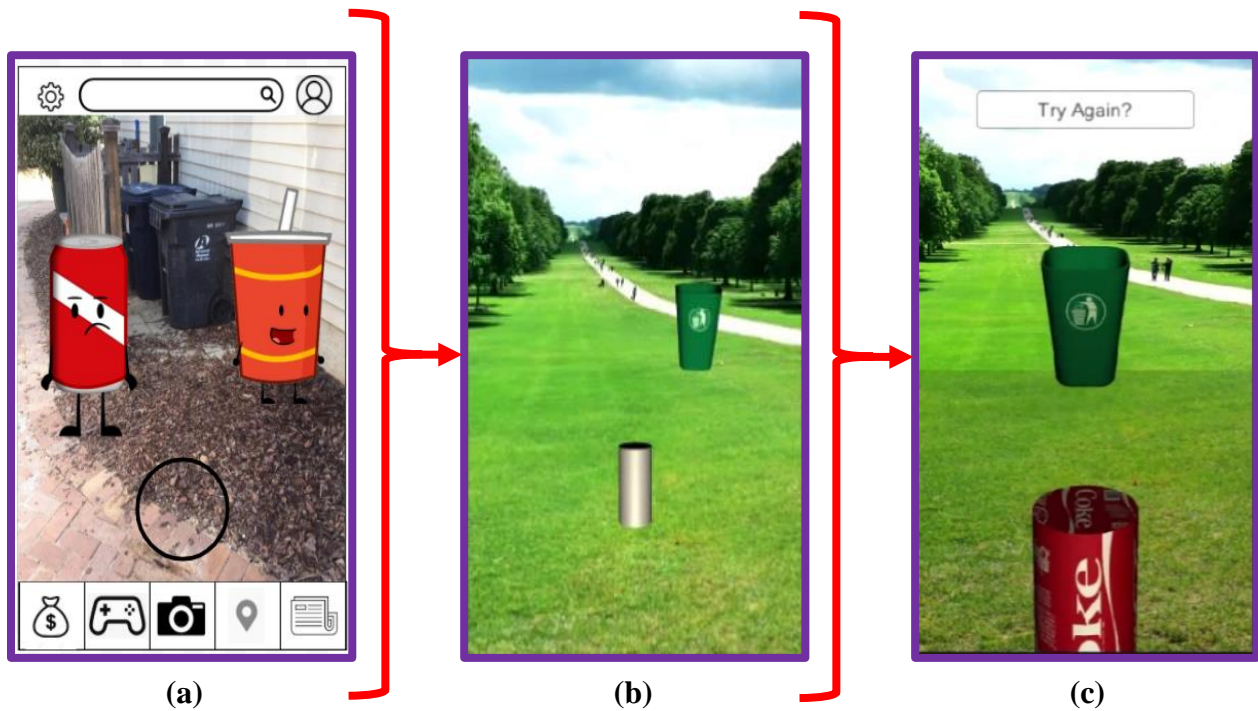


Figure 22. Game scene: From concept to preliminary result, to amended.

The **game scene** morphed in its objective, changing from asking the user to “throw” a capturing device at recyclable items to instead “throw” those recyclable items into a receptacle. The hunt-and-capture game, as seen in **Figure 22 (a)**, did not convey the means for proper recycling—only did it inform what items were recyclable. Thus, the ball-in-bucket-like game of **Figure 22 (b)** was truer to educating the user: Both a recyclable item and its proper receptacle were to be identified. Aesthetical improvements lead to **Figure 22 (c)**, the current **game scene**.

6.1.3 Settings Scene & Profile Scene

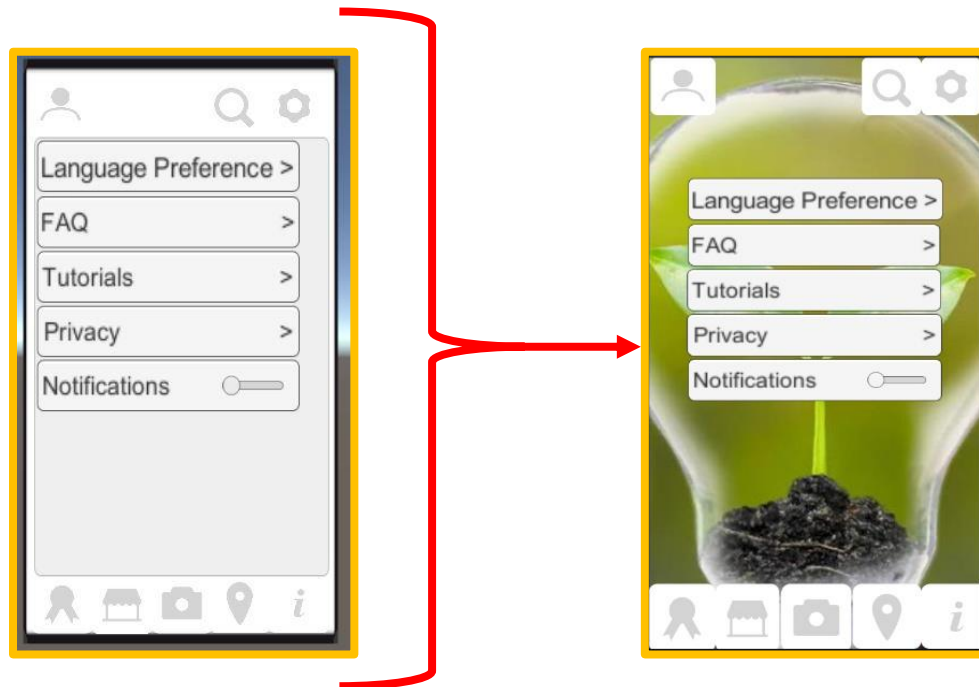


Figure 23. Settings scene: From earlier to later design.



Figure 24. Profile scene: From concept to design.

Uncomplicated: Aesthetics merely dictated the changes seen in **Figure 23** and **Figure 24**. Products with a more colourful appearance can be reasonably more appealing for potential users.

6.1.4 Map Scene

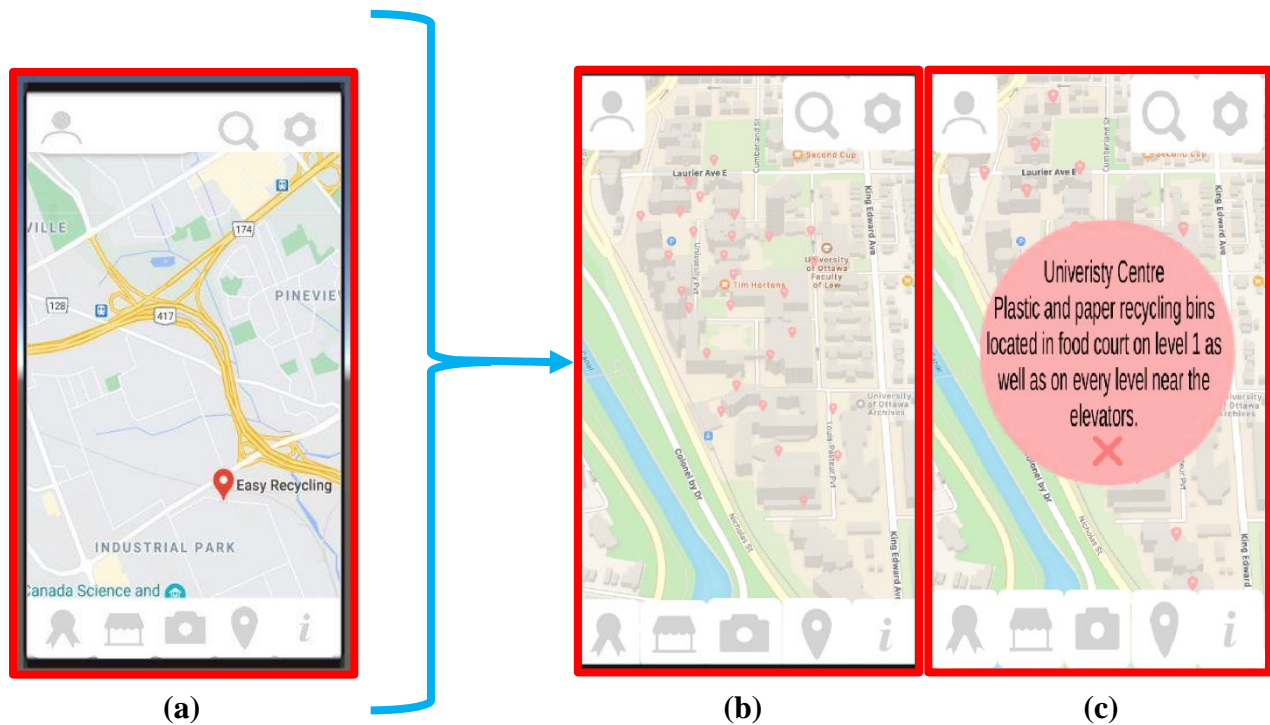


Figure 25. Map scene: From earlier to later design.

The **map scene** expanded in its scope. In the previous version, as displayed in **Figure 26 (a)**, only recycling facilities were the target, whereby providing the user with a pinned location on a navigational/road map for each facility. The map seemed barren, so a wider inclusiveness of locations was pursued. Numerous more locational pins are shown in **Figure 26 (b)**, representing recycling receptacles (bins) as well as recycling facilities. There, the University of Ottawa campus serves as a basis—as a sample of the capability of the app. Furthermore, as demonstrated in **Figure 26 (c)**, a locational pin also now exposes supplementary information when clicked as a button. The user is prompted with a specific address—that is, directions: which building and which floor—and what materials are accepted at that corresponding location.

For all the changes shown, for whichever scenes affected, Team RS operated by consensus. Inquiries were raised on whether a proposed change helped the functionality or appearance of the app—or, worse, was it detrimental. Group discussions were held weekly.

On the topic of group meetings, the outlined schedule is presented in the next section.

6.2 Schedule

Team work to the rescue—But: The fewer the members, heavier the load on each

A group size of merely three members does not lend itself to much viable division for assigning tasks. The only options stand as three parties of one member each or as a party of two, with another party of one member alone. Such options place unnecessary and burdensome demands on individuals and greatly diminish collaboration—the centerpiece in teamwork. In contrast, a typical group of five members would have been more generous in possible divisions: Parties of two and three members still provide many opportunities for collaboration. Thus, for this group, all three members were responsible for each and all deliverables, as displayed in **Table 4**.

Table 4. Tasks and their corresponding owner, time frame and due date.

Task	Owner	Duration	Due Date
Deliverable A: Team Contract	All Members	3 days	January 24, 2021
Deliverable B: Needs Identification and Problem Statement	All Members	7 days	January 31, 2021
Deliverable C: Design Criteria	All Members	7 days	February 7, 2021
Deliverable D: Conceptual Design	All Members	7 days	February 21, 2021
Deliverable E: Project Schedule and Cost	All Members	7 days	February 28, 2021
Deliverable F: Prototype I and Customer Feedback	All Members	12 days	March 7, 2021
Deliverable G: Prototype II and Customer Feedback	All Members	7 days	March 21, 2021
Deliverable H: Prototype III and Customer Feedback	All Members	14 days	March 28, 2021
Deliverable I: Design Day	All Members	9 days	April 8, 2021
Deliverable J: Final Project Presentation	All Members	6 days	April 13, 2021
Deliverable K: Archive/User Manual	All Members	14 days	April 18, 2021

For the successive phases in designing the app, their coordination was established through the Wrike® project management application, as presided by team member Melissa Helm. Tasks—subcategories of the deliverables—were assigned, and message reminders were sent. Examples of the Wrike® format are displayed in the figures below, as mainly pertaining to Deliverable D.

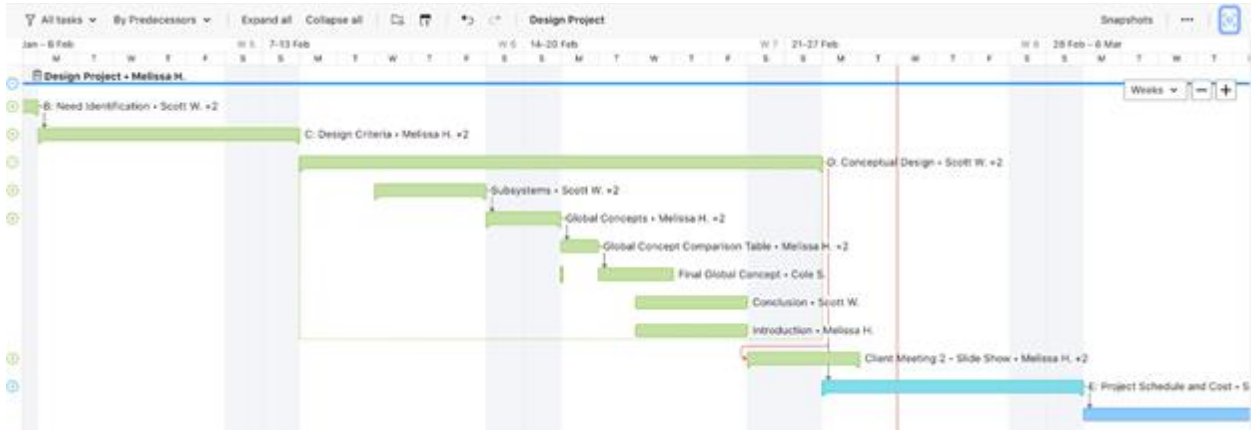


Figure 26. Gantt Chart: Deliverable D and the project dependencies.

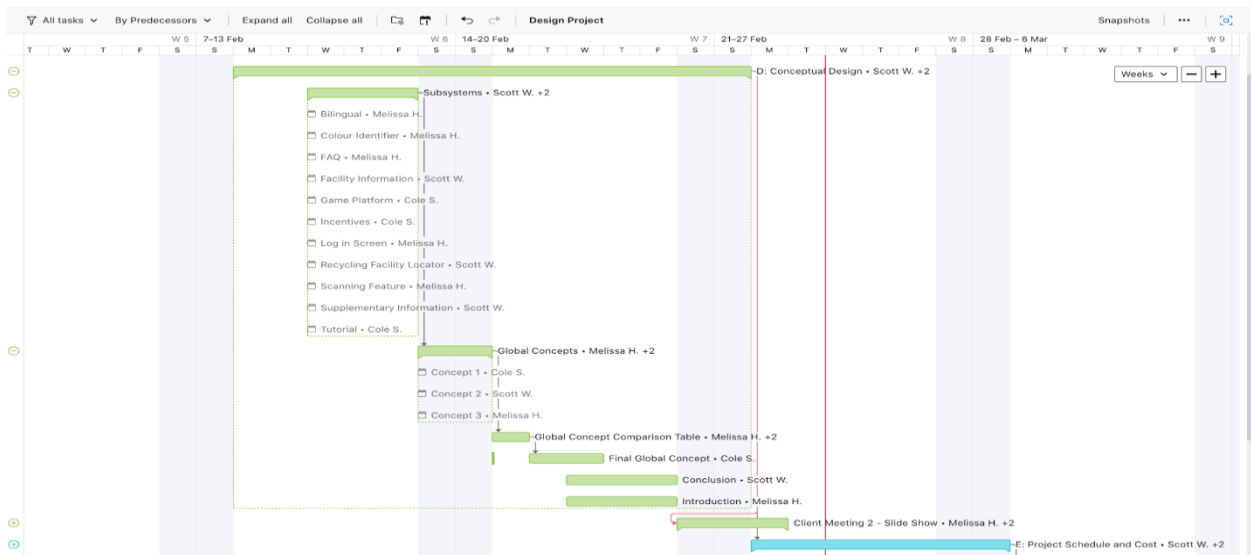


Figure 27. Gantt Chart: Deliverable D by subtasks and assignees.

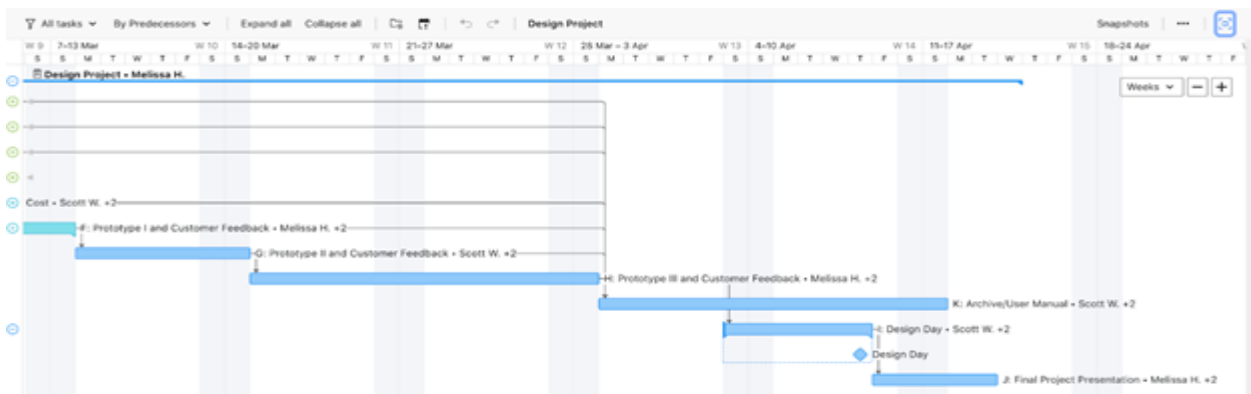


Figure 28. Gantt Chart: Design Day shown as a milestone.

6.3 Risk & Contingency Plan

Prepare for the worst; strive for the best

In the making of the app, Team RS anticipated possible issues that could hinder progress—or, at least, provide a few headaches. The three team members planned accordingly, as demonstrated below in **Table 5**. Indeed, some predictions came true: Features were reconsidered and altered for reasons of feasibility, as **Section 6.1** explains. Also, the Unity® platform emerged as only operational for two of the team members—and tasks were thusly re-assigned and reordered.

Table 5. Risks that may affect the design project, paired with contingency plans.

Risk	Likelihood	Severity	Contingency Plan
Infeasible app feature	Moderate	Moderate	Collectively decide whether the app will satisfy all design criteria in the absence of that feature; or determine an alternative feature
Inaccurate or unrealistic timelines for deliverables	Low	Moderate	As a team, re-evaluate the deliverable timelines; modify the schedule
A team member cannot complete an assigned task	Low	High	Divide the task among the other members, minimizing delays
Poor functionality of the chosen development platform (Unity®)	Low	Moderate	If only one member is affected, encourage use of a different computer. Otherwise, rely on the other members to code, while the affected member will instead focus solely on the writing of deliverables (and other non-coding tasks). If all members are affected, utilize a different platform.

6.4 Replication: Subsystems of Design

The app **Recycle Savvy** is a product generated on the Unity® platform, whilst benefiting from payment-free components and materials. With some exception, the subsystems of the app are made strictly on the game engine, advantaged by already owning computers. Other subsystems require additional equipment and software. For the **characters scene** and **rewards scene**, their designs can be acquired from the public domain or payment-free packages of icons—or by embracing the creativity of oneself.

Below, the subjects are organized by bill of materials, equipment and, if applicable, coding script.

6.4.1 Information Scene

For the **information scene**, news articles are clickable links on the screen. The Unity® platform is used to arrange the appearance and implement coding script, with a computer for interaction.

Table 6. Information scene: Bill of materials.

Item #	Item	Quantity	Unit Price	Amount
1	Unity® 2019.4.19f1	1	\$0	\$0
Total				\$0

Table 7. Information scene: Equipment.

Item #	Item	Description
1	Unity® 2019.4.19f1	Game engine
2	Computer (personal laptop)	Machine capable of loading Unity® project

```
using UnityEngine;
using System.Collections;

public class urlbutton : MonoBehaviour
{
    public void OpenURL()
    {
        Application.OpenURL("https://www.nationalobserver.com/2021/03/09/canada-drowning-plastic-waste-recycling-wont-save-us");
        Debug.Log("is this working?");
    }
}
```

Figure 29. Information scene: Code for accessing news articles.

6.4.2 Switching Scenes

For the user to transfer between scenes, to engage with one scene and then to another, clickable buttons are present on the screen. Two panels of buttons are displayed—one positioned at the uppermost top of the screen, and the other at the lowermost bottom of the screen. The Unity® platform is again used to implement the required coding script, with a computer for interaction.

Table 8. Switching scenes: Bill of materials.

Item #	Item	Quantity	Unit Price	Amount
1	Unity® 2019.4.19f1	1	\$0	\$0
Total				\$0

Table 9. Switching scenes: Equipment.

Item #	Item	Description
1	Unity® 2019.4.19f1	Game engine
2	Computer (personal laptop)	Machine capable of loading Unity® project

```

using UnityEngine;
using UnityEngine.UI;
using System.Collections;
using UnityEngine.SceneManagement;

public class ButtonsNextScene : MonoBehaviour
{
    public void RewardsScene()
    {
        SceneManager.LoadScene("RewardsScene");
    }
    public void InformationScene()
    {
        SceneManager.LoadScene("InformationScene");
    }
    public void GameScene()
    {
        SceneManager.LoadScene("GameScene");
    }
    public void MapScene()
    {
        SceneManager.LoadScene("MapScene");
    }
    public void MainScene()
    {
        SceneManager.LoadScene("MainScene");
    }
    public void SettingsScene()
    {
        SceneManager.LoadScene("SettingsScene");
    }
    public void ProfileScene()
    {
        SceneManager.LoadScene("ProfileScene");
    }
    public void GameplayScene()
    {
        SceneManager.LoadScene("GameplayScene");
    }
}

```

Figure 30. All scenes: Code to switch from one scene to another, using the panel buttons.

6.4.3 Camera Scene

For the **camera scene**, an item is scanned and then its recycling information is provided immediately on the screen, displayed over the item. To register items into a database, Vuforia® software is used, with the desired text then inserted. The Unity® platform is used to arrange the appearance of the **camera scene**, with a computer for interaction. Owing to the requirement of a camera to scan for an item, a mobile device is also useful: Connect the Unity® project, via Unity® Remote 5, to a mobile device.

Table 10. Camera scene: Bill of materials.

Item #	Item	Quantity	Unit Price	Amount
1	Unity® 2019.4.19f1	1	\$0	\$0
2	Vuforia® AR	1	\$0	\$0
3	Unity® Remote 5	1	\$0	\$0
4	Recyclable Items	2+	\$0	\$0
Total				\$0

Table 11. Camera scene: Equipment.

Item #	Item	Description
1	Unity® 2019.4.19f1	Game engine
2	Vuforia® AR	Augmented reality software
3	Unity® Remote 5	Application for the visual output of the Unity® project onto the screen of a mobile device (iOS™ or Android™)
4	Computer (personal laptop)	Machine capable of loading Unity® project
5	Mobile Device (Android™)	Smartphone with which to operate as a remote control, via Unity® Remote 5

6.4.4 Game Scene

For the **game scene**, coding script is required for the user to interact with the digital representation of a recyclable item. With the touch of a finger, the user can swipe at the item to move it. Gameplay involves the “throwing” of the item into a proper receptacle (i.e., recycling bin), as established with the code in **Figure 32**, and the prompting of the **congratulatory scene** upon completion, shown as code in **Figure 31**. The Unity® platform is used to arrange the appearance and implement coding script, with a computer for interaction. Owing to the requirement of a touch screen for the user interaction with the item, a mobile device is also required: Connect the Unity® project, via Unity® Remote 5, to a mobile device.

Table 12. Game scene: Bill of materials.

Item #	Item	Quantity	Unit Price	Amount
1	Unity® 2019.4.19f1	1	\$0	\$0
2	Unity® Remote 5	1	\$0	\$0
Total				\$0

Table 13. Game scene: Equipment.

Item #	Item	Description
1	Unity® 2019.4.19f1	Game engine
2	Unity® Remote 5	Application for the visual output of the Unity® project onto the screen of a mobile device (iOS™ or Android™)
3	Computer (personal laptop)	Machine capable of loading Unity® project
4	Mobile Device (Android™)	Smartphone with which to operate as a remote control, via Unity® Remote 5

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class ChangeScene : MonoBehaviour
{
    void OnTriggerEnter(Collider other)
    {
        Debug.Log("Nice Shot!");
        SceneManager.LoadScene("Congrats");
    }
}
```

Figure 31. Congratulatory scene: Code for when the user is victorious in the game.

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class SwipeScript : MonoBehaviour
{
    Vector2 startPos, endPos, direction; // touch start position, touch end position, swipe direction
    float touchTimeStart, touchTimeFinish, timeInterval; // to calculate swipe time to control throw force in Z direction

    [SerializeField]
    float throwForceInXandY = 1f; // to control throw force in X and Y directions

    [SerializeField]
    float throwForceInZ = 50f; // to control throw force in Z direction

    Rigidbody rb;

    void Start()
    {
        rb = GetComponent<Rigidbody>();
    }

    // Update is called once per frame
    void Update()
    {
        // if you touch the screen
        if (Input.touchCount > 0 && Input.GetTouch(0).phase == TouchPhase.Began)
        {
            // getting touch position and marking time when you touch the screen
            touchTimeStart = Time.time;
            startPos = Input.GetTouch(0).position;
        }
        // if you release your finger
        if (Input.touchCount > 0 && Input.GetTouch(0).phase == TouchPhase.Ended)
        {
            // marking time when you release it
            touchTimeFinish = Time.time;

            // calculate swipe time interval
            timeInterval = touchTimeFinish - touchTimeStart;

            // getting release finger position
            endPos = Input.GetTouch(0).position;

            // calculating swipe direction in 2D space
            direction = startPos - endPos;

            // add force to balls rigidbody in 3D space depending on swipe time, direction and throw forces
            rb.isKinematic = false;
            rb.AddForce(-direction.x * throwForceInXandY, -direction.y * throwForceInXandY, throwForceInZ / timeInterval);

            // Destroy ball in 4 seconds
            Destroy(gameObject, 3f);
        }
    }
}

```

Figure 32. Game scene: Code to allow the user to throw the item.

6.5 Testing & Validation

The app **Recycle Savvy**, in its sequential versions of developmental progress, endured the necessary assessments of critical feedback—and it survived with improvement. A staple of the design process was showcasing the current prototype—*warts and all*—to a select audience. Two meetings with the client Mitch Bouchard were held, as were four meetings with teaching assistants and laboratory curators.

This section is organized by the version of the app with its corresponding response.

6.5.1 Feedback: Global Concepts

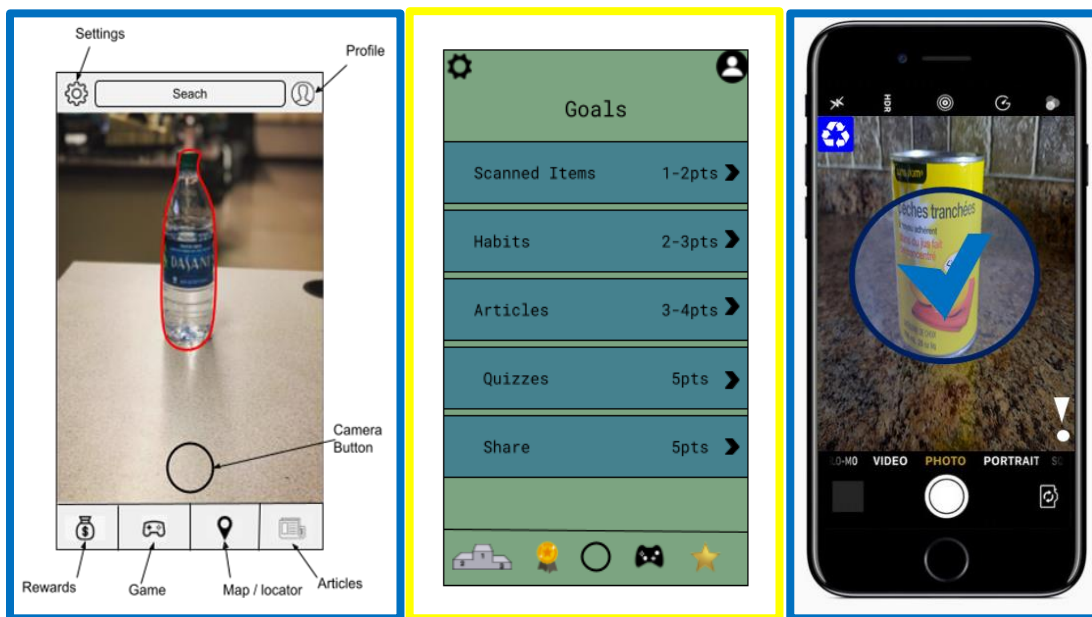


Figure 33. Conceptual designs for a recycling app: Identifying items.

From the conceptual art of the group’s app design, as portrayed in **Figure 33**, the feedback from the client Mr. Bouchard was thorough and appreciated. He highlighted concerns with incentives and ongoing maintenance—the promotion of use and updating of software are paramount for the technological scene. An interest in the app would best target a wide demographic audience—and therein recognize that the simplicity of use and rewarding experiences are critical for mass appeal. Recycling is an international known practice: hardly anyone is excluded. Furthermore, whether the incentives stem from financial gains or collecting token items, there may require the partnering with a financial backer or the permitting of adverts on the app’s screen. On the topic of permission, mobile hardware and licensing could hinder the feasibility of a proposed feature, such as the usage of the camera and mapping locations. Compounded with the restriction of time allotted to design a finished app, a hierarchy of importance in features for the app needs to be considered: with what features are we willing to part, if necessary. What are absolutely required? And what features are merely optional or like cherries on a sundae? Ultimately, for the capacity of the app, two main functions are asked from Mr. Bouchard: Identify a material as recyclable or waste and, subsequently, locate its proper receptacle.

6.5.2 Feedback: Prototype I

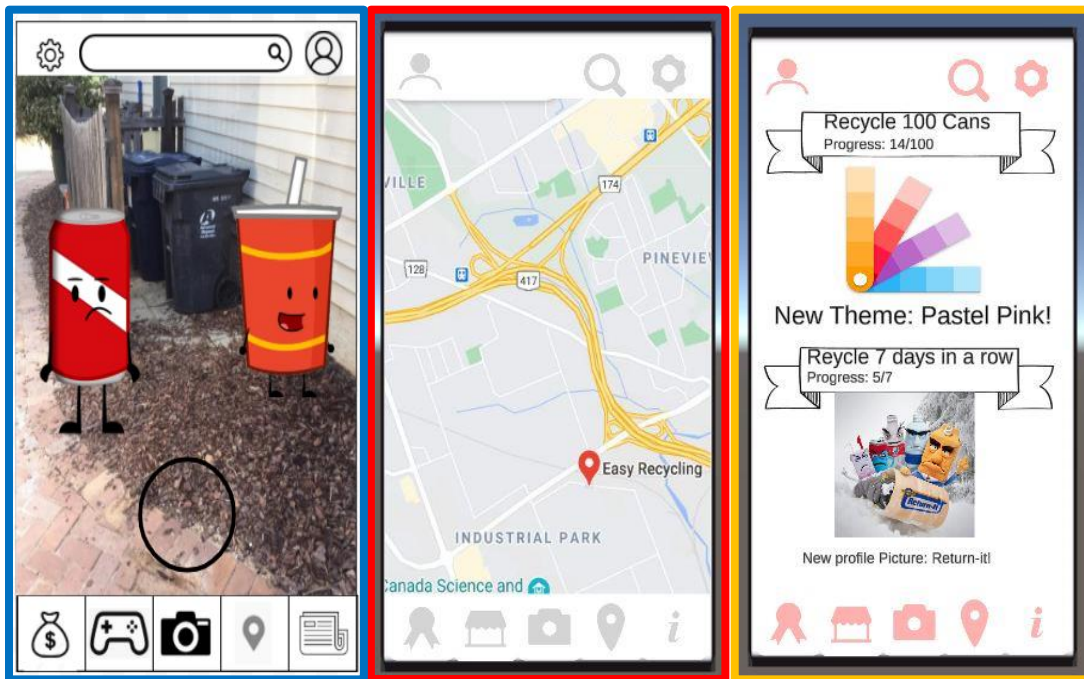


Figure 34. Design of prototype I: Game, map, and rewards.

Prototype I was not as developed as had been wished, but a few scenes were developed. Features such as buttons and icons and the augmented reality (AR) camera were implemented, but they still required improvements. A few of the features are shown in **Figure 34**.

The premise of the project design, in its segmented form, was toured before the 68-person audience, comprising of client Mr. Bouchard, Professor Majeed, and the GNG1103 class. Group member Cole Schieman narrated. The major components were briefly—yet competently—explained, consisting of the item scanning and the recycling facility locating. Most importantly, Schieman demonstrated the uniqueness in this app—what sets this design apart from that of the many other groups. The encouragement for recycling shall reside in the playfulness of a game: A “Pokemon Go™”-inspired interaction between the users and their environment.

The client Mr. Bouchard was brief with his comments. Given the constraint of 5 minutes, wherein the presentation for the group’s app was expected to carry for 2-3 min and the remainder for feedback, and the demand on the audience’s attention through the repetition in hearing the proposals from all groups on the same one project, Mr. Bouchard was understandably brief. He spoke of intrigue with the “Pokemon Go™”-like design, but he also spoke of concern over the group’s ability to finish it by the deadline. Group member Cole Schieman assured the client that such a risk was unlikely. Overall, the group netted a positive response: “Looking forward to seeing that,” Mr. Bouchard concluded.

6.5.3 Feedback: Prototype I ½

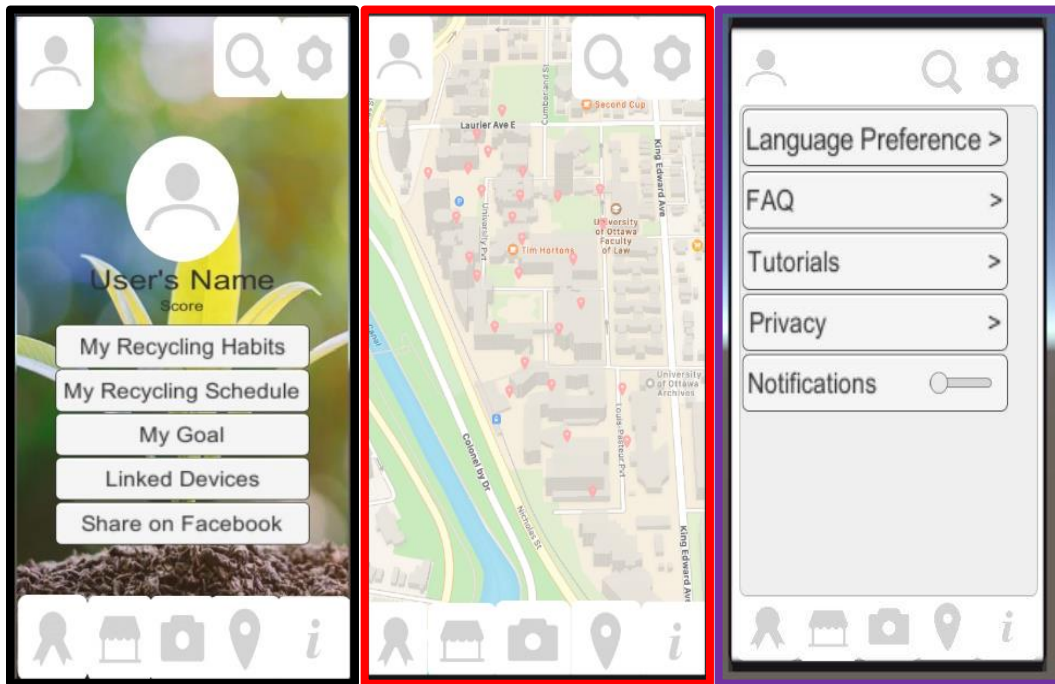


Figure 35. Intermediate prototype between I and II: Profile, map, and settings.

During a GNG1103 laboratory session, a meeting with the teaching assistants and laboratory curators was held: They wished to view the progress that the group had accomplished with the design project, in the scope of the Unity program. An intermediate model, set between prototype I and prototype II, was analyzed—the item scanning function and accuracy, map design, settings page, and game interface had been adjusted since the presentation, for the easing of use and for better aesthetics. The intermediate prototype is shown above, in **Figure 35**. The lab curator Ebin Joseph managed a thorough housekeeping of the design on a technical level, ensuring scenes and buttons were active and accessible. His help was most welcome. As recommended, the addressed technical issues were repaired by group members Melissa Helm and Cole Schieman shortly upon the conclusion of the meeting. Now, the wind in the sails was stronger and the waters were less choppy.

6.5.4 Feedback: Prototype II

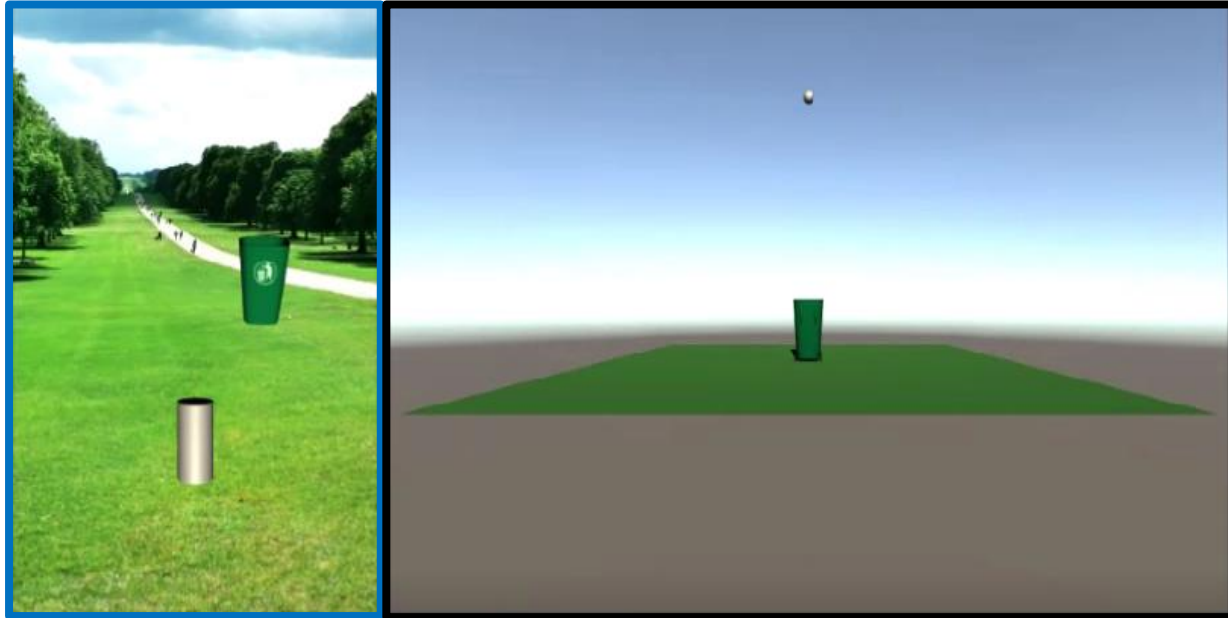


Figure 36. Design of prototype II: Game.

Prototype II, while an improvement over the previous prototype, still held onto technical issues as firmly as the Greek mythological god Atlas with the heavens. Any compliments for the app were overshadowed by the frustration in its troubled functionality. A most pressing issue, upending the “Pokemon Go™”-inspired gameplay, was the noticeable lack of interaction between the manipulatable object (default: grey, recyclable, cylindrical can) and the intended receptacle (default: green recycle bin). That is, the action of the user “throwing” the can—swiping with a finger—into the bin gave no indication that the can had *actually* entered the bin on the screen, unlike how a can is wont to do in the physical world. Instead, like a ghost through a wall, the cylindrical can seemingly passed through the recycle bin. Fortunately, the issue was resolved by the end of a meeting with the laboratory curator Ebin Joseph, courtesy of his assistance. Furthermore, on the following Friday, Ebin Joseph was kind to meet again with the group to address and fix any lingering errors. The game of prototype II is shown above, in **Figure 36**.

6.5.5 Feedback: Prototype III

A few volunteering users were asked to test prototype III through the Unity® Remote 5 software, opening the features of the related Unity® project on a mobile device. While the app had some limitations when linked with Vuforia®, the overall feedback was positive. There were a couple features that did not work as well as had been intended, but they did not affect the user friendliness of the application. The **information scene** and the **map scene** were well liked. The **game scene**, although it only consisted of one game, was also liked conceptually by the users.

During the last meeting with the teaching assistants and laboratory curators, their provided feedback was positive and encouraging. They appeared to appreciate the **map scene** and its ability to be pinched and moved around. While there was assistance required with the **game scene** in past meetings, the game now worked as Team RS had hoped it would.

7 Conclusions and Recommendations for Future Work

The feasibility of actions superseded the wishful elaboration of production: Compromise and partialness occupied the process in making the app **Recycle Savvy**. Essentially, a sample was created—a sample of the game with one targetable item, a sample of the map with one specific area, a sample of scannable items, a sample of viewable news articles, a sample of unlockable characters, and a sample of attainable rewards. For whoever else may wish to proceed with the design of the app, a finished project they will not find—but a solid foundation does exist, one of which Team RS holds in high esteem and pride.

Admittedly, difficulty arose in the unfamiliarity with the Unity® platform and, to a lesser extent, the Vuforia® software. Technology, when new to an individual, does require a learning curve, one that drastically increases in slope with the complexity of the technology. If the design project were a year-long endeavour, or even a few months longer, the learning curve would not have been as much a burden. Due to the time constraints and technical comfort for Team RS, prototypes were reconsidered and adjusted, accordingly. As such, a feature of the app may not have been made to its completion, but a taste of the idea was accomplished. Possible future endeavours and advancements upon the app are outlined in **Table 14**. Furthermore, on the technological hurdle, a member of Team RS was plagued by an apparent incompatibility between Unity® and his computers: frozen for hours upon loading the design project, frozen again with any click of the cursor on the project window—a paperweight became of his computers. With another attempt, the same event of perpetual computer freezing would transpire—again and again and again. His next computer will *not* be the same brand.

Overall, the final prototype works well, appears how Team RS wants it to look, and functions as intended. The product **Recycle Savvy** tested the abilities of the team members and pushed them to new limits, all in a short amount of time.

Table 14. Prospects to improve the app.

Affected Scene	Improvement
Game	Have a fully functioning game that consists of more than a couple of levels—more items with which to interact and aim them into different possible receptacles.
Map	Expand the addresses and area of coverage: Add additional recycling location icons.
Rewards	Include additional goals and incentives, ideally to encourage hours of gameplay or habitual gameplay from the users.
Camera	Increase the scanned item count, per the Vuforia® database. The more identifiable items for the app, the greater use is of the app.
Profile	Fulfill a function for otherwise null buttons, such as “My Recycling Goals” and “Link to Facebook.”
Characters	Implement more characters for the “Pokemon Go™”-inspired gameplay feature: Additional caricatures for obtainable items could be visualized. There are plenty of recyclable materials for any consumer of goods, so the pool is quite deep for ideas. Furthermore, cute, playful, and creative images support an enticing market; seemingly the rule of the Internet is that, just like salt or cheese with food, cute animals (kittens) enhance whenever involved.
Settings	Include multiple languages for the interface of the app, thereby netting a larger audience of potential users.

8 References

- [1] “Download the iRecycle App | Earth 911.” <https://earth911.com/irecycle/> (accessed Feb. 06, 2021).
- [2] “Recycling Right Made Easy!” <https://www.cityofvancouver.us/publicworks/> (accessed Feb. 06, 2021).
- [3] “Eugene by UZER I Waste less. Save more. Live better.” <https://www.eugeneapp.io/> (accessed Feb. 06, 2021).

9 Appendix I: Design Files

With the documents in **Table 15**, the **Recycle Savvy** app project is filed at a MakerRepo link:

<https://makerepo.com/Cschi099/874.recycle-savvy-projc12>

Table 15. Referenced Documents.

Document Name	Document Description	Issuance Date
TeamContractGNG1103C3-ProjC12.pdf	Deliverable A: Team Contract	March 22, 2021
DeliverableB_ProjC12.pdf	Deliverable B: Needs Identification and Problem Statement	March 22, 2021
DeliverableC_ProjC12.pdf	Deliverable C: Design Criteria	March 22, 2021
DeliverableD_ProjC12.pdf	Deliverable D: Conceptual Design	March 22, 2021
DeliverableE_ProjC12.pdf	Deliverable E: Project Schedule and Cost	March 22, 2021
DeliverableF_ProjC12.pdf	Deliverable F: Prototype I and Customer Feedback	March 22, 2021
DeliverableG_ProjC12.pdf	Deliverable G: Prototype II and Customer Feedback	March 22, 2021
DeliverableH_ProjC12.pdf	Deliverable H: Prototype III and Customer Feedback	March 28, 2021
DeliverableJ_ProjC12.pdf	Deliverable J: Final Project Presentation	April 18, 2021
UserManual_ProjC12.pdf	Deliverable K: Archive/User Manual	April 18, 2021