

# CS-6750 # Project # Summer 2021

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## 1 INTRODUCTION

Toyota Entune App Suite (EntuneAppStore, 2021) is the interface I have chosen to redesign in this project. Toyota Entune App Suite is an in-car multimedia experience to connect Toyota drivers and Toyota vehicles. Toyota Entune App Suite integrates smartphone applications into Toyota in-vehicle infotainment system and is similar to Apple CarPlay (ToyotaCarPlay, 2021) and Android Auto (MyAlexanderToyota, 2017). In this project I am redesigning Apple iPhone version of the Toyota Entune App Suite mobile application (EntuneAppStore, 2021). Toyota Entune App Suite is included in select 2012 and newer Toyota vehicles at no additional cost. Once Apple iPhone is connected to the Toyota vehicle using Bluetooth wireless technology (EntuneBluetooth, 2021), drivers can access applications on Apple iPhone. Toyota Entune App Suite allows drivers to access Apple iPhone applications using the in-vehicle touchscreen display (EntuneRegistration, 2021). Below are few tasks Toyota drivers can perform using Toyota Entune App Suite based on the Toyota vehicle they drive.

1. Stream Music through Pandora and Apple iTunes.
2. Check traffic and weather updates with a Sirius Satellite Radio.
3. Make dinner reservations with OpenTable mobile application.
4. Reserve movie tickets with CineMark mobile application.
5. Check Facebook status.
6. GPS Navigation.
7. Voice recognition to perform voice search (EntuneAlexa, 2021).
8. In case of Electric Vehicles (Prius Plug-in and RAV4 EV):
  - (a) Remote Charge Management.
  - (b) Remote Climate.
  - (c) Vehicle Finder.
9. In case of Hydrogen Vehicles (Mirai):
  - (a) Hydrogen Station Locator.
  - (b) Charge Hydrogen Fuel cells.
  - (c) Eco dashboard.

## 2 INITIAL NEEDFINDING

### 2.1 Choose at least one type of needfinding.

Reading existing Toyota Entune App Suite application reviews (EntuneAppReviews, 2021) on Apple App Store is the chosen method for initial needfinding.

### 2.2 Describe the needfinding approach(es) I chose and describe my plan.

I will collect the 100 most recent Toyota Entune App Suite application negative reviews and 100 most recent recent positive reviews from the Apple app store.

### 2.3 Perform needfinding plan and report my conclusions.

#### 2.3.1 Report the summary results of my analysis.

*Table 1*—Toyota Entune App Suite application reviews on Apple App Store - Summary Analysis

Feature	Positive Feedback	Negative Feedback
Application Sign up	Works great if VIN is recognized	Email authentication is not working
Application Sign in	App launches well after pairing	Asking repeatedly for password
Application Interface	Traffic and Weather updates work very well	Third party app integration is not intuitive
Entune Maps	Location search works well	Navigation suggestions are off at times
VIN Locator	VIN scan works well	Manual entry of VIN may be required
Spotify Integration	Worked very well in earlier versions	Missing in the current version
Bluetooth Pairing	Pairing is flawless	Unable to disconnect at times
Alexa Integration	Works great with audio books	Skipping music tracks is inconsistent
Voice search	Works great with location search	Inconsistent at reading messages
iHeart Radio Integration	Worked very well in earlier versions	Missing in the current version
Streaming Music	Apple iTunes integration works well	Pandora radio is missing in the current version

### **2.3.2 *What are the needs?***

1. Application registration should authenticate using email, password and VIN.
2. Application sign in should not ask for password every time a driver turns on the vehicle.
3. Third party app integration should be intuitive as native applications.
4. VIN locator should not force drivers to enter 17 characters VIN manually.
5. Bluetooth pairing should be disconnected when the vehicle is turned off.
6. Alexa interface should allow skipping music tracks.
7. Voice search should read out text messages consistently.
8. iHeart Radio, Spotify and Pandora music streaming applications should be integrated in the current version of Toyota Entune App Suite application.

### **2.3.3 *Are they improvements to the existing interface, or new features that would complement the existing interface?***

Below are improvements to the existing interface:

1. Application sign up using email and password.
2. Automatic application sign in by saving password.
3. VIN locator should work using last eight or nine characters.
4. Disabling Bluetooth pairing when Toyota vehicle is turned off.
5. Text messages should be read properly using driver voice prompts.

Below are new features that would complement the existing interface:

1. Intuitive Third party application integration.
2. Allowing Alexa interface to skip music tracks.
3. Integrate iHeart Radio, Spotify and Pandora music streaming applications in the current version.

### **2.3.4 *Are there things the interface does not presently do very well?***

1. Application registration and automatic sign in.
2. VIN locator.
3. Disabling Bluetooth pairing and enabling voice search.

### **2.3.5 *Are there features the interface is expected to have that it currently lacks?***

1. Third party application integration.
2. Allowing access to iHeart Radio, Spotify and Pandora applications.

### 3 HEURISTIC EVALUATION

#### 3.1 What works well?

##### 3.1.1 *VIN Scan*

Gulf of Execution: Scanning the VIN is discoverable in the Entune mobile application and is consistent with using camera in other mobile applications.

Gulf of Evaluation: Once the VIN scan is completed it is clearly visible in the Entune mobile application and is easy to interpret all 17 characters and evaluate the feedback confirming VIN characters.

##### 3.1.2 *Bluetooth Pairing with iPhone*

Gulf of Evaluation: Entune mobile application is giving constant feedback and is matching to the drivers [my] action to pair iPhone. Drivers [I] can directly manipulate the pairing interface by entering pairing code.

##### 3.1.3 *Alexa integration*

Feedback cycles to bridge gulf of execution and evaluation: Once the driver is initially signed in to the Entune mobile application there is an *Alexa* icon on the dashboard with *Sign in to your Amazon account to access Alexa* telling what sign in actions are feasible.

##### 3.1.4 *Ease of location search*

Invisibility by Design: Entune Maps application in the Entune App Suite application uses affordances showing nearby locations like restaurants, gas stations. Entune Maps application interface is also teaching drivers [me] on how to save addresses for navigation recommendations.

##### 3.1.5 *Traffic and Weather updates*

Human Abilities: Auditory feedback is received for perceiving inside the drivers [my] mind. Drivers [I] input zip code using haptic senses and traffic safety alerts are relayed back visually showing busier roads with red color.

##### 3.1.6 *Apple iTunes integration*

Consistency: Apple iTunes integration with Entune App Suite application is consistent with drivers [my] experience in controlling iTunes streaming application.

### **3.2 What makes it work well?**

#### **3.2.1 *VIN Scan***

Mental Models: Scanning the VIN in the Entune mobile application matches with drivers [my] understanding about the world around them as they open the camera and scan in the application as soon as VIN is placed below.

Representations: By bringing the VIN tag and Entune mobile application together their relationships are made explicit. During the scan except the text VIN characters every extraneous detail was excluded.

#### **3.2.2 *Bluetooth Pairing with iPhone***

Learning Curves: Bluetooth Pairing with iPhone has minimal learning and understanding to do for Toyota drivers [myself] using Entune mobile application. This is due to automatic pairing after the initial setup.

#### **3.2.3 *Alexa integration***

Metaphors and Analogies: Alexa sign in and access in the Entune mobile application is similar to other in-car infotainment systems like Apple CarPlay and Android Auto.

#### **3.2.4 *Ease of location search***

Distributed Cognition: Entune Maps application in the Entune App Suite application distributes cognitive load to the application and allowing drivers [me] to focus on the road and driving conditions. Entune Maps alerts drivers [me] with an ongoing traffic incidents and suggesting detours.

#### **3.2.5 *Traffic and Weather updates***

Simplicity: Traffic and Weather updates interface in the Entune App Suite application is very simple with ten day forecast as drivers [I] just need to enter zipcode or let the location picked up automatically.

#### **3.2.6 *Apple iTunes integration***

Flexibility: Apple iTunes integration with Entune App Suite application offers flexibility as drivers [I] can just carry their mobile devices to stream music and podcasts. Drivers [I] do not have pay for additional Satellite radio subscriptions.

### **3.3 What doesn't work well?**

#### **3.3.1 *Email authentication and repeated prompting of password***

Learned Helplessness: During the initial setup drivers [I] are unable to get the validation email so they aren't sure if there are any issues with email address or internet issues. Repeated prompts of password indicate drivers [me] that there is no mapping between the input and expected output. I feel that there is nothing I can do to resolve multiple password prompts due to lack of meaningful output I receive.

#### **3.3.2 *Third party app integration***

Gulf of Execution and Evaluation: Third party app integration feedback does not match with drivers [my] actions. Drivers [I] are unable to tell what actions are feasible widening the gulf of execution. Feedback is not immediate and drivers [I] are unable to tell if the Third party app integration is completed.

#### **3.3.3 *Navigation suggestions***

Feedback: Entune map navigation suggestions are not clear at times as there is no constant feedback confirming drivers [my] location and nearby locations. Feedback is not varied between a known route and a new route. Feedback to suggest favorite places near the driving location is off due to user favorites not saved properly.

#### **3.3.4 *Unable to disconnect Bluetooth pairing***

User Error: Bluetooth pairing is not disconnected when driver has turned off the vehicle as the interface fails to properly indicate if the connection is dropped. This is clear when drivers [I] are taking voice calls and the audio is still coming out from car audio system instead of drivers [my] mobile device when the vehicle is turned off.

#### **3.3.5 *Alexa voice prompts unable to skip Music tracks and read text messages consistently***

Mapping: Alexa voice commands are not mapped properly with underlying controls to skip iTunes music tracks. When voice command is issued to read text messages from a recipient, voice commands are not mapped to the mobile contacts properly as it tends to read text messages from an incorrect person.

### 3.4 Why doesn't it work well?

#### 3.4.1 *Email authentication and repeated prompting of password*

Gulf of Evaluation: Once I enter text password the email authentication is not providing constant and immediate feedback. Interface seems frozen as I was unable to match the screen response to the initial action. Interface is prompting for passwords and I was unable to get different feedback in the initial sign up registration process vs subsequent sign in attempts.

#### 3.4.2 *Third party app integration*

Constraints: Entune application suite constraints third party applications to have separate subscriptions along with the additional steps needed to link different accounts. Native applications are eligible for auto detection for pairing whereas third party apps need to link through *menu settings* and *Manage accounts* screens.

#### 3.4.3 *Navigation suggestions*

User Error: Entune Maps interface fails in few instances to suggest me the right action to perform a search for a favorite chain of restaurants in a new location although the restaurant chain was saved in the favorites. Although I have the right mental model to input the address in the search bar, maps interface prompted me for the same chain food restaurant in a different zip code far away from current location.

#### 3.4.4 *Unable to disconnect Bluetooth pairing*

Comfort: Entune Bluetooth pairing fails to disconnect voice calls when the vehicle is turned off causing discomfort as it requires manual override of the audio output so audio is received from the iPhone instead of vehicle audio system. At times I had to restart the vehicle to disconnect Bluetooth connection.

#### 3.4.5 *Alexa voice prompts unable to skip Music tracks and read text messages consistently*

Human abilities:

1. Input: Auditory sense is not perceived well as track skipping was unclear.
2. Processing: As track skipping was unclear I was trying to reason the process.
3. Output: Reading text messages is off as they are from an unintended person.

## 4 INTERFACE REDESIGN

Card prototypes with *Blue* colored circles in the bottom indicate original design mock up and prototypes with *Green* colored circles in the bottom indicate interface redesign.

### 4.1 Email authentication and repeated prompting of password

#### 4.1.1 Email Sign Up

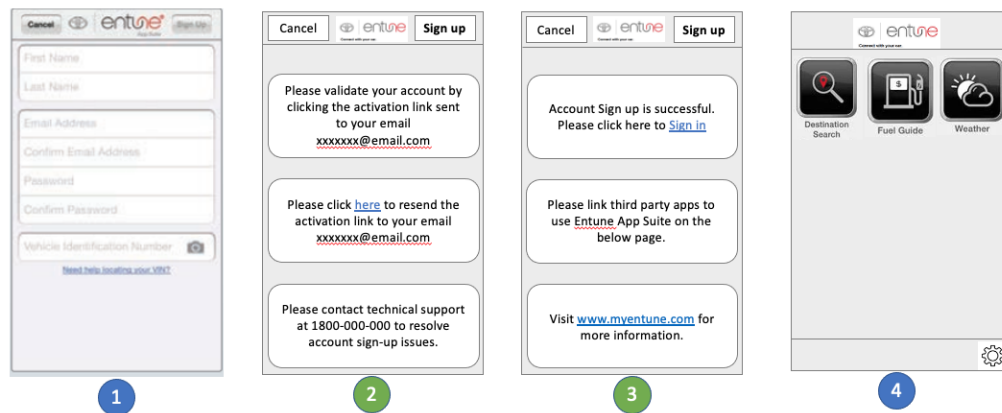


Figure 1—Entune App Suite application Sign Up

#### 4.1.2 Email Sign In

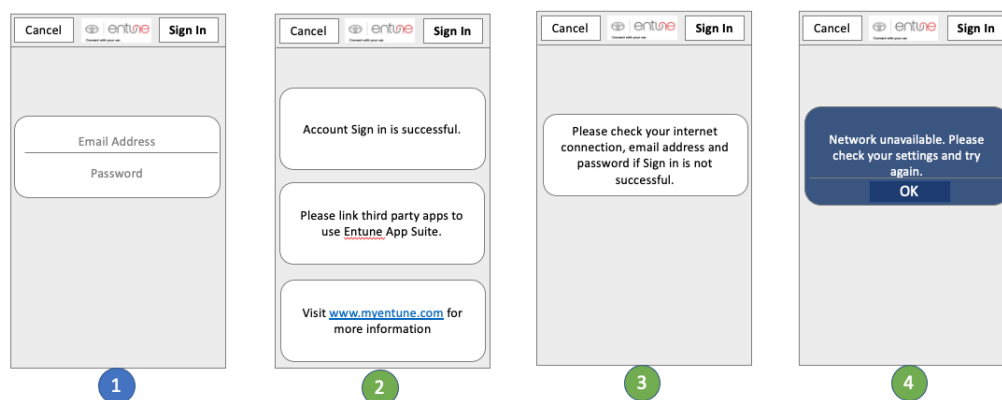


Figure 2—Entune App Suite application Sign In



## 4.2 Third party app integration

### 4.2.1 MovieTickets Account linking - Start

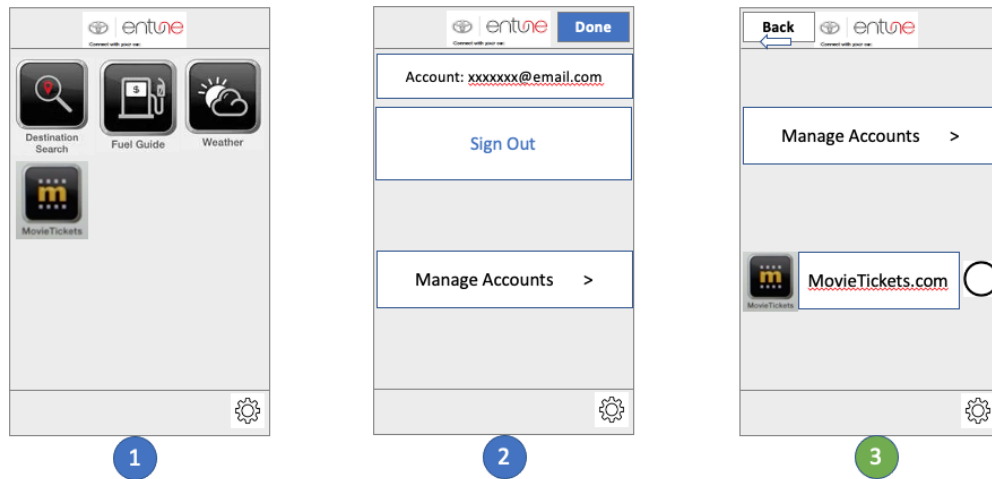


Figure 3—Third Party app MovieTickets account linking

### 4.2.2 MovieTickets Account linking - Successful

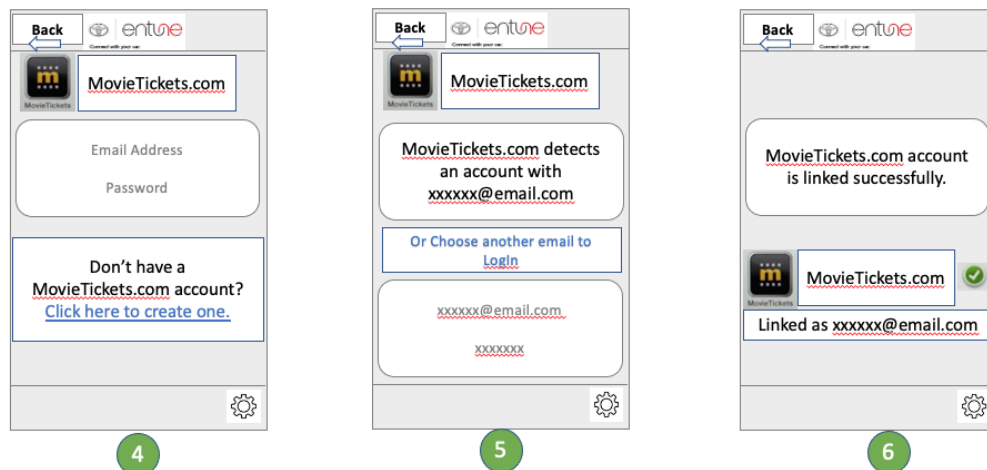


Figure 4—Third Party app MovieTickets Successful linking

## 4.3 Navigation suggestions

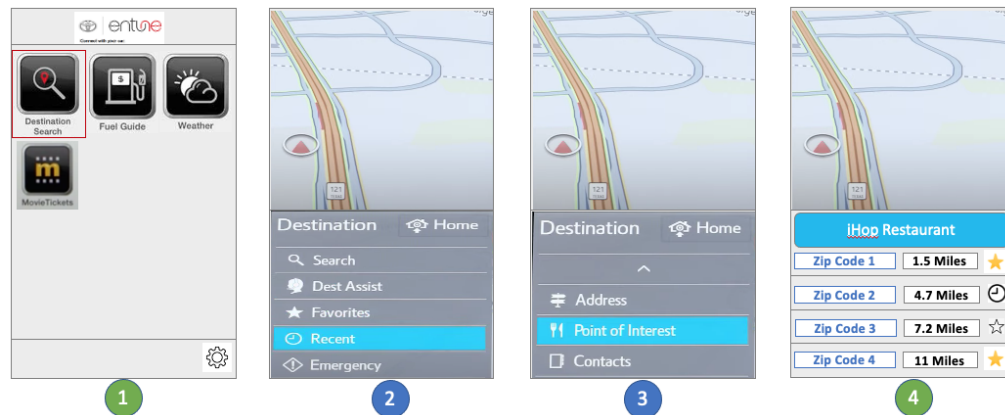


Figure 5—Entune Maps Destination Search navigation

## 4.4 Unable to disconnect Bluetooth pairing

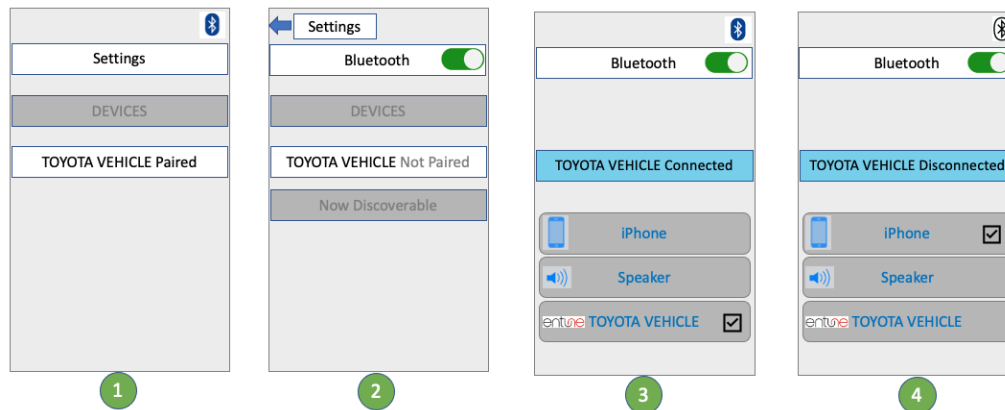


Figure 6—Entune Bluetooth Disconnection

## 4.5 Alexa voice prompts unable to skip Music tracks and read text messages consistently

### 4.5.1 Alexa voice prompts - skip Music tracks

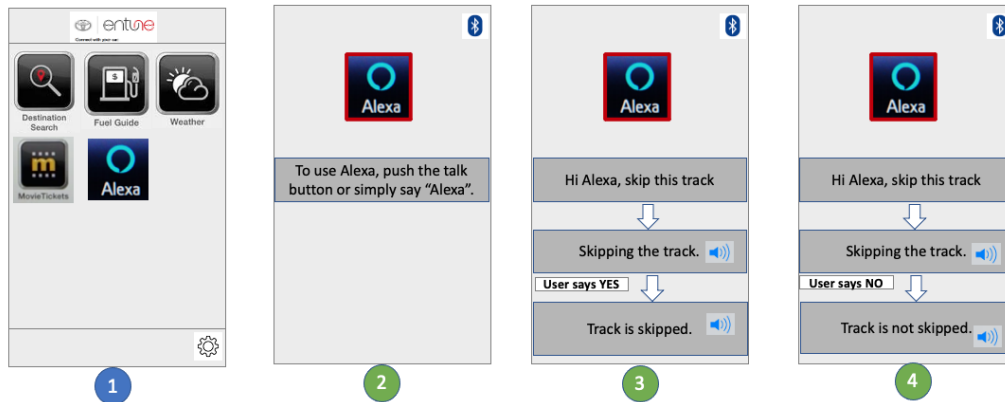


Figure 7—Entune App Suite Alexa Interface - Skip track

### 4.5.2 Alexa voice prompts - read text messages

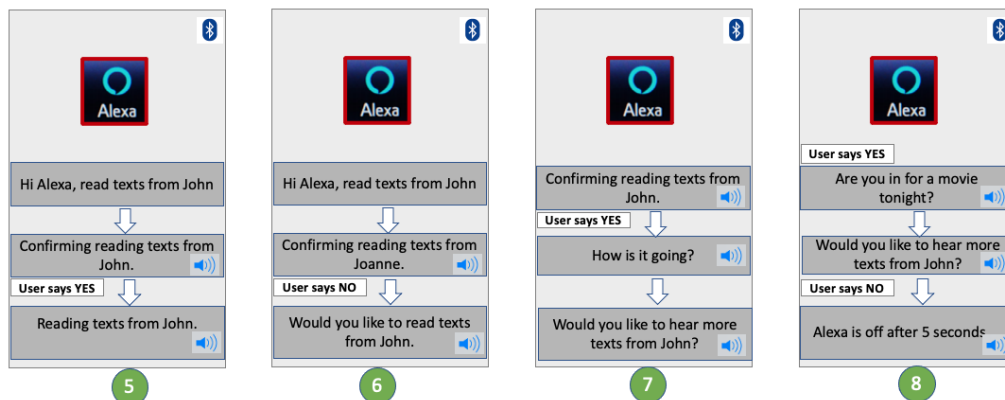


Figure 8—Entune App Suite Alexa Interface - Read texts

## 5 INTERFACE JUSTIFICATION

### 5.1 Email authentication and repeated prompting of password

Gulf of Execution and Evaluation: Drivers are provided with discoverable functions to resend the activation email link as well as an option to reach out 1800 contact number at technical support (refer figure 1). These options are consistent with other account sign up interfaces. Drivers can see the sign up interface with *Account Sign up is successful.* message with a *Sign in* link and interpret the output confirming sign up.

Invisibility by Design: In case of any network issues during the *Sign In* process, interface itself is teaching the driver by displaying the message *Please check your internet connection* (refer figure 2).

Affordances: After successful account sign up (refer figure 1), interface shows the native applications with an icon and application name on the *Entune app Suite* with a *Settings* icon at the bottom improving the user experience.

Consistency: In the event of an unsuccessful account sign in, drivers see a clearly visible *Network unavailable. Please check your settings and try again.* message in blue text box along with a *OK* button to receive acknowledgement from the driver and this experience is consistent with most other mobile applications account sign in error due to network issues (refer figure 2).

### 5.2 Third party app integration

Discoverability: Interface is redesigned to include *MovieTickets* logo, a text annotation and a *radio* button (refer figure 4) to improve third party integration. Here the logos, *Back* button with an *arrow* indicate the user what actions are feasible. Drivers see a text box with a message *Don't have a MovieTickets account? Click here to create one* and an *Email Address with Password* input fields to indicate driver to either sign in with existing *MovieTickets* account or to create an account.

Reduce the cognitive load: Drivers are given the control of the pace of the interface during the *MovieTickets* application integration by providing them the choice to use an existing account or to create a new account. Hyperlink to create a *MovieTickets* account is provided to emphasize essential content and reduce clutter (refer figure 4). Here account creation task is offloaded by providing them an option to use existing account.

**Mental Models and Representations:** Familiarity, generalizability and predictability are the principles addressed to improve user experience (refer figure 3). *Radio* button next to *MovieTickets.com* is shown as unchecked when the *MovieTickets* account is not linked and this changed to a green color tick mark confirming the account linking (refer figure 4). Drivers can predict the account linking and this matches with the behavior of radio buttons enabling the drivers to see through the sequence of actions performed to reach their desired state of account linking.

**Learning Curves:** Drivers have minimal learning curve as text annotations are provided at every step of the integration process. When the *MovieTickets* account is not linked a text box with message *Not Linked.* is displayed. To improve auto detection of *MovieTickets* account, a text annotation with message *MovieTickets.com detects an account* is displayed to let driver know there is already an account with the same email (refer figure 4). There is a text box with annotation *Or Choose another email to Login* displayed to provide the driver another email to login. Once the third party application account is linked there is a text annotation to display *Linked as xxxxxx@email.com* confirming the account linking.

### 5.3 Navigation suggestions

**Invisibility by Design:** Entune Maps interface is redesigned to show zipcodes of *iHop restaurant* location in the order of driving proximity (refer figure 5). Since drivers will be from both novice groups and experts, interface is redesigned to show the *Favorites* icon and *Recent* icon to enhance novices experience and a *Search lens* to enter entire physical address of the desired *iHop restaurant* for experts to receive navigation suggestions.

**Discoverability:** Entune app suite main dashboard icon gets highlighted with a red text box to indicate the user that *Destination Search* is the application selected (refer figure 5). Drivers can see icons and text annotations for *Search*, *Dest Assist*, *Favorites*, *Recent*, *Emergency*, *Address* and *Point of Interest*. Once Drivers enter *iHop Restaurant* text it will be displayed in blue below the map. Drivers can also notice *Zip code*, *Distance in Miles* sorted in the order of driving proximity.

**Representations:** Drivers can clearly identify the list of nearby *iHop restaurants* with a *Favorites* icon, *Recent* icon and a *grey Favorites icon* to indicate driver preferences. Grey *Favorites* icon indicates that this is a new location not saved in driver preferences and enables driver to add that location to *Favorites* (refer figure 5). Representations and relationships between driver preferences and search

address are made explicit and the icons bring the relationship between a new location and driver preferences together.

Ease: Redesign provides an easier way to pick the *iHop restaurant* of choice by displaying the options in proximity distance order, actual distance to reach and icons to indicate a new location versus an existing favorite location (refer figure 5). Drivers can opt to one of these locations at ease along with means to make changes to their favorite locations saved in preferences.

#### 5.4 Unable to disconnect Bluetooth pairing

Invisibility by Design: Redesign uses affordances such as a green toggle button next to *Bluetooth*, a *Settings* button with a *Left arrow* to go back to earlier interface page, under the *DEVICES* a list of paired Bluetooth devices to let the user know the pairing status of the *TOYOTA VEHICLE*. Here the interface also shows a blue colored *Bluetooth* connected icon on the top right section of the interface (refer figure 6).

Mental Models: Drivers can predict the state of the *Bluetooth* connection by synthesizing the actions to disconnect the *TOYOTA VEHICLE*. Drivers feel familiarity and predictability with the blue colored *Bluetooth* icon and its change in color to grey once the vehicle is turned off and blue tooth connection is disconnected (refer figure 6). Change in the *tick mark* from *TOYOTA VEHICLE* to *iPhone* matches with drivers mental model confirming voice call audio output will come out of *iPhone* instead of *TOYOTA VEHICLE*.

Feedback cycles (Gulf of Evaluation): Feedback of the redesign interface is immediate. Once the driver turns off the vehicle, *Bluetooth* interface displays *TOYOTA VEHICLE Not Paired* and a text box below it with a message *Now Discoverable* indicating the user to continue with pairing process (refer figure 6). *Bluetooth green and white* toggle button matches with the drivers intentions to pair a device and the desired state of the audio output from the iPhone.

Human Abilities: Visual input is improved in the redesign by showing a check mark next to the device a *Bluetooth* is connected. Also a text box with messages *TOYOTA VEHICLE Connected* and *TOYOTA VEHICLE Disconnected* are displayed to show the status of the Bluetooth connectivity of the Toyota vehicle (refer figure 6). This visual input improves the driver perception of the current state. This supports the reasoning of the input received on the interface.

### 5.5 Alexa voice prompts unable to skip Music tracks and read text messages consistently

Feedback cycles (Gulf of Evaluation): Redesigned interface lowers the gap in gulf of evaluation by providing constant and immediate feedback whenever driver asks for skipping a music track as well reading the text messages from the iPhone contacts. *Alexa* interface in the Entune app suite tells what state the system is currently in by a sequence of actions. When a driver asks *Alexa, skip the track*, *Alexa* responds by saying *Skipping the track* and waits for driver confirmation *User says YES*. and finally *Alexa* responds by saying *Track is skipped* (refer figure 7). Here the feedback matches with user action and the interface is directly manipulating the user task of *skip this track*. Similarly, whenever driver asks *Alexa, read texts from John*, there is immediate feedback to ensure if driver really intend to hear text messages either from *John* or *Joanne* (refer figure 8).

Human Abilities: In the redesign, drivers are provided with both visual and auditory stimuli. At every step of the task, the interface shows text annotation as well as a read-out-aloud voice prompt. This enables drivers to offload cognitive tasks to the interface so they could focus on road and traffic conditions. Both visual and auditory modalities of the text messages complement each other. Drivers do not have to recall if they did ask to read out messages from *John* as *Alexa* would confirm with the driver before reading out any text messages (refer figure 8).

Direct Manipulation: Redesign improves drivers experience by directly manipulating the interface to read text messages out loud. This helps as if the drivers are having a conversation directly with the person they received text messages from. *Alexa* interface is actually disappeared in this task as drivers are only focused on listening to the text messages instead of manually going through *iPhone Messages* applications.

Analogies: Redesign of the *Alexa* interface on Entune app suite makes the interface more learnable as reading out text messages simulate a natural conversation. This addresses representations as the driver can ensure the text messages are from *Joanne* due to the underlying mapping of the voice commands to the *iPhone* contacts. Reading text messages with driver confirmation also ensures that drivers can predict the outcome for their actions.

## 6 EVALUATION PLAN - EMPIRICAL EVALUATION

### 6.1 Prototype to be evaluated

Card Prototypes (Bobbili, 2021) illustrated in the *Interface Redesign* section of this project assignment will be evaluated using Empirical Evaluation.

### 6.2 Control group

Control conditions which I am not testing include experiment time of the day or night, mobile internet speed, signed in *MovieTickets.com* application, *Apple iPhone* cellular wireless coverage, *Apple iPhone* charge, *Toyota Entune App Suite* firmware version, *Toyota Model* version, *Toyota Model Trim* version and battery power output in *Toyota Vehicle*.

### 6.3 Experimental group

Due to the multiple interfaces redesign, there are multiple experimental conditions I am interested in evaluating. *Application Sign Up* and *Application Sign In* email validation and password issues will be compared with *Apple CarPlay* registration process. Similarly, *third party app integration* will be compared against *Toyota Entune App Suite* native applications. *Entune Maps* navigation suggestions will be compared against similar interfaces including *Google Maps*, *Apple Maps*, *Waze* and *Scout GPS*. *Bluetooth* connectivity at the vehicle turn off time will be compared against audio devices connected to a *Yamaha Audio Video Receiver*. For *Alexa* interface on *Entune app suite* I am planning to present voice input *Search* commands to *skip a music track* and to *read out text messages*. *Alexa* interface will be evaluated in similar infotainment systems including *Apple CarPlay* and *Android Auto*.

### 6.4 What am I testing?

1. Email authentication and repeated prompting of password: Response times, Number of clicks. Number of errors.
2. Third party app integration: Number of clicks, response speed, number of intermediate steps.
3. Navigation suggestions: Response time from *Entune* home dashboard, response times for retrieving search results, response time after clicking *greyed out Favorites icon*.
4. Unable to disconnect *Bluetooth* pairing: Response time after vehicle turn off



to turn blue color. *Bluetooth connected icon* to greyed out *Bluetooth connected icon*, response time of *check mark* getting populated next to *iPhone* instead of *TOYOTA VEHICLE*. Number of errors.

5. Alexa voice prompts unable to skip Music tracks and read text messages consistently: Response times between *Alexa* and *Driver* exchange.

### **6.5 What am I using as a point of comparison?**

I am comparing response times and number of clicks between *Toyota Entune App Suite*, *Apple CarPlay* and *Android Auto* interfaces. Entune Native apps response times will be compared against third party apps. *Entune Maps* response times will be compared against *Google Maps*. *Alexa* interface response times will be compared against *Apple Siri Personal Assistant* response times.

### **6.6 Null Hypothesis**

1. Response times, number of clicks and intermediate steps to perform a task in *Toyota Entune App Suite* interface is *SAME* as response times, number of clicks and intermediate steps in *Apple CarPlay* and *Android Auto* interfaces.
2. Response times and number of clicks to perform a task in *Toyota Entune App Suite* interface native applications is *SAME* as response times and number of clicks in *Toyota Entune App Suite* third party applications.
3. Response times and number of errors in *Toyota Entune App Suite Alexa* interface is *SAME* as response times and number of errors in *Apple Siri Personal Assistant*.

### **6.7 Alternate Hypothesis**

1. Response times, number of clicks and intermediate steps to perform a task in *Toyota Entune App Suite* interface is *NOT THE SAME* as response times, number of clicks and intermediate steps in *Apple CarPlay* and *Android Auto* interfaces.
2. Response times and number of clicks to perform a task in *Toyota Entune App Suite* interface native applications is *NOT THE SAME* as response times and number of clicks in *Toyota Entune App Suite* third party applications.
3. Response times and number of errors in *Toyota Entune App Suite Alexa* interface is *NOT THE SAME* as response times and number of errors in *Apple Siri Personal Assistant*.

## 6.8 Independent Variables

1. *Toyota Entune App Suite, Apple CarPlay, Android Auto and Apple Siri Personal Assistant* interfaces
2. Task - Email authentication, Task - Third party app integration
3. Task - Route Navigation, Task - Bluetooth pairing
4. Task - Skipping Music tracks, Task - Reading text messages

## 6.9 Dependent Variables

1. Response times
2. Number of clicks
3. Number of intermediate steps
4. Number of errors

## 6.10 Planned Statistical Analysis

1. Paired t-test: Since all the evaluation participants will see all the treatments, I compare paired sets of data to compare response times between *Toyota Entune App Suite* interface native applications and *Toyota Entune App Suite* third party applications.
2. ANOVA (Analysis of Variance): ANOVA will be used to compare response times between four interfaces *Toyota Entune App Suite, Apple CarPlay, Android Auto* and *Apple Siri Personal Assistant* interfaces from the same participants. Similarly ANOVA will be used to compare navigation response times and errors between *Toyota Entune Maps, Google Maps, Apple Maps* and *Waze*.

## 6.11 Will it be between-subjects or within-subjects?

Experimental evaluation method compares within-subjects as each participant will experience multiple treatments (Bobbili, 2021) in *Toyota Entune App Suite* interface, *Apple CarPlay* interface, *Android Auto* interface, *Toyota Entune App Suite Alexa* interface and *Apple Siri Personal Assistant* interface.

## 6.12 How will subjects be assigned to groups?

Participants will be randomly assigned to multiple treatments groups.

## 7 REFERENCES

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