Executive Summary

The main purpose of the report was to create a new and improved smart skateboard locking device. There was a visible need on ASU’s campus for a more effective system to safely secure student’s boards while they attend class. Often, the racks around campus are full, or there is a line forming to lock and unlock skateboards as people fumble with their keys and padlocks. The inconsistent locking mechanisms drastically slowed down the locking process.

K.Y.L.E was designed specifically to solve these problems, by making a uniform locking system. K.Y.L.E. has a smartphone activated locking system that utilizes preinstalled locks to secure any registered person’s board. One must simply create an account, scan their phone at the rack to unlock slot, place their board in, and re-scan their phone to lock. Once done with class, another re-scan will unlock the board. Utilizing a smartphone opens the doors to future additions as well. The system can be advanced to show nearby rack locations, and to notify users if stations are full.

Testing of the device showed that the product was feasible, and moreover very effective. The locking system produced great results, even though a change was necessary to make the lock more effective. The conclusion is that this design would be very effective on college campuses all around, as long as costs can be kept to a minimum.

Recommendations would be to create a full scale prototype, to see how the design works when stacking one on top of the other. Testing of materials needs to be done to see how sturdy the aluminum body is, and if the electronics will be safe from the elements and abuse. Moreover, prototyping needs to be done on the phone app. There is a lot of work to be done to get K.Y.L.E. into profitable business.

Table of Contents

1 Introduction

As skateboards become a more popular method of transportation around college campuses, it became clear that there is a need for a better locking system. Carrying around bulky and clumsy locks slows down a skateboarder, and makes them take more time than actually required to secure their board from being stolen.

The aim of the project was to create a product that expedited this locking process, making life easier and stress free for skaters around campus. The thought of a student being tardy to class simply because of a line at a skateboard rack is absurd. Pursuing this design has obvious benefits. This affects a student's ability to attend class. This would also affect a student's mental health. It is important that students have minimal stress on their life, and this would alleviate a major stress.

The report presents the data that was collected throughout the design and testing process. The design changed much over time. These results are analyzed further and future recommendations are also discussed.

2 Background

The current solution for skateboard storage varies depending on the environment and amount of storage needed. One example is a company and website called skateboard racks for schools. They offer racks that can hold 6, 12, 24 and 48 boards. The lowest prices for each product range from $599.99, $1,199.99, $2,699.99 and $5,399.99 respectively. These designs utilize vertical spaces for the board and rings in order to attach a personal lock connecting to rings; locking the board in the space. Other designs use the same ring locking method but another example in particular uses sideways slots for boards. Currently though, not much is being done to innovate this commonly used storage system. No use of smart locks or changes to improve how to retrieve boards have been implemented on any of the skateboard racks researched. Because of this fact, the team set out to produce the most efficient and effective skateboard rack for organizations to buy and users to operate. The potential customers for the product are college students. This appeals to a lot of college campuses worldwide as this is a great place to market and sell the product. This can also be marketed this to parks and other buildings/places as well but the main focus will be on college campuses. Any gender is more than welcome to use the product as performing the art and sport of skateboarding isn't bound by gender and in turn, anyone can use the product. Anyone from any income bracket can use the product as well. All they have to do is make an account and they can put in the credentials to use the K.Y.L.E. if they can't use a smart device. Using a phone to unlock the K.Y.L.E. is simply for the users convenience, not a requirement. Any age and therefore anyone at any height can use the product as well. The skateboarding market will be a $2 billion dollar industry by 2020 [3] and with more than 6.4 million people participating in skateboarding in 2016 in the US alone [4]. Both of theses statistics mean that there is a huge and ever growing market for skateboarding and in turn skateboard racks. Over all, there is a lot of potential not only in this ever growing industry, but in the product as well.

3 Design and Implementation

The design was created to store skateboards in the most time effective way. First, the team looked at at pre existing models to better understand what was out there. What was decided was that the best course of action was to mimic the racks that were already on the ASU campus for a number of reasons. The racks themselves were compact and used space in the most efficient way to store the most boards. The design allowed for many to be in the same place and still provide easy access from all angles. The K.Y.L.E. eliminates the use of locks as it comes with its own automatic locks. Lastly, the effectiveness of this design because of in person testing which strengthened the trust in design. However there were still things that needed to be improved upon. User feedback states that the design does not look aesthetically pleasing. To answer this, the design was slightly changed to hide the electronics. The angle that the boards were at was a little too steep and that more space would be available if the angle was reduced. The angle can also be used to create greater ease of use since adjustments have to be made at different heights. The team wanted to have an interactive interface so that people could use the product without cell phones and that was placed above waist height for a user-friendly experience. This was placed at the 7th slot when looking at the 3d cad model. The maximum height for each rack was to be 6 feet to 6 feet 2 inches. This was to keep a maximum occupancy of 10 boards and still have the height be accessible to all people. the back was to be about 2 inches thick and hollow. This aspect was to make it waterproof and at the same time store the sensitive electronics that power the screen and locking mechanisms. The locking mechanisms will be a drop down mechanism. There will be a strip of metal that is stored above the opening and then will be lowered to close the opening thereby locking the board in. The cost of each mechanism that is supposed to be in place has yet to be calculated but by reducing the amount of metal needed for each board space and the amount of metal needed on the back the frame is supposed to be cheaper while delivering the same amount of security.

This design increases efficiency and user satisfaction, but increases the risk of technological malfunction compared to the currently used design. This design also adds an increased electricity cost, but overall, these costs are trivial when compared to the benefits of the design.

The people interviewed for feedback talked about how they wanted a quicker option but also have more space for boards. The best way the team thought they could address this issue was to make it cheap enough to to have campuses buy more. The original thought was to create something that was either double, triple or quadruple sided. This is still a possibility of using something like that because it would reduce the cost of having more electric infrastructure for each individual rack. Instead there would just be one central system running all the locks. This would be situation but useful in those situations.

3.1 Final Design

The final design utilized an ultrasonic sensor that, when activated, rotate a motor to either open or close the locking mechanism. The locking mechanism rotated in a circular motion, with a piece of plywood (holding the place of metal) that would either cover up the slot for the board, essentially locking it, or would move out of the way, allowing for a board to either be removed or placed into the slot. This was one trade off made. Initially the plan was to make the lock travel on the vertical plane, sliding up and down, but limitations with materials did not allow this.

The design is unique because it does not utilize a lock or key that the user brings, but instead uses their phone, which is much more commonly found on college students, as the 'key'. This means students can carry less around with them, and also more efficiently, use their phone to scan their board locked. Customer research showed that the size of the gap needed to be large enough to hold multiple types of wheeled devices. This is why the gap was increased to 2”. This allows not only skateboards, but also scooters to fit effectively into the device.

The device adds value in both societal and economical manners. The device is competitively cheap. Costs were cut down by prototyping designs, and being able to use less material than competitors. Moreover, the cost of the electronics was kept down by using cheap wiring systems and commonplace sensors. Societally, the device also relieves stress of student skaters. The fear of forgetting a lock, or not being able to find an open space would disappear with the presence of K.Y.L.E. on school campuses. This played a critical role in the design process, how to most efficiently minimize student stress, while maximizing efficiency of the device.

3.2 Cost

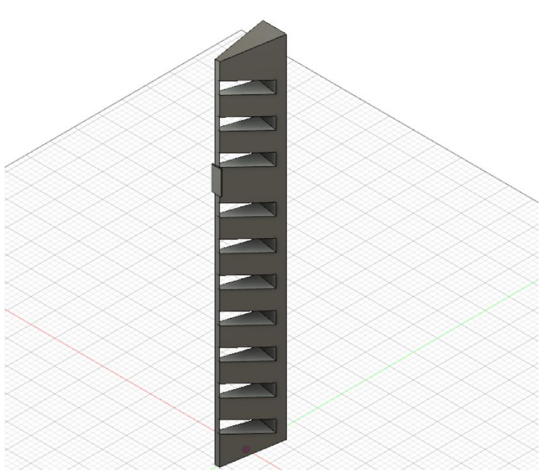
Table 1: Final Design Materials and Cost

Aluminum Sheet Metal	$4.00 per square foot	x108	$432
Arduino Board	$15.00 per board	x10	$150
Weatherproof Wires	$6.00 per foot	x39 feet	$234
Motors	$10.00 per motor	x10	$100
		Total:	$916

Table 2: Prototyping Materials and Cost

	Quantity	Cost	Total
Motor	1	$2.10	$2.10
Wires	9	$0.10	$1.00
Battery	1	$1.20	$1.20
1 x 2 pine 2ft	4	$1.00	$4.00
Plywood ¼ 12 by 12	1	$0.40	$.40
1" # 10-32 Phillips pan head machine screw zinc-plated finish (100pk)	7	$0	$0
10 Tooth gear	1	$0.40	$.40
50 Tooth gear	1	$0.70	$.70
Breadboard & Red Board	1	$26.19	$26.19
			$35.99

3.3 Final Product



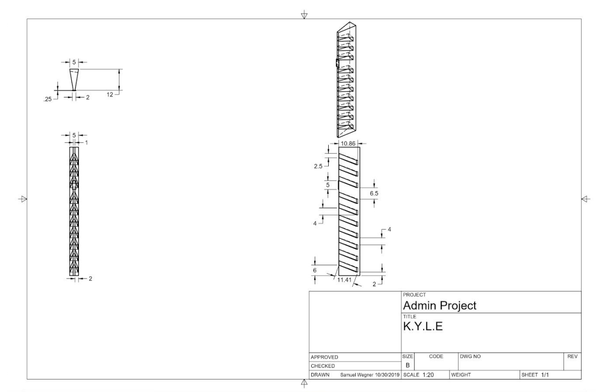


Figure 3.3.1

Figure 3.3.2

Figure 3.3.3

4 Results and Discussion

In order to ensure the K.Y.L.E. was functioning properly before the final demonstration it was first tested to see if its locking mechanism would function properly with the ultrasonic sensor and then was tested to see if it could support the weight of a skateboard. The locking mechanism was demonstrated to function properly as it locked and unlocked the mechanism properly several times. The K.Y.L.E. successfully held a skateboard, proving it met the strength requirement. During the final demonstration the K.Y.L.E. successfully unlocked with motion, held a skateboard, locked with motion and then unlocked again with more motion. This is exactly what the prototype was designed to do, making the prototype a success. However, the prototype did not completely solve the problem the theoretical design was meant to. Due to a lack of time and resources the prototype could not match the theoretical design, leading to it not completely solving the design problem.

5 Conclusions and Recommendations

At the final deadline of the project the K.Y.L.E. had a working prototype along with functioning code. However, the prototype was not aesthetically pleasing and did not have any connection to a smartphone application. Through this project Team 10 learned to better manage their time and how to divide labor efficiently based on individual skills and critical tasks. Given more time or a complete reset, Team 10 would utilize the time management skills to make the prototype look more aesthetically pleasing and would create a smartphone application to make the prototype more like the theoretical design.

Due to the time and resource limitations involved in the creation of the K.Y.L.E. prototype, if one were to commercialize this product they would need to change the design in three ways from the prototype that currently exists. They would first need to make the design an entire rack as opposed to the one slot design of the current prototype. Second, they would need to make the product out of metal as opposed to wood. Thirdly and lastly, they would need to make the product connect to a smartphone application that provides information on availability and location of nearby racks as well as act as a key for the user's skateboard slot.

References

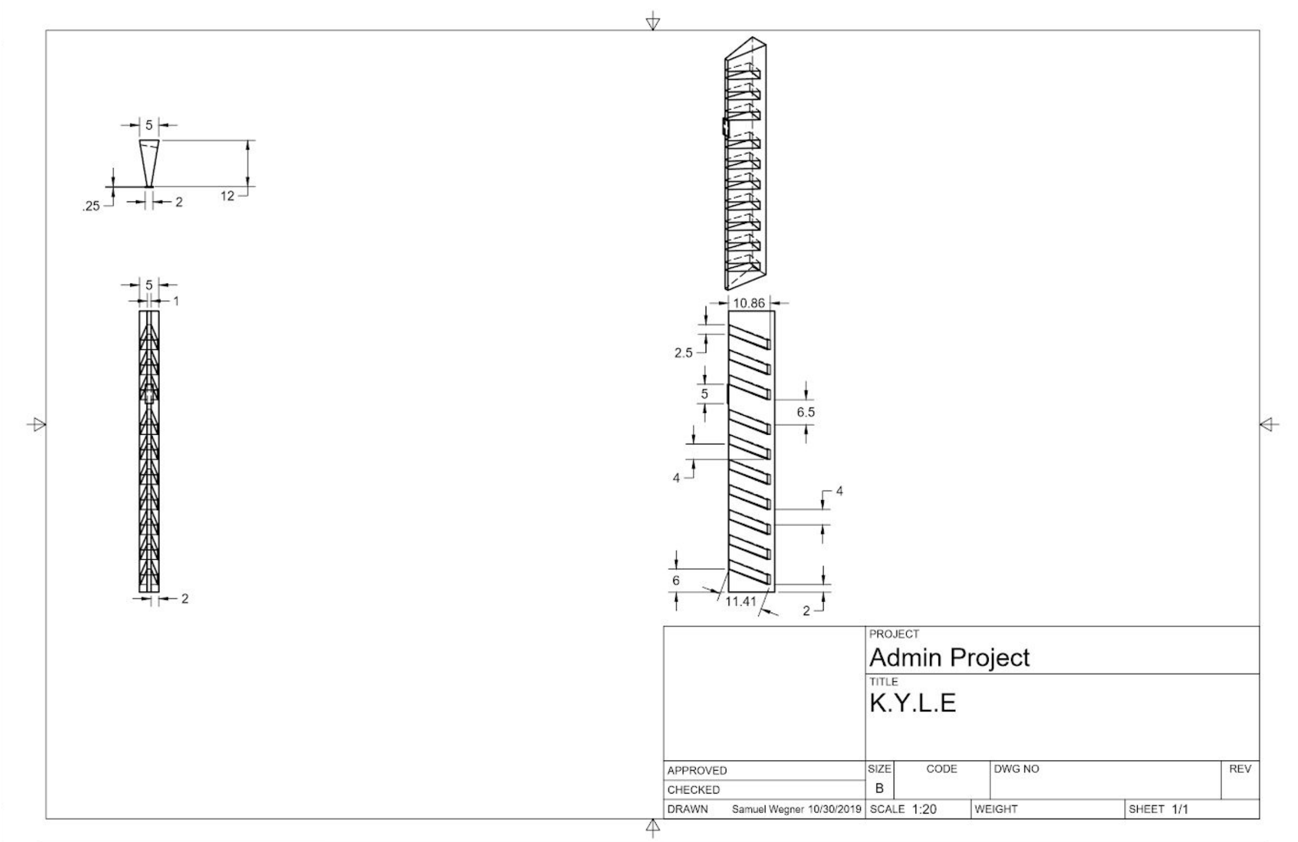
[1] D. Huff, *How to Lie with Statistics*. New York: Norton, 1954.

[2] D.B. Payne and H.G. Gunhold, "Digital sundials and broadband technology," in *Proc. IOOC-ECOC*, 1986, pp. 557-998.

[3] Maida, Jesse. “Rising Popularity of Skateboarding to Drive the Global Skateboarding Equipment Market Through 2020, Says Technavio.” Rising Popularity of Skateboarding to Drive the Global Skateboarding Equipment Market Through 2020, Says Technavio | BusinessWire,BusinessWire,5July2016, www.businesswire.com/news/home/20160705005261/en/Rising-Popularity-Skateboarding-Drive-Global-Skateboarding-Equipment.

[4] “Skateboard Market Size, Share: Industry Trends Report, 2019-2025.” Skateboard Market Size, Share | Industry Trends Report, 2019-2025 , Grand View Research, July 2019, www.grandviewresearch.com/industry-analysis/skateboard-market.

Appendix A: Detailed Engineering Drawing of Final Design



Appendix B: The Final Code Used to Operate the K.Y.L.E

```
const int IN1 = 3;

const int IN2 = 4;

const int speedPin = 5;

const int trigPin = 7;

const int echoPin = 6;

void setup() {

Serial.begin(9600);

pinMode ( IN1 , OUTPUT );
```

```
pinMode ( IN2, OUTPUT ) ;
pinMode ( speedPin , OUTPUT ) ;
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
}
void loop() {
long duration, distance;
 digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  analogWrite(speedPin, 0);
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = duration/58;

 if (distance > 0 && distance < 7) { // && represents AND
  analogWrite(speedPin, 200);
delay(500);

  }
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
```

```
 analogWrite(speedPin, 400);


if (distance > 8 && distance < 30) {
            analogWrite(speedPin, 200);
            delay(500);
}


if (distance >= 30) {
  analogWrite(speedPin, 0);
 }
  if (distance >= 30 || distance <= 0){ // || represents OR
            Serial.println("Out of range"); // print to IDE serial monitor
            }
 else {
            Serial.print(distance); // print to IDE serial monitor
            Serial.println(" cm");
 }
}
```