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## Trabajo Fin de Grado

Estudio sobre envases de esmalte de uñas y  
rediseño según criterios de usabilidad y ergonomía

Study on nail polish containers and redesign  
according to usability and ergonomics criteria

Autor

Lucía García García-Lisbona

Director

Zsolt Petér Balogh

Ingeniería en Diseño Industrial y Desarrollo de Producto

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Study on nail polish containers and redesign according to  
usability and ergonomics criteria

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# **FINAL PROJECT**

Department of Machine and Product Design

# **Study on nail polish containers and redesign according to usability and ergonomics criteria**

## **AUTHOR**

Lucía García García-Lisbona

**DIRECTOR:** Zsolt Peter Balogh

**Budapest University of Technology and Economics**

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## 0. Introduction

For this final project I wanted to study a popular object and redesign it (a certain product container in this case). Usually, Industrial Design relies on designing a solution to a certain problem, but many times it can consist of redesigning an already existing product to solve more necessities or to apply a different perspective. Also, in my condition of exchange student in a foreign university (where we are not given specific problems or topics to work with), the decision of choosing a common product and work on its redesign sounded very appropriate with the resources I had available.

I decided, then, to redesign the **nail polish containers**. I had to think about objects that could benefit from a redesign and, as someone who paints her nails on a weekly basis, I have always found complains about those bottles (discussing it with more people, they did too). Even if the bottles themselves change their shape (depends on the brand), they share the same principles and basic problems because they have the same components and are kind of cut on the same mold.

Together with the fact that we know that nail polish bottles have not evolved in almost 100 years (they continue to have the same structure and pieces since back then) while many other products -beauty industry or not- have been modified with time, I decided that working on a redesign could be interesting.

My final project topic will be then to research about nail polish containers, to find their most common problems and redesign this product focusing on usability and ergonomics.

### 0.1 Main goal

The main goal of this project is to redesign the nail polish bottles and develop the new concept. The point of view of the proposal will focus on the ergonomics and usability of the product, and it will try to solve as many of the current problems as possible.

### 0.2 Range

This project will reach the technical and design development of the new product, including the technical documents for its production. There will not be a physical prototype because of the restrictions given by my student situation (currently on an exchange program).

## 0.3 Methodology

To do this project I will use the following methodology:

- Study on nail polish itself, its evolution to predict future changes
- Market research to keep up with the latest products and innovations
- User tests to dive into the problems and issues
- Research on similar products that apply liquids to find analogies that could be used in the redesign
- Creative phase: To come up with ideas and propose viable solutions according to different criteria (mechanics, ergonomics, usability...)
- Once the idea is selected, to develop formal and functionally in terms of mechanics and ergonomics
- Collect all the work done in a document to present the results

It will be divided in 4 phases: **Research**, **Concept generation**, **Development** and **Final presentation**

## 0.4 Planification

This project has been done during the Spring semester of the academic year 2021/2022. Because of technical and academic issues that had to do with matters out of my hand (changes on supervisors, etc.), the project did not really start until mid-March.

*NOTE: It just mentions Mondays, but it refers to whole weeks.*

03.14 – 03.21	Decision of the topic.
03.28 – 04.11	Research, tests, user experiences... Find gaps and problems.
04.18	Concept generation, alternatives and viability. Decision.
04.25 – 05.09	Product development (further research, ergonomic study, technical specifications...)
05.16 – 05.23	Graphics (3D model graphic design), final specifications, plans, developments...
05.27	Final deadline

# **PHASE 1.**

# **Research**

# 1. Frame of reference

This phase will gather information on a variety of topics that will help with the following design. It will focus on two main blocks: nail polish itself and investigation on other products and related topics to gather information useful in further phases.

All these investigations on a range of different areas related to nail polish itself are made with the intention of first, get all the knowledge possible about the subject and second, finding possible gaps that our future design will try to fix.

## 1.1 Introduction

According to the Oxford Dictionary, nail polish is a *clear or coloured liquid that you paint on the nails on your fingers or toes to make them look attractive*. It is one of the most famous beauty products thanks to its easy application and approachability to the public.

As most of the rest of the products offered by the beauty industry, it is a product mostly used by women. However, nowadays it is very frequent to see more and more men "breaking the gender stereotypes" and it is something very valuable in the society.

Also, manicures and nail art are becoming more and more trendy due to social media and celebrities making popular some styles and trends. Audiences try to replicate it, by themselves or at beauty salons, but either way the nail polish industry has been making a strong revolution during these past years.



## 1.2 Evolution

Even if we do not know the exact date where nail polish was invented (at least, not our “modern” concept) there is proof dated of the Ancient Ages where they used similar products.

As the main goal of this project is to redesign the bottle/ container of nail polishes, we will focus on the differences between samples of this products and the changes they have suffered.

**3500 B.C., Egypt.** In the Arabic countries, **henna** has always been a very popular beauty product for both hair (as dye) and skin (tattoos) because of the reddish tone it leaves after application. But it can also be used in more body parts. Cleopatra used to dip her fingers in it, coating just her fingernails so she would get a bloody red effect (Nefertiti preferred Ruby red). It is possible that women had used this method since 5000 B.C.

**3200 B.C., Babylonia.** It's claimed that the warriors took care of their hair and nails before going to battle. They used to tint their nails with **kohl** (as well as using it as makeup), and the colour used probably indicated their class.

**3000 B.C., China.** During the different dynasties, they used nail colour as distinction of rank and each dynasty. Wearing royal colours (gold, silver) while being an upper/lower-class member may have meant death. To make those products they used **ingredients** such as beeswax, Arabic gum, gelatine and highly pigmented colours. Even if in other earlier time periods they used to dye the nails too, now it is when the “modern” nail polish birth is dated.

**1878.** **Mary E. Cobb** learned the art of manicure in France and in 1878 she opened “Mrs. Pray’s Manicure” in Manhattan the first-ever nail salon (she also included hairdressing and skincare too). Inside her contributions to the nail industry, she also invented the nail file and created an at-home manicure guide.

**1890s.** Around this time the concept of modern nail polish started to appear, even if not yet is the product we know and use. **Powder polishes** were buffing powder that women used with a leather buffer that people used to abrade the nail plate to get a smooth and shiny surface. These abrasive powders usually included dyed pigments so the nail would get a slight colour too. Powder polish quickly was produced in a wider range of forms, such as sticks, blocks and liquids.



Figure 1 Source: Google Stock Images

**1911.** The new brand **Cutex** released an extract that worked as a cuticle remover. Thanks to their intelligent advertisement where they tried to teach women to want perfect nails, they soon moved into the nail polish industry itself. In this area, they quickly developed powders that would slightly tint (or at least give a bit of shine to) the nails and would not require to be abraded as the powder polish did.



Figure 2 Source: Cosmetics&Skin

In the *Figure 2* we can see that for these solid products they started to use metal for a better conservation of the polish, as well as it gave more protection.

The liquid polishes released by Cutex in 1926 (based on dying the nails) firstly came with the brush as a separated piece, but later they were incorporated to the cap (so the brush could be submerged into the liquid). This cap, as seen in the *Figure 3*, was made from cork.



Figure 3 Source: Cosmetics&Skin

**1920s.** Michelle Menard, a French make-up artist, wanted to create a product that would remind people of the car's shine (the glossy nail effect). After seeing the potential of her idea (she worked altering car paint lacquer), her employers, the Charles Revson Company, partnered with chemist Charles Lachman to create the perfect polish formula.

The main innovation they came up with was a formula that was based on pigments instead of dyes (like the industry used to do), with an opaque effect. In 1932, they launched the brand **Revlon**. They would later expand their offerings by launching various other products such as lipsticks.

As they focused on enamels and using chemicals rather than natural ingredients, their products were more durable with more effective results, as well as easier to store and commerce.

The bottle where the first nail polishes were released does not differ a lot from the ones in modern times: a glass transparent bottle, with a cap that kept the brush as well as serving as closing. The closing had a thread to assure that the solvents would not evaporate. As it is noticeable in *Figure 4*, they put an effort following the trends of the time (Art Déco geometries and lines), telling us about how much they cared on the aesthetics and propaganda.



Figure 4 Source: Revlon

**1930s.** Manicure kits started to make an appearance. They contained liquid nail polishes, paste polishes, cuticle removers, emery boards, polish removers... These products combined all that needed to be used for an at-home manicure, and it shows that brands were starting to care about packaging and advertisement: the general view of the product follows a very cared line of style.



Figure 5 Manicure kit



Figure 6 CUTLEX booklet "Correct way to manicure", source: eBay

**1957.** Frederick Slack (dentist) broke a nail at work, and he used aluminium foil and dental acrylic from his lab to repair it. The faux nail looked too realistic, and he later left his job to work on the patent of what we know now as **acrylic nails**.

[This commercial](#) from 1962 shows tips on how to apply nail polish, false nails and repairing broken nails. We can appreciate that the techniques are very similar to the modern ones.

**1975.** The founder of Orly wanted to create a manicure who would not interfere with costume changes in the model industry. It was the birth of the **French manicure**, who soon became the most popular manicure style ever.

**1980s.** Essie, Chanel... Around this decade there were certain shades of nail polish (likewise with other beauty products) who, because of **popular culture** and media, became instantly famous and recognisable (e.g., Uma Thurman's in *Pulp Fiction*).

**21<sup>st</sup> century.** Now there are thousands of nails polish types of products that can give the nail many different finishes and effects: mirror, cracked, UV light, very intricate drawings, 3D sculptures... There is no limit to **nail art** and that tendency is only growing forward.

## Conclusions

We can sum that nail polish is a growing art that has been known from the Ancient Times. No matter when and the availability of resources, people have been able to adapt to achieve the standards of beauty of each time to finally, thanks to the natural grow and perfection of the formulas and products, build the nail industry that we know.

Nail polish evolution relies mostly on the formula, not so much in the containers themselves (since the creation of the modern nail polish). Brands evolve changing the exterior and upgrading the aesthetic and graphics so they adapt themselves to the time guidelines and styles, but there has not been yet a significant redesign that changes the product itself and offers something different.

## 1.3 Types of nail polishes & manicures

According to polish types and techniques:

Here is a quick reference about different techniques available in the nail polish industry:

**Basic.** The most common type of nail polish. There are a wide variety of finishes, but it is not the most long-lasting (around a week). This is the typical nail polish to use: the bottles are made from glass and (generally) have a plastic cap. The glass tends to be transparent so the buyer can see the exact colour of the polish but there may be exceptions.

**Gel.** The beautician will apply a hard gel on top of the nails, and it will cure with UV light to last for longer (2 weeks). It can be used to extend the nail shape. There are basic nail polishes that can resemble to the effect this technique gets. Because of the formula and its chemicals (and how they react with light), these bottles are always opaque, but they share the typical shapes of the basic polish bottles.



Figure 7 Source: Google stock Images

**Acrylic.** This polish is a combination of liquid and powder. The mixture is applied to the bare nails and then sculpt to get the desired shape (also to extend the natural length). It lasts for around 2 weeks. For this method a bottle of acrylic liquid is needed, so it does not need the typical nail polish bottles (just for arts and decorations once the shape is done).

**Breathable.** A quite new formula that allows oxygen and water to pass through the nail polish. With this polish the nails do not have a barrier and they can “breathe” normally. It is safer and healthier, but it only lasts for a week. The bottle shares characteristic with the basic nail polish one, because the product effect itself does not change significantly.

**PolyGel.** Technique that combines acrylic and gel nail polish. It is one of the most long-lasting manicures (3 weeks), but it is usually only done by nail technicians. As it close to a paste instead of a liquid (it is put on the acrylic nail and the glued to the natural nail), they come in a different packaging.



Figure 8 Source: Google stock Images

**Dip Powder.** After a base coat and sealant, you dip the fingers in a pigmented powder and it sticks to it. It can last from 3 to 4 weeks.

**Shellac.** Similar process to PolyGel (mix between gel and nail polish with UV light) but it can't extend the length of the nails.

## 1.4 Uses and usability

To paint someone's nails is a very easy technique but requires a bit of practice to get it perfect. Many people get their nails done in a nail saloon (it depends on the type of manicure and technique you want since some of them are more complex), but the activity of painting the nails is something very typical to do it at home. For this project I will focus on **self-done manicure** since is the more popular one and the one and the one that is closer to the public.

The process of nail painting implies:

### **PREPARATION**

1. Cleaning the nails with nail polish remover
2. Clip, file and buff the nails to get the desired shape
3. Push back the cuticles (with cuticle remover and a stick)
4. Exfoliate and hydrate the hands with the pertinent creams and serums

To get a perfect manicure these first steps should be done, but that does not mean that people do them. These "extra" steps make the process require much more time and effort and nowadays these days people want quickness and directness.

### **PAINTING**

5. Apply the **base coat** (a transparent polish that hydrates and protects the nail, and will help the main nail polish stick to the nail to last longer)
6. Apply **first coat** of colour (thin, not thick)
7. Apply **second coat** of colour
8. Finish with a **topcoat** (another transparent polish made to protect the nail polish and make it last longer; it can come with different finishes: glitter, matte effect...)

It is very important to not start painting the next coat until the one before is completely dried. Between coats you should wait around 2 minutes until you are sure it has dried -if not, their densities will be different and it will take a much longer time to completely dry, the underlayers will be soft while the top ones will be hard and so the whole polish may be damaged when touched (without knowing it).

## 2. Production

### 2.1 Composition

Nail polishes require a chemical process to work as expected. Their formulas have a wide variety of chemicals (even if laboratories are releasing new formulas trying to reduce them) that will react to create the thin film that covers the nail.

The formula for nail polish basically contains a **polymer dissolved in a solvent**. When applied, the solvent evaporates, and the polymer forms a film.

#### Fil-forming polymers

**Nitrocellulose**. It is the most common polymer used.

In gel nail polish, the basic compound is a monomer (e.g., *methacrylate*) and a photoinitiator (e.g., *benzoyl peroxide*) that, when exposed to UV light, it will react and produce the polymerisation and solidification.

#### Solvents & plasticizers

These liquids are used to mix the rest of ingredients to get an heterogeny mixture. The amount and type of solvent will determine how thick a polish is and how long it will take to dry. (Helmenstine, 2019)

*Ethyl acetate* and *butyl acetate* are the most common used solvents, while acetone and ethyl acetate are used in nail polish removers.

The use of **acetone** as a remover, while not toxic according to dermatologists, can be dehydrating to the nails so the number of acetone-free products is increasing.

**Plasticisers** (camphor, triphenyl phosphate, dibutyl phthalate -in the past, now banned) stop polish from cracking or chipping.

## Pigments & other agents

The pigments can be either **organic** (carbon-based) or **inorganic** (e.g., iron oxide). There exist **thermochromic** and **photochromic** pigments that can give the nail polish very interesting finishes.

To achieve the desired thickness there are **thickeners** that will suspend the pigments in the liquid (specially with heavy pigments such as *glitter* or *pearlescent minerals*).

To prevent an undesired change of colour because of sunlight there are **stabilisers** (e.g., *benzophenone-1*) that will help the nail polish to last up to two weeks.

**Resins** have also a big role in the formula, since they are responsible to make the film adhere to the nail bed. They also add texture and thickness to the polish. An example is *tosylamide-formaldehyde resin*.

To avoid messing up the formula, the brands always recommend keeping the nail polish bottles in lower temperature places avoiding direct contact with light. This will preserve the original thickness and will maintain "alive" the polish for a longer time.

**Table 5.** Information about products: nail polish ingredients

Function	INCI <sup>a</sup> name	CAS number <sup>b</sup>	Classification under Regulation (EC) No 1272/2008 given by producer	Concentration, % by weight
Solvent	Butyl acetate	123-86-4	H226, H336	25–50
Solvent	Ethyl acetate	141-78-6	H225, H319, H336	25–50
Film forming	Nitrocellulose	9004-70-0	H228	10–25
Plasticizer	Acetyl tributyl citrate	77-90-7	Not classified	5–10
Solvent	Isopropyl alcohol	67-63-0	H225, H319, H336	1–5
Binding, nail conditioning, viscosity controlling	Adipic acid/fumaric acid/tricyclodecane dimethanol copolymer	58891-19-3	Not classified	1–5
Gel forming, viscosity controlling	Stearalkonium hectorite	71011-26-2/ 94891-33-5/ 12691-60-0	Not classified	1–5
Buffering, chelating, masking	Citric acid	77-92-9	H319	<1
Film forming, viscosity controlling	Phthalic anhydridetrimellitic anhydrideglycols copolymer (1,3-isobenzofurandione, polymer with 5-carboxy-1,3-isobenzofurandione, 1,2-ethanediol and 2,2-dimethyl-1,3-propanediol)	NA	Not classified (information about sensitization in various patients available)	5–10
Cosmetic colourant				5–0.01

<sup>a</sup> International Nomenclature of Cosmetic Ingredients.

<sup>b</sup> Chemical Abstracts Service Registry Number.



## 2.2 Manufacture process

The current nail polish bottles share procedures with other glass bottles in the market, such as perfume. The type of glass that will come from this procedure is soda-lime glass. Even if the designed product does not share the same mechanism, materials or shape, it is interesting enough to have the current information so that the design can be adapted and we can find gaps along the manufacture process.

### Mould manufacturing

After designing the bottle with CAD programmes, they will create the perfect steel casts to produce it with diverse processes (depends on the brand necessities) such as resin, manual manufacture, stereo lithography, casting processes... The final moulds must be perfect so the product will come out nice: that is why they require many inspections and high precision analysis.

There are a total of 3 moulds for each design: a blank mould for the neck finish and a blow mould for the final shape.

### Bottle manufacturing

1. A mixture of silica, soda ash, limestone and cullet (recycled glass, 5-50% of the composition to lower the melt temperature) are combined to form a specific mixture
2. That mixture is melted (1300°C) and, after going by the refinery, it is ready to form
3. A timed blade cuts the molten glass into equally weighted gobs to make sure they all have the same dimensions. If not, they may not fit perfectly in the casts in following steps
4. By gravity the molted glass falls into the blank mould, where thanks to pressure the neck and basic shape are acquired. This partially formed bottle is called *Parison*.
5. The preform is carried to another machine that will reheat the parison and will blown it to its final shape, while creating the inside cavity.
6. The finished product is subjected to flame treatments to improve the shininess and surface conditions
7. The bottles will be reheated for 2 hours at 550°C to cool down without any risk of shattering, and then slowly cooled to 200°C.
8. An exterior coat is applied to reduce abrasion

During the whole process the bottles and parisons go into leak detection and quality inspections to assure the standards and specifications are reached.

## Cap and brush: plastic elements

The caps and the brushes will be manufactured according to the design specifications. They are two separated parts:

**CAP.** Completely in plastic. It is fabricated with injection or some similar procedures. Sometimes nail polishes have a cap and a extra cup that covers the first one (to make more comfortable the painting process and with an aesthetic purpose).

**BRUSH.** The hairs are made out of nylon and they will use a extruder machine to make them. The handle is a more complicated piece, so it uses injection to achieve all the details.

## Putting everything together

Depending on the brand the assembling process varies. Sometimes they put the brush inside the bottle (after being filled) and then the cap will fit on top, sometimes they will put together cap and brush before they will close the bottle.

Also, it depends on the brand when they label the bottles: sometimes before filling, sometimes after everything is assembled. Labels can be painted or can be a sticker.

Not every nail polish brand does, but some of them put one or two metal balls inside the bottles before filling them with the lacquer to serve as mixing beads. These steel balls are very common in the cosmetic industry.

## Nail polish manufacturing

The labs will design the formula with the required ingredients. Once the mix is done, a machine fills the bottles with precision (the bottles are transported with conveyer belts and moved with specific machines), to be labeled after that in order to be released into the distribution channels of choice.

## 3. Market study

### 3.1 Statics and current situation

According to a recent study made by Grand View Research (dated April 2022), the nail polish industry is one of the most relevant fields in the beauty industry. Its global market size was valued at USD 14.3 billion in 2021 (15.23 billion in 2022), with a CAGR (*Compound Annual Growth Rate*) of 6.8% from 2022 to 2030.

Most of the audience that this industry falls into are millennials (25-34 yrs.) followed by the closest age category audiences (18-24yrs. and then 35-44yrs.). The numbers on the public are increasing fast, probably due to the rising manicure art that has been going on during these past years. The internet and social media have a very relevant role in this effect, supported by the new tendencies of natural cosmetics and the new releases of natural and less-harmful formulas that goes with the social concern about sustainability.

In terms of which kind of nail polish is more successful, the 46% corresponds to regular nail polish. This is due to its easy application, variety of colors and low price. Also, because users can do it at home instead of in a saloon, the numbers of sells must be reflected. Gel nail polish follows is the one anticipated to expand fastest (8% CAGR from 2022 to 2030).

As seen in *Figure 10*, specialty stores are the most common distribution channel with a 36% of the global share. This kind of stores have a wide offer of products, colors and brands, and having specialists working there to help the customers is also a desired characteristic. While e-commerce is the less frequent supplier, it is the one with a higher CAGR (9%), something that makes sense due to the easy access to internet, the discounts and offers we can find there (no to forget the comfortability from online shopping). The pandemic influenced this matter too (it disrupted the production and supply chains), but it also had a significant positive effect on online sales in general (in most markets).

Asia Pacific made the largest contribution to the global market (39% in 2021) and has the highest CAGR too. In Europe, with a CAGR of 5.4%, customers lend toward more natural products (vegan, cruelty-free...) specially in countries like UK or Germany. In North America they are willing to pay a high price for the products, but it is the Middle East who has the second fastest growing number from 2022 to 2030. The most popular brands are Unilever, Revlon, L'Oréal S.A, Cosnova GmbH (Essence), Sally Hansen or NOTE Cosmetique, between others.

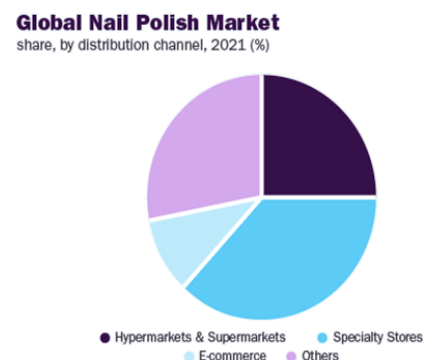


Figure 10 Source: GrandViewResearch

## 3.2 Product offer

Another of the analysis of the current products is though competition between a fraction of them. There is not possible way to study all the brands and nail polishes that exist, so I am picking a small group with different shapes and sizes to serve as example.



Figure 12



Figure 13



Figure 14



Figure 15



Figure 16



Figure 17



Figure 18



Figure 19



Figure 20



Figure 21



Figure 22



Figure 23



Figure 25

Sources: Google stock images

In the pictures we can see a very diverse offer of products, each with different shapes and sizes. I will not be discussing the nail polish colors as this samples are just examples of a few of the product offer out there in the market and each brand features a extensa range of shades.

In general we can say that, even if the products look very different from one another, they all share the same concept: glass bottle with a cap that has attached a small brush (the brush shape in every brand is different: I will not be analyzing that because there are not pictures of the interior of most of the bottles, but it should be kept in mind that they can be softer, harder, round or flat, longer or shorter, thicker or not...).

The main difference is the shape of the bottle and cap themselves. Usually, the bottle is prismatic with a cylindric cap (it is the easiest shape to produce) in a similar proportion (same height both pieces), but each brand takes creative liberties to shape them in different forms. Maybe rounder edges (*Figure 12*) or reliefs (*Figure 13*, *Figure 22*), maybe a different proportion (g), sometimes having completely different shapes for both pieces (*Figure 16*, *Figure 18*).

It is mostly the luxurious brands who go with more risky designs with the main goal of making their products stand out from the common offer. It is the case of 12, where Louboutin plays with intricate shapes and colors to create a very original design. Hermès or Marc Jacobs (*Figure 17*, *Figure 18*), while going for a less risky design, play with the traditional lines to create something more modern and newer but easier to the eye.

Sometimes experimenting with the shapes (as valid as the previous notes) can produce a design that can look "cheaper" (*Figure 19*, *Figure 21*) because the general idea does not seem to be cohesive nor has a "story" behind. Innovation is key, but it should maintain style and geometrics that do not seem forced.

In terms of colors, we see that the bottle is transparent (if not, it is tinted but still has a transparent finish) so the users can see the real color through the walls. It is the liquid polish which gives the objects their main color: usually the caps have a neutral color that will not interfere and that can look the same in the whole brand (that mean, all the containers are similar, and the only variation is their content). They tend to be black or white, sometimes metallic, but not colored because it could not combine with the polish color and in those occasions, it could look not good. ESSENCE (*Figure 12*) is the exception, because the caps have the color of the polish itself, but it is rare because it requires a more complex production.

## 3.3 Innovations

Even if they may have not been famous worldwide, I had the feeling that someone should have tried to create new designs for the nail polish bottle. Other famous products are served in a wide range of shapes and forms where the user cannot only choose the color or type but also the application form of their preference (think eyeliners, writing tools, concealers and many makeup products, perfumes, tools in the kitchen...). I find that in the nail polish industry there have not been this extensive investigation to come up with innovations and they focus on the traditional design (at least, not something that has had a remarkable impact on international markets).

As said in previous sections, the changes that the current nail polish bottles face are principally stylistic and aesthetic wise (to represent the brand, to look different...), but not in the design itself.

My assumption is that the current design is so famous that there is no “real need” to change it. We are used to it, and we do not mind about new designs because the typical one works (and frequently they are more expensive and do not get the same results). Also, the new and “more creative” nail polishes do not have a big marketing strategy because they are just not seen in stores or online.

Some examples of innovation in the nail polish industry:

### Nail Gel Varnish Pencil

When the user turns the wheel in the end of the pen, the nail polish gets pushed down by the dispenser and slides through a brush on the other end. It will be the main tool to spread the liquid across the nail area.



Figure 26 Source: [www.amazon.com](http://www.amazon.com)

## X-Brush

This product is an extendable brush that users can substitute their normal caps with. Just by turning a small wheel, the brush extends its length, so it is easier to achieve the bottom of the bottle. There is only one size of diameter available ( $\varnothing$  1cm) but there are 2 sizes of brush, depending on how long the user wants it to extend (2-3cm and 3-4cm).

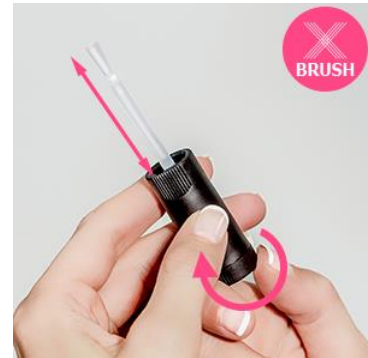


Figure 27 Source: [www.x-brush.com](http://www.x-brush.com)

## Avlon Nail Experts

It is not technically a nail polish but a strengthener polish with a very subtle color, but we will take it as another example. This bottle contains the product and, just by applying a small pressure, it will come out directly from inside the brush.



Figure 28

## Click & Go nail polish – Primark

This product works similarly as a retractable pen. There is a small button in the end of the pen that, when pressed, will pull out the brush that hides inside the glass bottle. This brush, when goes out, carries a small quantity of nail polish, enough for painting a nail. The cap closes with a thread, just as basic nail polishes.



Figure 29 Source: [www.tyla.com](http://www.tyla.com)

## Pledge Liquid Enamel (1940)

This vintage product dispensed the nail polish from inside an aluminum tube. The nib had a brush shape which was used to spread the polish. There are not similar products nowadays but it was worth mentioning how in the past they tried to stand out from other brands.

**NOTE:** I do not put this product in the Evolution section because I think it fits better in this one (back then, it was more a punctual release and it did not leave a significant mark -it goes better in this section of punctual innovations).

Figure 30 Advertisement poster, Source: [www.cosmeticsandskin.com/](http://www.cosmeticsandskin.com/)



## Alpha Nail

This product is specifically designed for males, and that it's the main message behind their advertisement. The nail polish itself is identical to the basic nail polishes (it comes in different shades, with mattes and metallic finishes), but they worked on the exterior and new mechanism to gain distance from the "feminine" products. By clicking a button on the end on the pen, a slight amount of polish will come out from the brush and will be ready to apply.



Figure 31 Source: The Huffington Post

## Mani Marker – Ciaté London

With the mechanism of a regular marker (felt tip and tube inside), this product is present in 5 vibrant colors. It required to shake well first and the push the nib to release the liquid polish.



Figure 32



## Refillable container with brush nib

With a similar mechanism as some liquid concealers, repeats the idea of having a dispenser and manually pull out the liquid in the interior. In this product, instead of rotating a button, you must press it. In this supplier you buy the empty product: you will fill it with your own nail polish.



Figure 33 Source: spanish.alibaba.com

## Analysis of innovations

### Nail Gel Varnish Pencil

The presentation works and I think that the hold, as it is like a normal pen, it is a very good idea and very comfortable to the user. However, having to change the position of the hand constantly (or use the other hand) to roll the button can be inconvenient. Also, on a different matter, when the polish left on the brush dries it will leave the brush hard and solid, and it can be a con to clean after or before every use.

### X-Brush

To be able to use for longer the product inside the bottle is an amazing idea. This product could be installed in a normal nail polish (but it could be more expensive). Its main con is the fact that only works with  $\varnothing 1\text{cm}$ , so even if it wants to be used universally it is very restricted (also, the thread itself will not work with every  $\varnothing 1\text{cm}$ ).

### Avlon Nail Experts

Very simple mechanism but kind of effective. Without having tried it but having knowledge about brushes from my own art practice, I could assume that the brush does not have a big quality (it is not very steady, and it folds easily, apart from having a very short shape). Probably difficult to get to the bottom of the bottle (and by means, to make the most of the product).

## Click & Go

I have bought and tried it myself to test its use. It is quite comfortable to grab, even if it can be a little bit too thick. The main complaint is the mechanism: it works fine but to change the position of the hand every time you need to extract more polish is exhausting and can make the thumb hurt. As there is no opening to access the polish, probably it will waste a lot of product at the end (there is no way to add polish thinner or to try to wipe clean it).

It is a little bit difficult to open because, firstly the slippery (smooth) and very round surface and secondly, the thread that closes the cap gets dirty because of the lacquer and it works as "glue". When it has not been used in a long time, you need a lot of strength to open it. On another hand, there is a very limited number of colors available.

## Alpha Nail

It shares mechanism with the refillable container, with the exception than this one does not permit access to the interior of the object (when it is finished, it is finished). There are not a lot of colors, but my personal objection would be the advertising itself: I truly appreciate the fact that it wants to get to the masculine public, but I do not think that announcing it exclusively for men (with hyper-sexualized messages) is the right approach.

## Refillable container with brush nib

Very cool design and comfortable to use. Similar problem with the Varnish pencil and Click & Go, that changing the position of the hand for each stroke is not the best solution. The size and diameter themselves I find them quite right, and the possibility of use it with your own nail polishes is a very interesting point (even they would probably need to use polish thinner to make them more liquid).

## Mani Marker – Ciaté London

The combination of the marker and nail polish is very interesting, and the hold in the hand must feel very natural. I think tough that the felt nib can be damaged very easily (especially after the user needs to shake it against a paper to get the polish down), and due to its flat shape and big size maybe the user will not be able to have the same precision as with different tools.

## Conclusions

Comfortable size so the object can rest on the user's hand, and it is neither too big nor small (in terms on length and section).

Simple mechanism that does not require to use both hands not change the position of the working hand. The most typical hand position is the "writing" one, so it could serve as inspiration.

Wide selection of colors: the user can choose between many options. If not, easy to personalize.

If there is access to the interior of the product (not necessary for refills), the user could work to

Mechanism that assures the user to make the most of the product (either by the mechanism itself or by having access to the interior). It will last for longer and will be better for both the environment and money wise.

Design that could be categorized as unisex.

The brush should be in constant touch with the nail polish: if not it will dry around the fibers and it will require an extra effort to clean each time (also, it wastes product and it will damage the brush itself).

Look for the most universal design possible (adaptable...)

## 4. Liquids application

As the main goal of the project is redesign the nail polish bottles, a big focus of the investigation will rely on other products who share the idea of displaying liquids (with precision) in order to different points of view on the topic. I will study how the ink or liquid comes out in each product to look for shared points with our main object.

### Paint brush

The simplest method to apply any kind of liquid product (the most natural way). It consists of just immersing the tip of a brush (bristle) on the bottle with paint and kindly spread the paint on the canvas. Depending on the type of paint, you may need to wet the brush before with water or other special liquids.

The application will vary depending on the paint or ink, the handle of the brush and its material, the hand hold of the brush... but specially on the hairs of the brush: the length, material, density, shape... This will determine the effect of the strokes and the comfortability of the user.

### Water brush/ fountain brush

This art tool is very frequently used with water techniques such as watercolor. In this product, instead of putting the brush into the liquid the liquid comes out from the handle itself. It is an empty flexible tube that the user must slightly press to push the liquid from the tip. The special tip has fiber bristles where the liquid has easy access to slide through.

Artists usually fill this special brush with water, but it can be used with certain types of ink (some with very light composition).

There are different types of fountain brushes: some of them use a piston to push the liquid (instead of a soft tube to press), the tip of the brush itself also changes (sharper, flatter, etc.) ...

### Ballpoint pen

It relies merely on **gravity**. The tip of the ink tube (or ink reservoir) has a small ball bearing that stops ink leaking. In its socket, this ball is allowed a continuous rotation, thanks to what it transfers the ink into the paper. The result is a fluid release of ink who dries very fast and will take a long time to run out.

The ink has a viscous oil-based formula, and the liquid is quite thick. This, combined with the ball bearing on the tip, makes this method require a little more pressure to write.

Rollerball pens share the ink delivery system but they use an ink consisting of dyes dissolved in water. This results in a faster delivery of the ink in each stroke (but it will run out of ink more quickly) and so require less pressure.

Gel pens also have the same ink delivery system, and the difference is again the ink formula: here the pigments are suspended in a water-based gel. This flow of ink is much smoother than the ones cited before (less thick), but it also takes more time to dry.

## Fountain pen

This system relies on both **gravity** and **fluid theory**. The nib (tip of the pen) has three channels for the ink and one larger for air. While writing, the air flows through the tube and makes the ink flow out in a continuous line of ink.

## Correction fluids (*Tipp-Ex*)

This kind of products are used to hide mistakes done while writing and, once they are dry, the user can write on top of them so the mistake is completely fixed.

There are many different types of correction tools (tape, liquids...) but I want to focus on the liquid versions because they are the closest to the nail polish format.

***NOTE:** There could be a possibility to combine the format of correction tape with the nail polish formula, getting a quick product to apply the lacquer. However, I find it quite hard to develop so I will not even propose in the concept generation section.*

Bottles. This correction fluid format is almost exactly as the nail polish bottle itself: a bottle where the cap has attached a brush that the user submerges in the liquid to "paint" outside. Depending on the brand, we can find a different kind of brush: a pointy sponge (chiseled with a flat edge) or a brush with its bristles. It depends on the user which one he does prefer.

Pen. They have a shape like a marker or a pen, but they are mostly empty on the interior. They are filled with the correction fluid and a metal ball or cylinder who moves freely and works as mixing element (it helps the liquid to not dry and to push correctly). There are a lot of shapes the object can present (usually they all have the same length -8-9cm-, but some are heavier, with more curves, with one or two protrusions...), but in terms of the mechanism itself we find only two possibilities: a **retractable nib** (only when it is pressed to the paper and the user applies pressure into the walls of the pen, the liquid will come out) and a **roll-on** similar to ballpoint pens (the user has to press the pen and then rub the nib around the paper to deposit the liquid).

## Markers

There are tons of different types of markers in terms of how they keep the ink on its inside. Some will use a plastic tube with a sponge inside (the ink is kept on that material), some are just the liquid being moved with a mixing bead. Usually, the first type is more frequent in the market with common use markers, while the second one is more used with permanent markers or markers where the exterior is aluminum (they have stronger chemicals). Sometimes, these last models have a semi-retractable nib so it takes better the ink from the tank.

In all cases, the nib of the marker is made from felt, which makes very easy for the ink to pass through it. When a lighter marker is used on top of a darker color, the smooth nib can easily pick a bit of that pigment and get dirty.

The nibs can come in a very extensive range of shapes: different diameters, pointy, flat, chiseled, flat with drawings (stamps)...

## Concealer pencil

Concealer is a cosmetic stick used to cover spots, blemishes, dark under-eye circles and other imperfections. It is flesh-toned, and it is commercialized in many different formats and finishes. I will focus only on the liquid concealer, but it can also come in sticks, balms and creams.

One of the most used liquids concealers are pens (the second most used are the ones that come in a small bottle with a brush). The mechanism is similar as the one seen in previous sections, where there is a **piston movement** that pushes the liquid to the end of the pen. Some of the pens will require to rotate a top piece to push, some will simply ask for click it as a button.

In this product this mechanism is not as uncomfortable to use as it could be in the nail polish innovations seen before: here the main goal is to take just a small amount of product and put in on place: the spreading will be done later with different tools -not to use it in big surfaces for a long time with a lot of product.

## Cuticle oil pen

This beauty tool is a product that people apply into the nail surface to nourish and take care of them. Its mechanism is almost identical to the concealer (piston that works with a button on the end), with the main difference that the nib is actually a brush (similar to a water brush).

## Conclusions

The liquid should come from the interior of the object ("slide through the hand") to avoid the process of dipping the brush into the bottle.

Possible ideas for pushing the ink down the tube: piston system (how to push, open to possibilities) or pressing the walls of the tube.

In terms of tips: brush, roll-on and retractable. Each one its pros and cons:

**BRUSH.** Easier to do the strokes, problems on how to keep it in good conditions (if not inside the liquid bottle)

**ROLL-ON.** Easier mechanism, but it needs a very flat and regular surface to be applied on and works better with very thin liquids. It requires more pressure applied on the tube because it will not eject big quantities of liquid (also, it leaves a more notable trace).

**RETRACTABLE.** More complex interior mechanism, it ejects bigger quantities of liquid with less pressure. Precision needed because it requires control on both the pressure and the tip. Can be exhausting to press non-stop depending on the size.

Not viable products with sponge pieces, especially if they are not in constant touch with the nail polish (it dries fast, and if cleaning dried polish takes some time, clean the interior of the sponges can be much more complicate).

Whichever tip is designed, it should be able to cover a adequate amount of surface with each stroke.

The formula should be more fluid than usual in order of making easier its "descend with gravity" through any mechanism.

If the mechanism is "putting pressure with the fingers" (see CORRECTION PENS AND WATERBUSH), the material of the tank should not be very hard so the user does not have to apply enormous amounts of strength (his hands would get tired in a very short period of time, especially the thumb -it could even cause finger injuries).

## 5. User experience

### 5.1 Sequence of use

One of the most typical methods to find problems and gaps in a product is to an exhaustive and detailed user experience with it. I include some comments and extra steps

*(Omission of the steps of prepping the nails -creams, cutting the cuticles, filing the nails...- I do not find them truly relevant to the painting process).*

1. Pick up the bottle
2. Roll the cup to open
3. Put the brush inside the bottle to pick some polish
  - a. If there is a lot of product on the brush, leave a bit inside the neck of the bottle by sliding the excess
4. Put a drop of nail polish in the middle of the nail and brush it twice or thrice to get the polish to cover the whole nail.
  - a. Make sure the coat is thin rather than thick
  - b. Do not brush the paint more than required because it will generate irregularities
  - c. It does not matter if you paint outside of the nails and in the skin: it will be easily removed after is dried (with nail polish remover, with tweezers...)
5. Wait until the coat has cooled down before starting the next coat (min. 2 minutes)
  - a. In the meantime, but close the bottle to avoid the drying of the nail polish (in both the brush and the bottle neck)
6. Repeat the whole process with all the necessary coats (base coat, colored polish, topcoat...)
  - a. If you want some nail art (such as drawings, add stickers or glitter...), remember to do it before the topcoat is applied

#### Problems found:

1. Pick up the bottle
  - Strange bottle shapes may be difficult to grab
  - Unstable (it does not stand by itself easily)
2. Roll the cup to open
  - Slippery surfaces
  - Some brands have a second cap (that covers the real cap). That means that if you roll the cap the bottle will not actually open: you must move away the exterior cap and then roll the small one



- The liquid that may have solidified around the neck of the bottle glues the bottle itself with the cap and it is very difficult to open (requires a lot of strength)
3. Dip the brush inside the bottle and take some polish
    - a. If there is a lot of product on the brush, leave a bit inside the neck of the bottle by sliding the excess
    - The brush does not get to the bottom of the bottle (1/2 or 2/3 of the bottle are reachable without having to roll the brush back again)
    - It is not always comfortable to grab the handle/cap: they are usually short and with a big diameter and you only can work with the tip of the fingers (not support of the whole hand)
  4. Put a drop of nail polish in the middle of the nail and brush it twice or thrice to get the polish to cover the whole nail.
    - a. Make sure the coat is thin rather than thick
    - b. Do not brush the paint more than required because it will generate irregularities
    - c. It does not matter if you paint outside of the nails and in the skin: it will be easily removed after is dried (with nail polish remover, with tweezers...)
    - It requires precision to get it perfectly done (people with no steady hand may find it impossible)
    - Because sometimes brushes have different lengths (between different brands), they are harder to control
    - When the nail polish is thicker (it has dried because of the time) it is even harder to take a drop, they will be bigger drops and they will stick even more to the neck
    - The brush itself varies on shapes: it can be longer, with round shape or flat, harder or softer... This has to do with the brand and the quality.
    - Dipping continuously the brush onto the bottle can be tiring
  5. Wait until the coat has cooled down before starting the next coat (min. 2 minutes)
    - a. In the meantime, but close the bottle to avoid the drying of the nail polish (in both the brush and the bottle neck)
    - Patience is required, it requires quite some time
    - While waiting for the nails to dry, every movement done with the hands can ruin the coats so one has to be very careful
  6. Repeat the whole process with all the necessary coats (base coat, colored polish, topcoat...)
    - a. If you want some nail art (such as drawings, add stickers or glitter...), remember to do it before the topcoat is applied
    - Working with the non-dominant hand is always more difficult (the precision, the dipping...)

## Conclusions

As we are redesigning an already existing product, my main objective is to solve as many problems as possible to achieve a new design where the user will feel more comfortable.

Here are some of the ideas found though the user sequence that should be kept in mind in the further conceptualization.

### Bottle

- Strange shapes maybe difficult to handle
- Unstable (some shapes may make the bottle roll in bug surfaces)
- Slippery surface (both bottle and the cap)
- Second cap → not practical

### Cap

- Solidified polish in the neck of the bottle → **difficult to open**
- Shape → problems to open, difficult to grab and hold
- Size → not comfortable to use, less precision, difficult to hold

### Brush

- Variety on brushes (length, shape, angle, density...) → difficult to adjust to their use, some are more efficient than others
- Difficult to use (slide the paint) when the nail polish has dried
- Brush handle short to get better precision (the closer the grab to the tip, the better)
- It has to be in constant contact with the liquid (when not using) because in other case it will dry and damage the brush

### OTHER PROBLEMS (from the sequence and other prior studies)

- The whole "dipping in the bottle" process (repetitive)
- Patience, precision
- Fragile materials (the glass bottle can break if it falls)
- Nail polish thickness (it increases with time, especially if not preserved in the right conditions)

## 6. Design specifications

In this section I am detailing the design specifications gathered from previous studies to have in mind when designing the different concepts.

### **Size.**

The size of the product should be correct in relation to the hand of any possible user (proportions using the correct percentiles and anthropomorphic tables).

### **Simple.**

This product would be used as a recreational activity, so it should not be difficult to use just so the users will enjoy their time. Also, as simpler it can be (in terms of mechanisms and structure too), easier the manufacture process will be, and it will decrease the price.

### **Efficient.**

It does not take a lot of time nor effort to the user to paint its nails with it. It must be practical and make the activity easier than the current bottles (to justify the innovation).

### **Appearance.**

Even if the design is new, it should maintain a resemblance to the traditional containers, just to be easier to the users to identify. Even though, it should add a fresh and more modern style that can work better in a wider public.

### **Materials.**

The product should be light, hygienic (easy to clean) and resistant, emphasize on *light* (the users need to work with precision with only one hand and a heavy object will not work). The design should be stable.

**PHASE 2**  
**Concept**  
**generation**

## 7. Conceptualization

As mentioned before, the nail polish industry has not suffered the most changes with the passing of time. In my opinion, this can be because the product itself is very simple but effective, and the design itself does not ask to be “fixed”. The brands play with the shapes and exterior to reflex their values and branding, but they do not actually focus on innovating the product.

Also, in the introduction I mentioned that as I am working already with a product and trying to see where a completely free redesign can lead to (it is not solving a specific need), I have worked with very different approaches to come up with a variety of ideas.

*NOTE: The colors shown in the drawings do not refer to the real colors/ materials the product should have. For a better understanding of the different parts that compose the concepts I tend to use a wide range of colors just so it is easier to see the ideas.*

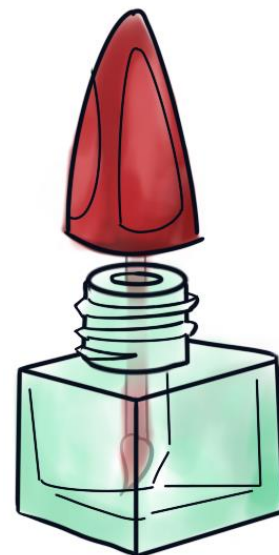
### 7.2 CONCEPT 1 – Traditional redesign

The first approach is the most traditional. With this redesign I propose to focus on solving all the individual problems found in the user sequence of the traditional bottle. Ergonomics, shapes, details about the closing... But with a concept visually closer to the current design instead of going further in terms of innovation.

With this concept I want to transmit the idea that the current bottle is open to modifications and upgrades, and not only in the aesthetic field.

In my drawings there is not a very defined proposal, but ideas that, if chose, could solve all the problems mentioned earlier. This concept is a mix on a variety of solutions for different problems, and I did not want to put them as completely different concepts because their characteristics are not exclusive from one another.

This concept is longer than the following ones because it features a wide range of ideas for the future design.



*Figure 34  
Drawings,  
source: own  
elaboration*

## Ergonomics

We talked about how one of the problems was that the bottles are difficult to open because of their ergonomics. One of the solutions is to play with different shapes and textures to adjust the cap and glass bottle to the user's hand.

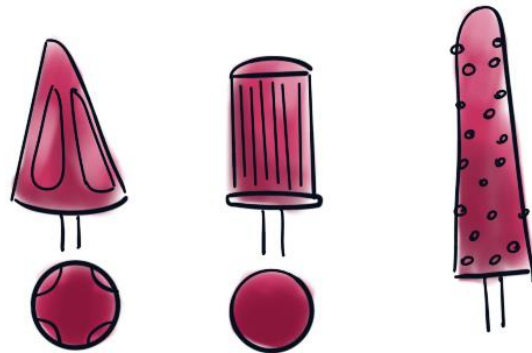


Figure 35 Drawings, source: own elaboration

## Closing

Users tends to clean the excess of polish taken out of the bottle in the edge of the bottle neck, which dries in that position and around the thread acting like "glue" between the bottle and the cap. This is the main reason why it is very difficult to open sometimes, so I propose to extend the edge to the interior so the point where the polish will stick is further from the thread and neck.

Another idea could be to eliminate the thread and instead use a hermetic cap like Tupperware's and jars have. This method would require more pieces so it may not be totally viable, but it is worth mentioning.

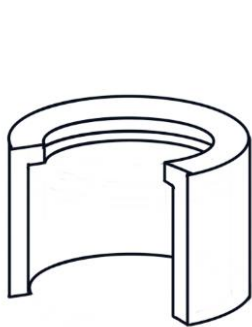


Figure 36 Drawings, source: own elaboration

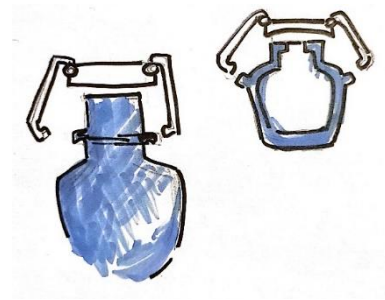
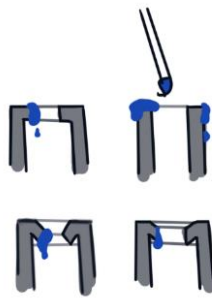


Figure 37 Drawings, source: own elaboration

## Brush

For hitting the bottom easier, the interior shape should need a different shape too, something where the polish will tend to rest on the same point.

Another idea could focus on the brush and cap themselves, where it is retractable or something similar (see X-BRUSH).



Figure 38 Drawings, source: own elaboration

## Brush and cap as separate pieces

To achieve better the bottom and have an easier hold of the brush, to have them as different parts could be interesting.

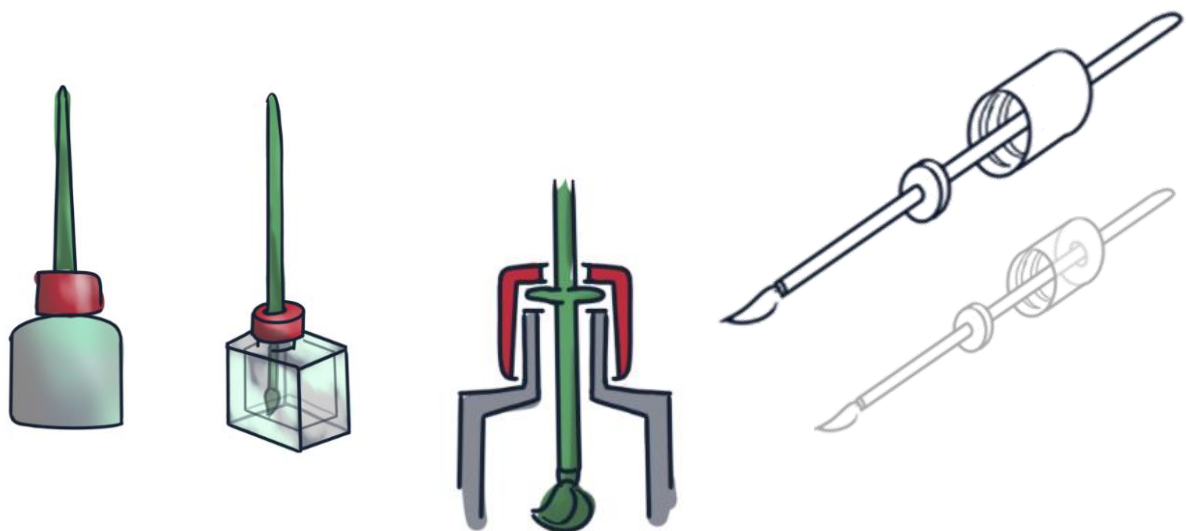


Figure 39 Drawings, source: own elaboration

## 7.3 CONCEPT 2 – Nail polish pen

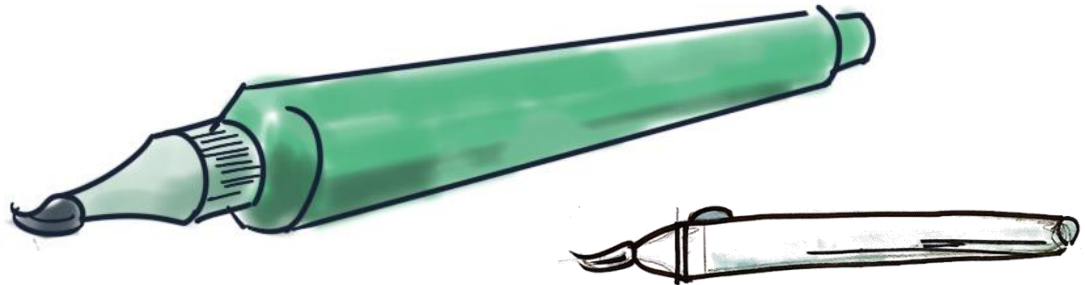
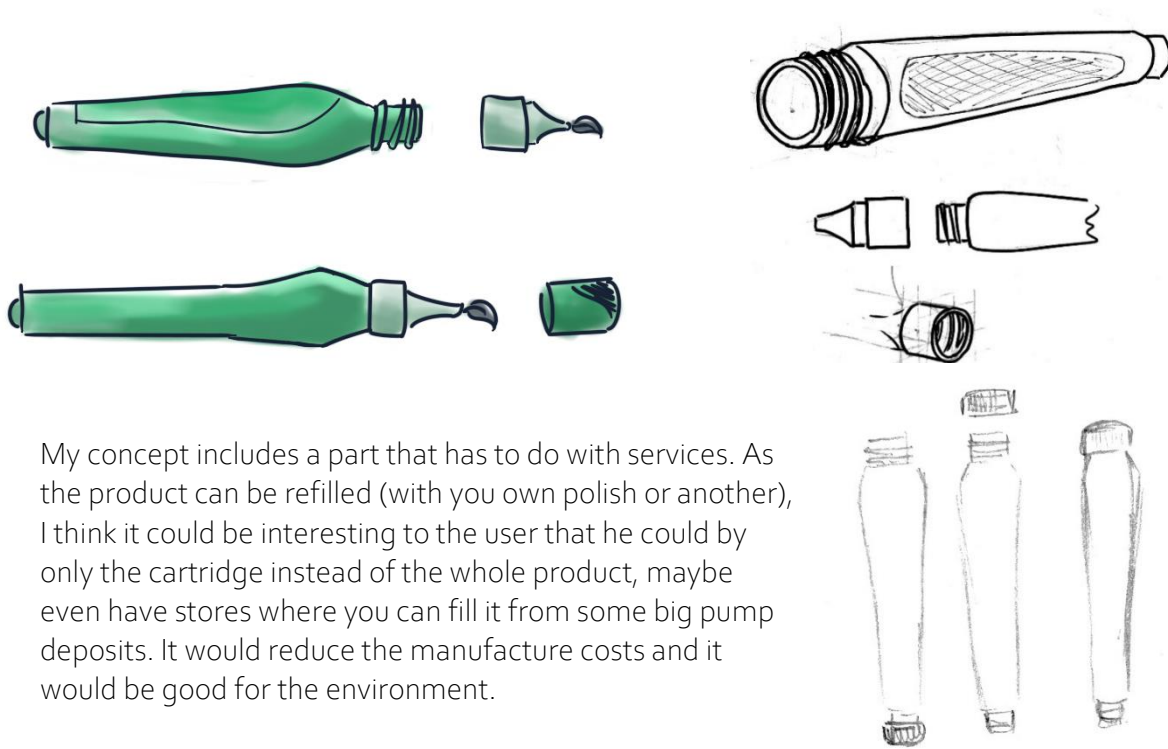


Figure 40 Drawings, source: own elaboration

One of the main cons of the nail polish is the actual motion of taking polish from the bottle for each stroke of the brush. As said earlier, it requires precision to take the right amount of lacquer and dunking the brush in the bottle constantly can become exhausting and repetitive.

The mechanism/ process for it to work should be developed in future stages (if chosen), but my initial proposals would be to have a small button/ wheel near the nib (where the fingers rest, not in the other end) that would propel the polish inside into the exterior without having to change the hand position to activate. Another possibility is to have a flexible tank/ structure where the user needs to apply pressure for the liquid to come out.



My concept includes a part that has to do with services. As the product can be refilled (with you own polish or another), I think it could be interesting to the user that he could by only the cartridge instead of the whole product, maybe even have stores where you can fill it from some big pump deposits. It would reduce the manufacture costs and it would be good for the environment.

Figure 41 Drawings, source: own elaboration



## 7.4 CONCEPT 3 – Attachable brush

Variation from the previous concepts, solution who finds a something in the middle ground between a product completely new (similar to Concept 2) and the typical bottles (Concept 1).

This concept is inspired by the water brushes used in watercolor, but in a way that it is attachable to the nail polish itself.

To make a universal brush cap that could work with every nail polish would be a very difficult (almost impossible) task, so if this concept were going to be developed probably it should come in different sizes or be specifically designed for certain brand.

To pull down the polish there should be some sort of mechanism and button or small wheel (to press the walls of the bottle is not an option due to its glass material) that would eject the polish from inside.



Figure 42 Drawings, source: own elaboration

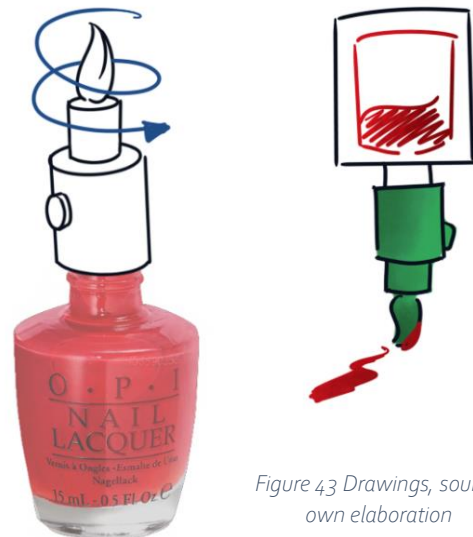


Figure 43 Drawings, source: own elaboration

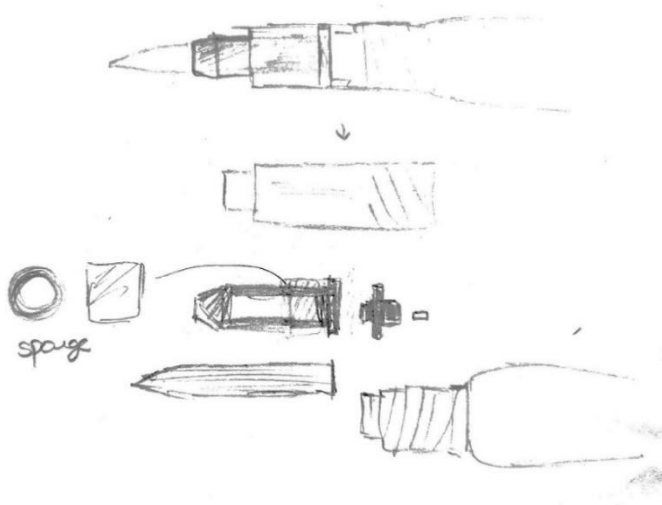


Figure 44 Explosion of the components of a water-brush drawings; Source: own elaboration

## 7.5 Comparison and selection

To select the final concept, I decided to make a weighted table with some important factors that I think the final product should meet. Each factor will be

- **Feasibility:** ease with which this concept will be able to be developed, feasibility of the design.
- **Utility:** how much this product can help its users, if it successfully achieves its goal and solves their problems.
- **Attractive:** how easy it is to promote the service, if the target audience finds it interesting and original.
- **Innovation:** the service offers novelties (either because there are no similar products or services or because it significantly improves existing ones).
- **Simplicity:** ease of user interaction with the product, if the actions involved are clear and simple.

*NOTE: The grades are given*

*on a scale from 1 to 3.*

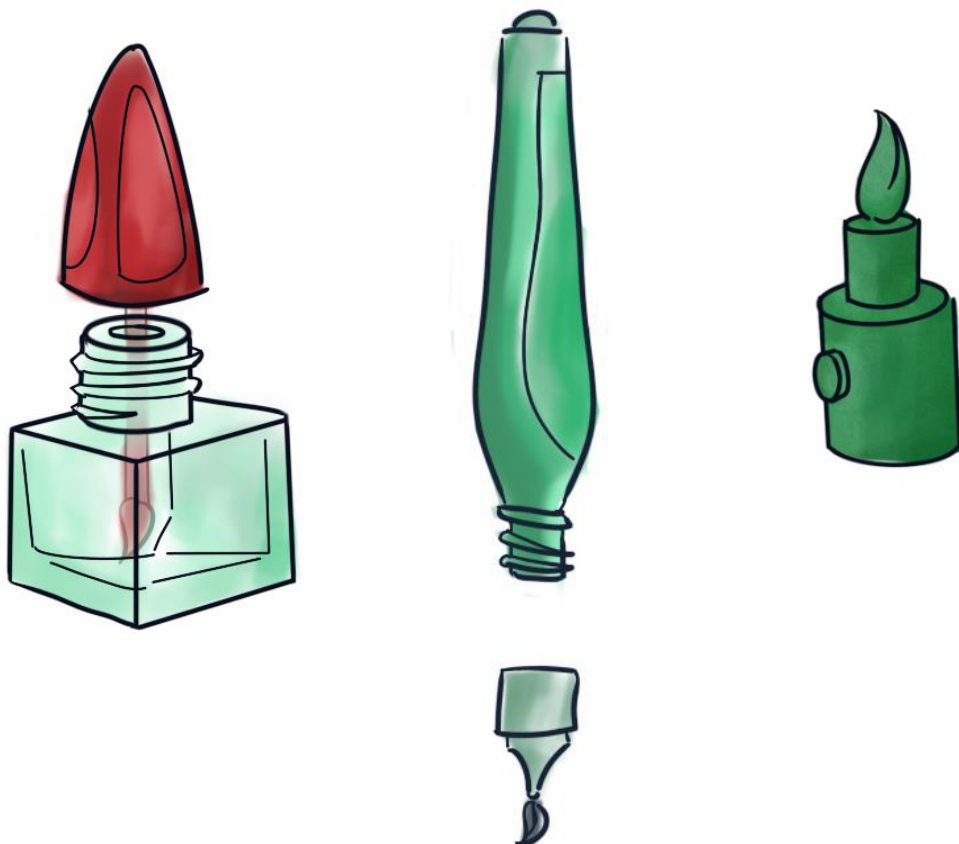


Figure 4.5 Manual renders, source: own elaboration

	<b>Traditional redesign</b>	<b>Nail polish pen</b>	<b>Attachable brush</b>
<i>Feasibility</i>	3	3	1
<i>Utility</i>	3	3	2
<i>Attractive</i>	2	3	3
<i>Innovation</i>	1	2	3
<i>Simplicity</i>	3	3	1
<b>SUM</b>	12	14	10

Table 1 Source: own elaboration

After the results from this evaluation, I decided to choose the second concept: the nail polish pen.

I find the nail polish pen a more interesting concept than its fellow proposals. Just from the first ideas, it looks more innovative and could sell better in the market, as well as would be more comfortable to use and to carry gaining portability (because it works as a independent product, not as for example *Concept 3*). On a different matter, it does not follow the same format as the traditional nail polish bottles (shapes, structure, looks...) detaching itself from the stereotypic product, so it can expand the user market.

# **PHASE 3**

# **Development**

## 8. Used methodology

To address the design development process, I will apply a methodology based on conducting various studies and experimental tests.

1. Problem analysis
2. Research on specific topics
3. Synthesis of information, conclusions
4. Ergonomic study, conclusions
5. Formal development
6. Technical development, materials
7. Components and characteristics
8. Graphic design

## 9. Problem analysis

The main issue that this redesign will have to work with is to redesign the method of application itself, so the users find it more comfortable, more practical and easier to use without earlier experience.

We have already discussed some problems featured in the current bottle design, such as the opening, the hold of the product, how the polish is spread on the nails... In the conceptualization I produced the idea to combine the idea of a marker or a paint brush (easier to hold and to use) with the basics of the nail polish bottle, so during this Development phase I will detail all the components to make this a viable and real product.

Once chosen the concept, the main problems my design will face are its own basics, how does the product work because it is what makes it different from the current market. The study on liquid applications gave me ideas on how to solve this matter, as well as the chapter on the chemicals and materials on the production process. In this phase I will dive into those ideas and, with help of a deep research, I will be able to accomplish these aspects of the design.

## 10. Documentation

### 10.1 Mechanism

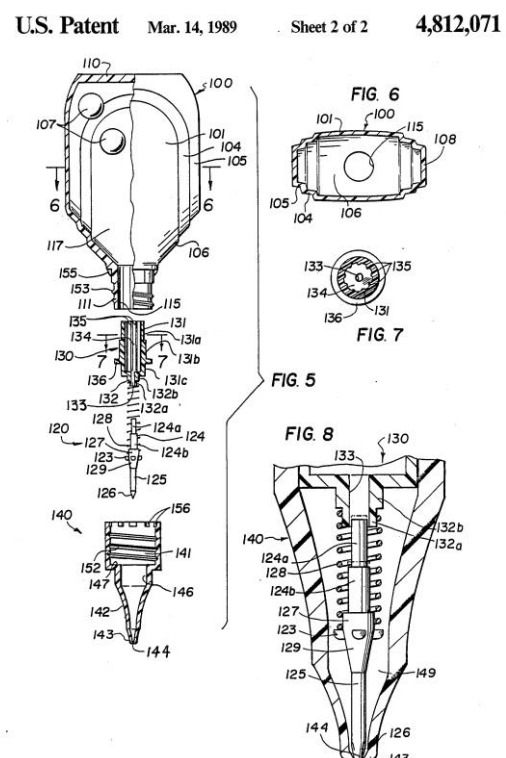
As we chose Concept 2, the big issue was to decide how the product would work, to study the mechanical possibilities.

From the previous study on other products that also display liquids, I found that the best solution could be to apply a system like the one from **correction pens**. Here, there will not be leaks from the body because it will only display the polish when the user applies pressure consciously and it the nib is pressed to the paper. Avoiding leaks is a big part characteristic of the product (that current nail polish bottles do not have solved) because it does not only make the product last for longer, but also is safer and cleaner.

I chose to implement the mechanism that featured a **retractable nib** instead of a roll-on one. As cited in said section, it is more effective (it leaks more amount of polish when the user wants to, he can control it very well) and safer too.

In *Figure 46* we can see the patent of the correction pen, and I take it as an example on how my design would work. I will not expand further in the mechanism itself as it is not my main object to study and I would not be able to test different solutions, so I take this example as a proof of how it could work. It would need some changes (on materials, dimensions, shapes...) but as I cannot get a functionable prototype and get it perfectly defined I do not find very useful to dive very profoundly in this section.

Figure 46 Correction pen mechanism;  
source: original patent (US4812071)



## 10.2 Shape and ergonomics

One of the main ideas behind this project was to create a product that could be the best adapted possible to the nature of the user's hands, as well as to the method of application.

To have a better understanding of the characteristics and features of the hand, I run an experiment where I could get different user's fingerprints when using different kind of products. This was a test to analyze the differences on the hold of each person, as well as to find common points and ideas that could be applied in the formal development of my final design.

See *Annex 1. Ergonomic test* to see detailed the whole experience, its results and conclusions.

### Conclusions of the experiment (*from Annex 1*)

- The triangular shape is the section that, according to the fingerprint tests, better worked in terms of adaptation to the shape of the hand itself.
- The section size should be medium: not big but not small either, enough for the whole fingertips to fit in the sides of the shape (talking about the triangular shape).
- If the product requires to apply pressure, to have flatter sides helps because it is more natural to push (also, the fingertips adapt better). They should not be completely flat but a middle ground between that and concave (if they are completely flat the user must apply much more strength).
- A symmetrical and regular shape is better: the user does not have to adjust the product or grab it in a specific way.
- If the section is not round, it will be harder for the object to roll and slide though the fingers and the user would not have to try to keep it in place.
- The handle should be at least 6-7 cm long, enough for it to rest on the base of the thumb (where it meets the rest of the hand).
- The closer the user can grab the tip of the object the better control he will have.
- The middle finger only works as support: if there is a better surface for the object to rest, the hold of the object itself will be more comfortable and it will add to a better balance.
- If the product requires to apply pressure and the material should be flexible, it should not be very hard to the touch because it will add to the strength the user must do with the thumb and he will get tired in less time.
- If there is a clear place for the fingers to fit in, the user will find the neutral position much more comfortable and easier to grab.
- The more surface (touch) between the object and the fingertips, the steadier the hold will be.

## 10.3 Materials and manufacture

This product has three main parts (**top**, **body** and **cap**), five counting the sliding **piece** inside the body tank and the **point**. Even if the product will be cheaper if all the parts are made out from the same material, it is not possible in this design because each part has different requirements, listed below:

***NOTE:** When designing a product, it should not be my business as the designer to detail all the contents around my design. This includes materials, manufacture process, interior mechanisms... Even though, I wanted to include here a slight view on what could be done in these areas, just as a notion of the viability and to show that I had in mind the feasibility of my design (specially in terms of materials, because is one the areas where I'm trying to innovate).*

***NOTE 2:** There are no mentions to the temperature requirements and characteristics because in this product I do not find them very relevant. There are no steps in any of the processes where there is work with high temperatures (not the main polish, not the containers or any specific pieces that could achieve certain temperature at some point of the process). This comes on one hand, from a very simple mechanism who does not feature electronics. Either way, as the main temperature at all points of the journey will be room temperature (it could change with the weather and location of the user, but those are external factors and even then, would not change relevantly the product), this aspect will not be weighted up with the rest of requirements of each piece.*

### Body.

It contains the nail polish, and with the necessary applied pressure it will also eject small quantities of nail polish (so it serves as container and as applicator).

#### Body's requirements:

- Rigid (always maintains its general shape)
- Resistant
- Soft, deformable (with pressure it can slightly deform but it will recover immediately; modifications are not definitive)
- Chemical resistant (to avoid damage from the polish formula)
- Easy to form (many details)
- Impermeable
- Resistant



As with many products, the material that will cover all these requirements will be some kind of **plastic** (the most common material to work with products with intricate shapes).

The most important requirement that the plastic must cover is chemical resistance because the main point of the body is to contain the nail polish and its formula demands it. The aggressive components on the formula are *Ethyl acetate* and *butyl acetate* (it depends on the formula, they will use one or the other), two solvents that help to mix the rest of the elements in a heterogeny mixture.

The most frequent plastic used to keep chemicals is **Polypropylene (PP)**. This thermoplastic, apart from having an excellent chemical resistance, does not absorb humidity (water resistant) and neither does suffer cracking because of pressure. It can easily adjust its formula with additives (color pigments, for example), it is easy to mold and can acquire different structures and results. Also, it is cheap to produce, and it is recyclable.

<i>Chemical</i>	<i>Compatibility</i>	
<i>Ethyl Acetate</i>	A <sup>1</sup> -Excellent	<p><b>Explanation of Footnotes</b>  <sup>1</sup>. Satisfactory to 72°F (22°C)  <sup>2</sup>. Satisfactory to 120°F (48°C)</p> <p><b>Ratings: Chemical Effect</b>  A = Excellent.  B = Good, Minor Effect, slight corrosion or discoloration</p>
<i>Butylacetate</i>	B <sup>1</sup> -Good	
<i>Alcohols: Isopropyl</i>	A <sup>2</sup> -Excellent	

*Table 2 Chemical compatibility; source: CPLabSafety*

As this body works like a bottle/ container and its main goal is to retain the liquid inside (and by so, having enough space for it), the manufacture process that will be used should be **blowing** (with **injection** at the beginning, to assure that the opening thread is perfectly formed).

## Top.

It is the most complex piece because it will contain the main mechanism of the product. The rough definition of the interior components is explained in the section 10.3, here I am focusing only on the exterior case where my design reaches.

### Top's requirements:

- Rigid, tough
- Does not deform
- Many details (easy to give its shape)
- Impermeable (will be in touch of liquid)
- Resistant
- Chemical resistance (but not as important as in the previous part)

This piece will be made from **polypropylene** as well but using a different manufacture process so the structure will be different. Here it will be completely rigid and has a complex interior (it will contain all the mechanisms), so the method to form it will be **injection**. It is the most common manufacture method used for specific pieces and, even if the original costs are higher, the pieces themselves are relatively cheap and they have great finishes.

## Nib.

It is part of the mechanism of the product and is connected directly to the top. There are more components in the mechanism that are connected to this point and inside the top case (many of them may use this same material because they ask for similar requirements), but in general terms this point should be rigid and anti-corrosive, and not suffer from damage or breaks for the longest time (in other words, a high fatigue resistance level).

The metal used for this material could be **nickel-plated steel**: thanks to being anticorrosive, it would not be affected by the chemicals from the nail polish that will be constantly going through it. Also, it is very light and easy to manufacture (probably with **extrusion** and some **rectifying** mechanical treatment to get the correct final shapes and tolerances) and is a very good material in terms of strength and resistance.

## Cap.

It protects the point from blows and bruises, as well as prevents any spillings the product could produce. It does not feature a complex geometry or any specific requirements, apart from the already seen:

- Rigid, tough
- Does not deform
- Impermeable
- Not easily breakable
- Fatigue resistance

Probably the main requisite would be resistance to the touch and rigidity, because being one of the parts that will be in constant use (the users will take it in and out permanently) it should not break easily.

That is why I think it should be made from Polystyrene, specifically **High Impact Polystyrene (HIPS)**. This family are very known for their impact resistance and are very well processed (as other thermoplastics). It is also opaque, which may not be the most remarkable quality but in terms of the aesthetics of my design is a better fit.

The selected forming process would be **injection**.

## 10.4 Chemical formula

I already talked about the components that feature in the standard nail polish formula and how they participate on it. In this section I want to point out some specific aspects about the formula that have to do with my design and their effect on it.

I am not knowledgeable to talk about chemicals because it is not part of my degree, so here are only just a couple notes that I think should be adjusted in order to fit with my design.

## Density, thickness

It depends on the brand and the nail polish function and effect (it is not the same to have glitter than not, or to be a protective coat or just a slight coat), but usually nail polishes are close to dense and thick.

As in the new design the polish must go through thin tubes and the user must spread it delicately, it should have less viscosity and have a consistency closer to ink than to thick paint. This is also present in some of other inspiration products (correction pens, makeup tools...), where the liquid product featured in more complex mechanisms is much less thick to make the process possible.

So, as its consistence will be more **liquid** -therefore, less pigmented-, the chemists should change the formula to be able to get colors and effects as strong as the usual polishes. That means working with the **pigment** and solvents proportion so one coat can cover as much as the current formula does.

## Body materials

My recommendation for the material of this part is PP (thanks to its chemical resistance), as mentioned earlier. This material works without problem with the solvents present on the nail polish (as seen in the *Figure 9* and *Table 2*), where we see that the solvents present in the formula have a very high compatibility with it).

Nail polishes can use two different solvents, **ethyl acetate** and butyl acetate (sometimes either one of them, sometimes both in different proportions). We have seen that PP works good with both solvents, but slightly better with ethyl acetate. In my opinion, it would be beneficial to avoid the butyl acetate (in case it is possible) or at least reduce its proportion (in *Figure 9*) we see that they can change between formulas).

I think the PP would not be relevantly damaged from the nail polish even if it would still contain Butyl acetate. Still, this investigation and possible changes should be done by chemical experts on this field as this is just a suggestion for the benefit of my product.

## 11. Formal development

After the ergonomic study (see *Annex II*), my starting points to develop the general shape were:

- Triangular section for a better adjustment to the fingers (at least the end that corresponds to them)
- Section between 1.5-2cm (maximum diameter)
- Shape that allows applying some pressure
- Body usable length minimum 6-7 cm (to be able to rest between the thumb and hand) – does not count the top nor the cap

*Plus, the rest of ideas that came in the conclusions of said Annex.*

I started to navigate through a variety of possible shapes and sections. As an extra method to play with the shapes and ergonomics (and test how the different possibilities worked in the hand), I also used white clay to create representations and to get more realistic models.

### 11.1 Development of components

#### Body

In the final model I decided to give the body a shape that started as a **triangle prism** and evolved to a **cylinder**. This way, the section where the fingers do their job of grabbing the product will have a steadier place to hold it, and the section where the product rests by its own (the U where the thumb meets the hand), will be better adapted to any kind of hand (also, it is a softer area so a rounder shape will be a better fit).

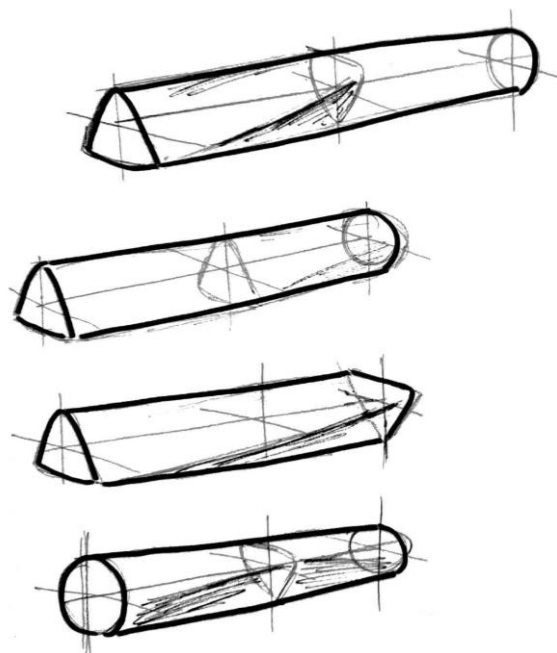
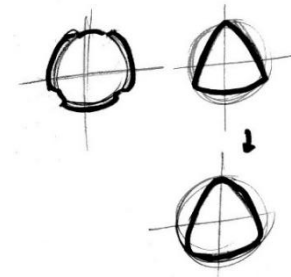


Figure 47 Drafts; source: own elaboration

A very important characteristic was to be symmetrical. Nail polish is used with both hands (when someone paints their own nails, or if left and right-handed people share it), so the design cannot be specifically orientated to only one of the hands. With that in mind, I had to discard some of the drafts because the turns and curves were not adequate to work both ways.



I wanted to give the product some more prominent reliefs (where the fingers meet the material) so the user would not need to apply a lot of pressure. A relief in each side of the triangular tank body would be appropriate. I also thought of making the reliefs inwards, but then there is not that "bubble shape" that makes easier to press -so they were discarded.



In terms of stylistic choices, I gave these reliefs an oval shape when watching them from plan view. Then, I continued that same shape onto the cap and the top to the general product would feel cohesive and with a more organic shape.

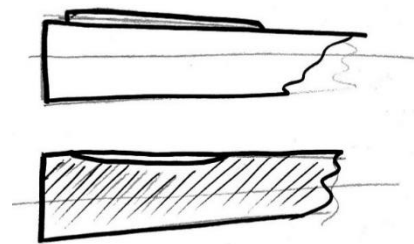


Figure 48 Drafts; source: own elaboration

## Cap

About the cap, I played with different concepts, but my main request was that the user could take it out with no problem. I followed the same pattern I used with the body (same triangular section), sharing with it the same dimensions so the design feels more united. Some of the other shapes included turning around itself, a shape that resembled to a brush... but all of them felt like "too much" and out of place with the rest of the design.

The final shape of the body together with the cap could remind of a marker but it is much closer to a makeup product. Nail polishes many times have their caps in a pyramidal shape (see the final cap) and the smooth lines that traverse all the pieces are details usually left for beauty products.

It is important to mention that the interior section of the cap (space left for closing the top) has been measured so it is possible to put in the end of the *body* and it will stay. This was a choice made so the user could use the product in an easier way, and they do not have to worry about losing this piece while painting their nails.

## Top

As the patents that I looked for inspiration for the mechanism, I tried to give the top piece the shape of a typical marker or pen.

The section that has the thread inside (the part that the user rotates to open) usually requires some kind of texture so it does not slide through the fingers. However, as the shape of the piece itself already has a triangular shape (as the other parts of the product, all follows the same style to get a more ergonomic and aesthetically pleasing silhouette), I do not find it strictly necessary- that shape already gives enough surface to grab it correctly. It also has some smooth curved lines to continue the oval shape used in the body (there is a practical function, here it is more aesthetic).

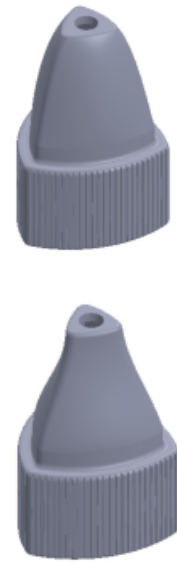


Figure 49 3D drafts; source: own elaboration

## Nib

The mechanism of this piece was already talked about in earlier sections. I gave this nib a **round shape**, avoiding sharp edges. As its main function is to slide through the nail, having edges can damage the surface as well as maybe scratch the nail polish already dried (and produce lines and irregularities). A round and soft head will be gentler for both the nail's health and the process itself.

It has a diameter of 2mm (1mm the retractable piece). This size is enough to release the correct amount of polish the user needs (and big so he can distribute it fast) but it is not small enough that it would not be able to work with precision.

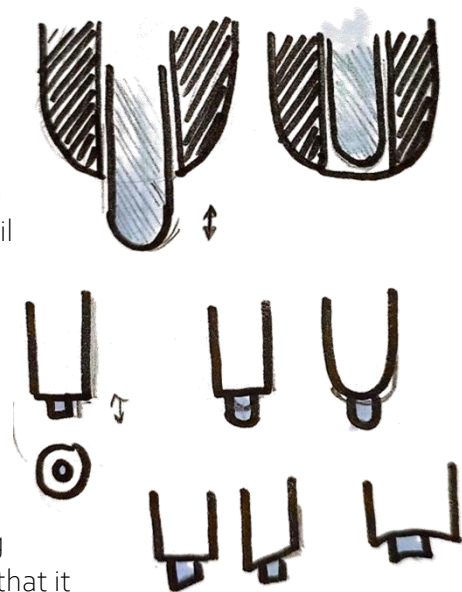


Figure 50 Drafts; source: own elaboration

## Other details

From the beginning of the development of this concept (and it was cited in the research too), to mix better the polish inside the tank there is need of putting **mixing beads** inside. As the body has a long shape, this mixing piece will be a cylinder of around  $\varnothing 5 \times 30$ mm made from steel. This piece is will not be included in the 3D model nor the renders because it does not affect to the exterior graphics (and being a piece with those simple dimensions I find it a little bit irrelevant to include in the plans).

I do not find realistic to have sharp **edges** in most product designs, so I gave all the edges of every piece at least a small round. Also, because of the product itself relying mostly on curves, rounder edges helped to unify the model general view and created an organic design.

In terms of the color palette, I want the body to be **translucid** (possible with PP) so the users can see the real color through the walls. Also, thinking in the manufacture process, it would be much easier to produce only one type of bottles (also, because getting the exact same color as the polish may be more complicate). On another hand, if the user decides to reuse the body tank with their own polish or refill it with a different color it would be easier to identify what is inside (and how much more polish is left on the bottle, too).



**PHASE 4**

**Final product**

## 12. ARADI nail polish

The ARADI nail polish is a new nail lacquer that works with the commodity of a typical pen. With it, the user does not need to worry about dipping the brush into the polish nor taking the right amount of liquid, because it will slide almost automatically.

The novelties that this product presents are plenty. Firstly, the formal shape itself, where it loses the traditional glass-bottle-cap-with-brush appearance for an object like a marker and that works with similar motions. Thanks to this new format, it is much easier to control and work with precision, as well as a much quicker process of painting and much more portable (there is no risk of leaking nor breaking).

Another good characteristic of ARADI is its service offer. This product is refillable: when the product is finished it is possible to unroll the body and put a new cartridge (they will sell on their own by a cheaper price). Or maybe the user wants to fill it with a polish of their own and create new shades. Thanks to this system, the production will be less harmful and gentler to the environment. Also, having the public “interact more” with the products will increase their interest on the product and the brand.

### 12.1 Renders



Figure 51 Several renders;  
source: own elaboration

Study on nail polish containers and redesign according to usability and ergonomics criteria

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Figure 52 Several renders; source: own elaboration

## 12.1 User sequence

1. Shake the ARADI nail polish so the liquid inside gets correctly mixed up and assures there will not be irregularities. This step can also be done after step 2 but shaking the bottle with the cap can be safer.
2. Take off the cap. You can leave it on a side or placed it on top of the tank.
3. Push slightly the nib of the product against the nail surface (so the retractable nib goes up).
4. Press with the fingers the walls of the body tank so, combined with the retired nib against the nail), the polish can leak gradually into the nail.  
*The nail polish will only come out of the bottle through the point when there is pressure applied in both the body walls and the nib. This method contributes to a safer and cleaner product.*
5. While the polish is coming out of the tank, slide the nib through the nail surface to correctly spread the lacquer. The user can also leak the desired amount of polish and then spread it (technique adaptable to each user).
6. Once you are done with the application on one nail, move to the next one and so until finish the whole hands.  
*If at some point the polish does not come out, retire the lacquer that might be dried around the nib.*
7. To change the tank, carefully roll the top piece and put back on the new one (or the old one refilled with more polish, as the user wish).

## 12.3 Graphic design

I decided to call my product ARADI, something that has a personal significant to me and this experience. I added the subtitle "nail polish" to make clearer what the product is about (also, most nail polish bottles have it written down too).



aradi  
NAIL POLISH

Figure 53 Logo; Source: own elaboration

I decided that it would be monochromatic for a few reasons: firstly, it is easier to print and to read and second, it would be more readable with all the colors of the nail polish. Its original color is total black, but it could change to white in specific occasions where the background must be dark (packaging, advertisements...).

The typography selected (*Stinger*) has been slightly edited so it would have rounder edges – on the same style as the product itself. Putting the title in lowercase letters and the subtitle in uppercase makes easier to read the name but without the strong tone that the last ones have. Also, in the beauty industry is very common to use uppercase for the brand names, so it was interesting to do it quite the opposite way (it would make a bigger difference).

## 12.2. Components

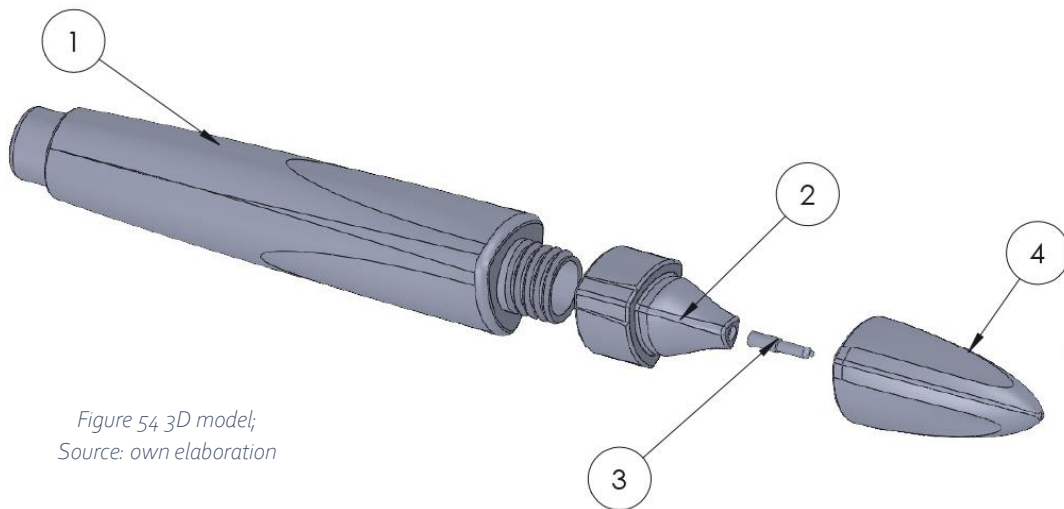


Figure 54 3D model;  
Source: own elaboration

- 1. Body.** It contains the nail polish (and a small steel piece to mix it). Semi flexible so it can be squeezed.
- 2. Top.** It holds the mechanism that makes the retractable nib work.
- 3. Nib.** Retractable piece that leaks the required amount of polish when retired and pressure applied from the body.
- 4. Cap.** To close the object and to protect the nib.

A **smaller cap** is the responsible to close the containers that only are sold as cartridges and without top nor nib. As seen in the picture, it follows the same lines and patterns as the resto of components.



Figure 55 3D model; Source: own elaboration

## 12.4. Sustainability

Traditional nail polish bottles are designed with one goal only (work as nail polish until they are finished), they cannot be reused for different practices after they are done. That is not a very sustainable, so the bottles themselves should focus on the recyclability.

Glass is recyclable, but because of the chemicals in the nail polish formula, the bottles require a very precise prior interior cleaning and that is not something recycling companies are always willing to do. That is why users are encouraged to clean them themselves so they can be recycled along other glass products, but it is not yet the usual habit. That is why the brands work on different areas to reduce their impact: formulas (not harmful), packaging (recyclable materials for the caps, not using boxes, the labels themselves), production...

ARADI, having a different format with different materials, varies from the typical stereotypes of polishes. From the base of the concept, users are encouraged to reuse themselves the products and refill the tanks with their own nail polishes (even if probably they must alter a bit the formula with some specific procedures) or refilling it from the store (from exposition bottles or similar). **Re-use** is, from the 3Rs rule, is the one that nail polishes do not usually cover, and my new design ARADI could solve that problem.

In terms of **recycling** itself, the product would require some interior cleaning. After that, PP and HIPS are both recyclable polymers so there would not be any problem about it. Probably the top piece would require some more treatments because it contains the mechanisms and smaller pieces, but apart from that we could consider that all the product is recyclable.

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