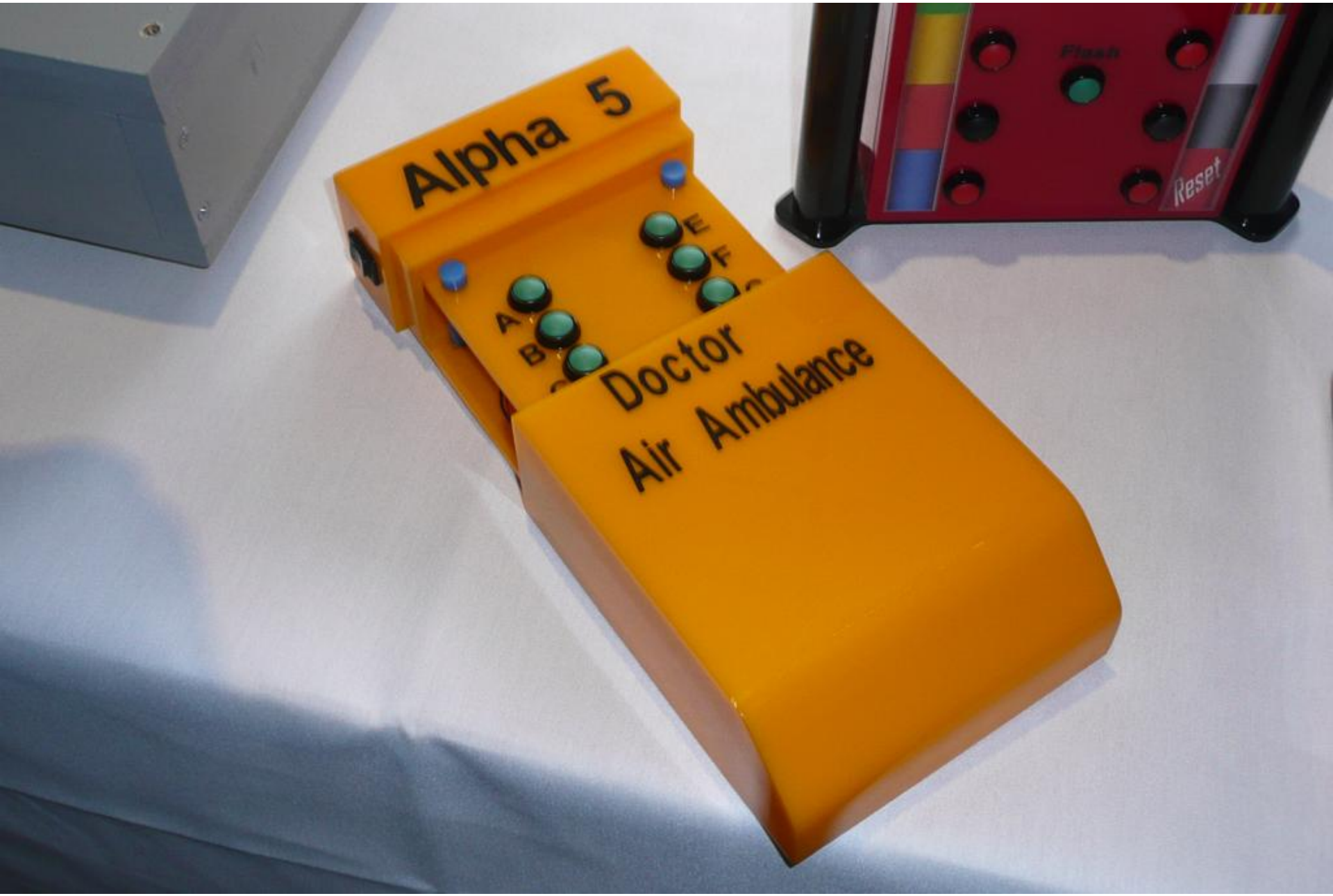
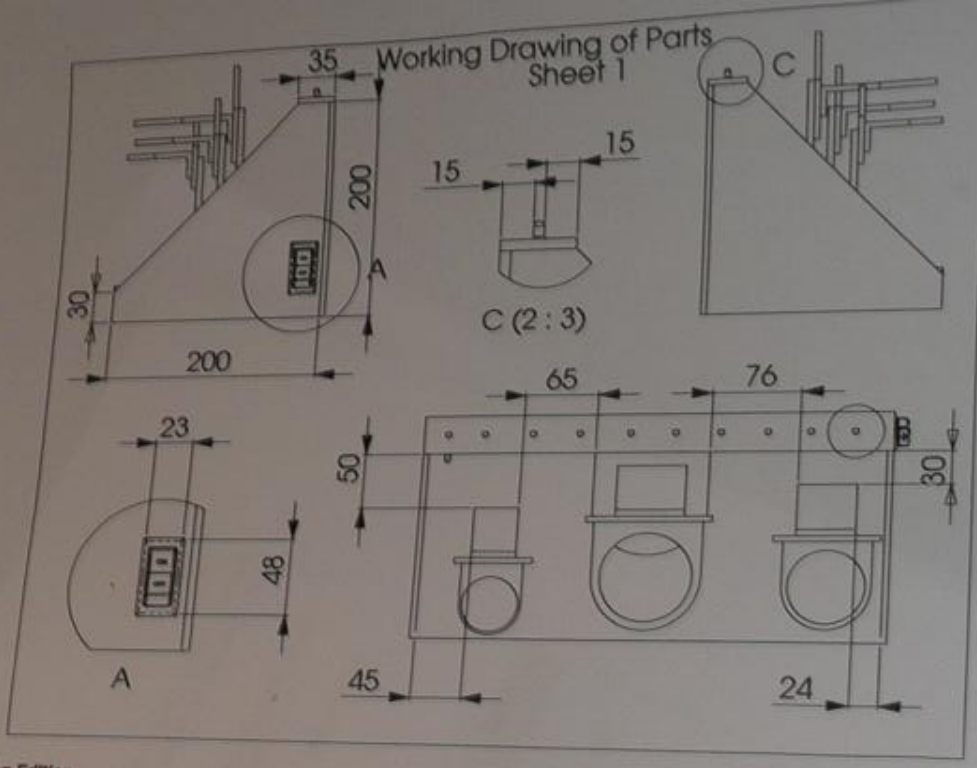
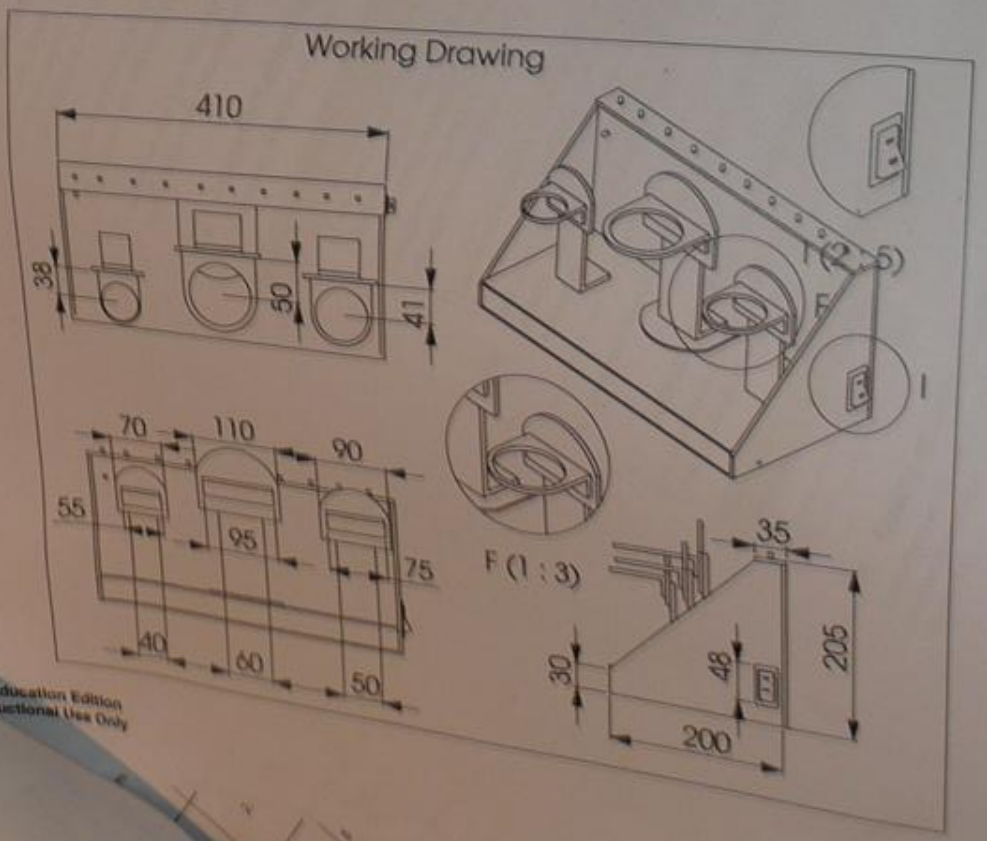
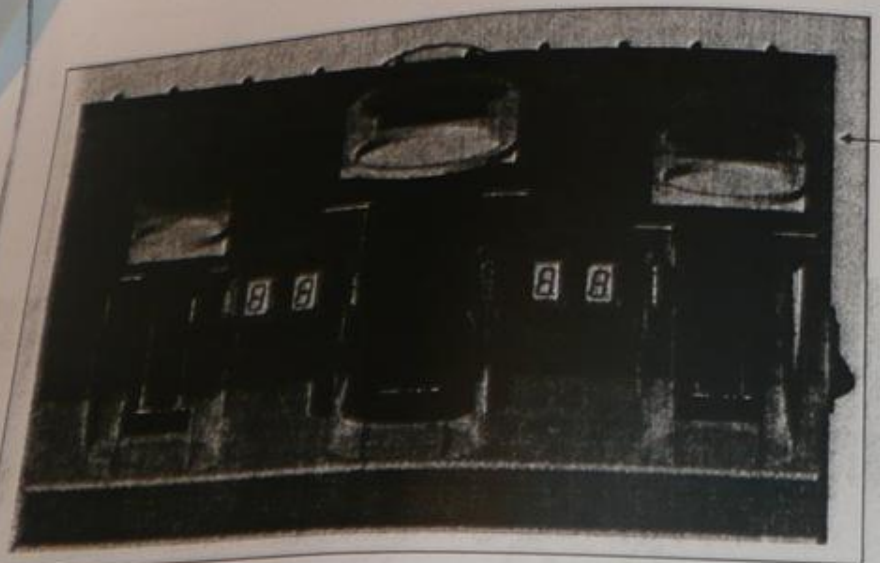

Alpha 5
A
B
E
F
Doctor
Air Ambulance
Reset





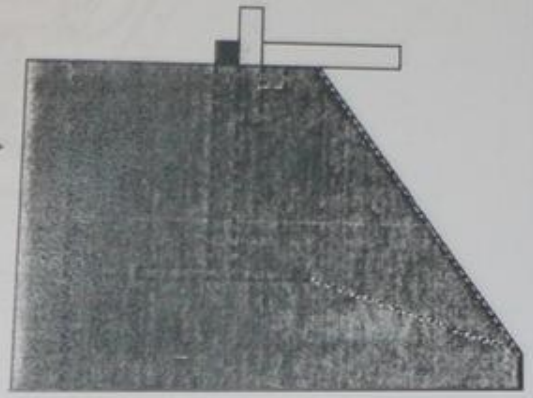
Modifications after Manufacture



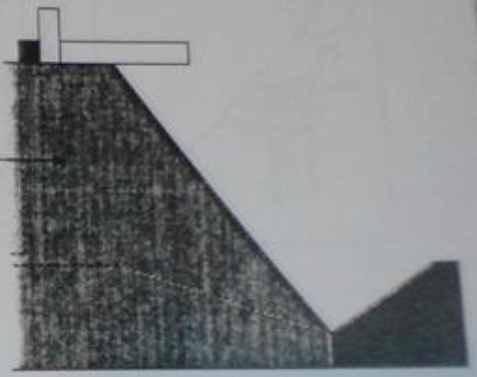
If I were to make my game, again I would add in tube that will collect the ball. This will allow the ball to fall straight onto the micro-switch if it was to go in the net but if the ball did not go in the net the ball could not hit the micro-switch. This would fix the problem with the original idea in which case the ball hit the micro-switch even if the ball did not go through the net. I would put one under each net to protect each microswitch.

This is a close up of the net and the tube that will collect the ball. I would make it out of clear acrylic so you could see the ball and the back of it. I would also put a hole in the bottom so the ball could be easily collected when it goes in the net.

Another modification I could make is to make a ramp for the ball to roll back. I wanted this in my original idea but I decided not to. If I was to make my game again I would like to add this in. It would be a good feature to have. It would mean that the ball would roll back for a player and they would have to walk all the way to get it as it would roll off towards them.



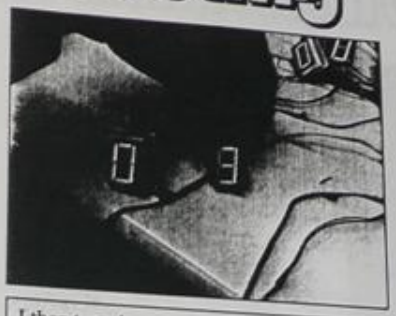
I could also modify it further to add a collector at the bottom. This would mean the ball would roll into a collector at the bottom and the player would just have to lift the ball from there.



Evidence of Testing

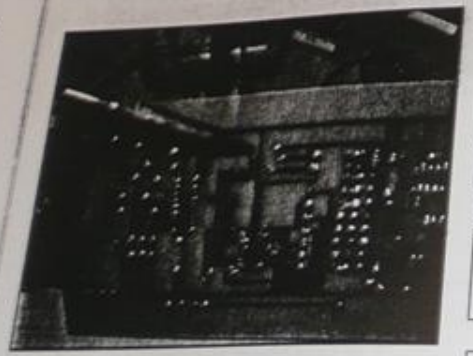
When I went to test my circuit I decided to use the regulated voltage supply from mains. I was able to set the voltage to just over 5v but under 6v in order to test my circuit. I tested the voltage coming from the mains using a multi-meter. I then attached this to the positive and negative terminals.

I tested my circuit to see if I could get my seven segment displays to work. They had a few loose connections which when I fixed they were working correctly.

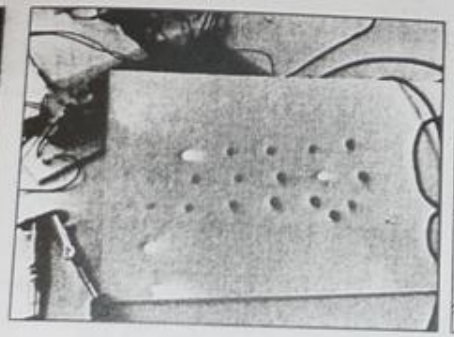


I then tested my switches to see if I could get them to count up right. The switches worked correctly and were able to count the different points for each switch.

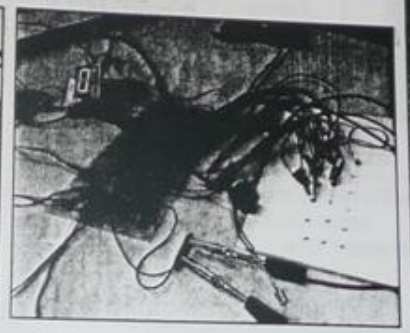
When testing my circuit I made a test program and programmed the PIC. I was then able to insert the PIC (see above) and test my outputs to see if they all worked and where connected properly.



I had a few wires that came loose and had to solder them back in. When testing my circuit I checked all the wires were solder correctly and soldered loose wirers and components back into place.



I had to test my chaser circuit in which the LED's would turn on in sequence. The LED's did not go round fast enough and so I had to change my programming to make them go round faster.



The picture above shows how I connected the mains voltage to the battery terminals. The black wire attached to the 0v connection and the red wire to the 6v connection. This powered my circuit while I tested it.

In my circuit the LED's were not working because the connections were touching. In order to get the LED's to light I added insulating tape to the connections. This means if they touched it wouldn't matter as the connections were covered.

Evaluation Against Specification

Function-

The main function of my product was to be a fun and enjoyable game for two players, which helps improve hand eye coordination and depth perception. I think my game has achieved this and carries out its function well by challenging their skills in children and helping them improve each time the game is played. The points that scored are displayed on the seven segment displays and goes up to 99 which I stated in the specification I wanted the game to do. In my programming I changed this to 30 as I thought 99 would be too high for the winning score. I also stated that different nets should be worth different points according to their size. I was able to establish this in the programming of my PIC chip and the idea worked well. Some points I didn't meet were that I wanted my game to have was to have a text display and for the ball to roll back. When coming up with my ideas and the designing I decided that the game didn't need the ball to roll back as the player would still have to get the ball as they would be throwing from meters away. I also had to change my idea on the LED's flashing when a player wins. Because I decided to use a 4017 running from one output it was impossible for me to make them flash. Instead I made a chaser circuit for aesthetic appeal. If I was to make the product again I would use an opto-switch for each net which would work much better to detect the ball going through the net and would add another PIC so I could have my original idea of LED's flashing when a player wins and would also program it so have different sequences to make the game more appealing. There was one small problem with my idea. I decided to have a switch in my circuit that would be pressed if a player missed. If a player missed the PIC would not know without a switch. In order to fix this I had to put a time limit in which the player had to score or it would change to the next player. I programmed in a timer to show when the time was about to run out. This worked really well and fixed the problem but also added another feature to the game.

Aesthetics

The main thing I wanted my game to be was stylish and aesthetically pleasing. I wanted it to appeal to children who would be buying the game. I think I achieved this in my product as it looks good, is well proportioned, has a good design, is colorful, a unique shape and has an excellent finish. All these points were criteria I wanted my product to meet and think it meet the standard I wanted my product to be. Although the game achieved all this I feel it lacked details such as basketball logos and mascots. If I was to make the game again I would add more detail to the game with more pictures and designs to make it even more appealing. Unfortunately I was unable to add a text display to my game as it was too expensive. If I made the game again I would also like to add this in as I think it would be a good feature to have and would be a unique selling point of the game. I was also able to add the runner lights to the product. I think this was a very good idea however I would have liked to have the LED's running from a PIC chip so I could have programmed different fun sequences of LED's flashing. All in all I think the games aesthetics were very good and I was pleased with the way the product turned out.

Ergonomics

In my game I used ergonomics and tried to make it so the proportions of the game and the size of the buttons would fit the average size hand. I used standard components which were already ergonomically designed in order to make sure my product had comfortable switches. I also made sure the product and the buttons were strong enough to withstand the strength and dexterity of different users. My game was able to meet all the points I stated in my specification and I was happy with the results of my product.

Safety

In my specification I stated very specific points about what the product should be like in terms of safety. The safety of the people playing and buying the game is paramount. In terms of safety I think my product meets the specification fully. It has no sharp corners, no small parts and the materials are non toxic.

Power Supply-

I wanted to use a PP3 battery to power my circuit however I had to change this and add a 6v battery as the PIC only runs from a 6volts. I also kept the 9v battery to power the 4017 as the 6v battery would not be able to power all the outputs in my circuit.

Manufacture

The manufacture of my game was simple and quick. I used cheap standard components and used simple techniques such as line bending and getting pieces laser cut to make my product. This means that my product was cost effective but yet gave me a high level of detail needed for certain parts of the game. The product itself was very simple to assemble. This also made it cost effective and saved time and money. During the manufacture of my game I feel I was able to meet all the points I set out in my specification and that the product is well manufactured and finished to a high standard.

Materials

When making my game I wanted to use acrylic to make the product and I had a colour scheme in mind. However with limited resources I had to use different colours which I think took away from the aesthetics of the product and some parts are also made from rigid polystyrene. The product still meets the criteria I set out in my specification as it was easy to clean or wipe, had a smooth shiny finish and was aesthetically pleasing so I am pleased with the outcome.

Size

The size of my game was very important as I wanted it to be able to be carried about easily by children but yet have enough space for the 3 nets and still be well spaced out. The game is quite big but yet is still comfortable to carry about. I was pleased with the size of the game and think that it is a perfect size. The size of the 3 nets was important as well as it must fit a 3inch ball through it. All my nets are able to do so therefore my nets are just right. The seven segment displays needed to be big enough to be seen from the distance the ball was been thrown from (2 metres). After carrying out tests my seven segments could be seen from 7 metres. The overall dimensions of my game were 410 x 300x 300 did not exceed the limit but was actual nearly half the size of the limit.

Weight

Because my game is for children I wanted to keep it as light but as strong as possible as I could so that the children. By using lightweight acrylic which is quite strong my product is very light weighing, just under1kg so it didn't exceed the weight limit. This weight could easy be coped with by children and so I was able to meet the points in my specification.

Maintenance

In my specification I stated that I wanted my product to be a self maintained product which I believe it is. The only maintenance is the removing of the back of the product to change the battery. The game is well manufactured and durable so shouldn't need any spare parts.

Cost

I wanted to be able to sell my game cheaply so that it would not be too dear for children to buy. I was able to meet my target of being able to sell the game for around £40-50. I was able to do this by using standard materials and components. I also used cheap and easy manufacturing methods which made the product more cost effective. Because of all this the game could be sold at this price and still make a good profit.

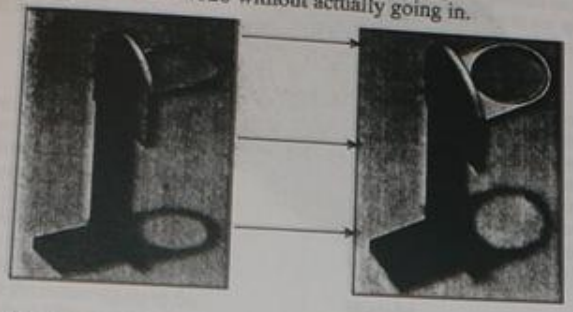
Modifications During Manufacture

When manufacturing my product I had to make a few changes to my design. Some of the design had flaws where as others changes where for aesthetic appeal. Below shows the modification I made to my product during manufacture.

When manufacturing my nets I had to make a few changes to it. When I came up with the idea for my net I wanted the score to be counted when the ball went through the net and hit the base of the game where a micro switch would be. See below-

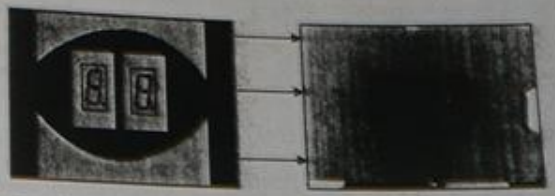
The micro-switch would be in the base of the game when the game and have a piece of acrylic attached to the top of it. When the ball went through the net it would hit platform on top of the switch. This would cause the switch to send an impulse to the PIC chip. However when making the game I found a problem with the design. Because the switch was in the base of product and not on the hoop of the net the ball sometimes hit the switch even if the ball did not go through the net. This was a flaw in the design. In order to fix this I decided to attach a micro switch to the actual net. See below-

The switch can only be pressed now if the ball goes through the net. When the ball passes through the net it will hit the arm of the micro switch and send an impulse to the 4026 which will count the pulses and display the score on the seven segment displays. This is a better idea however if I was to make the product again I would use a reflective opto-switch and place it below the net. This would look much better than a micro switch attached to the net and would also mean that there would be no way the ball could hit a switch and send a pulse to the 4026 without actually going in.



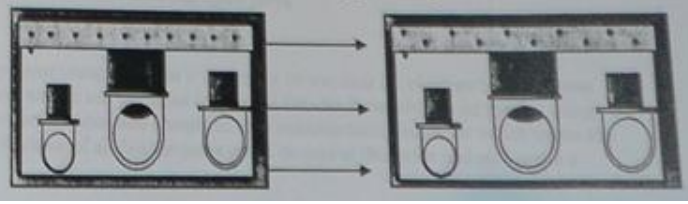
The back of the net also had to be changed. Because I had initially put the micro switches in the base of the box the wires where concealed away and where not seen. However because I moved the micro switch I had to hide the wires which would be down the back of the net. In order to hide these I had to make a case for the wires. I stuck this onto the back of the net which hide the wires and made the product more aesthetically pleasing.

When designing my seven segment display covers I measured the size of the displays and cut them out of a shape I designed. However when manufacturing I found out I didn't take into account the size of the PCB boards they are attached to. My design was incorrect as I had not left a big enough gap for the PCB boards they were attached to and so the seven segment displays could not be close together.



In order to fix this problem I had to make new surrounds and take into account the size of the PCB boards. I made new seven segment display covers and this time changed the shape. The seven segments now fit and sit quite close to each other even though they are tight beside each other as I had hoped.

Another minor modification was the layout of the LED's on my game. In my working drawings I had the LED's (chaser circuit) in a straight line. When manufacturing the product I decided to change this and have the LED's at different positions along the top of the product. I decided to do this as I think it makes the product look more fun and aesthetically pleasing.



Plan of Manufacture

PCB

The first thing I need to do is make my PCB board. Once I have made my PCB I will need to drill all the holes on the pads of my board for each component. I will then be able to solder all components into PCB in appropriate places. Once this is done I will test Circuit to make sure functions correctly and all components are working. In order to do this I will need to program the PIC chip to turn all the function on and off. This will allow me to see if the circuit is working correctly.

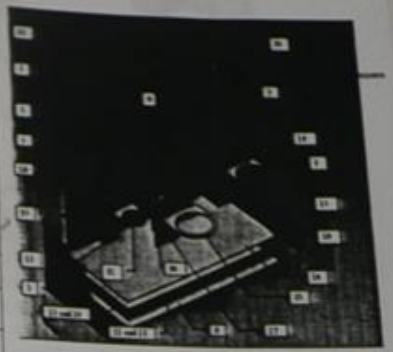
Marking out

When marking out the pieces of acrylic for each part I will need to get the measurements from my working drawings. I will then have to measure out and mark the size required for each part. The parts will then be ready for cutting and wasting.

Cutting Parts

All the Parts of the game will have to be cut out after they are marked. I will do this using a variety of tools and machines such as the hegner saw, the bandsaw, coping saw and laser cutting. Once all the parts are all cut out they will be ready for wasting and finishing.

Part Number	Description	Action	Week 1	Week 2	Week 3	Week 4	Week 5
0	PCB	Develop and make PCB					
0	PCB	Drill holes for Components					
0	PCB	Solder Components					
0	PCB	Test Circuit					
All Parts	3mm acrylic	Mark out pieces of acrylic					
All Parts	3mm acrylic	Cutting Parts					
All Parts	3mm acrylic	Wasting and finishing					
All Part	3mm acrylic	Polishing					
15,17, 19	3mm red acrylic (stands for nets)	Line bending					
	3mm white acrylic (nets)	Line bending					
2, 4, 5, 9, 10	3mm acrylic	Drilling					
9-14	Middle base	Assembly					
15-23	Net 1, 2 and 3	Assembly					
1-5	Main frame	Assembly					
6-8	Seven segment surtounds and court design.	Assembly					
0	PCB	Insert PCB					
0	PCB	Solder PCB to switches					



Drilling

I will need to drill holes in parts 2, 4, 5, 9 and 10. All these parts have components in them or wire needed to go through them. Below shows the components I will need to which part and what size of hole I will need to drill for each.

Part no:	Component	Size of hole (mm)
4	Seven segment displays.	32 x 32
5	LED's	6
4	On/Off LED	6
2	Rocker switch	20
9	Threaded screws	5
10	Wire for micro-switches	3

Wasting and Finishing

After the parts are cut they will then be filed down using files and the band-facer until the correct size. The parts will then have to be sanded down using different grades of emery paper to get a smooth finish.

Polishing

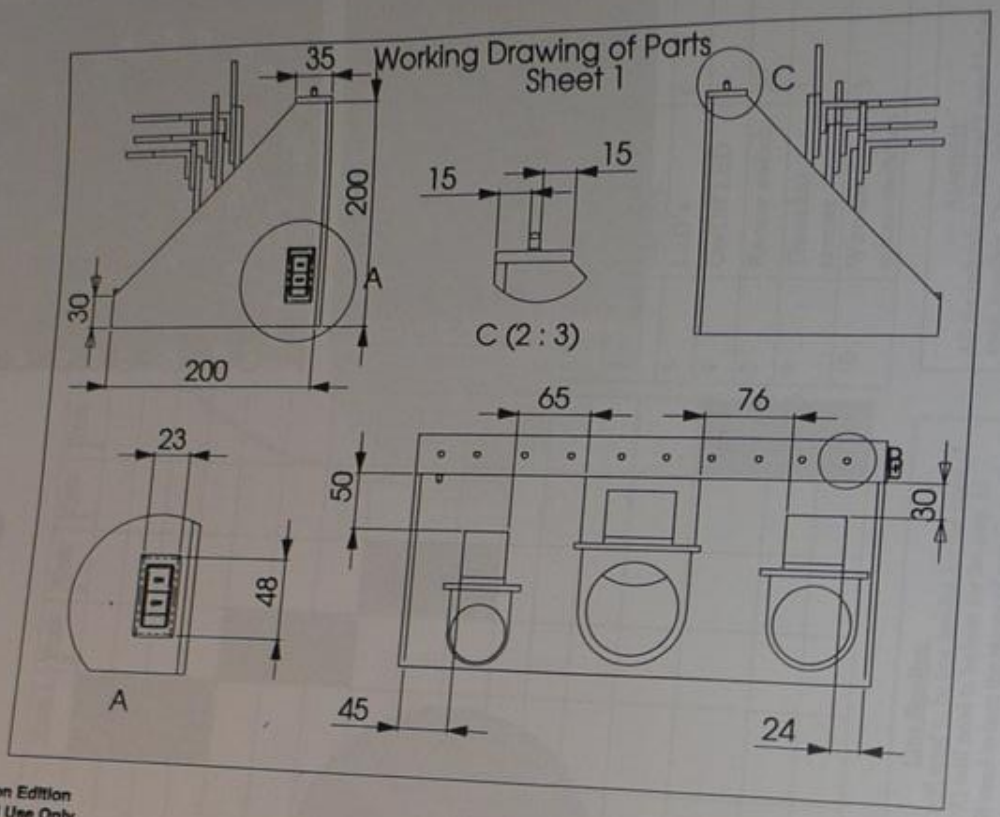
The sides of the parts will then have to be polished to give a shiny, aesthetically pleasing finish. This will be done on the polisher however all sides which will be stuck together must not be polished as this will make it difficult to get them to stick together.

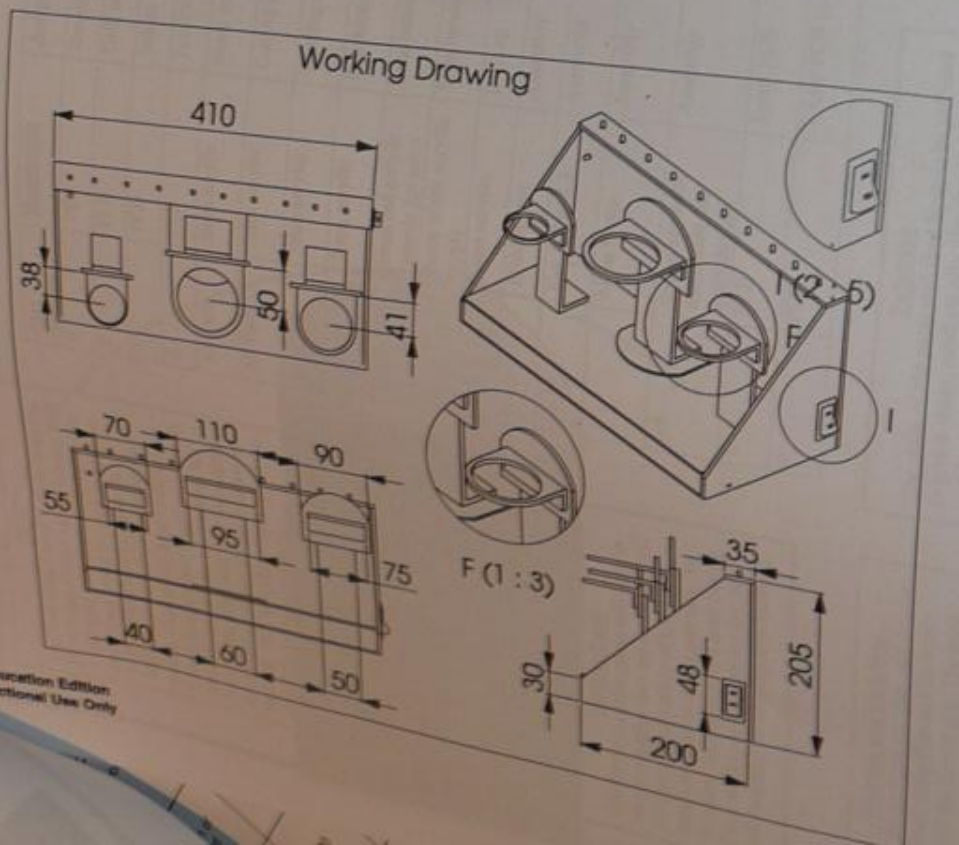
Line Bending

Parts 15, 17 and 19 will need to be line bended for the stand of the net and parts 21-23 will need to be bent for the nets. In order to do this I will need to heat the pieces of acrylic on the strip heater for 20-30 seconds. Once the plastic is soft these parts will have to be bent at a 90 degree angle. In order to do this I will use a former to get the sharp correct angle needed.

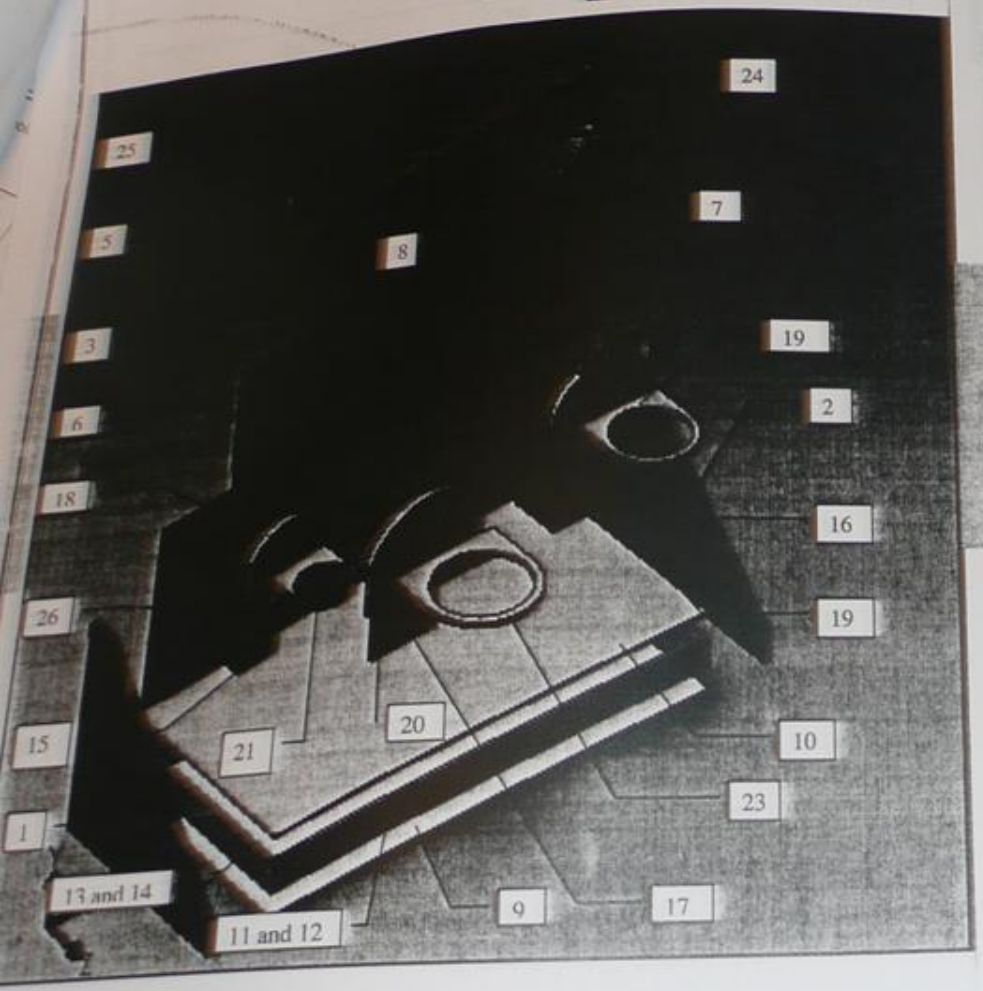
Assembly

All the individual Parts will need to be stuck together. This will be done by usi solvent cement which will fuse the Part together. I will make the middle base fi then the individual nets, then attach the main frame to the middle base and fina add the surrounds and the court design





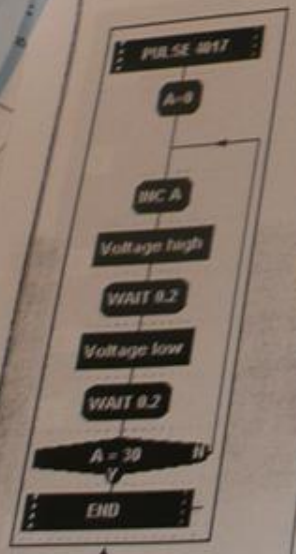
Exploded View



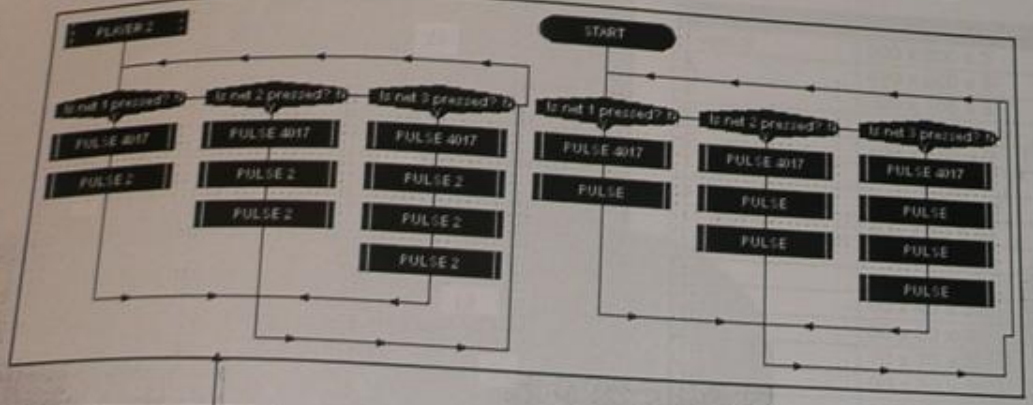
1 and 2	200 x 200 x 3	Sides of main frame
3	410 x 200 x 3	Back of main frame
4	200 x 165 x 3	Front of main frame
5	410 x 35 x 3	Top of main frame
6	100 x r 55 x 3	Court design piece
7 and 8	90 x 50 x 3	Seven segments surround
9 and 10	400 x 200 x 3	Top and bottom of base
11 and 12	400 x 30 x 3	Long middle sides of base
13 and 14	200 x 30 x 3	Short middle sides of base
15	100 x 50 x 3	Small net stand
16	90 x 40 x 3	Medium net stand
17	80 x 30 x 3	Large net stand
18	70 x 70 x 3	Small net backboard
19	90 x 80 x 3	Medium net backboard
20	110 x 90 x 3	Large net backboard
21	80 x 55 x 3	Small net
22	110 x 75 x 3	Medium net
23	140 x 95 x 3	Large net
24	20	Rocker switch
25	5	LED's
26	5	On/Off LED

Orange acrylic sheets	Full sheet 1m x 610mm	£9.20
Yellow acrylic sheets	Half sheet 500x 400	£4.60
Red acrylic sheets	90mm x 100mm	£1.50
Clear acrylic sheet	250 x250	£2.00
Blue acrylic sheet	200 x 200	£1.75

Design Proposal

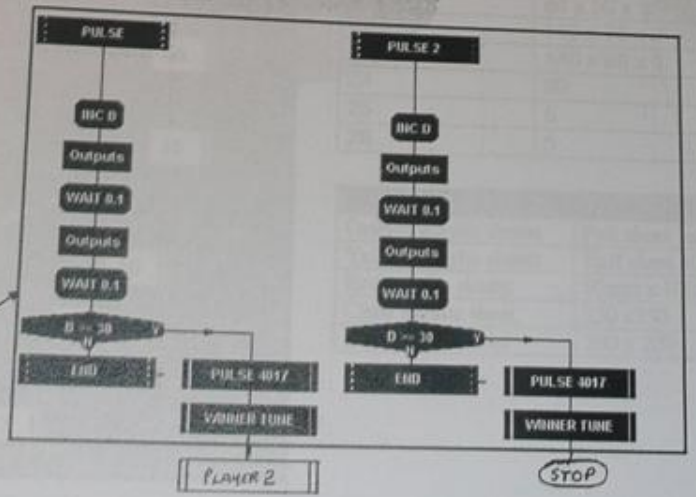


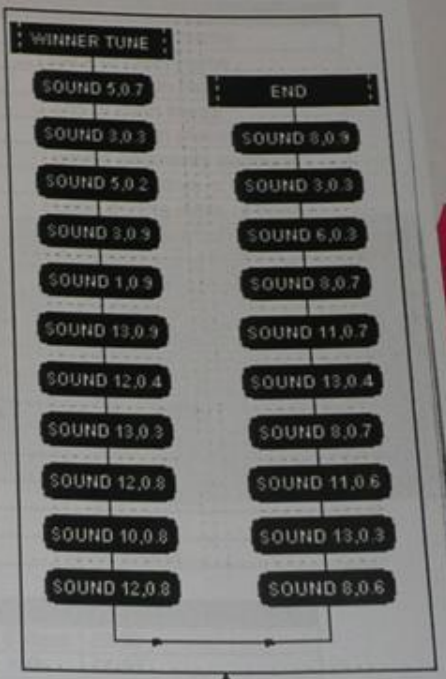
This is the sub-program that will control my LED's in my circuit. It will cause them to move round my game in a sequence like a chaser circuit. It will do this by sending pulses to my 4017 chip.



This is the main program for my circuit. It causes Macros to play when switches are pressed and controls the amount of pulses for each net.

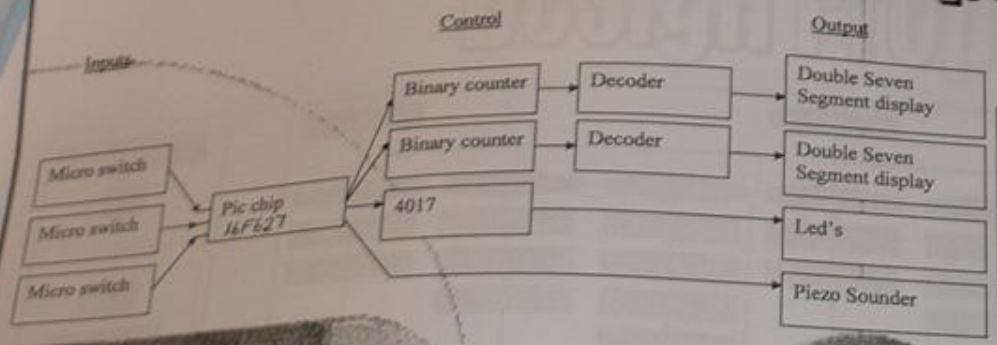
These are the macros for the Pulses. Once player has reached 30 the game will go to player 2 until they have reaches 30. The game will then be over but will play a tune and causes the chaser circuit to light up.



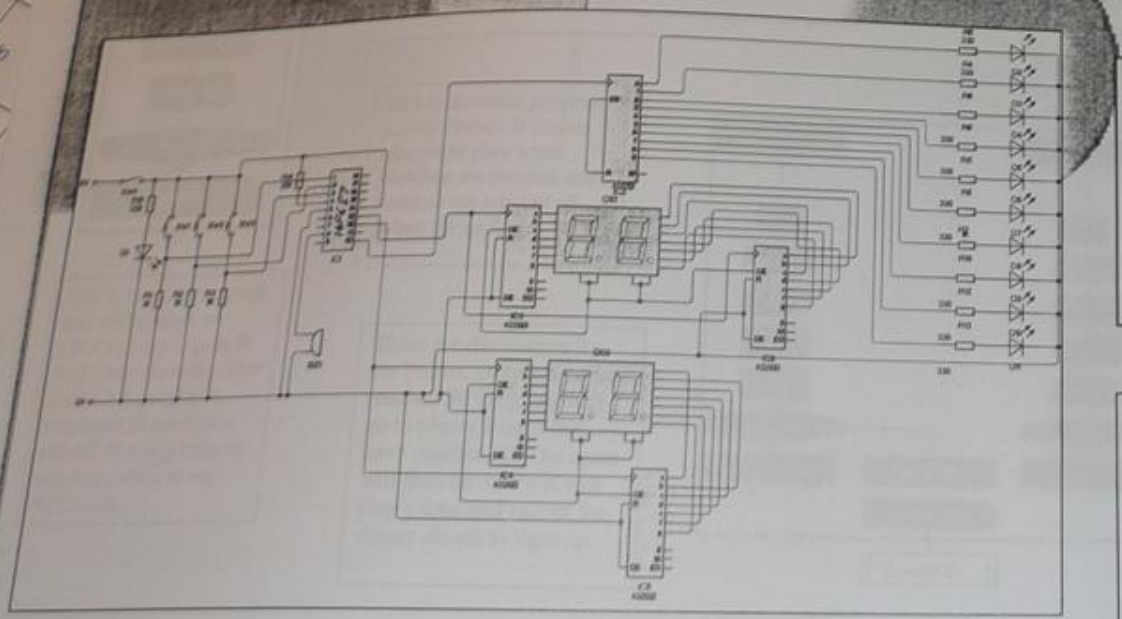


This is the sub-program that will control my tune that will be played off the Piezo buzzer in my circuit.

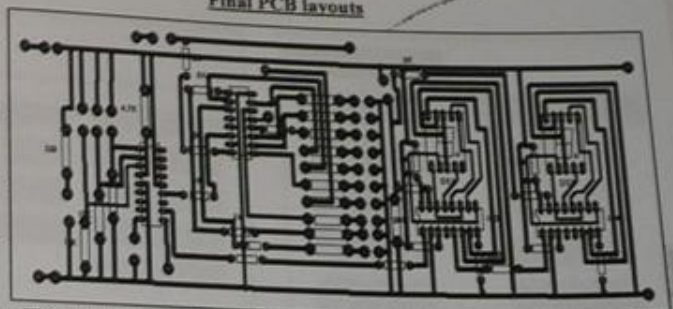
Design Proposal



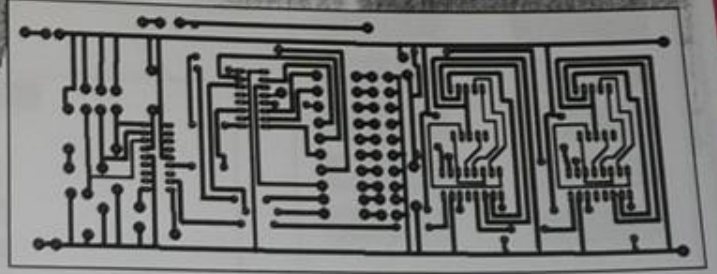
Final Circuit idea



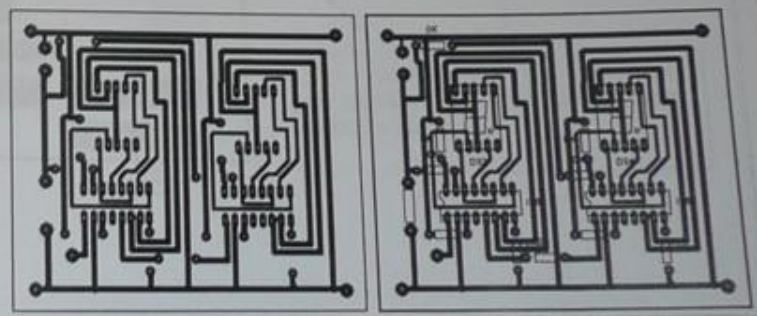
Final PCB layouts



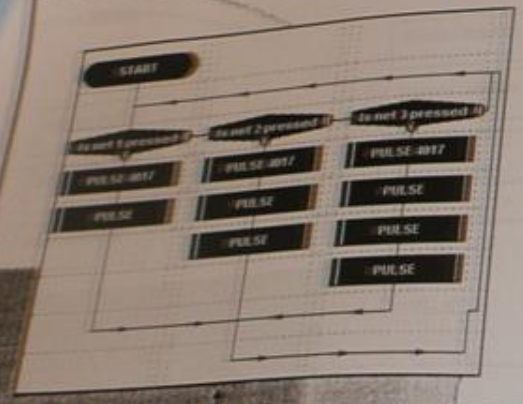
This is the layout of the main circuit with the resistors, 16F627 and the seven segment displays.



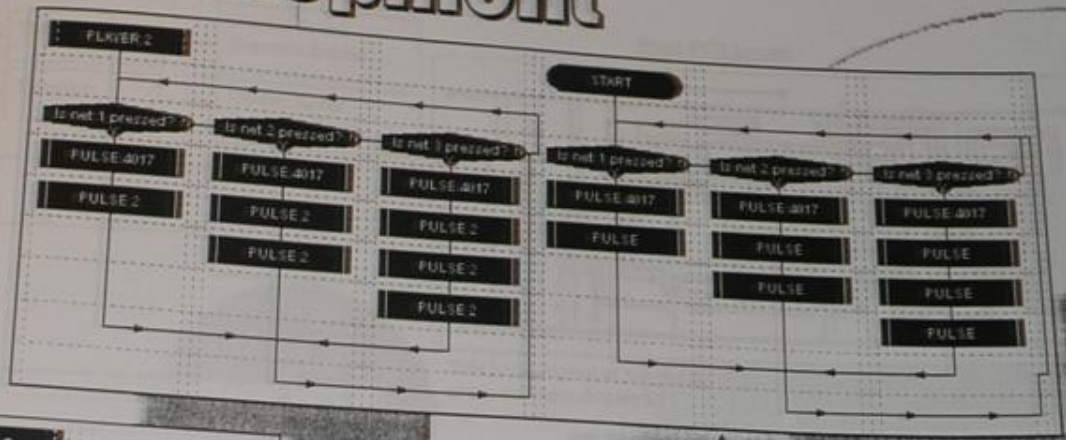
This is the artwork of the PCB with none of the components.

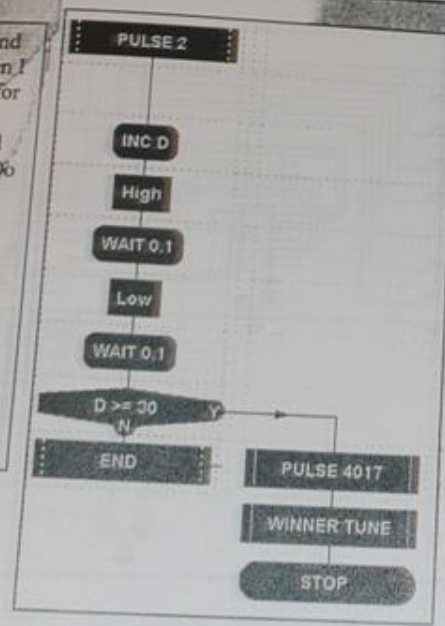


PIC Development



When developing my game I decided I would try and write a program for player one to work first and then I would get to player 2 to work once I had done this for player 1. This is the first program I wrote. When making and developing this idea I found that I could not do two things at once. I wanted the Pulse 4017 Do Macro and Winner tune Do Macro to go at the same time but this didn't work. Instead I had to have them one after each other. I also changed the score I wanted the game to go up to in my programming. Instead of the game going to 99 I decided to change the game to 30. This seemed a more reasonable score to have the game end as 99 seemed a little hard and the game would be too long. This program worked on screen when I tested it so I decided to use this and try and develop it for two players.





In order for my second idea 2 work I had to develop a new pulse for player 2. I did it the same way as player 1 apart from the outputs are changed so that it sends pulses to different seven segment displays. After this program finish I put in a stop. This means that the game will end after player 2 score 30 or more.

After developing my first program I came up with this idea. When writing the program I found it very hard to change the player after each through of the ball. I couldn't find a way of doing this without having an extra switch in my game to do this. Because I had not thought of this problem I had to change the way my game worked. Instead I had to program the game to do 1 player at a time. Player 1 would play the game until he or she got to 30. They would then be a winner for doing this. The game would then switch to player 2 in which they would throw until they get 30 points. Although this is not what I wanted my game to do it still carries out the main function of my game, to improve hand eye coordination and therefore I am still happy with the way the program works. In this program I also changed the Pulse 4017 macro to play when a player scores and not when the game is on so I moved the macro to under the decision box.

Development of PCB

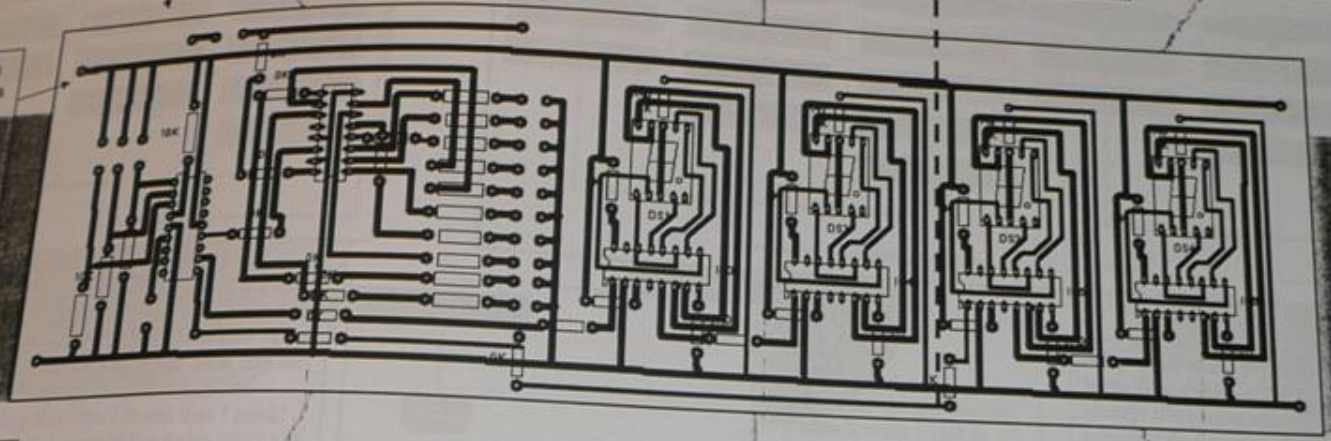
This is the layout of my first PCB idea. In my idea I made a lot of mistakes. The main problem is the PCB is too big. In order to fix this I will need to cut the board down to 9inches in length and 4 inches wide.

For my first PCB I decided to leave these pads instead of adding the PCB components for LED's. However the pads are too small as when I drill through them the circuit board the copper would tear away and I would have to fix this so this won't happen.

In order to get my circuit to fit the circuit board could cut the PCB here and take two of the seven segment displays and put them on a different PCB board. This would mean the circuit would fit in however I would have to change the PCB and develop it so it could get the seven segment displays to run off my Pic

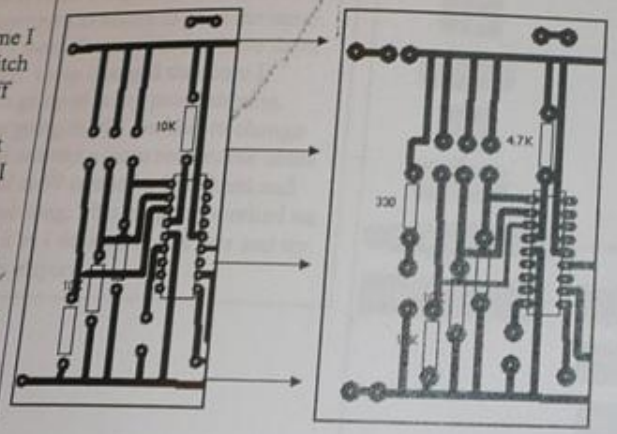
The Pads on the Seven Segment displays and chips are all too small. The pads for all these are too small and squashed. I will need to make them all bigger and round so that I can drill the holes for the Pins to fit.

In my first idea I forgot to add a master on/off switch. This is essential in every product so I will need to add this for my final PCB.

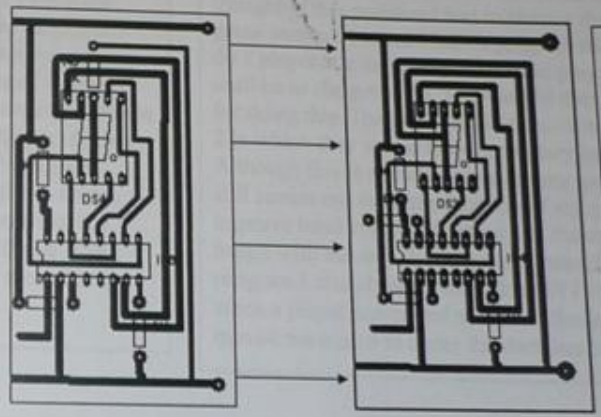


On my first PCB I didn't add reset switches to my seven segment displays. In order to reset them the game will be turned off. When developing my PCB I will add reset switches for each of the 0-99 counters so they can be reset without turning the game off.

When I was developing the game I added a master switch so that I can turn off everything on the game. I forgot to put this in my first idea. I also added an LED that will be on all the time if the game is on and off if the game is off. This will allow the players to see if the game is on or off.

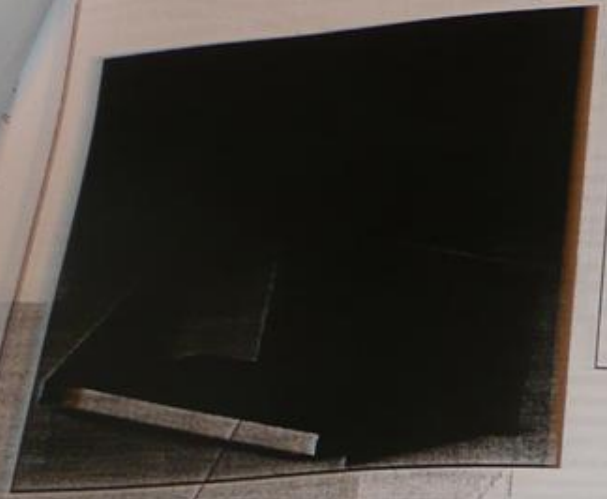


Some of the tracks on the PCB are too small. Like the pads these will also have to be made bigger. This will allow me to drill holes in the tracks without tearing the entire track away when I drill the holes.



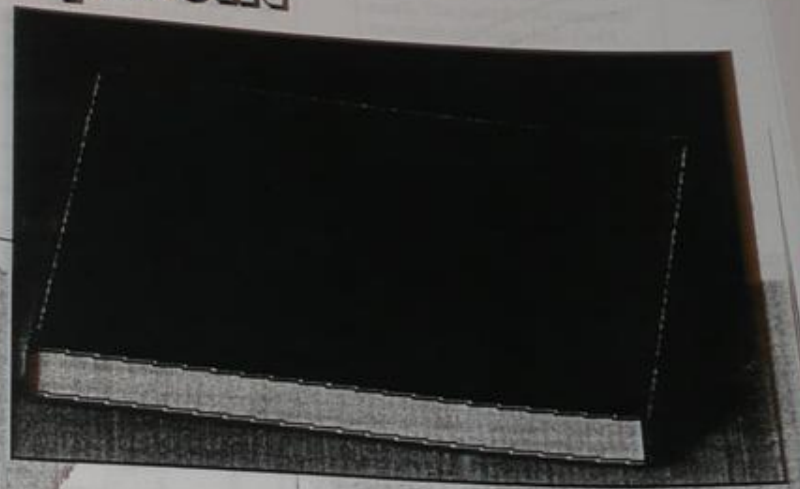
This is what the seven segment display will look like when it has been finished. I have fewer jumps and was able to make the tracks and pads bigger than they were in my first idea.

Design Development



Assembly of Main shell of product

This is how the main body of the product will look once assembled. The seven segment displays and surround have also been added to show were they will be positioned and stuck on. This is essentially the main shell of the product. Now the nets and component must be added to finish the manufacture of the product.

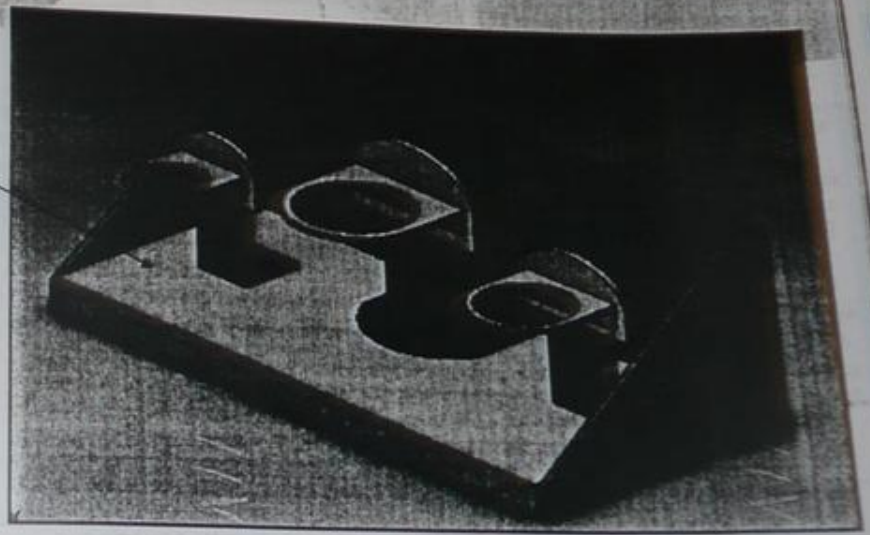


Exploded view of main shell of product

This is how the product will look before assembled. Here I have an exploded view of the main piece and briefly shows how and where each part fits together. I will stick all the pieces together using solvent cement apart from the bottom of the base. See base)

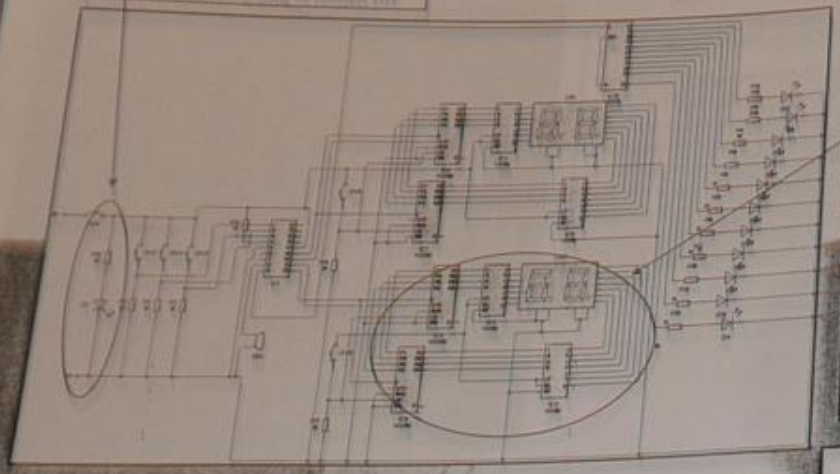
Finished Product

This is what the product should look like when finished. Here I have added the different size nets and the main components to show where they will be positioned and assembled to. I will have to cut holes for the switch and seven segment displays and drill holes in order to fit the LED's into.



Circuit Development

When developing my circuit I realized I had no master on/off switch. I decided to add one and to add an LED to show if the game was on or off. If the game is on it will stay on until the game is turned off.



In my third idea I decided to develop the scoreboard. Instead of using a 4026 I used a 4029 with a 4511B decoder. This allows my game to count up to 99 or down from 99. In order to do this I need to connect the 4029 to a 4511B decoder which will send the pulses into the 4029.

I decided to have the Piezo sounder in this idea. I will use it to play tunes that I will program into my 16F627 PIC chip. I will play a tune when a player wins the game and when a player scores a point. I will make a different tune for each different net. These will sound when the ball goes through the net.

In my final idea I decided to use the 4017 I used in my other ideas. This allowed me to have 10 LED's from one output of the PIC freeing up my output pins. I will control the 4017 by sending pulses into it from my PIC when a switch is pressed or when a player wins the game.

For my final idea I decided to go with the 0-99 counter using a 4026 from idea 2. I think this is the best idea of the three as it keeps the game simple but allows the game to go up to a high score. This is why I used it in my final circuit idea.

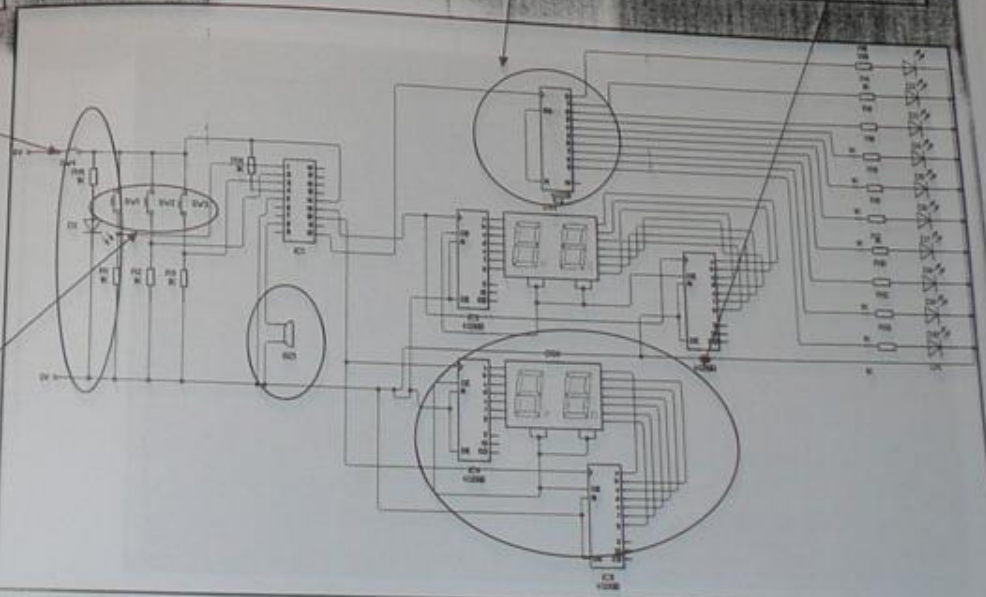
Components and Values

For my final circuit I worked out and found the values needed to run my circuit and make it function properly. I found out this information before making my product to test it and see if it works.

- *0Ω Resistors x*
- *330Ω resistors x 11*
- *10k resistors x 3*
- *100k resistors x 2*
- *7 segment displays x 4*
- *4026 x 4*
- *4017 x 1*
- *16F627 PIC x 1*
- *LEDs x 11*
- *Piezo sounder x 1*
- *6V battery x 1*
- *3 micro-switches*

I used the idea I had in idea 3 for my final circuit. I added a master switch for the circuit and an LED to show when the game is on. This will be a good feature in my game as it will allow the player to see when the game is on easily.

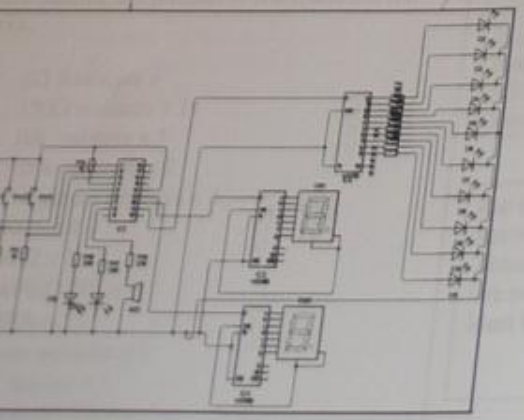
For my final idea I decided to use micro-switches from idea 1. These are simple and easy to use but also cheap so would be ideal in my final circuit idea.



Evaluation of Circuit Ideas

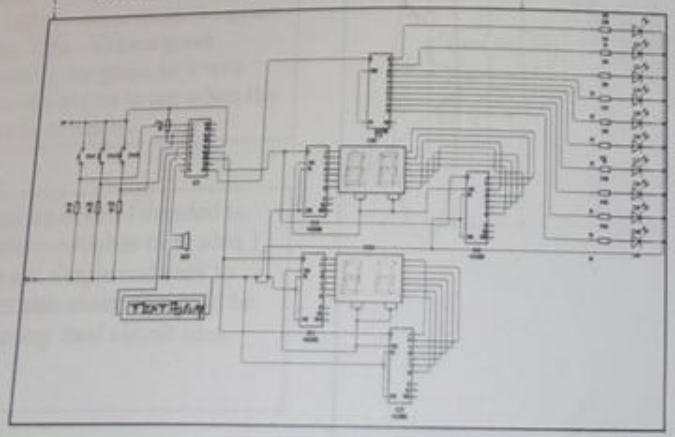
Idea 1

For my first idea I thought this was a good but was quite basic. I think the circuit overall is good but I wanted my product to have features that really stood out and were unique. This circuit has nothing really interesting in it. It is quite a bland circuit. I think the idea of showing the winner by an LED is quite a dull idea. The piezo sounder was a good idea. I think I would like it in my final circuit idea. After looking at the game I think that a seven segment display isn't enough for one player. It limits the game to only 9 points. In my game you can get three points in a single throw so the game could potential be over in three throws of one player. This is why I didn't like this idea and went on to change the idea to two 0-99 counters. This way the game can go up to 99 points and would be a much longer and more enjoyable game. I also liked the idea of using a 4017 chip to add LED's to my circuit. I came up with this idea because I was limited the number of outputs I could have if my circuit as I was using a 16F627 Pic chip. I would have been limited to only a couple of LED's. By using the 4017 I was able to get ten LED's from one output on the Pic chip. This is a very useful and handy idea so I think I will use this idea again. Because this is such a simple idea with no real features I decided that I will not use this circuit for my final idea.



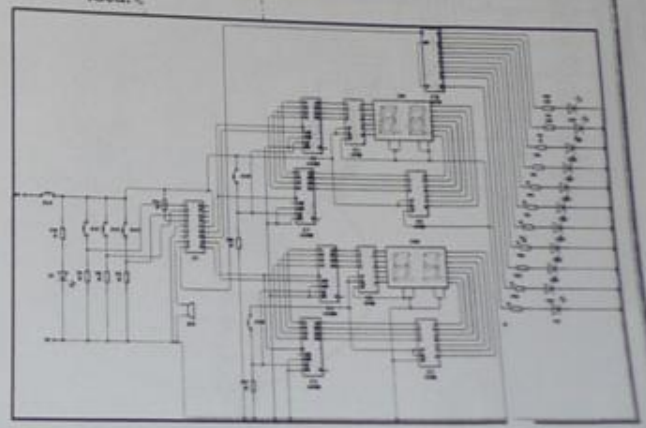
Idea 2

My second idea is my favourite idea. It is a simple circuit but has much more features than idea 1. In this circuit the game goes from 0-99 which I think instantly makes the game better and more appealing to people buying the game. In this idea I changed how the winner is shown. In my first idea I had two LED's. When player 1 won the game, the LED under player 1 would light up signalling that they were the winner and the same thing would happen for player 2 if they were the winner. I thought this was a bad idea so I added a text display. The text display would be able to say who won the game but would also be able to give encouragement and says the points that were just scored. I think this is a brilliant idea and really adds something to the product. With the LED's I used the same idea as idea 1. This was a good idea and so I used it again as it allowed me to have more LED's in my circuit which I wanted. I have also changed the micro switches in the product to touch pads. I think this was a good idea and would be more reliable than a micro switch as it would be more durable and less likely to break. It also would mean less manufacturing which would be good as it would save money and make my product more cost effective. Overall I think this is a good high standard circuit with many good features and because of this I decided to use and develop it for my final idea.



Idea 3

Idea 3 is again building on idea 2. Idea 3 has a really interesting feature. Like idea 2 it has a 0-99 counter but this time instead of using a 4026 I have used a 4029 chip with a 4511B decoder. This allows the game to count up to 99 and down from 99. This means this game can have to settings counting down from 99 or up to 99. This adds a little bit of extra fun to the game. I really like this feature and think it would work really well in my game. I came up with this idea from an existing solution from one of the existing solutions which was also able to do this as one of its features. Like idea 1 and 2, I kept the piezo sounder as I can program a tune to play when there is a winner and also when a player scores a point. The tune is done through the programming so it could make a couple of different tunes, one for each player. This would further distinguish between what set had been scored in but make a game appear more interesting and appealing to the children who would be playing it. I think my circuit idea 3 is a lot more complicated and would be really appealing. I kept the 4017 the same because once again my output pins on the PIC was limited and I wanted a few more LED's in my game. I was limited to However comparing it to idea 2 I think I like it features more and so I decided that I would not use this circuit for my final idea.

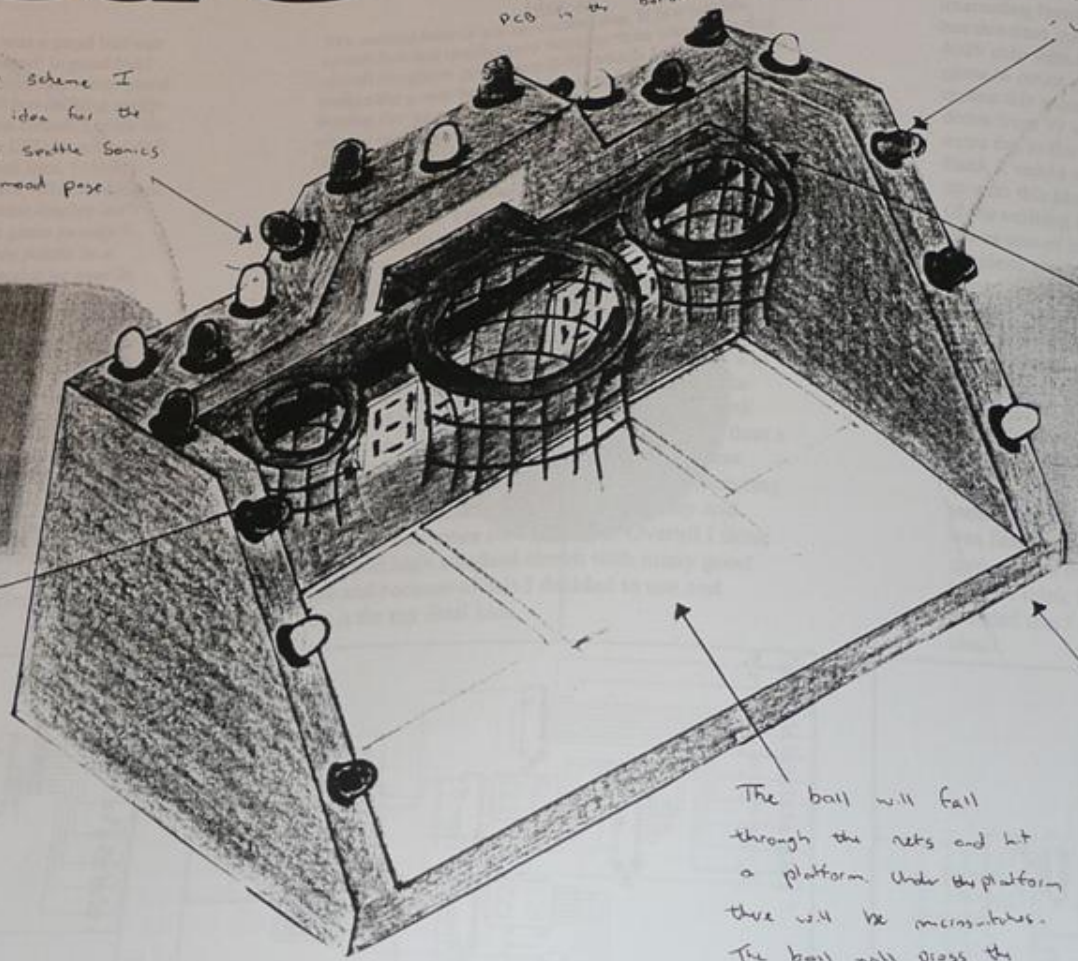


Idea 3

The wires will be hidden down the sides and back of the game as the cases will be hollow I will put my PCB in the bottom of the product.

The LED's are different colour these will light and go backwards and forwards when the game is over.

Like the colour scheme I also got the idea for the shape from the Seattle Sonics logo. in my mood page.



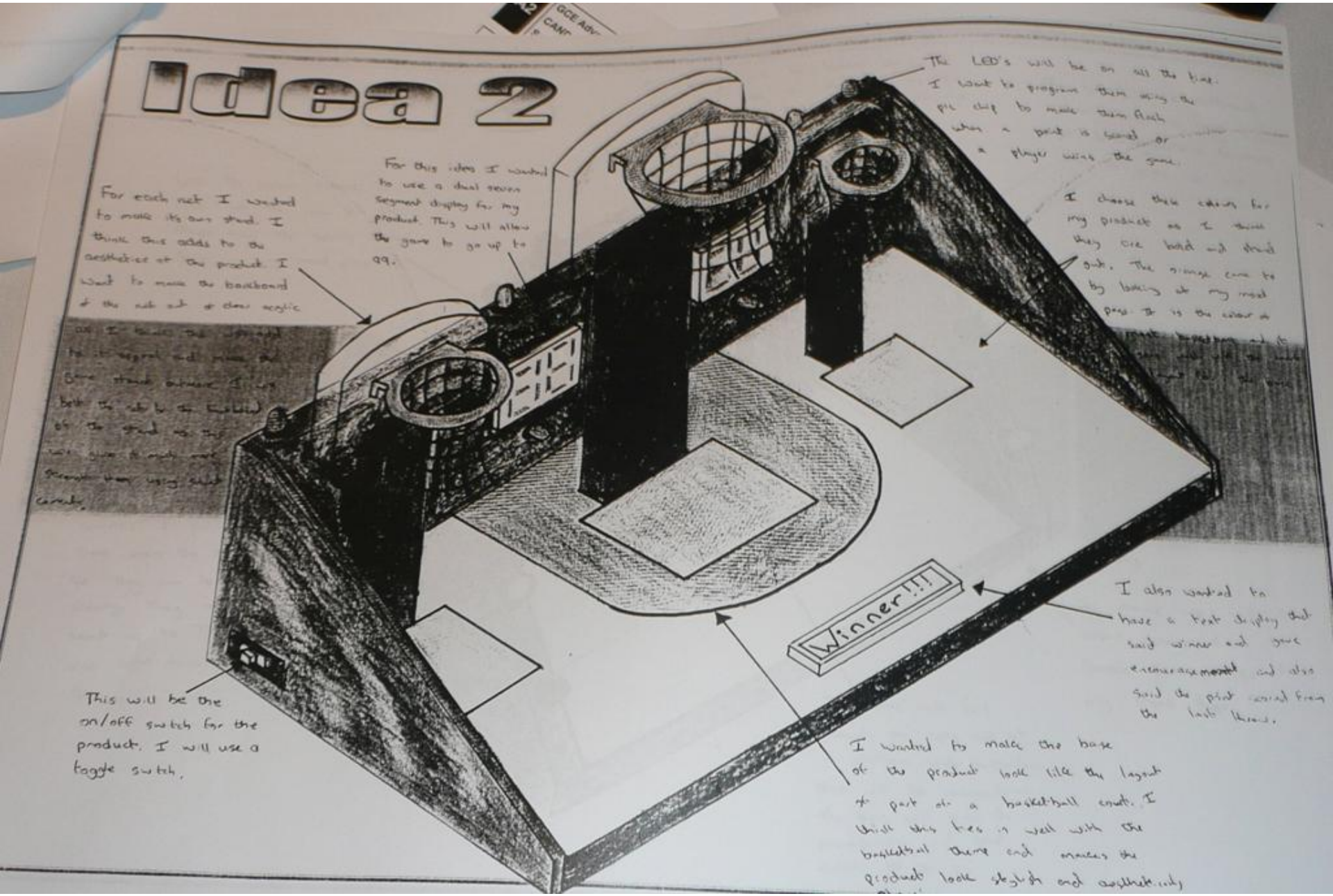
In this idea I wanted to have two 0-99 counters. I positioned them under the nets so they can be seen clearly. They will count up to 99 and also count down from 99.

In this idea I wanted all the nets to be connected to each other I thought this would be a good idea It allows me to hide the wires for the LED's and switches and the nets will not be in the way.

I come up with the colour scheme. From the Seattle Sonics logo from my Mood Page.

The ball will fall through the nets and hit a platform. Under the platform there will be micro-switches. The ball will press the micro-switches and send pulses to the pic.

Idea 2



For each net I wanted to make its own stand. I think this adds to the aesthetics of the product. I want to make the backboard of the net out of clear acrylic

For this idea I wanted to use a dual seven segment display for my product. This will allow the game to go up to 99.

The LED's will be on all the time. I want to program them using the pic chip to make them flash when a point is scored or a player wins the game.

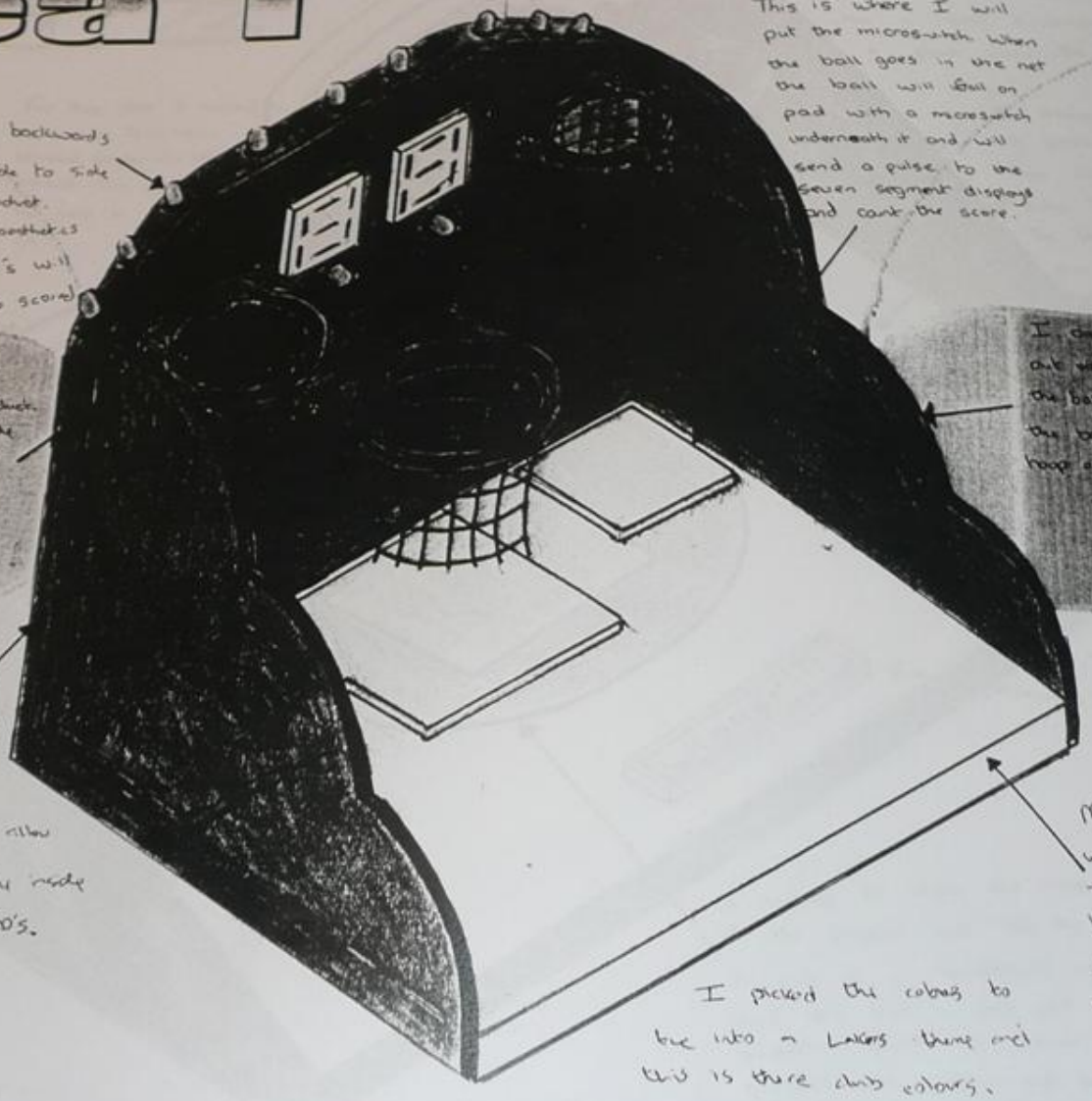
I choose these colours for my products as I think they are bold and stand out. The orange come to by looking at my mood pres. It is the colour of

I also wanted to have a text display that said winner and game over/restart and also said the point scored from the last throw.

This will be the on/off switch for the product. I will use a toggle switch.

I wanted to make the base of the product look like the logo or part of a basketball court. I think this ties in well with the basketball theme and makes the product look stylish and aesthetically

Idea 1



The L.E.D's will go backwards and forwards from side to side on the top of the product. It should add to the aesthetics of the product. The LED's will flash when a point is scored.

This is where I will put the microswitch. When the ball goes in the net the ball will fall on pad with a microswitch underneath it and will send a pulse to the seven segment displays and count the score.

I will have two seven segment displays on my product. One will be for player 1 the other for player 2. Each one will count to 9 and the first player to get to 9 wins.

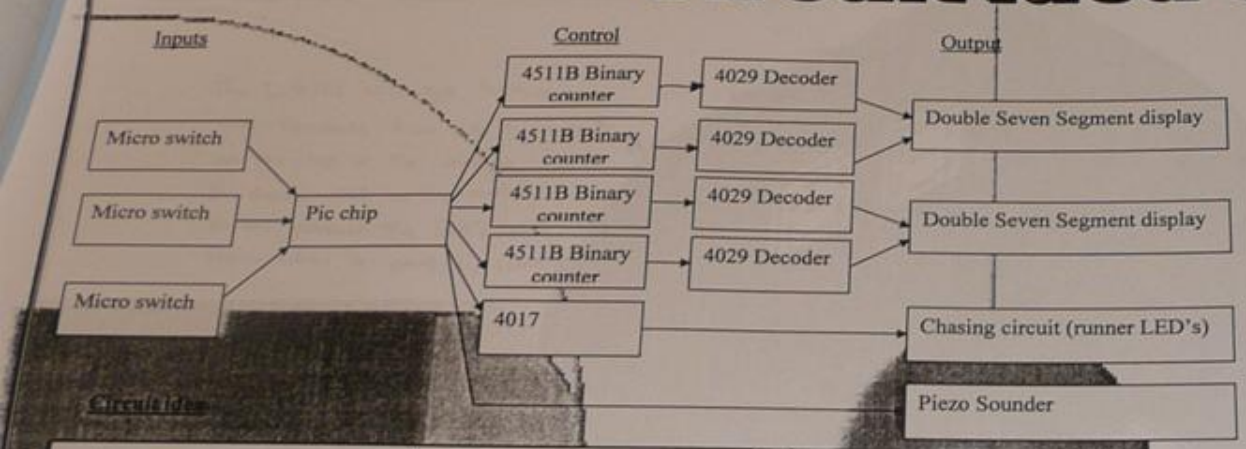
I am going to make sure the back is acrylic. This should stop the ball from being lost if the ball bounces off a basketball hoop or the back board.

My circuit will be in the base of the product but the LED's are at the top so the breadboard will have to allow me to input wires in the middle of it to illuminate the LED's.

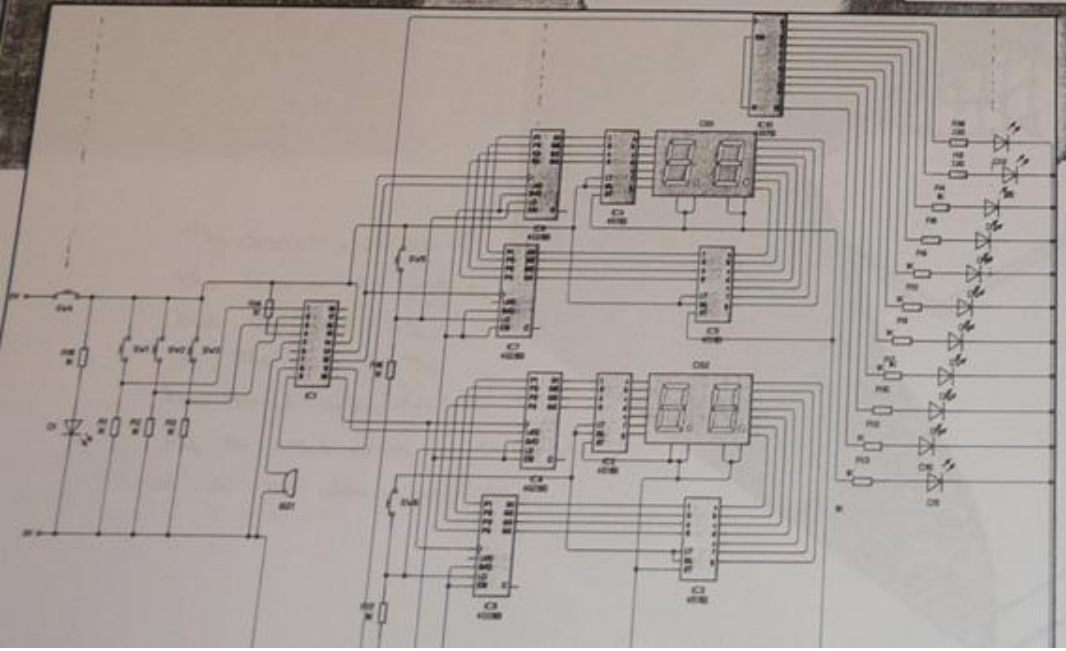
My circuit for my product will be in the base of the game. The bottom will be able to be screwed off so the batteries can be changed.

I picked the colours to be into a Lakers theme and this is there club colours.

Circuit idea 3



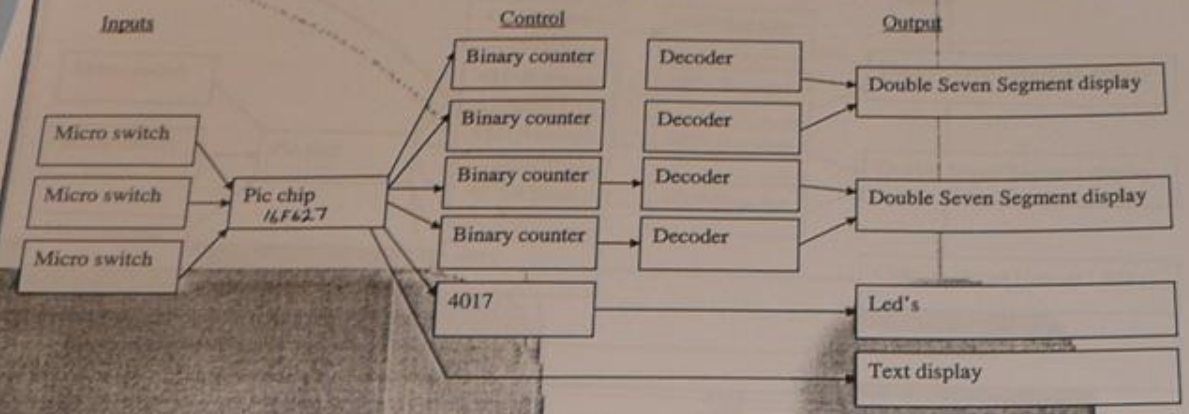
Circuit idea



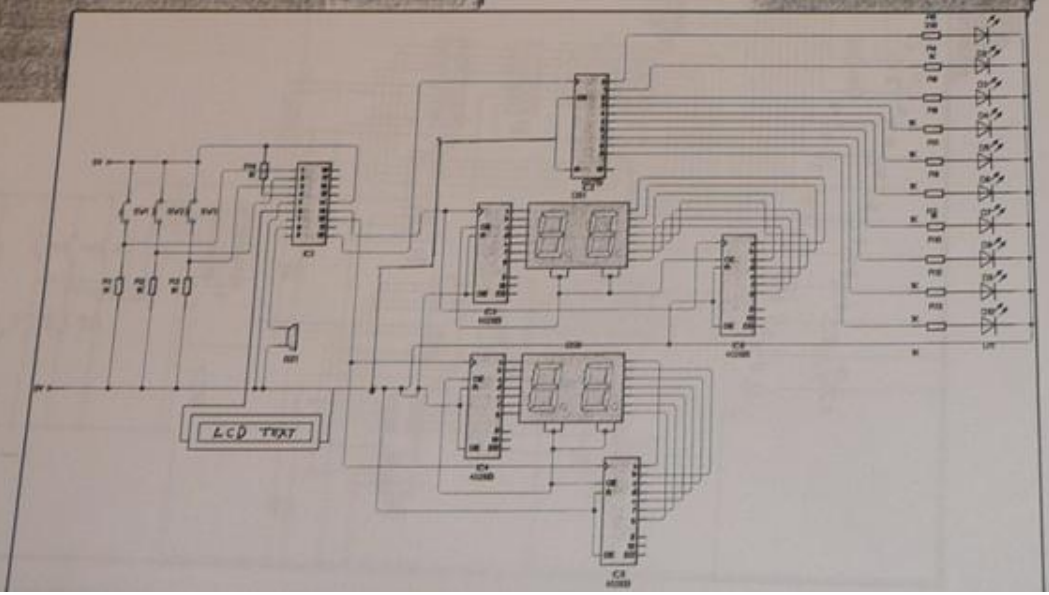
Circuit explanation

For my third idea the main change I made was to make my 0-99 counter an up down counter. In this circuit instead of using a 4026 chip I used a 4029 chip with a 4511B decoder. This allows the player to pick if the wanted there game to count up to 99 or down from 99. I think this is a fun feature and just makes the game that bit more different and original therefore appealing to children who would be buying the game. The piezo buzzer is still in the game but will play more tunes that I will program in the PIC chip for when players score and miss. The 4017 will be in this idea too which will light the LED's when a player scores and do a chaser sequence when a player wins the game.

Circuit idea 2



Circuit idea

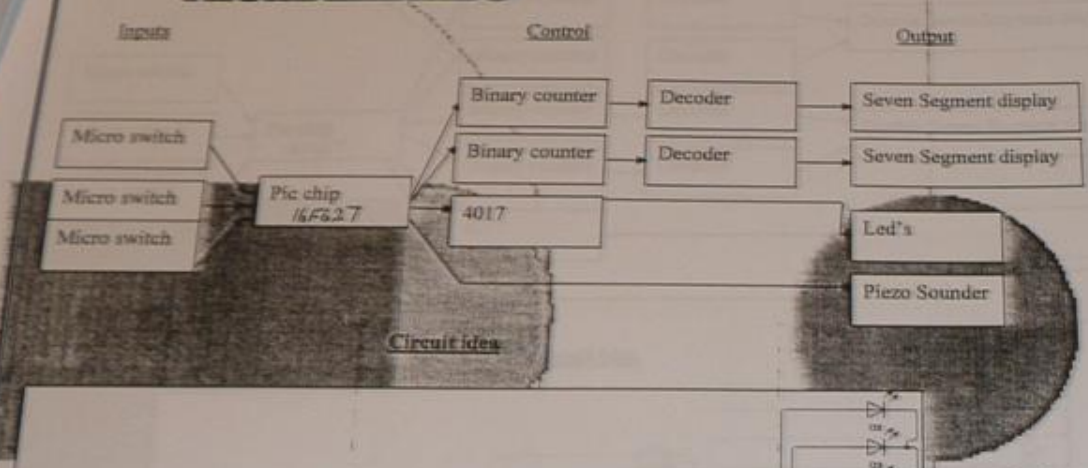


Circuit explanation

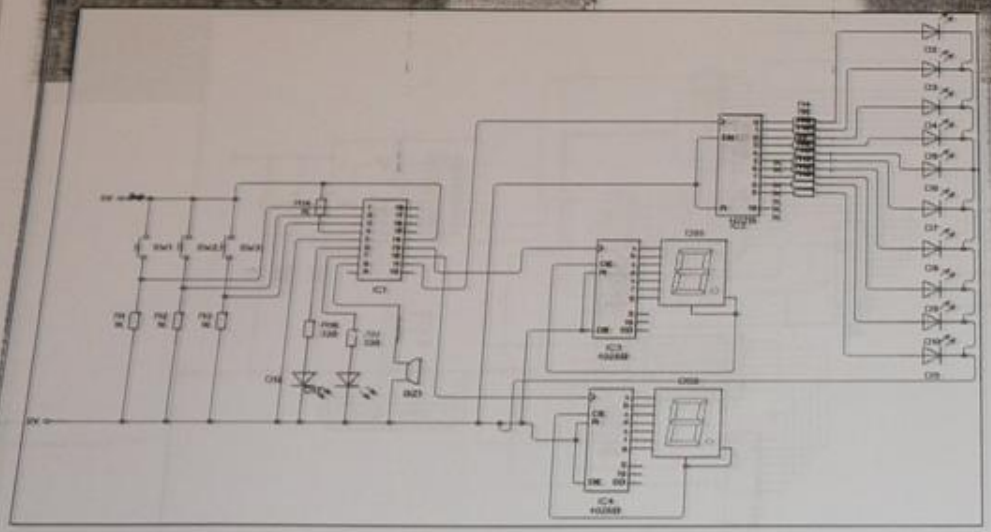
In this circuit I have changed the seven segment displays to dual segment displays which will allow me to play the game until ninety nine. This circuit will work the same as the last with the different trigger points on the dual seven segment displays. I wanted to have the game to go to ninety nine as the last game only went up to 9 and I thought this was a bit short for a game. I also added a text display to say winner instead of the winner being represented by an LED. The LED runner lights are the same as last time and will be programmed so the that there are runner LED's when the game is on and when there is a winner they will flash and a Piezo buzzer will sound with the tune that I will program into it. I also changed the micro switches to the pressure pads although there is no symbol for them but they will be used instead of micro switches.

Circuit Idea 1

Each time the ball falls through the net the ball will land on a platform which will in turn hit the micro switch and cause a different number of points, depending on the size of the net scored into, the seven segment displays will count and show the score. See Fig (1.1)



Circuit idea



Circuit explanation

Each micro switch input will each count different amount of points when pressed i.e. one net will count up three points on the seven segment display, another will count two points and the last will count one point. The points will count up each time to the different segment display as it will be two players and they will have a throw each time. The first player to get nine points wins and when they win a LED will light up which will sow which player has won. Also a Piezo buzzer will sound when a player wins to also show that a player has won the game. The LED's running off the 4017 will act as runner LED's to make the product look more appealing and vibrant.

Existing Solutions

Back To Basics Toys Arcade Basketball Hoops

Solution 3

Function- This is a very good example of a product similar to my idea. Two players battle for supremacy as the 60-second clock winds down or play solo to beat your own best score! Pressure mounts in the final 15 seconds as electronic announcer calls out 3-point shots. It plugs into standard outlet and includes timer, 4 rubber basketballs, and air pump. This game is targeted at Age 6+. This product is a very high quality product. It has many advanced features. I would like this to make my product different from this by making mine a smaller game with added games extras concentrating more on features that will better children skills and to encourage exercise

Manufacture- The steel frame needs to be assembled when bought. It can be assembled in approximately 20 minutes. I would like my game to have no assembly.

Safety- This game also seems very safe. It has no sharp corner or edges. However padding around the bars would have made it more safe incase a child was to hit into it.

Size- The product is 1500mm high, 1000mm wide and 2000mm long. This is a good size as it is not too big for the average size child for the products target age. I would like to make my product similar to this one but on a smaller scale.

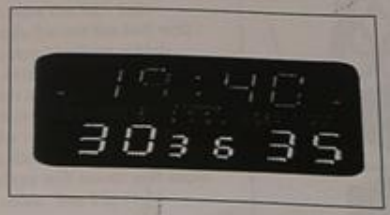
Cost This product is $189.99 which seems a fair price given the standard of this product.

Aesthetics I find this product very aesthetically pleasing and think that it will appeal to many children who would want to buy this game.

Materials- The main body is made from steel that has to be self assembled. It is has a backboard made of beech. The basketball hoop is made of steel also bent into shape. The base of the game is made of a fabric which allows the ball to roll back to the user.

Power supply- This game requires 6 AA batteries.

Game craft Scoreboards - 2222 Indoor Tabletop Scoreboard



Solution 4

Function- This is an example of a good scoreboard. This is a multi-functional indoor Scoreboard. It has stopwatch, clock with alarm and program timers. The clock counts up or down from 99:99 and counts scores to 199 has period, bonus, and possession indicator. It includes a Built-in control panel which also accommodates a Wireless Shot Clocks. This is an example of a top of the range scoreboard

Safety- This product seems very safe. It has round corners no sharp edges. It is wall mounted so also is out of the way of children

Size- The scoreboard is 4000mm x 2000m x 200mm. This is a very big scoreboard and would be used for in a real basketball court. I want to make a smaller one that will be built into my game.

Cost This product costs $530.87. This is a very high price scoreboard but I intend to manufacture a smaller, easier to use scoreboard.

Aesthetics The scoreboard is very plain. It has just a plain and boring background. The score and timer however look very good and have bright vibrant colours that would be able to see from a good distance away

Materials- The product is made from acrylic

Power supply- The product plugs into main voltage.

Specification

Function-

1.1- The function of my game will to be count the amount of points obtained from scoring through the basketball nets with a ball.
1.2- The game must help improve hand eye coordination and depth perception.
1.3- The points scored must be displayed on the seven segments displays for each player up to 99 for each player.
1.4- The game must allow for 2 players.
1.5- When a player scores 99 points before the opposing player a text display must say winner and LED's must flash and a buzzer sound.
1.6- The three inch balls also roll back when a point is scored.
1.7- The different sizes nets must have different points for scoring i.e. the largest net is worth 1 point, the middle net is worth 2 points and the smallest net is worth 3 points.

Aesthetics

2.1- The game must look as aesthetically pleasing and attractive as possible so it appeals to people and entices them to buy it.
2.2- It should have a smooth colorful finish with no sharp corners to not only make it safer but make it more attractive.
2.3- It should have a suitable design tied into the game of basketball such as the game being laid out like a basketball court with basketball logos as decoration to make more aesthetically pleasing.
2.4- The runner lights must go round the product and flash when a player gets a point.
2.5- The nets must look good and have a nice finish.
2.6- Labels should be added to show what the different buttons and switches do.
2.7- The text display must say winner when a player wins the game.
2.8- The product must have good proportions.
2.9- The product must be a good shape that is attractive and appealing that is based on the theme of a basketball court.

Ergonomics

3.1- The buttons on the game will have to be ergonomically designed so that they will be a suitable size for the average size hand.
3.2- The size and overall proportions will have to be ergonomically designed so that a child playing the game will be able to carry it easily and comfortably.
3.4- The nets should be positioned well so that the ball can be thrown into them without hitting off other pieces of the product.
3.5- The net must be strong enough to withstand a 3 inch soft ball bouncing off it at different speeds and strengths.
3.6- The buttons must be strong enough to withstand the strength and dexterity of different users.
3.7- The instructions for how to use the product should be easy to understand and easy to reed. The instructions should also have pictures to make it easier to understand.

Safety

4.1- The product must not have sharp corners or edges so that a user can't get cut or hurt.
4.2- There must be no small pieces or parts of the product that can be swallowed or eaten by small children.
4.3- The materials used to make the product must be non toxic so does not harm the children using it or the environment.
4.4- The product must meet all the safety standards set by the BSI.

Power Supply- 5.1- I will use a 9v pp3 battery to power my product.

Manufacture

6.1- The game must be easy to manufacture and use simple manufacturing processes.
6.2- It must be made a cost effective product.
6.3- It must use materials that are low in cost and easy to get (not needed to be imported)
6.4- Manufacturing processes must allow for the detail of the game to be achieved when finished.
6.5- The product must be easy to assemble when different parts of the product are made.
6.6- In order to make my product I will have to use the following manufacturing processes. I will have to line bend, vacuum form, use a laser cutter and cut and waste.

Materials

7.1- The materials used must be easy to clean or wipe.
7.2- The main body of my product will be made out of acrylic and some parts will be made from rigid polystyrene.
7.3- The back of the product will be made out of acrylic as it will give a smooth shiny finish and will make the product more aesthetically pleasing.

Size

8.1- The product should be small enough to carry but must be big enough to have 3 nets and a scoreboard.
8.2- The product must be not exceed 800mm x 700mm x 700mm
8.3- The nets must be big enough to allow a 3 inch soft ball to go through it.
8.4- The seven segment displays must be big enough to be seen from two meters' away as this is where the ball is being thrown from.

Weight

9.1- The product must be made out of suitable light materials as this a children toy and must be light so they can carry it.
9.2- The product must not weigh more than 2kg or 4.4lbs

Maintenance

10.1- The product should be a self maintained product and not nuts or screws etc tightened.
10.2- The product ideally should not need any repairs or spare parts other than the handles possible coming lose and falling off.
10.3- There should be ideally no problems with the product.
10.4- The only maintenance should be the changing of the battery.

Quantity

11.1-This is just a prototype therefore it should keep to the boundaries of one of production.

Cost

12.1- The toy must be cheap to buy in any toy or children store
12.2- The labour cost of the manufacture will have to be low so that a good profit is made by the manufacture.
12.3- The materials and the components used must be cheap for the manufacture to buy so the product is cheap to make and therefore cheaper to buy.
12.4- The game should be sold at a price between £40-50

5. Problem Identification

What is the problem?

Recently I have found my younger brother was getting bored and sitting around watching too much TV. The weather does not always allow him to go out and play. This has left him bored and with nothing to do. I came up with the idea of making a game that would be fun for him to play but at the same time help him better such skills as hand eye coordination and depth perception. This would be a more fruitful way of passing the time as it will not only improve these skills but offer hours of enjoyment.

Where the product would be used?

The product can be used anywhere. When manufacturing the product I want to keep the product small enough to be carried around and played anywhere. This way it can be easy for children to play with mates and also allows for easy storage of the product.

What is the product I will be designing?

The product I will designing will be a basketball game and scoreboard. My brother is interested in sports so I decided to combine his interest in sport with a game to come up with the idea of a basket ball game that will help improve skills and give him something enjoyable and fun to do. The game will consist of different size nets in which a ball must be thrown into from a distance. There will be three nets of different sizes and each with different points. The scoreboard will count the points scored by getting the ball in the nets and have added features to add interest to the game. The game will come with a 3 inch ball. The ball will be small so the product can be small and carried about easily by children who would be playing it.

Why would people want to buy this product?

I think this game will appeal to parents who will be buying the games as this game will not only keep children content but is also beneficial as it helps improve useful skills. It also encourages interaction as there can be two players. The game will be fun to play, be aesthetically pleasing and will bring enjoyment to children so I also think it will largely appeal to them and make them want to get this product.

Who does this product affect?

The game when manufactured will be aimed at the children's toy market. It will appeal to children as it will be a fun and enjoyable game with heightened enjoyment through the competitiveness of the game. The game is to be targeted at children between the ages of 5-12. It can be for boys or girls

Design Brief

For my A level project I am going to design and manufacture a child's toy to improve hand eye coordination and depth perception while keeping children content and excited.

Modification Page

Transmitter Modifications

This modification which I have chosen will for my transmitter design is to add buttons to it. This would allow the fourth official to see the decision which it needs to make more clearly as the buttons could be labelled to say foul, penalty and yellow card. This could be more efficient than the numbers which I have use

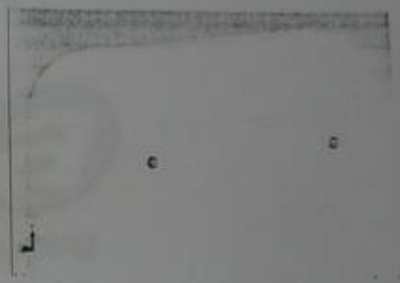
The second modification that I would make to the design of the transmitter is to add a clip to the back to make it more mobile. This was something that I mentioned in my specification which I did not fill and so I would like to do so now on the modifications page

Overall Modifications

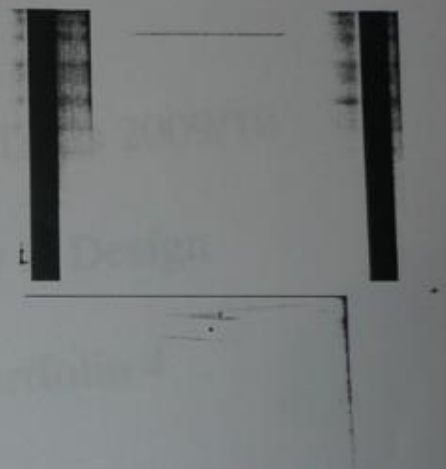
Now I am going to look at other modifications that I would make for my products. The major change that needs to be modified on this product is the s zie of the Printed Circuit Board. If this was modified then the weight and size of the products would be significantly reduced due to the fact that less plastic would be used as a result of reduction in size of the box. The reduction in size and weight will make this product more cost effective and will also allow the referees and fourth official to do there task more easily as they can carry this product around easily. Also finally I feel that these products need to have a guard fitted over there buttons as they can be easily pressed when the referee/fourth official is running and so this might cause a false message being sent to the referee.

Receiver Modifications

In this design I have incorporated the idea seen in receiver design page one of the removable back. This modification will allow the product to become more light weight. It will also allow the product to be more secure as the back will not fall out unless it is unscrewed.



I have modified the design again by adding a buzzer. This will allow the referee to be alerted more easily when there has been a foul committed. To do this I will drill holes into the top of the box. Also I will need to change my circuit design to incorporate a buzzer.



The final modification to my design would be to add a belt clip to it. The reason for this is that this design is not easily carried around by hand and because a referee needs to run around a lot, this clip attached to the belt of the referee will make it easily moved around.

Evaluation Against Specification

- The product should manufactured out of lightweight materials
  The product has been manufactured out of lightweight materials

Safety

- The product should have smooth edges and surfaces so that it does not cause injuries
  The product has smooth edges and surfaces so that no injury is caused
- The product must be waterproof so that it does not electrocute the users of the device.
  The product is waterproofed so that it does not electrocute the users of the device
- The product must pass British Safety Standards
  The product meets the British Safety Standards
- The product must be safe to use at all times and not harm the person using it
  The product is safe to use at all times as it does not harm the user
- The manufacturer of the product must use gloves and goggles.
  The product was manufactured using gloves and goggles
- There should be no wires sticking out of the product that may cause danger to the surrounding environment
  The product has no wires sticking out of it that would cause danger to the surrounding environment

Maintenance

- This product should be easy to maintain as it will be used quite frequently at football matches
  The product is easy to maintain as it can be cleaned easily
- The product should be made out of acrylic to help maintain the product
  The product is made out of acrylic so is easy to maintain
- The product must be able to be cleaned with ease so that there is not a build up of mud and dirt from being used at a pitch side
  The product can be easily cleaned so that mud is not built up

Weight

- The product should be light so that the referee/or linesman can carry the devices with them
  The product is light and can be carried around easily
- The product must not weigh over 10kgs so that it is easy to move.
  The product is lightweight and does not weigh over 10kg
- The product must weigh at least 5kgs so that it is strong and sturdy.
  The product weighs more that 5kgs and so is strong and sturdy

Cost

- This product should be relatively cheap to manufacture.
  The product is relatively cheap to manufacture
- The product should be manufactured out of acrylic do that the product is cheaper.
  The product is manufactures out of acrylic making the product cheap
- The product should be good value for money.
  The product is good value for money
- The product should be cheap enough to compete with similar products in the market
  The product can compete with similar products in the market.

Size

- The product should be no more than 50mm by 50mm in size so that it is easy to store and to be carried around.
  The product is bigger than 50mm by 50mm as it is a prototype and the machines in the manufacturing room

Mobility

- The product should be around 5kg to make it easy to be carried around by a referee.
  The product weighs 5kg so making it carried around easily

Storage

- This product should be designed in away that it is easy to storage.
  The product can be easily stored
- The product should be small enough to be stored in a pocket.
  The product is unable to be stored into to a pocket because of limited manufacturing tools

Durability

- This product should be durable because it is expected to have a long self life.
  The product is durable and so will have a long shelf life
- This product must be designed out of acrylic to give the product durability
  The product has been designed out of acrylic to make it durable
- The product should have a long battery life so that it is able to last at least 90 minutes and any extra time that is added on
  The product has a long battery life and can last the full time needed for a football match and any extra time.

Environmental

- The product must be as environmentally friendly as possible.
  The product is environmentally friendly as it has a long battery life and can be recycled
- The product should be made out of acrylic to make it environmentally friendly.
  The product is made out of acrylic to make it environmentally friendly
- The products colours must not be an eyesore to the surrounding environment.
  The products colors are not an eyesore to the surrounding environment
- The products should not be harmful to the environment when it is being manufactured.
  The product is not harmful to the environment when it is being manufactured.

Testing

- The product should be tested so that is safe for people to use while being used.
  The product has been tested and is safe to us
- The product should be tested to make sure that it works quickly so that a player does not warm down.
  The product is quick and so players will not get injured from warming down

Evaluation Against Specification

Function

- This product should be able to transmit a signal of at least 150 metres as it needs to be displayed over the full pitch.
  This product is able to transmit a signal of at least 150 metres and is able to transmit over a pitch
- This product should be able to transmit a message from the fourth official/linesman to the referee
  The product is able to transmit a message from the fourth official to the referee
- This product should be able to transmit a message of offside
  This product is able to transmit a message of offside
- This product should be able to transmit a message of goal
  This product is able to transmit a message of goal
- This product should be able to transmit a message of penalty
  This product is able to transmit a message saying penalty
- This product should be able to transmit a message free kick
  This product is able to transmit a message of free kick
- This product should be able to transmit a message yellow card
  This product is able to transmit a message of yellow card
- This product should be able to transmit a message red card.
  This product is able to transmit a message of red card
- The products buttons must be at least 20mm in diameter, making the buttons easy to press.
  The products buttons are at least 20mm in diameter making the buttons easy to press
- The product must have a guard so that the buttons are not accidentally pressed
  The product does not have a guard to protect the buttons
- The products must be able to last full 90 minutes and any additional time plus it should be able to last an extra 30 minutes and 15 minutes for penalty.
  The product is able to last the full 90 minutes plus any extra time
- The product should be waterproofed so that it will not electrocute the referee or the linesmen when they are using the devices
  The product is waterproofed and so will not electrocute the referee
- The product should be big enough so that the referee can read the letters on the LCD display
  The product is big enough so that the LCD display can be read
- The product should be fitted with a vibrating or sound system so when there is a problem the referee is made aware that there is a problem
  The product does not have a sound or vibrating device to alert the referee
- The product should be light weight so that a referee and his officials can carry the product around
  The product is light weight and can be carried around easily
- The product should have an attachment on the referees belt so that he can easily carry it around with out it falling out of his pocket.
  The product has handles which allow them to be carried around easily
- The product should have an ear piece attachment so that the referee can hear when or not there is s a problem.
  The product does not have an ear piece attachment
- The product should be cost effective and cheap to run as it will be used by poorer teams as well as the rich teams
  The product is cost effective so making it cheap to run and be used by poorer teams
- The product should be safe to use in all weather because it will be used outside
  The product is safe to use and can be used in all weathers
- The product should be made out of a material that is easy to maintain s it will be used out side frequently
  The product is made out of a material that is easy to maintain
- The product should be manufactured with blue yellow and black acrylic so that it keeping with the traditional refereeing colours.
  The product was manufactures out of yellow acrylic so keeping with traditional colours
- The product should be no bigger than 50 mm by 50mm so that the referee can carry it around easy in his/her pocket
  The product is bigger than 50mm by 50mm as a prototype
- The product should not be effected by large movement because the referee will have to run back and forth up and down the pitch
  The product is not affected by being moved across the pitch
- The product should be able to be seen in all weather conditions as the product will be used in all weather conditions
  The product is able to be seen in all weather conditions

Aesthetics

- The product must be manufacturst with colours that are easy on the eye e g. blue.
  The product has been manufactured with colours that are easy on the eye
- The product should be manufactured using blue black to keep with the traditional colors footballs
  The product was not manufactured with these colours but yellow
- The product should have a smooth finish so that it is aesthetically pleasing.
  The product has a smooth finish and is aesthetically pleasing

Ergonomics

- The product must be ergonomically pleasing
  The product is ergonomically pleasing
- This product must have a smooth finish in relation to that human touch
  The product has a smooth finish in relation to the human touch
- This product must have rounded edges and corners to make it ergonomically pleasing.
  The product has rounded edges and is ergonomically pleasing

Anthropometrics

- This product should be anthropometrically pleasing because in relation to the human anatomy this product needs to be big enough for someone to lift and to be able to see.
  The product is anthropometrically pleasing in relation to human anatomy

Materials

- This product should be manufactured out of acrylic so that it cheap to manufacture.
  The product has been manufactured out of acrylic as it is cheap to manufacture
- This product must be made out of acrylic so that the product is durable and strong for its desired use.
  The product has been manufactured out of acrylic as it is durable and strong for its desired use
- The products should be manufactured out of acrylic so that the product can be waterproof.
  The product has been manufactured out of acrylic to make it waterproofed.

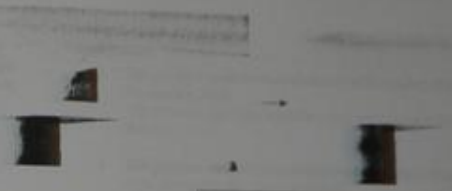
Modifications During Design

First Modification during Manufacture

When designing my circuit I first used the auto route feature that was available as it allowed me to route my circuit more effectively. However after doing this I found that the auto routing feature in the programme could only route my circuit on to the PCB at around 96% for both my circuits. To fix this problem I designed my circuit on to the PCB myself which allowed me to complete it to 100%.

Auto Routed to 97%

Auto Routed to 95%



Fifth Modification during Manufacture

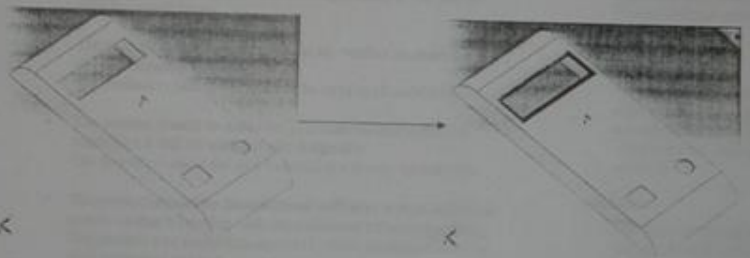
Second Modification during Manufacture

My second modification during design was the size of box. In my original design I never took in to account the battery. During manufacturing I realised this and so I needed to make the box bigger to allow the battery to fit in for my receiver box.

Second Modification during Manufacture

Third Modification during Manufacture

The third modification during design was adding a border around the LCD display. The reason for this border is due to the fact that this makes the box look more aesthetically pleasing because the method I used to cut out the hole for the display left undesired results as the edges where not completely straight. The use of this black border improved the design.



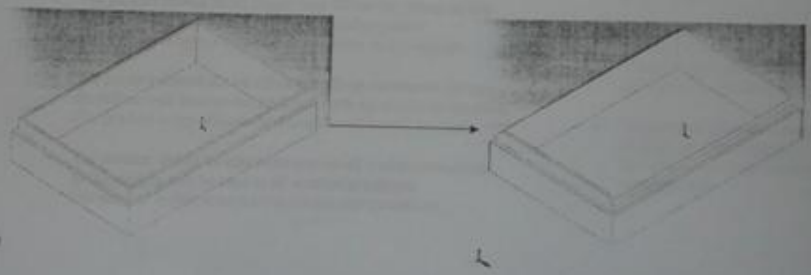
Third Modification during Manufacture

Fourth Modification during Manufacture

My fourth modification during Manufacture was changing the colour of my supports. The reason for changing the colour from black to yellow as it makes the design of the box more aesthetically pleasing.

Fifth Modification during Manufacture

In my original transmitter design I kept the inserts of the long sides of my box straight but during manufacturing I realised that if they where chambered to the same angle as the chambered top of the box then the box could be put together more easily.



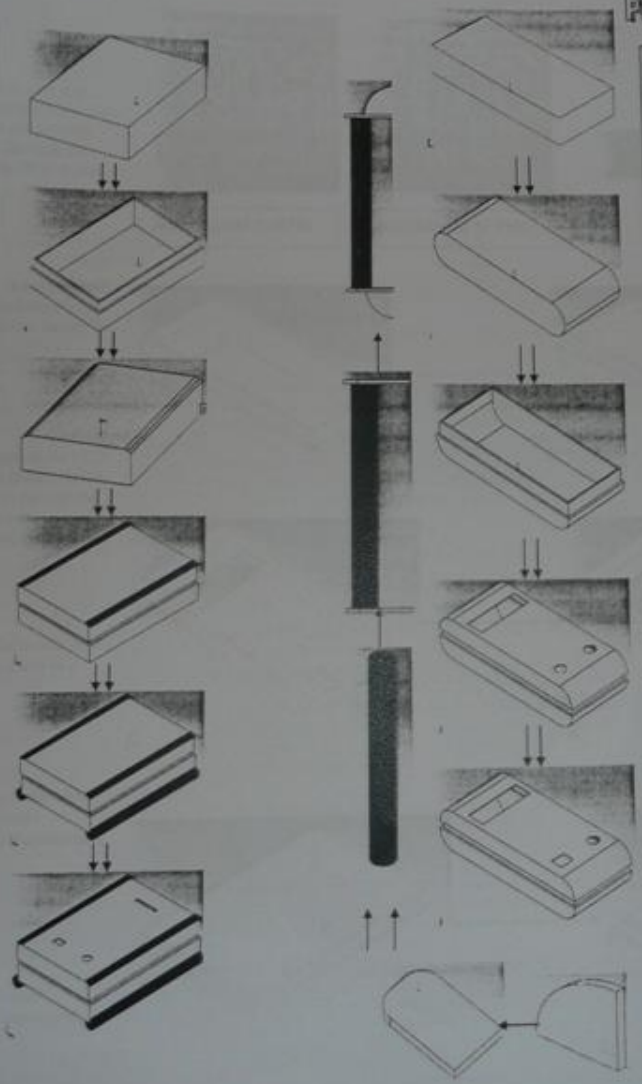
Fourth Modification during Manufacture

Sixth Modification during Manufacture

In my original design for my receiver I used 3mm plastic but when manufacturing the use of 5mm yellow acrylic allowed me to improve the aesthetics of the design and also makes the box more durable.

Plan of Manufacture-Transmitter

1. Cut two pieces of 3mm yellow acrylic to the size of 150mm by 100mm
2. Cut two pieces of 3mm yellow acrylic to the size of 150mm by 60mm
3. Cut two pieces of 3mm yellow acrylic to the size of 100mm by 60mm
4. Using try squares and liquid solvent cement build the box together
5. Using files, use the methods of cross-filing and draw-filing to make the edges of the box flush. This will also remove the cut marks that would have been seen when using the circular saw
6. Next using sandpaper, sand the box down firstly using 320 ,600 and finally 1000 grain sandpaper.
7. Using the circular saw cut the box in half
8. Next, again using the circular saw taper the edges of the box at a 30 degree gradient
9. Cut two pieces of 3mm black acrylic to the size of 150mm by 15mm
10. Using liquid solvent cement attach the black acrylic to the tapered edges.
11. Now cut two pieces of 3mm white acrylic to the size of 150mm by 40mm.
12. Next cut two pieces of 3mm white acrylic to the size of 100mm by 40mm
13. Attach these four pieces into the inside of the box without the tapered edges. Attach them using liquid solvent cement
14. Now using 10mm diameter black tube cut two lengths to the size of 153mm using the hanger saw.
15. Using the lathe face off this tubing to the size of 150mm. This will give it a smooth finish
16. Next using the milling machine mill the tubing to cut out quarter of a circle
17. Again using Liquid Solvent Cement attach this tubing to the bottom of the box.
18. Using the milling machine mill a hole into the box for the attachment of the Keypad
19. Using the pedestal drill, drill 2 holes of 14mm diameter for the components
20. Using a file, make one of the holes wider for the On/Off switch.
21. Now polish the product using the polishing machine.
22. Attach components
23. Use Stilka Plus to write the words Hawk eye
24. Attach this to the bottom of the box.



Plan of Manufacture-Receiver

Box

1. Cut 2x yellow pieces of acrylic to the size of 210mm by 70mm
2. Cut 2x yellow pieces of acrylic 70mm by 40mm
3. Build box together by using liquid solvent cement using try squares so that the box is straight
4. Once dry use a file to file down the edges to make the box flush
5. Next fillet the top and bottom edges to give the box to make it more aesthetically pleasing
6. Using 320 then 600 and finally 1000 grained sandpaper to get the filing scratches out of the box
7. Next using the circular saw cut the box in half.
8. Again using the Circular saw cut out 2 pieces of yellow acrylic to the size of 210 by 60mm
9. Using this saw again cut out 2 pieces of acrylic to the size of 60mm by 60mm.
10. Next get one half of the box and insert these pieces of acrylic as the boxes inserts.
11. Insert them by using liquid solvent cement and a try square so that the inserts are straight.
12. By using the milling machine mill a hole the size of 73mm by 25mm for the LCD display.
13. Next using the pedestal drill, drill two holes using a 14 mm drill bit for the on and off switch and re-set switch
14. File one of the holes to allow the On/off switch fit in.

Handles

1. Cut out using black cylindrical tubing of a diameter of 10mm to a size of 170mm. using the hanger saw
2. Next using the circular saw cut out 4 pieces of yellow acrylic of 40mm by 30mm.
3. Next round the edges of these pieces of acrylic to make the plastic more aesthetically pleasing.
4. Using the circular saw cut out 4 pieces of yellow acrylic of 30mm by 30mm.
5. Take these pieces and round the edges off to make the box more aesthetically pleasing by using the band facer

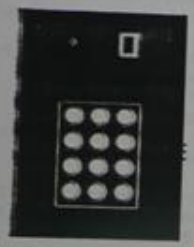
Assembly of Parts

1. Using liquid solvent cement and try squares attach 2 pieces, on each side, of the yellow acrylic with the rounded edge leaving a gap of 170mm between them.
2. Insert the black tubes in these gaps and attach using liquid solvent cement.
3. Use the last four pieces of acrylic with the quarter circle shape as supports for the handle attachments. Again use liquid solvent cement to attach these.
4. Next using Stilka plus write the words Hawk Eye
5. Finally insert components and PCB

Further Development of Chosen Designs

Transmitter

I have chosen my fourth transmitter design to further develop. I feel that this design is a mobile design that will allow the fourth official to carry it round easily. Although I feel that this design needs to be further developed. I could further develop this design by changing the colour of the box to yellow. I feel that this couloirs would make the box more aesthetically pleasing and will also go with the colour scheme that I have chosen for the other box. However I do want to leave the colour of the inserts the same



I also feel that the keypad on my design needs to be used and more central in the box. This will allow the box again to look more aesthetically pleasing and will also allow me to use Silka Plus to had a label for my product. The name which I have chosen for my design is Hawk Eye. Again the use of the name will make the product more aesthetically pleasing.

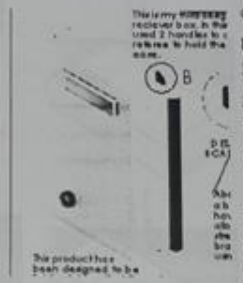
Another development for my design is to change the re-set switch to a black push to make button. This again will improve the aesthetics of this design. I also feel to make this product more light weight and easier to carry I will reduce the size of the box as this design did not take in to account the size of my transmitter circuit which is small and so will make the box smaller. With the reduction in the amount of materials used by making the box smaller it will also allow the price of the product to be greatly reduced.

The handles I feel also need to be made bigger so that the project is easily held and so will not slip out of the fourth officials hands when wet.

The diagrams to the right shows the further development of theses designs.

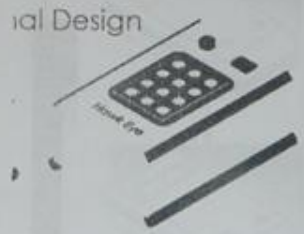
Receiver

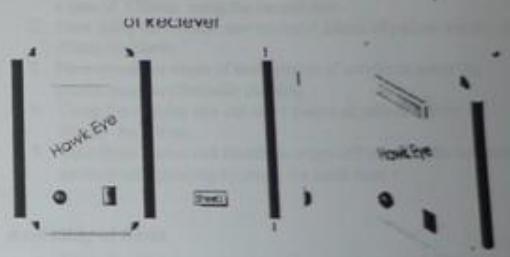
I have chosen my third design to further develop. I feel that this design will be a mobile and and lightweight design making it easily carried. However I do feel again that this design needs to be developed further. The first development that I would make to this product is to add an on and off switch to it. In designing this product I forgot to add an On/Off switch. This is necessary so that the product can be switched on and off. The product also needs to be made bigger than I originally specified in my design page as the receiver circuit is bigger than expected.



To make the box more aesthetically pleasing I am also going to add Stilka Plus to it. I will use the same name as I used on the Transmitter (Hawk Eye). To save weight I am also going to reduce the size of the handles that I suggested in my design. I feel that the handles unnecessary weight and so by using smaller handles weight will be reduced and also money will be saved as there will be less materials used. Also instead of whole tubes for the handles I am going to use hollow tubes as this will allow me to save weight for my design.

The designs to below show the further development of these designs





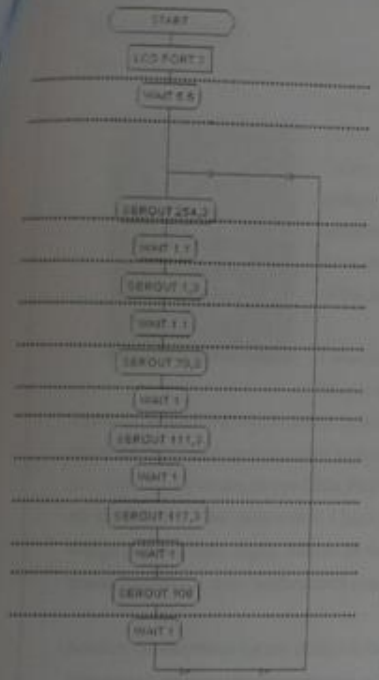
Development of Receiver Design

Development of Transmitter Design

Programming

This is my first programming page. To programme the PIC Micro-controller I will be using the PIC Logicator program. This will allow me to program my chip easily for both my transmitter and receiver circuit

The picture to the left shows a typical keypad that I use to send a message to my receiver circuit



Wait to allow the LCD display to turn on

Clears Screen

Wait for 1.1

Clears Screen

Wait for 1.1

Letter F displayed

Wait for 1

Letter o displayed

Wait for 1

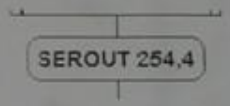
Letter u displayed

Wait for 1

Letter l displayed

This wait will allow the word Foul to appear

The diagram to the left shows m LCD display. This test is needed to make sure that the LCD is working correctly and there are no problems in the receiver circuit. By checking this now I am able to eradicate these problems for the future and know that there may be a problem with the programming that I am using



The SEROUT command that I have used in the above program allows you to output information form the microcontroller to a device such as a serial LCD screen which has been connected to an output of my micro controller. I used pin 3. The information is sent serially at a baud rate.

32		51	3	70	F	89	Y	108	l
33	!	52	4	71	G	90	Z	109	m
34	"	53	5	72	H	91	[	110	n
35	#	54	6	73	I	92	\	111	o
36	$	55	7	74	J	93	]	112	p
37	%	56	8	75	K	94	^	113	q
38	&	57	9	76	L	95	_	114	r
39	'	58	:	77	M	96	`	115	s
40	(	59	;	78	N	97	a	116	t
41	)	60	<	79	O	98	b	117	u
42	*	61	=	80	P	99	c	118	v
43	+	62	>	81	Q	100	d	119	w
44	,	63	?	82	R	101	e	120	x
45	-	64	@	83	S	102	f	121	y
46	.	65	A	84	T	103	g	122	z
47	/	66	B	85	U	104	h	123	{
48	0	67	C	86	V	105	i	124	|
49	1	68	D	87	W	106	j	125	}
50	2	69	E	88	X	107	k		

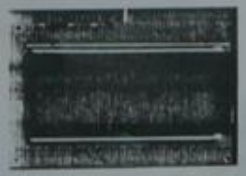
In the programming to the right you can see by using PIC logicator I have programmed my Keypad. To do this connects the keypad to the PIC microcontroller using inputs and outputs seen on my 4x3 matrix. Firstly the row is made "live" by sticking on the output to which it has been connected to. When the correct key is pressed, by testing for that input to be on. When the correct key is pressed a message is sent to the encoder to be

Summary of PIC-Logicator Flowsheet
File Name: LCDTEST.PFL
Author :

Port Output Functions	LCD PORT 3
	00001000

The diagram above shows the summary sheet for my LCD Test design

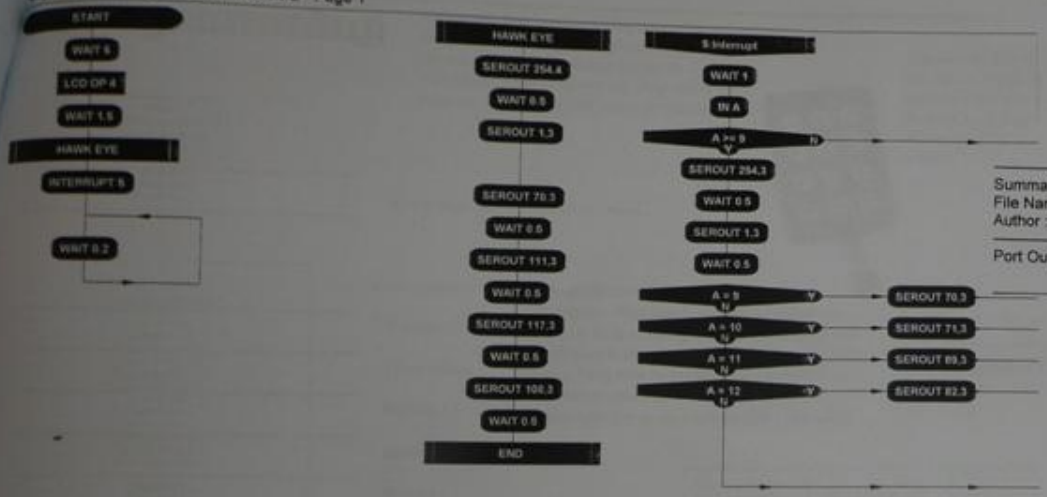
In the above diagram you can see the table that I have used to determine the correct number which corresponds to the letter which I need for my LCD



The above picture shows a typical LCD with a message that I could send to it using programming. In this case it shows the message I used in my test programme

```
Summary of PIC-Logicator Flowsheet
File Name: TEST.PFL
Author :
-------------------------------------------------------------------
Port Decisions          | Row a Input 3          . . . . 1 . . .
                        | Row b Input 2          . . . . . 1 . . .
                        | Row c Input 1          . . . . . . 1 . .
                        | Row d Input 0          . . . . . . . 1
                        |
Port Output Functions   | Column One- Port One   . . . . . 1 . .
                        | Column Two- Port Two   . . . . . 1 . . .
                        | Column Three- Port Three . . . . 1 . . .
                        |
Macros                  | SCAN KEYS
```

The above diagram shows the summary sheet of my keypad

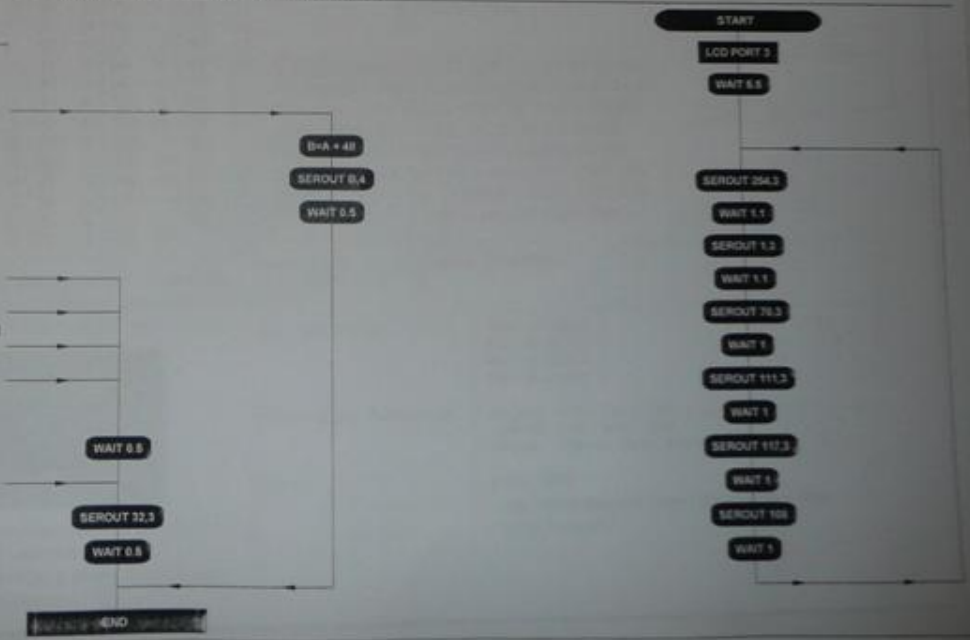


Summary of PIC-Logicator Flowsheet
File Name: LCDTEST.PFL
Author :

Port Output Functions	LCD PORT 3

000010

This summary sheet corresponds to the flowchart on the previous page. This flowchart is for the LCD test that is installed.

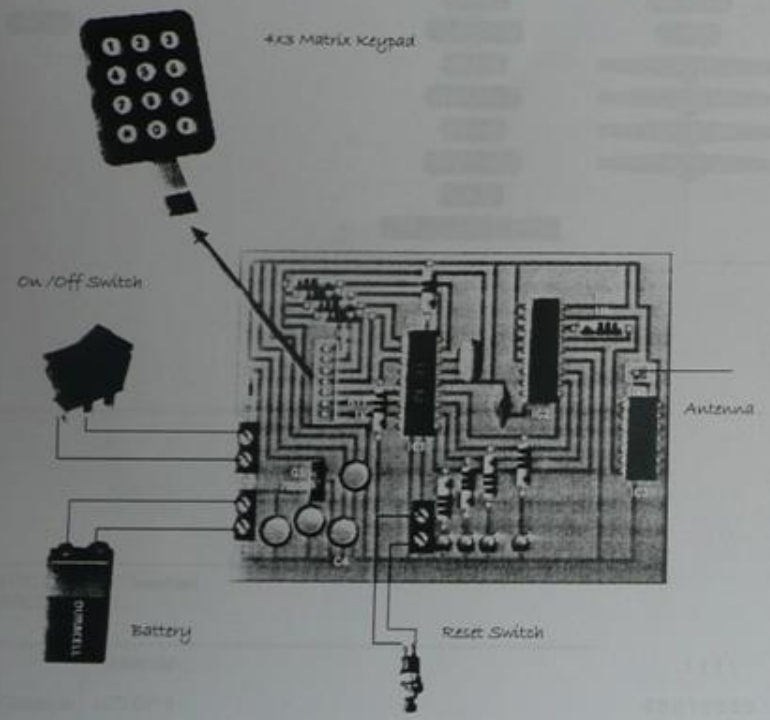


Summary of PIC-Logicator Flowsheet
File Name: RECEIVER.PFL
Author :

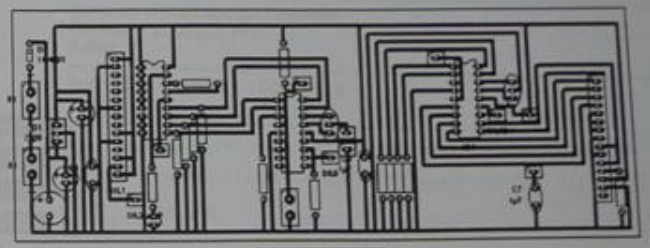
Interrupts	5:Interrupt	1111
Port Output Functions	LCD OP 4	00010000
Macros	HAWK EYE	

This summary sheet corresponds to the above flowchart and vice versa. As the programme is so long it has had to be on 2 pages

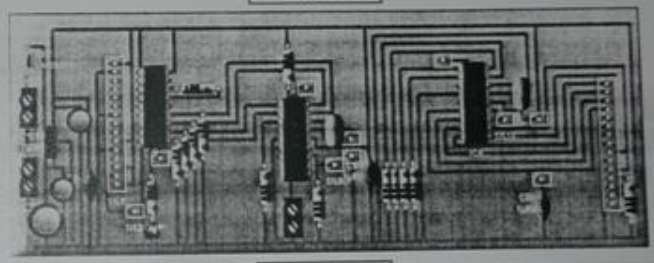
Transmitter Final Circuit



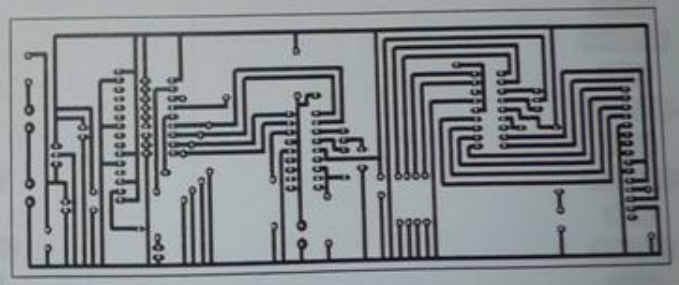
Normal View



Real World View



Artwork View



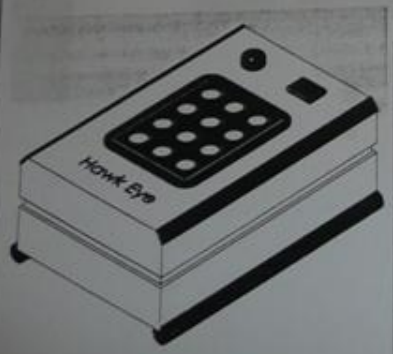
Parts List

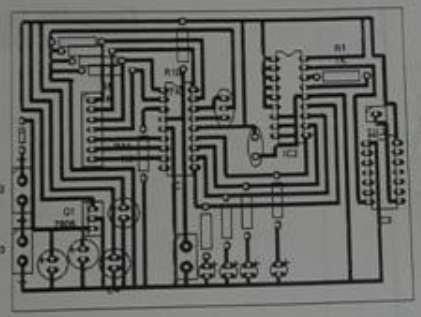
- 3x 1µF Capcitor
- 3x 100µF Electolite Capcitor
- 8x 10 K Resistor
- 5x 1 K Resistor
- 1x 1 M Resistor
- 1x 1N4001 Diode
- 3x 2 Pin Terminal Block
- 1x Printed Circuit Board
- 1x 7805 Voltage Regulator
- 2x PIC Microcontroller
- 1x LED
- 1x Reset Switch
- 1x On and Off Switch
- 1x 9 Volt Battery
- 1x Decoder Module
- 1x LCD Module
- 2x 15 Pin SILs
- 9x SILs
- 5 Jumper Wires

Design Proposal-Transmitter

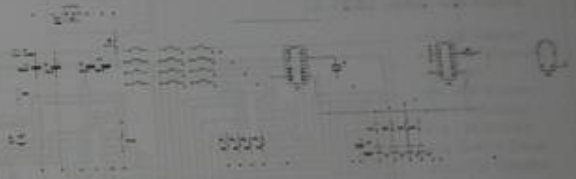
Transmitter Parts list

- 330K Resistor
- 4x Red LEDs
- 4 x 100K Resistor
- 1x (4x4) Matrix Keypad
- 4x 330K Resistor
- 3x 2 pin Terminal block
- 1x Printed Circuit Board
- 1x 16F84 PIC Microcontroller
- 1x 4MHz Resonator
- 1x 8 Pin SIL Header Socket
- 1x RT4 Transmitter Module
- 1x 7805 Voltage Regulator
- 1x 1N4001 Diode
- 4x 100µF Electrolytic Capacitor
- 1x 1000µF Electrolytic Capacitor
- 9x Push to Make Switch
- 1x Reset Switch
- 1x HT12E Encoder
- 1x 1 Pin SIL
- 1x 1M Resistor
- 1x 4.7K Resistor
- 1x 9Volt Battery

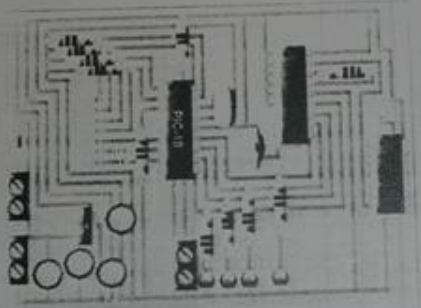




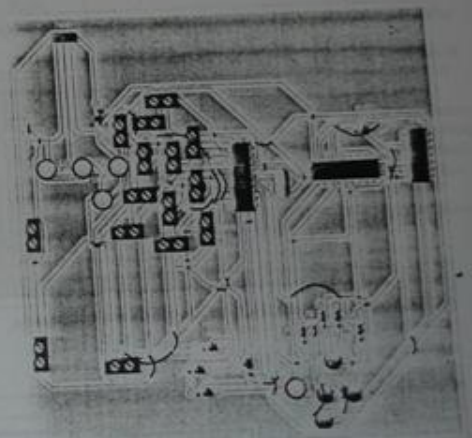
Normal View



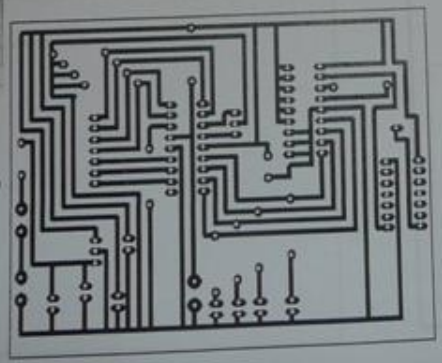
Circuit Diagram



Real World View



Auto-Routed



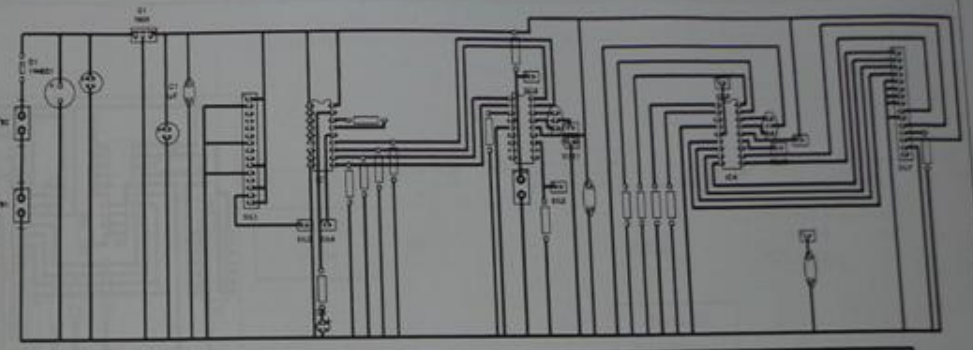
Artwork View

PCB Layout Design

Stage One

The diagram to the right shows the correct layout for my PCB for my Transmitter Circuit. The first thing that I will need to change is the overall size of the layout. I will first do this by reducing the size of the power supply by moving the capacitors closer together and by moving the power supply down to side of my PCB. I will also reduce the height of the circuit. I will do this by moving such components as the LED up. I will also reduce the space between the Receiver Module and the decoder.

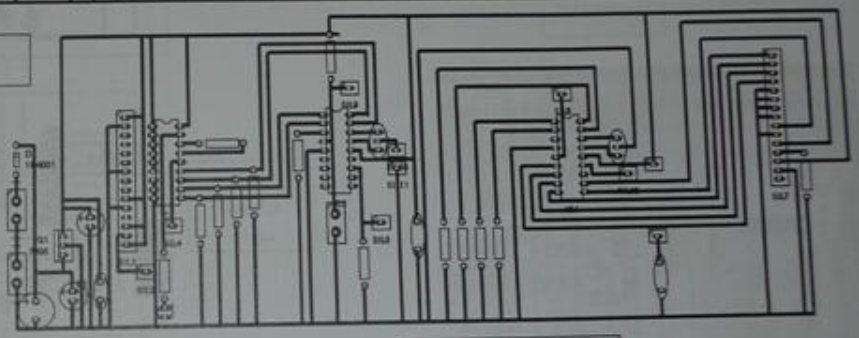
Stage 1



Stage Two

The diagram to the right shows the changes that I have made from the previous stage. I can now make the PCB smaller by moving the LCD Module down. This will the allow me to reduce the height of the circuit even more. I can also now see that I can move the tracks form the PIC to the LCD Module closer together. This will allow me to rduce the width of the PCB. I have also noticed that I have used the wrong capacitors in my product. By changing them I will also be able to save more space as these capacitors will be smaller. Finally I will be able move my power supply closer together.

Stage 2



Stage Three

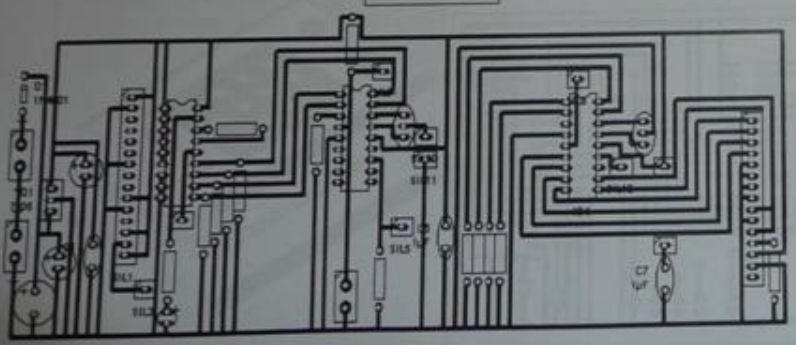
The diagram to the below shows the changes that I have made from my previous stage. However I had to make a change to the LED as it was not connected in the previous stage. The first thing that I am going to change about this is the position of the first PIC. By moving the PIC I am able to reduce the height of the PCB even further.

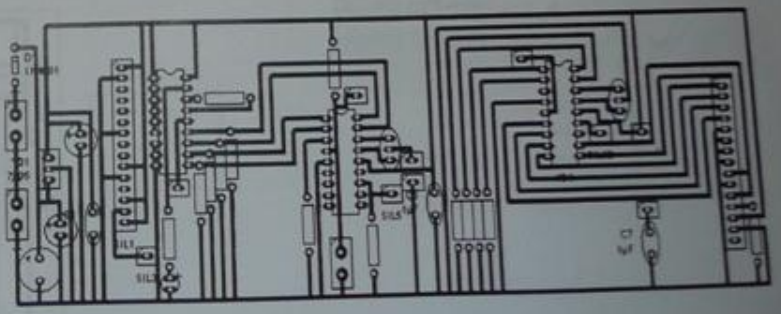
Final Design

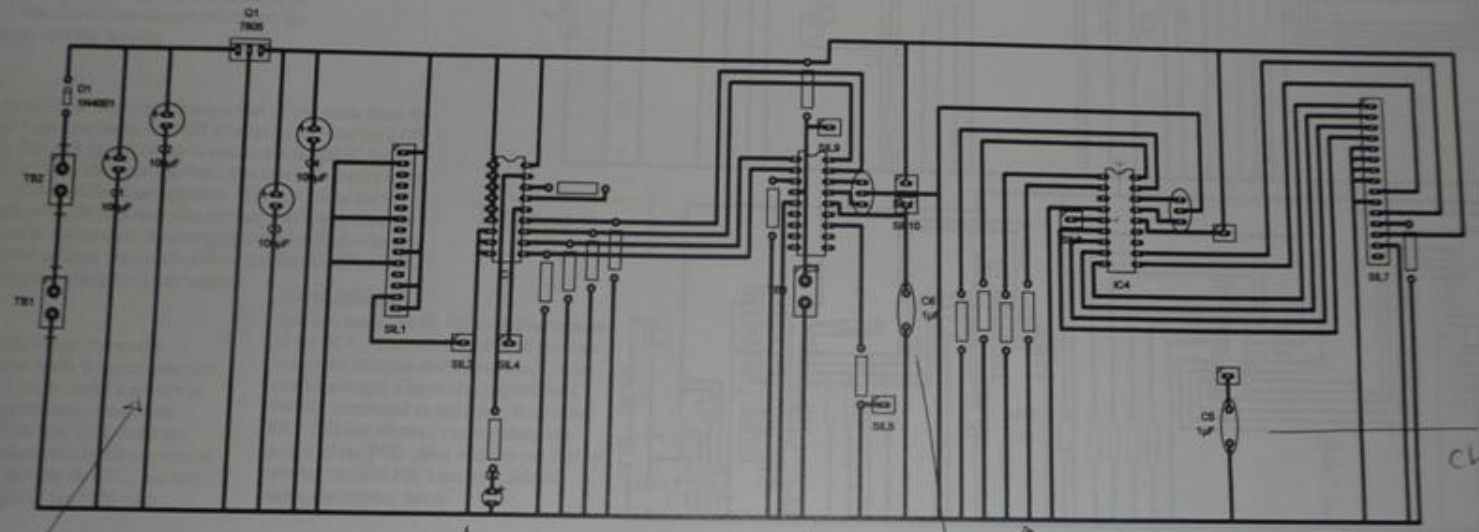
You can see in the far right my final design of my PCB. From my final design you can see all the changes that I have made in the precious stages. I have also moved the 1 Pin SIL connected to the top of the second PIC. This has allowed me to reduce the height of the PCB. Also you can see that by moving the first PIC I am now able to move the resistor down.

My Final Design

Stage 3






Change C
Size
run straight down
Put resistors in line
Change resistor values
Move TB3
out to the
left.
Change resistor value
This will alter jumper wire size

Evaluation of Designs

Transmitter Design Page 1

Function

As a transmitter box I feel that this design does its desired function as it is able to transmit the message that needs to be sent to the referee. This product will be able to do its functions in all weathers as it is water proofed and can be carried around with ease as it is no bigger than 50mm by 50mm and so does not interfere with the function of my product.

Aesthetics

This product is also aesthetically pleasing as I have used simple blue colours which are easy on the eye. The product is also smooth making it pleasing on the eye.

Ergonomics

This design is ergonomically pleasing as it has a smooth finish in relation to the human touch. The design also has a rounded edge making it ergonomically pleasing

Anthropometrics

In relation to the human anatomy this design is anthropometrically pleasing as its keypad buttons easy to see and press.

Materials

This design will allow me to use cheap and affordable materials. Also these materials are easy to manufacture with and are also light weight

Safety

This design is also safe. It has no sharp edges and also is waterproofed. I also feel that this product should pass the British Safety Standards.

Maintenance

This design should also be very easy to maintain as it should be able to be cleaned with a damp cloth. The materials that I have used allow it to be protected and so making it easy to maintain

Weight

This design is also lightweight and so should allow the fourth official to carry it around easily.

Cost

As I have used cheap materials for manufacture the cost of this product should be cheap. This design should also be cost effective.

Size/ Mobility

This design is small and mobile. This is necessary to allow the fourth official to carry it around easily.

Overall Evaluation

This design could be easily manufactured. The design could be opened and closed easily with the insert system which I am using. The product should be light weight and should be easily held. However I feel that the colour scheme could be changed.

Transmitter Design Page 2

Function

As a transmitter box I feel that this design does its desired function as it is able to transmit the message that needs to be sent to the referee. This product will be able to do its functions in all weathers as it is water proofed and can be carried around with ease as it is no bigger than 50mm by 50mm and so does not interfere with the function of my product.

Aesthetics

This product is also aesthetically pleasing as I have used grey colours which are easy on the eye. The product is also smooth making it pleasing on the eye. Also the circular shape of the design makes it pleasing to the eye

Ergonomics

This design is ergonomically pleasing as it has a smooth finish in relation to the human touch. The design also has a rounded edges and a circular shape making it ergonomically pleasing

Anthropometrics

In relation to the human anatomy this design is anthropometrically pleasing as its keypad buttons easy to see and press. Also the circular shape of the design will fit into someone's hand

Materials

This design will allow me to use cheap and affordable materials. Also these materials are easy to manufacture with and are also light weight

Safety

I feel that this is a safe design. It has no sharp edges and also is waterproofed. I also feel that this product should pass the British Safety Standards.

Maintenance

This design should also be very easy to maintain as it should be able to be cleaned with a damp cloth. The materials that I have used allow it to be protected and so making it easy to maintain

Weight

This design is also lightweight and so should allow the fourth official to carry it around easily.

Cost

As I have used cheap materials for manufacture the cost of this product should be cheap. This design should also be cost effective. I do feel however that this design will be hard to manufacture because of it cylindrical shape.

Size/ Mobility

This design is small and mobile. This is necessary to allow the fourth official to carry it around easily in there pocket.

Overall Evaluation

This design could be cheaply manufactured because of the materials that could be used however this design would be hard to manufacture because of the circular shape of the design. The product could be easily moved around and small enough to be in someones pocket.

Transmitter Design Page 3

Function

My third transmitter box design I feel does its desired function as it is able to transmit the message that needs to be sent to the referee such as foul and goal. This product will be able to do its functions in all weathers as it is water proofed and can be carried around with ease as it is no bigger than 50mm by 50mm and so does not interfere with the function of my product.

Aesthetics

This product is also aesthetically pleasing as I have uses grey and black colours which are easy on the eye. The product is also smooth making it pleasing on the eye. The curvaceous corners also allow the product to be aesthetically pleasing.

Ergonomics

This design is ergonomically pleasing as it has a smooth finish in relation to the human touch. The design also has a rounded edge making it ergonomically pleasing

Anthropometrics

In relation to the human anatomy this design is anthropometrically pleasing as its keypad buttons easy to see and press. Also it will fit in to someone's hand with ease.

Materials

This design will allow me to use cheap and affordable materials. Also these materials are easy to manufacture with and are also light weight

Safety

This design is also safe. It has no sharp edges and also is waterproofed. I also feel that this product should pass the British Safety Standards.

Maintenance

This design should also be very easy to maintain as it should be able to be cleaned with a damp cloth. The materials that I have used allow it to be protected and so making it easy to maintain

Weight

This design is also lightweight and so should allow the fourth official to carry it around easily.

Cost

As I have used cheap materials for manufacture the cost of this product should be cheap. This design should also be cost effective.

Size/ Mobility

This design is small and mobile. This is necessary to allow the fourth official to carry it around easily.

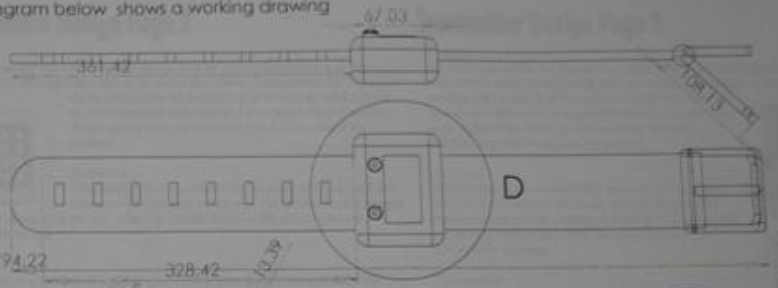
Overall Evaluation

This design could be manufactured easily and made cheaply. However the opening and closing of the box may be difficult to do. I feel that this design would need further medication so that it could be done easily. This may load weight to product and so it may not suit the desired function of the product

Reciever Design Page Two

This is my second design page for my receiver circuit. My design for the receiver box incorporates a simple design for a watch I feel that this design will ensure that the referee can carry it around easily

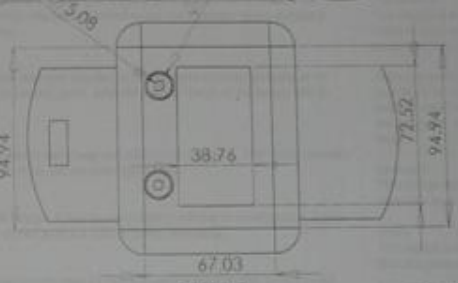
The diagram below shows a working drawing



The diagram to the left shows an above view of my design. This deisgn could incorporate a buzzer or motor to allow for a beep or vibration to make the referee aware that a message is being sent

This detailed view allows you to see the clip that I have that will allow the watch to be attached to an arm

This clip will swill up and down like in the diagram above.

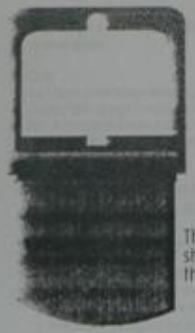


DETAIL D
SCALE 1 : 2

DETAIL G
SCALE 1 : 2

DETAIL A
SCALE 1 : 2

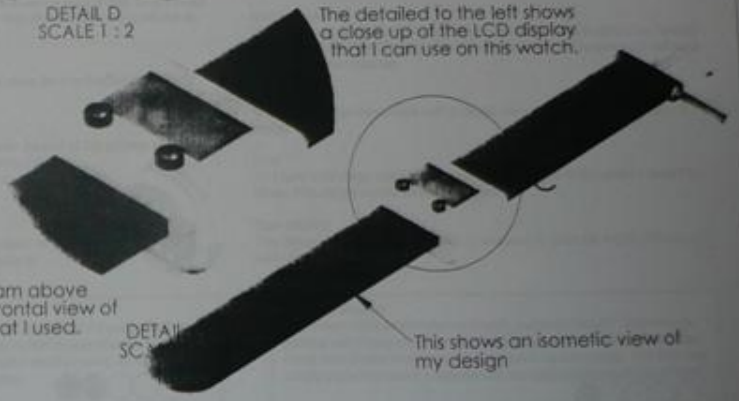
DETAIL B
SCALE 1 : 2



DETAIL F
SCALE 1 : 2

The diagram above shows a frontal view of the clip that I used.

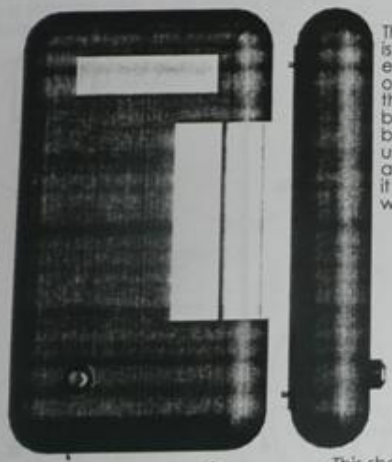
The detailed to the left shows a close up of the LCD display that I can use on this watch.



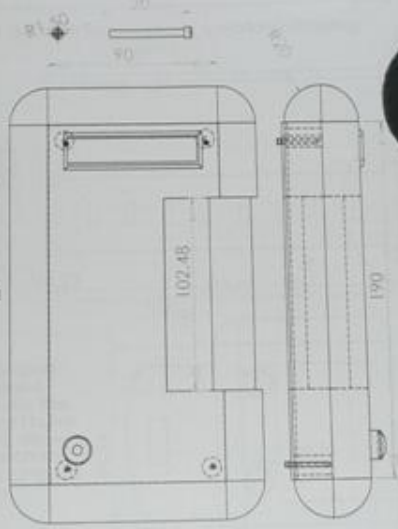
This shows an isometic view of my design

Receiver Design Page One

This is my first reciever design page. This design will allow the referee to carry the box around with ease

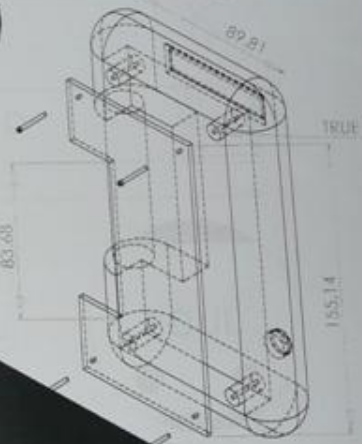


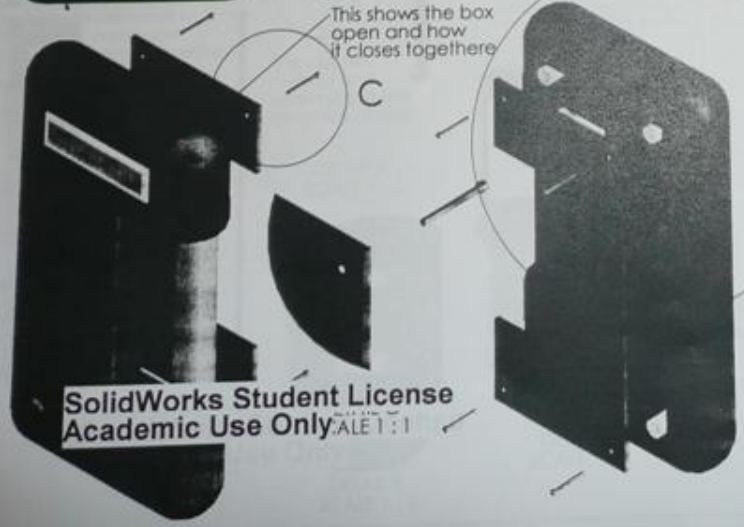
This design is a cost effective way of making the reciever box. It could be made using acrylic and so making it cheap and waterproof



DETAIL E
SCALE 2 : 1

This tapered acrylic in my design is used to hold the back of the product to the main box by screwing screws into it.





This shows the box open and how it closes togethere

C

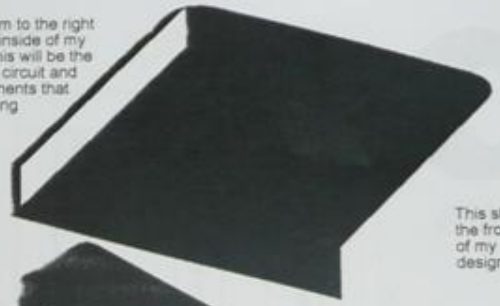
D

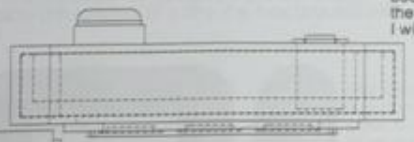
This shows the box open and how it closes togethere

SCALE 1 : 1

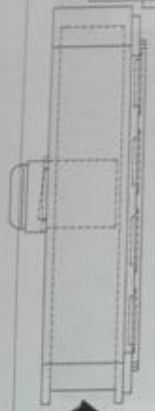
Tranmitter Design Page 3

The diagram to the right shows the inside of my product. This will be the bed for my circuit and the components that I will be using



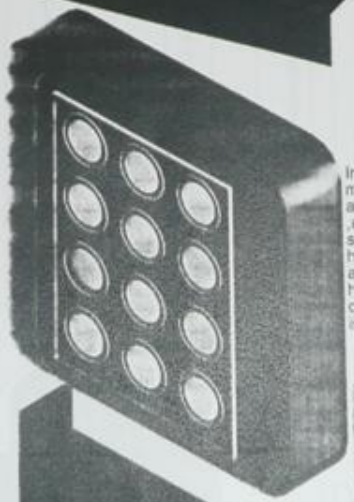


This is my third design page. This page again shows a tranmitter box which I will use as a storage and usage device.



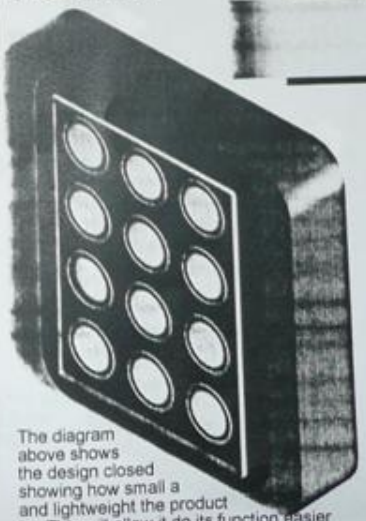
The diagram to the left shows how the box is opened. You can see that i used a design that will allow the bottom of the device to slide in and out of the device. You can also see that I have filleted the the edges of the box which will make the box aestheically pleasing. These design also means that the box is ergonmically pleasing as it is smooth to human touch

This shows the frontal view of my third design.

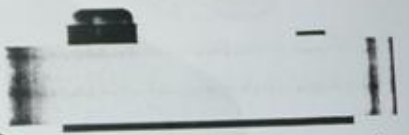


In this design I have also made the deivce easy to use as it has only got a thekepad ,a on off switch and a reset switch. I feel that the product has been made anthrometrically pleasing. I have also used neutral colours so that the prodduct is pleasing to look at.

The diagram to the left shows the design that I am using open



The diagram above shows the design closed showing how small a and lightweight the product is . This will allow it do its function easier



This is a detailed view of the inside bed for my circurt inside the the keypadbox that I will be using

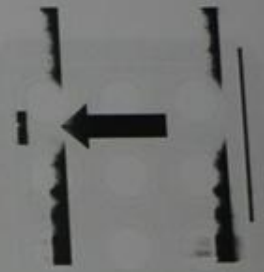
A

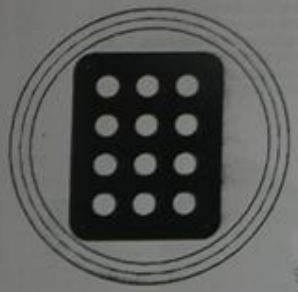
triometric view of product

Transmitter Design Two

This is my second design pagefor the storage and the usage of my tranmitter circuit. This design is done by the use of circuits. You can also see that I filleted the edges of the desighn so that I can make the design more aestically pleasing.

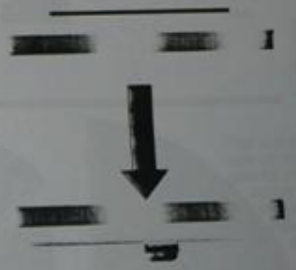
The view to the left shows the ON/OFF switch that I have used. This is the switch to th left I have also used a button which I will use as the reset switch for my device.



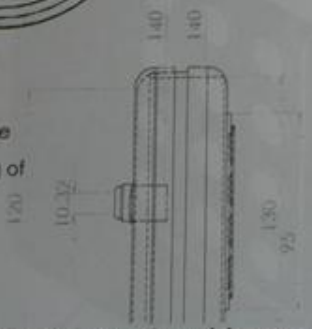


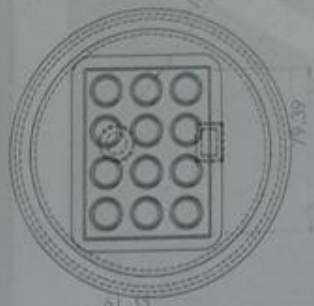
In this design I have used simple colours so that the the product is pleasing to the eye, I also feel that the use of the edges being filleted allows fthe product rto be pleasing to the eye.

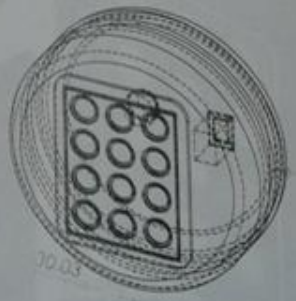
You can see from the deign above and below how my prduct opens up like the the previous design I have used inserts in my design. I also feel that this method will allow my design to be light -weight and allow the referee or fourth offical to carry the product around with ease and so this deisgn will not interferee with the function of the product which I am trying to design



The drawing to the right shows the workihng drawing of my design







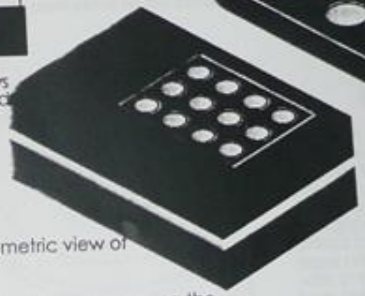
Design Page 1

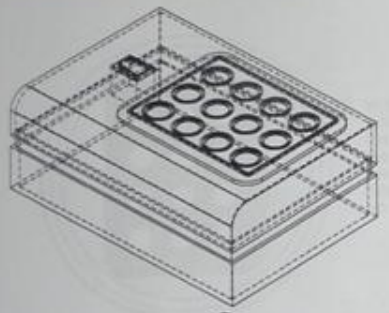
This is my first design page. From the digram below you can seemy first design that I can use for the storage and usage of my transmitter ciruit. The design I feel would enable the fouth offical to send a message to the referee telling him the decision that the have to to make.

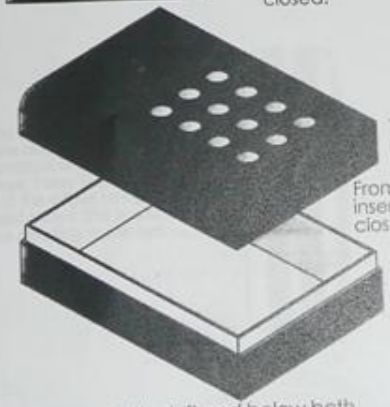
The two diagrams that you see shows my trasmitter box open

The digram to the left shows the design that I have used closed.

This is a close up ot the keypad that I have used in my design. I can label the kepads swicthes using the alphabet or numbers

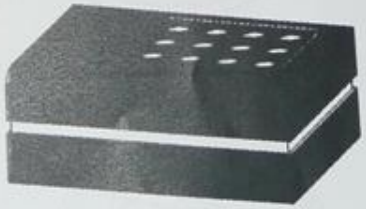






This is the isometric view of product.

From the digram above you can see the inserts that I have to allow the box to be closed so that by PCB is protected.



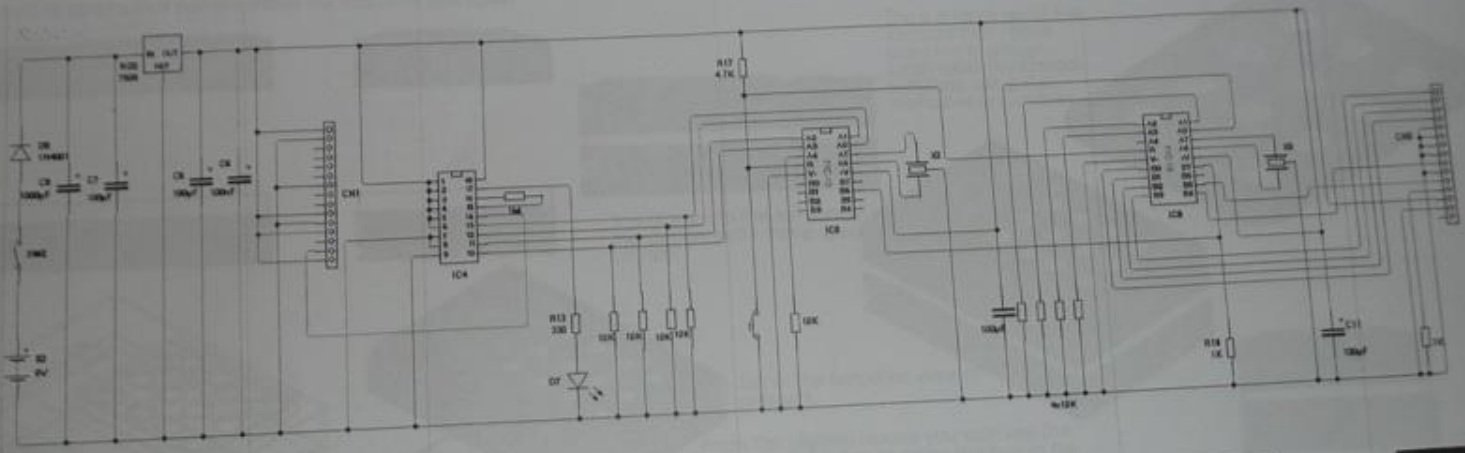
You can see from the box below that I have put in a curve into the side of the box to make the receiver box more aesthetically pleasing

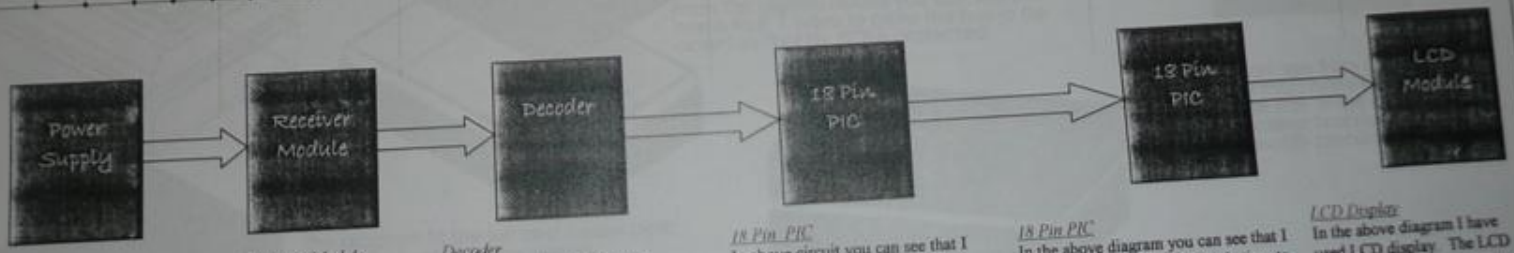
The diagram to the left and below both show the bottom of my deisgn

Assem6

A3

Receiver Circuit





Power Supply
In the above Circuit you can see that the 7805 takes any voltage between 7 to 12 volts and produces a 5 volt output. The reason for this is the fact that the PIC only requires 5 volts to its plus rail to operate. We can also see that I can have used capacitors. The reason for this is to cause smoothing and to stop any fluxation in voltage. We can also see that I have used a diode. The reason for this is to make sure that the current will only flow in one direction.

Receiver Module
In the above circuit you can e see that I have used a receiver module. This will be used to receive the signal from the transmitter. The signal that is received is transmitted in the receiver module through pin 3 from the antenna. This transmitted data signal leaves through pin 14.

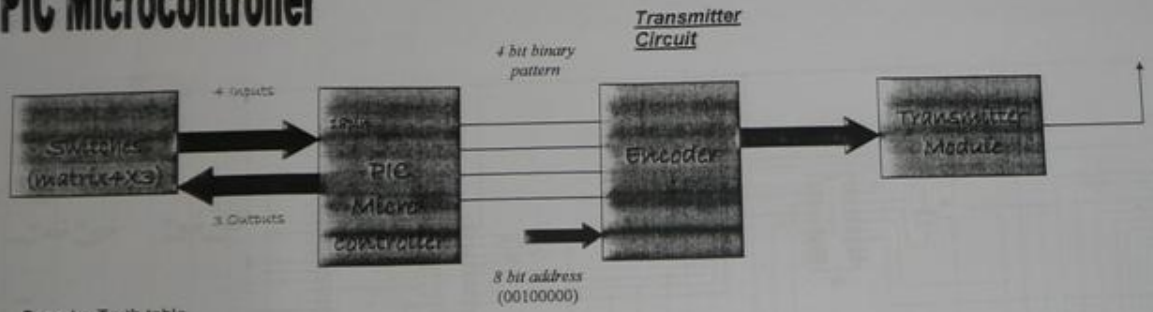
Decoder
In the above circuit diagram I have used a decoder. The decoder is used to decode the signal which has been received through the receiver module. Like the encoder it has address lines which are the same as the encoder so that it is individual. The decoder receives the signal from Pin 14.

18 Pin PIC
In above circuit you can see that I have used an 18 pin PIC. The 18 Pin PIC that I will be using has been programmed in such a way to recognise which pin is pressed. The reason for this is due to complex programming. The PIC produces a 4 Bit Binary pattern when the switch is pressed

18 Pin PIC
In the above diagram you can see that I have used an 18 pin PIC. All the inputs are tided to ground via 10K resistors. The PIC uses the signal which it has recievd from the previous signal from Pin 14 to send a signal to the LCD Display using the 4 output pins

LCD Display
In the above diagram I have used LCD display. The LCD is connected using output pins 7,8 and 9 connected to pins 11,12 and 13 of the LCD. The LCD module will then be able to display a number of messages form foul to offside.

PIC Microcontroller



PIC Microcontroller

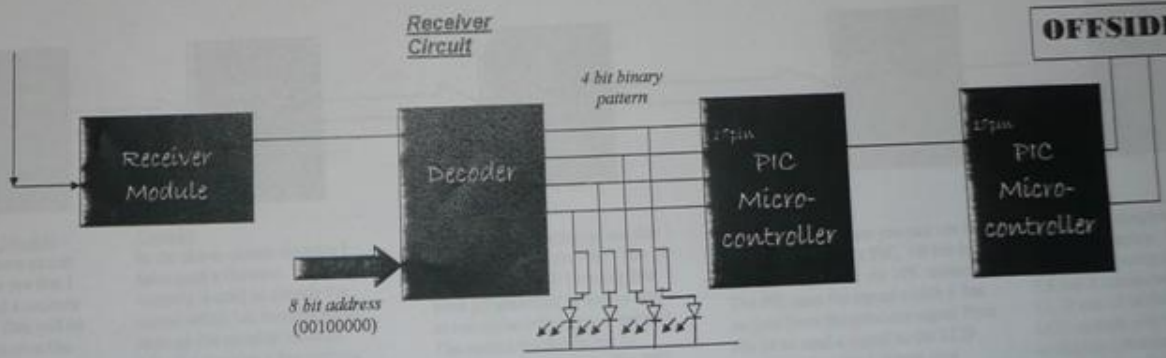
We are going to use a PIC microcontroller. A PIC microcontroller is a single chip that can be programmed to switch output devices on and off in sequences and in response to input forms sensors. A PIC microcontroller is a programmable device, which means that it is able to store and carry out the instruction as well as controlling devices. A micro controller contains all the elements of a micro processor system. This system which is a basis of a computer consists of a number of separate elements. In A micro process system each of these elements will be in the form of one or more individual chips.

Decoder Truth table

Transmitter Circuit

The diagram above shows a transmitter circuit The circuit begins with 12 switches arranged in a (4x3) matrix. The matrix coverts the 12 switches into the form of 4 outputs and then this will send them to PIC , which has used 4 of its outputs to connect to the matrix. The PIC will identify which number is pressed and send a unique 4 bit pattern of data to the encoder for every number. The encoder breaks this data down and sends it to the transmitter. The Information can then be transmitted and late decoded by the decoder. For this Circuit I will be using a HT12E encoder. This encoder is fed an 8 Bit Address line (00100000). The 8 bit address line is there so that the correct signal goes form the transmitter to the corresponding receiver. The 8 bit address lines distinguish each particular circuits signal from any others that may be operating at the same time. Therefore the address lines will be the same on both the transmitter and the receiver. The 4 bit digital signals are then converted into one analogue signal and sent form the encoder to the transmitter.

OFFSIDE



Different Types of PIC s

The two most common types of PIC are the 16F84 and the 16F872. The difference between the two PICs is that one is an 18 PIC, while the other has 24 pins PIC. The 16F84 PIC simply has five inputs and eight outputs where as the 16F873 has eight inputs and eight outputs. We will be using the 16F84
This has:

PIN 1, 2,3,17 and18 Inputs
PIN 6 to 13 are the outputs
PIN 14 is the supply
Pin 5 ground
PIN 4 Reset which is a r
combination
Pin 15 and 16 are
Connected to a resonator

Receiver Circuit

The information that has been sent by the Transmitter is sent to the receiver. This is then picked up the aerial on the receiver circuit and this is sent to the decoder to be decoded. The decoder seen above has been fitted with the same 8 address line as the Encoder e.g. (00100000) to allow it to obtain the correct data. Once the Decoder has converted this information the information is then passed on in the same 4 bit address used in the transmitter circuit above. The 4 bit address sends a signal to the PIC microcontroller. This data is the n passed on to another PIC which controls the outputs used. In the diagram above you can see that I am using a LCD screen and LED s are the outputs that I will be using.

Product Research
Page 2

positional tracking on the sports pitch. This would help the referee decide whether the player is offside or not.

Advantage

- An advatage to this sytem is that you can determine where the player is with mathmatical precision.
- With this sytem you can also determine a players fitness and whether or not the need to be substituted.

Disadvantage

- This is a costly system and probably would only be avaiable for the richer clunbs in football and so will make it a hard system to implent at a football club.

Product 3

The product to the left is a walkie talkie watch. This is another communication system that is used between referees and the other officials. This will allow the referee to ask his officials with speed the decision that he should make. It is also a light weight and is suitable for a referee and his officials to have on there wrists to communicate with each other

Advantage

The first advantage is that it is a lightweight product and be used with ease.
This also a cheap and affordable system that can be used.

Disadvantage

The first disadvantage to this is that it may be hard to communicate becusae of the distotion caused by a crowd as there could be up to 80,000 people at some staduims
There may also be interverrence from other radio systems that might be being used in the statduim.

Now I am going to look at different types of displays and remotes for the decisions.

Remote 1

To the left you can see a remote control. A remote control is an electronic device used for the remote operation of a machine. Remote controls for these devices are usually small wireless handheld objects with an array of buttons for adjusting various settings such as television channel, track number, and volume. In fact, for the majority of modern devices with this kind of control, the remote contains all the function controls while the controlled device itself only has a handful of essential primary controls. This sort of remote could be used to control a substitute board or even your average television. Most of these remotes communicate to their respective devices via infrared (IR) signals. They are usually powered by small AAA or AA size batteries.

Advantage

- The first advantage for this sort of remote control is that it is cheap to use.
- The second advantage for this remote control is that it is widely available and is cheap to manufacture.

Disadvantage

- The first advantage to this is that it can not be used at long range.

Remote 2

The remote to the right could be used to control a scoreboard or a system that would allow you to tell the referee the best decision to make. This sort of remote uses a different type of transmitter system it uses radio waves.

Advantage

- The first advantage to this system is that it can be used in long distances and would be ideal for a football device.
- This is also a cheap product to manufacture and is widely available
- Also this product is also cheap to run.

Disadvantage

- A disadvantage to this system is that there may be interference from other radio devices

Transmitter Module and Receiver Module

The diagram to the below shows a transmitter module and receiver module circuit. This sort of circuit could be used to transmit a signal to a receiver module that will emit/display a message. This message might display GOAL or offside. This system is controlled by PIC mircontroller. This is a single chip that can be programmed to switch output devices on and off in sequences and in response to input forms sensors. A PIC microcontroller is a programmable device, which means that it is able to store and carry out the instruction as well as controlling devices.

Advantage

- The first advantage is that this circuit can work form long distances.
- It is a cheap product to manufacture
- Also it is a cheap system to use.

Disadvantage

This system uses PICs which means that it may have a limited amount of memory and so there will be very few messages that can be saved to the PIC.

Display 1

To the right you can see at one type of display that is seen in the game of football. It is used to display the score in a match. It works by a remote control sending the score of the match to the score board. Some modern stadiums have displays like this one which are big and show the highlights, scores, the team's sheets and the refereeing decisions. This could be used by referees to see the replays.

Advantage

- The first advantage to a system like this is that it is easy to use
- It is also cheap and affordable and all levels of football and refereeing could use this system.

Disadvantage

- The disadvantage foe this sort of system if the referee was to us it as a way of checking decision that he makes is that the crowd could make him make a wrong decision

Substitutions board Injury time display

The product to the right shows a substitution board. It used in football to display the changing of players and also is used at the end of both halves to show the added on injury time. The product works when it receives a signal from a remote or from a panel on the back to input a time r the number of the player being changed. This is a form t of communication that already exists between a referee and a fourth official

Advantage

- This is a cheap and affordable system that is used
- Grass roots levels can use this system a sit is cheap and affordable to run and to manufacture

Disadvantages

- Can only be used for two different methods of informing the referee
- The numbers can sometimes be too small for the referee to see as he may be in a bad position on the place.

Product Research
Page 1

Introduction

Football is known as the "beautiful game." I am going to look at the many different mistakes that have been made by refereeing. I am going to look at making a device that will allow the 4th official to tell the referee the mistakes he had made. I am going to research these mistakes and look at similar products to mine.

Background

Over the years there have been many mistakes made by referees. Some of these mistakes have cost many teams whether they qualify for the Champions League or Uefa Cup or if they win the Premiership. One such incident was seen at Ewood Park home of Blackburn Rovers when West Ham the visitors where allowed a goal which had not crossed the line. If this goal had been disallowed then it would never have allowed another team in Sheffield UTD to be relegated from the Premiership. Referees also make bad decisions concerning disciplining players. Of these players being Michael Brown. Manchester United fans were incensed, after an intentional two-footed foul on Ryan Giggs in their 5-1 victory over Fulham on August 20, 2006. Brown received a yellow card for the tackle but many pundits believe that the tackle warranted a red-card as it was considered a tackle that would end a player's career. Although in this case he normally unflappable Giggs then sought retribution, bundling Brown over from behind and getting himself booked, but drawing huge applause from the crowd. Brown was once again in controversy after he stamped on Chelsea player Ashley Cole on September 23, 2006 during Fulham's match against them. This time, however, the tackle went unpunished by the referee. In the penultimate game of the season against Liverpool on May 5, 2007, he head-butted Xabi Alonso. The referee did not see the incident and took no action. At a Disciplinary Commission hearing on May 10, 2007, Brown received a 3 match ban relating to this incident. He denied violent conduct but the Commission found the charge to be proved. Another major decision gone wrong was that of Roy Carroll mistake for the "goal that never was" against Tottenham Hotspur; a speculative shot from the half-way line by Pedro Mendes that Carroll dropped well behind his goal-line then scooped back into play. The referee and his linesmen were unable to verify that the ball had gone over the line

Solutions 1

The first existing product that has been suggested to be used by the football association is this football chip. This chip will be inserted into as football and will be able to tell whether or not that the football has crossed the line are not as it will be able to send out a signal showing where the ball is. The same company also invented a system in where new shin pads are to have chips in them to determine where they are on the pitch and whether are not they are offside are not.

Advantages

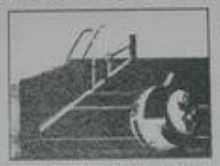
- An advantage to this product is that it is small and will be able to be inserted into a ball and into shin guards with out effecting the players performance or the way that they play
- Thsecond advantage to this product is that you will be able to detect where the ball is at all times and whether a player is in an offside position or not

Disadvantages

- The disadvantages to this product is that it is to expensive for the lower level league teams to bring in as the will not have the same budgets as the higher teams in the Leagues such as Manchester United

Solution 2

The second solution that I am looking at is the Hawk eye system used. This system is used at either corners of the park to determine whether or not the football has crossed the line. Six cameras per end will be installed up in the stands, at different angles. Hawkins, the inventor, admits that his system falls down if the ball is completely obscured – it needs to be 25 per cent visible to be foolproof – but claims that months of tests and ransacking of archives has shown that it works on just about every occasion. "We have a problem if the goalkeeper has the ball stuffed up his shirt," he said, "but the technology can also draw findings from knowing where the ball is not."



Advantages

- The first advantage is that it is a system which allows you to determine whether or not the ball crosses the line is not.
- Another advantage is that you can look at all the different angles to determine whether are not it has

Disadvantages

- The disadvantages to this product is that it is to expensive for the lower level league teams to bring in as the will not have the same budgets as the higher teams in the Leagues such as Manchester United.
- Another disadvantage to this system is that it is only able to tell you whether are not the ball has crossed the line.
- Another disadvantage is that the time it takes to determine whether the ball has gone cross the line as this would disrupt the game and causes the players to cool down and may cause them injury.

Solution 3

The third product that I am going to look at is the use of walkie talkies and cameras in the game. This method is where the referee uses his fourth official to decide on the decision that he has to make. The fourth official does this by using cameras that he has available to him and he then determines what the decision is e.g. is it a goal or not. The 4th official then will send a message to the ref by the use of walkie talkie communication systems, like in the picture above.

Advantages

- The first advantage to this system is that you can have a second opinion on every decision that is made making the game of football even more fairer

Disadvantages

- The disadvantages to this product is that it is to expensive for the lower level league teams to bring in as the will not have the same budgets as the higher teams in the Leagues such as Manchester United.
- Another disadvantage to this system is that it is only able to tell you whether are not the ball has crossed the line.
- Another disadvantage is that the time it takes to determine whether the ball has gone cross the line as this would disrupt the game and causes the players to cool down and may cause them injury.

Solution 4

The fourth product that I am going to look at is a Football shirt with on-board computer. Football shirts are being developed which have their own on-board computer, which will be able to track the pace and acceleration of the wearer. Researchers at the University of Birmingham, UK, who are specialists in "wearable" computers, are exploring ways of remotely monitoring the performance of people playing sports. With computer-carrying shirts, which send back data through a radio network, the performance of players in a live match can be recorded with great accuracy. Such a computerised football would mean that goal-line disputes, such as England's goal in the 1966 World Cup Final against West Germany, could be resolved with mathematical precision. This system could be used to looking at

Design Specification

Function

- This product should be able to transmit a signal of at least 150 metres as it needs to be displayed over the full pitch.
- This product should be able to transmit a message from the fourth official/linesman to the referee
- This product should be able to transmit a message of offside
- This product should be able to transmit a message of goal
- This product should be able to transmit a message of penalty
- This product should be able to transmit a message free kick
- This product should be able to transmit a message yellow card
- This product should be able to transmit a message red card.
- The products buttons must be at least 20mm in diameter, making the buttons easy to press
- The product must have a guard so that the buttons are not accidentally pressed
- The products must be able to last full 90 minutes and any additional time plus it should be able to last an extra 30 minutes and 15 minutes for penalty.
- The product should be waterproofed so that it will not electrocute the referee or the linesmen when they are using the devices
- The product should be big enough so that the referee can read the letters on the LCD display
- The product should be fitted with a vibrating or sound system so when there is a problem the referee is made aware that there is a problem
- The product should be light weight so that a referee and his officials can carry the product around
- The product should have an attachment on the referees belt so that he can easily carry it around with out it falling out of his pocket
- The product should have a ear piece attachment so that the referee can hear when or not there is a a problem.
- The product should be cost effective and cheap to run as it will be used by poorer teams as well as the rich team s
- The product should be safe to use in all weather because it will be used outside
- The product should be made out of a material that is easy to maintain s it will be used out side frequently
- The product should be manufactured with blue yellow and black acrylic so that it keeping with the traditional refereeing colours
- The product should be no bigger than 50 mm by 50mm so that the referee can carry it around easy in his/her pocket
- The product should not be effected by large movement because the referee will have to run back and forth up and down the pitch
- The product should be able to be seen in all weather conditions as the product will be used in all weather conditions

Aesthetics

- The product must be manufactured with colours that are easy on the eye e.g. blue
- The product should be manufactured using blue black to keep with the traditional colors footballs
- The product should have a smooth finish so that it is aesthetically pleasing

Ergonomics

- The product must be ergonomically pleasing.
- This product must have a smooth finish in relation to that human touch
- This product must have roundod edges and corners to make it ergonomically pleasing.

Anthropometrics

- This product should be anthropometrically pleasing because in relation to the human anatomy this product needs to be big enough for someone to lift and to be able to see

Materials

- This product should be manufactured out of acrylic so that it cheap to manufacture
- This product must be made out of acrylic so that the product is durable and strong for its desired use.
- The products should be manufactured out of acrylic so that the product can be waterproof
- The product should manufactured out of lightweight materials

Safety

- The product should have smooth edges and surfaces so that it does not cause injuries
- The product must be waterproof so that it does not electrocute the users of the device
- The product must pass British Safety Standards
- The product must be safe to use at all times and not harm the person using it
- The manufacturer of the product must use gloves and goggles.
- There should be no wires sticking out of the product that may cause danger to the surrounding environment

Maintenance

- This product should be easy to maintain as it will be used quite frequently at football matches
- The product should be made out of acrylic to help maintain the product.
- The product must be able to be cleaned with ease so that there is not a build up of mud and dirt from being used at a pitch side

Weight

- The product should be light so that the referee/or linesman can carry the devices with them
- The product must not weigh over 10kgs so that it is easy to move
- The product must weigh at least 5kgs so that it is strong and sturdy.

Cost

- This product should be relatively cheap to manufacture.
- The product should be manufactured out of acrylic do that the product is cheaper.
- The product should be good value for money
- The product should be cheap enough to compete with similar products in the market

Size

- The product should be no more than 50mm by 50mm in size so that it is easy to store and to be carried around.

Mobility

- The product should be around 5kg to make it easy to be carried around by a referee

Storage

- This product should be designed in away that it is easy to storage.
- The product should be small enough to be stored in a pocket.

Durability

- This product should be durable because it is expected to have a long self life.
- This product must be designed out of acrylic to give the product durability
- The product should have a long battery life so that it is able to last at least 90 minutes and any extra time that is added on

Environmental

- The product must be as environmentally friendly as possible.
- The product should be made out of acrylic to make it environmentally friendly.
- The products colours must not be an eyesore to the surrounding environment.
- The products should not be harmful to the environment when it is being manufactured.

Testing

- The product should be tested so that is safe for people to use while being used.
- The product should be tested to make sure that it works quickly so that a player does not warm down.

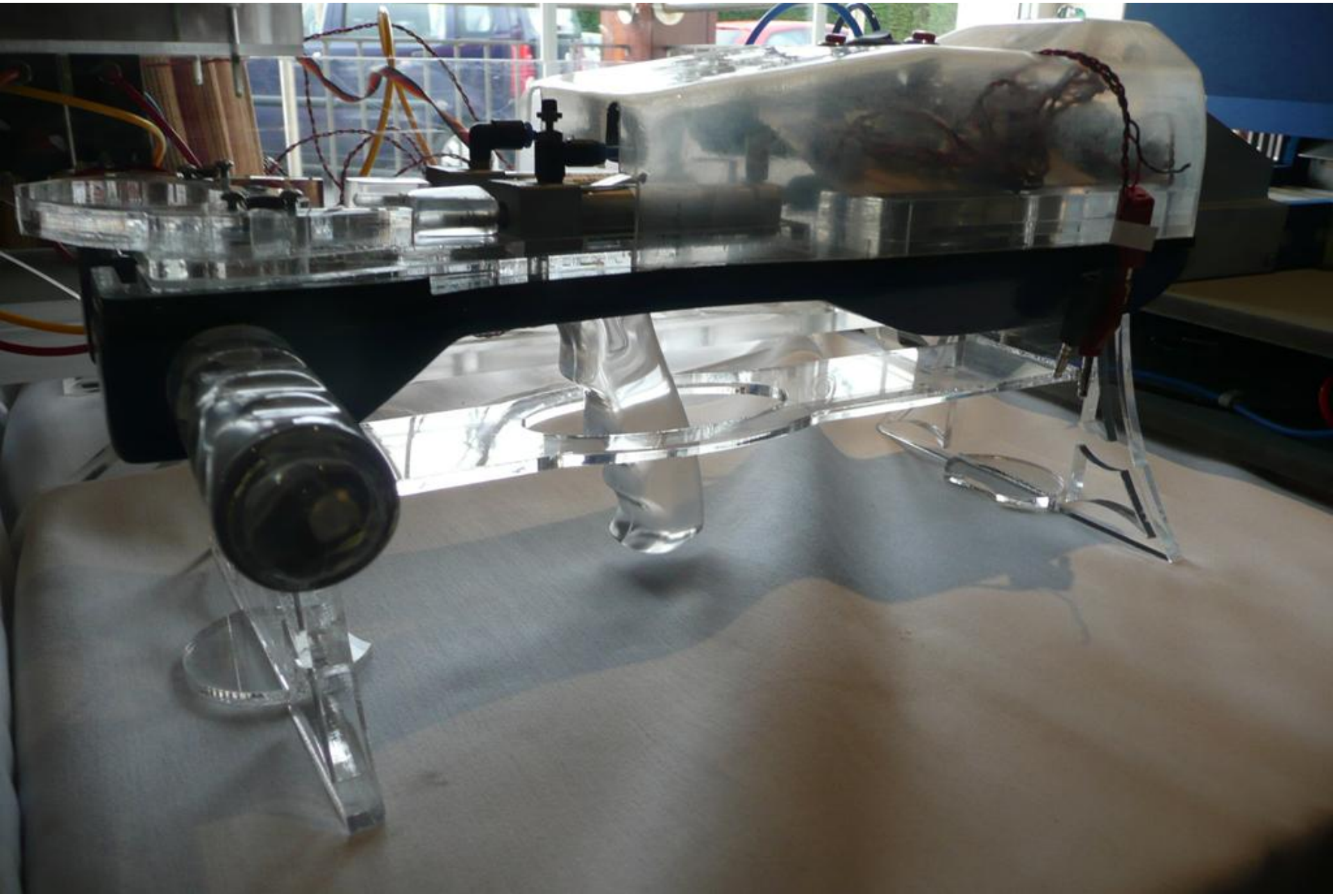
4.

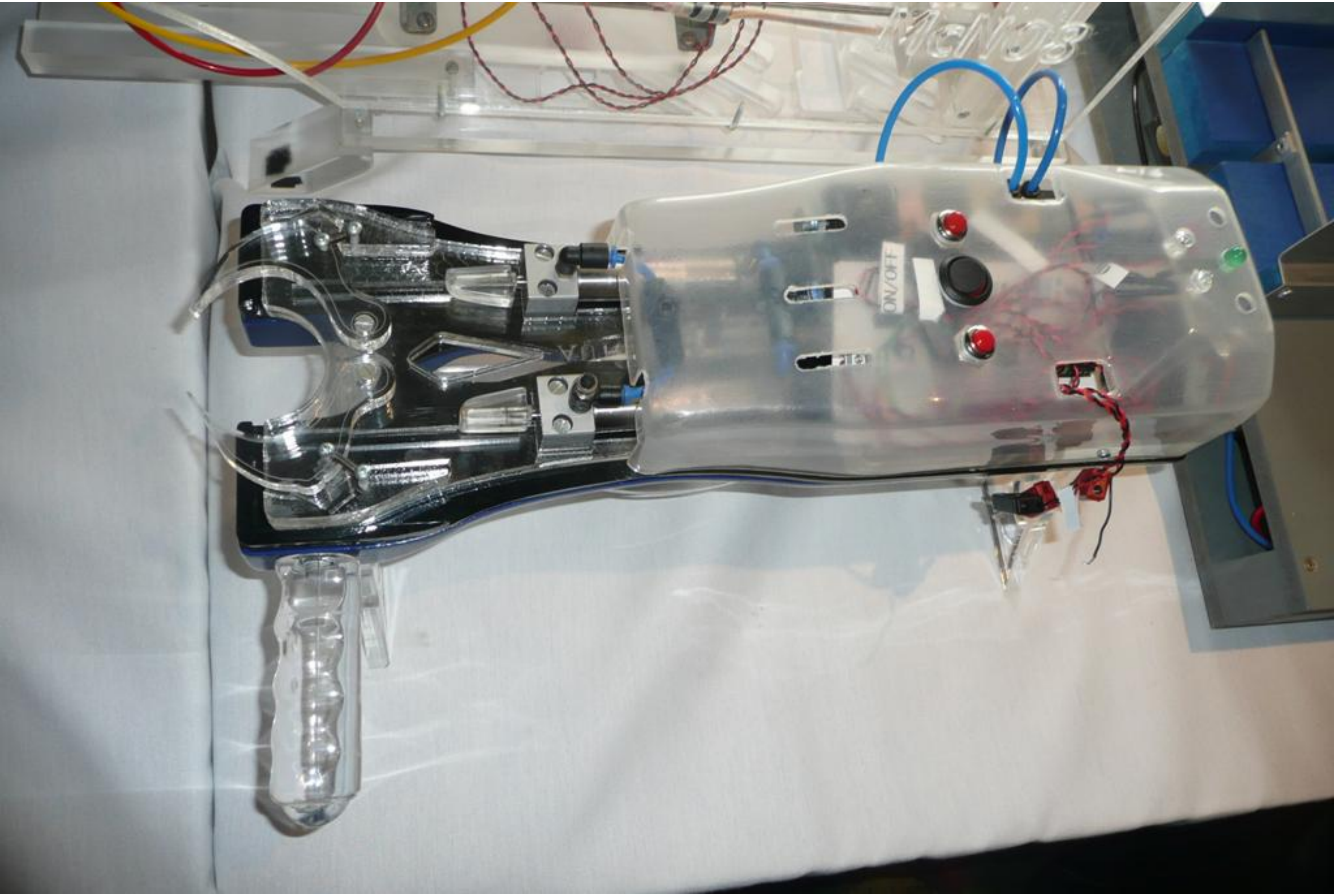
Problem Identification

Football or soccer is probably one of the world's most famous sports. It is a game where a spherical ball is skillfully passed around the pitch with the use of your feet and object of the game is to score a goal into the nets on either side of the pitch depending ofcourse of which team you are on. It s watched by millions of people around the world. Children want to be and play like there idols. Everyone in the footbaling world wants to see a fair games of soceer. However, players like Cristano Ronaldo and Wanye Rooney week in and week out risk serious injury by unjust tackles made by other players. The man that is in charge of seeing these decisions and punishing them is the referee. The referee has the power to hand yellow cards and red cards. He also has the power to allow or disallow a goal, to award penalties and free kicks and has to add time on at the end of the game. Time and time again we see referees making mistakes which is ruining the game of football. For exmaple the referee may not see a tackle because players might impare there vison and so not seeing the tackle. We see often enough how players like Wanye Rooney run up to referees complaining about the descions that they have made. Also it is an often occurrence to see goals that have not been allowed even though they are perfectly good goals. This occurrence is to often and there must be a system that can stop such things from happening. We also see players like Michael Brown making unfair tackles on players and not receiving any punishment for their actions. Referees themselves are coming under massive pressure to now because a bad mistake could cost a team the championship or being relegated. Referees, from making these kinds of mistakes could lose there reputation as a world class referee in the case of Graham Poll. Poll ,in World Cup 06, failed to send a player off after giving the player his second yellow card. This caused uproar and Graham Polls reputation was losed and was the reason why he left the game a year later.

Design Brief

Design and make a device to that will enable a referee to make the correct decision. This means it should be able to inform him that it is a red card, yellow card, offside, goal, throw in, corner, free kick or a penalty kick




ON/OFF

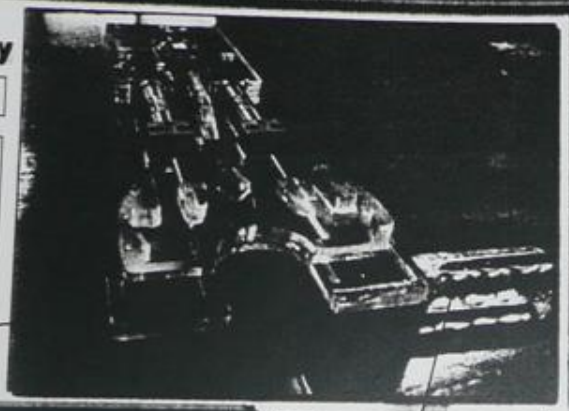
Testing And Evaluation Of Design

External Component Arangement and Assembly

The picture on the left shows the assembly of the components to check size and fitting of the design

The product needed to be tested to check the size and fitting of the components to the main materials and acrylic used in the design. It was found the acrylic fitted correctly and flush to the components without the need for any modification and gives a good representation of the final design and its mechanical usage in this system and product.

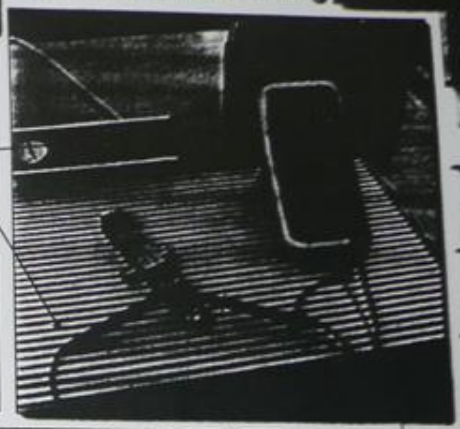
The initial design shown on the right below shows the bottom of the main slider half that was to attatch to the pulling cylinders. After making the original piece if was found that the slider did not move smoothly but showd during testing that the claws would work correctly with any situation and could remove any nails from the system to contribute.



The handle offers a large resistance to direction of motion and so during tested needed to be pulled back to there initial position by a strong screw. The spring chosen to advance the design is shown on the right.

Electronic Circuit Testing

The image to the left shows the testing of soleniods and pneumatic/electronic components of the system. After testing and sligh modification the solenoids suited the job correctly and efficiently for the design to carry out its fuction without any problem or lack of fuctionality. The image shows the pneumatic air supply also used for testing the performance of the solenoid speed.



The connector chosen for this design so that the pneumatic solenoid would connect to the pneumatic cylinder proved to large for the design and for this reason another method or component equivimant

A major problem found with this design was the spring mechanism which returned the claws to the original position. It was found the original springs which where

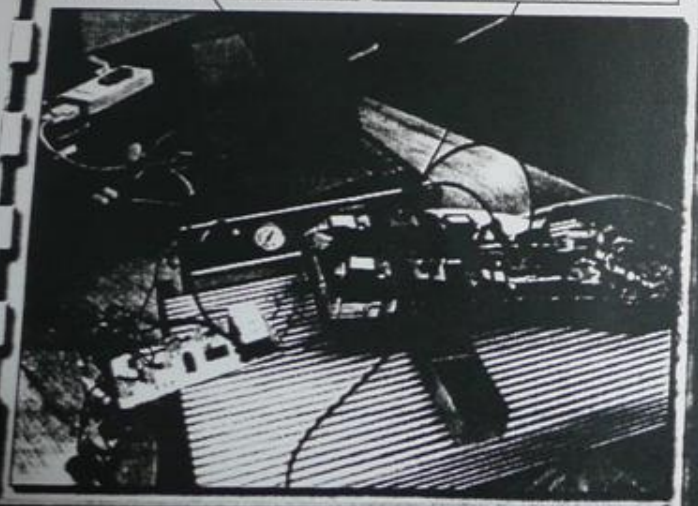
The design proved to have a few modifications needed during testing but overall worked correctly after some small change and no changes had to be changed to the main fuctions of the pneumatic system or to the setup that was chose to supply the pneumatic system of the product which worked

A major problem found with this design was the spring mechanism which returned the claws to the original position. It was found the original springs which where

Pneumatic System Settings And Testing

The laptop was used to set up and test the circtui for speed efficieny and correct use of the fuctions power the pneumatics in the system of the poduct shown below.

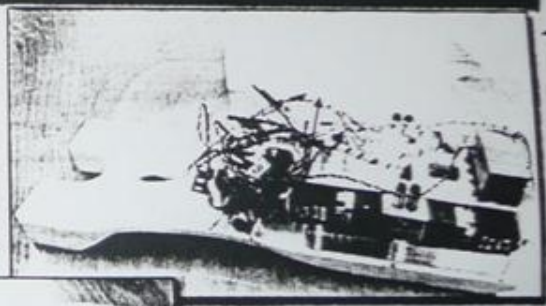
This shows the testing of the logic system inside the circuit pic which after modicfication proved efficient and correct for the fuction of the system that the design needed to remove the nail.



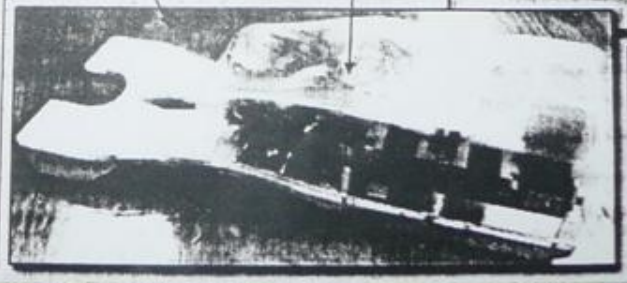
Internal Component Arangement and Casing

The product was tested to see that all components/wires and major changes would fit correctly inside the casing and fit tightly to the system function. The mechanism was also checked to work correctly. The image shown below and to the right show the cable needed for the system but after testing were modified to be the minimum length so that they would fit inside the casing much easier and less mess.

The connector chosen for this design so that the pneumatic solenoid would connect to the pneumatic cylinder was tested and proved to large for the design but after small modifications and retesting worked correctly and efficently inside.



This tested the body strength for holding the weight of the components and the impulse and momentum caused by the design causing recoil.



The reason for this choice of modification was due to the ease of manipulation of this piece. The bearings offered a simple solution to the major problem and could be completed by cutting two **6mm** tracks of length **45mm** Through the acrylic piece which would be glue to the upper piece to produce the sliding mechanism. In the bottom base smaller sliding trackes were etched out to let the balls run

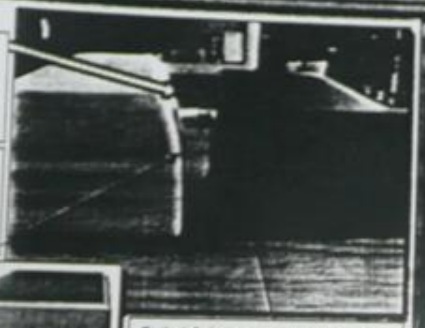
AUTOMATIC NAIL PULLER

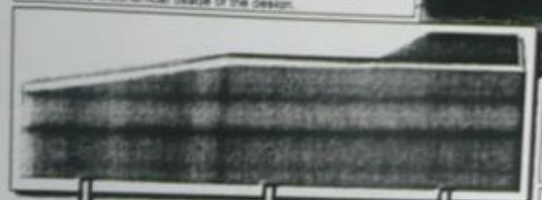
Modification During Manufacture Development

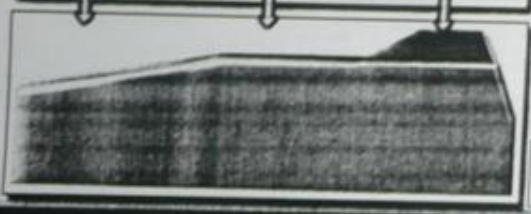
Top Casing Rear Taper

The main difference to the top casing is the tapered edge included at the rear of the design. The diagram on the right shows the tapered edge made on the mould after the test vacum formed piece had been moulded. The taper was included using the ban facer. The main reason for this modification during manufacture was due to the need for a more aesthetically pleasing design.

Another advantage for this design includes the lighter and mobile shape that will be achieved from this modified casing. In th original design it was assumed that the circuit board would need much more space to fit inside the casing but it was discovered the smaller space would offer a tighter hold on the circuit board meaning that it would not move about during the mechanical usage of the design.







On the left shows a cad cam drawing of the original design and the concluded design which was created once it was realised the shape should be changed, it is accurate to the ban faced version and offers a good resemblance of the final design.

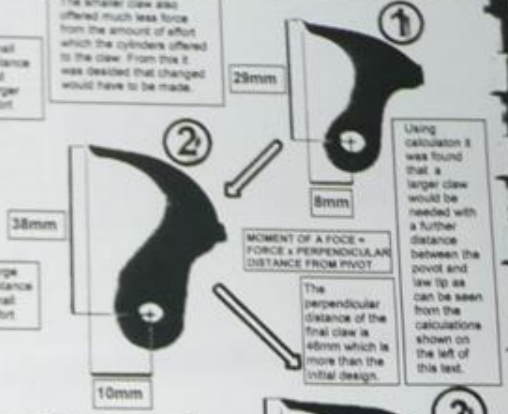
The design offers a much more aesthetical appeal than the original design which is helps the overal finished design. It also offers an anthropometrical advantage as most users shoulder lines would have been uncomforted by the above design but this secondary take means the should is not in contact with the design at all. The design is slighty lighter than the original.

The advantage of this retake of the design is substancial to the final design.

Claw Size and Design

Once the original design for the claws had been manufactured using the CNC Router on 12MM Acrylic it was found that the scale size of the claws was much to small to remove a larger nail from the wood that was tested on. For this reason it was confirmed that changes would have to be made.

The smaller claw also offered much less force from the amount of effort which the cylinders offered to the claw. From this it was decided that changed would have to be made.



MOMENT OF A FOCE = FORCE x PERPENDICULAR DISTANCE FROM PIVOT

The perpendicular distance of the final claw is 46mm which is more than the initial design.

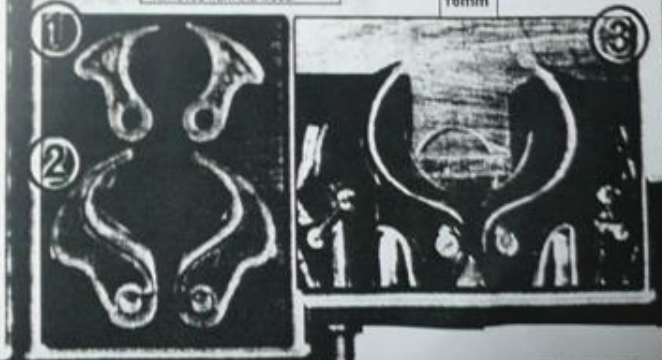
Using calculation it was found that a larger claw would be needed with a further distance between the povot and law tip as can be seen from the calculations shown on the left of this test.

The diagrams above show the use of mekano to illustrate the force applied by different variations and sizes of claws. The long arms are moved about a pivot at two different lengths between the pivot and effort and pivot and load. The wanted conclusion is a claw which can hold a nail in place with a large strength but will not need much more effort to create this.

It was found that this could be achieved as shown in the diagram.

The main design of the claw was assembled using past drafts but still needed modification after manufacture

A moment is the quantity which tells us the **turning effect of a force**. It is dependent on the **magnitude of the effort or input force** (in this case the cylinder force) and the **perpendicular distance from the pivot** to the force. This can be seen in the examples above. All the claws act as **Class 2 Levers**. The 3rd and final design offers the larges force due to having a larger distance between the piston end and the pivot of the claw which offers more force and this claw also allows for larger nails to be removed from the wood.



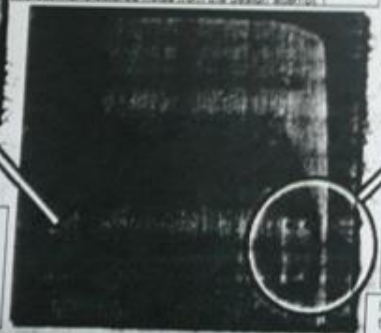
Top Casing Tubing Outlets

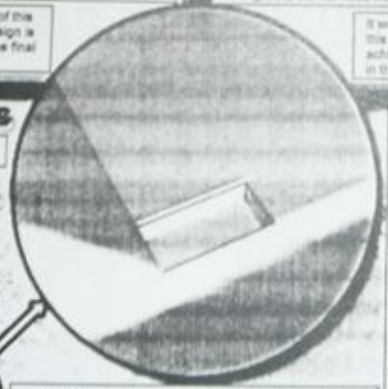
Diagram of first mould result of vacum form

3 initial attempts were taking at creating a mould from the main mould casing. The manufacture process used was vacum formed.

The design found that specific areas of the design could not be achieved by the vacum pump as the extrusions could not be vacum pumped out due to air not being able to escape the extruded areas. A way to overcome this was attempted in the second take by pressing which did not work effectively

The diagram to the left has been drilled as an attempt to creat manufactured holes from the design attempt 1





The exploded view shows the extent of the design which was created orgally compared to the failed extrusion from the first and second attempt at extruding the wholes. The design need holes to allow air to be exhasted.

The photo taken on the left shows the mould before the 3rd and final attempt at creatinf the final casing. It was found that including holes ment the extrusion was open.

It was found this because the the holes allowd for the air trapped between the extruded hole or the plastic finish could escape out of the bottom of the body. For this reason 7 holes were drilled into each extrusiosn which compiled completely through the body to the base so the air could escape correctly and efficiently leavinf a good finish of extrusion to cut around.

Modification During Manufacture Development

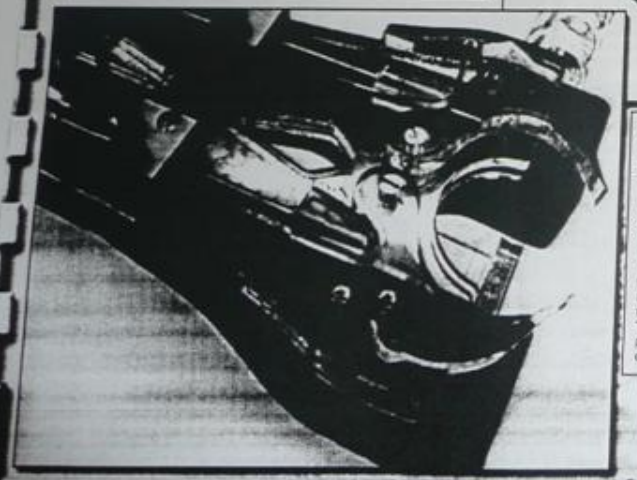
Choice and Location Of Springs

A major problem found with this design was the spring mechanism which returned the claws to the original position. It was found the original springs which where modeled for the design has insufficient pulling power to return heavey claws to there initial position. The original springs to be used can be seeon on the left of the diagram below. Now a new method had to be found.

The claws offer a large resistance to direction of motion and so need to be pulled back to there initial position by a strong spring. So the spring chosen to advance the design is shown on the right of the spring mechanism. For this reason it seemed appropriate to remove the original design claw stoppers and add more efficient ones which would fit the new springs adequately fitted. The springs which will replace the original are much smaller but cannot fit in the designed shapes which had been chosen.

Rather than redesign the whole section of the design the position of the spring was moved to the top of the claw stopper and claw and held together into the acrylic with 3mm screws allowing for movement.

This change in position effected the design in a good way which allowd the springs to pull the claw back and not stretch the spring beyond its elastic limit which would mean the spring could not return to its original position and would damage the mechanism efficiency of the final design. For this reason the position had to be chosen carefully to bypass this problem. It was found that the position of the spring needed to be further down the claw closer to the pivot for the springs to work efficiently and without the design structure being changed or altered effecting other mechanical aspectes of the function of the product that is being manufactured.



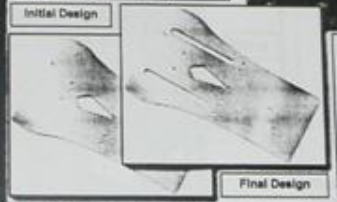
The magnified view shows how the product had to be evolved without removine initial details. The contrast can be seen between the design and the photo taken after manufacture. The spring is placed on top of the claw.

The original extrusions in the claw stopper for the spring become design features which allow the claw to slot into place. This is not and issue and adds addition aesthetical appeal to the final result obtained.
The only issue with this was the fitting of the stoppers which did not prove a problem thanks to the outher profile of the base allowing the stoppers to stick to the main base without complicating the final piece.

Addition of Ball Bearings

The initial design shown on the left below shows the bottom of the main slider half that was to attatch to the pulling cylinders. After making the original piece it was found that the slider did not move smoothly along the top base acrylic as smoothly as would have been needed for an efficient mechanism.
This resulted in an issue which needed to be overcome. Ideas were looked at such as roller tracks and lubricated surfaces but the final design consisted of ball bearings which offered the least friction.

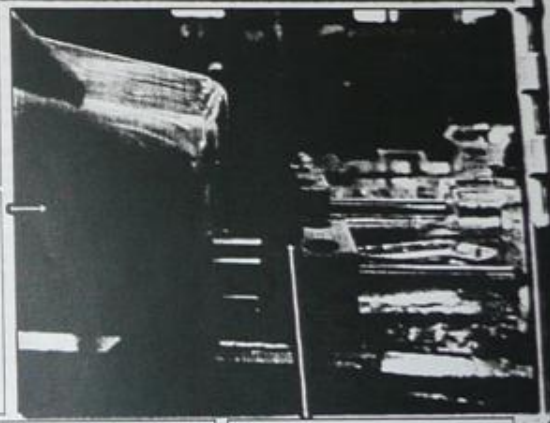
Initial Design



Final Design

The reason for this choice of modification was due to the ease of manipulation of this piece. The bearings offered a simple solution to the major problem and could be completed by cutting two 6mm tracks of length 45mm Through the acrylic piece which would be glue to the upper piece to produce the sliding mechanism. In the bottom base smaller sliding tracks were etached out to let the balls run smoothly along which allowd a far better surface with less fricilon of the slider to run on without damaging any componenta or surfaces of the design. This was a majorly important modification during manufacture and can be seen in detail on the photograph take above.

The connector chosen for this design so that the pneumatic solenoid would connect to the pneumatic cylinder proved to large for the design and for this reason another method or component would be needed so that the slider mechanism could work correctly.



The pneumatic connector shown at the arrow is the original connector chosen and is to large to fit inside the casing. The casing has two small but maximized holes to allow the passage of the connectors when the slider mechanism moves back and forward. The slider must run smoothly.

The design offers little movement or opertunity for manipulation so the most important design feature is the size of the connector which will be changed to the smaller and more mechanism friendly connector of the pneumatics. This allows the slider to move back an forward efficeintly and correctly without catching on the hole space for the top casing

The picture shows the final connector and the positioning chosen for it to move correctly. The flow control helps to add extra feature and design details to the final system. This overall makes the modification an important and relevant modification which needed corrected.

Pneumatic Connector Size

AUTOMATIC NAIL PULLER

Final Design

This design involves many separate components which much be assembled accurately and cautiously to ensure a safe and realistic function. The main body of the design is made in Obeshi wood and the upper base is made of acrylic plastic. This gives a well finished modern look about the design.

The circuit board fits neatly between the solenoids and valves

Air Tubing

|RENDER WITH TUBING|

The acrylic claws and stoppers would all be finely lazer cut and wet and dried off to give a clean clear finish which makes the product very sleek and intensely aesthtically pleasing.

The outer claw stops are accurately cut to fit precisely to the edge of the top slider.

|CASING REMOVED|

The slider moves 1 stroke length of the cylinder.

Simple claw mechanism, the push cylinders push the claws together. Stoppers prevent the claws from moving to far apart damaging the mechanism of the design idea below.

Acrylic Medium Base

Tapered Edges

The air inlets for the solenoids come out of the base of the product for ease of use and mobility of the mechanism.

Holes for pneumatic tubing

|FINAL RENDER|

Rouned edges at the prevent damage to the device rubbing on rough grains and a safety feature so that no users are injured.

The two front cylinders are double acting and present the pushing force needed to overcome the force of the springs acting on the claw, therefore closing the claw and cathcing the nail firmly. This mechanism is the strongest and most effect of the design ideas I have looked at previous.

T Connnectors

The secondary cylinder drives the system tray which pushes the claws against the wood and then retracts the claws out of the wood and therefore pulling the nail up to 40mm out of the wood in question. This cylinder is also double acting and much stronger than the smaller push cylinders presenting enough torque to remove nails.

The claw bearing holws will be drilled out after lazer cutting is complete ensureing a more accurate diameter

Tubing extrudes around casing

The frontal view is symetrical throughout the body apart from the handle giving good balance.

The left hand handle is made in two separate parts on the cnc router and attatched with tensol cement.

screw lock

Smooth rounds

This ensures a tight mobile design considering the size of the components needed. This shows strong robust design.

Sliding mechanism

|ACTIVE VIEW|

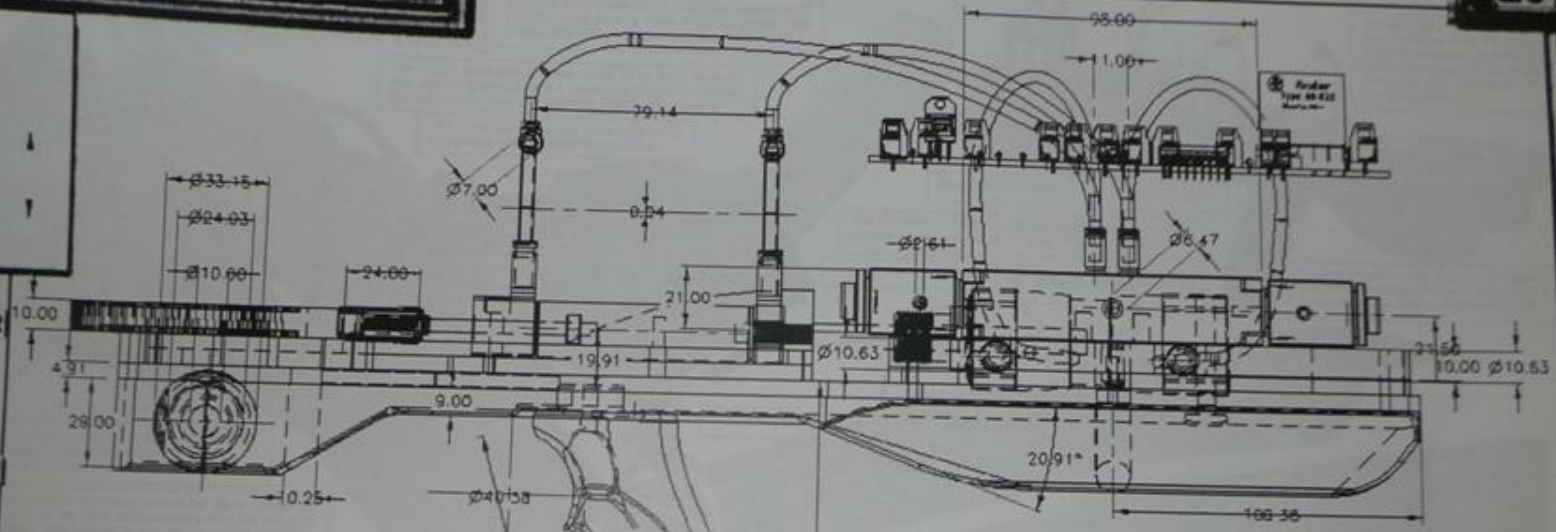
The left handle is made to fit comfortably around the hand of any user for a comfortable and good grip so that the task of the nail puller can be carried out effectively and with ease for any user that is of age to use.

The solenoids and 5 port valve is the foundation of the design, all the components and shape is made to fit around this.

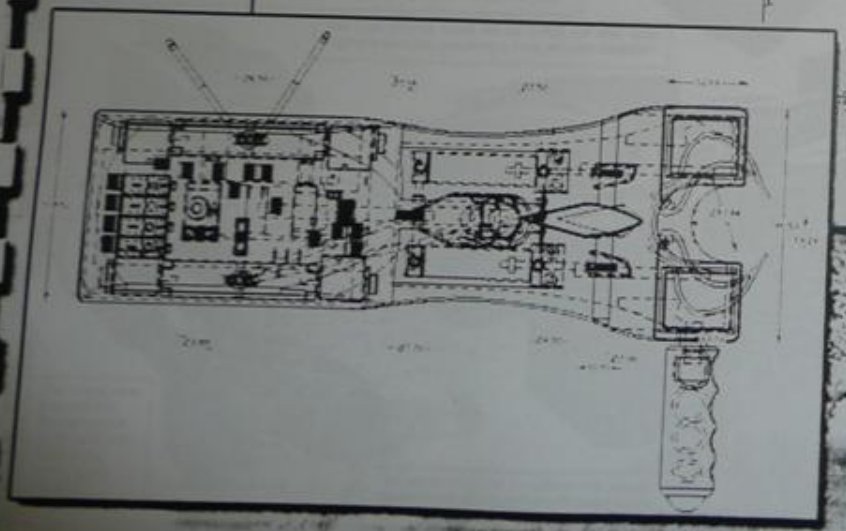
AUTOMATIC NAIL PULLER

Design Proposal

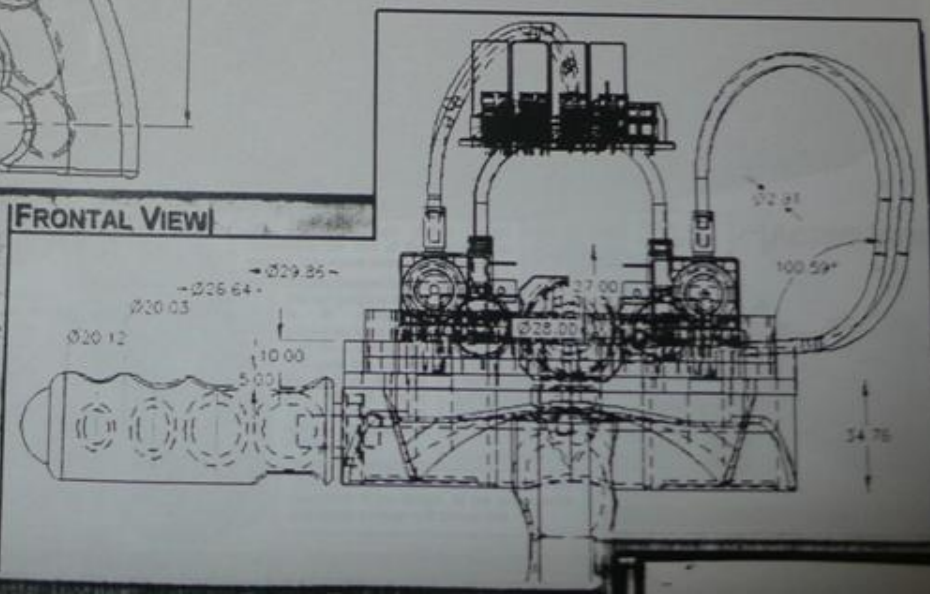
T CONNECTOR



LATERAL VIEW



BASE VIEW



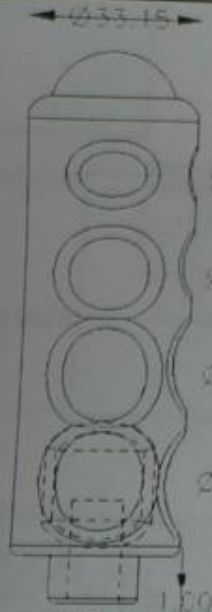
FRONTAL VIEW

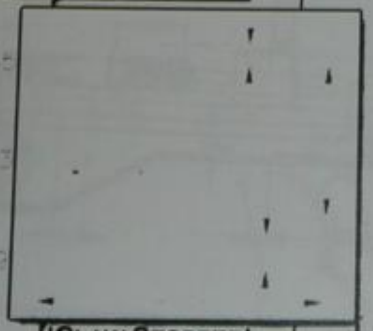
AUTOMATIC NAIL PULLER

Design Proposal

|5 PORT VALVE DIMENSIONS|

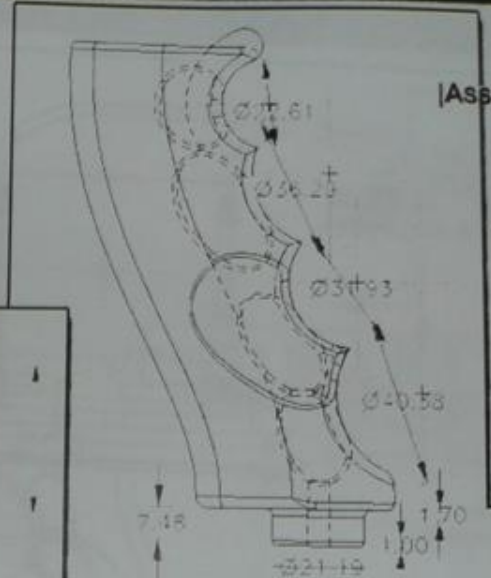
|LEFT HAND HANDLE|



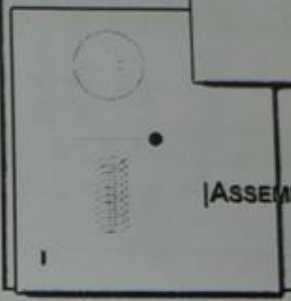


|CLAW STOPPER|

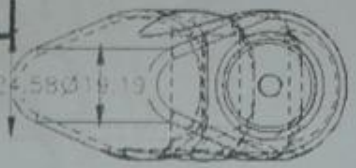
|RIGHT HAND HANDLE|

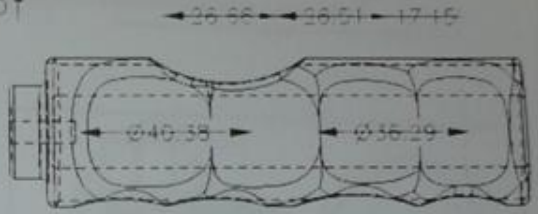


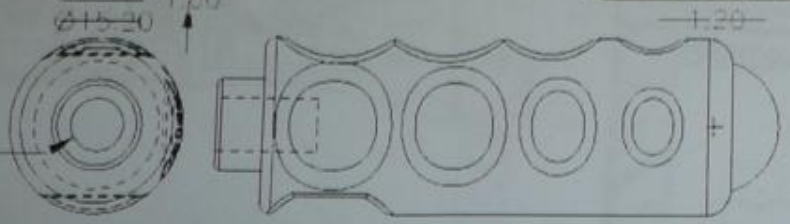
|ASSEMBLY SCREWS 3MM|



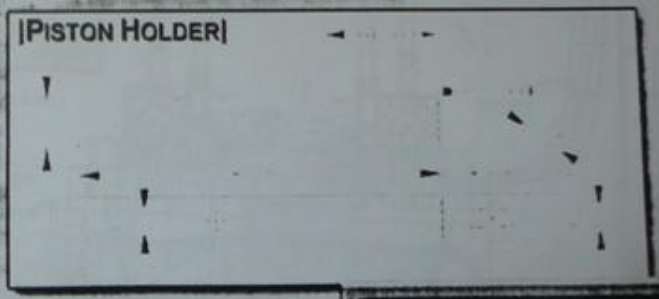
|ASSEMBLY SCREW 4MM|





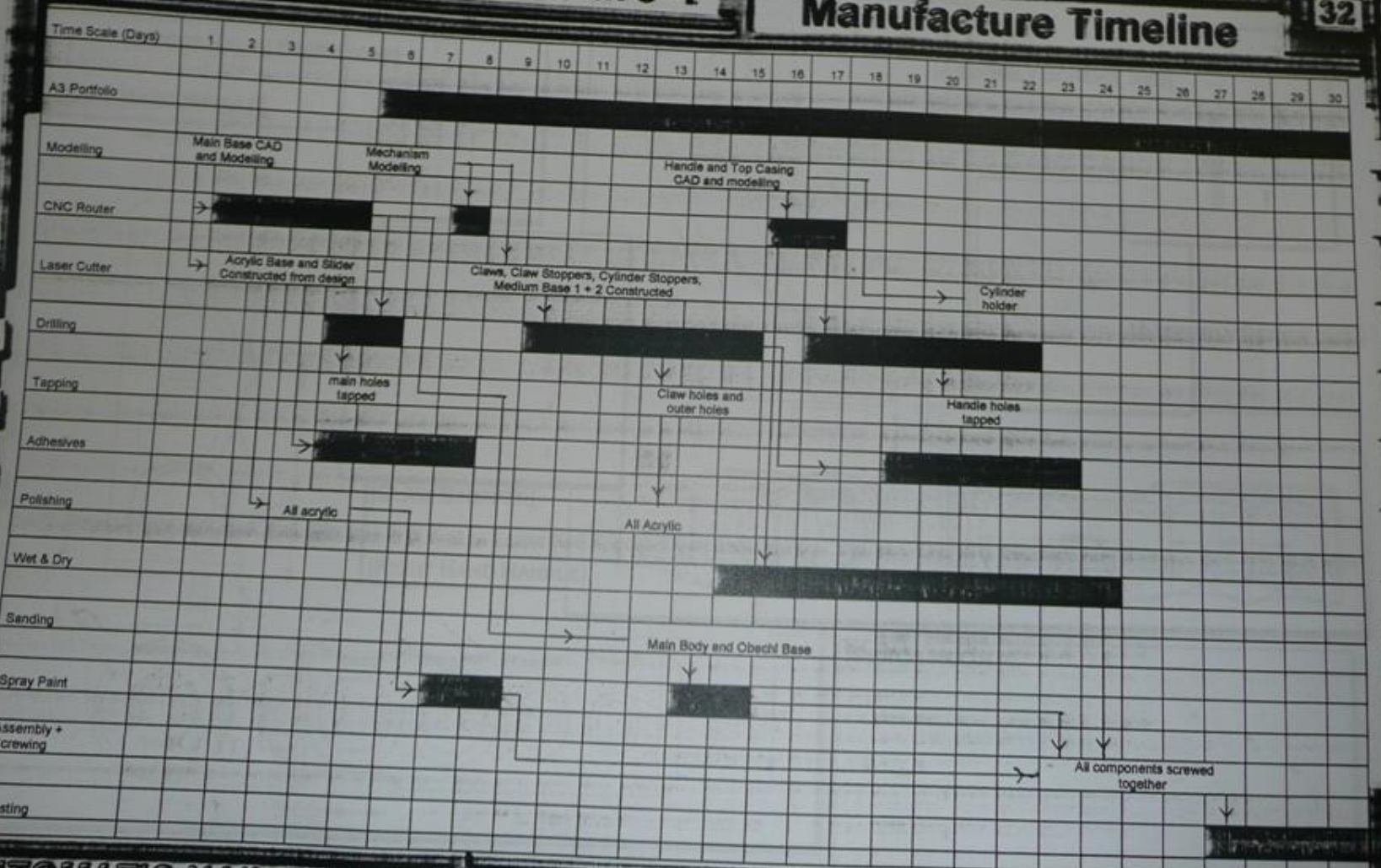


|PISTON HOLDER|



Planning For Manufacture 4

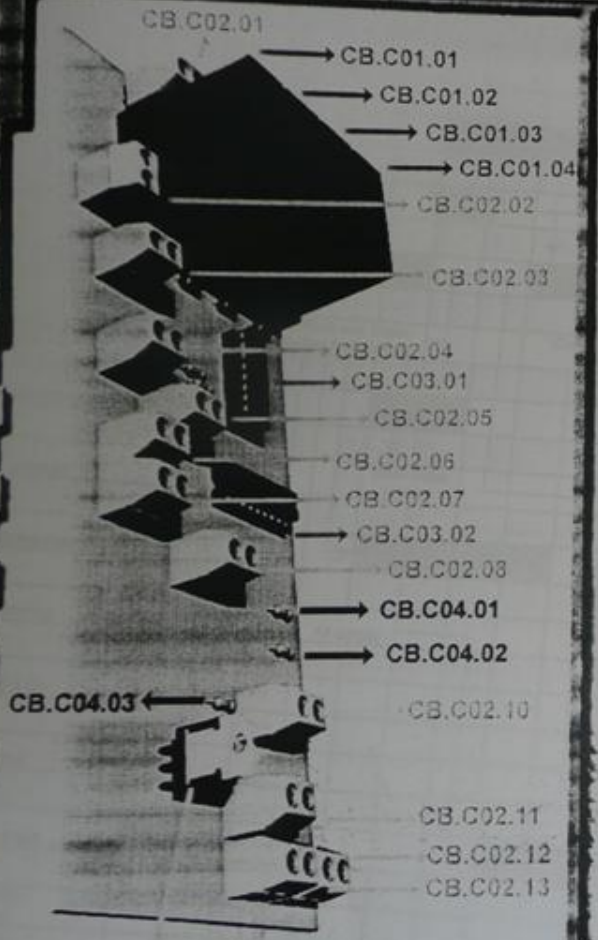
Manufacture Timeline

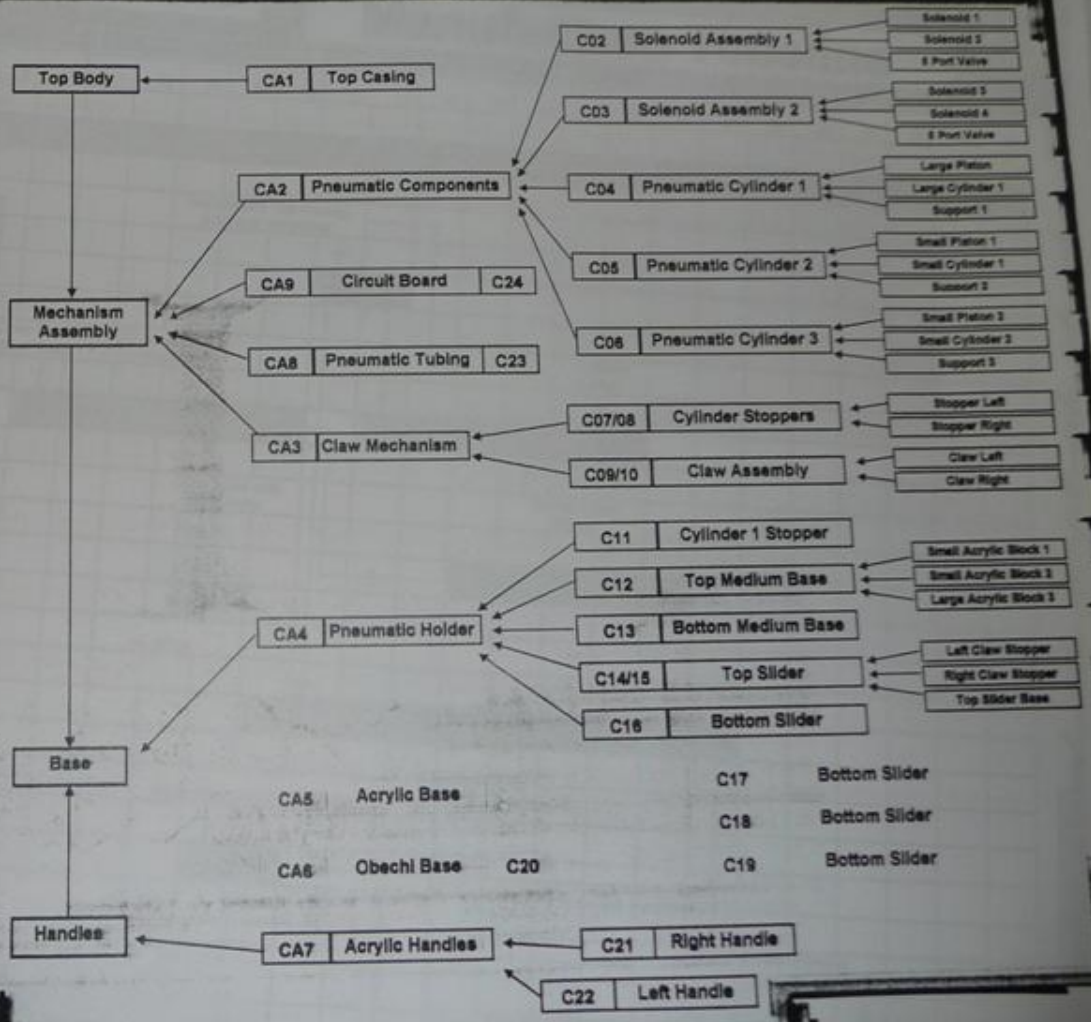


AUTOMATIC NAIL PULLER

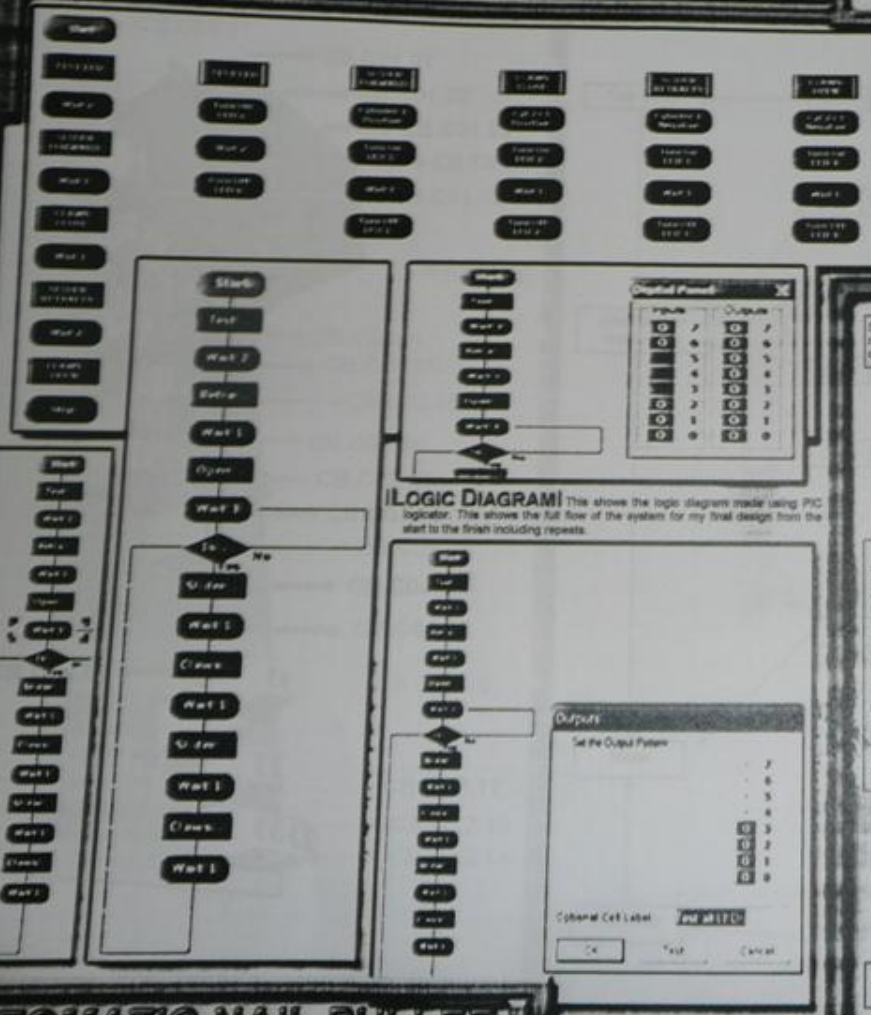
Planning For Manufacture 2

Component Assembly Tree Diagram





Development Of Design Idea



LOGIC DIAGRAM This shows the logic diagram made using PIC logicator. This shows the full flow of the system for my final design from the start to the finish including repeats.

CHOICES AND DEVELOPMENT FOR ASSEMBLY

Above we can see the holes left for pneumatic tubing to pass through to the pneumatic solenoids which are connected to the 5 port valves which power the main cylinders of the device.

The shape in this design has changed more rapidly compared to the original two ideas. This is due to recognising a need to be more flexible and yet comfortable for the user of the device.

The design was much more tricky to calculate than in the past designs. The more tapered edges involved in the design had to be precisely angled to fit the handles of the compiled design. But once this task was overcome the outstanding design could be easily compiled with the final design components.

The issue with the second design was that the body was much more thick than the needed outcome. It can be seen that the final design has a much thinner cross section area which allows for a lighter design than the past design ideas but yet the design is much stronger due to strong ribbing.

This design allows for flexibility around the stress areas which allows for the device to move without damaging. This was a very important design feature which we can see was developed through from the earlier design ideas. The only issue with this base was the small angles around the cross sectional centre of the design. This was easily corrected when compiled with the upper base which can be seen in later design development.

Final Design

|EXPLODED VIEW|

The frontal view shows the symetrical body of the design to ensure good balance on a users arms when it is in use.

The exploded view below allows you to see the large amount of components which make up the final piece. The design is mainly to be manufactured using lazer cut acrylic between 3mm and 12mm in thickness. This means that the final piece is mainly clear giving a smooth sleek aesthetically pleasing design.

12V Relays

Smooth comfortable finger grooves on both handles

Pneumatic Solenoid and 5 port valves

Circtuit board slots between

Pneumatic T Connectors

Screws all 4mm

Hammer Cylinder (Double Acting)

Top Slider made up of 2 5mm acrylic pieces.

Main base made from obeshi wood manufactured using a cnc router. This base attatches to the acrylic top base made using the lazer cutter and 5mm acrylic

Main Right Hand Handle attatched using a screw lock mechanism

The slider runs along the base thanks to the acrylic finish.

The top base will then be sprayed with primer and coated with black paint. Black goes best with the blue paint of the bottom base giving and aesthtically pleasing piece.

The yellow arrows indicate the components peicesing together to form the finished product device

The base attatches together with 4mm screws

Smooth rounds

Pneumatic Tubing

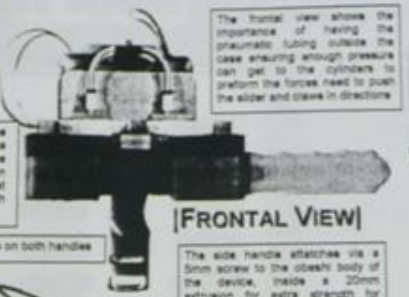
Circtuit Board

Pneumatic Solenoids

The base is made more aesthtically pleasing and lightweight using extruded panels

The hole between the claw drop is to allow the nail to fall out of the gun once the process has been completed. This could be into a bag or a box.

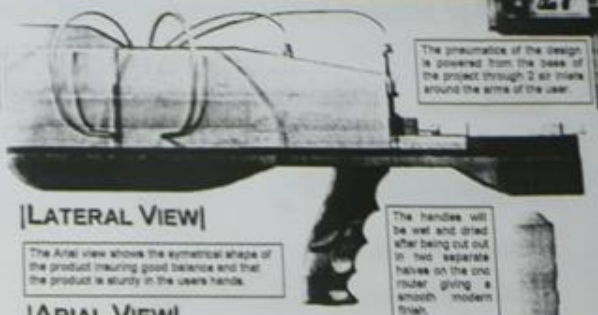
Acrylic Handle made in two parts



The frontal view shows the importance of having the pneumatic tubing outside the case ensuring enough pressure can get to the cylinders to preform the forces need to push the slider and claws in direction

|FRONTAL VIEW|

The side handle attatches via a 5mm screw to the obeshi body of the device, inside a 20mm extrusion for extra strength for heavey loads. This gives a better hold and sturdier handle for the user to be sure the device does not break or malfunction due to this.



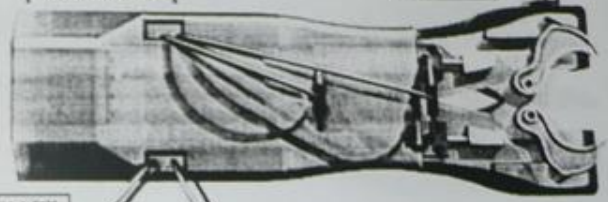
The pneumatics of the design is powered from the base of the project through 2 air inlets around the arms of the user.

|LATERAL VIEW|

The Arial view shows the symetrical shape of the product insuring good balance and that the product is sturdy in the users hands.

The handles will be wet and dried after being cut out in two separate halves on the cnc router giving a smooth modern finish.

|ARIAL VIEW|

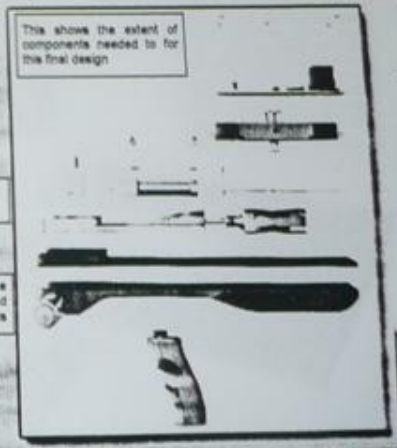


This ensures a tight mobile design considering the size of the components

Hole for exhausts

|EXPLODED LATERAL VIEW|

This shows the extent of components needed to for this final design



AUTOMATIC NAIL PULLER

CIRCUIT DEVELOPMENT 2

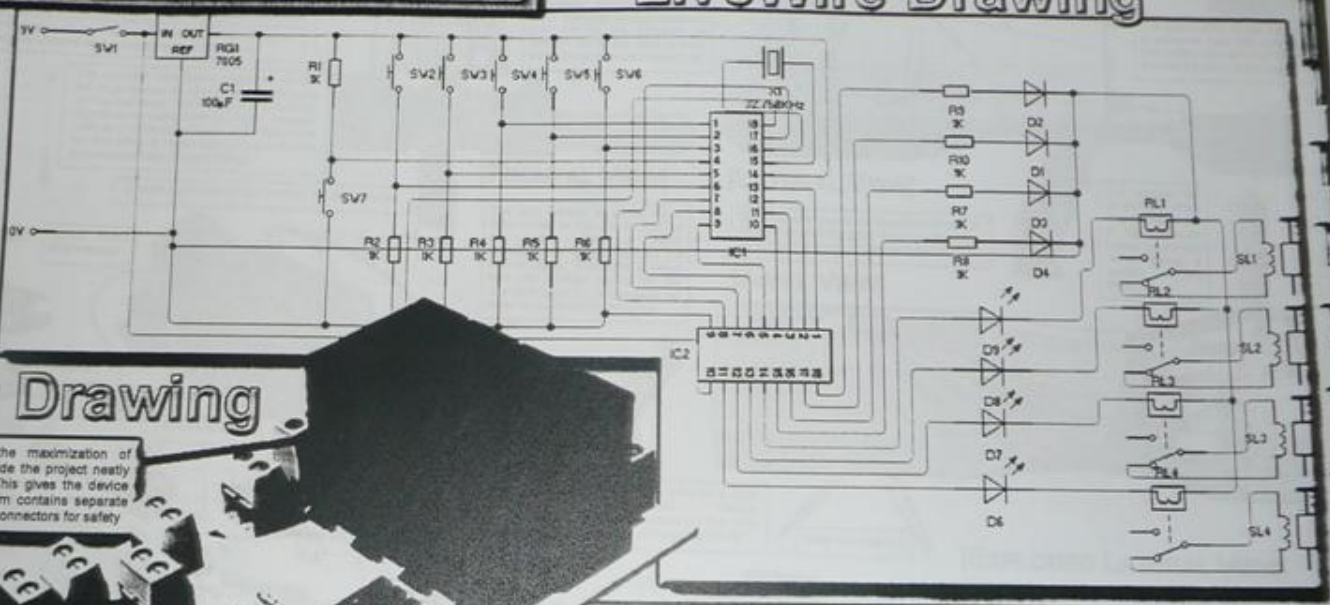
System

The circuit contains one voltage regulator attached to the live rail. It has 4 Relays which power the external solenoids which in turn power the cylinders for the pneumatic system of the device to drive the claw and slider movement.

The system contains only 4 LED outputs running off the main pic but has a separate circuit containing a simple LED setup when the circuit is live so that the user knows when the device is switched on. This is therefore directly connected to the On/Off Switch.

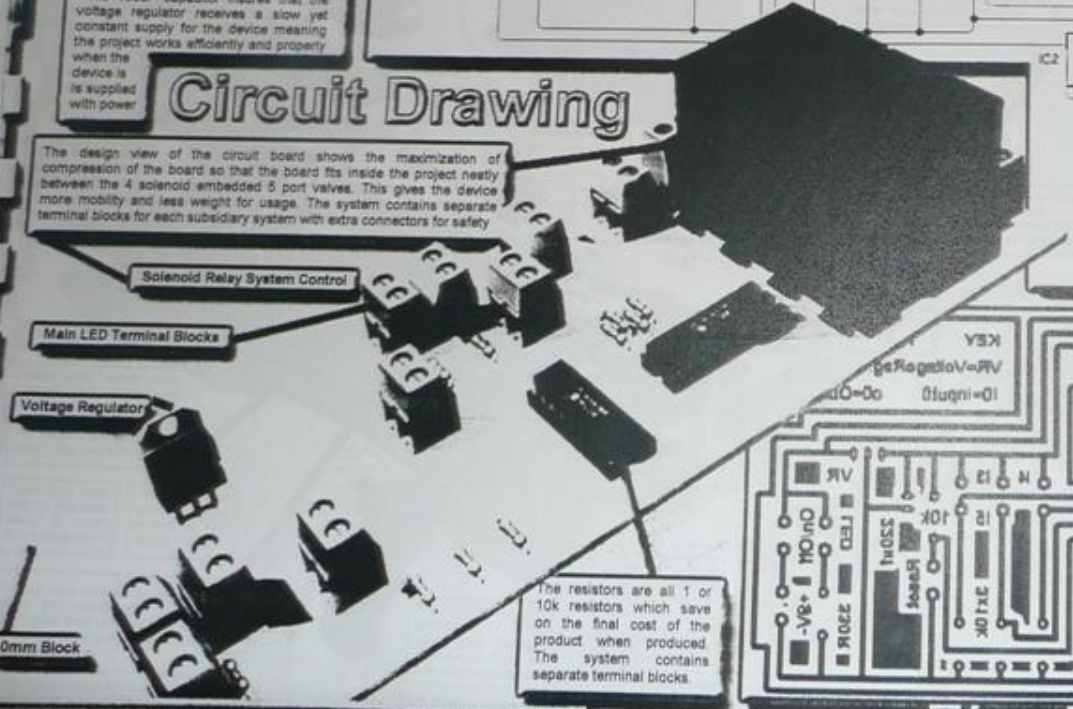
The 100uF capacitor insures that the voltage regulator receives a slow yet constant supply for the device meaning the project works efficiently and properly when the device is is supplied with power

LiveWire Drawing

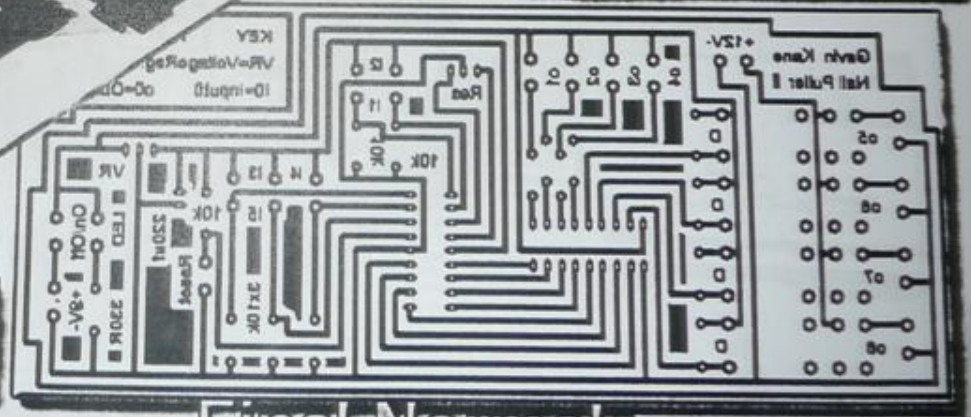


Circuit Drawing

The design view of the circuit board shows the maximization of compression of the board so that the board fits inside the project neatly between the 4 solenoid embedded 5 port valves. This gives the device more mobility and less weight for usage. The system contains separate terminal blocks for each subsidiary system with extra connectors for safety



The resistors are all 1 or 10k resistors which save on the final cost of the product when produced. The system contains separate terminal blocks.



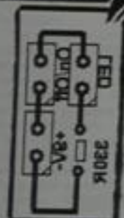
Final Normal

AUTOMATIC NAIL PULLER

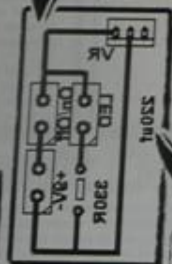
The circuit design which seemed most suited to my device is the 18 pin pic. It provides a variation of input and output setups which can be easily programmed to meet the needs of the automatic nail pulling device. The circuit will switch relays which will in turn activate solenoids powering the pneumatic cylinders.

These circuit diagrams have been designed and edited using **PCB Wizard.** I chose to use this program because it gives a realistic scale and representation of how the final circuit board should be constructed and manufactured. The circuit will be made as compact as possible.

1

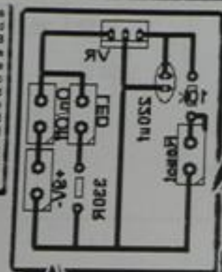


2



The first step of design the final circuit has been shown above. The terminal blocks represent the 9V rail, which is also connected to the main On/Off switch of the device. An LED has also been represented with a terminal block which will determine wither the power is On or Off on the device. The LED needs a 330 r resistor to protect the LED from the much larger current. The LED I will use in my circuit is an 8mm ultralight LED, this is the reason that a 330R resistor is needed to protect the LED from the PD.

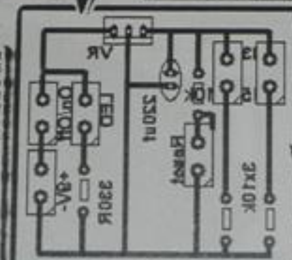
3



The diagram shows the **Reset** switch for the circuit has been added. This resets the overall output of the circuits power rail so that the 18 pin pic chip can be reset.

The diagram to the right shows input 3 and 5 added to the circuit, these inputs are ten connected to the 1st and 3rd pins of the 18 pin pic. They are protected by 10k Resistors as are all of the outputs. The circuit tracks are 2mm thick giving a good connection for the passage of current. Diagram 2 shows the variable resistor added to the circuit. More detail is shown about this throughout the page. The device has a 18 pin pic (16f84) and a **18 pin ULN (2803)** This will also be covered in more detail at a later stage. The 3rd step shows the reset switch being added to the circuit.

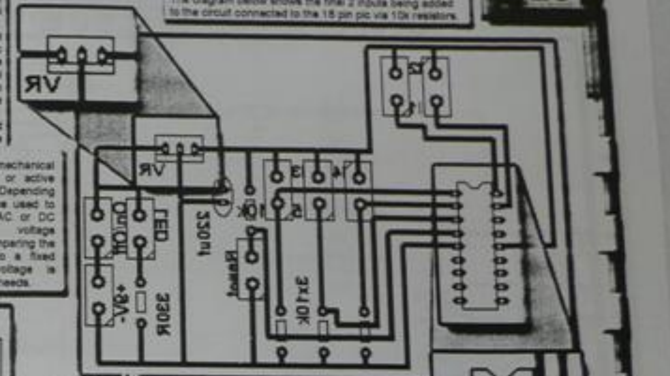
4



The diagram to the right shows the circuit symbol for a voltage regulator. This is a very important part of the 18 pin pic circuit. A **voltage regulator** is an electrical regulator designed to automatically maintain a constant voltage level. The regulator is polarised and the right pole must be connected to the correct. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. Electronic voltage regulators operate by comparing the actual output voltage to a fixed voltage. The fixed voltage is determined by the circuit needs.

The diagram below shows the final 2 inputs being added to the circuit connected to the 18 pin pic via 10k resistors.

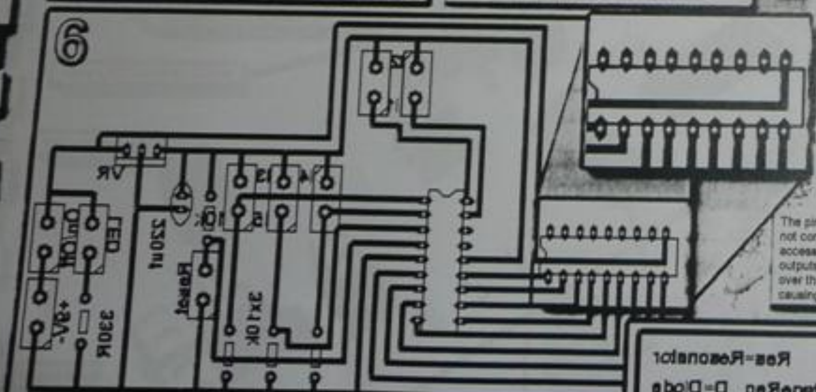
5



The 3rd input is added to the circuit board and is added to a 10k resistor

The **18 pin pic (16f84)** is the pic used for my circuit. The pic has 2 power supply pins. **VDD** is the positive supply, and **VSS** is the negative supply, or **0V**. The maximum supply voltage that you can use is **6V**, and the minimum is **2V**. The pic will be programmed to suit the needs of my device and circuit board. The ports connect on the diagram show the power and inputs. The 18 pin pic is connected to the board via a 18 pin adapter to protect the pin during soldering and making it removable.

6

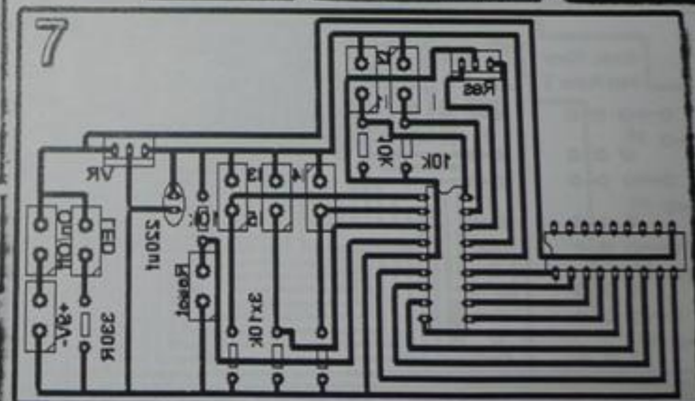


To the left is the 18 pin ULN, the outputs including 4 12volt relays and 4 LED's are connected to pin 6-13 of the 18 pin ULN chip. This pin acts as a series of diodes protecting the outputs from short circuiting.

The pins that have been not connected have free access to any external outputs without crossing over the copper tracks causing it to short circuit.

KEY
Res=Resonator
VR=VoltageReg.
D=Diode
I0=Input0
O0=Output0

7



The diagrams have been constructed using PCB Wizard

Selection Of Ideas For Further Development

|ANTHROPOMETRICS|

- The design idea 1 has strong anthropometric properties in its features such as the arm length size of the main body which is **320MM** which is suitable for the average size of arm of a user.
- The design has a handle width of **82MM** which is exactly accurate to the average size of hand width of a user which can be seen in the specifications table above.

RATING:

|FUNCTION|

- The designs weaker properties would include its range of possible functions such as the fact that in only has one major mechanisms pathway.
- The design pulls the nail out using pneumatics and drops it out. A collection method would have helped from loose nails falling out of the system.
- The design cannot remove nails from small angles which is a very possible situation, therefore making this design not fully functional in a real life situation.

RATING:

|MAINTENANCE|

- The design offers and easy and simple solution to accessing the product for maintenance. A small hinged rear panel allows the main casing to be removed from the product so that all inner components can be easily accessed.
- The design contains easily removable components which are very standard and should be easy to get replacement components for the design.

RATING:

|MANUFACTURE|

- The design is much more complicated to manufacture due to the large amount of sophisticated curves and angles the design presents.
- Due to this a lot of mechanical manufacturing methods to ease the process would need to be used.

RATING:

|ENVIRONMENT|

- The design runs off only compressed air and a 9v and 12v circuit which means it does not cause a serious damage to the environment due to pollution.
- The main problem that this design causes to the environment is due to the damage caused to wood and materials that he nail will be removed from making it damaging.

RATING:

|ANTHROPOMETRICS|

- This design is much less anthropometrically enhanced as the 1st design due to the shape the design must consist of to control its function.
- This design contains measures of unavoidable need for the system to function but which can prohibit the balance, comfort and ease of use of the device.

RATING:

|FUNCTION|

- The design offers few less functions than the other design ideas but its carries out its function with the most efficiency due to the ease of use of the mechanism on the system components.
- The design carries out its main function as a nail puller and also as a nail holder to transport the nails.

RATING:

|MAINTENANCE|

- The design is made to be easily maintained, the components can be removed for replacement or for servicing with ease.
- The top casing allows for components and inner mechanism to be easily accessed for servicing.
- The device locks into place that any removable parts will not be moved able or set off balance during functioning of the device and inner mechanism which controls the devices sub system.

RATING:

|MANUFACTURE|

- The main error of construction with the design is the capability to manufacture the design which is not as simple to justify as in the other design ideas.
- The design mechanism is very complicated and for this reason must be very accurately finished so that the mechanism will work correctly. This means that the time and quality of the system will be a major issue during the main construction.
- Another issue is that most of the design will have to be constructed in the cnc router due to the complexity and 3D shape so a lot more time will be needed to spend to clean up unfinished or rough edges which would not be needed with the laser cutter design.

RATING:

|ENVIRONMENT|

- The main error of construction with the design is the capability to manufacture the design which is not as simple to justify as in the other design ideas.

RATING:

|ANTHROPOMETRICS|

- The design is much more anthropometrically enhanced as it fits in one hand and is more lightweight and mobile than the other two design ideas.
- The small handle although is smaller than the other designs should still be enough for larger hands. The offers much more flexibility and improves the function of the device.
- It offers less protection but more manoeuvrability.

RATING:

|FUNCTION|

- This mechanism has a much more efficient mechanism than in the other designs but also creates problems with torque.
- It will only be able to remove small nails due to the lack of torque the design components carry out to remove the design.
- The functionality of the design offers little usage advantages other than its efficiency and it does not have any other major functions.

RATING:

|MAINTENANCE|

- One of the designs major failures is its complicated and compact design means that maintenance becomes a much harder task.
- The other casing is much harder to remove than other designs due to its complexed shape and lower casing containing the pneumatics is almost impossible to remove without removing several other components in the process.
- This means to remove a faulty part or to service and older part many of the other components need to be removed and are much more complicated to replace again making the design inappropriate for corporate use.

RATING:

|MANUFACTURE|

- The design has another main error in function which includes its ability to be manufactured quickly, cost effectively and with a good finish. This is not the case with the design which due to its complexed design has the same problem as the second design which is the finish it will made with on the router is much poorer and will need much more work than the first design idea.

RATING:

|ENVIRONMENT|

- The threat to the environment due to this designs functionality seems minimal but on a large scale would be definite compared to the other designs I have looked at.
- The use of two stepper motors mean much more electricity will be needed to run this device which although is efficient is also much more polluting to the environment.

RATING:

Design Idea 1 Final Rating 23/40

Design Idea 2 Final Rating 18/40

Design Idea 3 Final Rating 23/40

Design Idea	Aesthetics	Ergonomics	Cost	Anthropometrics	Function	Maintanence	Manufacture	Enviroment
Design Idea 1	3	4	3	4	1	4	2	2
Design Idea 2	2	1	3	3	2	3	1	3
Design Idea 3	4	4	2	4	4	2	1	2

|CONCLUSION|

- The design I chose to base my final design around was design idea 1, although a lot of features from this design will need modified it achieves a joint highest mark and appears most successful for the function and ease of manufacture.
- The manufacture process for the design will have to be enhanced but offers a much faster and more effective system finish.
- Some features such as mobility of the design idea 3 and the efficiency of the design idea 2 which will help to construct a much more effective final design.

AUTOMATIC NAIL PULLER

|TABLE SHOWING SYSTEM RATINGS AND CONCLUSION|

Selection Of Ideas For Further Development

INITIAL DESIGN IDEA 1

AESTHETICS

- The design is much more modern and futuristic than other designs making it interesting to look at to the consumer.
- The shape is very rectangular and has sharp base corners which are a large disadvantage for this design.
- The design has a smooth and complexed shape arm ridge which gives a very comfortable and sophisticated look to the design and contributes to the other areas of the design.
- The shape handle is stylish and arranged to give the feeling and look of a smart tool which will carryout the job extremely well.
- The main base has a deformed bottom which takes the simple and sluggish shape of the other designs to a new level.

RATING:

ERGONOMICS

- One of the designs best features is its ability to suit the users positioning and the position of a nail in most positions.
- The design is adaptable to suit different sizes of nails by changing the claw used to remove the nail from the wood.
- The main base is moderately adjustable to suit any users arm size at any length of distance away from the nail in question.
- The design is balanced accurately for a low centre of gravity.

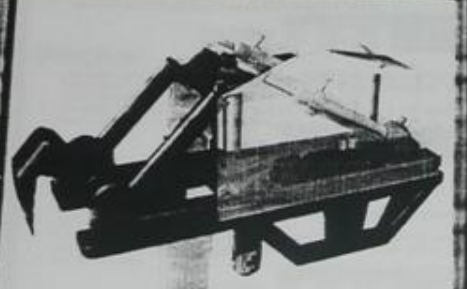
RATING:

COST

- The design will cost roughly £340 to manufacture and pay for components needed for the pneumatic and electronic circuitry inside the system.
- The design will need a component cost amount of about £240 which is less than other designs ideas.

RATING:

INITIAL DESIGN IDEA 2



AESTHETICS

- The design mechanism is very aesthetically pleasing to the user thanks to the large smart claw attached to the front of the main leverage system of the design.
- The shape is however much more clumsy and top heavy to look at which is a large disadvantage as consumers will be looking for a design which is compact and well balanced to carry out the function without causing unwanted extra work to run.
- The design frame is however much more interesting to look at thanks to sharp interesting angles and large neatly coordinated rounds around the hinge area of the claw.
- The design casing is also clear and when well finished would offer a smart and clean appearance.

RATING:

ERGONOMICS

- The shape of this design offers little ergonomic features due to having a very high centre of gravity meaning the design is very unstable and unevenly balanced which means more effort would be needed from the user.
- The design offers little comfort for the user due to the handle having to be placed very far back on the design which means the base sit rests on a very small surface area of hand and arm making it much more agitating and uncomfortable.

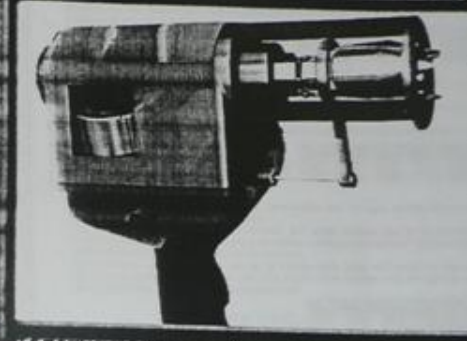
RATING:

COST

- The design will cost roughly £220 to manufacture and pay for components needed for the pneumatic and electronic circuitry inside the system.
- The design will need a component cost amount of about £180 which is less than other designs ideas.
- The small claw saves a lot of process cost due to its high efficiency meaning that the running cost of the device is much less than the input cost that will be needed for the equivalent type of tool with a standard mechanism.

RATING:

INITIAL DESIGN IDEA 3



AESTHETICS

- The body of this design is the most aesthetically pleasing thanks to the collectively smart and sophisticated mechanism.
- The design casing is much more modern and clear cut than the other design ideas which makes it much more interesting and appealing to the general consumers of this type of tool.
- The handle is smooth and slim line which gives the look of an easy to use design which an efficient usage ability.
- The main body is appealing due to its interesting shape and style which is very modern and yet still has a tradition gun idea.
- The design is collectively much more aesthetically pleasing to the consumer and adds a simple interest.

RATING:

ERGONOMICS

- This design has a much lower centre of gravity and offers a much better balance due to this making the design ergonomically usable.
- The shape allows for the device to be held in one hand compared to the 2 handed devices shown to the left, this is much more mobile and comfortable for the users and therefore makes the product the most ergonomically pleasing device.

RATING:

COST

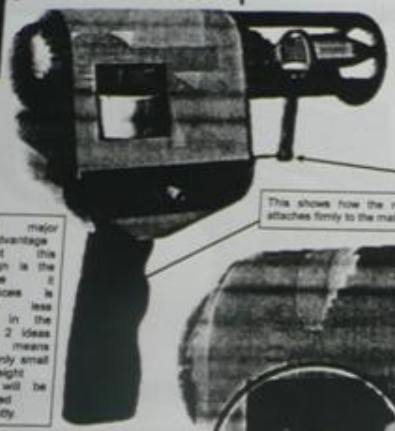
- The design will cost roughly £460 to manufacture and pay for components needed for the pneumatic and electronic circuitry inside the system.
- The design will need a component cost amount of about £320 which is less than other designs ideas.
- The design uses much less material.
- The product will use much less volume of material also due to the hollow inside of the handle and casing.

RATING:

AUTOMATIC NAIL PULLER

INITIAL DESIGN 3

|FINAL RENDER|



The main advantage of this design would allow for a much sharper pinpointed removal of the nail so that the wood is barely damaged other than the original holes of the nail left behind. The mechanism allows for the nail to be pulled out at a constant speed which creates less chance for wood to crack or break during the nail removal.

One major disadvantage about this design is the torque it produces is much less than in the other 2 ideas which means that only small lightweight nails will be removed efficiently.

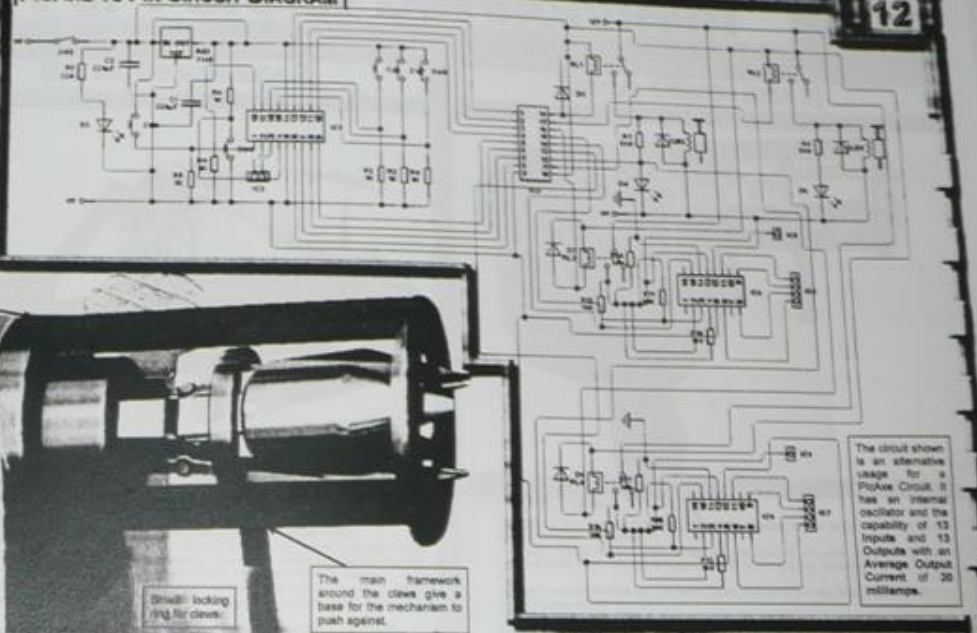
This shows how the main base attaches firmly to the main frame.

The final render shows the importance of the accuracy of the design for the working function of the mechanism to work. The exploded view shows the stepper motor function for this design. The two stepper motors act in time with each other to remove the nail from the wood without the ratchet becoming off cantered or being damaged by different mechanism speeds of the motors.

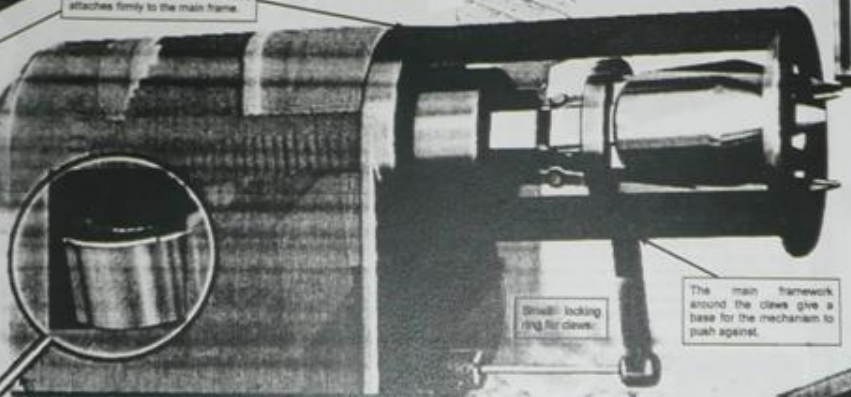
Magnified Exploded View

Another problem includes the top heavy weight of the design which may cause for the design to be unbalanced and potential dangerous to use in certain unsafe situations.

|PICAXE 18 PIN CIRCUIT DIAGRAM|



The circuit shown is an alternative usage for a PicAxe Circuit. It has an internal oscillator and the capability of 13 Inputs and 13 Outputs with an Average Output Current of 20 milliamps.



Small locking ring for claws.

The main framework around the claws give a base for the mechanism to push against.

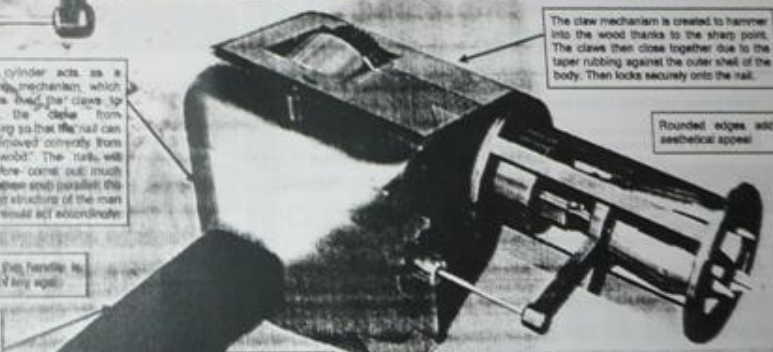
The claw mechanism is created to hammer into the wood thanks to the sharp point. The claws then close together due to the taper rubbing against the outer shell of the body. Then locks securely onto the nail.

Then cylinder acts as a locking mechanism which closes over the claws to stop the claws from opening so that the nail can be removed correctly from the wood. The nails will therefore come out much smoother and parallel this design structure of the main body would act accordingly.

Rounded edges add aesthetical appeal

This rounded edges ensures that handle is comfortable in the users hand at any age.

The rounded grooved handle attaches screwed onto the base of the body.



This shows the removable base.

AUTOMATIC NAIL PULLER

INITIAL DESIGN 2

09

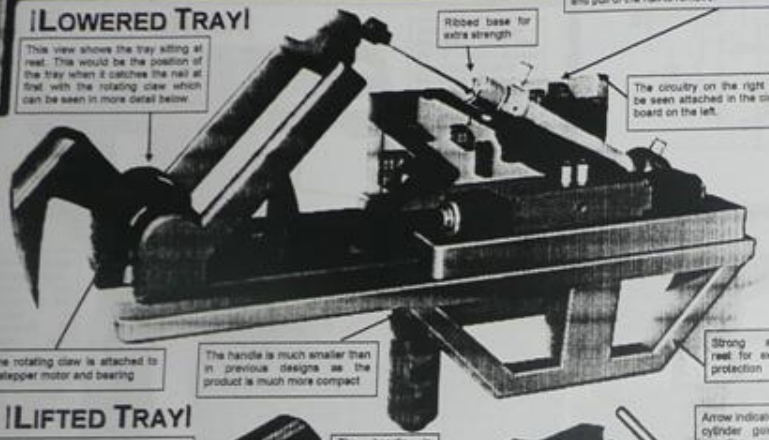
This design revolves around the idea that the main body will be attached to a separate body which can move up and down at an angle. This allows the mechanism to fall onto the nail for removal and pull of the nail to remove.

LOWERED TRAY

This view shows the tray sitting at rest. This would be the position of the tray when it catches the nail at first with the rotating claw which can be seen in more detail below.

Ribbed base for extra strength

The circuitry on the right can be seen attached in the circuit board on the left.



The rotating claw is attached to a stepper motor and bearing

The handle is much smaller than in previous designs as the product is much more compact

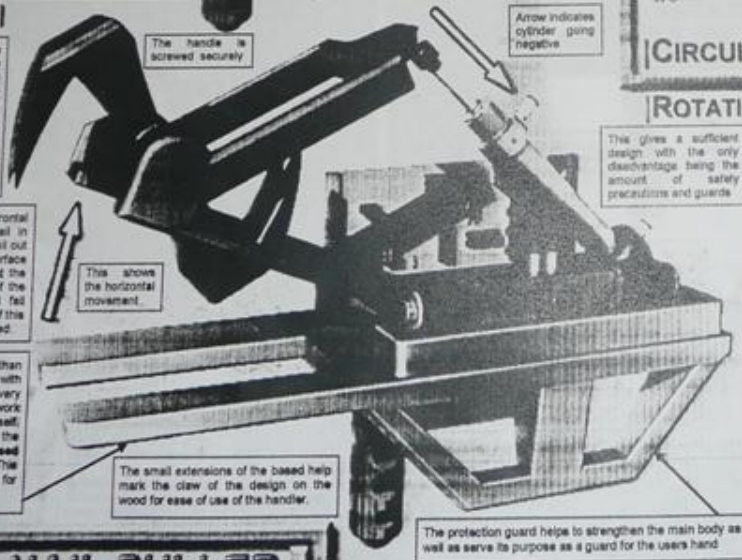
Strong arm rest for extra protection

LIFTED TRAY

The design functions so that the large pneumatic cylinder retracts which is the effort of a lever which lifts the tray which is enclosing the claw. This retraction lever is in the shape of a parallel lever and is the force which removes the nail out of the wood. At first it was assumed that the stepper motor would have the strength to pull the nail out but after much research this idea seemed much more realistic and proved more efficient.

The handle is screwed securely

Arrow indicates cylinder going negative



The design is made to function when the frontal base is set onto of the wood and nail in question allowing the design to pull the nail out once the claw has been inserted in the surface of the wood. It is by this mechanism that the whole device functions and if one part of the mechanism fails the whole system will fail which is a reason I would be very unsure of this design idea compared to the ideas exampled.

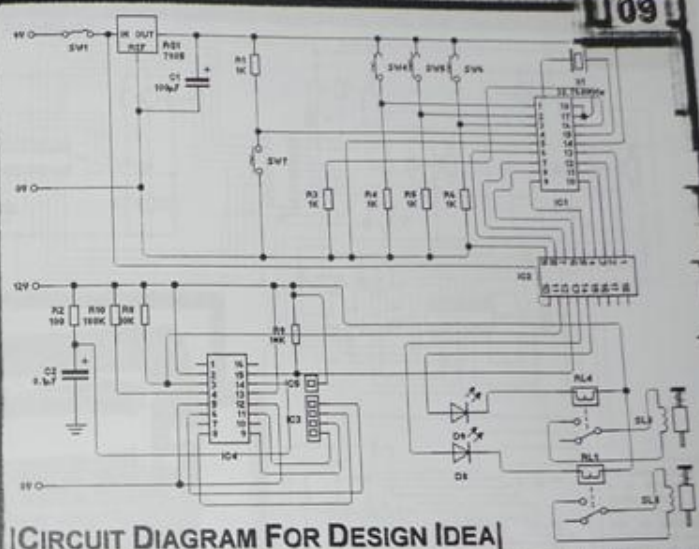
This shows the horizontal movement.

The design is much more compact than previous designs but presents a problem with recoiled and flow control which must be very carefully monitored of the design is to work correctly and without breaking the design itself. The machine is made to detect the point of the nail accurately so that the system can be used easily by most users in most situations. This ensures a well equipped and efficient tool for use in many situations and problems.

The small extensions of the based help mark the claw of the design on the wood for ease of use of the handler.

The protection guard helps to strengthen the main body as well as serve its purpose as a guard for the users hand

CIRCUIT DIAGRAM FOR DESIGN IDEA



ROTATING CLAW AND STEPPER MOTOR

This gives a sufficient design with the only disadvantage being the amount of safety precautions and guards

The strength is much more important in the claw which will be made of steel.

The force needed to remove the nail can be calculated by Force = Distance x Load.

Rotating claw shape has large curvatures

The load is the force acting against the pulling force of the nail puller. In this case it is the nails friction in the wood. The smaller the pivot distance was made the more force the claw offers against the load to remove.

The cylinder has a force of sin (" x (Weight + Load) of tray in the

This diagram shows how the nail would be removed. The claw locks in below the nail head and then the tray lifts up sufficiently to

The rounded edges make the claw rotations much more aerodynamic for efficiency.

This taper is sharp but allows the nail to be removed without damaging the wood.

AUTOMATIC NAIL PULLER

INITIAL DESIGN 1

08

|INITIAL CIRCUIT|

The following system is based on a pneumatic setup powered by electronic solenoids. This ensures a time delay for the system which will be needed for the system to work without recoil and accuracy.

The circuit below is used to power the pneumatics which must accurately run the cylinders for the circuit on the left.

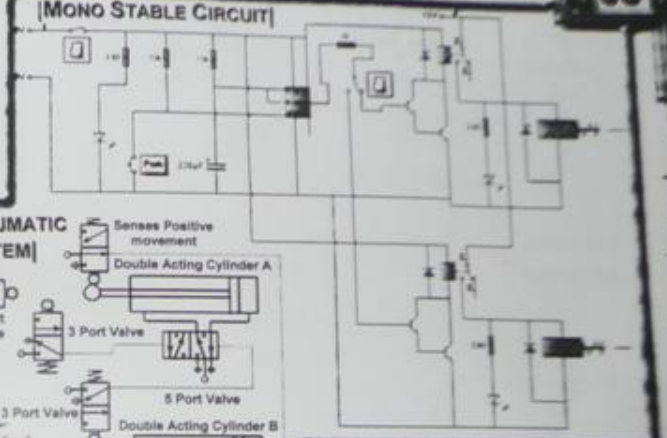
Solenoid Relays running at 12 Volts initiate the Pneumatic System.

The below is a system arrangement diagram showing cylinder setup

A heat block must be attached to the Voltage regulator to protect it

The relays power the solenoids which in turn run the pneumatic circuit for the cylinders and separate outputs. The 18 Pin Pic is used for this circuit as it supplies enough variable outputs to power all the relays which in turn power the solenoids for the Pneumatic Circuit.

|MONO STABLE CIRCUIT|

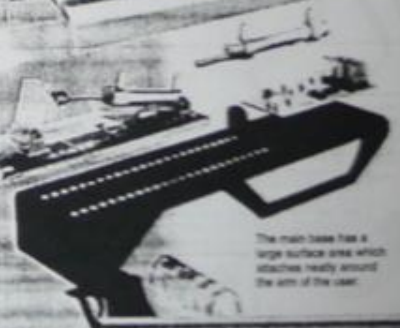


|PNEUMATIC SYSTEM|

The mono stable circuit above attaches to the Pneumatic system shown in the diagram below. The system shows how the two solenoids attaches in the place of the pneumatic cylinders on each side of the electrical circuit. This is an alternative circuit to the two circuits that have been looked at in the other design ideas shown over the next few years. This circuit runs off a 12V and 9V supply similar to the usage in the other circuit design ideas.

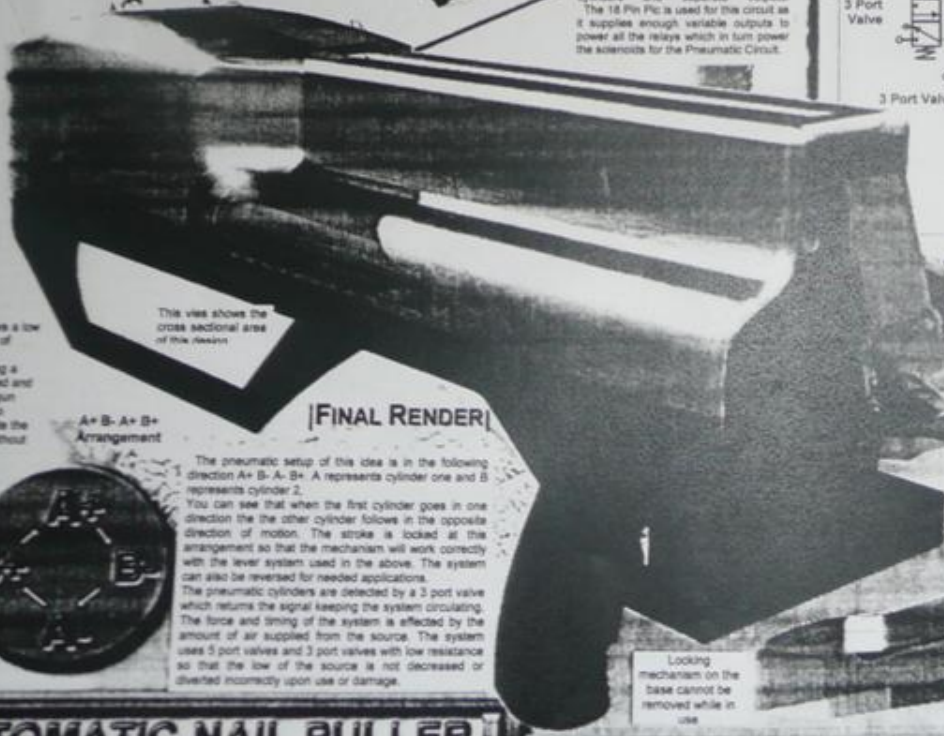
|DISASSEMBLED|

Internal bell crank arrangement fully assembled.



Simple slider mechanism

The main base has a large surface area which attaches neatly around the arm of the user.



This view shows the cross sectional area of this design

It shows a low centre of gravity ensuring a balanced and sturdy gun shape to penetrate the wood without recoil

|FINAL RENDER|

A+ B- A+ B+ Arrangement

The pneumatic setup of this idea is in the following direction A+ B- A- B+. A represents cylinder one and B represents cylinder 2.
You can see that when the first cylinder goes in one direction the the other cylinder follows in the opposite direction of motion. The stroke is locked at this arrangement so that the mechanism will work correctly with the lever system used in the above. The system can also be reversed for needed applications.
The pneumatic cylinders are detected by a 3 port valve which returns the signal keeping the system circulating. The force and timing of the system is effected by the amount of air supplied from the source. The system uses 5 port valves and 3 port valves with low resistance so that the low of the source is not decreased or diverted incorrectly upon use or damage.

Locking mechanism on the base cannot be removed while in use

Top casing vacuum formed

AUTOMATIC NAIL PULLER

SPECIFICATIONS 1

AESTHETICS

- The product will have **natural colours** with the same constant matching colours chosen for the whole assembly of the product. This means that the product will look professional and eye catching. It may also be considerably important to consider the surroundings the device will be used in, meaning a colour such as brown or yellow may be suitable to fit in with the colour of wood.
- It will be made to look strong and durable using a smooth **non-glossy finish** and strong framework. This will imply to the user that the product is made to withstand the large forces and work needed to remove large nails from heavy wooden boards. It also will need to be finished with a durable coating for the same reason.
- The style should be subtle with **interlocking shapes or flowing curves** and few square edges or corners which would bring the modern stylish aspects required for the prototype of a new product.
- The device should not have any texture and instead have a **smooth and clean finish** to prevent dust such as that from the wood catching on the surface and damaging it.
- The design will look **natural and flowing** rather than sharp and contrasting to the natural environment of industry it will be used in. Thus making it more pleasing to buy to a consumer such as a joiner or fencer.
- The product must have a distinct well applied coating. Either matt for wood or gloss for metals, all plastics must be polished
- Ultimately the design detail must be high quality and have a sophisticate style with a **modern theme**

ERGONOMICS

- The device will be designed to suit the average human being over the age of **18 years of age. The suitability of the device for anyone under this age would be very unprofessional as the tool is dangerous and should not be adapted to, or be used by anyone under the age limit above.**
- The device will be designed around the average adult's hand. To be held with either one hand or two hands.
- It will be made to suit use by a right handed user although it will be capable of being used by a left hand user.
- The device will have handles about **120mm** apart; this is a suitable distance for the arms to stretch to support the device against the wood.
- The handles will be at least **18mm** from the claws of the device for safety and ergonomically purposes such as how the claws could catch or nip the user.
- The device will have a small slot so that the user can easily see the **position of the nail** throughout the process so that assumption does not have to be made to wither the nail was successfully removed or not.
- The main barrel containing the claws will be shaped to fit comfortably over the users arm **spreading the weight** of the device equally across the surface area of the users arm and hand.
- The device will be made a suitable weight to be carried in the users hand with ease.
- The tool will have a battery pack accessible to the user from the side without effecting use of the device at any particular time throughout the removal process.
- The device will have **spring-loaded recoil** to prevent the user's arm being harmed or injured or just uncomfortably moved by the force of the device. The springs will absorb the momentum.
- The device will have a **strap** to give extra grip on the device when using for heavy duty nails or industrial work.

COST

- The device will be made within a budget of **£45.00**. This is a reasonably safe assumption for the amount the product should cost as long as material wastage is kept to a minimum.
- The design will be made using CNC technology thus cutting down on material wastage and cost due to human error. The overall cost of the usage fos the CNC machine would come to about **£5.00** at most.
- The finish must be well applied so that few coats have to be applied. The cost of primer costing roughly **£5.00**.
- The device will have less than **£135.00** cost for components.
- The device will be manufactured with great care to prevent human error which could cost more money for the overall manufacture process.
- The product will be in the budget range for the particular market of between **£150.00** and **£165.00** thus placing it in the middle bracket range for a tool of this size and material cost.
- The component cost will be minimized by re-using old components. This will save on time, money and effort.
- Any material wastage will be recycled or used to fill up another body of the object. This could save up to between **£40.00 - £50.00** in components and material cost.

SAFETY

- The product must not use more than a **12V supply** of electricity to ensure that if there is a [illegible] circuitry that the user is not put in danger.
- The product will be design to work under the regulations of the **British Standards Act**
- The device will have a **10MM** thick hand guard to protect moving parts which will attach to a **safety hinge**
- The distance between the handle and moving parts will be **40MM** to protect the limbs
- The system will have a safety lock mechanism to prevent the device being used in awkward positions or dangerous circumstances.
- The device will be sealed to protect against **water spillage, electrical conduction** of the external circuit board and other such implements.
- The design has **2** small holes for the air inlets of the pneumatic cylinders which will be sealed to prevent spillage or damage.
- The design will not be available for use for anyone under the age of **18 years** of age.
- The main body cannot come dethatched from the rest of the body during use thanks to strong **10MM** screws and a support for extra grip
- The handle cannot become dethatched from the main body during functioning as it has a screw lock.

ANTHROPOMETRICS

- This is a portable device and the dimensions of the human hand are vital for carrying and transporting the device around. This is shown in the table below.
- The overall weight of the device will be light enough so that the device can be held and transported in **one hand** meaning it is mobile and **user friendly** at removing the nails. This is shown in the table below.
- All outputs **should be appropriately placed** for the **ease** of use of the operator. The trigger should be in a suitable place so that a finger or thumb can activate it **easily**.
- The display showing the amount of nails removed will be placed in a suitable position so that the user can easily see and identify the amount of nails removed without having to reposition the device.
- Every solution to the problem should be able to be operated by a range of users above the age of 18 years of age.
- The device will be shaped to suit the user hand of anyone over the age of 18 thus adding a comfortable grip to the device for heavy usage.
- Research has shown a symmetrical diameter of **50MM** is the average hand size capacity when holding a ball or handle or any shape adequate to the descriptions shown in the table below. My Design for both handles will be **52MM** in breadth and **48MM** in breadth.
- The main length of the handle will be **85MM** which can be see is adequate with the table shown below

Body Part	Male 5%<	Male >95%	Female 5%<	Female >95%	Design Size
Upper Limb Length	720MM	840MM	655MM	760MM	760MM
Shoulder Grip Length	610MM	715MM	555MM	650MM	650MM
Elbow Span	1555MM	1925MM	1490MM	1490MM	1750MM
Hand Length	175MM	205MM	160MM	190MM	190MM
Hand Breadth	80MM	95MM	70MM	85MM	85MM
Forward Grip Reach	720MM	835MM	650MM	755MM	760MM

FUNCTION

- The automatic nail puller will have to main functional processes. The first is a hammer mechanism followed by a scissor mechanism from **2 double acting cylinders.** This will give the best torque grip on the nail.
- The only major input is a **trigger operation** and which will only work when two small buttons on the front of the device have been activated, insuring the device is locked against the wood.
- The device is made to pull the nail out of the wood by at least **2 inches**. Making sure the nail is **completely** removed.
- The device will hammer the claws about **3mm** into the wood so that the claws can catch around the nail head.
- The device will be locked into the wood by **a safety mechanism.** Only when the safety mechanism is in place the claws can hammer and remove the nail from the wood it is placed in.

Existing Solutions

PRIORY 150 NAIL PULLER

Aesthetics The Proiry 150 Nail Puller is simplistic tool with very little aesthetical appeal. Its basic shape and rustic finish is unstylish and not appealing to most consumers. The tool does not stand out against other tools and although this is not a major purpose it is still important to attract the consumers eye.

Ergonomics Not much consideration to design has been paid when considering the ergonomical importance of the device/tool. It has no consideration for the hand size of different age groups of user and is very simplistic in its purpose of using a large force to effectively hammer the tool into the wood without making it in anyway more accessible and easy on the users hands.

Economics On the plus side the Proiry 150 Nail Puller has accomplished a quite remarkable inexpensive price of just £34.95 compared to its bigger brother the 250 series which is £65.95. Although this is reasonably inexpensive it is not the most inexpensive on he market and for this reason material choices must have been less careful selected.

Function The specific class of tool/device is simple and very hard to build on but in general a poor attempt to add functionality to this device has been made. Its basic hammer mechanism is effective but not accurate and cannot cope with a large force or pressure.

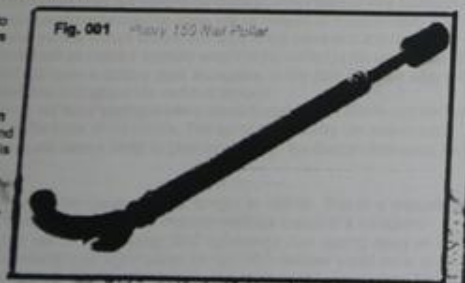
Manufacture The main body of the device is strong and durable due to well manufactured joints and weld around the main frame of the device. Its pump mechanism however is poor and flimsy showing a poor quality finish of manufacture compared to that of the rest of the device frame. Its strong claws help correct this problem and give the device a firm hold on the nail with a powerful hinge mechanism.

Material The material is a strong mild steel, although heavy it is durable and effective for its job and purpose. It is not capable of simple small fittings but capable of pulling nails on a large scale due to the strength of its materials.

Safety Possible the devices poorest feature is its lack of safety. Its simplest design is considered but overall its sharp claws have no protection and the pump mechanism (hammer) have no guard to prevent nipping the users hand or clamping down on the user in anyway. This device is particularly dangerous and a lot of changed could be made to improve and upgrade the device. Investigation shows that methods could be upgraded and used to create a better tool.

The diagram to the right shows the pump mechanism hammers the claws 3.00 – 6.00 mm into the wood and then the device is levered to removed to extrude the nail from the wood or another thick density material

Fig. 001 Priory 150 Nail Puller



Size, Shape and Dimensions The size and dimensions of the tool are similar to most tools in its category, its long funnel mechanism is approximately 280 mm by 38 mm with an inside extrusion of 33 mm for the rod. The pump retracts to 385 mm giving a large pressure force of 105 mm.

Overview

The Proiry 150 Nail Puller accomplishes its task of removing nails but the effort needed to do so is very large and makes the device very inefficient. Its Aesthetical appeal is very basic and functionality simplistic. Some useful ideas can be taken from this idea to create my design but a lot of improvements must be made to these ideas if the design is to improve and become more efficient.

BAHCO 38 NAIL PULLER 450MM

Aesthetics The Bahco 38 nail puller 450mm is slightly more aesthetically pleasing that the Priory 150 Nail Puller. It is more compact and slim line in design that the Proiry making it more appealing to the public and consumers such as joiner.

Ergonomics The device is very similarly enabled to be extremely economical as in both my other existing solutions. Small hand grips made to fit around the fingers help ensure a strong hold when hammering with the Bahco 38 Nail Puller 450MM and preventing injury or blistering.

Economics The Bahco 38 Nail Puller 450MM is slightly better priced than the other existing solutions. Priced at only £14.00 it is much more affordable for the everyday user or even for people in the business.

Function The device is much more suitable functionality than both other existing solutions. It is more capable at removing the nails than the original device but still has a simple usability. It does not have many functions other than to hammer in the claws into the wood and works as a lever to pull the nail back out of the wood.

Manufacture The body of the device is strong and durable due to well manufactured joints and weld around the main frame of the device. Its pump mechanism however is poor and flimsy showing a poor quality finish of manufacture compared to that of the rest of the device frame. Its strong claws help correct this problem and give the device a firm hold on the nail with a powerful hinge mechanism.

Material The material is a strong iron which is practical for the task, it is tough enough to withstand the wearing from being used in a toolbox and is strong enough to withstand large forces to remove the nail. Although heavy it is durable and effective for its job and purpose. It is not capable of simple small fittings but capable of pulling nails on a large scale due to the strength of its materials.

Safety As found with most tools in this category the device has not many safety features and is particularly dangerous if the user is not very capable or careful. The device claws are sharp and could easily injure the user but a small guard could have prevented this. This is a possible change which could be carried out in my design to implement a function to protect the users hands.

Fig. 002 BAHCO 38 NAIL PULLER 450MM

Fig. 003 BAHCO 38 NAIL PULLER 450MM

Size, Shape and Dimensions The size and dimensions of the tool are similar to most tools in its category, its long funnel mechanism is approximately 400 mm, 33 mm with an inside extrusion of 19 mm for the rod. The pump retracts to 47 mm giving a pressure force of 100 mm.

Overview

The BAHCO 38 NAIL PULLER 450MM is the most efficient of my three existing solutions, it is much more compatible with different sizes of nails and is strong and sturdy to hold but it is fully manual and needs a lot of effort to remove a nail, it is also large and clumsy to remove nails in small fine areas such as corner joints. Some ideas from the overall design may help me, in creating a more useful automatic nail puller but overall alot of upgrading and development will be needed, to make the device safer and more efficient for the average user and consumer to want to purchase one.

SHARK SAWS 21-2028 CHROME NAIL PULLER

02

Aesthetics SHARK SAWS 21-2028 Chrome Nail Puller has very little aesthetical appeal. Its basic design is large and sharp with very little appealing shape or imagination. Its bland colour is nothing less of basic and it has very little other colour to lift the tinge of satin.

Ergonomics The devices one strong point is its ergonomics. Its size is proportioned well for the size of an average users hand and it is much more comfortable to hold than either of the first existing solutions, the pump mechanism is short and effortless preventing the cause of a strain injury to a user, especially if the user will be needing the tool for continuous or frequent use. Its only downfall in this feature is its lack of grip in the users hand, a small pad of rubber would make this tool much more comfortable.

Economics The Bahco 38 Nail Puller 450MM is slightly better priced than the other existing solutions. Priced at only £14.00 it is much more affordable for the everyday user or even for people in the business.

Function The device is much more suitable functionality than both other existing solutions. It is more capable at removing the nails than the original device but still has a simple usability. It does not have many functions other than to hammer in the claws into the wood and works as a lever to pull the nail back out of the wood.

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Safety As found with most tools in this category the device has not many safety features and is particularly dangerous if the user is not very capable or careful. The device claws are sharp and could easily injure the user but a small guard could have prevented this. This is a possible change I could carry out in my design to implement a function to protect the users hands.

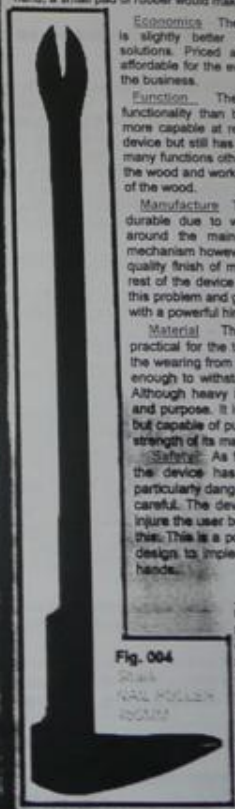


Fig. 004 SHARK SAWS 21-2028 CHROME NAIL PULLER

Size, Shape and Dimensions its long funnel mechanism is approximately 400 mm, 33 mm with an inside extrusion of 19 mm for the rod. The pump retracts to 47 mm giving a pressure force of 100 mm.

Overview

The BAHCO 38 NAIL PULLER 450MM is the most efficient of my three existing solutions, it is much more compatible with different sizes of nails and is strong and sturdy to hold but it is fully manual and needs a lot of effort to remove a nail.

AUTOMATIC NAIL PULLER

PROBLEM IDENTIFICATION AND DESIGN BRIEF

01

AUTOMATIC NAIL PULLER

PROBLEM BRIEF

In the construction and manufacturing industry there is a large demand for a device which can remove nails easily and quickly. Many hand held manual devices for pulling nails of every size and shape have been designed to help the needs of everything from Joiners and Builders to Gardeners, Design Manufacturers and Schools, Universities, Colleges and other teaching manufacture areas. Removing strong iron nails from wood such as oak and other hard woods can take a large amount of force with the use of a manual tool which is nearly to extreme for the strength of an every day human being, for this reason it seems necessary to produce a product that can carry out this task automatically without any effort from the user.

The problem with these devices is they are completely manual and are not very user friendly for there task, the effort taken to pull a nail from most woods using a manual nail puller is five times as much as the effort needed to hammer the nail into the wood in the first place.

It is apparent there is a gap in the tools and equipment market for the design of a fully automatic nail pulling device and semi-automatic mechanisms for removing nails, most of these attempts were either failures or had not fully developed the idea of creating an easy to use and efficient nail puller which needed very little effort from the user to carry out its purpose.

On further inspection it was found that most manual nail pulling devices left large marks, imprints or even cracks in the wood the nail had been removed from. It was found that most manual nail pulling devices left large marks, imprints or even cracks in the wood the nail had been removed from. There is a need in the industry category for a nail removing gun which would cause very little if not any damage to the nail or wood in question meaning the nail and wood could be re-used as needed in any case for most applied Professions. The purpose of the design would be implemented by its efficiency and would have to imply that any area or depth of nail head could be removed.

Overall it has been proven that in several key trades there is a need for an automatic nail pulling device which would increase the specific areas including the speed, efficiency and quality of certain areas of particular trades such as Joinery and Building much more sufficient.

WHO?

The product will be designed for a wide range of users to perform almost the exact or similar purpose. The user age group will be for only 18 year olds only due to the dangerous automatic high power hydraulic tools such as nail guns and in this case nail pullers. The main user group will obviously consist of joiners builders electricians plumbers and most employees in the grafting and manufacture trades. The design application will be made to fit specifically around the needs of these major trades as well as the needs of schools and universities for subjects such as Art and Technology And Design.

Professions Include:

Manufacture Professions: Joiner, Contractor, Plumber, Electrician and Technician
Engineering Professions: Civil Engineers, Structural Engineers, Mechanical Engineers a
Teaching and Colleges: University workshops, Secondary School Workshops, Contracting Colleges

Gardeners and fancers have a large need of equipment to produce a device for removal of stapes and nails.
(Other uses include for every day use such as gardening, everyday house maintenance and many others)

WHAT?

The product will be used to remove nails quickly, efficiently, and without any effort from the user from almost any shape of density of wood with any nails up to 6 inch in size.
It will be handheld and portable so that users can use it anywhere and in tricky areas and positions.

Its size will be as slim line and mobile as the components making up the mechanics and electricals of the device allow and it will be easily adjusted to suit different sizes of nails and wood for different densities and grains of the particular wood in question. Overall it will be made to be comfortable and effective in its purpose.

It has been identified that the devices of closest similarity on the market are much to large and clumsy
And therefore a nail pulling device which is small and compact should be constructed.
The product will be capable to removing nails without any user involvement other than the pulling of a trigger or level but will not need any other such effort such as hammering force or pumping mechanism applied from above.

DESIGN BRIEF

I intend to design an automatic, quick and efficient nail pulling device which is small and robust and capable of fitting in small corners or areas where usually it is impossible to remove a nail or staple from. It will have be capable of removing up to 6 inch nails or 3 inch staples from most woods and be durable against wearing and weather conditions such as rain. It will be fully mobile and contain no external components which could cause injury or be damaged by a user or conditions such as by the weather or water in general.

WHERE?

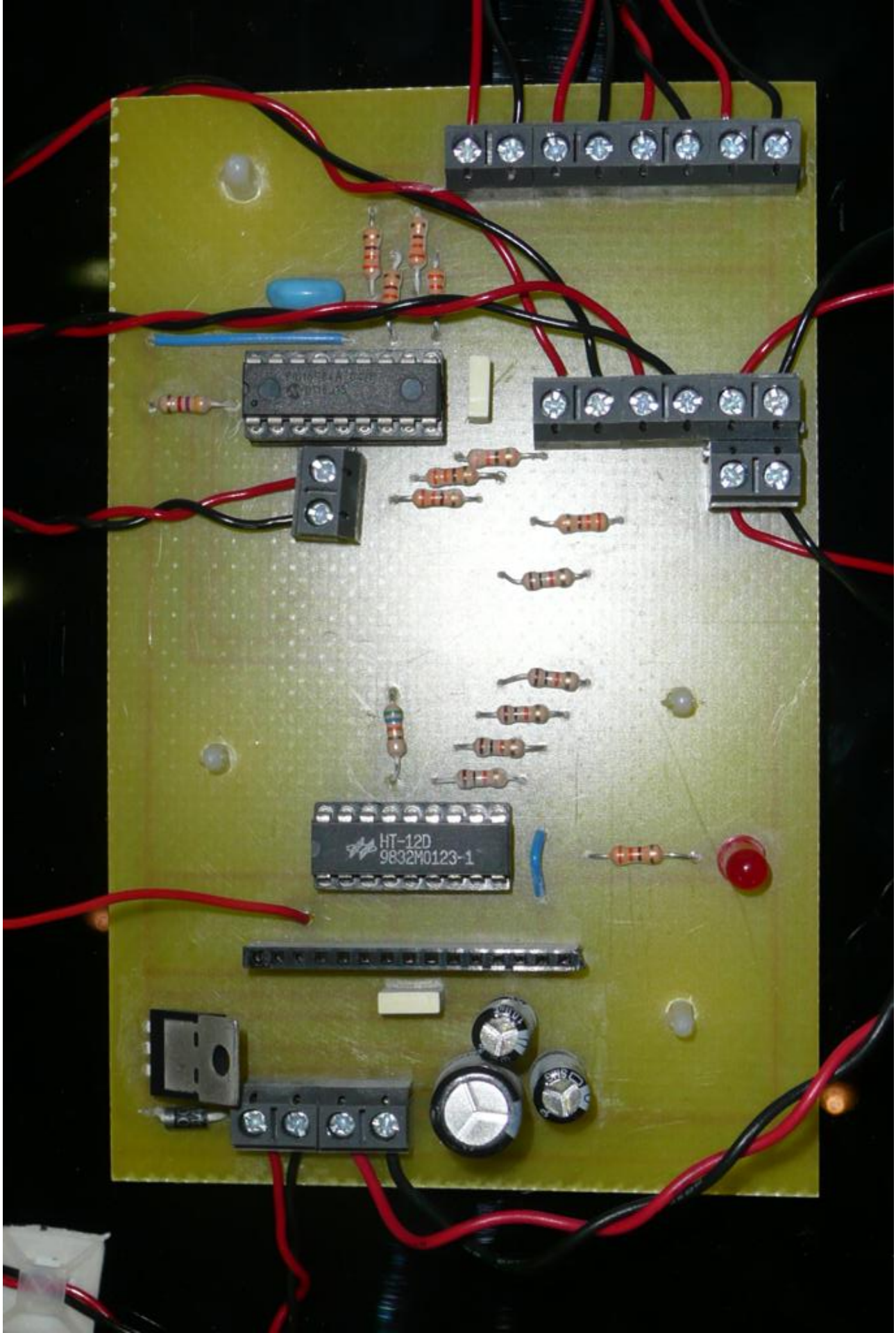
The product is mainly to be used in industry or joinery and building sites and areas. The device will Therefore need to be waterproof to prevent the electrics and pneumatics getting splashed or soaked when used outside in bad weather conditions.
It will also need to be able to withstand a lot of pressure and external force on its casing due to the heavy duty use and situations were it will be used by the consumer. The ability to fit in small spaces is also important giving the user an ease of use in any position needed.
It would be capable of clamping to a large body to give extra grip for large nails or dense wood with strong grain lines.

WHEN?

The product is most likely to be used during the opening hours of **9.00AM and 5.00AM** due to the fact this is the normal working hours of users such as builders, joiners and manufacturers. The product could be used in a large scale in industries during specific periods of time between these working hours.
It would also be used in the afternoons and evenings by average house hold owners to carry out work and maintenance on houses or gardens and many other household appliances that may need maintenance. The dev ice will be made for day use because during the night it would be dangerous to use a pneumatic system such nail pulling device.

WHY?

The product is designed to be more efficient and effortless for users such as joiners and builders to remove nails quickly and without causing damage to the nail or wood applied to.
There is a need for a fully automatic nail pulling device on the market which is mobile and slim line as well as small and compact. Most manual tools for the specific job are large and clumsy and unusable in small specific situations which require accuracy and large force to be applied to overcome the friction force of the nail to the wood therefore making it a desirable device.
There is a need for a fully automatic nail pulling device on the market which is mobile and slim line as well as small and compact. The design would have to consider the implications of Large nails in very thick wood or high density objects.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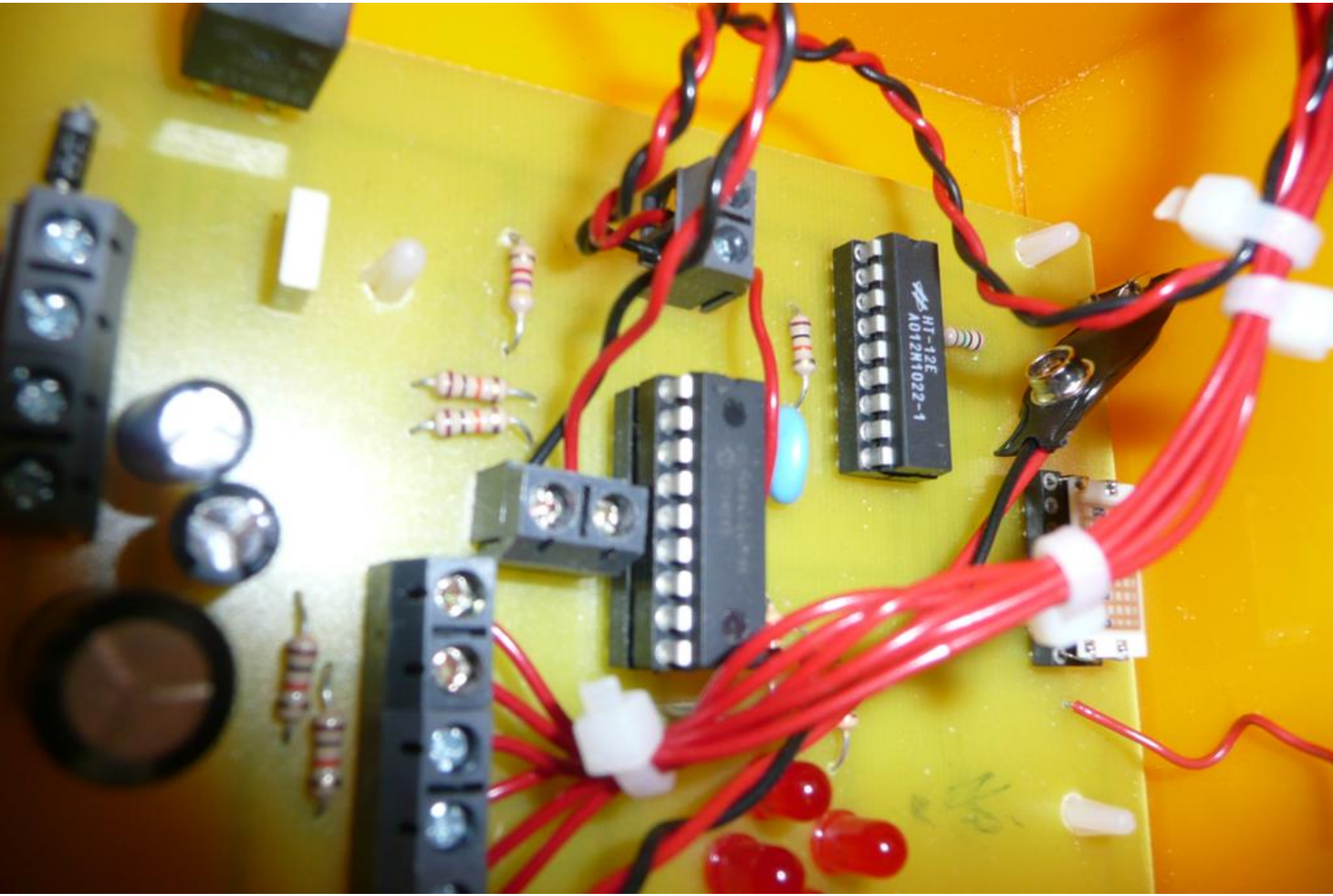
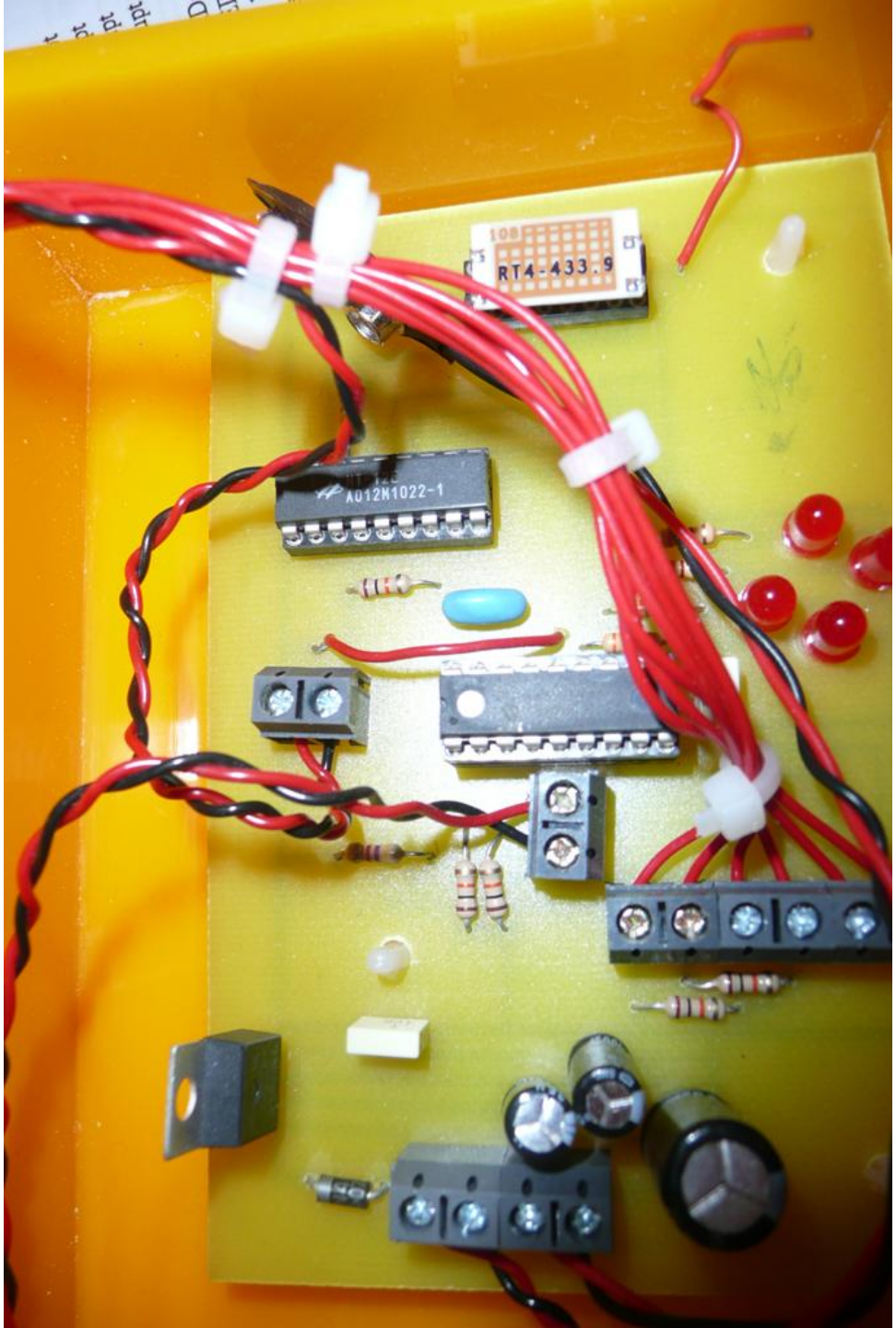

HT-12E
A012N1022-1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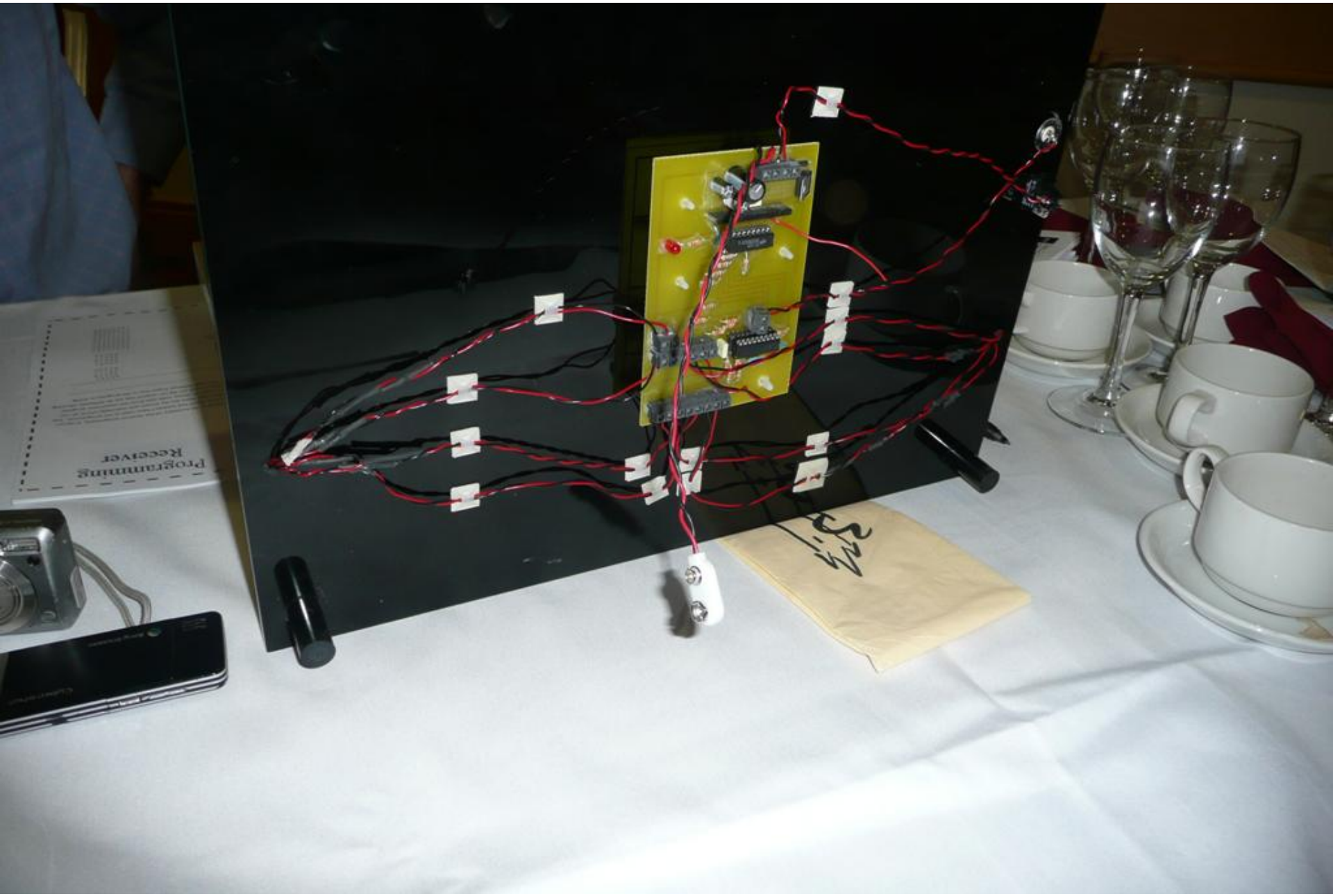
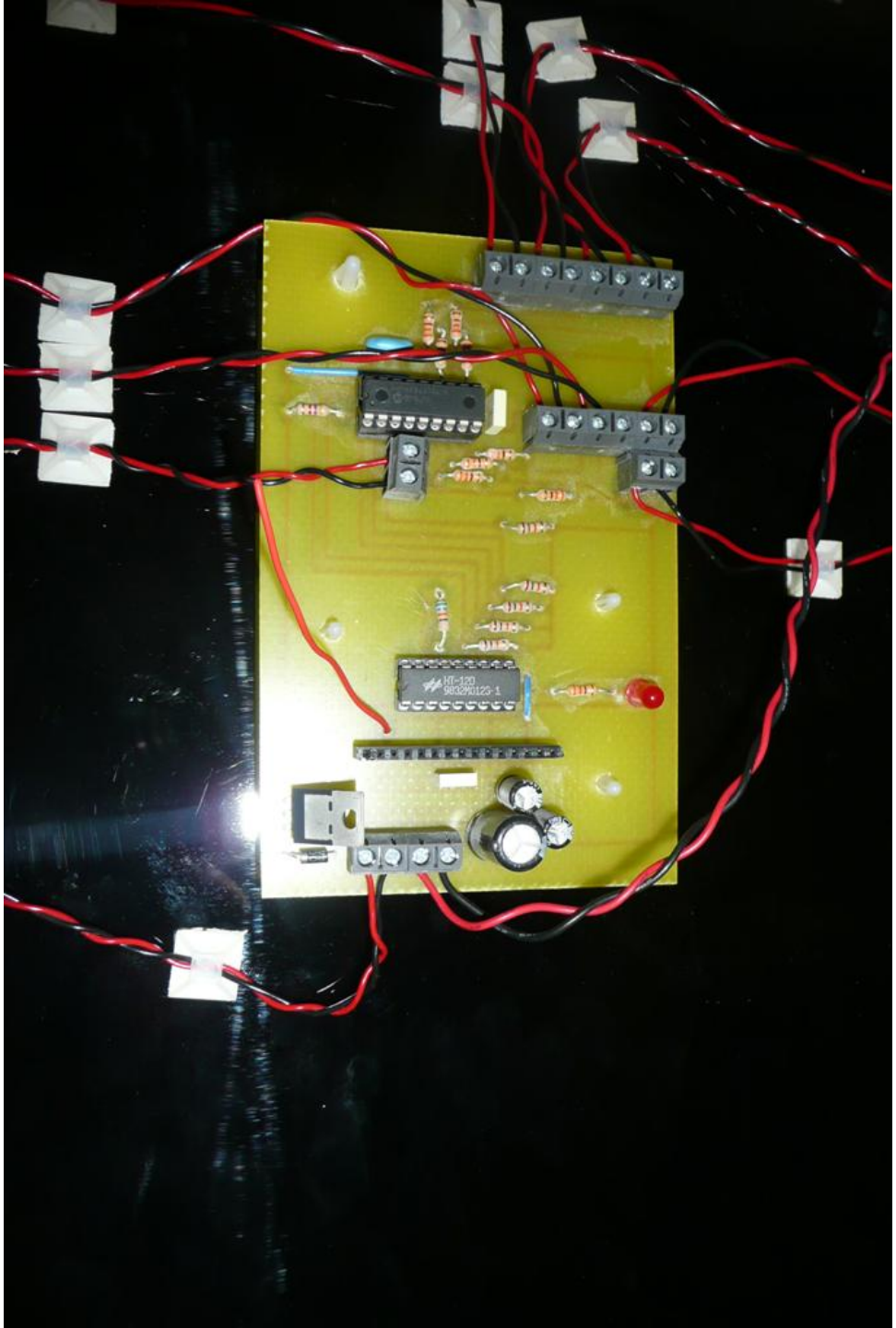
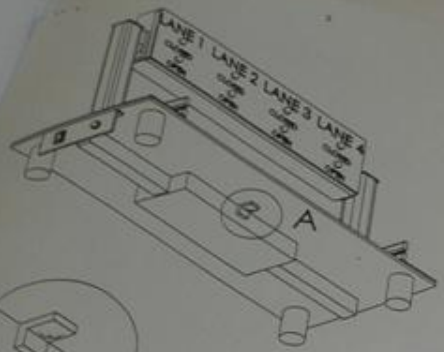

Programming
Receiver


HT-12D
9832M012S-1

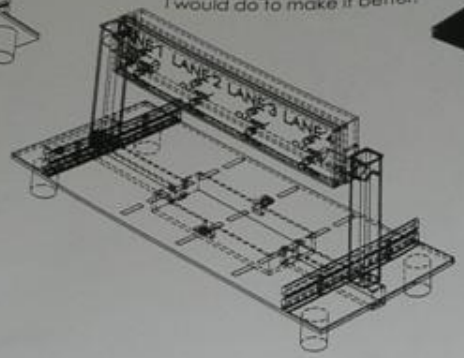
Modifications



DETAIL A
SCALE 1 : 2

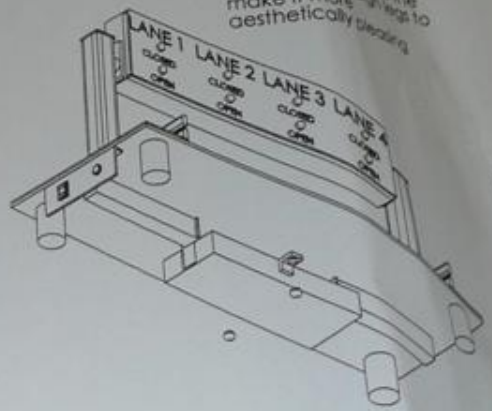
this detailed view shows that the box is attached by two screws on either side of the box.

On this page I have several views showing the way that, if I were to make my receiver product again the modifications I would do to make it better.



DETAIL B
SCALE 2 : 5

The detailed views B and C show my other modifications which are the barriers either side of the motors and the other side protect the sign and the filleting on the sign legs to make it more aesthetically pleasing



DETAIL C
SCALE 1 : 2

The views to the right and left show how I have designed a box so that it can be attached under the road so that it is able to house the circuit and the two tunnels allow for the passage of the wires from this box to the sign.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

FINISH:

DEBUR AND BREAK SHARP EDGES

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APPV'D			
MFG			
Q.A			

MATERIAL:

WEIGHT:

TITLE:

Modifications Drawing

Evaluation

Transmitter

Now that I have finally completed my transmitter and receiver products after much hard work and I see what my original designs on paper have become physically, I am extremely pleased with the outcome.

Now a day's road and motorway signs have become a very important part of the modern infrastructure. Without these signs our roads and motorways would be constantly blocked with traffic. I think my product would be an extremely good sign to be put into production and placed on motorways because it is a very effective sign due to the fact that the information on it can be instantly changed by the touch of a button. For my sign to be used to its best it would require one operator to watch the stretch of motorway ahead of the sign and if there are any cause of delays to the traffic in front of the sign such as a traffic accident, the user simply has to press a button on the transmitter product which he would be carrying with him and this would instantly tell the users that a certain lane on the motorway will be closed.

I think my transmitter is a very good design as it is a very simple design but yet it fulfils it function very well. The layout of the buttons is a very effective layout as the user will be able to learn the layout of the buttons after several hours use, the labels for the buttons also benefits any first time users as they well instantly know which button to press and the layout of the buttons in relation to the handles gives the product a very comfortable feel. The positioning of the reset is another factor that adds to the comfort of the product when the user is using the product because with the reset button at the top left corner on the back of the box the user does not have to adjust their grip on the handle. The position of the left side handle is also a factor that benefits the comfort because the handle is in tight to the box so as the user can get closer to the output buttons with their fingers.

The circuit layout for my transmitter is very good as all of the terminal blocks for the wires of the switches and battery connector are easily accessible for wiring the rest of the layout was very good as I didn't need any jumper wires to make sure the circuit would be complete. Also all of the circuitry fitted into the main box easily so the main box could have actually been manufactured smaller but this would also end up affecting the space for the buttons and labels so the layout of the buttons would have to be changed.

The aesthetics of my transmitter product are very good as I feel that the blue of the main box and the black of the handles are very complimentary and the white buttons and white labels also contrast very well with the blue and black. The anthropometrics of the product satisfy adult human measurements but at the same time the overall size of the product could be made smaller.

Receiver

My receiver product I believe was a complete success as the aesthetics of the product are great because the blue of the road sign contrast well with the black of the road. While again the white labels for each of the L.E.Ds that are displaying the information contrast well with the blue sign. The layout of the L.E.Ds are very simple as they are similar to the layout of a traffic light with the red L.E.D at the top to signal closed and the green L.E.D at the bottom to signal lane open. Each of the L.E.Ds have been labelled closed and open and a label for each lane above two L.E.Ds. This layout makes it very easy for any motorway users to have a quick glance at the sign and they will instantly know if the lane they are driving in is opened or closed. The colour does not just benefit the aesthetics of the product but the strong blue is also eye catching so this results in catching the motorway users eye so they are able to see the information displayed and the colour of the sign does not produce any glare so it does not distract the motorway users. For each lane the sign has been equally divided up so that each lane is given an equal section of the sign so as the driver in one lane does not get confused as to which L.E.Ds are displaying information to their lane.

I think that the now that I have finally manufactured the whole product I feel that it is a very strong product as the way in which the main sign is connected to the two legs contains a lot of contact area where they have been glued which it makes it very strong. Also the rectangular legs instead of the cylindrical legs give a stronger leg and a better way of connecting the main sign to the legs.

The layout of the circuitry I think is one of the best factors of this product because with the main circuitry all contained below the road and the wires for the L.E.Ds pass from under the road up the legs and into the main box to the L.E.Ds, the main box is a very good idea i think because it allows you access to the L.E.Ds if one needs to be changed and it gives protection to the wiring of the L.E.Ds. Also below the road where the main circuitry is kept there is good access to the battery and the position of the power and reset switch at the side of the road is in a good position as they are at the side for easy access. The circuit board itself was quite well laid out also as there was only need for two jumper wires in the circuit to make it complete and also the position of all terminal blocks for the L.E.D wires is very good as they can be easily accessed.

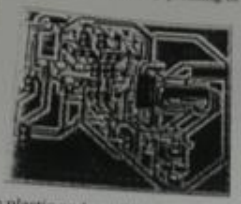
The problem with my receiver product is that everything about it is very square with corners so in other words if the projects had more curves it would look better. The other problem would be with the circuitry under the road, although it is good that it is easily accessed a cover or box of some sort to protect the circuitry from water would be a benefit overall

In conclusion I think both of my projects were a success as they both fulfilled their function and they both fit well into their environments. Even so they are not perfect projects and there are always modifications that can improve my projects.

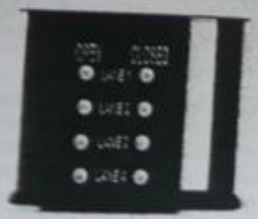
Modifications During Manufacture

During the manufacturing of my transmitter and receiver product I realized that some aspects of my designs on paper would not be easily manufactured and some aspects were also not going to make the products aesthetically pleasing or strong enough.

1. In the making of my transmitter the first modification I made was to not fillet the inside corners of the main box and the corners of the inserts. This would have been a very delicate procedure to do as I was using three-millimetre plastic for my box and inserts and to get these filleted would have been very difficult with such thin plastic. I thought about using five-millimetre plastic for the box but I thought this would have made the box too bulky and heavy so the best option was to stick with the three millimetre plastic and not fillet these sections.



2. During the development of our transmitter and receiver circuits I made several changes in the layout of the components. I did these to make the circuit as small as possible as this would allow me to have a smaller box that would be containing the circuit board and battery.
3. Also while developing my circuits, I had to manually auto-route each circuit because when I let the computer complete the auto route I was getting a very low percentage of around 15% for each circuit so when I auto routed them myself I was able to get the percentage up to around the high 70s.
4. When I was wiring both of my transmitter and receiver circuits I found that my wiring was very untidy so I decided to use cable ties in my transmitter circuit to keep the wires together and reduce the mess while in the receiver circuit I used small pads as well as the cable ties so that the wires would be kept up against the underside of the road and would not be hanging down.
5. When it came to wiring in my circuits I decided to use white push button switches instead of red ones because I felt that they would look better than red ones as they would match the white labels and they would also contrast stronger with the blue and black of the box more than they would if they were red. Also I decided to make the reset button a blue push button switch instead of a red or white one to highlight that it was the reset switch and not an output switch.



6. During the manufacture of my receiver product I was going to be using eight red L.E.Ds to signal the outputs but I decided that I would use four red and four green L.E.Ds so that the green L.E.Ds would be signalling that the lane is open. This would give the sign a similar layout to the traffic light so that the red would be at the top for lane closed and green at the bottom for lane closed, just like a traffic light sign red for stop and green for go.

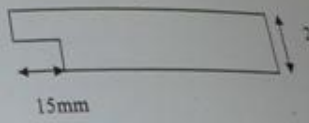
Plan of Manufacture

Transmitter

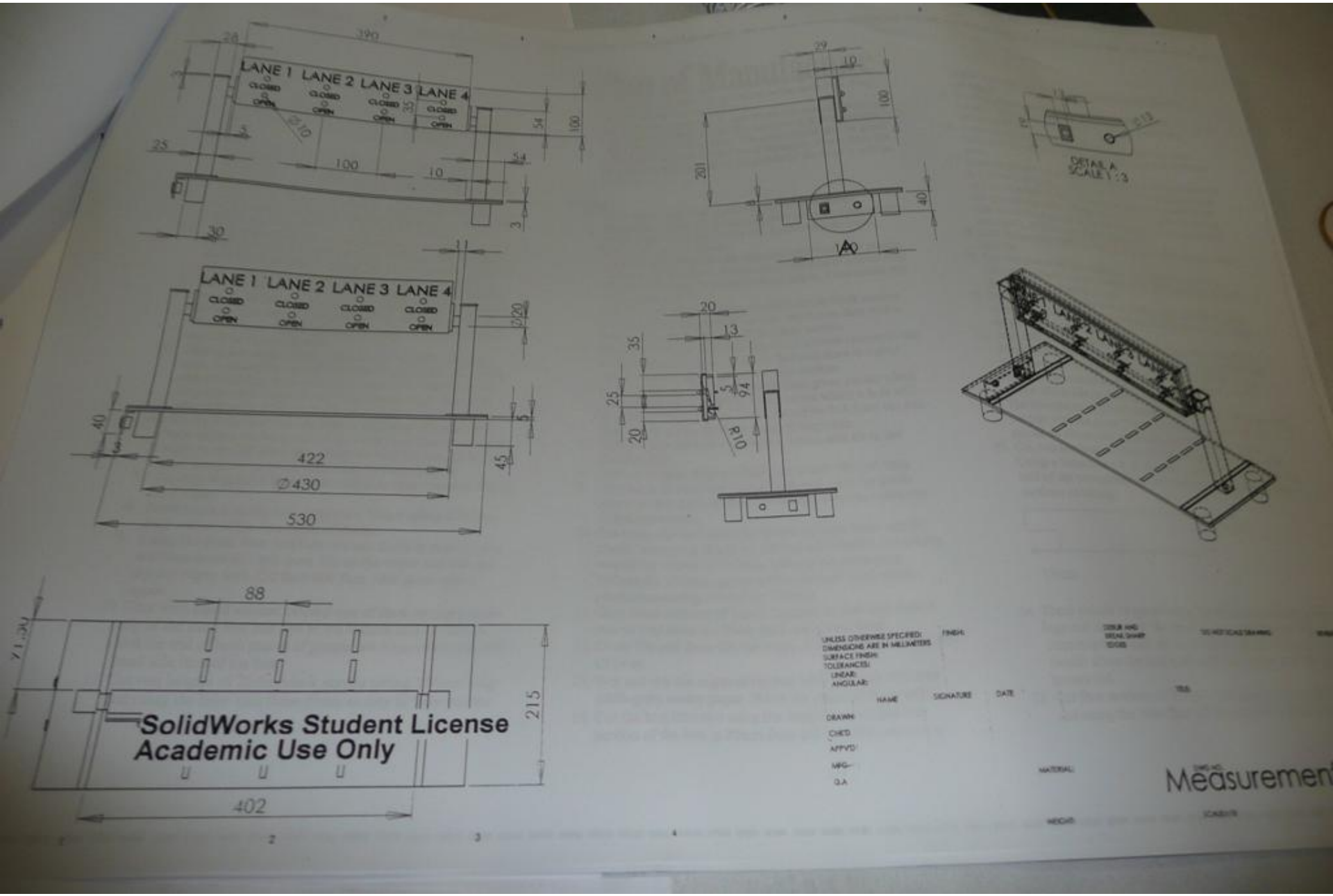
1. Cut two pieces of 3mm blue acrylic plastic measuring 174mm by 120mm, another two pieces measuring 114mm by 50mm and another two pieces measuring 174mm by 50mm. Glue the one 174mm by 120mm piece of plastic with the four other pieces so that they form a box with no lid.
2. Cut two pieces of 3mm blue acrylic plastic measuring 168mm by 15mm and another two pieces measuring 114mm by 15mm. Glue these four lengths of plastic with liquid solvent cement to the spare piece that measures 174mm by 120mm so that they are all 3mm from the edge of this main section and that they from of box of inserts that will fit into our first box. This will be the lid.
3. Cross-file and draw file all the edges where the plastic has been cut or joint to another piece. Wet and dry the edges of these three sections of plastic with 320 then 600 then 1000-grain emery paper. Then polish the edges of the plastic.
4. Take the lid and on the side that doesn't have the inserts mark out 8 holes with a scribe so that the bottom left hole is 30mm from the bottom edge and the side edge. The holes above this should be spaced at 35mm and the hole across should be spaced 40mm.
5. Drill these marks using a 10mm drill bit in the pedestal drill. A final hole should be marked and drilled above the rest so that it is in the centre of the box in relation to the side edge and 30mm down from the top edge. This hole should then be filed so that it measures 13mm by 19mm.
6. On the large box that has been manufactured mark out a hole using a scribe so that it is 20mm from the top and side edge on the left hand side of the back of the box. Drill this mark using the pedestal drill with a 10mm drill bit.
7. Cut two lengths of blue 3mm plastic so they measure 50mm by 210mm.
8. Mark using a scribe and compass a 10mm radius fillet on each corner of the two strips of plastic.
9. Using the band facer send the corners down to these marks and then cross-file and draw file all the edges and wet and dry the edges with 320 then 600 then 1000 grain emery paper.
10. Glue with liquid solvent cement one of these sections to the top of the main box and one to the bottom face to face so that the end of both pieces of plastic are 50mm from the left hand side face of the box.
11. Cut two lengths of 25mm black acrylic tubing 176mm long and using the lathe turn these down so they fit between the two pieces of plastic you just glued to the main box. They should measure around 174mm.
12. When to size, place one in tight to the left side of the box so they it is the middle of this face and glue it in this position using liquid solvent cement. The other should also be glued using liquid solvent cement but it should be 30mm from the right face of the box and in the middle of the faces it will be glued to.

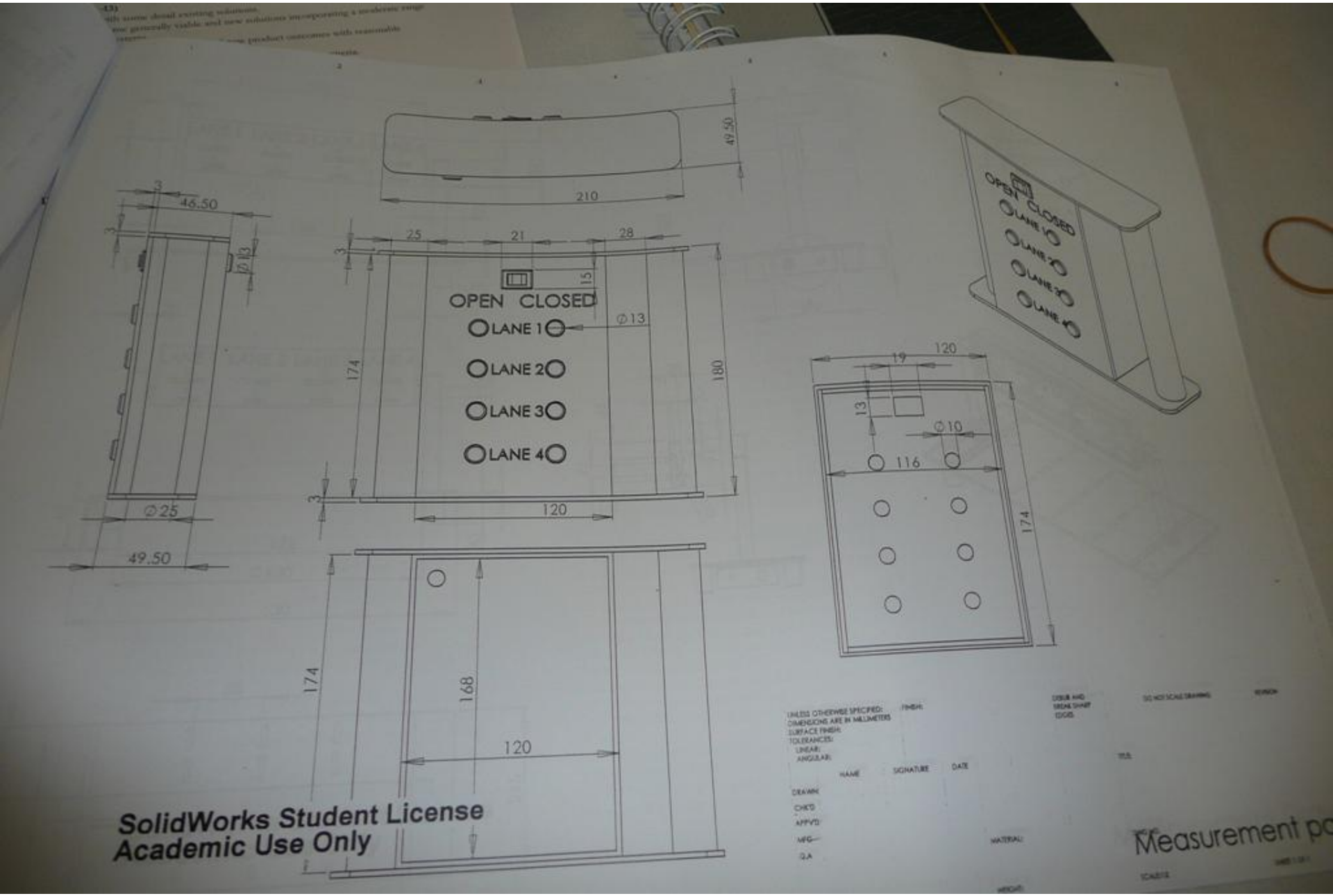
Receiver

1. Cut using a band saw, a piece of black 5mm plastic measuring 215mm by 530mm, a piece of green 3mm plastic measuring 215mm by 54mm and a piece of grey 3mm plastic 215mm by 10mm.
2. Cross-file and draw file the edges of each section of plastic.
3. Wet and dry the edges of these three sections of plastic with 320 then 600 then 1000-grain emery paper. Then polish the edges of the plastic.
4. Glue the two green sections of plastic to the black section with liquid solvent cement, so they are face to face with a green section at either end of the black section.
5. Glue the two grey sections with liquid solvent cement to the black section, so they are face to face and there is a grey section tight to the edge of each grey section.
6. Mark on the top of each of the sections green plastic which has been glued to the black with a scribe where a hole will be drilled, in the middle, which should be 103.5mm up, and then 42mm across from the edge of the plastic.
7. Drill the two marked holes with a 10mm drill bit in the pedestal drill.
8. Cut two lengths of grey 25mm box plastic 201mm long.
9. Glue each of these two box sections end on to the green plastic so that each of them are directly over the holes you drilled previously.
10. Cut using the band saw, two pieces of 3mm black acrylic plastic measuring 40mm by 100mm and another two pieces measuring 40mm by 390mm, and a piece measuring 390mm by 100mm and cut a blue piece of 3mm acrylic plastic measuring 390mm by 100mm.
11. Glue these sections of plastic together so that they form a box so that there is a black back and a blue front.
12. Cross file and draw file the edges of the box so that they are all level
13. Wet and dry the edges of the box with 320 then 600 then 1000-grain emery paper. Polish the edges of the plastic.
14. Cut the box into two using the hanger saw so that one section of the box is 30mm deep and the other section is 10mm, and then finish by lightly draw filing these newly cut edges.
15. Cut four pieces of black 5mm acrylic plastic, so two measure 20mm by 187 mm and two pieces measuring 20mm by 97mm.
16. These four sections will be the inserts for the box. Glue these with liquid solvent cement into the box that is 30mm deep.
17. Mark on the box with the blue face using a scribe where the L.E.Ds will be going. There should be two marked 45mm in from the end of the box and one should be 40mm from the top and the other 15mm below it. The next two should then be 100mm across from the first and so on, until there are eight L.E.Ds on the face of the box.
18. Drill these eight marks with the pedestal drill using a 10mm drill bit.
19. Cut two pieces of 3mm black acrylic plastic measuring 18mm by 45mm and cross-file, draw file and then wet and dry the edges of these pieces.
20. Drill a 20mm diameter hole in each of the pieces of plastic with the pedestal drill in the centre of the plastic but 10mm up from the bottom end.
21. Also drill a 20mm hole on the both sides of the box that is 30mm when the lid is on so that the hole also goes through the inserts on the main box. These holes should be 15mm up from the bottom of the box and they should be in the centre of the side in relation to the edges.
22. The two pieces of plastic should then be glued to the side of the box with the other 20mm holes so that there are two pieces on either side and the holes match up perfectly.
23. Cut two sections of 20mm black tubing 60mm long each. Using a lathe face off all ends for a smooth finish. Then cut half of the circumference off 15mm in on one end of both sections of tubing.



24. These should be glued using liquid solvent cement to the legs and the box at the same time so that the end with the circumference half cut is in the box tubing. When glued this should allow the box to be held in position with out any human aid.
25. Cut four sections of 30mm black tubing to a length 45mm and using the lathe face off the ends for a smooth finish.


LANE 1 LANE 2 LANE 3 LANE 4
CLOSED
OPEN
390
100
422
Ø430
530
88
215
402
DETAIL A
SCALE 1 : 3
SolidWorks Student License
Academic Use Only
Measurement


49.50
210
3
46.50
3
Ø13
25
21
28
3
15
OPEN CLOSED
LANE 1
LANE 2
LANE 3
LANE 4
Ø13
174
180
3
120
Ø25
49.50
174
168
120
19
120
13
Ø10
116
174
OPEN CLOSED
LANE 1
LANE 2
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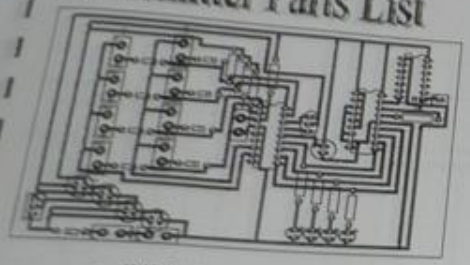
LANE 4
SolidWorks Student License
Academic Use Only
Measurement po

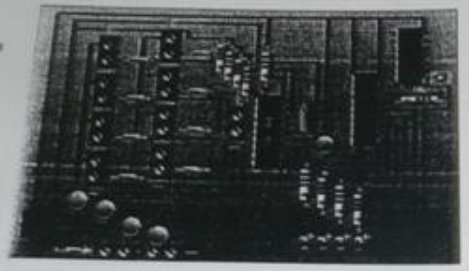
Transmitter Parts List



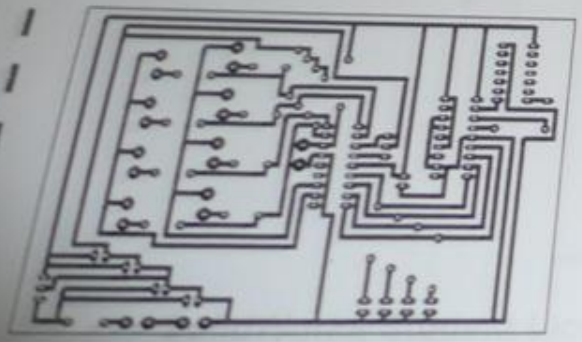
- 4 x 100µF Electrolytic Capacitor
- 1x 100nF Electrolytic Capacitor
- 1x 7805 Voltage Regulator
- 2x 18 Pin PIC Microcontrollers
- 1x Single in line pins
- 11x Terminal Blocks
- 1x 3 pin Resonator
- 4x 3mm L.E.Ds
- 9x Diodes
- 4x 330Ω Resistors
- 4k7Ω Resistor

- 1MΩ Resistor
- 4x 10kΩ Resistors
- 1x 9 volt Battery
- 9x Push to Make Switches
- 1x Toggle Switch

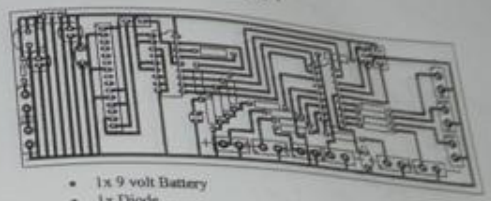
REAL WORLD VIEW



ARTWORK VIEW

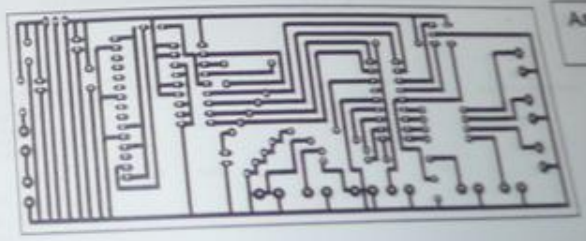


Reciever Parts List



- 1x 9 volt Battery
- 1x Diode
- 1x Toggle Switch
- 1x Push to Make Switch
- 1x 1000µF Electrolytic Capacitor
- 3x 100 µF Electrolytic Capacitor
- 1x 100nF Capacitor
- 1x Receiver
- 1x Decoder
- 1x 18 Pin PIC
- 1x 1MΩ Resistor
- 5x 10k Resistors
- 9x 330Ω Resistors
- 1x 4K7 resistor
- 9x LEDs
- 1x Resonator
- 1x 7805 Voltage Regulator
- 12x Terminal Blocks
- 4x One Pin SIL

REAL WORLD VIEW

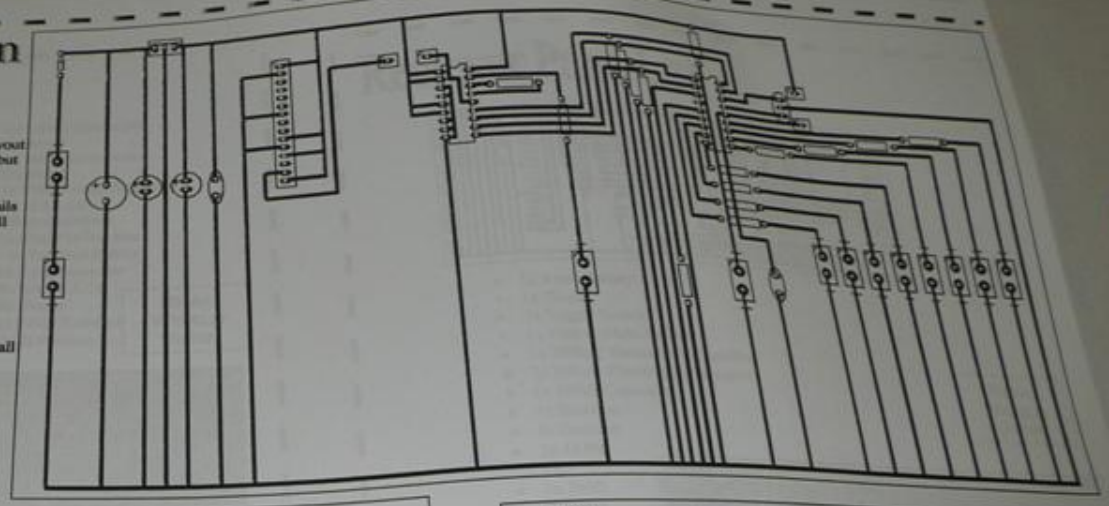


ARTWORK VIEW

PCB Layout Design

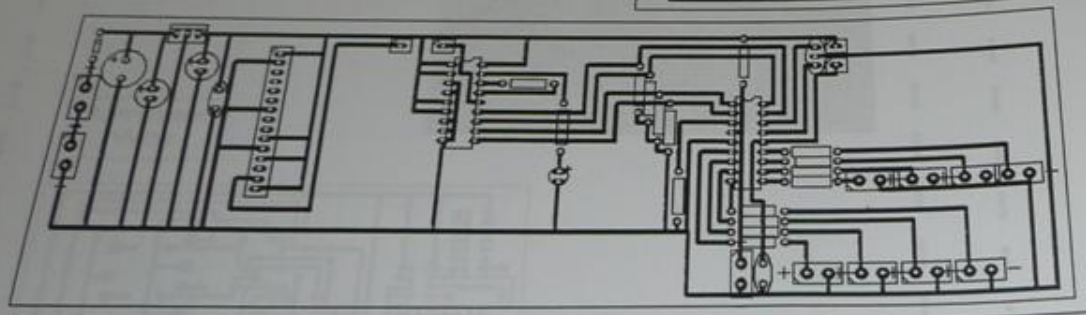
Stage 1

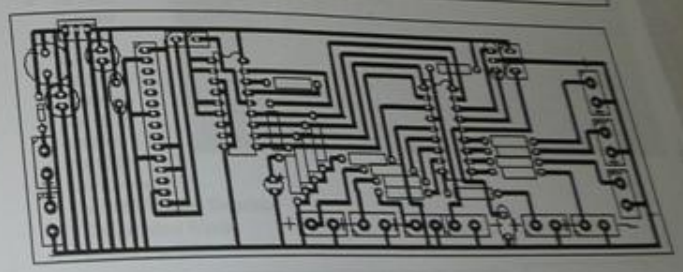
In the image to the right you can see my final PCB layout for my receiver circuit. I have completed my receiver circuit but it is very large so the next stage I will do is make my layout much smaller. I will do this by moving all components closer horizontally and vertically and move the + volts and o volts rails closer. You can see that there are large spaces free where I will be able to move the components closer to each other.



Stage 2

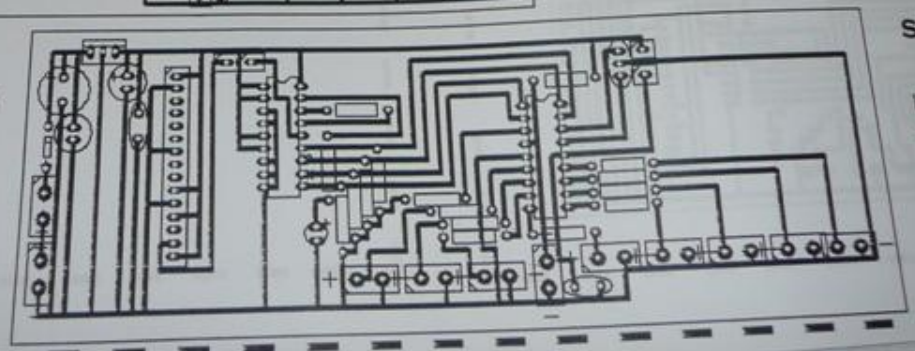
The second stage of my PCB layout is shown in the image below. In the image you can see how I have compacted all the components on the PCB layout. I have staggered the capacitors of the power supply so they can move closer and all the PICs have been moved closer. There are still some areas of space so in the next stage I will be able to move all the components closer.





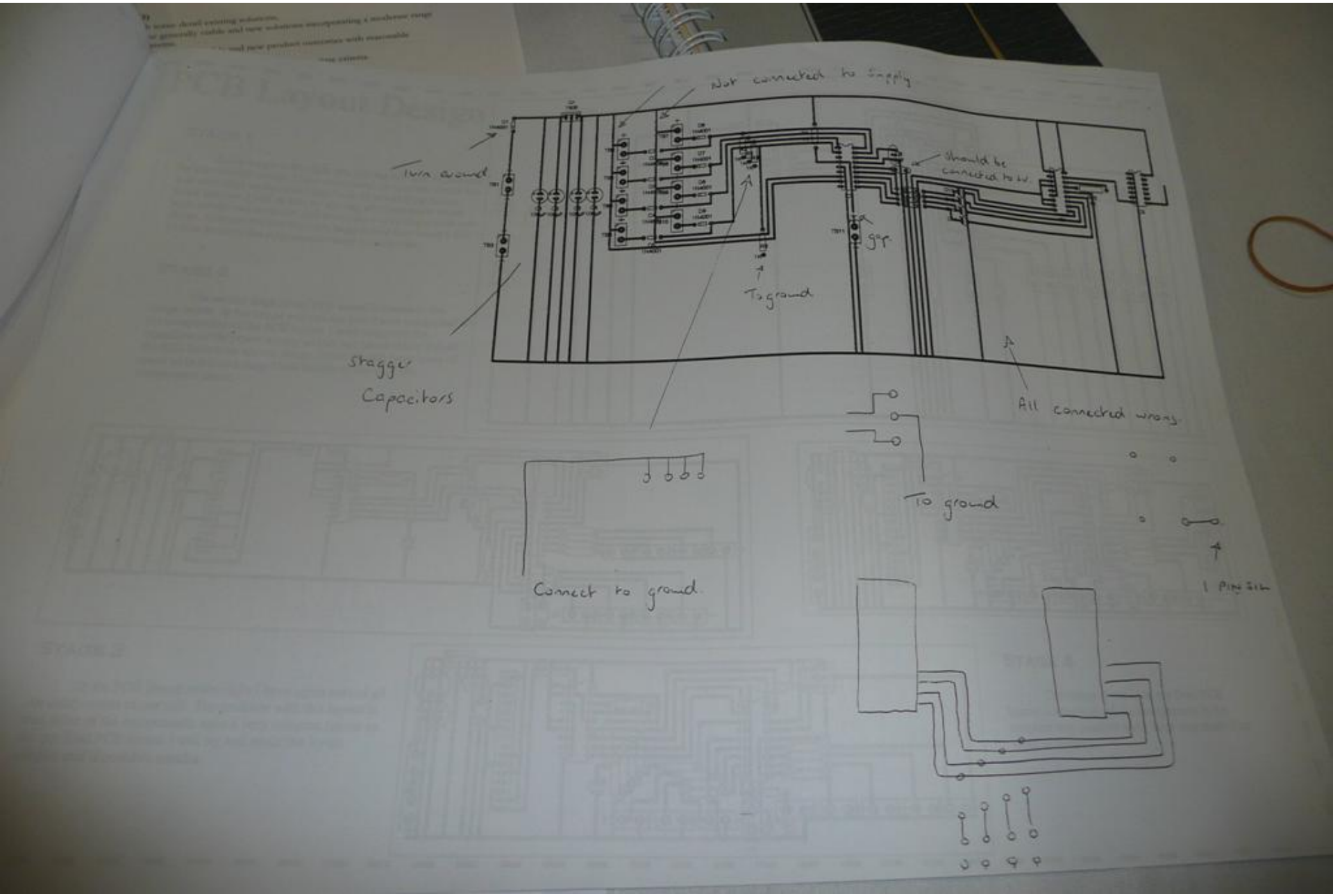
Stage 3

In the PCB layout to the right I have again moved all the components closer still. The problem with this layout is that some of the components have a very complex layout so for my final PCB layout I will try and make the layout simpler and if possible smaller.



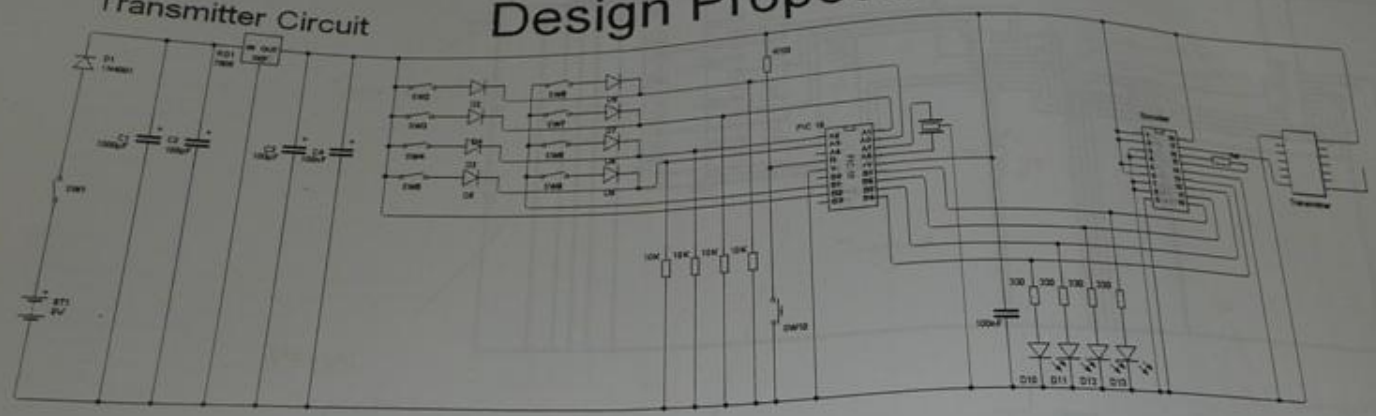
Stage 4

The image above is of my final PCB layout. I have laid out the components in the simplest way possible and I have also made it as small as possible.

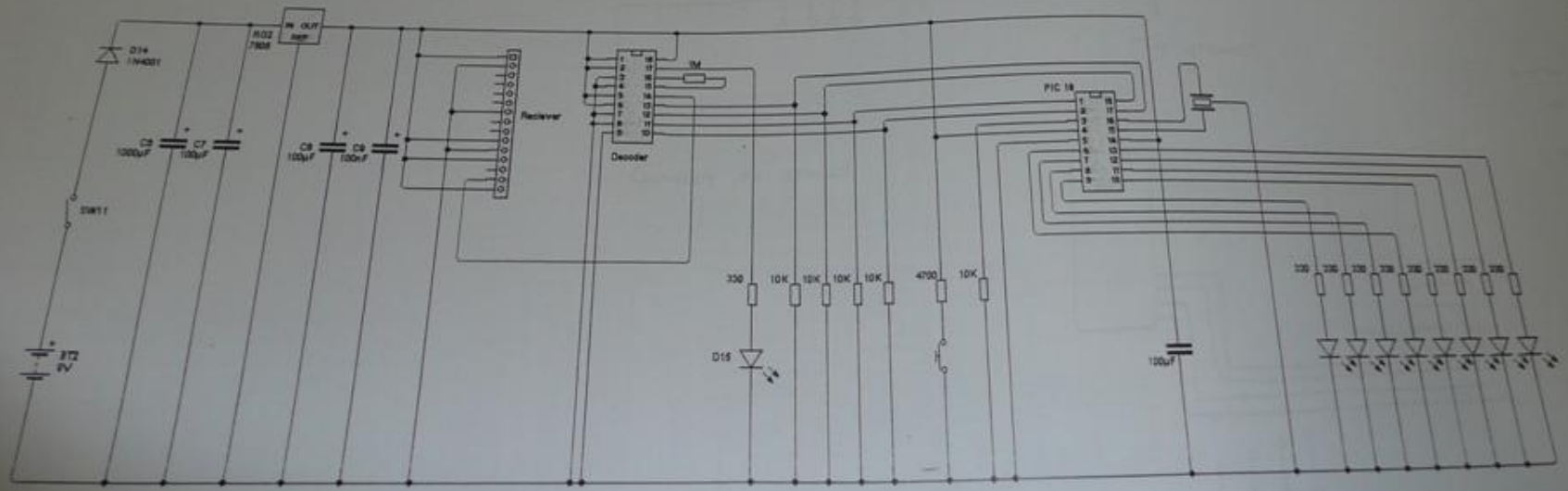

Not connected to supply
Turn around
Should be connected to 5V
To ground
Stagger Capacitors
All connected wrong
To ground
Connect to ground
1 PIN SIL

Design Proposal

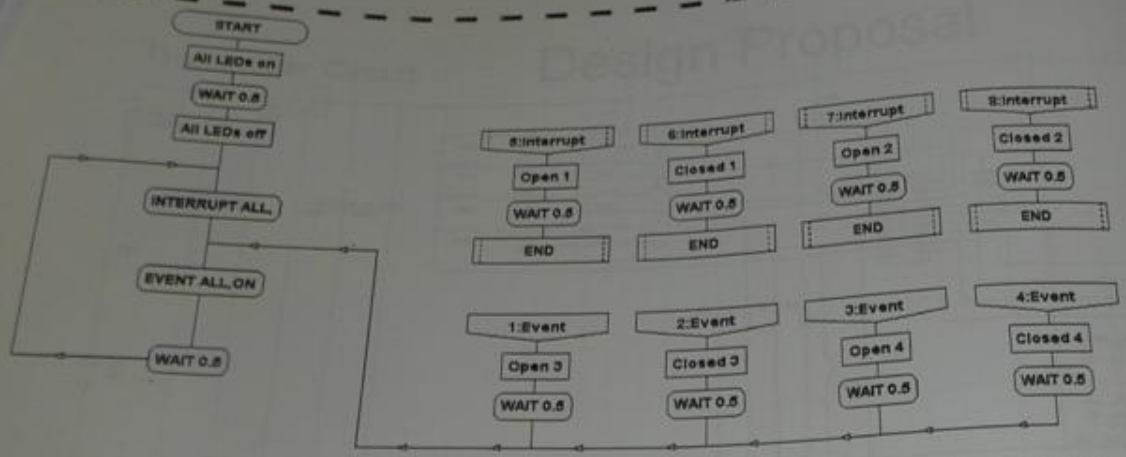
Transmitter Circuit



Reciever Circuit



Programming Receiver



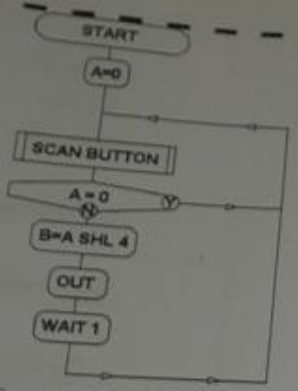
Below is the summary of the receiver programme. It shows which inputs and outputs I have used in my programme. The first eight items are my events and interrupts which all run through the binary code sent from the transmitter program. Below those are the ten outputs that are all different, showing what each different output box in the program is doing.

Above is the main part of my receiver programme. It begins with an OUTPUT box that will turn on all the L.E.Ds and is then followed by a WAIT of 0.5s so that the user can look to make sure the L.E.Ds actually turned on. Another OUTPUT follows this so that all the L.E.Ds will turn off. This acts as a simple test to make sure that all L.E.Ds in the product are working. These three boxes could be simplified into a DO MACRO but I thought my way would be a more simply method so I was less likely to make any errors in my programming. To read the input from the decoder the receiver PIC needs to be programmed with INTERRUPTS and EVENTS, these two boxes work in the same way but the only difference is that the EVENTS need to be connected back to the main part of the programme while INTERUPTS are like a macro and do not need to be linked. I programmed my EVENTS and INTERRUPTS so that they turn on whenever they receive the appropriate binary pattern. The two boxes in the main programme called INTERRUPT ALL and EVENT ALL, ON switch these on.

Summary of PIC-Logicator Flowsheet
File Name: LEDS.PFL Author :

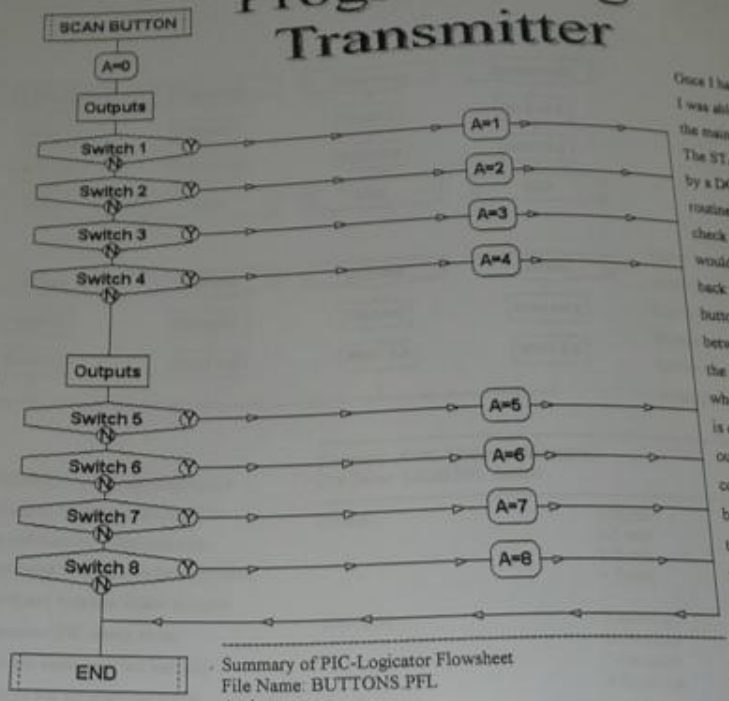
Events	1:Event	...00101
	2:Event	...00110
	3:Event	...00111
	4:Event	...01000
Interrupts	5:Interrupt	...00001
	6:Interrupt	...00010
	7:Interrupt	...00011
	8:Interrupt	...00100
Port Output Functions	All LEDs on	11111111
	All LEDs off	00000000
	Open 1	00000001
	Closed 1	00000010
	Open 2	00000100
	Closed 2	00001000
	Open 3	00010000
	Closed 3	00100000
	Open 4	01000000
	Closed 4	10000000

Programming Transmitter



To program my PIC-Micro controller I used the PIC-Logicator programme, which is a fast and simple way to program my chip. I have two chips to programme so on this first page is the programming of my transmitter ship and the next page is the programming of my receiver circuit.

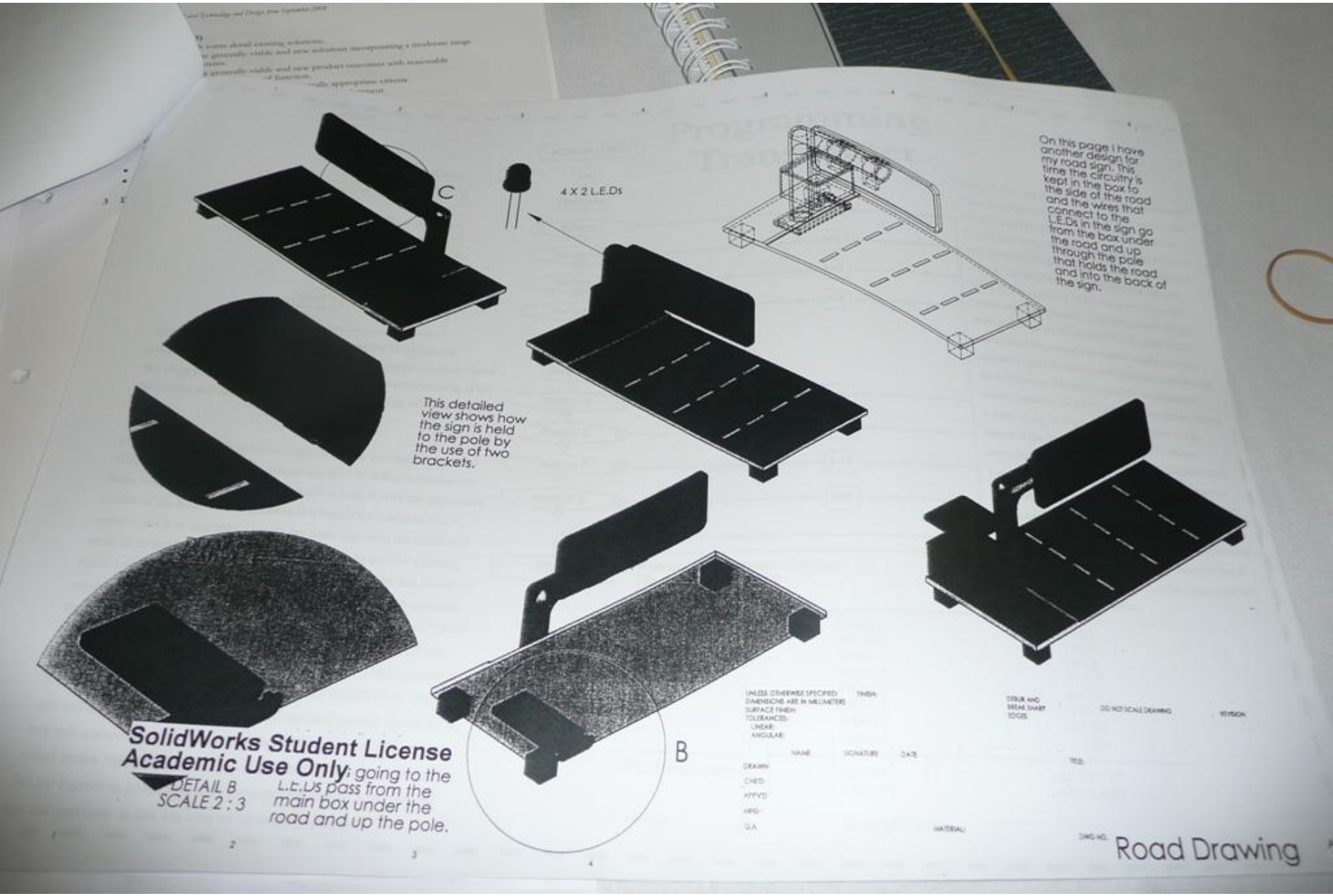
This is a sub routine that I have programmed for my transmitter called SCAN BUTTONS. This macro is so that the PIC-Micro controller can detect which button has been pressed and to label A with the appropriate number of the button. An expression box begins the macro so that A equals 0 this is so that after a button has been depressed the circuit will return to its stable state. I have arranged my buttons in a 2 x 4 matrix, which has been connected to two outputs, and four inputs that allows my required eight combinations. So these would work I had to programme the outputs so that they could be switched on separately using OUTPUT boxes and the inputs read from the DIGITAL boxes to see which one button is being pushed. As on the left if no buttons have been pressed the A will remain at 0 and the programme will reach the END box, which will end my sub routine. However when a button is pressed the DIGITAL box will connect to an expression box that will label A according to which button has been pressed. The macro that I have programmed to the left the expression boxes have been programmed to give A the number that that particular switch has been wired to in my product.



Summary of PIC-Logicator Flowsheet
File Name: BUTTONS.PFL
Author :

Port Decisions	Switch 1	0001
	Switch 2	0010
	Switch 3	0100
	Switch 4	1000
	Switch 5	0001
	Switch 6	0010
	Switch 7	0100
	Switch 8	1000
Port Output Functions	Outputs	00000010
	Outputs	00000100
Macros	SCAN BUTTONS	

Once I had my sub routine, SCAN KEYS, programmed I was able to incorporate this into the programming for the main part of my PIC program for this transmitter. The START box is where the program begins followed by a DO MACRO that runs the SCAN BUTTONS sub routine. The next box is a COMPARE box that will check if A is equal to 0. If A is equal so 0 no switch would have been pressed and the programme will go back to through the SCAN BUTTONS macro until a button has been pressed and when A equals a number between 1 and 8 inclusive it will continue down through the programme. The next stage of the programme is where it needs to OUTPUT a 4-bit binary pattern, which is done by the OUT box. But this will result in the output of the first four outputs on the PIC-Micro controlled, so to prevent this I placed an EXPRESSION box above the OUT box which will shift the binary so that is on the last four outputs. The final box is a 'WAIT' which lasts for 1 second, and this allows the receiver enough time to register the output. Then the programme returns back to the SCAN BUTTONS macro to test if any buttons have been pressed and this programme will repeatedly follow this pattern.


C
4 X 2 L.E.Ds
On this page I have another design for my road sign. This time the circuitry is kept in the box to the side of the road and the wires that connect to the L.E.Ds in the sign go from the box under the road and up through the pole that holds the road and into the back of the sign.
This detailed view shows how the sign is held to the pole by the use of two brackets.
B
DETAIL B
SCALE 2 : 3
L.E.Ds pass from the main box under the road and up the pole.
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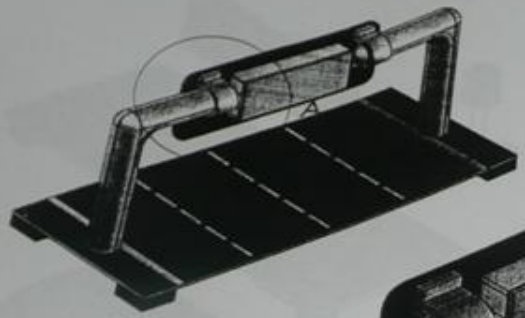
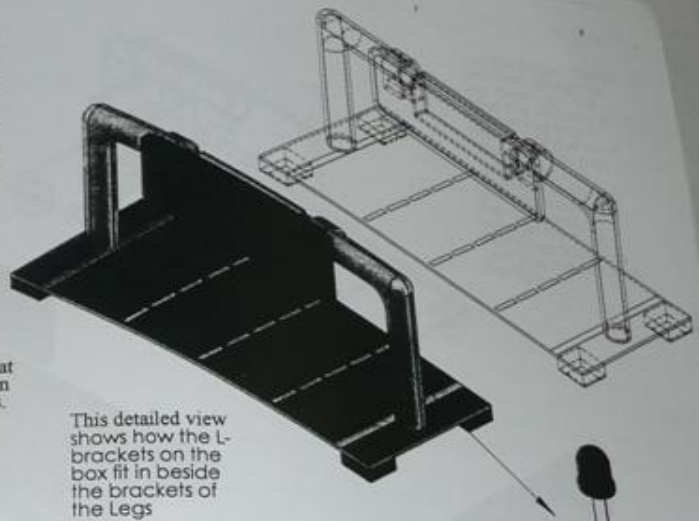
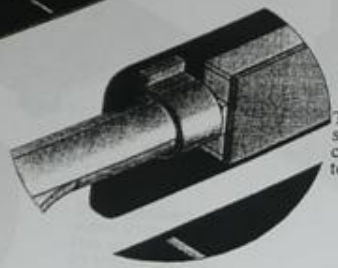
Road Drawing



On this page is a design of a road sign for my receiver. On the front on the sign there will be eight L.E.Ds four red ones that will display if the lane below is closed and four green ones to display if the lane below is open.



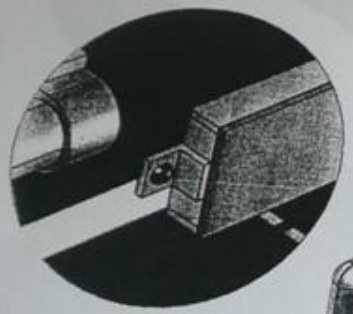
Below is an image of the box that goes on the back of the sign. It has been detached from the sign by the round headed screws that go through the two L-brackets.



This detailed view shows the bracket that connect the main sign to the one of the legs.

This detailed view shows how the L-brackets on the box fit in beside the brackets of the Legs

2 X 4 L.E.Ds



DETAIL A
SCALE 2 : 3

DETAIL B
SCALE 2 : 3

DETAIL C
SCALE 2 : 3

UNLESS OTHERWISE SPECIFIED: FINISH:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

DEBUR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

REVISION

NAME SIGNATURE DATE

DRAWN

CHK'D

APP'VD

MFG

Q.A

MATERIAL

TITLE:

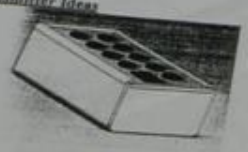
DWG NO.

Final

A3

Selection of Ideas for Further Development

Transmitter Ideas



Idea One

For this first idea of my transmitter project I have designed a rectangular box, which has most of its edges filleted. The top and end of the box are joined together by two quarter circle joints. The top and end can be removed from the main box by sliding them out in the direction of the end. This is so that the circuitry inside the box can easily be accessed. The top slides into the main box very easily as there are two groves on the inside of the sides of the main box which the top slides into. It is not a loose fit but a slightly tight so that the top and end do not easily slide out when someone may be using the product. There are eight output bottoms on the top of the box. These are simple push buttons that have been laid out in two columns and four rows. Below these are the power switch and the circuit reset switch these respectively are a toggle switch and another push button switch.

Evaluation

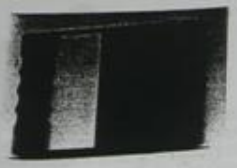
Function: This design easily fulfills the function as it the eight buttons allow for the eight output signals to be sent.

Aesthetics: The design itself is quite aesthetically pleasing as the red and black switches contrast well with the main colour yellow and the filleted edges give it a smooth look.

Ergonomics: The ergonomics of the buttons are very pleasing and the sliding motion of the top and end is very pleasing but the main design is very large and it would be quite awkward to carry in one hand.

Anthropometrics: The buttons are very easy to use but the problem with them is that they have not been labeled and there is nowhere to label them so the user may become confused when trying to use the product at first. The sliding of the top and end is a very simple way to access the circuitry if the user ever needed to change the battery or repair the circuit.

Overall: This is a very basic design that easily fulfills its function and would be very easy to manufacture but it is just too large for such a simple design and is just too simple.



Idea Two

This second design for my transmitter is a much more intricate design than my first idea. The main box that contains the circuit is designed to one side while a handle is placed to the left at a distance from the box. This handle has several grooves on it to fit the users hand so they have greater comfort and more grip. The main box has both sides filleted and the right hand side acts as a handle also. To access the circuitry of the design the user just has to remove four screws from the back of the main box, which will allow the back panel to be removed. The four screws hold this panel on by going through the panel and screwing into four cylinders that have been glued to the main box. The eight output buttons for this design are also laid out into two columns and four rows, and there has been enough space left for a label to be placed above each button so the user knows what each button does. The power button has been placed on the top to the right side of the main box while the reset has been placed on the bottom to the left side of the main box.

Evaluation

Function: As this design is able to transmit eight signals, it fulfills its functions as it has the eight buttons to do so.

Aesthetics: The design is very intricate and easily catches the eye with a nice colour and its sleek curves. It greatly improves upon my first idea's aesthetics.

Ergonomics: The grooves in the left handle for the fingers are very pleasing and the curve at the left side of the main box also improves the ergonomics of this design. The handle is the perfect size for most adults making the design very easy to carry.

Anthropometrics: As there are places left to label the buttons, the product can be very easy to use and the placing of the reset button on the bottom of the project means the user will definitely not become confused. Screws are a universal part so any user would easily be able to access the circuitry if the needed to.

Overall: This is almost the perfect design as fulfills all of the users needs but this would be a very difficult project to make and when made it would not be able to balance right on its on as it has no flat surface due to the buttons and screws.

Idea Three

For this design of my transmitter I have created an idea where there is a main box to contain the circuitry with two handles on either side of it. I have designed if so that one handle is in tight to the right hand side of the box while the left side handle is several centimeters from the main box. Two strips of plastic that go across the top and bottom of the main box keep the main box and handles together. The front of the main box is not actually attached to the rest of the box. It has four inserts on it so that it can be removed from the box and the circuitry can be accessed. The inserts are a slightly tight fit into the main box so that the front does not easily fall out. The eight buttons again are arranged into two columns and four rows and the power button is placed in the middle below the output buttons. While the reset button is placed in the bottom left corner of the back of the box.

Evaluation

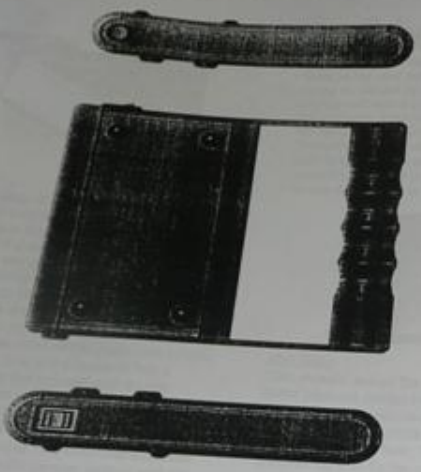
Function: This design also easily fulfills the function as it the eight buttons allow for the eight output signals to be sent.

Aesthetics: This design has several contrasting colours red, black and blue, which give it very good looks, and the curves also benefit its aesthetics.

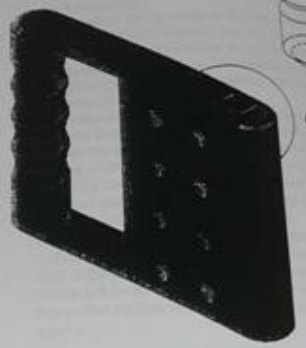
Ergonomics: The two cylindrical handles on either side of the main box give the user a good grip of the design with good comfort as well. The positioning of the buttons also allow for good ergonomics as all buttons are on the front apart from the reset button which is on the back which can easily be pressed without having turn the project round to look at it.

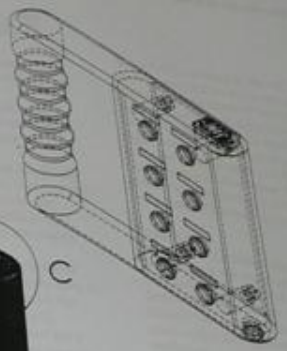
Anthropometrics: In this design there are also places left to label the buttons and again the reset is on the back so the user will not get confused with the other push buttons. The removal of the front face of the main box is very simple as it is just held in by inserts.

Overall: This is a very good design as it is simple to use looks and feels pleasing and fulfills its function, yet it is still a simple design and would be very easy to manufacture.

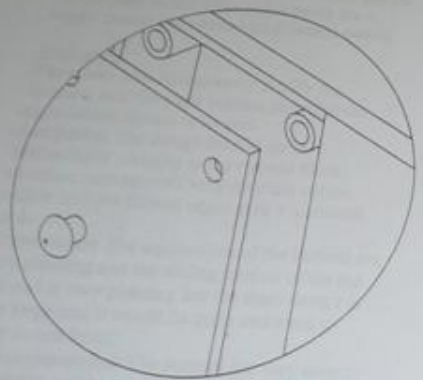


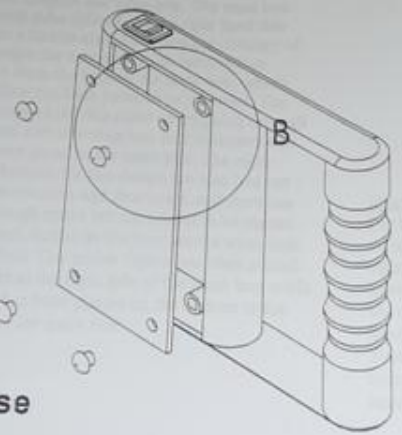
This is another design for my transmitter. This design has a handle to the left which has grooves for the fingers of the holder.





The detailed view shows how the corners of the box have been filleted to make it more ergonomically pleasing. On the front you can see that there is an area for the label of each of the L.E.Ds to be placed.





This image to the left is showing how the circuitry can be accessed by removing the back of the product.

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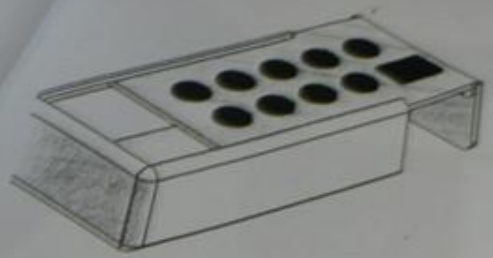
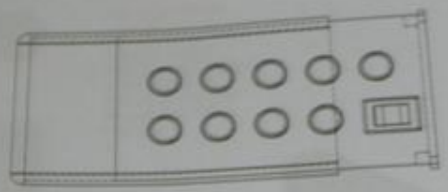
This detaild view show how the screws go through the back and into thescrew threads on the main box

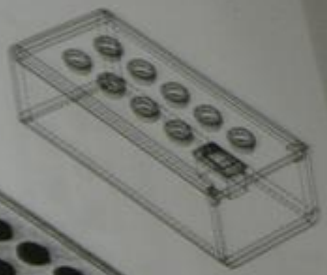
DETAIL C
SCALE 1 : 0.75

Final Drawing

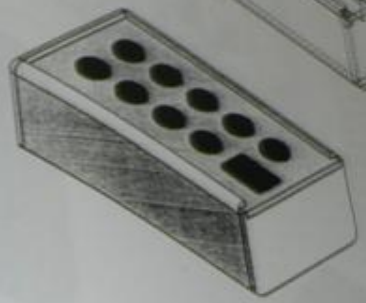


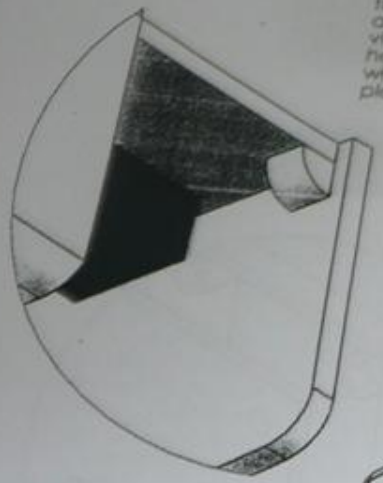


This is my first design of my transmitter box, I have designed it so that the lid and end of the box slide out so that the circuit can be easily accessed.



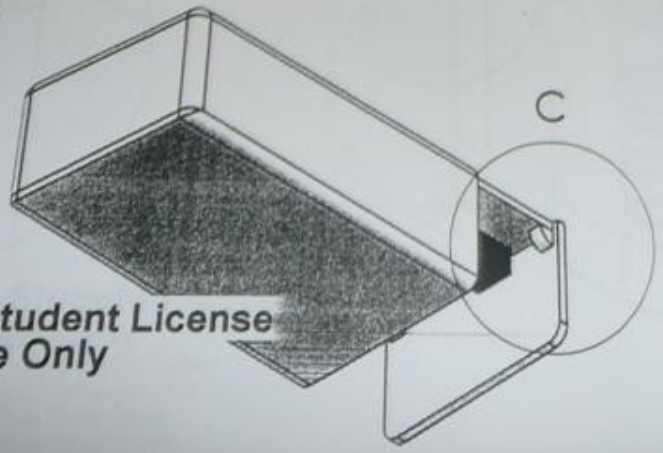
These are three views where the lid and end have been slid out so that the circuit board can be accessed. The detailed view shows how the joint has been strengthened with the quarter circle of plastic.





These are the two types of switches that I am using in my product. A toggle switch and a push button switch.

These are sevral views of my design idea. You can see how I have filleted the edges of the design to make it more asethetically pleasing and also the colours I have chosen compliment each other and this also helps the aesthetics of the product.



C

DETAIL C
SCALE 2 : 1

UNLESS OTHERWISE SPECIFIED: FINISH:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

DESIGN AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

VERSION

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APP'VD			
MFG			
Q.A			

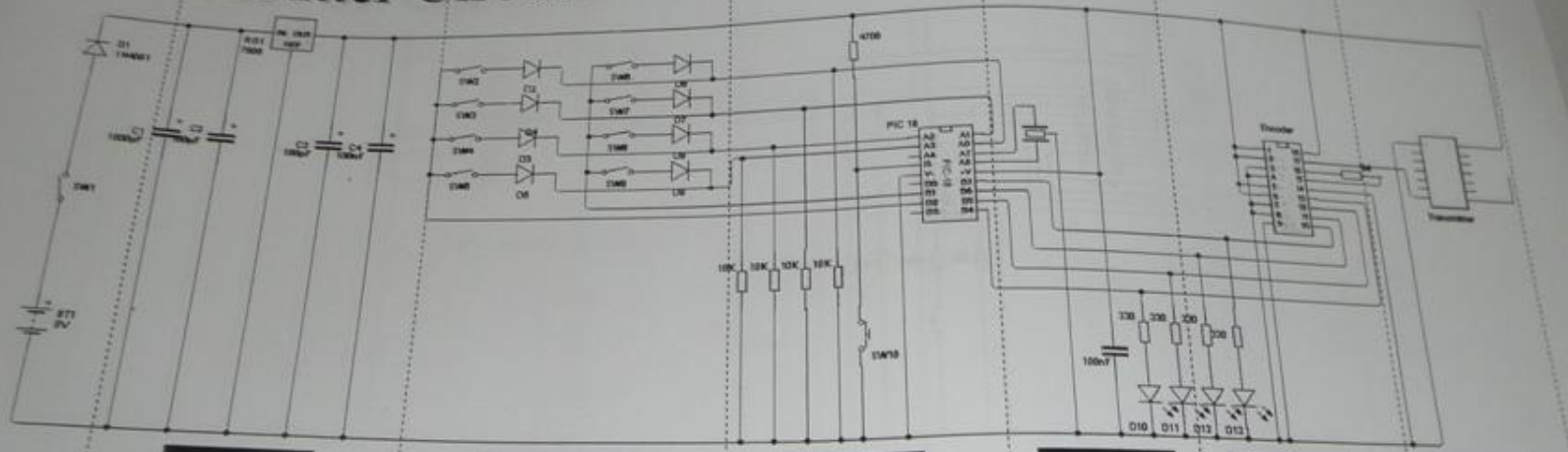
TITLE:

MATERIAL:

DWG NO.

Final Drawing

Transmitter Circuit



The 7805-voltage regulator can take any voltage between seven and twelve volts and converts it to a smooth five-volt output. This is done because the PIC microcontroller requires five volts into the top voltage line. The capacitors are used to smooth the voltage. The diode is to prevent current flowing in the wrong direction. It stops the current running back into the switch and damaging it.

The matrix of switches is needed to allow the PIC to have eight inputs instead of five. The eighteen pin PIC has five input pins but using the matrix allows it to use up to eight. Combining all the input pins and two output pins allows us to design a matrix system for the switches. This means that when a switch is activated the PIC microcontroller knows what one has been pressed and what output signal to send to the encoder.

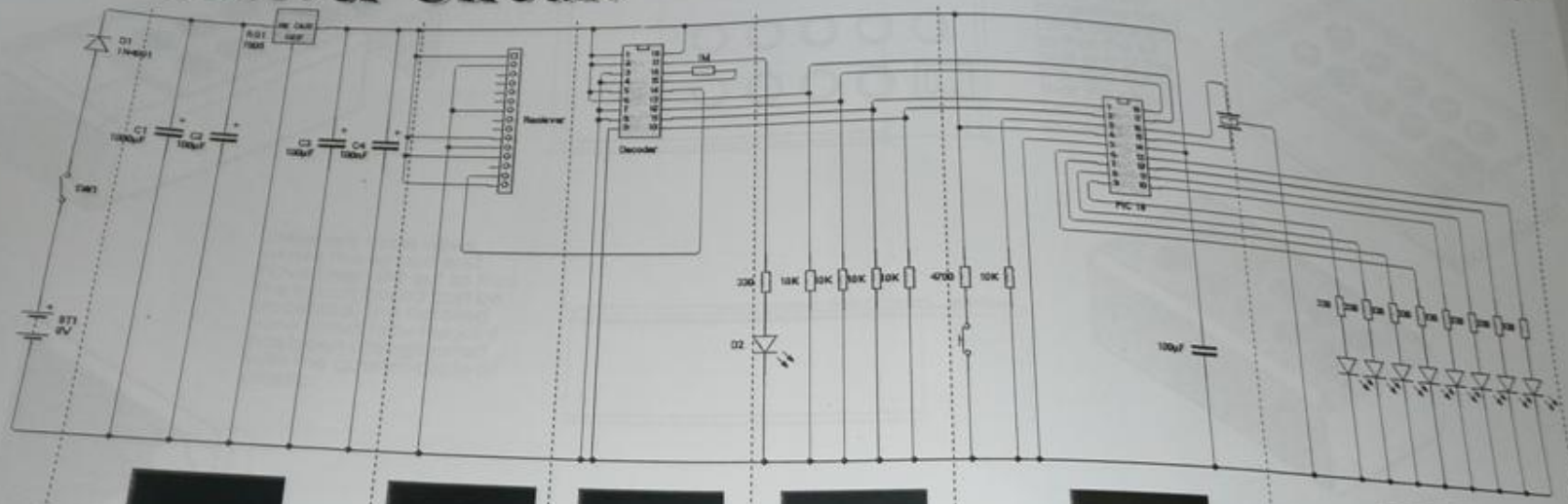
The microcontroller is programmed in such a way that it has the ability to recognize what switch is pressed in the matrix. Due to the complex programming of the PIC the microcontroller produces an individual four-bit binary pattern, such as, " 1 0 0 0." This system means that the first switch has been activated and the message is sent onto the encoder.

This is the individual four-bit binary pattern, for example, "0 1 0 1." This indicates which input switch has been pressed.

This incorporates my eight-bit address line, which are four high and four low. High means it is tied to the five-volt line and low means it is tied to the zero volt line. Pins one to eight are the address line. It is capable of sending a four-bit data stream / binary pattern to the transmitter. The data out pin, pin seventeen, leads to the transmitter.

The transmitter module receives data into pin three, the data in pin. It sends a signal to the receiver circuit via an aerial that comes from pin 4. In order for the transmitter to communicate with the receiver both must have the same address line.

Receiver Circuit



Identical to the transmitter circuit. The 7805-voltage regulator can take any voltage between seven and twelve volts and converts it to a smooth five-volt output. This is because the PIC microcontroller requires five volts into the top voltage line. The capacitors are used to smooth the voltage; they are smoothing capacitors and stop fluctuations in the voltage. The diode is there so current can only flow one way in the circuit. It stops the current running back into the switch and damaging it.

The signal received from the transmitter comes into the circuit via the antenna that is pin three on the receiver module. The transmitted data then leaves the receiver on pin fourteen.

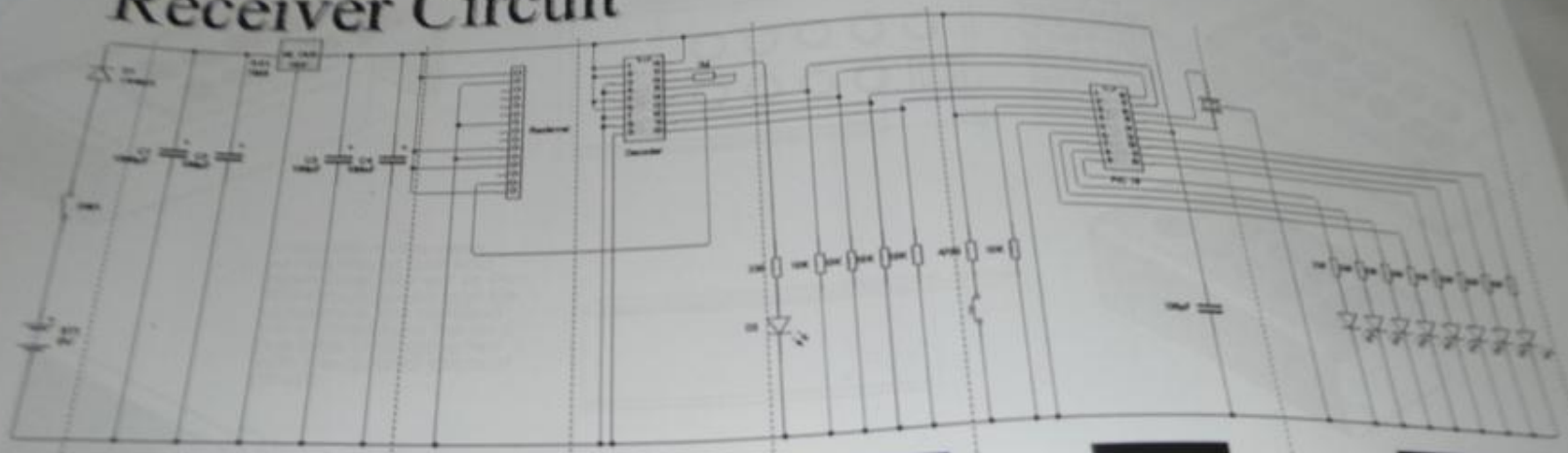
This module receives data on pin fourteen. It has the same eight-bit address line as the transmitter so that the correct data is received. It then decodes the information and sends it to the PIC. My address line is 11001100

Once again this is the individual four-bit binary pattern, for example, "0 1 0 1." This displays which input switch has been pressed and what output code has been sent from the transmitter.

The microcontroller is programmed to receive information from the decoder and it takes this information, which allows it to turn on or off the outputs.

Eight L.E.Ds are connected to the PIC through pins 6 to 13. A signal is sent form each pin to each individual pin allowing them to turn on or off.

Receiver Circuit



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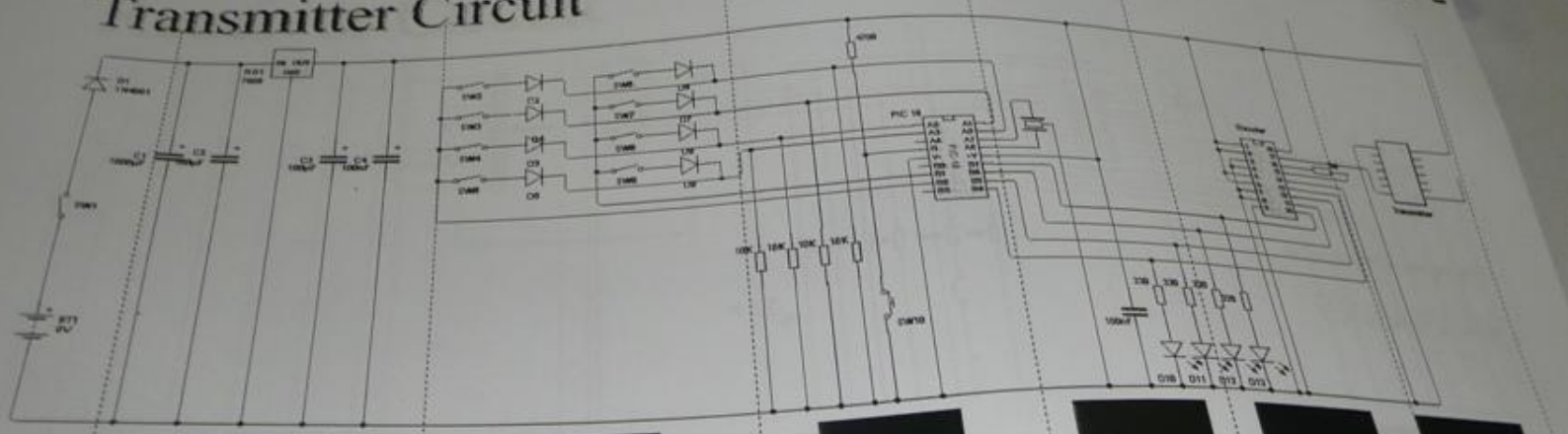
Transmitter Circuit



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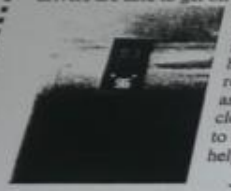
The transmitter module receives data into pin three, the data in pin. It sends a signal to the receiver circuit via an aerial that comes from pin 4. In order for the transmitter to communicate with the receiver both must have the same address line.

Investigation and Research

Traffic in the world now a day is becoming a serious problem for the government and local councils to deal with in the U.K. This is due to the rise in car ownership throughout the country. It is also clear that in the world there is more and more people commuting to and from work, as people prefer private travel to public transport and as people have their own car they may as well use it. Due to this rise in vehicles on the road there the traffic at rush hours is becoming a serious problem, as there is a resultant increase in traffic accidents. And this increase in traffic is extremely bad for the environment as there are more emissions from the greater number of vehicles and as the reality of global warming is becoming such an important problem in our lives this increase in traffic will have serious consequences on the environment. This is major cause for concern on a motorway as an accident can result in serious traffic jams on a motorway and the tailbacks can go on for miles as the photo on the right shows.

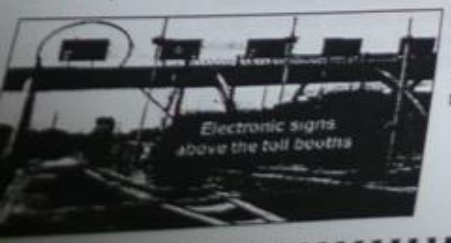
To help with this problem traffic signs could help divert traffic away from the area of the accident spot and reduce the time cars may be waiting in cues. All the sign would have to say would be lane closed or accident ahead or delay, it would mean that someone would have to be watching the whole length of the motorway using cameras and as soon as they see an accident they can control a sign remotely to display the warning. It would only take a sign every 500m or one a short distance before each slip road so that drivers are able to get off the motorway and take a different route.



To the left is an example of a motorway sign that warns people of there speeds. This is a very good sign as it tells people how fast they are going and how fast they should be going. It helps reduce accidents as it makes people realise that they should reduce their speed. But that is all this sign is good for, as it doesn't indicate to drivers if there is a hold up ahead or the road may be closed. So overall it is a decent sign but it doesn't display enough information to the road user. It is not the type of sign that I am looking for, as it will not help in reducing the time spent by drivers on the road.

★★★☆☆

The image below is a picture of tollbooths on a motorway, which has electronic signs above each lane. These electronic signs display to the road users which lane they should be in so that they pay for the correct vehicle that they are driving and it also tells them how much they should pay. These are very good signs as it gives drivers a considerable amount of time to get in the correct time resulting in saving time on their overall journey time. It also helps to reduce tailbacks on the motorway during rush hour times. A person can control the display on the signs by using a nearby computer. They can make the sign display closed or a different type of vehicle so that they could have more than one sign per type of vehicle incase there are more cars on the motorway at the time, such as a bank holiday when there will be more cars than commercial vehicles. The problem with these signs are that they do not give any information to the driver about the road ahead so drivers may end up driving into a traffic jam a few hundred meters down the road without any notification.



★★★★☆

Today the infrastructure of the U.K. is constantly being upgraded due this increase of traffic so many roads are often closed for a period of time or some lanes on a motorway may be closed while the workers improve the roads. At these times there is serious need for indication to road users that there will be a delay ahead and that they may need to re-route. The D.O.E has road signs such as the one in the picture to the right. This sign is actually a portable sign that can be towed behind a vehicle. This is a very useful type of sign as it can be moved from one road to another extremely quickly. The sign has an electronic display that can be used to display whatever the user wants. This is extremely useful as it is able to warn the user of anything that may be on the road ahead but the problem is that they are only ever used when road works are taking place. They are not very suitable for a motorway as the sign itself is quite large so it takes up about a lane itself so by the time the user gets to the sign they will have to changed lane and planned a new route.

★★★☆☆

The SPEEDCHECK-1530P

Speed check radar speed signs are ideal for use in areas where speeding is an ongoing concern that requires long-term, low maintenance traffic calming. School zones, high traffic neighborhoods, and approaching dangerous bends are common applications for pole mounted Speed check signs. Powered by the sun, or connected to the power grid, permanently installed Speed check signs effectively slow traffic, providing a low maintenance, long-term solution to speeding. The speed check radar has an easy to read LED display. It does not register traffic moving in opposite direction and flexible pole mount allows easy attachment to virtually all sized traffic poles. High visibility speed display—up to 1000 feet and the UltraClear II technology optimizes contrast, glare, and clarity under all lighting conditions. Auto dimming LEDs are used for optimum display in night conditions as well as vandal resistant shatterproof window and impact absorbing display absorb shock by deflecting together up to 2.5 inches. The weather resistant housing and hardware are 100% aluminum and stainless steel to protect from corrosion. This speed check radar will reduce the speed of drivers and make the road safer but it is the more expensive option as it ranges between £200-£300. This product meets both the needs of the consumer and the manufacturer. The sign is energy efficient and requires little maintenance therefore it is ideal for the consumer. The problem with this sign though is that it doesn't give any indication to the road users of what maybe ahead so there may be children crossing ahead at acertain time and drivers wouldn't know

Specification

Function

- *The product must be able to change the information on the sign up to a distance of 200m.*
- *The transmitter must be able to transmit up to 8 inputs so the receiver can display if any of the four lanes are opened or closed.*
- *The inputs on the product must be clearly labeled and the outputs on the transmitter must be clearly labeled lane 1 to 4 with open or closed.*
- *The buttons on the remote must be easy to press and in suitable positions so the user does not press more than one button at once.*
- *The sign must be clearly visible to road users from at least 100m so they can react to the information within a suitable time without being rushed and it must be at a suitable height so the users can see it over the top of vehicles.*
- *The receiver must be able to withstand all weather conditions.*
- *The product must have a reset button to return it to its stable state.*
- *The outputs must be clearly visible during day and night and in all weather conditions.*
- *The outputs must have large enough labels so that the road users can see then from 200m.*
- *The receiver must be made from a high visibility material so that they reflective the car lights at night so the sign is visible but at the same time it must not produce a glare from the sun.*
- *The receiver must be able to be attached to a large stand so that it can be raised to the appropriate height.*
- *The outputs of the receiver should be bright enough so that they draw the attention of all road users.*
- *The product must have a strong structure so that if any vehicle were to crash into it the product would still be upright and would sustain a minimum amount of damage.*
- *The receiver must have a simple layout so that all road users can easily understand the information displayed.*

Ergonomics

- *The direction sign should be built first for function and then ergonomics.*
- *My product must suit its environment and be able to cope with the settings it is placed in.*
- The transmitter should have a complete smooth finish so it is pleasing to the user's touch.

Aesthetics

- My product should improve upon other products aesthetics.
- The product should be finished with a smooth and shiny finish to look impressive.
- My product should not discolour easily when exposed to light.
- The product must have a clear and simple but effective layout.
- My product should have an aesthetically pleasing appearance and not be an eye sore.
- The colours of the materials used to make my fuel nozzle should all compliment each other.

Anthropometrics

- The product must satisfy human measurements.
- The receiver should be a suitable size in relation to the average size of human hand.
- The receiver should be a suitable size so when the user is pressing one of the buttons they do not press two buttons at once.
- The product should be a suitable size so people do not have to squint to see the information displayed.

Reliability

- The receiver must be able to withstand all weather conditions and not corrode, as it will be used outside.
- The transmitter must be able to withstand any accidental knocks are bumps caused by the user
- The receiver must be watertight so the circuits can work normally in all weather conditions.
- The direction sign must be ever lasting
- The direction sign must be able to withstand any encounters with animals e.g. birds, badgers.

Safety

- The product must pass all safety measures e.g. BSI Kite Mark.
- The joints in the product should all be sanded down smooth and there should be no sharp edges so the users don't damage themselves.
- The base of the transmitter must be large enough so that it is a large enough distance from the road reducing the chances that it will cause an accident.
- The direction sign's circuitry must be protected and any current earthed if it was short-circuited.
- The direction sign should come with a guarantee.
- The direction sign must not have any sharp or rough edges, which may protrude from the sign and harm the public.
- The direction sign's components and circuitry should be safely stored away to avoid damage due to rain or water.

Materials

- The transmitter's materials must be able to withstand any bumps or knocks.
- The receiver's materials must be able to reflect light but not produce any glare. The materials of the stand must also so be able withstand any strong knocks from vehicles when there may be an accident.
- The products materials must be easy to work with in the manufacturing process.
- The product must be able to be manufactured using only the available tools.

Cost

- The product will not cost the road users any money as the government or local councils will be paying for it but at the same time it must be competitive with the prices of similar products.

Size

- The product should be large enough so that the information been shown relates to the size of the product. It should not be too small so that people cannot see the sign.

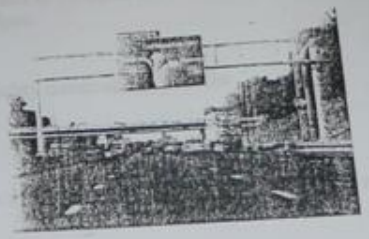
Problem Identification

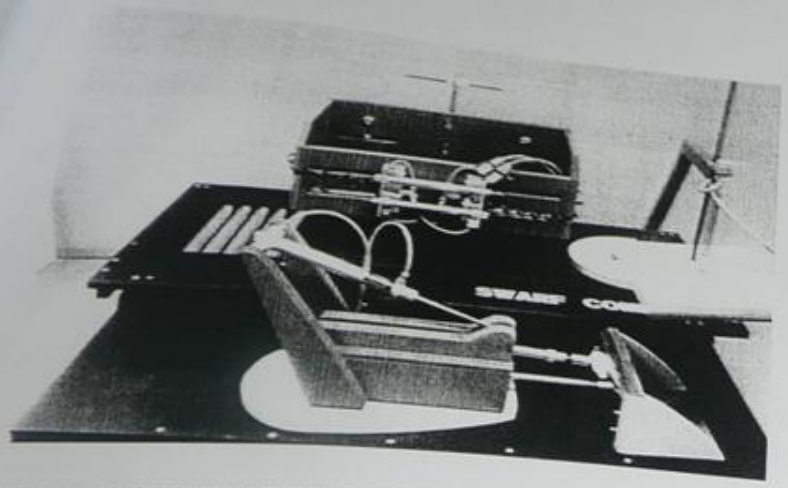
Now a day many people commute to work everyday so there are many vehicles on the road in the morning and in the evening so the roads are very busy. With so many vehicles on the roads and motorways accidents are likely to happen nearly everyday resulting in serious hold-ups and closure of motorway lanes. This can be a very irritating event when a motorist drives into the scene of an accident, because they did not know that there would be a problem up ahead, resulting in serious delays and even long tail backs miles long at rush hour times. The police arriving on an accident can be very slow at times as they are dealing with other problems or may be even caught up in the traffic themselves. This means that by the time they arrive and have their warning signs up or the traffic diverted there is already a backlog of traffic.

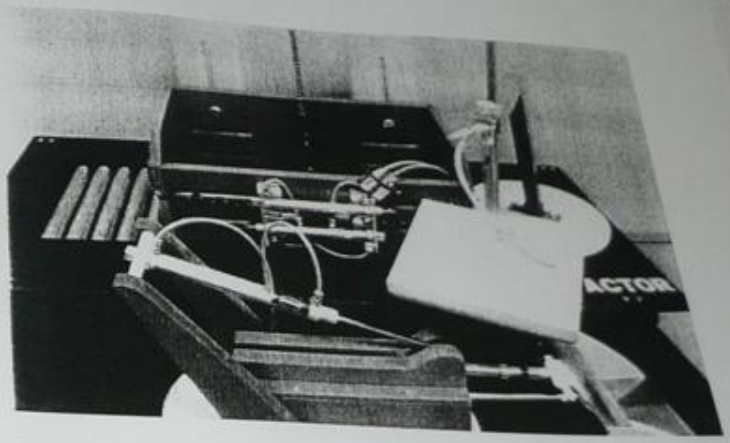
A way round this problem on the motorways would to be have visual aids that would show motorists that there may be an accident or a delay ahead so they would have time to change lane or even take a different route to what they had originally planned. This would be a great help because if motorists were pre-warned about a delay they would be able to save fuel by taking a quicker route than being stuck in traffic resulting in less fuel emissions. Also drivers wouldn't become as frustrated if they knew they could avoid a delay by rerouting than if they were stuck in traffic, and it is a common known fact that frustrated or angry drivers are more likely so do dangerous driving and cause an accident. So the less frustrated drivers the better. So any system that can warn drivers of an accident or delay up ahead may result in saving lives.

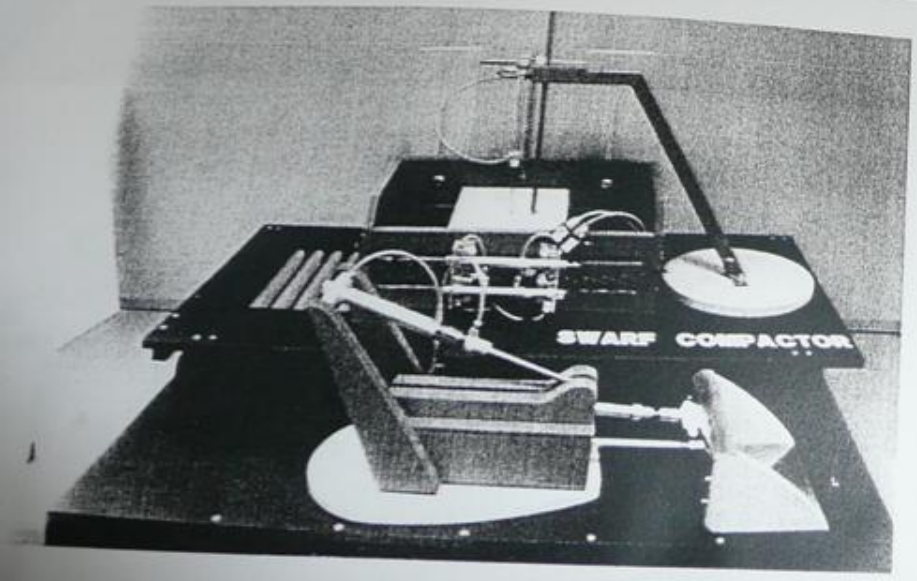
Design Brief

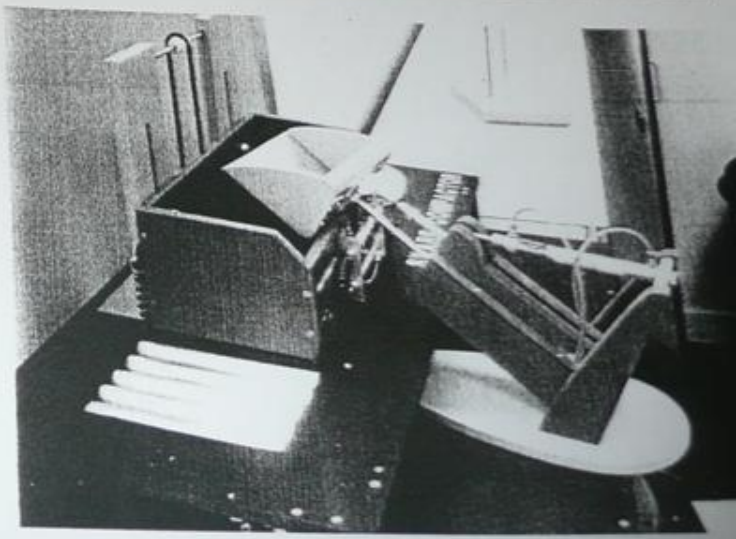
Design, make and test a device to show motorists that certain lanes on a motorway are opened or closed.



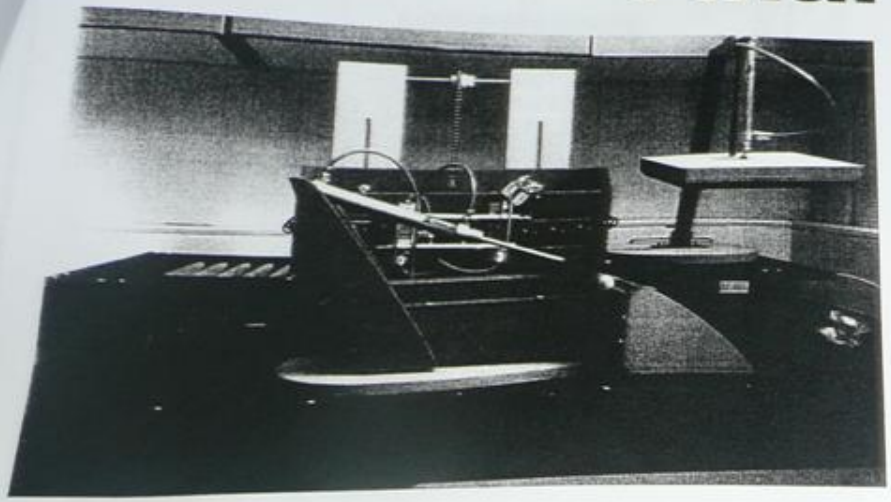


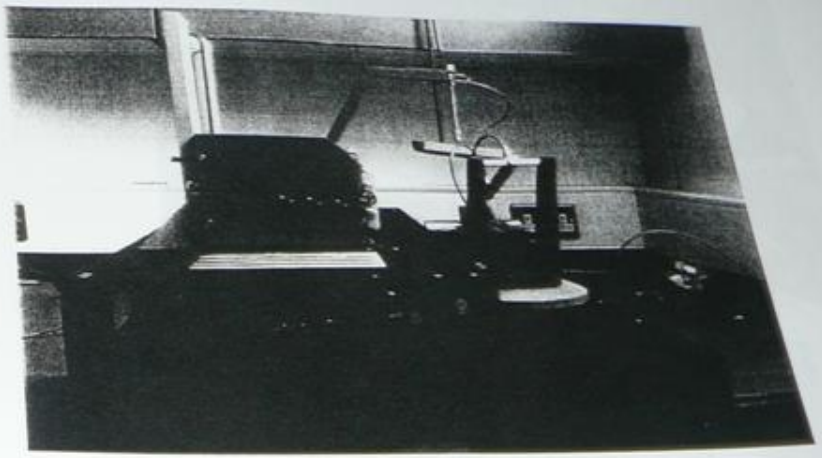


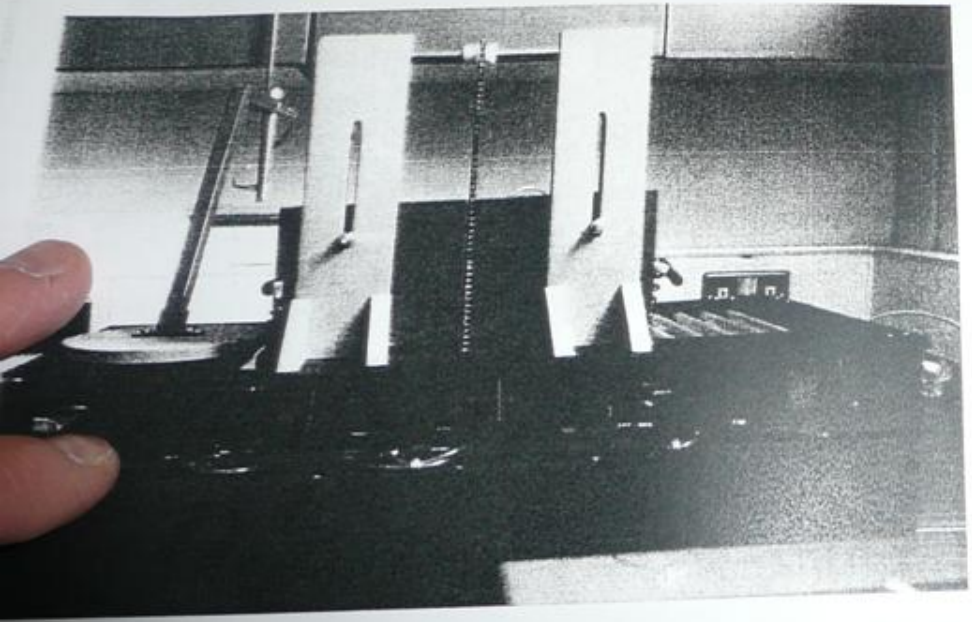

SWARF COMPACTOR

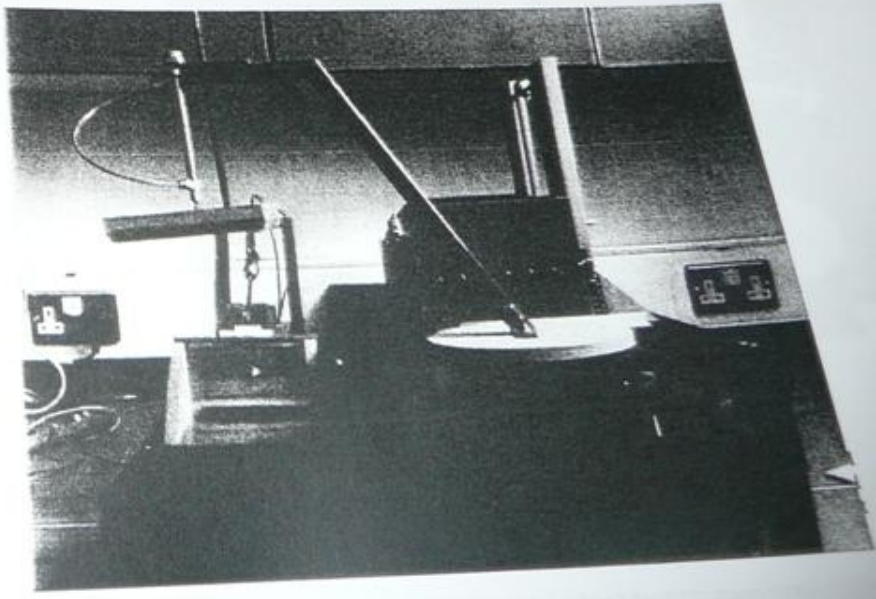


Final System

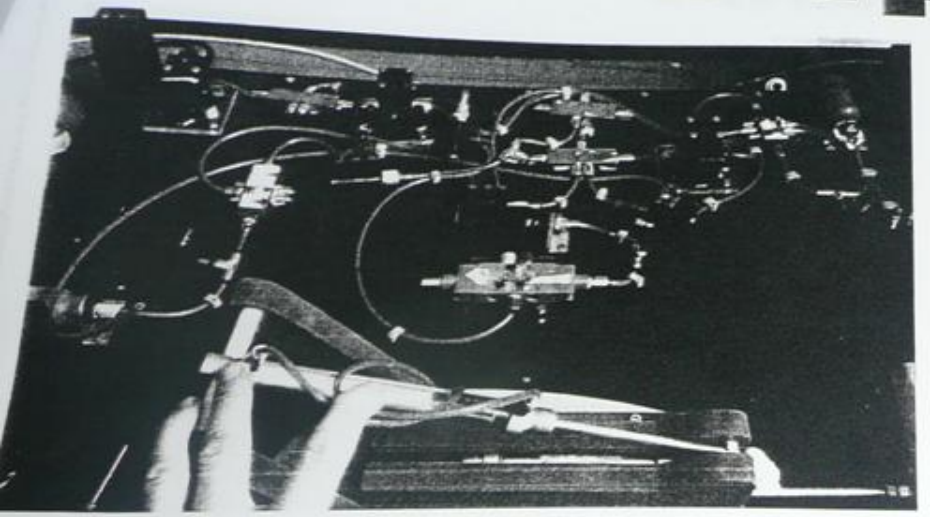


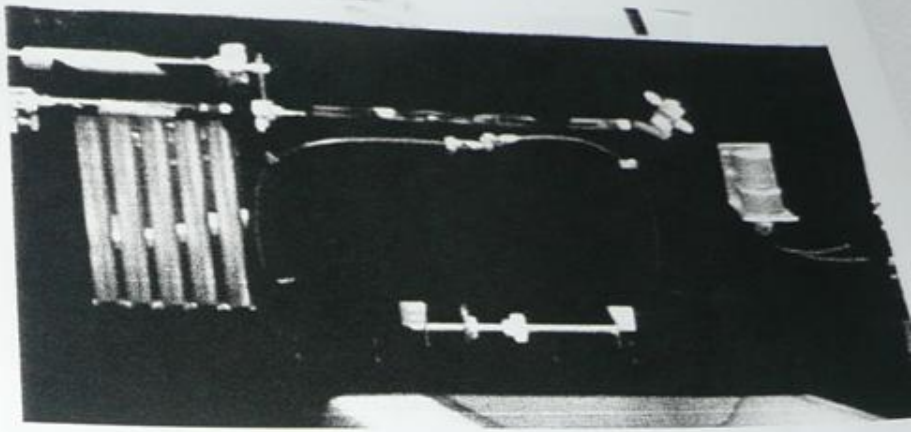


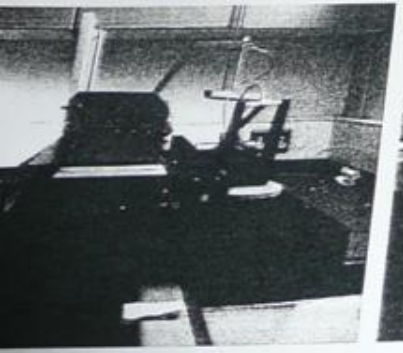


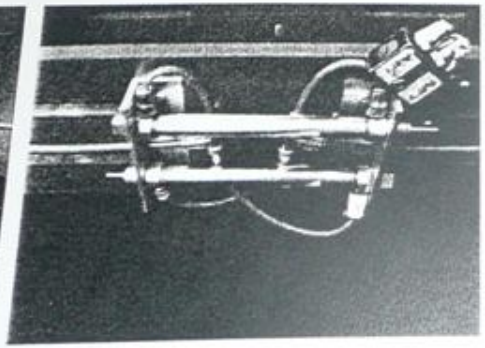


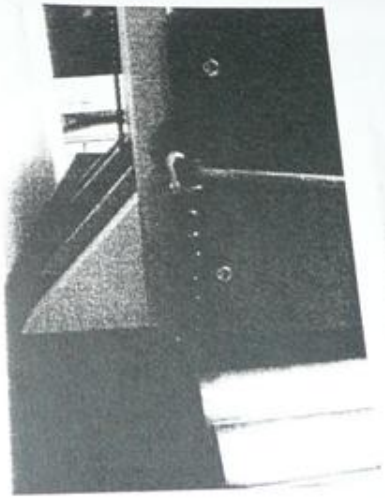
Piping











Evaluation Against Specification

Function:

- The system does make it easier and safer for employees to empty machines of swarf.
- The system would compact swarf into cubes if it was scaled up.
- The system does not make it easy to access the swarf block. This would have to be changed to make the system viable in a factory environment.
- The system does do the compacting automatically but requires someone to be at the machine to operate the scoop and to fill holding area with swarf.

Safety:

- My moving parts are not properly guarded, this is a big problem with the safety of the system. I feel this would need to be changed to be accepted into an industrial environment.
- There are no sharp edges on my product as all edges have been sanded or filed down. The system meets this point of the specification.
- The product has minimal safety symbols. This would have to be improved if this system was to be viable in the industrial world.
- The system does include an emergency stop button, but I feel that more than one would be better to improve the overall safety of the product.

Ergonomics:

- The machine is very easy to fill with swarf.
- The switches and buttons are very clearly labelled and well spaced and laid out.
- As the system uses air, it can be quite noisey in operation
- The operation of the machine is very simple with minimal input from the user.

Aesthetics:

- All of the pipes wires and connections on my system are very neat and tidy and are clipped down to the baseboard.
- The edges of the product have been smoothed down to give a good aesthetic appearance.
- The product itself looks industrial and I feel that the selection of colours works well with the system.
- The product has been painted in industrial colours and all bare metalwork has been cleaned up with a combination of emery cloth and wire wool.
- I feel this product would look very appealing in a factory environment.

Materials:

- I have used MDF, Aluminium, and Mild Steel. The MDF and mild steel have been painted to protect them from corrosion and aluminium can withstand corrosion because of its make-up. I therefore feel that my system is very well protected against corrosion.
- All materials used are strong and durable. I have used mild steel where I fell the part may be under strain (such as compacting arm) to improve stability and give extra durability.
- MDF and mild steel are very suitable for painting. The paint took well to the materials and I feel it is good for aesthetics.

Cost:

- I feel that I have kept quite well to my budget but I estimate that I may have exceeded this budget by £50-100. This is mainly due to the price of pneumatic components as outlined in my research section. I feel that the price could not be reduced.
- The system runs on compressed air and low voltage electricity. I think that this is a very efficient way to power the system and I feel that I have achieved this point of my specification.

Dimensions:

- The origional size constraint of my project was 1000x500mm and the actual size was 830x600mm. Although I have gone over on the width, the length of my project is greatly reduced. The target surface area was 500000mm^2 and I have exceeded this by 2800mm^2. I feel that this is ok as it was necessary for the given system.
- I feel that the machine does look in proportion. All parts have some connection therefore are linked in size.
- Although the piston extensions were between 100 and 200mm it was necessary for me to have a longer stroke for my scraper, therefore I developed a telescopic set-up using two cylinders to achieve this.

Ease Of Use:

- It is very obvious how the machine is used due to labelling etc. but I may be necessary to brief anyone using the machine for the first time on proper and safe use.
- The switches are well located and also well spaced.

Maintenance:

- Most of the system components are simply screwed on and are easily removable. This will help greatly for any maintenance to be performed. Because of lubrication in the air compressor parts are kept free moving.
- Swarf should not trap any mechanical parts as all motors and gears are underneath the system and I feel that a pneumatic piston would be sufficient enough to operate properly even if covered in swarf.
- All parts are easily accessed from all sides of the system. Simple screws and brackets have been utilized and this allows anyone to remove/replace parts.

Constraints:

- I did not manage to completely finish the system by the beginning of April 2009 as outlined in my specification but after a short amount of time I did manage to complete the project.
- The project was completed using a combination of class time and free time on my timetable.

Product life:

- The product is very durable and I feel that all mechanical parts are strong enough to withstand h use and should not need to be replaced.
- All pistons, motors and other pneumatic components are standard components and are therefo available to be replaced easily.

Power:

- The system is sufficient to work on power of 9-12V
- The system is sufficient enough to be operated using air compressed to 4BAR.

Modifications During Manufacture

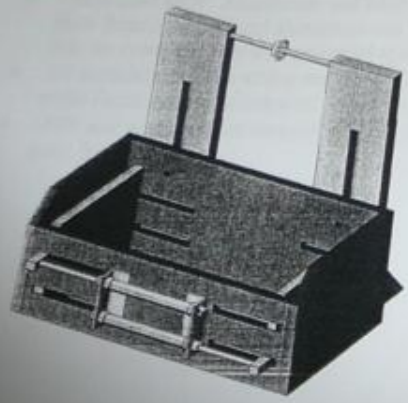
When it came to the stage of manufacturing there were some problems with my Plan Of Manufacture. These problems had to be solved as they came up. In this section I will outline those changes that I have made from the Plan of Manufacture.

Major Problems

Slots in compacting box

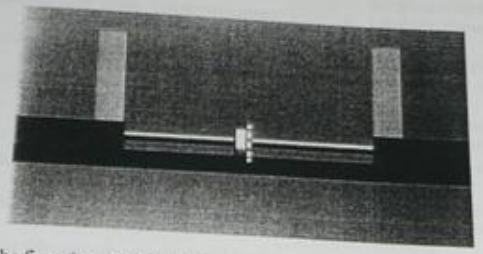
The first major problem I encountered was that the box compactors were no coming along the box straight. Therefore I had to take the measure of changing the amount of guiding slots. The structure of the pistons would remain the same but the extra slots would help the movement. The picture below shows the idea outlined in my Plan Of Manufacture.

The picture below shows the new design. There are now 4 slots guiding each compactor but still only one is being provided with the force from a cylinder.

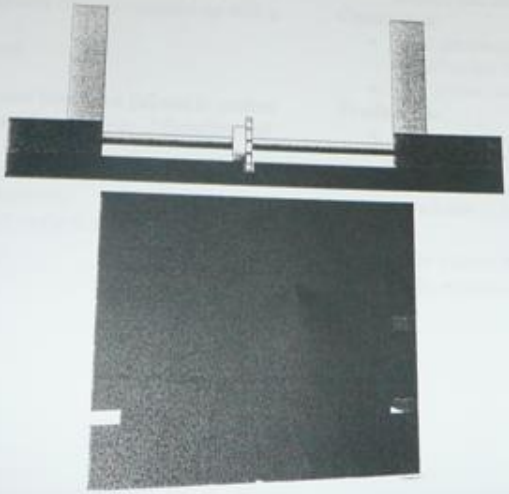


Chain Colliding With Compacting Box

The problem is that the positioning of the sprocket means that the chain is bent around the compacting box. I had to solve this by milling a slot at the back of the box to allow the chain to pass down to the sprocket underneath in a straight line. The picture below shows the previous line-up of the sprocket and box.



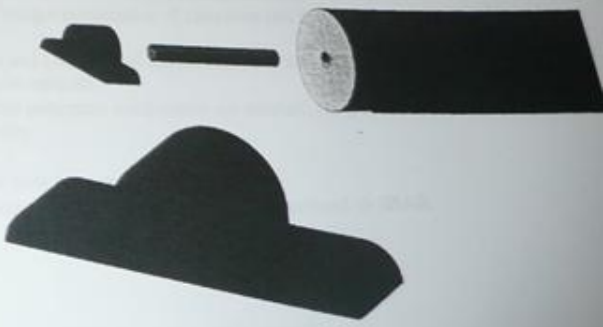
The first picture below shows a second arial view, this time with the problem solved. The second picture shows a close-up of the solution.



Change in Roller Design

Whilst making the roller table I decided to change the design and this was for two reasons, the first being that it would have been difficult to drill the holes where they were designed to be, the second reason was the immediate availability of aluminium bar. Therefore I used larger bar and less rollers. The sketch below shows the original design of the roller table.

Because the rollers are flush with the surface of the baseboard, and they are bigger, the centre of them is lower and becomes to be underneath the baseboard. It is this that allows me to use a standard bracket attached from the underside of the baseboard. The standard bracket and roller assembly is seen below.



Plan Of Manufacture

Brief Over-View Of Steps Involved And Timescale

1.	Creation Of Upper Baseboard	4 Periods (2 Hours)
2.	Creation Of Compacting Box	8 Periods (4 Hours)
3.	Creation Of Towers	6 Periods (3 Hours)
4.	Creation Of Lower Baseboard and Alt Stilts	2 Periods (1 hour)
5.	Creation of Turning Compactor	7 Periods (3.5 Hours)
6.	Creation Of Scoop	10 Periods (5 Hours)
7.	Creation Of Roller Table	4 Periods (2 Hours)
8.	Creation Of Scraper	4 Periods (2 Hours)

This is the order in which I will complete this task. The timeframe given is a total of 48 periods or 24 hours work. Although I have taken into consideration all parts of these tasks, the time given may not be completely accurate therefore I have set aside an extra 10 periods in case of delays. The descriptions and steps given on this page should be used as a guide to supplement the design proposal in the previous unit of work.

Step 1- Creation Of Upper Baseboard (4 Periods)

1. Cut Baseboard 600x838 in 12mm MDF
   ½ Period
2. Cut slot for rollers using Jigsaw. File and sand the edges of the slot smooth.
   1 Period
3. Cut out slot for scraper using mill and 14mm cutting tool. File and sand edges smooth.
   1 Period
4. Cut chain slot using 10mm Cutter on mill. File and sand until smooth.
   1 Period
5. Mark out and drill hole for compacting turntable. 6mm diameter.
   ½ Period

Step 2- Creation Of Compacting Box (8 Periods)

1. Cut back in 12mm MDF. Use mill and 10mm cutting tool to cut slots. Use 8mm drill bit to drill hole
   2 Periods
2. Cut out sides in 12mm MDF. Use a saw to cut corners and clean up with the band-facer.
   1 Period
3. Cut front in 12mm MDF. Use the mill and a 10mm cutter to mill slots
   2 Periods
4. Create the sideways compactor. Cut out two pieces of 8mm MDF. Mark out and cut using Band-Saw. Drill 4mm hole in each to fit cylinder. Fit cylinder to the front using 25x25 angle aluminium
   2 Periods
5. Fit the complete box together using 3.5x30mm screws to hold outside and 2x10mm screws to attach piston brackets to front of box.
   1 Period

Step 3- Creation Of Towers (6 Periods)

1. Cut main towers in 18mm MDF and use 8mm cutter to mill slots
   2 Periods
2. Create 4xsupports from 18mm MDF. Use Band-Saw and Band-Facer to shape into triangles.
   1 Period
3. Create moving parts for motor.
   Bend 25x3mm aluminium to create bracket for underside, fit spur gear and sprocket to 6mm steel bar and using brackets, fit to underside of baseboard. Fit motor in position to mesh with spur gear.
   Fit sprocket to 6mm steel bar, allow for free turning and place 2 interference fit nylon guides on either side to prohibit movement. Drill 5.9 hole on inside of each tower and fit the steel bar into holes.
   2 Periods
4. Fit tower to supports using 3,5x30mm screw per support then fit each support to baseboard from underneath using a combination of 3,5x30mm and 3,5x25mm screws.
   1 Period

Step 4- Creation Of Lower Baseboard And Standing Supports (2 Periods)

1. Cut baseboard from 12mm MDF. Cut two lengths of pine 838x70x18mm. Cut four pieces of pine 35x45x80mm
   1 Period
2. Fit together using 3,5x30mm screws. For linking upper and lower baseboard I will place two screws from the top and two screws from the bottom in each of the supports. For the lower supports I will use 4 equally spaced screws through from the top in each of the supports.
   1 Period

Step 5- Creation Of Turning Compactor (7Periods)

1. Create Turntable. Cut 200x200 piece of 12mm MDF. Use compass to draw circle of 200mm diameter. Drill 4mm hole on centre. Use Band-Saw to cut around circle outline. Use predrilled hole to secure to jig and set up on Band-Facer to create perfect circle. Re-drill hole at 5.9mm. Drill two 4mm holes to attach arm. Counter-bore at one side at 8mm.
   1 Period
2. Cut arms from 20x20x2 steel box section. Cut 20x3mm steel plate for piston attachment. Cut 20x20 angle steel for bottom. Weld together structure. Drill two 4mm holes in bottom. Drill 12mm hole for piston and 8mm hole for guide at top
   3 Periods
3. Create compacting plate and thread guide bar 8mm.
   1 Period
4. Fit together all pieces. Use 4mm nut and bolt to attach compacting arm to plate. Use 12mm and 4mm bolts to attach cylinder and 8mm bolt to attach guide. Fit mechanism using bevel gears. The steel bar should go into the turntable and through the baseboard. There should then be a bevel gear. The motor should be attached to underside of baseboard so that the bevel gears are meshing.
   2 Periods

Step 6- Creation Of Scoop (10 Periods)

1. Create box for piston. Cut top and bottom from 6mm MDF and sides from 12mm MDF. Use 25mm screws to fasten sides on from top and bottom. 2 in each side. Cut two pieces of 18mm MDF and drill 22mm hole 6mm deep on one, drill 4mm hole whole way through and then drill 22mm 6mm deep in the front piece.
   2 Periods
2. Create Scoop Bucket. Take two pieces of 12mm MDF. Mark outline and use Band-Saw to cut outline. Use Band-Facer to tidy up. Take 2mm aluminium sheet and cut to size. Then shape to fit around the sides already formed. I plan to bend this by hand using a vice, I will use the sides already made as a guide to shape.
   2 Periods
3. Create Turntable. The turntable should be made from 12mm MDF. Cut out on band-saw the shaped on the band-facer.
   1 Periods
4. Create the lifting Mechanism. Start with 2 pieces of 12mm MDF, use double sided sticky tape to tape together and shape using band-saw and band-facer. Drill 2 holes partially though in each. Use 6mm bar to assemble piston and to make pivot.
   2 periods
5. Fit together. Place all pices together. Bevel gears and motor assembled to underside for turning.
   2 Periods

Step 7- Creation of roller table

1. Cut 5 equally sized rollers from aluminium bar. Drill 3.9mm hole in each end approx 20mm deep.
   2 Periods
2. Cut 10 pieces of 4mm copper bar.
   1 Period
3. Fit together using standard brackets. Place bar in end of roller and through bracket. Fit bracket to underside of baseboard.
   1 Period

Step 8-Crete scraper

1. Create aluminium section to allow telescopic link between cylinders. Drill holes to meet end of piston and piston rod. Create brackets to hold cylinder to underside of the baseboard.
   2 Periods
2. Create scraper plate using 10x10mm angle section. Use 10x2mm length of bar to link scraper and cylinder underne
   2 Periods
3. Fit together.
   1 Periods

Plan Of Manufacture

Brief Over-View Of Steps Involved And Timescale

1.	Creation Of Upper Baseboard	4 Periods (2 Hours)
2.	Creation Of Compacting Box	8 Periods (4 Hours)
3.	Creation Of Towers	6 Periods (3 Hours)
4.	Creation Of Lower Baseboard and All Stilts	2 Periods (1 hour)
5.	Creation of Turning Compactor	7 Periods (3.5 Hours)
6.	Creation Of Scoop	10 Periods (5 Hours)
7.	Creation Of Roller Table	4 Periods (2 Hours)
8.	Creation Of Scraper	4 Periods (2 Hours)

This is the order in which I will complete this task. The timeframe given is a total of 48 periods or 24 hours work. Although I have taken into consideration all parts of these tasks, the time given may not be completely accurate therefore I have set aside an extra 10 periods in case of delays. The descriptions and steps given on this page should be used as a guide to supplement the design proposal in the previous unit of work.

Step 1- Creation Of Upper Baseboard (4 Periods)

1. Cut Baseboard 600x838 in 12mm MDF
   ½ Period
2. Cut slot for rollers using Jigsaw. File and sand the edges of the slot smooth.
   1 Period
3. Cut out slot for scraper using mill and 14mm cutting tool. File and sand edges smooth.
   1 Period
4. Cut chain slot using 10mm Cutter on mill. File and sand until smooth.
   1 Period
5. Mark out and drill hole for compacting turntable. 6mm diameter
   ½ Period

Step 2- Creation Of Compacting Box (8 Periods)

1. Cut back in 12mm MDF. Use mill and 10mm cutting tool to cut slots. Use 8mm drill bit to drill hole
   2 Periods
2. Cut out sides in 12mm MDF. Use a saw to cut corners and clean up with the band-facer.
   1 Period
3. Cut front in 12mm MDF. Use the mill and a 10mm cutter to mill slots
   2 Periods
4. Create the sideways compactor. Cut out two pieces of 8mm MDF. Mark out and cut using Band-Saw. Drill 4mm hole in each to fit cylinder. Fit cylinder to the front using 25x25 angle aluminium.
   2 Periods
5. Fit the complete box together using 3.5x30mm screws to hold outside and 2x10mm screws to attach piston brackets to front of box.
   1 Period

Step 3- Creation Of Towers (6 Periods)

1. Cut main towers in 18mm MDF and use 8mm cutter to mill slots.
   2 Periods
2. Create 4xsupports from 18mm MDF. Use Band-Saw and Band-Facer to shape into triangles.
   1 Period
3. Create moving parts for motor.
   Bend 25x3mm aluminium to create bracket for underside, fit spur gear and sprocket to 6mm steel bar and using brackets, fit to underside of baseboard. Fit motor in position to mesh with spur gear.
   Fit sprocket to 6mm steel bar, allow for free turning and place 2 interference fit nylon guides on either side to prohibit movement. Drill 5.9 hole on inside of each tower and fit the steel bar into holes.
   2 Periods
4. Fit tower to supports using 3,5x30mm screw per support then fit each support to baseboard from underneath using a combination of 3,5x30mm and 3,5x25mm screws.
   1 Period

Step 4- Creation Of Lower Baseboard And Standing Supports (2 Periods)

1. Cut baseboard from 12mm MDF. Cut two lengths of pine 838x70x18mm. Cut four pieces of pine 35x45x80mm
   1 Period
2. Fit together using 3,5x30mm screws. For linking upper and lower baseboard I will place two screws from the top and two screws from the bottom in each of the supports. For the lower supports I will use 4 equally spaced screws through from the top in each of the supports.
   1 Period

Step 5- Creation Of Turning Compactor (7Periods)

1. Create Turntable. Cut 200x200 piece of 12mm MDF. Use compass to draw circle of 200mm diameter. Drill 4mm hole on centre. Use Band-Saw to cut around circle outline. Use predrilled hole to secure to jig and set up on Band-Facer to create perfect circle. Re-drill hole at 5.9mm. Drill two 4mm holes to attach arm. Counter-bore at one side at 8mm.
   1 Period
2. Cut arms from 20x20x2 steel box section. Cut 20x3mm steel plate for piston attachment. Cut 20x20 angle steel for bottom. Weld together structure. Drill two 4mm holes in bottom. Drill 12mm hole for piston and 8mm hole for guide at top
   3 Periods
3. Create compacting plate and thread guide bar 8mm.
   1 Period
4. Fit together all pieces. Use 4mm nut and bolt to attach compacting arm to plate. Use 12mm and 4mm bolts to attach cylinder and 8mm bolt to attach guide. Fit mechanism using bevel gears. The steel bar should go into the turntable and through the baseboard. There should then be a bevel gear. The motor should be attached to underside of baseboard so that the bevel gears are meshing.
   2 Periods

Step 6- Creation Of Scoop (10 Periods)

1. Create box for piston. Cut top and bottom from 8mm MDF and sides from 12mm MDF. Use 25mm screws to fasten sides on from top and bottom, 2 in each side. Cut two pieces of 18mm MDF and drill 22mm hole 9mm deep on one, drill 4mm hole whole way through and then drill 22mm 9mm deep in the front piece.
   2 Periods
2. Create Scoop Bucket. Take two pieces of 12mm MDF. Mark outline and use Band-Saw to cut outline. Use Band-Facer to tidy up. Take 2mm aluminium sheet and cut to size. Then shape to fit around the sides already formed. I plan to bend this by hand using a vice, I will use the sides already made as a guide to shape.
   2 Periods
3. Create Turntable. The turntable should be made from 12mm MDF. Cut out on band-saw the shaped on the band-facer.
   2 Periods
4. Create the lifting Mechanism. Start with 2 pieces of 12mm MDF, use double sided sticky tape to tape together and shape using band-saw and band-facer. Drill 2 holes partially through in each. Use 6mm bar to assemble piston and to make pivot.
   2 periods
5. Fit together. Place all pices together. Bevel gears and motor assembled to underside for turning.
   2 Periods

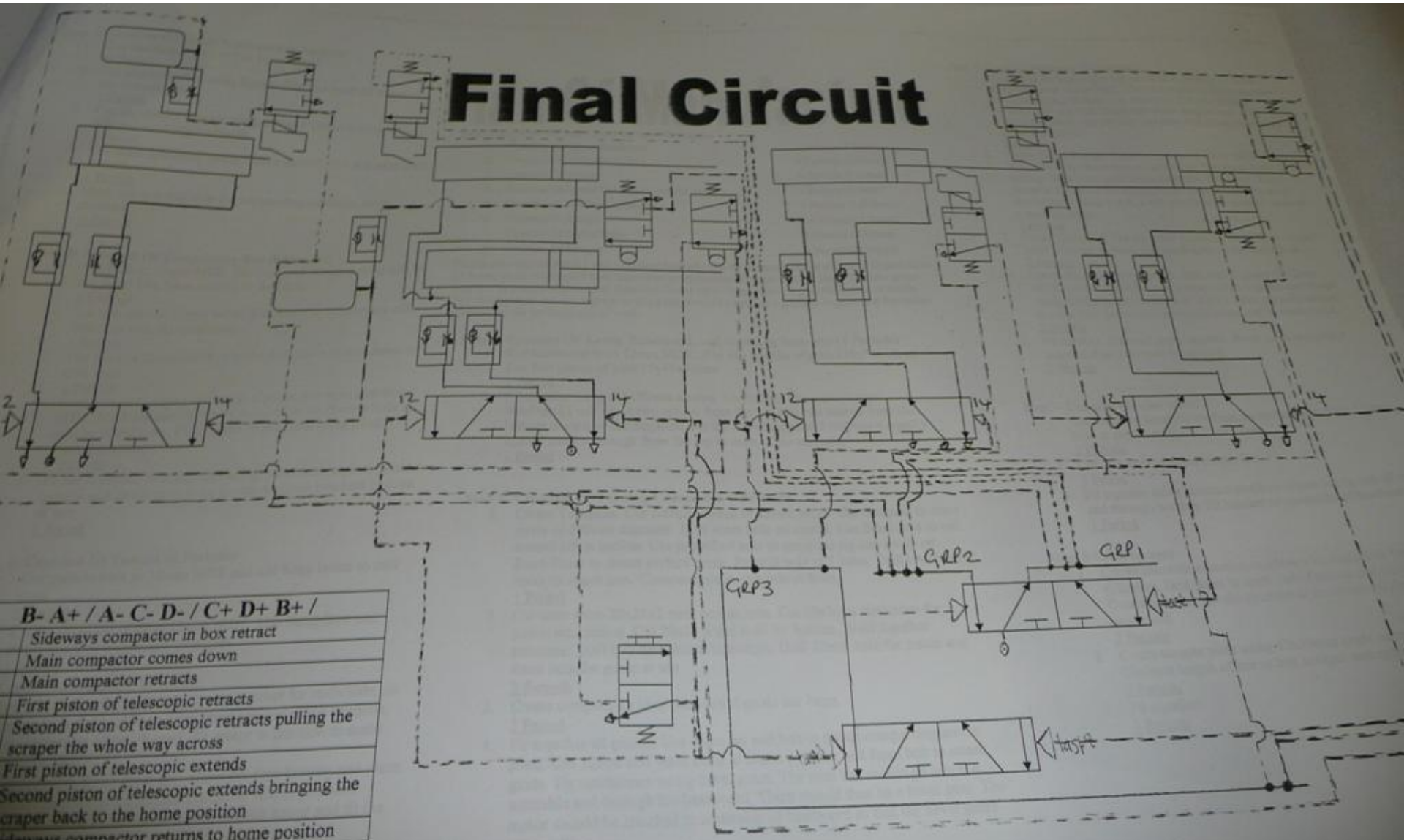
Step 7- Creation of roller table

1. Cut 5 equally sized rollers from aluminium bar. Drill hole in each end approx 20mm deep.
   2 Periods
2. Cut 10 pieces of 4mm copper bar.
   1 Period
3. Fit together using standard brackets. Place bar in and through bracket. Fit bracket to underside of
   1 Period

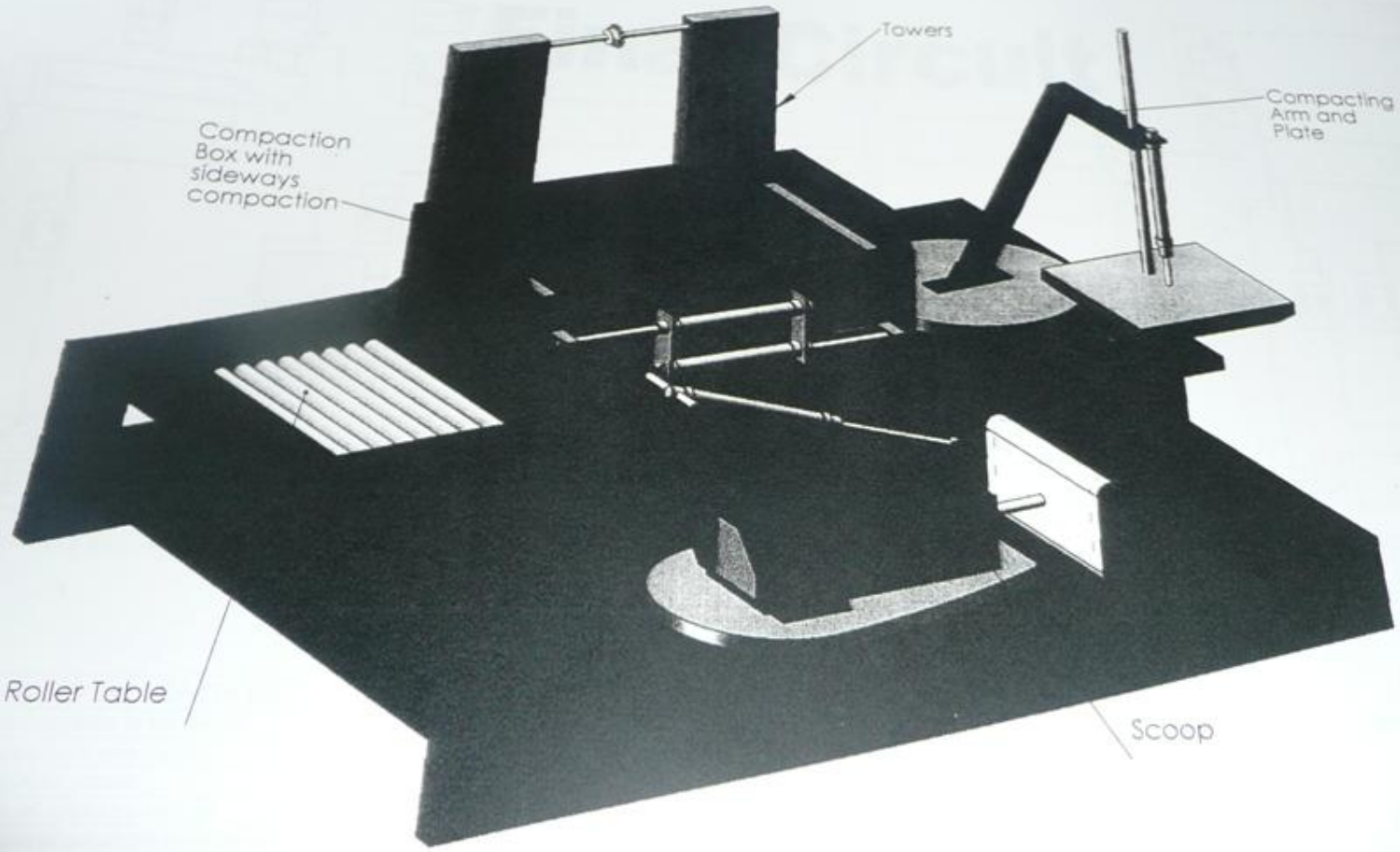
Step 8-Crete scraper

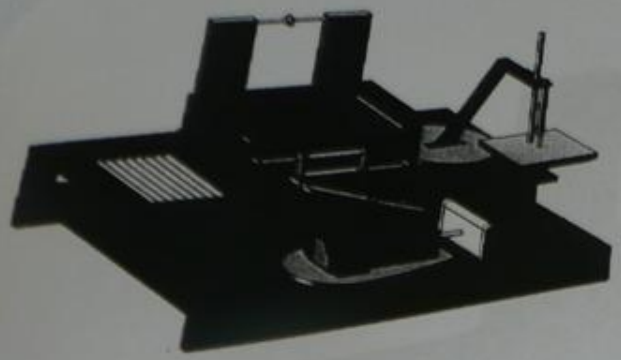
1. Create aluminium section to allow telescopi cylinders. Drill holes to meet end of piston Create brackets to hold cylinder to unders baseboard.
   2 Periods
2. Create scraper plate using 10x10mm an 10x2mm length of bar to link scraper
   2 Periods
3. Fit together.
   1 Periods

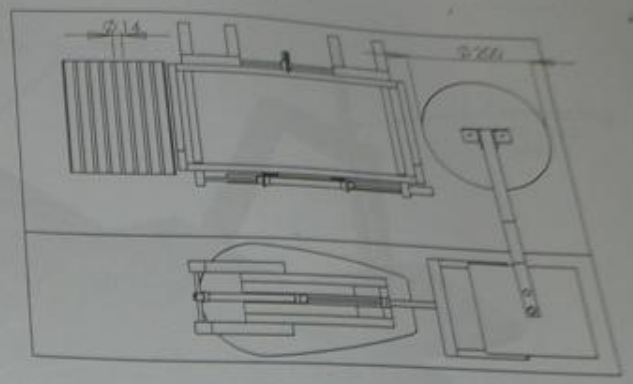
Final Circuit

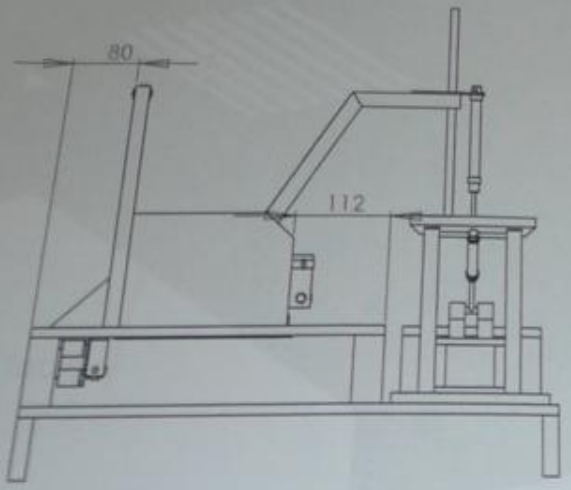


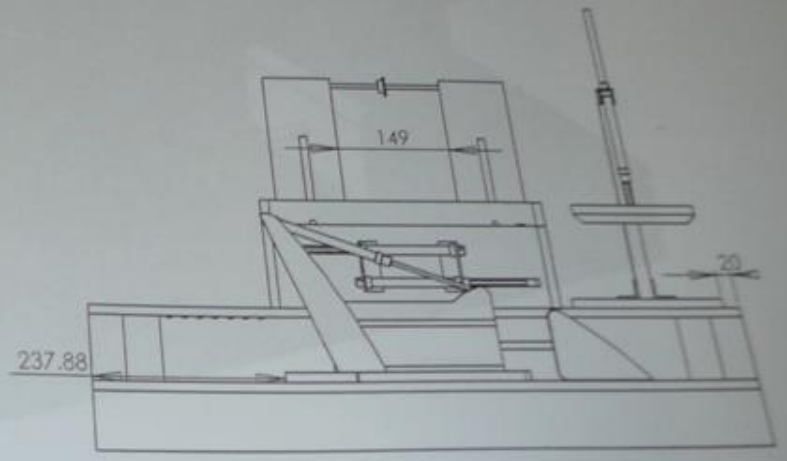
B- A+ / A- C- D- / C+ D+ B+ /
Sideways compactor in box retract
Main compactor comes down
Main compactor retracts
First piston of telescopic retracts
Second piston of telescopic retracts pulling the scraper the whole way across
First piston of telescopic extends
Second piston of telescopic extends bringing the craper back to the home position
ideways compactor returns to home position


Towers
Compacting Arm and Plate
Compaction Box with sideways compaction
Roller Table
Scoop









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TOLERANCES:
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	NAME	SIGNATURE	DATE
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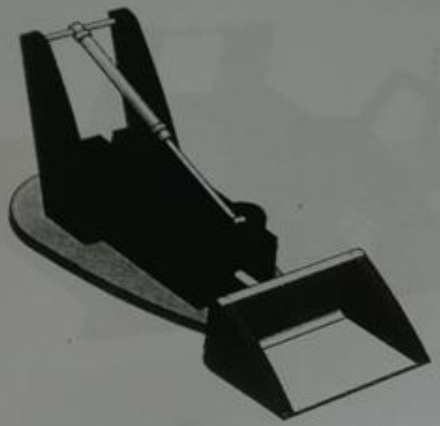
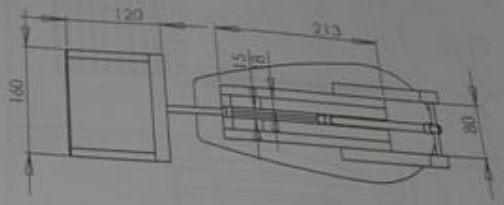
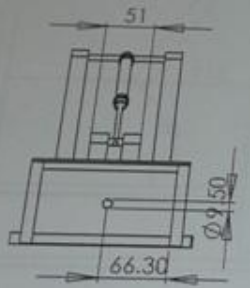
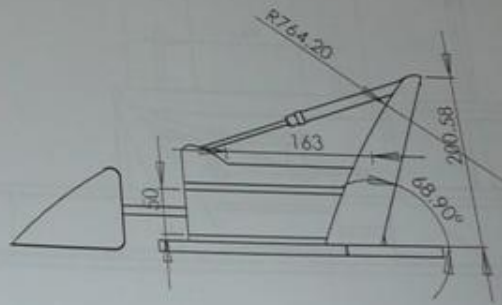
CHK'D			
APP'D			
MFG			









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DEBUR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

REVISION

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APP'VD			
MFG			
Q.A			

TITLE:

MATERIAL:

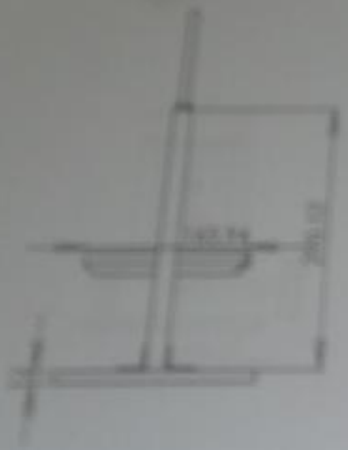
DWG NO.

Scoop

WEIGHT:

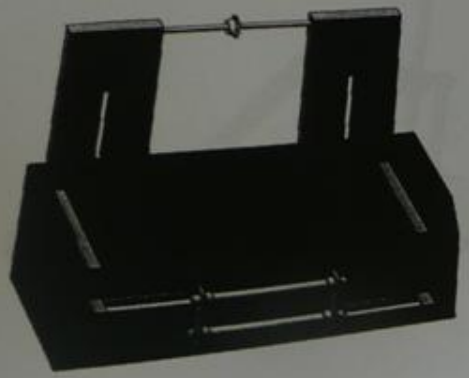
SCALE:1:5

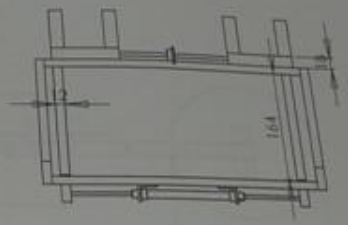
2 3 4

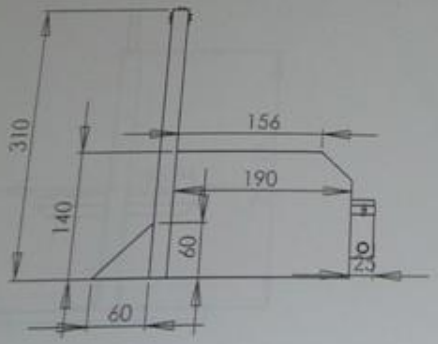


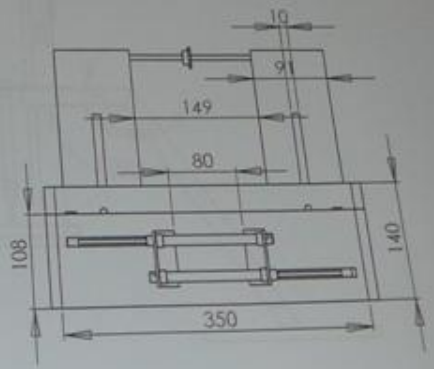
- The control system is reasonably developed to outcome
- Some evidence of numerical analysis in development

SECTION 7 - DESIGN PROPOSAL









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CHK'D			
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Q.A			

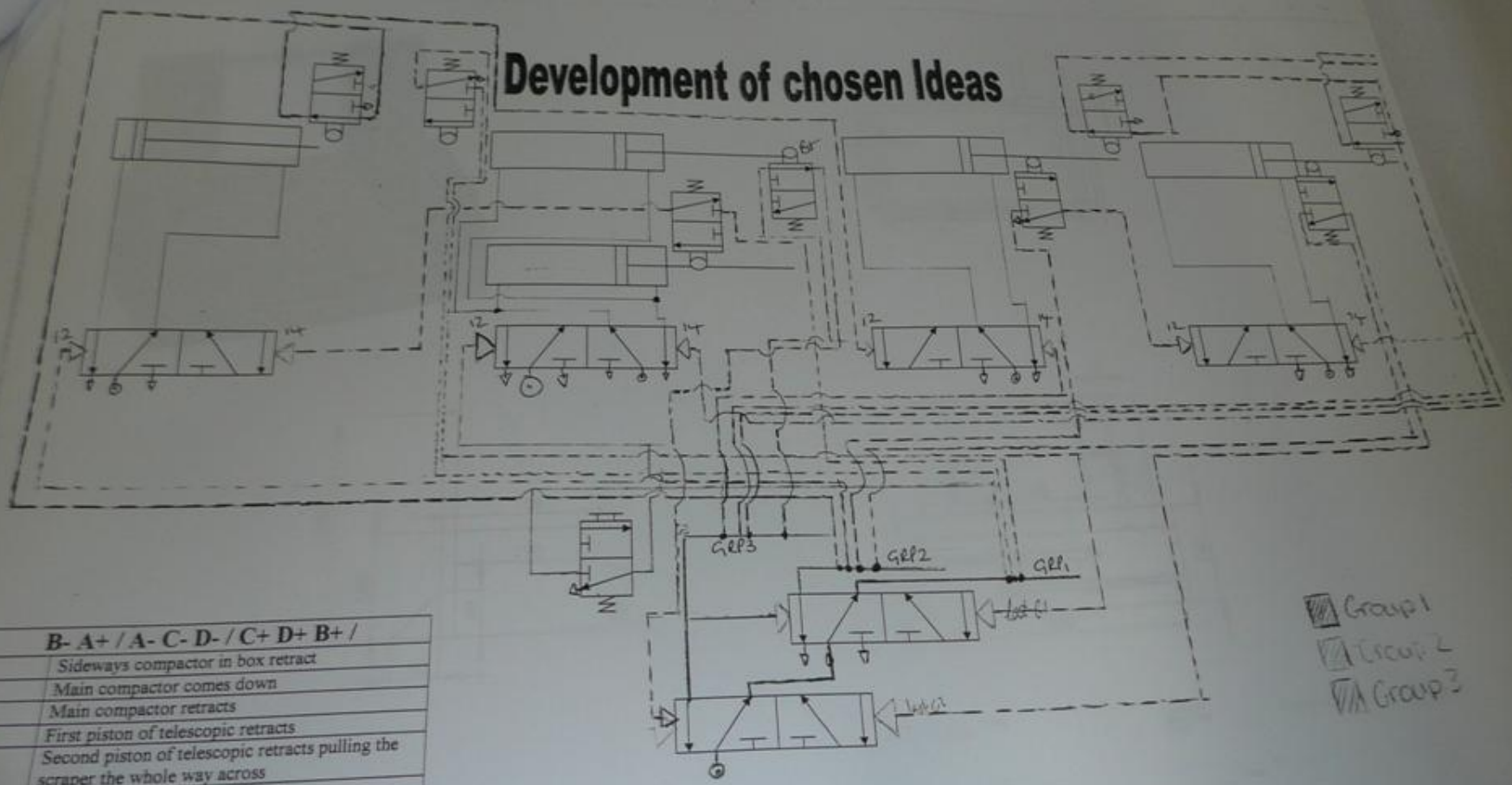
TITLE:

Compacting Box A3

MATERIAL: DWG. NO.

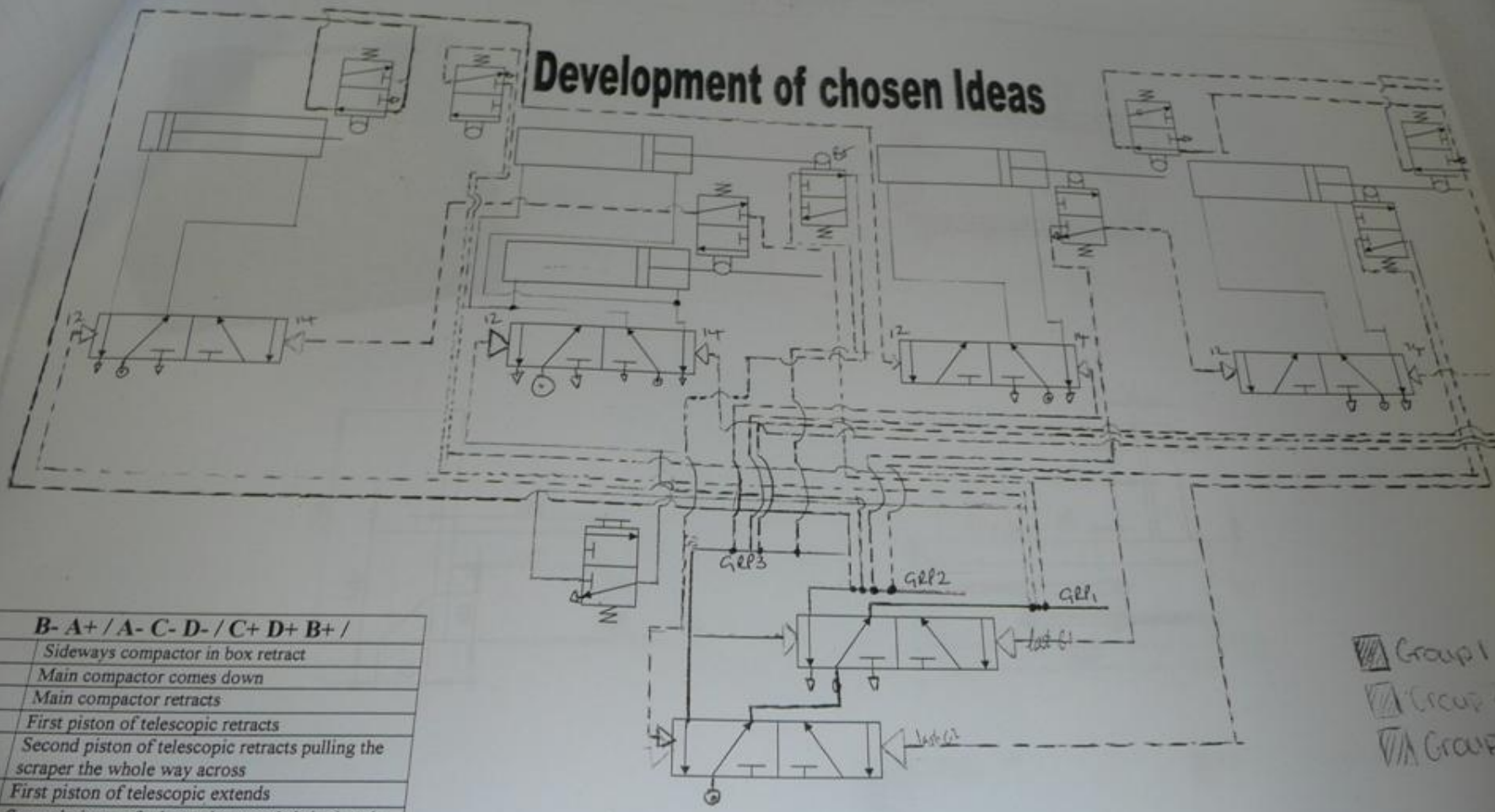
WEIGHT: SCALE:0.3 SHEET 1 OF 1

Development of chosen Ideas



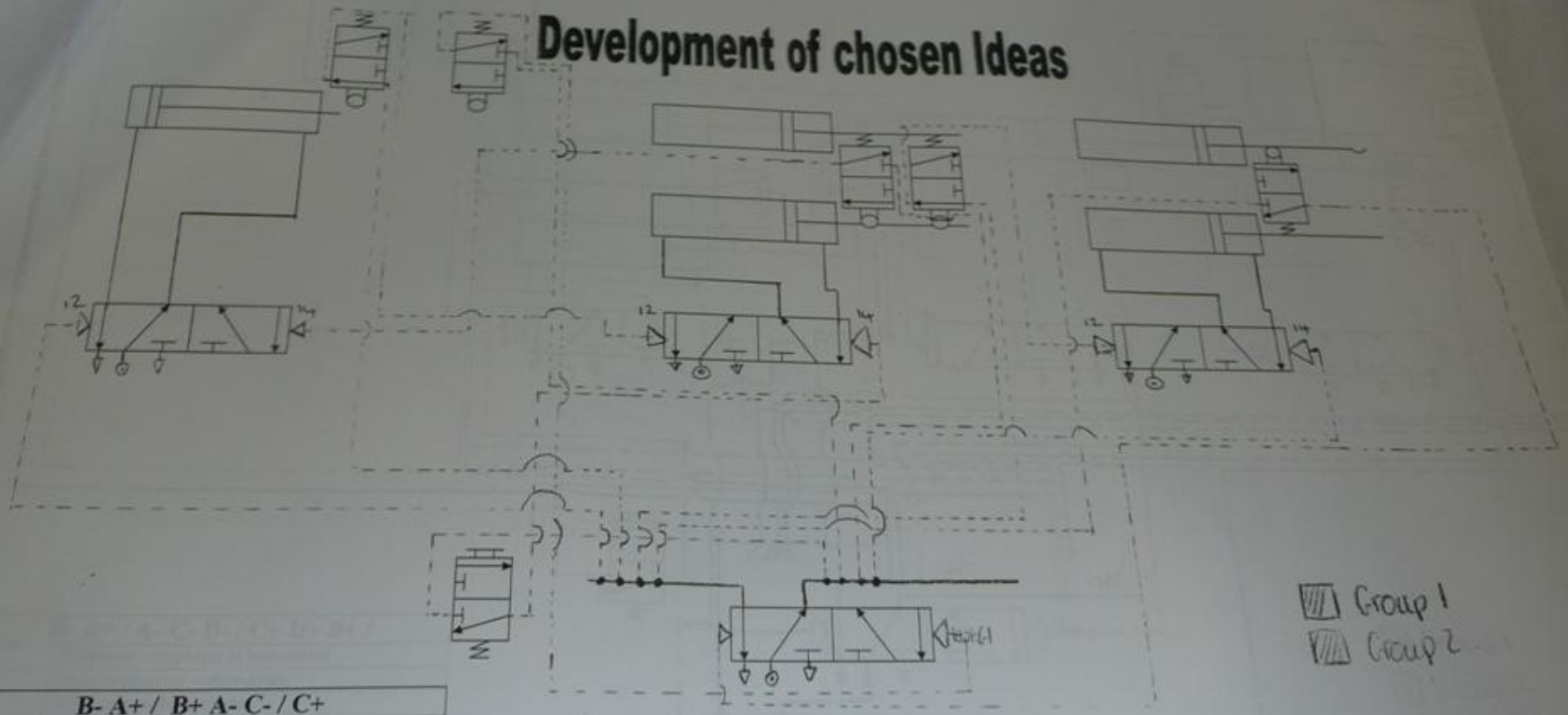
B- A+ / A- C- D- / C+ D+ B+ /	
B-	Sideways compactor in box retract
A+	Main compactor comes down
A-	Main compactor retracts
C-	First piston of telescopic retracts
D-	Second piston of telescopic retracts pulling the scraper the whole way across
C+	First piston of telescopic extends
D+	Second piston of telescopic extends bringing the scraper back to the home position
B+	Sideways compactor extends to home pos

Development of chosen Ideas



	B- A+ / A- C- D- / C+ D+ B+ /
B-	Sideways compactor in box retract
A+	Main compactor comes down
A-	Main compactor retracts
C-	First piston of telescopic retracts
D-	Second piston of telescopic retracts pulling the scraper the whole way across
+	First piston of telescopic extends
-	Second piston of telescopic extends bringing the scraper back to the home position
	Sideways compactor extends to home pos

Development of chosen Ideas



Group 1
Group 2

B- A+ / B+ A- C- / C+	
B-	Sideways compactor in box retract
A+	Main compactor comes down
A-	Main compactor retracts
B+	Sideways box compactor goes back to home position
C-	Telescopic pistons retract pulling the scraper across
C+	Telescopic pistons extend bringing the scraper back to the home position

Development Of Ideas

Scoop

The scoop will comprise of a bucket and a piston. The piston will be concealed inside a box for reasons of aesthetics and safety. An exploded view of the piston and box shows how they all fit together.

To complete its task, the scoop must lift into the air and also turn. I will look at both of these aspects separately below to design this part of the system. I think the scoop should be at a lower level than the box to allow it room to turn and dump. This possibility will be investigated at the end of this section.

Turning the scoop

To turn the scoop I will look at using the idea designed for the compacting arm's turning mechanism. The scoop will sit on a circular plate. This plate will be attached to a motor attached to the underside of the baseboard. When the motor turns, the plate, and therefore the scoop, also turns.

But because the box for the piston will have to sit on top of this turntable, it will have to be longer. My Proposed idea is shown here below

Lifting The Scoop

The scoop will also have to lift up and down. There are two ways to achieve this through pneumatics, piston extending from underneath or piston retracting from above. As there wont be much room on the underside I have decided to go with the piston being held from above

This picture shows how this design would look on the proposed system. I think this design would work well with the parts of the system already developed. The picture on the right shows how the piston is would be attached to the supports.

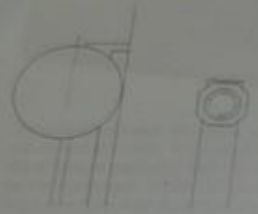
The end of the piston must now be attached to the box to lift it. This could be done by the use of a dimple bracket but I have decided to integrate the idea in the previous part. I will use curves to add to the aesthetics of my overall system. The picture on the left shows this mounted to my system and the picture to the right shows the linkage at the bottom.

The idea above will be the basic structure to the lifting mechanism. The picture shown left shows a slightly developed version which is shaped for aesthetic reasons

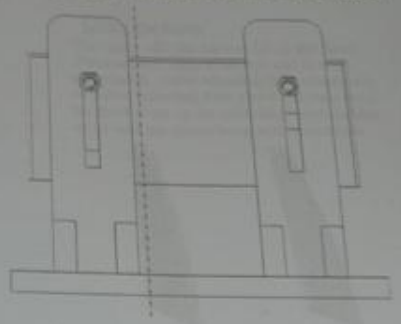
Development Of Chosen Ideas

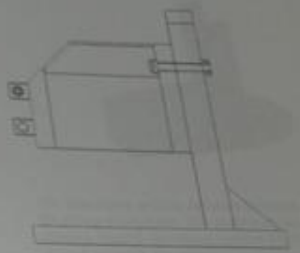
Development Of Lifting Box-Transferring Motion

The box must be moved up and down by an electric motor through the use of a mechanical system. The first option is to mount a motor to the side of the box and mounting a rack to the side of the tower. This would allow the box to move up and down easily through the use of the rack and pinion.



The second option would be to use a chain driven system which would be powered by a motor mounted on the underside of the baseboard. The chain would be attached to a sprocket at the top of the towers and also be permanently fixed to the box. This system is shown here.





Sectional view A-A

Development of Compacting Arm

As part of the system the compactor will be mounted on an arm. This sketch shows a basic arm that goes straight up and across.

This compacting arm looks slanted, I think this will appeal aesthetically and adds character to the design.

Rotating of Compacting Arm

The compacting arm would be secured to a plate as seen in the development section on left. This plate will then rest on the baseboard and turn through the power of an electric motor. The sketch below shows the compacting arm along with the parts of the system already developed.

This sketch shows how a cylinder would be mounted upo the arm. Attached to the end of the cylinder is a compacting plate. The problem with this is that the piston rod is free to turn, therefore I must use some sort of guiding system.

is sketch shows how the guide would be created. This would simply be a length of round metal bar, running alongside the cylinder. The round bar would have an interference fit at the bottom and clearance fit at the top to allow it to move freely as the piston extends/retracts.

Shown here above is how the mechanism would fit together. Below is the close up of the bevel gears used in this system

Development Of Chosen Ideas

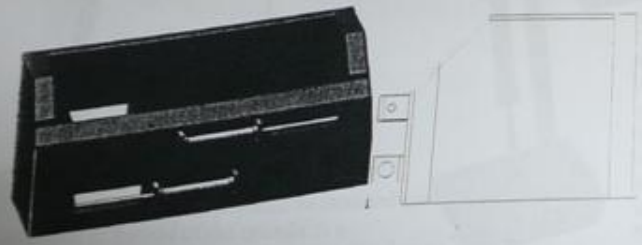
Development Of Compacting Box

The main part of the compactor will take the form of a double open-ended box. The sketch below shows the basic idea for the compactor

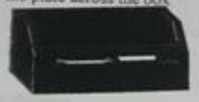
As it will be loaded by a scoop, it may be a good idea to lower the front end for access. I will also improve the aesthetics of the box by rounding off the edges. The sketch on the right shows the developed shape of the box.

To add to the efficiency of the compacting system it may be a good idea to also compact the swarf in another direction. This will create a more compact block of swarf. The sketch below shows how the compacting plate would move across the inside of the box powered by a cylinder, effectively halving the amount of room taken up by the swarf.

As a development to the above idea I have decided that it would be better to use the same idea but with two cylinders and two compacting plates. This will reduce the amount of effort for each cylinder and would also add symmetry to the system for aesthetics.



The cylinder retracts pulling the plate across the box



This sectional sketch shows how the compacting plate is guided. There is a milled slot on the front and the back of the box, which holds the plate straight as the piston pulls it across.

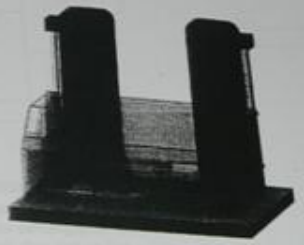
The two cylinders working together pull two plates against each other inside the box.

This sectional sketch shows the development of the milled slots in the developed idea.

Development Of Lifting Box

The compacting box will have to move up and down to allow the block of compacted swarf to be ejected. To do this I propose that two towers run up the back of the box that are fitted to the baseboard. These towers will allow for some sort of guides to be put in place.

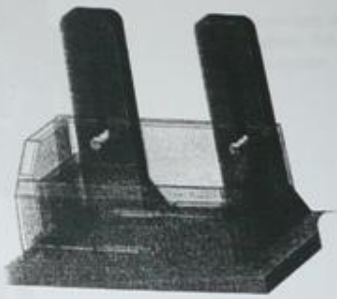
The first guides that I propose use round bar fitted to the towers and some hollow round bar fitted to the box. The hollow bar will fit around the bar fitted to the tower. This will mean that when the box moves up, that it will be held dead straight. This is shown below.



The box risen up against the tower.

A zoomed view of the guide. Showing how everything is fixed down.

A better idea may be to use bolts put through a milled slot in the towers. This will allow the box to travel up straight and will be cheaper to produce than the proposed idea above. The idea is shown here below.

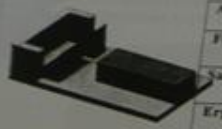


The box risen up against the tower.

A zoomed view of the guide. Showing how everything is fixed.

Selection Of Ideas For Further Development

Methods Of Moving Swarf To Compactor:
Method 1



Area	Comment	Score 38/50
Function	This scoop would function well in the proposed system and suits the guidelines set out in my specification.	10/10
Safety	This component is not very safe, it would need strict user guidance and safety features included.	5/10
Ergonomics	I think this component would be fit to purpose in the proposed project. If this component were to be piped up separately to the rest of the system then the user could manually fill the compactor and decide when it is full.	9/10
Aesthetics	This product would be well suited to my project as is very industrious looking.	8/10
Ease Of Use	It would be fairly easy to use as the motions would all be in sequence and therefore the user would only have to actuate the start valve to start the process.	6/10

Method 2

Area	Comment	Score 37/50
Function	Hoppers would offer good function to the system.	8/10
Safety	They are relatively safe, moving parts are generally within the hopper and other parts can be guarded.	7/10
Ergonomics	It would work well with the system, it would allow a preset and exact amount of swarf into the compactor. It would also act as a storage device for swarf before compacting.	8/10
Aesthetics	I feel that the hopper is not very aesthetically appealing as it would be quite big and could become out of proportion with the rest of the system.	4/10
Ease Of Use	It would be very easy to use, the sequence would continue automatically after a start valve is pressed and this could also be incorporated in the main sequential circuit.	10/10

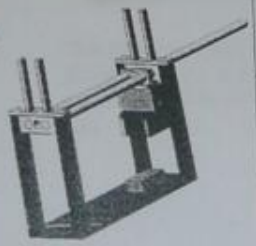
Methods Of Moving Swarf For Collection:
Method 1

Area	Comment	Score 32/50
Function	This part would suit its function well as it would easily move the swarf for collection.	8/10
Safety	The product would be relatively safe but with moving parts there is a present danger to the user, there is a possibility of installing guards to prevent this.	5/10
Ergonomics	The product would perform its purpose but with the uneven weight of the block of swarf there is a possibility of belt slippage.	3/10
Aesthetics	This part is aesthetically pleasing and looks industrial.	7/10
Ease Of Use	The system would be very easy to use. It would run on a standard motor which would be operated by a switch.	9/10

Method 2

Area	Comment	Score 41/50
Function	This part would function well in the proposed system and would easily transport the swarf.	8/10
Safety	This product would be relatively safe but with moving parts guards may have to be installed to protect the user.	5/10
Ergonomics	The product would perform to its purpose and could work on a chain driven by a motor or could be free rolling allowing a piston to push the swarf across.	9/10
Aesthetics	The product is aesthetically pleasing and the rollers would be made of aluminium which would offer aesthetic value to the system component.	9/10
Ease Of Use	It would be very easy to use as it would be operated by a switch or, if free rolling would need no user input.	10/10

Method 3



Area	Comment	Score 30/50
Function	This component would function well and would transport the swarf easily.	8/10
Safety	The product wouldn't be very safe to use as the crane is moving both in the X and Z directions and it also clamps the block causing massive danger to the user.	1/10
Ergonomics	The product would perform well and would lift the block to an exact location which the other two methods do not offer. If electronics are used then this component could also be programmed to stack the blocks onto a pallet.	10/10
Aesthetics	The product is very aesthetically pleasing and offers a high end industrial look.	9/10
Ease Of Use	This component would not be very easy to use as there are many parts to its sequence of operation.	2/10

Methods Of Compacting Swarf:
Method 1

Area	Comment	Score 36/50
Function	This option would perform its purpose well.	8/10
Safety	This would be a relatively safe method as most of the compacting happens in the concealed chamber, but the block that exits the compactor would be moving presenting some sort of danger that could be rectified by installing guards.	7/10
Ergonomics	The product works well but would be very difficult to manufacture. The swarf that is lost to exit slots may not be properly compacted.	8/10
Aesthetics	This part is relatively aesthetically pleasing and offers a low cost industrial look.	7/10
Ease Of Use	It would be very simple to use as one person is doing all the work.	9/10

Method 2

Area	Comment	Score 40/50
Function	This product would perform well to the proposed system.	8/10
Safety	It would be very safe as the compacting all happens inside the chamber.	9/10
Ergonomics	It would work well as it would ensure that all of the swarf is compacted correctly.	8/10
Aesthetics	This is very aesthetically pleasing and offers a very industrial feel.	10/10
Ease Of Use	It would be relatively easy to operate but there are many moving parts and this may present difficulties.	5/10

Method 3

Area	Comment	Score 29/50
Function	This product would work for its intended purpose.	8/10
Safety	It would be very difficult to protect the user from harm with this type of system as there are so many moving parts which would be difficult to guard against.	3/10
Ergonomics	It would work well as a product and would compact the swarf easily but may be difficult to build and maintain.	
Aesthetics	It looks quite industrial although may look out of proportion with the rest of the system.	
Ease Of Use	It would be relatively hard to use due to the amount of moving parts, some of which would be difficult to add to a pneumatic sequence.	

Conclusion:

- Methods Of Moving Swarf To Compactor:
  - The highest scoring of the two methods was Method 1, the scoop.
  - I will choose this for its high scoring in Ergonomics, aesthetics and Function
- Methods Of Moving Swarf for Collection:
  - The highest scoring of the three methods was the roller table.
  - I will choose this for its Functionality, Aesthetics and Ease Of Use.
- Methods Of Compacting Swarf:
  - The highest scoring of the three methods was Method 2, the swivel compactor.
  - I will choose this for its Functionality and Aesthetic appeal.

Initial Ideas

Methods of Moving The Swarf For Collection:

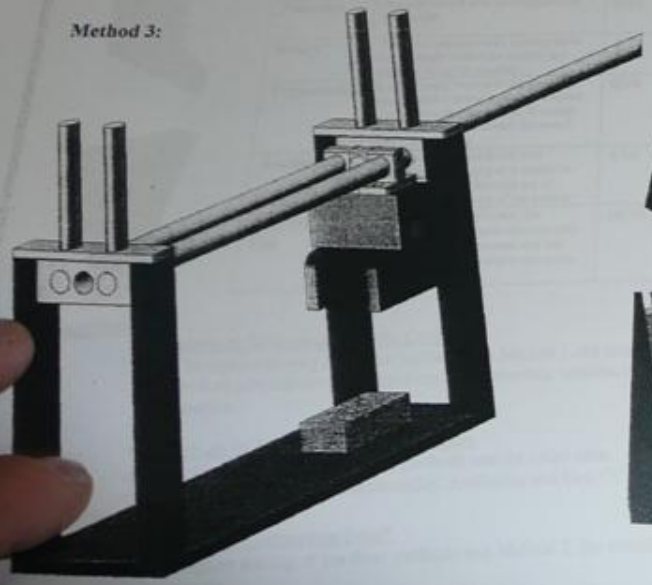
Method 1:

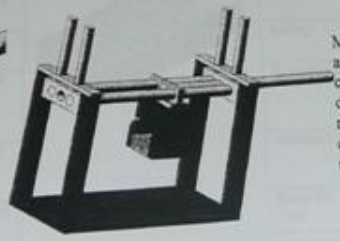
The first possible method is a conveyor belt system. This is made up if two rollers connected to two customised brackets. These brackets are attached to a baseboard for support. There is also a board underneath the belt to support the belt and prevent sagging. The conveyor is wrapped around the rollers. A motor and chain-drive mechanical system would be used to create this conveyor belt. This conveyor could be driven by a motor, shown below is an example as to how this may be achieved.

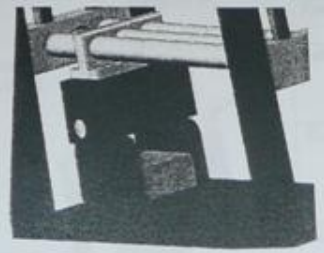
Method 2:

The roller table is also an ideal way to move the block of compacted swarf. It is made up of a series of rollers along a chassis. A motor through a chain drive system will drive the roller. The roller table can also be used without motors, as the rollers are free moving it would be easy for humans to push heavy objects across it. If I include a roller table in my project it will be driven by a chain and sprocket system to make the system completely self-sufficient.

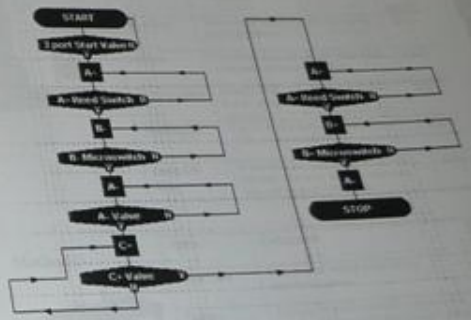
Method 3:







Method three is the idea of a crane lifting across the swarf. The crane drops down, clamps, rises, moves to its destination, drops down and releases the swarf before returning to its home position. Pneumatic cylinders, mechanics or a combination of the both could drive this crane. If motors are involved then micro switches could be used to control them.

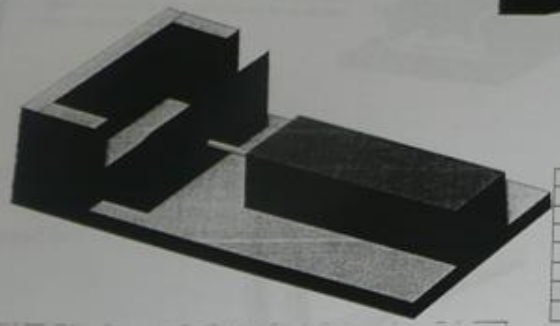


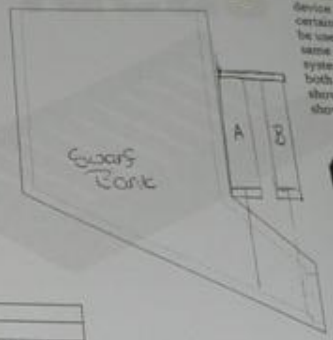
This flowchart represents the pneumatic sequence for this crane. Cylinder A controls the movement up and down of the crane. Cylinder B is the clamping mechanism and cylinder C is the across movement. The sequence is A+ B- / A- C+ / A+ B+ A-

Initial Ideas

ethods Of Moving Swarf To Compactor:
Method 1:

This method uses a scooping device to load the swarf to the compactor. This scoop would be operated by pneumatic cylinders. The extending cylinder would be housed in a box as seen in the exploded view (far right). There would also be a cylinder raising the scoop into the air and one tipping the bucket (see hand-drawing on right.) A possible pneumatic system can be found below

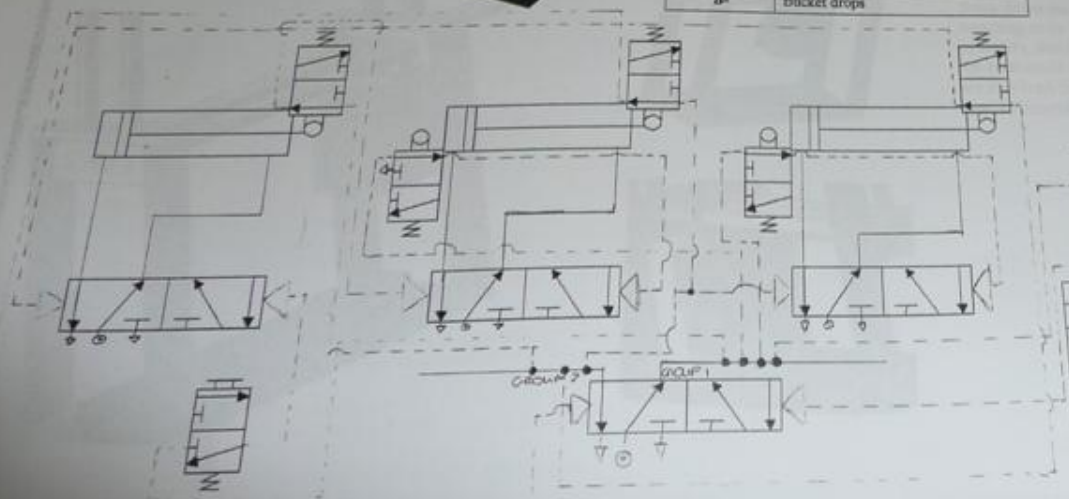


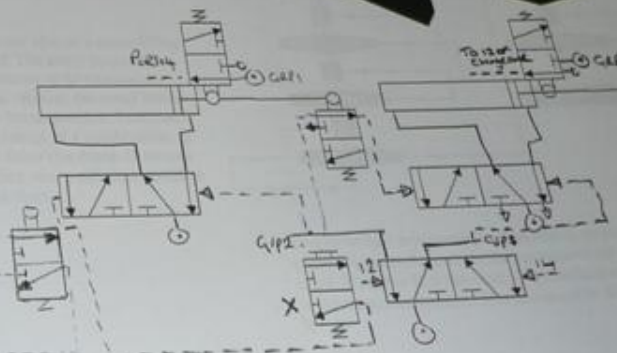


Method 2:

This method would use hoppers. A hopper is a basic storage device that is integrated to the system and designed to allow certain amounts of material release in a certain time. This would be useful to fill a compactor because the amount would be the same every time and this could be synchronised into the main system. There are two possible hopper designs shown below, both could be used in different scenarios. The drawing left shows how the pistons would be placed and the circuit below shows how they would be piped up.

A+ B+ C+ / C- A- B-	
Cylinder	**Action**
A+	Bucket extends to fill with swarf
B+	Bucket is lifted into the air
C+	Bucket is tipped
C-	Tipper retracted
A-	Bucket Retracted
B-	Bucket drops





A- / A+ B- / B+	
Cylinder	**Action**
A-	Allows allocated amount between A and B
A+	Returns Home
B-	Allows the allocated amount to destination
B+	Returns home

Medium (7–13):

- The control system is reasonably developed to outcome.
- Some evidence of numerical analysis in development.
- The product is developed with some integration of system with the user and

Initial Ideas

Methods Of Compacting The Swarf:

Method 1:

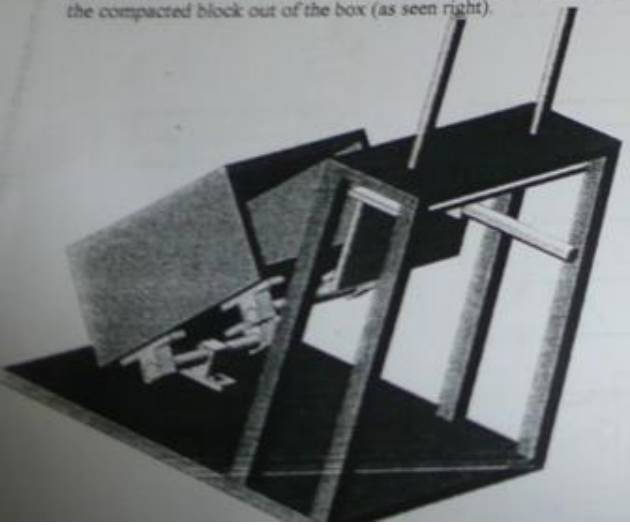
The compactor is shown here. The idea is that swarf is forced through a continuously narrowing tunnel to emerge as a compacted block. The swarf would enter the compactor through the hole in the top. A piston then extends and pushes a plate through the box. This plate is shown to the right and has two arms which are spring loaded. This means that as the space is getting narrower, the sided of the compactor will force the retractable arms inwards thus allowing the plate to force the swarf the whole way to the end.

Method 2:

This compactor compacts the swarf inside a box. The large picture below shows the starting position of the system. The compacting plate is fixed to a rotating arm, possibly powered by a DC motor which can be found in the research section. The first step is for the arm to rotate and place the compactor directly above the swarf filled box. A piston then pushes the plate down into the box. This will compact the swarf. The arm then returns to its home position and to allow the box to rise up and the compacted block of swarf to be kicked out.

Method 3:

Method three involves a tilting compacting box. The box tilts upwards to allow it to be filled. This action could be performed through the use of a pneumatic cylinder. Once it is filled it will become horizontal an the compacting placte will compact the swarf inside the box (as seen right). Once this is done the compacting place will retract and the back end of the box will become a kicker plate, forcing the compacted block out of the box (as seen right).



- The control system is reasonably developed to outcome.
- Some evidence of numerical analysis in development.
- The product is developed with some integration of system with the user and

Specific Research

Cardboard Compactors

Small Cardboard Compactor/Bailer.

This size of compactor would be suited to small businesses to compact cardboard. The cardboard is placed in the chamber and electric power is used to generate the 4 tonnes of force to compact the cardboard. The cardboard is the tied into bails 750x650x500mm. These bails can be lifted by hand and weigh approximately 30kg.

Large Horizontal Cardboard Compactor/Bailer.

This compactor is used for massive amounts of cardboard. It features a hopper at the top which feeds into a chamber that compacts the cardboard with a force of 50 tonnes. The ejected bale is 1450x750x1100 and can weigh up to 600kg. The machine used electricity to power the massive hydraulic rams. The motor has a power of 15kW.

Cardboard Bales

This picture shows a mass collection of cardboard bales, similar to those that would be produced by the compactors shown left. These bales are compacted and tied up using plastic strapping. This is a cheap and effective way to hold the bales together. A picture of the plastic strapping is shown below

Plastic Strapping Machine

This is an example of a plastic strapping machine. This machine, designed to strap boxes, would use a similar procedure as a cardboard compactor. The box is fed through the machine by a series of rollers and passes through an arch forcing the strapping over the top.

Current Swarf Bags

These bags are made of a synthetic nylon strips which are weaved together to give the bag strength. The base measures 1000mm x 1000mm and they are 2000mm tall. They can hold a capacity of 1 tonne of weight and are lifted by forklift using the straps at the top of the bag.

Containers

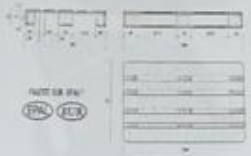
These containers are used ordinarally for the transportation of goods around the world, but they also make a good outdoor storage room. They are made of solid steel and are sealed to protect from water and fire. They are easily locked and very secure. I am proposing these as a storage method for my compacted 'blocks' of aluminium swarf. They are available in sizes ranging from 8ft (2.44m) to 40ft (12.2m)

Pallets

Pallets can come in a variety of shapes and sizes but to limit these sizes and try and standardise pallets a system has been made called the europallet system. This consists of four different standard sixes of pallet and these have been designed to allow hauliers to fit as much onto a trailer as possible and, as the pallets are standardised, the same pallets need not be returned to sender but can be sent back through the system and the sender will collect the same number of pallets to use in the next shipment. The sizes of the europallets can be seen in the table below:

Name	Dimension (mm)
EUR	800 x 1200 (Designed to fit through doorways)
EUR2	1200 x 1000
EUR3	1000 x 1200
EUR6	800 x 600

Size Chart For EUR Pallet



I will Use the europallet for my protype model, but as it is a model I will scale the pallet down 1:8 of the size.

Car Crusher

This is compaction on a large scale. These machines are designed to crush cars once they have passed their useful life. The car is placed inside the chamber and thousandas of pounds of pressure, provided by hydraulic cylinders, crushed the car into flat pieces of metal. This makes them easier to dispose of.

Specification

Function:

- *It should make it easier and safer to empty the swarf from the machines.*
- *It should compact swarf into cubes.*
- *It should make the cubes of compacted swarf easy to take away through use of a forklift.*
- *The system should be trusted to run automatically without much input or manual labour from the staff.*

Safety:

- *All moving parts such as pistons, gears and motors, must be guarded.*
- *There must be no sharp or dangerous edges on the product.*
- *The product must be clearly labelled with safety symbols to alert users to possible dangers.*
- *There must be a number of emergency stop buttons to allow the user to stop the machine immediately in the case of an emergency.*

Ergonomics:

- *It must be easy for the person using the machine to fill it with the swarf and to operate it.*
- *The switches should be proportionate to the system and clearly labelled.*
- *The machine must be relatively quiet in operation.*
- *The system must be easy to work.*

Aesthetics:

- *All pipes, wires and connections must be neat and tidy.*
- *It must have smooth edges.*
- *It must look as industrial as possible.*
- *The system must be finished and polished well so to have the best aesthetic appeal possible.*
- *Must not look out of place in a factory.*

Materials:

- *The materials used must not be open to corrosion by air, water or oils.*
- *The materials used must be strong, durable and able to resist impacts of cylinders.*
- *The materials used must be suited to being finished well as the product must look good as outlined in the aesthetics section.*

Cost:

- As the system will be made using pneumatic and mechanical components, it will be quite expensive to manufacture. The cost of this prototype must not exceed £600.
- The machine must be efficient and use as little energy as possible so to minimise the cost of running it.

Dimensions:

- The base of the product must not be bigger than 1000mm x 500mm. (School constraint)
- All parts of the machine must be kept in proportion with the rest of the system.
- The extensions of the pistons should be between 100mm and 200mm and should be considered in the design of the project.

Ease of use:

- It should be instantly obvious to the user on how to operate the machine without the use of an operator's manual.
- The switches should be in a good position to make it easy for the user to operate the machine.

Maintenance:

- All the components of the system must be easy to clean and free moving.
- There should be no swarf trapping mechanical parts.
- All parts must be easily accessed.

Constraints:

- The project must be fully completed by April 2009.
- I must work to complete the project using class time.

Product Life:

- This product should be completed to industrial standards and therefore never have to be replaced because of breakdowns or damages.
- Components such as cylinders and chains should be standard components so that they can be easily replaced.

Power:

- All electrical systems must run on voltages of between 9v and 12v DC.
- All pneumatic systems must operate at 4 BAR of pressure.

Identification Of Problem

Identification of Problem:

During the previous summer I was working in a local engineering firm, Doran Precision Engineering in Newcastle. During my work there I noticed some things which could be made easier, safer and more economically viable through the use of an automated system. The company operates CNC vertical milling machines which are programmed and used to create aluminium parts to be used in the aircraft interior industry. During the manufacture of these parts the machines create a metal waste known as "swarf". Swarf is made up of small sharp cuttings of metal which needs to be removed from the machines and disposed of. Instead of this valuable resource going to landfill, it is sold to another company which deals with waste recycling. When the staff remove the swarf from the machines, they place it into large bags which are moved by forklift into the yard where they are stored. The company waits to build a stockpile of roughly 14 bags before arranging for the waste material to be taken away. This means that the yard becomes very full of these bags. This is a disadvantage as it limits staff car parking and hinders lorries making deliveries. The other problem with this method of storage is security. Aluminium waste is increasingly expensive and is very susceptible to theft which makes it a major security risk.

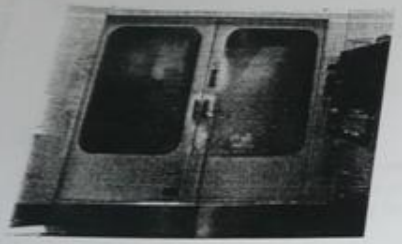
Problems:

⇒ The current system creates too much clutter and takes up too much valuable space.
⇒ The current system creates a considerable security threat.
⇒ The current system presents a risk to the staffs' health and safety.

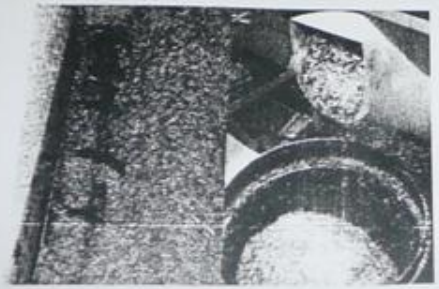
Design Brief:

To design and make an automatic system through the use of pneumatics and mechanisms that will promote recycling within industry by making waste metal easier to store and store securely by compacting them into cubes of solid metal which in turn makes the waste material easier to move and transport.
The system must be safe and easy to use, safe to manufacture and economically viable.

These pictures show the CNC Vertical milling machines that the company in question are working with. These machines use computer control to mill slots and drill holes in solid aluminium. This creates the swarf.

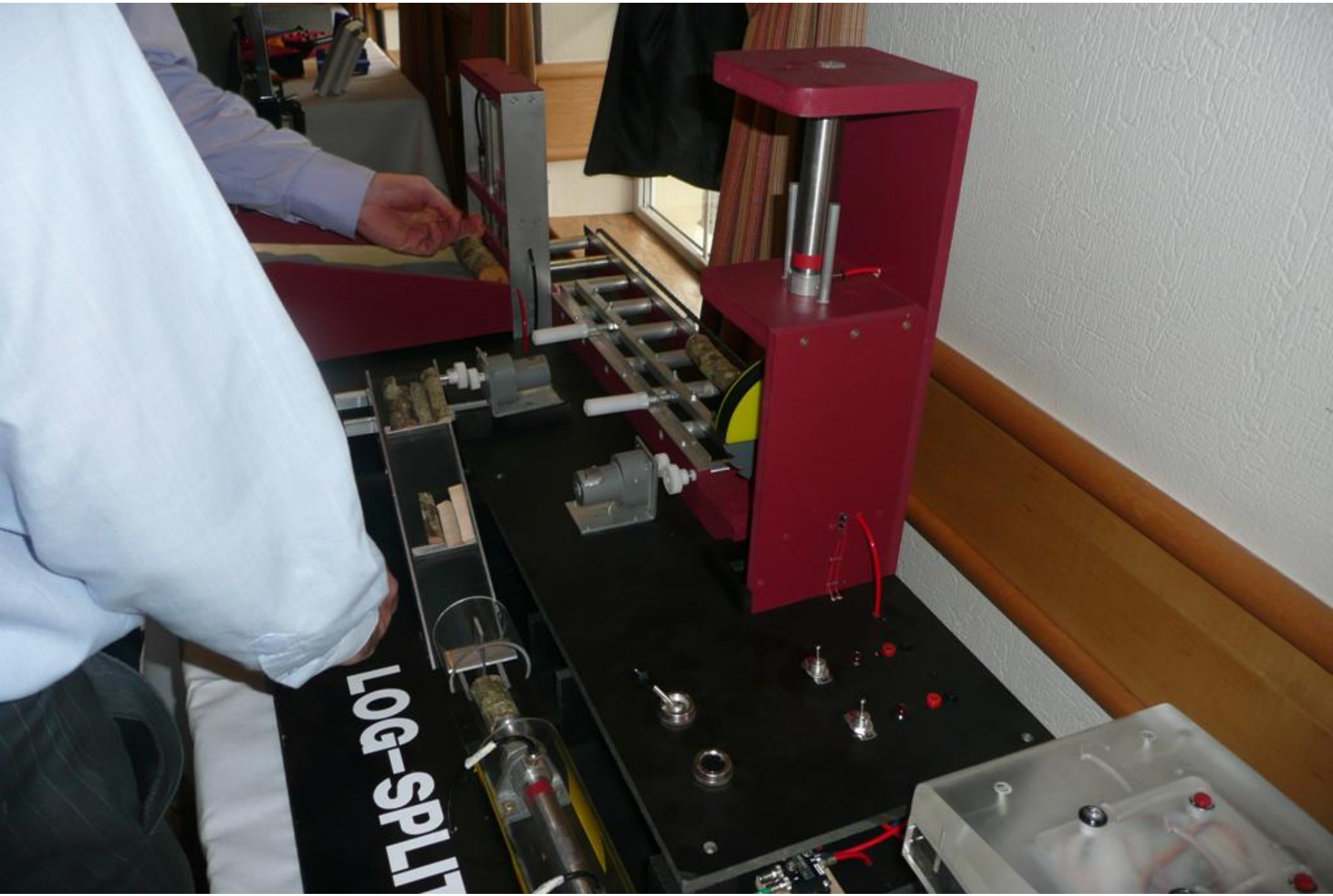


These pictures below show the machine full of swarf. There is an auger in the machine which, when turns on, pumps the swarf out into a large bin at the side of the machine



The first picture below shows the bin full of swarf. Depending on the density of the material, the swarf can weigh anything between 20-35 kg. The picture below that shows the bag in which the swarf is stored and transported. As you can see the bag is getting full, therefore a stepladder must be needed to reach the opening

A member of staff must then climb the ladder with the bin and tip it into the bag. As I have done this myself I can realises the danger with this action. The bottom picture shows the bag when it is filled with swarf.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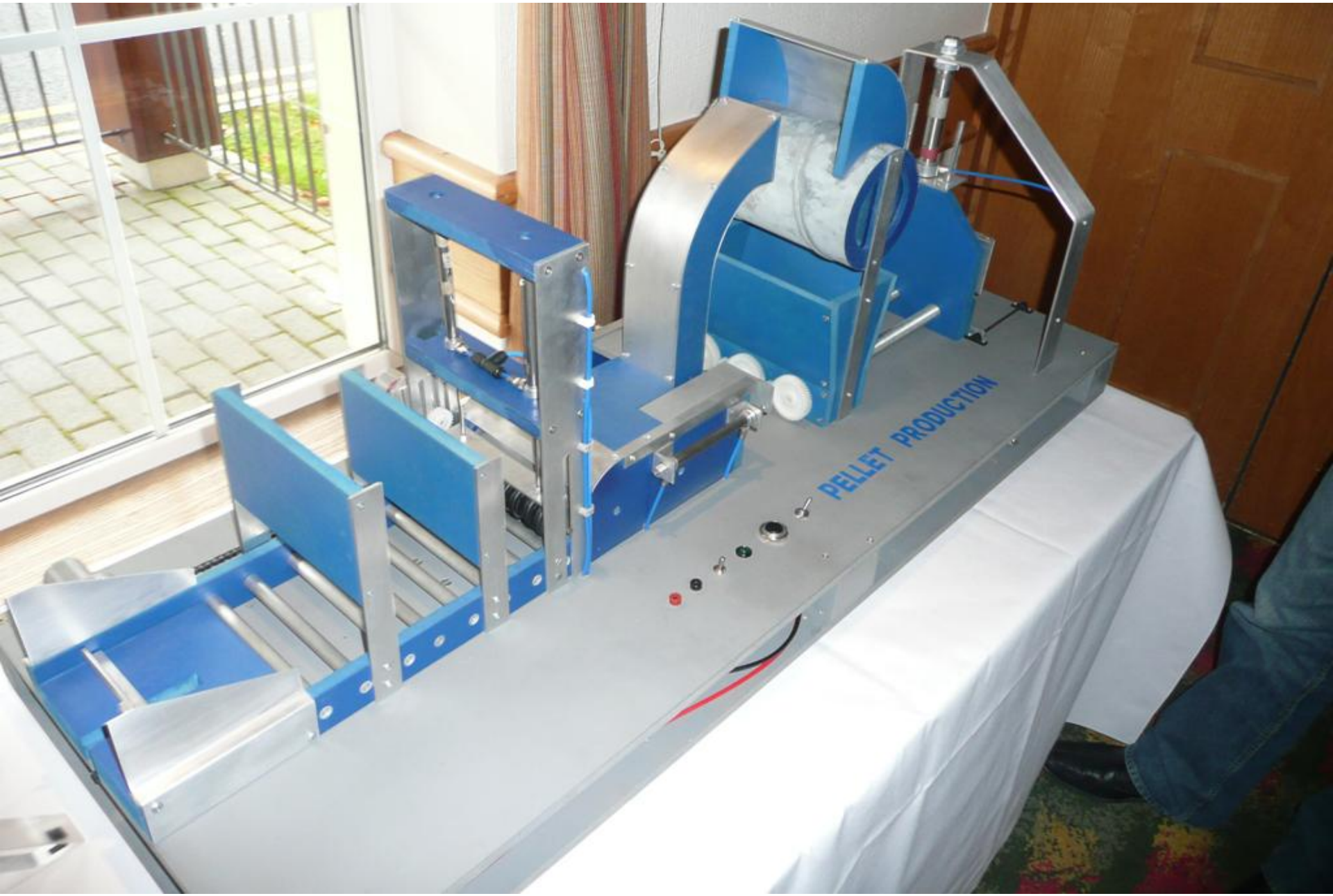
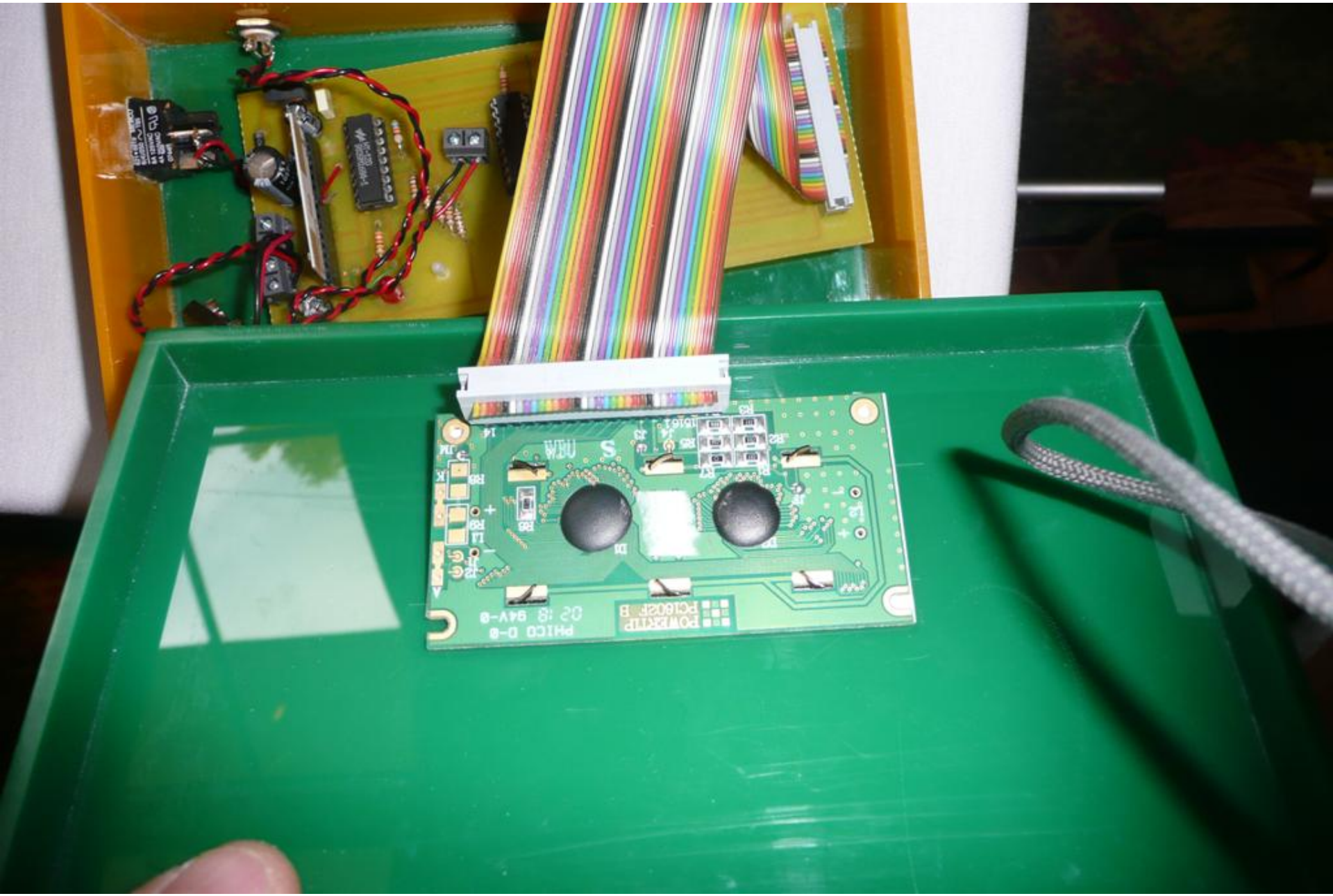

PELLET PRODUCTION

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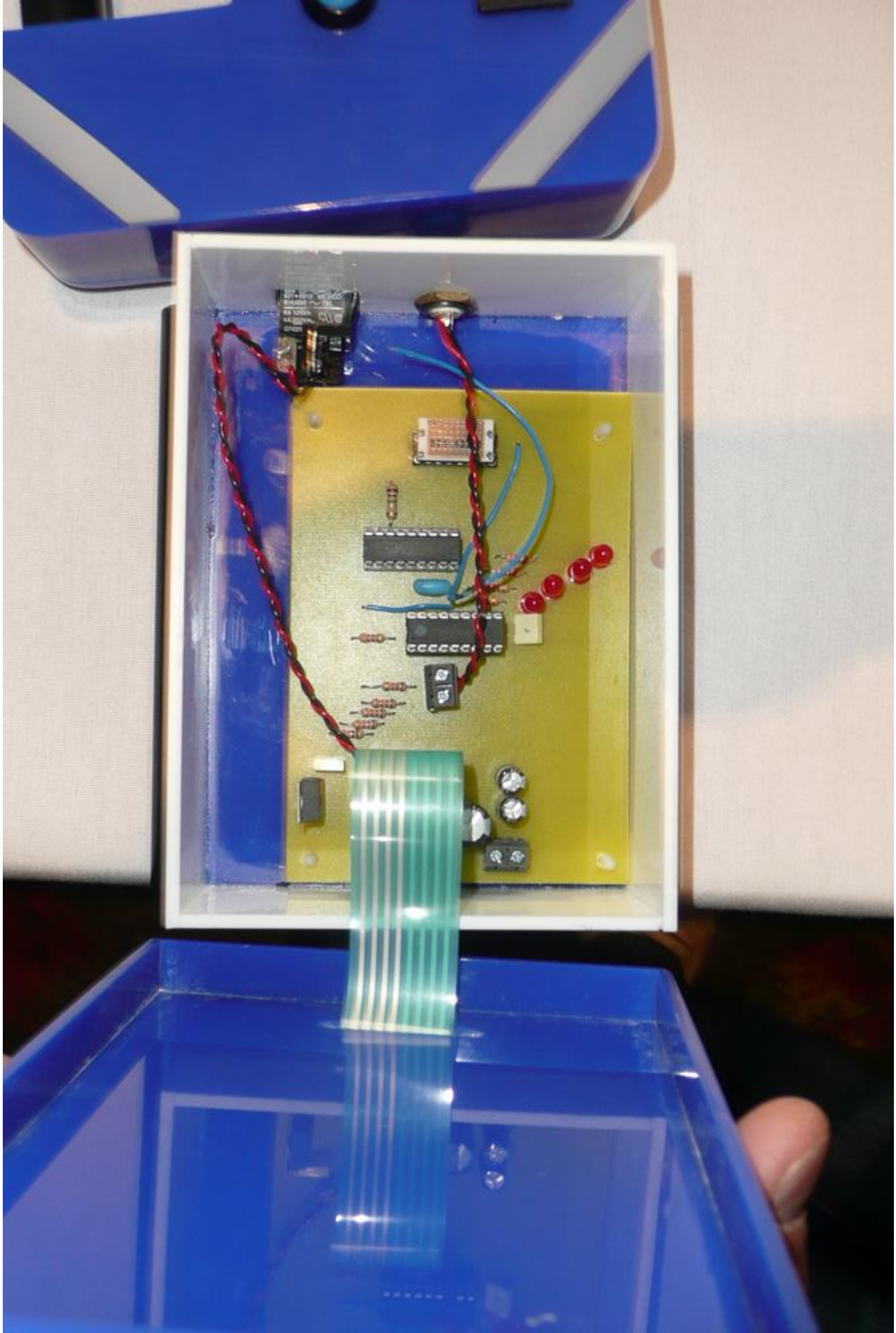
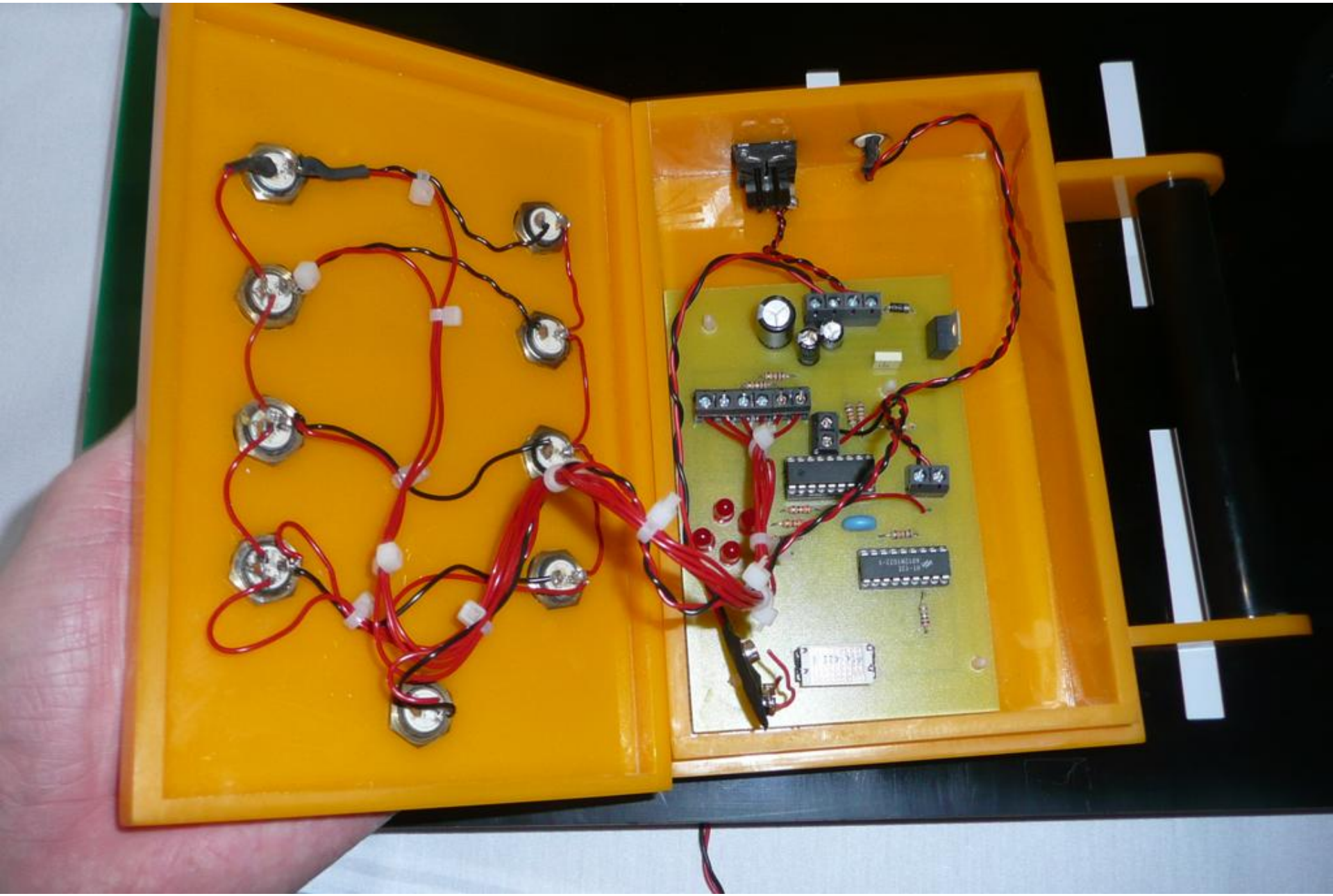
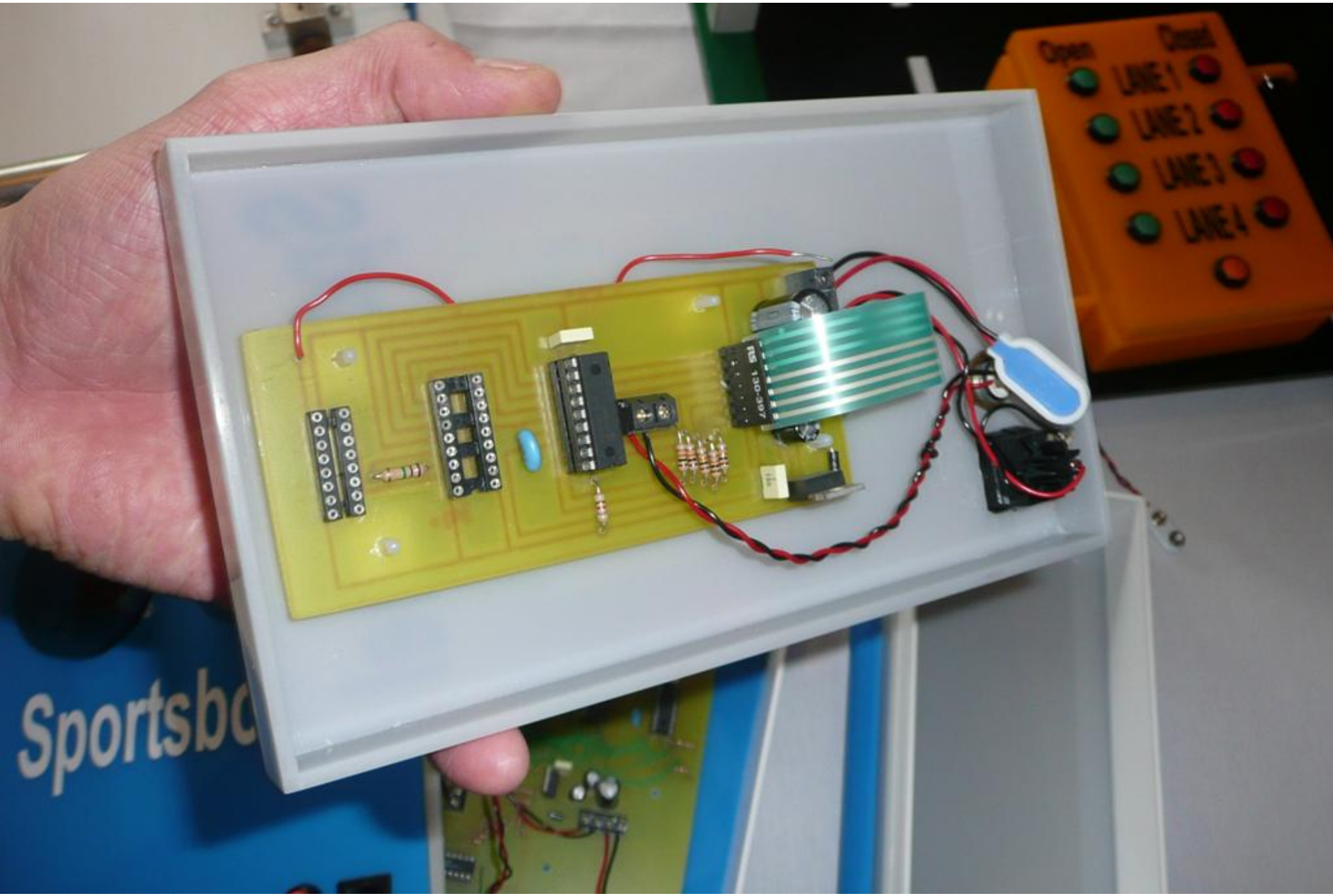
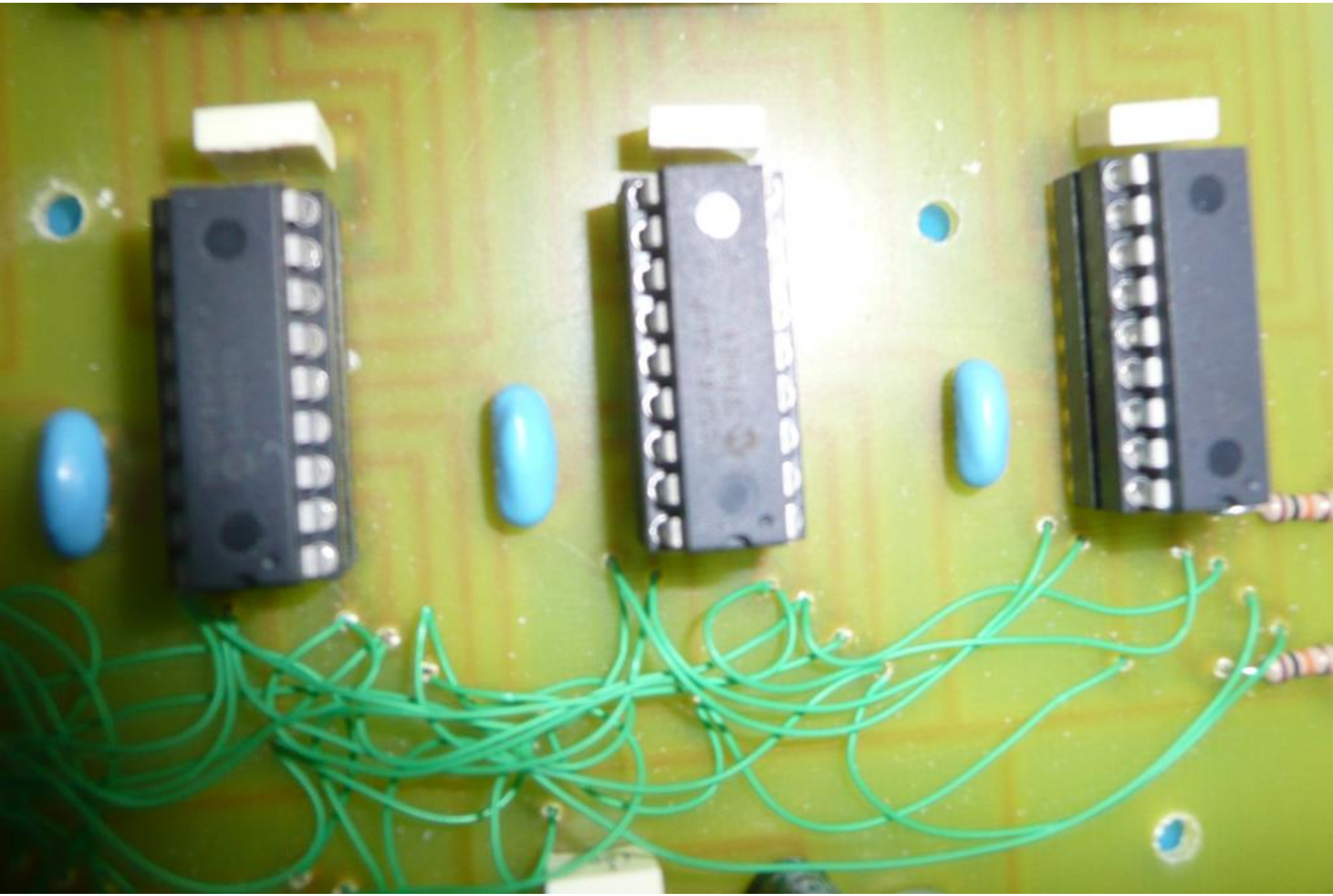
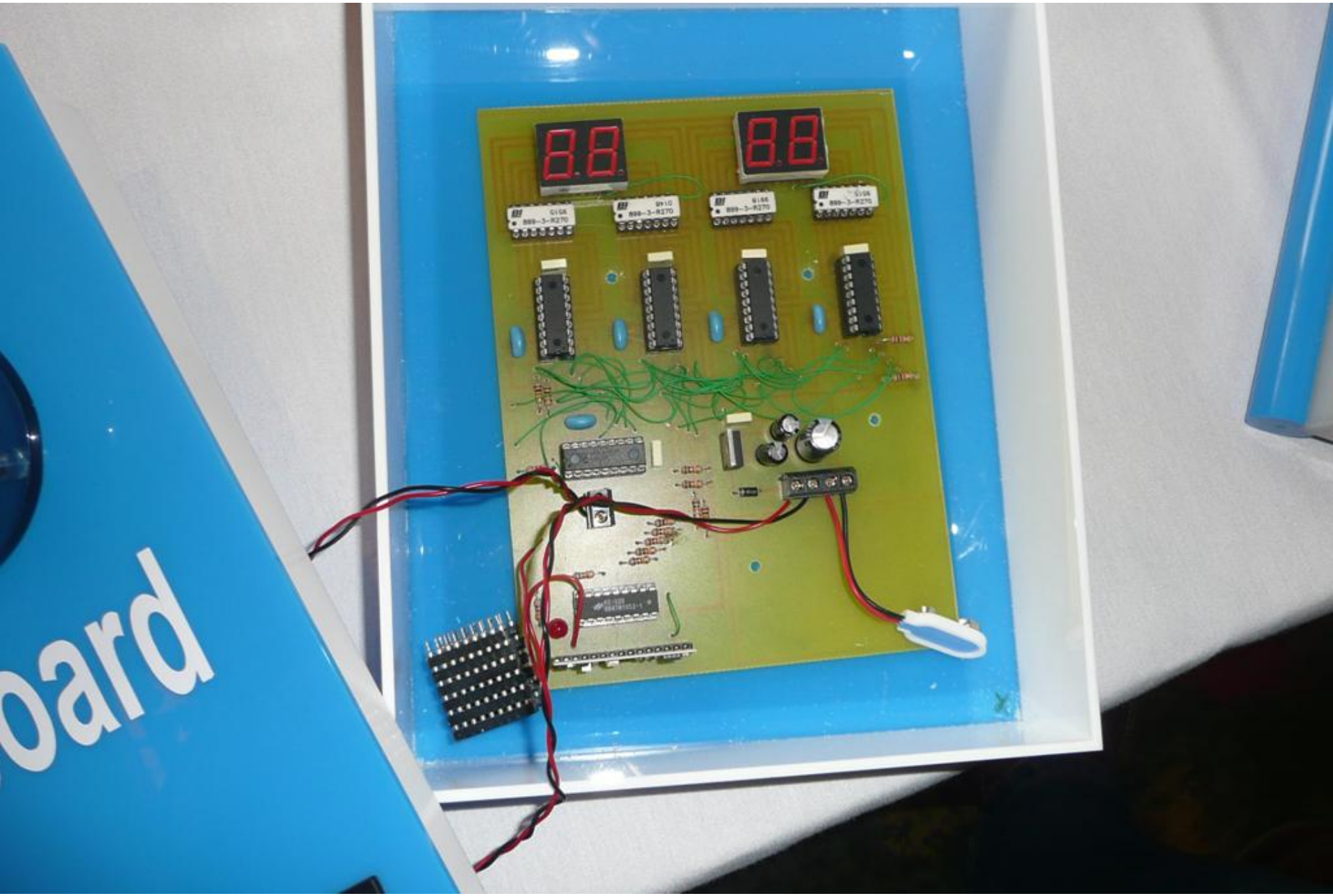
SYSTEMS






Open
Close
LANE 1
LANE 2
LANE 3
LANE 4
RS 130-397
Sportsbo




oard


LANE 4
Sportsboard
Sports Panel
1
2
3
4
5
6
7
8
9
*
0
#


Closed
Open
Closed
Open
Closed
LANE 1
LANE 2
LANE 3
LANE 4


LANE 1
Open
Closed
LANE 2
Open
Closed
LANE 3
Open
Closed
LANE 4
Open
Closed
Open
Closed
LANE 1
LANE 2
LANE 3
LANE 4
Sportsboard
Sports Panel
Bridge


LANE 1
Open
Closed
LANE 2
Open
LANE 3
Open
Closed
LANE 4
Open


Bridgestone
BMW


Bridgestone


SYSTEMS


SUBWAY
SUBWAY

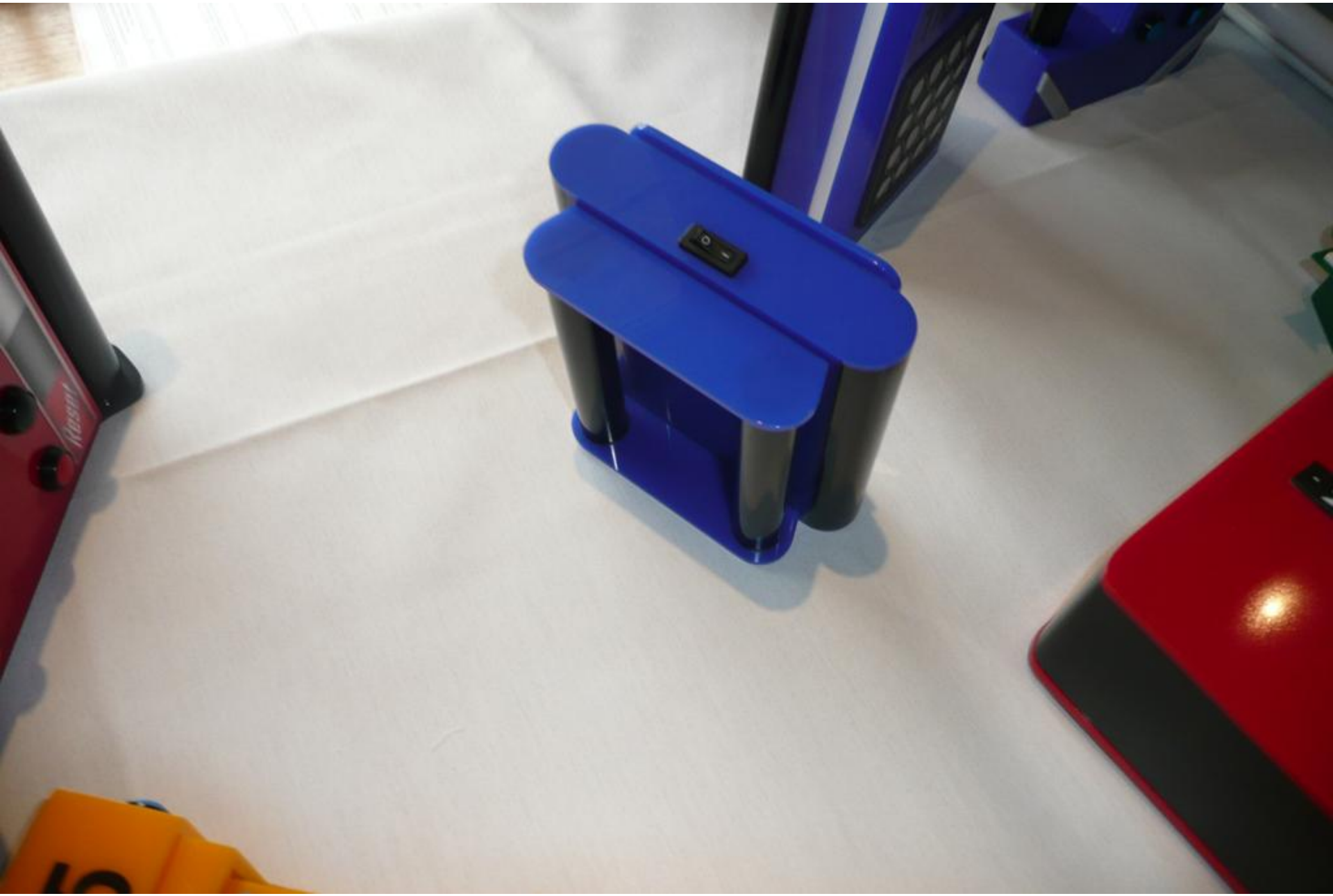

SUBWAY
SUBWAY


Volkswagen
1
10


Third Eye
Volkswage


Third Eye
Third Eye
Volkswagen
1


Third Eye




Flash
Reset


Alpha


Alpha


Flash
Reset


Reset