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Final Design Report: Equipment Checkout Team

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Bryce, William; Davis, Destinee; King, Joshua; Liu, Charlotte; and Suarez-Domit, Andres, "Final Design Report: Equipment Checkout Team" (2019). *Engineering Senior Design Reports*. 37.
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Final Design Report

Equipment Checkout Team

ENGR - 4381

05/01/2019

Executive Summary

The Trinity University Communication Department is currently using a handwritten logbook to keep track of expensive cameras kits and associated equipment. Check-in and check-out are documented in the logbook by a student worker. Unfortunately, this time consuming and labor-intensive process leads to inventory mismanagement and expensive equipment loss each semester. The purpose of this project is to create an inventory database that will remove responsibility from the student worker, increase the speed of check-in/check-out, and ultimately prevent loss of equipment. The prototype described in this report uses an Ipad app to implement the user interface, FireBase to implement the database, and RFID tags and a RFID reader¹ for input into the information processing subsystem. In order to ensure that the designed prototype meets the project objectives, various tests were conducted. The prototype tests are divided into four modules: manage inventory, manage users, check-in/check-out, and RFID tag testing. The purpose of these prototype tests are to analyze the functionality of the following capabilities: ability to automatically check-in and out equipment using RFID tags and the U-Grok-It RFID reader, keep track of users and kit items (includes adding and removing users or kits), check availability of kits, and confirm that the person borrowing the equipment is authorized to borrow. An added function is the ability to manually check-in/out equipment if needed. After conducting these tests, the results proved that the designed prototype meets most of the objectives outlined in the final Project Charter. The designed system eliminates the need for paper documentation, speeds up the check-in and check-out process, and ultimately removes responsibility from the student worker. Two features described in the project charter were not met. These include email notifications for overdue equipment and a printable late fee invoice that may be submitted to the student billing department. Currently, we have been testing one prototype kit. We will finish implementing the system for nine other kits before our final presentation.

¹ RFID reader - This is the same thing as a RFID "scanner"

I. Introduction

Each semester thousands of dollars' worth of equipment is loaned by the Communication Department to both faculty and students. Currently, all equipment check-out is documented by a single student worker using a paper form. These forms are stored in a logbook that is difficult to keep track of leading to unorganized inventory management. In addition, this tedious process puts much responsibility on the student worker. Workers may not thoroughly check through the kit to ensure all items are present or simply do not realize that an item is missing. As a result, thousands of dollars worth of equipment are lost each semester.

The purpose of this project is to design an inventory management system for the Communication Department that digitally keeps track of the most popular audio-visual kit, which consists of a camera and five accessories. The objectives of this project are to eliminate paper records, speed up the check-in/check-out process, and prevent loss of equipment. In order to accomplish these goals the designed system must be able to automatically scan all items in the kit, store necessary information about the person checking-in/out, and keep track of the time and date that an item was checked in or out. The system must also be able to keep track of whether an item is available or not. As stated in the project charter, the prototype must be implemented for ten of the most popular kits and fulfill all desirable features listed above. The constraints of this project are the following: the prototype must fit inside the equipment storage space and the use of system cannot damage² equipment.

The capabilities of this prototype relate to the four modules which include the following: manage inventory, manage users, check-in and check-out, and database. The main capability of the manage inventory and users module is to allow the worker to add and remove users and kits. In addition, the user should be able to check the availability of kits. The main capability of the check-in and check-out module is automatic scanning of equipment using RFID tags and the U-Grok-It RFID reader. The user should also be able to check that the person borrowing the equipment is authorized to borrow. In addition, a manual check-in/out option is available if needed. This manual process is still be faster than the current paper documentation process therefore satisfying the constraint of increasing the speed of check-in and check-out. An additional capability of this project includes the ability to write a customized identification number to the RFID tags. The database module is implemented using Google's Firebase and acts as storage for all of the information for this project. Using Wi-Fi, the other modules communicate with Firebase to retrieve and store necessary data.

This report identifies the prototype capabilities that were tested, summarizes the evaluation of the prototype's performance against each project objective, and briefly presents the conclusion. These are illustrated through an overview of the design as tested, prototype test results, and conclusions.

² Equipment must still work as usual after the designed system is implemented. i.e. when RFID is connected to camera camera should still function

II. Overview of the Design as Tested

The system consists of four modules which were tested individually: 1) manage inventory 2) manage users, 3) check-in /check-out function, 4) database backup. The only change since the Project Charter is the addition of a manual check-in/check-out function which will be discussed in the check-in/check-out prototype test section. Descriptions for the four modules are listed below:

Manage Inventory

For the manage inventory module, we must test that the module can add kits and delete kits. When a kit is added the program should automatically create the ID numbers for the items in relation to the kit's number. For example adding a kit numbered 301 should also create ID numbers for the camera, microphone, ect. as 30101, 30102, etc.

Manage Users

For the manage user module, we must test that the software can add users and delete users.

Check-in/Check-out

The check-in/check-out module must be able to check-in equipment from the inventory and check-out the equipment. The manual check-in/check-out option will be first be tested in the simulation by inputting the data into the app and then physically with the app downloaded on to the iPad. Once the app is downloaded on to the iPad we must test that the RFID reader, called the U-Grok-It, interfaces with the iPad. The U-Grok-It feature is the most complex part of the design. The software must receive input from 6 RFID tags and enter the read ID number into the text fields. Because there are multiple kits in the room while reader is scanning another test is conducted to confirm that the reader only picks up the tags from the desired kit and not the other nearby kits.

Database

The final feature we will implement and test is backing up the database of kits and users to an outside source. For our design we have chosen Firebase. We need to test that our software can write the saved database to the Firebase and receive the database if the data on the iPad is corrupted.

III. Prototype Tests

i. Manage Inventory

Test Overview and Objectives: The manage inventory module receives information regarding the kits from the firebase database and allows it to be viewed. In order to work properly, the module must allow the worker to add/delete kits and view different kits.

Test Scope and Test Plan: In order to ensure that this functionality works, the module will have to pass three tests to be acceptable. For the first test, a kit will be added to the database using the “add” function. Next, the kit will be selected and viewed in the “view details” view controller. Finally, the kit will be deleted from the database.

Acceptance Criteria: For the first test, the program will be accepted if it can differentiate between valid information and invalid input. If the add function successfully adds valid kit information then it will pass the test. The view details test will be accepted if a kit can be viewed in the “view details” view controller after it has been selected. The delete test will pass if the kit information can successfully be removed from the database.

Test Results and Evaluation: The manage inventory module passed all the given tests within the given acceptance criteria

ii. Manage Users

Test Overview and Objectives: The manage user module receives information regarding the user from the firebase database and allows it to be viewed. In order to work properly, the module must allow the worker to add/delete users and view different users.

Test Scope and Test Plan: In order to ensure that this functionality works, the module will have to pass three tests to be acceptable. For the first test, a user will be added to the database using the “add” function. Next, the user will be selected and viewed in the “view details” view controller. Finally, the user will be deleted from the database.

Acceptance Criteria: For the first test, the program will be accepted if it can differentiate between valid information and invalid input. If the add function successfully adds valid user information then it will pass the test.

The view details test will be accepted if a user can be viewed in the “view details” view controller after it has been selected. The delete test will pass if the user information can successfully be removed from the database.

Test Results and Evaluation: The manage inventory module passed all the given tests within the given acceptance criteria

iii. Check-in and Check-out Module

a. Manual Check-in and Check-out

Test Overview and Objectives: The manual check-in and check-out option is designed as a backup for the U-Grok-It scanner as the scanner cannot be used while it is charging. To confirm that it works as intended, the worker should receive a prompt asking which kit they are checking in or out. Then they should receive a checklist of items that they must confirm are in the kit. The module should only allow kits to be checked out if the operator confirms that every item is in the kit.

Test Scope and Test Plan: Separate tests are performed on a kit that is checked out and on a kit that is checked in. Within these tests, both functions will be tested by on a kit that contains all items and on a kit that is missing some items. The user is alerted about critical items being missing, specifically the camera or microphone as they are the most expensive. Therefore, these items require personal attention from the Communications Department Operations Manager, James Bynum. If any other items are missing there will be no alert, but the terms and conditions will include the amount due for the missing item(s). Using Firebase, the check-in/check-out status of the kit is confirmed to either change if the kit can be checked in or out or remain unchanged if the kit is unavailable due to missing items.

Acceptance Criteria: The test is considered successful if the status of the check-in/check-out changes when a kit is available and if it remains unchanged if the kit is not available.

Test Results and Evaluation: The ability to label the kits as checked in and checked out works as desired with the app properly switching the kits label as checked in and checked out as needed. When we attempted to test these functions without confirming all the items, both the critical item alert and the amount due appeared as expected.

b. Scanning Item and Kit Identification

Test Overview and Objectives: The U-Grok-It test involves the ability to properly read the identification number from a RFID tag and use that same number in the app's programming for other operations. In order to facilitate an automatic check-in, the U-Grok-It must be able to read the six tags and tell which kit they belong to. The program must then send the app into the next screen which is the check-out agreement page.

Test Scope and Test Plan: In order to make sure that the read function works, a two-step testing procedure is used. First, the system is simulated under perfect conditions where all item ID tags are available. The purpose is to see if upon scanning, the proper RFID tags are matched to the appropriate kit. The second step is presenting the scanner with fewer than six tags to see if the program will notice the missing items.

Acceptance Criteria: The scanner must be able to read all six tags and proceed to the signing page. If given less than the six items/tags, it must notice that there are items

missing and not move onto the next screen. The items there were detected are shown allowing the user to quickly discern what item or items are missing.

Test Results and Evaluation: When testing the scanning functions, we found that it reads all six tags and moved onto the signing screen. When given less than six tags, the program did not proceed to the signing screen and only the given items were checked off from the item checklist page. Also to note the scanner will not be operable while it is being charged

c. Scanning Range

Test Overview and Objectives: The purpose of this test is to ensure that only the tags in the kit being scanned are read. Tags from kits stored on the storage room shelf should not be read by the reader.

Test Scope and Test Plan: Scanning is tested in the storage room where the system will be used to ensure that the range of the tags does not affect the reading during operation. A test kit is set on the table which is normally used for check-in/out and tags are placed inside kits on the storage room shelf. The kit on the table is then scanned.

Acceptance Criteria: In order to pass this test the U-Grok-It must read only the six tags in the kit being scanned.

Test Results and Evaluation: On the first attempt, the U-Grok-It scanned the six tags in the kit being scanned, however, it also scanned tags from kits stored on the shelf. The range for this scan was the default setting, “locate distance”, which has a power range of 23 - 30 W. To solve this issue, the range was reduced to the lowest setting for scanning of multiple tags. This range is the “locate very short range” with power of 5 - 12 W. With this setting, only the six tags in the relevant kit were scanned.

iv. RFID Tag Testing

a. Tag Selection

Test Overview and Objectives: The purpose of this test is to determine which tag will work best for our project. The objective is to test all 24 tags and choose the one that best meets the project objective of decreasing the time to check-in/out. In addition, it is important that the tags can be re-written to a customized identification number.

Test Scope and Test Plan: This test uses the RFID reader connected to the iPad and the various sample tags. In order to conduct this test, the tags were first re-written. Next, the tags were scanned in sets of six outside of the bag. The tags that scanned successfully were then scanned inside the bag while attached to the equipment using tape.

Acceptance Criteria: The tag must be able to have its identification number changed (re-written) and must scan “instantaneously³.”

³ If working properly, the scanning is fast enough that there is no need to determine an acceptable scanning time frame. Instead, the word instantaneously is used.

Test Results and Evaluation: The results of this test showed that some tags were unable to be re-written. These tags were immediately eliminated due to the requirement of being able to be rewritten to a customized identification number that represents the kit number and item number.

b. Tag Orientation

Test Overview and Objectives: The purpose of this test is to determine how the tags should be oriented on the equipment in a manner that will allow the tags to be scanned quickly. It is desired that the equipment be scanned with the RFID reader above the kit. Based on this, the only orientation which needs to be tested is the tags placed on the top-most surface of each item.

Test Scope and Test Plan: This tests requires use of the tags and audio-visual equipment. The test is executed by applying the tags on the equipment and then scanning the closed bag with the reader placed above the kit.

Acceptance Criteria: The orientation can be considered successful if all six tags are read instantaneously.

Test Results and Evaluation: The placement of the tag on the top of the camera proved to be successful as it was read when scanned with the reader. The camera is always placed in the bag with the tag face up. However, the other five items are dependent on how the user places the item in the bag. Therefore, these items were placed in the kit so that the tag is facing the top of the bag. This is not vital for scanning, however, this orientation provides the best line of sight from the reader to the items. Users will be required to place items with the tag facing up. With this setup, four of the five remaining items scanned successfully with each test. The only item that wasn't successful with each test was the tag on the microphone. This is because the microphone does not have a flat surface to place the tag on. From testing, it was observed that the tag must remain flat to scan properly. To fix this we placed the RFID tag on the microphone case, instead of directly on the microphone. This is not ideal, but it does provide a cost effective solution.

IV. Conclusions

We found that for the four modules tested passed each of the acceptance criteria defined above. The project objectives and constraints were also met based on the following: the system eliminates the need for paper documentation, the check-in/check-out process is automated, and the time for check-in/check-out is significantly decreased due to implementation of an automated scanning system. In addition, the equipment does fit within the Communication Department storage room, and the implemented system allows the audio-visual equipment to be used without restrictions.

While our design meets the majority of our objectives, we did not have the time or the resources to implement the email notifications feature or the late fee invoices feature, which

were mentioned in the charter. These features proved to be more difficult than expected. In addition, they were a lower priority features compared with the critical functionality that needed to be implemented.

While we believe that we have delivered an excellent product it could be improved in the future by adding the previously mentioned features, tweaking the user interface and by adding more types of kits to the database structure.

Signatures

SIGNATURES		
Project Name: Equipment Checkout System		
We agree that this project plan is realistic and that the team can accomplish the stated goals of the project. We authorize the project to continue, and we authorize construction of a prototype.		
	Date Received	Date Approved
Team Adviser: Keith Bartels	5/1/2019	5/1/2019
Project Sponsor:		
Other signatures required by the Project Charter:	Date Received	Date Approved

DOCUMENT CHANGE CONTROL		
This section records the revisions to this document.		
Version Number	Date of Issue	Brief Description of Change

Appendix A: Instruction Manual

Instructions Manual

Equipment Checkout Team

ENGR - 4381

05/01/2019

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I. Check-in and Check-out

The check-in and check-out begins on the main page shown in Fig 1.

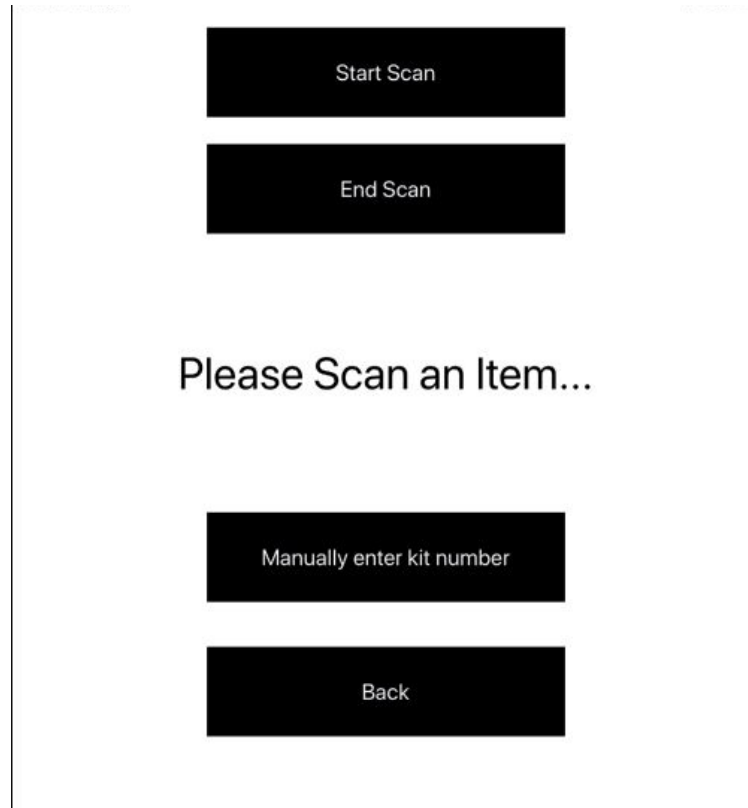
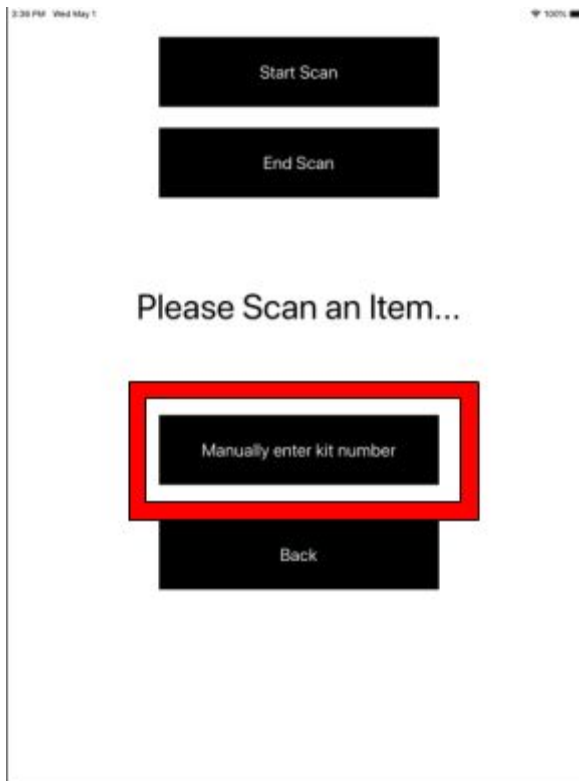


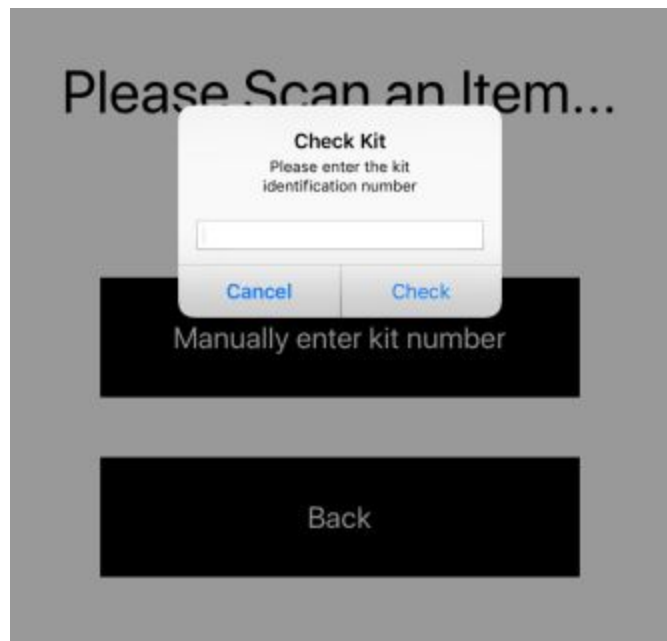
Figure 1. Main Check-in/Check-out Scan Page

A. Manual

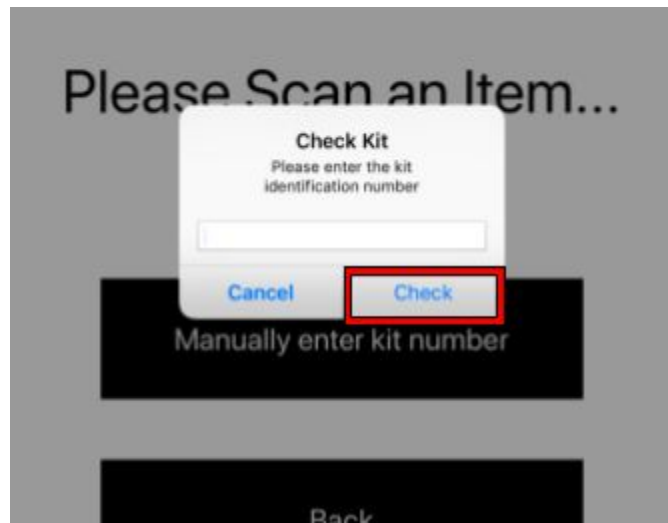
1. Begin by selecting the “Manually enter kit number” button



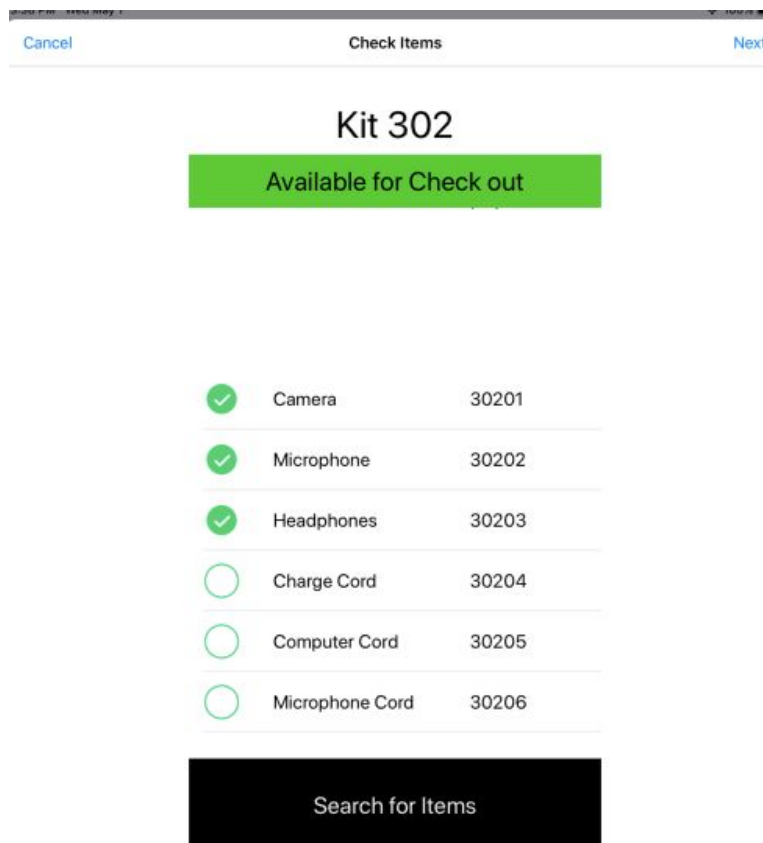
2. The “Check-Kit” pop-up screen will appear. Enter the identification number (i.e. 302)



3. Select "Check"



4. The item checklist page will appear. Select the checkboxes for all items that are present in the kit.



5. Select "Next" in the top right corner

Cancel Check Items Next

Kit 302

Available for Check out

✓	Camera	30201
✓	Microphone	30202

6. The check-out agreement form below will appear. The person checking-out should select "I agree to the terms above" after entering their information.

< Check Items User Terms and Conditions

Checkout Agreement

You assume complete responsibility for the equipment you take and agree to PAY replacement value if lost, stolen, damaged OR not returned within 10 days. You agree to PAY a late charge of \$10 per day PER ITEM onequipment returned late. Equipment checkout is provided as a courtesy and NOT guaranteed. Detailed rules and policies are posted.

Email Address Student ID number

Equipment: Kit 302

✓	Camera	30201
✓	Microphone	30202
✓	Headphones	30203
○	Charge Cord	30204
○	Computer Cord	30205
○	Microphone Cord	30206

The following items were not found: Charge Cord, Computer Cord, Microphone C...

Check out date: 5/1/19 Check in date: --/--/--

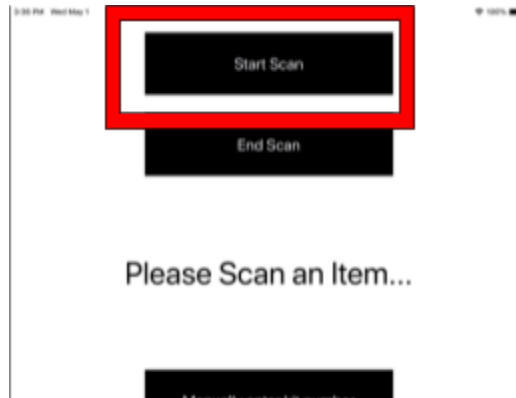
Due date: 5/11/19 **Amount Due: \$30.00**

I agree to the terms above

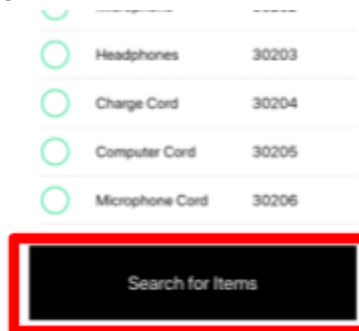
7. The check-in/out is now finished and the database has been updated

B. Using RFID Scanner

1. Begin by selecting the “Start Scan” button



2. The items checklist page will appear. Select the “Scan for Items” button



3. Ensure that the U-Grok-It is not being charged as it will not function while charging and run it over the top of the kit
4. Once all items are scanned the user will be taken to the same Agreement form from the manual checkout process. The person checking out should agree to the terms.
5. Note that if items are missing you will not automatically move onto the agreement form page. You may select the the next button in the top right corner to see the amount of money owed for the missing items.

II. Manage Inventory

Manage inventory begins on the main page in Fig. 2

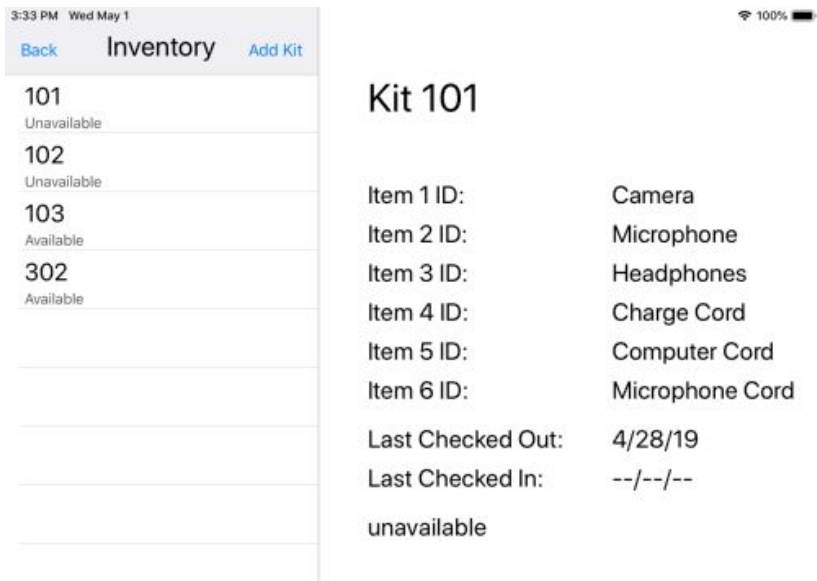
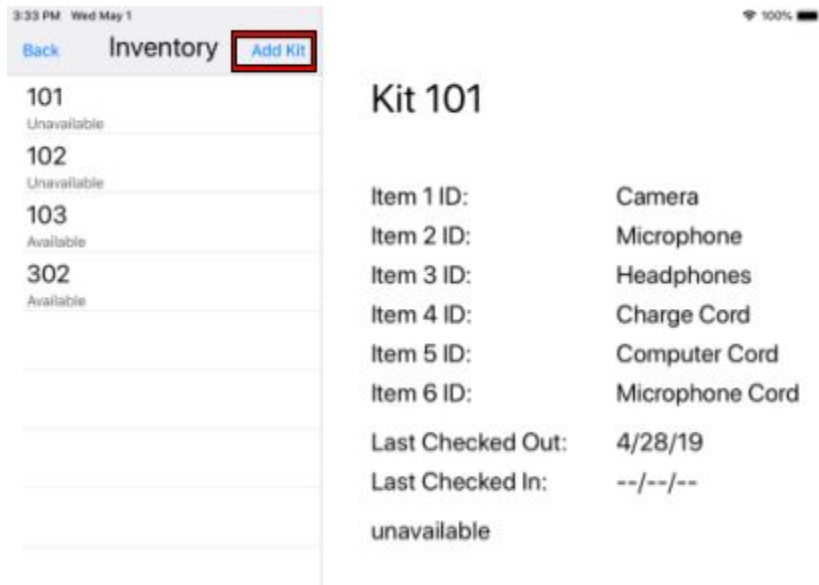


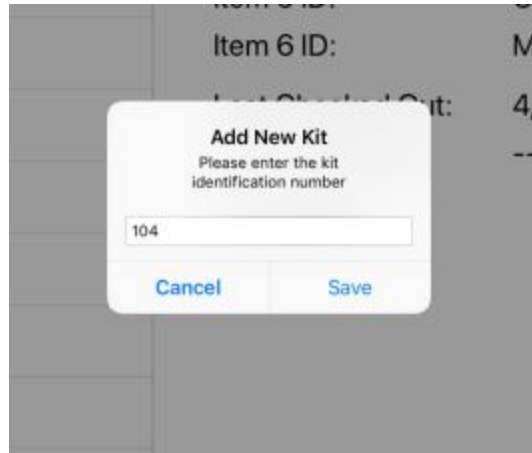
Figure 2. Main Manage Inventory Page

A. Adding Kits

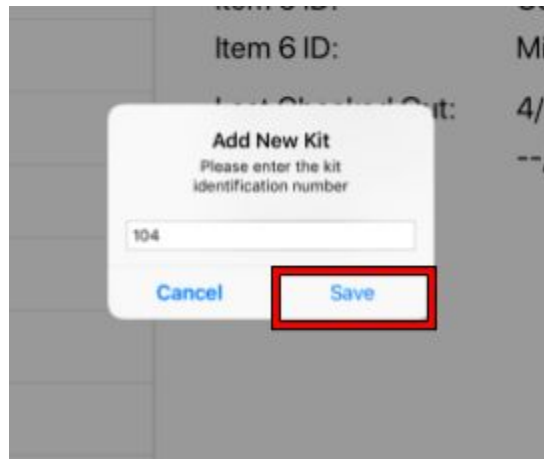
1. Select "Add kit"



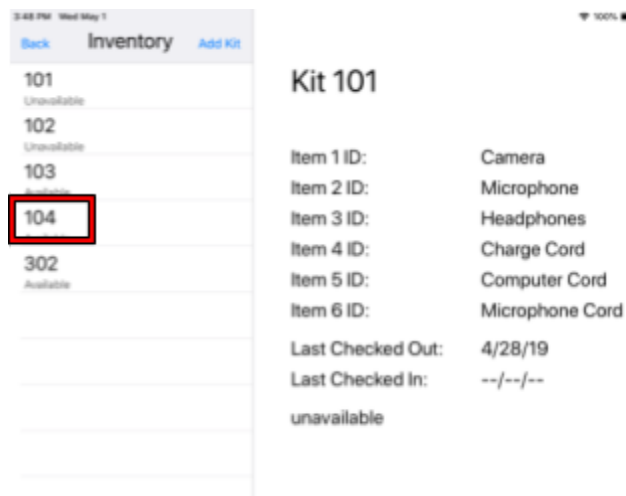
2. The pop-up screen below will appear. Enter the desired kit number.



3. Select "Save"

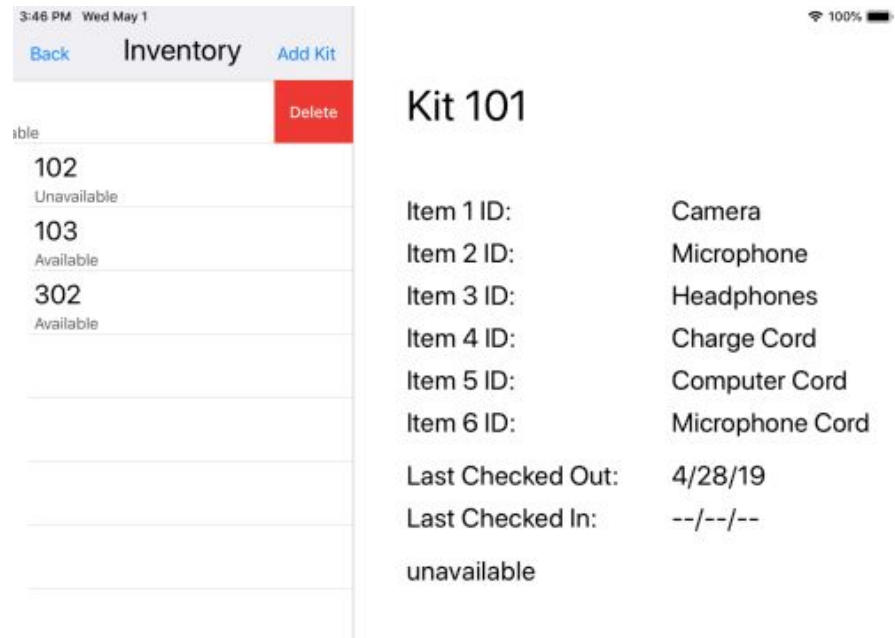


4. A new kit has been added to the list on the main manage inventory page



B. Deleting Kits

1. Begin by swiping the name of the kit you wish to delete to the left. A “delete” option will appear
2. Select the “Delete” button



3. The selected kit has been removed

III. Manage Users

Manage Users begins on the main page in Fig. 3

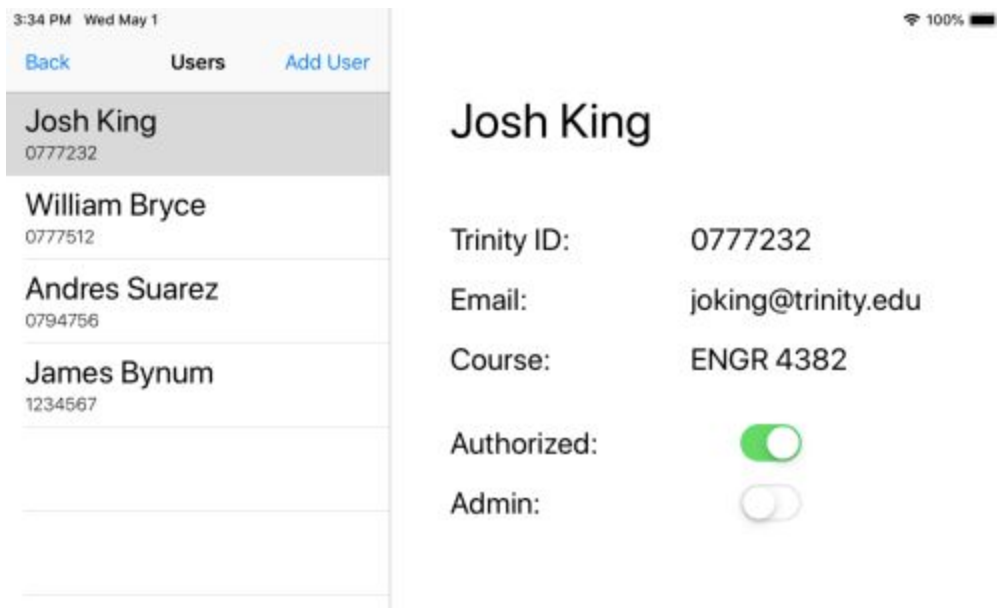
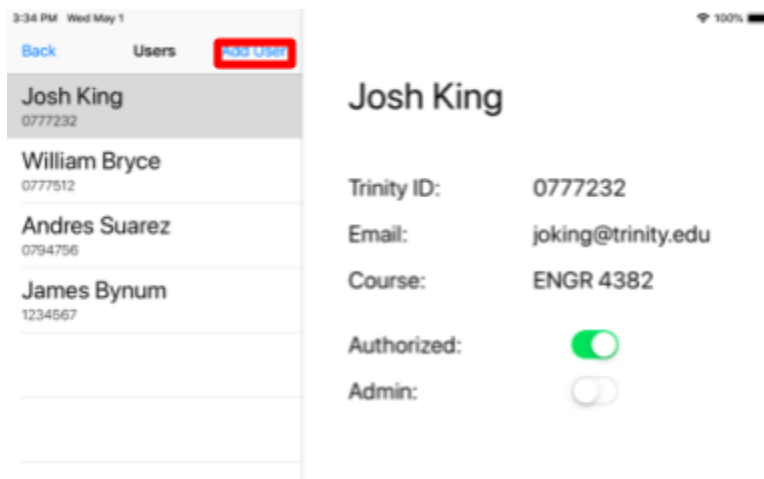


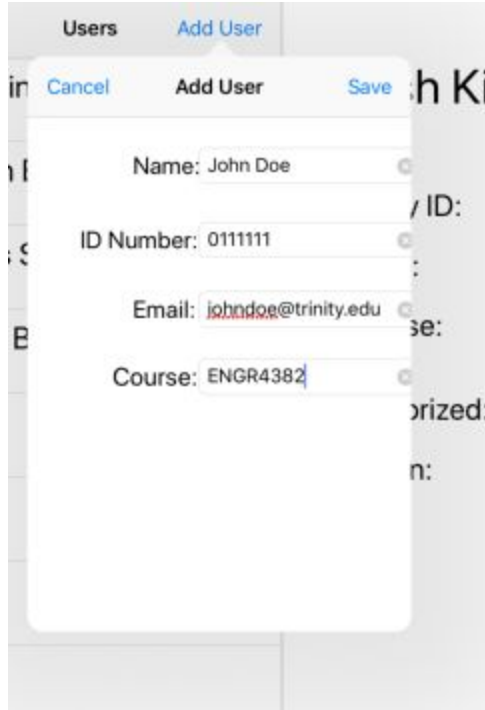
Figure 3. Main Manage Users Page

A. Adding a User

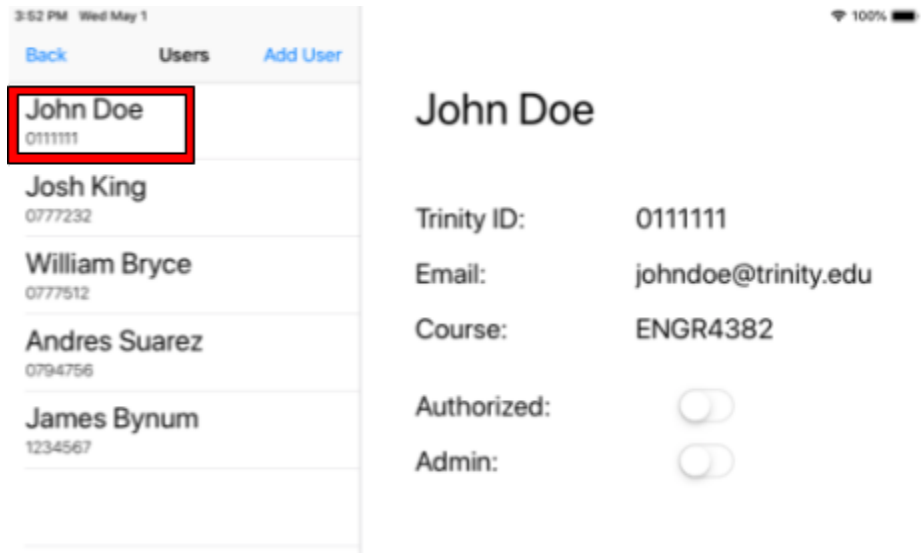
1. Begin by selecting "Add User"



2. The pop-up window below will appear. Enter the user information.

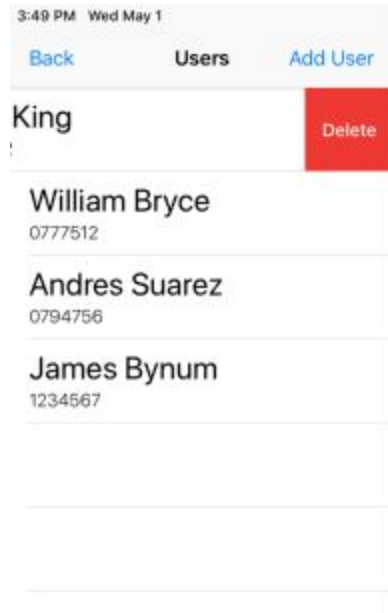


3. Select "save"
4. The user information has been saved to the database and will appear on the main manage user page.



B. Deleting a User

1. Begin by swiping the name of the user you wish to delete to the left. A “delete” option will appear.



Josh King

Trinity ID: 0777232
Email: joking@trinity.edu
Course: ENGR 4382
Authorized:
Admin:

2. Select the “Delete” button
3. The user has been removed