Engineering Notebook Group 2: Happy Forest Friends

Honors Introduction to Engineering
440-191 Section H1
Dean Antoine

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Executive Summary

The goal of the project is to create a human-centered design using a designated list of materials. The project will have to be completed by December 2nd, along with a visual presentation. The materials allowed are the following, along with additional materials approved by Dean Antoine:

- Paper Clips
- Rubber Bands
- Toothpicks
- Poster-board or Cardboard (may be cut to any size)
- String or Twine (may be cut to any size)
- Cardboard Tubes (any size)
- Glue and/or Adhesive Tape (any kind)
- Things easily found in a person's house (must be approved by Dean Antoine)
- Sparkfun Inventor Kit

Creating a human-centered design means creating a product that satisfies the need of people. As such, our design process will consist of brainstorming human-centered problems that we encounter, analyzing those problems and choosing one as our project, more brainstorming on how we solve that problem, creating prototypes that could solve that problem, and eventually designing a final product. We will have to make sure our design is ergonomic to fit a person's needs.

The three phases of human-centered design are the Inspiration Phase, Ideation Phase, and Implementation Phase. During the Inspiration Phase, we will analyze the issue facing us and understand significance of the problem. In the Ideation Phase, we will brainstorm on how to solve this problem. And lastly, we will create our final product during the Implementation Phase. Using this process, we can be sure that we specifically address the problem that we chose to resolve, always keeping the people using the device in mind.

Based on the constraints on the materials, the project will be both lightweight and cheap. The materials given are not considered strong or durable. Therefore, we will have to find a way to make our product by enhancing the materials given so the product will be viable. This requires rethinking the way that these everyday objects function so that we can design something both unique and useful.

Written By: Forest Song
Reviewed By: Angela Yao Date: October 11, 2016

Team Biographies

Name: Shilp Shah
Type: Guardian/Integrator
Major: Electrical/Computer Engineering

Shilp Shah was born in India, and moved to Toronto, Canada at the age of 3. When he was 13 years old, he moved to East Windsor, New Jersey and attended Hightstown High School. In high school, Shilp was very involved in his school robotics team, inspiring him to pursue engineering. Shilp will major in Electrical/Computer Engineering because he enjoys tinkering with computers and coding. In his free time, Shilp likes to play basketball and watch football.

Name: Forest Song
Type: Pioneer/Driver
Major: Mechanical Engineering

Forest Song was born in New York, and moved to Livingston, New Jersey when he was less than 1 year old. He attended Livingston High School and decided to do engineering after doing robotics in high school. He plans to do mechanical engineering because he enjoys building and it is also a very broad and diverse major. In his free time, Forest enjoys playing Go, running, and coming up with clever jokes. He also participates in the Go Club and Ping Pong Club here at Rutgers.

Team Biographies (cont'd)

Name: Amy Su
Type: Pioneer/Driver
Major: Mechanical Engineering

Amy is from Bridgewater, NJ. She attended Bridgewater-Raritan Regional High School, where she took an interest in both art and STEM fields. She was a head editor of her school newspaper, the vice president of the German Honor Society, and an officer in multiple clubs. Her interests include running, martial arts, painting and sketching. She now does ballroom dancing in the Rutgers Ballroom Club and volunteers with SWE.

Name: Angela Yao
Type: Pioneer/Integrator
Major: Industrial Engineering

Angela Yao grew up in Metuchen, New Jersey. She attended Metuchen High School and developed an interest in the arts and STEM. She decided to do Industrial Engineering because she enjoys managing systems and making them run efficiently. Aside from her studies, Angela is very involved with clubs around campus, including SWE, EWB, and ballroom. In her free time, she enjoys reading and talking with her friends.

Team Biographies (cont'd)

Name: Stefan Luong
Type: Pioneer/Driver
Major: Industrial Engineering

Stefan Luong is from Randolph, New Jersey. In high school, he took a large amount of STEM classes and was a part of many academic and service clubs. Now at Rutgers, he chose Industrial Engineering because he could improve systems and streamline complex structures. He partakes in Engineers Without Borders and Developmental and Experiential Learning. He is interested in cooking and tennis.

Name: Alison Bansil
Type: Guardian/Driver
Major: Civil/Environmental Engineering

Alison Bansil was born in the Philippines and moved to the U.S. on April 26, 2006. She is fluent in two languages and proficient in three others. In high school, she was captain of the field hockey team and participated in the math and science teams. At Rutgers, she is a part of the Ballroom Club and HARU Kpop Dance Club. Her hobbies include dancing, singing, playing instruments (ukulele, guitar, piano, violin), watching TV shows on Netflix and Dramafever, and solving the daily Sudoku puzzle in *The Daily Targum*.

Team Biographies (cont'd)

Name: Salman Omer
Type: Guardian/Integrator
Major: Undecided

Salman Omer is from Millburn, NJ. In high school, he held an interest in science related courses and decided to go into engineering to learn more technical aspects. He was also on his high school team's volleyball team. Currently, Salman is involved in Engineers with Borders, because he enjoys applying his knowledge so that he can help others. His hobbies include playing squash, volleyball, and League of Legends.

Name: Brian Ma
Type: Pioneer/Driver
Major: Computer Engineering

Brian Ma attended Hightstown High School. In high school, he participated in robotics and developed an interest in video games, leading him to pursue Computer Engineering. His current hobbies include playing League of Legends and watching anime. Furthermore, he always dresses well by wearing khakis and polos.

Group Chemistry Analysis

An important part of the project is the team chemistry. Based on Deloitte's Business Chemistry model, our team has 4 Pioneer-Drivers, 2 Guardian-Integrators, 1 Pioneer-Integrator, and 1 Guardian-Driver. We can utilize the Deloitte system to predict how the team will operate. We have a good variety of personality types, meaning that Team Forest Friends always has a voice from each combination. Our team have a good mix of people that can generate ideas, meet goals, be realistic, and include everyone. However a possible downside could be conflicting opinions for decisions. This information can assist in forming roles and dividing the tasks to optimize effective work output.

We took advantage of the Business Chemistry knowledge to create a smooth team environment. Each member understands the differences between the four types and how each operates in their own way. We can use the system to predict possible conflict points and prevent them before they start. For example, the drivers understand that they shouldn't push too hard for progress and deadlines without consulting the rest of the team. This behavior might upset others because they would feel left out of the decision-making period. Also, the pioneers have a slight majority. This means our team tends towards creating ideas rather than implementing them. We compensated with a precise schedule of deadlines. It forces us to start bringing our ideas into reality and having something to show for the mental power we put into the project.

The biggest initial problem is discord between the Pioneer-Drivers and the Guardian-Integrators. On the Business Chemistry chart, they are polar opposites, each type preferring what the other one is uncomfortable with. The two types would view the other type with disdain, because it was a different way of behaving. Pioneer-Drivers are too insensitive and unrealistic; Guardian-Integrators are too unimaginative and inefficient. However, we came to the conclusion that both types had their own pros and cons and balanced each other out.

In addition, we strive for the ideal team according to Google's research. An effective team can rely on all of its team members for their opinions and thoughts on a subject. This results in a free-flowing conversation, where each person can build off of each other's ideas, developing possible ideas and pointing out any possible problems or issues. We are also very open-minded, so no plausible idea is ever immediately disposed of until we have discussed it at enough length.

The most useful quality of this team is our friendliness. Conveniently, we live fairly close which allows us to meet, socialize, and work together with ease. Another major point of the Google article on effective teams is ability to talk about anything, even unrelated to work. Everyone is safe to say whatever is on their mind with a sense of security in the room.

A huge challenge is determining the idea we are choosing for the project. The pioneers want to keep generating ideas while the guardians want to seek out plausibility of each idea before moving on. Pioneers think it's unproductive to find problems while brainstorming while guardians think it's unproductive to brainstorm without realism. We will overcome this problem by creating stages in which we would solely brainstorm and then later solely discuss the practicality of an idea with the materials allotted. This satisfies the desires of everyone on the team, a perfect compromise.

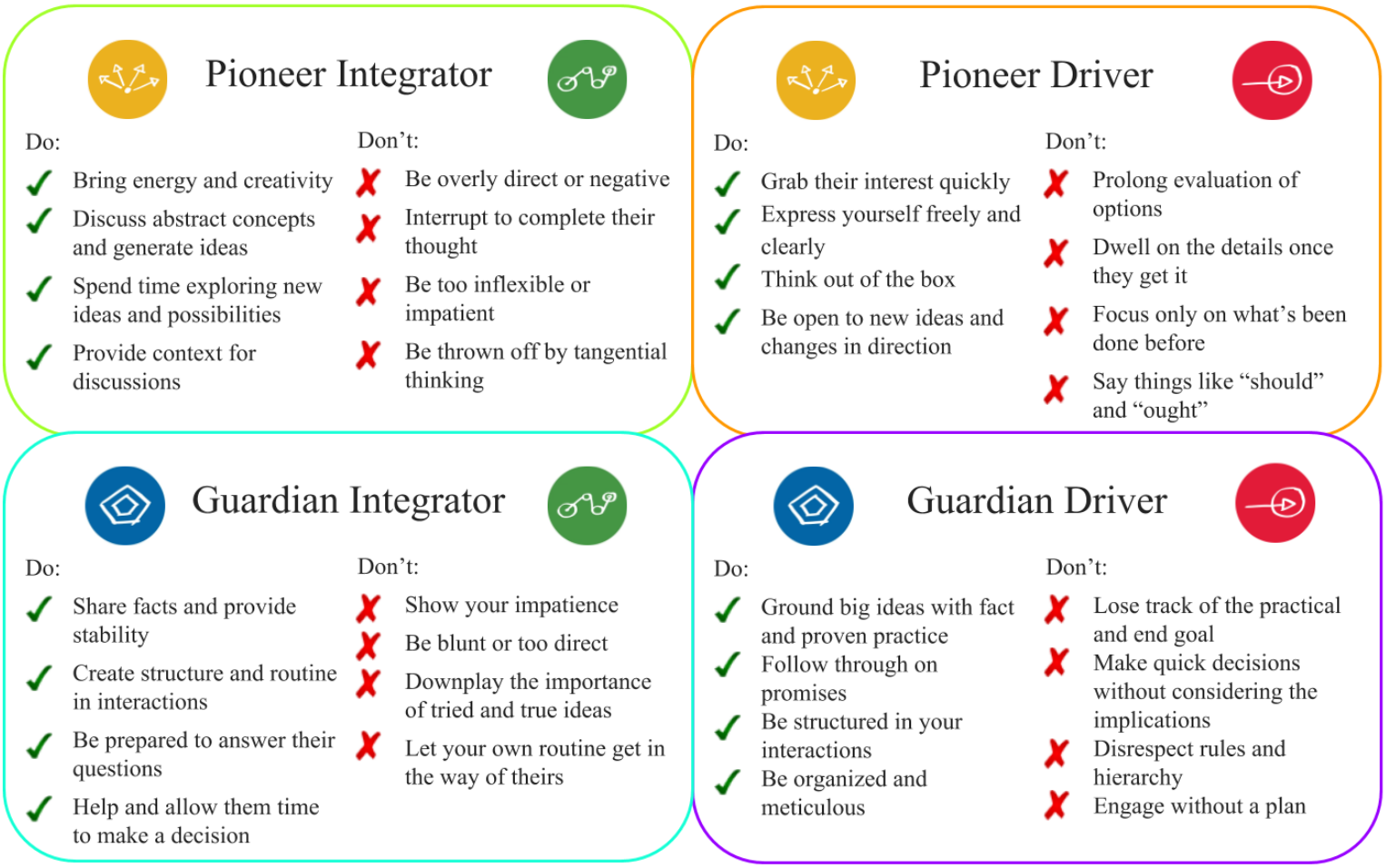
In the future, the team members will split into specializations. The experienced coders will take on the software task with the Arduino. Their objective is to take information, such as time of day or temperature and have the Arduino peripherals act accordingly. We plan for the blinds to change at certain points in the day and for the window to move to adjust the temperature in the room.

For hardware, we operated with a free-flowing cycle. Whoever was present for construction contributed for the cutting of the poster board. Overall, the hardware crew is a joint effort by everyone. Each member has contributed to the frame construction and continues to work on the window screen body. We naturally fell into efficient actions; any person that wasn't needed for the current precision cutting process automatically chose another task that they could help with. We boosted our productivity by simultaneously working on the engineering notebook, construction, and coding.

In the end, we all understand that each person is a unique being and that in order to work successfully as a team, we need to cooperate in a progressive, mindful way. All of us have our own gifts to contribute, while also having areas of weakness. We're lucky that we have such a large team. Eight people certainly has enough room for each person to choose a task that they prefer, granting them the chance to work more excitedly. We want everyone to be at their best, and know that they are valued members of Happy Forest Friends.

Written By: Stefan Luong
Reviewed By: Alison Bansil Date: October 12, 2016

Group Chemistry Analysis (cont'd)



We also created a table of pointers for interacting with each type. These will help to keep a harmonious team environment.

Written By: Stefan Luong
Reviewed By: Alison Bansil

Date: October 12, 2016

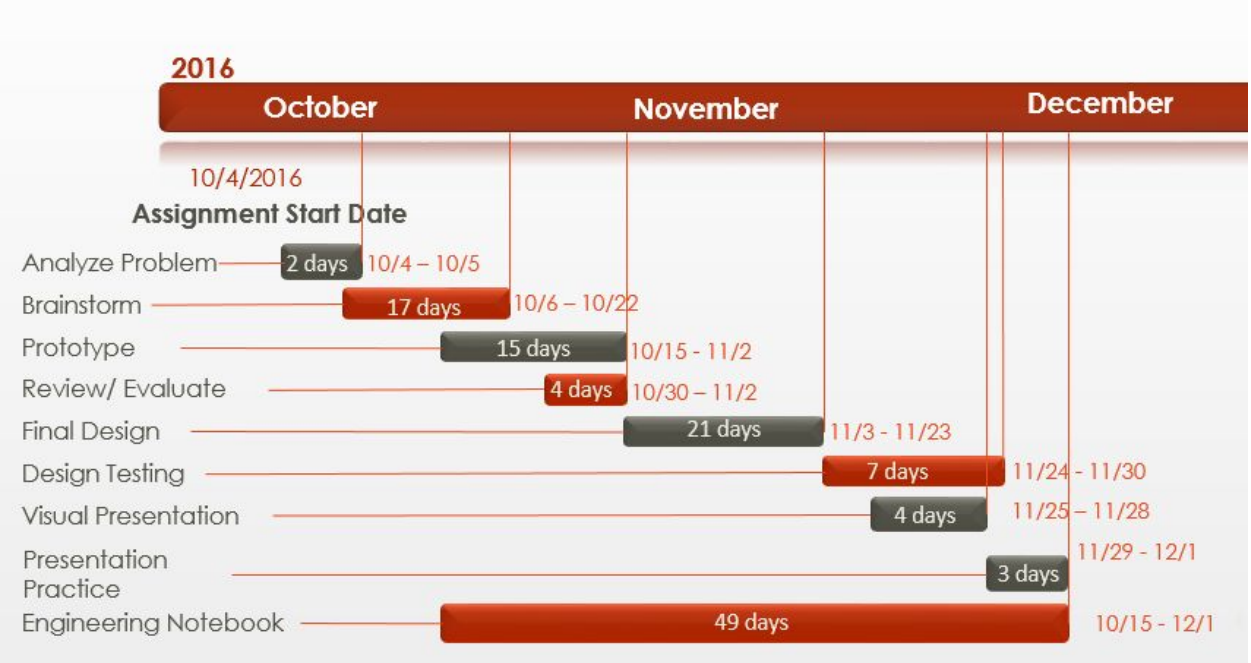
Meeting: Determining a Timeline for Our Project

Task: To create a timeline for our project so that we can stay on task and finish our project on time.

- We met in Amy and Angela's room to create a timeline for our project so we would stay on task
- We made sure to give ourselves large chunks of time to brainstorm
- Schedule may be subject to change due to group members being busy with classes and exams
- Made sure to leave time at end for testing and preparing for presentation

Angela and Brian working on the Gantt Chart

Using Microsoft Excel, we created a Gantt Chart and sectioned off time for brainstorming, building, and finalizing.



Finalized Gantt Chart

Reflection: Creating a Gantt Chart will enable us to stay on task and make sure that we finish the project on time.

Written By: Forest Song
Reviewed By: Amy Su
Date: October 15, 2016

Meeting: Idea Brainstorming

Task: To come up with various designs for a human centered design.

Plan:

- Meet to discuss and take note of ideas
- Be as creative as possible, choosing quantity over quality
- Refine ideas by choosing the most exciting yet practical ideas
- Discuss then vote on the final idea we will create

Idea Brainstorming:

Collapsable Ladder	Shower Shelf Caddie	Clothing Dresser
Stress Ball Energy Converter	Clothing Hanger	Burn Alarm for Food
Multi-Size Pan	Irrigation Device	Condiment Machine
Enhanced Swiss Army Knife	Item Glider	Homeless Portable Shelter
Self-Sustainable Porta Potty	Bungee Chair Sanctuary	Umbrella Heater
E-Piano	Exo-Suit	Candy Dispenser + Game
Countertop Cleaner Roomba	Thermos Temperature Stabilizer	Stair Cart Climber
Hoverboard	Bed height changer	Movable TV
Pocket Table	Ball Finder Robot	Arduino DJ

- We discussed various problems we could fix
- We tried to be as open as possible and not discount improbable ideas in order to stimulate our creative thinking
- When we couldn't come up with more ideas, we decided to narrow the 27 ideas down to a top 4
- We based the best ideas based off of practicality with the given time and materials, creativity, and usefulness

Meeting: Idea Brainstorming (cont'd)

After narrowing our ideas down through a voting spreadsheet, as pictured below, we arrived at our top 4 choices (bolded in green).

										Everyone has 5 votes, order them(1-5) 1 is your top idea choice
										top 3-5 ideas we'll discuss at 9:pm and choose a final
Ideas/Names	Description(If necessary)	Alison	Amy	Angela	Brian	Forest	Salman	Shilp	Stefan	have a clue about plausibility with materials
Self Destructing House										
Collapsable Ladder							4		3	
Stress Ball Energy Converter										
Multi-Size Pan										
Self-Sustainable Porta Potty										
Countertop Cleaner Roomba	Moves around objects on floor/counter to clean dust			2						
Pocket Table	Super small collapsable table	3	5		3					
Clothing Dresser										
Burn Alarm for Food										
Condiment Machine										
Portable Homeless Shelter			2		2	1	5	4		
Umbrella Heater	warms hands while holding					5				
Candy Dispenser + Game										
Stair Cart Climber		4				2	3	3	4	
Movable TV										
Arduino DJ	Detects mood of room and finds music accordingly	5				4	1			
Shower Shelf Caddie										
Clothing Hanger	a machine/vacuum that hangs clothing for you			1						
Irrigation Device										
Item Glider								2		
Bungee Chair Sanctuary	stress relieving chair								1	
A system that controls window	Opens/Closes blinds and window automatically based on outside and inside temperature, light and attempts to match the settings created by user or can be manually activated through phone or computer	1	3	3	1	3	1	1	5	
Thermos Temperature Stabilizer	Input designated temp-fan/heater to stabilize temperature quickly			4				5		
Bed height changer										
Ball Finder Robot	Like the automated ping pong machine but instead puts it back on baseball tee or something instead of shooting it back like usual.									
Paper airplane folder										
Light mover	Use 2 mirrors to deflect light towards a book or away from a screen; attaches to book/laptop/phone, helps when it's inconvenient to turn your book towards the sun or screen away from it									
Charger ejector	Bad for batteries to be plugged in for too long; this can draw information from the phone when it reaches 100% and un plugs one end, so you can charge it overnight w/o worry	2	4	5					2	

Top Choices:

Automatic Window & Blinds - This project would open and close blinds and window automatically based on temperature and lighting. The user sets preferences and the design will attempt to match the temperature and lighting settings created by user or can be manually activated through phone or computer

How:

- use the arduino and light and temperature sensors to open and close the blinds

Pros:

- could be synchronized with an alarm clock to open the blinds when a person is supposed to wake up
- a form of temperature control that does not use air conditioning or heating; a cheap convenient alternative

Cons:

- windows have different resistances to movement
- window not useful in wintertime

Homeless Tent- cheap design distributed to the homeless to set up, then fold up and transport

How:

- using a tarp and toilet paper roll tubes formed into a "telescope" for reinforced by paperclips

Meeting: Idea Brainstorming (cont'd)

Pros:

- creates affordable housing that provides much more shelter than a cardboard box and more space than a crowded homeless shelter for homeless people

Cons:

- needs to afford same comforts of a tent with much less money

Stair Cart - a type of cart/dolly that can be used to carry heavy objects up stairs easier

How:

- by using some kind of gear system (similar to a bicycle) or a pedal (which would allow one to use their body weight to push the object) a person would be able to put a little force over a longer period to carry heavier objects up stairs easily

Pros:

- especially useful in areas where buildings do not have elevators
- less worry about purchasing heavy objects and having to carry them up many flights of stairs

Cons:

- already exists in a similar form (but can still be improved)

Charger Ejector-draws information from the phone when it reaches 100% and unplugs one end, so you can charge it overnight without worry.

How:

- will collect information on when the phone has reached 100% using arduino
- will eject charger using a servo as soon as a full charge is indicated

Pros:

- overcharging can cause a battery to burn out more quickly, so the ejector could prolong battery life

Cons:

- not intricate enough
- might not be worth it
- once unplugged, the device starts to lose battery

Reflection: By brainstorming all of these ideas, we were able to be creative and open to all possibilities for our project. We ultimately decided on building an automatic window and shade system, which is creative, useful, and practical to make in our timeframe.

Written By: Alison Bansil

Reviewed By: Salman Omer Date: October 22, 2016

Meeting: Goals for Our Window Design

Task: to set goals and deadlines for our group and define how we will accomplish them.

The window design will:

- Move and adjust window blinds based on user preference
- Open and close the window depending on the temperature
- Respond to user feedback and settings

To maximize the group efficiency, we decided to split up into two groups: hardware and software. However, we kept the division relatively flexible, so that people could work on whichever area they had more interest in.

Hardware Goals	Software Goals
Brainstorm mechanism to move the window and mechanism to move and adjust blinds Create the scaled-down model Make sure to leave enough time for testing and troubleshooting	Test out various functions of the Arduino, including: ● Motor ● Servo ● Temperature, light, and flex sensors ● LEDs Become more familiar with the code Potentially connecting the Arduino to a iPhone/Android app

Stefan outlining tentative objectives and potential ideas for both software and hardware aspects

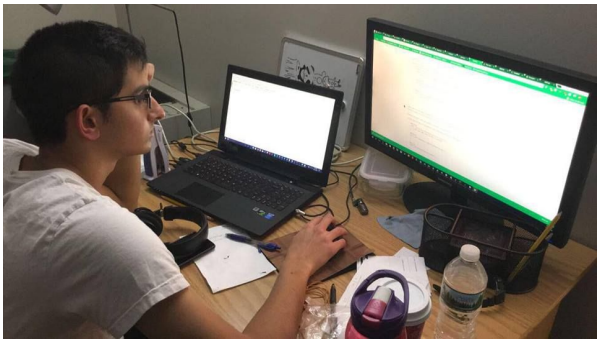
Reflection: these meetings were useful because they helped us to come up with a series of solid and timely goals, rather than being vague and then eventually having to rush to finish the project. We also discussed a lot, which helped us explore our strengths and weaknesses as individuals and a group.

Written by: Amy Su
Reviewed by: Shilp Shah Date: November 2, 2016

Meeting: Software: Learning and Testing Arduino DC Motor

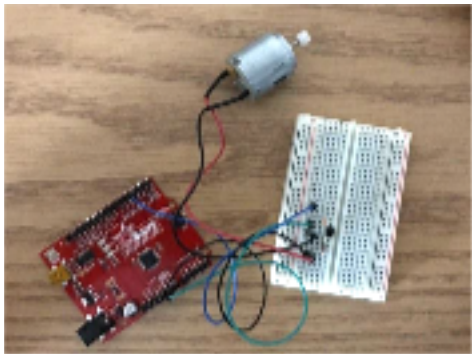
Task: To learn more about arduino and test the motor.

-People that were interested in programming met in Brian and my room
-we all decided to download arduino on our laptops and work on learning the language and wiring



Here I'm looking online for tutorials on how the arduino works.

- After consulting various online tutorials and the instruction booklet, we managed to code and wire a system for the motor to move
- We tested out the motor because it was essential to our project and we wanted to make sure we knew it worked
- Created arduino code based on tutorial of dc motor movement
- We able to make motor spin at varying speeds designated by the computer



Our motor setup and configuration

-We might have to gear the motor up because it does not seem that powerful

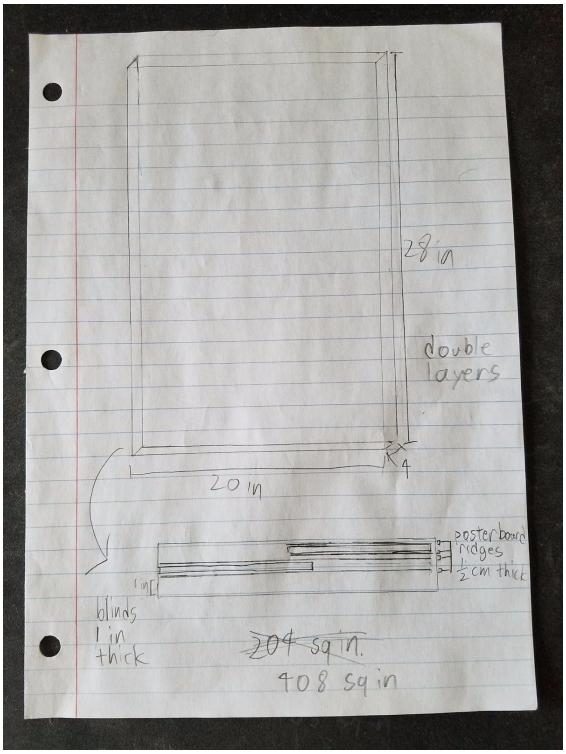
Reflection: Exploring arduino this early on will make sure we stay on track while we are doing the project.

Written By: Salman Omer
Reviewed By: Forest Song Date: November 3, 2016

Meeting: Hardware: Designing the Window Frame

Task: To design a scaled down window frame to form the base on which to mount the rest of the device.

We decided to scale down the size of the window to accommodate for the lack of power of the motor. Consequently, we had to buy blinds in order to fit this smaller window. We determined the size of both window and blinds by figuring out a ratio that would work with a window about 3 feet in height. The following is a rough sketch of the specifications of our window.



Blinds:

- 20in x 28in

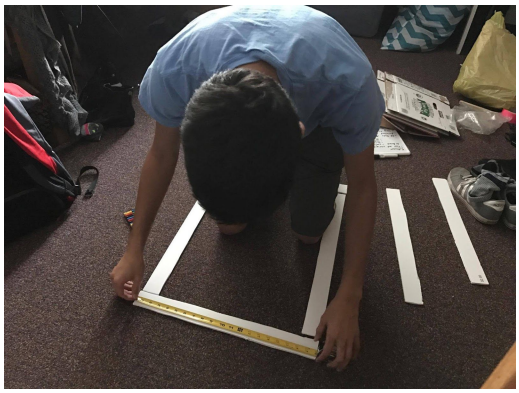
Window:

- 20in x 28 in frame
- Double layer for strength

Window Pane:

- Two 27 in x 9.8 in frames
- Laminate area between two frames
- One pane stationary
- Other pane moves along window track

Reflection: After this meeting, we all knew what we needed to either bring from home or buy from a store to put the window and blinds together. We decided to buy 4 foam boards which would be used as the basis for the window. We also decided to use hot glue guns to bind everything together quickly.



Salman measuring out potential dimensions for the frame

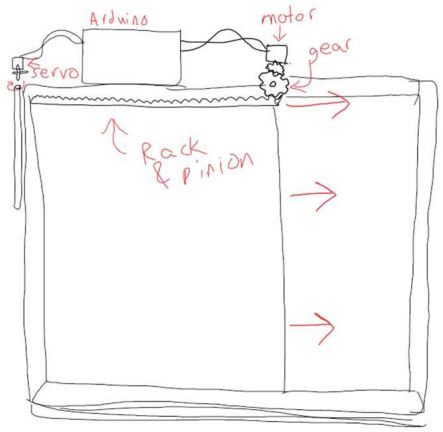
Written by: Brian Ma
Reviewed by: Angela Yao Date: November 4, 2016

Meeting: Hardware: Window Moving Design

Task: To create a design that would enable us to open and close a window pane

Possible Designs:

Rack & Pinion Design



Description:

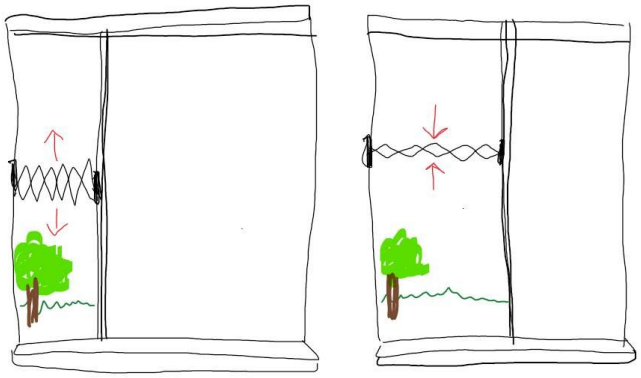
- Motor connects to gear
- Gear connects to rack & pinion
- Rack & pinion attached to window glass
- glass slides right as gear pushes the teeth

This was the first design we came up with. It is a very logical way to move the window, however proved impractical with the materials we had. We needed a gear that would fit the motor's ridges exactly, and then a rack and pinion that would fit these teeth as well. In addition to this, the rack and pinion would need to be stuck along the length of the window in some way and this is not practical to have on a window.

Accordion Style Design

Description

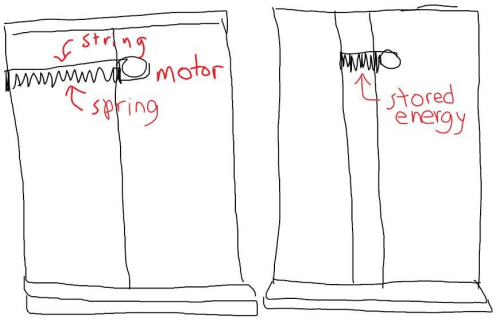
- Accordion bar between window and frame
- Motor attached to string
- String tightens bars in one direction
- opens bars in other direction



This design was an interesting idea because it meant that the motion of opening and closing a small segment could be used to open and close a larger window. This turned out to be even more impractical though because the motion of the motor does not lend itself well to applying force on the outer and inner parts of the clamp. The clamp between the glass and frame would also mean that the window would never close completely.

Meeting: Hardware: Window Moving Design(cont'd)

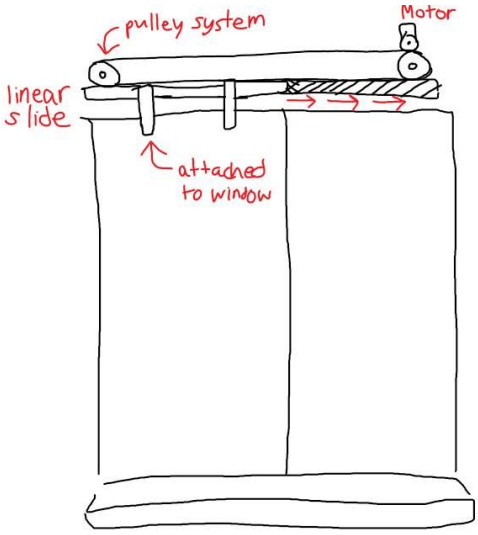
Windup Spring Design



Description:

- Motor attached to spring
- spring attached to window
- Spring compresses to open window
- Spring retracts to close window

While this design would allow for no work to be done to close the window, it would require double the work initially to pull the window back. This puts an even greater strain on the motor. In addition, it would be difficult to make function and would not look good visually to attach a spring to the front of the window.



Linear Slide Design

Description:

- Motor attached to pulley
- Pulley moves linear slide
- Linear slide attached in parts to window

This is the design we ended up choosing. While it is bulkier than the rest, it minimizes the work done by the motor by eliminating much of the friction that comes from opening a window. In addition, there only needs to be a small part of the design that sticks to the window, whereas the other designs required larger areas of the window to be covered.

Reflection: We ultimately decided on the Linear Slide design because it was the most practical for us to build in the time frame and with the materials we had to work with. This brainstorming session was useful for us because everyone was able to share their ideas and we were able to come up with a solution to progress our project.

Written By: Angela Yao
Reviewed By: Stefan Luong Date: November 5, 2016

Meeting: Software: Arduino Exploration Continued

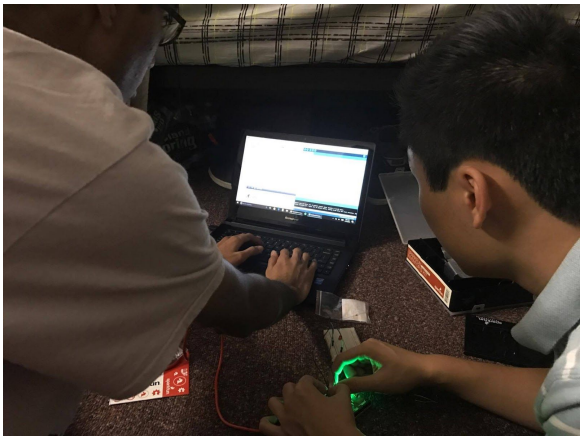
Task: To learn more about the Sparkfun Inventor Kit, specifically with the breadboard and Arduino.

Upon getting the Sparkfun Inventor Kit, our group had not tested it thoroughly and we were more focused on the hardware of the window at the time. But Brian and I decided to test some sensors and wiring so we could get learn more about the circuit and functionality of the Arduino. No one in the group had much experience with the arduino so we wanted to get a head start by testing the basics.

Some of the things we tested and learned were:

- Wiring the LED (even though we do not use it for our project we wanted to start small)
- Writing code to change the brightness of the LED and have it blink
- Wiring a multicolored LED
- Attaching the light sensor
- Writing code to change the brightness of LED based on the light received by the sensor (this simulates the opening and closing of blinds based on the light in the room)

With some basics tested, Brian and I thought we had good handle on how the wiring would work for all the components of the project.



Picture of Brian and I writing code and wiring the breadboard

Reflection: This software meeting was extremely productive because we were able to get a true idea of how the arduino language works. This will make programming and wiring for the actual project a lot faster and easier.

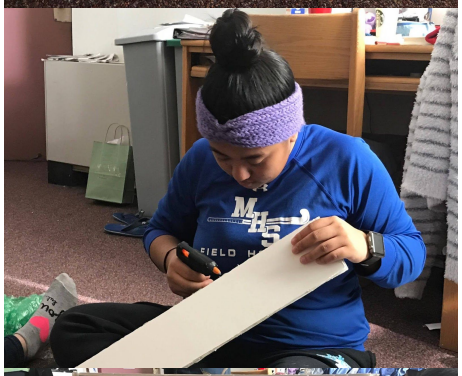
Written By: Shilp Shah
Reviewed By: Brian Ma Date: November 10, 2016

Meeting: Hardware: Constructing the Window Frame

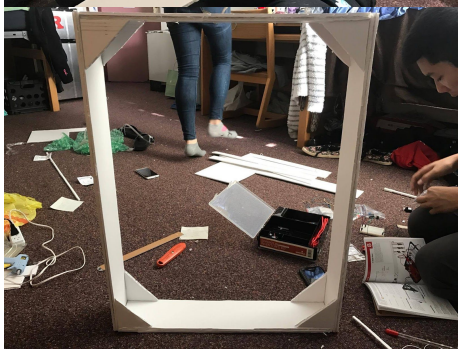
Task: To construct the frame of the window that holds all components of the project

- Using the dimensions we figured out from the past meeting (pg. 18), we marked the dimensions on bought foam core and cut it out.
- Double layered each side for more strength
- Added 8 triangle supports on inside to keep the joints structurally sound

Pieces cut out from foam core



Assembling the window



Completed window frame

Reflection: The only challenge we ran into was in cutting the foam core precisely. We ended up with a lot of jagged edges but didn't have enough foam core to just make new pieces. This challenge was faced by trying different techniques. Overall, this meeting was very productive because of our time spent planning during the last meeting.

Written by: Angela Yao

Reviewed by: Alison Bansil Date: November 11, 2016

Meeting: Preparations for Break

Task: To create a plan so we can maximize our efficiency of working over Thanksgiving break.

We met in Amy and Angela's room to figure out what we had to accomplish during the four-day Thanksgiving weekend.

Everyone meeting to decide what to do over break

After discussion, we ultimately decided:

- Necessary materials we needed
    - Needed to buy blinds, get gears, axle from toys
    - Potentially buy new motor, servo if they were not strong enough
    - Costs would be split at end
- How to build the slide for the window
    - Linear slide system with strings
    - Forest would work on it because he had past experience with it in robotics
- Not everyone would work together over break
    - Brian takes SIK (Sparkfun Inventor Kit) to work on wiring and programming
    - Forest takes window frame to work on linear slide
    - Everyone else would give advice and improve and update the logbook

Reflection: This meeting was useful for us to figure out what we still had to accomplish and how to use our time over break.

Written By: Alison Bansil
Reviewed By: Amy Su Date: November 21, 2016

Meeting: Software: Coding

Task: To write the code for all of the necessary components of the project.

```
float getVoltage(int pin)
{
  return (analogRead(pin) * 0.004882814);
}

void turnServo(int light, int level)
{
  boolean min = false;
  boolean max = false;
  light = analogRead(lightPin);
  while((light - level) > 100 && min == false)
  {
    int position = servo1.read();
    light = analogRead(lightPin);
    if(position - 2 < 0)
    {
      min = true;
      break;
    }
    else
    {
      max = false;
      servo1.write(position - 2);
      delay(20);
    }

  }
  while((light - level) < -100 && max == false)
  {
    int position = servo1.read();
    light = analogRead(lightPin);
    if(position + 2 > 180)
    {
      max = true;
      break;
    }
    else
    {
      min = false;
      servo1.write(position + 2);
```

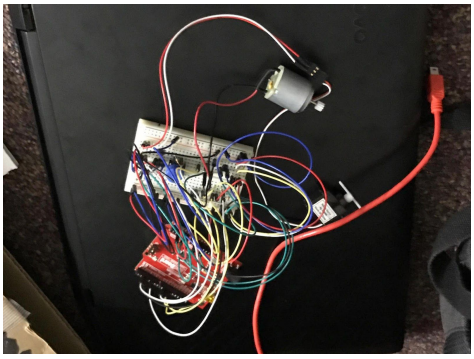
turnServo function takes in 2 inputs, light reading and light level you want in the room. Based on these 2 inputs, the servo opens or closes the blinds until the light level reaches a certain amount. This is done by using a for loop that turns the blinds until the light sensor reads a minimum value.

```
    {
      max = true;
      break;
    }
    else
    {
      min = false;
      servo1.write(position + 2);
      delay(20);
    }
  }
}

void turnMotor(int degrees)
{
  if(degrees - yesTemp < -5)
  {
    if(analogRead(2) > 0)
    {
      break;
    }
    while(analogRead(2) = 0)
    {
      analogWrite(enablePin, 100);
      digitalWrite(in1Pin, ! reverse);
      digitalWrite(in2Pin, reverse);
    }

  }
  if(degrees - yesTemp > 5)
  {
    if(digitalRead(buttonPin) == LOW)
    {
      break;
    }
    while(digitalRead(buttonPin) == !LOW)
    {
      analogWrite(enablePin, 100);
      digitalWrite(in1Pin, reverse);
      digitalWrite(in2Pin, ! reverse);
    }
  }
}
```

turnMotor function takes in degrees, which is the reading from the temperature sensor. Based on the temperature, the motor fully opens or fully closes the window. This is done through a while loops which checks if the outside temperature (since we cannot get data of outside temperature, we input this value) is greater than or less than the desired temperature in the room.



This is the final picture of the arduino with all the wiring complete. We need to make wires longer to ensure that we can connect to all of our components

Reflection: We were able to quickly and efficiently code all of the parts of the project and learn how to wire because of our previous planning.

Written By: Brian Ma
Reviewed By: Stefan Luong Date: November 23, 2016

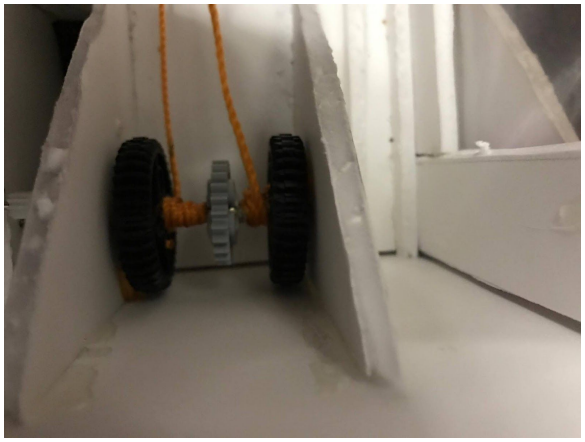
Meeting: Hardware: Linear Slide Design

Task: To create a design for the linear slide that will enable us to move back and forth.

- After discussing various designs our previous meeting, we decided to go with the linear slide design to move our window back and forth
- I disassembled a drawer in my house and took out the linear slide that came with it
- After lubricating the slide, it was both smooth and compact, which would be effective for our window

Problem: Commonly, when powering linear slides, they are powered one way using string, and use gravity to let it fall the other way. However, in this case because the slide will be placed on its side, it will have to be powered both ways.

Solution: We use two strings that go in opposite ways on the same axle that are wound opposite ways so they pull the linear slide in opposite directions.



- One string goes from the top of the axle and the other goes from the bottom
- Separated by plastic gears that we disassembled, so the string could be tied easily and not get caught on each other
- String is wound around an axle, which turns using a motor so the string pulls one direction and loosens the other direction

- One end of string goes through a pulley that is attached to immobile part of slide
- This loops around the pulley (made of plastic parts from old toys) and pulls the window “closed” from that immobile point
- The other string is attached to the end of the mobile part of the slide, which pulls the window “open”

Meeting: Hardware: Linear Slide Design (cont'd)

Benefits of Double String System:

- Compact system that allows us to easily also fit the window panes and blinds
- Uses easily found materials(drawer slide commonly found in homes, string) to construct something that moves easily side to side with little friction
- Easy to make in the time frame given
- I've had previous experience with building a similar system so it will be easier to fix problems if issues arise
- ***Creative*** solution to the problem: a system that has easily replaceable parts and can be easily added to any window system

Linear slide when the window is "closed"

Linear slide when the window is "open"

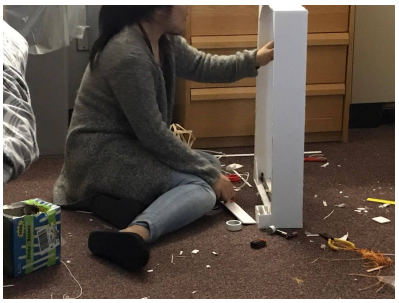
-We will have to make sure to regularly lubricate the slide so it moves with as little friction as possible
-Potentially replace the string after testing because it gets worn out easily
-Create attachments on the slide that will attach the slide to the window pane and allow it to move easily

Reflection: This linear slide system is an innovative solution to our project that is both functional and practical. More testing and fine tuning will have to be conducted so the slide can move the window pane seamlessly.

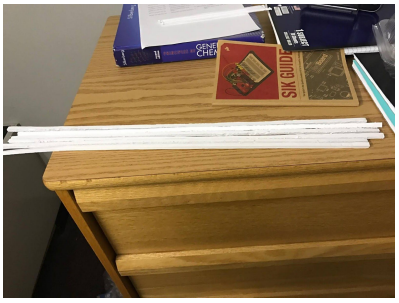
Written By: Forest Song
Reviewed By: Shilp Shah Date: November 24, 2016

Meeting: Hardware: Designing the Window Panes

Task: to construct the window pane and rails that would hold them in place.



Step 1: We measured and cut out the frame of the window panes so that they fit inside the outer frame.



Step 2: We glued together the pieces of posterboard to form the frames for the panes.

Step 3: We measured, cut up, and added clear garbage bags as the transparent panes to create more of a resemblance to real windows.

Step 4: We cut out guide rails so the panes would be held in place in the window.

Reflection: We effectively made window panes that are lightweight and will be held securely in place by guide rails. We were very satisfied with the finished appearance.

Written By: Amy Su
Reviewed By: Angela Yao Date: November 28, 2016

Meeting: Hardware: Gearbox

Task: To create a gearbox that will enable us to use to motor to power the linear slides

-In our constraints, we are not allowed to use lego gears, and buying would waste time
-We decided to disassemble household items, which we were allowed to, in order to get our gears

- I disassembled an old toy car. From the car I was able to take both an axle and gears, which would be really useful for gearing our motor

- Because our motor spins at a very fast rate but does not have a lot of torque, we wanted to gear it for torque so we had enough power to move the slide and window pane
- To gear it for torque we placed a small gear on the motor and a larger gear on the axle
- We mounted the motor on foam core and hot glued it securely on two plates so that it would not wobble while we were testing

After testing it several times, we were able to successfully move both the linear slide and window pane using a 9V battery. This shows that this gear ratio is enough for this motor to move this system.
Reflection: This gearbox was essential to making sure the motor had enough power to move the window forwards and backwards.

Written By: Forest Song
Reviewed By: Salman Omer Date: November 29, 2016

Meeting: Hardware: Tilting the Blinds

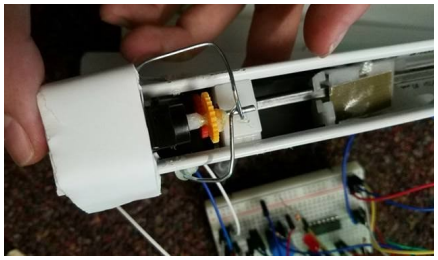
Task: To attach the servo to the blinds and have them open and close based on the light sensor

While some of the hardware team was working on the gearbox for opening and close the window pane, Brian and I moved onto the next major part, which was attaching the servo to the blinds. Our initial plan was to attach the servo to the wand that controls the blinds but we ran into a major problem, the servo only turns 180 degrees but we needed the blinds to turn at least 6 revolutions. This quickly fell through and we started thinking of new ways to solve this problem. Some ideas we tested were:

- Making a gearbox to turn the wand more times per each 180 degrees turn of the servo
    - Problems encountered: Not enough gears and would be hard to maintain consistency
- Get another motor to control the wand
    - Problems encountered: Motor is too fast and we cannot stop it in an exact spot
- Attach the servo at the top of the blinds to directly control tilting instead of the wand (picture included)
    - Problems encountered: Small space for servo to fit inside and we would need long wires to connect all the way at the top of the window

From the three ideas we tested, the most effective plan of action would be to attach the servo at the top of the blinds and control tilting directly instead of using the wand.

While executing this idea, we ran into another major problem, the servo was not strong enough to turn the blinds directly. We solved this issue can by using a higher torque servo into place.



This is the location where the servo is attached. The metal rod only turns 90 degrees to fully open the blinds from a fully closed position

Reflection: We have finalized this design and it was a big step forward. The only issue is that the servo may not have enough power to completely turn the metal rod.

Written by: Shilp Shah
Reviewed by: Brian Ma Date: November 29, 2016

Meeting: Software: Phone App

Task: To create a phone app in which you input data of light and temperature and it adjusts window appropriately.

```
inputData = Serial.readString(); // all inputData strings should be the format "yesLight_yesTemp_outTemp_"
int first = 0; //used to mark the first char for int
int last = -2; //mark the last char for the int
int dataPoint = 0; //refers to either the 1st, 2nd, or 3rd number in the string which correspond to sensor values
for (int i = 0; i < inputData.length(); i++)
{
 if (inputData.charAt(i) == '_')
 {
   first = last + 2;
   last = i - 1;
   if (dataPoint == 0)
   {
     yesLight = (inputData.substring(first,last)).toInt();
   }
   if (dataPoint == 1)
   {
     yesTemp = (inputData.substring(first,last)).toInt();
   }
   if (dataPoint == 2)
   {
     outTemp = (inputData.substring(first,last)).toInt();
   }

   dataPoint +=1;

 }
}
Serial.println(yesLight);
first = 0;//reset the values of the numbers used in the loop if there is a new input
last = -2;
dataPoint = 0;
}
if (yesLight == 600)
{ // If 1 was received
```

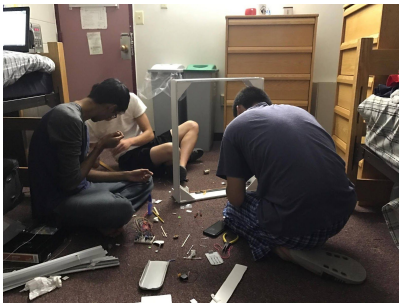
Takes input values from phone and uses if statements to determine if blinds need to be turned or if window needs to be opened

Written by: Salman Omer

Reviewed by: Stefan Luong Date: November 29, 2016

Meeting: Hardware: Final Construction

Task: To attach all of the separate subcomponents of our project together.



We assembled in Forest and Shilp's room to finalize the project

We attached the blinds to the frame using Super Glue.

We glued the rails in and inserted the frames between them.

We attached the window pane to the linear slide using popsicle sticks and glue.

Reflection: After testing each subcomponent, we were able to effectively assemble the final product.

Written By: Alison Bansil
Reviewed By: Forest Song Date: November 30, 2016

Meeting: Final Preparations

Task: To finish final preparations for our project

- We needed to polish our presentation and go through practice runs
- Additional testing for all the components of the project to ensure everything works

Angela and I are practicing our parts for the final oral presentation

Our team also created a bill of materials to illustrate our completion of requirements.

BOM: Team #2

Item	Source	Quantity	Price per unit	Total Cost
Foam Core	Household item	4 20 x 30 Boards	$0	$0
Hot Glue	Household item	N/A	$0	$0
Blinds	Bought online	1 Set	$24	$24
Linear Slide	Household item	1 Slide	$0	$0
Sparkfun Inventor Kit	Supplied	1 Kit	$0	$0
Gears	Household item	4 Gears	$0	$0
Axle	Household item	3 Axles	$0	$0
String	Household item	50 Inches	$0	$0
Clear Garbage Bag	Household item	1 Bag	$0	$0
Scotch Tape	Household item	N/A	$0	$0
Popsicle Sticks	Household item	5 Sticks	$0	$0
Batteries	Household item	1 9 Volt Battery	$0	$0
Toy car wheel	Household item	3 Wheels	$0	$0

Reflection: This project was completed due to excellent planning, teamwork, and hardwork. We had a lot of fun working on it!

Written By: Stefan Luong
Reviewed By: Amy Su Date: December 1, 2016