



# KOI

**BACHELOR THESIS 2021  
BY ELIAS COX**

**KOI**

By Elias Cox

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Main field of study Industrial Design  
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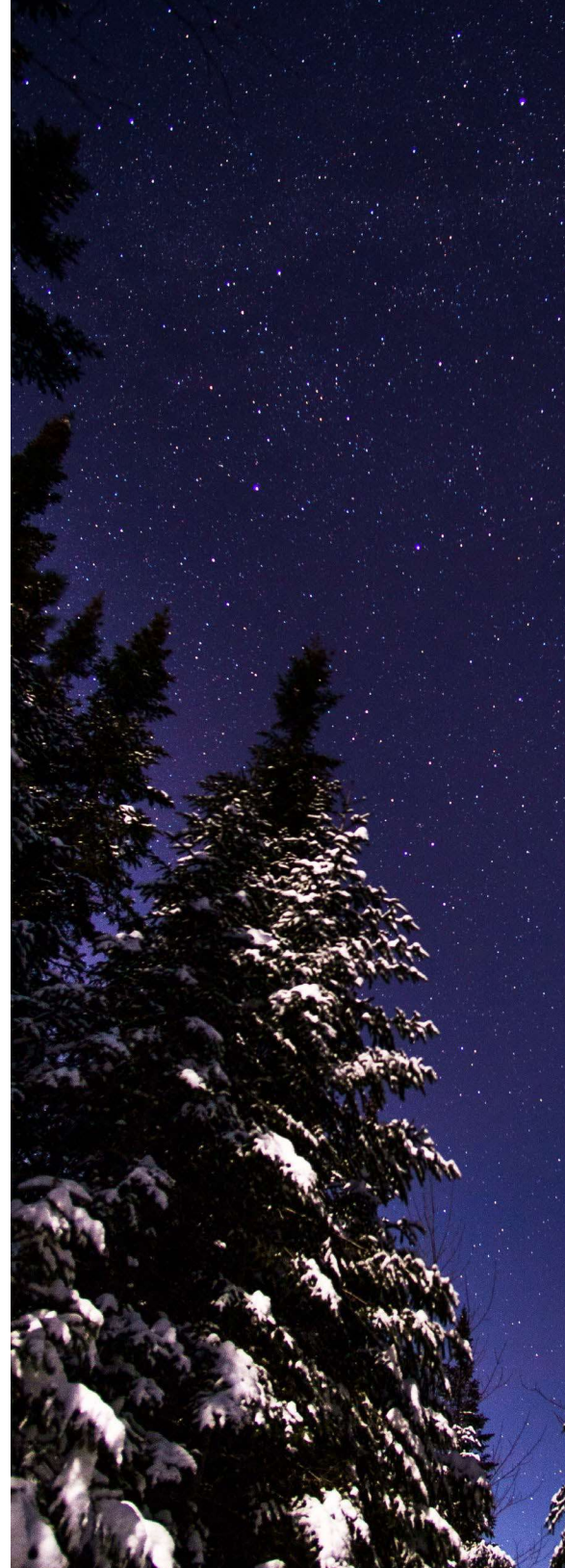
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## ABSTRACT

In the cold and dark countries of Scandinavia, light is a precious thing. Furthermore in recent years cycling has become an increasingly popular means of transportation in Scandinavia. The common use of bikes in these dark landscapes results in a high demand on bike lights.

An issue is that people have their bike lights stolen.

Therefore “be seen” bike lights, that are meant to be attached and detached from the bike each use, is a good solution. However, many of them provide very little light and are powered by disposable batteries, making them unsafe and unsustainable.



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**BACKGROUND**

# BRIEF

Design a pair of pocket sized “be seen” bike lights, meant to be attached and detached from each use. They should be sustainable, specifically this should be achieved through the right choice of electronic components, materials and production methods. Furthermore they should provide an intensive light, specifically a minimum of 50 lumens for the front light and 30 lumens for the rear light. Lastly, they should be practical and easy to use.

# TARGET GROUP

Empathetic Scandinavian middle-aged person who cares about sustainability as well as safety, and cycles on a daily basis, as a means of transport.



# INSPIRATION

Bookman is a Swedish company that makes lights for urban visibility, including reflectors, wearable lights and bike lights. I was inspired by the high level of quality and durability of their products, as well as their focus on Scandi-minimalistic aesthetics.



The fact that Bookman provides quality- and durable products, is one of the reasons why their products are driven by rechargeable batteries, which allow for a long life span. Even Bookman's tiny lights on their bikes, which can be seen at night, provide 50 lumens of light. This is the minimum requirement of light intensity for a cyclist to be seen in the city, according to the British Cycling Cycles UK. Rechargeable batteries are a much more sustainable solution than disposable ones.



Another factor that demonstrates their concern for sustainability is the packaging of their products, which consists primarily of recyclable paper material.



Their large number of color options on their products show that they put a lot of energy into aesthetics.

Of course all this comes with a price. The lights shown above cost around 75 euros, which is most 20 times as much as an inexpensive bike light on the market. I believe that this is the maximum amount of money people are willing to pay for a set of “be seen” lights.

# FUNCTION ANALYSIS

function		class	comments
emit	light	MF	a minimum of 50 lumens from front from rear light
be	sustainable	N	have low life-cycle assessment print of a product from production
minimize	theft	N	
withstand	weather conditions	N	rough weather conditions (such as high temperatures)
fit	handlebars	N	
fit	seatposts	N	
easy	activation	W	
quick	mounting	W	
practical	charging	W	
fit	in pocket	W	
cost	<750 SEK	W	
be	aesthetic	W	be visually intriguing

**RESEARCH**

# SCANDINAVIAN DESIGN

Scandinavian design (referring to industrial design) is very popular internationally. IKEA, Volvo and Electrolux are some of the most successful Scandinavian industrial design companies that are hugely successful worldwide. However popular the concept of Scandinavian design is abroad, it's even more popular within Scandinavia. That's why businesses like the optics company Carl Zeiss Jena market their products towards Scandinavian people and use the term "Skandinavisk design" (Scandinavian design) in order to market their products towards Scandinavian people. We're proud of our rich design heritage. However, many Scandinavians would probably struggle to pinpoint what Scandinavian design is really about. So what is it really about?

In simple terms it's about two things; minimalism and functionality.

## Minimalism

Minimalism is noticeable in Scandinavian design in the form of simple lines and lack of excess. It emphasizes light, bright and spacious rooms. This minimalism is sometimes referred to as "Scandi minimalism".



*The "Thermal Carafe" for Stelton by Danish designer Erik Magnussen, is an example of a very minimalist design piece. It's basically a perfect cylinder with a handle. It consists of only the parts necessary in order for it to perform its function.*

## Functionality

The emphasis on functionality is obvious through clever ways to convey functions.



*The "PH Lamp" by Danish architect Poul Henningsen is the most famous Scandinavian design piece. It's an example of a piece created with a focus on functionality. The shades are created to optimize the light output of the lamp.*

## Playfulness

Although I previously claimed that there are only two ingredients in Scandinavian design, I'd like to add a third, distinguished like the two other ones, but it's rather a personal analysis. In the book "Scandinavian Design" by Charlotte and Peter Fiell, they write; "The marriage of beautiful organic forms with everyday functionality is one of the primary strengths of Scandinavian design. The book covers Scandinavian design classics, and I agree that organic shapes, inspired by nature, is a recurring theme. I reckon that these organic shapes often allow for a playful expression. Furthermore I believe that this is not the case in Scandinavian design as it is today, but that it takes a different shape. Today I think this playfulness is usually expressed through simple geometric shapes and bright coloring. This aesthetic seems to be a modern spin on the design of the 1950s. However, it's difficult to tell whether this aesthetic is just a trend or if it's here to stay.



*This silver and teak tea service for A. Michelssen, by Søren Sass, possesses the organic shapes that are part of one of the primary strengths of Scandinavian design, according to Charlotte and Peter Fiell.*



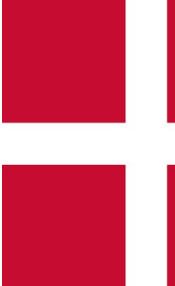
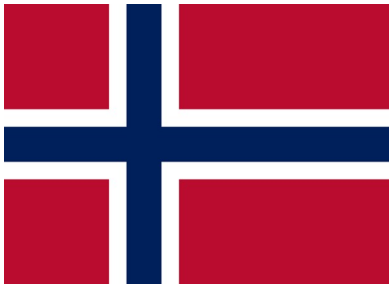
*The "Sowden Kettle" for HAY, by George Sowden, is a product that expresses playfulness through bright color.*

# BIKE LIGHT LEGISLATION

As a starting point, I looked into the laws surrounding bike lights in the Scandinavian countries (Sweden, Denmark, Norway) in order to make sure that the bike lights I design would in fact be legal to use in these places.

As a cyclist in any of these countries, you're bound by law to use a white or yellow front light pointing forward and a red light pointing backwards whenever the visibility is poor due to darkness or weather conditions. The lights must be attached to the bike, except for in Sweden, where it's also legal for the cyclist to wear the bike lights themselves. Regarding light intensity, the only requirement is that they can be seen from 300 meters. Lastly, blinking lights are accepted in Norway, but in others, they're not.

Due to little knowledge on the laws on the part of consumers and salesmen, they're regularly broken. Some people use smaller "be seen" lights that consist of only one 3mm LED don't fulfill the requirements on light intensity in these countries, and Swedish manufacturers sell blinking front lights, which are actually illegal in Sweden.



# LIGHT TECHNOLOGY



The front light should be more intense than the rear one, because the front light should help the cyclist see t

Many “be seen” bike lights, such as the ones shown above, provide very little light. The front light emits arou  
rear light provides even less. They pass as legal in all Scandinavian countries, providing that they can be se  
meters, but according to many hobby cyclists and other credible sources they emit too little light to be cons

The reason why many “be seen” bike lights provide such a weak light, is because they’re powered by dispo  
capable of generating more intense light. As I wanted my bike lights to provide intense light, (specifically a r  
from the front light, and 30 lumens from the rear light), it was clear to me that I needed to integrate a recharg  
big benefit of using a rechargeable battery, which I took into consideration, is that it has a much smaller env

# ELECTRONIC COMPONENTS

Through research and physical dissection of bike lights, I was able to pinpoint the necessary components for constructing a bike light.



## **led**

- a diode (component that only conducts in one direction) that emits light when electricity flows through it

## **heat sink**

- a passive heat exchanger that transfers the heat generated by an electronic or mechanical device to a fluid medium, such as air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature

## **button**

- activates switch  
- tailor-made for the product

## **switch**

- any device that can open or close a circuit  
- clear "ready to go component"

## **resistor**

- a passive two-terminal electrical component that implements electrical resistance as a circuit element

## **transistor**

- a transistor is a semiconductor device used to amplify or switch electronic signals and electrical power



# BODY AND MATERIALS

Through research and physical inspection of bike lights I pinned down possible materials to implement on my own design.



## **aluminum**

- corrosion resistant
- lightweight
- durable

## **stainless steel**

- corrosion resistant
- high tensile strength
- durable
- environmentally friendly (recyclable)
- easy formability and fabrication

## **natural rubber**

- high tensile strength
- high tear strength

## **silicone rubber**

- high tensile strength
- high tear strength
- elastic
- temperature resistant
- weather resistant
- UV-resistant

# HANDLE BARS AND SEAT POSTS

The diameter of the handlebars on commuter bikes can vary, but they're not below 25.4mm and very seldom thicker than 31.8mm. The large majority are closer to the lower number.



*Image taken in my courtyard demonstrating that a thinner diameter on handlebars is the standard of commuter bikes.*

As for the diameter of the seatpost, it usually ranges from 22 to 31.8mm, and the most common size is 27.2mm.



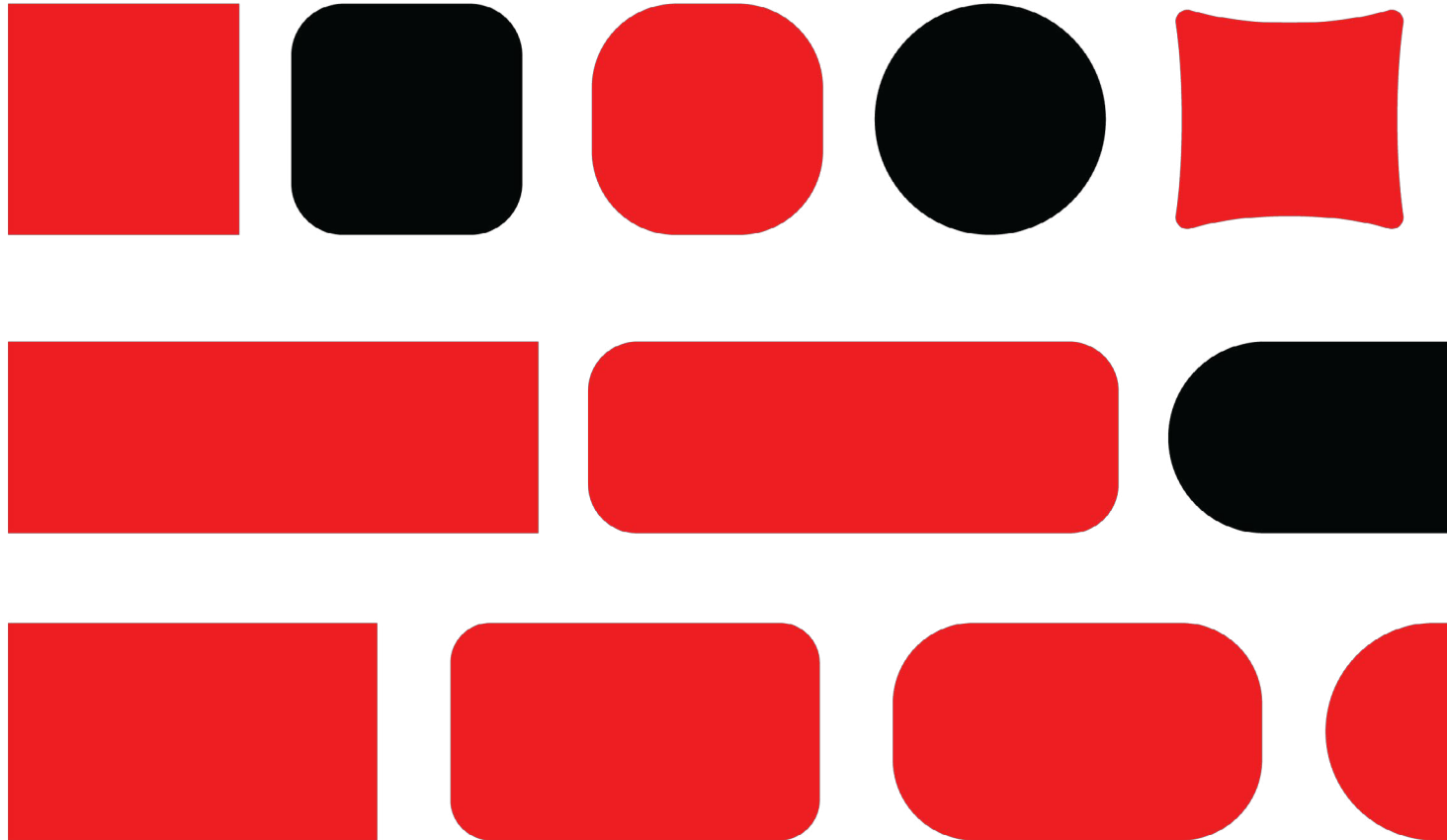
*Image taken in my courtyard demonstrating that a thinner diameter on seatposts is the standard of commuter bikes.*

I wanted to make sure that different sizes of handlebars and seatposts as possible.

# IDEATION

# INITIAL CONCEPTS

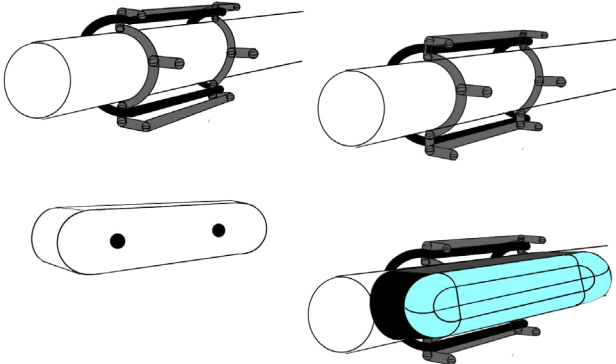
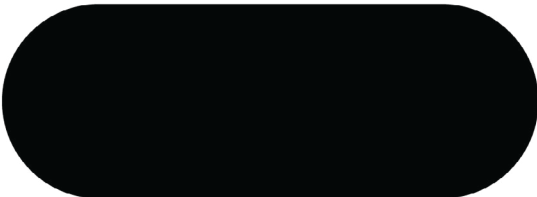
I initiated my ideation by generating some 2D-profiles in order to gain a sense of what kind of shape I wanted my bike lights to have.



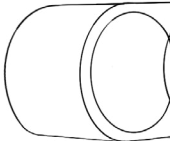
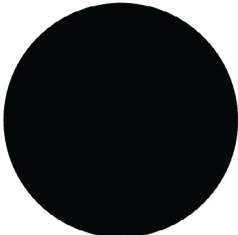
The profiles that are colored black are the ones that I chose to develop. Each one of these shapes is bulky, which in my opinion gives them a playful expression. This is an aesthetic I wanted to incorporate

Based on the 2D-profiles, I made simple sketches of three different concepts. With each one I explored a unique mounting method.

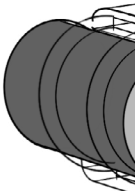
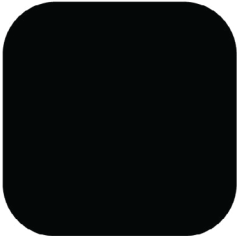
*concept 1*



*concept 2*

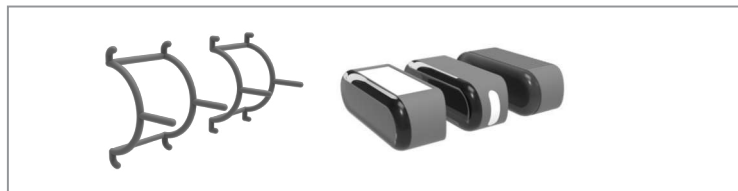
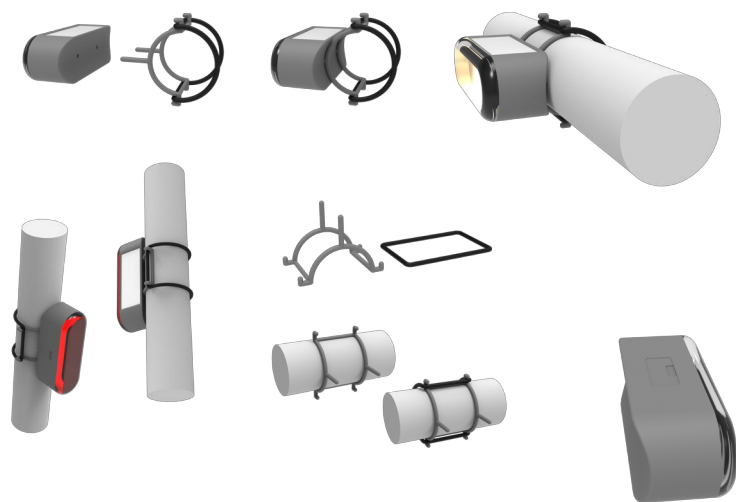


*concept 3*

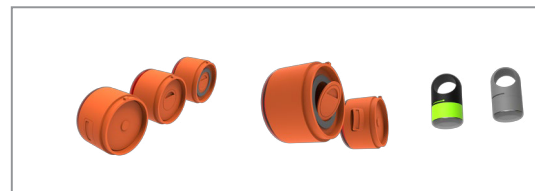
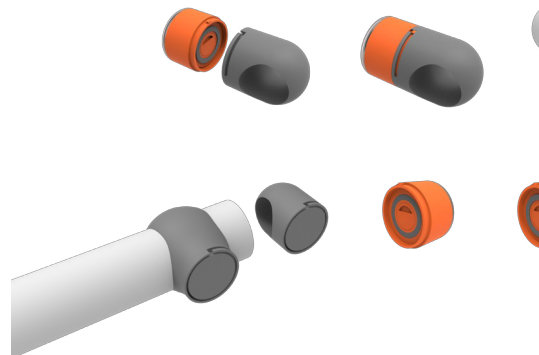


I translated my sketches into CAD models.

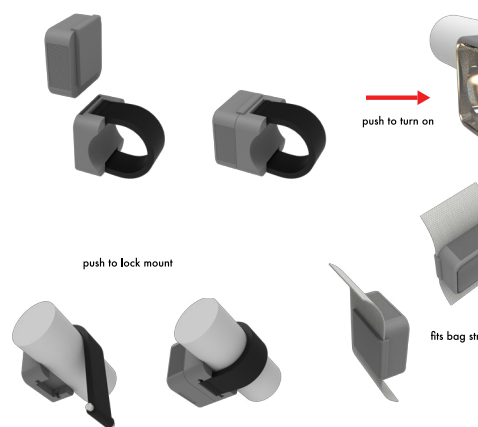
*concept 1*



*concept 2*



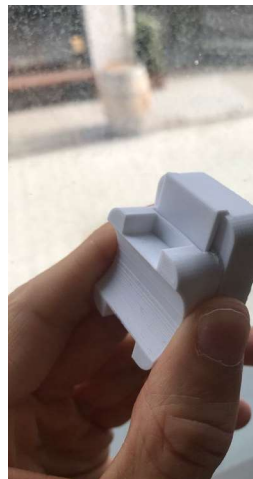
*concept 3*



# IN PRACTICE

I made mockups of each concept in order to evaluate the form and functions in a hands on way.

I was drawn particularly to the one that was nice to hold and handle, and that it had a multi-functional form. I thought that the lamp could be attached to many things than the mount itself. I liked the idea of clipping it on. Therefore I settled on concept 3 as the one to develop.

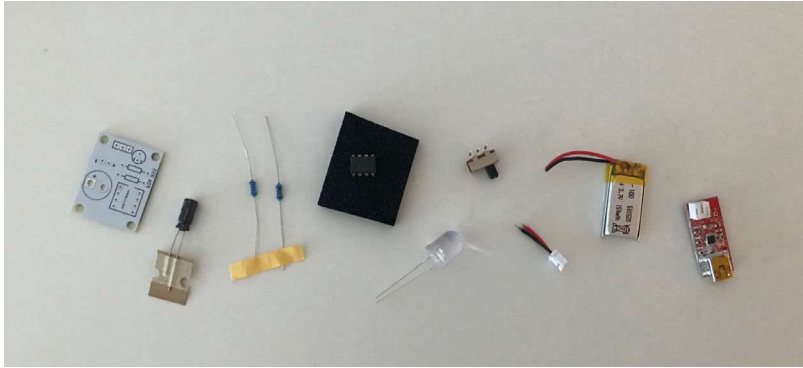


*concept 1*

*concept 2*

*concept 3*

# DESIGN CONSTRAINTS



I got my hands on the electronic parts that were necessary to create a circuit for a prototype.



Therefore, I integrated instead of a 10mm one. I was able to fit the elements into a smaller body. I wasn't able to shrink the circuit any more. So the proportions I had to work



When building my initial circuit, it was obvious to me that it would require a body that was too big to be practical to carry in one's pocket.

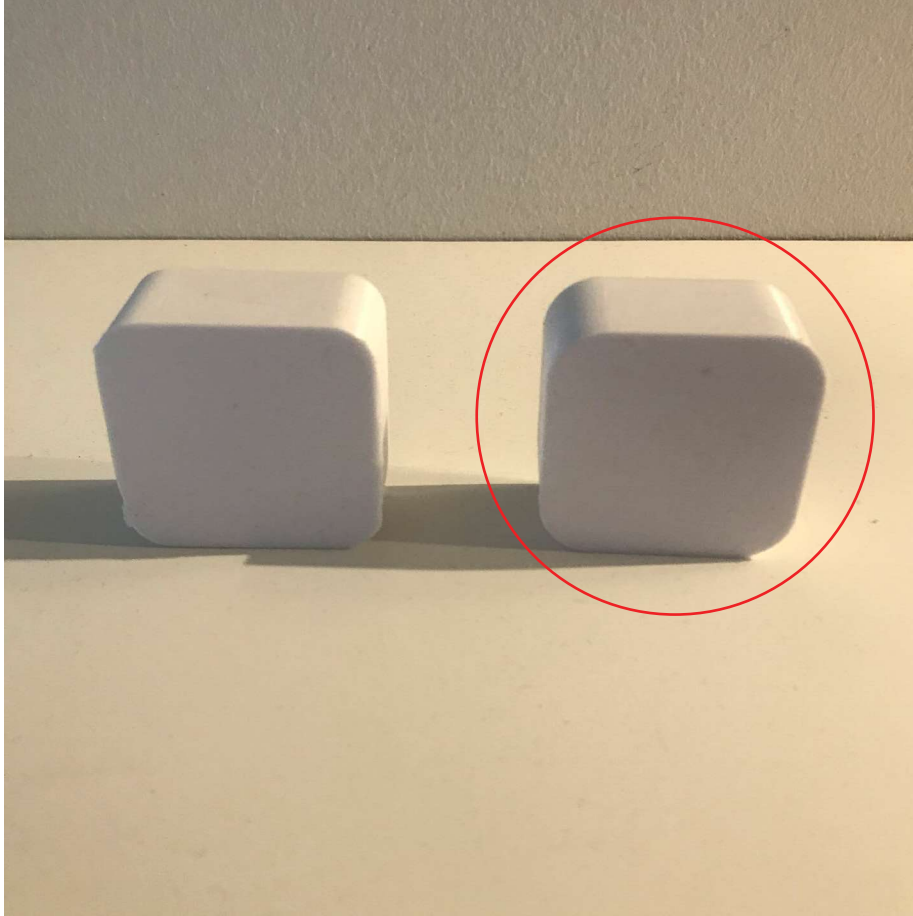


Furthermore, I knew where I needed to implement the power button.



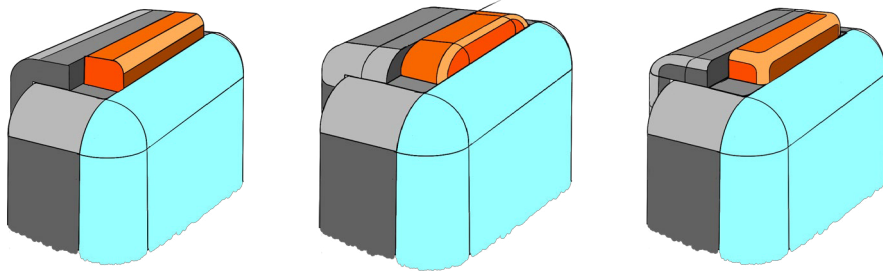
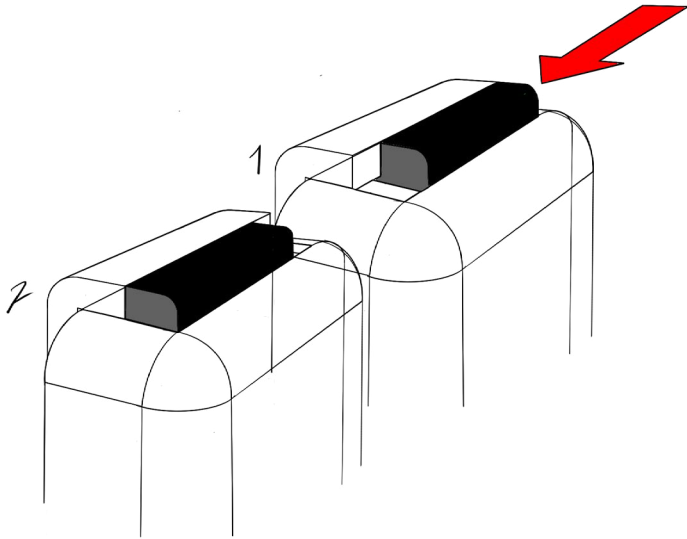
# FINAL FORM

I 3D-printed some mock-ups, which the electronics would fit in, to decide on the exact form that I wanted for my design.



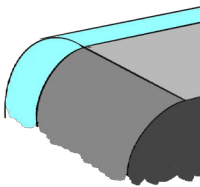
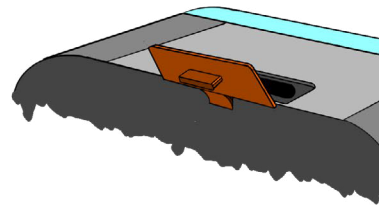
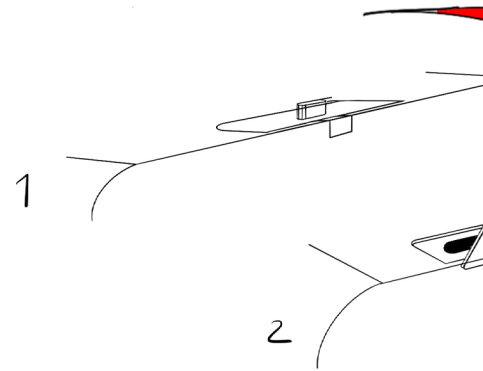
The shapes that are circled were the ones I decided on, based on aesthetics and

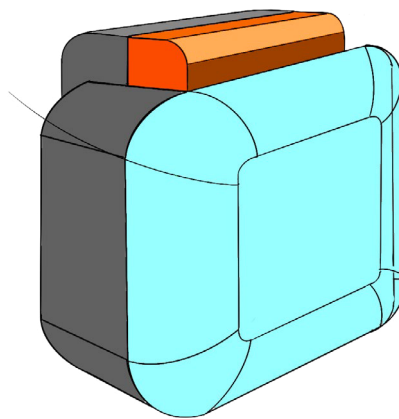
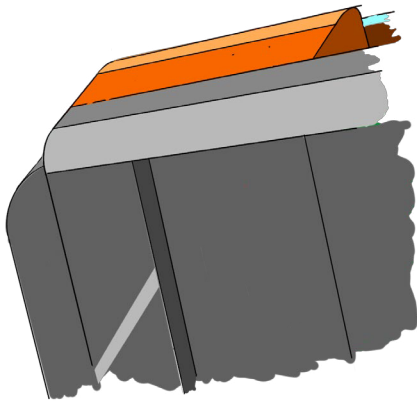
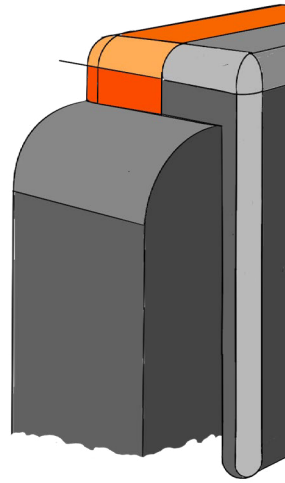
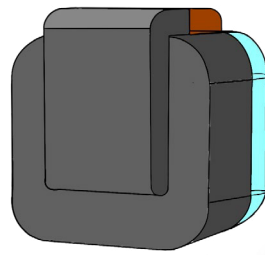
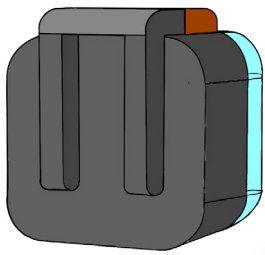
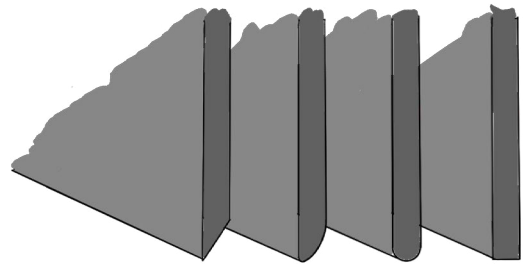
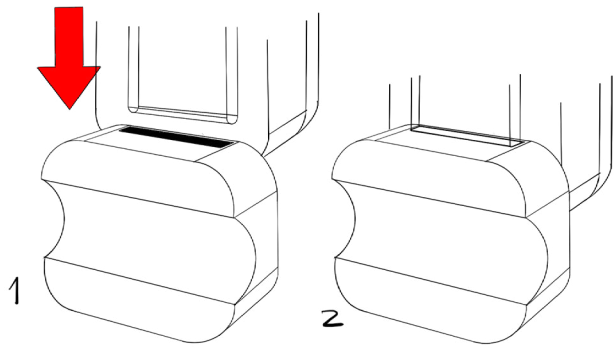
# DETAILS



As I was constrained by the circuit I had created, and wasn't able to integrate any other type of button than a slide button, I had to work with this.

I decided that the best way to protect the outlet was with a silicone rubber lid. The lid is made of a material which makes it easy and pleasant to use. The outlet is protected from dirt and rain.



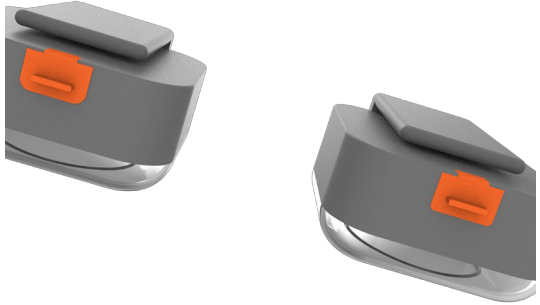
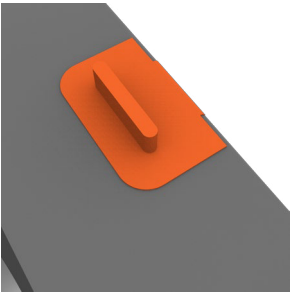
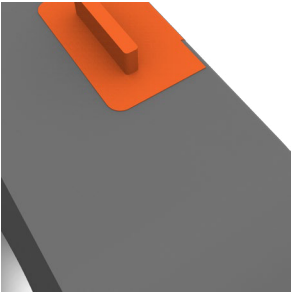


The shaping of the clip was o  
clip plays an integral role in u  
important that it conveyed th  
it performed this action well.

I implemented these details in CAD software as well, to get a more realistic result.



button



USB-C lid

# REFLECTOR

I 3D-printed a few reflectors and added aluminum foil to the surface, in order to evaluate the light



fig. 1



fig. 2



fig. 3

I could particularly tell a difference between fig. 3 and the previous ones, being that fig. 3 provided much more focused light beam, whereas the two other ones allowed for a larger distribution of light. When it comes to bike lights it's ideal for the light to be widely distributed, as people in traffic can come from many directions. I chose to settle on fig. 2 as it seemed to me that it would provide the most evenly spread

**FINAL CONCEPT**

# PROTOTYPE



Simply slide the button on top to turn the light on.



It's charged via USB-C.



Fasten the mount by simply pushing the pins of the strap into the small slots on the mount.



Then just slide the lamp into the main slot on the



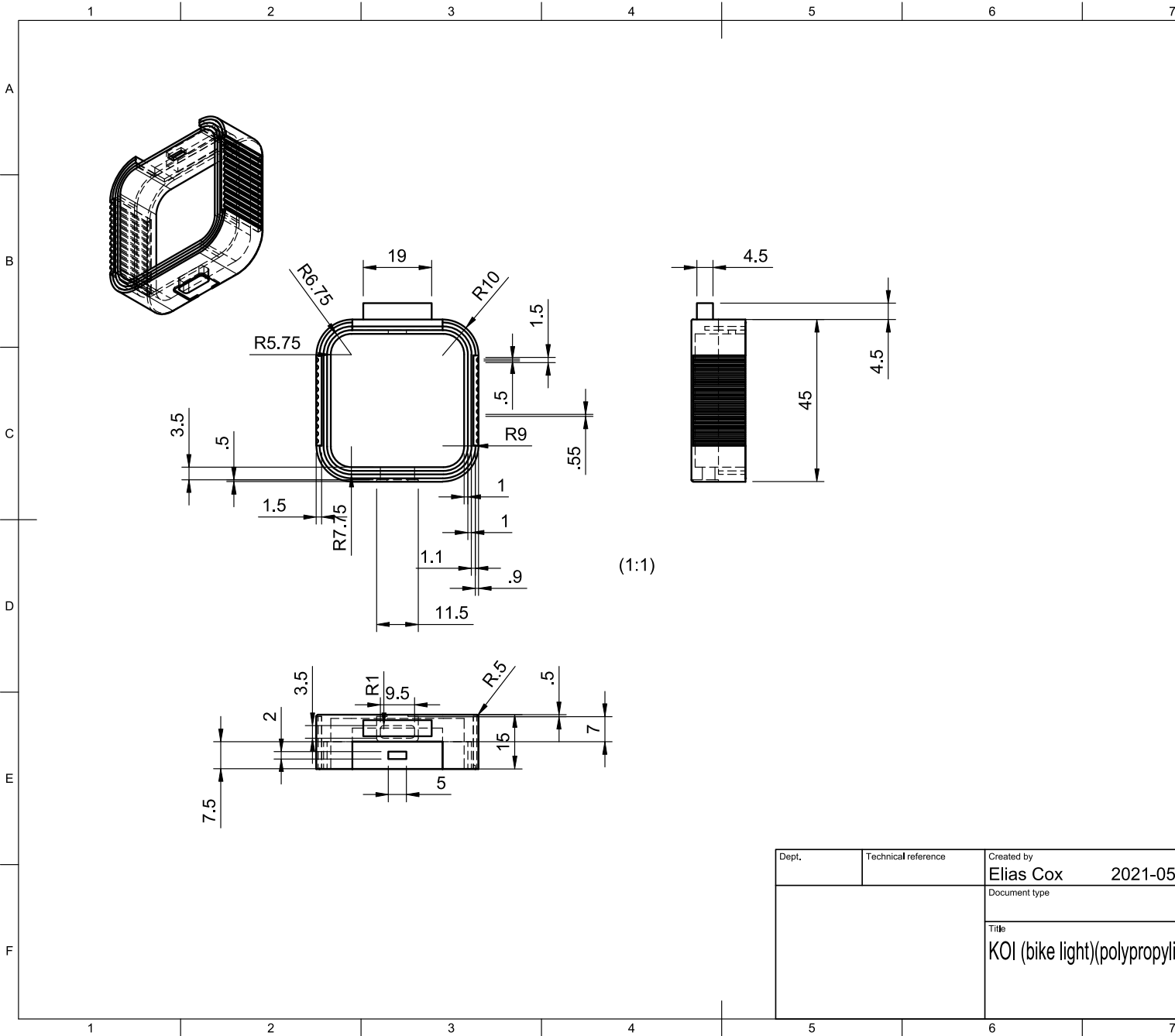


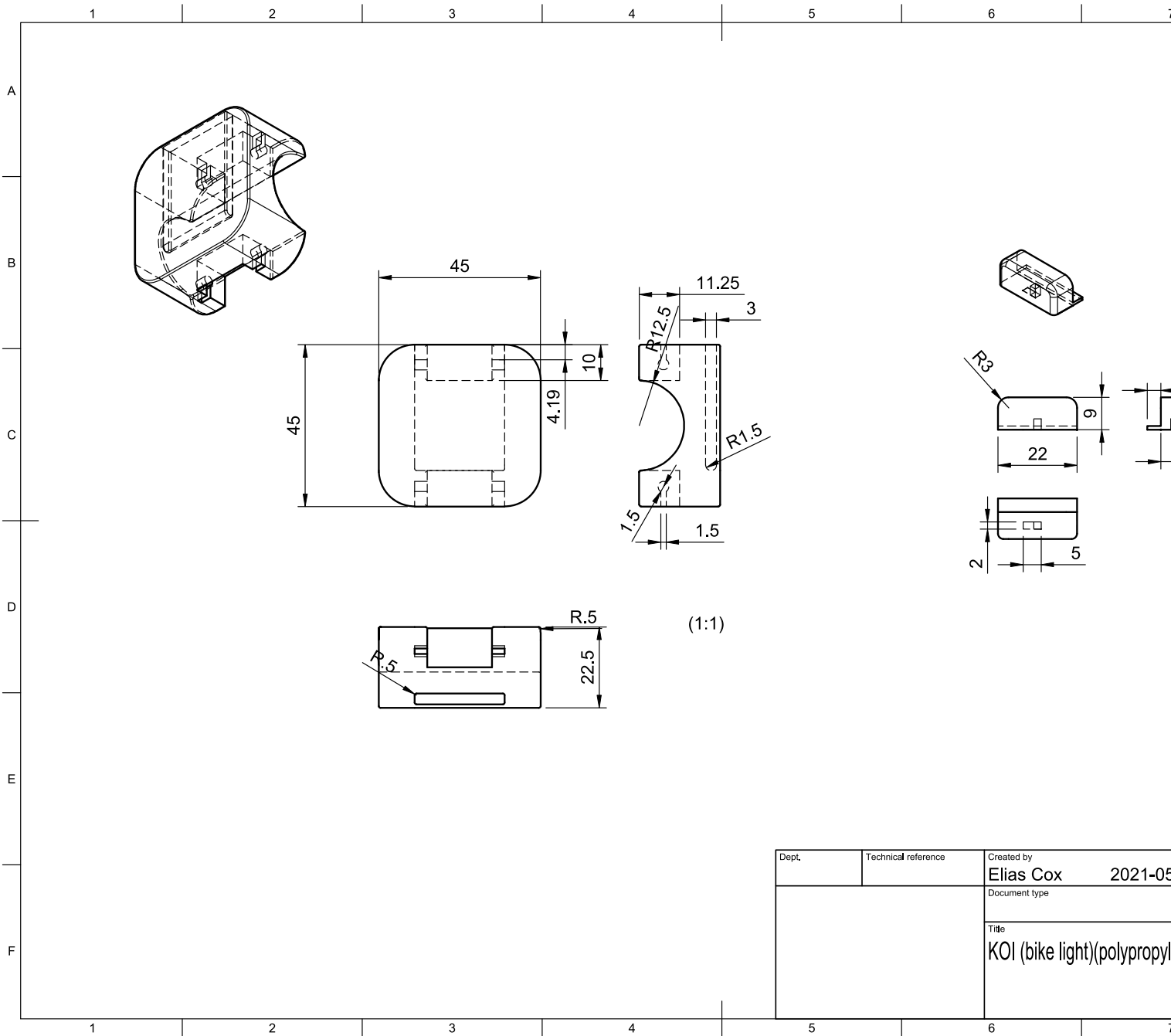
Attach it to the bike.

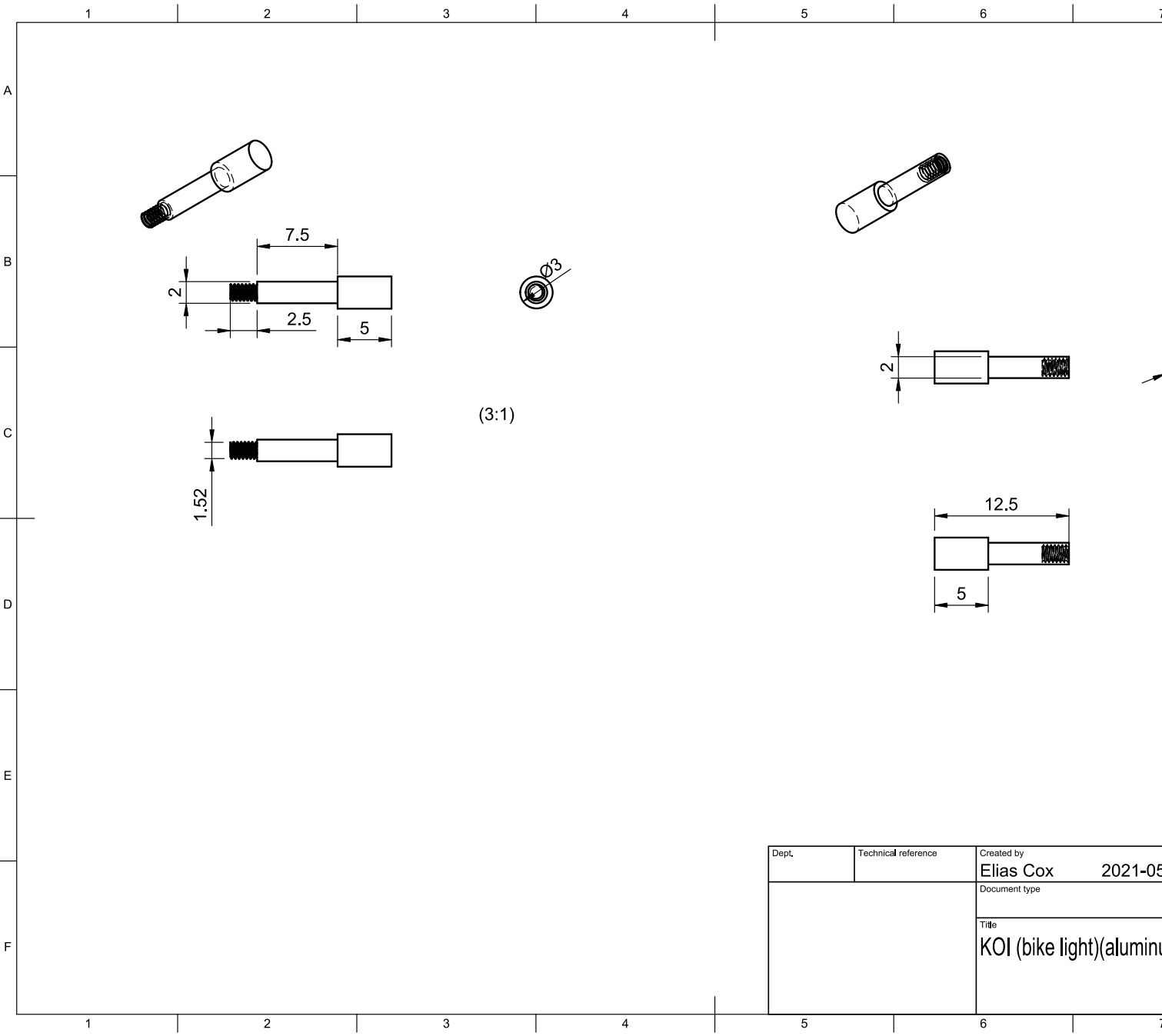


Or attach it to yourself.

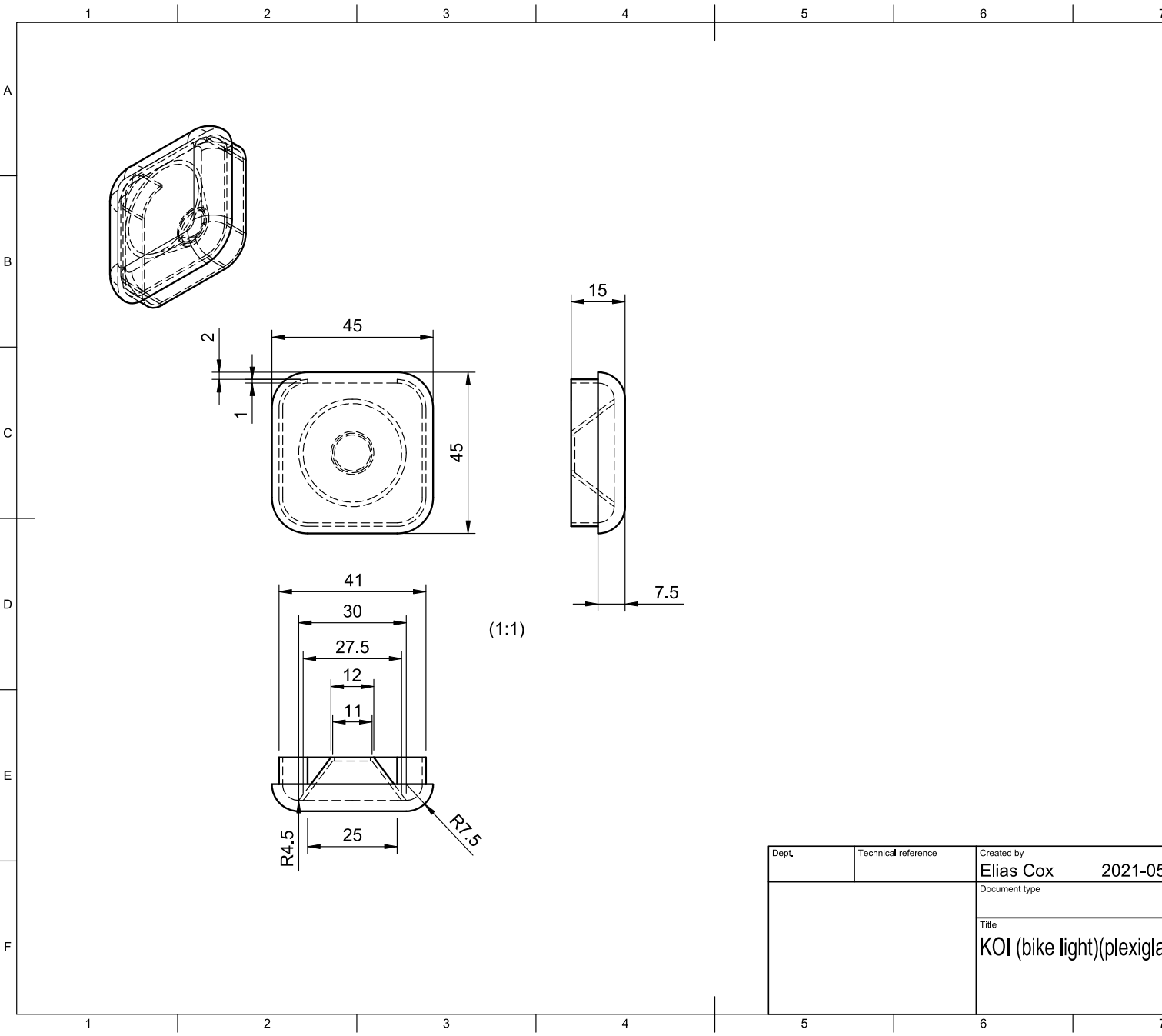
# TECHNICAL DRAWINGS

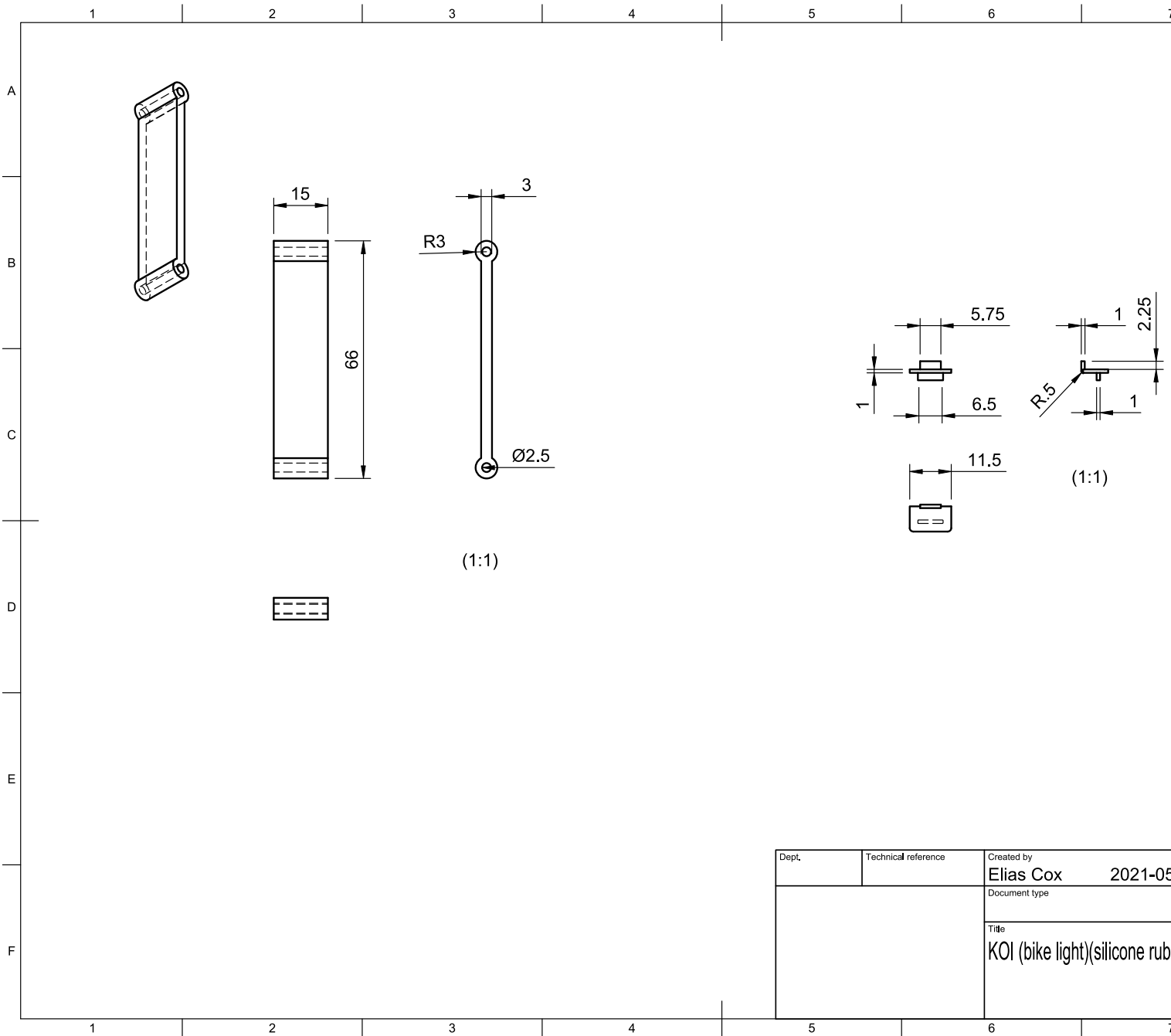






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		Title	KOI (bike light)(aluminu





Dept.	Technical reference	Created by Elias Cox	2021-05
		Document type	
		Title	KOI (bike light)(silicone rub

# EXPLODED VIEW

## strap

colored orange to suggest the function of pressing the button and the radii applied to the frame is meant to emphasize this further

## pins

fasten the strap to the mount



## mount body

mounts to the handle bars and seat post

## lamp body

contains all the electronic components and the textured surfaces imply how to hold the lamp in order to attach it to the mount while also allowing for a comfortable grip

## clip

attach the lamp to the mount or other (such as bag strap)

## button

the orange color suggests a function, and the form conveys how it should be pressed



## usb-c outlet lid

colored orange to suggest the function of opening the lid to access the charge outlet

## glass

constructed as an ideal light

# MATERIALS



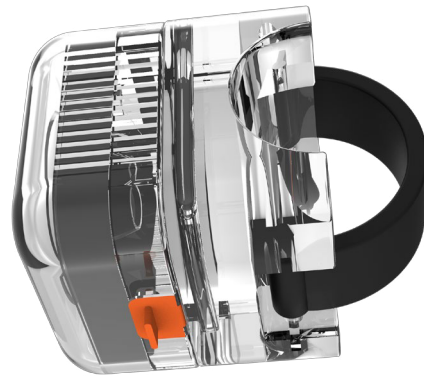
## polypropylene (pp)

The body of KOI should be semi rigid. It must be able to withstand some pressure without folding, since it's protecting the inner components, yet it should be flexible enough to adjust to different sized handlebars and seatposts.



## plexiglass

The cap needs to be far less fragile than glass.



## silicone rubber

The strap and orange parts are going to be pulled and pressed a lot, and a soft, flexible material suits this well.



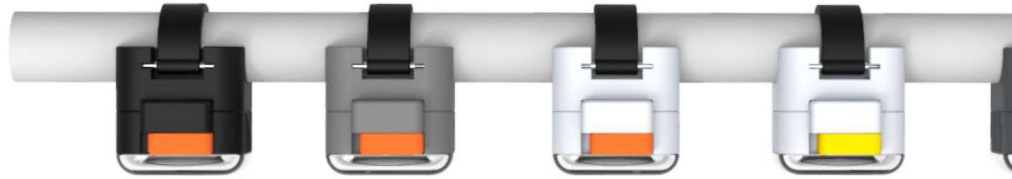
## aluminum

The pins... as they... sure wh... mount a... resistan...



# COLOR/FINISH

KOI comes in a couple of different color combinations. They all follow a similar color code; The button and USB-C lid are the same, as they both play a function in powering the device. Furthermore, they're a bright color in order to tell the user of their important role.



1.

2.

3.

4.



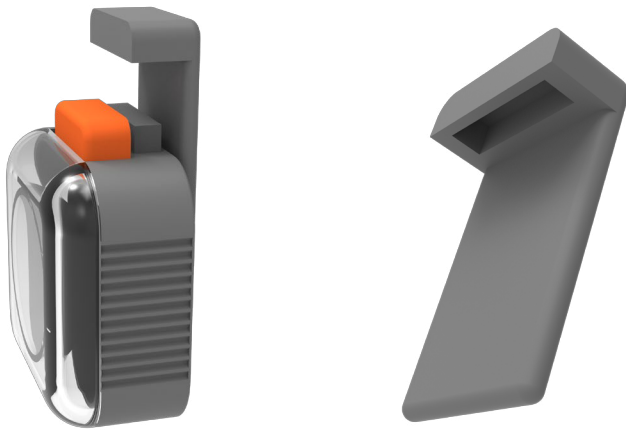
## color/finish specification

1. **body:** carbon black - matte, **button and usb-c lid:** bright orange - glossy, **strap:** carbon black - glossy
2. **body:** light grey - matte, **button and usb-c lid:** bright orange - glossy, **strap:** carbon black - glossy
3. **body:** snow white - matte, **button and usb-c lid:** bright orange - glossy, **strap:** carbon black - glossy
4. **body:** snow white - matte, **button and usb-c lid:** bright yellow - glossy, **strap:** carbon black - glossy
5. **body:** dark grey - matte, **button and usb-c lid:** bright yellow - glossy, **strap:** carbon black - glossy

# DESIGN FOR DISASSEMBLY

It consists of plastic and metal components, and on top of that, it contains electronic components.

Most important is that the electronics are disposed of correctly. For practical, but also safety reasons, the electronics should be disposed of while encased in the lamp body.

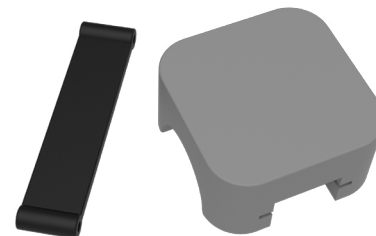


However, the clip can be pulled off the lamp body and disposed off separately as plastic waste

As for the mount, the pins can be removed and detached from the rubber in order to be disposed off as metal.



The rest of the mount consists entirely of plastic materials, and should therefore be disposed of as that, along with the clip.



# **BUSINESS PLAN**

# BUSINESS PLAN

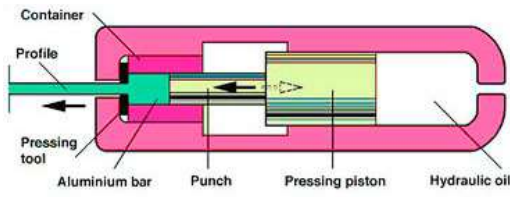
A pair of KOI should cost maximum 750 SEK. This is the price of a pair of Bookman's Curve Light, and I believe it is the highest amount that people are willing to pay for a pair of bike lights such as these. However, thanks to the simple design and small variation of materials in my product I believe that they can be manufactured and sold for much less. They can be sold in two different manners. They should be available to buy as a pair, but there should also be the option to buy them individually. This as the price for both the front- and rear light will most likely be above the price range of many customer's current bike lights. The addition of rechargeable battery and high intensity LED. Furthermore, many bikes come with only a rear light and a front light. It is logical to purchase only the front one. Other people may simply choose to purchase a high intensity lamp, a rear light and a less bright one for the rear as the front light is considered to be of highest importance in safety reasons.

It comes disassembled. This saves assembly costs. Furthermore, by assembling the object themselves, the user gets a better understanding of how it's constructed. This results in the user valuing the object more, and therefore treating it with more care. This can give the bike light a longer life time. Assembling the object also makes it easier and more natural for the user to disassemble it and dispose of the components and materials in a recyclable way once the product life time is over.

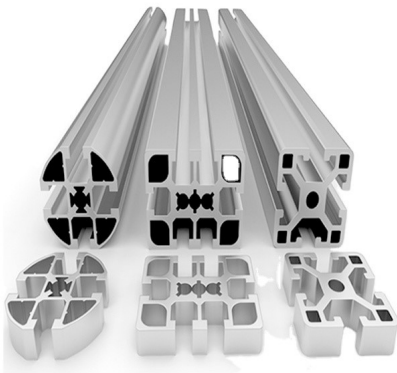
# PRODUCTION

## pins

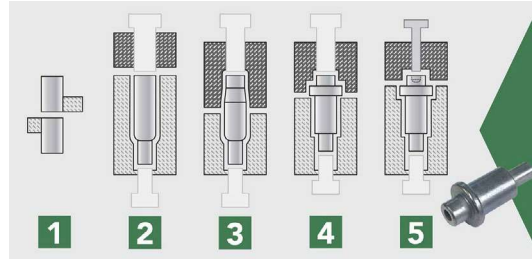
In order to achieve the cylindrical profile of the pins, they must initially be hot extruded. The cylindrical profile is then cut into pieces with the specified length.



Parts made through hot extrusion below.



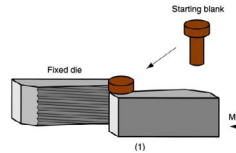
As the pins consist of one thicker and one thinner part, the pieces must then be cold headed.



Parts made through cold heading below.



Lastly, the thread of the pins together, must be made through thread rolling.

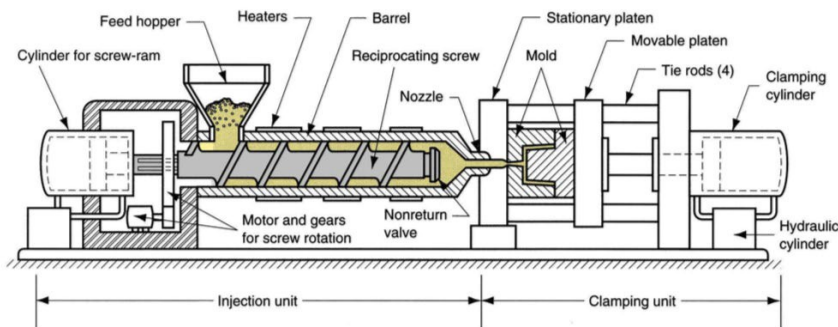


Parts made through thread rolling below.



# plastic parts of the device

As for the rest of bike light's structure, being the mount body, the lamp, the strap and the plexiglass, should be manufactured using plastic injection molding. It's a plastic shaping process which is suitable for smaller parts and can provide high precision. Given that my parts are small and the fact that I put a lot of emphasis on aesthetic shaping of my product, this production method seems ideal for this project. Furthermore, the method results in less plastic waste, which is in line with the values of sustainability in my project.



Parts made through plastic injection molding are shown below.



# EVALUATION

# EVALUATION

## process

This project has been very fun and rewarding. I've also learned many things.

For one, I've learned that I should make more general explorations with mockups before I go into detail. In the mistake of exploring each of my initial concepts too thoroughly, which is unnecessary since all except one will be discarded. I should have explored the overall shapes through mock-ups, and once I'd chosen one of the concepts I could have refined it more thoroughly using 3D-print, by implementing and evaluating details.

Furthermore I've been reminded about the value of making mockups. Not only for evaluating tactile attributes but also for visual ones. CAD-models seldom give a fair picture of how the model would look in real life. Radii, for example, usually look much better on a computer model than on a physical model.

Working with the technical components parallel to the shaping of the product is another lesson that I take with me. I often have to reshape the entire product once I got my hands on the electronic components.

## research

The research on laws surrounding bike lighting could have been done more thoroughly, as I failed to notice that the lamp as a stand alone product wouldn't be legal in all Scandinavian countries except for Sweden, as you need to have the bike lights in those countries.



## prototype

I'm happy with the fact that I seem to have been able to produce a fully functional circuit in the end, whereas I had to buy electronic components for a "dummy".

A shortcoming of the prototype is that it doesn't provide as many lumens as I strove for, which was 30 lumens. I think that I wasn't able to create a circuit while integrating a heat sink, which would be necessary if I were to incorporate as many lumens as 30.

Furthermore, the circuit provides a blinking light. As established previously, this condition is for a rear light in certain circumstances.

## design

Did I manage to maintain a Scandinavian design language?

### **functionality**

I believe that I succeeded in implementing the "functionality" of Scandinavian design aesthetics, which is about conveying the intended use to the user. My high focus on functionality is visible through the many functions of the product, and attributes such as the orange color which signals a function.

### **minimalism**

I think that the end result is very minimalist in its construction, in the sense that it consists of 12 individual parts. Most of these can be assembled/disassembled by the users themselves. During manufacturing assembly is done without screws or bolts are incorporated into the structure. Whether this is realistic or not, I'm not qualified to say, but it is simplified as possible as a starting point at least.

### **playfulness**

Lastly the bike lights have a playful expression, due to the large radii applied to most of the parts, as well as the smooth finish.

Overall, I feel content with the result.

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