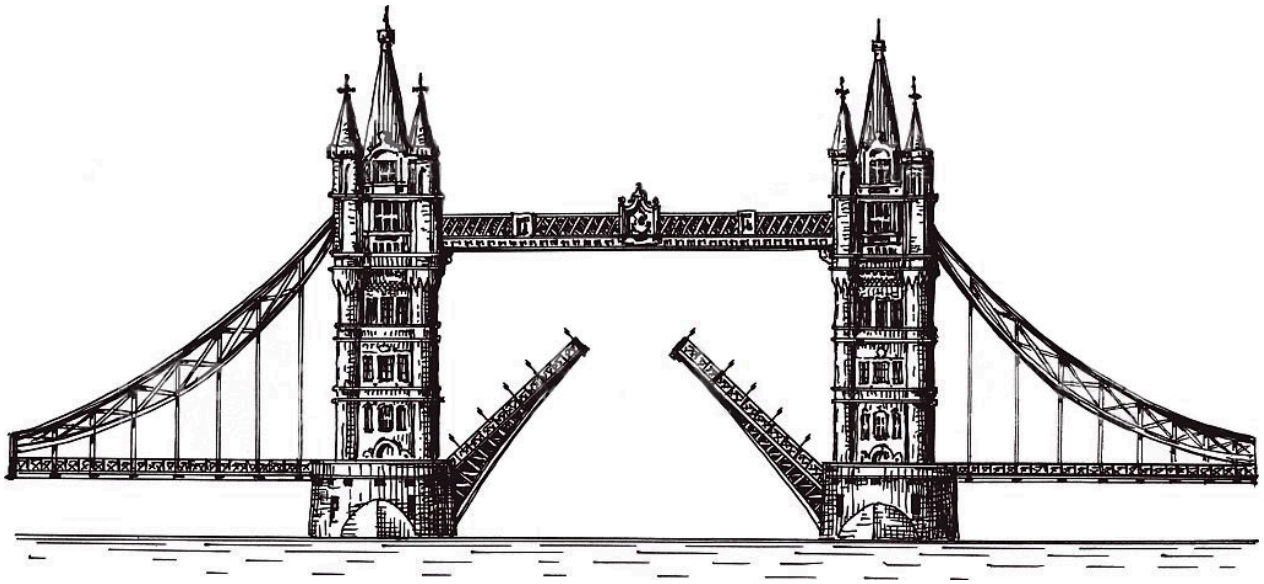
Junior Cert Technology
2018 -2019
Project Folio

Project Design Brief:

Design and make a working model of an electro-mechanically controlled drawbridge to allow river traffic to pass. The drawbridge must include limit switching to control the bridge when it's fully raised and fully lowered positions.



Examination Number: 67796

Table Of Contents

1. Analysis Of Brief

1.1. Problem Analysis.

In this subsection I am going to analyse the design brief I have been given by asking questions about it.

1. What model of a drawbridge will the design reflect?
2. What budget is available for my project?
3. What is the definition of a drawbridge?
4. What materials are available ?
5. What maximum size should the model drawbridge be?
6. When is the completion date?
7. What mechanism will be used to fully raise and lower the drawbridge?
8. What will be used to control the mechanism?
9. Will it have any additional features/sensors in the drawbridge?
10. What safety features should be incorporated?

1.2 Initial Design Specification

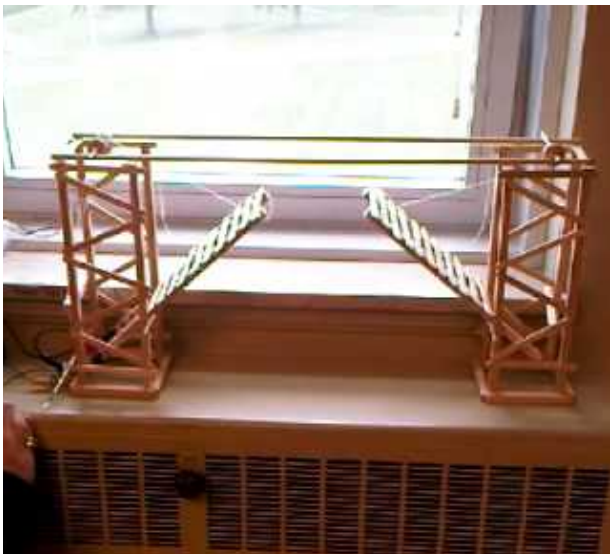
In this subsection I will answer the questions listed in 1.1 .

1. The design will be based on a scale - model of the landmark London Bridge in London.
2. The budget is around approximately €30(minimum) - €35 (maximum) .
3. A drawbridge can be defined as any bridge that lifts, either as a single or double leaf, vertically or pivotal from one end or both "....basically any movable bridge that isn't a swingbridge".
4. The main material used will be 3mm or 5mm acrylic sheet in various colours.
5. The longest dimension in any part of the artefact should be 400mm.
6. The completion date is 3rd May 2019.
7. The mechanism used will be a single pulley mechanism and a worm drive on each side. On both of the drives will have string so it can fully raise and lower using single pulley mechanism on each side.
8. The mechanism and all other outputs will be controlled by the GENIE 18 Motor Board.
9. The features in the drawbridge will have 4 LEDs,an LDR and 2 Motion Sensors.When it becomes dark,the LEDs will turn on.Two motion sensors will be fitted on 2 sides in front/behind the drawbridge.When there is an object near the motion sensor, the drawbridge will be fully raised for river traffic to pass and it lowers when there is no river traffic nearby.
10. The safety features should be incorporated :
    - 10.1. No sharp edges
    - 10.2. No places where fingers can get caught in mechanisms etc.

2. Research and Investigation

2.1. Analysis of Existing Solutions

In this section I will research existing model drawbridges and modern drawbridge landmarks in order to find suitable design to inspire my own ideas.



I could do this drawbridge with this structure and replace it with a worm drive motor on each side to act as a winch to raise and lower the drawbridge.I could install LEDs on the road or on the roof to make it stand out and look attractive.

Source:https://www.youtube.com/watch?v=3w2HHAqH80w

I could use this as my overall design on the exterior so it will look attractive and it will stand out because its a famous landmark.My mechanism can be hidden inside so it will also look attractive.I could also add LEDs so it will stand out at night.

Source: http://cp.c-ij.com/es/contents/CNT-0009944/index.html

I could do this single leaf drawbridge and insert the mechanism inside the house seen on the left to raise the drawbridge.I could also add LEDs to make it stand out and attractive at night.

Source:https://www.altramotion.com/de-DE/newsroom/2015/01/ap-custom-reducer-for-bascule-lift-bridge

I could make this drawbridge and insert the mechanism underneath shown on the left.I could also add LEDs on the road to make it stand out at night.

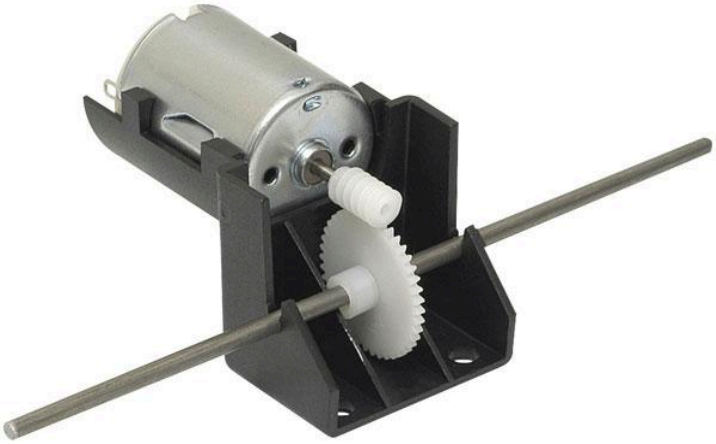
Source:https://theconstructor.org/structures/types-movable-bridges-details/17941/

I could make this vertically bridge and could add a cover on the outside and make the mechanism hidden and also make it stand out.I can also add LEDs to make to make it stand out when it's dark.

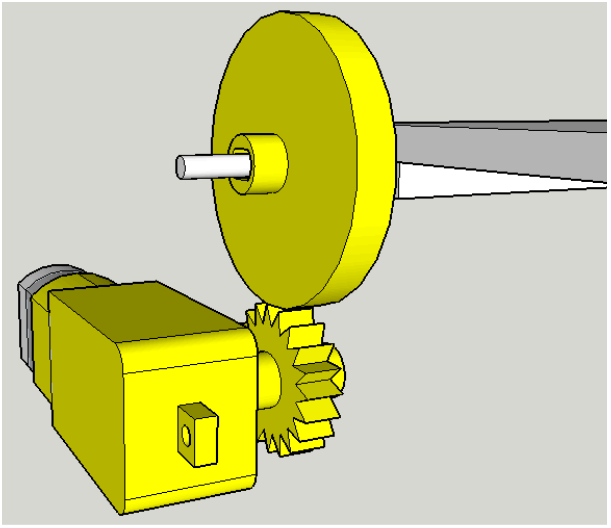
Source:https://sites.google.com/site/modelrailroadlayoutbuilder/model-train-bridges

2.2 Mechanism Research

In this section I will research mechanisms that could be used to lower and raise the drawbridge.



I found this image on www.rapidonline.com
This is RVFM Worm Drive Gearbox with Motor.
This gearbox slows down the motor speed by a ratio of 42:1 ie it slows it down 42 times.
However it gives the drive shaft a lot more torque (turning power) than if I connected the motor directly to the drive shaft.
The drive shaft is 3 mm diameter.
It requires between 1 and 6 volts to operate it.
Its order code is 37-0310 and its costs €3.34.

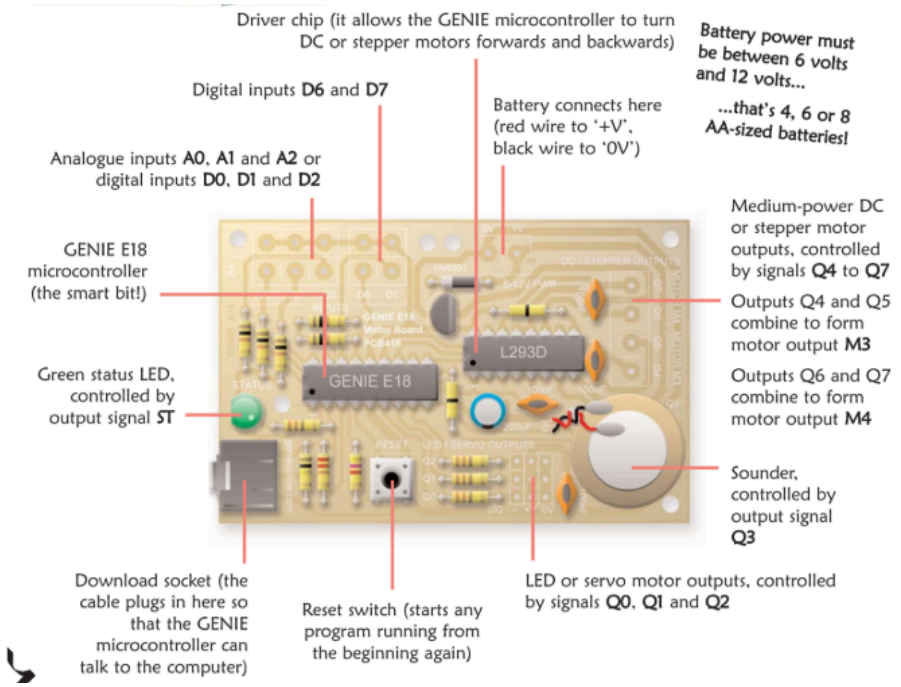


This is a mechanism I made and researched for the drawbridge using CAD software.
It shows a gearbox motor connected to gears that are connected to the road and move up/down when the gearbox motor is activated.It also makes the mechanism hidden so it will stand out. (Note: The metal rod is connected to acrylic so it improves stability ove raising or lowering the drawbridge.

I found this image on www.rapidonline.com
This is a RVFM Gearbox Motor.
This economy motorised gearbox is fitted with a 3 to 12V DC motor. The output shaft is 5.5mm diameter and 9mm long with 2 flats. Ratios of 1:120 give final speeds of between 70-140 RPM depending on voltage used.
It requires between 1 and 6 volts to operate it.
Its order code is 37-1217 and its costs €2.85.

2.3. Control Circuit Research

In this section I will research a suitable control circuit and any additional components that may be needed.



This is the GENIE 18 Motor Board. It has the following main features:

- It allows forward/reverse control of a motor via the L293D motor driver chip.
- It has 5 inputs - 3 of which can be either analogue or digital sensors and 2 of which are digital only. Their names are A0/D0, A1/D1, A2/D2 and D6 and D7.
- It has 8 outputs labelled Q0 to Q7. One motor (M3) will be connected into Q4 and Q5. I could connect another motor (M4) into Q6 and Q7 but this will not be necessary. I can connect LEDs, speaker etc to the remaining 6 outputs.
- It needs a 6 to 12V power source form either a battery pack or via a power socket.
- It got this information on www.rapidonline.com

- The order code for the kit is 13-6016 and they cost €10.03 each.

I will need additional components along with the control board in order to build the control circuit. I will outline these on the following pages.

RVFM DC-022 2.0 2.1mm Chassis Mounting DC Power Socket and Nut.

I got this image from www.rapidonline.com

This is RVFM DC-022 2.0 2.1mm Chassis Mounting DC Power Socket and Nut.

I could put this along with a suitable 6 - 12V power supply to power the project instead of using a battery pack.
Its order code is 20-0988 and they cost €0.592 each.

SCI TA101A1 Miniature Toggle Switch SPST On-Off

Source: www.rapidonline.com
This a Miniature Toggle Switch.This is used to turn the batteries.
will use this on my project to power the GENIE 18 Board.
Cost is €0.99 and the order code is 750125.

RVFM 1:120 Inline Motor and Gearbox

I found this image on www.rapidonline.com
This is a RVFM Gearbox Motor.
This economy motorised gearbox is fitted with a 3 to 12V DC motor. The output shaft is 5.5mm diameter and 9mm long with 2 flats. Ratios of 1:120 give final speeds of between 70-140 RPM depending on voltage used.
It requires between 1 and 6 volts to operate it.
Its order code is 37-1217 and its costs €2.85.

Kingbright L-7113PWW-A 5mm 3.2V White LED 1000mcd (Output)

I found this image on www.rapidonline.com
It is an LED (Light Emitting Diode) that is used to light up something.
I will use it to light up my drawbridge in my project.
Price: €0.471
Order Code: 55-2490

RVFM DF-P1S-42P Micros 0.1A 30VDC Lever

I found this image on www.rapidonline.com
It is a microswitch limit switch that is used to stop something (eg. a motor) when something hits it.I will use it in my project to stop the motor when the bridge is fully raised.
Its order code is 78-0870 and its price is €0.39.

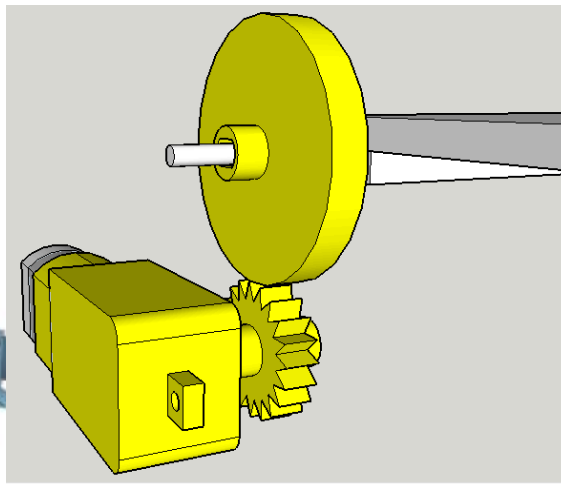
The total cost of the control circuit components is:

GENIE 18 Motor Control Board Kit	€10.03
RVFM Inline Motor and Gearbox	€2.85
RVFM DF-P1S-42P Micros 0.1A 30VDC Lever	€0.39
RVFM DC-022 2.0 2.1mm Chassis Mounting DC Power Socket and Nut.	€0.59
Kingbright L-7113PWW-A 5mm 3.2V White LED 1000mcd x 4	€0.88
SCI TA101A1 Miniature Toggle Switch SPST On-Off	€0.99
Total	€15.68

2.4 Final Design Specification

In this section I will detail exactly what my final design is going to look like and how it will work.

1. The design will be based on the scaled model of London Bridge shown below but with electro-mechanically mechanism similar to that shown on the right below.The mechanism will be hidden and housed under the arch of the road.I will also add LEDs to make it stand out.



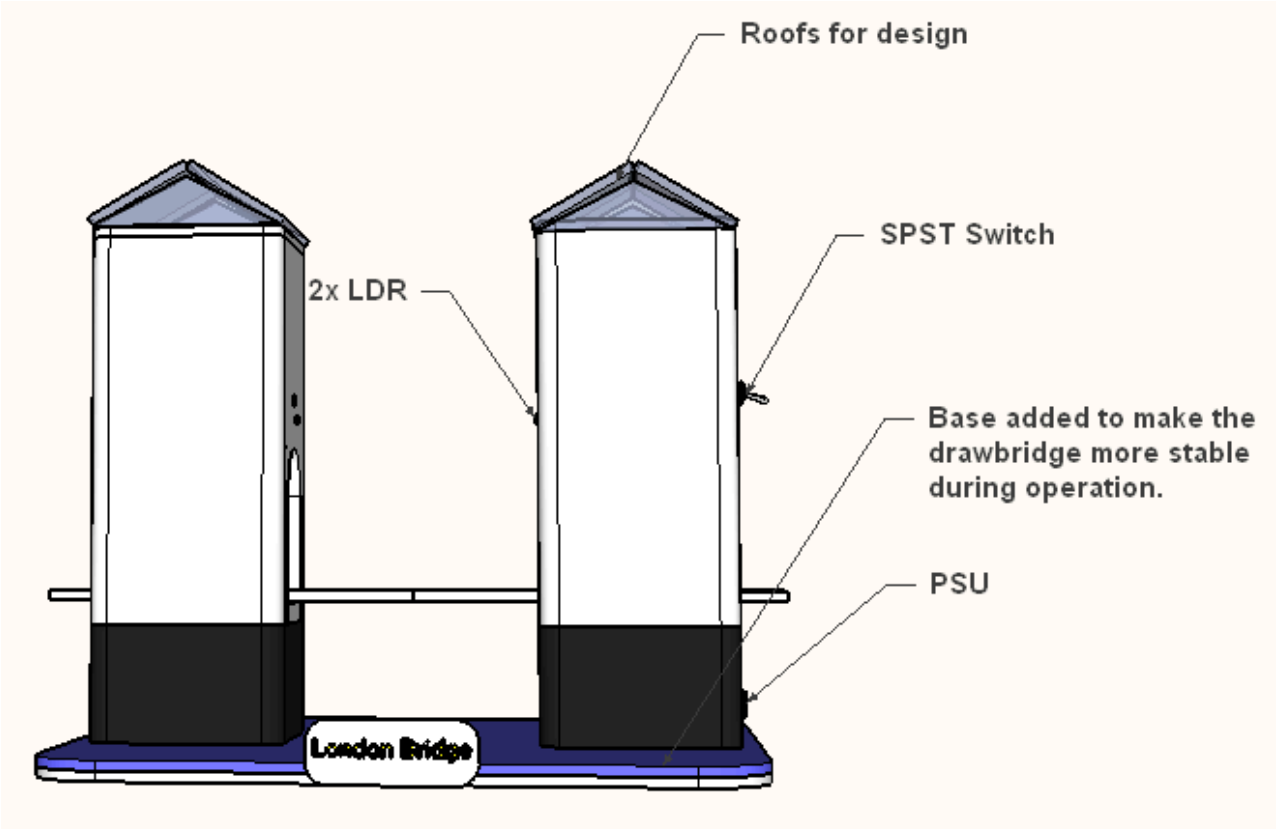
2. The budget is €35.00.The control circuit costs €16 which leaves €19 for the acrylic which I will be using various colours but only approx. ¼ of the full sheet
3. The main material used will be various 5mm colours -blue,black and white.
4. The longest dimension in any part of the artefact should be 400mm.I need to keep the budget for acrylic sheet to approx €11 which is just slightly more than half a large 5 mm thick sheet.
5. I will finish manufacture of the project by 12th April 2019 which then allows 3 weeks to get it to work consistently ready for marking after the deadline of 3rd May 2019
6. The mechanism used will have a gearbox with gears to raise/lower the drawbridge.
7. The mechanism will be activated automatically and controlled by the GENIE 18 Motor Board.The mechanism will be controlled by 2 Limit switches to detect when its fully raised/lowered. The control and mechanism will be able to be accessed via a removable panel.

8. The design will incorporate LEDs on the road and on the building to make it stand out at night.
9. The safety features should be incorporated :
   9.1. No sharp edges
   9.2. No places where fingers can get caught in mechanisms etc.

3. Design Ideas

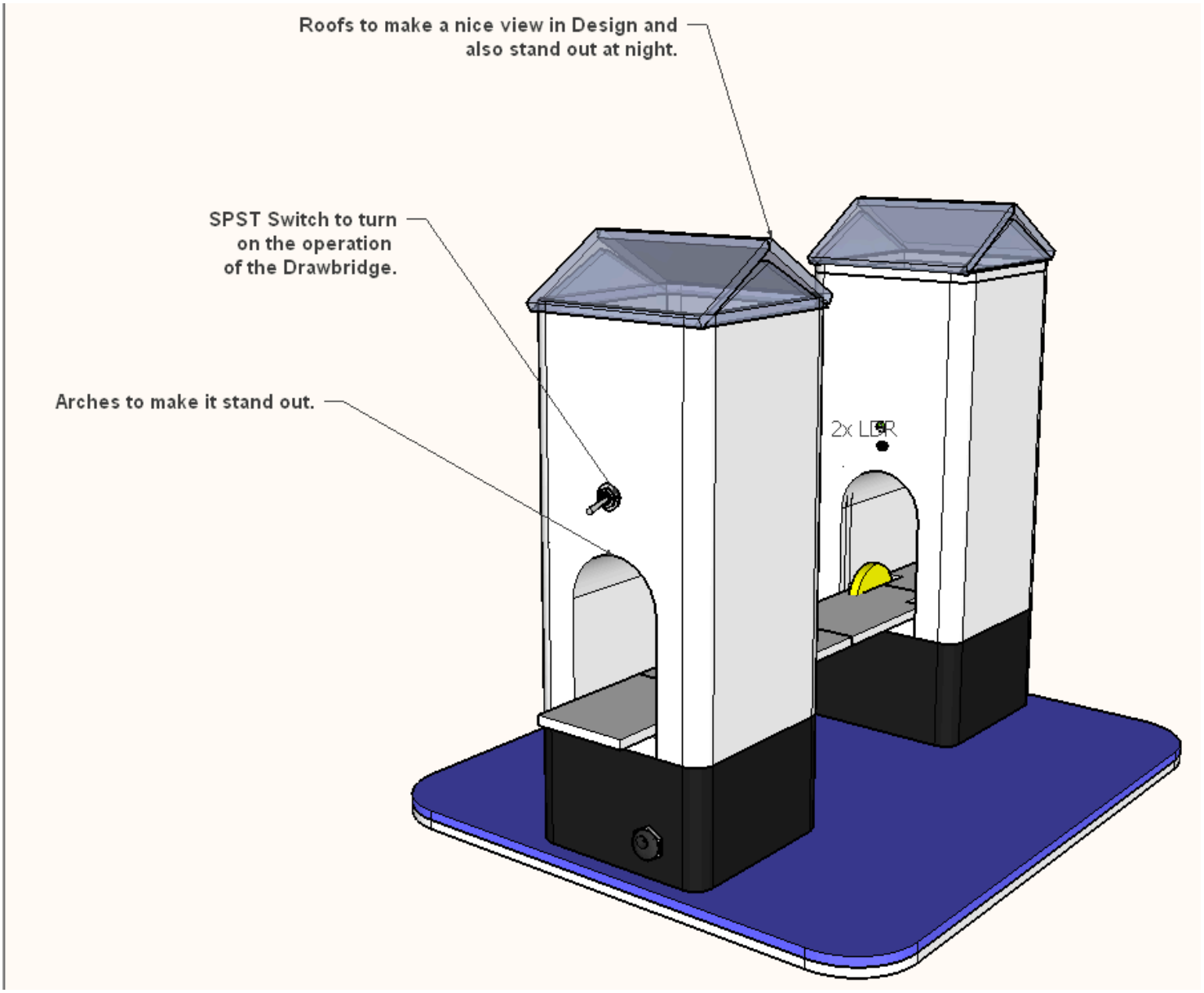
3.1 Idea 1 (First Idea)

(Front View)



Explanation:

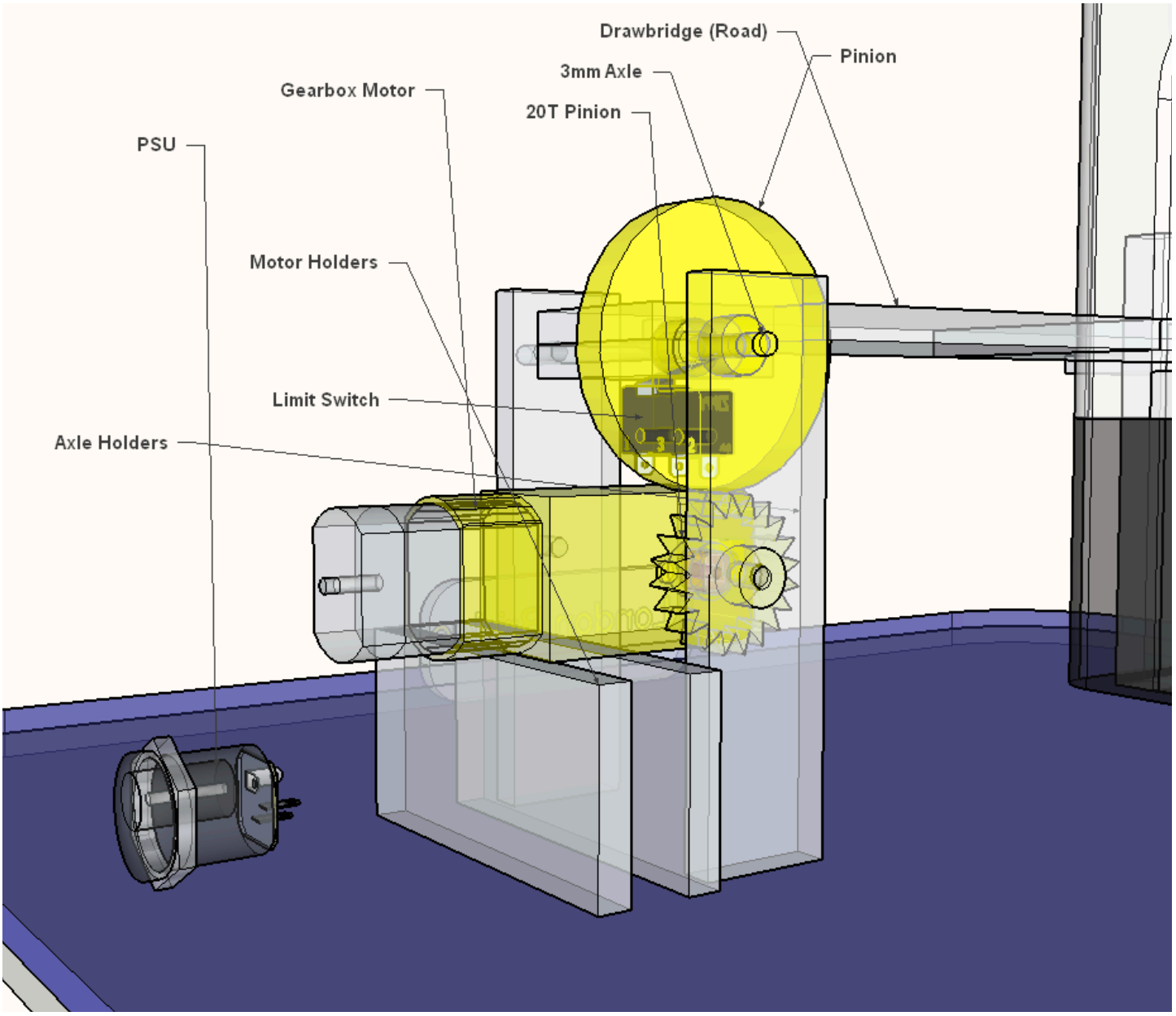
- This design is based on my initial research of existing drawbridges (Tower Bridge).
- There are 2 LDRs (Light Dependent Resistor) on each side they could illuminate at night and also allow the operation of the drawbridge to occur.
- A base with a 5mm White and 5mm blue is used underneath the drawbridge to make it more stable and firm during operation.The blue colour of the drawbridge represents the river Thames in London.
- The base of the drawbridge measures 350mm x 300mm



Explanation:

- Arches in the drawbridge are used make it stand out and make it more realistic to modern engineering designs today.
- An SPST Switch is used to start/ignite the operation of the drawbridge.

- The roofs are used on top of the drawbridge to make a nice view in design and also make it stand out at night..

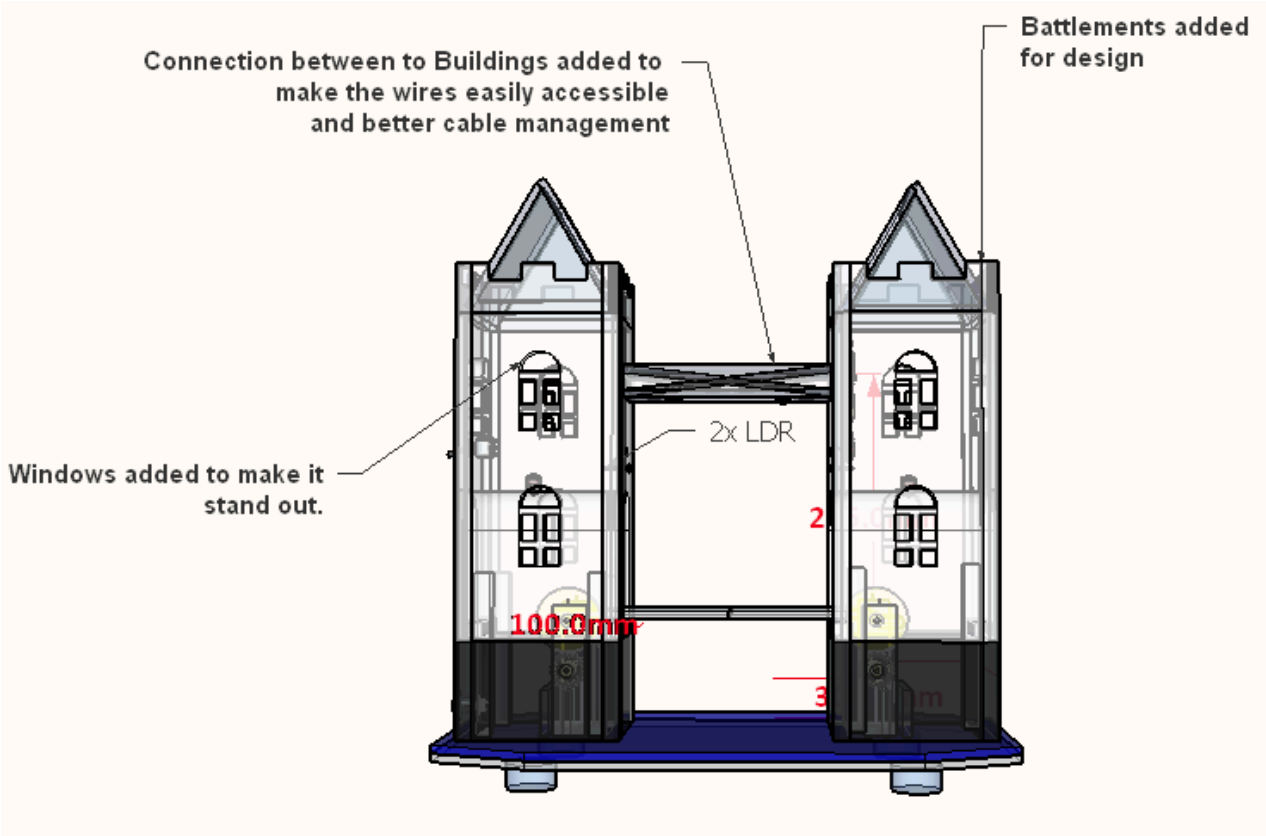


Explanation :

- A PSU (Power Supply - 12V) is used so the the energy will not run out and keep the current constant.
- Axle Holders are used to hold the 3mm axles firmly and to make the operation more stable.

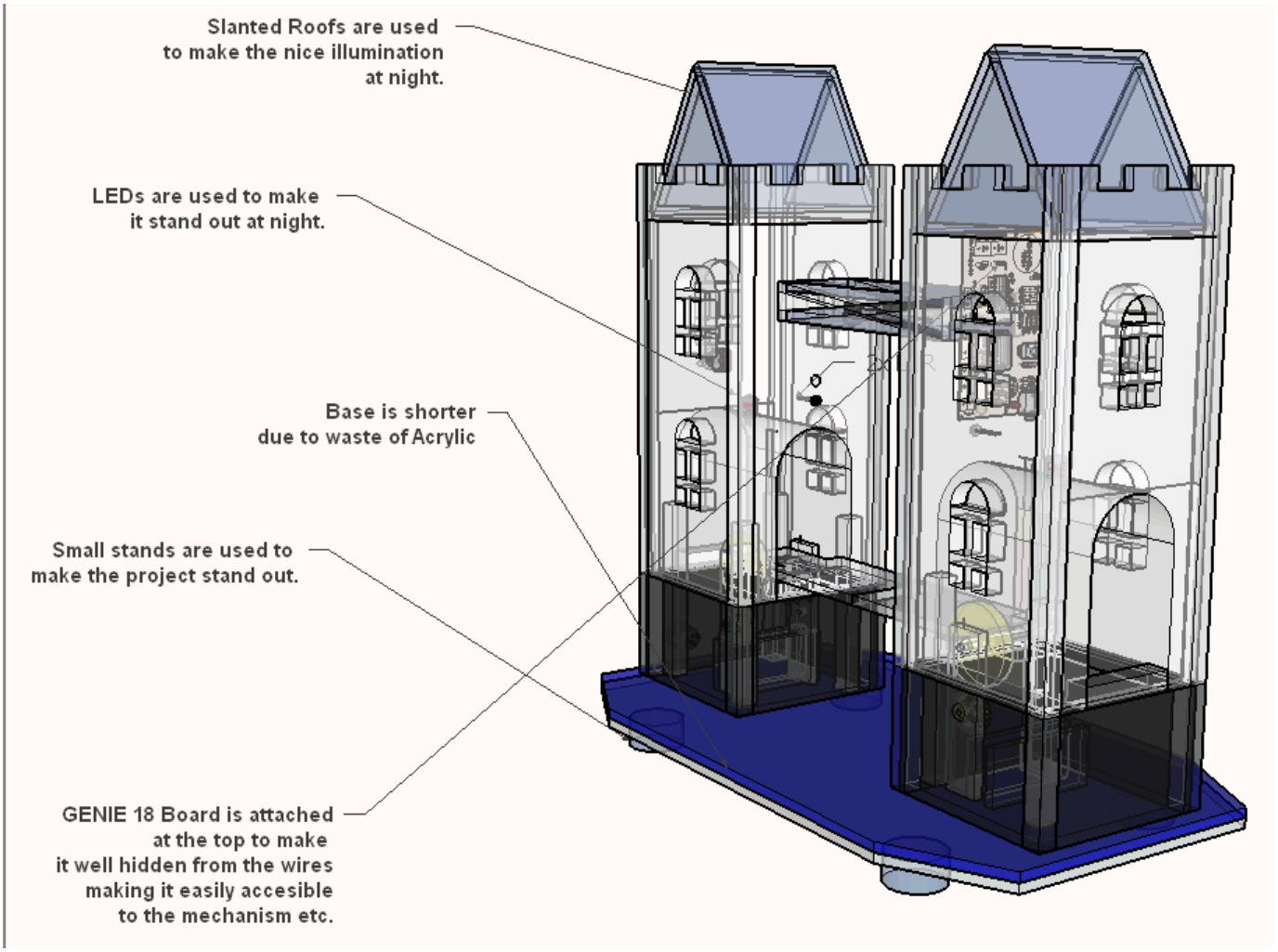
- Motor Holders are used to make the motor gearbox secure firmly without falling out of the mechanism.
- A pinion mechanism is used to make the process of raising / lowering the drawbridge easier.
- The gear box motors will be stopped by LDR's and limit switches when it is covered / touched.
- The motors will be started automatically when the SPST switch turns on.

3.2 Idea 2 (Final Idea)



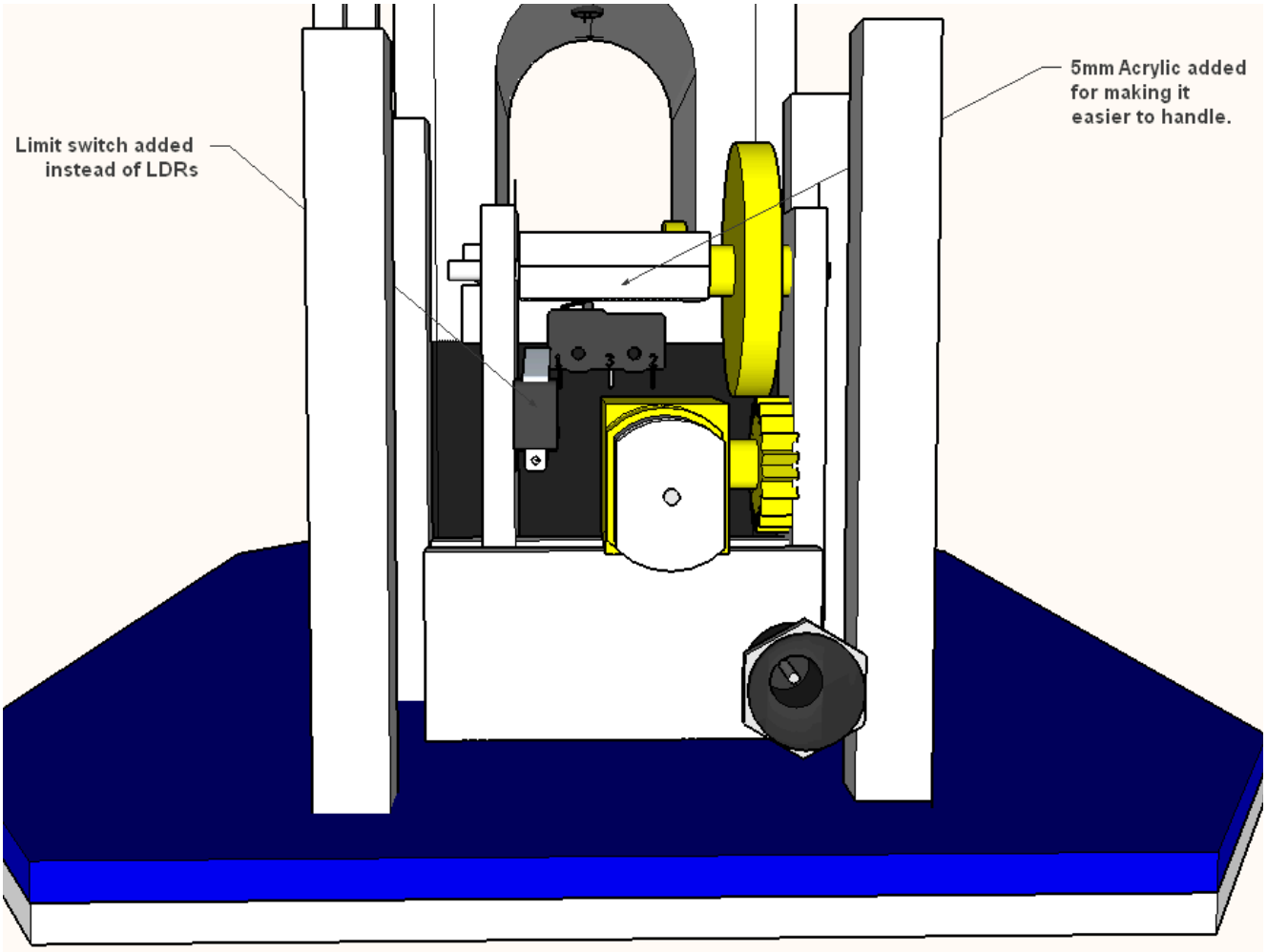
Explanation:

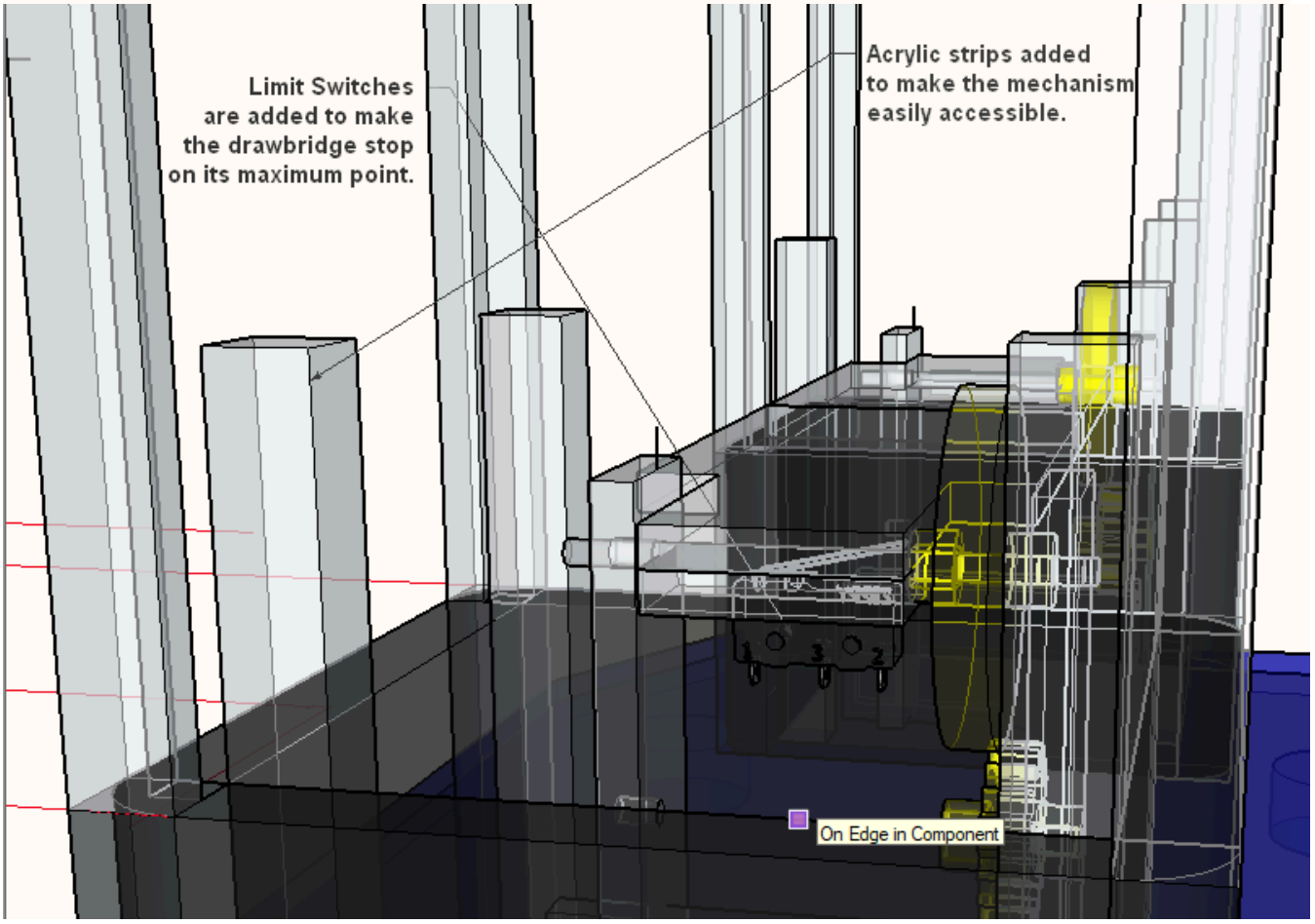
- Windows are added to the drawbridge to make it stand out.
- Battlements are added to the top of the two building to make it more medieval.
- A connection between two buildings are added to make the wires more accessible,better cable management and to make the drawbridge more realistic.



Explanation :

- Slanted roofs are used to make nice illumination at nights instead of flat roofs.
- More LEDs are used to make it stand out at night instead with 2 LEDs.
- The base is shorter (350mm x 200mm) due to the waste of Acrylic.The original base dimensions were 350mm x 300mm.
- Small stands underneath the drawbridge are used to prevent any scratches that could damage the base.
- The GENIE 18 Board is now on the top because it can be well hidden from the wire making it easily accessible to the mechanism etc.


Limit switch added
instead of LDRs
5mm Acrylic added
for making it
easier to handle.


Limit Switches
are added to make
the drawbridge stop
on its maximum point.
Acrylic strips added
to make the mechanism
easily accessible.
On Edge in Component

Explanation:

- Another limit Switch is added on the mechanism instead of LDRs because the tip of the drawbridge won't touch it.
- 5mm Acrylic is used underneath the drawbridge for making the mechanism easier to handle

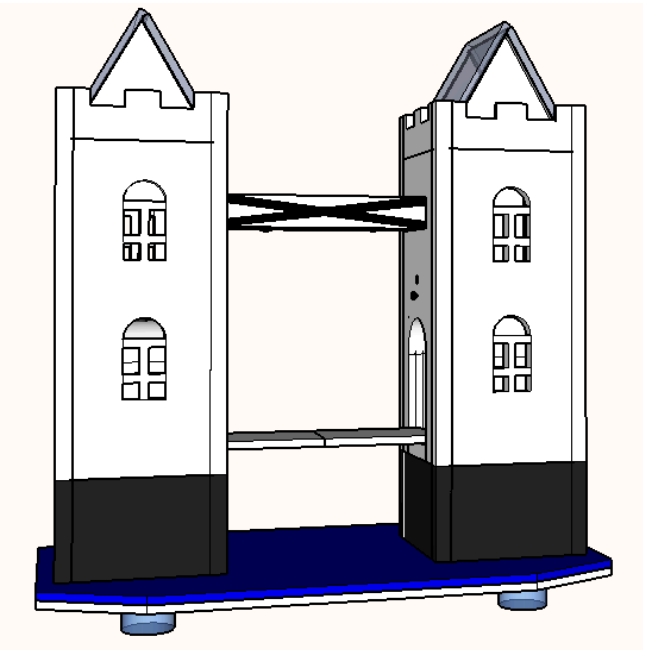
- Limit Switches are added to make the motor stop when it has reached its maximum point.
- Acrylic strips are added to it so that it can be easily accessible to the mechanisms and to the GENIE 18 Motor Board for any errors.

4. Criteria for Selection of Solution

4.1. Justification Of Selected Idea

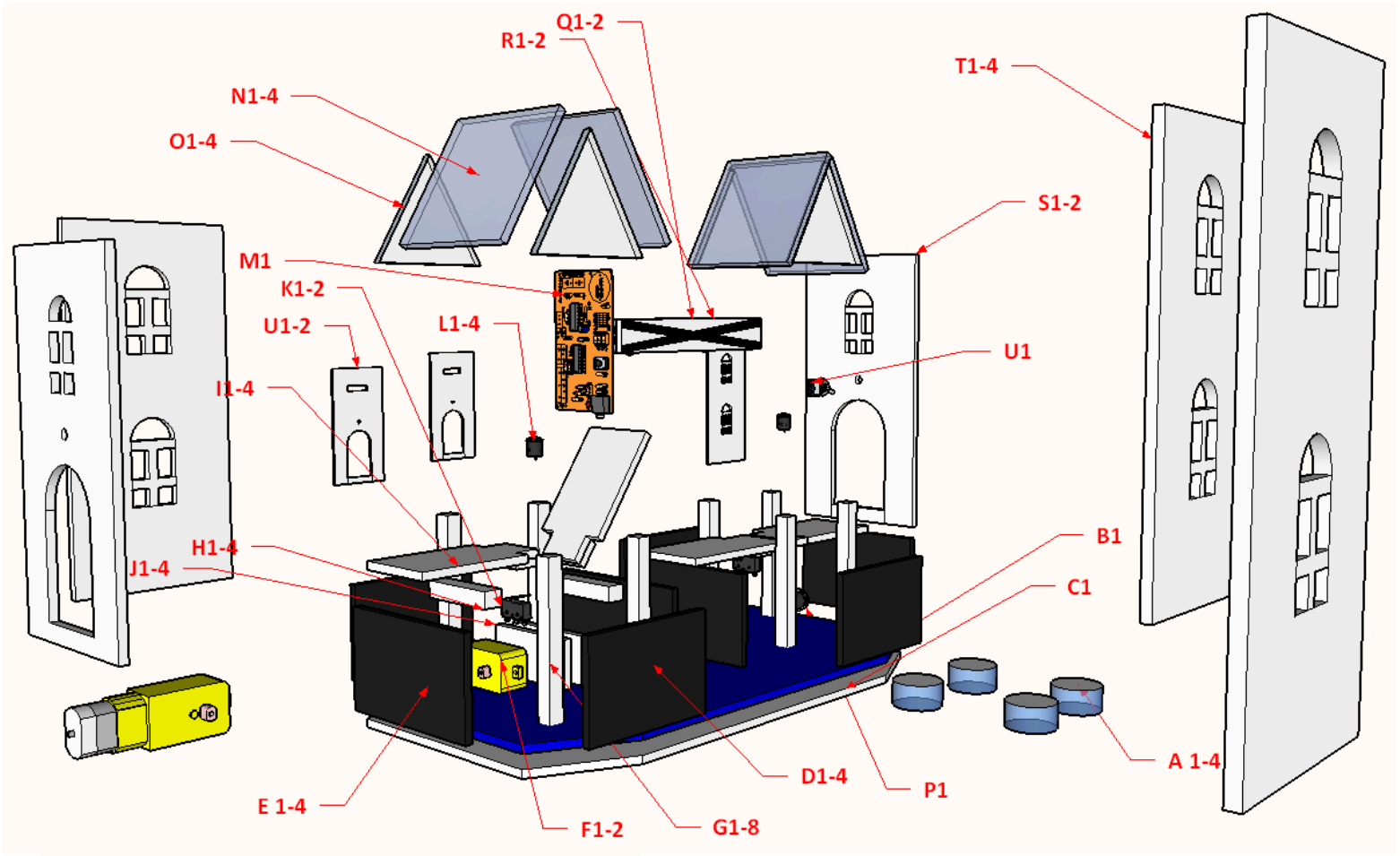
I showed Idea 2 as my final idea for the following reasons:

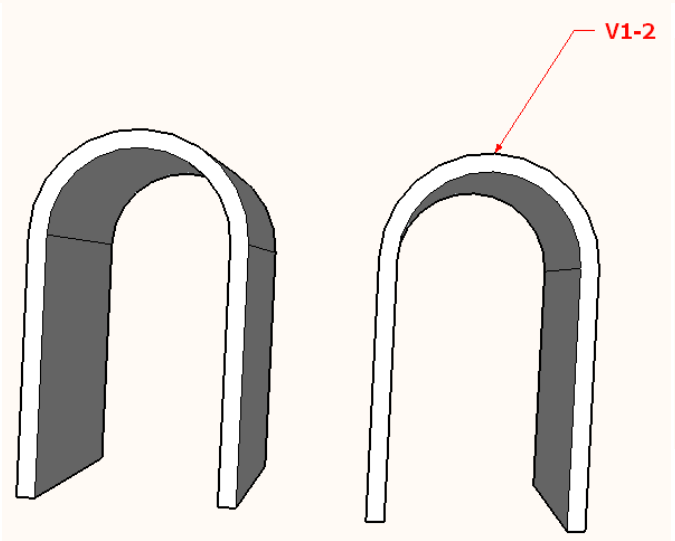
1. I believe that it complies with the requirements of the design brief.
2. The design is based on the modern - day drawbridges.
3. I believe I can manufacture this project within the time available and within the budget available.
4. I like this design because it stands out in first person view.
5. I also like the design because it looks really good from all angles and also give an example of modern drawbridges.
6. The design complies with all necessary safety precautions in terms of:
    a. No sharp edges
    b. No dangerous moving parts
    c. No dangerous or toxic materials used
7. This is a project which I look forward to making and bringing home afterwards.

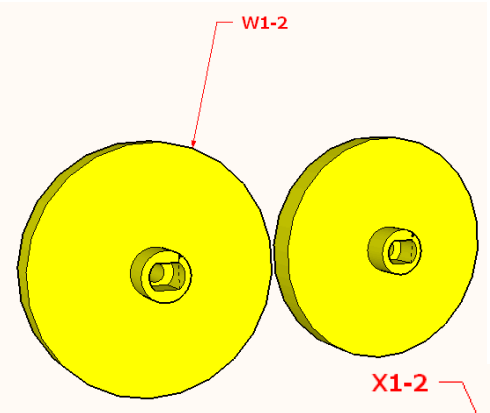


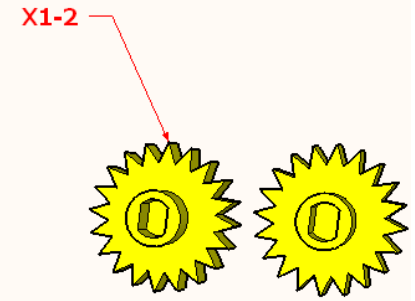
5. Sketches / Drawings For Manufacture

5.1. Exploded View

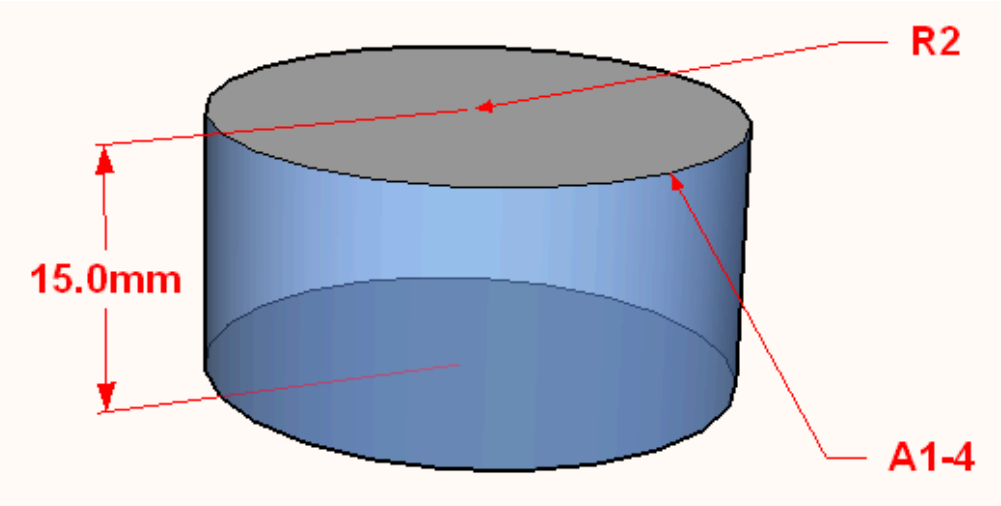


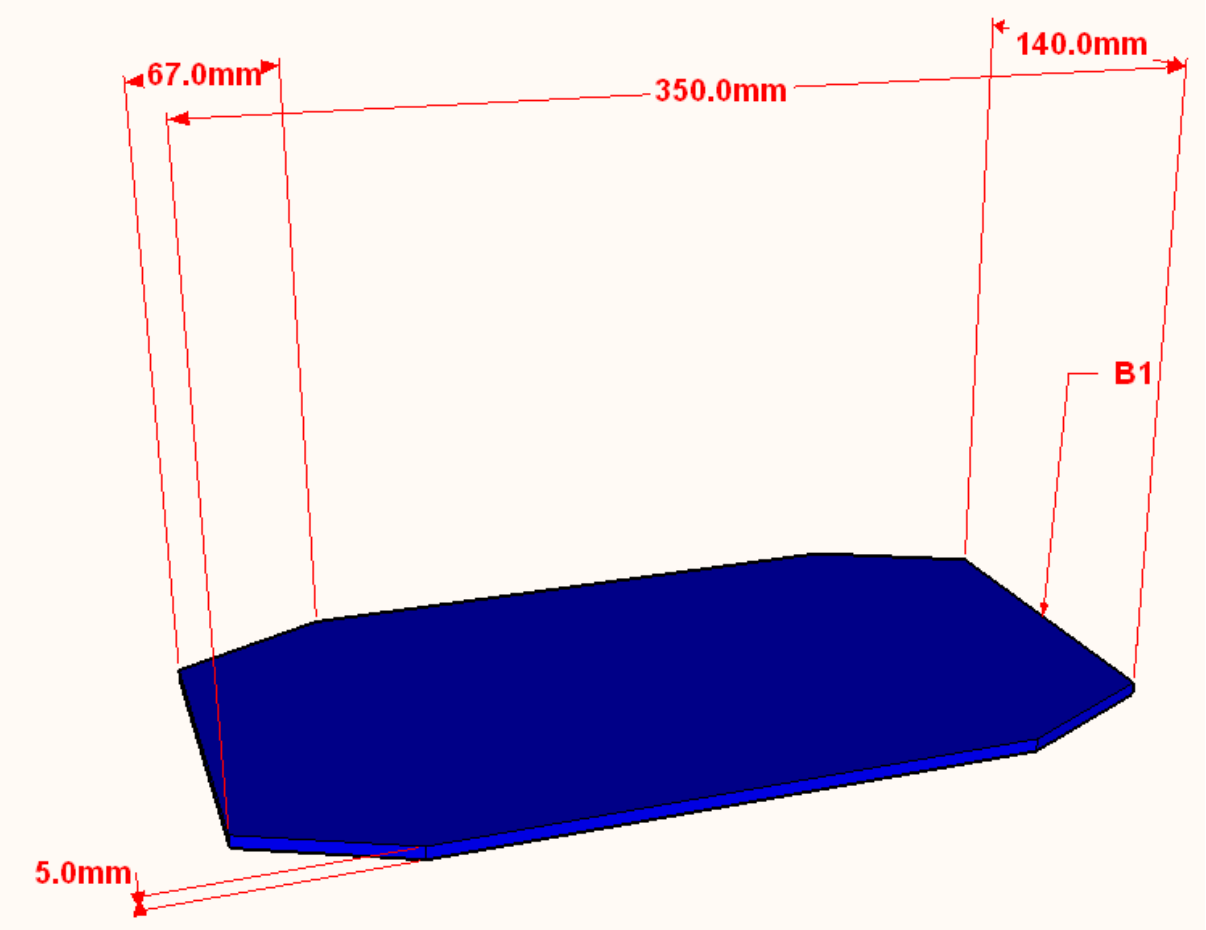


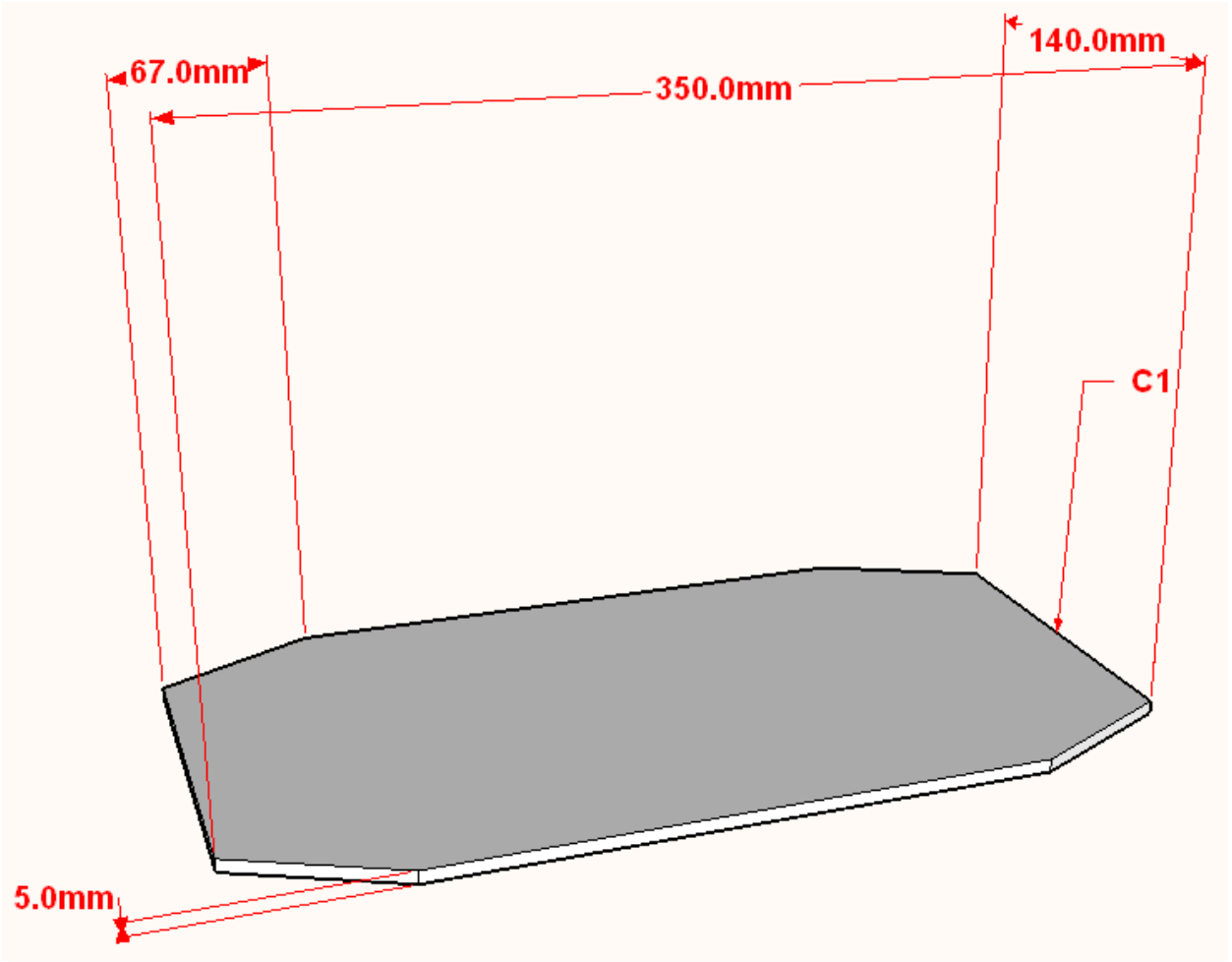


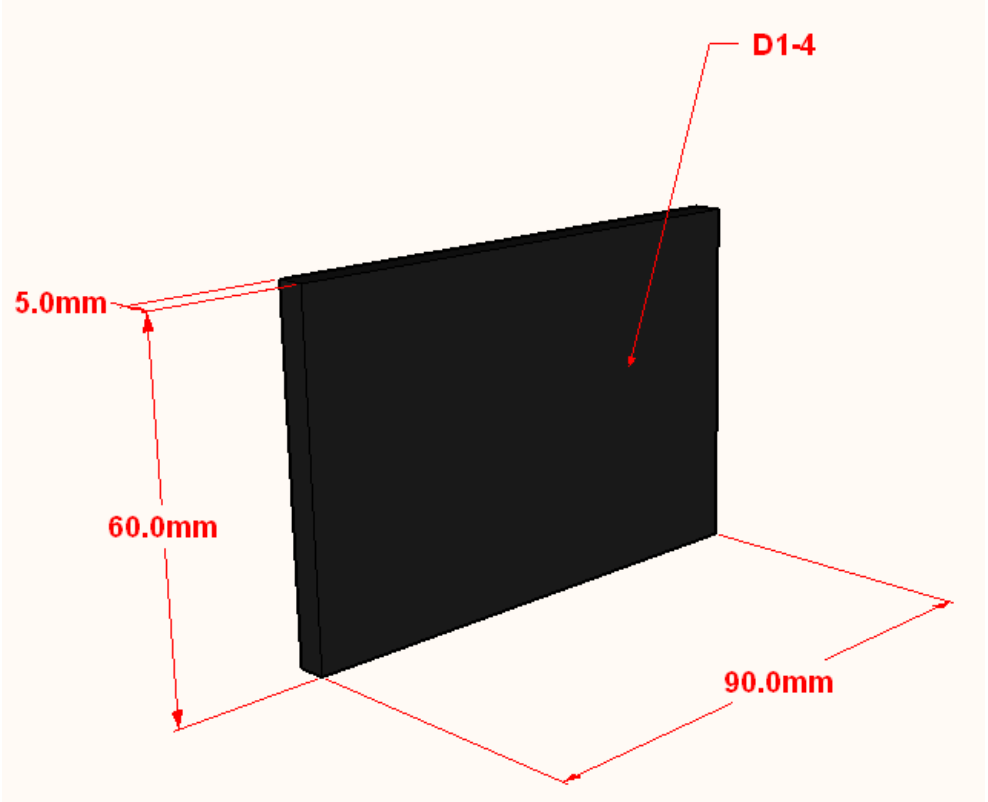


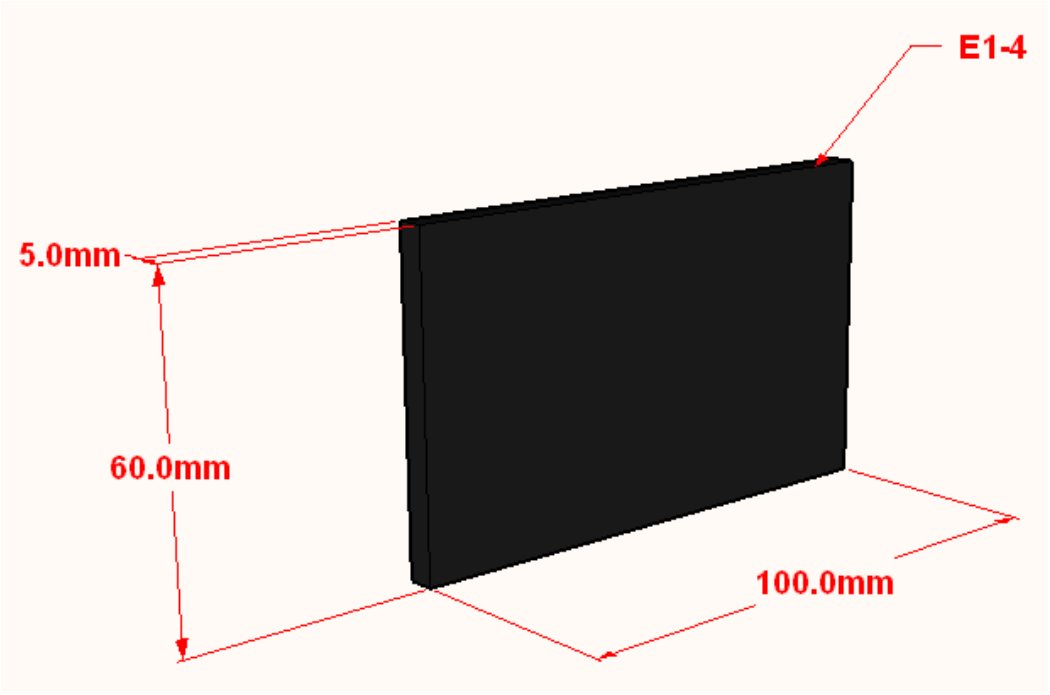
5.2 Individual Part Working Drawings

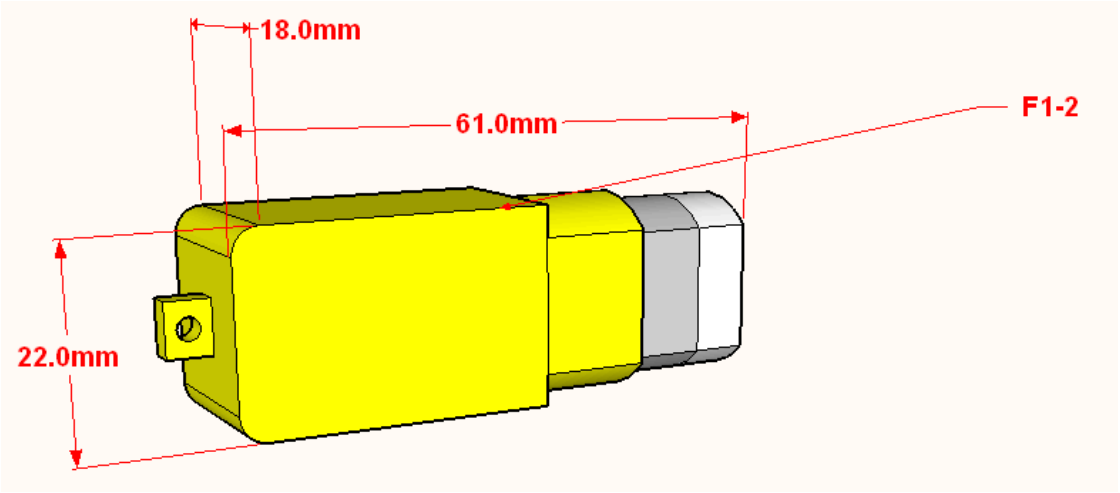


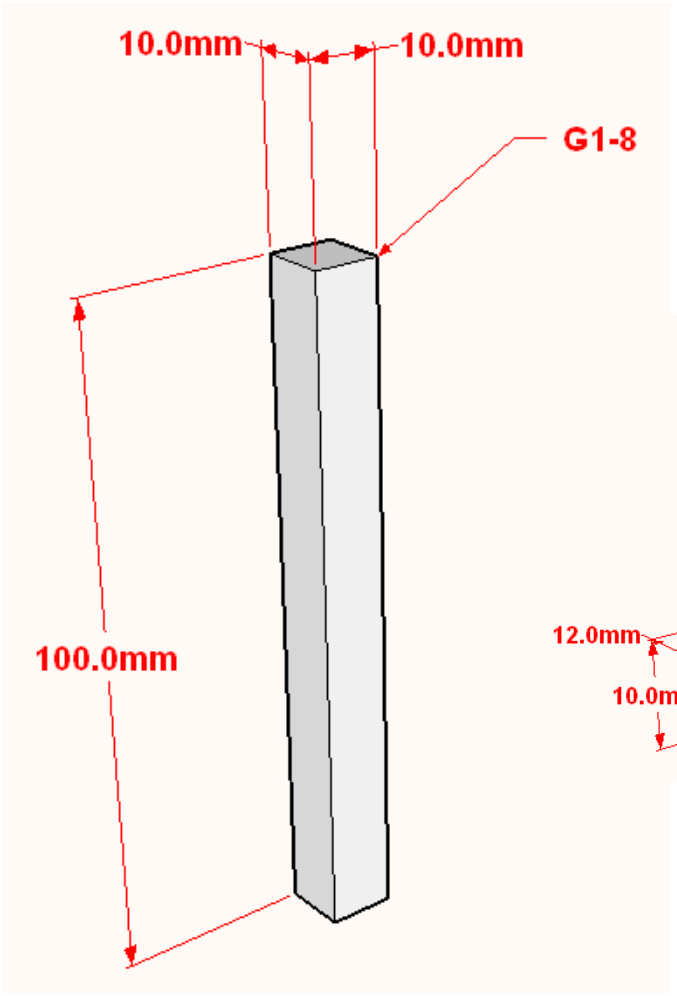


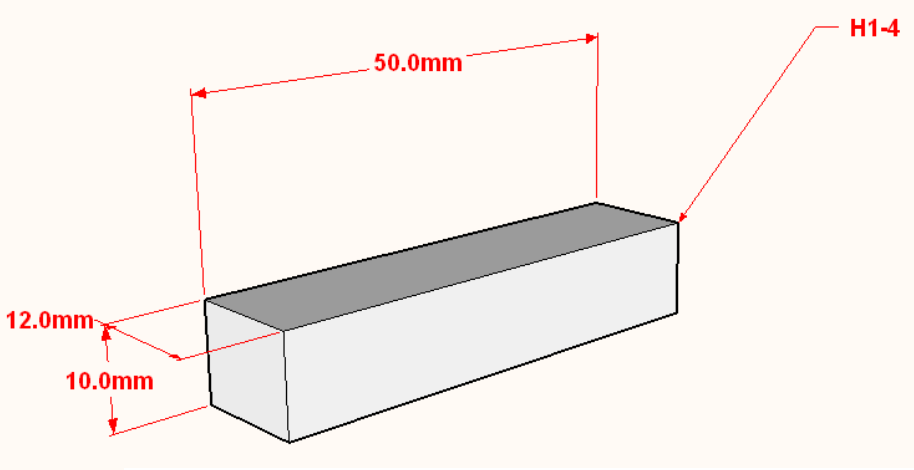

67.0mm
350.0mm
140.0mm
C1
5.0mm

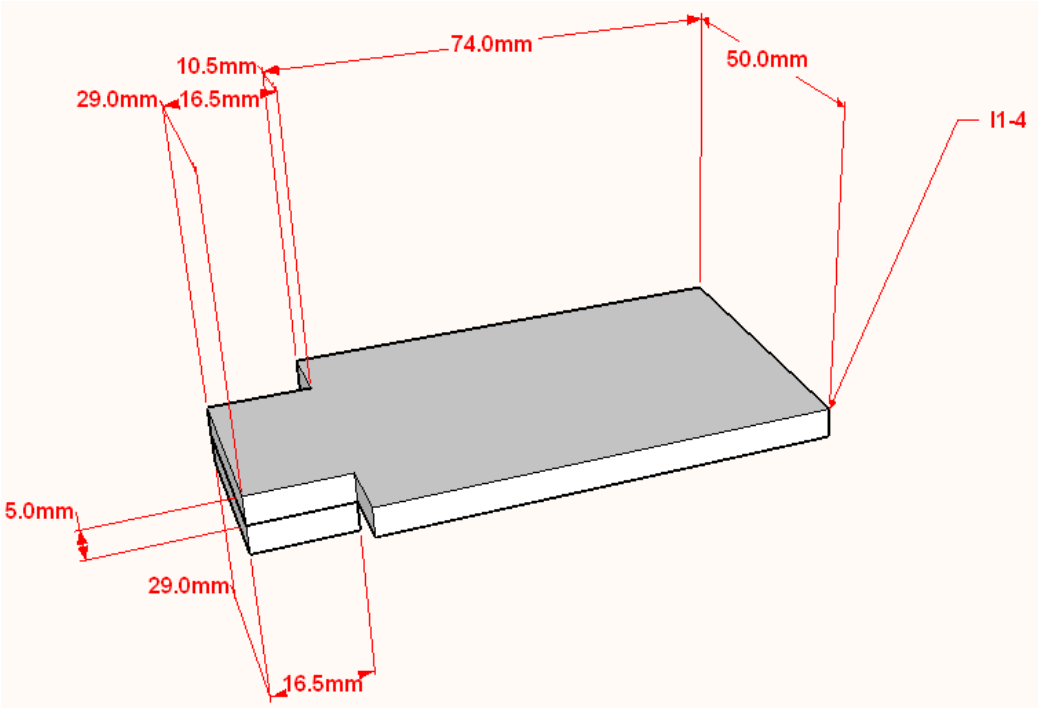

D1-4
5.0mm
60.0mm
90.0mm

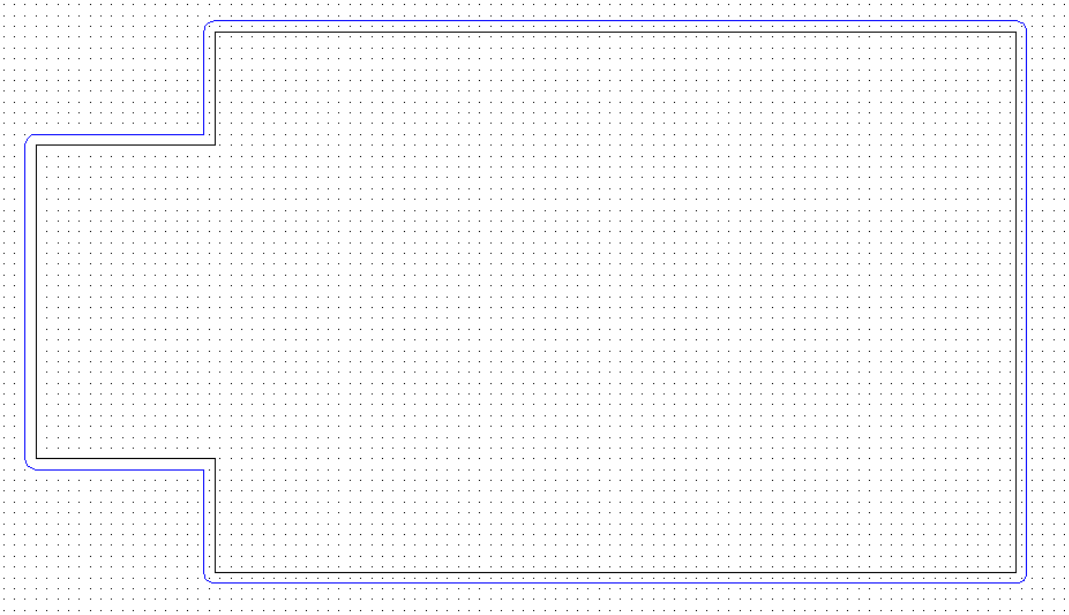

E1-4
5.0mm
60.0mm
100.0mm

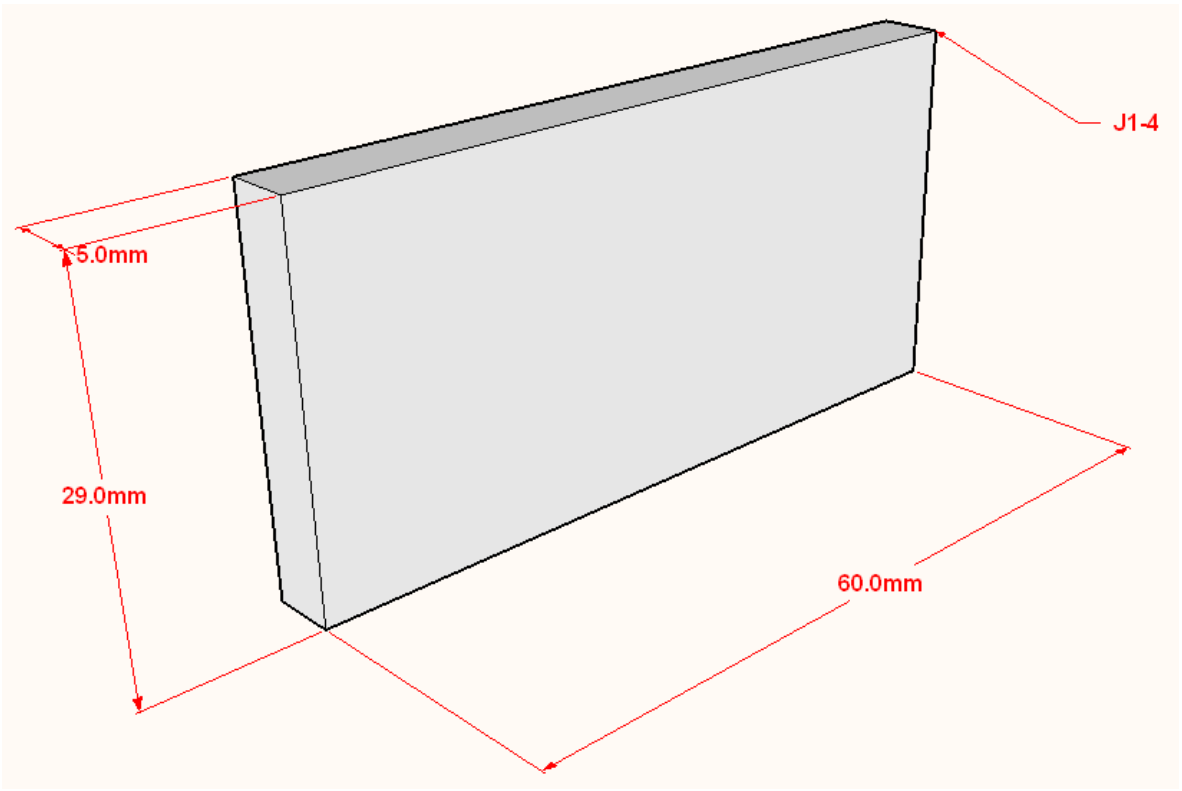

18.0mm
61.0mm
F1-2
22.0mm

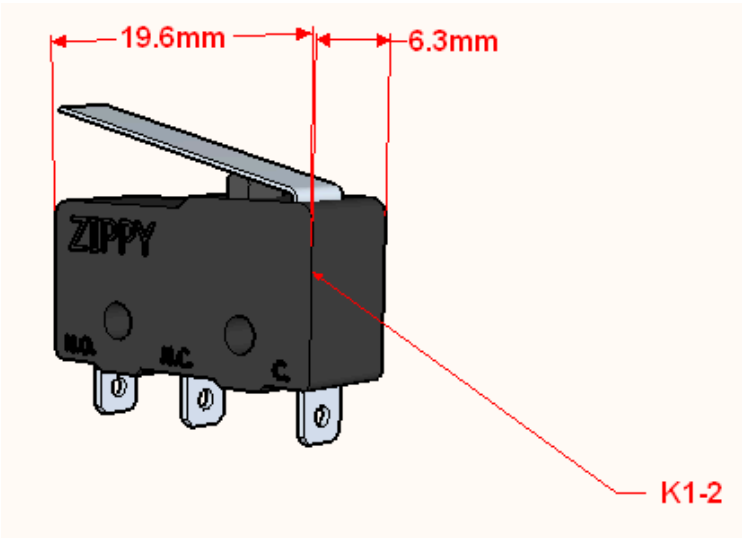

10.0mm
10.0mm
G1-8
100.0mm

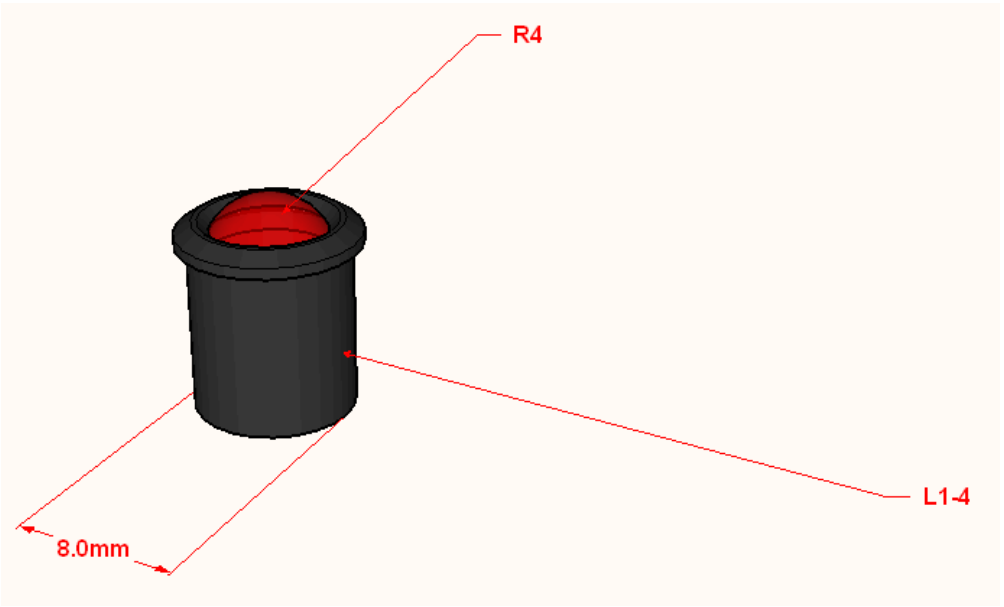

H1-4
50.0mm
12.0mm
10.0mm

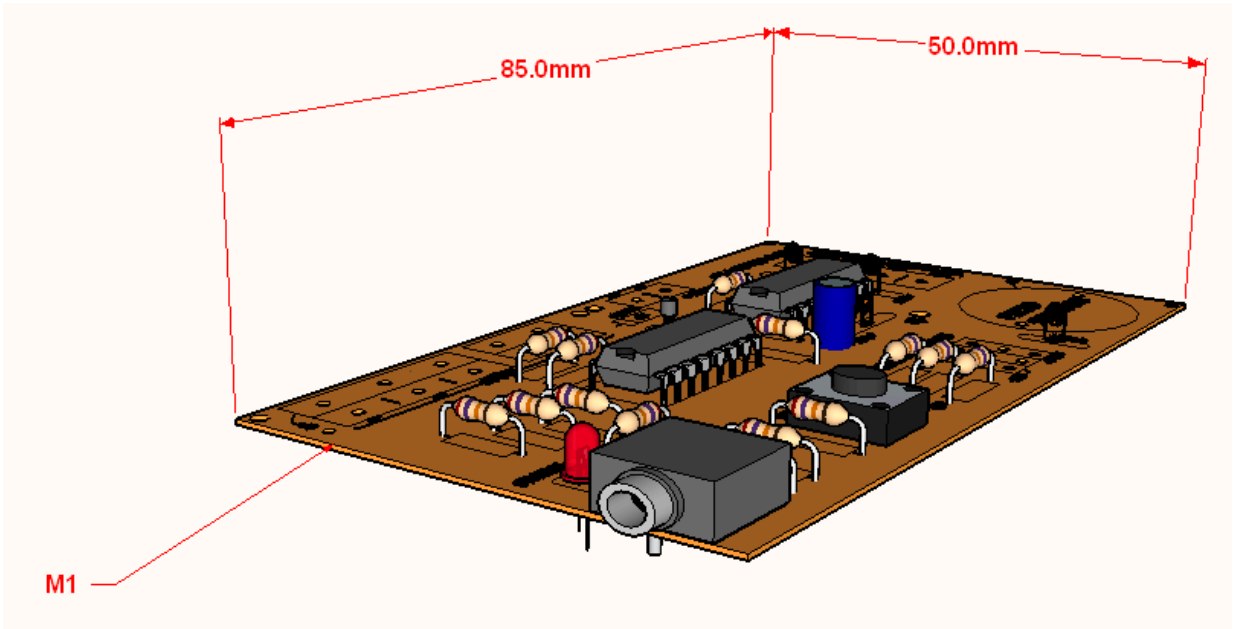

74.0mm
50.0mm
10.5mm
29.0mm
16.5mm
I1-4
5.0mm
29.0mm
16.5mm

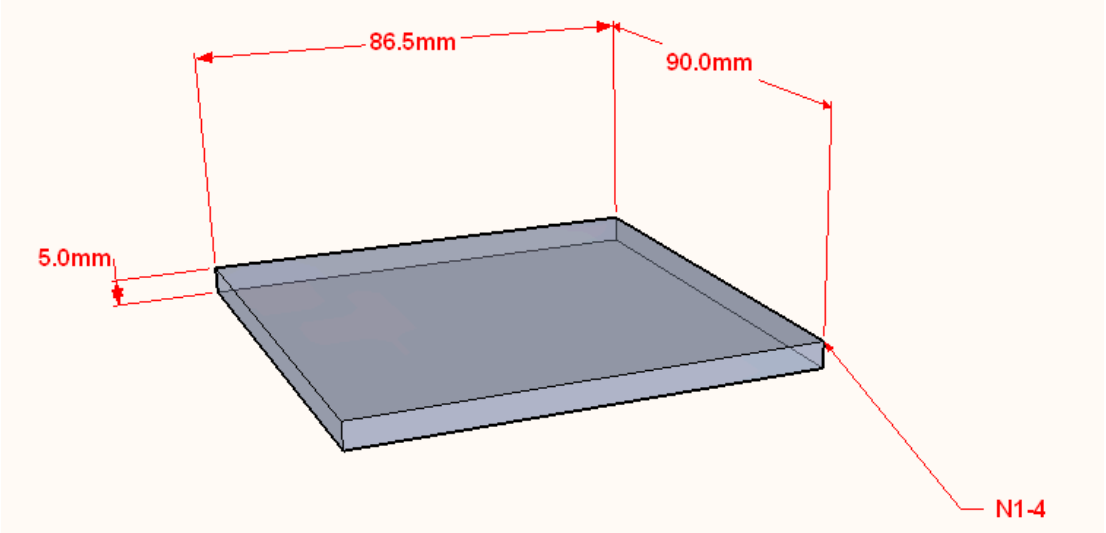


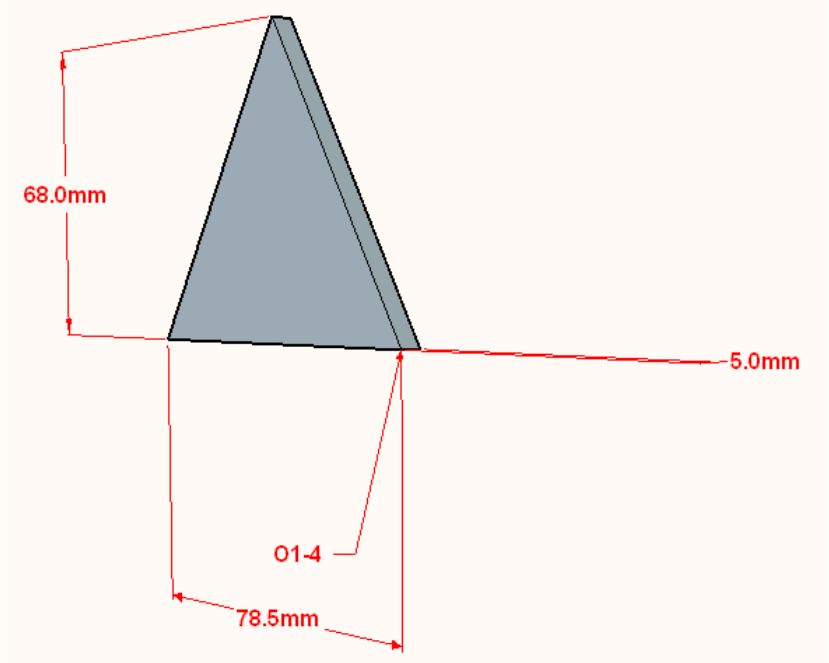

J1-4
5.0mm
29.0mm
60.0mm

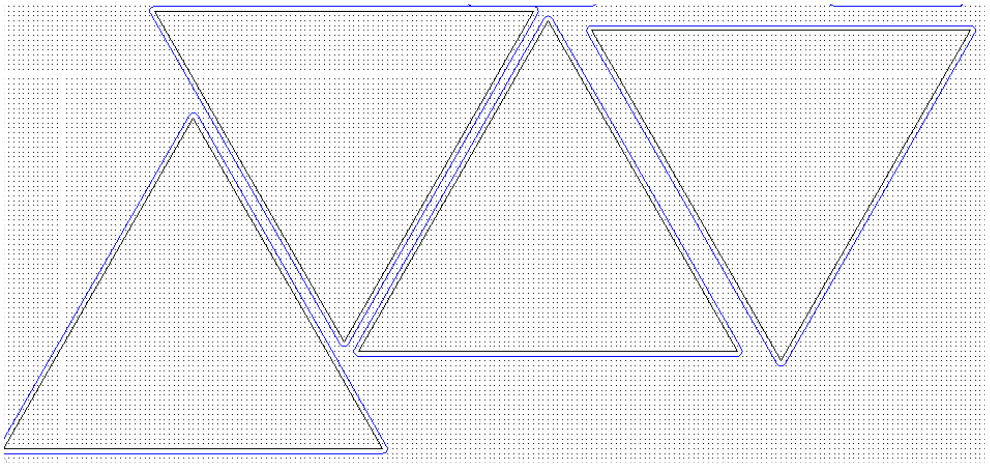

19.6mm
6.3mm
ZIPPY
N.O.
N.C.
C
K1-2

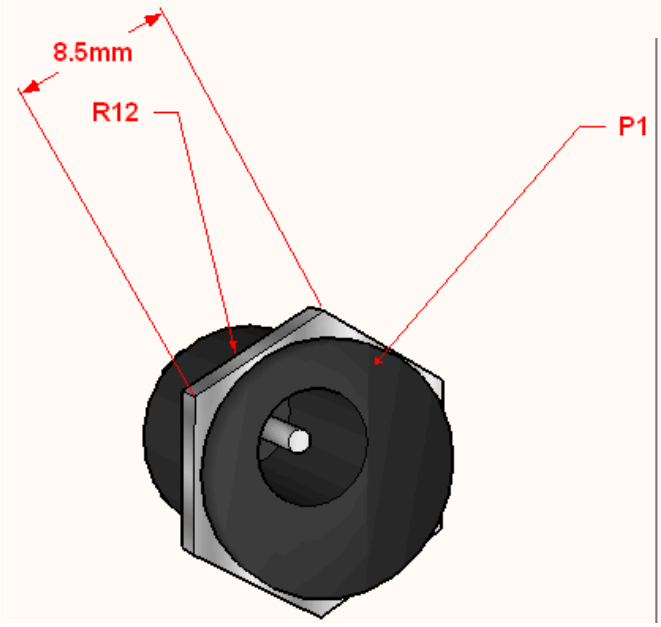

R4
L1-4
8.0mm

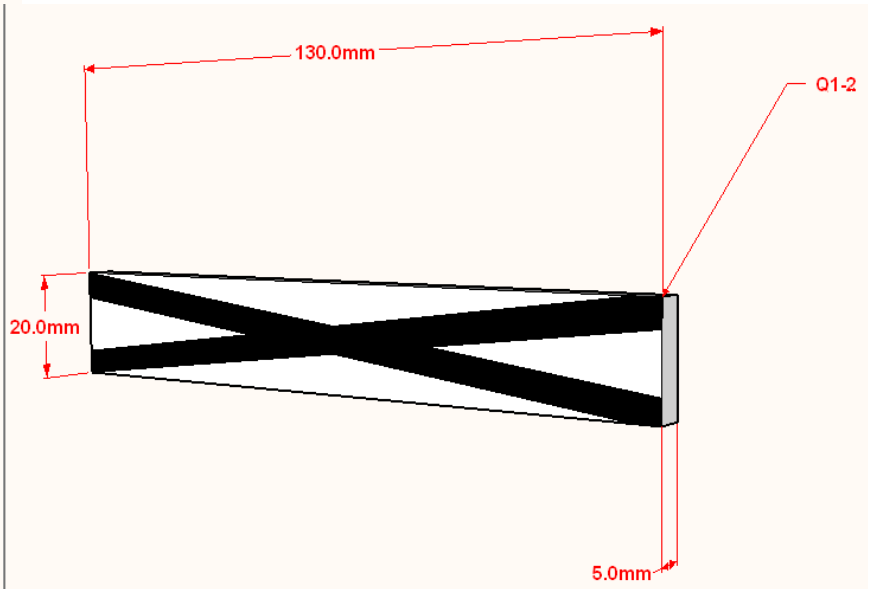

85.0mm
50.0mm
M1

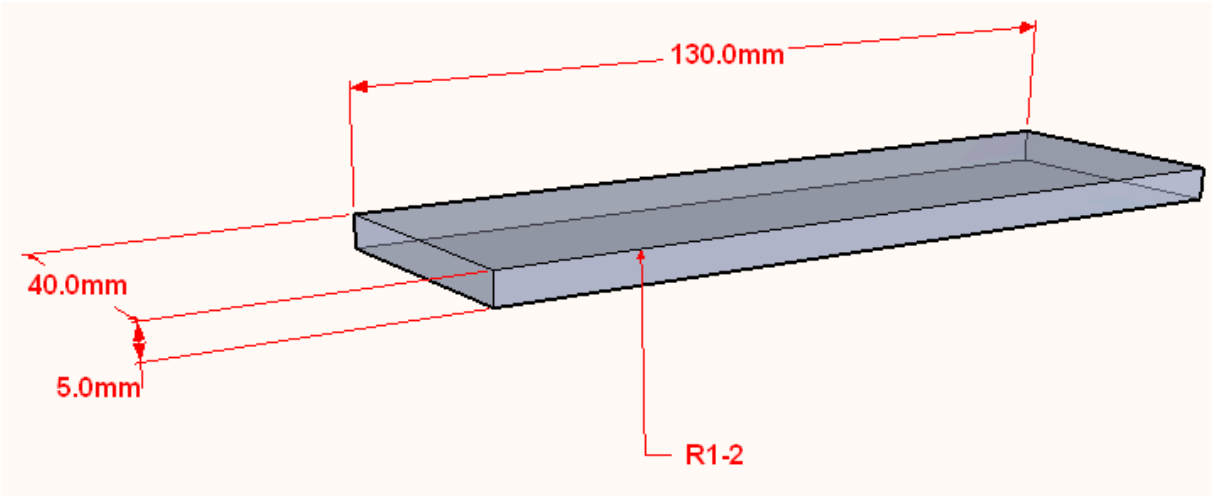

86.5mm
90.0mm
5.0mm
N1-4

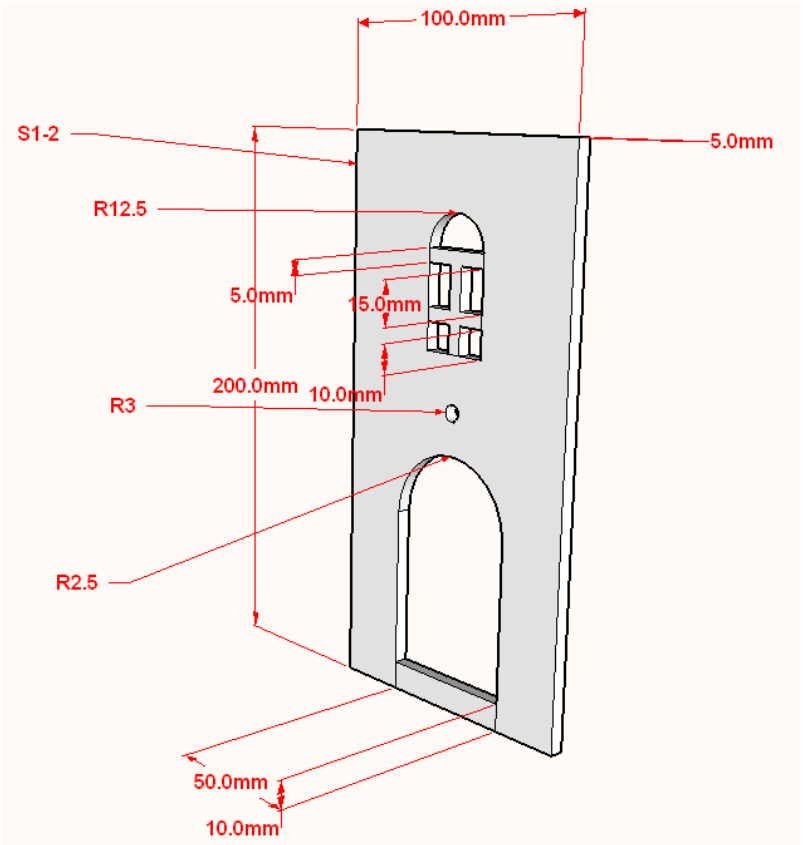

68.0mm
5.0mm
O1-4
78.5mm

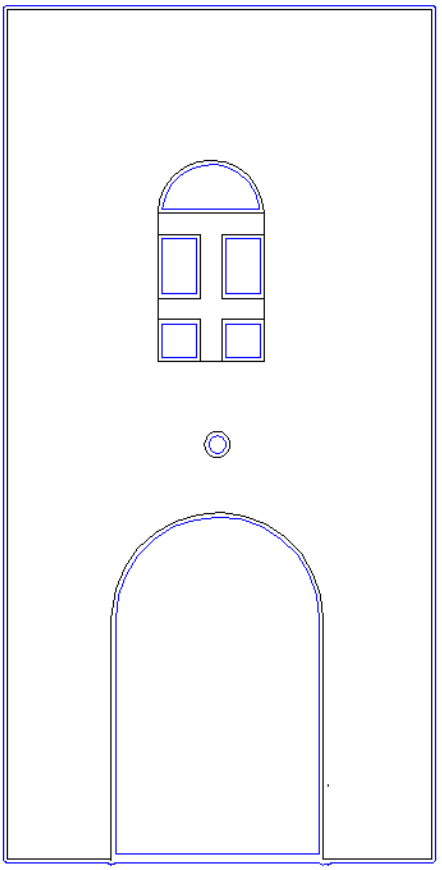


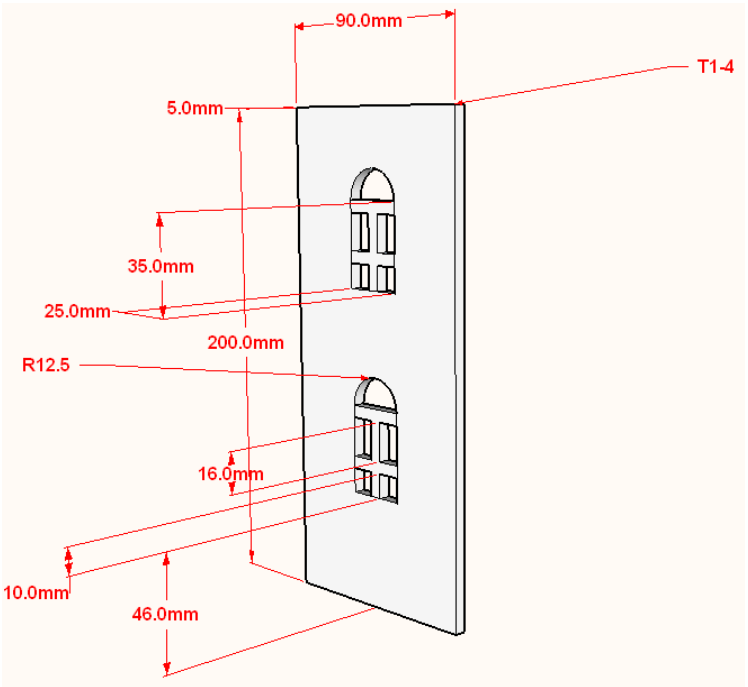

8.5mm
R12
P1

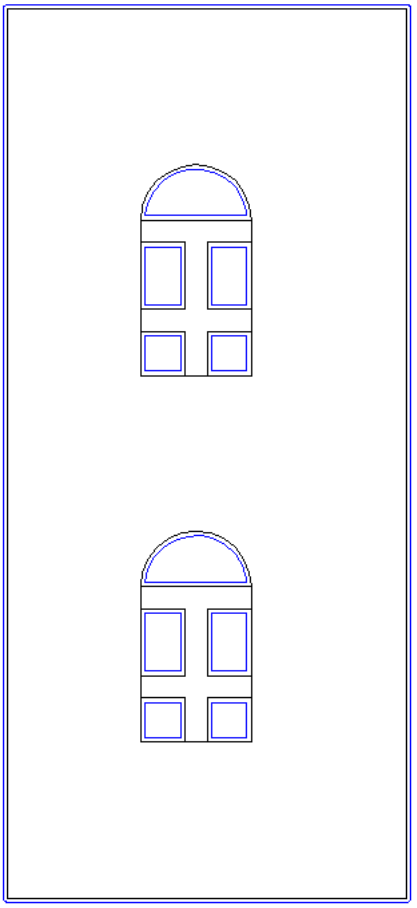

130.0mm
Q1-2
20.0mm
5.0mm

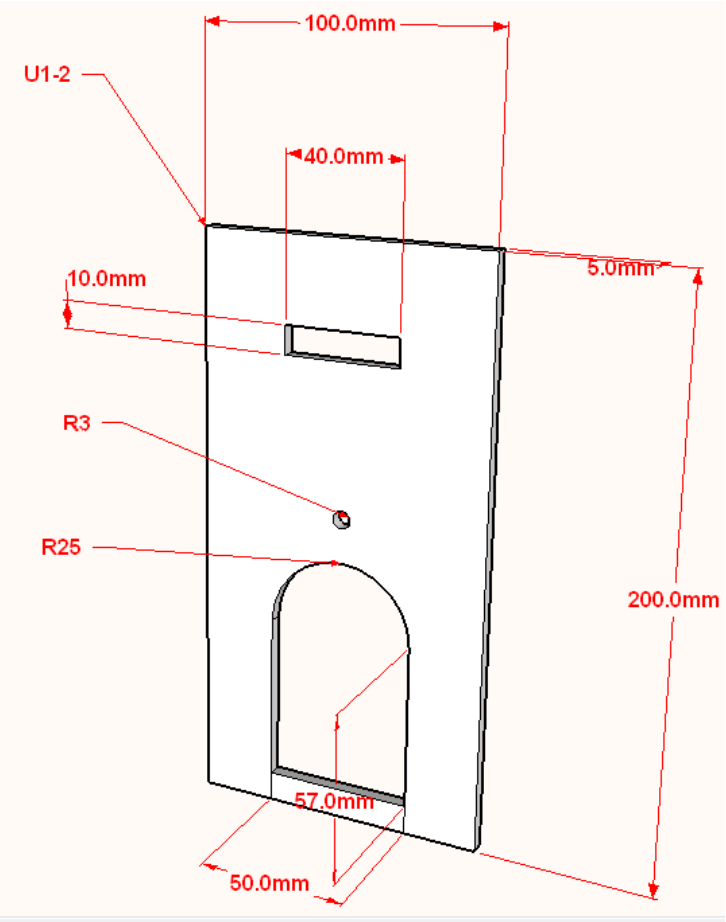

130.0mm
40.0mm
5.0mm
R1-2

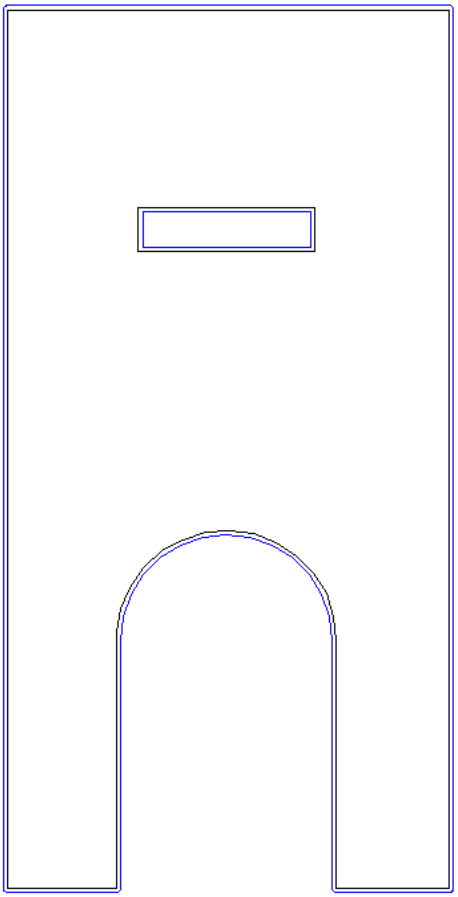

100.0mm
S1-2
5.0mm
R12.5
5.0mm
15.0mm
200.0mm
10.0mm
R3
R2.5
50.0mm
10.0mm

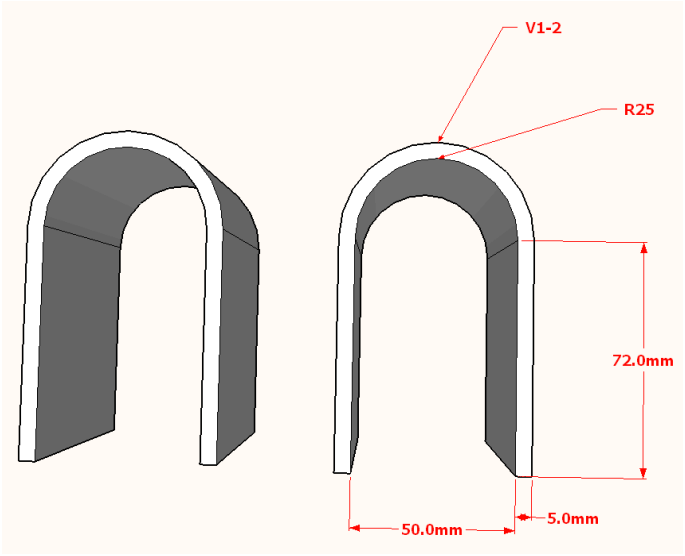


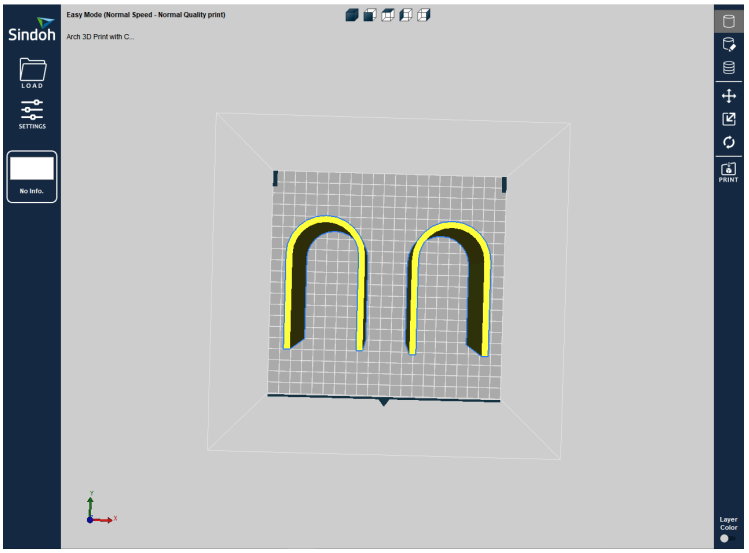

90.0mm
T1-4
5.0mm
35.0mm
25.0mm
200.0mm
R12.5
16.0mm
10.0mm
46.0mm

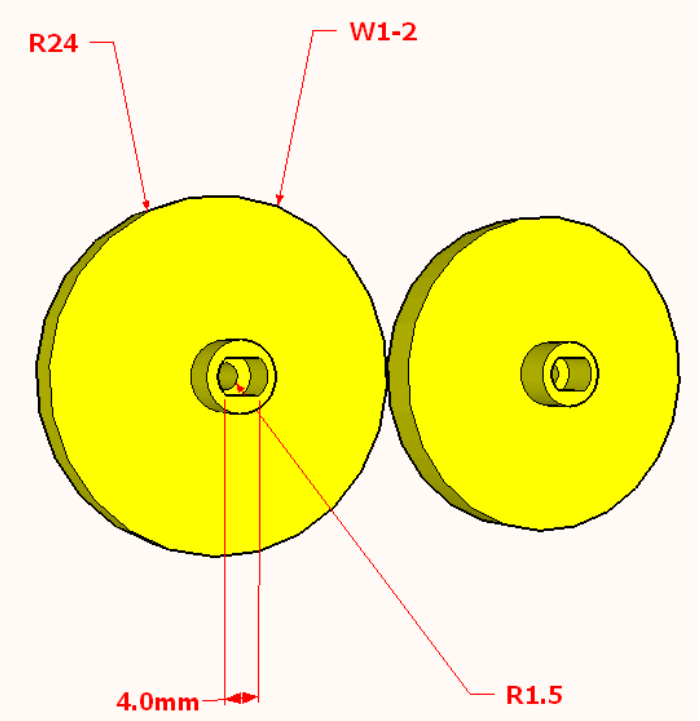


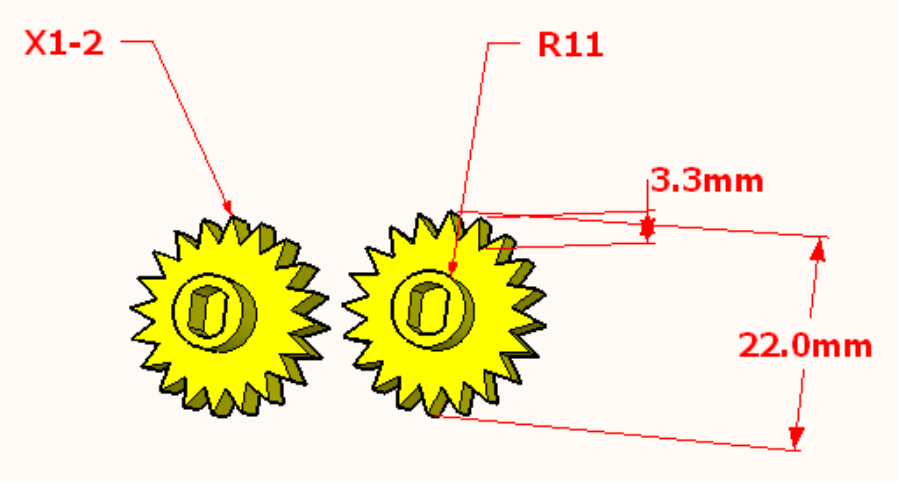

100.0mm
U1-2
40.0mm
10.0mm
5.0mm
R3
R25
200.0mm
57.0mm
50.0mm




V1-2
R25
72.0mm
50.0mm
5.0mm


Sindoh
LOAD
SETTINGS
No Info.
PRINT


R24
W1-2
4.0mm
R1.5


X1-2
R11
3.3mm
22.0mm

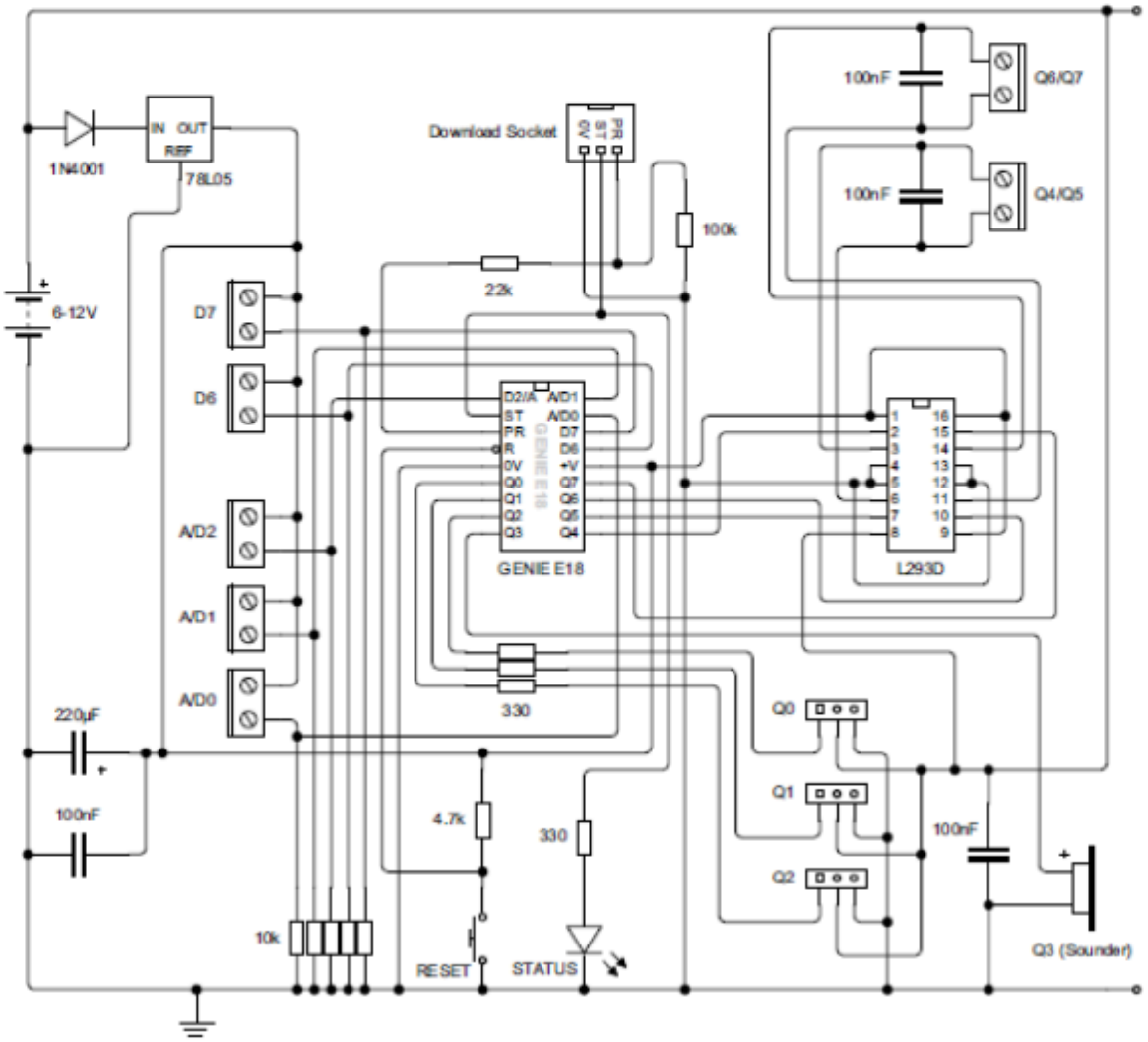
Components Table

Part	Description	No. of Pieces	Dimensions (mm)
A1-4	5mm Glass Acrylic	4	Diam 4 x 15
B1	5mm Blue Acrylic	1	350 x 150 x 5
C1	5mm White Acrylic	1	350 x 150 x 5
D1-4	5mm Black Acrylic	4	90 x 60 x 5
E1-4	5mm Black Acrylic	4	100 x 60 x 5
F1-2	Motor Gearbox	2	Given Size
G1-8	5mm White Acrylic	8	100 x 10 x 10
H1-4	5mm White Acrylic	4	50 x 12 x 10
I1-2	5mm White Acrylic	2	90 x 50 x 5
J1-2	5mm White Acrylic	2	60 x 29 x 5
K1-4	Limit Switch	2	Given Size
L1-4	Clear LED	4	Given Size
M1-2	GENIE 18 Motor Board	1	Given Size
N1-2	5mm Glass Acrylic	2	86.5 x 90 x 5
O1-4	5mm Glass Acrylic	4	78.5 x 68
P1	Power Socket	1	Given Size
Q1	5mm White Acrylic	2	130 x 20 x 5
R1-2	5mm Glass Acrylic	2	130 x 40 x 5
S1-2	5mm White Acrylic	2	200 x 100 x 5
T1-4	5mm White Acrylic	4	200 x 90 x 5
U1-2	5mm White Acrylic	2	200 x 100 x 5
V1-2	5mm White PVC/ABS	2	102 x 60 x 5
W1-2	40T Pinion	2	Given Size
X1-2	20T Pinion	2	Given Size

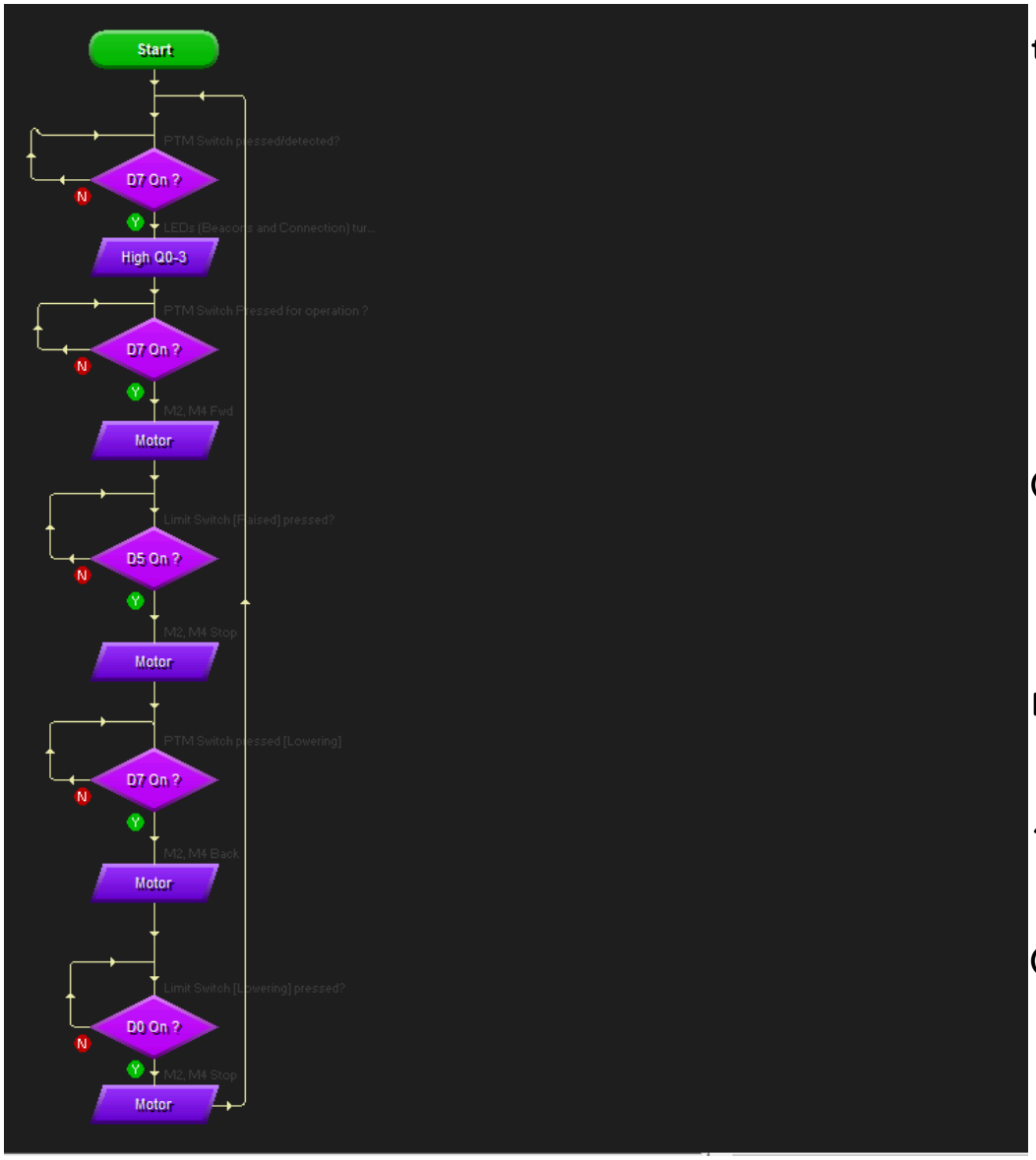
5.3 Circuit Drawing & Flow Chart

Circuit Diagram

This is the basic circuit diagram for the GENIE 18 Motor Board:



Flow Chart Diagram



1.When the SPST switch is turned on and the LEDs are turned on the directly and D7 command checks if the PTM switch is pressed to start the operation of raising the drawbridge.

2. The D5 command checks if the drawbridge has touched the D5 input ([Raising]Drawbridge) so it stop raising it.

3.The D7 command checks again if the PTM switch is pressed so it can lower the drawbridge.

4.The D0 command checks if the drawbridge has touched the D0 input ([Lowering]Drawbridge) so it stop lowering it.

5.The program then loops back to the start and checks if the PTM switch is pressed so it can start the operation again.

6. Manufacturing Sequence/Processes

6.1 Plan of Manufacture

In order to manufacture this project in a logical manner I decided to divide it into a number of smaller manufacturing tasks :

1. **CNC Machining of the side panels and the front / rear panel with windows and arches for better design and also easier raise/lower the drawbridge.**
2. **Hand machining of the remainder of the acrylic parts for the base,mechanism holder,removable building and the connection between the 2 drawbridges.**
3. **The gearbox mechanism for raising and lowering the drawbridge.**
4. **Populating the GENIE 18 Motor Control Board Kit.**
5. **Commissioning and testing of the GENIE 18 Motor Control Board Kit.**
6. **Finishing.**

I will now describe the steps involved in each of these in more detail.

1. **CNC Machining and 3D Printing of the side panels and the front / rear panel with the slot to allow the plane launch**
    a. Create the drawings for pieces Q1,R1-2,S1-2,T1-4,U1-2 and V1-2 using the Techsoft 2D Design software 3D Printing software - as shown in section 5.3.
    b. Cut out suitable pieces for the CNC machine, apply double sided tape and insert in the CNC machine.
    c. Load 2D design files into CNC machine.
    d. Set up and start CNC machine.
    e. Assemble all completed pieces using liquid solvent cement.
    f. Finish any edges that will be seen using draw filing, P400/800 and polish.

2. **Hand machining of the remainder of the acrylic parts for the base,runaway and all interior parts.**
    a. Mark out pieces A1-4, B1 ,C1 ,D1-4, E1-4,G1-8,H1-4,I1-2,J1-2 ,N1-2 and O1-4 using the steel ruler, scriber and square.
    b. Cut out the pieces using the junior hack saw and/or band saw.
    c. Shape the pieces using belt/disc sander and rough/smooth files.
    d. Assemble all completed pieces using liquid solvent cement.

e. Finish any edges that will be seen using draw filing, P400/800 and polish.

3. The drive mechanism for raising/lowering the drawbridge.

a. Attach the 40T Pinion to the drawbridge axle and the 20T Pinion on the Gearbox.

b. Then attach the mechanism with the motor to the mechanism holder

c. Connect the motor cables to the GENIE 18 Motor Kit.

4. Populating the GENIE 18 Motor Control Kit.

a. Populate the printed circuit board (PCB) with the components as supplied in the kit using the data sheet also supplied.

b. Attach the following components using flying leads:

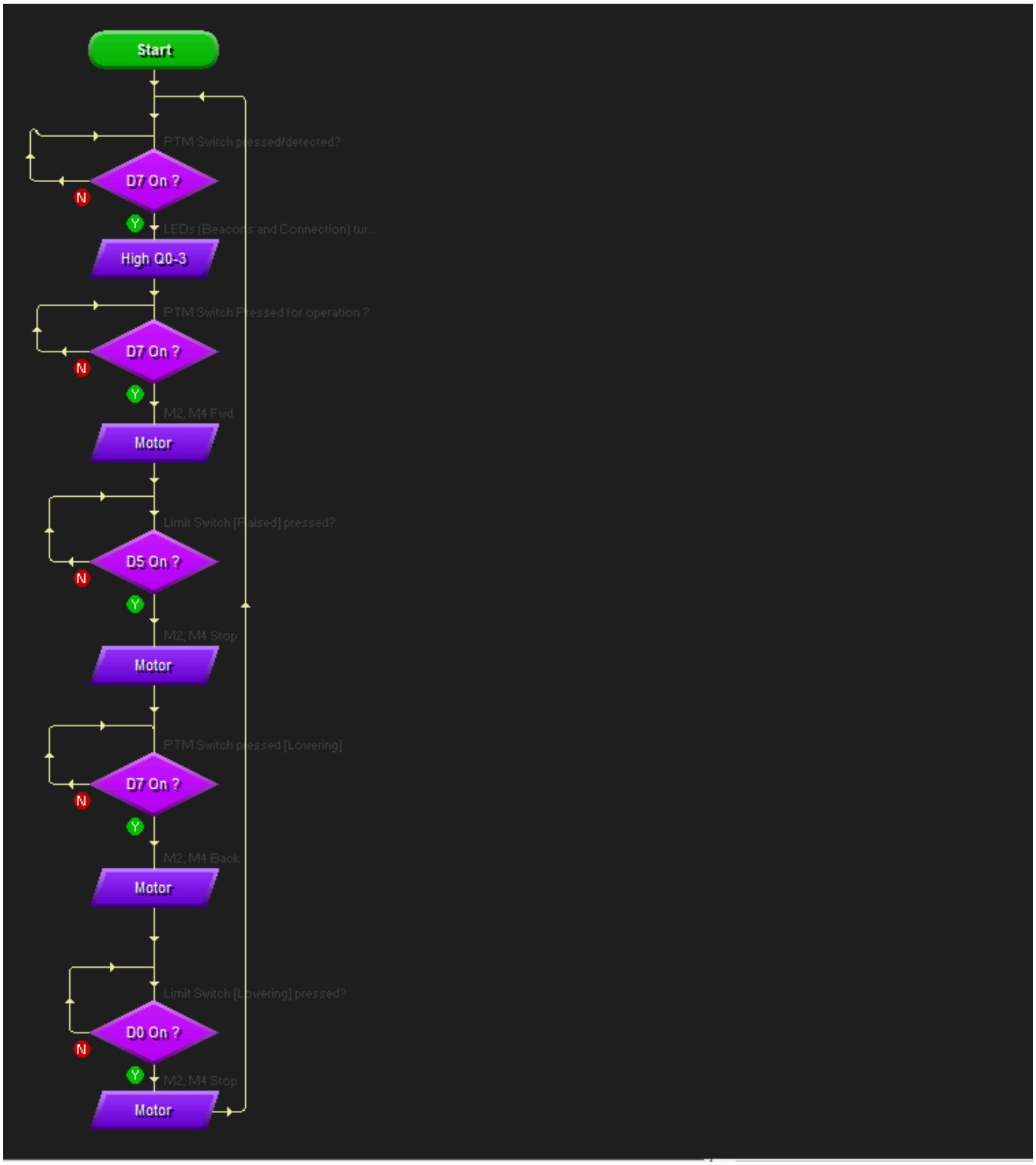
(i) Limit Switches

(ii) LEDs

(iii) SPST on/off

(iv) PTM Switch

5. Commissioning and testing of the GENIE 18 Motor Control Kit.



a. Ensure that GENIE 18 board is connecting to PC and Programming Editor software by connecting the GENIE USB cable and selecting 'Control Device'. Turn on/off each output used and check any inputs are working.
b. If the board is not connecting then check for the following:
    i. Voltage at the PIC chip should be at least 3V.
    ii. Properly soldered joints
    iii. Breaks in the strips connecting components on the PCB
c. Download the program as shown above and test its operation.
d. Calibrate the LDR to operate when the plane is covering it.
e. Ensure that all components are working properly i.e. motors turning correct direction, GENIE board etc.
f. Where necessary, troubleshoot using multimeter etc.

6. Finishing.

a. Ensure that all parts of the project are assembled and secure.
b. Check for any possible safety hazards such as sharp edges, moving parts that may catch small fingers etc.
c. Ensure that all cables are tidied inside using cable ties etc.
d. Sand and polish any glue stains using P400 and P1200 both wet and dry.
e. Polish sanded edges using PEEK polish by hand initially and finally using buffing wheel in battery drill.

f. Add any final vinyl decals to improve the appearance of the project

6.2 Material List with Size and Cost

Part	Description	No. of Pieces	Dimensions (mm)	Cost Of Acrylic
A1-4	5mm Glass Acrylic	4	Diam 4 x 15	€1.00
B1	5mm Blue Acrylic	1	350 x 150 x 5	€3.00
C1	5mm White Acrylic	1	350 x 150 x 5	€3.00
D1-4	5mm Black Acrylic	4	90 x 60 x 5	
E1-4	5mm Black Acrylic	4	100 x 60 x 5	
F1-2	Motor Gearbox	2	Given Size	€2.85
G1-8	5mm White Acrylic	8	100 x 10 x 10	€2.10
H1-4	5mm White Acrylic	4	50 x 12 x 10	
I1-2	5mm White Acrylic	2	90 x 50 x 5	€1.10
J1-2	5mm White Acrylic	2	60 x 29 x 5	€1.10
K1-4	Limit Switch	2	Given Size	€0.39
L1-4	Clear LED	4	Given Size	€0.88
M1-2	GENIE 18 Motor Board	1	Given Size	€2.85
N1-2	5mm Glass Acrylic	2	86.5 x 90 x 5	€1.10
O1-4	5mm Glass Acrylic	4	78.5 x 68	€1.10
P1	Power Socket	1	Given Size	€0.59
Q1	5mm White Acrylic	2	130 x 20 x 5	€1.25
R1-2	5mm Glass Acrylic	2	130 x 40 x 5	€1.25
S1-2	5mm White Acrylic	2	200 x 100 x 5	€1.00
T1-4	5mm White Acrylic	4	200 x 90 x 5	€1.00
U1-2	5mm White Acrylic	2	200 x 100 x 5	€1.00
V1-2	5mm White PVC/ABS	2	102 x 60 x 5	€1.50
W1-2	40T Pinion	2	Given Size	€0.53

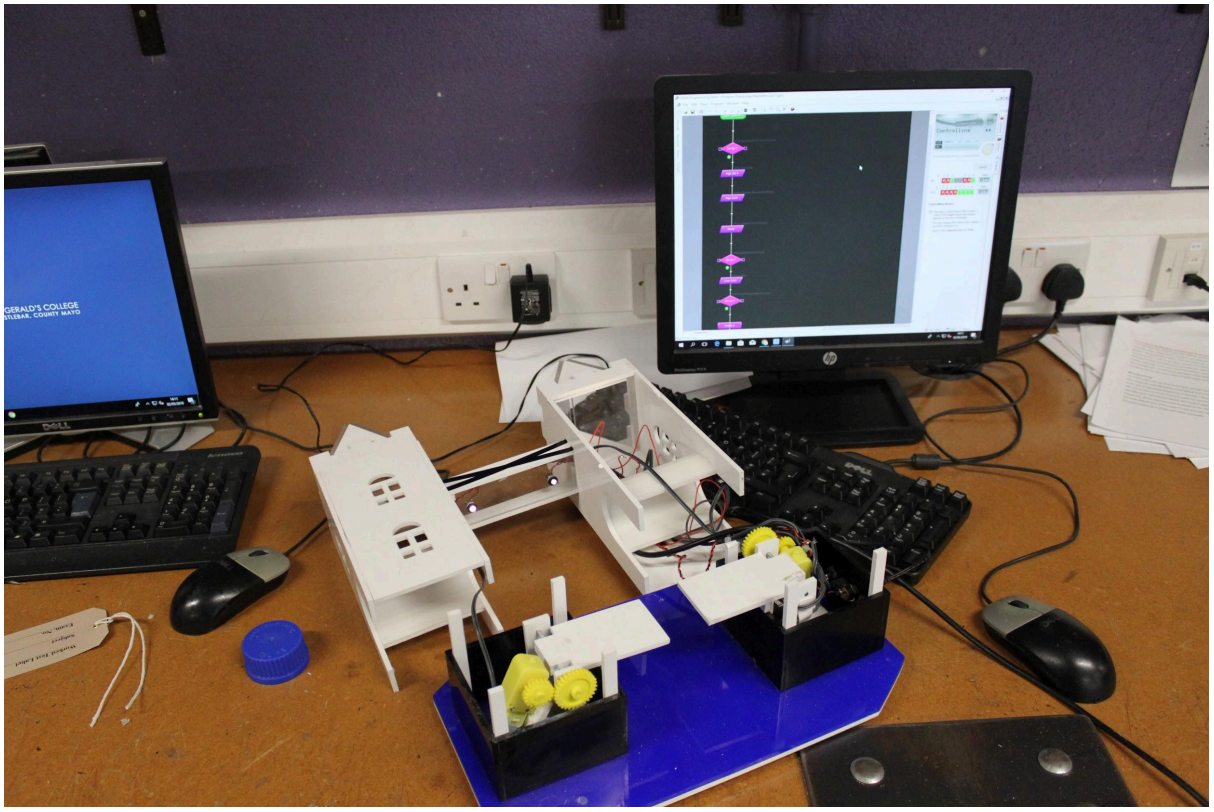
X1-2	**20T Pinion**	**2**	**Given Size**	**€0.53**

Total Cost	**€30.12**

7. Testing and Evaluation

7.1. Evidence of Testing/Modification During Manufacture

Project Testing



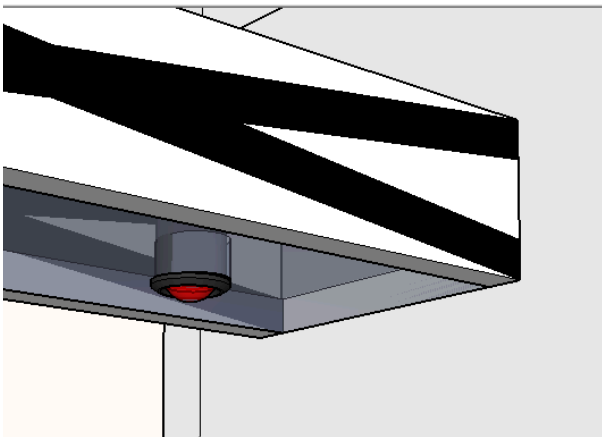
This picture shows my project being tested. The GENIE control program can be seen on screen.I used these steps to do my project correctly without failures or errors:

1. I simulate my drawbridge program in the GENIE Programming Editor to confirm that everything in the program works properly without any errors.
2. I test the operation of my program in the project using the 'Debug Live' option.
3. I downloaded the final program on my GENIE 18 board and used the 'Run Live' option and tested it.
4. I modified any input or output operation where necessary.

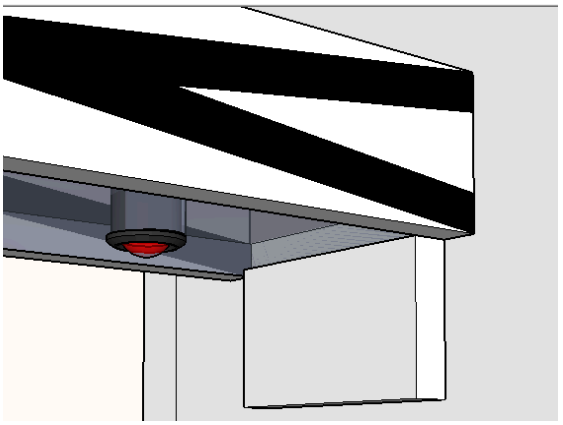
Modifications

I added small acrylic strips underneath and inside the connection between the two buildings because further on in the project I found the connection had the weakest structure holding the 2 structures so I added small acrylic strips for better stability and structure.

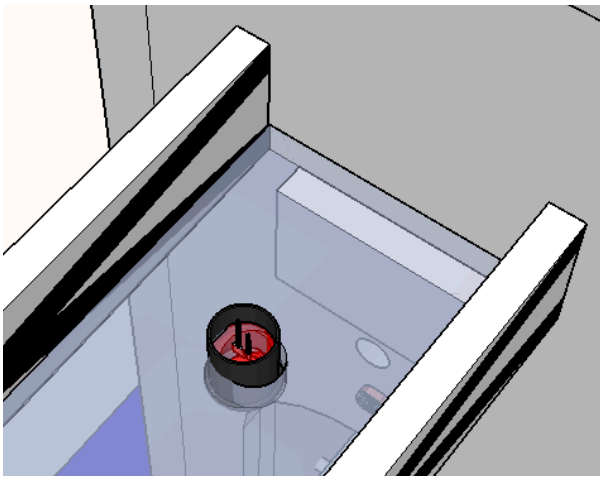
(Outside) [Before]



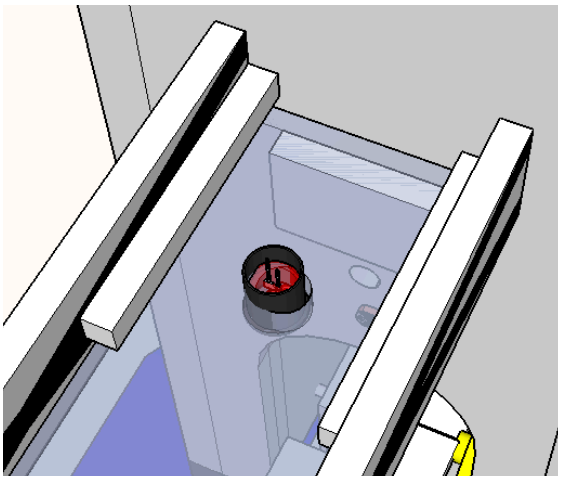
[After]



(Inside) [Before]

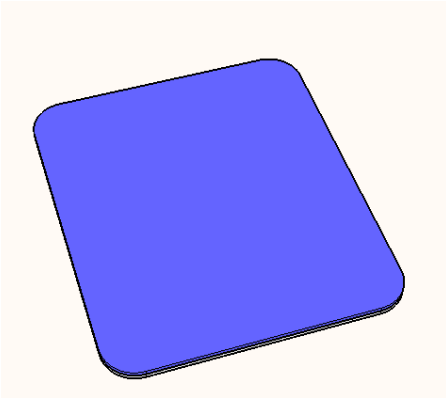


[After]

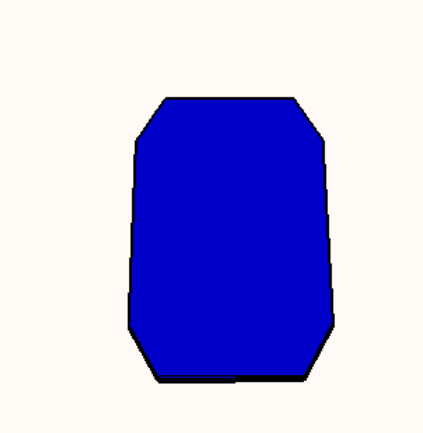


I made the base of acrylic shorter because it was a waste of acrylic and it was also a waste of money which could've lead to over the budget.I also made a different shape instead of a rectangle so it also stands out and gives better design.

[Before]

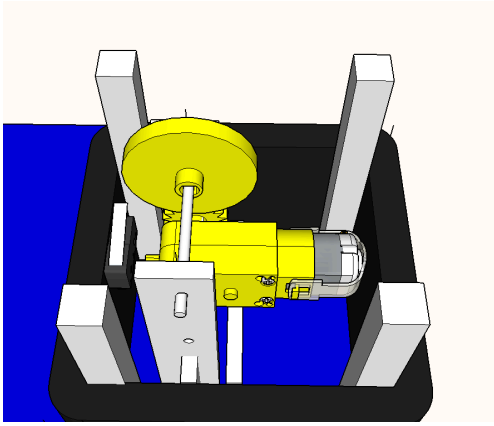


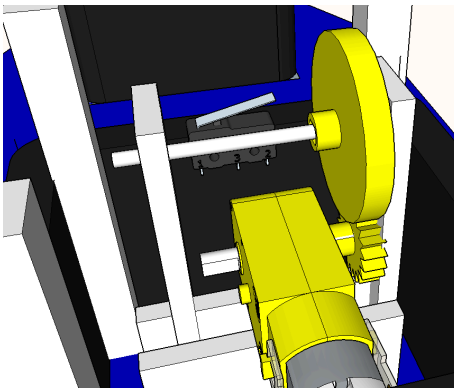
[After]



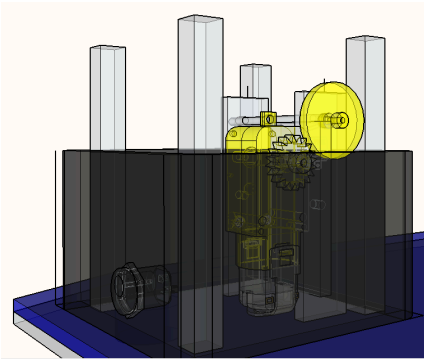
I made two different mechanisms because on one side the cables,GENIE board and power supply etc. are located there so it will be impossible to lock the mechanism into that cramped area.I also used a different mechanism than the old one because the gear couldn't reach the 40T Pinion gear so I had to think of an alternative mechanism.

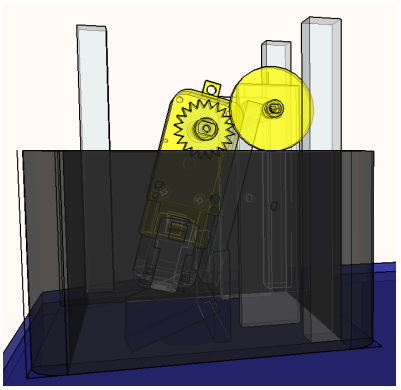
[Before]





[After]

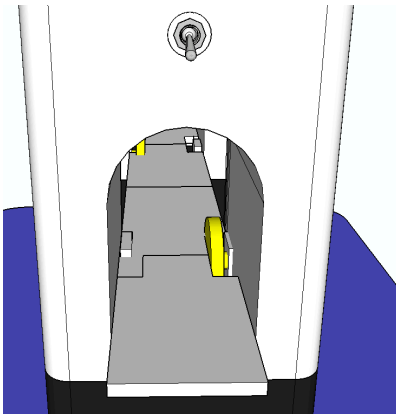


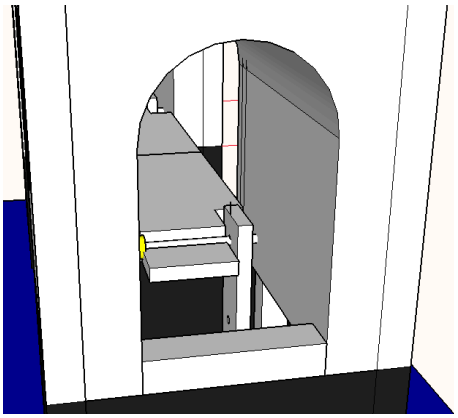


[1st Mechanism] [2nd Mechanism]

I removed pieces of acrylic that were on Idea 2 and 1 that showed roads connected to the drawbridge.I've removed them because it will be hard to manage the cables and nearly impossible for the mechanism to work smoothly and the limit switches will find it hard to detect that the drawbridge has raised/lowered.

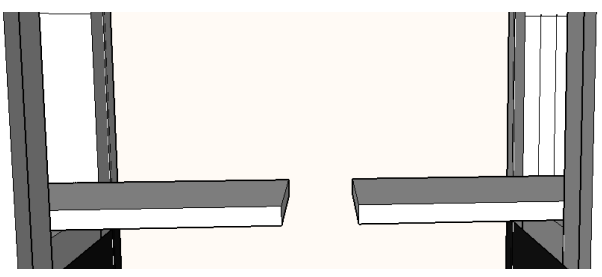
[Before] [After]

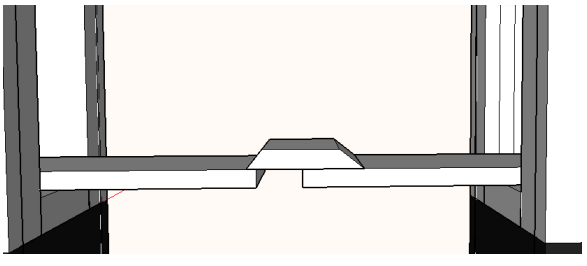




I've added a ramp/acrylic piece on to one one drawbridge because further on the project I found out there was a gap between the the two bridges which was unexpected.I've checked the measurements and they were correct but the main factor why there was a gap because of the placement of the two mechanisms.I started thinking and found a suitable structure that would connect the two bridges easily and also create a firm structure between them so its stable which is a mini ramp.

[Before] [After]





7.2 Evaluation vs Final Design Specification and/or Third Party

1. *The design will be based on the scaled model of London Bridge shown below but with electro-mechanically mechanism similar to that shown on the right below.The mechanism will be hidden and housed under the arch of the road.I will also add LEDs to make it stand out.*

   I have designed my project similar to London Bridge and it's fitted with an electro-mechanically mechanism.The mechanism is hidden in the project and housed underneath the arch of the road.I also added LEDs in my project to make it stand out.

2. *The budget is €35.00.The control circuit costs €16 which leaves €19 for the acrylic which I will be using various colours but only approx. ¼ of the full sheet .The main material used will be various 5mm colours -blue,black and white.*

   For my project it has costed €30.12 which was €4.88 lower than my budget.I have used 1/4 of an acrylic sheet fro various colours of 5mm acrylic [White,Black,Blue,Transparent] which took most of the price down.

3. *The main material used will be various 5mm colours -blue,black and white.*

   In my project as my main material I have used 5mm black , blue and white acrylic.

4. *The longest dimension in any part of the artefact should be 400mm.I need to keep the budget for acrylic sheet to approx €11 which is just slightly more than half a large 5 mm thick sheet.*

   My longest dimension in my project was 300mm which was 100mm less than the maximum dimension.My dimensions were less so I could spend more on other colours without going over the budget.

5. *I will finish manufacture of the project by 12th April 2019 which then allows 3 weeks to get it to work consistently ready for marking after the deadline of 3rd May 2019*

   My manufacture was 3 weeks before the 12th of April but due to the weak structure and mechanism problems my project was completely finished before a week before the deadline [3rd May 2019]

6. *The mechanism used will have a gearbox with gears to raise/lower the drawbridge.*

   I have used this mechanism on my project and when the drawbridge is lowered/raised it runs smoothly.

7. *The mechanism will be activated automatically and controlled by the GENIE 18 Motor Board.The mechanism will be controlled by 2 Limit switches to detect when its fully raised/lowered. The control and mechanism will be able to be accessed via a removable panel.*

   I have used this mechanism on my project it is activated by the Limit switches and it is controlled by the GENIE 18 Motor Board. I have a removable panel to it is easy to access the mechanism and the GENIE 18 Motor board.

8. *The design will incorporate LEDs on the road and on the building to make it stand out at night.*

   My design has included 2 LEDs in the connection to give a stage like lighting and also an LED on each structure facing up to act as a beacon.

9. *The safety features should be incorporated :*

   No sharp edges

   No places where fingers can get caught in mechanisms etc.

   In my project there are no sharp edges and the gap in drawbridge is thin so the finger can't get caught in the mechanism.

Websites:

Drawbridge:

1. https://www.youtube.com/watch?v=3w2HHAqH80w
2. http://cp.c-ij.com/es/contents/CNT-0009944/index.html
3. https://www.altramotion.com/de-DE/newsroom/2015/01/ap-custom-reducer-for-bascule-lift-bridge
4. https://theconstructor.org/structures/types-movable-bridges-details/17941/
5. https://sites.google.com/site/modelrailroadlayoutbuilder/model-train-bridges
6.