Engineering Notebook

RMP²

Team 190

Cupertino High School, Cupertino, CA

Table of Contents

Team Summary

Dear judges, we are a collection of impossibly lazy individuals. We entered this challenge in order to gain extra credit for our school subject. In the process, we have realized this challenge was not for extra credit, but a supremely beneficial and educational experience for everyone. We have also realized the hardships to work as a team and succeed from our many failures.

Here are some of our most notable achievements this season:

- Gaining the wisdom and knowledge to create a robot
- Maintaining a growth mindset after every fail
- The ability to use our creative minds to obtain the “Spirit Of The Challenge”

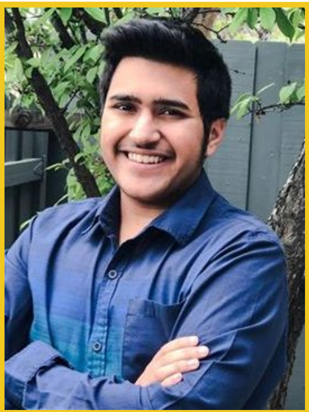
We ask that you take a look at the following pages, which have also been tabbed for your convenience.
[insert page numbers here]

We would like to graciously thank you for your time and consideration in reading this notebook, as well all that you do for The Tech Museum.

Regards: Pranay, Massad, Prateek, Raymond

Meet the Team

Name: Pranay Rajpaul
Grade: 10
Bio: Hi my name is Pranay Rajpaul, and I am currently a sophomore at Cupertino High School. This is my first year doing the tech challenge.I got interested in robotics after my friends showed me what they built, and allowed me to control their robots. I also got an interest after watching the tv show battlebots. I enjoy building and designing a lot. I have designed different prototypes on a 3D animation software called blender. I have used blender to make many different objects, from simple ones like teddy bears, a world to more complex projects like prototypes for inventions. In my free time I play for the school water polo and swim team. I am really excited to participate in the tech challenge.



Meet the Team

Name: Pratheek Sarma
Grade: 10
Bio: Hi my name is Pratheek Sarma. I am currently a sophomore in Cupertino High School. This is my first year doing the Tech Challenge. I have been interested in how things work, so this challenge was fun for me. This is really helpful for my possible future in engineering. I had lots of fun with this project.

Meet the Team

Name: Raymond Cao
Grade: 10
Bio: I am currently a sophomore. This year is the first year I have entered the tech challenge. I have interest in electronics and computers. I thought this experience would be self-rewarding and help me build a variety of skills with electronics and problem-solving. The experience of making the Tech Challenge was fun, and I am happy I chose to enter the tech challenge.

Meet the Team

Name: Masaad Khan
Grade: 10
Bio: I am a sophomore in Cupertino High School. I have interests in computers in general, and usually enjoy working with technological products. Although I am not really considered an overachiever outside of academics, working hard is one of my natural talents, and I am also at least partially funny (I’m sure we can agree sooner or later). Even though our teachers were the ones that introduced us to this challenge, the idea of making a product from scratch is not completely unfamiliar to me. During my sixth grade, our science teacher let us do a fun project of making an rc car, which had given some partial help to us in this project. I can also remember times when I was younger that I would cut the ends of USB cables, trying to change one end of the cable to fit my needs(However that doesn’t really work as I soon found out).

Team Picture

Meeting Minutes

Meeting 1:

Minutes

- We got to know the members on our team.
- Begin trying to brainstorm ideas, only vague outlines at this point.
- One team member came up with an idea for a jumping robot. In order for it to touch both tables at the same time at least once, we thought of trailing a strip of cloth behind the robot.
- Team member was inspired by a robot called the Jumping Sumo.

Meeting 2

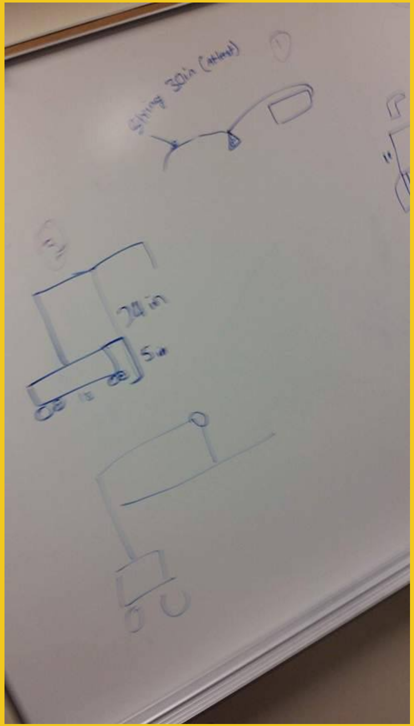
Minutes: Continue Brainstorming Session

- Propose a bridging robot that would utilize a crane to bring a bridge over the ravines.
- Small Robot that would shoot grapple hooks (hooks would be attached to the robot through string) to hitch onto the next table and drag the robot up the table. Had to be lightweight.
- Discussed how to implement the three robot ideas so far: jumping, crane, and grappling hook. We were interested in the jumping robot, but had no real idea of how to implement the jumping robot or what type of technology we would use to allow it to jump. The crane robot seemed possible, but we were afraid it would pass the required dimensions, and the crane would have to be able to extend over the gap. The grappling hook robot seemed possible as well, but it would require motors to draw in string, a system to shoot the hooks, etc.

Meeting 3:

Minutes:

- We were also skeptical of the amount of space the crane would take up, it seemed it would surpass the robot size requirements. Would need a motor or something similar to extend the crane.
- If we decided to use the jumping robot idea, we would need to figure out how to create a device that would launch the robot. The robot would have to be as lightweight as possible to jump the farthest distance. We had to ensure that on landing the robot would remain stable and wouldn't fall off after.
- We discussed how to make a device that would shoot hooks for the grappling robot.



Meeting 4

Minutes:

- The crane robot seemed complicated, as it required designing a rotating and extending system. As most of us did not have extensive programming experience, we were also unsure of how we would program the crane.
- Decide to use either a circular or triangular prism exterior for the grappling hook robot, a motor inside would turn a spool of thread attached to a grappling hook, bringing the robot up to the next table. The robot might also have two wheels at the sides so it could move itself on the second table and prevent having to reset.
- Still unsure how to create a robot with a jumping mechanism. Searched up a few videos of jumping robots to try to gain some inspiration.

Meeting 5

Minutes:

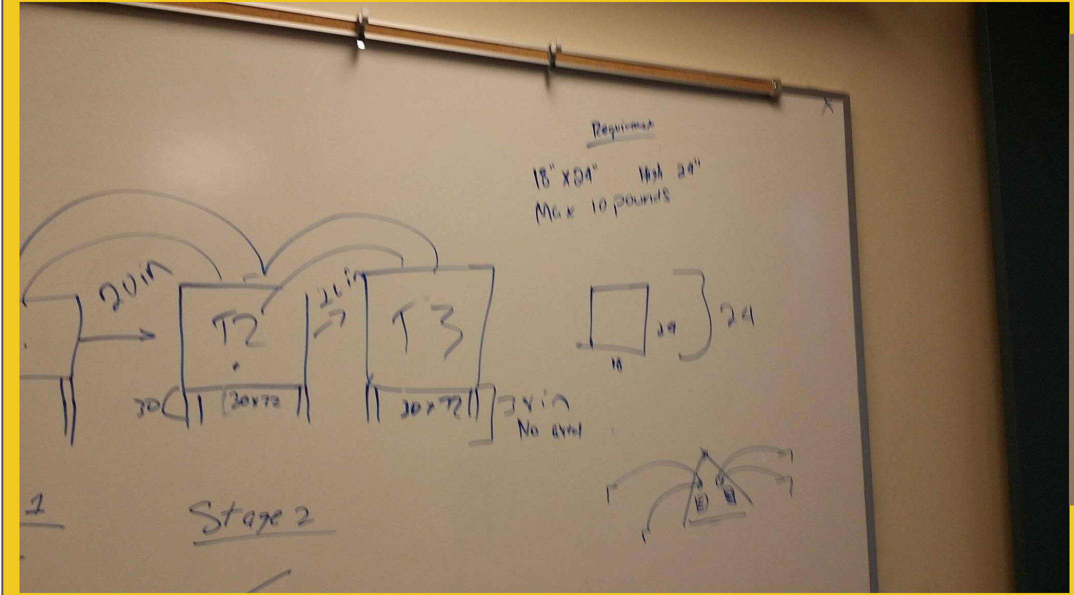
- We had to eliminate two of the designs soon and focus on one so we would not run out of time for the tech challenge.
- Decide to use either a circular or triangular prism design for the grappling hook robot, the robot would reel it self back in like a fishing rod.
- The circular or triangular design was planned for ease of getting onto the table.
- We decided against doing the crane robot, the mechanics behind it seemed like something we were not very familiar with, and the programming as well. However, we still kept it as an idea we could go back to.
- The jumping robot also had mechanisms that we were unsure of how to implement, designing the robot would require the ability to program different amounts of pushing force, a lightweight design and material, and we were skeptical of the precision the robot would give us.

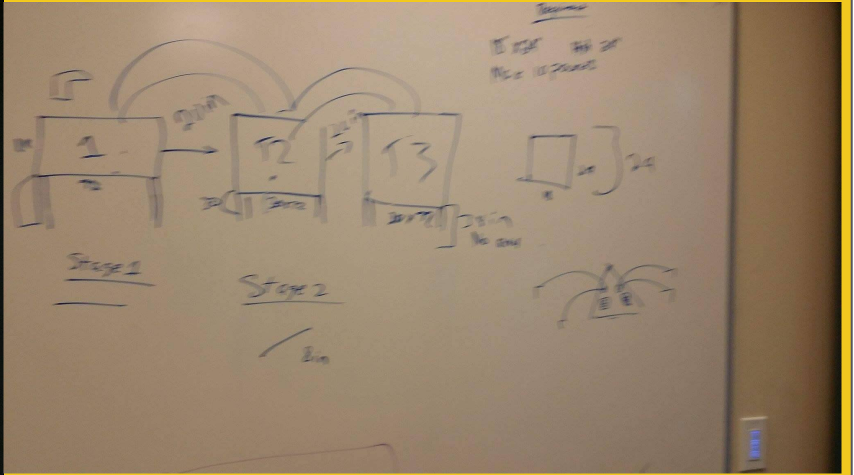
Meeting 6

Minutes:

- In the end, we decided to go with the grappling robot for the time being, as the jumping and crane robots required systems that we were skeptical of being able to complete.
- We began discussing structures for the grappling robot: insert some kind of image
- We looked at different types of hooks, mainly fishing ones.
- The largest problem we faced was finding a remotely operable hook launcher that would shoot the hook far enough to hook onto the next table.
- We had to design a system to retract the string connecting to the grappling hooks.

Meeting 6 - Sketch





Meeting 7

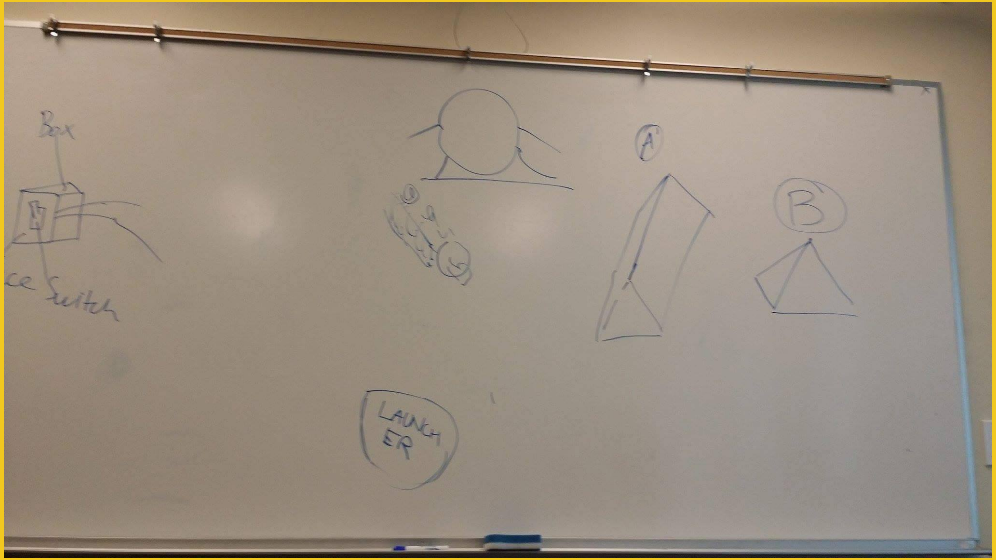
Minutes:

- Decided to place grappling hook launchers on the front surface of the robot.
- Spools of string connected to a motor behind the hook launcher would turn when activated, bringing the string (connected to a grappling hook) back in.
- We decided to do a robot with a rectangular frame, with the front being the longer side.
- For now, we decided to use 3 grappling hooks on the front that would shoot out simultaneously to hook onto the next table and pull the robot up.
- The triple grappling hook setup was so the robot would be pulled up with stability, and minimized risk, e.g. if one hook missed, two others were still there.
- If we had time, we decided we would add wheels onto the sides of the robot, to help it take off of a table with more speed, and give us a possibility to reset the robot without needing to physically touch it.

Meeting 8

Minutes:

- We decided to use a wooden frame for the robot, as one of us had a saw at their house.
- Researched types of grappling hook launchers
- We decided on using fishing hooks as grappling hooks. We would make the fishing hooks dull so we didn't damage tables during the final test.
- Looked up types of motors on sale, e.g. on Amazon, to bring in the string.



Meeting 9

Minutes:

- After looking and researching for some time, we decided the grappling hook idea would be more complicated than we had first expected.
- We had trouble finding a grappling hook that would fit into the small robot frame we had decided to use.
- While continuing to research how to implement a grappling hook, we also looked into other ideas to see if there was a simpler and more efficient method to cross gaps than our current one.
- Near the end of the meeting, we came up with a robot that would use a bridge to cross gaps.
- The robot would have a bridge we held up using string, we would lower the bridge by dropping the string.
- The end of the bridge would have a ring of string. When the robot drove over the end, the hook we used in the grappling robot would be attached to the end of the robot, hooking onto the ring of string and draggin the bridge onto the next bridge.

Meeting 10

Minutes:

- We decided on changing our idea to the new bridge idea, as it was a simpler and more efficient way to cross the gap.
- Instead of a triangular frame, we decided on creating a four wheeled vehicle to drive across the bridge.
- We decided if there were problems with this idea, we would work around them. Thus, we began making a list of parts to purchase.
- Of the parts, we found a good plastic vehicle frame with several different holes to attach things to. The frame came with 4 motors and wheels, so it was very convenient for us.

Meeting 11

Minutes:

- We looked into a variety of websites and videos to find how we would arrange the robot. We looked into types of electronic chips that we would be able to use to control the directions the motors moved.
- We had to discover a method to remotely control the robot. One member proposed using bluetooth, as it would only require a bluetooth chip and a device like a smartphone, and all of us had smartphones.
- We bought a bluetooth chip (HC-06) off of amazon after looking at similar projects and seeing what types of bluetooth chips they used to control their robots.
- We needed to find a chip that would allow us to insert code to control the motors. One of us proposed using an arduino nano, as an arduino was more expensive and larger, and had capabilities we didn't need.

Meeting 12

Minutes:

- We ordered a nano-arduino on Amazon. We used amazon as one of us had prime and so it was convenient.
- Of course, we needed to order male-female wires to connect the different chips. We went to a nearby Fry's to buy them.
- In order to allow the nano-arduino to communicate with the motors, we had to figure out a way to synergize the motors, power, and nano-arduino together.
- One team member accidentally broke a motor in the process of trying to connect it to the power wire.
- We also had to decide on a power source.

Meeting 13

Minutes:

- We bought a four-AA battery case to power our robot.
- We had to buy a breadboard to connect wires to the nano-arduino.
- By looking up different wiring systems using the chips we had bought and doing a quick study of how nano-arduinos work, we were able to construct what we thought would be a working wiring system between the chips, motors and power supply.
- We began work on the bridge, debated what materials we would use for it. We decided to use a light wood bridge for now, with a consideration for card or poster board if the wood proved to be too heavy.

Meeting 14

Minutes:

- After finishing arranging the wiring, we entered our code.
- Before the challenge, most of us were not very experienced in coding. However, Pranay had the most out of us.
- We made our code partly by looking at codes of other robots similar to ours and analyzing their code to see how we could transport it to our own.
- Pranay helped figure out some of the bugs and discrepancies in our code, and eventually we were satisfied with the code and it seemed to make logical sense.
- We found a mobile app on the play store on one of our smartphones that could communicate with the nano-arduino to control our robot.
- We uploaded the code to the nano-arduino at the end of the meeting, tried testing it through the app but the motors did not respond. We decided to try to debug this issue at the next meeting.

Meeting 15

Minutes:

- We had many failed attempts to debug and make the motors work. At a point our bluetooth module itself stopped turning on.
- We checked all our wiring, tried uploading different versions of our code, and troubleshooting and testing if each part of our robot worked individually.
- After connecting the robot to a laptop, we found that the bluetooth module turned on, which insisted that the bluetooth module was working perfectly, and that there was a problem with the voltage that was being received from the battery pack.
- This was supported by the fact that when the bluetooth module had been working and we had sent signals via remote, the motors had responded with a click, but nothing more, which may have meant they needed more power.
- This could only mean that there was something wrong with the power being received from the battery pack, as the power did not reach the bluetooth module.
- We concluded we probably needed more voltage than the current 4 AA batteries provided.

Meeting 16

Minutes:

- Considering we needed more voltage, we decided to test our theory by temporarily attaching another three AA battery pack to the 4 AA battery pack already installed, connecting the new power to our robot circuit using a simple daisy chain wiring system.
- With the added battery pack, we discovered the bluetooth module now responded well.
- When we tried to control the robot with our app, it responded quickly and well.
- We began building our bridge, which we ended up deciding to create out of posterboard.
- None of us had a drill bit large enough to drill holes through the wood large enough to thread rope through.
- We decided to drill two holes on either side of one end of our posterboard, then thread a string through those holes and then tie it at one end, with the other end of the rope planned to be used by us to drop the bridge during the test trial.

Meeting 17

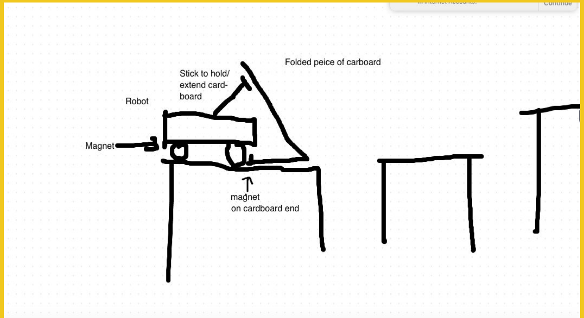
Minutes:

- Almost right before the test trial, we had this meeting.
- We discovered the bluetooth module was becoming unresponsive, and would respond to one order from the phone remote control before it would cut off.
- We troubleshooted this by directly connecting the bluetooth module to a power source. We found that it turned on and was transmitting signals properly when directly connected. This suggested that we were once again lacking more voltage
- We had to purchase an 8-pack of AA batteries, and also we tried rechargeable NiMH batteries, but they didn’t make a large effect.
- In the process of troubleshooting, we accidentally connected the bluetooth module almost directly to 8 AA batteries, burning it out. Thus, we had to order a new one.
- Therefore, these problems took a very long time to troubleshoot, and lead to us having a poor result on the test trial.

Meeting 18

Minutes:

- After attending the test trial, we found we could not use the previous string idea we had planned because it involved direct human power, which was not allowed at the Tech Challenge.
- We had to quickly come up with a new solution to cross the gap. We already had a bridge and a four wheeled moving robot
- We decided to use a stand that would hold the bridge upright when the robot was idle, and when the robot moved forward the stand would push the bridge down.
- The bridge would have a section that remained under the robot so the bridge was stable when it fell onto the next table.
- We decided the hook idea may be a little unreliable, so we changed it to using magnets. We would stick magnets on the back of the robot, and on the end of the bridge, so when the robot drove over it would pick the bridge up and bring it with it onto the next table.
- The bridge fell sideways and was unable to remain straight at the test trial. Thus, we decided to add a section of the bridge that would sit under the robot and ensure the bridge remained straight.



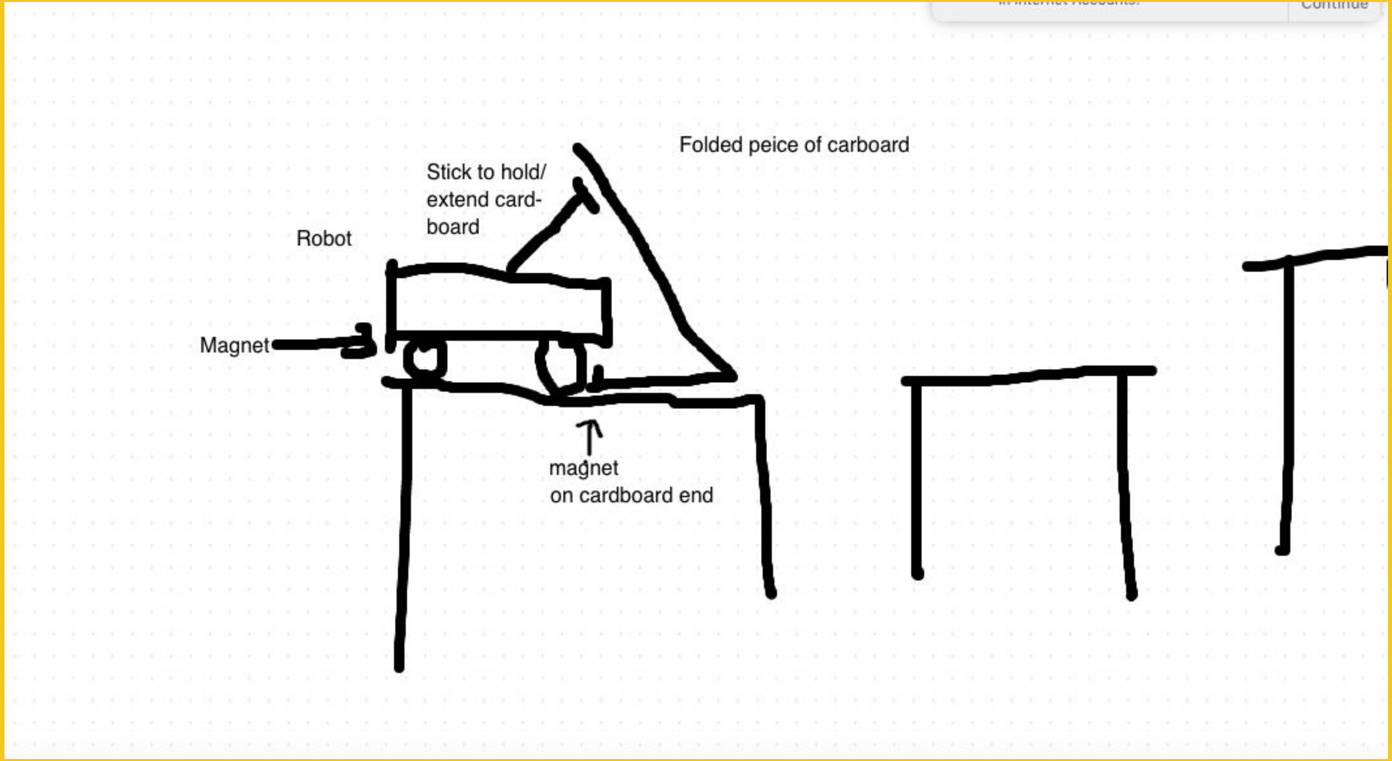
Hardships During Building

- Broke motor, had to re-order.
- Burned bluetooth chip, had to re-order.
- Wiring sometimes didn’t respond correctly, fell out.
- Code seemed like it didn’t respond, though we discovered later it was due to voltage deficit.
- One wheel turned the opposite direction.
- Bridge was unstable.

Final Design

- Robot base is a frame with four moving wheels, can be controlled via a bluetooth remote.
- The robot has a stand for holding a cardboard bridge.
- Robot moves forward, pushing the bridge and dropping it over the gap. Then the robot drives over.
- At the back of the robot, magnets that are attached to the robot and to the bridge attach, and the robot drags the bridge onto the second table.
- Part of the bridge is kept under the robot base because the bridge needs something to stabilize it so it falls accurately over the gap and not sideways.

Final Design Cont.



Controls // Software

Spotlight: Control

Bridge Used

Our robot uses a bridge to cross over the three tables. The bridge is made out of cardboard but has extra support by tape and a poster board. Our bridge is about 24 inches and is collapsible to fit regulation size. The bridge is able to support the full robot while crossing both tables two and three; it is fitted below the robot.

Pushing Device Used

Our robot uses a pushing device, a dead bamboo stick(GO GREEN!), to allow the bridge to lower to the next table. It supports the bridge at the start of the challenge and lowers the dimension of the robot. We will use its length to hold the bridge while standing and push the bridge while moving.

Spotlight: Control

Magnets Used

We have four magnets placed on our robot and bridge, two on the robot and two on the bridge. These magnets will attract while the robot is going on our bridge. After completely going over the bridge, the bridge will attach to the robot and the robot will be able to drive with the bridge, taking it to the next table.

Bluetooth Module

Our robot features a bluetooth module to allow us to control the robot from our cell phones. The bluetooth required us to synergize itself with the nano-arduino by connecting wires. This was required in order to transmit commands to our arduino. The code allows the robot to move front, back, turn left, and right. The bluetooth will help us control our robot with ease.

Spotlight: Control

Arduino Base

Our robot is based on an arduino nano chassis. We have built the full robot from ground up, buying the various parts including a breadboard, LM298H Motor Control Module, mini breadboard, bluetooth module, and the other parts on top of the chassis. We have assem

The Motor Controller

Our robot features a motor controller. This allows all the motors to work coactively. Without this, the synergy between the arduino nano, and the motors would not be possible. This is also where the battery pack is connected.

Spotlight: Software

Code Based Robot

Our robot is based on code to allow us to function the robot from our phones. Our code allows us to control our robot through a phone based app. It lets us move forward, backwards, turn left and right. It will give us an advantage as we will be able to control the robot without using wires to move it.

```
int izqA = 5;
int izqB = 6;
int derA = 9;
int derB = 10;
int vel = 255; // Velocidad d
int estado = 'g'; // inicia d

void setup() {
Serial.begin(9600); // inicia
pinMode(derA, OUTPUT);
pinMode(derB, OUTPUT);
pinMode(izqA, OUTPUT);
pinMode(izqB, OUTPUT);
}

void loop() {

if(Serial.available()>0){ //
estado = Serial.read();
}
if(estado=='a'){ // Forward
  Serial.println(estado);
analogWrite(derB, 0);
analogWrite(izqB, 0);
analogWrite(derA, vel);
analogWrite(izqA, vel);
}
if(estado=='d'){ // right
    Serial.println(estado);
analogWrite(derB, vel);
analogWrite(izqB, 0);
analogWrite(derA, 0);
analogWrite(izqA, vel);
}
if(estado=='c'){ // Stop
    Serial.println(estado);
analogWrite(derB, 0);
analogWrite(izqB, 0);
```

Cost

Cost

Amazon

- Robot base +wheels+motor = $18.75
- HC-06(Bluetooth Module) $7.99
- Arduino Nano $8.99
- Mini Bread Board $5.49
- Motor Drive Controller Board: $5.99
- Poster Board $3.00 - $4.00 ($0 for us, we used leftovers)
- Cardboard (From Boxes, or other source)
- Stick to Prop Bridge (Even a pencil could work)
- Magnets x 2 (2 Magnets per Box) $6
- Duct Tape $3.50 ($0 for us)
- Energizer Max AA Batteries $5.29
- Battery Pack for 8 Batteries $1.50

In The Making

Bought extra motor (one broke) $5.99

HC-06 $8.99 (Broken not used cant return)

Cost to Produce: $67.50

Cost (Including Defects and products we already had): $68.19