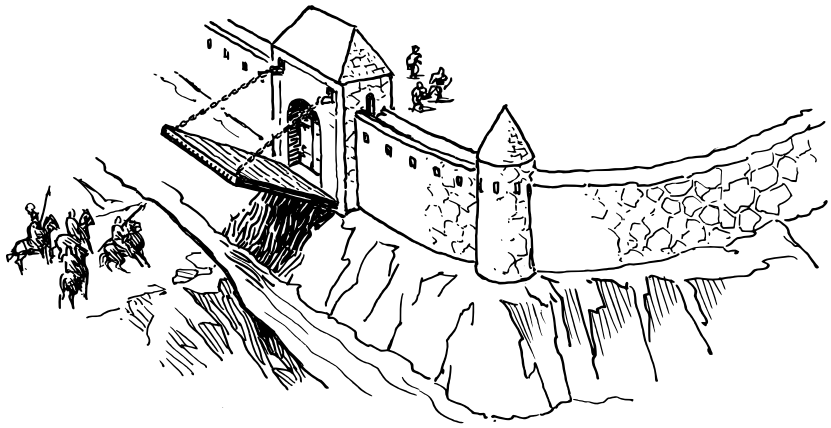
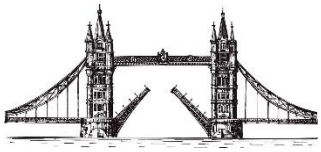
JUNIOR CERTIFICATE TECHNOLOGY



"Design and make a working model of an electro-mechanically controlled drawbridge to allow river traffic to pass. Your solution must include limit switching to control the bridge at its fully raised and fully lowered position."

HIGHER LEVEL



DESIGN FOLIO

YEAR: 2019

DESIGN TASK: E

EXAMINATION NUMBER: 25080

SCHOOL ROLL NUMBER:

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1. Design Task

Design and make a working model of an electro-mechanically controlled drawbridge to allow river traffic to pass. Your solution must include limit switching to control the bridge at its fully raised and fully lowered position.

1.1 Why I Chose This Design Task

I chose this assignment as this design task gave me the opportunity to construct a drawbridge. I have a passion for electronics and mechanisms and with this project, I would have been able to develop my passion for both.

2. Design task Specifications

A further investigation of the requirements of the design task was carried out before deciding on the final design specifications. The requirements are as follows:

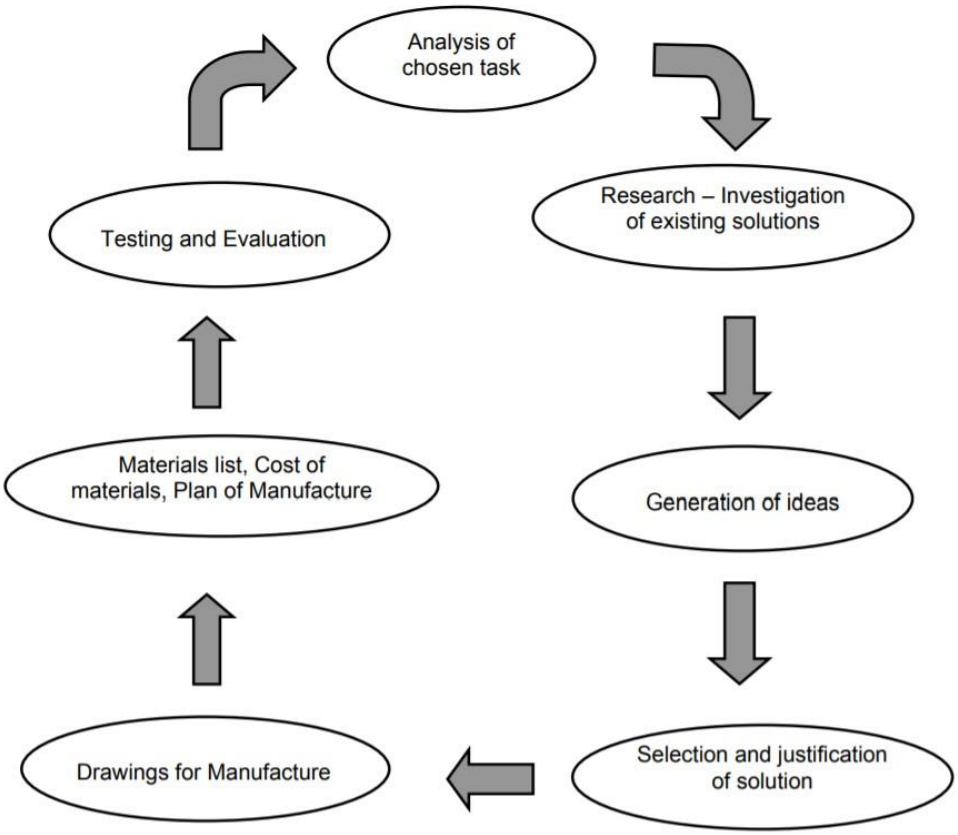
- Power sources, where used, must not exceed 12V DC.
- Where appropriate, all switches should be clearly labeled and the voltage at which the artifact operates should be clearly indicated.
- Incorporate the use of limit switches to stop the bridge at its fully raised and lowered positions.
- Use and electro-mechanical circuit to allow river traffic to pass through.
- Use of strong, sustainable and suitable materials for the porpoise of the project.
- The model must be well assembled, realistic and with a high quality of finish suitable for presentation.

- The model must be eye-catching to attract customers into the showroom.

- The total cost must not exceed €25.

- My chosen task has to be completed with the given time frame.

A simple model of the design process is shown below. It is recommended that you follow the logical sequence of this design process and that evidence of each stage is reflected in your design folder. Shading and color (pencils etc.) should be used where appropriate in your design folder.



3. Analysis of Chosen Task

Design and make a working model of an ***electro-mechanically controlled*** drawbridge to ***allow river traffic*** to pass. Your solution ***must include limit switching*** to control the bridge at its fully raised and fully lowered position.

3.1 Conformance

My project will meet all the required expectations, it will include an ***electro-mechanically controlled*** and ***limit switching*** to ***allow river traffic*** to pass

3.2 Performance

The drawbridge mechanism will allow it to be raised to its fully raised position and allow river traffic to get through, it will also allow it to go to its fully lowered position to, therefore, allow pedestrians to cross the river. It will have a continuous and consistent speed to allow it to “flow”.

3.3 Design

- My project will be simple and reliable
- The user will be easily and quickly be able to use it
- It will have an aesthetically pleasing design and well assembled
- It will also be relatively cheap so that in real life circumstances it will be a possible solution

3.4 Durability

It will be strong and durable allowing it to withstand common use and any light falls. The mechanism must be fully functional consistently at all times.

3.5 Safety

My project should not have any sharp edges to prevent an injury to the health and safety of the user. The bridge's safety must prevent from fingers getting caught in it while moving. I would sustain the view that my project is not designed for people below the age of 3 as the small part present in it may harm small children.

3.6 Cost

The prototype I will construct will be aimed at a budget maximum of 20 euro as buying individual parts once is more expensive than bulk buying, it will still be relatively cheap to construct.

3.7 Perceived quality

The design of my project will need to attract the user, to accomplish this I will aim for a simple but high-quality product to allow it to stand out and be eye-catching.

3.8 Time

I have a double class and 2 single classes a week of technology giving me 160 minutes per week. I have planned to finish everything a week before to allow a margin for unexpected events so that I will not be under pressure finishing the artifact

3.9 Reliability

The drawbridge mechanism will work consistently all the times without jamming and will always immediately stop once the fully lowered or raised position is reached.

4. RESEARCH

To decide on a final solution that will satisfy all the previously stated requirements I have planned to research from a number of different sources that will allow me to see already existing solutions in the real world.

- Exploring existing drawbridges in Ireland and the UK
- Internet (always cross-checking any information)
- Technology school book and other book sources books I own
- Discussion with several classmates regarding their opinions on my ideas and with the teacher.

For the simplicity of this research, I subdivided it into three main parts

- Design
- Mechanism
- Electronics

4.1 Design Research

The aim of my design was to be a relatively simple design but aesthetically pleasing. I also wanted it to be 100% effective all the times by being robust and therefore able to withstand light falls and common use.

4.1.1 Exploring existing drawbridges in Ireland

https://www.otd.ie ***EAST-LINK BRIDGE*** https://www.youtube.com/watch?v=6bG4eqW77a8

SHERIFF STREET BRIDGE

https://www.flickr.com

https://www.pinterest.cl

http://www.buildingsofireland.ie

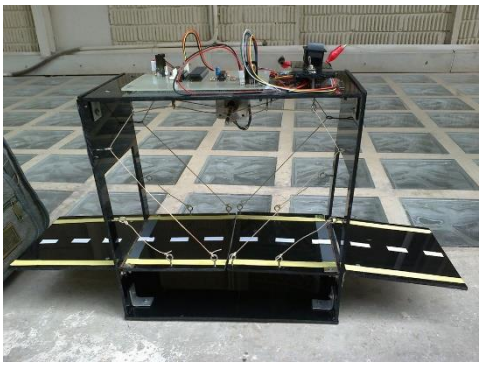
http://www.kildare.ie

4.1.2 Internet Research

Thanks to my Internet research I was able to investigate on already existing solutions of models created by other people, this was therefore greatly beneficial as I could easily figure out which way was the most logical and popular. These are some of the images I found in my internet research;

http://www.mootio-didactic.com

https://www.pinterest.ie



https://www.instructables.com

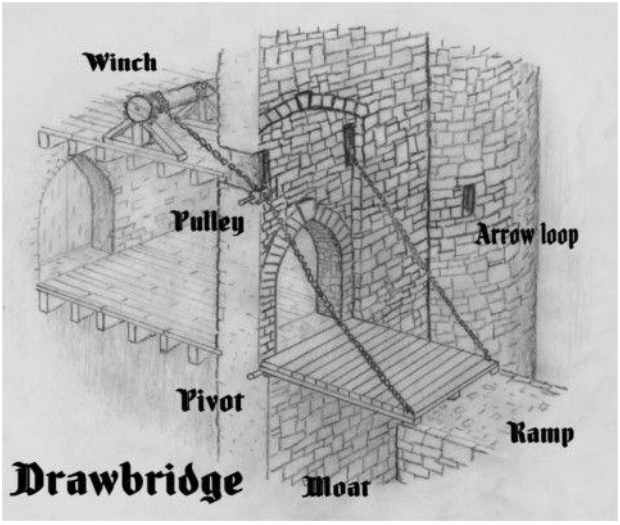
https://runningfreeinhighheels.wordpress.com

Medieval castles are known to utilize the drawbridge solution to allow wanted visitors in and unwanted enemies out of the castle. I, therefore, researched medieval methods on constructing drawbridge and found that a compact pulley was the most popular solution.

https://en.wikipedia.org

https://thrills.millenniumweb.co

https://3dexport.com



https://www.pinterest.ie

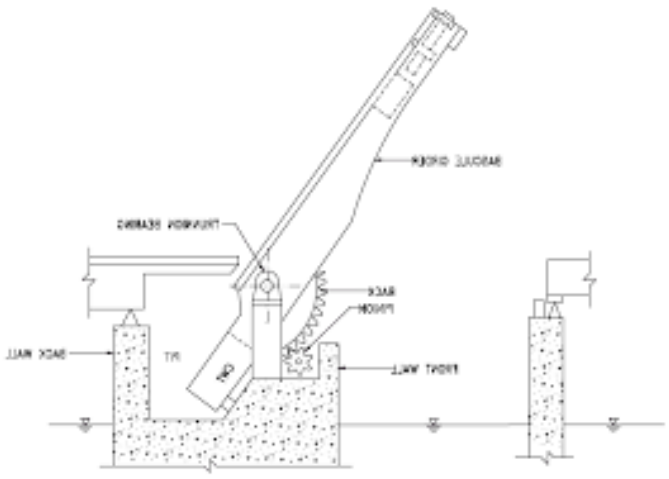
4.2 Mechanism

For the mechanism of my project, I had in mind two methods.

My first idea was to use a compound gear system to lift the bridge. I would allocate a gear (B) on a shaft at the pivot of the bridge and then use another gear (A) to turn the gear B and the bridge with it. This would allow my method to stick out from the other projects as I noticed most were using pulleys. The disadvantage of this method was the weight of the bridge, this was a serious problem as it would limit the possibilities of design of the bridge, in real life situation it would also not permit a vast amount of vehicles or pedestrians to walk across at the same time as the weight limit would be low because I would be lifting the bridge from the bottom corners instead of the top ones.

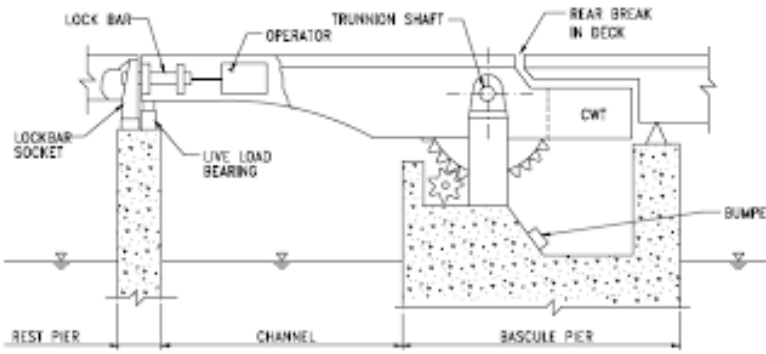
My second idea involved pulleys, for this I would need to include a tower to my bridge and have rope start at the bottom of the tower where a worm gear operated by a DC motor would turn the shaft with the rope, it would then go to the top of the tower where it would turn around the pulley and reach the further top corners of the bridge. The advantages of this idea are the increased weight support allowing me a wider range of possibility when constructing the bridge and it would also lower the effort needed to lift and lower the bridge. The disadvantage is that this method is more common among other projects and would make my project more common.

Idea 1:

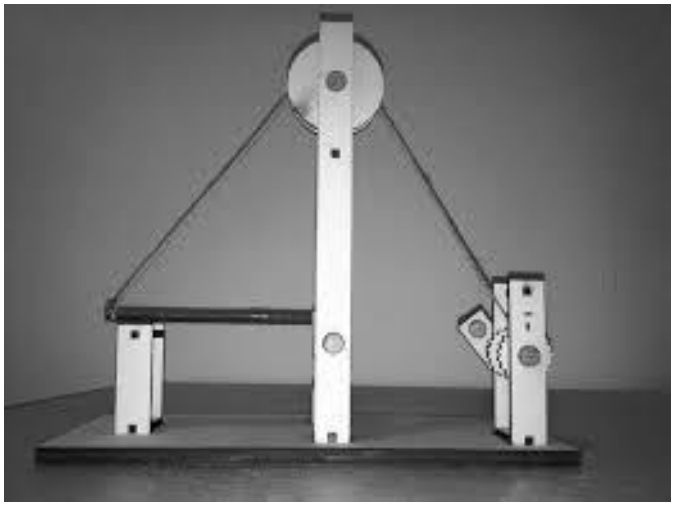


Open bridge (https://www.rms.nsw.gov.au)

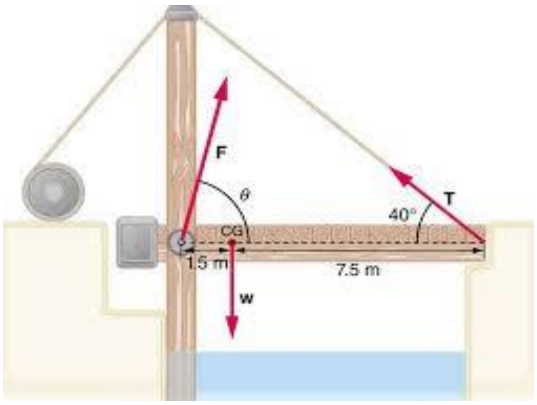
Closed bridge https://www.rms.nsw.gov.au



Idea 2: Pulley system

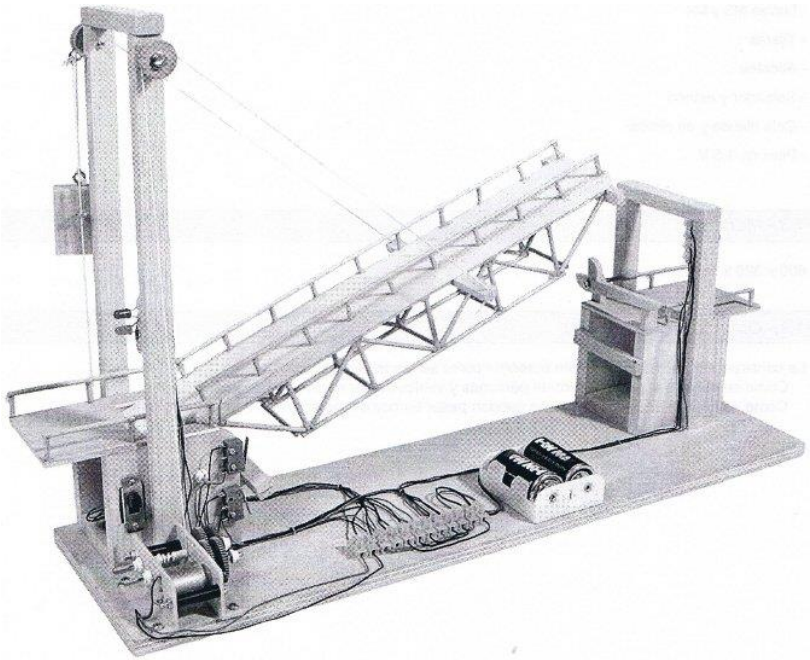


https://pn40352016.wordpress.com



https://www.pinterest.ie

https://www.petervaldivia.com



5. Generation of Ideas

After all my research was completed, I used it to create three main ideas that suited my project. All the ideas met the design task specifications. My research was able to help me make decisions on materials and different designs to implement in my different solutions. It also helped me prevent problems or when encountered, solve them.

5.1 Project Idea 1:

My first idea consisted of a pulley mechanism that would operate the bridge in the two directions, it was made of acrylic and because if the simple design I planned to create two sides making it a double leaf bridge that would raise two platforms at the same time.

Advantages:

- Simplistic design.
- Double bridge.
- Easy to use.
- Made of plastic, easy to work.

Disadvantages:

- Too simple
- Too similar to other drawbridges

5.2 Project Idea 2:

My second idea was the one where I planned to use the compound gear system, this method would give me more freedom around the towers as I would not necessitate them anymore and therefore would have more freedom in the design.

Advantages:

- Mechanisms stand out
- No need for towers
- Different design to other ideas

Disadvantages:

- Mechanism more complicated and time-consuming
- Bridge weight limited

5.3 Project Idea 3:

My third idea was inspired by the main features of a castle drawbridge, I planned to use metal in this idea and the design would resemble a castle wall. It would be single leaf and operated by a pulley system inside the castle tower.

Advantages:

- More creative
- Design stands out
- Pulley system is simple yet effective
- Easy to use
- One folded piece idea (not involving a piece for every side)

Disadvantages:

- The piece would be big and complicated to work when filing, drilling, and bending
- The mechanism would not stand out

	ADVANTAGES	DISADVANTAGES
Project idea 1	• Simplistic design. • Double bridge. • Easy to use. • Made of plastic, easy to work.	• Too simple • Too similar to other drawbridges
Project Idea 2	• Mechanisms stand out • No need for towers • The different mechanism to other ideas	• Mechanism more complicated and time-consuming • Bridge weight limited
Project Idea 3	• More creative • Design stands out • Pulley system is simple yet effective • Easy to use • One folded piece idea (not involving a piece for every side)	• The piece would be big and complicated to work when filing, drilling and bending • The mechanism would not stand out

6. Selection of Final Idea And justification

For my final decision I took into a count all the disadvantages and the advantages and from that and all the research I completed prior to this I have chosen my final idea that I will construct for my junior cert.

The idea I have chosen is Idea 3 and Circuit 1. I chose this because of many factors such as the following:

- All the design specifications are easily met in this project.
- The design inspired by a medieval castle allows my project to stand out and to be eye pleasing.
- The materials I will use in this project will make it durable and robust as I wanted when I analyzed the chosen task.
- The easy use makes it attractable to the user as he/she would enjoy using my drawbridge.
- One of the main reasons is that it is an effective solution in real life. the situation as proven by its popularity in medieval castles entrance.
- It will be able to work smoothly 100% of the times.
- The circuit would stand out and work perfectly.

6.1 Idea 3 Development

After deciding which one of the three ideas I would use I developed it, I drew a couple of more sketches to progress the idea. In these sketches I tried to add some features to enhance the bridge, some were used and some were disregarded at the end. I used these sketches to get an idea of what my project was going to be like, many of these drawings are not to scale as I may have been focusing only on certain features of the bridge, they were crucial to allow me to decide the size of the different pieces and the different procedures I would then use in the manufacturing of my project.

6.2 Drawings

Now to draw out properly my measurements I preferred to do it by hand as I had no access or knowledge on the use of any designing software.

7 Manufacturing

SHAPE A

The first step was to mark the main tower structure on the metal, the idea of this solution was to have 3 walls made from the same folded metal piece. This meant that I had to work with a big sheet of metal which at times proved to be a bit challenging but never a problem. I then drilled the necessary holes for the 4 rods and the screws for the attachment of the other wall. After the initial shape was cut out and properly filed, I bent it using the cornice brake.

SHAPE B & SHAPE C

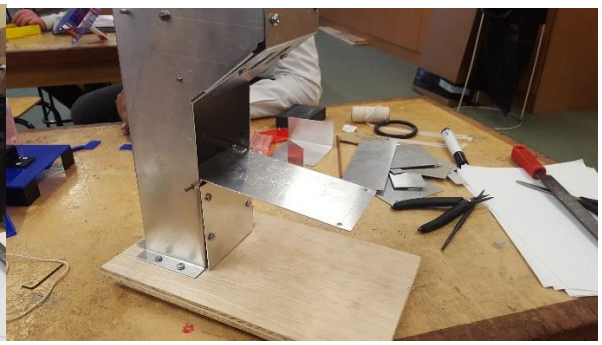
Now that shape A was constructed, I cut out the remaining wall parts for the competition of the tower structure. I had to be certain of measuring out correctly the holes, this was necessary for the correct attachment to part A.

I used nuts and bolts to secure the three parts together. The main tower structure was now completed.
I was able to utilize a wooden base that was luckily the Perfect size so that I did not need to amend it.

SHAPE D

I marked out part D which was the bridge, because of my inspiration towards medieval castles the bridge is rather short as they needed to be pulled up and down quickly. I used the bandsaw again to cut the piece out and then

filed the rough edges down. I used the drill and the cornice brake to finish it off.

SHAPE E & SHAPE F

The next part was the circuit box this is where I planned to put the DPDT switch and the RGB acting as a traffic light. The overall design of the circuit box was very simplistic. I used electrical tape to insulate the circuit from the metal base to prevent any malfunctions. I used the hand drill to create the holes for the two screws that would hold the circuit. I then used the hand drill to make the holes to attach the parts to the wooden base.

SHAPE G

The final piece that had to be fabricated was the roof to the tower, it was an easy task, I used the drill to make the two holes and then the cornice brake to bend the metal piece.

The final step was drilling the holes for the wires to pass through, I did so with the hand drill. I used sandpaper and a file to round the corners of the base and smoothen it all out.

I also used wood glue to raise the base allowing me to store the electrical power source underneath and to easily pass wires through.

7.1 Materials and Costing

Product	Quantity	Size	Cost
Reely Aluminium Sheets	2	400x200x0.5mm	€9.94
Battery	2	3.7 Volts	€3
Limit switches	2	N/A	€1.60
RGB LED	1	N/A	€0.60
Pulley wheels	4	~~ø~~20	€1.75
Motor	1	N/A	€0.70
Battery Holder	1	N/A	€0.80
5mm Acrylic	3	65x50x05mm	€0.64
Rope	2	200mm	€0.40
Wooden base	1	350x175x15mm	€5.40
Base corners	6	N/A	Used scrap material

Total :	€24.83

7. TESTING AND EVALUATION

7.1 Testing

By carrying out several tests I was able to determine the following information:

TEST	PASSED	FAILED
Does it go up and down?	xx	
Is it Durable?	xx	
Does the circuit work?	xx	
Does it work constantly?	xx	
Is the structure removable?	xx	
Is it within the budget of €25?	xx	
Is it quick and easy to use?	xx	
Is it aesthetically pleasing?	xx	

7.2 Evaluation

There were some unexpected small problems towards the competition of my project such as the RGB Led yellow color not being saturated enough but I was able to fix all of this inconveniences.

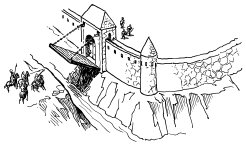
Time management was an issue at the start of the year as I had no prior experience in constructing a time plan for a project and following it, I am happy to have learned and now be able to plan out projects over a selected time span.

I have learned an incredible amount from this project, from time management to new skills such as working with metals. I will be able to learn from my mistakes and the times I have succeeded. I will be able to apply the new skills I learned in new projects.

I sincerely hope you have enjoyed reading my Technology Project Brief.

AKNOLOGMENTS:

https://fineartamerica.com/featured/4-clockwork-mechanism-michal-boubin.html



http://graphics8.info/pixabay/mphoto/

https://es.123rf.com/photo_37350740_bosquejo-puente-en-inglaterra-sobre-un-fondo-blanco-ilustraci%C3%B3n-vectorial.html

CIRCUIT 1 ARDUINO CODE:

```
// Semaforo
int redLedPin = 3;
int greenLedPin = 5;
int blueLedPin = 6;

// Limit Switches
int limitSwitchOpenPin = 11;
int limitSwitchClosedPin = 10;

// Direction Switch
int CommandSwitchOpenPin = 8;
int CommandSwitchClosedPin = 12;

// Motor
int motorOpenPin = 7;
int motorClosedPin = 9;

// Bridge State
 const int up = 1;
 const int down = 2;
 const int moving = 3;
 const int unknown = 0;
int bridgeState = unknown ;

// Switch State
 const int doOpen = 1;
 const int doClose = 2;
 const int idle = 0;
int switchState = idle;

// Action
 const int actOpen = 1;
 const int actClose = 2;
 const int actStop = 0;
int action = actStop;


void setup() {
  Serial.begin(115200);
    pinMode(redLedPin, OUTPUT);
    pinMode(greenLedPin, OUTPUT);
    pinMode(blueLedPin, OUTPUT);
    pinMode(4, OUTPUT);
    turnOff();
```

```
  pinMode(limitSwitchOpenPin, INPUT_PULLUP);
  pinMode(limitSwitchClosedPin, INPUT_PULLUP);
  pinMode(CommandSwitchOpenPin, INPUT_PULLUP);
  pinMode(CommandSwitchClosedPin, INPUT_PULLUP);
  pinMode(motorOpenPin, OUTPUT);
  digitalWrite(motorOpenPin, LOW);
  pinMode(motorClosedPin, OUTPUT);
  digitalWrite(motorClosedPin, LOW);
  digitalWrite(4, HIGH);
 Serial.println("started");
}

void loop() {

  Serial.println(" NEW DATA ");
  bridgeState = unknown;

  if (digitalRead(limitSwitchOpenPin) == LOW)
  {
   bridgeState = up;
  }
  if (digitalRead(limitSwitchClosedPin) == LOW)
  {
    bridgeState = down;
  }

  switchState = idle;
  if (digitalRead(CommandSwitchOpenPin) == LOW)
  {
    switchState = doOpen;
  }
  if (digitalRead(CommandSwitchClosedPin) == LOW)
  {
    switchState = doClose;
  }

  action = actStop;
  switch (switchState)
  {
    case doOpen:
      action = actOpen;
      Serial.println("switch is doOpen");
      break;
    case doClose:
      action = actClose;
      Serial.println("switch is doClose");
      break;
    case idle:
```

```
      Serial.println("switch is idle");
      action = actStop;
      break;
    }

    switch (bridgeState)
    {
     case up:
      redLight();
      if (action == actOpen)
        action = actStop;
      Serial.println("Bridge is up");
      break;
     case down:
      greenLight();
      if (action == actClose)
        action = actStop;
      Serial.println("Bridge is down");
      break;
     case unknown:
      Serial.println("Bridge is unknown");
      break;
     case moving:
      Serial.println("Bridge is moving");
      break;
    }

    switch (action)
    {
     case actOpen:
      yellowLight();
      delay(1000);
      openBridge();
      break;
     case actClose:
      yellowLight();
      delay(1000);
      closeBridge();
      break;
     case actStop:
      turnOff();
      stopBridge();
      break;
    }
}

void openBridge()
{
```

```
  digitalWrite(motorClosedPin, LOW);
  digitalWrite(motorOpenPin, HIGH);
  Serial.println("Opening bridge");

}

void closeBridge()
{

  digitalWrite(motorClosedPin, HIGH);
  digitalWrite(motorOpenPin, LOW);
  Serial.println("Closing bridge");
}

void stopBridge()
{
  digitalWrite(motorClosedPin, LOW);
  digitalWrite(motorOpenPin, LOW);
  Serial.println("stopping bridge");
}

void yellowLight ()
{
  RGB_color(150, 150, 0);
  Serial.println(" YELLOW LED On ");
}

void redLight ()
{
  RGB_color(255, 0, 0);
  Serial.println(" RED LED On ");
}

void greenLight ()
{
  RGB_color(0, 255, 0);
  Serial.println(" GREEN LED On ");
}

void turnOff ()
{
  RGB_color(0, 0, 0);
  Serial.println(" LED Off ");
}
```

```
void RGB_color(int red_light_value, int green_light_value, int blue_light_value)
 {
  analogWrite(redLedPin, 255 - red_light_value);
  analogWrite(greenLedPin, 255 - green_light_value);
  analogWrite(blueLedPin, 255 - blue_light_value);
}
```

WHAT DOES THE CODE DO?

In the code I assign different variables to the limit switches and the DPDT switch that are constantly controlled and recalibrated in the “void loop”. This allows me to know their state and then decide what to do. For example when the limit switch is pressed the reading of the pin that is connected to the switch comes back positive, this allows me to know that the switch has been pressed and that I need to stop the bridge.

One of the main features of the code is the traffic light, when the DPDT switch is activated the led becomes yellow for a short period and then the relays are activated. When the limit switches are pressed depending on which, the Led will either turn green or red.