Final Prototype Journal

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Why Our Product Matters

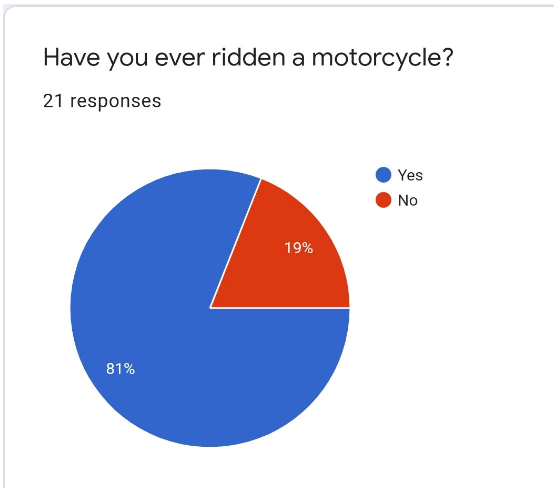
As many motorcyclists can agree, it is very common to drop a motorcycle. Whether it be caused by an overturn at a stop sign or a crash, laying down a bike is almost guaranteed to cause damage. In a small survey, we asked 17 people in the community, if they currently own a motorcycle. Of those 17 people, 7 responded that they do own a bike of their own, and 7 of them admitted to dropping their bike at least once. Therefore, approximately 71% of motorcycle owners have dropped their motorcycle. According to our data, approximately 90 million people in the U.S., at least, have dropped a motorcycle at some point. Data from MIC shows that households owning motorcycles rose from 6.94 percent in 2014 (the last full survey) to a record 8.02 percent in 2018, an increase of more than 1.5 million homes (Lieback, 2019). This means that there is also a quick increase in the number of motorcycle owners who could potentially damage their motorcycles. Therefore, also increasing the market and demand for our product. Also, of those 17 motorcycle owners, 13 said they are or might be interested in purchasing our product if it was created.

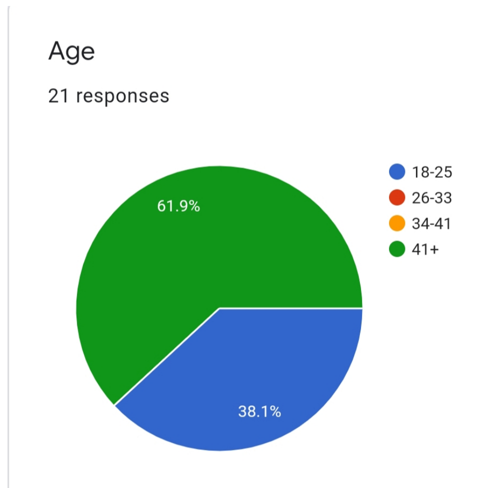
Most often, the damage may be limited to pure cosmetics. Given that the average motorcycle weighs about 400 pounds, the impact with the ground will almost guarantee scratches or cracks. An article we read states: “Some common cosmetic issues you’ll run into with a dropped motorcycle are a scratched crankcase, broken/bent mirrors, a bent handlebar, bent footpegs, scratched/broken fairings, a dented tank, and a scratched exhaust pipe” (Cannon, n.d.) However, dropping a motorcycle could also result in the release of fluids like gas, or oil due to cracks, bends in shifting forks which could cause the motorcycle to downshift involuntarily which results in a very dangerous riding situation, damage to front brake calipers which could result in insufficient braking, damage to levers or pedals which are a huge factor in speed control, or in more significant crashes, there can be damage or bending in the frame of the motorcycle, resulting in balancing issues (Dropped Motorcycle Damage Checklist: Learn What To Check, 2019).

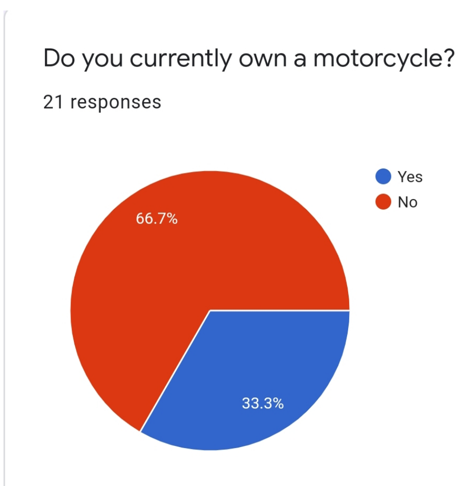
The price of damages can range from hundreds to thousands of dollars and even just cosmetic damage can cause a large decrease in the resale value. One of the most common cosmetic damages to a motorcycle, depending on the style and customization of the motorcycle, is to the fairing and cost to replace the fairing could be anywhere between $50 and $3,000. That doesn’t include the price to repair/replace any other damaged components.

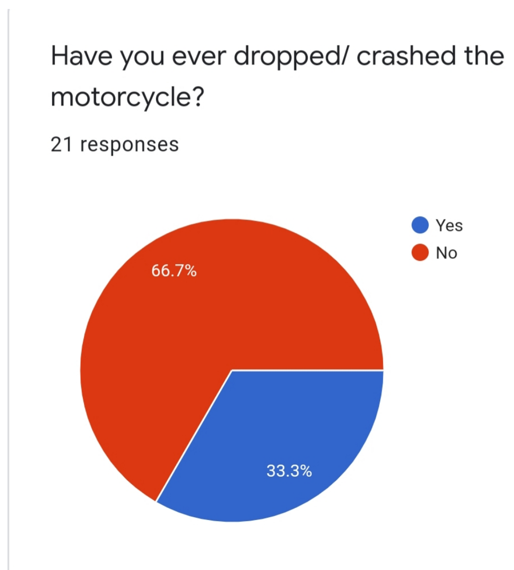
In the end, our project will decrease the potential damage to the side of the motorcycle caused by dropping or crashing. This will decrease the amount of money paid to fix or replace parts and could potentially keep a motorcycle from being totaled. Our project will also help to keep up the resale value and for those who invest a lot in their motorcycles, it will keep their hard work safe.

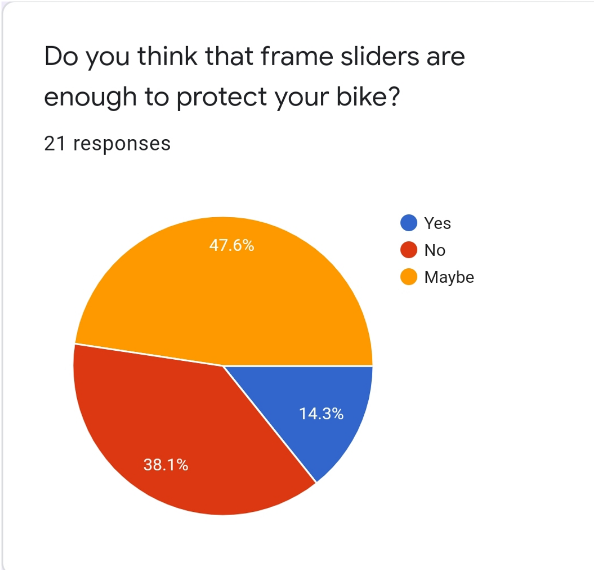
Survey Results

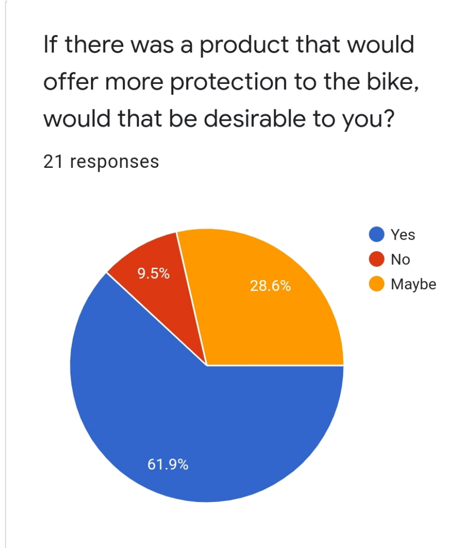


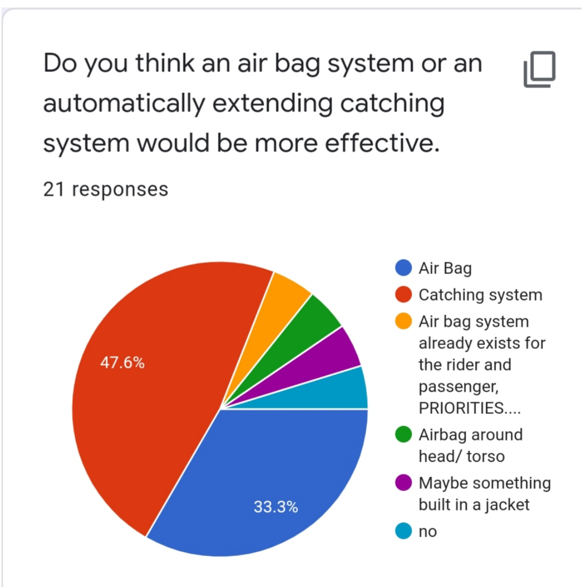


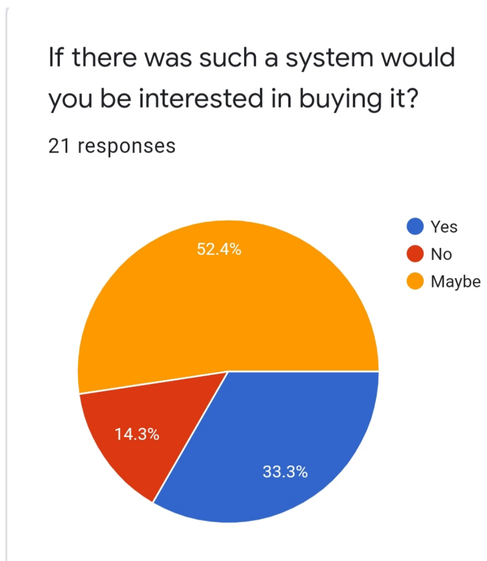





Do you think that frame sliders are enough to protect your bike?
21 responses
Yes
No
Maybe
47.6%
38.1%
14.3%


If there was a product that would offer more protection to the bike, would that be desirable to you?
21 responses
Yes
No
Maybe
9.5%
28.6%
61.9%


Do you think an air bag system or an automatically extending catching system would be more effective.
21 responses
Air Bag
Catching system
Air bag system already exists for the rider and passenger, PRIORITIES....
Airbag around head/ torso
Maybe something built in a jacket
no
47.6%
33.3%


If there was such a system would you be interested in buying it?
21 responses
Yes
No
Maybe
52.4%
14.3%
33.3%

Defining Our Problem

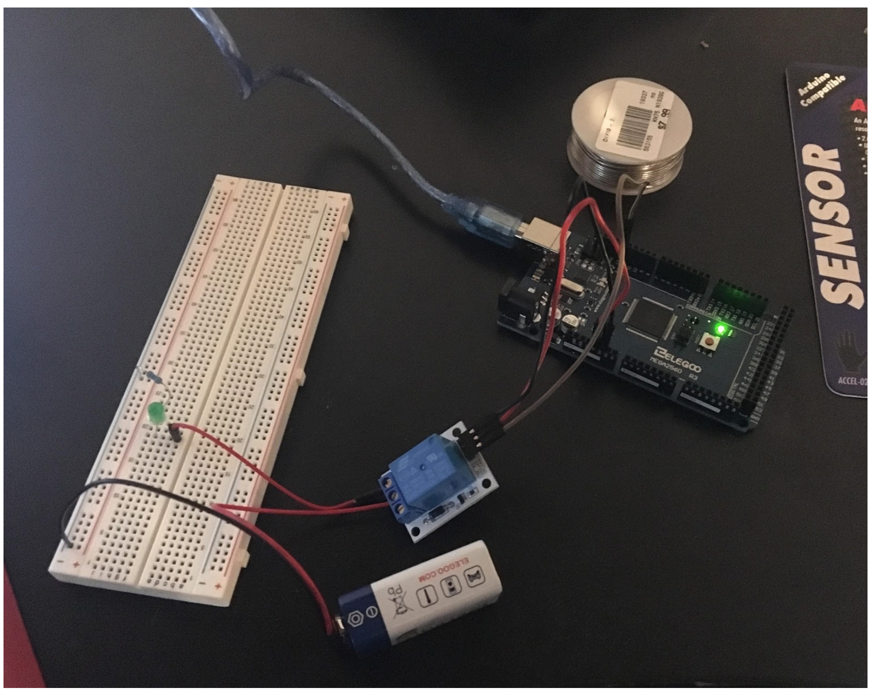
Motorcycles have become a common use of transportation, leading to millions of people all over the world to own or ride them in general. These forms of transportation are quite dangerous, and should only be ridden with the complete knowledge of how to properly use one. A common occurrence with motorcycles is the act of dropping them. This entails the bike itself to fall over sideways to the ground, commonly damaging the mechanics or cosmetics of the motorcycle. As stated before, bikes are very heavy leaving anyone to drop one to have a low chance of catching it before it hits the ground. With this being such a large problem for those in the motorcycle community, we have produced a prototype that will allow for more protection to be offered to a motorcycle. Motorcycles are quite expensive, and having any damages that come from a simple drop can cause many issues. With our prototype, we hope to show, with a scale model of a motorcycle, how it can protect the bike and prevent any damages that may occur from the sudden drop or crash. Our prototype is made to release an airbag once the motorcycle is dropped in order to create a slow fall to the ground that can either allow for the user to catch the bike completely or for the impact of the fall to have reduced damages.

Ideation

After brainstorming and thinking of numerous problems we could solve, we finally came to an agreement on a product we think can be incredibly helpful. In the process of brainstorming, each member of the group thought up roughly 5 ideas for potential solutions to problems we have personally or we know occur in the world. One of our first ideas came from our group member Joshua Brisson, who is also a motorcyclist. He knows personally how common dropping a motorcycle can be because of his experience and the experiences of his family of motorcyclists. Most of the other members in our group agreed that we knew someone who had a motorcycle who may have dropped their motorcycle and could potentially benefit from a device that could protect the mechanics and cosmetics of their bike if they were to do it again. So, we quickly agreed on this idea. We then began brainstorming the different ways that we could provide protection to motorcycles with an aesthetically pleasing mechanism that doesn’t hinder the functionality of the motorcycle. Our first idea was an extendable frame or kickstand mechanism that would catch the motorcycle with springs once it reached a certain angle in relation to the ground, but this idea would be harder to install on a motorcycle without being very visually noticeable. Also, the angle of the motorcycle in relation to the ground could be decreased intentionally and therefore, the mechanism could be deployed even if it isn’t needed. We then decided to use an airbag like mechanism which will deploy in the event of a drop or a low-speed crash while riding your motorcycle. After settling on a method of deployment we went about designing the circuit as well as the physical aspects of our prototype. We created a design on paper which we all agreed on and began the process of developing the different systems and components needed for our prototype.

Prototyping and Testing

The initial stages of prototyping were to build and test the different components separately. The first step in this process was to test a simple relay circuit to ensure that the Arduino and the relay would be able to handle and trigger the battery to power the valve. In this first basic circuit, the battery was simply hooked up to the relay in order to power a light based on the output from the Arduino.



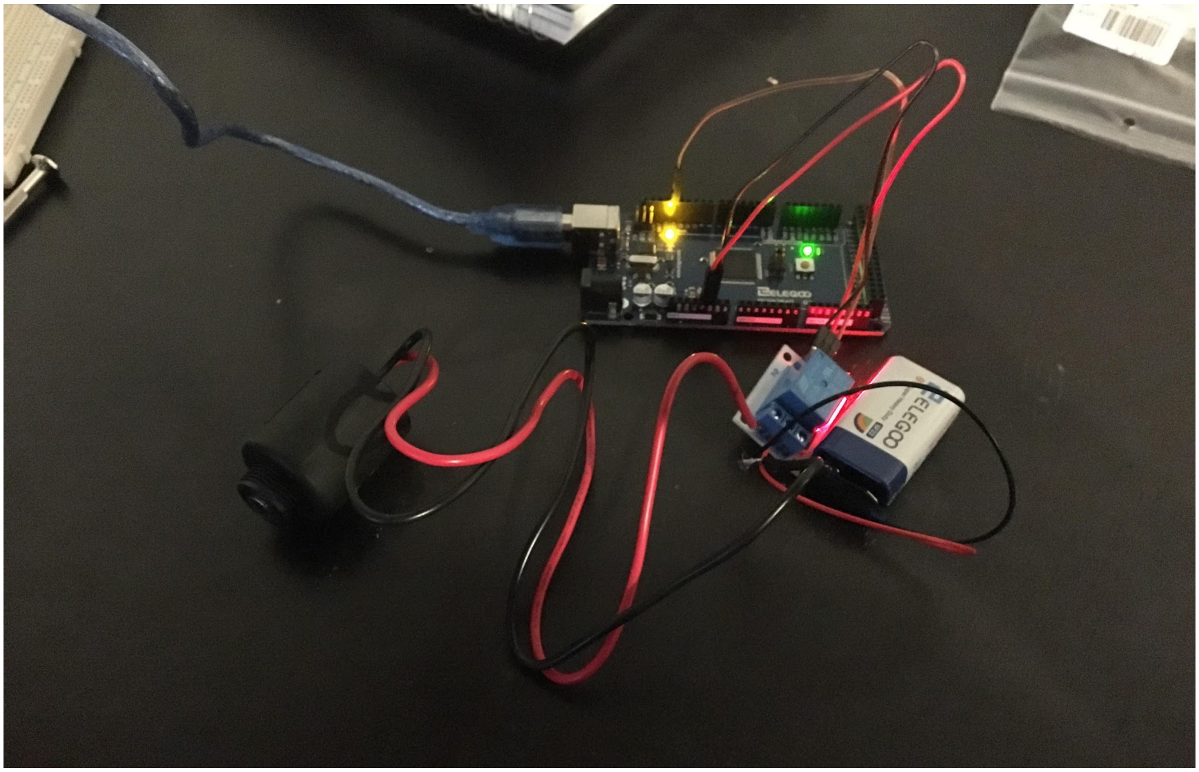
The code below is the simple loop that was created to turn the relay on and off repeatedly, therefore, testing that the relay would work in the way we intended.

sketch_oct15a

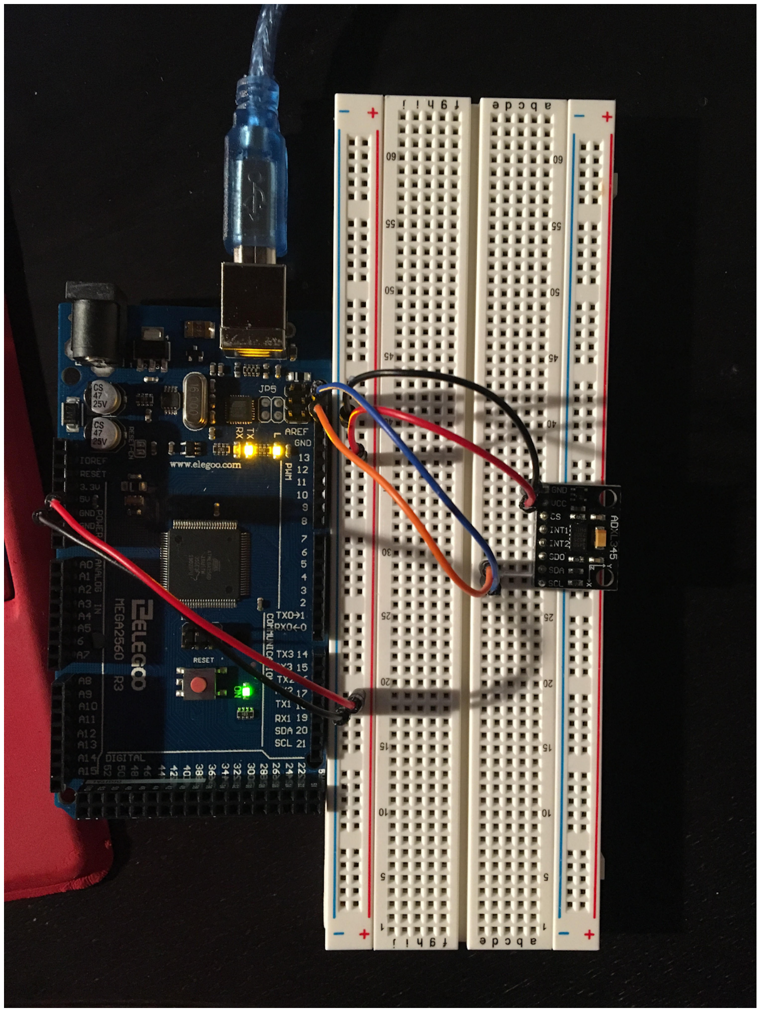
```
const int RELAY_ENABLE = 13;

void setup(){
  pinMode(RELAY_ENABLE, OUTPUT);

  Serial.begin(9600);
}

void loop(){
  Serial.println("Relay on");
  digitalWrite(RELAY_ENABLE, HIGH);
  delay(1000);

  Serial.println("Relay off");
  digitalWrite(RELAY_ENABLE, LOW);
  delay(1000);
}
```

The next step was to test the relay using the actual valve mechanism rather than just an LED. In the image below the black cylindrical object is the mechanism that will open the valve to let the pressure to fill up the airbag.

During this test, the valve would function but we didn't believe that it was using its full range of movement. Because of these results, we concluded that one of the possibilities was that the 9V battery we were using was not strong enough to actually open the valve. After this test, we decided to get a more powerful battery. We decided on using an actual motorcycle battery as it would also be incorporated into the system in the higher fidelity prototypes. Using the motorcycle battery we were able to determine that our initial conclusion was correct. The motorcycle battery was able to move the valve using its full range of motion.



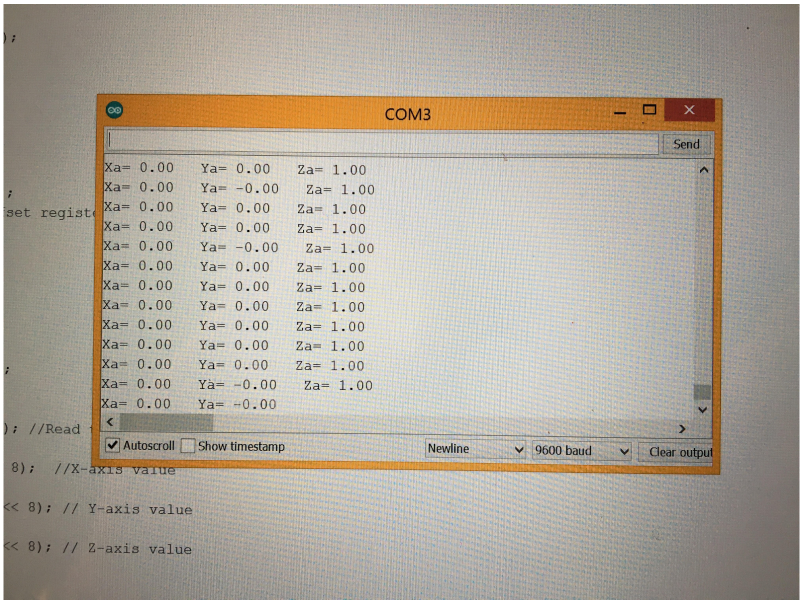
After finding the error in the previous step the next section of the system to test was the accelerometer. There were a few different reasons for this test, the first being to ensure that the sautering of the components was successful. The accelerometer came in two separate pieces that had to be put together. The second reason for this test was to calibrate the accelerometer to ensure accurate measurements during our later prototyping stages. The third and final reason was to create the beginning of the code that would eventually be part of the final stages. We had to figure out which measurement would change for the specific motion of our prototype.



The code below had the purpose of initiating communication between the accelerometer and the Arduino and displaying the measurements of the accelerometer in the form of G's (measurement of earth's gravitational pull). With these measurements, we can take action based on the orientation of the accelerometer, which is the method we will use in the final prototype.

```
//Accelerometer Test
#include <Wire.h>    //Wire Library for I2C Comms

int ADXL345 = 0x53;
float X,Y,Z;  //Outputs

void setup(){

  //Starts communication with the accelerometer and Serial monitor
  Serial.begin(9600);
  Wire.begin();
  Wire.beginTransmission(ADXL345);
  Wire.write(0x2D);  //Access power_ctl register

  Wire.write(8);  //Enables measuring on the accelerometer
  Wire.endTransmission();
  delay(10);

  //Z axis calibration
  Wire.beginTransmission(ADXL345);
  Wire.write(0x20); // Z-axis offset register
  Wire.write(+6);  //Z-axis offset amount
  Wire.endTransmission();
  delay(10);
}

void loop(){
  //Read Data
  Wire.beginTransmission(ADXL345);
  Wire.write(0x32);
  Wire.endTransmission(false);
  Wire.requestFrom(ADXL345,6,true); //Read the 6 registers

  X = (Wire.read()|Wire.read() << 8);  //X-axis value
  X = X/256;
  Y = ( Wire.read()| Wire.read() << 8); // Y-axis value
  Y = Y/256;
  Z = ( Wire.read()| Wire.read() << 8); // Z-axis value
  Z = Z/256;
  //Print out results
  Serial.print("Xa= ");
  Serial.print(X);
  Serial.print("   Ya= ");
  Serial.print(Y);
  Serial.print("   Za= ");
  Serial.println(Z);
}
```

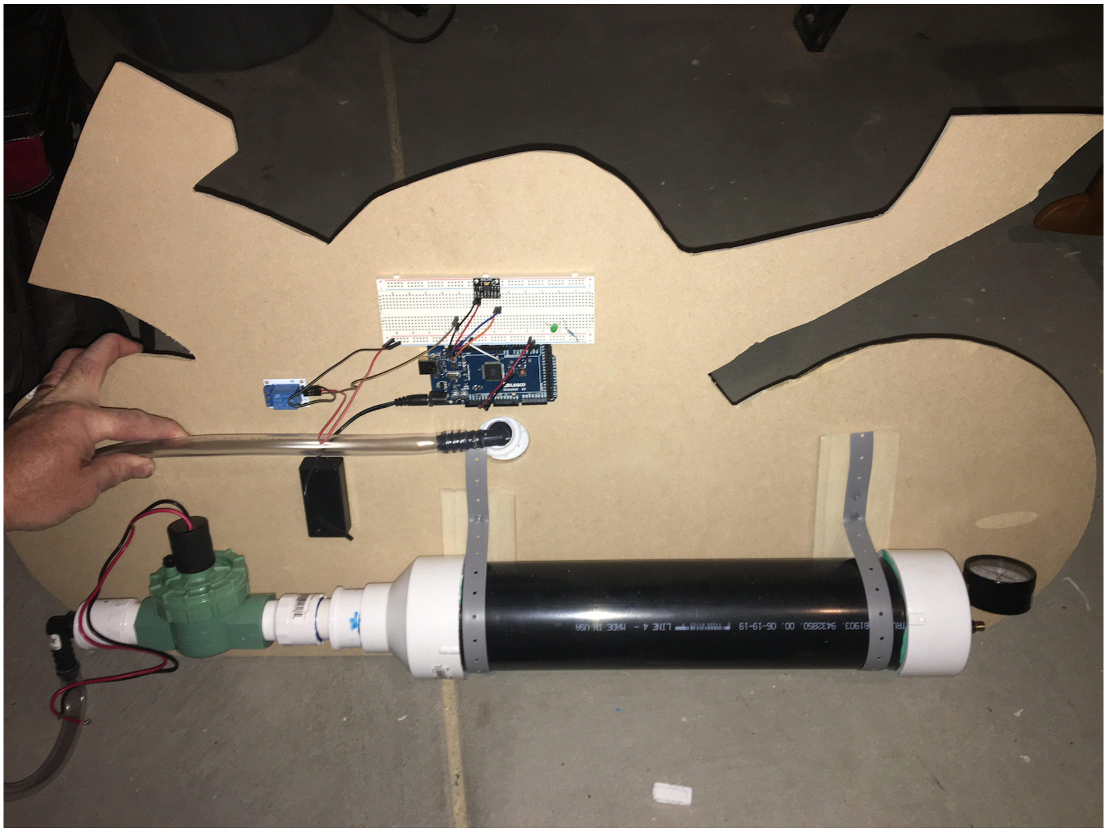
Below is an example of the results from the accelerometer, with the three axis X, Y, and Z. Using these 3 axis measurements we can tell the exact orientation of the accelerometer which will be attached to the motorcycle.

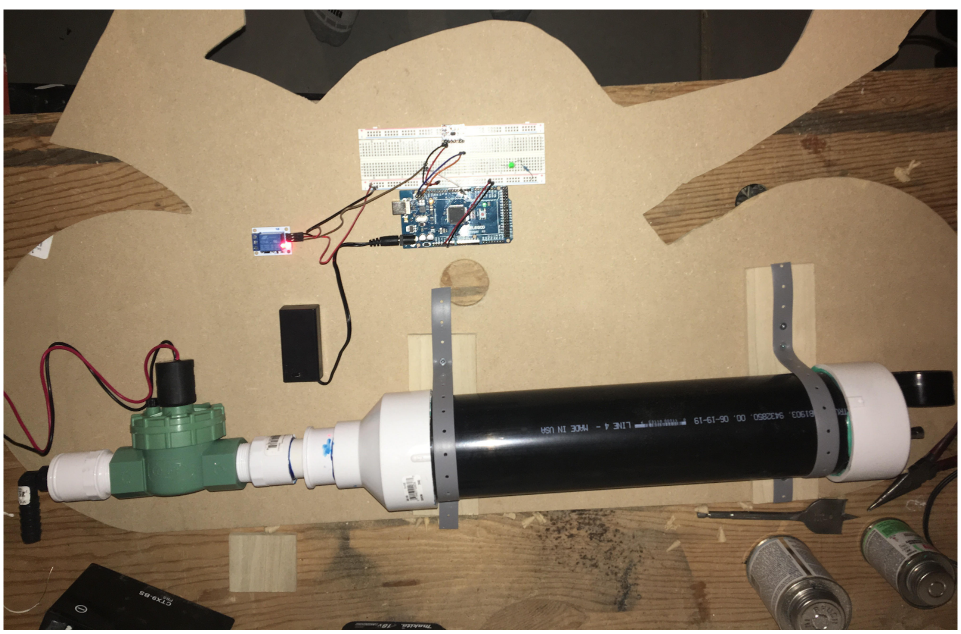


After the testing of the different systems needed to produce our prototype, we had to begin the creation and development of the physical aspects of our prototype. The first piece was the pressure vessel to hold the required air to inflate the airbag. This was done by simply using specialized adhesive along with a pressure gauge and valve to create a pressure vessel capable of holding the required gas. We tested the integrity of the vessel by pumping it up to 60 PSI and then using the valve to release the gas into the airbag. Based on those tests and the rating of the pipe (240 PSI) we deemed the vessel to be a success.

After the creation and testing of the pressure vessel, the next step was to create a simple wooden cutout of a motorcycle to serve as our demonstration model. After that the development of the actual airbag which was one of the more difficult aspects of our prototype. We had to find a bag durable enough to withstand the pressure but also well sealed to keep that pressure inside. We ended up modifying a Ziploc vacuum bag by implementing a hose system that would be hooked up to the valve. By testing the airbag repeatedly we decided to reduce its size to better fit on our model as well as reduce the amount of pressure needed to inflate it.

The next step which was the beginning of the creation of the final prototype was to create a mounting system for all of the components that we needed to make our prototype work. The pressure vessel was just using plastic straps and extra pieces of wood, while the electronic components were attached using double-sided tape. The valve was hooked up to the airbag via a tube that used pipe to attached to each end. A hole was drilled in the middle of the wooden cutout to provide the tube with a way to attach to the backside of the airbag. The motorcycle battery will be placed on the base of the cutout to provide stability as well as reduce the risk of the wood failing under its weight. With this our intention is to prove that our design works as well as demonstrate the various mechanics of it without the actual explosion that is used to inflate airbags as that would cause unnecessary risk to our classmates.





The last step in our prototyping process was to test the final prototype to ensure that everything functions as it should. The results of those tests are shown below:

Materials

- 1 Arduino Mega 2560 starter kit
- 1 12V Motorcycle Battery
- 1 Relay Switch
- 1 Pressure Gauge
- 1 Sprinkler Valve + Actuator
- 1 Valve Stem
- 1 Sheet of wood
- 5ft of Wire
- 3ft of Clear Tubing
- Assorted PVC Pipe
- 2 Ziploc Vacuum Bags
- 9V Battery
- 9V Battery Adapter
- 1 ADXL345 accelerometer
- Assorted Arduino Cables
- 2 Plastic Straps
- Double-Sided Tape
- PVC adhesive
- Duct Tape

Conclusion

After several test runs and hours of building prototypes, we came up with a successful low-fidelity prototype that can be used as a demonstration of what our product will be like. The components we used to create this prototype were a pressure vessel to hold the required air to inflate the airbag, a wooden cutout of a motorcycle to serve as our demonstration model, and the actual airbag (a modified Ziploc vacuum bag) along with the electronic components that worked with the accelerometer. We ran a number of tests to make adjustments to the calibration of the accelerometer as well as the pressure vessel. We had to ensure that the right amount of pressure was being released as well as the timing of its release was correct. After these tests, we did a number of repeat tests to ensure that our prototype would function the way that we intended as often as was necessary to demonstrate its function.

References

Cannon, K. (n.d.). Should I Buy A Motorcycle That Has Been Dropped? Retrieved December 3, 2019, from https://motorcyclehabit.com/should-i-buy-a-motorcycle-that-has-been-dropped/.

Dropped Motorcycle Damage Checklist: Learn What To Check. (2019, February 19). Retrieved December 3, 2019, from http://blog.susquehannavalleyhd.com/news/dropped-motorcycle-checklist.

Lieback, R. (2019, February 7). Motorcycle Statistics in America: Demographics Change for 2018. Retrieved December 3, 2019, from https://ultimatemotorcycling.com/2019/02/07/motorcycle-statistics-in-america-demographics-change-for-2018/.