D.A.D.D.S. Automated Bartender

SACRAMENTO STATE

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ELEVATOR PITCH

Drunk driving has repeatedly caused nationwide tragedy and hardships. Our team will create a device that will make alcohol users more aware of their intoxication levels and reduce drunk driving.

EXECUTIVE SUMMARY

For our senior design project, our team decided to focus on the societal issue of driving under the influence (DUI). Some causes of DUIs are people's lack of awareness of how intoxicated they are, as well as not having someone, or something, to tell them that they may be unsafe to drive. The problem that inspired us to work on a DUI and drunk driving safe and automated bartender is the impact that drunk driving has. Drunk driving has taken many lives. A solution is needed to deter people from driving drunk and risking death. This is where D.A.D.D.S Automated Bartender, can provide a possible solution.

In the work breakdown structure, we discuss the organization of the work needed to complete this project among the team members. This section serves as a timeline of events that lists the work done throughout the project. We calculated how many hours each task and feature took. In our appendix, we displayed tables and grids to help with the visualization of how long each feature and task took. To understand the time sequence of the project we used a Gantt chart and PERT diagram, which showed assigned tasks and project milestones.

With any engineering project there are many risks. Our team estimated about 13 risks in our automated bartender safe. Some of the risks we laid out were related to sanitation, circuit building, social distancing, and personal issues that may arise. The risks that come with any of these features are significant enough to delay our project. The most significant risks in our project are any that would stop one of our main features from functioning.

Blood alcohol concentration is determined through several factors like height, weight, and how much alcohol is consumed. Breath alcohol concentration is determined through a simple exhale of a breath. The alcohol in the breath could then be tested through a sensor which could create a BAC measurement. As engineering students we are not able to produce blood alcohol content because it would require a medical professional and lab equipment that we are not accustomed to. So we have settled on measuring the breath alcohol concentration (BrAC).

For our project components our team tested every component that we needed for our design.We tested our breathalyzer, peristaltic pumps, GUI files, RFID system, and lockers. We tested each component to ensure that it met the engineering requirements and specifications which the team set out to accomplish at the beginning of the project.

An automated bartender with a DUI deterrent system is an advanced and creative method for serving liquor. Young adults generally drink as a method of social connection. D.A.D.D.S. Automated Bartender can give an entertaining and safe way for youthful grown-ups to drink safely. Our plan thinks about the client's wellbeing by creating an efficient method to deter drunk drivers.

ABSTRACT

Driving under the influence has caused many unfortunate deaths. Some people start drinking at a young age, sometimes leading to alcohol abuse patterns later in life. To target the drunk driving issue, we proposed making an automated bartender with an attached locker. We are calling this design D.A.D.D.S (DUI and Drunk Driving Safe), and automated bartender. For our design to be built efficiently, the project device was broken down into 5 different tasks for each of our main components: the breathalyzer, G.U.I - touch screen, RFID reader, Automated drink maker, and locker. We are splitting the group in half, so a pair of two would be targeting different tasks. Within the project timeline section, we will be going over when and in what order our tasks and work packages will be accomplished. We will visually display our time sequence, tasks, and work breakdown through the use of a Gantt chart as well as a PERT diagram. We will be testing the peristaltic pumps, breathalyzer, RFID, lockers as well as the GUI. To make each and every component work to our desired feature set we will need to create several files of Python code and test these files throughout our project design. The D.A.D.D.S. Automated Bartenders can provide an amusing and safe way for young adults to drink responsibly. Our design takes into consideration the user's safety by providing a carefully calculated way to cut you off from drinking and holding your keys until you may safely drive.

Index Term--- Driving under the influence, Alcohol effect on health, Alcohol Use, Automated Bartender, RFID, peristaltic pumps, solenoid lock, Gantt, PERT, python coding language

I. INTRODUCTION

A. Societal Problem

Drunk driving affects thousands of people's lives on a daily basis. Many have lost precious loved ones and family members to drunk driving. More than 10,000 deaths occur every year due to drunk driving incidents. This contributes to a quarter of all traffic deaths according to the National Highway Traffic Safety Administration (NHTSA) [1]. Although there are many deterrents to driving under the influence, the crime persists. Oftentimes drunk driving is the result of alcohol users being unaware of how much they are drinking and how intoxicated they are. Some people may feel less intoxicated than they really are, causing them to make poor decisions. One poor decision that is made too often is getting behind the wheel.

Society has taken action to deter driving under the influence, however, the crime persists. DUI checkpoints have proven to be effective as they are publicly announced beforehand. Generally being aware of these societal measures is enough to deter most, but definitely not all. Although effective DUI checkpoints are not regularly conducted, Nationally only 14% of law enforcement agencies reported conducting checkpoints monthly or more frequently in 2011 [2]. Societal measures that fight driving under the influence are necessary but often tested.

Over the last year, alcohol sales have risen significantly due to the Covid-19 pandemic and restrictions leaving many stuck at home. Alcohol sales rose by 55% in March of 2020 compared to sales in 2019 [3]. This increase in sales may have caused an increase in the use and abuse of alcohol throughout the pandemic. This increase in alcohol sales and use may have been due to the psychological stress that the Covid-19 pandemic caused throughout the world [4]. Also, previous psychological conditions may have been triggered while many were left without social interaction. As we see the Covid-19 restrictions being lifted, many are left with the ill effects of habitual alcohol use throughout daily life. As we see more and more restrictions being lifted, this raises the concern of there being an increase in drunk driving over the course of the following years.

Our team plans to battle this trend by placing our device within social gatherings where alcohol is a highly enjoyed substance. Using our intoxication scale, we will be able to significantly lower the drunk driving rates. We will inform individual users about how high their blood alcohol concentration is, making them more aware of how intoxicated they are. This device will also keep track of who will be driving by employing a safebox for car keys. This will make it more difficult for users to access their car keys when intoxicated due to the design of our device. This device also gives the host more control over the monitoring of each guest's BAC as well as how many drinks they have had.

Even though we can not solve the psychological addiction of alcohol abuse in society, the least our team can do is to try to save the lives of those who are unaware of their blood alcohol concentration as well as the unaware bystanders around them.

B. Design Idea

The deployment of our DUI and drunk driving safe-automated bartenders is needed to aid in deterring individuals from driving while under the influence of alcohol. This device would perform best within bars, clubs, college parties, and generally, anywhere alcohol is being served. Many individuals who intend to drive home after drinking alcohol may not realize how drunk they are until they are operating a vehicle and the alcohol greatly impairs them. This risks the safety of the driver, passengers, as well as bystanders around the impaired driver. This is where our automated bartender and safebox would come in handy.

DUIs and drunk driving will be limited by creating a highly attractive automated bartender and safebox. We want our drunk driving safe and automated bartender to encourage alcohol users to monitor their blood alcohol concentrations (BAC), while also keeping their vehicle keys in a place where they are not accessible to anyone above the legal BAC level. Our device will help not only the host/owner by monitoring guests' BAC but the guests themselves as they continue to drink.

Our team will be creating a way to monitor how much one has been drinking by incorporating a breathalyzer in our automated bartender. Alcohol abusers will be able to set their own limits using our monitoring system which will keep a count of how many drinks each individual has had.

A guest's BAC will also be displayed on a screen after blowing into the breathalyzer, giving them the opportunity to cut themselves off. Even though we are not stopping individuals from drinking, we are limiting how much alcohol they are served and can consume with this device. We are also making the users aware of their intoxication levels and limiting over-intoxicated individuals from getting behind the wheel by integrating a key locker system. This will help decrease how much alcohol individuals will intake, making them less likely to drive under the influence.

The design is broken down into a couple of key features for this device to work as it is intended. We are planning to implement an RFID tags reader into our automated bartender, which would also have a touch screen and a breathalyzer. Each of these functions or key components would be communicating with each other from the main microcontroller. They would all be connected either through ethernet cables or wirings, making it easier for the devices to send commands to each other. With the guest interacting with the device, they would be able to go through a series of actions that would allow the guest to activate a locker and use the automated bartender machine.

Our device is intended to be in a fixed location, but for the project, we are going to try to make it as portable as possible. The device is to be powered by an outlet power source so it wouldn't need a charging port. As the devices are just running off our microcontrollers, the microcontrollers are the only item that would need to be powered, as for other components they would be powered by the microcontroller.

C. Work Breakdown Structure

In this section of the report, we will be discussing how our team has broken down how we will divide up tasks over these two semesters. Along with reporting assignments given by our instructor, we also have our physical tasks that will lead to the building of our overall project design.

We began by selecting a societal problem that was proposed by one of our team members. After deciding what societal problem we wanted to tackle with our project we were instructed to research specific details related to the societal problem. As our topic was driving under the influence, we were able to find an abundance of articles that fueled our research. Once we had a better understanding of what sort of issues cause people to drive under the influence we were ready to come up with our design idea.

The design idea was another major task in our report as it was a contract with our lab instructor. The design idea was used to outline a design philosophy, which is a basic review of what we want our project to do. We were also tasked with creating a feature set to outline the different components of our project design and their specifications.

After approval of our design contract, we are allowed to start building a prototype with our specified features. We have several electrical components that are going to require both hardware and software troubleshooting. Some components that are essential to our design are the RFID tags, the breathalyzer, drink dispenser, key safe lockers, and touchscreen GUI. The circuit building for these individual components will be divided up by our team of four. After we have each component working individually we will come together as a group and collaborate on how to integrate all the pieces together in a final build.

D. Project Timeline

To be able to manage our schedule for both semesters, we made a project timeline that would portray all the important activities, assignments, and tasks. To make an effective schedule, our team made both a Gantt chart and a PERT diagram. These charts helped divide up the assignments and tasks on when we wanted to finish tasks. The charts give us a visual representation of our schedules, so we would be able to time manage ourselves on building our prototype.

Most of our important milestones involve the written report assignments and the building of our features. We prioritized writing the report over the building of the device at the beginning of the semester and then later on transitioned to doing both at the same time. We first had to research and write about a societal problem that we wanted to target on September 13, then we went into writing about a design idea that would help with that problem. We continue to write reports about how the tasks are going to be broken down along with future planning of the assignments. Most of the planning was discussed on November 1 about how we want to tackle each task. We would then talk about the risk that is associated with our design in a report that is due on November 8th.

Planning out our future activities and tasks, we had to take into consideration important dates such as the prototype progress review on November 15th, along with the public presentation on December 10th. We have to be able to get a functional device before being able to present them to others. To be able to make the deadline, we would have to work gradually on each component each week.

For the development of our device, we would use the work breakdown structure that was planned out before this project timeline. The team would divide up the task that each component is required to complete. The task was broken up into 5 categories for our prototype design. We had to split up the work for the drinks dispenser, RFID system, key lockers, breathalyzer, and GUI. The physical casing was also involved but it wasn't as important as getting the components to work. Deepak and Tahima are in charge of getting the breathalyzer and locker to work while Shammah and Shawn would work on the drink dispenser, GUI, and RFID system. Once everything is complete and integrated we would then build a physical casing for it. Even though the tasks are divided up among ourselves, the team is still expected to help each other complete them. Each team member will work on trying to finish most of the coding or building the circuit for that specific task in the estimated time period, starting from December 11. The estimated time for each part would take about 60-70 hours which means we might finish most of it before December 8. This will keep the team on track to completing the project before the final prototype presentation on May 25.

E. Risk Assessment

There are 13 risks throughout our design. The project's design consists of critical paths that must be developed throughout the semester. These critical paths are GUI, Breathalyzer, Drink dispenser, Integration, and Lockers.

Within the GUI, our main goal is to create an easy-to-use and intuitive graphical user interface that communicates with all the devices to seamlessly run each device in accordance with the breathalyzer data and RFID data. We will be displaying important information to the user such as BAC and the number of drinks. The GUI will also interact with the user, prompting them to do actions such as blowing into the breathalyzer and scanning their RFID. There are two risks associated with the GUI. Those risks are sanitization and responsiveness. The touch screen will be the primary interaction between guests and a big concern would be sanitization. The touch screen may be loaded with harmful bacteria and pathogens over time. To mitigate this we will need an associate to regularly sanitize the screen as well as give out hand sanitizer to each guest who is using the device. The other risk is the responsiveness of the GUI. There may be a lag due to multiple components being used at one time. This will be mitigated through the use of a sleep function within our code to stop ongoing processes from proceeding within the background of the raspberry pi. The breathalyzer is a crucial path due to it being the only device that will be collecting valuable data. It will gather the user's BAC levels to be passed between files. The four risks that the breathalyzer had were inaccurate reading, error conversion, guest testing for other guests, and not being able to tell if the user is blowing into the device. To mitigate the inaccurate readings, we will do our best to calibrate the settings of the MQ-3 by dialing in the sensitivity through the use of the knob on the back of the device. This knob will change the voltage of the MQ-3, thus making the device more or less sensitive. When converting kilo-ohms to BAC, there may be errors depending on who is blowing into the device. The calculations may have errors within them due to the fact that there may be inaccuracies within our logic. To mitigate this, we will be doing extensive testing with alcohol readings to dial in the settings and verify that the equation is functioning as expected. To solve the problem of guests breathing in for other guests we might add a camera to verify if the user is taking their own test. We also may use an attendant to regulate this issue as well as have social distancing in place so that there cannot be more than one person at a time interacting with our machine. Another risk would be that the breathalyzer would not be able to tell if the guest was blowing into the breathalyzer. To mitigate this, we will be placing small holes to draw in the fresh air and have a range of clean air vs CO_2 air. To tell if a person is blowing into the breathalyzer, we will write code to differentiate between clean air and exhaled air.

The drink dispenser will be our main appeal to the users and will be regulated. It will be able to dispense mixed drinks within an 8-ounce cup, satisfying each individual user with our 11-item drink menu. The dispenser does come with risks that we must keep in mind to mitigate them. Those risks are that we may not have enough voltage for our pumps and locks and there is also a risk of killing our pumps due to a flyback current when powering off the device. Using a relay board, we will be powering 4 locks and 4 pumps. The raspberry pi does not have enough power for all of these devices so we will be powering them with an external 12v power supply. This will mitigate the risk of not having enough power for all of the devices. To counter the flyback current would need to deploy a flyback diode in between both the positive and negative points of the device.

The integration is a crucial step within our project. At this stage, we will be integrating all of our devices to a central file where it will call all of the function files. We will be performing all of our safety checks and performing our functions within this file. There does pose a risk to doing this. That risk is that we may not be able to integrate some files due to GPIO pin settings. Some files that we have created run BCM (Broadcom chip-specific pin numbers) and some run BOARD for the GPIO layout. To mitigate this, we will be setting the settings within the main file. We will be switching between settings before each function is performed.

The lockers are a crucial device that will prevent users from accessing their car keys. They will only be allowed access after they have passed the crucial tests that verify that they are able to drive. The lock will have one risk that will pose a challenge. This risk is that one user at a time may use the lockers and the device will not be able to complete the locker function until the locker is pushed back in and the user is done using the lock. To mitigate this, we will try to implement code that will help the device continue working while the locker is malfunctioning due to an error happening. That error is that the locker is out and not placed back inward.

Due to covid-19, we will have to form specific protocols to mitigate the spread of the virus with the use of our device as well as the building portion of our device. To mitigate the risk of spreading the virus, we, as a group have been fully vaccinated, maintained 6 feet apart, masks on at all times, and have only met when necessary. To mitigate the spread of covid 19 with our device, we will have to make sure that our device stays sanitary, users maintain 6 feet away from each other, users use hand sanitizer before each use, and use the provided disposable straws for the breathalyzer. To keep everything sanitary, we will entrust an individual with wiping down the screen with every use as well as maintaining a uniform line. To make sure that guests know how far they should be, we will also put dots on the floor to indicate where they should stand as well as arrows pointing to where they should leave after using the device. Doing these things should keep everyone safe and healthy when building the device as well as using it.

F. Problem Statement Revision

For the last two years, the world has been in an unusual and unfortunate state due to the COVID-19 pandemic. As the world shut down for months many people were left without work, business, education, and socialization. This state of uncertainty affected many people psychologically. Another effect the pandemic has had on the economy is the dramatic increase in alcohol sales.

The pandemic left many working from home or not working at all. This sort of isolation and the combination of bars, restaurants, and social gatherings being shut down left many people with nothing but time and possible disposable income. Alcohol sales rose dramatically in the first few weeks of the pandemic giving us the impression that people may develop, or trigger their previous alcohol disorders. This increase in alcohol sales and consumption may dramatically increase the number of drunk driving accidents in the near future.

Alcohol consumption and abuse is an issue that affects many people throughout society. An issue that stems from the consumption of alcohol is drunk driving. According to Benjamin Hansen, “since the NHTSA began recording fatal traffic accident data in 1975, drunk-driving was a factor in 585,136 traffic fatalities through the end of 2012." [5] Drunk driving is one of the most fatal crimes in the World even with all the warnings and laws that try to prohibit it.

Society has taken many measures to try and prevent drunk driving including DUI checkpoints, financial repercussions, and driving restrictions. DUI checkpoints have proven effective more often when checkpoint locations are announced in advance. Driving restrictions, like losing your license or having a breathalyzer in your vehicle, may pose a threat but can prove ineffective to habitual lawbreakers. Financial repercussions are probably the most effective deterrent for drunk driving.

One of the reasons people get behind the wheel after drinking is the misconception of their own intoxication level. Some people think they are "okay to drive" because they only had one beer, or have had a glass of water but the reality is that it can take much longer to completely sober up. Everyone is unique in height, weight, and tolerance which makes it difficult to tell whether someone is intoxicated up to the legal limit (0.08 mg/dL or 0.08% BAC).

Our team has decided to create an automated bartender that allows users to store their keys and monitor their own intoxication levels using a breathalyzer. The breathalyzer will allow users to view their current intoxication level between drinks and before they receive access to their keys. Our goal is to make alcohol users aware of the risks posed when getting behind the wheel as well as provide a sort of supervisor. When someone goes to a bar, restaurant, or party they are responsible for monitoring their own drinks and intoxication levels. This is usually the cause of a DUI or fatal accident. Leaving an intoxicated person in charge of their own decisions is not a wise thing to do, yet it seems to be the norm in society.

In our design, our team is using a sensor that will read the alcohol concentration in a user's breath. We will be using the measurement of Breath Alcohol Content (BrAC) rather than the more common Blood Alcohol Content (BAC). To measure a user's BAC would require a medical professional to draw blood and measure the amount of alcohol in milligrams in 100 milliliters of blood. As we are Engineering students we cannot accurately produce law enforcement levels of BAC so we will be estimating BrAC.

G. Device Test Plan

To start testing our machine we decided to test every component that we used for our design. The components we are going to test are a breathalyzer, peristaltic pumps, GUI files, an RFID hat system, and a safe design. Our team plans to test all of these components independently and if all of them work fine we will put them together.

The peristaltic pumps are an important feature of our design and we need it for our drink pumps. For our device, we use four peristaltic drink pumps and each of these pumps will pump one different liquid. Shammah will test these pumps and each of these pumps should work together to make eleven possible drinks; each drink will be eight ounces. To conform accurately to these peristaltic pumps we need to test them for about four to six weeks.

A breathalyzer testing plan is a key feature of our design. We want a breathalyzer to give us an analog reading output from Raspberry Pi and our final reading be in BAC percentage. Deepak will test the breathalyzer and when the BAC percentage of the user is above 0.06% the user will not be allowed to get more drinks. To figure out the accuracy percentage of our breathalyzer we will test someone's breath after certain drinks. This test takes about three to four weeks since our volunteers only perform the testing two to three times per week. When we are testing BrAC values we will record the voltage at all these readings, to do that we will be able to know at what voltage what would be our BAC percentage value.

GUI testing is one of our main testing features because it is the first interaction menu our guests will see and use. This part will be tested by Shawn. We used the Python Tkinter library to create the menu and this includes GUI features like buttons and colorful design. We need to add a simple to use interactive drink and locker menu. We will test the drink menu button first to see if all pumps following the corresponding drink are selected. GUI testing will take about five to seven weeks.

RFID tags and the locker system are another important part of our design because we want our guests to put their car keys in the locker before starting drinks. This part will be tested by Tahmina. It is very important to test every single locker and RFID tag combination and only one locker opens when a tag is scanned. It is really important that one RFID tag can open one locker and also if the user’s BAC percentage is above our legal limit (0.06%), the user's lock will not open and he/she will not be able to get access to their keys. This test will take about four to six weeks.

There will be several electronic components we will use in our project design. Our team uses a Raspberry Pi microcontroller to run all these components. This will be tested by Shawn. To make sure each component and feature set works properly we will need to create several files of Python code and test all of these files throughout our project design. We will need to create and test code files that run RFID tags with their corresponding locker number and also we need to create and test code alcohol sensors that can read BrAC and analog to digital converter. A testing time for our software will be about ten to twelve weeks because every part of our design needs some code.

H. Market Review

An automated bartender with a built-in drunk driving deterrence is a smart, futuristic, innovative, and safe way to serve alcohol. In many cases, bars, restaurants, and events that serve alcohol are not responsible for the consumers` intoxication levels. Another consumer for our design may be young adults and college students who are just reaching the legal drinking age. D.A.D.D.S. Automated Bartenders can provide an amusing and safe way for young adults to drink responsibly. Our design takes into consideration the user`s safety by providing a carefully calculated way to cut you off from drinking and holding your keys until you may safely drive. This product will be competing against real-world bartenders who have to pour and serve the drinks. Within the automated bartender space, there are not very many who have integrated a system that will keep the users of the device safe.

There are numerous automated bartenders on the market today, but many are overpriced, out of reach, and lack safety. There are no safety features within any of the automated bartenders on the market today. Our automated bartender is unique in the way that it incorporates a breathalyzer and safe locker into it. The product is also cheaper than other automated bartenders on the market. The marketed price for most automated bartenders tends to be around $400 to $500, not including the shipping cost. For only $300 or so, customers would not only get an automated bartender but also lockers and a breathalyzer feature included. Other automated bartenders may be able to perform better and faster than our current project. This means that our robotic bartender has an opportunity to expand.

Since Covid-19 started many businesses prefer to use less human elements in their customer services and more robotic features, and it is going to change consumer preference and really open up new opportunities for automation. This gives opportunities for our robotic bartenders to compete in the market. Our robotic bartender has some abilities like lockers, breathalyzer, screen, and RFID tag that not any automated bartender in the market has, and this gives opportunities for our device to be liked and chosen by businesses. In addition, our robotic bartender is in a good size and not heavy, and it is also affordable to buy, so these specifications give opportunities for our device to be chosen by individual buyers as well. Different competitors could be lowering their prices for their current products.

I. Testing Results

For our project devices, we tested every single component that we needed for our design. Peristaltic pumps were one of our components that were tested by Shammah. We used four peristaltic drink pumps that each pump one liquid. The four pumps were tested to work in conjunction with one another to create five possible drink combinations. These four pumps should run at the same time to pump 8 ounces of liquid. Shammah tested pumps with different temperature liquids. The temperature he used was between 15 to 40 degrees Celsius. Also, he tested pump duration to find out how long pumps take to pump 8 ounces of liquid and he found it takes 123 seconds to pump 8 oz of liquid. The pump was tested by running a script that ran the pump for an unlimited amount of time. He tested pumps to see if different changes in water temperature would affect the overall speed of the pumps. To find out, he ran 3 different tests. In the first one, he used liquid at 99 degrees Fahrenheit, the second was hot water at 123 degrees, and lastly cold water at about 50 degrees. All these test results gave him the same amount of time to fill 8 oz of liquid.

The breathalyzer was another component of our device that was mainly tested by Deepak. We want the breathalyzer to give us an analog reading from the raspberry pi. We want the device to output a BAC reading that shows the user how intoxicated they are and if their BAC level is above the limit it should not allow them to drink anymore. To better understand how our breathalyzer reads our estimated BrACs we will test someone's breath after certain drinks. We tested a person's intoxication level after a specific amount of drink 2 to 3 times a week. When we are testing BrAC values we also want to record voltages at these readings. As the test subject blows into the device, we measure how much voltage is being used to transmit the information to the raspberry pi. We used a voltmeter to read the actual voltage that goes through the MQ3. First, we tested the sensitivity of alcohol on a person's hands. It took us a while to figure out MQ3 is analog and we need to use an ADC and change the Python code. Deepak tested the BrAC level based on different drinks. The first test was based on the consumption of a single 12-ounce beer. The result showed that after consuming the beer and waiting 5 min. sensor dedicated to alcohol while it was present in the mouth. After 30 mins the results were a bit different. To get more accurate testing we went to the Chemistry Department and with help of a chemist, we made a 40% alcohol solution and tested it with different BAC percentages. We used the $C1V1=C_2V_2$ equation to test different BAC percentages. The reading from the breathalyzer gave us exactly the same BAC percentage as the ethanol percentage measure.

Our graphical user interface is the main interaction menu our guests use and this is tested by Shawn. We used the Python Tkinter library to create this. It has a drink and locker menus and a home screen. We tested the GUI to work with our components when a button is pushed. The drink buttons were tested individually, first by creating the code for each button and labeling it with a drink title. Then we tested each button to make sure each of them connects to the right drink pump. For the lockers, we just use one and in the GUI screen, it shows as "open locker" if a guest accidentally hits the wrong button they would have to repeat the process.

The RFID tags and locker system are other components of our device that were tested by Tahmina. We want only one locker to open when one tag is scanned. Our locker system has two safety features, an RFID tag and a breath alcohol test that shows if the locker door should open or not. She tested RFID tags and locker combinations after scanning RFID tags, she also tested solenoid locks to make sure they open after the tag scan and remain open for 10 seconds. She also tested RFID tags with a breathalyzer. The breathalyzer has a direct connection with the locker, so she tested different BrAC percentages to make sure the lockers are working properly.

The software testing of our overall project was tested by Shawn. We create several files of Python code and test them all during our project. We used files to run our pump, and created files to run RFID tags with their lockers. And we create files for our breathalyzer. Software testing takes about ten to twelve weeks.

J. End of Project Documentation

The project was created from an idea that would help mitigate drunk driving along with providing some refreshments for people. The design idea was originally to make ways that drunk driving could be prevented. Since public locations such as bars exist there is a risk that people could get drunk away from home, causing them to drive home. So if we could have an automated bartender that also prevents people from getting too drunk, it would solve our societal problem and also save the bar some money from hiring an employee. This causes us, as a team, to want to implement a breathalyzer feature.

Going into the project, we knew that we wanted to build it using raspberry pi. We have been using a raspberry pi in multiple classes and are quite familiar with it. We went to multiple websites and researched the best way we could build the automated bartender. Our project is pretty unique in the sense that nobody has incorporated a breathalyzer feature into an automated bartender machine. We would have to research different components that were incorporated into our device and try to implement them.

The testing that went into the project was quite time-consuming. Everyone in the group had to test a component. We tested the ADC components for about 3 weeks. We had to find out if the correct input was coming out of the raspberry pi. We also had to spend time testing out the pumps to see how long it would take for each pump to dispense up to 8 ounces. Each pump was dispensing at relatively the same time. For the breathalyzer, we went to the chemistry department to test if our sensor is actually getting the correct ethanol reading.

II. SOCIETAL PROBLEM

A. First Semester Interpretation of the Societal Problem

Alcohol consumption has been around in the US since the 1630s. In today's society, almost everyone has tried alcohol at one point in their life. Some start as young as 12 years old and engage in under-age drinking. More than 70% of teens have consumed at least one alcohol beverage by the time they reach the age of 18 [6]. One cause of this could be due to social norms. As kids are trying to fit in with their respective groups they may be suffering from peer pressure that leads them to drink. Compared to adults who go out drinking for social interaction with other people. Drinking at a young age could represent a step into adulthood for many children. They want to experience one of the benefits of being an adult, making alcohol an easy alternative to turn to since it is easily accessed if their parents are also users. Alcohol is being consumed by almost everyone, but not everyone is taking the time to consider the consequences that may arise. Alcohol consumption is a factor for many health problems and can be a contributing factor to many others [7]. Shown in Figure 1, it shows that although alcohol does help prevent cardiovascular disease, it causes more issues such as cancer, liver disease, pancreatitis and oftentimes injury. One often deadly issue that alcohol is a direct contributing factor to is drunk driving.

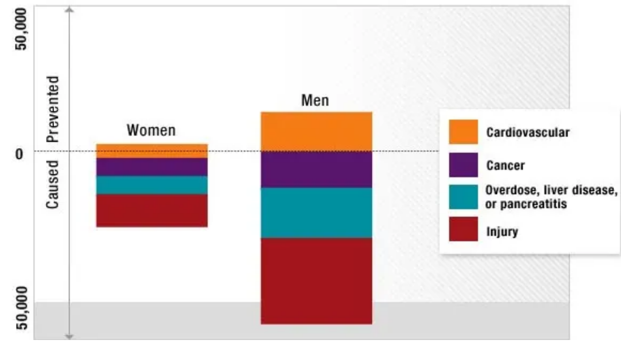

Figure 1. Deaths prevented or Caused by alcohol each year [8]

Although there are many health complications and stories of DUI related deaths, people continue to drink even while knowing the consequences could be harmful for themselves and those around them. In the early stages of drinking people would experience alcohol as a stress reliever. Alcohol causes higher amounts of cortisol to be released, altering the brain's chemistry. Doing so affects the brain's reward or pleasure systems, making drinkers want to achieve the same effect by drinking more [9]. As people continue to drink more, it can become an addiction leading to alcoholism and impaired judgment, which can lead to further poor decision making. That drive to keep that pleasurable feeling causes people to believe they are not as intoxicated as they might really be so they may go back to the liquor store to pick up another drink. Needing that extra drink or two causes people to make the judgment error that puts them behind the wheel when they have no business being there. Lack of judgment and awareness is just one of the many contributing factors to driving under the influence.

According to Harvard health "there is an estimated 10% of adult men and 5% of adult women who have alcohol use disorder"[10]. Alcoholism causes an individual to have an uncontrollable craving for alcohol. The first drink would be due to craving which then leads to spree or binge. It affects people mentally, changing their personality, making them more aggressive while at the same time deteriorating some of their mental function. It makes it difficult for them to hold a job or maintain their relationships with friends and family, making other people distance themselves from them. It is the mental obsession with alcohol that is difficult to overcome without professional support.

One one of the major issues that can be caused by alcohol is drunk or impaired driving. Drinking and driving has been an issue in society that there does not seem to be a solution to. Drunk driving is the cause for 25% of traffic-related deaths [10]. There are many deterrents to driving under the influence, like jail time or a loss of a driver's license, but no one has been able to end the problem completely. One study shows that people with high risk alcohol consumption are less likely to agree that alcohol causes more crashes, and are more likely to agree they drink and drive when they believed they could get away with it [11]. In this case, people who have been drinking for a long period of time would be more unwilling to accept that alcohol as an issue. Society has taken many measures throughout recent years to fight the perpetual threat of drinking and driving.

One of the general deterrents to drinking and driving is DUI checkpoints. Many DUI checkpoints are publicly announced leading to a potential decrease in drunk drivers or even decrease in people who are likely to drink. Being more aware of the consequences before taking part in the action is likely to decrease the chances someone gets behind the wheel after drinking. Although checkpoints are an effective deterrent, not all states in the US conduct checkpoints on a regular basis. According to Eichelberger (2016), " based on the highway safety office survey, 38 states conducted sobriety checkpoints in 2011, with only 14% of national agencies conducting them monthly or more often" [2]. 14% nationally is a horrendous figure knowing the damage caused by DUIs.

TABLE I.
Law Enforcement Perception of D.U.I.[12]

Law enforcement beliefs	Frequency	Percentage
Perceived likelihood of stop	58	100.0
Almost certain	6	10.3
Very likely	15	25.9
Somewhat likely	19	32.8
Somewhat unlikely	5	8.6
Very unlikely	1	1.7
Don't know	12	20.7
Perceived likelihood of arrest	58	100.0
Almost certain	32	59.3
Very likely	17	31.5
Somewhat likely	4	7.4
Somewhat unlikely	0	0.0
Very unlikely	1	1.9
Don't know	4	—
Perceived likelihood of conviction	58	100.0
Almost certain	44	75.9
Very likely	7	12.1
Somewhat likely	3	5.2
Somewhat unlikely	0	0.0
Very unlikely	1	1.7
Don't know	3	5.2

In this table we see that DUI offenders are less likely to believe that they will be arrested for a DUI compared to the general public. This may be due to the perceived heightened tolerance of heavy drinkers. They are unaware of their blood alcohol concentration and are willing to take more risks due to the influence of alcohol. Everyone's alcohol intake tolerance is different depending on their body height, weight, and amount of previous use. A larger person would be able to drink more than someone lighter than him and still have the same blood alcohol concentration. One equation that is used to calculate the BAC is shown in [13, Figure 2]. It is based on how much someone weighs and how much alcohol they have had. As their blood alcohol concentration rises, it begins to affect their mental skills. The more someone's BAC increases the more it impairs their judgments, many times making them do things that they might not want to do which leads to irreparable mistakes such as drunk driving. It only takes one mistake, as big as driving under the influence, to take someone's life.

BAC = Blood Alcohol Concentration

$$BAC = \left(\frac{150}{\text{body weight}}\right)\left(\frac{\%\ \text{ethanol}}{50}\right)(\text{ounces consumed})(0.025)$$

Example: 175-lb man who drinks four 12-oz cans of beer.

$$BAC = \left(\frac{150}{175}\right)\left(\frac{4}{50}\right)(48)\ (0.025)$$

$$= .86 \times .08 \times 48 \times .025 = .08\%$$

Figure 2. BAC Equation[13]

On average, three drinks or more will produce negative effects on an individual. Continuing to drink on a daily basis would make some feel less lively, making them less aware of how badly impaired they are. Shown in [13, Figure 3], the higher the BAC the longer it would take for it to lower to the appropriate level to be safe. The less intoxicated someone is, the faster they would be able to sober up and regain some of their judgment and motor function back. Although the graph suggests an estimated time period before one may feel sober, these numbers are just estimates and the time it takes for alcohol to leave your system varies between users. The safest way to moderate your intoxication is to keep track of how much you have been drinking and stop when you feel you have reached a noticeably impaired state. The safest way to avoid intoxicated driving is to take into consideration where you will be going and how you will be returning before taking that first drink.

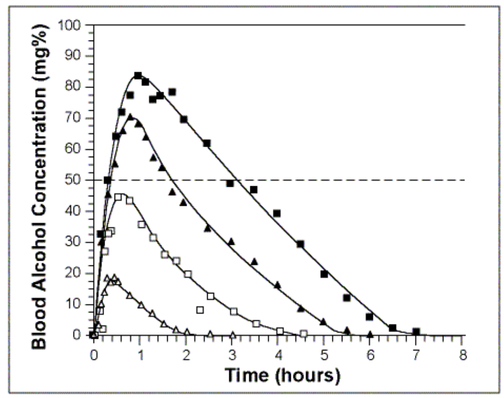

Figure 3. Estimated Time Alcohol leaves the system[13]

This is one of the main causes for drunk driving. People who don't realize their own limits, and believe they will always be fine after a couple of drinks will be the ones who make the irreparable mistakes on the road leading to injuries and even deaths. According to the National Highway Traffic Safety Administration, about 1.5 million people are arrested yearly for driving under the influence [1]. Even with so many arrests, it is impossible for there to be checkpoints everywhere to check if everyone is safe to drive. Although checkpoints have proven to be effective, this small flaw is making it possible for drunk driving accidents to continue to happen.

TABLE II.

The Effects of Blood Alcohol Concentration- table provided by National Highway Traffic Safety Administration.

Blood Alcohol Concentration (BAC) level	**Typical Effects**	**Effects on Driving**
.02	Some loss of judgment, relaxation, altered mood.	Visual function decline, divided attention.
.05	Exaggerated behavior, lowered alertness, impaired judgment.	Reduced coordination, difficulty steering, reduced response to emergencies.
.08	Poor muscle coordination, memory and reasoning impaired.	Short term memory loss, lack of speed control, impaired perception.

The COVID-19 pandemic caused many problems in our society today, but the increase in alcohol consumption globally over the past year is one we want to focus on. According to Stanton's (2020) online survey done in April 2020 in Australia, "the 1491 adults tested showed an increase of 26.6% in alcohol intake" [14]. It has been reported that alcohol sales have increased across the globe since the start of the pandemic in early 2020. With this increase in alcohol consumption and stay at home mandates being lifted, we are predicting an increase in the often-deadly crime of driving under the influence. As more alcohol is being purchased and consumed, tolerances are being built to alcohol. What used to make a person feel "buzzed" may now not make that person feel the same although the same amount of alcohol was consumed.

Some issues that may have factored into the alcohol consumption increase during the pandemic could be psychological due to the lack of social interaction caused by schools and businesses being shut down. Also, depression builds through extended periods of time spent at home. Often people can find solace in the fact that if things are not going well at home, they can escape a few times a week by going to work, school, or even the local grocery store to interact with their fellow human beings. The pandemic started off by putting a halt on everyone's social interactions with quarantine and stay at home orders. Later as things began to open again, but mask mandates were still in place, people were once again deterred from interacting or socializing with others in public. Masks not only make it difficult to hear one another but also takes away from that face-to-face interaction people used to be accustomed to. Now we just see eyes and a mask in others.

Not being able to leave the house or socialize may not be a big deal for some, but for others it can have a drastic effect on their mental health. Some people may take this isolation to reflect on some personal issues that may trigger their urge to drink. Others may just feel isolated and not have the ability to communicate digitally, making them drink as an outlet. Any number of issues may have led to the increase in alcohol sales throughout the pandemic, but what we do know is more people are drinking or people are drinking more. Either way this fact could be a gateway for people to underestimate the effects alcohol has on their driving or overestimate their driving ability while intoxicated. Even if the coronavirus does not directly correlate to drunk driving, it may be contributing to the increase of alcohol intake over the past year, which in turn may lead to an increase in drunk driving numbers.

B. Second Semester Improved Interpretation of the Societal Problem

Alcohol consumption continues to be an issue that affects many people throughout society. It's especially an issue when a user uses it while driving. It causes unexpected accidents that could undoubtedly be prevented if the user isn't under the influence. About 40% of all traffic mortalities are associated with alcohol, regarded as the most important human cause of severe automobile crashes [15]. The driving performance of someone under the influence leads to risky driving and increases the frequency of traffic accidents and related injuries and mortalities. Even with all the warnings and laws that have prohibited drunk driving, it is still unable to prevent drunk driving from happening. It is most likely due to people's misconception of their intoxication level. Even though people might understand the risk that could occur while they are under the influence since it has not happened yet, most believe it wouldn't happen. “Several studies have shown that more than a third of adults and half of teenagers admit they have driven drunk. We also know that most of them were not detected. Generally, the rate of arrests for driving under the influence is very low and even those drivers who were arrested were mostly "first-time" offenders” [16]. This encourages alcohol users to keep driving, due to not being caught. Even if their intoxication level increases, since nothing has happened yet, they are assuming it is fine to do something they have already done before.

Society had made use of different deterrents to help limit drunk driving. One of the more effective ways that was implemented was Financial repercussions. “Using harsher punishment and sanction on driving under the influence is effective in reducing repeat drunk driving” [16]. The harsher the punishment on having a higher blood alcohol content(BAC) while driving, the less likely someone would try to do that same offense again. The chance of them getting caught and having to pay the fine decreases as they have already been through that risk before. Nobody wants to pay a significant amount of money for something that could be prevented. Taking chances on if they are going to be caught or not, is sometimes not worth it for them. This does not completely stop alcohol abusers from making the wrong judgment since they already are in the right mindset. It does, however, help prevent some people from making the same mistake again since they don't want to pay the fine that was put upon them again.

Alcohol continues to be a substance that, when abused, would lead to damages to the user and also the people around the abuser. Children are especially vulnerable to lasting damages since they can be easily influenced by their surroundings. Most children growing up around alcoholism are sometimes left with psychological and emotional damages that would last a lifetime. Subjects, between 12 to 22, "who experience family alcoholism had difficulty identifying feelings and emotion correctly" [17]. Children, who had yet experienced much of this world, are being negatively affected by their alcoholic families. Children of abusers would lead a life of uncertainty on who to trust and depend on since their role models are undependable. Developing trust issues or lack of self-esteem will often lead them to struggle with romantic relationships and avoid getting close to others. It would also lead them toward the same route as their parents. Children with an alcoholic family tend to initiate alcohol and other drug use at a younger age of 12 to 14 [18]. Early uses of alcohol could potentially lead the children to try harder substances. This would impede the children's health. Children are not supposed to be drinking or using dangerous substances to help prevent the development of health problems at a young age. Children are supposed to grow up healthy enough into their adulthood to experience more of life before actually encountering any kind of health problems. Alcohol causes interference with children, holding them back from their true potential. It could prevent them from having a good education and involve them in risky situations. Children shouldn't need to experience traumatic events in life until they are mature enough to handle them.

As Covid highly affected the country in 2020, cafés and bars endured the greatest financial hit, constraining them to close and some for great.[3] This doesn't imply that it wasn't any harder to get a beverage during the pandemic. With an end goal to keep the neighborhood economy above water, alcohol stores and different stores were permitted to sell liquor with no sort of control put upon them. They were named COVID-19 fundamental assistance. As the years passed and COVID 19 was on the rise, many went to liquor stores to ease the pressure and tension. Liquor deals have been on the rise since the time COVID-19 had first shown up back toward the beginning of February of 2020. As indicated by the National Survey on Drug Use and Health, liquor utilization was up 14% starting in 2020 contrasted with 2019.[19] As we see the utilization of liquor going up, so does liquor prompt lethal auto crashes. As per the NHTSA, lethal accidents including liquor were up 9% compared with 2019. My group predicts that this pattern will keep on moving upwards as COVID-19 has become more predominant with its new and more infectious strains. We foresee that individuals will keep on moving in the direction of the utilization of liquor to attempt to facilitate each of the adverse consequences of the infection. The results of letting the liquor utilization increase might outlive the Covid and continue to drive these insights increasingly elevated.

One thing that we have a better understanding of is that BAC is checked through the blood and BrAC is through the breath. Blood alcohol concentration (BAC) is determined through several factors of weight, gender, how much alcohol consumed, period of time you drink alcohol and what medication was being taken during the time of drinking. On the other hand, breath alcohol concentration (BRAC) is determined through a simple exhale of a single breath through a breathalyzer. When someone breathes, blood passes through the lung to provide it oxygen. The alcohol evaporates during the breathing process and is expelled through the mouth. The alcohol in the breath could then be tested through a sensor which could be converted to a BAC measurement. BrAC is a quicker way of measuring someone's BAC since they don't have to go through the extra testing. The ratio of BrAC to BAC is about 2100:1 , meaning that every 2100 milliliter of air in the breath will have the same alcohol content as one milliliter of blood in the body [20]. As engineering students we are not able to produce blood alcohol content because it would require a medical professional and lab equipment that we are not accustomed to. Although BAC is more accurate than the BrAC, we will still be able to measure an estimated BAC with the BrAC using sensor components.

Our team is made up of three computer engineering majors and one electrical engineering major. As computer engineers we have a general understanding of circuitry with a focus on coding knowledge. As computer engineers, our main skill set is coding for the hardware that we have chosen for this project. We will serve as the bridge between hardware and software, making “drivers” to interact with our chosen hardware. The electrical engineer is here to confirm our hardware logic and design choices as well as to make changes to the overall components list as they seem fit. The electrical engineer has very minimal coding knowledge, but emphasizes knowledge of circuitry, voltages, and general signal flow.

My group intends to alleviate these measurements and assist with discouraging people from placing themselves just as everyone around them in a hazardous space. This will be finished by drawing in the crowd with a machine that is fit for making various beverages and blends that will keep clients engaged and fulfilled while likewise dissuading them by following their BrAC and keeping their keys in a capacity box until they can pass a specific BrAC range. This will discourage inebriated individuals from driving and harming themselves and the people around them.

III. DESIGN IDEA

A. Design Philosophy

To combat Drinking and driving, we thought about creating a device that would be able to limit people from driving when they are too drunk. It is a device that we call D.A.D.D.S(DUI and Drunk Driving Safe) Automated Bartender. An automated bartender with an attached key safe. Its functionality is to store the guest's car key before they start drinking which would then allow them to be able to access the automated bartender, who would then make a drink of the guest's choice. When the guest is satisfied, or it's time for them to leave, they would need to blow into the attached breathalyzer that would test if they are fit for driving. If the device indicates that they are too intoxicated to drive safely, it would restrict them access to their keys until they reach a safe BAC (Blood Alcohol Concentration) level.

There were different approaches to this design idea when we talked about it. For starters we want the structure of the system to be compact, and semi portable to be able to bring it along to school. The automated bartender should have a flat base, with multiple tubes running to the motors that would then suck up the alcohol and other drinks on one side and dispense them on the other through a nozzle and into an 8 ounce glass . We will be enclosing most of the electrical components within a wooden box. Then we could easily place the alcohol and mixers to the back of the wooden casing to keep components safe from any spills or leaks. We are also thinking about making the key locker safe to be expandable, so it would be adjustable for any kind of event with any number of people.

For the safe, we have a few ideas to include in our design. One was that we were going to make everything into two separate devices and the other was making it into one combined unit. There are pro's and con's to each of these ideas. The advantages to making it two separate units were that it would be easier to construct with limited wiring. The safe could be located at the entrance of an event to store the keys and the automated bartender will be located somewhere else for convenient use. The disadvantage however is that we would have to buy multiple units of the same parts and both devices repeating some of the same actions. The devices would not be communicating with each other due to each of them having their own built-in functions and possibly being separated by long distances. This is convenient for the construction of the device; however, the guest would have to breathe into the breathalyzer twice, once to get their drinks and a second time to get their keys, making it tedious and redundant.

For the combined unit, it would increase the difficulty of the build due to it being a custom design. The device however would be more convenient for use since everything is there for you in one place. We would not need to buy multiple units of the same parts, decreasing our cost for the build. As we talked it through, our group decided to make it a combined unit, to limit the cost of the build while at the same time making it easier to target our societal problem since everything could be done with one unit.

After figuring out the design we should be going for, we were thinking about incorporating RFID tagging to make it so different guests would be assigned their own locker or locker number to store their keys. The tagging that we intend to use are 125 KHz tags, which are low frequency. It could only be written to once, but can be reused after that many times.The guest would be able to get a tag if they talk to the attendant, who would hand them the RFID tag, after they register themselves in the system with the touchscreen and submit their keys. Each RFID tag has its own specific identification number that would be unique to each guest and each locker. The tag would be their identification for their locker, which stores their keys. The guest could use their tag to unlock and relock their locker so long as they are under a certain blood alcohol concentration.

RFID tagging was a chosen idea instead of doing some kind of barcode system since RFIDs are reusable and rugged while barcode was only usable once. It's a physical device that different people could use one after another until it is broken. RFID tags are able to work at further distances without needing to be in the direct line of sight of the sensor. RFID tags can produce a high level of security. Its data is encrypted with password protection and a “kill” feature to remove data permanently once a user no longer needs it [21]. The tags are more convenient for this design due to each tag being able to read and write data. After setting up each tag for their respective use, the owner/programmer would not need to interact with it anymore until it is broken.

For the system to find out who is too intoxicated to drive, the system would be equipped with a breathalyzer, located near the front of the screen. The guest would only need to check their blood alcohol concentration at the end when they need to get their keys to leave, or if they wanted to check their intoxication level. The breathalyzer would analyze the concentration of alcohol in the air exhaled by an individual, and send the information to the system. The system would determine if a guest is too drunk if their BAC is 0.06% or above, and it will alert them that it would be unsafe for them to continue drinking. This would also restrict their access to their locker, since it would put a hold on their RFID tag until further notice. For sanitation purposes, we will be incorporating a replaceable tube and replaceable mouthpieces for each person blowing. The breathalyzer would be equipped with an interchangeable clear vinyl tubing. The tubing would be cut to an appropriate length and set on the side of the machine for intended use.

This device's purpose is to limit the amount of DUIs and potential drunk drivers. It is supposed to prevent people who are going out to bars from being involved in unsafe situations after drinking too much. D.A.D.D.S not only helps bar owners from being sued, it also helps innocent bystanders from being involved in tragic accidents that might be caused by someone who is under the influence.

D.A.D.D.S is unique in its approach to the drunk driving issue. It doesn't restrict drinking, but it allows individuals to drink in moderation. It locks away the user's car keys to keep them safe from self-harm. People who use this device should already understand its intended use is just for their safety. Accident Prevention is one of the key functions to this device, along with making it do something fun and convenient for everyone. DADDS utilizes people's breath to determine if they would have access to their keys or not. Preventing unwanted accidents from occurring after they leave the building.

There are some necessary resources that are needed to make this design a success. One of the main components that need to be totally accurate for this build would be the breathalyzer. Since the breathalyzer is the main feature of the design, it needs to function correctly with correct BAC data. If the breathalyzer does not function properly it would ruin the project build since the device would not be able to read BAC levels correctly and would fail to alert users of their intoxication levels. We would not be able to test this breathalyzer at school, so we intend to go to Shawn's house to test each competents before splitting the work into 4 ways for independent work at home. The automated bartender machine and safe could be built at the provided space at Sac State in RVR 3001 or they could be built at each member's individual home. If we were going to approach this design by making two individual devices that would be separated from each other then we would have to make it have connection to a 3rd party server to be able to share information with each other. Allowing exchanges of data, making it possible to activate some functionality featured in the device from afar. To be able to display information and graphs of how intoxicated someone would be, we would need to use an API from the website InitialState which is an IoT platform for data visualization. It could stream the information the breathalyzer obtains from the user and displays it, letting them see information about their result.

TABLE III.
The "punch list" for the feature set

Features	Measurable Metric
RFID Tags Allow multi-use identification, allow the guest with the corresponding access to an individual key safe, and identify guests as potential drinkers.	RFID tags are reusable for future guests. The tags are placed 0.3 inches above the reader to scan their identification numbers.
Functional locker/safe Allows potential drinkers a safe storage place for their vehicle keys, limits guests at an unsafe BAC from accessing their keys or operating a vehicle. Key safe will be accessed after a guest scans RFID and blows in the breathalyzer presenting a BAC below 0.06%.Automatically opens using solenoid lock to control whether or not it opens.	3 small lockers, 4 x 4 x 4 inches each that are intended to store at least 1 key holder in each one. The lockers will automatically open the safe door using a solenoid lock for about 10 seconds.
Automated drink making Creates 24 possible drinks desired by the guests, uses suction tubes to dispense drinks using different mixers, and pours combinations in a glass.This will be done one at a time and only if the guest passes the breathalyzer test , having a BAC of below .06% and has a RFID tag. It can keep track of what drinks were ordered based on RFID tags.	Uses 4 peristaltic pumps to dispense up to 5 possible drink options. 4 drinks will be dispensed within an 8 ounce cup with a level of 7 ounce +/- ½ ounce. 1 drink will be dispensed within a shot glass of 1.5 ounces.
Touchscreen - GUI Identifies a guest when their RFID is scanned. Allows a guest to select what drink they would like dispensed, and displays the BAC of the guest blowing into the breathalyzer. It also has the ability to change between bartender mode and safe mode, meaning that 1 guest can remove their keys at a time per interaction with the device. After scanning an RFID the screen shows one guest ID(Guest 1) and the amount of drinks the guest has had.	The screen would display 2 menu options for locker or drinks. Allows only 1 guest at a time to order out of a 5 drink combination menu or unlock their locker.

Features	Measurable Metric
Breathalyzer Check the blood alcohol concentration of users, if BAC is below 0.06 keys may be accessed, if BAC is 0.06 or above guests are prompted to wait and possibly drink water and keys can not be accessed until a lower BAC is blown. One at a time guests would blow into a 7 x 0.3 inches tube that directs it into the breathalyzer. This device will collect 12 or more guests's BAC within the system.	One alcohol checker sensor that has a +/- 20% error margin. The concentration scope for alcohol is 0.05mg/L - 10mg/L.

A. *Specific Design Components*

The main hardware component that we are using is the Raspberry Pi 4, featured in [21, Figure 4]. It is going to act as our main system controlling everything. The Raspberry Pi 4 is a cost efficient, small single-board computer that uses the Linux operating system. The GPIO would be able to give us simple input and output functions along with UART(Universal Asynchronous Receiver Transmitter), SPI(Serial Peripheral Interface), and I^2C(Inter-Integrated Circuit) [23]. Depending on the design we are going for, we are going to use about 1 to 2 of this device to power our machine. We would use one of these devices to act as a keypad communicator to send drink order information to one of the add-on components. The pi would also send information to the RFID locker to indicate if it would be allowed to open or not based on the result that pi received from the breathalyzer test. If it comes down to us using 2 devices, we would use an ethernet cable to connect the raspberry pi, making a cluster. We would be able to set one raspberry pi as the main head and the other would just be sending information into it. We would program everything in python using the integrated development environment called IDE.

Figure 4. Raspberry Pi 4 [22]

The next component,shown in figure [24, Figure 5], would be the relay board. The relayboard we specifically used was a 5v 8 channel relay interface board, each one needing 15-20mA driver current [24]. The relayboard is used so we would be able to power all 8 the solenoid locks and peristic pumps together. With this relayboard, we would be able to program the raspberry pi to activate when and which relay channel should be activated at a time. This would not only allow us to use the pumps and locks, one by one, but also allow for simultaneous use of all 8.

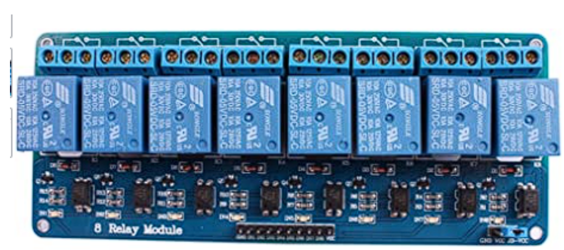

Figure 5. Relay Board [24]

This power supply adapter is used to power the peristaltic pumps and the solenoid locks shown in [26, Figure 7] and in [32, Figure 13]. These components will need additional power to run them, so we are using a 12V 5A 60W AC DC power supply for everything to run smoothly and quickly. This component will also need a microcontroller to drive it. The microcontroller we will be using is shown in [22, figure 4].

Figure 6. AC DC Power Supply Adapter [25]

With the Peristaltic liquid pump we are able to reverse the flow of the pump to clean and unclog. The flow rate is 1mm ID x 3mm OD 2~17 mL/min; 2mm ID x 4mm OD 5~40 mL/min ; 3mm ID x 5mm OD 19~100 mL/min [26]. These pumps are also easy to take apart meaning that cleaning them in between uses will be easy to do. They are also powerful enough to transport liquids from one end to the other. This pump has a wide variety of uses such as experimental, biochemical analysis, pharmaceuticals, fine chemicals, biotechnology, pharmaceuticals, products, ceramics, water treatment, environmental protection, etc. These pumps will be used in conjunction with the raspberry pi and the motor hat to be able to move multiple milliliters of liquid from one side to the other side.

Figure 7. Peristaltic Liquid Pump[26]

In [27, Figure 8] we will be using a 3mm ID x 5mm OD High-Strength Silicone Tubing for the transportation of drinkable substances. These tubes are in compliance with FDA and 3A Sanitary Standards. USDA also approved it for the use of meat and poultry plants. This tubing is extremely flexible and will be very useful for moving liquids through the device. The tubing will remain clear for the purpose of sanitization and being able to see if anything is clogged. This extremely flexible, food grade silicone is suited for general low pressure industrial applications for the conveyance of chemicals, liquids, gasses, and solids of suitable granular size, such as factory air lines automation machinery and pneumatic lines [27].

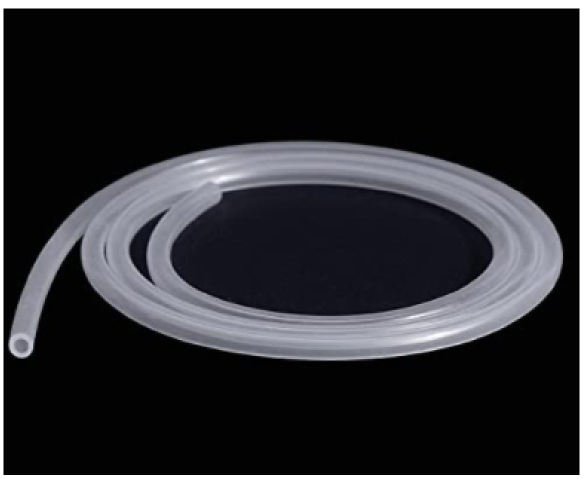

Figure 8. Silicone Tubing[27]

The RFID (radio Frequency identification) HAT we are using for the raspberry pi would be used to read RFID key fobs and tags. It comes with an UART communication interface that can support 125 KHz cards, keyfob, and tags. It could fit on the top of a standard raspberry pi 40 pin GPIO. It also is equipped with a programmable 0.91 OLED(organic light-emitting diode) display which our team could use to test its functionality and see if it works properly [28]. The RFID HAT is able to analyze the tag and identify it and then collect the data that is stored on that tag. Since every tag has its own unique identification, it would be able to read each and every one of them and store its information until coded to do something with it. In our case, we would use this HAT to identify drinks ordered from an individual person based on their tag id. We would also try to program this device to send information to the locker/safe to make it open or close.

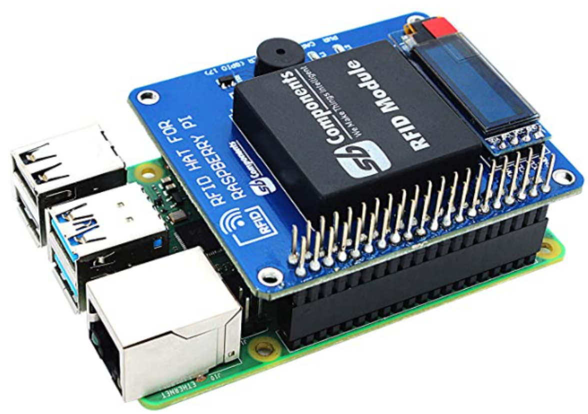

Figure 9. RFID Hat [28]

This MQ3 sensor will output an analog signal that will be able to be read by the raspberry pi. This device has an analog output voltage with concentration. The higher the concentration, the higher the voltage. This device is sensitive to liquefied petroleum gas, natural gas, city gas, and smoke. This means that this device will be able to sense the concentration of substance within the air. This device will be used to read the user's BAC(blood alcohol concentration) through their breath, by having them blow into the sensor. A signal will then be sent to the MCP3008 microchip shown in [29, Figure 11] which will then send data to the raspberry pi. This component is vital to our design due to its sensitivity to gasses.

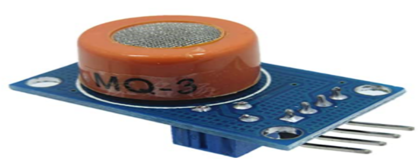

Figure 10. Alcohol Ethanol Gas Sensor [29]

This MCP3008 converts analog inputs and outputs to digital inputs and outputs. Raspberry Pi can not be programmed for analog like an Arduino. With a little more code you can get analog readings from digital hardware. This allows the Raspberry Pi to use an analog signal. It is an Analog to Digital converter for use with devices such as pressure transducers and temperature sensors. Without this component the raspberry pi is limited to digital inputs and outputs [30]. This device will be used in conjunction with the MQ-3 shown in [29, Figure 10] to convert its analog signals to digital ones for the raspberry pi to read.

Figure 11. MCP3008 MicroChip [30]

The raspberry pi touch screen is going to be mainly used for selecting the drinks. It is going to be our main communicator with our guests. It would be able to display their BAC after they blow into the breathalyzer after we program it to be connected to the visualization website called InitialState. This touch screen that we are using is a 7 inch display which is perfect for portability. It could display in full color up to 800 x 480 with capacitive touch sensing capable of detecting 10 fingers [31]. It is powered from the GPIO pins from the raspberry pi to the DSI(Display serial Interface) port. It only functions as a display, without any speaker integrated into it. Since most of the equipment for setting up a device is already provided, we should be able to get it to function correctly before actually coding it to interact with the 3rd party server.

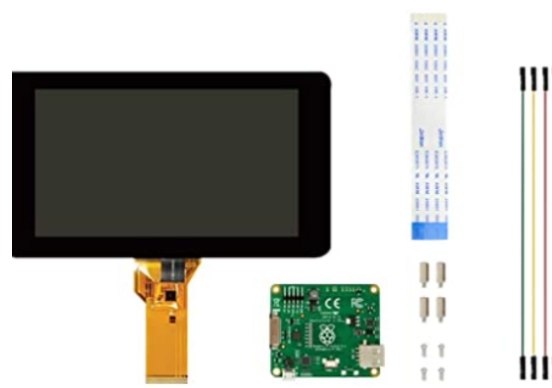

Figure 12. Raspberry pi Touch Screen Display [31]

The software that will be used within this project will be using the Raspberry Pi OS that is based on linux. Within the raspberry pi OS, we will be constructing a

GUI to house all of our function buttons. This will all be done in python. We will also be running a script to automatically start into the gui that we have designed. Once the screen starts up, it would display the two menu options: Drinks and Safe. The guest would interact with the device choosing the option that they want. If they go through the drink option, they would find a list of 11 possible drink options. Otherwise they would go into the safe option which would ask them to test themselves with the breathalyzer then allow them to access their safe if they are at an acceptable BAC. The touch screen would be implemented on the raspberry pi through the dsi ribbon cable.

The four main parts of our project will be the GUI, pouring drinks, RFID, and breathalyzer. We will be splitting each part up between all four group members. Shawn Bacani will be taking the task of being able to automate the bartender. Shammah will be in charge of making the RFID run for both the safe and the bartender. Deepak will be in charge of creating the breathalyzer. Tahmina will be in charge of the GUI. We will be working as a group to complete each of these tasks, but the head of each task is as stated.

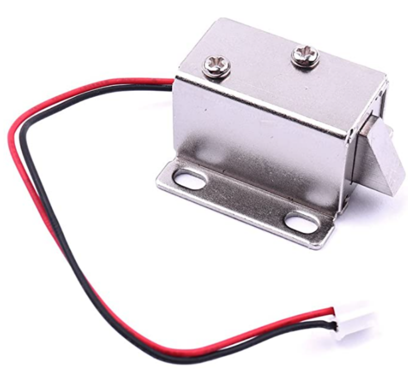

Figure 13. Solenoid Lock [32]

The solenoid lock shown in [32, figure 13] will be used to activate the opening and closing of the key locker door. This will be our main security feature, preventing the door from being opened without verifying proper identification and producing safe BAC levels. The lock would unlock after the guest verifies himself by scanning their RFID tag then breathing into the breathalyzer, in which case it would unlock the lock after a 10 sec interval if the guest has a legal BAC.

We estimate that it will take the team around 30 hours to finish the RFID feature within the automated bartender.

Since we would have to custom build the structure, alongside the drink dispenser and safe we estimate that it will take about 45 hours in total.

The breathalyzer will take the team around 80 hours to implement due to the complexity of trying to read the analog signal of the MQ-3 to the digital signal of the raspberry pi.

We estimate the GUI to take about 80 hours due to the amount of buttons and features we will need to provide within each button.

After the completion of the structure and every other part, we estimate about 20 hours of setting up the components inside of it. It should be completed with all wiring and finishing touches.

Each individual team member brings about their own unique skill set.

Shawn Bacani is proficient in state machines as well as python and has briefly worked with the raspberry pi.

Shammah has experience working with the raspberry pi from previous projects. He is confident in the physical construction of the design and connecting all the devices together.

Deepak is proficient in the use of arduino and circuits. He is also well skilled in python and GUI design.

Tahmina is proficient in circuit design and robotics. She is also familiar with how signals are read between devices.

IV. FUNDING

TABLE IV.
The list of components and cost need for the project

Item	Price/ Unit	Amount	Total
Raspberry Pi 4	$94.95	1 Already Own	$94.95
RFID Hat	$34.99	1	$34.99
Alcohol Ethanol Gas Sensor Module	$8.00	1	$8.00
60W AC DC Power Supply	$16.99	1	$16.99
Peristaltic Liquid Pump Dosing	$9.80	4	$39.20
Silicone Tubing	$7.69	1	$7.69
Relay module	$9.99	1	$8.99
Raspberry pi 7" Touch Screen	$74.99	1	$74.99
Adafruit MCP3008 8-Channel 10-Bit ADC With SPI Interface	$7.07	1	$7.07
Logic Level Converter	$3.50	1	$3.75
Wood, Glue, Screws, nails	$31.45	1	$31.45

ESTIMATED TOTAL	ACTUAL TOTAL
$325.96	**$231.01**

Table 4, featured above, is the estimated cost for everything that was needed for the completion of this project prototype. The funding of the project was provided out of pocket by the team members. For the fairness of the funding, we decided to allow one member, Shawn Bacani, to order everything. Once everything is ordered and calculated, we would split the total evenly with everyone then we would reimburse the cost, so in our case we would split it 4 ways and pay Shawn the amount that was owed. There are some parts that are already owned by one of the members, for this we would take that out of the total cost, and depending on who wants to keep the project at the end, they would have to reimburse the owner a portion or full price of the part. Most of the parts that were ordered through amazon.com there were some parts that weren't available there which were ordered on different websites that have convenient shipping times.

V. WORK BREAKDOWN STRUCTURE

Our team decided our project would be an automated bartender robot with a key locker, breathalyzer and RFID tags because we wanted to tackle the societal problem of drinking and driving. This project is going to be a year long project that we began in early September 2021 and will span until May 2022. Our team consists of three Senior Computer Engineering students and one Senior Electrical Engineering student. This project is going to incorporate several electrical components and multiple microcontrollers requiring a great amount of time and effort from each teammate.

In this section of the report, we will discuss how our design idea will be broken down so that each individual feature is divided amongst teammates. We chose to work in two groups, with each group taking responsibility for a single component of the overall design. Each group will be tasked with creating a circuit that powers the components and generates code to make it run our specific commands. Once we have connected and generated code for each individual component, we will begin integrating them together. Once our design components all function properly together, we will have the skeleton of our project. The next step will be to create a physical design to properly house each component.

In TABLE *V* it shows the overall breakdown and structure for our design for the project. The features mentioned throughout the table mainly focus on the hardware and software aspects of the project. These hardware and software features are then broken down into smaller subsections exploring how our team may approach each design. This is indicated through the levels. Level 1 will be our task, level 2 will be the subtasks of that task, and level 3 is the work package associated with the subtask.

TABLE V.
The level breakdown of the design

Level 1	Level 2	Level 3
1) Graphical User Interface (GUI)	1.1 Intuitive drink menu and safe functionalit y	1.1.1 Hardware 1.1.2 Software 1.1.3 Gather and Display Data
2) Breathalyz er	2.1 Blood alcohol tracker	2.1.1 Hardware 2.1.2 Software 2.1.3 Data Passing
3) RFID	3.1 Reads RFID Number and Keeps Track of Data	3.1.1 Hardware 3.1.2 Software 3.1.3 Temporary Data Storing and Passing
4) Drink Dispenser	4.1 Dispensing of Drinks	4.1.1 Hardware 4.1.2 Software 4.1.3 Communicatio n
5) Key Locker	5.1 Open Locker when Requiremen ts are met	5.1.1 Hardware 5.1.2 Software 5.1.3 Implement conditional logic

A. Intuitive Drink Menu and Safe Functionality 1.1

The GUI, being the main component for communicating with the guest, needs to be able to display what the whole device has to offer. Since the device is supposed to be an automated bartender as well as a locker to store guests' keys, there will need to be an interactive display for these two options in our initial screen. These options will be accessing either the drink menu or the safe functionality. When the drink menu option is selected by the guest, it will lead to a different page with eleven drink combinations. The safe option will prompt the user to blow into the breathalyzer and scan their RFID to access their keys.We are also intending to implement a feature where it would display the guest’s BAC and their drink count after every time they blow into the breathalyzer and scan their RFID.

1) Hardware 1.1

For the hardware, we are going to be using a 7 inch touch screen for displaying and interacting with a guest. Since the touch screen that we bought is made for the raspberry pi, we would have to connect the screen with a DSI ribbon cable and jumper cables that connect from the touch screen to the gpio pins located directly on the raspberry pi.

2) Software 1.2

The GUI is mainly implemented using python's standard GUI packages. It allows for a simple way to create a user friendly and easily understandable interface that allows the user to interact with the screen. Since the raspberry pi already has existing interpreters in its processor, it was easier to just choose to write in python compared to other coding languages. Using the python library, we can easily implement code as well as debug any existing errors within our code. The program that we are implementing into the GUI will allow the guest to go to different screens to complete their interaction with the device. We would have to implement clear instructions and prompt the guest on what should be next.

3) Gather and display Data 1.3

The GUI would communicate with the raspberry pi, but the raspberry pi would be using information that it obtains from the other devices. The other devices such as the RFID tags and breathalyzer would be able to send information to the raspberry pi that would trigger different prompts and warnings based on how high or low their BAC is.

B. *Blood alcohol tracker 2.1*

The breathalyzer will be a main feature of our automated bartender due to it being one of the two test points for our guests.It will allow access to both the drink menu and key locker. It will be the safety feature in our project that lets a guest know when they have reached an unsafe BAC level. The blood alcohol tracker will also need to pass data to the GUI after each blow, displaying the user's BAC. The BACs will be tracked and recorded so that our guest can see where they are and if they would like to continue drinking.

1) Hardware 2.1.1

Our breathalyzer will be designed with an MQ-3 alcohol sensor that can produce an analog or digital output. We are using a raspberry pi microprocessor to control our breathalyzer so we want to produce a digital output. The detection range of the MQ-3 sensor is 10 ~ 1000 PPM which is equivalent to a BAC range of 0.010-1%.

2) Software 2.1.2

The software necessary to run our MQ-3 sensor will need to be a python function that is loaded into our Raspberry Pi. Our code will need to be able to designate between safe and unsafe alcohol levels that will give access to or restrict a guest’s key locker. We will need to implement an algorithm in our code that will read a guest’s blow in PPM and calculate an accurate BAC. Once a BAC of 0.06% or above is reached our guest will be prompted to wait until they sober up to try again. If a BAC under 0.06% is detected the user will be able to continue drinking or access their key locker.

3) Data Passing 2.1.3

After we have a running breathalyzer that can produce accurate BAC readings, we will need to integrate it with the rest of our components. We want our breathalyzer to be able to pass data to the GUI as well as the key lockers. We would like the GUI to receive the sensor reading in PPM and display the appropriate BAC percentage. We want the calculation to take place in our breathalyzer code but will have the option to produce the BAC in our GUI. Also our breathalyzer will need to send an output to the key safe system that will not unlock the locker unless a safe BAC is blown. When a safe BAC is blown, the locker should get a signal that will unlock the appropriate door specified by the RFID.

C. Reads RFID Number and Keeps Track of Data 3.1

The RFID is one of the key features in distinguishing one guest from another. The tags will be operating at 125khz as well as being preloaded with unique identification codes. This will be crucial in identifying things such as how many drinks one has consumed, the tracking of the guest's BAC levels, and the ability to locate the guest's key safe locker.

1) Hardware 3.1.1

The RFID hardware that we will be using is an off-the-shelf product that will be able to detect if there is an RFID tag placed above it. This off-the-shelf unit will attach directly to our raspberry pi, taking advantage of its 5v power. The AC reading of the tag will be handled within the software. This RFID hat also takes advantage of a universal asynchronous receiver- transmitter(UART). This means that its main goals are to transmit and receive serial data. This makes it easy for us as the users to read from the UART to gain access to the unique identification code.

2) Software 3.1.2

The software aspect of the RFID will be written in Python within the Rasbian OS. To operate the RFID hat, we will have to implement python code that is able to take data from the UART and read each unique identification from the 125khz tags. This code will be referenced throughout the entirety of the project due to it being the main identifier of each guest.

3) Temporary Data Storing and Passing 3.1.3

We will be temporarily storing information such as the count of how many drinks they have gotten and BAC levels. This temporary data will also be shared with the GUI to be able to read from and display to the user in real time. Using RFID we will be passing the data into the guest's individual memory. This will be held in the data and information handler.

D. Dispensing of Drink 4.1

The Drink dispenser is a key feature that would allow the dispensing of 4 different drinks with a combination of 11 drinks total. We are expecting it to be able to dispense to a 8 ounce cup with a 7 ounce +/- ½ ounce. The guest would be using the GUI to select the drinks of choice which would then activate a series of pumps that would dispense the drinks for them.

1) Hardware 4.1.1

Our drink dispenser is going to use four peristaltic liquid pumps with a 12 volt power supply. We will also need to connect a relay board to the pumps so we can switch from open and closed pumps, pouring just the right amount of liquid into a cup and then sealing off the pump. The nozzles on our pumps are relatively short so we will need to attach silicone tubing to the ends of each pump so the tubes can reach into a bottle and pour into a glass without making too much of a mess.

2) Software 4.1.2

The software that is going to be implemented is in python, inside the existing raspberry pi interface. We would be importing the motor pre-existing library that the company created for it then create additional python codes that would let the motor to function the way we want it to. Also based on what the user selects during the drink selection, the coding that would activate would be different since the different proportion of each pump would dispense differently. All together the pump should stop after pumping 8 ounces of liquids.

3) Communication 4.1.3

The guest will first interact with the graphical user interface (GUI) to select a drink of their choice. This will signal the drink dispenser to use certain pumps in order to dispense the specified drinks.The drink dispenser will also run conditional logic that has to be met by both the RFID as well as the breathalyzer in order for the drinks to be dispensed. The RFID and the breathalyzer will both return true or false depending on the status of the guest.

E. Open Locker when Requirements are met 5.1

Key locker is another important feature of our device. The locker is a place for the guest to store their key until they are finished using the device. Guests will be able to open the lockers only after scanning the RFID tag then blowing in a breathalyzer. If the BAC level is above 0.06% the device would restrict access to the locker until further notice. If the BAC level is below 0.06% , the lock on the locker will open at an interval of 10 seconds.

1) Hardware 5.1.1

We will build four small wooden lockers with a size of 4x4x4 inches. Each locker can store only one vehicle key per guest. This will be achieved with the help of solenoid locks within each safe box. The solenoid will unlock the lock after 10 seconds of the guest scanning their RFID tag and having a legal BAC. We use a raspberry pi to control a 5v relay which will then control the solenoid locks.

2) Software 5.1.2

The software that we will use for the lockers is python code. We will then implement logic that will run both the RFID and breathalyzer functions to figure out if the guest is able to access their locker or not. This code will also unlock the lockers for approximately 10 seconds which will give the user enough time to put their car keys within the locker.

3) Implement conditional logic 5.1.3

We will write code that will determine whether the guest may access their keys or not. We will implement conditions through the linking of the RFID function and breathalyzer function. In order for the solenoid lockers to open, the guest must scan their RFID tag and blow into the breathalyzer. If their BAC percentage is below 0.06% the guest will be able to open the lock. If their BAC percentage is not below the limit or they do not have their RFID tag they will not be able to open the lock.

The table below shows the total amount of hours each team member contributed into designing the project. We split the time according to each semester then added the sum from both semesters for each team member to yield their total amount of hours for the whole year. Essentially, each team member will contribute about 200 to 250 hours of work into the project over the course of two semesters. We estimate that each member will be able to successfully finish their feature set in the appropriate time.

TABLE VI.
Total Hours between group members

Team Members	*Fall 2021 Hours*	*Spring 2022 Hours*	*Total Hours*
Shawn Bacani	*180*	*180*	*360*
Deepak Sharma	*155*	*160*	*315*
Shammah Thao	*160*	*175*	*335*
Tahmina Jurat	*150*	*161*	*311*
Total	*645*	*676*	*1321*

TABLE VII.
Shawn's Feature Set Hours

	Fall 2021 Hours	*Spring 2022 Hours*	*Total Hours*
Graphical User Interface (GUI) *Software* 1.1.2 *Gather and Display Data* 1.1.3	*60*	*50*	*110*
RFID *Hardware* 3.1.1 *Software* 3.1.2	*10*	*10*	*20*
Breathalyzer- Hardware 2.1.1 Software 2.1.2 Communicatio n 2.1.3	*80*	*100*	*180*
Drink Dispenser *Hardware* 4.1.1 *Software* 4.1.2	*20*	*10*	*30*
Key Lockers *Implement conditional logic* 5.1.2	*10*	*10*	*20*
Total Hours	*180*	*180*	*360*

TABLE VIII.
Deepak's Feature Set

	Fall 2021 Hours	*Spring 2022 Hours*	*Total Hours*
Breathalyzer- Hardware 2.1.1 Software 2.1.2 Communication 2.1.3	*80*	*80*	*160*
Key Locker Hardware 5.1.1 Software 5.1.2 Implement Conditional Logic 5.1.3	*75*	*80*	*155*
Total	*155*	*160*	*315*

TABLE IX.
Shammah's Feature Set

Tasks	*Fall 2021 Hours*	*Spring 2022 Hours*	*Total Hours*
RFID - Hardware 3.1.1 Software 3.1.2 Temporary Data Storing and Passing 3.1.3	*70*	*85*	*155*
Drink Dispenser - Hardware 4.1.1 Software 4.1.2 Communication 4.1.3	*90*	*90*	*180*
Total	*160*	*175*	*335*

TABLE X.
Tahmina's Feature Set

	Fall 2021 Hours	*Spring 2022 Hours*	*Total Hours*
Breathalyzer Hardware 2.1.1 *Software 2.1.2*	*80*	*86*	*166*
Key Locker Hardware 5.1.1 *Software 5.1.2* *Implement conditional logic 5.1.3*	*70*	*75*	*145*
Total	*150*	*161*	*311*

VI. PROJECT MILESTONES AND TIMELINE

In our project timeline we will break down our design tasks to better understand what components are the most crucial in our project. To create this timeline we used a PERT diagram to give us a visual understanding of where we might experience critical delays. We also used a Gantt chart to give our team a more descriptive understanding of the time allotted for certain tasks. The Gantt chart fills in the gaps that the PERT diagram leaves, letting us know when we began a task and our expected completion date.

Within these diagrams we have listed some of the milestones we will need to reach throughout these two semesters. The biggest milestone we have this semester is a prototype demonstration on November 15. This demonstration will require us to prove some of the features we have listed in our feature set. This milestone caused us to create smaller, more detailed milestones that will be displayed in our PERT diagram.

To be able to perform well at the big milestone, we broke down our key features into smaller milestones. Doing so, we would be able to break up the work among the team members. Each of the milestones will either be completed in a pair of two or just by one individual person. We would try to complete the tasks in the estimated time period so we would be able to be on track on finishing the projects.

Within the beginning of this class, we were tasked to come up with solving a societal problem through the use of our engineering knowledge. We had all agreed upon trying to deter drunk drivers from entering their cars while also managing how many drinks they have. Through the help of the research we had initially done, we were able to procure a design idea. This helped us identify goals for our project as well as help us order the correct parts to achieve our specific tasks. Those tasks are to track BAC, have personalized RFID tags, dispense drinks, lock users' lockers, and have an intuitive GUI. To track the BAC, we will be using an MQ-3 to be reading the BAC and we will use software to track and store each guest's information. We will be using an RFID sense hat to keep track of each individual guest through the use of unique identification codes. For the drink dispensers, we will be using peristaltic pumps to dispense our drinks in conjunction with a relay board to signal each pump. To lock users' lockers, we will be using solenoid locks in combination with a relay board to signal the solenoid locks to open. The intuitive GUI will be created primarily with software. This GUI will be the keystone of interaction between the machine and our guests.

One of the milestones we have is to create a working breathalyzer that can detect alcohol, and produce an accurate BAC level based on its reading. Deepak and Tahmina were the group members responsible for this feature. Tahmina was responsible for wiring the MQ-3 sensor to the Raspberry Pi. While Deepak was in charge of creating the code that would read the MQ-3 sensor data and alert the terminal. We began working on this feature on October 11th, and we hope to have all the functions working properly by November 15th. We began using an Arduino board to create the breathalyzer function with the MQ-3 sensor and had it functioning, but realized that we needed to transition to a Raspberry Pi to make our other components integratable. This drawback led us to spend another week doing research on the Raspberry Pi and acquiring the necessary components, like power supply cables and HDMI wires. Once we had the proper components we rewired our circuit and produced code that sent an alert when alcohol was sensed. We did not, however, determine accurate BAC readings. This is something we have spent more time on than we originally anticipated, and will have to complete before November 15th.

An additional milestone for our project is the drink dispenser. Shawn and Shammah would have to make the code to operate the pump to dispense liquid into an 8 oz cup. The amount of liquid coming out of the pump should differ between the different kinds of drinks. The circuit is also a required subtask milestone; we have to make it so the device would be able to dispense up to 11 drinks total. This will require us to increase the number of components we will use. It will also require additional power for the overall device. Both the coding and the features are expected to be finished before November 11. The coding was started around October 18 and It should have some of its basic functionality finished before our prototype progress review on November 15.

The third milestone that we have is the GUI. We are required to write coding that would display the drink menu, accessing the locker button, BAC and User ID. Since the GUI is the main communicating device with the guest, it should be presentable and easily understood. It should provide prompts to guide the guest through the device to get their drinks or access their locker. Displaying all this information and prompting the guest would be all written in the GUI python file. Shawn would do most of the coding for the GUI. He started the coding of the GUI around October 11 and is expected to get the drink menu option finished by November 15..

The fourth milestone is the locker feature of our design. The lockers are only accessible after a user has scanned their RFID tag and blown in the breathalyzer. If the breathalyzer determines the user is below the safe BAC limit, the key locker will unlock. Deepak and Tahmina were responsible for wiring the solenoid locks and producing code that would unlock the lock for ten seconds. Shawn and Shammah helped wire the locks to the same relay board attached to the peristaltic pumps, and modified the code to make the lock run. We began the solenoid lock circuit on October 18th. We produced a working lock circuit using a relay board and code on October 25th, and estimate we will have a fully functioning locker accessible with a RFID tag by the November 15th prototype presentation. A concern we had with our relay board, which holds 8 relays, was that we may need a second power supply to provide an ample amount of power. After testing a lock and drink pump on the same board we concluded that a 12 volt power supply should be sufficient. Another aspect of our key lockers is the physical container that we will need to create to hold up to four guests keys. This will require mainly mechanical engineering from our team members. We want at least one locker built and working for our prototype, but will need a 4 locker system for our final project demonstration in April. We began designing the locker on October 30th and need it ready to function on November 15th.

The fifth milestone is the RFID tags. The RFID tags are the easiest to implement compared to the other components. Most of the coding was done by shammah and shawn. They were able to make the RFID reader read the RFID tags and take in the RFID tags id as of October 19. The reader would be able to read the tag when it is placed about 3 cm above it. This would make it possible for us to cover the device when we begin constructing the structure of the design. There isn't much to build for the circuit for the RFID reader since it is an add-on component of the raspberry pi. So, we would just have to focus on the coding of the device and try to implement it to other components that we are using. We are estimating that by November 15, we would be able to open the locker after scanning the RFID tag. This is so we would be able to show what we did at the prototype progress review.

An important milestone that must be completed is the integration of all components. The device's intended functions only work as a whole. Without one of the components, we would not be able to target our societal problem. Although each of our components have their own functionality, they would be sharing data and information with each other. Each component would have at least 2 other components communicating with it. The whole team is expected to work on this starting as soon as they finish making the individual component work. We started integrating some of the components before the prototype progress review on November 15. We wanted to at least show that we can operate the RFID tags to open one solenoid lock. After the prototype progress review, we would then focus on putting each of the other components together, especially the breathalyzer. We would have to integrate the codings and combine in more components for the device to be complete. We are expected to have everything together by December 1. Although it might not be working perfectly, the codes and structure should be in the process of being completed. The project design should be in an acceptable position to present publicly on december 10th.

This project has had a lot of milestones that we plan to complete in a timely manner. The first three milestones were to create a team problem statement, design idea contract, and a complete work breakdown structure. To initially start the project, we each had to find an individual problem statement. This was done to complete the corresponding assignment. With that done, we each had to present to our group our individual problem statements. Then we came to a vote about whose project idea and problem statement we wanted to do and try to solve. Afterwards, we came up with a design idea contract that was approved by the professor. This was done so we may start building the design for our project. Multiple hours were used in the initial research and planning of our design. We also had to create a parts list to aid in our design ideas. After these tasks were completed, we had written a work breakdown structure that allowed each team member to figure out what part of the project they were going to be leading. This breakdown allowed the team to come up with a project timeline that entails our milestones and our future milestones for both fall and spring semesters. The next three milestones we were planning to complete in the following weeks are risk assessment, technical evaluation, and the lab prototype. For the risk assessment, we will be identifying the crucial paths and risks that our project will show. We will need to plan and prepare for these certain risks. This will be done through the use of a list of possible solutions and countermeasures for these risks. For the technical evaluation, we will prepare a video presentation that will evaluate the project overall. Lastly, we will be preparing an oral presentation to virtually present our working prototype. This will mark the completion of our fall semester.

For the next semester, we continue to improve on our reports and design. We will try to get precise data from our prototype design.We will also be going back to revise and add more to each of our reports that we did last semester. We would revise the problem state along with the device test plan report. We would then do two prototype progress reviews on february 14 and on the march 28th. We would write a testing result report on April 4th, leading to the Last team prototype evaluation on April 25.

VII. RISK ASSESSMENT

1) Critical paths

The project's design had many critical paths that had to be considered while it's being developed. Most of our critical path would originate from our punch list. Since each one of our device's punch list features are interdependent with each other. Each one of the main components should all be functioning properly with minor errors. Once individual components are working, we would start combining them together to make working features. The integration of the individual components is essential for the completion of our project. As we progress through making this project, we will encounter some risks involved with the making of this project. We have 13 numbers of risks that we have encountered in the building of the prototype.

a) GUI Critical Path

One of our critical paths would be the GUI. The GUI is the main communication device with the guest. Its main function is for the guest to select what they want to do, either to use the automated bartender or access their locker. The GUI would then prompt the guest to scan their RFID tag and blow into the breathalyzer. After blowing into the breathalyzer and scanning their RFID, the GUI would display their BAC and also their guest number. All of these features would have to be implemented through python coding and used through the GUI touch screen. The risk associated with the touch screen is that it may hold harmful germs and pathogens that may cause illness to the general population using the invention. The GUI can also fail to display important information to the users due to lag and the use of multiple files being called within a given sequence.

To mitigate these issues, we will be using an attendant to clean and disinfect the touch screen. We will also be asking the users to use hand sanitizer before each and every use. To decrease the lag and increase the responsiveness of the GUI, we will be placing timers within our code to stop unnecessary code from running in the background. We will also be shrinking how many files we will be calling from within the main running code.

b) Breathalyzer critical path

The breathalyzer is essential in our design as it creates one of the safety features that addresses our societal problem. The breathalyzer is used to detect a guest's BAC and alert them when they have reached the legal limit. It will also serve as one of the authentication methods to access your key locker. The breathalyzer should also display its results on the GUI. This serves as one of our critical paths because it will essentially be connected to each of the other components in our feature set.

The risks that the breathalyzer may pose are either sanitation related or circuit related. The MQ-3 sensor requires a user to blow into it to detect the presence of alcohol in their breath. Having multiple users blowing into the same device poses a potential threat to their health and does not meet new COVID-19 social norms. Our team has discussed a removable or disposable mouthpiece for each user. The mouthpiece alone does not solve the sanitation issue, because they can leave saliva remnants on the actual sensor after blowing.

The next risk posed by the breathalyzer is the circuit wiring and necessary components. Our team learned the MQ-3 sensor in the breathalyzer can produce an analog or digital signal but the Raspberry Pi can only take a digital signal. The analog signal gives us accurate measurements of alcohol in the air that can be converted into a BAC percentage. The digital output of the sensor only tells us if alcohol is detected or not, using a one or a zero. This caused our group to have to shop for more components, like an analog to digital converter, delaying the completion by a couple weeks. Also when we received the converter we had to do our research to understand how to use it properly. After reading through the datasheet we learned the converter needs a 3.3V power source but the MQ-3 needs a 5V power supply. This caused our team to have to rotate pins on the Raspberry Pi.

Another risk with the breathalyzer is that it is totally reliant on an honor system. We are expecting the guest to blow into the breathalyzer to get their BAC accounted for. We also expect the users to be by themselves when doing any functions on our device. The device wouldn't be able to tell if the guest is getting someone else to blow for them or not. The machine also wouldn't be able to tell if the person has blown or not. The script for the breathalyzer would run, but it doesn't have the capability to check if the data it is getting is from someone blowing into it or the current air around it.

To mitigate these risks stated above, we would have to adjust the sensitivity of the breathalyzer components. Doing so, the breathalyzer would be able to be more sensitive to people blowing into it. We would also set a time period on when the guest should blow into the breathalyzer. We will be placing small holes near the MQ-3 sensor to draw in fresh air. If the device does not detect slight change in CO2 it could signify that the guest isn't actually blowing into the device. We could also use a camera to be able to identify the guest so we would be able to know if they were the one who needs to blow.

c) *Drink dispenser Critical path*

The next critical path is the drink dispenser. Its purpose is to dispense liquid located at the back of the machine to the front. The amount of liquid dispensed from each pump should be different depending on what drinks the guest is ordering. One risk was that each one of these motors uses about 12 volt. The microcontroller that we are using was only able to provide 5 volt maximum. We had to use an external power supply to power them. Using 4 pumps, there is a possibility there might not be enough power supplied not only to the 4 pumps but also the 4 lockers. There is also a risk that we might encounter a flyback current when powering off the device since we are connecting all the pumps to a relayboard. This would kill our pump since the current would be too much for the pump to handle

Some way that we mitigated some of these issues was that instead of using the motor hat, we used a relay board. Not only is this relay board able to power the pump, it is also able to control which pump would be in use at a current time. This would make controlling and powering 4 different pumps a lot easier. For the power supply usage, we thought of using two external power supplies that would provide 12 volts each. They would power a side of the breadboard, where we would connect the 2 pumps to each side. To tackle the flyback current issue, we would use a flyback diode that would prevent huge voltage spikes from arising when the power supply is disconnected. This would prevent the issue of flyback from occurring when we are shutting down our device.

d) Lockers critical paths

The next critical path is the Lockers. Its main function is to store the user's vehicle keys to prevent them from accessing their car when they are intoxicated. The lockers will serve as a deterrent to operating vehicles while intoxicated due to the use of both the breathalyzer and RFID. It could only be accessed if the user gives an acceptable BAC reading from the breathalyzer.

One risk that comes with this is that the device would only function one at a time. The lock would be unlocked for a set period of time. During that time however, the device would only be able to continue once the lock clicks back into place. If the lock was to malfunction then it would cause the whole device to be stuck in the mode. At that point, the guest wouldn't be able to operate the device anymore and would require an assistant to help with restarting the device. This would lead to further compilation since the device is locked, the guest's BAC and locker number would then reset.

One way we thought of mitigating this issue is to make a timer prompt for the user to know how long they have to wait before the locker locks itself. We are also trying to implement a way for the device to continue working even if the locker lock malfunctions. The other software would run even if the lock does not click back into place. This would make it possible for guests to continue to use this device even if something was to break.

e) RFID tags critical path

The next critical path is the RFID tags. The RFID tags are used to identify the guest. This makes it possible for us to identify who the guest is and what their BAC is. The guest will be able to see their corresponding BAC levels, how many drinks they have gotten and whether or not they will be able to get a drink or get their keys. The RFID tags are integral to identifying who the guests are and tracking information such as the amount of drinks and the tracking of their BAC levels throughout the time they have arrived.

The risks that are associated with the RFID tag is that guests may lose their RFID's or try to use someone else's. Doing so may make it difficult to access their keys and/or buy a drink. The information that is stored about the guest will be lost every time they access their locker. This is due to users accessing their cars within the middle of their drinking sessions and being able to go home. This means that there will be information loss such as how many drinks they have had and their past BAC levels.

The use of the RFID is based on the honor system, meaning that we as designers will have to trust that each user is using their assigned RFID tag. To remedy these risks, we will be depending on an attendant to be able to identify who had lost their RFID and be able to SSH into the machine to enter the new ID and RFID tag. To combat the data loss, we may have to implement two new buttons that sign out or pause activity and open the lockers. We will also be setting timers to wipe data if the user decides to leave as they have gone to their car. We are depending on the user to turn in their RFID tag into the attendant so the attendant may redistribute it.

f) Integration

The last critical path is the integration of each individual device. The integration is needed to create one cohesive design that can perform all the safety checks and actions. Within Integration, we will have to integrate the breathalyzer, RFID, GUI, Drink dispensers, and lockers. Multi-file integration will be performed to support all the devices listed above. This will combine all of the devices.

The risks that are associated with this critical path are that some files may not be able to be integrated together due to settings within each function file. As we started to write integration files, we noticed that we couldn't run both GPIO pin settings such as BCM (Broadcom chip-specific pin numbers) and BOARD.

To remedy this risk, we will have to switch settings within the integration files themselves. We will have to call specific settings for specific functions that we will need to perform.

2) Social Distancing and Potential Risks

Potential events and risks that we would have to take into account for would be the extension of the COVID 19 pandemic restrictions. We are unsure if the pandemic will continue or get worse. The continuation of the pandemic would mean that we would be unable to physically meet as often.

The restrictions put in place due to the Covid-19 pandemic have created difficulties in the completion of our project design. Over the last year we have experienced new social norms such as wearing masks indoors and keeping six feet apart from others. These new social norms created a ripple effect in how we think about future projects of any kind. In our first semester of Senior Design we still have not been able to attend in person classes. Having to attend class virtually has impacted several members of our team. We have to schedule time, outside of class time, to discuss how we want to proceed with weekly tasks. A risk we run into every week is the potential for one of the four of us to have a scheduling conflict. If any one of us is unable to attend a meeting, we run the risk of not completing a weekly task or an essential feature in our design. We also have to take into consideration the location we meet at. Whether we meet on campus or at the local Starbucks, we are required to wear a mask and maintain a safe distance from each other as well as others.

One of the risks in our automated bartender is how we combat any sanitation issues that may occur. Our breathalyzer feature requires users to blow into a sensor, but the option of having multiple users poses the threat of one person's saliva being left over on the device. Another potential sanitation risk that may arise when we put our design into practice is the drink dispenser tubes. We are dispensing multiple liquids through plastic tubes straight into a guest's glass. We must create a convenient cleaning method for these tubes between guest's so we are not letting the tubes touch several used glasses.

3) Significant risks

The most significant risks in our project are any obstacles that would delay one of our main components from functioning. Blowing out multiple power supplies or microcontrollers would have a significant impact and could cause a halt in our build completely. Our breathalyzer not functioning properly is a risk that could delay the prototype from being presentable. Another significant risk that comes with a project this big is not having backup copies of all of our code and software. Not backing up our software could cause us to lose all progress we have made thus far. Most of our components require some code and not having copies would prevent our team from integrating multiple components together. Also the risk of any one of our team members being unavailable for an extended period of time could potentially delay or halt progress in our project. We have to take into account all four of our health, family, religious, school and work obligations, and the possibility of sudden changes.

TABLE XI.
Critical Paths Risk Assessment

Risk Assessment Matrix

Probability

5			Sanitation	Microcontroller Blow	Integration
4		Team Schedules	GUI software files		Breathalyzer-BAC Conversion, Honor system, inaccruate reading
3			Code Backups	Drink dispenser-flyback current	
2			RFIDs- Theft		
1			Lockers - insuffienct coding	Social Distancing	
0	1	2	3	4	5

IMPACT

VIII. DEPLOYABLE PROTOTYPE STATUS

A. Deciding what to test

For our project devices, we decided that we should test every component that we needed for our design.We would test our breathalyzer, peristaltic pumps, GUI files, RFID hat system, and safe design. Each of these components are essential for our design to function as intended. As a team, we intended to test each component separately before putting them together. We want to test each component so they would ensure that they meet the engineering requirement and specification which the team set out to accomplish at the beginning of the project.

B. Peristaltic Pump testing plan

One of the features of our design that will need extensive testing is our drink pumps. We will be using four peristaltic drink pumps that will each pump one liquid. The four pumps will be tested to work in conjunction with one another to create five possible drink combinations. This component will be tested by Shammah. Since I, Shammah, were more familiar with the pump and also which GPIO pin the pump was plugged into.

We will need to test how long it will take for all four pumps, running at the same time, to fill an eight ounce cup. We will also test the time it takes for one pump to fill an eight ounce cup versus all four pumps running together. It is also important for our team to test that we are pouring approximately eight ounce drinks consistently because if we serve someone an eight ounce drink and another guest a twelve ounce drink, we would be inconsistent in our serving size and unfair to our guests. The overall drink pump testing will take about four to six weeks to confirm accuracy.

We will continue to test the pump to see if different temperature liquids will affect it. We are mostly working with lukewarm and/or cold liquid, around 15 to 40 celsius, so we will run different temperature liquid through the pump to see if it would change the overall performance.

I tested the pump's duration, to see how much time it would take to get to about 8 ounces of liquid in a cup. Each peristaltic pump was tested individually as the test was processed. The pump was tested by running a script that ran the pump for an unlimited amount of time. The pump will dispense liquid to a cup that is on top of a scale. Once an 8oz amount is taken, we would stop the pump and then record the time. Each pump gave us roughly the same time of 123 seconds which amounts to 2 minutes per 8 oz from one pump. Only 1 pump was 1 to 2 seconds off but the other 3 pumps that we were using gave exactly 123 seconds. Using this, I did a secondary test where he imputed the recorded second into the python code for the pump. The pump then ran for 123 seconds which gave us exactly an 8 oz amount.

I then tested the pump to see if different changes in water temperature would affect the overall speed of the pumps. This would help us determine roughly the average temperature that the pump works best at dispensing liquid. I ran 3 different tests using 3 different water temperatures. First was the lukewarm water which was at 99 degree Fahrenheit, second was hot water at 123 degree, and lastly cold water at about 50 degree. For each of the tests I then measure how long it would take to fill up an 8 oz cup. At the end of the test, each different water temperature gave me the same result which was about 2 min to fill up an 8 oz cup. This tells me that the overall temperature of water that we put in wouldn't affect the overall speed of the pump dispensing liquid. So using this, even if we were to use cold or lukewarm alcohol beverages, the speed of the pump would stay constant.

C. Breathalyzer testing plan

Another feature of our design that will need a great amount of testing is our alcohol sensor that will serve as our breathalyzer. We want the breathalyzer to give us an analog reading from the raspberry pi. We want the device to output a BAC reading that shows the user how intoxicated they are. It should show a BAC range that could indicate the user is too intoxicated and shouldn't be allowed to drink anymore after a 0.06% BAC reading. This will be tested by Deepak.

To better understand how our breathalyzer reads our estimated BrACs we will test someone's breath after certain drinks. This testing will take us about three to four weeks as we will need a test subject. As we do not want to make our test subject intoxicated multiple times a week, he/she will only perform the testing about 2 to 3 times a week. Increasing the intake of alcohol slowly each time the subject is expected to drink. At the end of each session, he/she would blow into our breathalyzer device along with an actual breathalyzer. This will give us a rough estimate of the accuracy of our device compared to a marketed device.

When we are testing BrAC values we will also want to record voltages at these readings. As the test subject blows into the device, we will measure how much voltage that is being used to transmit the information to the raspberry pi. We will connect a voltmeter before and after the A to D components. This way we will be able to find out the actual voltage required to get the smallest and highest BAC value possible.

One feature we are able to test ourselves, is the sensitivity of alcohol on a person's hands, like hand sanitizer or a spill, versus their actual breath concentration. We want to measure how close someone can get with hand sanitizer before the sensor reacts. This test should take us about two weeks. In our tests we noticed that our alcohol sensor can begin to detect alcohol in the air about a foot away from the front of the sensor. We used hand sanitizer, cleaning alcohol, and a drinking alcohol to run our tests and noticed the stronger alcohols made more of an impact from farther away. The drinking alcohol needed to be closer to the sensor to begin being sensed.

In our breathalyzer testing we noticed some difficulties when trying to develop BAC readings. When testing our breathalyzer we quickly learned that the Raspberry Pi microcontroller does not read analog readings and we would need to incorporate an analog to digital converter. Once we added the converter we had to make some drastic adjustments to our code files. Our code now had to take into account the reference voltage of the converter as well as the MQ3 sensor. After a long testing period we were able to accurately demonstrate BAC readings.

To test BrAC level comparisons based on different drinks I tested the breathalyzer after consuming some alcoholic drinks. The first test was based on the consumption of a single 12 ounce beer. The result showed that after consuming the beer and waiting 5 min. Our sensor was able to detect alcohol since it was still present in the mouth. After waiting 30 min the results came out a bit differently. It showed us that although the BAC reading went up, it didn't indicate that we went past the limit. The test proved that our sensor would read the alcohol on my breath and did not break the legal limit. The next test was the consumption of a shot of alcohol. Since we did most of our testing at school and we are not allowed to bring alcohol to school, Shawn decided to contact the chemistry department and with help of one of the chemistry department professors, Janee Hardman, we made a solution of 40% alcohol with ethanol. We used the $C1V1=C_2V_2$ equation to test different BAC percentages. In this equation C_1 is the initial concentration of solution, V_1 is initial volume of solution, C_2 is final concentration of solution, and V_2 is final volume of solution. We tested different BAC percentages like 0.06%, 0.025%, and 0.08% to get the most accurate results. Since we have a measure amount of ethanol, we put it through a gas bubbler which would cause the alcohol to evaporate toward the breathalyzer. Our breathalyzer would read the evaporated ethanol to see if we got an accurate reading. The result that we got was very accurate. The reading from the breathalyzer gave us exactly the same BAC percentage as the ethanol percentage measure. This is an accurate reading that proves that our breathalyzer can read correct ethanol in the air, which is needed to detect alcohol.

D. GUI Testing

Our graphical user interface is the main interaction menu our guests will see and use. This is going to be tested by Shawn. To create this menu we used the Python tkinter library, which gave us access to several GUI features like buttons and colorful designs. We will need to create simple to use interactive drink and locker menus, as well as a “Home” screen. We will need to test our GUI to make sure it works with our components when a button is pushed. The first test we will run is the drink menu buttons. When we have a user accessing the drink menu we want to test to make sure the proper pumps flow when the corresponding drinks are selected. We do not want to allow the wrong pumps to flow when a specific drink is selected as this could upset our guest or much worse. The locker button needs to be tested to open just one locker and the proper locker. The locker buttons will also be tested with the RFID tags as each tag is linked to an individual locker. Our overall GUI testing should take us approximately five to seven weeks, and possibly longer once more of our components are integrated into our system.

The drink buttons were tested individually, first by creating the code for each button and labeling it with a drink title. The next step was to make sure each button was clickable on our touchscreen. After creating the buttons I had to link the drink code files. I tested each button so that each button was linked to the correct drink pump or pumps. The drink buttons were tested to run our pumps for up to an 8 ounce cup. Some of the buttons and pumps had to be tested to pour as little as 1 ounce.

The locker button was originally four separate locker buttons, but after some tests we decided to stick with a single “open locker” button. The single button was a result of testing with multiple buttons and realizing the inconvenience our guests would face if they accidentally hit the wrong button. If the guest pressed the wrong button they would have to repeat the entire cycle of scanning their tag and blowing into the breathalyzer again. Creating the single button allowed me to test that only the proper RFID tag scan would open a locker. I went through our systems routine with each RFID tag and made sure the GUI locker button worked properly for each.

E. RFID Tags and Locker System

The locker and RFID tag system is important to our design because we want our guests to be able to lock up their car keys if they are going to be drinking. This is going to be tested by Tahmina. It will be important to test each locker and RFID tag combination so only one locker opens when a tag is scanned. We do not want our guests to be able to access another person's keys because this could cause a safety issue. The locker system relies on two safety features, including the RFID tags mentioned before. The other is a breath alcohol test that will read a safe or unsafe level that will release the locker door. We must test to make sure no lockers open when a BrAC of 0.06 or above is blown. This test will take us approximately four to six weeks because we not only need to integrate our locker and RFIDs together, but we will need to incorporate our alcohol sensor readings. I tested RFID tags and locker combinations. All RFID tags we use have a unique code and just one individual locker open with one RFID tag. I tested RFID tags to make sure they are working properly and just one lock open when scanning one RFID tag. For the lockers we also used a solenoid lock and I tested solenoid locks separately to make sure they open after the RFID tags are scand and they keep open for 10 second and close back. Locker and RFID tags have a direct connection with the breathalyzer and if the user's BrAC percentage is above 0.06% the locker should not open and they don’t get access to the drink menu either. I tested lockers with different BrAC percentages to make sure they work fine.

F. Software Testing

Our overall project design is using several electronic components, each with unique features, running on a Raspberry Pi microcontroller. This will be tested by Shawn. To make each and every component work to our desired feature set we will need to create several files of Python code, and test these files throughout our project design. We will need files that hold our drink menu options that work with our pumps. We will also need to create and test code files that run our RFID tags with their corresponding locker number. Just as important, we will need to create and test code files that produce accurate readings of our alcohol sensor and analog to digital converter. We will need to test this file extensively to produce readings that are convincing BrAC measurements. The software testing portion of our design will take a large portion of our time, I estimate ten to twelve weeks because every feature of our design needs some code to make it run in the proper sequence.

TABLE XII.
Test Plan table

	Test Equipment	**Expected Results**	**Timeline**	**Team Member(s)**
Pump Testing				
How long 4 Pumps take to fill an 8oz cup	4 Peristaltic Pumps 1 8oz cup 4 containers with any Liquid	Get a timer result of how much secs it takes to fill an 8 oz cup	1 week (2/7 - 2/14)	Shammah
Different liquid Temperat ure	1 Peristaltic Pump 1 8oz cup 1 container with any Liquid	The pump should not be affected by the temperature of the liquid, should work at the same speed at all temperature	1 week (2/7 - 2/14)	Shammah
8oz Accuracy	1 Liquid 1 8oz cup 1 Drink pump 1 timer	Should always get about 8 ounces every run	2 weeks (2/14 - 2/21)	Shammah
Breathaly zer Testing				
BrAC Levels after Certain Drinks	1 Volunteer 3-4 Different alcoholic beverages Mq3 sensor	Get a BrAC estimate from test subject	4 Weeks (2/7 - 3/14)	Deepak
MQ3 sensitivity	Mq3 sensor Hand Sanitizer	Should be a different BAC from breath and hand santazier	2 Weeks (2/7 - 2/21)	Deepak

	Test Equipment	Expected Results	Timeline	Team Member(s)
Breathalyzer Testing				
BrAC Accuracy	Mq3 sensor Alcoholic Drink Breathalyzer	Should be in the same estimate as a marketed breathalyzer	6 Weeks (2/7 - 3/21)	Deepak
Software Testing				
Drink pump code	computer	Activate all 4 Drink pump together and/or separately	1 week (2/7 - 2/14)	Shawn
RFID and Solenoid Lock code	computer	RFID tags are able to scan and activate lock	1 week (2/7 - 2/14)	Shawn
Alcohol Sensor code	MQ3 sensor MCP3008 A2D converter Raspberry Pi	MQ3 code are functional and getting adequate data	3 weeks (2/7 - 3/7)	Shawn
RFID & Locker Testing		RFID are able to activate the correct locks	3 weeks (2/7 - 3/7)	Tahmina
GUI Testing				
Drink buttons	Drink pumps 7 inch touchscreen Python code	GUI is able to run all components together, Allow tap to perform action on the screen	7 weeks (2/7 - 2/14)	Shawn

IX. MARKETABILITY FORECAST

A. Consumer

An automated bartender with a built in drunk driving deterrence is a smart, futuristic, innovative, and safe way to serve alcohol. In many cases bars, restaurants, and events that serve alcohol are not responsible for the consumers' intoxication levels. Some venues may have a standard where they cut you off when you are noticeably intoxicated or you have sporadic behaviors, however they do not go as far as checking to see if someone is driving home or not. Another consumer for our design may be young adults and college students who are just reaching the legal drinking age. Many young adults commonly drink as a way of social interaction. D.A.D.D.S. Automated Bartender can provide an amusing and safe way for young adults to drink responsibly. Our design takes into consideration the user's safety by providing a carefully calculated way to cut you off from drinking and holding your keys until you may safely drive. Some students, age 21 and above, choose to drink at parties and other social events. Whether they choose to drink responsibly or irresponsibly is normally up to them. With D.A.D.D.S Automated Bartender you can take the responsibility out of the guest's hand. With our automated bartender, young adults can get the bar and restaurant experience in their own homes.

B. Environment products compete

This product will be competing against real world bartenders who have to pour and serve the drinks. It will also be competing with a bartender's judgements and ways of perceiving someone's alcohol tolerance. A bartender may perceive a very intoxicated individual as someone who is "ok" to have another drink while our automated bartender will eliminate that guessing factor and have a point where one may have to be cut off from drinking. This also eliminates the need to pay for a bartender's wages as well as the consumer not needing to tip.

C. Competitor products

Within the automated bartender space, there are not very many who have integrated a system in which it will keep the users of the device safe. There are numerous automated bartenders on the market today, but many are overpriced, out of reach, and lack safety. There are two main automated bartender companies that are the most notable. These products are Bartesian and Barsys 2.0. These products have more advanced pumps, meaning that it will pour the drink into the cup faster. They cost significantly more , the barsys is $1,500 while the bartesian cost $369 with subscriptions to pods that help produce those drinks.There is a kit that is $500 but it comes with the challenge of having the user build and program the automated bartender. It also needs things such as a screen and other interfacing devices. There are no safety features within any of the automated bartenders on the market today. This means that we are doing something that is unique. The competition has not thought about the tragedies and deaths that have surrounded alcohol abuse for decades. They are mainly built for wealthy consumers who either host many parties and/or drink a lot or for inexperienced bartenders with no knowledge of mixology. The sirmixabot is intended for those who want to experience the building process of such a device as well as those who want to tinker.

D. SWOT analysis

Our automated bartender is unique in the way that it incorporates a breathalyzer and safe locker into it. It is a combination of two existing devices into one. So now, people could have a drink then check their BAC level before getting on the road and risk getting caught by a police officer. The product is also cheaper than other automated bartenders on the market. The marketed price for most automated bartenders tends to be around $400 to $500, not including the shipping cost. Our automated bartender would only be around $300. For only $300 or so, customers would not only get an automated bartender but also lockers and a breathalyzer feature included. Our team, who designed this device, are experienced in handling microprocessors and python coding. The team is able to write proficient python coding that would make the device perform all its intended purposes.

There are a couple of weaknesses that exist with our project. One of them is that there are better working existing products than what we have. Other automated bartenders may be able to perform better and faster than our current project. We could make our product comparable to other existing products but that would mean the cost would increase. Another is that the current design casing might not be appealing to many customers but since it was cheaply made it is really affordable. We could instead use a cc machine or 3D printed casing but this is something that could be considered if we increase the budget. Another one of the big issues was that components that were used weren't fully understood by all team members before they were implemented into the project. It is a learning process going through multiple articles and datasheets about our components but we will make it work.

The globe Robotics market expands very fast each year. According to Mordor intelligence research, the Robotics Market was valued at USD 27.73 billion in 2020 and is expected to reach USD 74.1 billion by 2026. This means that our robotic bartender has an opportunity to expand. Since Covid-19 started many businesses prefer to use less human elements in the customer services and more robotic and it is going to change consumer preference and really open up new opportunities for automation. This gives opportunities for our robotic bartender to compete in the market. Our robotic bartender has some abilities like lockers, breathalyzer, screen, and RFID tag that not any automated bartender in the market have, and this gives opportunities for our device to be liked and chosen by business. In addition, our robotic bartender is in a good size and not heavy, and it is also affordable to buy, so these specifications give opportunities for our device to be chosen by individual buyers as well.

There are some threats that could potentially cause issues with our device going into the market. Different competitors could be lowering their prices for their current product. This project is also something many people could create themselves, either with the same price point or lower. This will lower the possible sales counts. There are also issues where people might not want to buy this product due to the restriction it will be placed on them.

X. CONCLUSION

A. Societal Problem

Alcohol consumption has been around the US for a long time and many people have tried alcohol at one point in their life. Many people consume alcohol regularly, but not everyone puts in the effort to learn about its side effects and possible consequences. Alcohol abuse can lead to many issues in a person's life often getting in the way of relationships with close ones. More importantly alcohol abuse can lead to poor decision making often leading to the horrific crime of driving under the influence.

Alcohol consumption can lead to impaired driving and increases the chance of traffic accidents which can cause injuries and death. There is a powerful linkage between alcohol consumption and risky driving behaviors. People who drive under influence lose driving skills like choosing an appropriate speed, time and frequency of overtaking, braking, steering, determining the distance with other vehicles, and so on. It affects their mental judgment, causing them to make risky moves that could endanger someone else's life including their own.

Drinking alcohol causes lasting mental damages, killing gray and white matter in the brain. It also is a main contributor to memory loss, short attention span and liver fibrosis, along with other diseases. It is known to be slightly beneficial if consumed at a small amount but overall it affects people's body negatively. It damages nerves, decreasing body functionality. The more someone drinks the less they are able to control themselves with their emotions and actions. Many of these conditions are caused by the lack of awareness people have when consuming alcohol. Some people do not have that ability to realize how intoxicated they are often leading to further drinking and poor decision making.

The COVID-19 outbreak is also a reason people may have begun drinking, if not drinking more. The pandemic has shown an increase in the sale and consumption of alcohol. The amount of alcohol sales and usage increased during COVID-19 restrictions possibly due to stress and social isolation, as well as spending a lot of time at home. Now that COVID-19 restriction mandates are being slowly lifted, people are adjusting back to their regular lifestyle. Those that were heavily consuming large amounts of alcohol during the pandemic might bring along that habit with them as they return to work and school. Habitual drinkers would be going to bars or restaurants, and possibly consuming more than usual, leading to an increased risk of drunk driving, endangering themselves and others.

Our team will propose a design that will not take the fun out of drinking but will provide a safety feature that will hopefully put an end to the horrific crime of driving under the influence. We want to provide bars, restaurants and other alcohol establishments with a device that can use multiple steps to determine a consumer's intoxication level and advise them to take precautions based on their BAC level.

B. Design Idea

The DADDS Automated Bartender system is necessary to help deter drunk drivers. This device would perform best in bars, restaurants and any other places where drinking is permitted. Many bars and restaurants serve alcohol but do not take into account their customers' transportation methods. Also most people at those bars and restaurants are not aware of how intoxicated they are until they are already behind the wheel and it is too late. DADDS Automated Bartender would be that extra employee or friend that everyone needs to tell them they may be too drunk to drive.

The automated bartender and safebox will be a deterrent to drunk driving by taking multiple steps to ensure someone who has reached unsafe BAC levels does not get behind the wheel. We want our device to encourage alcohol users to monitor their BAC levels while drinking, while also providing a safe storage location for their keys until they are ready to leave. Our design will not only help keep potential alcohol users safe from driving, but may also prevent alcohol abuse by keeping track of how many drinks each registered individual has had. Also once someone has reached the legal BAC limit of 0.08%, no more drinks will be dispensed to that individual.

Our design idea consists of a key safe system that will take a guest’s keys if they are drinking and exchange them for an RFID tag. The RFID tag will be used to identify the user to the matching keys at a later time. Once the user is registered with an RFID tag they will be able to use the automated bartender which dispenses a drink of the user's choice. The automated bartender will have a screen interface that the user selects their drink from. Once a drink is selected the automated bartender will use liquid pumps and silicone tubing to suck measured amounts of each liquid from the attached drinks, and pour all the liquids down into a glass creating the perfect cocktail.

Once users of our automated bartender are satisfied and would like to leave the drinking area, they will be asked to blow into a breathalyzer that will be attached to the device. The breathalyzer will permit users who blow a BAC level below the legal limit access to their keys. If the breathalyzer reads a BAC of 0.08% or higher the user will be prompted to wait and advised to drink water, also their keys will not be returned.

The unique approach to our design will not prevent people from drinking, but will give those drinking the awareness to make the right decision at the end of the night. Some people may even find it amusing to know their BAC levels after a certain amount of drinks, or beneficial to know how they feel at certain BAC levels.

C. Work Breakdown Structure

The work breakdown structure served as an aid to help plan and directly observe all of our different tasks as well as sum up how many hours we have spent toward the completion of our project. Through the use of tables, we are able to examine the workflow of each team member as well as their contributions to the project. As a team, we were forced to recognize the workflow of each individual member. This helped us recognize and relieve some of the pressures placed on our team members.

Our team decided to build an automated bartender robot with a key locker. The device is going to be built from five important parts. These parts are Graphic User Interface (GUI), Breathalyzer, RFID, Drink Dispenser, and Key Locker. Each of these features were broken down into 3 subsections. The team split up each of these sections among themselves. Each team member was asked to build and code one specific part of the project. After code for each part is generated and the parts are connected in each individual component, the team will begin integrating them together.

The Graphical User Interface is the only component that communicates with the guest. It displays on the menu screen for getting drinks and opening the key locker. Also, it would display the guest's BAC and their drink count after every time they blew into the breathalyzer. Only Shawn would be working on this part since, using the python library, the GUI is not as complicated to implement as other devices. It is estimated that it would take him about 45 hours to implement the software of the GUI. The hardware of the device would be dealt with as a team after each individual part is functioning.

The breathalyzer has a key role in the automated bartender. It functions with the key locker and drink menu. This feature required approximately 100 hours to design properly. If a guest's BAC is in the appropriate range they will have access to their key locker. This additional feature required some extra time to ensure our locks would not open after just a breathalyzer blow.

RFID tags are another important feature in our design. The tags will distinguish guests from each other, as well as serve as one of the security features for our key lockers. This feature took approximately 80 hours to design individually, and another 50 hours to integrate within the overall design.

A Drink Dispenser is the other feature that would allow dispensing of 4 different drinks with a combination of 11 drinks in total to an 8-ounce cup. The Guests will be able to choose their drink at the selection screen in the GUI. This feature is estimated to take about 100 hours for the software aspect and another 30 for the hardware.

The key lockers are the last feature of the automated bartender. It allows a guest to put their vehicle's key in a safe locker and restricts access unless they are below a 0.06% BAC level. Because they work in conjunction with the breathalyzer and RFIDs, the lockers took approximately 60 hours to connect. They also required an additional 30 hours to manufacture an attractive outer shell design.

D. Project Timeline

The project timeline is an organized schedule used by our team to understand when we should have certain tasks completed. We used this section to better understand which components of our design idea were needed first. We created a PERT diagram that gives us a visual display of what tasks are necessary to begin others. This let our team members know that if we were to experience delays, we could end up with bottlenecks in our overall design. It also gives us the ability to understand the amount of time necessary to complete any given task.

We then created a Gantt chart that, like the PERT diagram, gives us a better understanding of what our necessary tasks are. Unlike the PERT diagram, the Gantt chart is a more descriptive table that displays the tasks we were assigned, along with who worked on that task. The Gantt chart also gives an estimated timeline for when each task was started and when we expect completion. Another feature of the Gantt chart is the listing of reporting assignments as well as design tasks. Some of the benefits of these tables are the visual display of how our project trickles down to several small tasks, and then comes together as a large-scale design.

We also used this timeline to understand where our milestones are and when we need to reach them. Our first large milestone is our prototype demonstration on November 15th, at which time we will need to display several working features of our project. To meet this milestone, we broke up our design by its different components and used these tasks as miniature milestones. The milestones we need to meet to create our final design are an accurate breathalyzer, a RFID tagging system, key safe lockers, a drink dispenser, and an interactive GUI. We began working on these features in early October in hopes of having most of the functionalities working for our prototype demonstration. The perfected features we will need to produce before April, for our final project demonstration.

Along with our project's physical features, there are several reporting assignments our team has, and will have to accomplish. We first had a Team Societal Problem statement, then our Design Idea contract, and our Work Breakdown Structure. We will also write a Risk Assessment report before our Prototype review in November. After our review we will be mostly working on the physical design features until our Prototype Evaluation in December. In the Spring semester we will pick up more reporting assignments beginning with a Problem Statement revision. After we have revised our Problem Statement and Design Idea, we will write a Device Test Plan that will show functionality of some of the features in our design. We will also be writing a Market Review that will explain who our potential consumers may be.

E. Risk Assessment

During the making of the project, we have to take into consideration the risk that might be involved. We used the work breakdown structure and figured out what our critical paths are. We assessed each of the key features and found issues associated with it. We had to also take into consideration future events that might cause complications for the completion of this project. Since Covid 19 restriction is still around, we have to think about ways to prevent it from spreading from our device. Looking at our overall project, there are 13 risks that we have found.

The GUI has two risks that we must take into consideration. There might be a sanitary issue that the GUI could bring since it is a touch screen. Also, information that the GUI displays to the user could lag since multiple files are being called in each sequence. To mitigate this issue, we consider using an attendant to clean and disinfect the touch screen. For the lag we would place a timer within the code to stop unnecessary code from running in the background.

For the breathalyzer, there are 4 risks associated with the building of this feature. There could be inaccurate reading coming from the breathalyzer. This could be caused by a wrong conversion of the BAC in our codes. Since there are many BAC equations out there, it might be difficult to use the correct one without trials and errors. The last two risks come from the fact that the breathalyzer system depends on an honor system. There might be a situation where the guest would get someone else to blow into the machine for them.

The Drink dispenser, we have a total of 2 risks that we accounted for. There is a possible issue with not providing enough power to the peristaltic pump since they require 12 volts while our microprocessor only provides 5 volts. We are targeting this issue by using an external power source, but since we are using 4 pumps, we must put the power supply connection to series, connecting them to each pump. The other issue is the risk of flyback current from using the relay board. The fly back current would occur when the device is turned off and it releases a huge voltage spike. To prevent this, we are thinking of using a flyback diode to connect our power supply to the pump. This would prevent fly back current from occurring.

For our lockers, we only found 1 risk. There is a risk with the coding of the locks, and it needs improvement for it. The current code for the locks unlocks it for a period of time. During that time however, the device would only be able to continue once the lock clicks back into place. If the lock were to malfunction then it would cause the whole device to be stuck in the mode. At that point, the guest wouldn't be able to operate the device anymore and would require an assistant to help with restarting the device. This issue is something that we would mitigate with improvement of the code. We would implement a way for the device to continue working even if the locker malfunctions.

The RFID tags only have one issue. We must consider the chance that someone might use a stolen RFID tag. This would keep an account for individual BAC, and makes it difficult for the actual guest to access their keys and or buy a drink. If the guest was to use someone else's rfid they would be able to gain access to someone else's keys, making it possible for theft. We based our RFID off an honor system, so we are hoping each guest would respect each other's rights. We would also remedy these risks by depending on an attendant to be able to identify who had lost their RFID and be able to SSH into the machine to enter the new ID and RFID tag. We will also be setting timers to wipe data if the user decides to leave as they have gone to their car. We are depending on the user to turn in their RFID tag into the attendant so the attendant may redistribute it.

Integration has one important risk that we have to tackle. The risks that are associated with this critical path are that some files may not be able to be integrated together due to settings within each function file. As we started to write integration files, we noticed that we couldn't run both GPIO pin settings such as BCM (Broadcom chip-specific pin numbers) and BOARD. To remedy this risk, we will have to switch settings within the integration files themselves. We will have to call specific settings for specific functions that we will need to perform.

For our risk we had to consider the potential risk and social distance. We have to consider our current pandemic and how our device wouldn't be able to spread the COVID19 virus. Since our device might have multiple people to interact with it, we must make it as sanitary as possible. We are just expecting people to be using this device one at a time so we are expecting the next guest to wait at least 6ft away from the person interacting with the device. Our design uses disposable breathalyzer tubes and also requires an attendant to sanitize the RFID tags and touch screen after use.

Our most Significant risk involving our device would be the breathalyzer. The breathalyzer is a crucial part of our device that requires a lot of our attention. We have to focus on fixing these risks, making sure that the amount of error that we receive from it would be minimal. We are doing a testing and trial run where we would find the most accurate data and use it for the overall device.

F. Problem Statement Revision

Alcohol consumption continues to be an issue that affects many people throughout society. It's especially an issue when a user uses it while driving. About 40% of all traffic mortalities are associated with alcohol, regarded as the most important human cause of severe automobile crashes. The driving performance of someone under the influence leads to risky driving and increases the frequency of traffic accidents. Children are especially vulnerable to lasting damages since they can be easily influenced by their surroundings.

Most children growing up around alcoholism are sometimes left with psychological and emotional damages that would last a lifetime. Alcohol causes interference with children, holding them back from their true potential. It could prevent them from having a good education and involve them in risky situations. As Covid highly affected the country in 2020, cafés and bars endured the greatest financial hit, constraining them to close and some for great[19]. With an end goal to keep the neighborhood economy above water, alcohol stores and different stores were permitted to sell liquor with no sort of control put upon them.

As indicated by the National Survey on Drug Use and Health, liquor utilization was up 14% starting in 2020 contrasted with 2019 [19]. Blood alcohol concentration (BAC) is determined through several factors of weight, gender, how much alcohol consumed, period of time you drink alcohol and what medication was being taken during the time of drinking. Breathalyzer breath alcohol concentration (BrAC) is determined through a simple exhale of a single breath through a breathalyzer. BrAC is a quicker way of measuring someone's BAC since they don't have to go through the extra testing.

G. Device Test Plan

Our project design has many electrical components that will need to be tested. The main components in our design are the drink pumps, alcohol sensor, RFID tags and locker system, and GUI. The RFID tags and locker system will need to be tested together because they will work in sequence with one another. We will need to test that each RFID will open one and only one locker. The drink pumps are essential to our automated bartender and must be able to pour eight ounces of liquid at a consistent rate. Our alcohol sensor is a key safety feature in our design that will need to be tested extensively to provide accurate breath alcohol readings. The breath alcohol readings will serve as a warning to our locker system that someone is or is not able to access their keys. Our GUI is the main interaction menu for our guests and will provide buttons that access other components. Our GUI will need to be tested thoroughly to make sure our users can navigate through our design easily. The GUI is important to test so there are not any hiccups in our final design.

Our device test plan is important for our final design because it will show our team where we may need to correct some flaws as well as where we can add additional features.

H. Market Review

Automated bartender we built is smart and safe. Many restaurants, bars and events that serve alcohol are not responsible for their consumer’s intoxication levels. Some venues may have standards to cut off consumer’s drinks if their intoxication level is noticeable, but they are not accurate. Our automated bartender has the ability to show users accurate intoxication levels, so it makes bars and restaurants our main consumers. Young adults and college students are our next consumers. Many people who reach 21, start drinking at parties and social events. Our device gives them a chance to drink responsibly.

Our product will be competing against an actual bartender who makes and serves drinks to customers. Also, it competes with bartenders who judge users' intoxication level .

In the automated bartender’s market there are not many devices that prioritize consumer’s alcohol usage safety. There are many automated bartenders in the market and most of them are lacking safety, overpriced, and out of reach. Bartesian and Barsys 2.0 are two automated bartenders that will compete with our device. The advantage of these devices is that they can pour drinks fast because they have advanced pumps. The disadvantages of these devices are; they are overpriced, the buyer has to program the automated bartender, and they lack safety features.

Our automated bartender is unique. It has the ability to read users BAC level with its built in breathalyzer and keep users keys in its built- in safe locker and keep it till the user has a legal limit BAC percentage. In addition, our product is significantly more affordable than any other automated bartender in the market.

There are a couple of weaknesses that exist in our automated bartender. First, it has fast functionality. Other automated bartenders in the market are working better and faster. If we make our design computable with them it would increase our cost. Second, our design appearance is not appealing to many customers but since it was cheaply made it is affordable to many people. To make our design look more appealing we can use 3D printing or use cc but it would increase our cost.

Robotic market expands very fast each year and this will give our device more opportunities to expand. Since Covid-19 started many businesses prefer to use less human elements and more robots and this gives opportunity to our device to compete in the market. Features of our device have given it more opportunities to be chosen by individuals and businesses.

Some threats that our devices face in the market are; other competitors might lower their current price, might people start to build the same project for themselves, and people might not want to buy it because it has the restriction and it will be placed on them.

I. Testing Results

For our project devices, we decided that we should test every component that we needed for our design. We tested our breathalyzer, peristaltic pumps, GUI files, RFID hat system, and safe design. As a team, we intended to test each component separately before putting them together.

Our drink pumps are one of the aspects of our design that will require considerable testing. We'll use four peristaltic drink pumps, each capable of pumping one liquid. The four pumps will be tested to see if they can operate together to make five different drink mixes. Shammah will put this component to the test. We'll need to see how long it takes for each of the four pumps to fill an eight-ounce cup independently. The pump was put to the test by running a script that allowed the pump to run indefinitely. The liquid will be dispensed from the pump into a cup that sits on top of the scale.We would stop the pump once an 8oz amount was taken and then record the time. Each pump took around 123 seconds, equating to 2 minutes for 8 oz from a single pump. I then put the pump through its paces to examine how varied changes in water temperature affected the total speed. Each variable water temperature gave me the same outcome at the end of the test, which was around 2 minutes to fill an 8 oz cup.

Our alcohol sensor, which will serve as our breathalyzer, is another aspect of our design that will require extensive testing. We'll test someone's breath after certain beverages to see how our breathalyzer reads our projected BrACs. Because we'll require a test subject, this testing will take three to four weeks. Because we don't want our test subject to become inebriated many times a week, he or she will only be tested 2 to 3 times per week. The first experiment was drinking a single 12-ounce beer. After ingesting the beer and waiting 5 minutes. Because alcohol was still present in the mouth, our sensor was able to identify it. After 30 minutes, the outcomes were slightly different. It demonstrated that, while the BAC reading increased, it did not suggest that we were over the limit. The test confirmed that our sensor detected alcohol on my breath and that I did not exceed the legal limit. We headed to the chemistry department for our next test, and with the help of Janee Hardman, a chemistry department technician, we were able to generate a 40 percent ethanol solution that we tested against our breathalyzer. We got the same exact BAC percentage from the breathalyzer reading as we did from the ethanol percentage measure. This is an accurate reading that proves that our breathalyzer can read correct ethanol in the air, which is needed to detect alcohol.

The major interaction menu that our guests will view and use is our graphical user interface. Shawn will put this to the test. We'll need to make dynamic drink and locker menus as well as a "Homepage” that's straightforward to use. When a button is pressed, we'll need to test our GUI to make sure it works with our components. The drink buttons were tested one at a time, starting with the creation of the code for each one and identifying it with a drink title. The next step was to check that each button on our touchscreen was clickable. I had to link the drink code files once I finished developing the buttons. I double-checked each button to make sure it was connected to the correct drink pump or pumps. Our pumps were tested to run for up to an 8-ounce cup using the drink buttons. It was necessary to test some of the buttons and pumps to see if they could pour as little as 1 ounce.

Our design includes a locker and RFID tag system since we want our guests to be able to lock up their car keys if they plan on drinking. Tahmina will put this to the test. It will be critical to verify each locker and RFID tag combination to ensure that when a tag is scanned, only one locker opens. All of the RFID tags we employ have a unique code, and only one RFID tag can access a single locker. I put RFID tags to the test to make sure they worked properly. Because we want our guests to be able to lock up their car keys if they plan on drinking, our design includes a locker and RFID badge system. This will be put to the test by Tahmina. It will be necessary to double-check each locker and RFID tag combination to guarantee that just one locker opens when a tag is scanned. Each of the RFID tags we use has a unique code, and each locker can only be accessed by one RFID tag. To ensure that RFID tags functioned properly, I put them to the test.

We, as Team 3, would like to extend our thanks to Janee Hardman from the chemistry department. For helping our team do the testing for the breathalyzer by providing us a lab and materiales to work with. We are grateful for her support and flexibility to fit us into her schedule.

J. End of Project Documentation

Our Senior Design project was designed for users of our system to have a safe interactive way to lock up their keys and check their BAC levels while drinking. The societal problem we chose to base our project on was drunk driving. Drunk driving is often a deadly crime that persists in society. When coming up with our project idea we had to think about what the contributing factors are to DUIs and alcohol related traffic accidents. Our team believes that people who drink and drive lack the awareness of how intoxicated they are before they get behind the wheel. Many places that serve alcohol are not responsible for their guest's intoxication level. Because of this we believed that creating an automated bartender that incorporates a breathalyzer and a key locker is the best way to increase awareness to those who drink.

Our project began with a Design Idea Report. We began by coming up with ideas that would serve as features for our project. When we had all the ideas we wanted to incorporate into our design we had to research what kind of electrical components were necessary to complete these ideas. Once we had a decent understanding of what was necessary for our design idea we made a contract with our professor.

In the next couple weeks after our contract we were required to create a structured report on how our work will be broken down throughout the 2 semesters. We also created an estimated project timeline of major events in our design. At this stage we began plugging in parts and trying to make individual features work. Once the construction of our design began we wrote a report about all the possible risks that we assessed. Early on in our design we realized the greatest risks that would affect our project would be any individual feature not working properly. After about 2 months of research and early designs we had a prototype progress review. In our review we were graded on how much progress we had made building and how much technical data we were able to present. At this stage our team had a working alcohol sensor and we had wired up drink pumps and solenoid locks to relays to show their functionality.

Our next big milestone in the first semester of Senior Design was our Public Prototype Demonstration. Our demonstration was done at Sacramento State infront of Engineering students and professors. To reach this milestone we had to prepare our design and working parts to the standard that we had set in our Feature Set. To meet these measurable metrics we spent many hours working on both the hardware component and software code for each individual feature.

The first feature we worked on was the peristaltic drink pumps. We were able to connect a single peristaltic pump, plastic tubes, and 12 volt power supply to make the pump turn on, however it was not controlled or on a time limit. The pump would use suction to collect water from a container and pour it out the opposite end. To control the time limit of how long a pump ran, and to allow more than one pump to run at the same time we needed to incorporate a relay board to serve as a switch between pumps. This relay board came in handy as one of our other project features is a locker system with solenoid locks. The solenoid locks also needed to run on a time-based system. The relay board we used is an 8-Channel Relay Module because we have 4 pumps and 4 lockers each needing its own relay to control the switch of voltage. The next feature that we added into our design was a RFID tag reader. This feature was created using an RFID HAT for the Raspberry Pi. The RFID HAT came with 4 uniquely identifiable tags that could be traced by the HAT. Another feature of our design was the graphical user interface that would serve as a touchscreen interaction menu. This feature was designed using Python code and the Tkinter library. The Tkinter library made it easier for us to code interactive menus and buttons for our design.

The most complex feature of our design was the breathalyzer system that we wanted to create. The breathalyzer was made using an MQ3 alcohol sensor and an Analog to Digital converter along with Python code. This feature was supposed to serve as a user's test to access their key locker or order more drinks. The breathalyzer feature of our design was the only feature incomplete in our first semester Prototype Progress Review. We spent several weeks working to better understand the analog to digital converter and the alcohol sensor and we eventually made the correct adjustments to calculate and produce an accurate BAC measurement.

In the second semester of Senior Design our prototype build was expected to be mostly finished. We began the term with a report about how much of a better understanding we had of the societal problem we chose, and a test plan for our design features. After these reports we had a demonstration review where we showed the progress in both our design build and our technical knowledge. It was here we finally were able to get the approval of our breathalyzer feature. The next few weeks of the semester were mostly filled with reports and presentations. We wrote a report about how our project would fare on the market and who our consumers may be. We also had individual presentations where each team member spoke about what features they contributed to and how much knowledge they presented in the project design.

After Spring Break we came back and reported on how well our test results of each feature had performed. We were given a few weeks to polish up our design before our final prototype demonstration. During our final prototype demonstration we had some hiccups but were able to perform each feature according to our original feature set. At this point we received approval from our Professor that our year long project meets the standards of our feature set and we will move on to the end of the year public demonstration.

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GLOSSARY

DUI (Driving Under the Influence) -is the offense of driving, operating, or being in control of a vehicle while impaired by alcohol or drugs (including recreational drugs and those prescribed by physicians), to a level that renders the driver incapable of operating a motor vehicle safely.

COVID-19 (CoronaVirus Disease 2019)- A highly contagious respiratory disease caused by the SARS-CoV-2 virus.

RFID (Radio Frequency Identification) -is a technology that uses radio waves to passively identify a tagged object.

BAC (Blood Alcohol Concentration)- the percentage of alcohol in the bloodstream: under the laws of most states, a BAC of 0.10 is the legal definition of intoxication, although a few states use a slightly lower percentage, as 0.08.

Buzzed- drunk or under the influence of a drug.

Cortisol- Cortisol is a steroid hormone that your adrenal glands, the endocrine glands on top of your kidneys, produce and release. Cortisol affects several aspects of your body and mainly helps regulate your body's response to stress.

RAM (Random Access Memory)- is the hardware in a computing device where the operating system (OS), application programs and data in current use are kept so they can be quickly reached by the device's processor.

GB (Gigabyte)- is a multiple of the unit byte for digital information. The prefix giga means 109 in the International System of Units (SI). Therefore, one gigabyte is one billion bytes. The unit symbol for the gigabyte is GB.

GPIO (General purpose input and output)- is an uncommitted digital signal pin on an integrated circuit or electronic circuit board which may be used as an input or output, or both, and is controllable by the user at runtime.

PWM (Pulse Width Modulation)-is a modulation technique that generates variable-width pulses to represent the amplitude of an analog input signal. The output switching transistor is on most of the time for a high-amplitude signal and off most of the time for a low-amplitude signal.

DC (Direct Current)- is a one-directional flow of electric charge. An electrochemical cell is a prime example of DC power.

OCP (Overcurrent Protection)- is a piece of equipment used in electrical systems that are at risk of experiencing overcurrent due to overloads, short circuits, or ground faults.

TSD (Thermal Shutdown)- is a circuit that prevents deterioration and breakdown due to a significant increase in ambient temperature and heat generation of the device itself due to an unintended large current load.

OLED (organic light-emitting diode)-a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current.

DSI (Display serial Interface)-a specification by the Mobile Industry Processor Interface (MIPI) Alliance aimed at reducing the cost of display controllers in a mobile device.

GUI (Graphical User Interface)- a visual way of interacting with a computer using items such as windows, icons, and menus, used by most modern operating systems.

UART (Universal Asynchronous Receiver-Transmitter)-is a computer hardware device for asynchronous serial communication in which the data format and transmission speeds are configurable.

PPM (Parts Per Million)-is a commonly used unit of concentration for small values. One part per million is one part of solute per one million parts solvent or 10^-6.

AC (alternating current)- is an electric current which periodically reverses direction and changes its magnitude continuously with time in contrast to direct current (DC) which flows only in one direction.

Gantt (generalized activity normalization time table)- type of chart in which a series of horizontal lines are present that show the amount of work done or production completed in a given period of time in relation to the amount planned for those projects.

PERT (program evaluation review technique)- is a project management tool that provides a graphical representation of a project's timeline.

BCM (Broadcom chip-specific pin numbers)- pin numbers that follow the lower-level numbering system defined by the Raspberry Pi’s Broadcom-chip brain.

CNS (central nervous system)-the complex of nerve tissues that controls the activities of the body. In vertebrates it comprises the brain and spinal cord.

BrAC (Breath Alcohol concentration)- is the amount of alcohol in the bloodstream or on one's breath.

Appendix A. Hardware

TABLE A-I.
Device Testing plan/Result

	Test Equipment	**Expected Results**	**Timeline**	**Team Member(s)**	**Pass or Fail**
Pump Testing					
How long 4 Pumps take to fill an 8oz cup	4 Peristaltic Pumps 1 8oz cup 4 containers with any Liquid	Get a timer result of how much secs it takes to fill an 8 oz cup	1 week (2/7 - 2/14)	Shammah	PASS
Different liquid Temperature	1 Peristaltic Pump 1 8oz cup 1 container with any Liquid	The pump should not be affected by the temperature of the liquid, should work at the same speed at all temperature	1 week (2/7 - 2/14)	Shammah	PASS
8oz Accuracy	1 Liquid 1 8oz cup 1 Drink pump 1 timer	Should always get about 8 ounces every run	2 weeks (2/14 - 2/21)	Shammah	PASS
Breathalyzer Testing					
BrAC Levels after Certain Drinks	1 Volunteer 3-4 Different alcoholic beverages Mq3 sensor	Get a BrAC estimate from test subject	4 Weeks (2/7 - 3/14)	Deepak	PASS

	Test Equipment	Expected Results	Timeline	Team Member(s)	Pass or Fail
Breathalyzer Testing					
BrAC Accuracy	Mq3 sensor Alcoholic Drink Breathalyzer	Should be in the same estimate as a marketed breathalyzer	6 Weeks (2/7 - 3/21)	Deepak	PASS
Software Testing					
Drink pump code	computer	Activate all 4 Drink pump together and/or separately	1 week (2/7 - 2/14)	Shawn	PASS
RFID and Solenoid Lock code	computer	RFID tags are able to scan and activate lock	1 week (2/7 - 2/14)	Shawn	PASS
Alcohol Sensor code	MQ3 sensor MCP3008 A2D converter Raspberry Pi	MQ3 code are functional and getting adequate data	3 weeks (2/7 - 3/7)	Shawn	PASS
RFID & Locker Testing		RFID are able to activate the correct locks	3 weeks (2/7 - 3/7)	Tahmina	PASS
GUI Testing					
Drink buttons	Drink pumps 7 inch touchscreen Python code	GUI is able to run all components together, Allow tap to perform action on the screen	7 weeks (2/7 - 2/14)	Shawn	PASS

	Pump 1	pump 2	pump 3	pump 4
Times	123 sec	125 sec	122 sec	123 sec
Ounces	8.1 ounce	8.5 ounce	8.2 ounce	8.0 ounce

Figure A -1 . Pump Speed[32]

Figure A-2. Relay board counter[33]

TABLE A-II.
MCP3008 Voltage[34]

Tested Input			Tested Output						Expected Input	Expected Output	
Input voltage through the Logic level converter	voltage after Logic level converter (into mcp)	Input voltage directly to MCP3008	Actual Binary Output measured from logic analyzer	Actual Decimal value measured from logic analyzer	BAC % measured from Putting direct voltage to MCP	BAC % measured from Voltage going through Logic level converter	Drinking Status		Calculated Input voltage using ADC value*(Vref/1024)	Calculated Decimal value	Expected Binary value
0.1	0.1	0.1	1111	32	0	0			0.103125	32	1111
0.2	0.21	0.2	111100	63	0	0			0.203027344	63	111100
0.3	0.31	0.3	1011101	93	0.001	0.001			0.299707031	93	1011101
0.4	0.41	0.4	1111100	124	0.001	0.001			0.399609375	124	1111100
0.5	0.51	0.5	10011011	155	0.002	0.002			0.499511719	155	10011011
0.6	0.61	0.6	10111010	186	0.003	0.003			0.599414063	186	10111010
0.7	0.71	0.7	11011001	217	0.004	0.004			0.699316406	217	11011001
0.8	0.81	0.8	11111000	248	0.005	0.005			0.79921875	248	11111000
0.9	0.92	0.9	100010111	279	0.006	0.006			0.899121094	279	100010111
1	1.02	1	100110110	310	0.008	0.008			0.999023438	310	100110110
1.1	1.12	1.1	101010101	341	0.009	0.009			1.098925781	341	101010101
1.2	1.22	1.2	101110100	372	0.012	0.012			1.198828125	372	101110100
1.3	1.32	1.3	110010011	403	0.014	0.014			1.298730469	403	110010011
1.4	1.43	1.4	110110010	434	0.017	0.017			1.398632813	434	110110010
1.5	1.53	1.5	111010001	465	0.02	0.02	clean		1.498535156	465	111010001
1.6	1.63	1.6	111110000	496	0.024	0.024			1.5984375	496	111110000
1.7	1.73	1.7	1000001111	527	0.029	0.029			1.698339844	527	1000001111
1.8	1.83	1.8	1000101110	558	0.035	0.035			1.798242188	558	1000101110
1.9	1.93	1.9	1001001101	589	0.42	0.42			1.898144531	589	1001001101
2	2.03	2	1001101100	620	0.051	0.051			1.998046875	620	1001101100
2.1	2.14	2.1	1010001011	651	0.062	0.062	Drunk		2.097949219	651	1010001011
2.2	2.26	2.2	1010101010	682	0.76	0.079	Legally intoxicated		2.197851563	682	1010101010
2.3	2.42	2.3	1011001001	713	0.92	0.11			2.297753906	713	1011001001
2.4	2.59	2.4	1011101000	744	0.113	0.163			2.39765625	744	1011101000
2.5	2.75	2.5	1100000111	775	0.144	0.261			2.497558594	775	1100000111
2.6	2.92	2.6	1100100110	806	0.185	0.465			2.597460938	806	1100100110
2.7	3.06	2.7	1101000101	837	0.251	0.958			2.697363281	837	1101000101
2.8	3.18	2.8	1101100100	868	0.347	2.83			2.797265625	868	1101100100
2.9	3.28	2.9	11 1000 0011	899					2.897167969	899	11 1000 0011
3	3.3	3	11 1010 0010	930					2.997070313	930	11 1010 0010
3.1	3.3	3.1	11 1100 0001	961					3.096972656	961	11 1100 0001
3.2	3.3	3.2	11 1110 0000	992					3.196875	992	11 1110 0000
3.3	3.3	3.3	11 1111 1111	1023					3.296777344	1023	11 1111 1111

Appendix B. Software

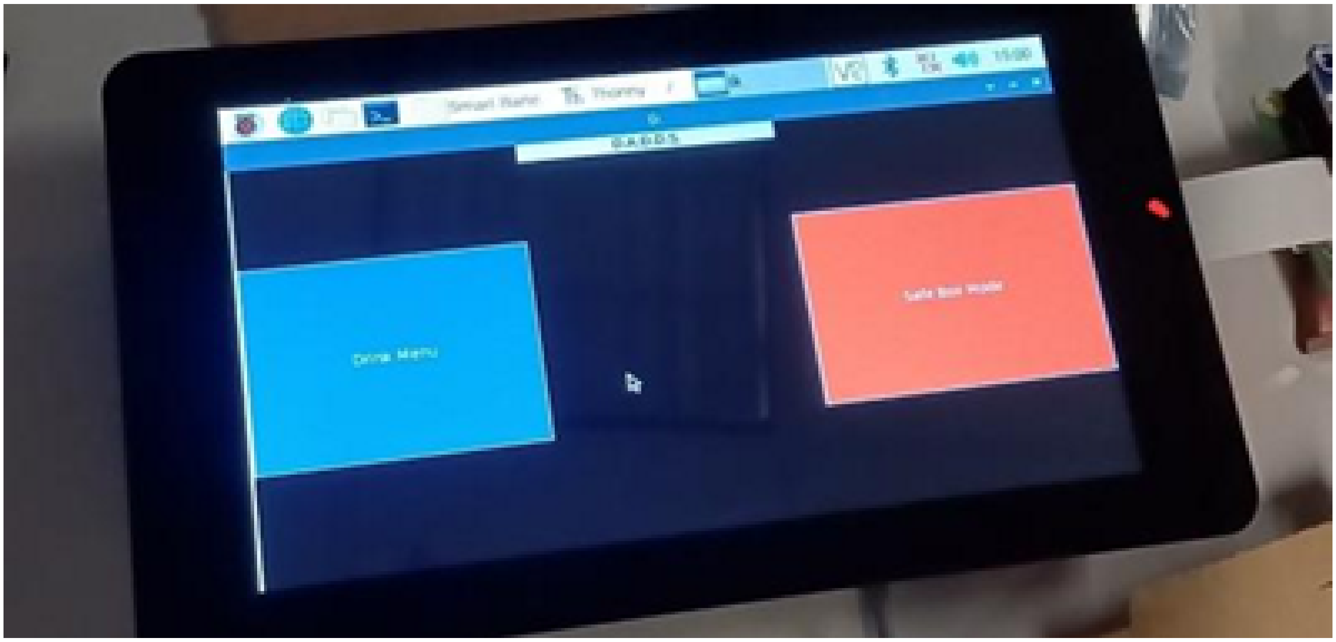

Figure B-1. GUI Home Table. [35]

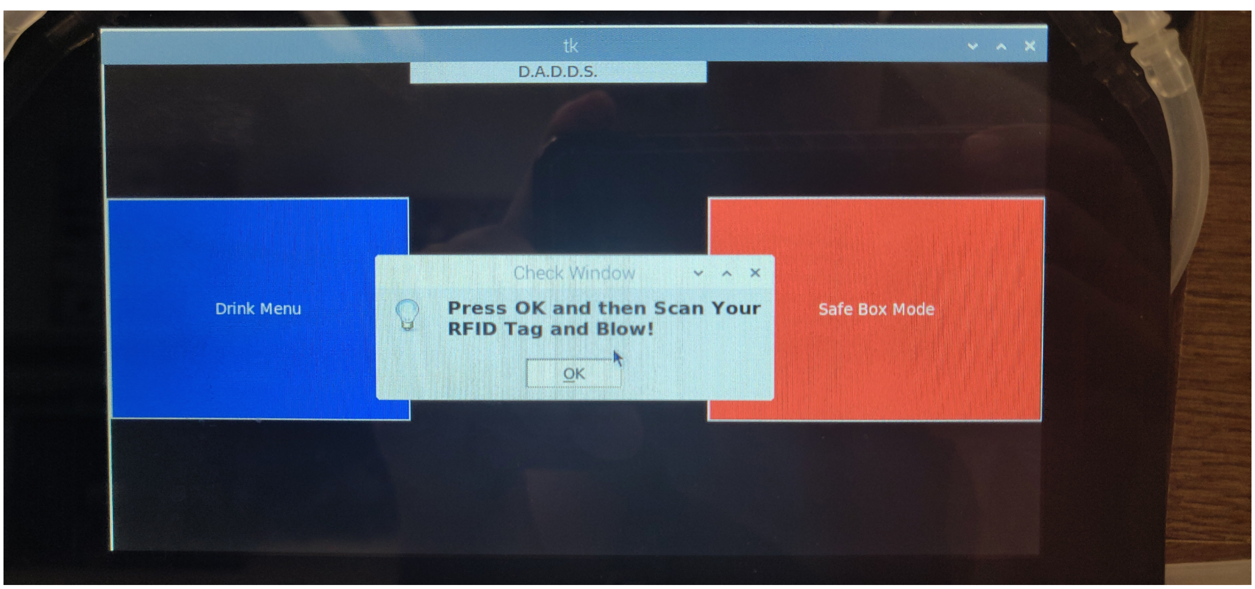

Figure B-2. Pre Check Window[36]

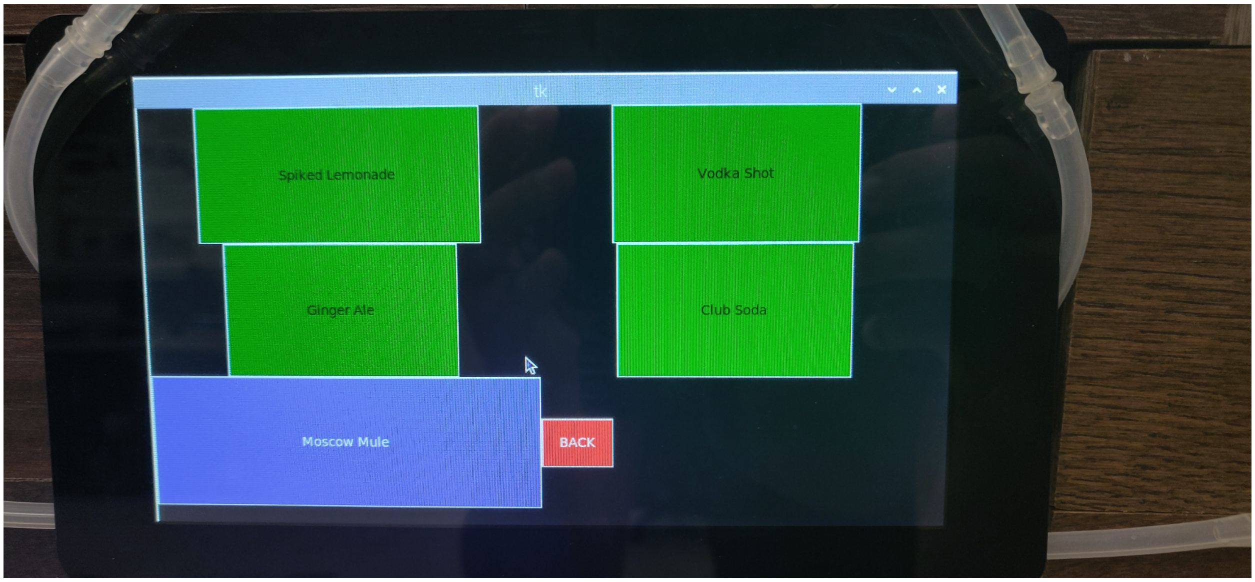

Figure B-3. Drink Menu Screen[37]

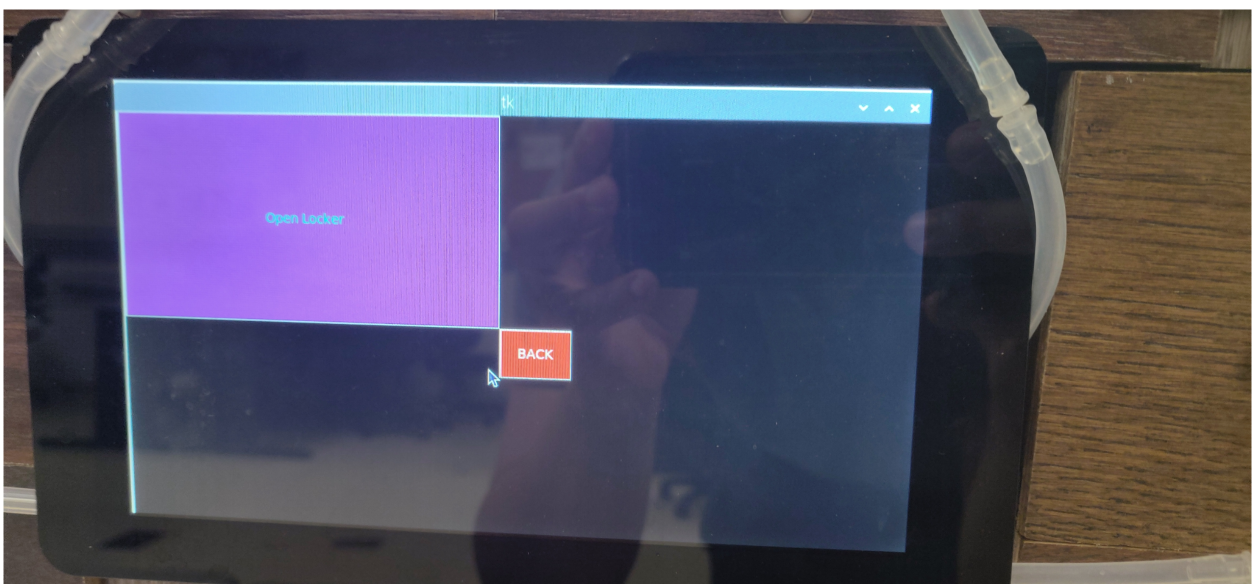

Figure B-4. Open Locker Screen Menu [38]

Appendix C. Mechanical Aspects

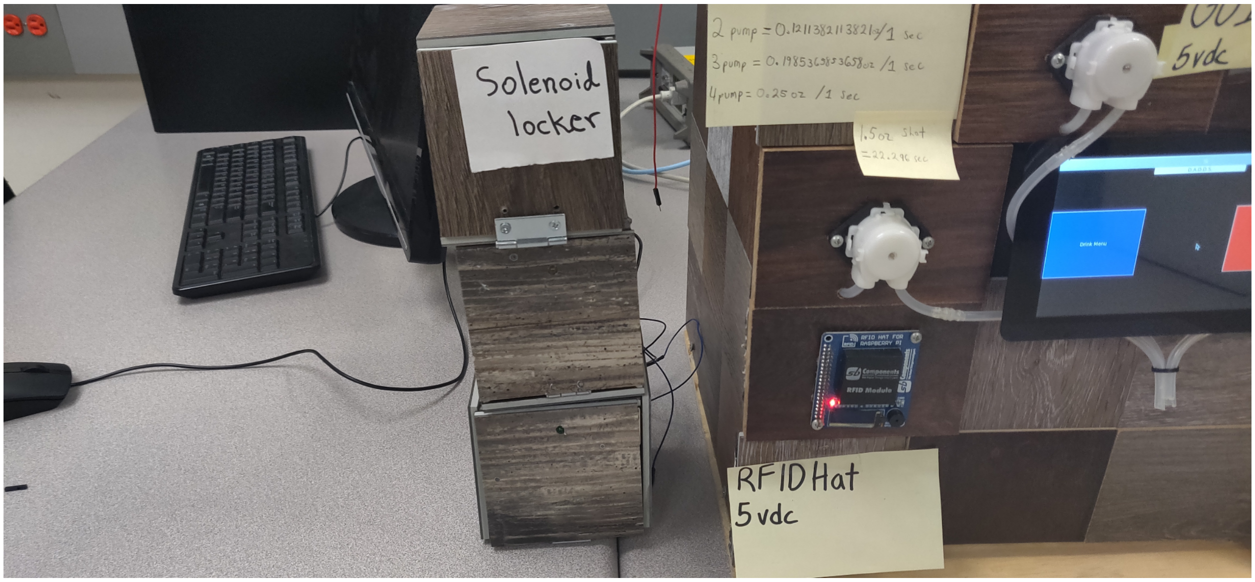

Figure C-1. Lockers [39]

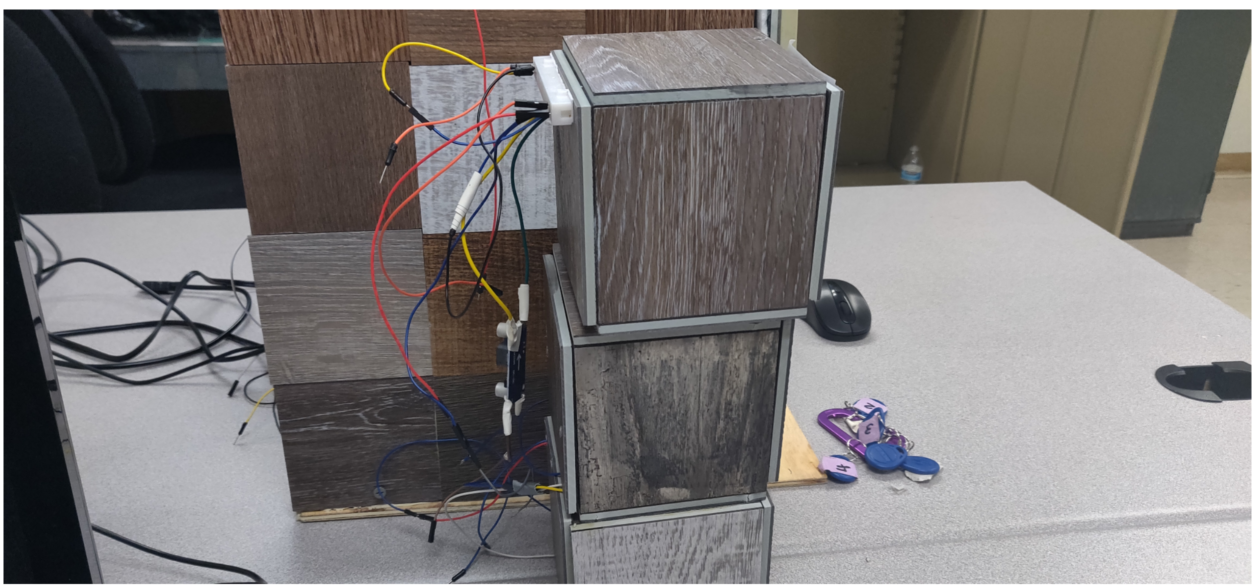

Figure C-2. locker wiring[40]

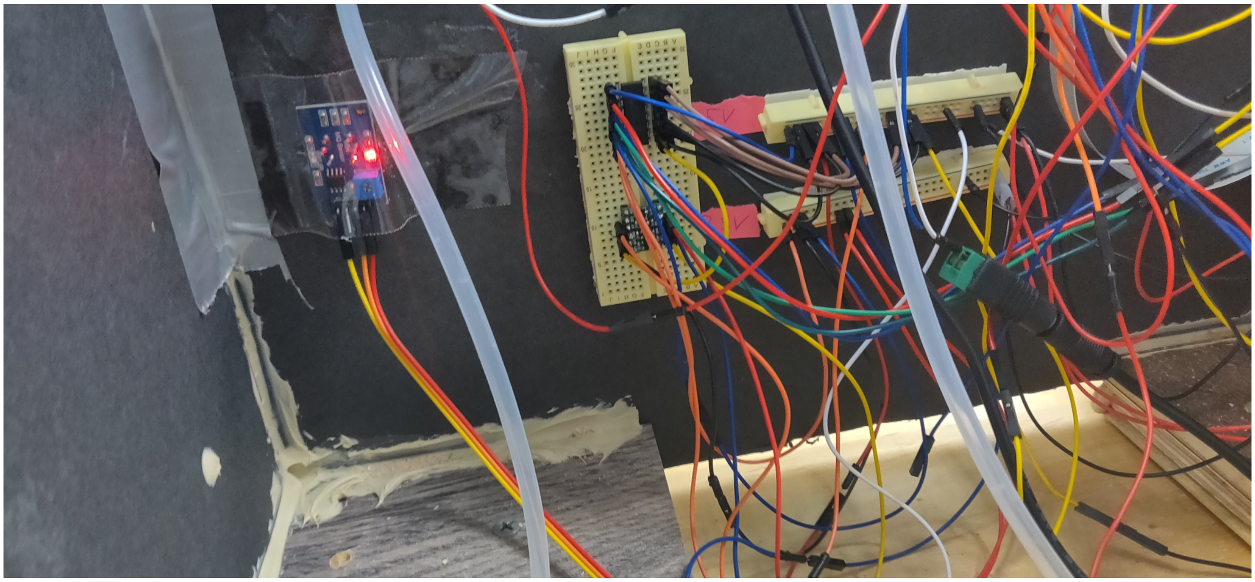

Figure C-3. Breathalyzer Wiring[41]

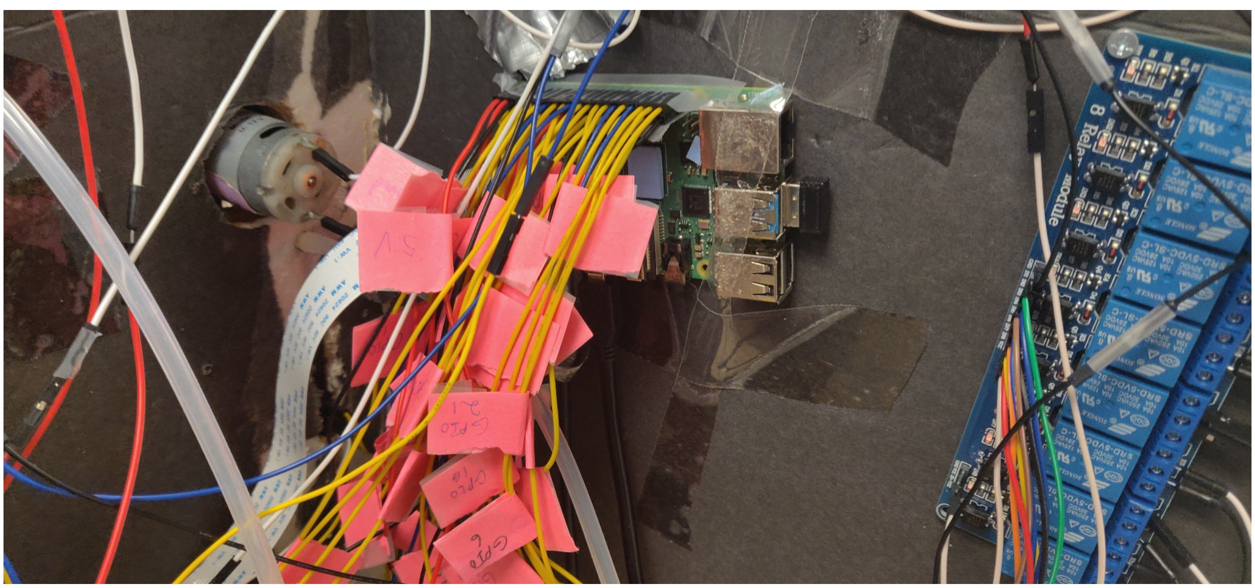

Figure C-4. Raspberry Pi Wiring[42]

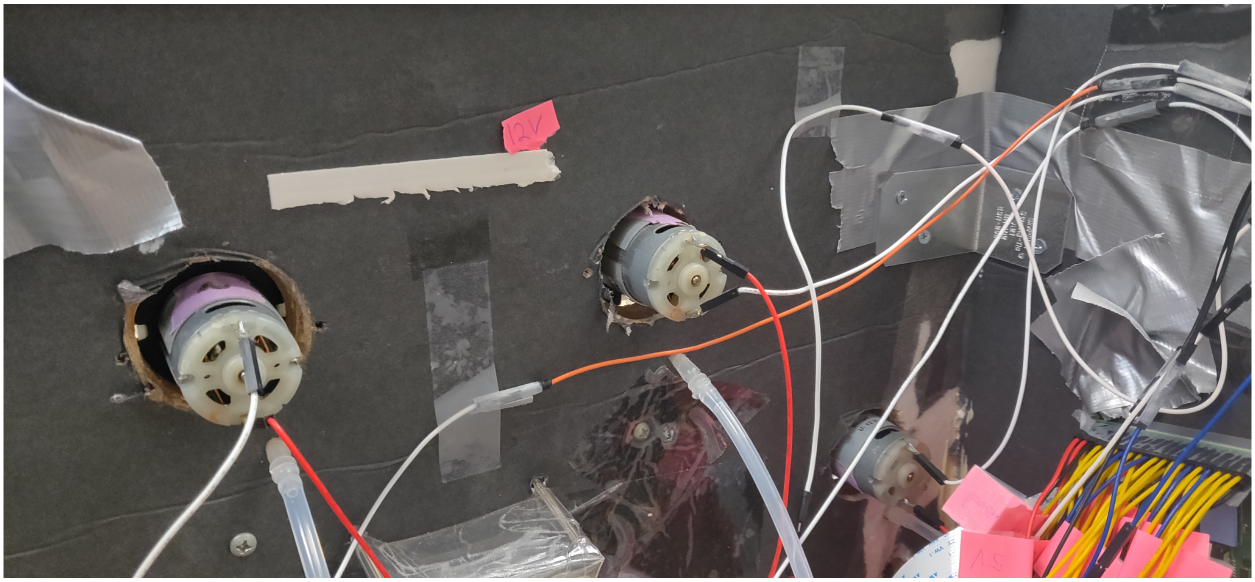

Figure C-5. Drink Dispenser Wiring[43]

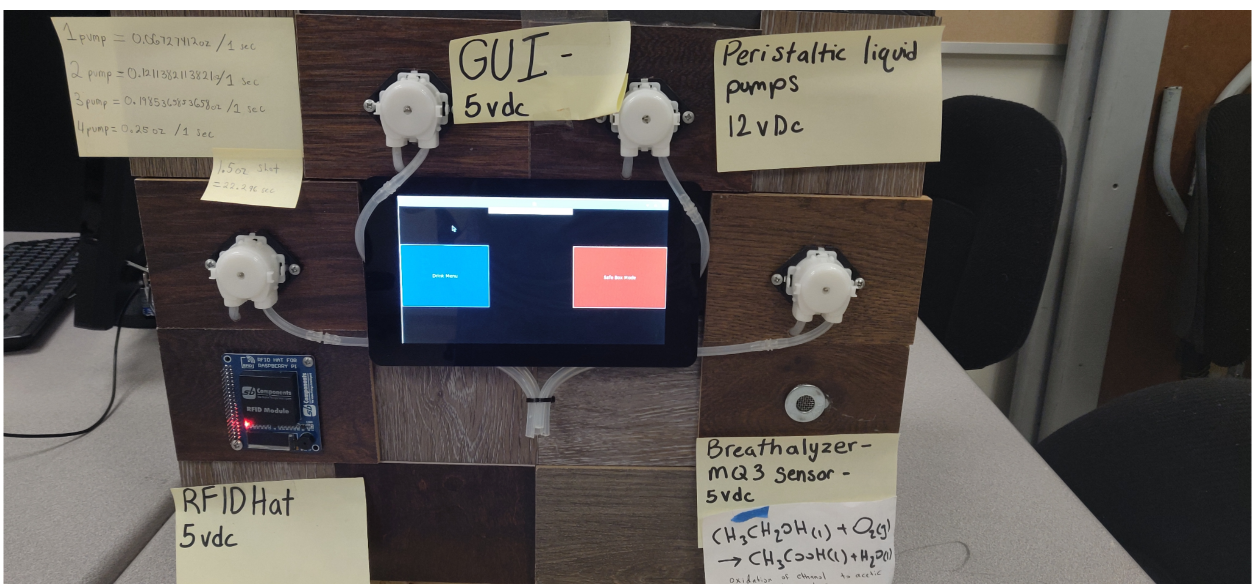

Figure C-6. Front Project Design[44]

Appendix D. Work Breakdown Structure

TABLE D-I.
Work BreakDown Structure[45]

Feature	Subtask	Activity	Start Date	Completion Date	Name
Level 1	Level 2	Level 3			
1. Graphic User Interface(GUI)					
	1.1 Intuitive drink menu and safe functionality				
		1.1.1 Hardware - Build the touch screen attachment to the Raspberry Pi	11-Oct	15-Nov	Shawn
		1.1.2 Software - Code the widgets and options for guests	11-Oct	15-Nov	Shawn
		1.1.3 Gather and Display Data- Take information from the breathalyzer and RFID and then display them to the screen	1-Nov	6-Dec	Shawn
2. Breathalyzer					
	2.1 Blood alcohol tracker				
		2.1.1 Hardware- Use the MQ-3 and Raspberry Pi to create a functioning alcohol reader	11-Oct	15-Nov	Deepak and Tahima
		2.1.2 Software- Use hardware to read from the MQ-3 and create a limiting function that will return true or false depending on BAC	11-Oct	15-Nov	Deepak and Tahima
		2.1.3 Data Passing - Pass a true or false to the main file and pass the data to be displayed to the screen	1-Nov	6-Dec	Deepak and Tahima
3. RFID					
	3.1 Reads RFID Number and Keeps Track of Data				
		3.1.1 Hardware- Get RFID to read on the RFID HAT	11-Oct	15-Nov	Shammah and Shawn
		3.1.2 Software- Code the Hat to take in the RFID tag number and store it	11-Oct	15-Nov	Shammah and Shawn
		3.1.3 Temporary Data Storing and Passing - Pass RFID information into the main file	1-Nov	6-Dec	Shammah and Shawn
4. Drink Dispenser					
	4.1 Dispensing of Drinks				
		4.1.1 Hardware- Use relay board to control parastaltic pumps	11-Oct	15-Nov	Shammah and Shawn
		4.1.2 Software- Use python to control the parastalic pumps and get specific amount of liquid in the cup	11-Oct	15-Nov	Shammah and Shawn
		4.1.3 Communication- Drink dispenser will communicate with the RFID, Breathalyzer, and GUI to dispense drinks	1-Nov	6-Dec	Shammah and Shawn
5. Key Locker					
	5.1 Open Locker when Requirements are met				
		5.1.1 Hardware - Solenoid locks will be controlled with the raspberry pi, and initiated by the RFID and Breathalyzer.	25-Oct	15-Nov	Deepak and Tahima
		5.1.2 Software- Use python to activate the solenoid locks	25-Oct	15-Nov	Deepak and Tahima
		5.1.3 Implement conditional logic- Implement logic that will activate the solenoid locks if RFID and Breathalyzer return TRUE	15-Nov	6-Dec	Deepak and Tahima

Appendix E. Timeline Charts and PERT Diagrams

TABLE E-I
Full Timeline Chart [46]

TABLE E-II.
First Semester Timeline[47]

D.A.D.D.S Automated Bartender

	Group 3							
	Project lead		Shawn Bacani		Deepak Sharma		Shammah Thao	Tahmina Jurat
	Project Start Date:	8/30/2021	8/30/2021-10/25/2021		10/26/2021-12/10/2021		12/10/21 - 3/15/20	3/16/2022- 5/13/2022
	Scrolling Increment:	1						

ID	Task Name	Duration	Estimated Time	Actual Time	Start	Finish	Assigned To	% Complete
1	**Societal Problem**	**16 days**	**88 hours**	**65.5 hours**				
2	Research into Societal Problem	6 days	48 hours	36.2 hours	09/13/2021	9/27/2021	Team	100%
3	Select Societal Problem	4 days	5 hours	3 hours	9/13/2021	9/20/2021	Team	100%
4	Draft Societal Problems	2 days	5 hours	5.5 hours	09/20/2021	9/27/2021	Team	100%
5	Present Societal Problem	4 days	30 hours	20.8 hours	09/27/2021	9/27/2021	Team	100%
6	**Design Idea**	**15 days**	**26 hours**	41 hours				100%
7	Design Idea Report	6 days	7 hours	7 hours	09/27/2021	10/4/2021	Team	100%
8	Design Idea Contract	9 days	9 hours	9 hours	09/27/2021	10/11/2021	Team	100%
9	Research &Order Parts	14 days	10 hours	25 hours	9/1/2021	11/15/2021	Team	100%
10	**Work Breakdown Structure (WBS)**	**8 days**	**62 hours**	56 hours				
11	Write WBS report	7 days	60 hours	55 hours	10/18/2021	10/25/2021	Team	100%
12	Hazard Assessment Form	1 day	2 hours	1 hours	10/18/2021	10/18/2021	Team	100%
13	**Project Timeline**		**20 hours**	20 hours				
14	Project Timeline report	7 days	20 hours	20 hours	10/25/2021	11/01/2021	Team	100%
15	**Risk Assessment**							
16	Risk Assessment report	7 days	25 hours	20 hours	11/01/2021	11/8/2021	Team	100%
17	**Prototype progress Review**							
18	Lab Prototype Presentatio	1 day	5 hours	20 hours	9/1/2021	11/15/2021	Team	100%
19	**Breathalyzer**							
20	Breathalyzer Function	40 days	20 hours	150 hours	10/11/2021	1/27/2021	Tahmina & Deepak	100%
21	Breathalyzer Intregration file	2 days	10 hours	80 hours	10/25/2021	3/26/2022	Tahmina & Deepak	100%
22	**RFIDs**							
23	RFID Function	10	12 Hours	30 hours	10/11/2021	10/25/2021	Shawn & Shammah	100%
24	RFID Integration file	2 days	10 hours	20 hours	10/25/2021		Shawn & Shammah	100%
25	**GUI**							100%
26	Drink Menu	30 days	30 Hours	50 hours	10/11/2021	11/15/2021	Team	100%
27	Safe button	12 days	10 hours	20 hours	10/11/2021	12/18/2021	Team	100%
28	Integrate module files	1 days	10 hours	25 hours	11/31/21	11/31/21	Team	100%
29	Pop-up prompts and counters	2 days	4 hours	10 hours	12/1/2021	12/03/2021	Team	100%
30	**Locker**							100%
31	Integergate RFID and Breathalyzer Check into Locker	3 days	20 hours	50 hours	10/25/2021	11/15/2021	Team	100%
32	Solenoid Lock Function and integration	2 days	10 hours	30 hours	10/25/2021	11/1/2021	Team	100%
33	**Pump system**							100%
34	Peristaltic pump function	3 days	16 hours	30 hours	10/18/21	11/5/2021	Team	100%

TABLE E-III.
Second Semester Timeline[48]

	D.A.D.D.S Automated Bartender							
	Group 3							
	Project lead		Shawn Bacani		Deepak Sharma		Shammah Thao	Tahmina Jurat
	Project Start Date:	8/30/2021	8/30/2021-10/25/2021		10/26/2021-12/10/2021		12/10/21 - 3/15/20	3/16/2022- 5/13/2022
	Scrolling Increment:	1						
ID	**Task Name**	**Duration**	**Estimated Time**	**Actual Time**	**Start**	**Finish**	**Assigned To**	**% Complete**
1	**Second Semester Work**							
2	**Case Building**	7 days	35 hours	40 hours	1/9/2022	1/15/2022	Team	100%%
3	**Reports**							
4	Winter Break Team Work	21 days	100 hours	270 hours	12/17/2020	1/24/2021	Team	100%
5	Revised Problem Statemer	7 days	20 hours	25 hours	01/24/2021	1/31/2022	Team	100%
6	Device Test Plan Report	7 days	25 hours	25 hours	1/31/2022	2/7/2022	Team	100%
7	Proteype Progress Review	1 day	3 hours	3 hours	2/14/2022	2/14/2022	Team	100%
8	Market Review	7 days	25 hours	30 hours	2/21/2022	2/28/2022	Team	100%
9	Feature Report	7 days	25 hours	20 hours	2/28/2022	3/7/2022	Team	100%
10	Feature Presentation	7 days	2 hours	4 hours	3/7/2022	3/14/2022	Team	100%
11	Prototype progress Reviev	1 day	3 hours	3 hours	3/28/2022	3/28/2022	Team	100%
12	Testing Result Report	7 days	30 hours	15 hours	3/28/2022	4/4/2022	Team	100%
13	Engineering Ethics Quiz	1 days	2 hours	2 hours	4/18/2022	4/18/2022	Team	100%
14	Deployable Prototype Eva	7 days	50 hours	4 hours	4/25/2022	4/25/2022	Team	100%
15	End of Report	7 days	60 hours	45 hours	4/25/2022	5/2/2022	Team	100%
16	Public Presentation	1 days	4 hours	4 hours	5/13/2022	5/13/2022	Team	100%

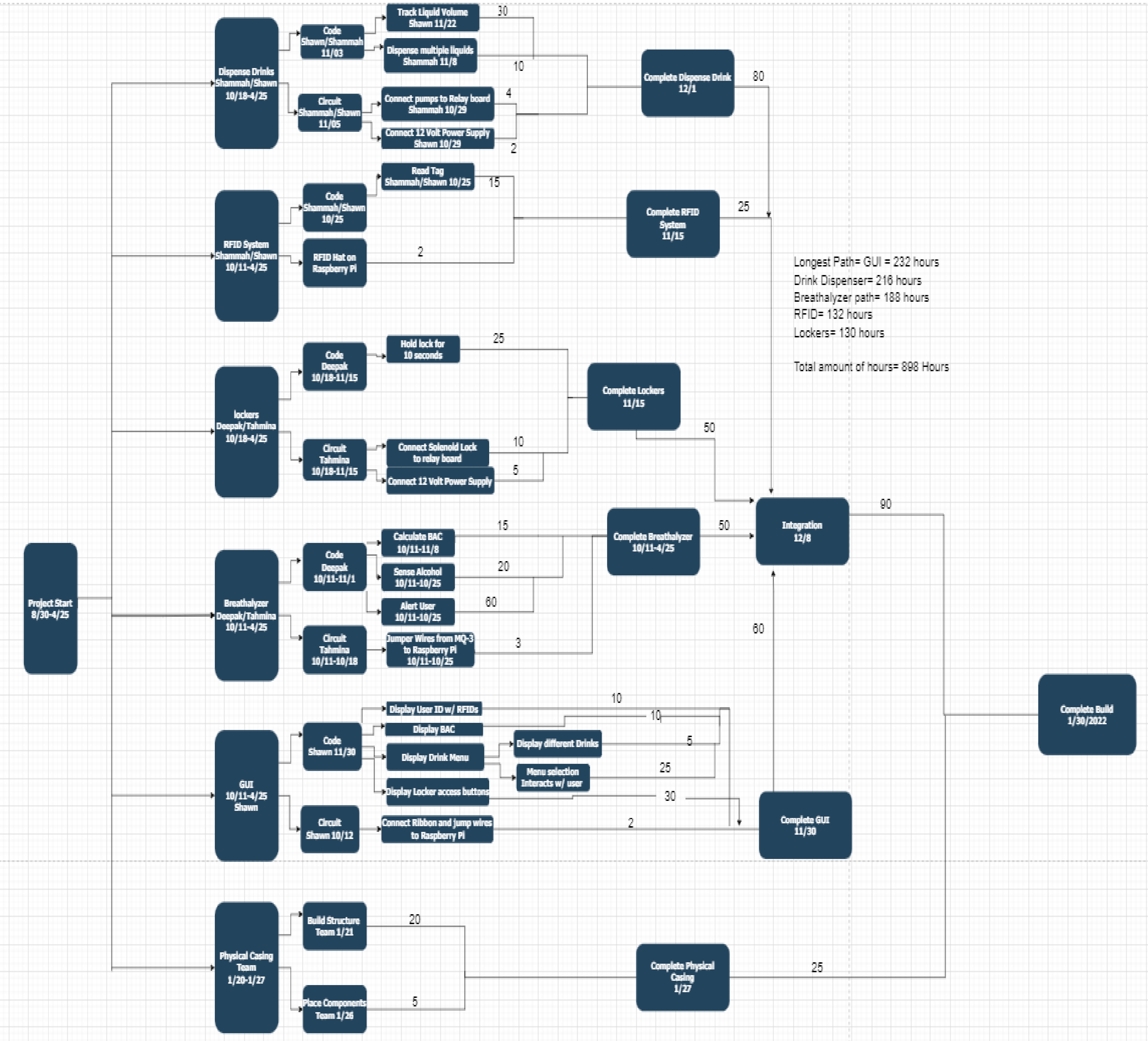

Figure E-1. PERT Diagram [49]

Appendix F. Resumes

Shammah Thao

EDUCATION

California State University, Sacramento **2016 - Expected 2022**

- BsCPE Computer Engineer

TECHNOLOGIES AND LANGUAGES

- Languages: Java, Verilog, Vhdl, C/C++
- Software: Multisim, Vivado, Wireshark, Putty, initial state
- Skills: Circuit Analysis and Construction, Computer Assembly

PROJECTS

- **Weather Station Project** *(Computer Interfacing)*
  - Designed and completed a working weather station that can sense wind speed, temperature, wind direction, as well as barometric pressure. This is all actively updated through a finite state machine implemented within the code. Using the on- board sensors of the attached sense hat, I was able to create a finite state machine that is able to display weather data in real time. The whole project was done in python to help further aid understanding of the language.
- **PCI Arbiter (***Computer Hardware Design)*
  - Created and implemented a fully functioning PCI Arbiter using Verilog with the methodologies learned in class. The purpose of this project was to understand at an intimate level hot the PCI Arbiter grants permissions to allow for multiple masters to be able to write to the data bus using the round robin scheme.
- **Simplified Microprocessor Design** *(Advanced Logic Design)*
  - Designed a simplified microprocessor using the block diagrams provided in the lab manual. Used the given structural hierarchical design method to implement within each individual sub design using Verilog. Created a test bench simulation of the top-level microprocessor data path design.
- **State Machine Project** *(Intro to Logic Design)*
  - Designed an "implied" system clock state machine solution in accordance to a diagram provided by the professor. Utilized K-maps to find equations for each of the inputs to the D flip-flops. Used D flip-flops and assign statements to implement the design. Used the design to create a Verilog code that is able to be assigned pins to test each part of the state machine for correct outputs.

WORK EXPERIENCE

Waitstaff, Carlton Senior Living Oct 2017 – Feb 2020

Sacramento, CA

- Worked in a team orientated, fast-paced environment, providing exceptional customer service to hundreds of clients
- Mentored 4 trainees – applying personal experience giving useful insights resulting in a well prepare team

Shawn Bacani

Education

B.S. Computer Engineering • CSU Sacramento • Overall G.P.A. 3.142 • Graduating May 2022

Related Courses:

Data Structure & Algorithm Analysis
Computer Networks and Internets
Intro Circuit Analysis
Discrete Structures
Intro to Logic Design
Differential Equations
Intro to Systems Programming
Microcomputers and Assembly Language
Mechanics
Calculus I & II
Programming Concepts & Methodology I & II
Intro to Engineering
Computer Interfacing
Advanced Logic and Design
Computer Hardware Design
Network Analysis
Advanced Computer Organization
Operating Systems Principles
Electronics I
Signals and Systems
Probability and Random Signals
CMOS and Digital VLSI Design
Operating Systems Pragmatic
Computer Software Engineering
Senior Design Project I
Senior Design Project II

Work Experience

Student Assistant for the Attorney General's Office ***1300 I Street*, CA** 11/06/2019 to Present

Responsible for renewing non-profit charities' statuses along with ensuring that said charities are not delinquent. Ensures data is correctly processed through the channel of individual program teams within the office. Worked with the renewals team to efficiently process information as well as handle delinquent status programs, helping with their renewal process.

Baker ***2102 Natomas Crossing Dr. #150*, CA** 5/12/2015 to 8/16/2017

Worked with coworkers to sell and produce multitudes of pastries. Helped optimized time to produce as many pastries as possible with the use of data from what was sold.

Courtesy Associate ***4100 Northgate Blvd*, CA** 9/05/2019 to 11/18/2020

Used special communication skills learned on the job to relay to the loss prevention office of suspicious or previous offenders of theft. Carefully read and checked items in customers bags from their receipts.

Pizza Editor ***2281 Del Paso Rd #150*, CA** 11/06/2019 to 8/06/2021

I pay careful attention in accommodating customers with their pizza. Produced a multitudes of foods while also keeping the restaurant clean. Carefully reading and following the directions of the customers. Produced an efficient and friendly work environment for coworkers and customers. Looked over the production and quality of work.

Strengths

- **Languages:** Python, Java, x86 Assembly, Verilog, C, VHDL
- **Hardware:** Raspberry pi, FPGA Board, Arduino Uno
- **Software:** Vivado, ModelSim, Capture CIS, PuTTY, Multisim, Wireshark, Quartus Prime, Cadence Virtuoso,PSpice
- **Tools:** Multimeter, Analog Discovery Tool, Logic Analyzer
- **Systems/Platforms:** Windows, Linux, Mac
- Capable of learning and adapting to new skills needed in the field.
- Able to communicate complex concepts clearly across different audiences verbally and in writing.
- Strong communication, organization, and team working skills.

Projects

Drunk Driving Safe Automated Bartender *(Senior Design Project I & II)*

Worked with three other students to create a drunk driving safe automated bartender. This automated bartender had an integrated breathalyzer, safe lockers, pumps, and RFID reader. I played a pivotal role in the planning and creation of this entire project. I had created a functioning breathalyzer that has been tested and verified by the chemistry department of Sacramento State. This project was done in python using the raspberry pi as the main device.

Weather Station Project *(Computer Interfacing)*

Designed and completed a working weather station in python using a raspberry pi as well as an attached sense hat within a four person group. This device is able to sense wind speed, temperature, wind direction, as well as barometric pressure. It also actively displayed data gathered. This is all actively updated through a finite state machine implemented within the code. I was able to create a wind speed monitor as well as using the onboard gyroscope to sense the direction of the wind.

Simplified Microprocessor Design *(Advanced Logic Design)*

Designed a simplified microprocessor using the block diagrams provided in the lab manual. Used the given structural hierarchical design method to implement within each individual sub design using Verilog. Created a test bench simulation of the top-level microprocessor data path design.

Professional Activities & Honors

Member, Tau Beta Pi, LSAMP, MEP, *IEEE,* Math Honor Society

TAHMINA JURAT

PROFILE

Dedicated and motivated electrical engineering student seeking entry level positions/internships that will expand my knowledge with working on microprocessor designs, robotics, circuit and signal analysis, and embedded systems.

EDUCATION

Bachelor of Science in Electronics and Electrical Engineering **May 2022**
California State University, Sacramento

Associate of Science **Jan 2020**
American River College

EXPERIENCES

Tutor – American River College **Feb 2019-Sep 2020**

- Tutor math, Science, and engineering
- Provided one-on-one and group tutoring instruction for over 50 students.

Student Assistant – American River College **May 2018-Sep 2018**

- Prepared bulletin boards, classroom materials and individual student portfolios to support teacher plans.
- Performed a wide range of simultaneous job tasks to support professor's academic, research and operational needs.

TECHNICAL SKILLS

- MATLAB/ Simulink
- Python
- C/C++
- Analog Discovery 2
- Multisim
- Microsoft office
- Raspberry pi
- Arduino
- Oscilloscope

Deepak Sharma

PROFESSIONAL SUMMARY

Dynamic and motivated entry-level professional with proven ability to adapt and multitask in the workplace as well as communicate effectively. Experienced in customer care, computer programming, and restaurant operation. Punctual and reliable; willing to learn and expand professional skills.

SKILLS AND ABILITIES

- Solid work ethic—dependable, trustworthy, energetic
- Excellent verbal and written communication
- Skilled in Microsoft Office Suite including Excel
- Experienced in Programming C++, Java, Python, HTML, CSS
- Excel at effective, positive communication
- Personable and professional with both employees and customers
- Team player with the ability to work well independently and under pressure
- Excellent critical thinking and problem solving skills
- Well organized and can effectively multitask while maintaining accuracy
- Take interest and pride in work; completes all projects with integrity

WORK EXPERIENCE

Window Installer, *Truck Accessories Group,* Woodland, CA 07/2020-08/2020
Analyze campers on assembly line for dents or scratches, provide the proper windows and install them into the camper.

Delivery Driver, *Mothership LLC,* Elk Grove, CA 07/2019-09/2019
Provide excellent customer service and push sales and increase customer retention. Answer questions regarding products and services and provide customers with knowledge of new and incoming products.

Courtesy Associate, *Fry's Electronics,* Sacramento, CA 05/2018-05/2019
Provide excellent customer service to drive sales and increase customer retention. Answer questions regarding products and services and maintain proven ability to curb loss prevention.

Personal Care Aid, *Carlton Plaza of Davis,* Davis, CA 07/2015-12/2018
Responsible for providing personal care with upmost integrity. Assisted individuals with activities of daily living to improve mobility, independence, and quality of life.

Restaurant Lead, *Picasso's Pizza.,* Woodland, CA 06/2014-12/2014
Ensure all restaurant operations run smoothly, train employees, manage schedules, responsible for money handling at the beginning and end of shifts, resolve customer complaints, adhere to food handling and employee safety regulations.

Catering Chef, *Aramark,* Hayward, CA 09/2013-12/2013
Estimate food consumption, prepare selected recipes, ensure equipment and operation and maintenance.

EDUCATION

- *California State University, Sacramento,* Sacramento, CA—**Bachelors of Computer Engineering**
  Expected Graduation Date: June 2022
- *Sacramento City college,* Sacramento, CA—**Transfer Studies**
  2014-2018

Appendix G. Vendor Contacts

We did not contact any specific vendor

Acknowledgement

We would like to thank all of our professors for guiding us through this project experience. We would like to thank Neal Levine, James Cottle, and Russ Tatro for all of your help. We have had the pleasure of receiving knowledge, insight, and experience through the struggles we had faced as a team. We would also like to give a massive thank you to Janee' Hardman and the Chemistry department for helping us devise a plan for testing our components. Without her massive knowledge of chemistry and the equipment, we would have never been able to effectively test our device. Thank you to all of you who have supported us throughout this project. You all have helped us learn so much throughout these two semesters.