PRODUCT DESIGN, DEVELOPMENT AND VIABILITY ANALYSIS

MOTORCYCLE HELMET LIGHT SECURITY SYSTEM

“DragonFlight”

MÄLARDALEN UNIVERSITY
SWEDEN

THESIS

SUBMITTED TO

MÄLARDALENS HÖGSKOLA

FOR THE DEGREE OF

MANAGEMENT ENGINEERING

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ABSTRACT

Every single one of us have heard ones or know someone who have had a bad experience with a motorbike, maybe it was his or her fault, perhaps it was originated due to the mistake of other vehicle or just was a simple distraction that caused as a result that small fright or that horrible accident.

All the people who ride motorcycles assume that when an impact comes, our body is the chassis, our own body is in jeopardy to the unexpected just protected with a helmet and some protection clothes.

The main goal of this project will be to try to reduce the possibilities of motorcycle users of having a fatality accident or at least reduce the gravity of them.

I will talk further on about why I decided to do this study and which kind of accidents I am trying to prevent however I will like to say that my personal objective developing this thesis has been to save lives, maybe sound quite hard to archive but I would be really proud of myself if I could safe at least one life on the road the day of tomorrow.

APPRECIATIONS AND THANKS

This project-work wouldn't be possible without all those people who acknowledge me with their wisdom since the very beginning of my studies from the high school to MDH passing through my home university and my different work experiences all across my life.

I personally would like to offer thanks to all the support from Mälardalens Högskola, especially in Eskilstuna where Ragnar Tengstrand (my coordinator) has given me monitoring and full feedback from the beginning and where I have received really useful support from the entire workshop team mostly from one of the workshop assistants, Erik Skarp who has given me the knowledge needed to use the appropriate machines making possible the development of my design part in this thesis.

I am definitely thankful as well to the company which started this idea, the firm is called Delta (Development Technology AB) and they have been always available to meet me and dedicating me time to discuss about the project especially the person who start all of this contacting us, Patrik Eggenberger.

I don't have to forget the recognition and appreciation to the work of Javier Quintín Rico (robotic engineer exchange student in MDH) who mostly has made the technical part including the programing.

Last but definitely not least I would like to thank my family.
Thanks mum, dad and sister for all your unconditional support and inspiration across the years, you have been always there for me and I wouldn't be here without you all, that's the reason why I will dedicate to you all my achievements in life.

METHODOLOGY

First to say that the directives from the company haven't been really thorough in board terms due to they only had the general idea of what they would like to do and why, nonetheless I have had to make my own decisions most of the time (always basing them in my researches and own knowledge) for the properly development of the project.

In terms of research methods I have to say that my thesis-work hasn't have a well define methodology due to the huge design part where it has been only me, my knowledge, my computer and my patience drawing and making prototypes hours and hours per day.

About the business developing parts just to say that the most common research type has been qualitative research methods coming from the internet and books in the library, even though I have used quantitative research methods as well to develop the business plan and general researches.

Due to the technical part of the project wasn't one of my most developed fields of knowledge (we have been use quite advance electronics) I made a big effort in terms of research to be able to keep the level of the work with Javier and try to help him as much as I could.

It should be noted that I haven't have almost any research limitation due to the general idea that we are developing in the paperwork, perhaps the only limitations that I could have would be some quantitative data which are quite difficult to find on internet for free, financial results from competitor firms for example.

PRESENTATION

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REASON OF THE PROJECT

Motorcycle accidents generate social, economic, and huge health impact problems nowadays, in all around the world 1.2 million people die per year due to motorbike accidents, this means that 3000 people die every single day because of that.
Most of motorbike fatalities are concentrated in underdeveloped countries due obviously to first, the fact that the 65% of the motorbikes are based in the south east of Asia and second, we could talk about bad road conditions, not really good and quick medical attendance, almost inexistent safety road systems etc.

However I am going to analyse the impact in developed countries due to they are the countries where we want to have business activities.
I'm going to take the United Kingdom like an average example in Europe.
There were 331 motorcycle users killed in 2013, 5000 serious injuries and 13.982 less serious injuries, most of the accidents involving injury to a motorcyclist took place at a junction, the vast majority of accidents involve one other vehicle (70%) and with the other vehicle involved most likely to be a car (79%).

We are going to apply this percentages in our UK accidents:

- 229.6 motorbike fatalities, 3500 serious injuries and 9787.4 less serious injuries **involve another vehicle**.
- 181.4 motorbike fatalities, 2765 serious injuries and 7732 less serious injuries **involve a car** only in 2013.

One of the worst accidents for bikers are the ones which the crash come from behind due to the un-expectation of the biker.
This kind of accidents happen due to some reasons:

- Huge deceleration from the biker.
- Too much speed from the vehicle behind.
- Bad visual conditions.
- Distract or mistake from the vehicle behind.

My main goal in this thesis it going to be to decrease the possibility of having this kind of accidents.

For make that possible, we have to know about **Perception and Reaction time** in accidents.
We can break down this concept in:

1. Perception Time: Start with the danger and finish when the driver focus his eyes in the problem ahead. (≈0.3 sec)
2. Reaction Time:
    a. Identification: Start with the reaction time and finish when the driver realise the danger. (≈0.3 sec)
    b. Evaluation: Start just after the identification step and finish when the driver discover if the problem ahead is a real danger for him. (≈0.5 sec)
    c. Decision: Start just after the last step and finish when the driver start the answer, in this step the driver realise if it's convenient to modify the speed, the acceleration or the direction. (≈ 0.5 to 1 sec)
    d. Volition or Answer: Starts when the motor sense of the driver's brain send the message to the muscles and finish when the muscles start to do the action.
3. Mechanic Answer Time: Starts when Reaction time ends and finish when our vehicle start to react. (≈0.5 sec)

If we plus all this times we obtain the total perception and reaction time (≈2.1 sec).

The line between survive or die in an accident depends of this time and each millisecond count, that's why one of our goals is going to be reduce this time in motorbike accidents.

How we can do that?

Well, our principal goal is going to be improve the perception of our deceleration to all the vehicles behind us, and yes, you are thinking now, "ok that's why we have break lights in the back of our motorbikes" nevertheless sometimes it's not enough due to some reasons or specific situations:

- Imagine that we are involved in an accident and we don't have time to break at all, that means that we are not showing up any light to warn the vehicles behind us.

- Another situation could be when we find bad road conditions but it's not safe to break like ice, sand etc. so we are going to decelerate however we are not showing up any warning lights again.

- We don't have enough visibility in night accidents just showing up the breaking light.

- In bad weather conditions where the visibility is practically null we don't warn enough the vehicles behind.

- We have broken our brake light but we haven't realised yet.

GENERAL IDEA

We are going to create and develop a device to install in our helmets that turn on lights if the helmet and obviously "the biker" is decelerating.
We will set up an emergency system as well in cases when the biker falls when we'll show up as much lights as possible.

The number of lights and as a result the intensity of the view are going to increase with the percentage of deceleration, this means that if the biker do an small deceleration we are just going to show a little light up however if the biker do a huge deceleration we will show an alarming and easy to see light in our helmet reducing then the perception and reaction time of the vehicles behind us.

Our objective is to create a portable dispositive to be able to use it in more than one helmet so you as biker only have to buy one for all your helmets or to share with your family and friends.

THESIS EXPECTED STEPS

1. **PRESENTATION**: *What I'm going to do?*
   Initial document with information about the company, coordinators, date, general idea and our GOALS.

2. **SCHEDULE**: *When I'm going to do each part?*
   Steps of our process "Schedule". (Gantt Diagram)

3. **MARKET RESEARCH**: *Why we are better? Why people is going to buy our product?*
   Previous research about our competitors, prize fights, pros and cons of our product in compare with our competitors.

4. **TECHNICAL EXPLANATION**: *How work our device?*
   Full explanation about the running of our product including electronic and programming details.

5. **MATERIAL RESEARCH**: *What are we going to use to build our device?*
   Research about all of our material options to make the project and selection of the best one.

6. **DESING STUDIES**: *How is going to be our product design?*
   Research about where to put it, how to put it, which shape is going to have our product and why.
   a. Device design. (Protection, shape, waterproof…)
   b. Bracket design. (How to affix it, swappable…)
   c. Led design. (Colour research, how many lines, direction…)

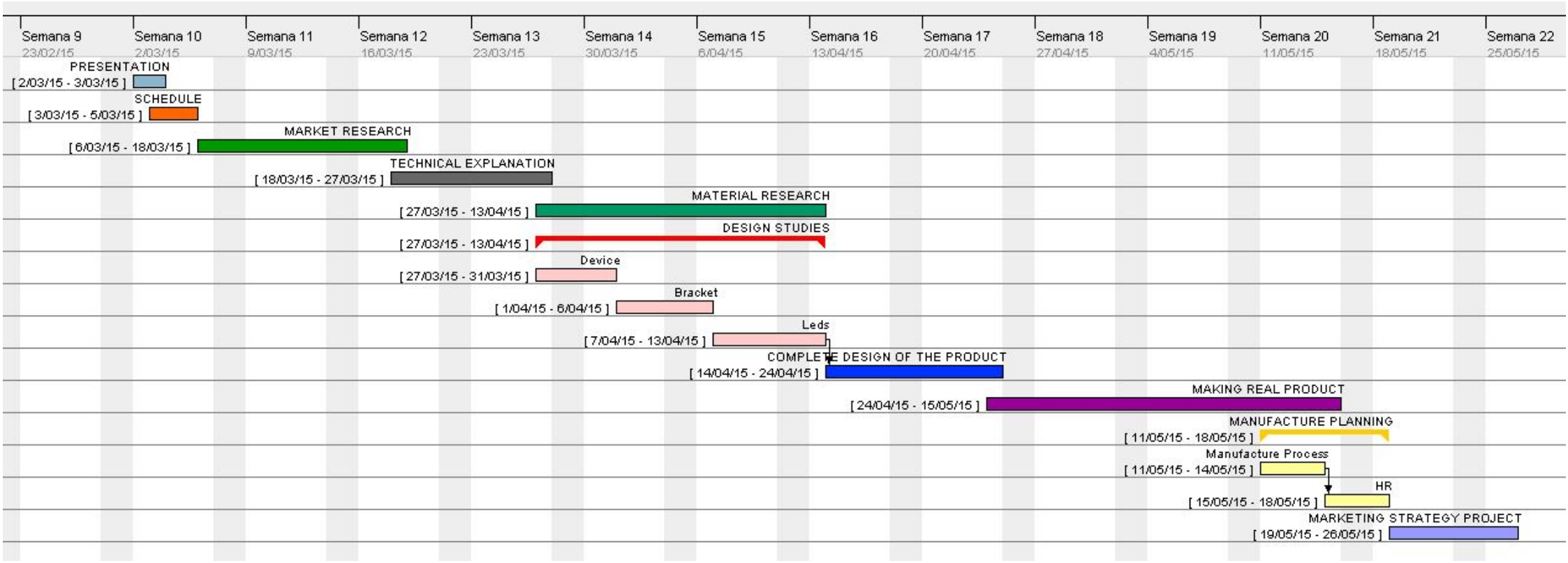
7. **COMPLETE DESIGN OF THE PRODUCT**: *How is going to look like our product?*
   3D complete design of our device.

8. **MAKE REAL PRODUCT**: *Is it possible to make it? Let's do it!*
   We will try to make the real product or at least the first prototype documenting all our manufacturing steps, tools and materials used, pictures of all the process etc.

9. **MANUFACTURE PLANNING**: *Which steps we need to follow to make our product?*
   Complete diagram of manufacture steps and all the goods, tools, times and personal that we need to make the manufacture possible.

10. **MARKETING STRATEGY PROJECT**: *How to make a successful entrance of our product to the real market?*
    Segmentation of our future costumers, check and develop different marketing strategies to them.

PREVIOUS GANTT DIAGRAM



MARKET RESEARCH

The first and most important question that we have to ask ourselves always when we start a market research is **which our sector is**.

In our case we could think some different sectors which we belong to:

Motorbikes market? Led market? Vehicle technology? Helmets market?

If we choose one of these ones we are going to make a big mistake from the very beginning because we are reducing our final sector where we are going to bring our product.
As bigger our sector is, more opportunities of success we are going to have, perhaps we don't have to be avaricious because if we choose a sector too big for us we can die from our success from the beginning due to the inability of serve all our customers.

So finally, I will decide that our sector in this product development is:

SECURITY SYSTEMS IN VEHICLES.

Knowing this, we can define our straight competitors like all the other security systems in vehicles that need of helmet security.

We are going to analyse the different competitors that we can find in the market nowadays.

THE COMPETITION

In terms of Motorbikes, Quads and ATVs:

We have a "similar" device in the market nowadays which has the same goal than us, to raise our visibility to the other vehicles and decrease the perception and reaction time of the vehicles behind us when we decelerate.

This product has a similar design and that's why is our hardest competitor nevertheless the function is simpler, it works with push buttons in both brakes. When we brake and we activate ate least one of them, this push button send a Wireless or Bluetooth signal to the device in the helmet making the LEDs receive electrical impulse and light them up.

Talking about brands and prices, we have two different groups to classify this kind of products:

- Cheap devices made in Asia with suspicious running which cost between $20 and $50.
  These are not our competitors at all because first, we have much better characteristics and guarantee than them and second, we are not a low cost device so we can't decrease the price until that range.

- Developed and proper devices made it with good materials and with guarantee of function. These are our direct competitor in the market.
  The best point for us is that I'm not able to find any product with the same characteristics than us in the real market, this means that our one and only competitor in terms of motorbikes, quads and ATVs is going to be the low cost brands.

Looking for deeply I have found one product of the second group but it's only a prototype called HelStar device.

The brand which belongs to is called Third Eye Design and the price in the market would be around $179 (168€) more or less.

Figure 1 "HelStar Device"

The last upgrade of HelStar remove the need for an On-Off switch for the helmet. Additional features include:

- Breakaway design to help prevent neck injuries in the event of a fall.
- Automatic diagnostics of battery, RF communication, and LED function.
- Hundreds of thousands of unique codes to prevent cross communication with other units and stray interference.
- Functionality with virtually all 12V systems, including CAN-Bus.
- User programmable for compatibility and future enhancements (e.g., brake modulation).
- Meets or exceeds DOT standards.

Figure 2 "HelStar Device"

We are going to try to have equal conditions than this competitor and have at the same time better characteristics to offer and convince our customers that they need to buy ours.

One of the first issues that we find trying to equal the conditions is the turn on/off system, they don't have any due to it is connected by wireless to the motorbike so if the device don't receive the wireless signal means that the motorbike is switched off so the device stop working, by the other hand, our device works without the help of the motorbike so we have to design a system to turn it on and off automatically.

To set up an automatic turn off is quite easy in our device, we could program our Arduino (brain of the technical device) in such a way that if we don't receive any signal from the sensor in "x" minutes automatically to order to the device to turn off itself.

Nevertheless we have a challenge when we try to set up an automatic turn on system to our device that works without any help from the outside.
One of our options is to keep the device checking each "x" seconds if we are receiving any signal from the sensor so the first check that we receive with results our Arduino will turn on the system, for make this possible we have a low power consuming mode inside our accelerometer. We'll study this option in our future technical report.

As well as we try to improve our device taking the better characteristics of our competition, we can learn about their mistakes, nowadays HelStar don't find investors due to the bad critics about the weight and the dimensions of the device.

We have to try to make a really small and thin device to avoid this problem which was one of our first premises in design.

Ones finished the market research of motorbikes we could think that we already finished but I want to go further, I want to think bigger, I want to take a look of our future. Why we are building barriers around the motorbikes? Why we don't make a research to have more future target customers? And my final question, why we don't investigate our business possibilities in every single vehicle that use helmet to ride? That's exactly what I am going to do next.

In terms of Bicycles:

- Standard light for ride without enough day light, both front and rear lights:

  We have different kind of standard lights for bicycles, the most common ones are the white front lights to improve the visibility ahead and red rear lights to improve the possibility of been seen to the other vehicles behind.

Figure 3 "Bike front light"

Figure 4 "Bike rear light"

  Approximately the price range of this kind of security systems is from 20€ to 100€ depending of the brand, quality, function and power.

- New safety lights:

  We could introduce in this group the new and trendy laser lights for bicycles.

Figure 5 "Laser bike light 1"

Figure 6 "Laser bike light 2"

The worst point in these trendy lights is that they are still developing the product so we can only buy a "beta" version.
Approximately the price range is from 40€ to 60€.

- Future products (Projects):

Finally we could comment about projects in research for example project Aura developed by Jonathan Ota and Ethan Frier in Carnegie Mellon University (Pennsylvania), they create the energy from a dynamo in the wheel and use RGB LEDs to create a powerful light in the wheels increasing the visual footprint of bikers from all directions especially from the side.
The colour change from white to red depending of the speed.
We don't have price yet for the product perhaps personally I think that is a really good idea and project however I don't think that is going to be legal everywhere due to the possibility of generate distractions in other drivers.

Figure 7 "Project Aura"

Like a conclusion I'm sure that We shouldn't be preoccupied about this kind of competence because our essential goal is completely different, actually we can use both security systems at the same time, this means that if we are focused in our primary function (security in decelerations) and in our goal (reduce perception time in road incidents) we can easily define our differences with this competitor.

In terms of Snow sports like Snowboard and Ski:

- Avalanche airbags:
  System to save your life in case of avalanche, the function is quite simple, consist in a kind of airbag that swell of air when you pull a plastic ring and makes you stay in the surface of the snow.

Figure 9 "Avalanche Airbag 2"

Figure 8 "Avalanche Airbag 1"

Our product has a completely different goal so we don't need to be worried about this security system.

- Different lights used:

After spend some time doing research of security lights systems in snow sports I haven't find absolutely anything about that instead of some ideas from professional snow and ski athletes, almost all of them dedicated to make possible to snow or ski in the night like pants and jackets with lights or LEDs all around the snowboards or the skis.

Figure 11 "Snowboarder light suit"

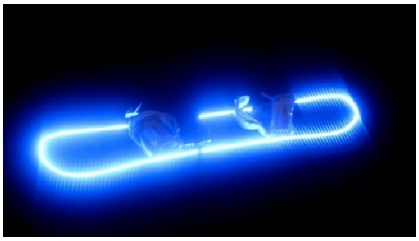


Figure 12 "Snowboard LEDs""

Figure 10 "Ski sticks lights""

The most similar device that I've found in the market is a simple line of LEDs collocated in snowboard and ski helmets which just show light whit one ON/OFF bottom.

Figure 13 "Helmets ski lights"

Again, we have the conclusion that we don't have to worry about the competition of this kind of products because they have a completely different goal and use than our useful device.

In terms of Snowmobiles:

Obviously we all know that we are not going to find our biggest customer group in Snowmobile users due to the sales number of that kind of vehicle in the world but personally I think that is going to be one of the most useful vehicles to use our dive for different reasons:

- Normally we use Snowmobiles in regions that we don't have too many hours of light like here in Scandinavia so most of the time we ride them with bad visual conditions.

- For the same reason we use quite often this vehicle with bad weather conditions rising the risk of incidents.

- Generally we drive snowmobiles in groups of people so we have an elevated risk of crashes between them.

- Snowmobiles are use really often to do natural excursions in the mountain with people that are not accustomed to drive this kind of vehicles so we can reduce the perception time in that cases as well.

Figure 14 "Snowmobile lights"

CONCLUSIONS

We have some useful conclusions thanks to this small market research:

- The first one is the fact that we find a market opportunity (niche) with this product project.

- We know now that nobody have a product like this one in the market nowadays.

- We have some essential characteristics analysing the advantages and the mistakes of the competition and we'll base our product in these attributes.

One of our first big decisions is that we are going to design separately the generic device and different kind of brackets depending of the kind of helmet, so our customers will buy the device and the kind of bracket that could work in his helmet, or obviously more than one if he has different kind of helmets.
Our goal in this part is to make this bracket really cheap to our customers so they can buy as many as they need without almost any cost.

After checking and calculating how big our work ahead is I have decided to focus it only in motorcycle helmets for now due to they are going to be our first customer sector and we have already different kind of helmets in it, so they give us the opportunity to make different bracket designs.

Now I would like to summarize the most important advantages, and I am going to call them "The reasons of why our project is going to be better than any existing competition":

1. Our device is going to have only one piece and the immovable bracket, fact that give us the advantage of make a cheaper, lighter and thinner device.

2. Easy to install without cables and connections inside the motorcycle.

3. Thin and light but hard and compact.

4. You can swap it to another helmet really easy, just installing another bracket in your second helmet.

5. It's going to be useful to different kind of helmets like full face, flip up, motocross, off road ones... and maybe in the future to different vehicles like bicycles, snowboard, ski, snowmobiles etc.

6. Sometimes we decelerate but we don't break at all, for example:

    a. When we have a quick accident with another vehicle in a junction and we don't have time to touch the breaks.

    b. When we find roads in bad conditions like ice or dirty and we can't touch the breaks otherwise we would take risk of slide, skid and finally fall down.
    So we start to decelerate but we don't break at all.

    c. When we have night incidents, we decelerate (obviously) however sometimes we fly out from the motorcycle so any motorcycle light shows up to warn the vehicles behind us after we release the brake.

7. Having the information of the degrees of the helmet we will use them to more purposes than the deceleration like detect when the biker is having an accident. We will be able to do this because the helmet will be laying in the floor for a time so we could activate an emergency mode when we show up as much lights as possible.

BUSINESS PLAN

Ones that we have done our market research and find a market niche which we think that it can be successful we should figure out how we are going to build this project up from the beginning.

The very first question that we should ask ourselves to start a business plan is:

Is my business idea feasible?

Obviously, if I have thought that this business idea was not viable I wouldn't be writing this right now but, why I see a profitable future in this business?
Well my point in here is the same strategy that any other security system, really simple, **How much it cost your life?** Because that is what I will be selling, safety.

Having this strategy and previously knowing that our final manufacture price is not going to be so high, definitely I think that this idea is completely feasible.

The second question that we should ask ourselves is:

Why I am doing this?

First of all to say that this idea came to me from Delta AB and through MDH University, nonetheless since the first time that I heard about it I completely get involved into it, first because I love motorbikes since I am a child, my dad use to have one and I have had one since I am sixteen years old (an small one obviously) but still, I have been always rounded of motorcycles.
Secondly and more important, about three years ago I had an accident in a bridge driving my motorbike when all of the sudden one of the cars skipped a stop signal in the junction just in front of me.
I didn't have time to break at all so I crashed with the driver door breaking the window with my helmet and flying flipping my body till the top of the car where I finished sit down.
After a few minutes and ones that I was in the floor waiting for the ambulance I realised that the car that it was behind me it was stopped just a couple of metres from the car involved in the accident which means that it could be much worse if the other driver hadn't had time to break after me.

This "not really good "experience was the first thought to come to my mind when I heard about the project due to that car behind me in the accident.

VISION/MISSION

The next step in the development of our business plan is to define our **Vision** and **Mission** for our future company or production.

First and with the goal of remind our business knowledge I will define this two expressions.

Vision:

- It outlines what the organization wants to be, or how it wants the world in which it operate to be.
- It is a long-term view and concentrates on the future. I can be emotive and is a source of inspiration.

Mission:

- Defines the fundamental purpose of an organization or an enterprise, succinctly describing why it exists and what it does to achieve its vision.

We could say that the **vision** of our project or future organization is to help the bikers preventing accidents reducing the reaction time of vehicles behind us and improving their visibility. Evidently, as an organization, our purpose will be earn profits selling this product.
We will take care of our **employees** offering good jobs inside the manufacture process.
At the same time we want to have good relationships with our **suppliers** offering fair prices for the material that we need.
In terms of **customers** we will worry about them a hundred per cent of our time.

The **mission** to achieve this previous define vision will be basically to offer our customers a useful product which they use to improve the safety in every condition during their motorbike rides.
To take care of our customers we will have an extensive customer relationship program where we will worry about every kind of feedback that they could offer us.

KEYS OF SUCCESS

At this point when we are concern about our goals and what we want to archive, we should specify our most important steps ahead where we can't aloud ourselves to fail, we should define our **keys of success:**

- **Psychology success.**

  We should be convinced that our product is going to satisfy an immediate need, if we (as a company) forget the goal of our product, "Improve the safety in the roads out there" we will fail in this business experience.

- **Fair price.**

  We must make as much efforts as needed to get a fair product price for our future customers.

- **Quality.**

  We were talking about the price but even more important is the fact of offering the proper quality to meet our customer's expectation.

- **Maximize our marketing.**

  Some entrepreneur companies tend to think that the main goal is to get profits of their activity, big mistake due to the true purpose of the business should be to create and keep customers. Profits will be the result of creating and keeping a sufficient number of customers in a cost-effective way.

- **Core Skill.**

  We mustn't forget the three most important skills in a successful business, with regard to the product, SELL! SELL! and SELL! One of the most important single skills we must develop for succeeding in our business is the ability to sell ourselves and our product to our customers.

FINANCIAL SUPPORT

The very next step would be how to get the financial support needed to be able to build up the company.

I have some possible financing ways in mind that I think we should study:

- **Government Support:**

We have the advantage of making a project that could change the number of accidents per year in every country, thus we could try to apply for government money support to build this product up.

- **Bank Loan:**

Classic example of financing where we just take a loan of the amount of money that we need to start our project. Personally I would discard this option due to the fact that the loan standards have gotten much stricter in the last years.

- **Online Lending:**

Recently, online lending services such as OnDeck and Kabbage have become a popular alternative to traditional business loans. Online lenders have the advantage of speed. An application takes only up to an hour to complete and a decision and the accompanying fundscan be issued within days.
In contrast, the traditional loan process can take weeks, or even months.

- **SBA Loan:**

We have some advantages applying to a Small Business Administration Loan from a Bank or Loan company, however, in order to qualify a small business we should meet the government's definition of a small business or even more criteria depending of the type of loan.

- **Factoring:**

Basically factoring consist in selling our receivables at a discount to get cash up-front. We could sell these receivables to "Factors" or companies that want to get profits buying them. So in our case we would sell our material and manufacture invoices to these Factors paying them with a 20% interest in three months for example (when we already get paid of the firsts sales).

- **Product presales:**

We specially don't have a big period of manufacture so one of the best financing propositions will be to presale our products to companies or customers who are interested in be the first sub-seller in get our product.

- **Angel Investors:**

These days are full of examples of entrepreneurs that got his money attracting an Angel Investor nonetheless to be able to do it we should have a competitive analysis and a solid market and sales plans, even if we are a young company we should demonstrate our complete knowledge about the market around us.

- **Winning a contest:**

One of the first ideas that came to my mind when I start thinking about financing my project was to present the product to different product development contest where first, they give money to the winners and second and even more important, I could attract the attention of some future investors.

- **Crowdfunding:**

Last but not least at all I have done some research in Crowdfunding options where through webpages like Kickstarter and Indiegogo I could present the idea and the project to attract some investors in a delimited period of time.
One of the rules of this kind of webpages is to define since the beginning how much money do we need, the time to have it change depending of the start-up.

WHERE TO SELL

At this point we should discuss about **where and how to manage the sales of our product.**

The first topic that we have to discuss is about online versus face to face sales.

We all know that it's always better to view on live the product which we are going to spend our money on, however we have the advantage that our customers don't necessary have to touch or view our device on live to know that it's going to work properly in their helmets due to we are assuring them that it will work perfectly in all different kind of helmets, because of this, we have a huge online market to develop.

Now I am going to define all the different ways to sell our product:

- ONLINE:
    - <u>Our own webpage hiring a distribution company.</u>

      Nowadays is really easy to create a simple webpage where we could offer our product to our customers with the condition of paying a little extra to contrast the shipment costs.
      One of the first steps to take care of would be the hiring of the distribution company responsible of the product shipment, we have an entire catalogue of transport companies which we could hire and even better, we have the possibility of use more than one depending of the shipment cost that they offer.

    - <u>Selling it in generic accessories and motorbike stuff webpages.</u>

      One of our biggest challenge in terms of sales plan will be to contact as much possible agent companies as we can due to they are the best way in my opinion to start selling a product like this one from the beginning for on big reason, they already have the customer attention so they will work as a big first connection between us and our future customers.

- IN STORES:

    - Agreements with helmet brands to sell our device in their stores.

      Talking about the search of agent companies who could connect us to our new customers, What if we could have the possibility of offering our product to someone who is going to buy a new helmet?
      They could sell it like one accessory more, but the real purpose of these agreements would be to start bringing our product to the street.

    - Agreements with motorbikes brands to sell it in authorised dealers.

      As same as the previous agreements we could have our product in motorbike brands merchandising accessories.

    - Agreements with vehicles maintenance centres.

      Another agent option would be to contact with maintenance centres with high motorcycle riders attention where they have sales area.

DESIGN STUDIES
AND
MATERIAL RESEARCH

Step after our market research I am going to develop this chapter dedicated to study all our designs and material possibilities of each component of our product and select the best options just before start drawing it.

First, we will make some design studies about our product, defining all the different parts that we need to manufacture, the size and shape of them and how to assemble them.

Last but not least we'll make an small material research of each component in our product, really important research due to we need to study all the characteristics that we want to have in each component like chemical, mechanical, physical, thermal, manufacture and environmental.

It's really easy to say that we have to have really good materials but the problem in here is the price of them, we have to spend the right amount of money in each material because if we spend less means that it's not going to achieve our expectations however if we spend too much money on them we'll be wasting resources affecting to the final price that our customers will have to pay.

We have to remember that we have to sell this product so we have to make it sellable, which means that customers have to **LOVE** our product for the function performed but for the design and the appearance as well.

DESIGN IDEA

First of all we have to know where exactly in the helmet is going to be our device located and the reasonable answer is where we have the best angle to show our lights up and improve the visibility of them from the vehicles behind, protecting the product at the same time from the air impact and crashes, from small ones (drop the helmet to the floor) to strong ones (real accident).

Starting from that point, I obviously decided to locate the device in the centre back of the helmet but slightly moved to the bottom due to a simply reason, when we break we move our body and the head to the front of the motorbike and that is the most important situation to show our deceleration lights so in that position we will have the maximum angle of visibility.

About the **design**, I thought about something to **stand out** nevertheless to be able to **combine with the helmets and stylize them**.

One of the first topics that came to my mind when I was thinking in the design was flora and fauna shapes but it was quite difficult to think about ideas due to my lack of knowledge about the electronic part like what kind of shape and size is going to have or how are going to be the LEDs.

At the beginning I was thinking to install a horizontal device with LED lights above it climbing up until the top but all of a sudden I ask myself, why we can't install the device vertically?

At this point an idea came to my mind, if we put it vertically looks like a worm climbing to the top of the helmet, but, where were we going to put the LEDs? On the sides? Then, I was thinking about how to put big LED arms to our "*worm*" and trying to draw it in my paper when suddenly one of my colleagues from the university told me "*what's that? A worm with wings?*" and yes, maybe hand drawing it's not my best skill, but at this point I completely realised that he was right, it didn't look like a worm with arms, looked like a worm with wings, or in other words, like a butterfly.

After having the idea I started to look some information about butterflies' shapes on internet, they were beautiful nevertheless all of them were quite feminine and that wasn't really good for our future market of bikers, my next step was then to swap butterflies for similar animals but less feminine like dragonflies.

So we had then the design idea:

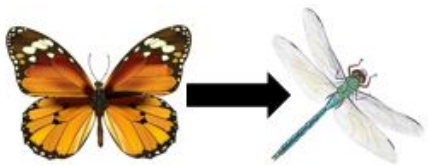


Figure 15 "Design Change"

Dragonfly shape, with his thorax where all the electronic part will be located and the see-through wings where the LEDs will be installed.

About the second part (material research) basically consist in the action of linking the design idea (dragonfly with LED wings) with the main characteristics of each component.

Now that we know the general idea of the design and how to start with materials I am going to start dividing the parts and explaining each one separately from the design to the material research.

It must be clear that we are going to make two different parts:

- **Device**: Where all the electronic and light parts are installed. We will be able to transport and swap between different helmets.

- **Bracket**: Stuck on and immovable from the helmet it's going to be our bridge to retain the device on the helmet when we are riding.

Consequently and to make the explanation easy I am going to separate our design studies and material researches in two different parts with some subgroups.
I'm going to separate the device in four different parts (Thorax, Wings, Bottom rubber and Magnets) and the bracket in two of them (Main pillar and Drops), as a result we will have the next disposition of the studies.

- Design studies and Material research of our **DEVICE**:
    - Thorax.
    - Wings.
    - Bottom Rubber.
    - Magnets.

- Design studies and Material research of our **BRACKET**:
    - Main Pillar.
    - Drops.

DEVICE

The first premises that we have to develop are the main characteristics of our device:

- As **light** as possible.
- As **thin** as possible.
- As **hard** as possible.
- And why not, as **cool and stylish** as possible, we know how bikers are with the aesthetic (we like to show off).

The first problem that I had to fix when I was developing the first designs was a valid, safe, cheap and easy to manufacture connection between device and bracket, I made a huge number of designs at the beginning, my firsts options had mechanic hooks like a kind of tongs, pegs, micro gates activated with buttons for hook the bracket etc..

I was working in this designs quite a lot of time and I was making some progress however I wasn't feeling comfortable about the idea of making different bracket designs for each kind of motorbike helmet due to they have different back shapes.

My point of view changed when I realised that we don't have only three or four kind of motorbike helmets, we have three or four groups depending of the purpose of them but inside these groups we have dissimilar helmets, actually we can find another groups inside these ones that include more different back shapes.

THORAX

I have called Thorax to the central box of the device due to the body of the dragonfly which is going to contain the "brain" of our product with all the electronic part.

DESIGN

Basically consist in the biggest part of our product and it consist in a rectangle of 80 x 25 x 20 millimetres (length·width·high) but with rounded and fine finished.
I have smoothen the top and the bottom parts of the thorax to make it more streamlined using a longer angle in the bottom one to make it similar to the dragonfly thorax.

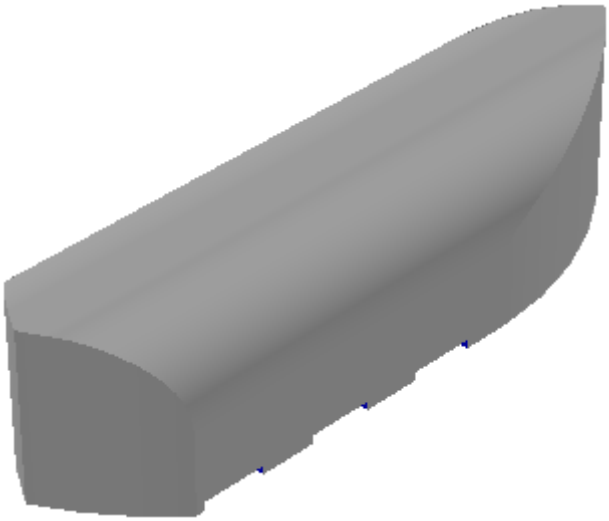


Figure 16 "Thorax upper view 1"

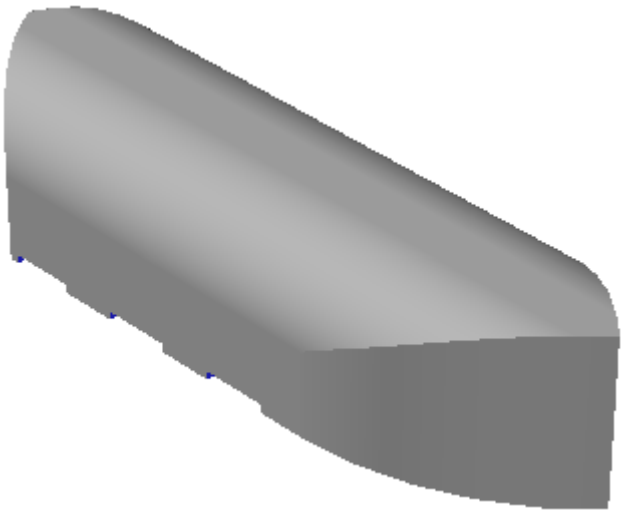


Figure 17 "Thorax upper view 2"

In terms of connection between parts, I have made a cavity in the bottom of the thorax (the part looking to the helmet) with the shape of the interior part of the wings where they are going to fit in just in the attachment between thorax and rubber making them immovable but replaceable at the same time.

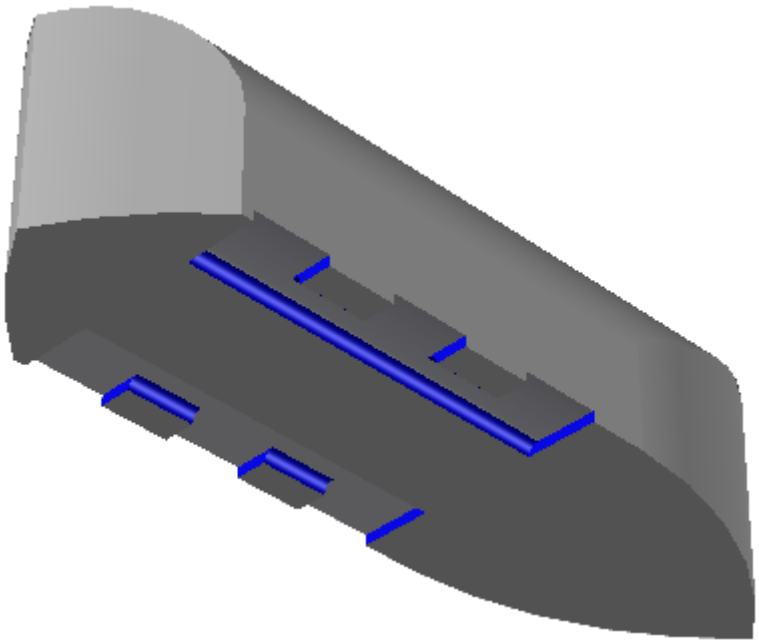


Figure 18 "Thorax bottom view (Wings cavity detail)"

MATERIALS

We should summarize the characteristics that we want in this part of the product to be able to analyse them and choose a proper material for it.

- Hard enough to tolerate hits.
- Waterproof due to we will have all our electronic parts inside.
- We don't need special thermic properties because our electronic components bear a big range of temperature.

Considering these attributes I think that the best option to make the Thorax is going to be a kind of **plastic** due to nowadays we have really good develop plastic with amazing mechanic and physical characteristics.

WINGS

Obviously the name is referred to the wings of the dragonfly and this is the place where the LEDs are going to be located.

We have six see-through wings (three in each side of the thorax) collocated twenty per cent up to the top of the thorax to make it look like dragonfly wings.

DESIGN

The measures in the biggest part of the wings are 54 x 12'3 x 5 millimetres, nevertheless we have a part of them (10 mm) inside the thorax consequently the visual length will be 44 mm instead of 54 mm.

I have made holes of 3.2 mm deep to introduce and paste the superior drops (magnets inside the wings), these magnets are 2 mm width so we have 1.2 mm of free space to introduce the bracket drops which are 2mm width as well, consequently we will have 0.8 mm of space between our wings and the helmet.

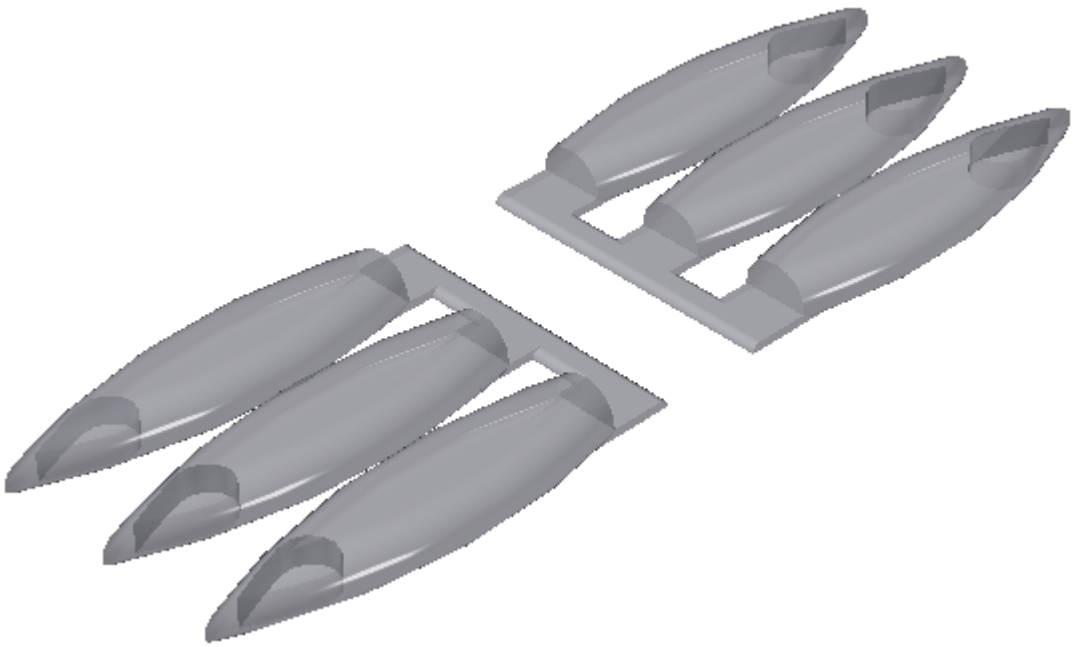


Figure 19 "Wings upper view"

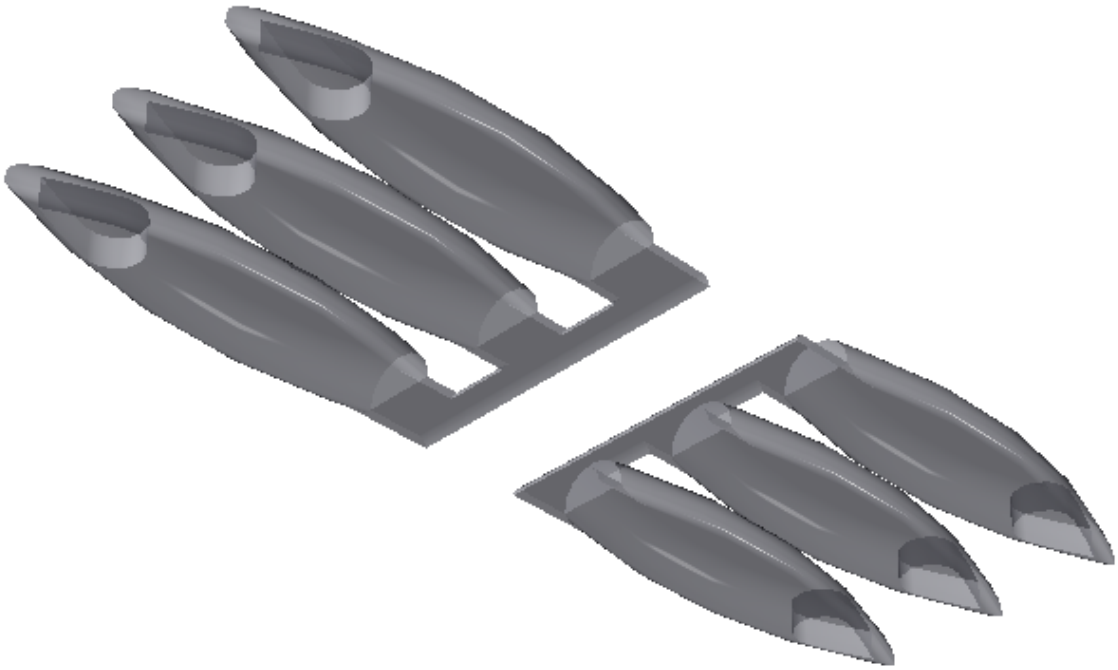


Figure 20 "Wings bottom view"

MATERIALS

We have some main characteristics for the wings as well:

- They must be see-through to be able to transmit the light of the LEDs without any power light (cd = candela) lost.
- Flexible to make possible to move them up and down and simulating the effect of the wings and connecting with the helmet drop magnets.
- Waterproof to protect the cables and LEDs.
- We don't need thermic properties neither.
- Traction resistance due to the case of one of the magnets failing during the riding.

Considering these attributes I think that we have two options to choose in this case and pending of study:

- See-through Silicone Rubber.
- Kind of see-through elastic plastic.

BOTTOM RUBBER

Connection between device and bracket, this means that should be one of the strongest part of our project.
The main function of our bottom rubber is to give our device the elastic and flexible properties that we are demanding to be able to adapt it to every single different back shape of motorbike helmets.

DESIGN

In terms of design, the shape of the rubber looks like a continuation of the thorax nevertheless I rounded the bottom part of it (the one that touch the helmet) to give our product a softer and less aggressive aspect.

The general measures of the bottom rubber are 80x25x4 millimetres in the centre which is the longest and widest part.

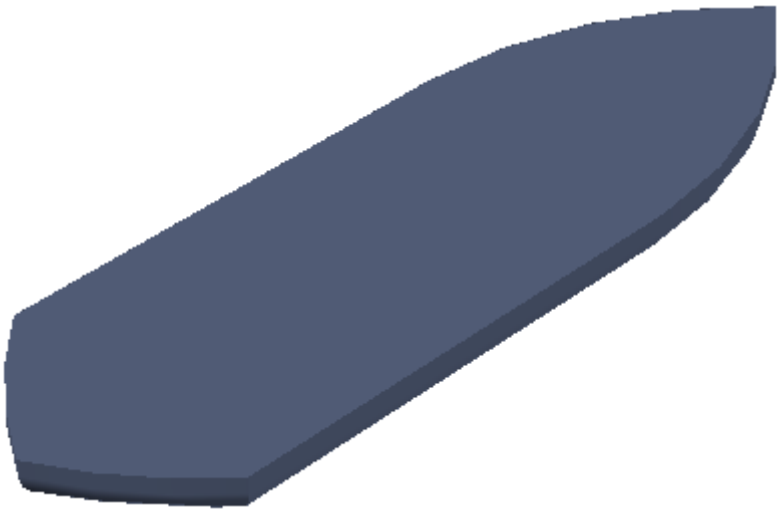


Figure 21 "Bottom Rubber upper view (Continuation of Thorax detail)"

In the bottom side we have fourteen holds where our **principal magnets** are going to be located, the deep of these cavities is 0.5 mm, been our magnets 1 mm width we will have 0.5 mm of external visual magnet.

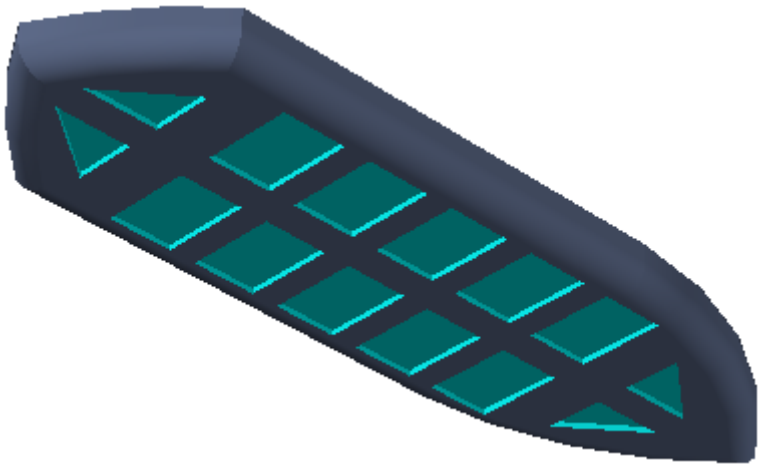


Figure 22 "Bottom Rubber bottom view (Principal Magnet holes detail)"

MATERIALS

It's relatively easy to find strong and hard rubbers but I have two challenges to beat in this research.
The first challenge is the compatibility between that strong characteristics and the amount of flexibility that I want in this part, the bottom rubber should be as flexible as possible to be able to adapt itself to any possible shape and any irregularity in the bracket surface.
The second challenge is to design or create a strong connection between bottom rubber and the thorax due to it is going to be the part in receive the strongest external forces of our product.

To solve the first issue we will see in the next task or point how I did it, to sum up I will say that I fixed it with the 3D printers and the material versatility that they offer me.

To fix the second issue I would use a strong industrial adhesive to rubber materials, they are quite simple to find everywhere so I will not go deeply in research in terms of this material.

MAGNETS

The main issue to fix in our magnet parts of the product is to calculate how strong they should be staying sure of how much power we need.

I wouldn't like to install magnets too much strong because we could break the rubber trying to take the device out from the bracket.
At the same time I don't want to install weak magnets due to we should not take the risk of lose the device when we are riding.

First we have to know that the power magnetise is measured in Teslas or Gauss units and the relation between them is ($1G = 10^{-4}\ T$) been ($1G = 1\ cm^{-1/2} \cdot g^{1/2} \cdot s^{-1}$).
To have an idea about the power of these units I have some examples:

- Earth magnet field = 0,5 G
- Small magnet = 100 G
- Small neodymium magnet = 2500 G
  (Most powerful magnets without external forces)
- Big electromagnet = 15000 G

We don't have to calculate exactly how many Teslas or Gauss we need to each magnet but we must have an idea about what range of power we want to install in our device.

For be able to calculate this range, first we should calculate the density of the air which we are in contact, to do that I have to suppose the average characteristics of the environment like altitude (300 m), temperature (20ºC) and humidity (50%).

Knowing this characteristics we can do the first step, calculate the pressure of the air:

$$P = \frac{P_0}{e^{\frac{Z \cdot g}{R \cdot T}}}$$

Being:

P = Pressure Z altitude (HPa).
P_0 = Pressure in 0m "sea" = 1013.3 HPa.
Z = Altitude in P pressure (Metres) = 300m.
g = Gravity acceleration = 9.80617 m/sec²
T = Average of temperature (ºK) = 20ºC + 273 = 293ªK
R = Gas Constant (dry air) = 287.04 m²/seg²·K

We can replace by our data now.

$$P = \frac{1013.3}{e^{\frac{300 \cdot 9.80617}{287.04 \cdot 288}}} = 1009.762\ HPa$$

I will round it and say **1010 HPa** which are **101.000 Pa**.

To calculate what we are looking for (Density) we have to use the following formula:

$$P \cdot V = n \cdot R \cdot T$$

Being:

P = Pressure (Pa) = 101.000 Pa.
V = Volume (m^3).
n = number of moles.
R = Gas Constant (dry air) = 287.04 $m^2/sec^2 \cdot K$.
T = Average of temperature (ºK) = 20ºC + 273 = 293ªK.

Following the density equation, $D = \frac{m}{V}$ and knowing that our mass is the same than our number of moles, we have $D = \frac{n}{V}$ and we can replace it in our previous equation, having now…

$$D = \frac{P}{R \cdot T} = \frac{101000}{287.04 \cdot 293} = 1.2009\ Kg/m^3$$

I will round it now to **1.2 Kg/m³**.

The next step is calculate the maximum force per mm that affect to our biker.

If we are talking about a wind of **250 km/h** (our maximum speed addend headwind), converting, we have approximately **55.5 m/s**.

This means that it moves 55.5 m^3 per second, consequently, multiplying by the density (weight) of each m^3 that we have calculated before (1.2 Kg/m^3) we will obtain **66.6 Kg**.

One square meter has 1.000.000 square millimetres, thus dividing those 66.6 Kg per 1.000.000 we will get 0.0000666 Kg/mm^2, converting to grams, **0.0666 g/mm²**.

That is our result and basically means that our biker will receive **0.0666 g/mm²** as maximum.
Our device have irregular shape nevertheless to calculate how many mm² has more or less I will count if it would be a normal rectangle.
This rectangle would be 113x80 mm so it would have 9040 mm², if we multiply for our result we will obtain approximately the total maximum force that our magnets has to support **602 g/mm²** or **0.602 kg/mm².**

Obviously our device is in the back of the helmet so it won't never receive that amount of direct force however for stay sure we will prepare our magnet connection for that situation.

Remember that the goal of our calculations was basically to know the range of magnets power that we need to build up our product.

I am going to separate now the two different kinds of magnets that we have in the device part of the project:

- The ones in the bottom rubber (**Principal Magnets**)
- The ones inside the wings (**Superior Drops**).

Principal Magnets

DESIGN

The design of them is quite simple, as we could see in the bottom rubber holes we have ten rectangles with the following measures (6x8x1) mm and four triangles rectangles of (5.5x7x1) mm.
I rounded the bottom of each magnet however I don't know if it's going to be possible in terms of manufacture due to the small measures which we are working for.
We have two triangles in each side of the rubber having the rectangles between them. The space between rectangles is 2.5 mm and between triangles and rectangles is 5 mm, all of them have a central space of 3 mm to make possible the movement needed.

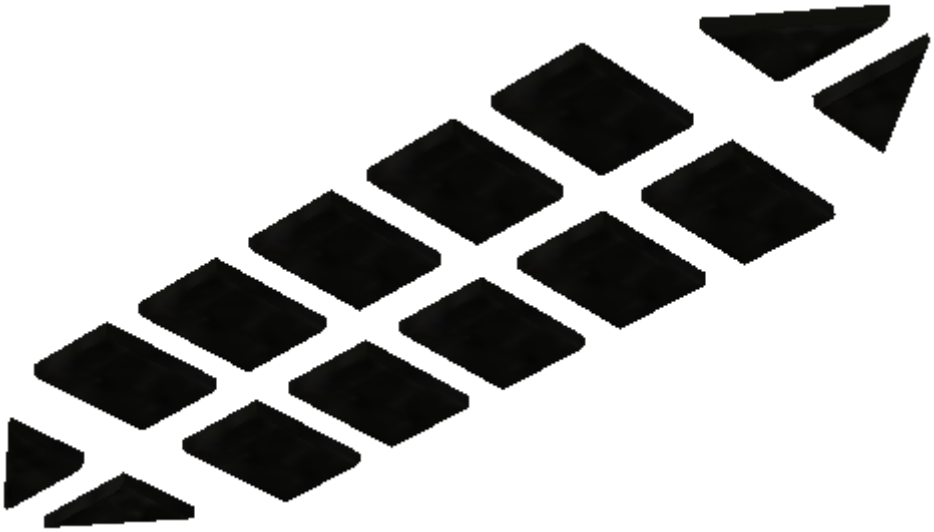


Figure 23 "Principal Magnets bottom view"

As we remarked before, these magnets stand out 0.5 mm from the rubber, enough space to make their function properly.

Figure 24 "Principal Magnets bottom view (Effect with Bottom Rubber)"

Superior Drops

DESIGN

To design the superior drops I have followed the same lines of the wings to don't break the style that they create and to make a stylish finished I made them end in a semi-circle making at the same time a beautiful overall shape similar to raindrops.

The biggest measures of the Superior Drops are (7x2x2) millimetres.

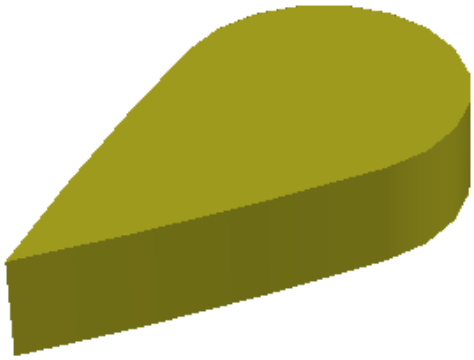


Figure 26 "Superior Drops upper view (single detail)"

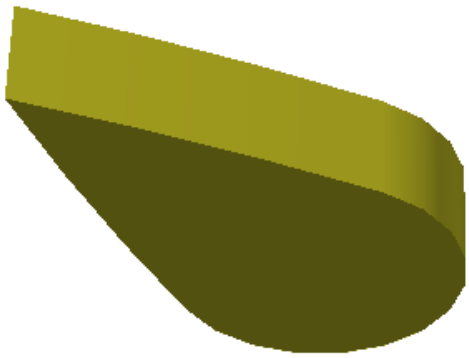


Figure 25 "Superior Drops bottom view (single detail)"

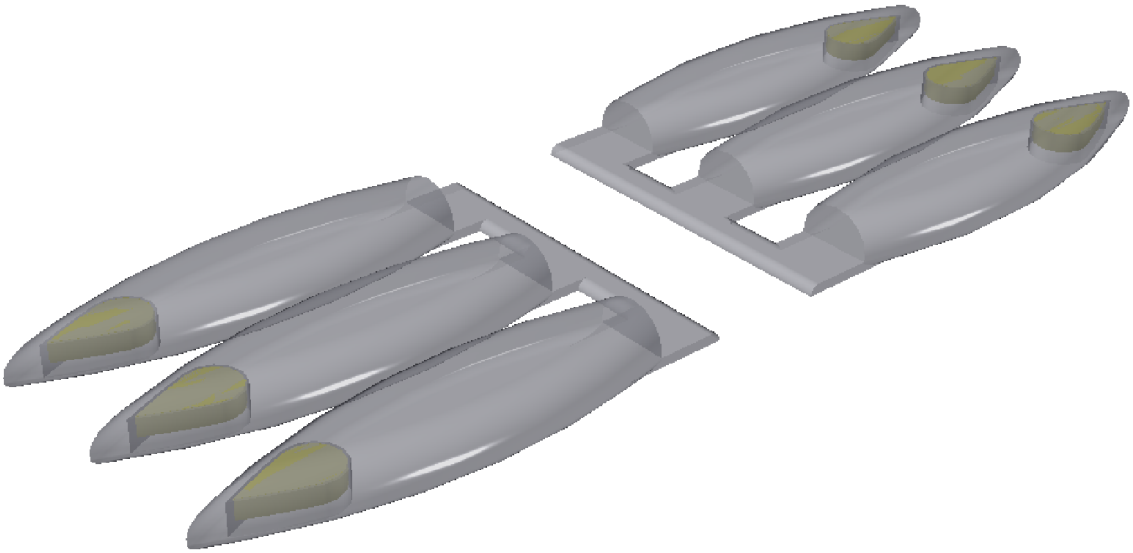


Figure 27 "Superior Drops upper view (effect inside the wings)"

BRACKET

Main characteristics of our bracket:

- As **light** as possible.
- As **hard** as possible.
- As **small and thin** as possible.
- **Flexible** enough to be able to past it in different back curves of helmets.
- **Discreet** due to we want to see as much as possible the helmet draw.

The first that we have to think about the bracket design is the connection with the helmet, we obviously can't make holes in the helmet (we will spoil it) so this piece should be stick on it.

If we paste the bracket, it is going to be always in our helmet, with or without the device, this means it is going to be part of the helmet forever, consequently and knowing how bikers are and how we like to show off, I don't think that is going to be really attractive to them the fact of covering the draw of their helmets and that is why we need the "discreet" requirement and that is why I have tried to design a discreet and visual attracting bracket.

Nevertheless, we have the point of the design in our favour here because in terms of price our bracket is going to be ridiculously cheap, thus, we can design infinite different models of brackets to stay sure that all of our possible customers love at least one of them, discarding then the possibility of loose customers because they don't like the bracket.

We could develop in the future a system or process to make bespoke brackets customizing them with the customer preferences like colour, shape, draws etc...

I'm going to divide the bracket in two different parts:

- Central piece where the device will be placed (**Main Pillar**).
- Little pieces which superior drops in the wings get attached with (**Drops**).

MAIN PILLAR

DESIGN

The central piece of the bracket have smaller size than the Thorax due to I have made it with the same shape and size of the lower part of the Bottom Rubber (it's rounded) because that is going to be the part contacted.

As a result, we have the following measures for the Main Pillar, (74x20x2) millimetres.

We can verify now that the fact of rounding the Bottom Rubber have affect in 6 mm the length and 5 mm the width of it.

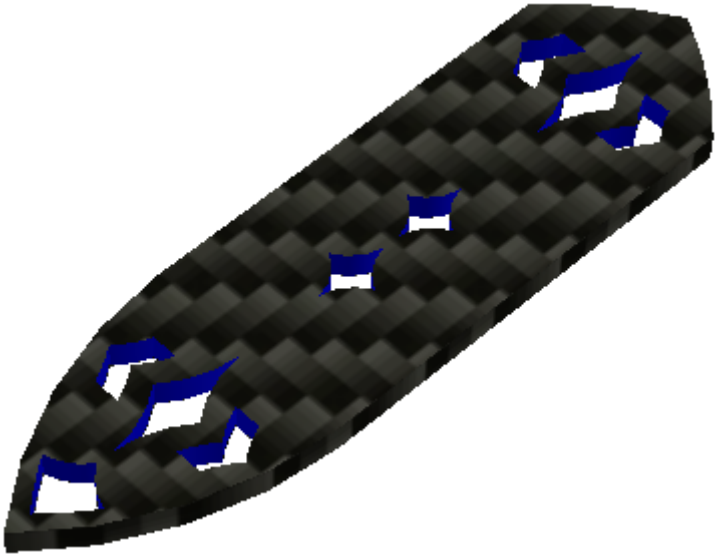


Figure 28 "Main Pillar of Bracket upper view"

MATERIALS

Our bracket must be manufactured of metal with good magnetism properties (ferromagnetic materials) to be able to get attracted with our device magnets.

This kind of metal should be as flexible as possible because we have to stick it in all different shapes of helmets skipping the different irregularities of the back of them.

Summarising, we need a hard, light and flexible ferromagnetic metal that we can past in the helmet.

DROPS

DESIGN

The design of our helmet drops has any difficulty due to they are exactly the same than the Superior Drops, actually we will use this fact in our benefit and we will design the patterns at the same time.

The measures are completely the same (7x2x2) millimetres.

Figure 30 "Drops upper view (single detail)"

Figure 29 "Drops upper view (single detail)"

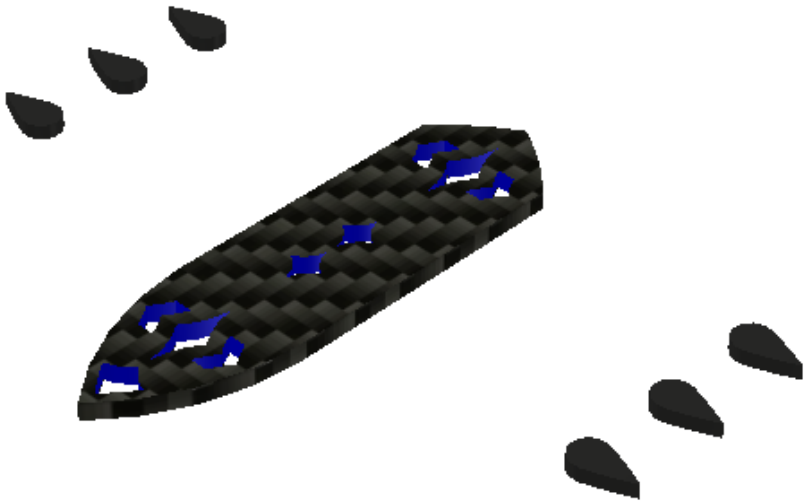


Figure 31 "Drops and Main Pillar (Full Bracket)"

MATERIALS

The material of our drops will be the same material than the main pillar, the whole bracket is made it with the same ferromagnetic flexible metal.

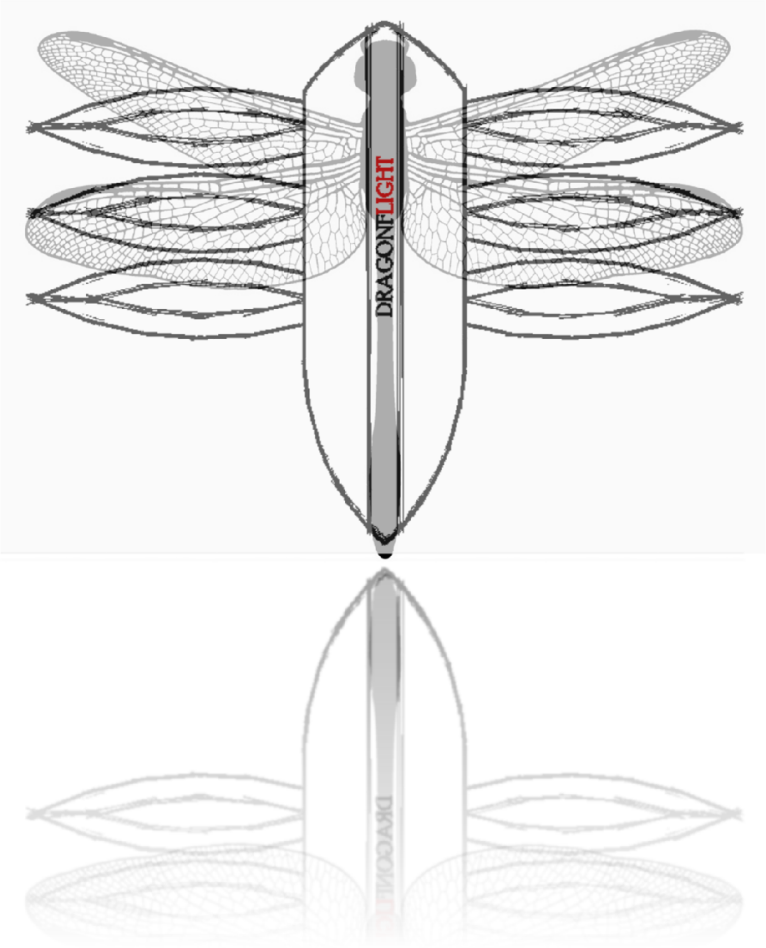
SUPPLIERS

If we could have more time to make a real prototype I would take all necessary materials through the company (Delta), they work with a lot of different material suppliers and in this case we will use two of them:

In terms of plastic and rubber components I have been in contact with “AB Carlsson & Möller”.
They are based in Helsingborg and they work with a really big catalogue of different kinds of plastics.

About the magnets, I have been in contact with “Svenska Magnet Fabriken AB”.
They are based in Västerås and they work exclusive with magnets, fact that benefit us due to the enormous knowledge about the topic that they have, therefore they would be able to help us with our doubts in terms of the magnet power needed.

FINAL DESIGN AND PROTOTYPES



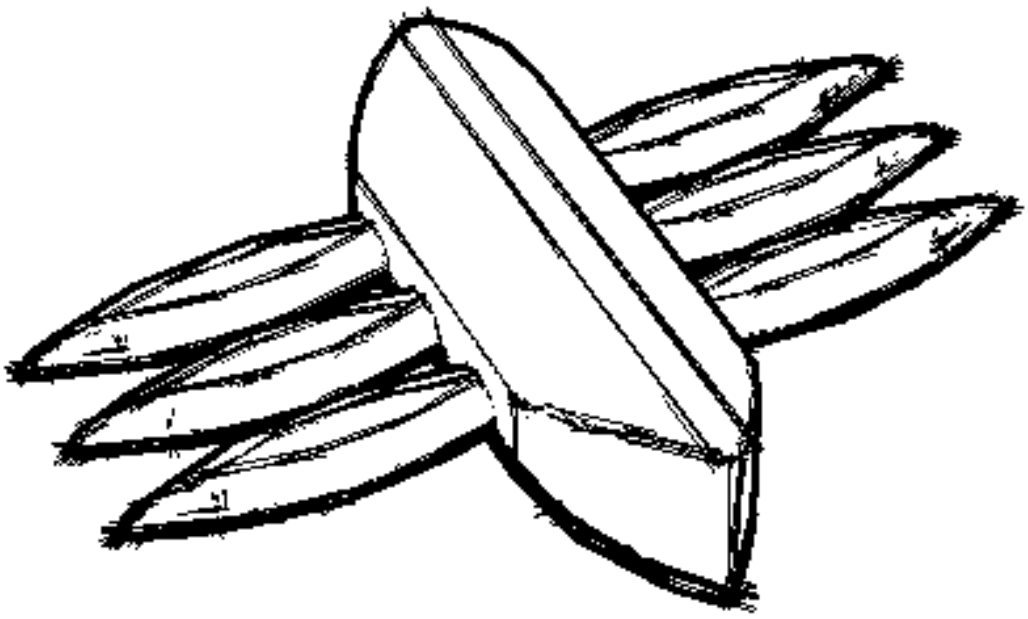


Figure 32 "DragonFlight pencil 1"

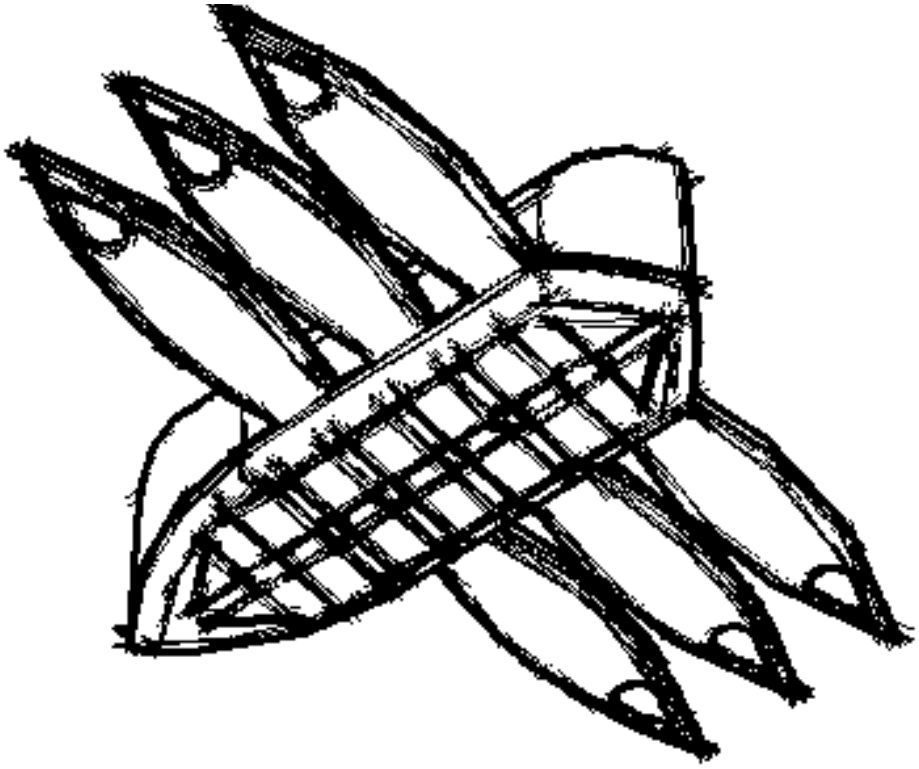


Figure 33 "DragonFlight pencil 2"

Presentation of the final design in 3D:

DEVICE

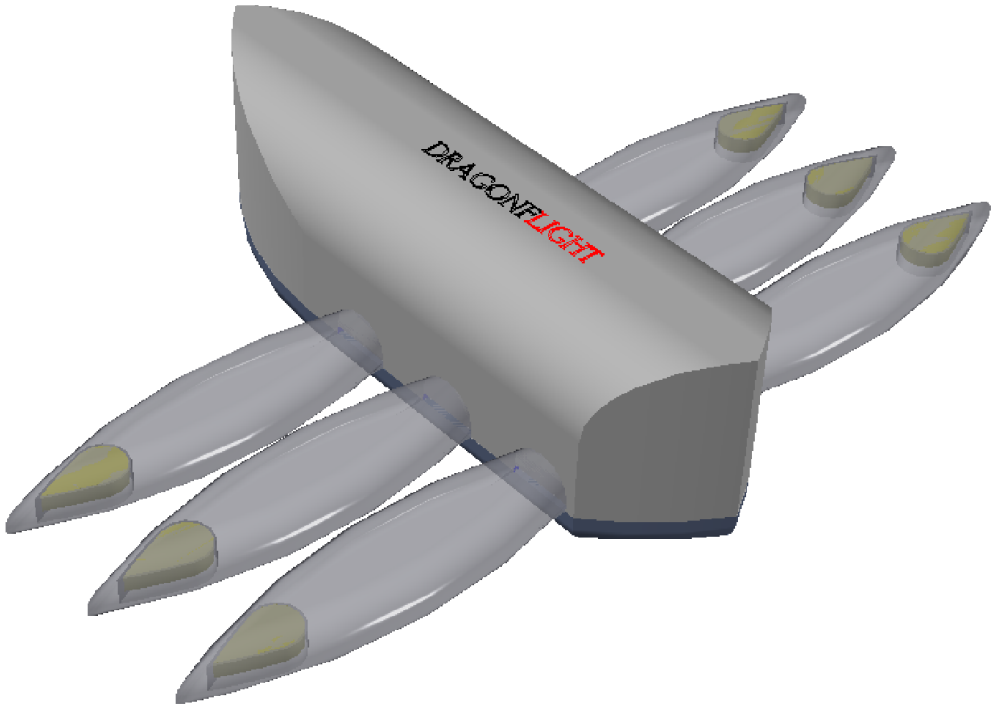


Figure 35 "DragonFlight final design 1"

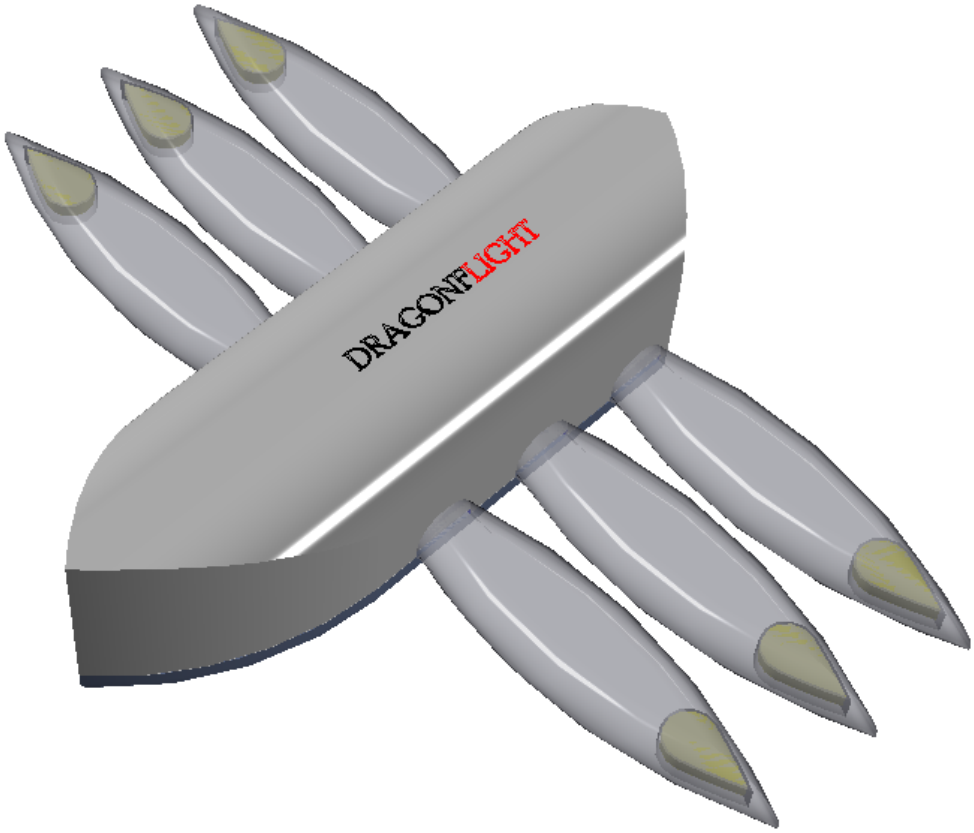


Figure 34 "DragonFlight final design 2"

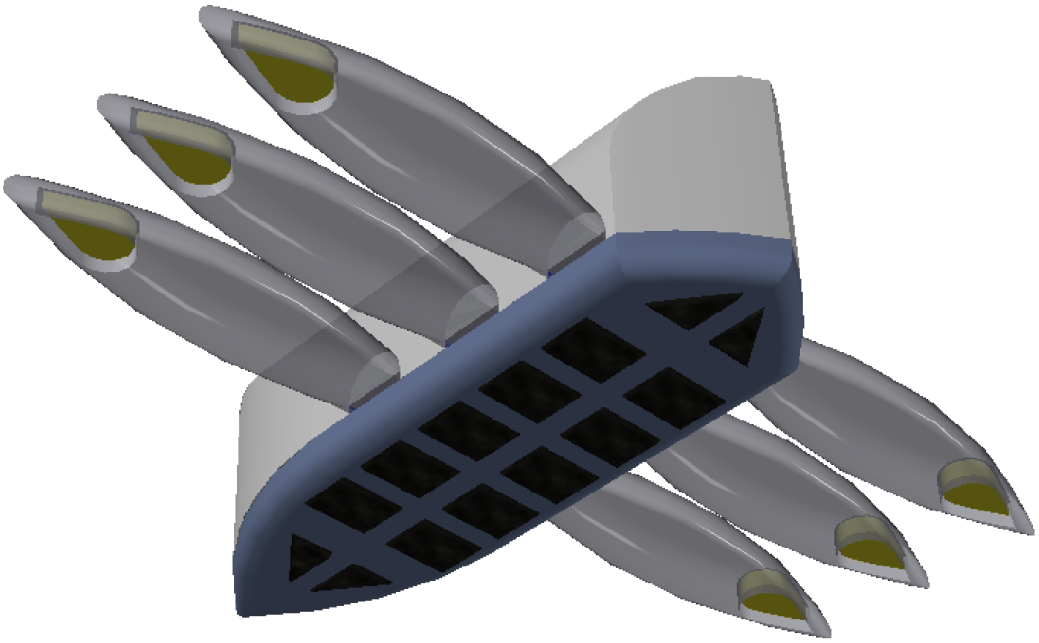


Figure 36 "DragonFlight final design 3"

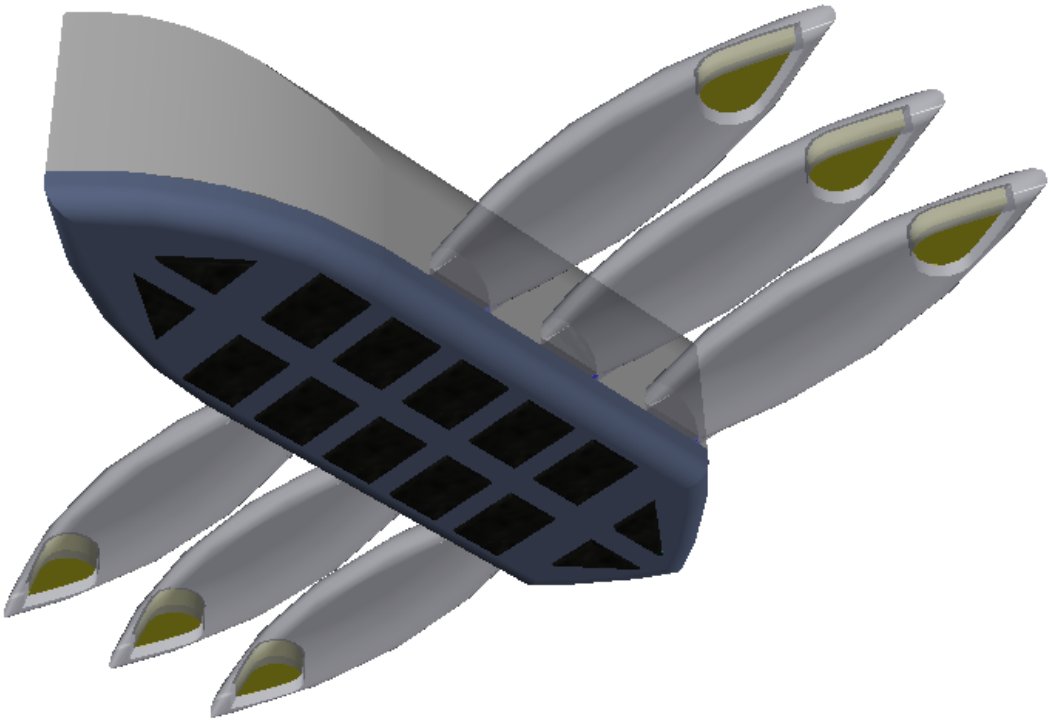


Figure 37 "DragonFlight final design 4"

BRACKET

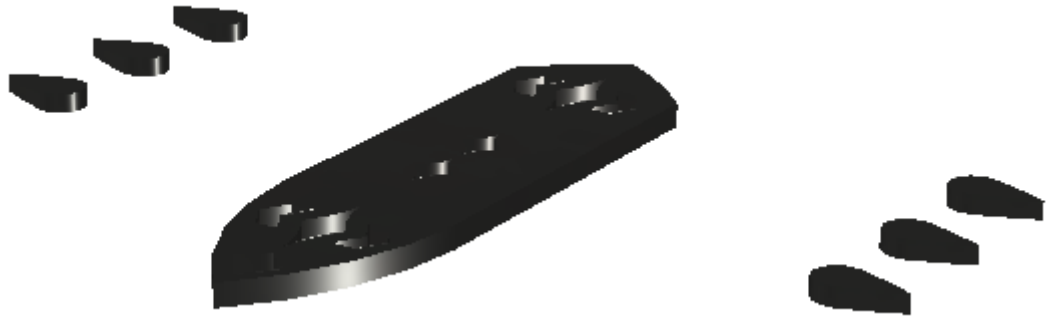


Figure 39 "Bracket final design 1"

Figure 38 "Bracket final design 2"

3D PRINTERS AND PROTOTYPES

To represent physically this design I have made some prototypes using 3D printers.

My first contact with 3D printers was on February when I discovered how they works and I "played" a little bit with the one in MDH Västerås Laboratory which is the model Duplicator 4 from to the brand WanHao.

Figure 40 "WanHao 3D Printer"

I worked with two extruders at a temperature of 230ºC, in this occasion I heated the build plate till 110ºC to improve the base finish and make more easy the extraction of the final piece.
The "problem" of this printer was that I was obligated to work with his own software which made me design and build all the support columns for the process, as a result I had to figure out how the piece was going to act during the process of printing due to we never know if the columns are going to be enough if we don't make the proper calculations.

Finally and trying to figure out how to build the support columns I designed something like this:

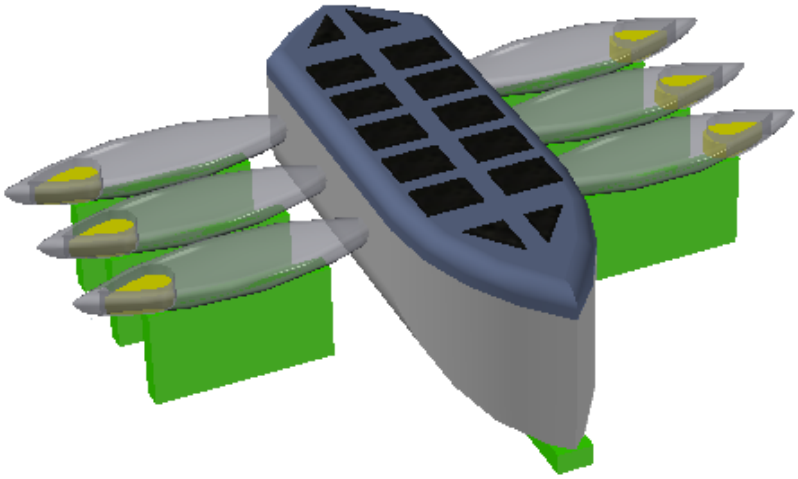


Figure 41 "Design Support columns"

Where obviously the green pieces are the support columns.
I wasn't really satisfy after print a couple of times with this printer when I received an answer of my previous application to use the 3D printers in MDH Eskilstuna which are much better than the Duplicator 4.

Tuesday the 14th I printed my prototype in Eskilstuna in two different 3D printers, one of them with more quality than the other due to the print method.

I played a little bit with an Ultimaker2 from Ultimaker (similar to Duplicator 4 from WanHao).

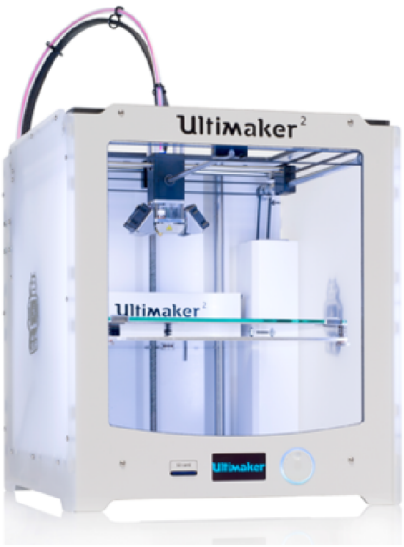


Figure 42 "Ultimaker 3D Printer"

Nonetheless I used an old one called Prodigy Stride which works with a normal extrude and a sponge build plate to build my first prototype.

Personally I wasn't expecting a lot from this printer due to the his oldness however after the long waiting of the process (3 hours more or less) I was quite surprised with the finished of my first proper prototype.

The result was the following one:

Figure 43 "Prodigy Stride 3D Printer"

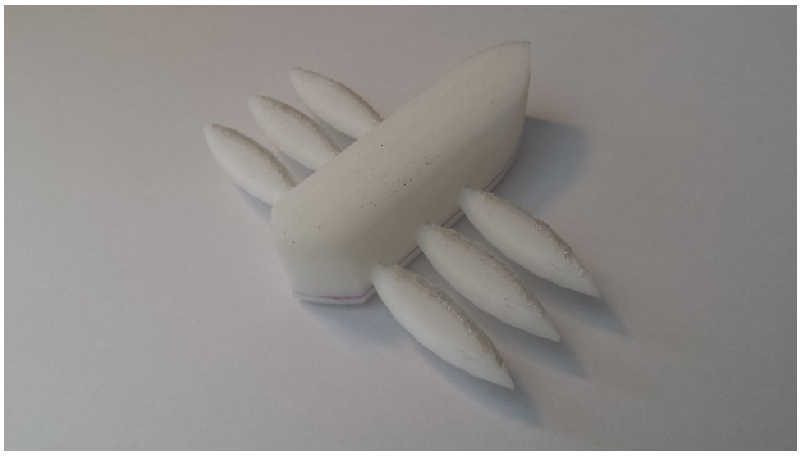


Figure 44 "Prodigy prototype"

All of this printers (Duplicator4, Ultimaker2 and Prodigy Stride) are FDM systems (Fused Deposition Modeling).
3D printers that run on FDM Technology build parts layer-by-layer from the bottom up by heating and extruding thermoplastic filament, they have some benefits comparing with the other systems:

- The technology is clean, simple-to-use and office-friendly.
- Supported production-grade thermoplastics are mechanically and environmentally stable.
- Complex geometries and cavities that would otherwise be problematic become practical with FDM technology.
- Cheap material.

The last but definitely not least printer is called Object Eden 260V and the print method is totally different, this system is called PolyJet.
PolyJet 3D printing is similar to inkjet printing, but instead of jetting drops of ink onto paper, PolyJet 3D Printers jet layers of curable liquid photopolymer onto a build tray.

PolyJet 3D Printing technology offers many advantages for rapid tooling and prototyping, and even production parts including astonishingly fine detail, smooth surfaces, speed and precision.

- Create smooth, detailed prototypes that convey final-product aesthetics.
- Produce short-run manufacturing tools, jigs and assembly fixtures.
- Produce complex shapes, intricate details and smooth surfaces.
- Incorporate colour and diverse material properties into one model with the greatest material versatility available.

In this machine we can build models up to 255 × 252 × 200 mm (10.0 x 9.9 x 7.9 in.) with a clean, quiet system that fits our creative environment. With 16-micron layer accuracy, the Eden 260VS renders smooth surfaces, thin walls and fine details in your choice of 15 rigid and flexible materials.

We have two amazing characteristics in this printer for my case:

The first one is related with the support columns, I already knew from the Prodigy prototype that it's quite hard to take that support material from the final piece increasing the risks of damage the prototype. Nevertheless in this printer we have the opportunity of pint with a soluble support option to minimize to hands-on time and effort and my experience with that was really successful, I could take the support material out just with my hands and a little bit of water having a perfect finishing touch.

Figure 45 "Object Eden 260V 3D Printer"

The second one is about the materials to print available in this machine, it offer 15 distinct materials including:

- Transparent materials for producing clear models with great dimensional stability and surface smoothness.
- Rigid Opaque materials (Vero family) in a variety of colours including white, grey, blue and black.
- Simulated Polypropylene materials with toughness and durability to create smooth prototypes with living hinges, flexible closures and snap-fit parts
- Rubber-like materials (Tango family) suitable for a range of applications requiring non-slip or soft surfaces.
- High Temperature (RGD525) for advanced functional testing, hot air and water flow, and static applications.

The first prototype using the PolyJet system (using only one material) has really good finished touch, maybe too much weight because our final device will not weight that much:

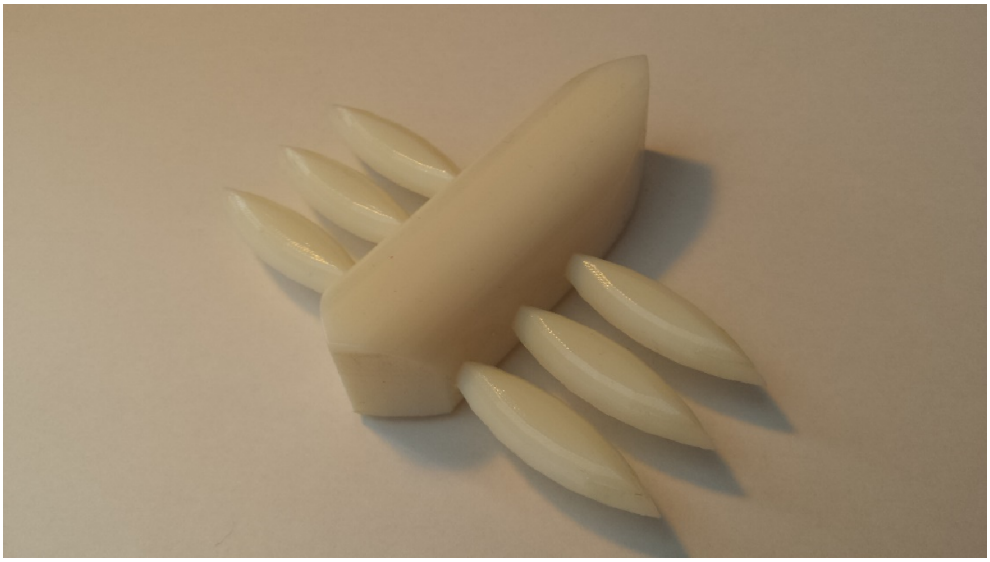


Figure 46 "First Object Eden prototype"

After a few changes in the design I decided to print each part of our product separately to be able to explain properly the manufacture process and how the product works.

I printed them with Object Eden 260V on 13th of May.

First I printed with VeroBlue FullCulture@840 which is a hard material the immovable parts of the device like Thorax, Principal Magnets, Normal Drops and Superior Drops.

After these ones I changed the material to print with TangoGray FLX@950 which is a flexible kind of rubber which imitates perfectly to the real rubber that we should use to manufacture the Bottom Rubber.

I printed with the same material the Main Pillar of the Bracket due to obviously they are going to be flexible as well so we could make and idea of how is going to work in the helmet.

After print all different parts I printed again the entire model with the new changes, I printed it with the strong material (VeroBlue) and this was the result just finished inside the printer and ones outside and cleaned:

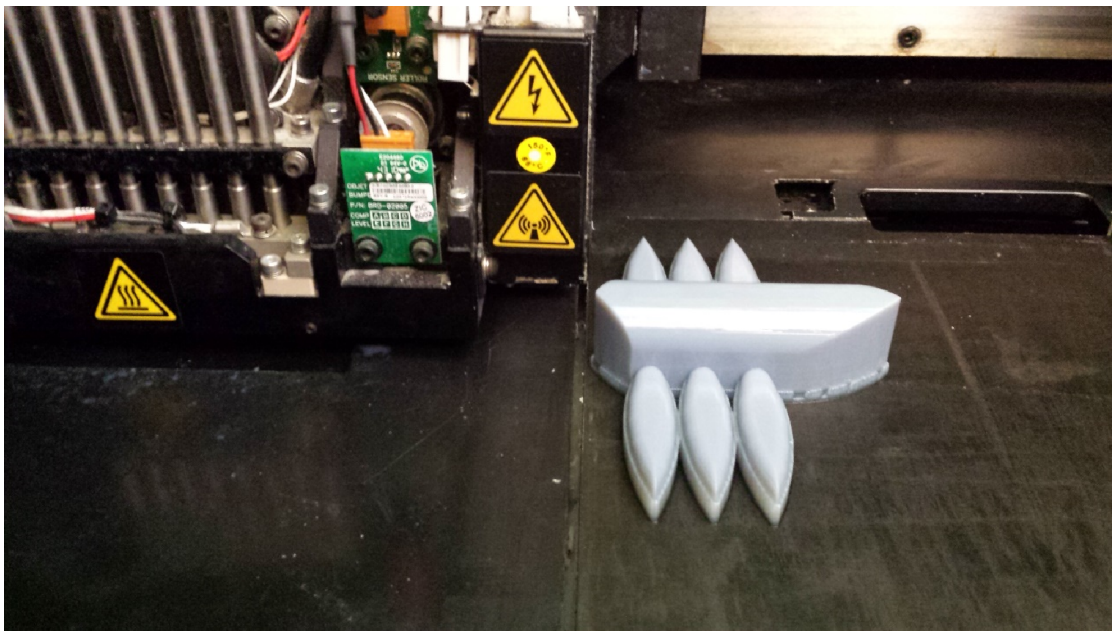


Figure 47 "Second Object Ede prototype just finished"

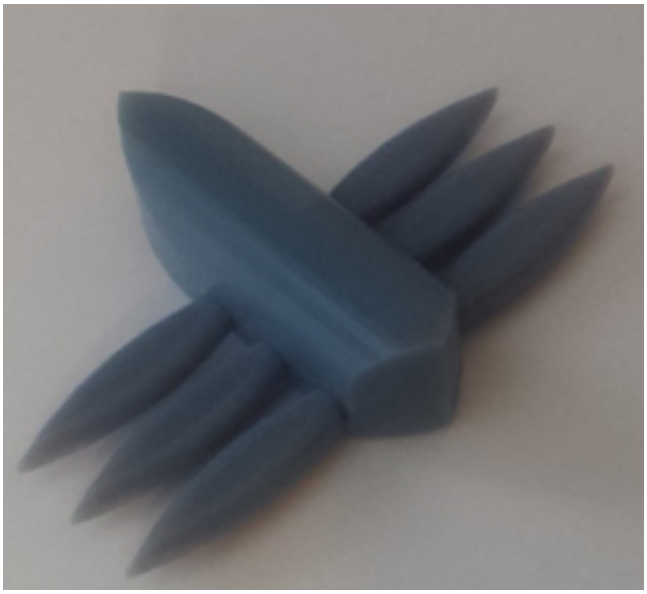


Figure 48 "Second prototype Object Eden 1"

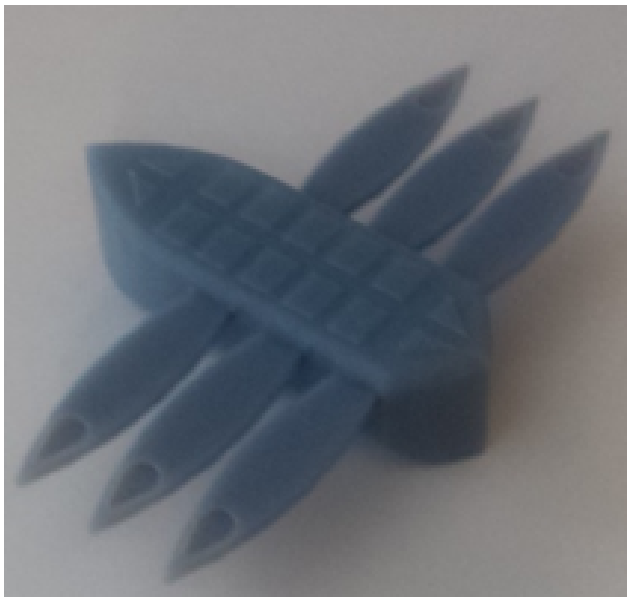


Figure 49 "Second prototype Object Eden 2"

The next step then would be start getting all our materials and build part by part until be able to assemble all the pieces to achieve our final "empty" product ready to fill in with the brain of our dragonflight.

MANUFACTURE PROCESS

Ones that we have printed the different parts of our product separately it is quite simple to explain the manufacture process.

First I will show the different parts printed and after that I will summarize how to assemble them.

Pictures of all the immovable elements that we will install in the helmet, **main pillar bracket** and **bracket drops** (magnets).

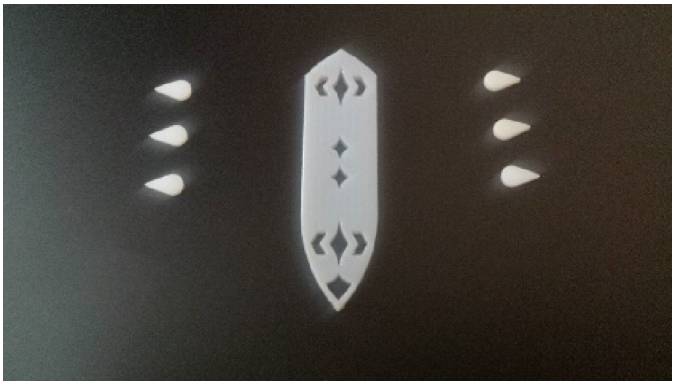


Figure 50 "Bracket prototype"

Our main part of the device and container of the "brain" of the dragonflight, the **Thorax** with detail of the wings cavities:

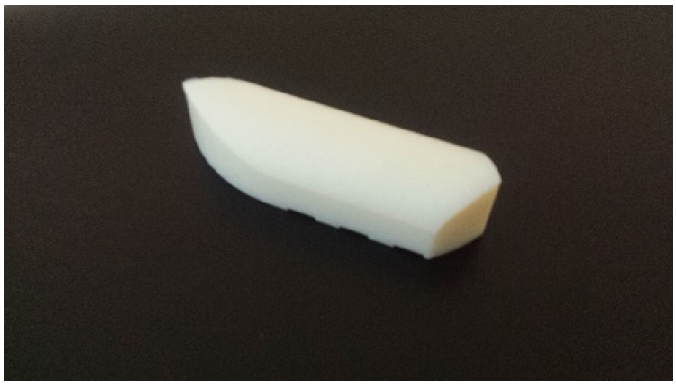


Figure 52 "Thorax prototype 1"

Figure 51 "Thorax prototype 2"

Our six **wings**, detail of the hole needed for superior drops and the union between them to be able to assemble them with the Thorax and Bottom rubber:

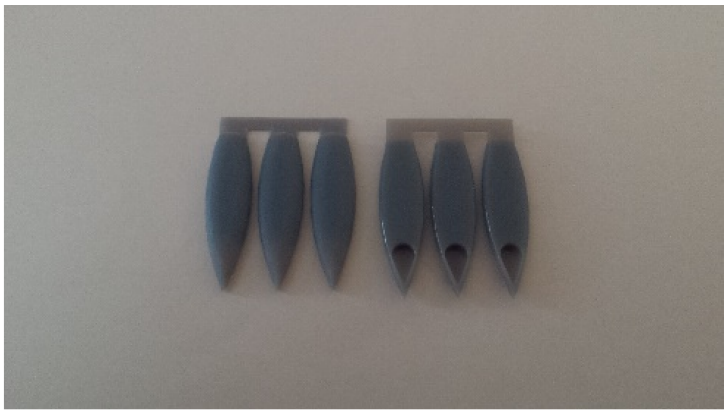


Figure 53 "Wings prototype"

Bottom rubber, detail of the cavities for the magnets and the soft print material which is flexible enough to adapt itself to any kind of back helmet shape:

Figure 54 "Bottom Rubber prototype"

Bottom rubber again but fulfilled with our fourteen **Principal magnets**:

Figure 55 "Bottom Rubber with Principal Magnets prototype"

Before to explain the manufacture process I would like to remark that we could definitely change the process order depending of the convenience or easiness of the assembly steps, I made this process just because is more visual in the pictures.

We could start assembling the wings in the thorax, they won't have any paste or glue in the connection.

Figure 56 "Manufacture wings-thorax"

We will apply glue to our superior drops before introducing them in the wings holes.

Figure 57 "Manufacture drops-wings"

After this, we will apply strong glue to our bottom rubber to paste it just in the bottom of our thorax with the wings already installed.

Figure 58 "Manufacture Bottom Rubber"

Ones that we make sure that the rubber is already pasted and immovable we will start pasting with special glue all the principal magnets.

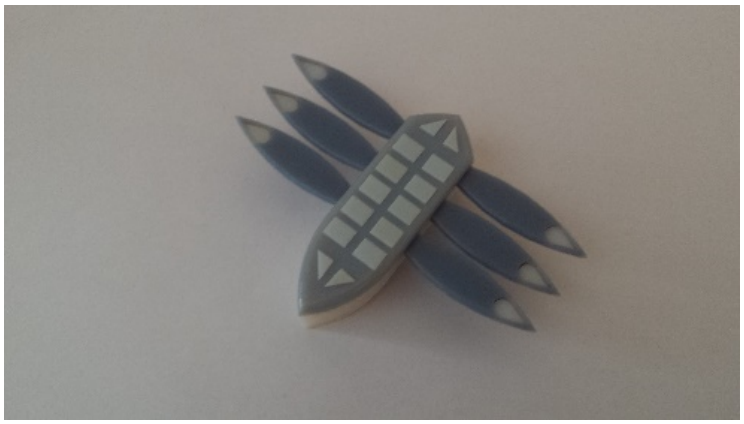


Figure 59 "Manufacture finished"

About the **bracket section** I have had an idea to collocate all the parts (the main bracket and the drops) in the right position and easily to our helmet, basically we will sell them in a kind of **double plastic sticker** in both sides. We will have already prepared the back side with the glue needed to paste the pieces in the helmet. Our customers will install in their helmets taking back the first applicator plastic, collocating the bracket right after that to finally take back the second applicator plastic in the outside.

CONCLUSIONS ABOUT DESIGN

Trying the new prototypes in real motorbike helmets I have had the opportunity to realise some conclusions about my final design.

For further prototypes we should manufacture the main pillar bracket thinner due to we don't really need to have a piece of 2mm high, we could try just with 0.5 mm. We will have the same result in terms of resistance but making the entire project thinner and giving a robustness appearance to it.

About the bottom rubber I have realised that it should be more flexible than expected, we only have 4mm width to be able to adapt the device to the shape of the helmet so we should use as much as we can of that width to make possible the full and comfortable adaptation squashing it to the helmet. The last thing that we want is to make the magnets uncomfortable and working too much against our device just to get the rubber in the proper position.

It should be mentioned that the wings design assemble perfectly between our thorax and bottom rubber and remark that they are working really good in that position, like and advise just say that we shouldn't change that part of the prototype in further design changes if it's possible.

TECHNICAL REPORT

Components and Prices

1x Arduino Mini 05 Series = 10€ 4€(ones in the future which we can model)

1x Accelerometer MMA 8452 = 9€ 3€(ones in the future which we can model)

1x Voltage Regulator 2937 of 3.3V = 1.8€

3x Resistor 220 Ω = Depreciable price.

2x Resistor 330 Ω = Depreciable price.

1x Capacitor 0.1 μF = 0.23€

1x Capacitor 10 μF = 0.41€

12x or 18x or 24x LEDs 150353Rs74500 of 55lm and 625nm (reds) = 3.9€ each, 2.7€ (+100), 2.45€ (+500), 1.55€ (+3000)

Electronic research

Microcontroller

Which basically consist in the brain of our device where we connect all the different elements and where we introduce the programming code.

I have already worked with Arduino microcontrollers so my challenge in this technical part was to find an Arduino microcontroller small enough to fit in the device.
Arduino Mini seems to be the perfect microcontroller for this project since is small and I already know how to use it so I could skip the function research part.

The microcontroller (an ATmega328) on the Arduino Mini is a physically smaller version of the chip on the USB Arduino boards, with the following small difference:

- There are two extra analogue inputs on the Mini (8 total). Four of these, however, are not connected to the legs that come on the Arduino Mini, requiring you to solder wires to their holes to use them. Two of these unconnected pins are also used by the Wire library (I2C), meaning that its use will require soldering as well.
-
- Also, the Arduino Mini is more fragile and easy to break than a regular Arduino board.

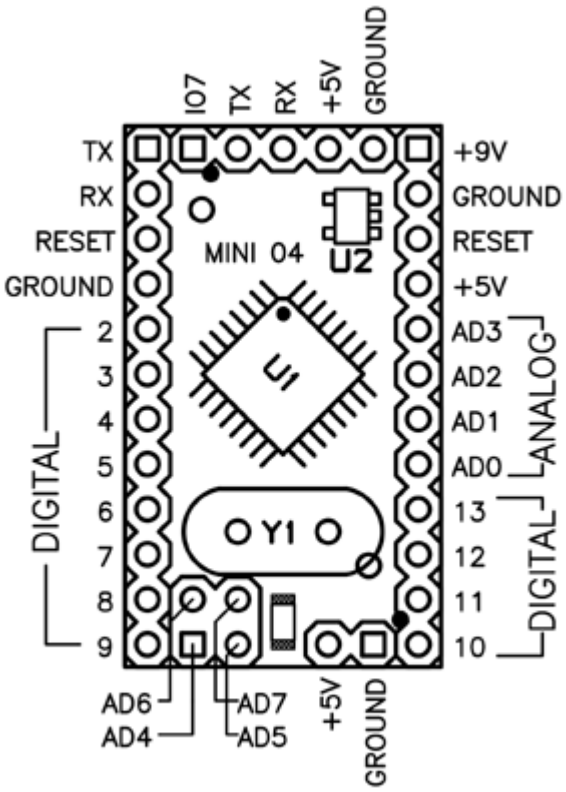


Figure 61 "Arduino Mini 1"

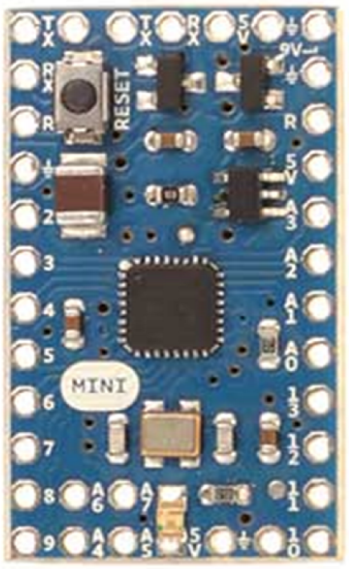


Figure 60 "Arduino Mini 2"

Accelerometer

One of the principal component which receives and give us all the information needed in terms of acceleration and position.

There is a really big market for this sensor and I have never worked with an accelerometer, so at first there are no preferences for one or another, but looking deeply there is a brand of sensors that work really good with Arduino, Sparkfun, where we have the Sparkfun Triple Axis Accelerometer Breakout - MMA8452Q

The MMA8452Q is a smart low-power, three-axis, capacitive MEMS accelerometer with 12 bits of resolution. This accelerometer is packed with embedded functions with flexible user programmable options, configurable to two interrupt pins. Embedded interrupt functions allow for overall power savings relieving the host processor from continuously polling data.

The MMA8452Q has user selectable full scales of ±2g/±4g/±8g with high pass filtered data as well as non-filtered data available real-time. The device can be configured to generate inertial wake-up interrupt signals from any combination of the configurable embedded functions allowing the MMA8452Q to monitor events and remain in a low power mode during periods of inactivity.

This board breaks out the ground, power, **I2C** and two external interrupt pins.

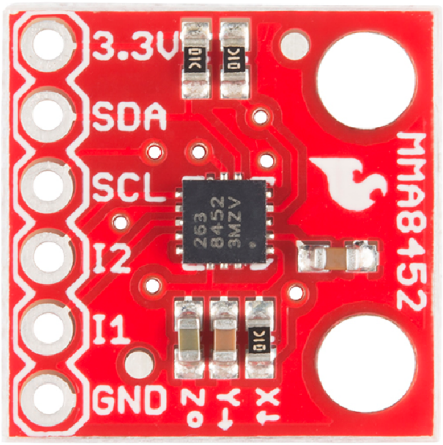


Figure 63 "Accelerometer 1"

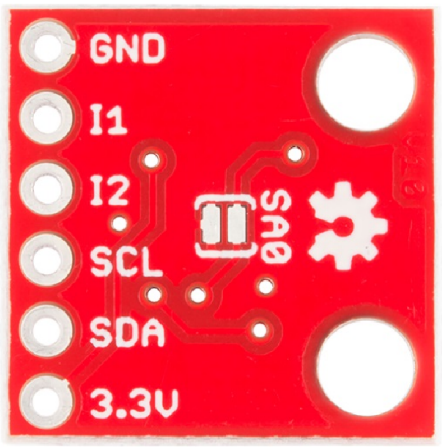


Figure 62 "Accelerometer 2"

Voltage regulator

The accelerometer works with 3.3V while Arduino mini works with 5V so it is needed to reduce the voltage that comes from Arduino so is possible to supply the accelerometer without another kind of supply.
One option to do it and the one I have chosen is to use a voltage regulator that I will configure to only allow 3.3V to pass through it.
I have work with two different voltage regulator, the LM317 and LM293 so we have to decide one of them.
The LM317 has three pins: INput, OUTput, and ADJustment. The device is conceptually an op amp with a relatively high output current capacity. The inverting input of the amp is the adjustment pin, while the non-inverting input is set by an internal bandgap voltage reference which produces a stable reference voltage of 1.25 V.

A resistive voltage divider between the output and ground configures the op amp as a non-inverting amplifier so that the voltage of the output pin is continuously adjusted to be a fixed amount, the reference voltage, above that of the adjustment pin. Ideally, this makes the output voltage:

$$V_{out} = V_{ref} (1 + R_L/R_H)$$

Because some quiescent current flows from the adjustment pin of the device, an error term is added:

$$V_{out} = V_{ref} (1 + R_L/R_H) + I_Q R_L$$

To make the output more stable, the device is designed to keep the quiescent current at or below 100µA, making it possible to ignore the error term in nearly all practical cases.

So using a resistor of 330Ω as R_H and to have 3.3V it is needed a resistor of 676.5Ω (680Ω) as R_L.

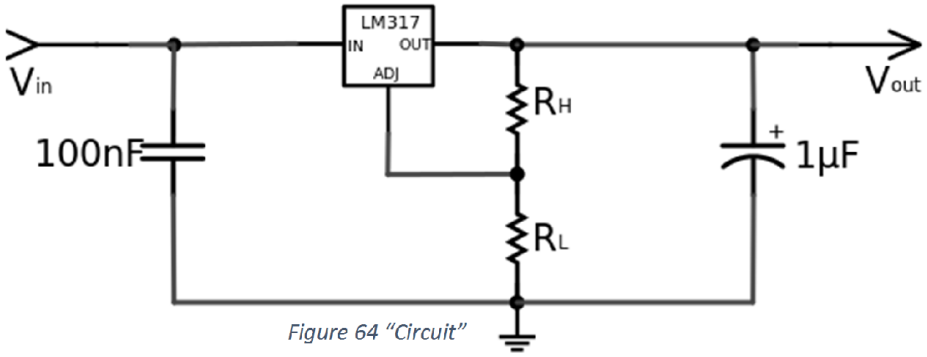


Figure 64 "Circuit"

The LM2937 has three pins: INput, OUTput, and ADJustment. The device is conceptually an op amp with a relatively high output current capacity. The inverting input of the amp is the adjustment pin, while the non-inverting input is set by an internal bandgap voltage reference which produces a stable reference voltage of 3.3 V so we will choose this one due to we don't need any resistor or other things to change the voltage to 3.3 V

LED´s

We want a really powerful LED's, because we need people to see us from the distance.

Delta supply me with some different LED's and I have chosen the LED 150 353 RS7 450 0 Ceramic 3535 Red 625nm 55 lm 2.2 V 125º.

A Dimensions: [mm]

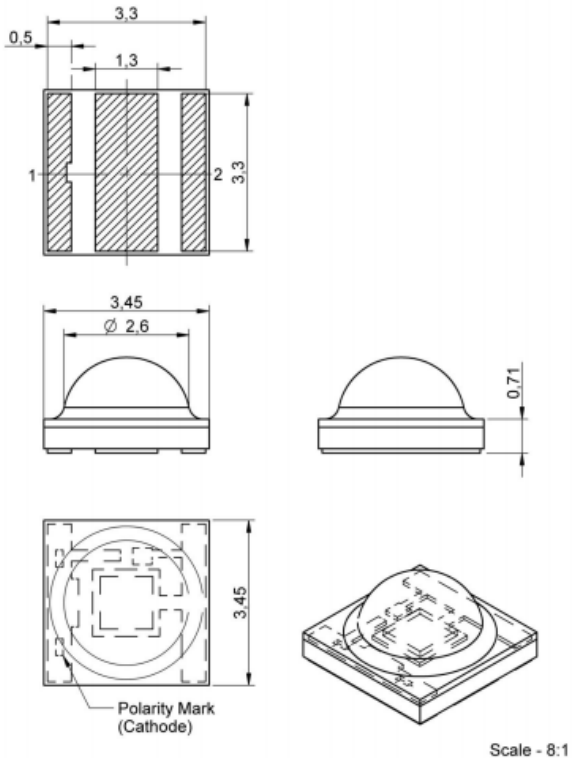


Figure 68 "LED's Dimensions"

C Schematic:

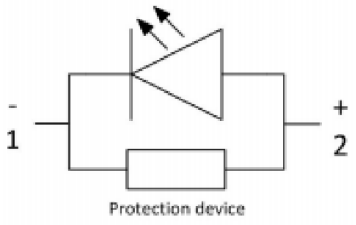


Figure 65 "LED's circuit"

F3 Forward Current vs. Forward Voltage:

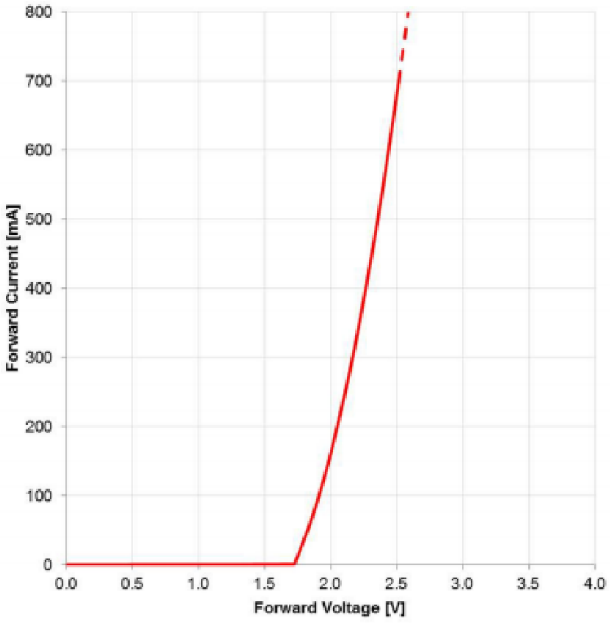


Figure 67 "LED's Voltage"

D Electrical & Optical Properties:

Properties	Test conditions		Value			Unit
			min.	typ.	max.	
Peak Wavelength	350 mA	λ_{Peak}		635		nm
Dominant wavelength	350 mA	λ_{Dom}		625		nm
Luminous Flux	350 mA	Φ_v	44	55		lm
Forward Voltage	350 mA	V_F		2.2	3.0	V
Spectral Bandwidth	350 mA	$\Delta\lambda$		15		nm
Viewing Angle	350 mA	$2\theta_{50\%}$		125		°

Figure 66 "LED's properties"

Circuit

In this circuit the supply is with 9V but you can supply it with a 5V battery just introducing the voltage through a 5V pin.

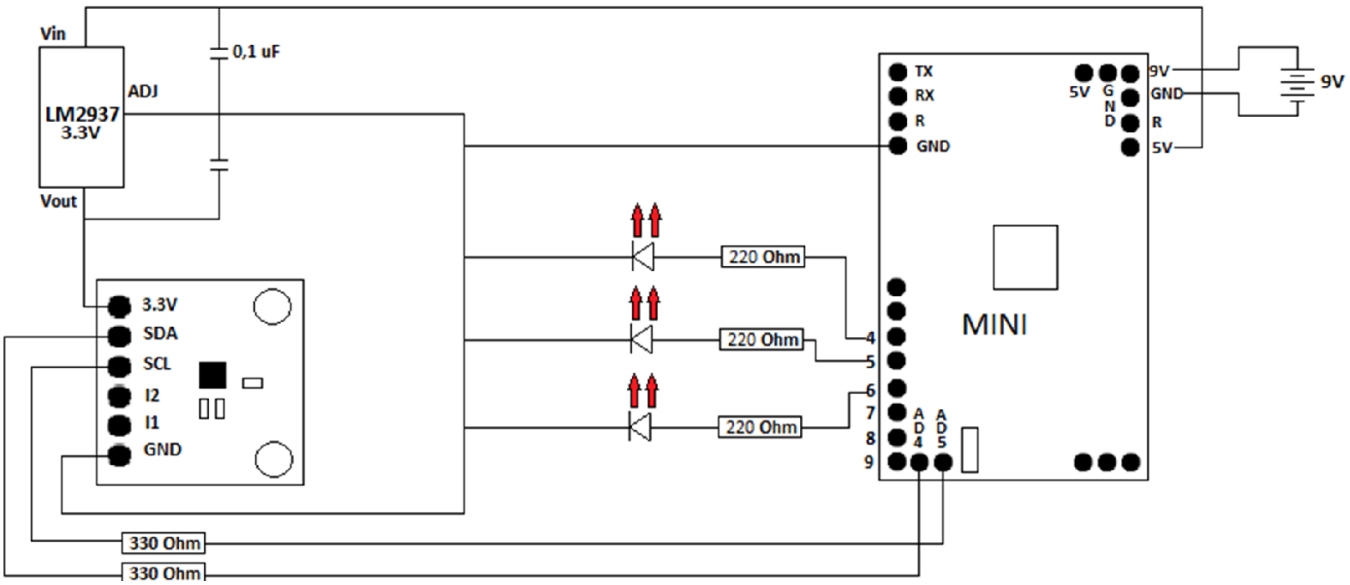


Figure 69 "Real Circuit"

PCB´s

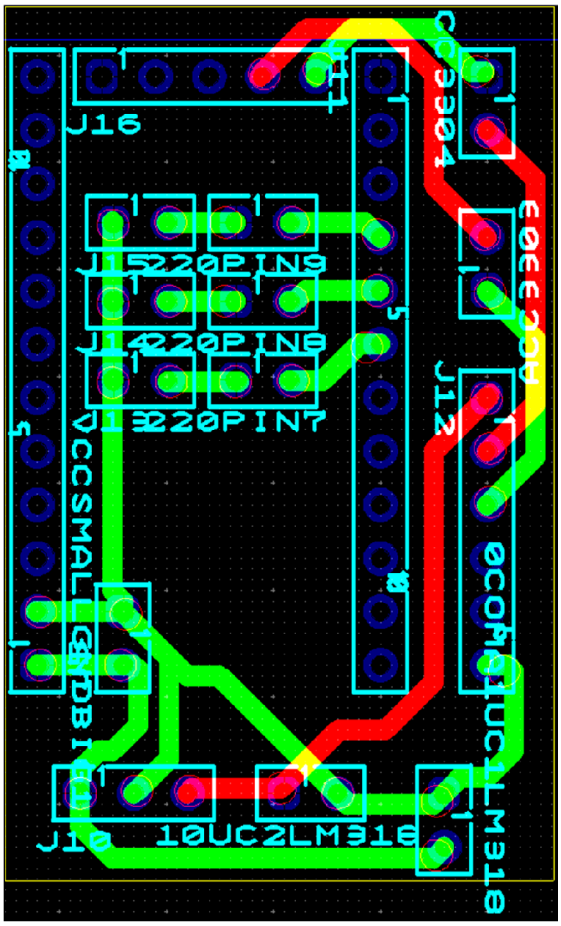


Figure 71 "PCB 9V"

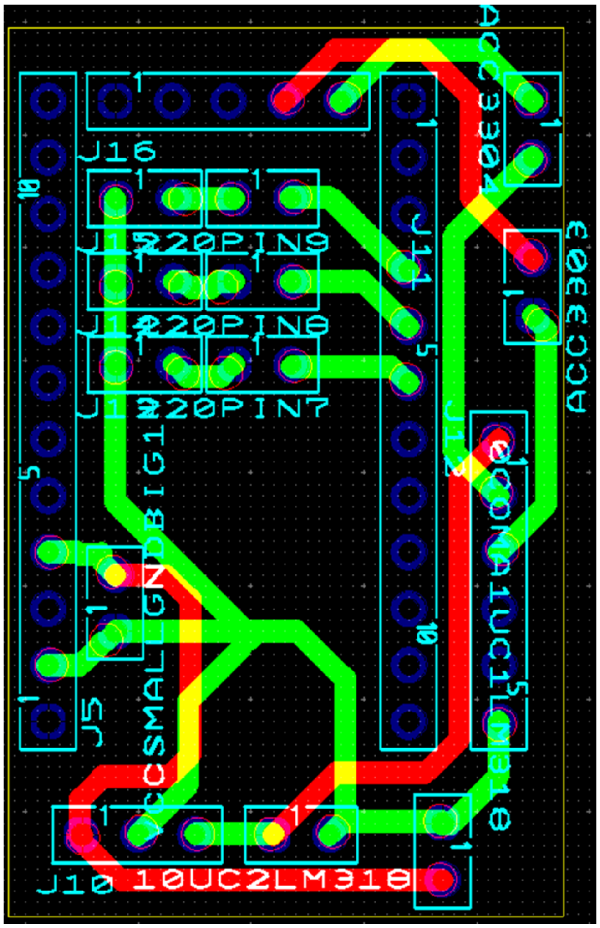


Figure 70 "PCB 5V"

Programing

What we want is to detect different levels of deceleration and in the web page of the accelerometer they give us for free one example code to work with the accelerometer and Arduino so I took it and made the necessary changes to adapt it for the objective of the project, show different levels of light when needed.

The example code work with G forces and I know that 1G force of deceleration is more or less a reduction of 35 Km/h per second. I don´t know which kind of deceleration we are going to need to have an accurate answer so I just adjust it to show 3 levels of light: 1G force, 1,4G forces and 1,8G forces.

If you want this working you will need to install some libraries for the accelerometer, and it´s possible to get them from the web page of the accelerometer.

At the beginning of the program you have 3 variables (light1-light2-light3) with the values of G forces where you want to show the light.

MMA8452Q_Basic.ino
SFE_MMA8452Q Library Basic Example Sketch
Jim Lindblom @ SparkFun Electronics
Original Creation Date: June 3, 2014
https://github.com/sparkfun/MMA8452_Accelerometer

This sketch uses the SparkFun_MMA8452Q library to initialize the accelerometer, and stream values from it.
Hardware hook-up:

Arduino ---------- MMA8452Q Breakout

3.3V ----------3.3V

GND ----------GND

SDA (A4) --\/330 Ohm\/-- SDA

SCL (A5) --\/330 Ohm\/-- SCL

The MMA8452Q is a 3.3V max sensor, so you'll need to do some Level-shifting between the Arduino and the breakout. Series Resistors on the SDA and SCL lines should do the trick.

Development environment specifics:

IDE: Arduino 1.0.5

Hardware Platform: Arduino Uno

Updated for Arduino 1.6.4 5/2015

CODE:

```
#include <Wire.h> // Must include Wire library for I2C
#include <SparkFun_MMA8452Q.h> // Includes the SFE_MMA8452Q library
// Begin using the library by creating an instance of the MMA8452Q
//  class. We'll call it "accel". That's what we'll reference from
//  here on out.
MMA8452Q accel;
int light1=1000;  //First line of LED´s-----> The value in G forces is the number of light divided by 1000, here 1G force
| If you change this value you will
int light2=1400;  //Second line of LED´s----> The value in G forces is the number of light divided by 1000, here 1,4G force
| change in which moment the light is on
int light3=1800;  //Third line of LED´s-----> The value in G forces is the number of light divided by 1000, here 1,8G force
|
// The setup function simply starts serial and initializes the
//  accelerometer.
void setup()
{
 pinMode(6, OUTPUT);  //Connect the led in the pin's 6, 5 and 4 to show different levels of deceleration
 pinMode(5, OUTPUT);
 pinMode(4, OUTPUT);
 Serial.begin(9600);
 Serial.println("MMA8452Q Test Code!");
  digitalWrite(6, HIGH);
 digitalWrite(5, HIGH);
 digitalWrite(4, HIGH);
 delay(100);
 digitalWrite(6, LOW);
 digitalWrite(5, LOW);
 digitalWrite(4, LOW);
 delay(100);
 digitalWrite(6, HIGH);
 digitalWrite(5, HIGH);
 digitalWrite(4, HIGH);
 delay(100);
 digitalWrite(6, LOW);
 digitalWrite(5, LOW);
 digitalWrite(4, LOW);
 delay(100);
 digitalWrite(6, HIGH);
 digitalWrite(5, HIGH);
 digitalWrite(4, HIGH);
 delay(100);
 digitalWrite(6, LOW);
 digitalWrite(5, LOW);
 digitalWrite(4, LOW);
 delay(100);
 // Choose your adventure! There are a few options when it comes
 // to initializing the MMA8452Q:
```

```
  //  1. Default init. This will set the accelerometer up
  //     with a full-scale range of +/-2g, and an output data rate
  //     of 800 Hz (fastest).
  accel.init();
  //  2. Initialize with FULL-SCALE setting. You can set the scale
  //     using either SCALE_2G, SCALE_4G, or SCALE_8G as the value.
  //     That'll set the scale to +/-2g, 4g, or 8g respectively.
  //accel.init(SCALE_4G); // Uncomment this out if you'd like
  //  3. Initialize with FULL-SCALE and DATA RATE setting. If you
  //     want control over how fast your accelerometer produces
  //     data use one of the following options in the second param:
  //     ODR_800, ODR_400, ODR_200, ODR_100, ODR_50, ODR_12,
  //     ODR_6, or ODR_1.
  //     Sets to 800, 400, 200, 100, 50, 12.5, 6.25, or 1.56 Hz.
  //accel.init(SCALE_8G, ODR_6);
}

// The loop function will simply check for new data from the
//  accelerometer and print it out if it's available.
void loop()
{
  // Use the accel.available() function to wait for new data
  //  from the accelerometer.
  if (accel.available())
  {
    // First, use accel.read() to read the new variables:
    accel.read();
       // accel.read() will update two sets of variables.
    // * int's x, y, and z will store the signed 12-bit values
    //   read out of the accelerometer.
    // * floats cx, cy, and cz will store the calculated
    //   acceleration from those 12-bit values. These variables
    //   are in units of g's.
    // Check the two function declarations below for an example
    // of how to use these variables.
    printCalculatedAccels();
    //printAccels(); // Uncomment to print digital readings
       // The library also supports the portrait/landscape detection
    //  of the MMA8452Q. Check out this function declaration for
    //  an example of how to use that.
    printOrientation();
      Serial.println(); // Print new line every time.
    if (accel.z < -light1)
    {
     digitalWrite(6, HIGH);
     digitalWrite(5, LOW);
     digitalWrite(4, LOW);
    }
    if (accel.z < -light2)
    {
     digitalWrite(5, HIGH);
     digitalWrite(4, LOW);
    }
    if (accel.z < -light3)
    {
     digitalWrite(4, HIGH);
    }
    if (accel.z >  -light1)
    {
     digitalWrite(6, LOW);
```

```
    digitalWrite(5, LOW);
    digitalWrite(4, LOW);
   }
  }
}
// The function demonstrates how to use the accel.x, accel.y and
//  accel.z variables.
// Before using these variables you must call the accel.read()
//  function!
void printAccels()
{
  Serial.print(accel.x, 3);
  Serial.print("\t");
  Serial.print(accel.y, 3);
  Serial.print("\t");
  Serial.print(accel.z, 3);
  Serial.print("\t");
}
// This function demonstrates how to use the accel.cx, accel.cy,
//  and accel.cz variables.
// Before using these variables you must call the accel.read()
//  function!
void printCalculatedAccels()
{
  Serial.print(accel.cx, 3);
  Serial.print("\t");
  Serial.print(accel.cy, 3);
  Serial.print("\t");
  Serial.print(accel.cz, 3);
  Serial.print("\t");
}
// This function demonstrates how to use the accel.readPL()
// function, which reads the portrait/landscape status of the
// sensor.
void printOrientation()
{
  // accel.readPL() will return a byte containing information
  // about the orientation of the sensor. It will be either
  // PORTRAIT_U, PORTRAIT_D, LANDSCAPE_R, LANDSCAPE_L, or
  // LOCKOUT.
  byte pl = accel.readPL();
  switch (pl)
  {
  case PORTRAIT_U:
    Serial.print("Portrait Up");
    break;
  case PORTRAIT_D:
    Serial.print("Portrait Down");
    break;
  case LANDSCAPE_R:
    Serial.print("Landscape Right");
    break;
  case LANDSCAPE_L:
    Serial.print("Landscape Left");
    break;
  case LOCKOUT:
    Serial.print("Flat");
    break;
  }
}
```

Electronic prototype pictures

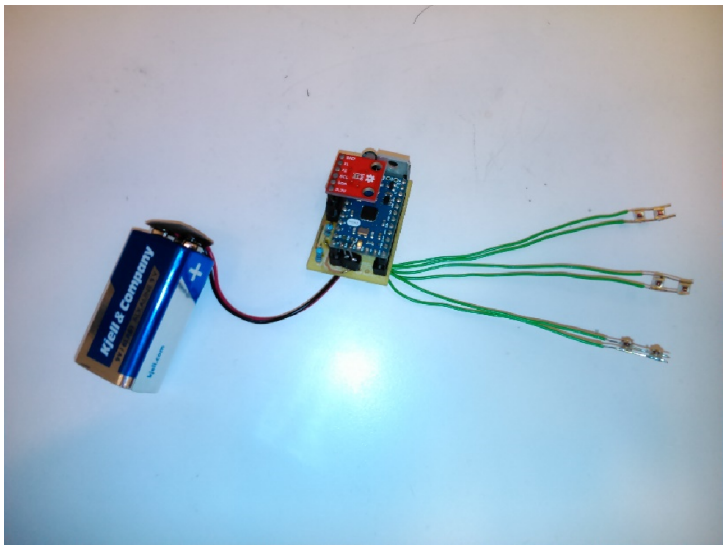


Figure 72 "Electronic Prototype 1"

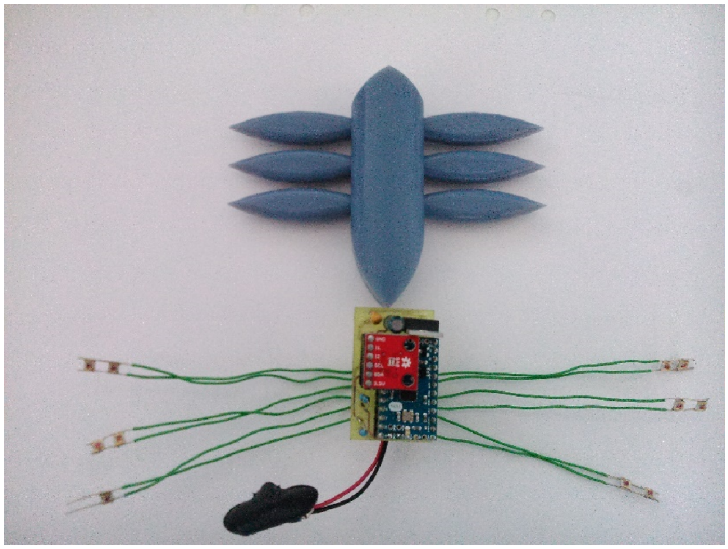


Figure 73 "Electronic Prototype 2"

BUSINESS REVIEW

At this point of the project where we have already described all the different parts of it and we have a main idea of how could we convert this amazing idea into a business we should review our future business activity.

We didn't mention it in our keys of success previously but we should remember to make a business project like this one work we must be focused all the time, don't let our guard down for a moment, even when we think we are out of risk because our product is already in the market and we are making figures.

Market changes all the time and we should anticipate to our problems to come, one of the ways to do it consist in the continuous checking of our position in the market.

Therefore and with the intention of prove and test our actual business I am going to analyse the activity using two different methods with the purpose of make the review as accurate as possible.

SWOT ANALYSIS

SWOT analysis is one of the most useful tools in terms of companies and projects reviews, it's one of the best decision maker tools to use at any point of your activity.

Basically consist in analyse all the Strengths, Weaknesses, Opportunities and Threats that we have nowadays in our project.
We separate this four parameters in internal and external origin and helpful and harmful to achieve the objective making the SWOT matrix:

Figure 74 "SWOT analysis"

I will start with external origins, mentioning first the helpful activities to achieving our objective and the harmful ones after.

OPPORTUNITIES:

- Lack of competitors in the market.

  What means the absent of other similar products which could steal us part of the market or put our business on risk.

- Good project aim (prevent and avoid motorbike accidents).

  Which it will help us to convince every single customer that we want to help the motorbike society.

- Raise every year of motorbike riders and motorbike sales.

  What means the raise of target customers every year.

THREATS:

- Completely new product to bring into the market.

  What could result in taking some risks like mistrust from customers.

- Easily apparition of copy competitors.

  Ones in the market we will be in jeopardy from big companies which will be able to copy our product and bring it to the market so quickly.

Ones defined the external origin points I will go for the internal ones:

STRENGTHS:

- Illusion and hard work.

  As every start-up or new firm we have the illusion to start doing business, and this runs in our advantage.

- Good background information.

  We have time to make the needed researches to have as much control as possible ones that we will bring the product to the market.

- Certainty of the opportunity business and the developing of this one.

  We trust our product and that is why we are doing this.

- Lead knowledge.

  We know that we are pioneers so we don't have to beat any other previous product which customer will compare with.

WEAKNESSES:

- No previous activity in this sector.

  I mentioned something similar in our threats but now has an internal meaning, we don't have any experience in motorbikes sector or in safety sectors so we will have to learn during the activity.

- No brand name.

  Obviously we don't have any recognition from customers because of the non-existent previous activity and that runs against us.

- Lack of contacts and relationships.

  We don't have any agent company contact or any manufacture or material supplier previous relationship which would be really helpful.

Knowing now all our factors we should analyse them and try to reduce the impact of the harmful ones and try to maximize the impact of the helpful ones.

I will sum up my conclusion and solutions point by point:

OPPORTUNITIES

We should maintain as much time as possible our product details in secret until we bring it to the market to keep the lack of competitors.
We have as well to let as many people as possible about our "good aim project" to make sure that ones in the market our future customers already know at least something about us.

THREATS

To work against these factors we should make a really high inversion in Marketing directed to every single person who has a motorbike or even more important, every single person who knows people that ride a motorbike and is worried about his safety.

STRENGTHS

We should keep that illusion motivating all the employees and people in the project making sure that they feel part of the team and keeping telling them that we all together can make this world safer and this business profitable.

WEAKNESSES

Difficult factors to dodge but we have to try to reduce them trying to control every single relationship that we make and avoiding beginner mistakes like communication misunderstandings etc.

FIVE FORCES OF PORTER

The next study which I am going to use to test our business is called **five forces of Porter** and consist in a framework to analyse level of competition within an industry and business strategy development.

Basically it analyse five different key forces, **three from 'horizontal' competition** as "*the threat of substitute products or services*", "*the threat of established rivals*" and "*the threat of new entrants*"; and **two forces from 'vertical' competition** as "*the bargaining power of suppliers*" and the "*bargaining power of customers*" resulting some matrix like the next one:

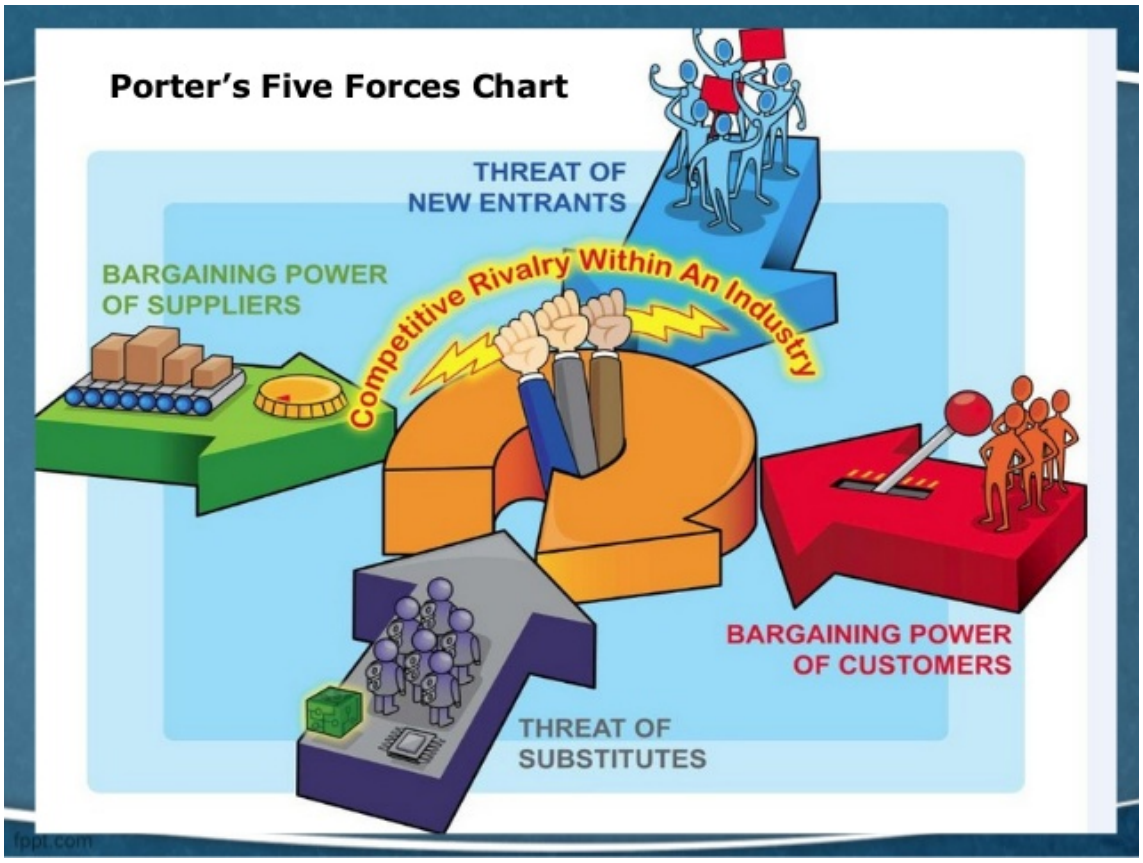


Figure 75 "Porter's Five Forces"

I will start analysing the horizontal aspects:

THREAT OF NEW ENTRANTS:

This force analyse the ease of entry for new participants in the marketplace.

We don't have any brand identity yet which means that we don't have any consumers yet, our sector don't require big inversion to start and we don't have any barrier to stop the competence coming apart of our own effort to obtain customers and keep them far from the future competence.

All of this means that the door to enter is quite big so we will need to be careful in the future and stay aware of this threat.

THREAT OF ESTABLISHED RIVALS:

Means obviously the evaluation of the number and activity of our company's rivals.

Nonetheless and as we already know, we don't have any direct competitor nowadays, therefore we close this force immediately.

THREAT OF SUBSTITUTES:

Basically consist in the possibility of new goods or services coming onto the market and eroding sales of our established product.

We have to differentiate two factors of what could happen ones that we have our product in the market in terms of product substitutes:

- One option could be the entrance in the marketplace of a similar product with better characteristics and well developed. This product will come up some time after us in the market.
  Obviously our future competitors will be able to take our product copy our technology and develop it more.

- Other option could be the entrance in the market of a simple copy of our product but really quickly after us.

To prevent this and be able to bear these possible substitutes we should first assure ourselves that it's not going to be that simple to copy our product and with this I don't mean to make impossible to copy it because that would be really expensive, I mean that we should stay sure that if someone come up with a copy of our product, that device is going to be much worst that ours.

Another prevent factor will be the continue development of the product ones in the market so we will be able to beat our future competition that want to improve our project to bring it to the market. My personal proposal will be to make changes in the product bringing up to the market different improved versions with the time.

Ones that we have talked about the horizontal forces I will develop and analyse in our case the vertical forces:

BARGAINING POWER OF THE INDUSTRY SUPPLIERS:

Like the proper name describe, consist in the fact that depending of the amount of supply material or supplier companies and clearly the competition that make purchases to them the costs could change.

Directly I think that our case has nothing to aware in terms of suppliers power due to we don't depend of a single supplier in any of our materials. This is because we manufacture our device with materials that a lot of suppliers control.
Actually we will be able to take some advantages in terms of supplier competition due to our electronic material suppliers are always in price war and continue developing them and bringing new improved versions to the market.

BARGAINING POWER OF THE CUSTOMERS:

Basically means that if our customers have a strong bargaining position, it will drive down prices for the finished good and erode then our profitability.

The first point to think about in terms of customer power is the volume of them, how many possible customer we will have?
If our target consumers is really small it will means that they will have a lot of power due to us (like a company) won't have another option than sell our product to them, nevertheless if we conduct our business to a big target group we won't have problems with that.

In our case, our target group in my opinion is big enough to don't be really worried about the empowerment in customers.

As a final conclusion of this five forces of porter I could say that it have been useful to define our weaknesses in this near future and to get some more knowledge of how to prevent our failure in the market.

I have used two of the most famous strategy analysis in the world however we could choose different ones because the results will be quite similar.
As an advise to the forthcoming I will say that we should repeat these studies more than one time per year in the future and even more thoroughness due to we will have real competitors and real problems to strategically fix.

INTERNATIONALISATION PROCESS

Some people could think that it is too early to think about expanding our company when is no even in the market yet, however I know from experience that perhaps we don't need to get in deeply but we should start thinking in what we are going to do in the next step ones we are in the market.

In recent years the world is becoming more globalised, therefore the multinationals are growing and the competitors are getting stronger. As a result the ability of entering into new markets is getting increasingly difficult, nevertheless, after conducting thorough market research as we know we have no direct competitors which could penetrate in our market niche. However, there are some factors that can affect us and hinder our internalisation process. These factors could be the psychic distance between the countries and also on the knowledge that is needed to be successful. Thus, the best option to sell our product abroad is by using people (agent, subsidiaries, franchise etc.) from the host market, in order to do not fail and try to take advantage of the knowledge of this people.
I would like to introduce you first the meanings of psychic distance to after that be able to explain what my plans are for our internationalisation process model in this case.

The psychic distance:

The psychic distance postulate sustain that firms start their process of internationalisation in closer markets due to the differences in language, culture and business practices (Arenius, 2005).

Research has suggested that entering to closer countries reduces the level of uncertainty of the firms and are easier for the companies to enter (O'Grady & W.Lane, 1996).

On the other hand, they claimed that when a company enter to a closer market forget some important facts because they are not prepared for the differences (O'Grady & W.Lane, 1996).

I am going to assume that we are planning to have our manufacture process in Scandinavia (concretely in Sweden) near our head offices. Through my researches I have found the two best places to start our internationalisation ones that we have our product in the market.
I decided to start the process in the United Kingdom and Spain. The main reason to choose these countries obviously is the huge market of motorbikes that travel around every single day in there (270.000 in Sweden, 1.38 million in UK and 2.8 million in Spain), nevertheless they are not the countries with more motorbikes travelling in Europe, so, why I have chosen them then? Well, in between a lot of reasons I specifically have chosen these two countries due to the connection percentage between number of motorbikes per person, number of accidents involving a motorbike and tendency to increase of motorbike sales market in the past years.

We already know before entering these countries about the problems that we could come across due to the psychic distance. For example, the culture, language and currency will be completely different between the three countries (counting with Sweden). Furthermore, thanks to my Spanish origin, I know that entering in Spain is not going to be a problem in terms of psychic distance due to my knowledge about the culture and the way to do business in there. Nonetheless, our business plan is going to be quite similar to the begin one, we will contact to our customers through agencies that will help us with their knowledge about the market. It's all about how many risk do we want to assume in our beginning and the answer of this question should be, as little as possible.
Perhaps I know perfectly the market in my home country and obviously because of that we will be more comfortable making relationships in there, but it would be a huge mistake to assume that only for that reason we should assume more risks than needed. Personally I have some experience in business in the United Kingdom as well due to I have been working there for almost one year. One of the advantages to keep in mind in terms of the UK is the currency, considering the change the product is going to be much cheaper for them.

I have been talking about my business experience however I have to remark that the most useful aspect that I can use from my living periods in these two countries is the customer knowledge. I am totally convinced that British and Spanish people will buy our product if we make the right decisions.

Conclusion:

To sum up, I have come to the conclusion that going abroad via agents is the best option that we have. To be honest I think that it is the only option that we have to enter into this market due to the fact that we do not have enough purchasing power to get into a new market and make a huge impact, however I will try to do it with the resources that we have.

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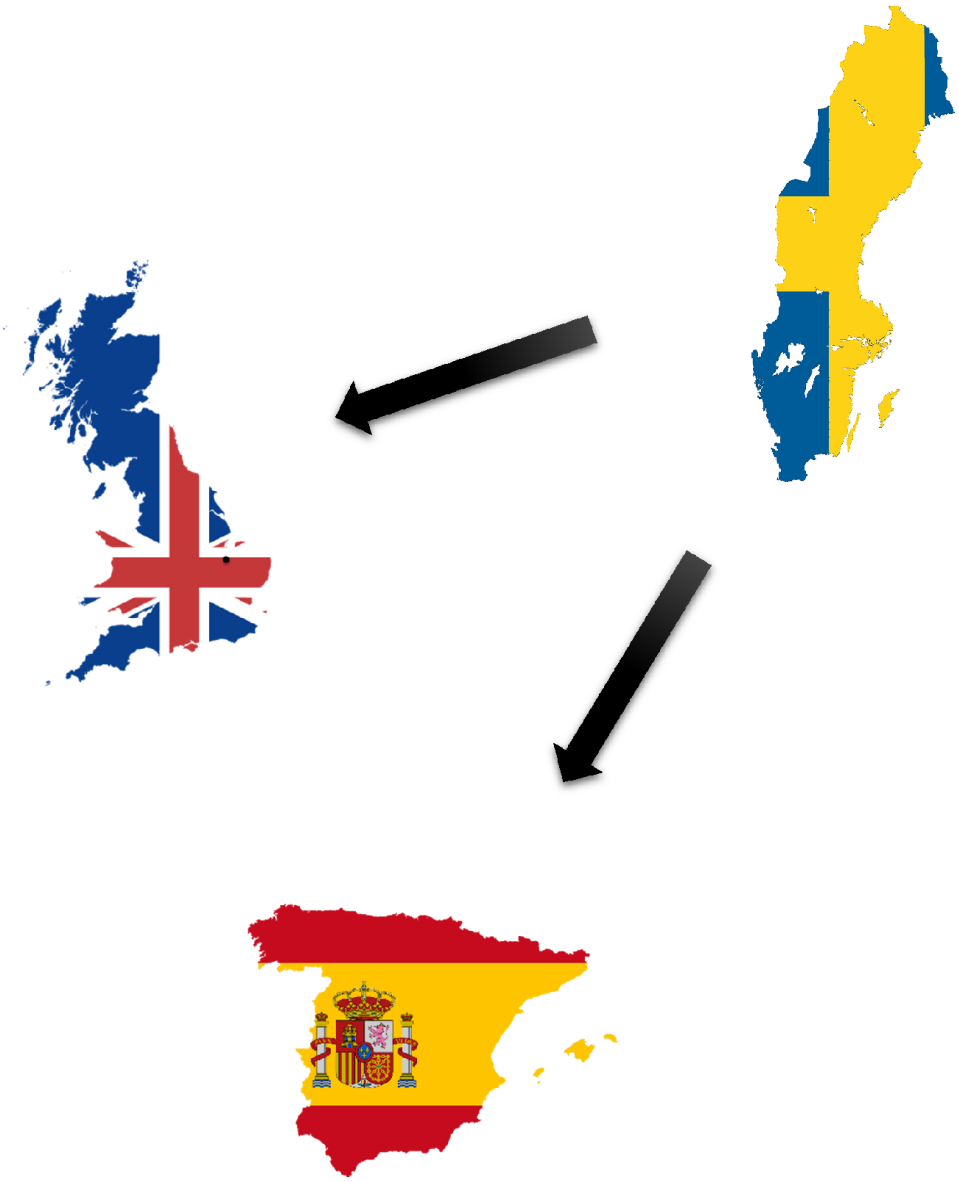
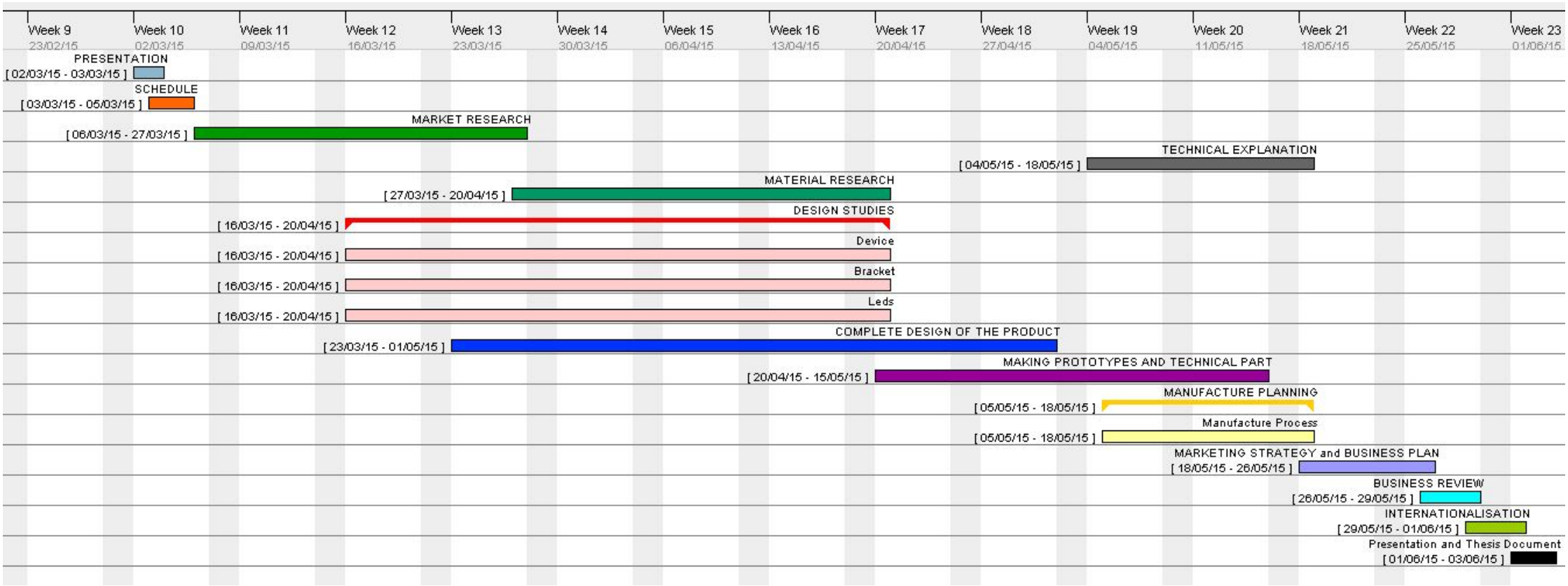


Figure 76 "Internationalisation Process"

REAL GANTT DIAGRAM FOLLOWED



CONCLUSION

Developing this thesis I have had the opportunity to reflect and apply some of my knowledge learned in these years of hard study but even more important I have had the occasion to obtain a lot of new knowledge.
I want to say that I definitely would have liked to have more time to continue developing this thesis-work which I am really involved in for a simple reason, I see this product like something needed in the motorbikes' world. Nevertheless I am quite proud and happy with the final results. We have converted a simple idea not really contemplate as a future business to a real product with a real business plan almost ready to bring it to the market and with a lot of possibilities of success.
I am happy as well with the design part of the work because as we know it was not my most developed field of work in my degree specialization, consequently I have had to make some researches and get some more knowledge in terms of 3D design.
Perhaps is not as important as the content and the knowledge used however I am proud about the fact of been able to develop an entire bachelor thesis in English due to is not my mother language and that was a challenge for me.

From now, *DELTA AB* is going to manage the project developing it until finally have the product ready to the market.
My personal recommendations to their further work are well-defined.
First, to test the product in a real situation with different kinds of motorbikes and riders, applying the force changes afterwards to the programming code to adjust the reaction of the LEDs as much as possible making it accurate.
Second, make some more technical researches to be able to reduce the manufacture price and the size of the electronic part as much as possible. This will let us make the final product cheaper, thinner and lighter as the market need, always maintaining the quality expected for the future customers.
Third, ones we have the final "brain" developed I would make the convenient changes in the design, making it settle to the new electronic part.
Forth, with the product finished knowing now everything in terms of manufacture prices and other additional costs I would look for finance to start the business showing the final product working and testing it on live.
Fifth and last, if they are lucky managing the right movements, making the right contacts and finally getting some financial support, I would meet the entire directive of the company and I would develop a thorough business starting plan.
After that, it will be time of join the business adventure of our "dragonflight".

I would like to finish this thesis coming back to the beginning of it, I wrote that my main personal goal was to save lives, we didn't make any impact in the society working in this product design, development and viability analysis however I really feel that I made the first step to be able to achieve my objective one day.

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