GNG1103

Final Design Report

Submitted by:

AUTOMATION TEAM 2

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Abstract

The following report outlines the solutions implemented by the Automation 2 team for a representative of the Western Ottawa Community Resource Centre in the construction a modular home prototype. The project was constructed around the course curriculum of Engineering Design where as a team we studied and applied the design process to our project. The solutions were developed and integrated into the home over the course of the semester in between client meetings and consultations with our project manager and teaching assistant.

The report documents the design, prototyping and manufacturing process of the implemented systems and provides an in-depth analysis of the client needs, product specifications and project methodology. Technical documents and diagrams developed throughout the project can also be found in the appendix section report with appropriate explanations. The project was presented to the client and a panel of judges at the University of Ottawa's Design Day event on March 29th, 2019. A

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List of Acronyms

Acronym	Definition
RFID	Radio-Frequency Identification
LCD	Liquid Crystal Display
LED	Light Emitting Diode
SIM	Subscriber Identification Module
GPRS	General Packet Radio Service
PSU	Power Supply Unit
WIFI	Wireless Local Area Network
MDF	Medium Density Fibreboard
DC	Direct Current
AUTO	Automatic
AWG	American Wire Gauge

1 Introduction

In Ottawa, there exists a need for cheap housing that can be thrown up at a moment's notice. Many at risk groups such as the homeless or victims of domestic violence require such cheap houses, which is lacking in Ottawa at the moment. As a result, a solution to this problem under the form of cheap housing would be greatly beneficial at the moment.

The main customers would be the city and the police departments, as they are the main people interested and responsible in giving the homeless a roof and keeping victims of crime safe. It's principle users would be the previously mentioned victims and homeless who need temporary housing for a short period of time. Additionally, various environmental groups have taken notice and as a result, our solutions should be entirely green/environmentally friendly.

The reason our solution is superior is because in addition to utilizing electronics to augment several standard features (such as the lock), we also implemented several additional features to improve safety. Thus, the occupants of our solution will not only have a roof to sleep under, but they will feel safe as they do it.

2 Need Identification and Product Specification Process

Problem Statement and Overview of Task

The client requires the construction and design of modular homes for victims of domestic abuse and their children. The home needs to be cost effective, energy efficient, transportable and capable of housing up to four people. The home should be comfortable to live in for up to 2 months and necessities include clean water, lighting, bedding and heating. As the automation team, we have presented the following as possible solutions to addressing the clients needs.

Client Needs

The modular home must be transportable and easy to set up, in the context of automation this means all the wires and other connections must be on simple and easy to use interconnects that allow the structure to come apart.

Automatic water collection and filtration are a major aspect of the modular home and will be implemented by adding gutters and a cistern to the roof of the building, additionally snow melting may be considered for the winter. The water supply can also be automated by introducing automatic taps which would increase the water efficiency of the home and reduce waste.

Brightness and/or motion sensor controlled automatic lights will optimize the energy efficiency of the building, providing illumination for quality of life.

A Smoke and Carbon Monoxide detector will be installed and wired to the power system of the modular home for extra safety measures considering the most of the structure will be built of flammable materials.

Internet access is a basic human right that is often neglected and a small cellular-wifi modem that is hooked up to the solar power supply can provide a wifi network to the residence.

To ensure the resident's safety and to provide comfort, a panic button can be implemented. This button can be pressed to call the authorities in case of any sort of emergency.

The implementation of an automated thermostat would help to regulate temperature and limit the energy consumption of heating supply.

A basic doorbell will also be implemented to alert the occupant of a visitor. Depending on the financial constraints, a video doorbell could potentially be introduced so the resident is able to visually see her visitors prior to opening the door. This will ensure the resident is comfortable and secure in the home. As a final measure, an RFID door lock can also be implemented which will provide additional security capabilities

In total, the design for our client will suit the need of being a small modular home for victims of domestic abuse. Our role as the automation team will be to incorporate various automated mechanisms throughout the home to optimize the living experience, convenience, and safety of the home. The mechanisms are planned to be as cost effective as possible, portable, easy to use and have a fast installation.

Product Specification and Design Criteria

As the automation team, we created a list of design criteria to ensure that the client's needs are met efficiently and effectively. With these, we have included target specification of various possible solutions that we feel would meet the demands of the client.

Ease of use

The client expressed the need for the modular home to be easy to use, this means an untrained and unskilled person should be able to figure out how to use each feature of the home, set it up and pack it up, following a simple manual. Within the scope of this team, this means we will strive to use simple interconnects and strive to minimise the amount of work required to reach basic operation. Additionally, any non-essential or transient features should also be easy to use and documented in a manual.

Target Specs: Products have to be basic enough that anyone can use them just by looking at them. This means proper icons indicating the buttons and controls, and signs for what each product is specifically.

Transportability / Modularity

The modular home must be easy to relocate, this means that it must fit within volume and mass constraints when packed up. Furthermore, as mentioned above, it should be fast and easy to set up and pack. In terms of what is being done by the automation subteam, we will strive to make each system self-contained and easily storable if needed. It is also important to ensure each proposed solution is characteristically modular, this will allow for the client and the resident to customize the home to their specific needs. For example, removing the rain-water collection system during the winter.

Target Specs: Products have to have easy to use attachments to the home so that you are able to remove them and install them with ease. High quality crimps for easy attachments

Affordability / Scalability

Following the fundamental needs communicated by the client, the modular home should be low-cost and potentially scalable. Therefore the installation and implementation of the technologies used in the home must be effective and low-cost so that the fixed expense of each unit is minimized. In order to ensure this criteria is met, when drafting and proposing solutions, cost should be given main priority.

Target Specs: All components should be of decent, reliable quality, but remain cost efficient. Overall components need to be under $100 CAD.

Access to water

The client has noted that there is likely a water source capable of meeting most of the basic living needs. Should there be a shortage of access to water, a backup source must be engineered. It was determined that a rainwater collection system would be the most efficient way to address this need. Plumbing would also be a necessity.

Target Specs: Rainwater collection should be large and made with good build quality while at the same time being cost efficient and light enough to transport or remove with little effort.

Security / Safety

The target group for this modular home is individuals/families that suffer from domestic abuse and need a temporary place to stay. This puts safety security as a top priority in the automation group to make the people who live in the modular home feel safe. This means that our goal will be to make solutions to this need within the restrictions of how the products will be built. It was concluded that a smoke/carbon dioxide detector and a door lock are at our top priority for the safety of our clients. Other products that will possibly be implemented include a panic button and a doorbell with the additional security of a video camera that the resident can monitor, in order to ensure safety further.

The safety and security products have to be implemented into the house, keeping in mind the ability to install them with the possible power limitations that are given. Although this is an easy fix as the products like the camera and security button can be powered by portable batteries that can be easily bought at a cheap price when replacement is needed.

Target Specs: Our products for safety make are very easy and clear to use in case of an emergency and all compliment the person's safety who is staying at the house. A card reading solenoid lock would be ideal if possible with resources.

General Comfort

Occupants require basic amenities in order to live in the house, such as a bed, running water, heating, electricity and possibly internet connection. Some are more important than others, while others may or may not be removed due to factors such as insufficient power and/or design constraints. However, it goes without saying that the more amenities are present, the better it will be for the client/occupant.

The primary limitation for amenities will be the energy available. Heating water requires significant amounts of energy, which in turn limits water-based amenities such as showering and other general hygiene. Other significant energy hogs include space heating, whose energy cost will depend on how competent the construction team is. (yet to be determined)

While amenities should be implemented into the house, they should be implemented in ways that make the most out of available energy. Efficiency can be improved via the use of

sensors to detect occupancy; examples include not heating the house when there is no one present, turning off unnecessary lights, and using low energy devices.

Target Specs: Our products will make the resident feel intuitive and comfortable in their own home. Having possible motion sensing lights will be a must which just depends on how much power is available.

3 Conceptual Designs

Introduction

We met with the client for the second time and were able to converse and receive feedback over the various ideas that we had brainstormed. The client indicated that water supply and plumbing system would be outside our domain of responsibility so that category has since been removed from our problem statement. This will allow us to focus more time and energy on delivering the other solutions to an exemplary standard.

The next stage of our design process is to begin conceptualizing the proposed solutions in order to prioritize each solution based off of feasibility, relevance and importance to objectives of the project. This document serves as a collection of rough and unpolished solutions for each specified subsystem.

Security

RFID Lock

The implementation of an RFID Lock Mechanism will allow the client to distribute access to the resident of the home simply by providing them with a programmed card. The RFID system will also mitigate the hassle that comes with a key and lock system should be lost.

The construction of an RFID Lock Mechanism is relatively simple and requires an Arduino Uno, RFID Module (including cards and tags), Solenoid, LCD Screen, Push Buttons, Door Handle, Battery Power Supply and various other electronic components.

The internal components will be housed within a laser-cut wooden casing which will be fully integrated into the door itself using screws and metal framing pieces. There were multiple different approaches to the actual locking mechanism. While a servo-powered lock was considered, a solenoid-powered lock was determined to be simpler and

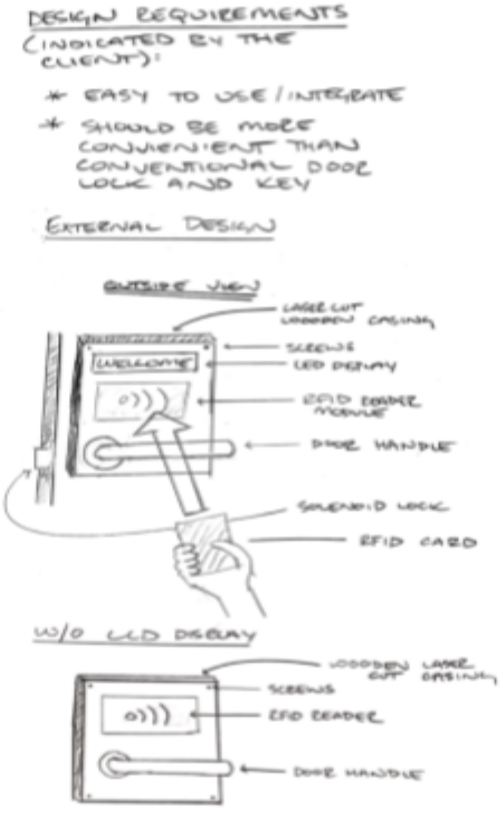


Figure 1. Outside View of RFID Door Lock

more energy efficient solution. A solenoid is a device which converts electrical energy into mechanical energy using a coiled wire and magnetic field. The solenoid will be engaged once the RFID reader recognizes the scanned card and the lock will be retracted granting access to the home.

The implementation of a wired push button on the inside of the home becomes necessary as the door handle will not mechanically be connected to the lock itself. Hence, a push button on the inside door handle will engage the solenoid and unlock the door. The location of the push button is a key design consideration as it needs to be located conveniently to make unlocking the door from the inside a seamless process. There were three proposed locations for the push button: above the door handle, integrated within the door handle and integrated into the wall beside the door handle. The most favourable location was determined to be above to the door handle as the other proposed solutions bring about circuitry complications.

We also discussed the implementation of an LCD Display that using the Arduino Uno could be used to translate on behalf of the RFID reader and display messages such as “Access Granted”, “Access Denied”, “Welcome Home” etc.

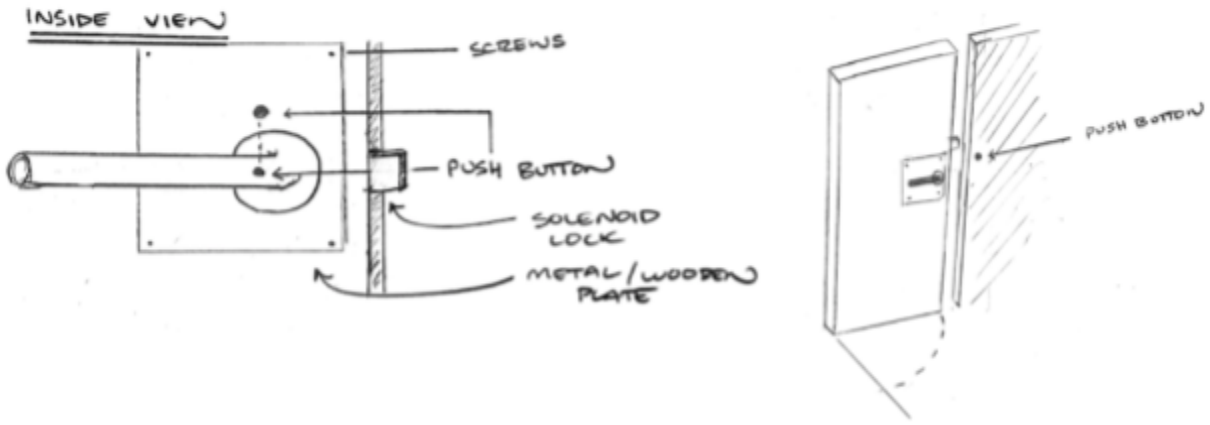


Figure 2. Inside Design of RFID Door Lock

Smoke Detector

Naturally, smoke detectors and carbon monoxide detectors will be installed as necessary safety features. They should remain operational 24/7 as their service is mandatory for the wellbeing of its occupants. Evidently, their power usage should be as low as possible. Upon triggering, they should be able to notify the fire department, either from a user prompt or automatically.

Installation of a smoke/CO detector will be on the ceiling of the modular home which is standard in most homes. It will be built with cost efficiency in mind and will have a sound system that will beep when smoke is detected. Usually, the smoke detectors use a bit of radioactive material between two plates and go off when the ion flow between the two plates from the smoke disrupts it. This would be hard to implement given our limited knowledge so we may

have to take the actual smoke detecting system from another smokes detector. Then we would automate it and design it according to our users in the modular home. We are aiming for it to run 24/7 and preferably have low power usage. This may be hard to make as a group but we will try our best as we know it is an essential piece of a home in terms of safety and wellbeing of the residents.

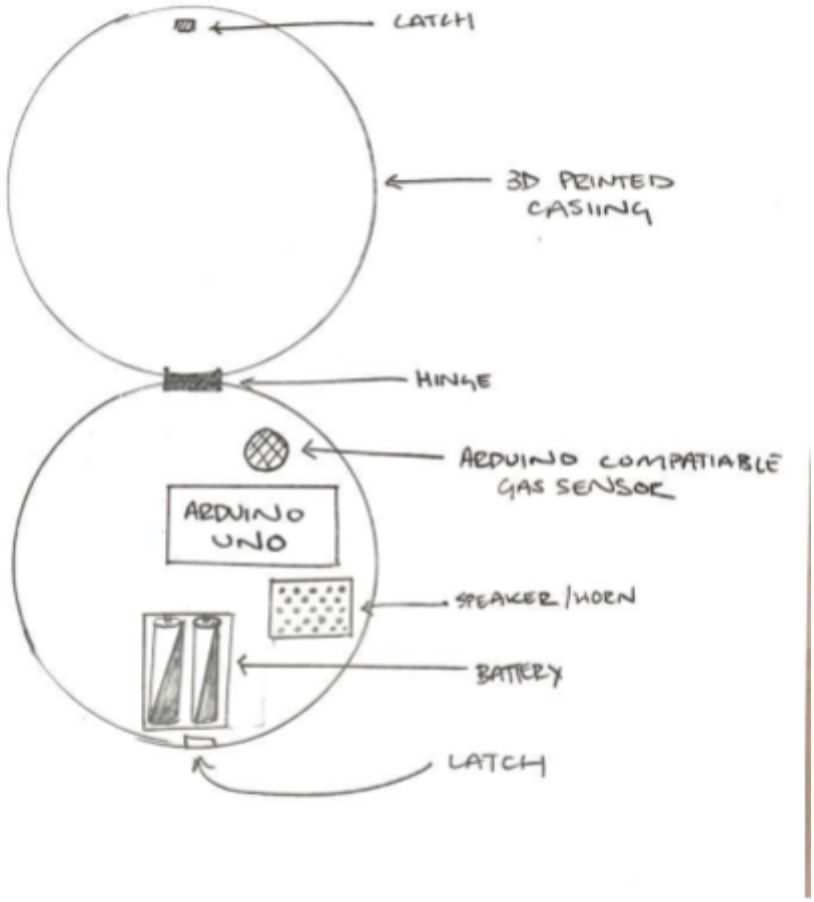


Figure 3. Smoke Detector Diagram

Video Doorbell

The video doorbell is an accessory idea that our group had in order to make the modular home safer and more secure. It allows the resident to see who is at their front door through a screen without having to peer through a magnifying hole or risk opening the door. This could prevent an intruder from knowing that the resident is home. It also gives the resident more time to act and be closer to the panic button if there was an un-welcomed visitor.

The way that we will implement the camera into the doorbell is we will either build a small solid mechanism to press an on/off switch on the video camera when the doorbell is

pressed and then the resident can turn it off after they have identified the person at the door from another solid mechanism within the house. Having this solid mechanism to turn the camera on and off may be more reliable with than having it all in wiring but may be hard to implement.

Depending on the budget, a more modern solution would involve implementing a Raspberry Pi Video Camera Module and an Arduino Uno. The system could also implement a proximity sensor that would control when the video displayed. The video display will also be triggered when the doorbell is rung.

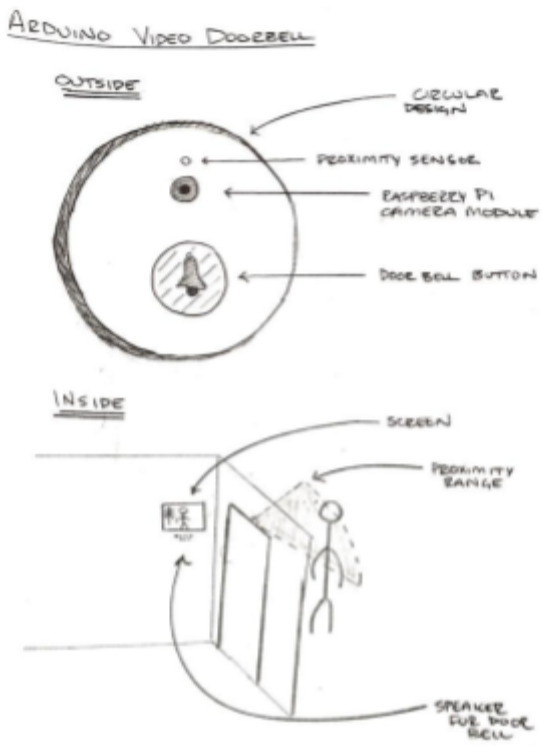


Figure 4. Video Doorbell

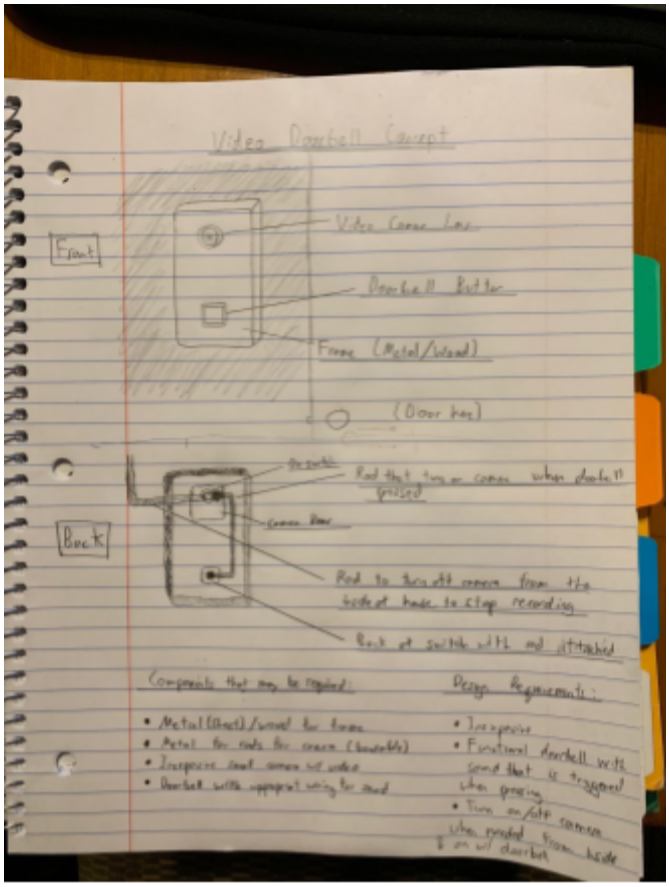


Figure 5. Video Doorbell (Mechanical)

Comfort

Panic Button

The panic button was is a device that our client expressed a keen interest in and therefore has been deemed a high-priority solution. The client indicated that it was essential for the button to be “childproof” and discrete in order to avoid false alarms and any potential paranoia.

These two comments were kept in mind during the design process as we took a holistic approach to design the visual aesthetic of the panic button. There were multiple key factors to consider such as the colour, symbol displayed and location of the panic button. We opted for the

actual colour of the button to be either gray, white, black or brown as this would be the least inviting to children. As for the symbol, we considered multiple different designs that we found online. The symbol needed to be subtle and friendly while still communicating the intended purpose of the button. Seen below are some of the symbols that we considered:

Figure 6. Different Symbol Designs

We determined that the designs shown above were either too alarming, too inviting or didn't communicate the intended purpose of the button. So, instead, we settled on the following design which we believe meets the design aspects we are looking for.

Figure 7. Final Panic Button Symbol

The system itself will be constructed using an Arduino Uno, Momentary Button Switch and various other electronic components. This will all be housed within a wooden box laser cut out of wood. The symbol will be laser-engraved into the frame of the box which will allow for the symbol to blend in well with the material whilst still being visible.

The box will be located below the ceiling and above the bed in order to prevent children from playing the device and making sure that the button is easily accessible should there be any disturbances at night.

Lighting

Internal Lighting

The lighting in the home will be optimized by a series of sensors in order to maximize efficiency and minimize wasted energy. High efficiency LED lights on strips will be used as the actual lights in order to get the most out of every joule put into lighting. Additionally, sliders will be implemented for the major lights in the house to allow the occupant to use only as much light is required. Finally, the lights will be highly segregated in order to allow only what is necessary to be turned on.

Automation of the lights will be used primarily to conserve energy. During the day an automated system will turn off all lights in the house automatically, and should the occupant turn on a light it will turn on with reduced power. Naturally, a manual override will exist should the occupant or others find it necessary. A motion sensor will also exist around the bottom of the bed so should the occupant choose to exit the bed at night, the key features of the house will automatically be lit up.

Installation of the lights will require careful but straightforward wiring to the power and optimization systems. LED strips can be purchased inexpensively on various online retailers, while sensors and processors required for automation may be obtained from hardware stores. Motion sensors are fairly cheap as well, while a few simple processors such as an Arduino can be used for the optimization system.

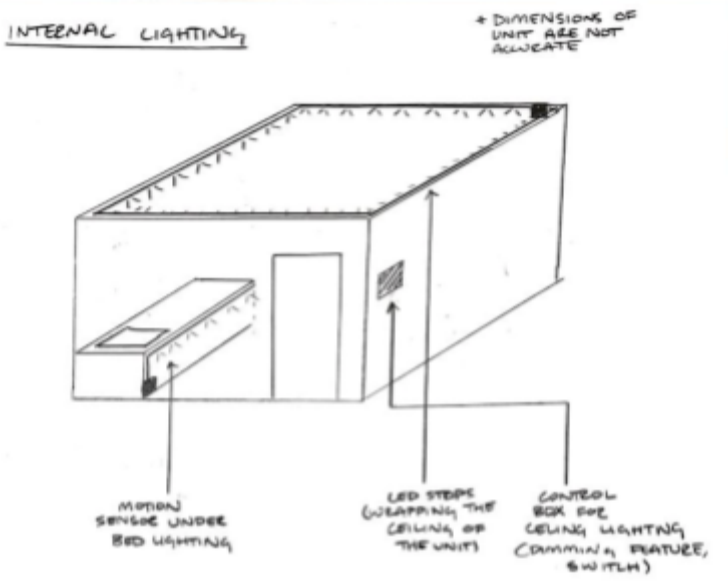


Figure 8. Internal Lighting

Porch Lights

Porch Lights will be present on the outside of the house near the entrances and/or key areas (windows, etc). Their function will be customizable from a control box on the inside depending on the security concerns of the occupant. Else, they could also be simply controlled by a simple switch on the inside while still being connected to the system which shuts off the lights during the day.

The purpose of these porch lights is to be automated to turn on when a resident or person walks near the house at night so they can see the door. This is essential in many homes mainly for safety reasons at night. Also, it makes the place more welcoming when a visitor is arriving in when it is dark.

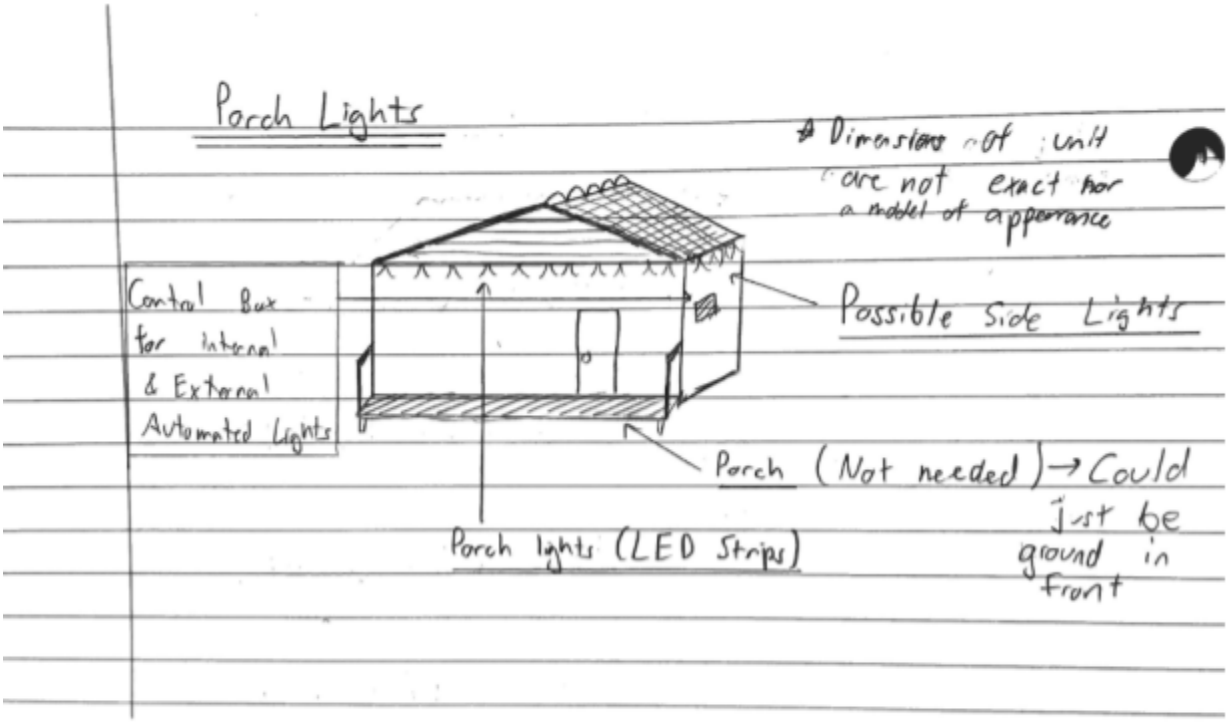


Figure 9. Porch Light Design

Our idea for the lights is to have a line of LED strips that will be installed on the corner of the roof and the front of the wall. We can also possibly implement automated LED strips on the sides of the house in the same area as well if resources are available for the scenario where someone needed to go behind the house and needed a bit of light.

To Conclude Conceptual Designs

These initial designs serve as a foundation for the more thorough and complete ideas in the future. In the coming weeks, we aim to reflect, revise and evolve these presented solutions. The next step in our design process is to begin looking at the circularity and to develop a cost analysis of each solution. There may need to be some benchmarking along the way in terms from a lack of financial resources, but we will maximize the resources at hand and create the most effective solutions products we can for the modular home.

4 Project Plan, Execution, Tracking & Bill of Materials, Benchmarking

The purpose of this section is to provide a basic overview of what costs can be incurred from our section of the project. Primarily, the objects that require a purchase are specialized objects that we cannot build ourselves, such as electronic locks, RFID chips, processors (Arduino) and more. This list is currently a rough outline of what needs to be purchased, but everything here is subject to change depending on how the situation develops as physical work begins. For the priority list, we have listed their importance on a scale from 1-5, 5 being the highest and 1 being the lowest importance.

Cost Analysis

Project	Priority	Material and Components	Cost	Link
RFID Lock	3	Electronic Solenoid Lock Assembly Door Lock	$11.38	https://www.ebay.ca/itm/DC-6V-12V-24V-Electronic-Solenoid-Lock-Assembly-Door-Lock-RFID-Cabinet
		Arduino Uno R3 Development Board Clone	$10.00	https://www.ebay.ca/itm/Arduino-Uno-R3-Development-Board-Clone-USB-Cable
		RFID Module	$2.54	https://www.ebay.ca/itm/MFRC-522-RFID-IC-Card-Inductive-Sensor-Module-S50-NFC-Card-Keyring-For-Arduino
		Door Handle	$9.35	https://www.ebay.ca/itm/Stainless-Rotation-Round-Door-Knobs-Handle
		Push Button	$0.36	https://www.digikey.ca/product-detail/en/schurter

				-inc
		Wires / Batteries	~$10.00	No Link
		Total:	$43.42	
Smoke Detector	5	Kidde Pro Series 120V Hardwire Smoke Alarm with Hush Button and Battery Backup	$19.95	https://www.homedepot.ca/en/home/p.pro-series-120v-hardwire-smoke-alarm-with-hush-button-and-battery-backup.1000144259.html
		Total:	$19.95	
Panic Button	4	SIM card	$0.99	https://www.ebay.ca/itm/Bell-Mobility-SIM-Card
		Arduino Uno	$10.99	https://www.ebay.ca/itm/Arduino-Uno-R3-Development-Board-Clone-USB-Cable
		GSM GPRS Module	$18.99	https://www.ebay.com/p/1x-Sim800-GSM-GPRS-Module
		Coin Battery	$2.24	https://bbmbattery.ca/products/panasonic-cr2032-coin-cell
		Generic Switch Button	$1.80	https://www.aliexpress.com/item/10Pcs-5mm-Momentary-Push-button
		Wire / Batteries	~$10.00	No Link
		Total:	$45.01	
Wifi	3	3G/4G Wireless Router	$18.99	https://www.amazon.ca/

		WiFi Wlan Hotspot AP Client		Yosoo-Portable-Wireless-Hotspot-150Mbps/dp/B01AWBYMMI
		Rogers Data Only Plan	$10.00 per month	https://www.rogers.com/consumer/wireless/mobile-internet
		Total:	$28.99	
Doorbell	2	Water/weatherproof button (overkill but cheaper than a normal doorbell button)	$5.65	https://www.digikey.ca/product-detail/en/e-switch/RP8100B1M1CEBLKBLKNIL/EG4569-ND/1785728
		Buzzer	$0.82	https://www.digikey.ca/product-detail/en/soberton-inc/WT-1205/433-1028-ND/479674
		Total:	$6.47	
Lights	5	LED strips		https://www.amazon.ca/Activated-Illumination-Automatic-Adjustable-Staircase
		Total:	$18.99	X2 if we need more
Porch light	2	LED strips		https://www.amazon.ca/MoKo-Flexible-Waterproof-Wardrobe-Basement
		Total:	$18.99	
		Overall Cost:	$181.82	
		Money Available	$100	
		Difference:	- $81.82	

Benchmarking and Metrics

After extracting our design criteria from the needs identification and developing initial solutions to the clients needs. We begun judge and measure the feasibility, viability and importance of each solution through benchmarking. This process was started by translating our design criteria and overall project limitations into functional and non-functional requirements as well as constraints which can be seen below:

Constraints	Functional Requirements	Non-Functional Requirements
Estimated Size	Safety	Visual Aesthetic
Estimated Weight	Security	Environmentally Friendly
Power Consumption	User Friendly	Maintainability
Cost	Modularity	Reliability
	General Comfort	Weather-Resistance

Once we established our the above criteria, we begun to layout our benchmarking table that looked at all of the proposed solutions and tallied the success of each solution against the specified category before summing the scores of each solutions. Our defined importance scale was from 0-5 (negative to positive); this range was selected to ensure that the calculated results are accurate while still providing differentiation between the results. A ‘-’ symbol is given to categories that the specified metric is not applicable and provides a maximum score. The benchmarking tables can be seen below:

RFID Lock

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	4 x 6 x 3 (in.)	4	20
Est. Weight	**2**	6~8 lbs	4	8
Power	**4**	-	3	12
Cost	**5**	$43.42	0	0
Functional Req.				
Safety/Security	**5**	5	5	20
User Friendly	**3**	5	5	15
Modularity	**3**	5	5	15
General Comfort	**3**	5	5	15
Non-Funct. Req.				
Visual Aesthetic	**2**	4	4	8
Environmentally Friendly	**1**	3	3	3
Maintainability	**2**	3	3	6
Reliability	**4**	4	4	16
Overall				138

Smoke Detector

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	4	4	16
Est. Weight	**2**	4~5 lbs	5	8
Power	**4**	-	3	12
Cost	**5**	$19.95	3	15
Functional Req.				
Safety/Security	**5**	5	5	20
User Friendly	**3**	-	5	15
Modularity	**3**	5	5	15
General Comfort	**3**	-	5	15
Non-Funct. Req.				
Visual Aesthetic	**2**	2	2	4
Environmentally Friendly	**1**	2	3	6
Maintainability	**2**	2	3	6
Reliability	**4**	5	4	20
Overall				152

Panic Button

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	3 x 3 x 2 in.	5	20
Est. Weight	**2**	6~8 lbs	5	8
Power	**4**	-	3	12
Cost	**5**	$45.01	1	5
Functional Req.				
Safety/Security	**5**	5	5	25
User Friendly	**3**	5	5	15
Modularity	**3**	4	4	12
General Comfort	**3**	5	5	15
Non-Funct. Req.				
Visual Aesthetic	**2**	2	2	4
Environmentally Friendly	**1**	2	2	2
Maintainability	**2**	2	2	4
Reliability	**4**	5	3	15
Overall				137

Wifi Module

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	2	2	10
Est. Weight	**2**	10+ lbs	2	4
Power	**4**	1	3	4
Cost	**5**	$28.99	3	15
Functional Req.				
Safety/Security	**5**	1	1	5
User Friendly	**3**	4	4	12
Modularity	**3**	4	4	12
General Comfort	**3**	4	5	20
Non-Funct. Req.				
Visual Aesthetic	**2**	1	1	2
Environmentally Friendly	**1**	0	0	0
Maintainability	**2**	2	2	4
Reliability	**4**	1	1	4
Overall				88

Doorbell

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	5	5	25
Est. Weight	**2**	2	2	4
Power	**4**	-	3	12
Cost	**5**	$6.47	3	15
Functional Req.				
Safety/Security	**5**	2	2	10
User Friendly	**3**	5	5	15
Modularity	**3**	2	2	6
General Comfort	**3**	4	4	12
Non-Funct. Req.				
Visual Aesthetic	**2**	1	1	2
Environmentally Friendly	**1**	2	2	2
Maintainability	**2**	2	2	4
Reliability	**4**	4	4	16
Overall				112

Lights

	Importance	**Solution:** RFID Lock	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	-	5	25
Est. Weight	**2**	-	2	4
Power	**4**	2	2	8
Cost	**5**	$18.99	3	15
Functional Req.				
Safety/Security	**5**	1	1	5
User Friendly	**3**	5	5	15
Modularity	**3**	0	0	0
General Comfort	**3**	3	3	9
Non-Funct. Req.				
Visual Aesthetic	**2**	1	1	2
Environmentally Friendly	**1**	1	1	1
Maintainability	**2**	1	1	2
Reliability	**4**	2	2	8
Overall				94

Porch Light

	Importance	**Solution:** Porch Light	**Score**	**Score X Importance**
Constraints				
Est. Size	**5**	5	5	25
Est. Weight	**2**	2	2	4
Power	**4**	1	2	4
Cost	**5**	$18.99	2	10
Functional Req.				
Safety/Security	**5**	1	1	5
User Friendly	**3**	5	5	15
Modularity	**3**	0	0	0
General Comfort	**3**	2	2	6
Non-Funct. Req.				
Visual Aesthetic	**2**	0	0	0
Environmentally Friendly	**1**	0	0	1
Maintainability	**2**	1	1	2
Reliability	**4**	2	2	8
Overall				80

Overall Score

After measuring each solution, we compared the results of the benchmarking and ranked them accordingly. We then excluded the solution that received the lowest score after benchmarking. As seen below, the porch light was eliminated from our final selection of solutions. This determination was not only based off of the data collected from the benchmarking but the porch light was also the specific solution that was forcing us to exceed our allocated budget. Therefore, going forward, we would discontinue the development of this solution

	Porch Light	Lights	WIFI	RFID	Panic Button	Doorbell	Smoke Detector
Score	80	94	88	138	137	112	152

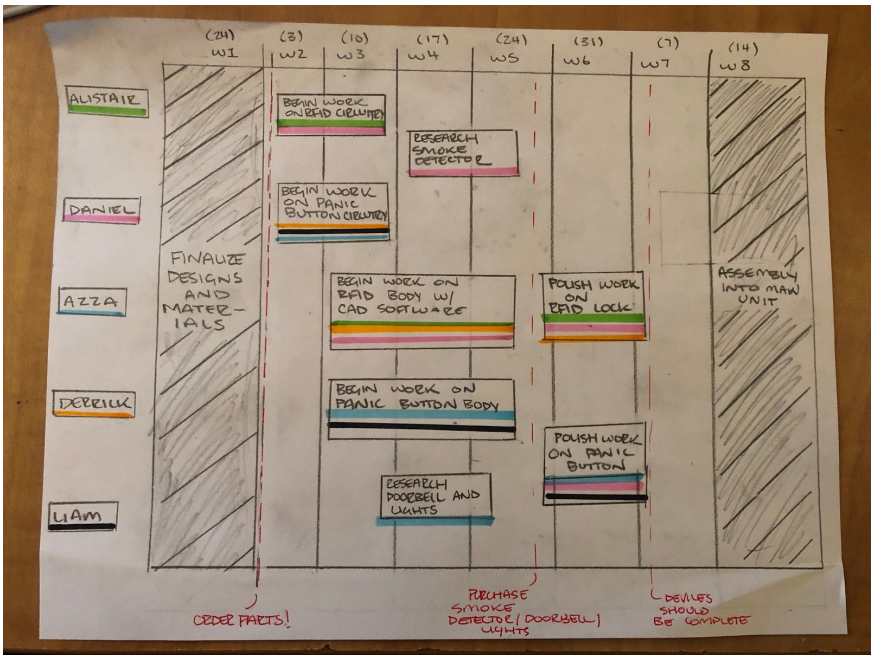
Final Cost Analysis

Project	Material/Components	Cost
RFID Lock	Solenoid (Mar 11-20)	$23.02
	Arduino Uno	~$20
	RFID Module	$5.49
	Relay	
	Total Cost	~48.51
Smoke Detector	Smoke Detector	$4.16
	Total Cost	$4.16
Siren	Siren (Mar 4-22)	$15.29
WIFI Router	WIFI Router	$18.99
	Total Cost	$18.99
Interior Lights	LED Lights	$10.31
	Motion Sensor (Easier)	$13.99
	Total Cost	$24.30
Wires	Black Wires	$4.16
	Red Wires	$4.16
	Total Cost	$8.32
PSU	PSU or Amazon Better PSU	$14.70
	Total Cost	$14.70
Total Cost:		$93.49

Project Schedule for Late February to March

MARCH 2019						
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
In-Person Meeting Review: - designs required - materials - order materials					1	2
In-Person Meeting Review: - assign project work through the group	4	5	6	7	8	9
10	11	12	13	14	15	16
In-Person Meeting Check-in meeting	BEGIN WORK ON PHYSICAL WORK ON PROJECT (CIRCUIT DESIGN AND MAIN BODY CONSTRUCTION OF DEVICES)					
In-Person Meeting Check-in meeting	WORK ON PHYSICAL WORK ON PROJECT (CIRCUIT DESIGN AND MAIN BODY CONSTRUCTION OF DEVICES)					
In-Person Meeting Check-in meeting	WORK ON PHYSICAL WORK ON PROJECT (AESTHETICS AND FINISHING TOUCHES)					

GANTT DIAGRAM



Risks

Wifi

1. *There could be a weak signal depending on the location of the house*
   SOLUTION: - nothing we can do about this
2. *Power outlet may not be that strong for wifi from the solar*
   SOLUTION: - use a wifi router that needs very little power

Smoke detector

1. *Power ran out*
   SOLUTION: - finding one that runs on batteries in case that power runs out

Doorbell

1. *button needs a very hard press to work*
   SOLUTION: - getting a button that has a low amount of tension to push it down

Internal Lights

1. *power ran out*
   SOLUTION: - designing a battery backup in case that the power stops running
   SOLUTION: - if no backup, having a flashlight/battery powered night light

RFID lock

1. *Parts malfunctioning/installation messed up*
   SOLUTION: Test out the lock before installing it, multiple times
2. *Keycards lost/desynced*
   SOLUTION: Make key cards easily reprogrammable/multiple on hand

Panic button

1. *False alarms sent out by accident*
   SOLUTION: Do not set it up to call automatically, prompt user instead where to call
   SOLUTION: Cover button with a case that can be easily lifted/broken with a nearby tool, but prevents accidental button presses

Porch Light

1. *Power ran out*
   SOLUTION: backup battery if the power goes out just like the internal lights.

5 Analysis

The first step in our analysis of our expected solutions was figuring out what exactly we can produce with the budget kept in mind and still produce valuable products that meet most of the clients needs that she expressed to us. Reviewing the cost analysis, we noticed earlier that we were much over budget so when we benchmarked, we got rid of some of our less significant solutions.

As shown in the figure above, based on our benchmarking of importance, we decided to get rid of the two main solutions that we thought were not as important which put us at a steady price.

Calculations, formulas and data collection before construction:
Current Draw

First the current draws of each subsystem must be identified. The following table was gathered from datasheets and product information.

Subsystem	Current Draw
Fire Alarm	0A (Internal Supply)
Panic Siren	320mA
Door Strike Solenoid	240mA
Led Lights	0.1A/30cm * 2m = 0.66A
Total:	1.22A

Therefore it was determined that a power supply capable of supplying 1.22A at 12V (As all of the systems run on 12V). Using the power formula P=I*V gives a maximum power draw of just under 15W.

Wire Gauge

Knowing the maximum current of 1.22A the following chart can be used to select an appropriate gauge for all the automation systems. Since the wire lengths will all be less than 14ft and the absolute maximum current is only marginally larger than 1A, 22AWG is selected as the size to be used.

Wire Gauge	Current Draw in Amps (12 Volt System, 2% Drop)																					
	1	2	3	4	5	7.5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	
22	14.4	7.2	4.8	3.6	2.9	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
20	23.0	11.5	7.5	5.5	4.5	3.0	2.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
18	36.5	18.3	12.2	9.1	7.3	4.9	3.7	2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	
16	57.5	28.8	19.2	14.4	11.5	7.7	5.8	3.8	2.9	x	x	x	x	x	x	x	x	x	x	x	x	
14	92.0	46.0	30.7	23.0	18.4	12.3	9.2	6.1	4.6	3.7	3.1	x	x	x	x	x	x	x	x	x	x	
12	x	73.5	49.0	36.8	29.4	19.6	14.7	9.8	7.4	5.9	4.9	3.7	x	x	x	x	x	x	x	x	x	
10	x	x	78.0	58.5	46.8	31.2	23.4	15.6	11.7	9.4	7.8	5.9	4.7	x	x	x	x	x	x	x	x	
8	x	x	x	93.0	74.4	49.6	37.2	24.8	18.6	14.9	12.4	9.3	7.4	6.2	5.3	x	x	x	x	x	x	Max Length
6	x	x	x	x	x	78.7	59.0	39.3	29.5	23.6	19.7	14.8	11.8	9.8	8.4	7.4	6.6	5.9	x	x	x	of Wire in
4	x	x	x	x	x	x	94.0	62.7	47.0	37.6	31.3	23.5	18.8	15.7	13.4	11.8	10.4	9.4	x	x	x	Feet
2	x	x	x	x	x	x	x	99.5	74.6	59.7	49.7	37.3	29.8	24.9	21.3	18.7	16.6	14.9	9.9	x	x	
1	x	x	x	x	x	x	x	x	94.3	75.4	62.8	47.1	37.7	31.4	26.9	23.6	20.9	18.9	12.6	9.4	x	
1/0	x	x	x	x	x	x	x	x	x	95.2	79.3	59.5	47.6	39.7	34.0	29.8	26.4	23.8	15.9	11.9	x	
2/0	x	x	x	x	x	x	x	x	x	x	100.0	75.0	60.0	50.0	42.9	37.5	33.3	30.0	20.0	15.0	12.0	
3/0	x	x	x	x	x	x	x	x	x	x	x	94.5	75.6	63.0	54.0	47.3	42.0	37.8	25.2	18.9	15.1	
4/0	x	x	x	x	x	x	x	x	x	x	x	x	95.2	79.3	68.0	59.5	52.9	47.6	31.7	23.8	19.0	

Max Length Per Given AWG and current

(From https://info.waytekwire.com/blog/automotive-wire-gauge-guide/)

Estimated Run Time and energy usage

The runtime for these systems was also estimated, the following table is an estimate of runtime of each system and its power draw. The formula C=P*T was used to calculate the last column.

Subsystem	Power Draw	Runtime per day	Capacity usage/day
Panic Siren	3.84W	0h (Emergency Only)	0Wh
Lights	7.94W	~8h	63.52Wh
Door Solenoid	2.88W	24h	69.12Wh
Total	~	~	132.64Wh

The total battery capacity draw was calculated to be ~135Wh per day. The battery has a capacity of:

140Ah capacity * 24v battery voltage * 0.5max discharge = 1680Wh.

And the solar panel replenishes the battery at:

260W solar output * 8h of operation * 50% efficiency = 1040Wh per day.

It was determined that the automation system uses 133/1040 = 13% of the available power generation of the shed, and 133/1680 = 8% of total power storage everyday.

6 Prototyping, Testing and Customer Validation.

Prototype 1

This is a compilation of the prototypes completed for our design project thus far. The purpose of the prototypes shown are mostly to address our objectives of security and comfort for our user. After additional testing and feedback from project supervisors, these prototypes will be refined into secondary prototypes and finally into finished models.. The mentioned prototypes

include; a panic button, RFID Lock, automatic lights, and a doorbell. Their purpose and function will then be briefly explained.

Panic Siren

The panic button will be a simple circuit where a switch is attached to a siren. Pressing the button will complete the circuit and allow the siren to activate, which will cause a sound that should scare away potential intruders and alert nearby people to the situation. To prevent false alarms, the button will be stored in a glass case which can be bypassed easily, but will prevent accidental button presses. As the circuit is incomplete without the switch being pressed, the full system will not consume any energy while the button is not pressed.

To ensure that the siren stays on after it is pressed, the button will activate a latch to keep the siren on until a second button is pressed to deactivate the siren.

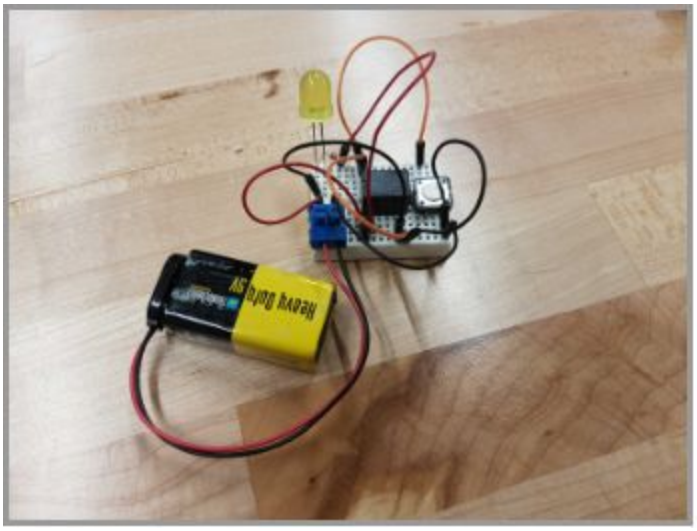


Figure 9. Panic Siren Prototype

RFID Lock

The photo below is our initial prototype of our RFID lock system for the modular home. The RFID lock uses an arduino and an RFID reader module. The RFID reader module gives a unique number or hexadecimal value for each key tag. Once the key tag is placed again the reader, the arduino then compares it and send a signal to a relay module.

In the next prototyping stage, we will implement the solenoid lock. The relay module will be attached to the solenoid lock so that when the RFID reader module is stimulated, the relay module activates the solenoid lock to unlock the door.

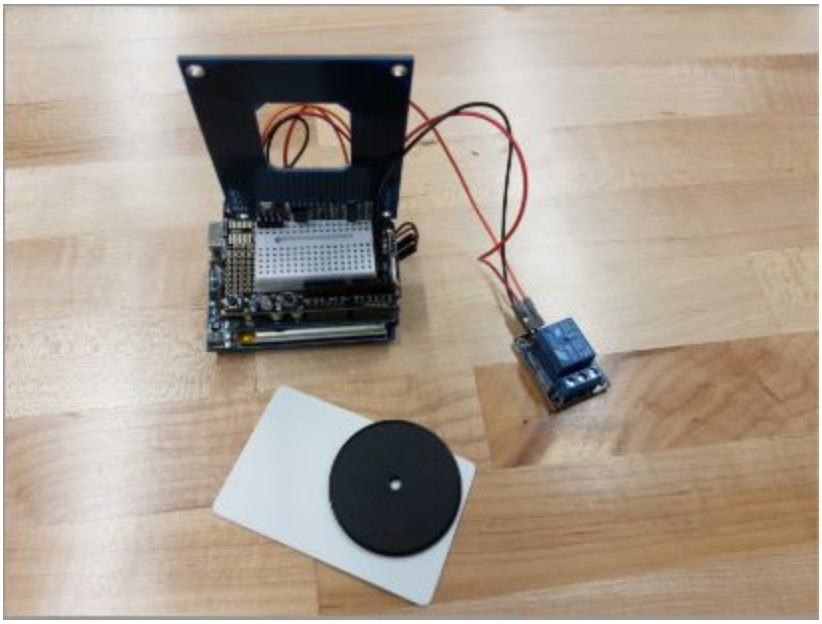


Figure 10. RFID Prototype

Smoke Detector / WIFI

We were unable to make prototypes for the smoke detector and WIFI modems as these devices will be purchased.

Automatic Lights

The prototype for our automatic lights can be seen below. The automatic lights use a PIR motion sensor module which will be connected to a relay which will be connected to our lights and switches for manual override (not seen in photo below). We used a yellow LED to simulate the relay that is connected to the full LED light array as we do not have those components at this moment in time.

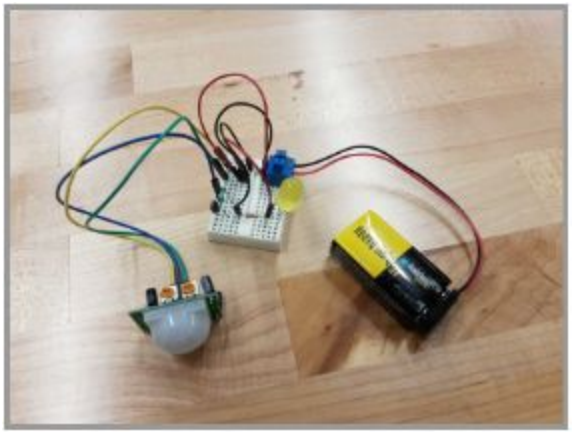


Figure 11. Automatic Lights Prototype

Doorbell

The doorbell system is similar to the panic button system, except instead of latching and keeping the doorbell on when the button is pressed, the doorbell will play a pre programmed sound when the button is pressed.

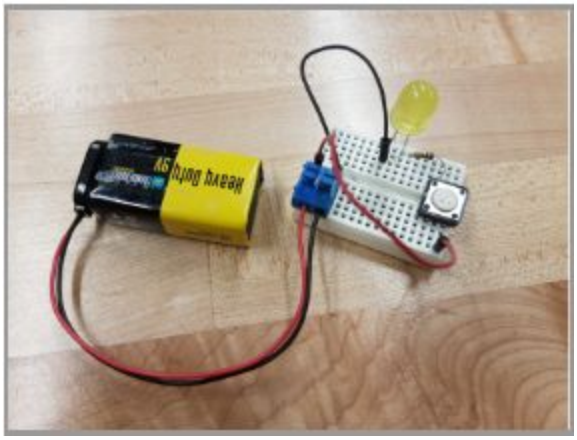


Figure 12. Doorbell Prototype

To Conclude the First Prototype

The mentioned prototypes will continue to be tested. A secondary prototype will then be created based on tests and suggestions from teammates and project supervisors. The prototypes so far were in working order and we expect the finished versions to be essential to the security and comfort of the user.

Prototype 2 & Customer Feedback

Introduction

Since the last prototyping stage, we have been focusing on how we are going to implement our devices and technologies into the home. This has involved designing cases for the RFID lock, doorbell, light switch and siren. We considered two major factors when designing the device cases: user-friendliness, aesthetic appeal and manufacturing efficiency. We wanted the cases to be easy and cheap to manufacture so we've decided to use laser cut them out of medium density-fibreboard and assemble them with gorilla glue. As for meeting the user friendliness and visual appeal criteria, we have included copyright-free vector icons on the panic alarm, light switch, RFID lock and doorbell. These icons serve to communicate how to use the device and what the purpose of the button, switch or sensor is. This ties back to our original mission statement as a team of prioritizing the comfort of the resident in the unit by eliminating any confusion or discomfort.

We have also met with the client for the final time to receive customer feedback and she indicated that she was more than happy with our progress. We have included any comments she made on anything into the relevant sections below.

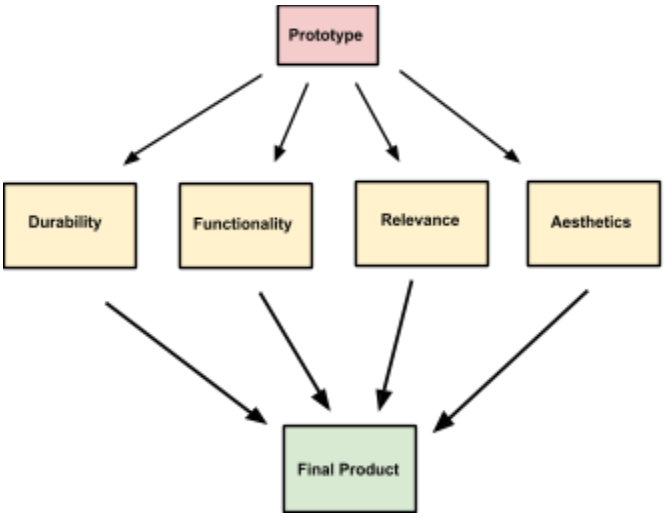


Figure 13. Prototype Test Plan

Prototyping Test Plan

The diagram on the left outlines our prototyping test plan. We defined four criteria that we are going to test our prototypes against.

1. **Durability**: The product's ability to withstand the pressures of time, weather and wear.
2. **Functionality**: The product should fulfill its intended purpose
3. **Relevance**: The prototype should be relevant to the needs of the client
4. **Aesthetics**: The product should be visually appealing and communicate its function effectively.

RFID Lock

The RFID Lock will be embedded near the door, in a box which will be laser cut from a board of MDF. The circuitry, schematics, and code for the lock are ready, however we are still waiting on the arrival of a solenoid to complete the lock. We have made some progress as we have created a box to hold the RFID lock and we are one week closer to the arrival of the solenoid to complete the lock.

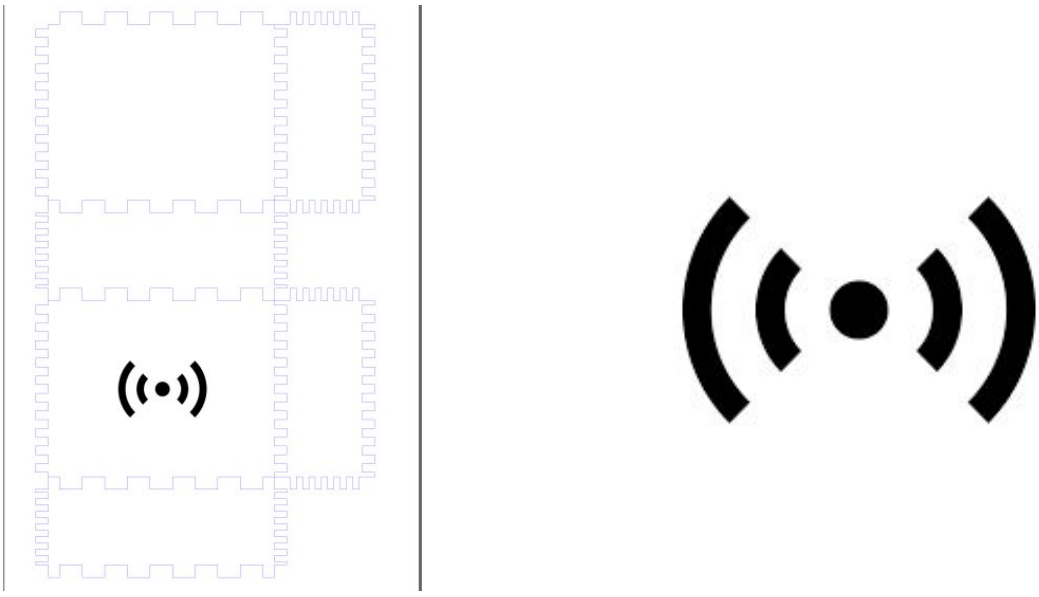


Figure 14. RFID Box Module

The design for our icon that will be engraved on our box is shown above. This symbol was the closest thing that we thought symbolized the RFID automated door lock. Overall for the RFID lock, our progress is going well, however, we are waiting for the solenoid to come. Once it comes, we will finalize our circuitry, try to make it compact, and then install it in the door when we have access.

Doorbell

In terms of our doorbell, with prototype 1, we have the basic design and circuitry for the doorbell to work perfectly, but we did not have the piece for the sound that goes off when the doorbell is pressed. This sound will be a generic sound and it is also arriving within the next few days along with our motion sensing lights. We have already made a few small adjustments for the circuit to work with the sound box that we are using so now all we need to do is test it. We are in the process of making the boxes for the doorbell and already have the measurements and design finished. We just need to gather the materials for all of our boxes and make them during the following week.

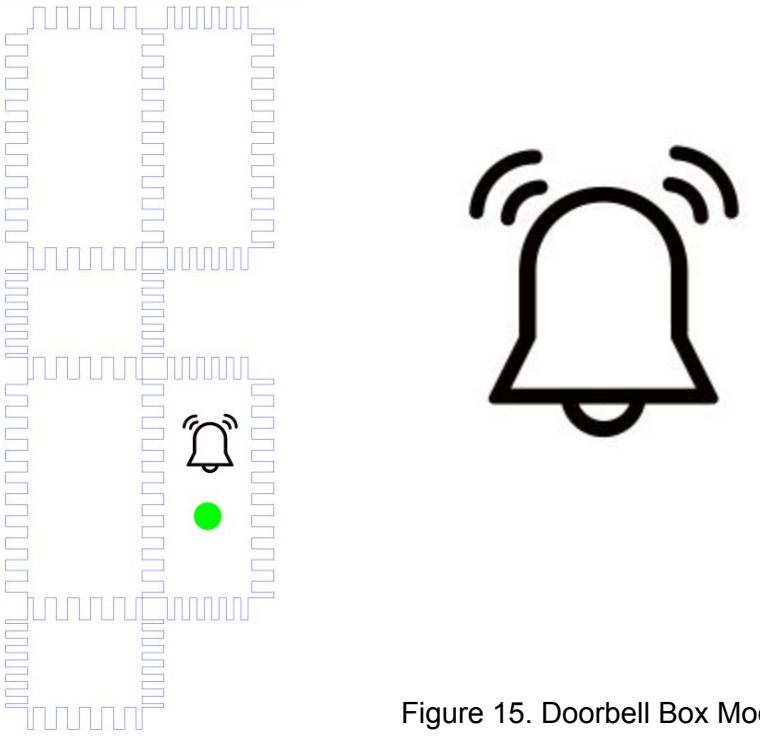


Figure 15. Doorbell Box Module

This icon that will be laser engraved into the doorbell box on the top is shown above. We decided on using this design because it communicates the purpose of the button simply and effectively. To sum our process since our last prototype of the doorbell, we are just going to finalize our internal design of the product when the sound box comes and then work on our installation of it as soon as possible into the home.

Motion Sensor Lights

Since the first prototype, in terms of the motion sensing lights, we are now transitioning to install the LED strips, but are still waiting for them to arrive from a online order. We are also in the process of making the box for the light switch and plan on laser cutting it within the next few days.

The icon that will be laser engraved into the top of the box for the lights will be as shown above. This is a universal symbol for a light and will make the box easy to distinguish from the other products that we are making. Overall, we just need to implement the LED strips into our circuit when they come in the next few days, and make the box where the lights will be stored and we are well on our way into our third and final prototype before finalizing it and making look as inviting and aesthetically pleasing as possible

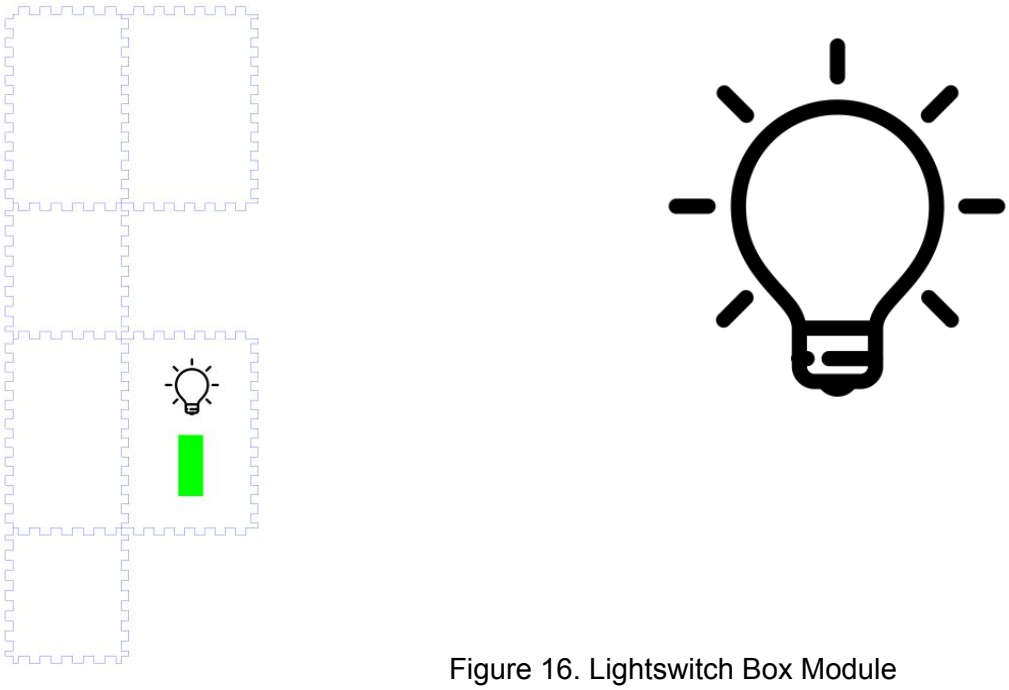


Figure 16. Lightswitch Box Module

Panic Alarm

During the third client meeting, the client expressed a keen interest in emitting the panic siren sound outside the modular home rather than having it go off inside. We have agreed on implementing this suggestion as we also think it will be more effective in alarming neighbours in case of an emergency. To add, we have finalized the design of our box and are planning on cutting it in the next few days along with the other boxes.

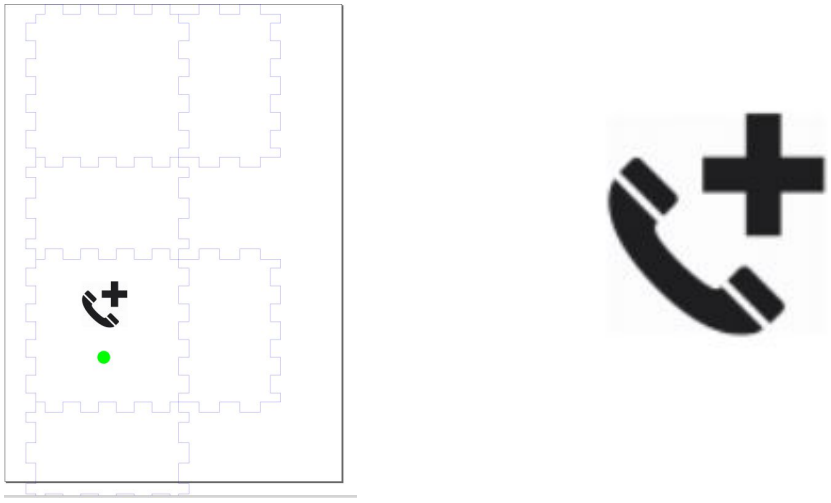


Figure 17. Panic Button Box Module

The icon for the panic alarm box is shown above and will be laser engraved into the top of the box. We found that this symbol was straight forward and appropriate for the panic siren. To sum up the next steps for this part of our project, we are working towards revising the wiring in our circuit to allow the alarm piece to be outside the home rather than inside. This may be financially demanding of a few extra dollars, but according to our cost analysis, we have some room to meet the 100$ budget so accommodating this modification shouldn't be a problem.

To Conclude the Second Prototype

Our objectives when designing these prototypes were to improve, aesthetic appeal, and manufacturing efficiency. As mentioned in the paragraphs before, we believe that our prototypes have done well to serve the client's purpose which is to create a comfortable environment for whoever decides to live in the home. The client expressed that the siren for the panic alarm would be better situated outside the home. We are working to make this adjustment. As a group, we have currently forecasted a prototype completion date of **March 22nd, 2018**. This will provide us with an ample amount of time to install the devices into the

home, proceed with any troubleshooting and be ready for the showcasing of the unit on Design Day.

Prototype III & and Customer Feedback

As we are in the final prototyping stage, we are now focused on finishing the final working versions of our prototypes. The purpose of these finished versions is to provide the most comfortable and secure environment for the user. A purpose that was made clear in our mission statement. This includes the RFID Lock, Doorbell, Motion Sensor Lights and the Panic Alarm. We have implemented features in our designs that contribute to our product's overall user-friendliness, aesthetic appeal and manufacturing efficiency. This was done in order to fulfill the user's criteria for our product. All designs and changes previously discussed are being finished while our main focus is currently the process of implementing our final prototypes into the house.

Prototyping Final Test Plan

The test plan for our third and final prototype is shown to the right. Since our prototypes are pretty much our finalized products that are in the process of being installed in the modular home, our test plan incorporates the process of how we are now implementing our prototypes in the structure and testing them to make sure that they are fully functional. We defined a performance criteria and that we must work towards now going into the finalized implemented products in the modular home. The product must perform consistently and accurately prior to integrating the system into the modular home. This will mitigate any issues and ensure that the devices are in an exemplary working condition once we install them into home.

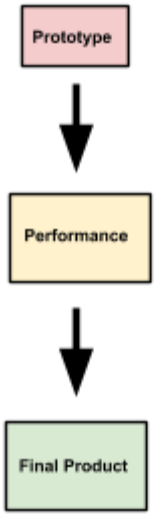


Figure 17. Final Test Plan Diagram

Final schematics for Prototype III

Shown below is the final schematics that will be implemented and perfected during the beginning of the upcoming week for each product that we are making for the house. Last steps of construction and modification are planned for the lab session and the installation should be done well before the design day towards the end of the week. There is 5 subsystems shown below, the first one and most major one for everything to be functional is the power supply. The next one is the simple schematics for the doorbell. The next one after that is the door lock with the RFID which is the most complex subsystem that we have. Lastly, there is the automatic lights and panic siren subsystems.

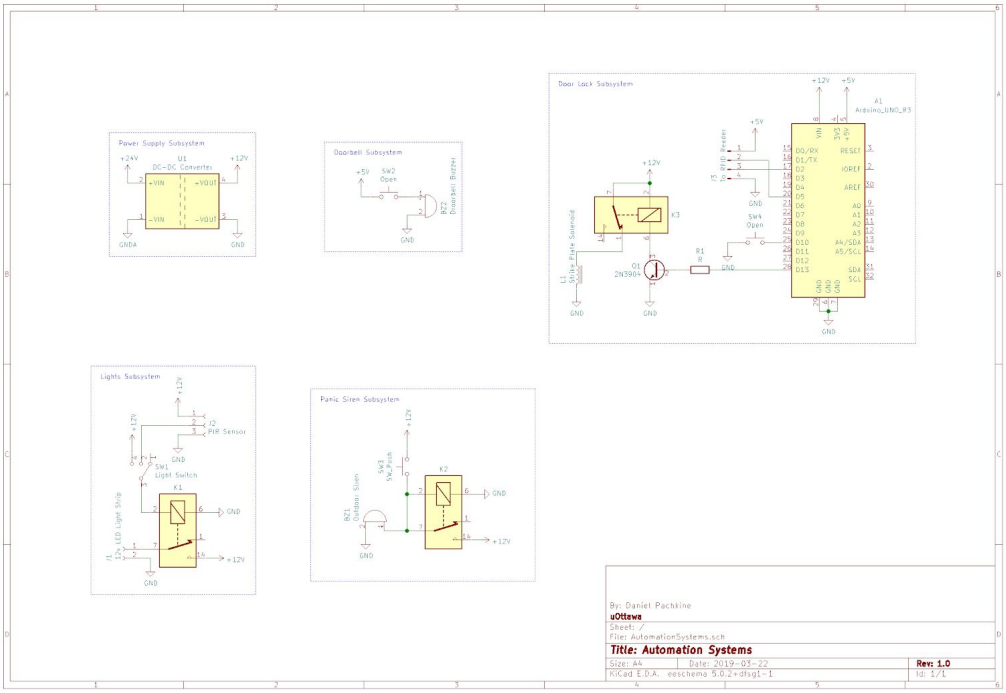


Figure 18. Electronic Schematics

Doorbell / RFID Lock

We decided to integrate the doorbell and RFID module into the same case. This decision was made as it would minimize the number of materials needed and simply the system for the user by aggregating both devices to the same location. There were no issues laser cutting and constructing the box enclosing the doorbell and RFID lock. As for the actual circuitry, it took some time to determine the necessary wire length to connect the two systems. However, once

we got a general idea of the physical size of the two systems, we were able to get a reliable gage on the required wire length. We also ran tests on the doorbell to make sure that the volume was sufficient. Going forward, we plan to complete our prototyping plan by testing the performance and integrity of the RFID lock and doorbell. Once we complete this stage, we will begin to integrate both systems into the home. We have established communications between the construction team and they are aware that we need the door hinged in a certain way in order to have room to install the RFID module and doorbell.

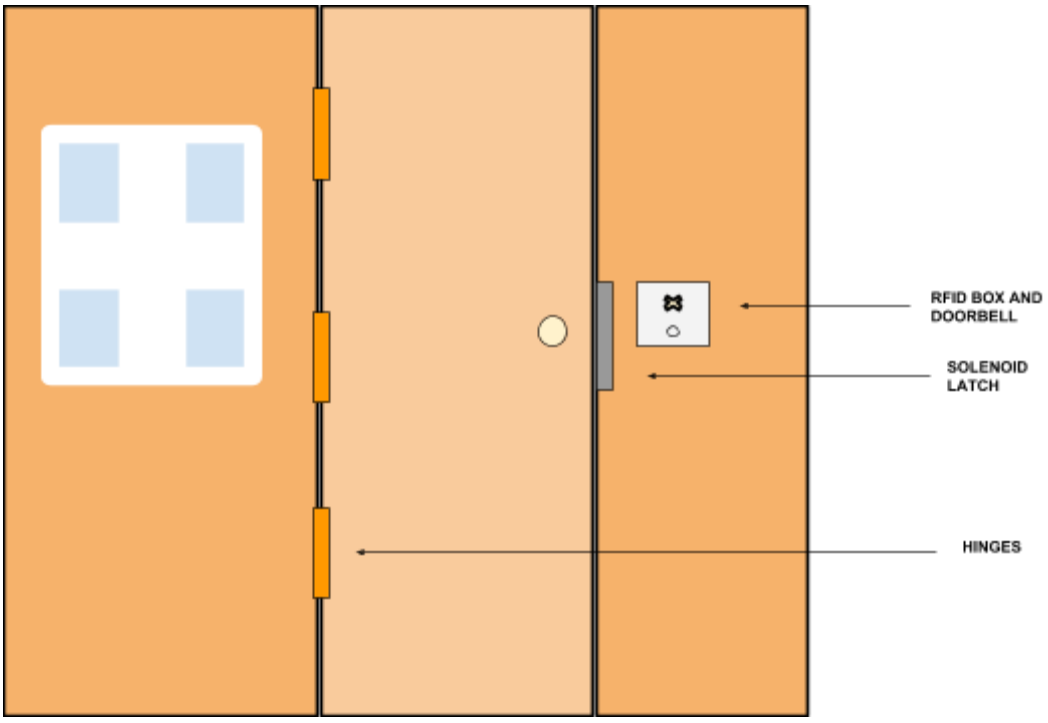


Figure 19. Implemented Mock-Up Drawing of RFID Lock

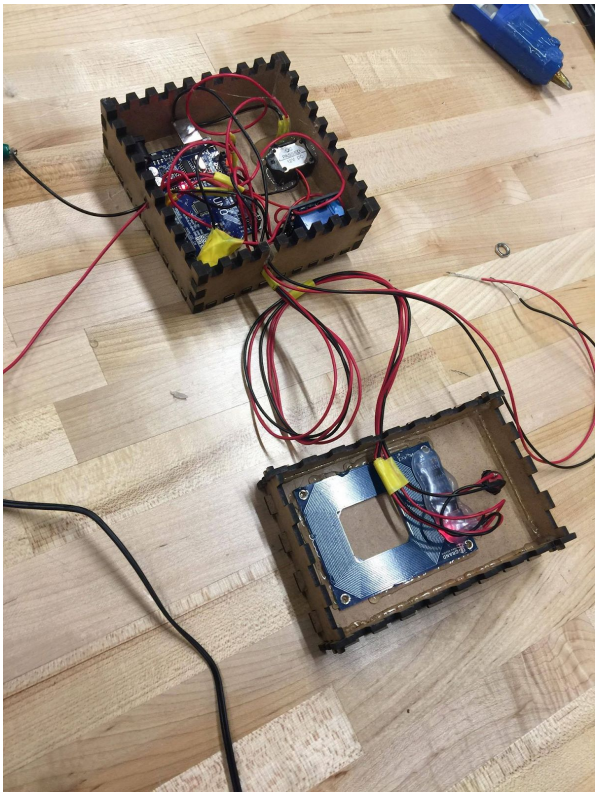


Figure 20. Photo Inside of the Final RFID Prototype

Motion Sensor Lights

The box for the light switch has been laser cut and assembled and the LED strips. The lightbulb icon engraved in the enclosing box is there to clearly communicate the light switch's purpose and to distinguish it from the other products we're making. We are now currently focused on installing the lights directly into the home. Final tests have been run showing that the LED lights are in working order. We are now communicating with construction so that the implementation of the lights can be done as smoothly as possible. Installation of the lights should not take too long once the switch components have been installed in its box, the job simply consists of attaching the lights and the switch box to the structure. Wiring up the entire system will be the last task before this project can be considered to be finalized and in working order. All things considered, the motion sensor lights are well on track to be completed before Design Day.

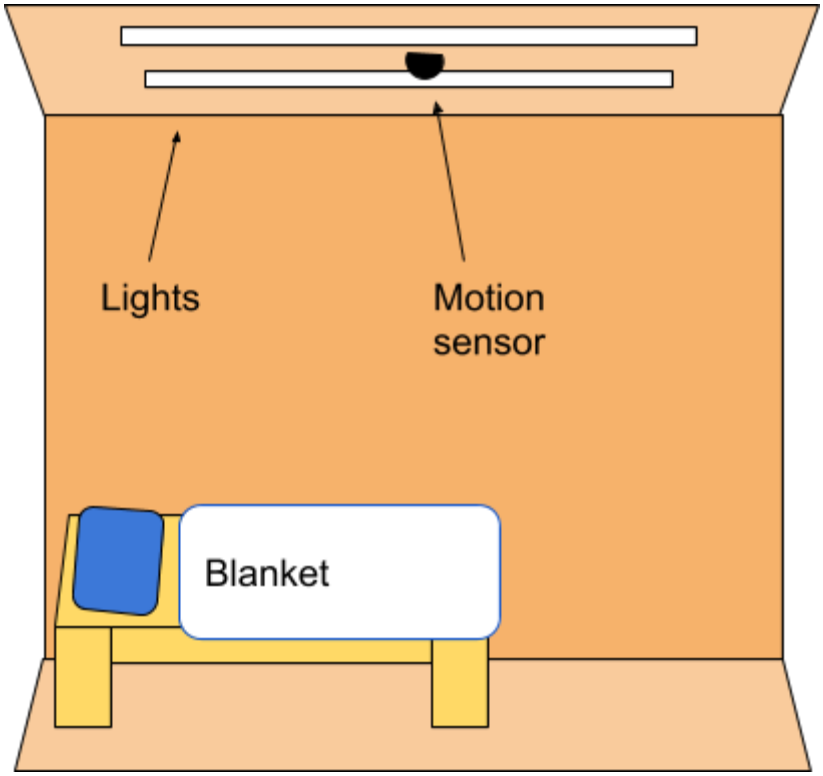


Figure 21. Implemented Mock-Up Drawing of Motion Sensor Lights

Panic Alarm

The panic alarm is in its final steps in installation into the modular home as of now. As shown below, the panic alarm is shown outside of the house. It is in its designated box as of now that has the symbol laser engraved on it. The red button that is on the outside of the box is the button that the user will press inside the house, in case of only an absolute emergency, and then the siren at around 90dB (decibels) will play outside the home showing the neighbours that there is an emergency. This was the idea that the client told us she would like so we have will install it accordingly on the home.

The panic button will be slightly modified for the modular home when installed, having longer wiring that connects the button to the sound control box which is external. All of the circuitry and the relay is inside the box which controls the signal that triggers the alarm. In terms of the slight problems that we encountered when making the panic button so far, we found that all the connections in the wiring had to be very tight in order for the sound to work optimally and be loud enough. Also, we had some trouble in making the box big the right size to fit all of the internal components but this was an easy fix with a few modifications when laser cutting again. In terms of the next few days approaching design day, we may find some difficulty in the

installation as this prototype has two parts to it that are quite far from each other. So, we need to make sure that the wires connecting them are not in any place where they can be stepped on or touched by people entering as this may cause the wires to disconnect. This should not be too much trouble though as we can tape the wiring along the wall as minimalistic as possible. Overall, the panic button is approaching its completion very fast and should be ready and installed well before the design day.

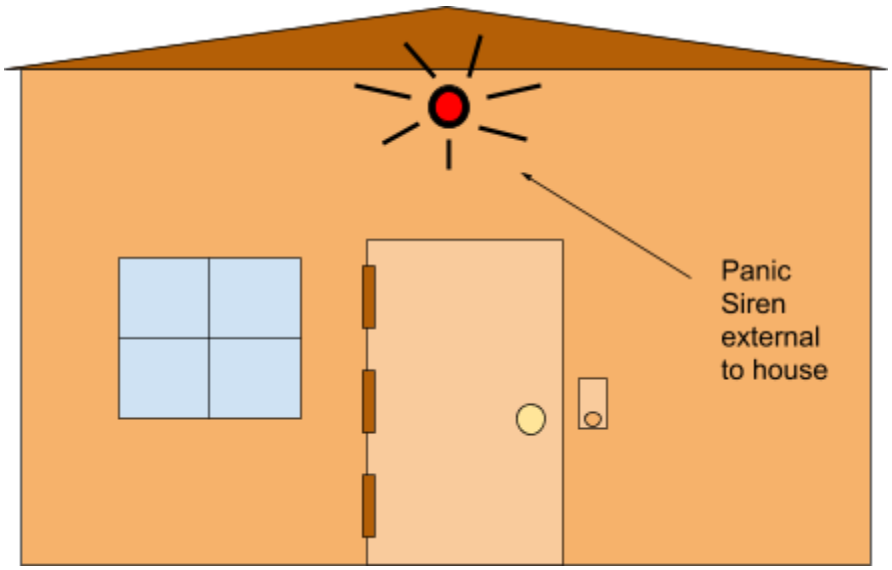


Figure 19. Implemented Mock-Up Drawing of Panic Siren

Smoke Detector & Power Supply

As for the smoke detector, it has arrived we just have to test its performance and install it within the home. The power supply (DC/DC converter) has been constructed and the box has been assembled. Again, we simply have to test it with power.

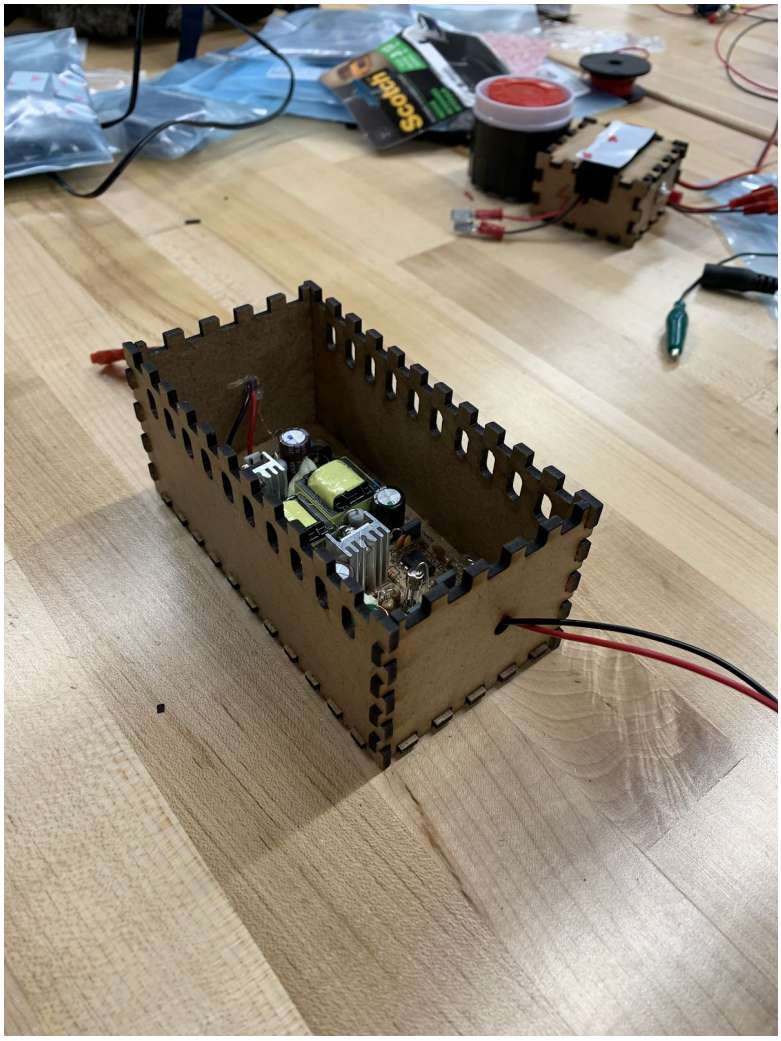


Figure 20. Photo Inside of the Final Panic Siren Prototype

To Conclude the Third and Final Prototype

To sum everything up, we believe that all the major components are fully developed and ready to install. The boxes for each project have been fully realized via laser cutter, and the only thing left to do is to put our components inside, a task which should take less than 10 minutes for everything. Once the construction team has made their structure available for us to work with, we should be able to get our devices installed quickly and easily. Thus, we are prepared and easily capable of finalizing everything before the deadline/Design Day.

7 Final Solution

Motion Sensing Lights

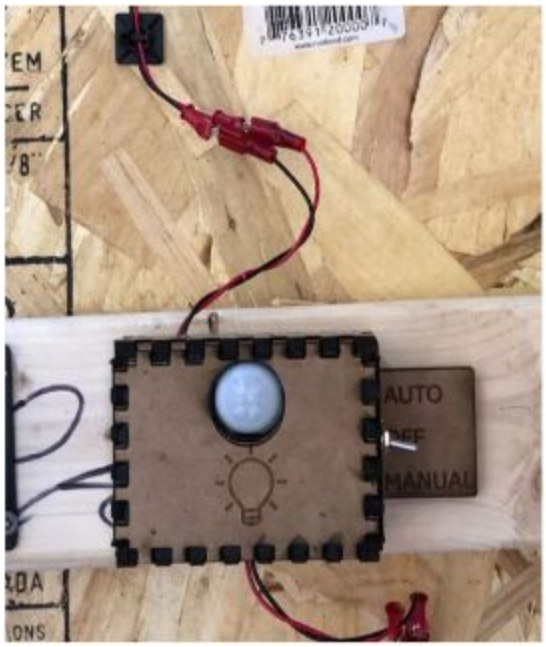


Figure 21. Photo of Motion Sensing Lights Fully-Integrated

The image above displays our final motion sensing lights module. We have three available modes on it. One being auto (top in the picture), which stands for automatic, the another which is off (middle in the picture), and the last mode being manual (bottom in the picture). All of these modes were fully functional when testing the lights. When on the automatic setting, as soon as a person would walk into the house, the lights would go on and remain on if there is any movement in the modular room. According to our code, we put the reset time as 13 seconds which means when there is no movement in the house, the lights will automatically turn off after 13 seconds. This feature can be easily modified though as all it takes is removing the lights from the wall, and setting the reset to a different amount of seconds. When the switch is in the middle setting, the lights are off, no matter if there is movement or not, they are off. Then, the last setting at the bottom is the manual setting which the lights are on right now. This setting is for if somehow the motion sensor is not working at any time, you can still just use the manual switch to turn the lights on and off. The attachments for the wires on it are called crimps and makes the light module modular if in case there needs to be an adjustment or the unit needs to be transported. Overall the motion sensing lights worked absolutely perfectly and the lights were far bright enough for the room.

Power Supply Below the Motion Sensing Lights

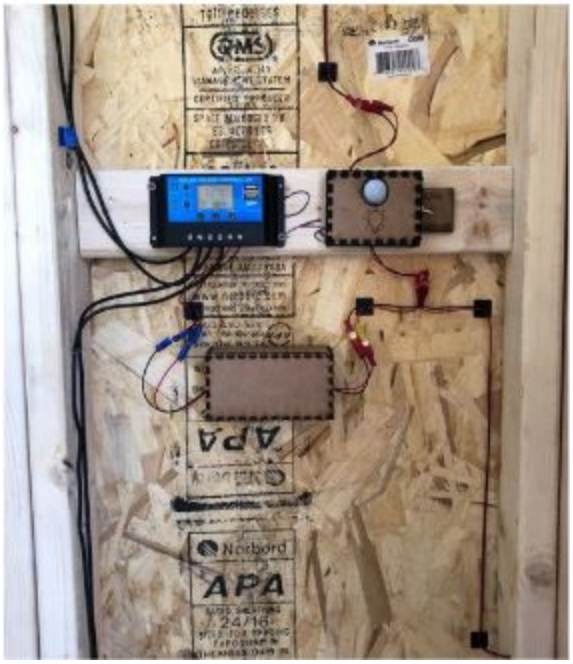


Figure 21. Photo of Motion Sensing Lights connected to power supply

In this image above, we have he motion sensing lights on the right, the solar power converter on the left, and then the power supply on the bottom which all of our products are attached to. This power supply box just makes sure that the right amount of power is being put into our devices to work optimally and not get damage from too much power being put into their inputs. Overall this is an essential component of our system of products and makes sure that they all get the right voltage and power.

Emergency Siren

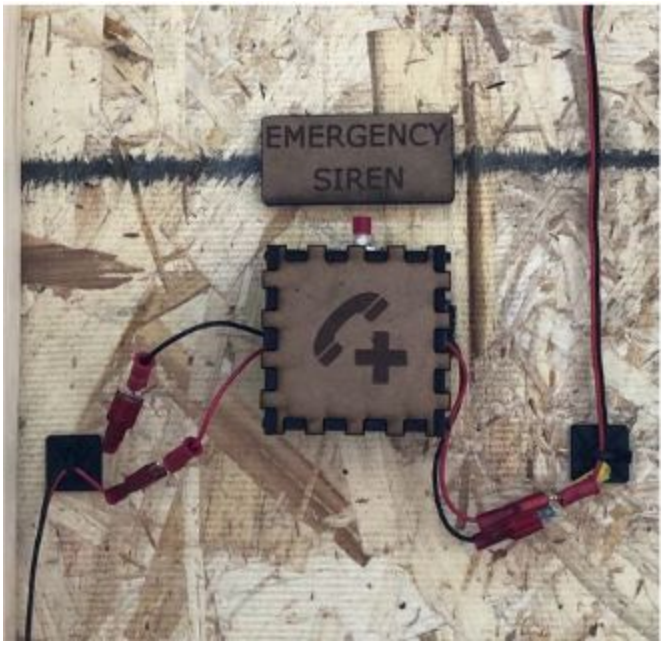


Figure 22. Photo of Emergency Siren Fully-Integrated

Pictured above, we have the emergency siren module, the input and output crimps are on the sides and there is a sign indicating what the module is above the control box. We have a nice icon with a phone on it indicating the panic sound that plays when using it. The button to set off the alarm which is outside the home is on the top and is in red. This alarm is set up about 6 feet off the floor to make sure that little kids can not get to it easily and press the emergency siren. It emits a 90 decibel sound which nearby neighbors can hear easily and react when their is danger or an intruder in the home. Overall, this is a very easy to use, handy accessory to the home that ensures an extra level of safety and security for the person living in the home. It is fully modular like the other products that we made and functioned perfectly when testing it on design day.

Doorbell and RFID Lock

The electronic lock is a circuit consisting of a solenoid, a microprocessor, an RFID tag reader, and a button to unlock the door. Should someone wave the correct pre programmed RFID tag in front of the reader, it will unlock the door for around 10 seconds. Since the lock does not require a physical lock and key, it greatly simplifies things should a key be lost, stolen, or changing hands. The RFID reader is easily programmable to accept different cards. Additionally, the doorbell is a simple circuit with a buzzer connected to a button on the outside, next to the

RFID tag reader. It creates a sound on the inside, but is on a separate subsystem than the RFID lock. An occupant may chose to press a button on the inside which has the same effect as tapping the correct RFID card; unlocking the door for around 10 seconds.

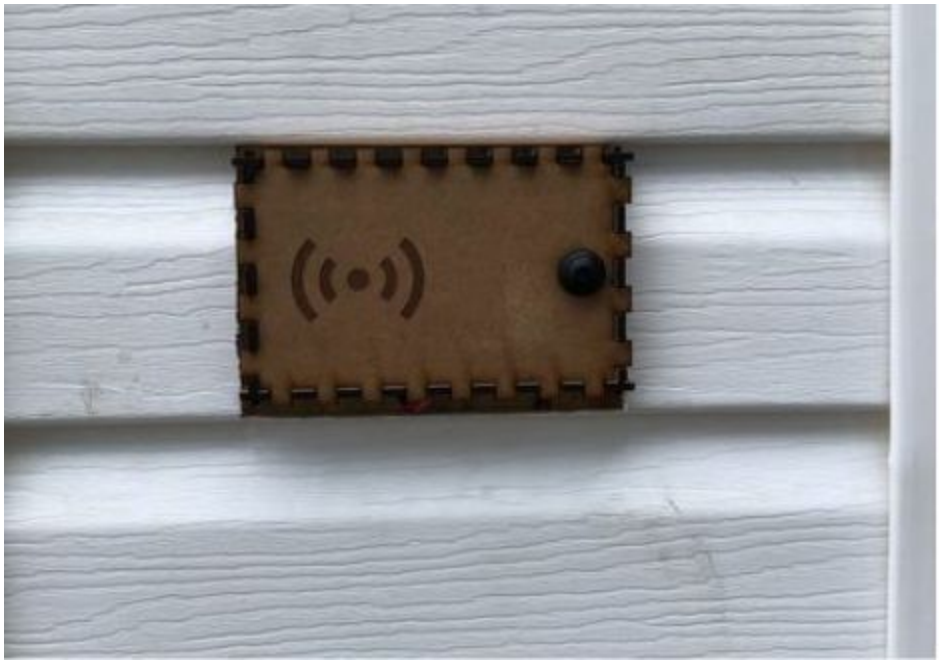


Figure 23. Photo of RFID Lock and Doorbell Fully-Integrated

Control Module for RFID Lock, Doorbell

The inside of the house contains the control module for the RFID lock, as well as the siren for the doorbell. Additionally, it also has a button to unlock the door should external access be allowed, or should the occupant wish to leave the house. Pressing the unlock door button will unlock the door for around 10s, the same way tapping the card against the reader does.

Figure 23. Photo of RFID Lock Control Module

8 Conclusions and Recommendations for Future Work

Summarize your lessons learned and your work and suggest the most productive avenues for future work

In short, during this project our group learned a lot about the process of design. As a result, if presented with a future problem to solve, we feel that we can confidently apply the design process to create a solution which fulfills all the functional requirements. Additionally, it has taught us a variety of skills required for good project management, such as cutting redundancies, identifying a list of priorities, managing time and money, and many more.

As for the future of this solution, the solution could be vastly improved with some more money in the budget. Examples include our panic button, which had to be downgraded from an actual button that notifies the police/authorities to a simple siren. Additionally, improving solar power collection and storage systems will give us more power to work with so we can implement systems which may provide the occupant with some degree of comfort (heating, wifi, device charging ports, etc). Since the principal constraints of this project was the amount of power available and the price, allocating additional resources to both areas will allow for greatly increased freedom when it comes to implementing subprojects.

9 Bibliography

Solenoid. (2019, April 08). Retrieved April 18, 2019, from https://en.wikipedia.org/wiki/Solenoid

Lasercut Tabbed Box. (2016, April 30). Retrieved April 18, 2019, from https://inkscape.org/~Neon22/★lasercut-tabbed-box

APPENDICES

APPENDIX I: User Manual

RFID LOCK

To use the RFID lock, tap the appropriate card on the reader on the outside. The door will unlock and the door can be pulled open. Note that should the electronic lock be unlocked, the doorknob does not need to be turned. Additionally, there is a button on the inside that will also unlock the door. Pressing it has the same effect as waving the correct keycard near the reader.

Panic Button

This button causes a siren to sound in order to alert nearby people to a potential threat. The button is located above the RFID lock system, on top of a box with a bell on it.

Lighting

The lighting systems has three modes: ON, OFF, and AUTO. On and Off are exactly what they say: they turn the lighting system on or off. AUTO allows for the motion sensor to take over; the lights will be off until the motion sensor detects movement, which will in turn turn the lights on. Additionally, after a set period of time without movement, the sensor will turn the lights off. This setting is recommended in order to save energy.

APPENDIX II: Design Files

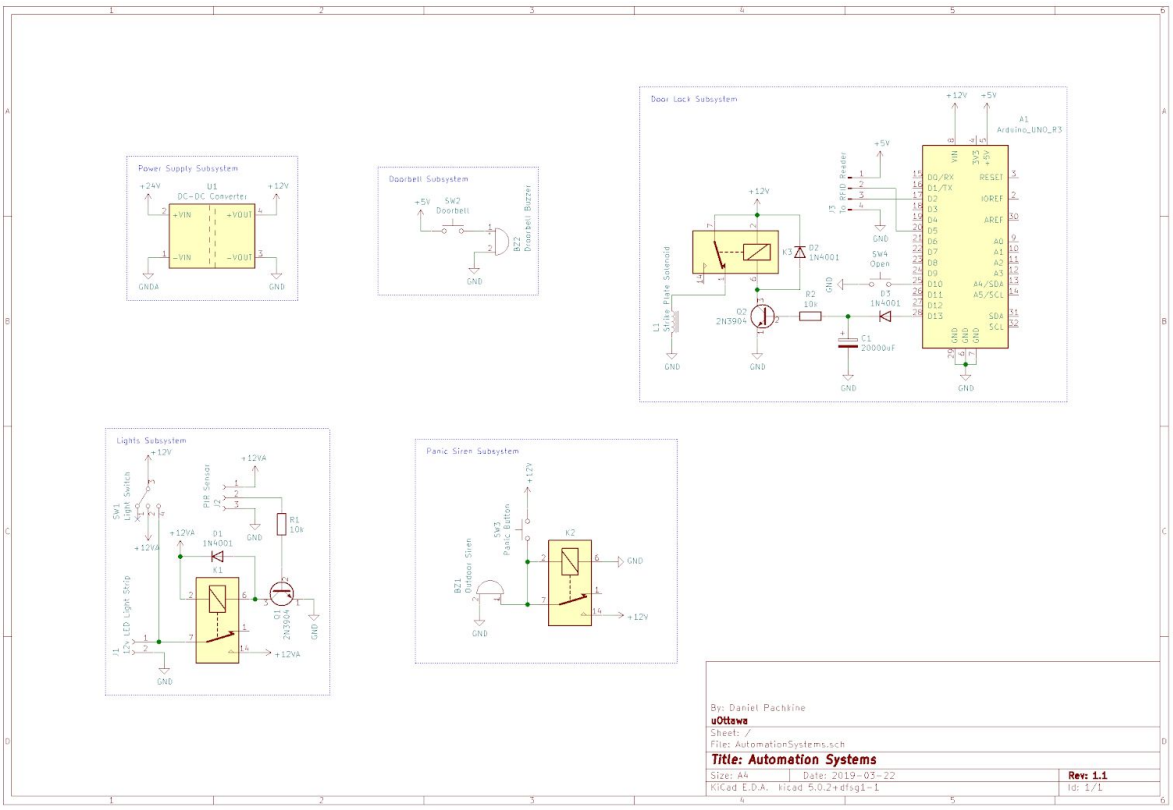
RFID Reader Code

```
#include <SoftwareSerial.h>


//Parallax RFID Reader
#define RFIDEnablePin 2 //Pin that enables reading. Set as OUTPUT and LOW to read an
RFID tag
#define RFIDSerialRate 2400 //Parallax RFID Reader Serial Port Speed
#define RELAY_PIN 12

#define OPEN_PIN 3

#define ALLOWED_TAG "0F03040982"

//Using SoftwareSerial Library to locate the serial pins off the default set
//This allows the Arduino to be updated via USB with no conflict
#define RxPin 5 //Pin to read data from Reader
#define TxPin 4 //Pin to write data to the Reader NOTE: The reader doesn't get written to,
don't connect this line.
SoftwareSerial RFIDReader(RxPin, TxPin);

String RFIDTAG = ""; //Holds the RFID Code read from a tag
String DisplayTAG = ""; //Holds the last displayed RFID Tag

unsigned int timeOpen = 0;

void setup()
{
  // RFID reader SOUT pin connected to Serial RX pin at 2400bps
  RFIDReader.begin(RFIDSerialRate);

  // Set Enable pin as OUTPUT to connect it to the RFID /ENABLE pin
  pinMode(RFIDEnablePin, OUTPUT);
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(OPEN_PIN, INPUT);

  // Activate the RFID reader
  // Setting the RFIDEnablePin HIGH will deactivate the reader
  // which could be usefull if you wanted to save battery life for
  // example.
  digitalWrite(RFIDEnablePin, 0);
```

```
  digitalWrite(OPEN_PIN, 1);

  Serial.begin(9600);
  Serial.println("Initialized!");

}

void loop() {
  if (RFIDReader.available() > 0) ReadSerial(RFIDTAG); // If a tag is available, read it

  if (!timeOpen) {
          if (DisplayTAG != RFIDTAG) {
          DisplayTAG = RFIDTAG;
          Serial.println(RFIDTAG);
          RFIDReader.flush();
          if (RFIDTAG == ALLOWED_TAG) {
          RFIDTAG = "";
          DisplayTAG = "";
          timeOpen = 1;
          delay(100);
          setDoor(1);
          }
          }

          if (!digitalRead(OPEN_PIN)) {
          setDoor(1);
          timeOpen = 1;
          }
  } else {
          timeOpen++;
          if (timeOpen >= 40000) {
          setDoor(0);
          timeOpen = 0;
          }
  }
}

void setDoor(byte state) {
  if (state) {
          Serial.println("Opening...");
          digitalWrite(RELAY_PIN, 1);
          digitalWrite(RFIDEnablePin, 1);
  } else {
          Serial.println("Closing...");
          digitalWrite(RELAY_PIN, 0);
          digitalWrite(RFIDEnablePin, 0);
  }
```

```
}

void ReadSerial(String &ReadTagString) {
  int bytesread = 0;
  int  val = 0;
  char code[10];
  String TagCode = "";

  if (RFIDReader.available() > 0) {     // If data available from reader
          if ((val = RFIDReader.read()) == 10) {  // Check for header
          bytesread = 0;
          while (bytesread < 10) {                  // Read 10 digit code
          if ( RFIDReader.available() > 0) {
          val = RFIDReader.read();
          if ((val == 10) || (val == 13)) { // If header or stop bytes before the 10 digit reading
          break;                     // Stop reading
          }
          code[bytesread] = val;           // Add the digit
          bytesread++;                     // Ready to read next digit
          }
          }
          if (bytesread == 10) {           // If 10 digit read is complete

          for (int x = 0; x < 10; x++)      //Copy the Chars to a String
          {
          TagCode += code[x];
          }
          ReadTagString = TagCode;              //Update the caller
          while (RFIDReader.available() > 0) //Burn off any characters still in the buffer
          {
          RFIDReader.read();
          }

          }
          bytesread = 0;
          TagCode = "";
          }
  }
}
```

Schematics for all 5 subsystems



Link to MakerRepo Page

https://makerepo.com/dpach056/community-shelter-2-automation-system