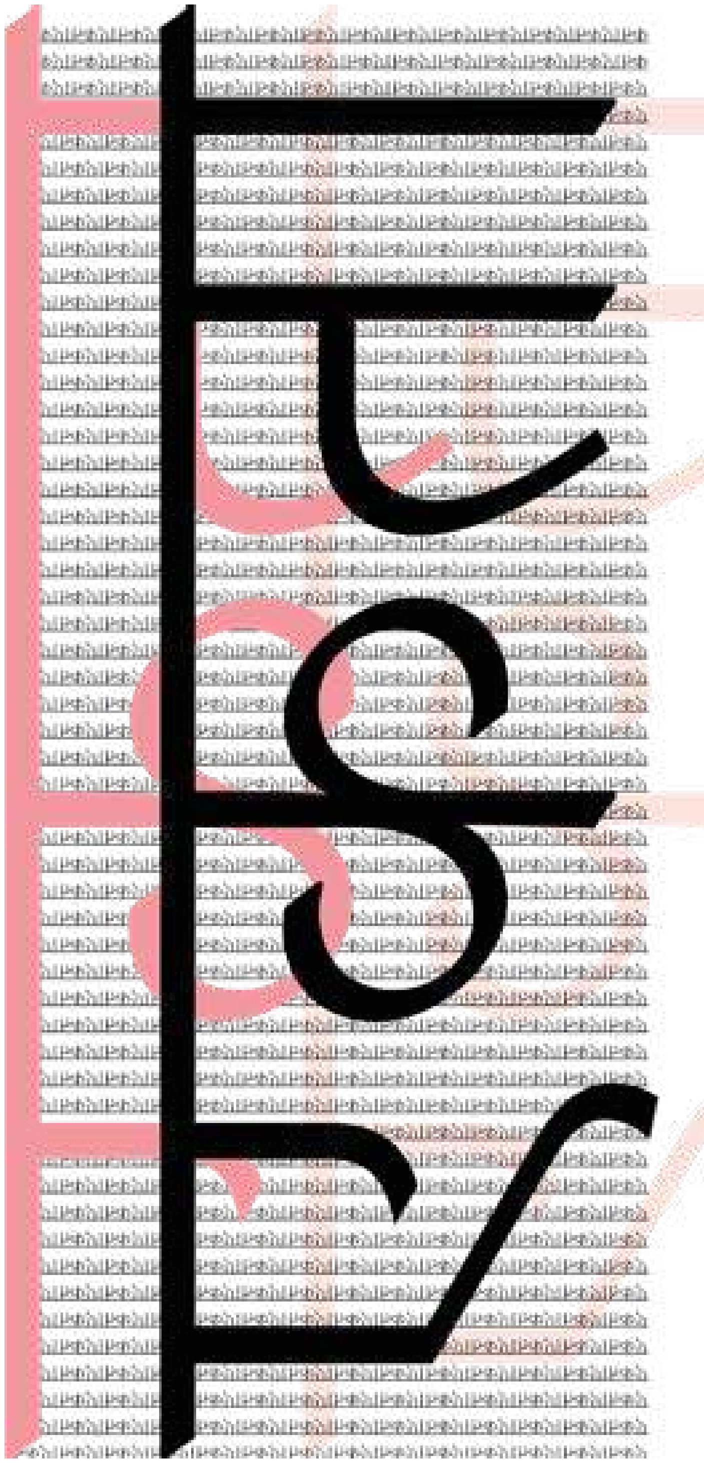
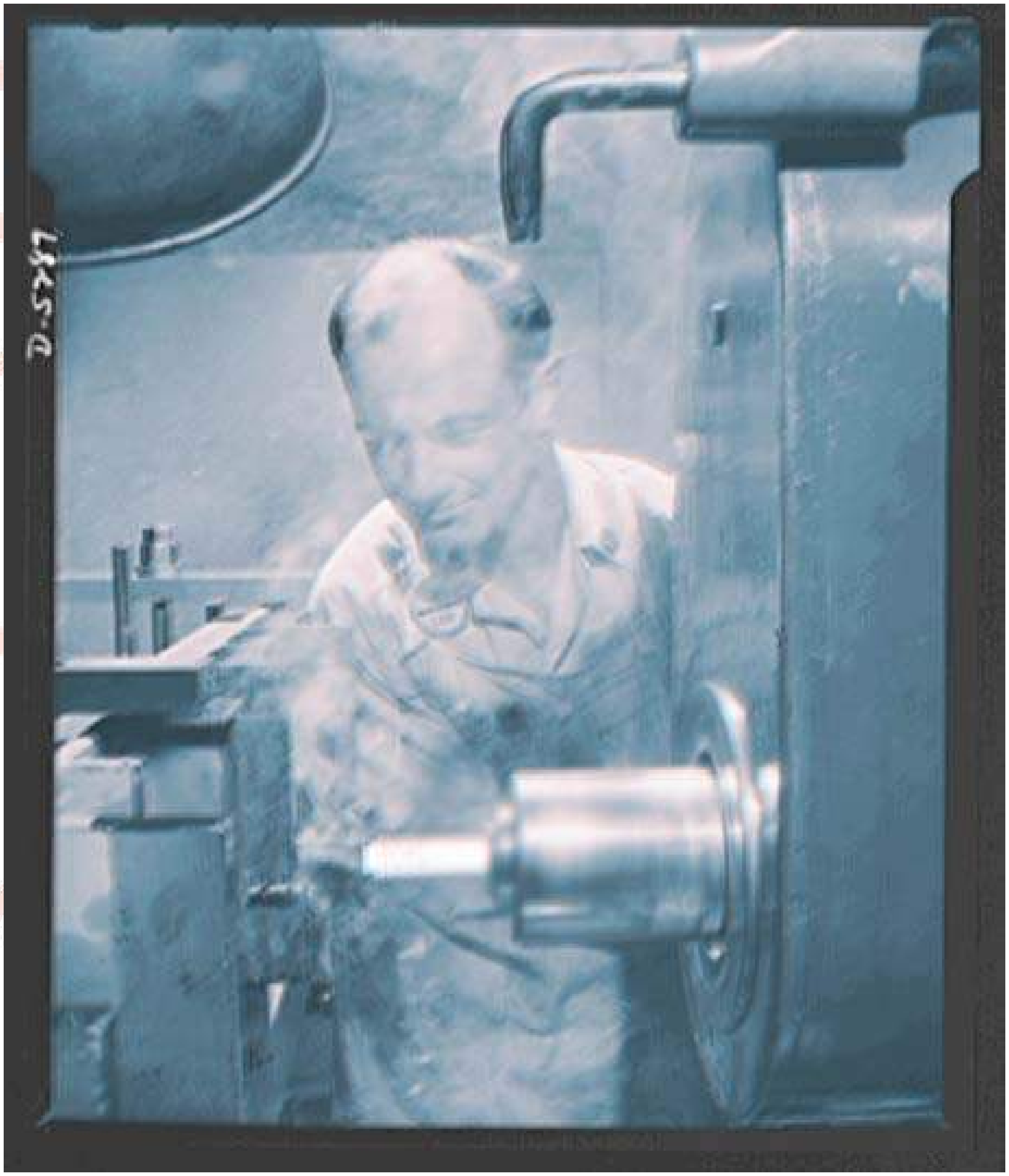
DESIGNING FOR SUSTAINABILITY.

VISUALIZING OF HAND-POKE TATTOO PROCESSES.





Designing for Sustainability.
Visualizing of Hand-Poke Tattoo Processes.

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HOW CAN THE IMPACT OF TATTOOING BE VISUALIZED TO CREATE AWARENESS & CAN IMPACT REDUCTION FOSTER A MORE SUSTAINABLE FUTURE?

“Good design is obvious. Great design is transparent.” — Joe Sparano

Disclaimer:

When conducting LCA (Life-Cycle-Analysis) based on research if the companies producing the product don’t provide answers about it through E-Mail or information on the product packaging itself, the LCA will never be 100% accurate. The chosen system to conduct the LCA´s is Sustainable Minds 2013 (SM-13). The Data will always lack precision since all subareas of an LCA (Raw Material, Production, End-of-Life, and Transportation) can vary in precision when analysis are conducted through educated guesses. Furthermore there is no Use-Stage for the majority of products since it doesn’t apply to the application style of hand poke. The LCA type in my specific case is mostly Cradle-to-Grave (Raw Material, Manufacturing,Transportation and the EOL Scenario of Incineration) with Incineration being the provailing EOL Solution for biohazardous Material in Germany.

With that in mind, this LCA will try to be as accurate as possible highlighting missing information due to the lack of access to company-specific data. But to counteract the impreciseness of this LCA, results will be displayed transparently by highlighting missing information and giving explanation why Data Gaps occur and how they could be overcome .

The Data presented will lay the foundation of ongoing research and improvements to data sets as its accuracy increases when new processes and materials are added to SM-13 in the future.

The LCA will focus on the following aspects, Raw Material Stage, Production, Transportation, and EOL (End- of-Life). Cradle-to-Grave utilizing American data sets provided by SM-13, and the local EOL scenario of incineration.

The Solutions proposed in this Thesis will focus on the present:

1. Current status quo and how products are dealt with in their EOL.
2. Propose possible alternative EOL scenarios like mechanical or chemical recycling, highlighting the pros and cons.
3. Propose alternative Materials or reinvent a product to reduce single-use impacts.
4. Explaining the importance of education to promote social and political changes towardsm sustainability.

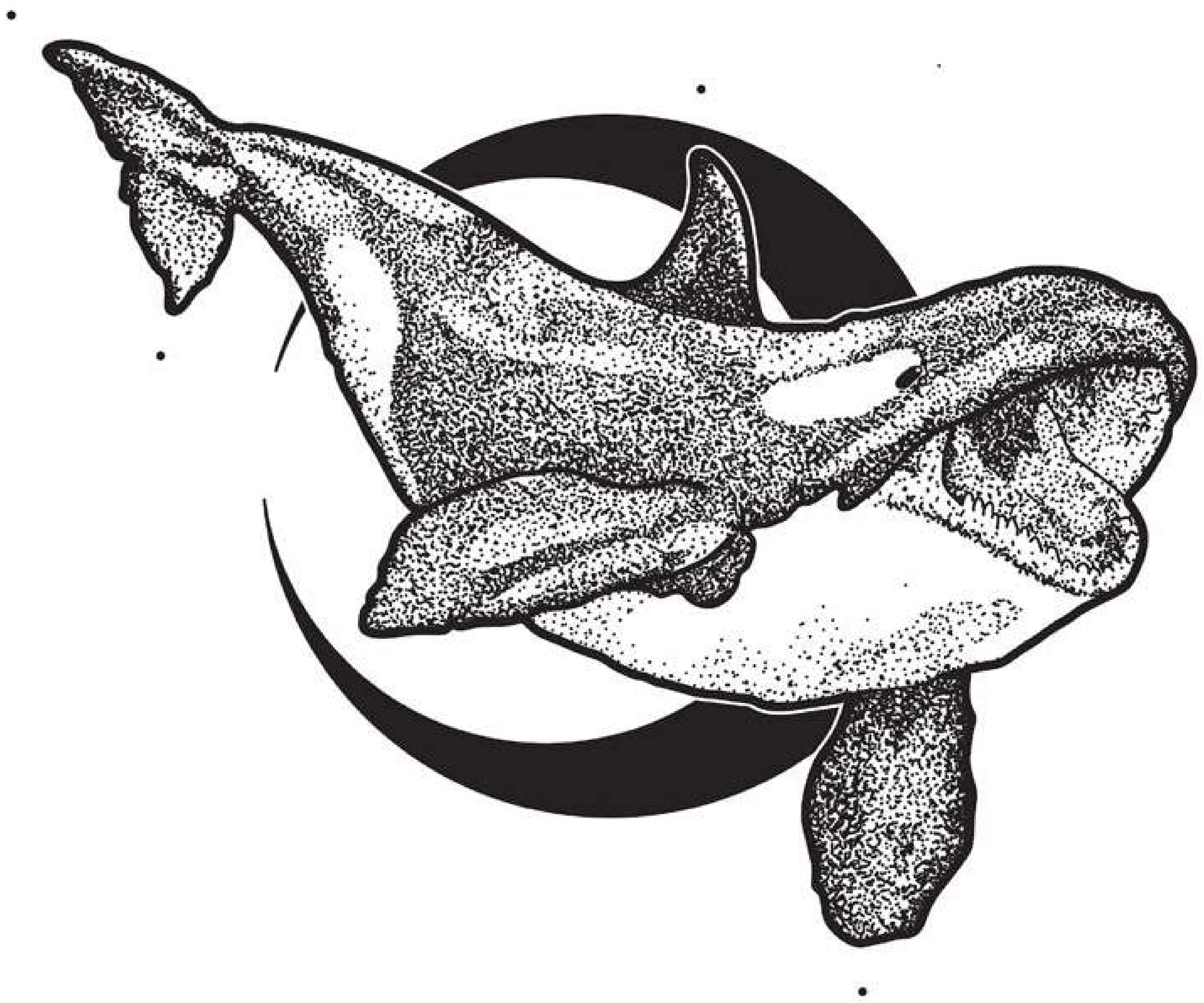
PERSONAL MOTIVATION

Curiosity for manufacturing processes and products EOL has helped to summarize a complex project in four categories, that aim to highlight possibilities for product improvements, in order to reduce application impacts.
There is no one solution to solve it all, nor a perfect LCA, nor green or Sustainable Design, but rather an improvement of a product to be greener or more sustainable. To prevent greenwashing the data displayed, explanations are highlighting Data Gaps transparently in this Thesis.

On a personal level, the goal is to minimize the amount of rubbish produced in a single tattoo session. Calculating the true impact of a product and its product alternatives, finding out if green truly means sustainable. This data is calculated in SM-13, in certain scenarios this comparison can not be executed due to missing material, process or EOL data. Some products are promoted as sustainable, eco, or green, but the LCA data is displaying a different story. This shows a current problem of not having to prove a product's sustainability, but rather the sole statement of it being green, being enough to pull a claim. In order to improve this behaviour data should be accessible and understandable. This was one of the motivations to conduct a "complete" LCA for my specific product constellation for hand poke application, to highlight areas that can be improved in order to lower the impact of a single tattoo session, while being transparent about missing information. All Data will be provided without a Brand name.

The Result should portray the current impact of my style and product constellation of choice, providing a simple way to calculate a specific tattoo session's impact through data standardisation. The correct product unit plays a major role in making the data set usable, meaning that the impact of a product will be displayed as such that it makes calculation easy and versatile for multiple scenarios. The Data includes the product and its packaging. For the "Session Impact Calculator" the data is subdivided to give the Product, including its packaging proportion associated with the product, which is stated within its functioning unit. This will allow other artists utilising similar products to get a rough understanding of how big the impact of a single tattoo truly is. The Data set can not be used to give accurate Results since in the first place LCA calculations are always customized to personal use case scenarios, but for artists within Cologne and Bonn the Data provided shows great accuracy within the usual margin of error of 10-15% that is associated with LCA calculations. When Data is especially unreliable in cases of major Data Gaps, the concern is highlighted within the LCA. In addition of LCA Reports, the Website ***(handwerk.ink)*** is provided. The Website will be constantly updated when new data is available.

While putting a strong focus on eliminating single-use cartridge grips for hand poke application, the justification for the sustainability of the Ekatā S (Ekatā Simplified) is validated through LCA data. This will ensure that I'm not making the same mistake of greenwashing my proposed solution for a single aspect of the application process as some new brands in the industry have done through marketing. In general all reusable products will end up having lower impacts compared to their single-use counterparts, with higher initial Impacts in their LCA. This is due to the reason that reusable products are made from Stainless Steel (SAE316) and metals in general have higher manufacturing impacts, due to their weight and the higher energy consumption required to manufacture them.



PROBLEM STATEMENT

While analysing the product constellation utilised during the application, there have been five problems that I can address within the Thesis.

The first problem identified is the use and especially the inadequate use of single-use products, especially concerning those of crude oil origin. Plastic as such, utilised in single-use products and the neglect for proper EOL solutions. This behaviour has environmental and toxic consequences we should be all aware of and motivated to reduce and resolve for the wellbeing of the human and environmental well-fare. But the responsibility for this change is complex, a need for better material choices, fair working conditions, political agenda, implementation of greener EOL solutions, but most importantly awareness and education.
Changing one facet merely improves a product's impact but never makes a product sustainable or green. (Casoli & Ramkumar 2020)

"There is no such thing as 'away'. When we throw anything away it must go somewhere." – Annie Leonard

The lack of concern for preserving the wellbeing of our planet is partially caused by lacking awareness to see its direct impact. We are barely aware of where Materials end up and how they are dealt with in their EOL – *"out of sight, out of mind"*. This is a problem of education and political ignorance in combination with money-driven decision making. For example, if a company that produces a product would have to deal with the products EOL responsibly, certainly the motivation for Cradle-to-Cradle systems would be preferred over Cradle-to-Grave. But with inadequate EOL solutions and the lack of financial responsibility for the damage produced, the system is deemed to fail in its entirety. Sustainable design starts with education, creating awareness, pushing for political change, greener production, and finding adequate EOL solutions following the Pyramid of the 4R`s of Recycling. This ensures that everyone involved in the products production from Raw Material to EOL as well as from producer to consumer is responsible for the impact a product creates. This shared responsibility could lead to a more sustainable future.

The 4R´s of Recycling explain the hierarchy of importance in reducing impacts meaningfully and sustainably.
"Reduce" being highest priority, meaning that the creation and use of plastics, especially those of single use nature should be avoided all together to mitigate environmental impacts created.
"Reuse" being the second highest in the hierarchy and one of two goals that should be set in order to have a meaningful impact. Material choices should be made in order to accommodate Reuse practices.
"Recycling" being the third and one of the less favourable practices since the process is cyclic and eventually will lead to products of lower quality than virgin plastics.
"Recover" being the least desirable, energy is recovered from the waste stream of plastics through thermal combustion (Incineration).

This will render the Material useless for further applications and has a highly toxic byproduct that will be discussed in a later chapter.
Some Technologies that are used today like incineration are chosen for their ease of EOL handling. Incineration is the favoured solution in Germany for medical and household waste, eliminating the reuse of materials since the materials are transformed into toxic ash rather than recycled into new products. Plastic is at the misconception of being a non-eco-friendly material per se, but in reality, their environmental impact are often far lower than materials that claim to be eco-friendly.

This claim assumes that no plastic enters the ecosystem and all materials are recycled into new products. But with incineration being the status quo on EOL handling in Germany, the effect on our planet is more harmful than we think.
Possible solutions for this problem would be education and more precise material separation at the consumer level, using mechanical recycling.
Adding value to the materials we consume will change the perception of single-use towards reuse. But in the end, waste is just a type of resource, and if we treat it right, it leads to a positive impact towards sustainability.

Furthermore, products like the Cartridge needle for example use Medical Grade Epoxy resin to fix the needle grouping to the needle shaft (figure1). This Introduces an additional material that increases complexity for EOL handling. This is a common problem in products, and EOL is rarely considered to be an important aspect of design, but I would like to argue that it might be one of the most relevant tasks in good design today. Considering ease of EOL handling and striving for more sustainable solutions. Finding mechanical solutions for glued connections will minimize a product's impact significantly while solving EOL disassembly problems within a single design change.

This Methodology was described in Victor Papaneks book "The Green Imperative" and is called DFD (Design for disassembly) This Methodology focuses on reducing a products EOL impact within the design process, by designing parts to be composed of single materials rather than Composite materials. Furthermore the design process should involve take-apart technology utilising standardised instead of speciality screws, two way fasteners and pop in pop out rivets, forming the new backbone of Product design. These design methodologies foster lower product impacts, especially EOL impact reduction through ease of disassembly when a product has served its lifecycle. Instead of glueing, welding or using other mastic agents the product can also be repaired or partially replaced more easily and parts become universally accessible without the need for speciality tools to perform repairs; this prolongs the products lifecycle.

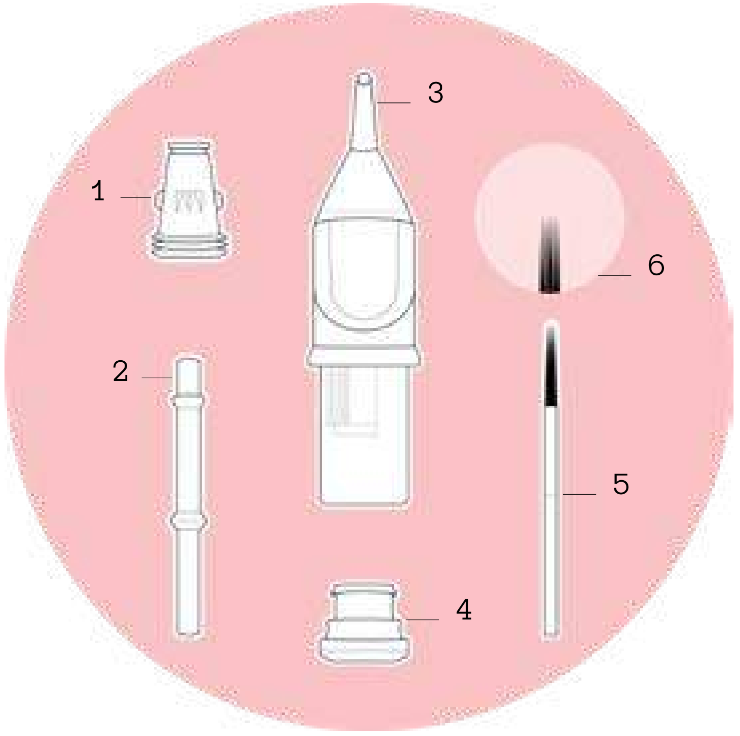


figure1
1. Safety Membrane
2. Needle Shaft
3. Cartridge Body
4. Cartridge Cap
5. Needle Grouping
6. Needle Grouping Detail (RS)

Aims & Objectives T

The aim of this Thesis is to evaluate the true impact of a “Tattoo Session”. The data sets are based on my personal preference of a product constellation used during application. In order to create scientific data, SM-13 is used. Using SM-13 has the benefit of comparing products which serve the same purpose but are composed of different materials, SM-13 allows to evaluate which product is more sustainable through in-build tools.

Accessing Data to evaluate a product’s environmental, socio-economical, and toxicity impact, helps to point out the areas that currently have the biggest potential for improvement. While reflecting data it is important to see beyond the facts they present, keeping the bigger picture in mind helps to switch in and out of holism and atomism.

Establishing comparison between two products with the same purpose but different material choices, in these cases the materials should be compared directly through SM-13. Data can be compared in relation to SBOM (Lifecycle Stages) total and SBOM Carbon footprint (Lifecycle Carbon Impact) as well as Impact by life cycle total (mPts) and life cycle Carbon footprint (CO^2 eq. kg). The Scorecard feature also allows to highlight major impacts by impact category, this will, in turn, provoke research for possible solutions.

In areas beyond my influence where industry standards dictate, for example the way medical waste is treated, future technologies should be critically analysed on the topic of impact, sustainability and ecotoxicity. Potential for environmental harm reduction or Greenwashing should be highlighted.

Aims :

Conducting LCA
Analysing LCA
Visualizing LCA
Recommend Solutions

Goals & Insights

Switching from the Okala LCA data to SM-13 allows for more precise insights, access to larger data sets, and overall more detailed recommendations for the reduction of a product’s impact.

1. Justifying the reduction or preferably elimination of the necessity for single-use products. Redesigning selected products from the Product Constellation. For example eliminating the need for single-use cartridge grips, replacing them with a long-lasting reusable product that can be recycled at its EOL and is designed with DFD guidelines, will result in impact reduction. Rethinking the status quo will help to generate awareness and show a diversity of solutions tailored to specific products. There will not be one solution applicable to all products due to their diversity in material composition and the possibility of being classified as bio-hazardous material which adds complexity to solution oriented proposition.

2. Recommending system change on a political level would result in better EOL solutions, further minimising the impact. Scenarios recommended in the LCA´s, would not be applied by the industry due to competitive reasons. Until the entire industry sector is obliged by law, companies will strive for the most profitable manufacturing solution which most of the time is not the most sustainable one.

3. Improving awareness of the hidden impact of a tattoo session.This could trigger discussions which make the hidden visible to a wider audience, creating awareness, fostering the want and need for change, creating more sustainability within this industry.This being a long term goal the thesis will only be able to scratch the surface of this complex problem.

4. Gaining a deeper understanding of the current impact of sustainability within the medical industry in the topics of material choices, production, and end-of-life decision-making. Alternative materials like bio-based plastics, mechanical and chemical recycling instead of incineration. Highlighting the benefits and downside of each technology or proposed partial or complete solution for products and how we deal with them in their EOL.

LITERATURE REVIEW

The succeeding literature review will examine six topics that are interconnected to the thesis research question.

The first chapter will highlight the impacts of toxic pollution on humans.

Chapter two will take a look at Microplastic's impact when introduced to the environment.

The third chapter will look at a possible solution for medical-grade plastics utilising biopolymers.

Chapter four will look at waste incinerations and the creation of environmental toxins.

In the fifth chapter we will investigate the proclaimed green technology of chemical recycling.

The sixth and last chapter will look at the misconception of Plastics recycling capability .

1. How Pollution Affects Humans

The very same pollution we are negatively impacted by, is the pollution we have caused as a species. The misconception that we are not affected by remote pollution in a world with interconnected ecosystems is becoming evident with scientific data proving negative effects on a global scale and not only in the places where the waste and pollution is introduced into ecosystems at first. It is only a matter of time before the effects of local pollution are spreading, causing further ecological destruction to a greater proportion of our planet. Releasing pollutants into the environment are already documented to cause a variety of risk to the human species inhabiting the very same ecosystem which we pollute. Bad air quality raises the chance of lung disease, bad water quality poisoning the body directly through contaminated water consumption or indirectly through the animals we eat that live within the polluted bodies of water. But one of the most concerning development is the increasing number of plastic products that end up roaming around in the ocean. But the main focus will be laid on air pollution with its relation to the current status quo of EOL for biohazardous material and its negative impacts in Germany.

Air pollution for example is the world's 4th most lethal Killer. (The World Counts)
On average 8,8 million people die every year from the consequences of air pollution, this means every 4 seconds someone on this planet dies from the very same pollution caused by his kind. 90% of the world's population live in places with an air quality standard, that doesn't meet the standards set by the WHO. (WHO 2021)

The current status quo of single-use plastics used for medical application in hospitals as well as in the tattoo application will end their EOL in Incineration. The fact that transforming waste into energy is seen as an ecofriendly solution for EOL is wrong to begin with. An article written by ClientEarth summarises this with the following statement :
"At the end of the day, converting plastic waste into energy does nothing to reduce demand for new plastic products and even less to mitigate climate change. To push for these approaches is to distract from real solutions like reuse systems at scale." (ClientEarth 2021).
But not only does the current EOL "solution" causes the demand for plastics to grow, but much worse, causes exposure to toxic smog which is released from these facilities. As poor air quality is already a major contribution to toxicity introduced by our kind and has lethal consequences, this system can not be perceived as a true solution for the amount of waste we produce. To put a number on this topic I would like to quote a Paper of Roland Geyer et.al *"We estimate that 8300 million metric tons (Mt) as of virgin plastics have been produced to date. As of 2015, approximately 6300 Mt of plastic waste had been generated, around 9%of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment. If current production and waste management trends continue, roughly 12,000 Mt of plastic waste will be in landfills or in the natural environment by 2050."* (Geyer et al., 2017)

China used to be a major importer of European waste and with them closing their doors on the import of the waste we have created, the next incentive was local incineration. But this is not a solution in the long run, since burning plastics causes toxic smoke which is released in the very same air we breathe:
"But waste does not just disappear in a puff of smoke. The more waste and plastics are sent to be burnt, the more our environment and health will suffer in parallel."(ClientEarth 2021). The Toxic ash leftover at the end of the incineration process is called filter cake and is dealt with in a similar manner as nuclear waste, but compared to the concerns of nuclear waste having to be stored for 1 million years securely , the filter cake is as toxic in its own manner and the toxicity of the waste will not deteriorate over time. The solution for the toxic waste would have to endure the history of mankind. Since these scenarios are not likely to be found anytime soon, the current solution is storage in metal containers in retired salt mines with the concern of contamination due to leakages into the environment while making the stored material unreachable for visual inspection and replacing the barrels if needed, due to backfilling of waste. In other Scenarios in Germany the toxic waste from incineration was stored in open pit landfills against German EOL guidelines in order to save money due to high EOL cost of the Salt mine process. This is often the case when money is the driving factor in finding solutions rather than the wellbeing of the environment we are so reliant upon. (Recycling Magazin, 2011)

As in an example from England, the negative environmental impact as well as misuse of resources is not the only downside of Incineration, but also its social impacts. The incinerators built are affecting the deprived areas of the country in the northern part of the country. In fact they are three times more likely, to be built in these areas. People having to live close to these sites do not only complain about poor air quality but experience a variety of downside related to the technology of EOL handling like noise, increased traffic, bad smell, as well as litter around the facility being the major issues accompanying toxic fumes. (ClientEarth 2021)

To tackle this problem, a social change is needed, where waste is no longer perceived as such, but rather a resource that can be utilised to form new products.
A second step would be adding value to more plastic waste materials (if applicable) like it was done with PET in the German recycling system, this will ensure smaller amounts of plastics to enter the waste system and rather being utilised in recycling. When adding value to the material as well as the artificial cost, to unsustainable solutions like Incineration, recycling in the form of mechanical recycling could lower the impact we have upon our ecosystem.

The most sustainable solution at hand and implementable, is an elimination of plastic use or a redesign of the product towards packaging where the materials are reusable in a deposit-return system. This will ensure a minimal impact when performed locally since a global deposit-return system would have the hidden impact of transportation over large distances.

LITERATURE REVIEW

2. Microplastics in the Environment

Based on the overview of impacts plastic have to the ecosystem as well as the humankind, in specific the ones classified as Micro and Nanoplastics (MNPs), published by A.Amboyeji et all in 2021 through frontiers in microbiology, this chapter will aim to highlight its concerns. Due to their increased bioavailability caused by the decreased size which is directly correlated to an increase in their toxicity. (Amobonye, et al., 2021)

MNPs have been recognized majorly as marine contaminants with estimates of hundreds of thousand metric tons floating on the surfaces of the major marine ecosystems. (Wright et al., 2020)
With plastics being exposed to the marine environment, especially in the form of MNPs, the bioavailability to the scale of phytoplankton allows for its impact to move up the food chain, potentially ending up on our dinner plates.
The exposure of MNPs to the environment can be associated with primary and secondary sources. (Ma et al., 2020)

A primary source could be microplastics used in the cosmetic industry and cleaning products, such as abrasive cleaning products or peelings in the form of cosmetics. Textile particles enter the waterways from textile washing, drying, or dyeing on an industrial scale but also happens in daily life when executing chores around the house. (da Costa., 2018)

Secondary MNPs are formed through plastic exposed to the ecosystem either through the waterways, incineration, or landfills and are created when excessive UV radiation, physical, animal, or microbial exposure cause the material to degrade forming MNPs. (Laskar and Kumar, 2019).

2.1 Understanding Toxicity

The presence and global exposure to MNPs through human neglect for proper EOL solutions have been documented to access all parts of the globe from the remote polar regions of the north and south, frozen in ice, to the waters around the equator. (Amobonye, et al., 2021)

Causing a major concern is the increased bioavailability due to particle size which has strong correlation to their increased toxicity.
This is summarized by a statement from Ferreira:
“ Although there is still more to be learned about the eventual fates of MNPs in various biological systems, especially in humans, it has, however, been noted that the biological reactivities of plastic particles like most other materials increase with decreasing particle size and surface area. “ (Ferreira et al., 2019)

This toxicity is caused mostly by nanoparticles, for example, polystyrene particles of 60nm in size or less which possess the ability to be uptaken by cellular environments like the macrophage or epithelial in living organisms and causes damage to the inhabited cells. (Bhattacharjee, et al., 2014)
The cytotoxic effects of MNPs have also been documented in various human cells like lung tissue when exposed to contaminated air (An et al., 2020), intestinal cells when exposed through ingestion (Stock et al., 2019) as well as cerebral and epithelial cells (Schirinzi et al., 2017).

An example given in the scientific paper by Amboyeji shows the exposure of MNPs in approximately 80% of all bottled brand water investigated. ( )
In comparison a person relying on bottled drinking water is estimated to ingest 90,000 microplastics annually compared to 4,000 microplastics for people relying on tap water. (Cox et al., 2020)

2.2 Solutions Suggested

A suggested partial solution to the growing exposure of MNPs and the dearth knowledge on their true impact recommends a partial move towards more sustainable plastics of the bioplastic type in combination with political regulation and consumer awareness creating a more sustainable future for us all.

A feasible approach is the introduction of bioplastics replacing crude-oil derived plastics in order to allow for environmentally friendlier materials being introduced to the current industrialised system in place.
Bioplastics include:
polylactic acid, poly-3-hydroxybutyrate, polyhydroxyalkanoates, polyhydroxyvalerate, polyhydroxyhexanoate, and polyamide 11, which are derived from renewuable organic materials which ensure degradation through microbes and enzymes as well as hydro-degradation (Filiciotto & Rothenberg, 2020).
An example of hydro degradation will be given in the next chapter, therefore no further argument will be made towards this effect.
Bioplastics replacing crude-oil-based plastics, therefore, have the potential to replace their counterparts with similar material properties but a lower impact to the environment. (Ogunola et al., 2018).

This move from crude oil based plastics towards biodegradable plastics should only be applied to products where reuse is not an option. Although potentially lowering the impact we have on the environment concerning MNP´s the downside of using feedstock for creating plastics increases the need for larger land masses in order to compensate the relocation of resources previously used to feed the human population. With increased agriculture especially the common practice of monoculture farming the equation is doomed to fail since one environmental pollution is not reduced, but rather replaced with another form of pollution. Monoculture farming sees the excessive use of fertilizers to keep nutrient deprived soils yielding large harvests, this excessive use of fertilisers is seeping into groundwater and neighbouring water streams and creates an imbalance of the aquatic bodies, changing living conditions for microorganisms and aquatic life in general. (Unger et al., 2017)

In order to truly reduce the impact we should foster awareness and political change, in order to promote local reuse systems at scale, this minimises transportation impacts compared to global reuse systems. In addition creating workplaces and adding values to products with lower overall environmental impacts compared to SUP (Single-use-Plastic) oriented products. This will not be applicable to all types of products, for example medical Products like bandages in some cases should and can not be reused without risking the patients health, at our current state of technology, in these cases waste reduction, material reevaluation and better EOL solutions would be a more adequate way of trying to solve the increasing plastic waste production.

2.3 Political Action

A politically motivated phase-out of the utilisation of microplastic beads in cosmetics through legislation will enhance the universality and effectiveness in reducing MNPs in the environment.(Anagnosti et al., 2020).
Although this would be a great step towards sustainability the reduction of secondary sources through decomposition can be mitigated and supported by introducing recycling systems which help to reduce the huge amount of plastics potentially entering the ecosystems in the first place. This would also be a desired approach in the tattoo industry since this relates to a broader range of products from the product constellation identified.
At this point in time, recycling plastic is just not economical due to the low cost associated with virgin materials and the low value associated with plastics due to the stigma of single-use products being perceived as waste, rather than a resource. A politically imposed tax could evoke an incentive towards a recycling-oriented society in the specific case of plastics. (Calero et al., 2021).

As an example, the imposition of a plastic bag tax in Portugal was estimated to cause a 400% reduction in the consumption of plastic bags per person, per shopping trip. (Martinho et al., 2017). This shows the power of imposition, evoking social behavioural changes with positive environmental impacts as a result of the political incentives.

But not only European countries are showing a change in social behaviour towards sustainability also developing countries like India have adopted an awareness and willingness for change. The introduction of different bans and restrictions for example, the Indian capital Delhi banned all forms of disposable plastics while the State of Karnataka in India has totally banned single-use plastic items.(Radha, 2019).

The most recognisable passage from the text is in some way a call to action which I would like to quote, to sum up this chapter:
“Furthermore, there is also the urgent need to develop and implement sound legislation and regulations regarding MNPs and plastics materials in general. Efforts at standardising monitoring methods, identifying technical and waste management gaps, and encouraging recycling will all go a long way in mitigating the detrimental effects of MNPs.” (Amobonye et al., 2021) .

3. A glimmer of hope

In the third chapter, I will take a look at a discussion on single-use plastics in the medical sector. In the paper provided by A.Jahnken in 2020 the discovery of an enzyme from the ideonella sakaiensis bacterium in japan is described and will be discussed.
The enzyme from the bacterium is capable of degrading and digesting plastics, in specific polyethylene terephthalate also known as PET.
The chemical process is described by Jahnken in the paper in the following degradation process:
“The bacterium cells adhered to the surface of polyethylene terephthalate (PET) products and released a PET hydrolase (PETase) that degraded the PET into mono(2-hydroxyethyl)terephthalic acid (MHET).This MHET was then further degraded by a MHET hydrolase (MHETase) on the outer membrane of the cell, with the broken-down compounds and molecules being used by the cell for biological processes. Once the PET was assimilated by I.sakaiensis, the wider microbial community mineralised 75 percent of the degraded PET into carbon dioxide.” (Jahnke, 2020).
Although this process gives a glimmer of hope to our ecosystem fighting the increased introduction of plastics to it, it should be noted, that the bacterium cannot resolve all our plastic-related pollution. The bacterium is limited to the specific material PET and specific to lower grades of the material since high-grade PET need to have the precondition of being weakened before the bacteria can start its process of degradation.

As in the chapter described earlier, Jahnke argues for the recurring political change that has to be made in order to create a more environmentally aware and responsible future:
”Plastic manufacturers need to move towards more environmentally friendly alternatives to petroleum-based plastics, consumers need to reduce their reliance on unsustainable plastics and recycling needs to become a greater priority for governments and consumers alike.”(Jahnke, 2020)

An Example mentioned by Janke:
“Moves have been made towards this in recent years, notably in the European Union (EU) and its member states. In March 2019, the European Parliament approved the final draft of what has been dubbed the SUP directive, Directive on the reduction of certain types of plastics. This directive was first proposed to tackle the widespread issue of plastic marine litter. The directive issues a total ban on the 10 most common kinds of plastic litter that washes up on beaches in EU countries – including items such as straws, cutlery, sticks for balloons and plastic cotton buds – where alternative materials are available. In addition to this, it emphasized a focus on limiting the use of other SUPs and making manufacturers become more responsible for waste management and clean-up.” (Jahnke, 2020)

3.1 SUP for Medical Applications

According to the WHO an estimated 16 million injections are performed each year, of which a majority is composed of SUP syringes that have the potential to end up in our environment.
A notable example of medical waste introduced to our ecosystems is exemplified in the so-called "Syringe Tide" in Connecticut, New jersey in 1987 and 1988, where large quantities of medical waste including syringes and hypodermic needles washed up on the shore of Jersey. (Jahnke, 2020)
But similar to the tattoo industry the utilisation of dermic needles, PP plastic cups, PVC blisters, Nitrile surgical gloves, and lately the additional introduction of surgical masks build a variety of SUP with a diversity of material compositions within both industries alike. Therefore investigating the medical industry can highlight opportunities to reduce the impact of the chosen industry, since no scientific data is available at this point in time for tattooing in specific.

3.2 Bioplastic & Biodegradable Plastics

Polyethylene terephthalate (PET), can be classified as a bioplastic even if the terephthalic acid is not from a biological source. This provides the distinction between true biodegradable plastics and bioplastics: biodegradable plastics will be made of natural feedstock and can degrade naturally. (Jahnke, 2020)

The company that sponsored the written discussion by A.Jahnke is Teysha Technologies. They have spent almost a decade of research into developing biodegradable alternatives to existing polymers that can be used in a variety of industries, with the additional focus for plastics capable to perform within one of the toughest regulated industries- the medical industry.

The article argues that at this point in time it's not economically viable for industries to change from crude-oil derived plastics to lower impact biodegradable plastics due to the 50 year lead in technology of their counterparts. Having a significantly lower impact on the environment is often ignored by manufacturers focused on reducing overhead costs. (Jahnke, 2020)

Teysha Technologies states that their platform for biopolymers has not yet reached commercialisation, but has proven to be a highly versatile means in creating more eco-friendly materials with lower impacts in comparison to their counterparts. This is especially interesting in the medical setting, since single-use allows for a higher degree of client safety, without requiring the extensive knowledge and machinery reusable products would require. Furthermore specific products like gloves are a product not capable of being reused due to the nature of their design.
"It is feasible that we may finally observe a sea change in the medical plastics industry – one that allows the sustainable, continued use of single-use biodegradable plastics without the products occupying our oceans or washing up on our shores."
(Jahnke, 2020)

4. Incineration

Every year Germany incinerates 26.3 million tons of waste (DW). One Third of all plastic waste incinerated in Germany ends up as toxic waste (NABU). In 2011 450.000 tons of highly toxic filter cake and fly ashes were produced (Recycling Magazin 2011).

The Incineration Technology uses waste sources like: household, biohazardous and plastic based waste streams, that can not be recycled with traditional mechanical Recycling due to contamination affecting the quality of the recyclate. Waste Incineration is not the solution to our waste stream, but being portrayed as such, this technology has major downsides with minor benefits. While creating energy that can replace Coal and oil-based power plants efficiency per ton of waste burned when comparing CO2 emissions. Waste Incineration producing on average 677 kg of CO^2 per mWh of energy produced compared to coal emitting 1020kg of CO^2 per mWh of energy produced. But these numbers can also differ depending on the mixture of waste incinerated. In addition, the waste incineration releases a lot of unwanted air pollution, especially toxic fumes like dioxin and furan. (Deutsche Welle, 2019)

The leftover waste from incineration called filter cake and fly ash are both highly toxic byproducts especially when burning waste with high plastic content. This byproduct is one of the most toxic waste products humankind has created. The further processing of these products varies from country to country, but they are mostly treated as highly hazardous. An adequate EOL solution has not been found yet. The current practice mostly resolves the issue at hand, by backfilling salt mines with the highly toxic waste, but study's only account for the materials safe storage of a maximum of 20 years. In some cases the tests that confirm the safe storage in the case of water solubility only lasted 24 hours .These tests are meant to prevent the stabilised material to be washed from their container and contaminate water sources. These short duration tests therefore give no proof of safe storage, especially with such highly toxic waste especially over extended periods of time. The toxicity of these byproducts is not mitigating over time and will stay hazardous to humans and the environment for the eternity of mankind. (Deutschlandfunk Nova, 2017)

In an example in Saxony-Anhalt in the time between 2007 and 2009, four million tons of this waste were used as substitute landfill building material and the company involved is feeling blameless for their reckless behaviour towards public safety and the unearthing of this fact .Test results that show significant soil contamination at their facility prove the leakage into the surrounding environment .
(Recycling Magazin, 2011)
Furthermore fly ashes are often used as substitute building materials for road and pavement building with the one exception of uses near and in water reserves. This practice being financially lucrative for deposition companies due to low costs compared to salt mine backfilling.

As such the Incineration technology is a burden from the 80s and 90s and is if even, a transitional solutions towards a circular economy, but this transition never occurred, leaving Germany stuck with environmentally damaging technology risking the public wellbeing and not having adequate EOL solutions for toxic waste byproducts produced in Incineration plants.

The population often lacks the understanding of the impact of the so called Thermal recycling and therefore does not recognise the amount of greenwashing it is subjected to. Communes suffer of a conflict of interest as they profit from the longterm operation of the facilities they are invested in. The technology shouldn't be utilised with the insights already at hand, due to no adequate long term solutions for safe storage of highly toxic waste products over extended periods of time.

5. EOL Solution - Chemical Recycling?

Concerns: Alternatives to Waste incineration are claimed to be a variety of chemical recycling models that are still in the testing stage and are not commercially viable as of now. But with this being an emerging technology the data at hand is greenwashed by corporations from the chemical and petrochemical sector wanting to put a sustainable label on the practice in order to mitigate concerns towards the use of plastic, especially in single use applications. The very same companies producing the waste we have no adequate solutions for, are making their decisions profit oriented rather than environmentally aware. On the one hand the Cefic (the European Chemical Industry Council) which is composed of the major European chemical companies, is claiming that the chemical recycling technology is going to revolutionise the recycling industry without any drawbacks mentioned, or data provided that back up their claims. This is the obvious case of greenwashing facts, since leading unbiased researchers in the field always claim significant inefficiencies, environmental and human toxicity potential, as well as material deterioration.
Like in most recycling processes, contrary to the common belief of endless cycling, the materials' polymer structures are damaged through the process of recycling. I am highly skeptical that a report provided by the Cefic which provides 15% of the worlds chemical production isn't biased in this topic of reselling the very same waste they have created in the first place. The LCA Data is based upon calculations and estimates rather than proven data from commercial sized plants. Efficiency of the processes being stated of up to 90% ,which are most likely fantasies showing no hard proof, in order to promote a highly debatable technology.
The LCA data also doesn't take into account any human or environmental risks of the process, the material quality produced, as well as highly toxic byproducts associated with this technology. To say the least, greenwashing at its very best leaving out the negative aspects and failing to give transparent proof to data and sources. Doubtable claims are made by the petrochemical company financed paper Cefic. (Cefic, 2022)

What is Chemical Recycling?

In this chapter we will analyse non biased reports explaining the technology of chemical recycling, especially concerns towards sustainability and environmental, as well as human health risks associated with the technology praised to be the solution to our waste problems. The Paper "Chemical Recycling : Status, Sustainability, and Environmental Impacts" Published by Andrew N.Rollinson and Jumoke Oladejo critically assesses scientific papers from the late 70s till today. The Paper shows growing concerns for greenwashing the technology especially by companies that have a great interest in prolonging the excessive use of plastics and petrochemicals in order to greenwash the general population in thinking that no behavioural consumer change is needed in order to transition to a greener future.

Chemical Recycling as such is described by Professor Peter Quicker in 2019 who states: *"The technology is promoted ...independent of its ecological sense and rationality"*. The Technology of Chemical Recycling can be subdivided into 3 major approaches to chemical recycling but will only be explained in a simplified manner since in depth explanations would go beyond the scope of this report. In detail information can be found within the following resources: *Knaupp ,1984; Reed & Das, 1988 ; Rollinson, 2018 ; Rollinson & Oladejo , 2019.*

Pyrolysis is a technology where preferably plastic material is heated within a reactor in the absence of oxygen, the temperature varies according to the desired output between 500°C to 850°C. The heat is added through external sources and is often not accounted for in the LCA of this technology. The output of the process is Gas, oil, char and a complex product mixture; the quality is often of much poorer quality compared to the gasification approaches outputs. Output products can not be reused immediately and depending on intended use, the product has to undergo further processing. Most common use of the produced outputs are P2F (Plastic to Fuel) or with even more complex processing P2P (Plastic to Plastic) is possible, although it should be noted P2P cycle can not be performed indefinite and rather deteriorates the polymer structure with each cycle performed similar to mechanical recycling. Therefore material outputs will always have a lower quality and therefore end up in less demanding product applications .

Gasification is a technology where preferably plastic material of a single material origin is heated within a reactor in the absence of oxygen, the temperature varies according to the desired outcome between 500°C to 850°C. The output is a gas mixture that could replace a gas used as feedstock for plastic manufacturing called Syngas. Therefore the idea developed that gasification of plastic could be a method of chemical recycling by replacing crude oil feedstocks for manufacturing plastics. Some of the gas produced is used internally to fuel the process of gasification. The Outputs are similar to the one of pyrolysis and the use of the products require lower but similar efforts to process the product for higher demanding purposes.
"Product quality and operational stability is governed by complex and highly challenging chemical, physical and thermal inter-relations, making gasification and pyrolysis more akin to chemical processing plants than ordinaryincinerators."
(Rollinson, 2018; and Rollinson & Oladejo, 2019).

The third technology grouped within chemical recycling is solvent based chemical recycling (Solvolysis / Liquefaction) in this approach a variety of solvents are used to change the chemical structure of plastic in order to produce purified polymers and oligomers (building blocks of plastics). The Process requires high pressure of several hundred bar as well as high temperatures between 100-350°C and catalysts. This technology is the least researched in academic papers due to a multitude of factors like system complexity, process overlap and intellectual property .
(Crippa et al., 2019)

5.1 Solvolysis

The process aims to dissolve or liquify the plastic without damaging the polymeric structure often used for operation of mixed plastic or targeting specific polymers from plastic composites. It is a staged process where the removal of dyes, impurities and contaminates is followed by precipitation and an anti-solvent process. (Sherwood, 2019)
The choice of solvent is highly specific to a strictly homogenous feedstock or target compound, the process depredates the product quality and is therefore not cyclic which has clear links to the problem of mechanical recycling where the product can't cycle infinitely to replace virgin polymers. (Crippa et al., 2019)
Furthermore residual toxic contaminate can remain in the product and the disposal of spent chemicals can pose further environmental problems. (Sherwood, 2019).
This technology is in a research stage and therefore feasibility has not been proven.

5.2 Liquefaction

In this process a variety of depolymerisation processes dissolve plastic waste in liquid baths to produce oligomers and monomers (building blocks of plastic). The baths applied to the plastic waste are named after the chemicals they yield from the process: water (neutral, acid, or alkaline hydrolysis), methanol (methanolysis), glycol (glycolysis), ammonia (ammonolysis), and various amines (aminolysis), among others.
"The process might be facilitated by high pressure and temperature, since this process is the most novel of all chemical recycling options , information on energy consumption and product quality are mostly underreported and unresolved." (Rollinson & Oladejo 2020)

5.3 Comparison to Mechanical Recycling

Mechanical recycling of plastic waste is subdivided in various processes, sorting mixed waste plastic, crushing pre-sorted waste plastic, washing and cleaning of leftover residues from food or contamination as well as shredding the process output, extrusion and the option of palletising the output.

The product produced by mechanical recycling can be melted and reshaped with the help of additives. This process is less energy intensive as chemical recycling but nevertheless requires a significant energy input. (Levidow & Raman, 2018)
Mechanical plastic recycling aims to replace virgin plastic, but due to contamination and structural degradation of the polymers through the process of recycling, 100% recycled plastic is extremely difficult and in some applications not feasible. While Mechanical recycling aims to preserve the polymers , in reality the polymer length is generally shortened, therefore resulting in lower quality plastics compared to virgin material. (Baytekin et al., 2013).
The degredation of the process is known as down-cycling or open-loop recycling.

Although both technologies have their downsides, chemical recycling being less mature comes with even bigger problems for the resulting product output. But for the simple fact of lower energy consumption and lower risk of toxic byproducts production, the mechanical recycling technology is environmentally preferred.
"The product requirements demand highly stringent quality control, and when not attained, the resultant gas or oil is, at best, burnt. Consequently, the distinction between P2P and P2F is often not clear and attempts to conflate the two practices as chemical 'recycling' have been associated with claims of 'greenwash'."(GAIA, 2019)

5.4 Major Concerns for Thermolysis Technology

"When plastics are made to thermally decompose, hydrocarbon fragmentation produces molecules which are different to their component monomers (the 'building blocks' of plastic)."
(Rollinson & Oladejo, 2020)

As an example, when PP is decomposed, high amounts of benzene, xylene, toluene and poly acrylic hydrocarbons (PAHs) are formed. (Williams & Williams, 1999)
When thermal decomposition is performed with PVC, nephtalene ,indene and alkylated naphatalenes are formed.(Scheirs & Karminsky, 2019)
These chemicals along with many commonly used plastic additives are hazardous to the human health and the environment. Scaling up these technologies further complicates the recycling process, while ensuring the purity and quality of feasible waste inputs in the laboratory are hard to control, when scaling up the very same process to an industrial scale, the input waste is often a mix of materials rather than of single material origin.This can alter the product quality or increase the risk of producing undesired byproducts.
"While it is possible to produce satisfactory product yield and composition in laboratory scale, it will be a challenge for the industrial developers to maintain the desired result when scaling up polymer pyrolysis".(Wong et al.,2015)

There is no evidence to support current claims of technological efficacy of chemical recycling. I would like to Quote Lopez et al. and Quicker in order to show the current concerns of this technology:
"Although plastic pyrolysis has been widely investigated, most of the studies are of a preliminary nature, with the level of development of pyrolysis units being in general limited".
(Lopez et al., 2017)

"Since there is currently no known pyrolysis plant in (semi)industrial operation that produces relevant amounts [of chemically recycled plastic] for further upgrading, e.g. in the chemical industry, no process examples can be presented here". (Quicker, 2020)

The major problem is when the process is performed with low temperature in the reactor, the cost of the process is reduced but also the yield of product shows incomplete depolymerisation. But if the process is run at high temperature in the reactor, cost of operation is increased, the depolymerisation is increased while also the formation of heavier aromatic molecules increases, those chemicals of high toxicity. Gasifiers were designed to mitigate this problem but only when run with homogenous feedstock and not with non-standardised waste material like it would be the case in industrial-scale operations. The estimations for the feasability of the technology vary from 2030 by Doherty, to 15 years until growth can be achieved by the Closed Loop Partners. (Doherty, 2019 ;
Closed Loop Partners, 2019)
But this can hardly be considered a solution for our current problems, since the timeframe is where we should have adapted our consumerism towards sustainability rather than starting to solve our problems.

5.5 Toxicants

Toxicants are inherit to the composition of petrochemicals which are primarily composed of hydrogen and carbon with significant quantities of oxygen and other chemicals known as heteroatoms. Various additives are added to modify material properties and production costs, these include antioxidants, flame retardants, plasticisers, lubricants and heat stabilisers. The composition and amount is catered to the intended manufacturing technique and the desired product properties. But plastics can also acquire toxic contaminates from its surroundings. (Rodrigues et al., 2019).

Plastic toxicants are for example: Bispehnol-A(BPA) cadmium, benzene, brominated compounds, lead, tin, antimony and volatile organic Compounds(VOCs). (Rollinson & Oladejo, 2020)

Antioxidants are used in plastic packaging material to delay degradation caused by light or heat sources. Arylamines, phenolics and organophosphates (such as BPA),tris-nonyl-phenyl phosphate, lead and cadmium compounds which are present in concentrations of 0.05 - 3% by mass. (Hahladakis et al., 2017)

Flame retardants like halogenated hydrocarbons, phosphate esters, antimony, aluminium oxides, brominated and phosphorus polyols (like polybrominated diphenyl ethers (PBDEs)), chlorinated paraffin (MCCP or SCCP), boric acid, and phosphorus compounds (TCEP or TCPP) which exist in concentrations of 0.7 - 25% by mass. (Hahladakis et al., 2017)

Plasticisers are added to improve the elasticity of plastics and are present in contraption of 10-70% by mass. These Plasticisers include hydrocarbon-based phthalates (DBP/BBP/DEHP/DHCP), adipates (DAH/HAD/DOA/HOA) and chlorinated paraffins (LCCP/MCCP/SCCP). (Hahladakis et al., 2017)

Recycling techniques, especially those of higher temperature nature, therefore increase the exposure to the harmful compounds. *“These substances, like styrene, formaldehyde, ethylene, epoxy resins, BPA and vinyl chloride, have also been identified as toxicants.”* (Rollinson & Oladejo, 2020)

Direct operational hazards and the volume of toxicity in all products, byproducts and spent process residue or chemicals require sound operation practices. Someone could expect that chemical recycling therefore focuses it’s attention to the toxic and harmful effects and risks of this technology, but surprisingly this is not the case. When in reality the banned substances created in the chemical recycling process and the need for the recycling plants having to comply to chemical hazard regulations has been identified as a major cause of commercial test plant closure. In the academic field, similar neglect towards risk assessment can be seen.
“While it is possible for organic toxicants to be depolymerised and hence destroyed, they can equally pass through unaltered, or worse there is a high likelihood that the process will reform them into more toxic molecules”. (Rollinson & Oladejo 2020).
Products created through chemical recycling containing toxicants are marketed as commercial goods, but the contamination systemic to the output (products) can be present in all three product phases : gas , liquid and solid. Furthermore, heavy metals present in plastics will not be destroyed during depolymerisation and will transfer to the output. This material output for example would not be suitable for the use in high demanding tasks like packaging especially food grade packaging. The Incineration of this output could create airborne particles, vapours or concentrate them in the char and therefore increase the risk of exposure to humans and the environment.
In a study of mixed plastic pyrolysis, the product oil contained antimony, bromine, zinc, calcium, chlorine, and sulphur, while the gas contained chlorine and bromine, with the largest fractions of non-volatiles in the char. (Miskolczi et al., 2013)

The same research group found proof for the accumulation of large quantities of resynthesised heavy aromatic polymers in the products even from substances previously claimed to produce monomers under pyrolysis conditions like polystyrene. (Miskolczi et al., 2004)

“Seo and Shin (2002) analysed the products of mixed plastic pyrolysis and found that the distilled product oil contained significantly more aromatics than engine fuel, amounting to 60–82% of the total hydrocarbons, and that the pyrolysis oils contained few of the branched hydrocarbons desirable by internal combustion engines. They described how many of the aromatics were polynuclear PAHs which were either directly toxic or which were precursors to more toxic substances”.
(Rollinson & Oladejo, 2020)

When researching PAH formation and chlorine distribution in all product yields from PVC pyrolysis. The PAH content in pyrolysis oil was especially high at 95.3% while the concentration of chlorine was far greater than predicted within oil and char. (Cao et al., 2019)

“Mohr found that 80% of the PCDD/F product was contained in the pyrolysis oil making its toxicity four times higher than that of the feedstock.”
(Mohr et al., 1997)
This might be the reason for the one of the solvent-based PVC purification plants (Vinyloop) being shut down. (Rollinson & Oladejo, 2020)

“Mølgaard (1995) determined that pyrolysis had the highest global warming and photochemical ozone formation impacts of all options, and the second largest solid waste impact after landfill.”
(Rollinson & Oladejo 2020).

5.6 Energy consumption & Carbon emissions

Most energy consumed in the technology of chemical recycling is used for waste pretreatment and is often not taken into account in the energy cost audits. (Vehlow, 2016)
The process of pyrolysis is highly energy intensive so if the process is fueled by its own input, the process consumes almost all of its input to self-sustain the reaction, therefore no circularity is achieved and no virgin plastic will be replaced.
The process in general is far more energy intensive compared to mechanical recycling as well as maintenance and start up cost being certainly higher.(Sherwood, 2019)
In terms of post-depolymerisation energy demands, two studies have illustrated how processing needed after what is considered to be primary depolymerisation uses over 53% of feedstock in oil upgrading and 48% in gas upgrading.
(Soliz et al., 2020; Seidl et al., 2020)
The listed inefficiencies are on top of energy inputs for pyrolysis and therefore defeat the claim of sustainability for P2F processes. Emissions with direct incineration without pyrolysis processing emit equivalent amounts of CO2 with lower energy inputs since the additional processes are spared.
When leaning towards the P2P approach additional energy is used to depolymerise the oil gained from pyrolysis which is often not accounted for in technology appraisals.

Initial Plastic resin production accounts for 61% of GHG (Greenhouse Gas) emissions, another 30% for manufacturing and only 9% for EOL emissions.
W(Zheng & Suh, 2019)
This is purely GHG emissions and not taking into account volatile and toxic compounds released into the environment depending on the EOL solution.

All in all, the technology is far from reaching commercial viability, with risk in health and safety. The numbers found in academic papers don’t add up to the claims made by petrochemical companies or the scientists who support them. The technology comes with human health and environmental burdens, that are probably not justified by inferior material outputs that will not be able to replace virgin plastics in the first place. Creating Fuel out of Plastic P2F is unlikely to have a great impact on the environment, since the fuel is inferior to common used fuels for energy production and still produces highly toxic byproducts. Solvent based recycling is not mature enough to claim viability, this is likely due to the chemicals involved in the process while strict chemical regulations further complicate eco-friendliness. In the end it is a technology portrayed as the green future without any risks by the very same companies who caused the problems in the first place. Greenwashing facts and not transparently displaying data or sources are all warning signs for anyone interested in looking at greener recycling alternatives. The incentive is more clear than ever: there will be no net zero solution with plastic recycling, especially not in the near future. The most impactful attempt of cleaning our mess will be mechanical recycling and avoiding plastic waste creation in the first place. This means we have to move away from unnecessary uses of plastics, avoid single use and find sustainable alternatives that don't impact the environment to the extent of plastic.

6. Recycling Symbol & Resin Idenfication Code

The recycling symbol was created for the first Earth Day in 1970. In 1988 the Plastics Industry Association created the resin identification Code. The design characteristics fostering a close association to the commonly known recycling symbol, created 18 years prior. This misconception has led to the belief that all plastics can be recycled, which was the goal of the Plastics Industry Association. It gives the general population the belief that plastics can be recycled no matter which kind and indefinitely, while it is already proven to be a cyclic process where material quality deprecates over time and some plastics not having the capability of being recyclable at all. This shows negative uses of design and the association with symbols we are already familiar with. From all seven resin identification codes only resin identification code one (PET) and two (HDPE) are commercially viable for recycling with the remaining five codes not being financially viable or rather yield undesirable material output when recycled. Therefore the misconception of the recyclability has caused more harm than good. Expensive and complicated sorting systems both performed by machines and humans have caused the recycling system to be inefficient. Rather than discarding non recyclable plastics in household waste, the presumed recyclables are mixed with recyclables for the benefit of the population thinking they are doing something good for the planet by disposing of plastics of number three to seven within the recycling container. The elimination of this misconception could clean up the recycling stream, lower running costs as well as ensuring higher purity of recyclate by minimising the risk of waste contamination. The plastic waste is also commonly washed to rid the material of contamination from food sources and therefore lower amounts of waste. Leaving out the washing process for materials that can't be recycled anyway, would save large amounts of water and energy.

Hard-to recycle plastics include resin identification code three (PVC) , four (LDPE), five (PP), six (PS) and seven (others).
This might change in the future when new recycling techniques become commercially viable, Polystyrene has seen some approach of microbial recycling in lab conditions as well as small scale attempts in decompressing the material with heat and pressure into solid blocks of less volume. The resulting Material can be used to reform packaging, with missing sources on volume and resulting product quality, a conclusion to viability is not possible. When recycling PP the recyclate often turns black and therefore becomes undesirable for many applications. LDPE often absorbing smell of the first or last use case scenario it was exposed to, makes the recyclate undesirable, although the practice of recycling LDPE is increasing.

The worst case scenario for mechanical recycling, are still composite materials that are fused from multiple plastics, or a combination of non-plastic and plastic materials. The separation is in many cases impossible or too cost extensive to perform under industrial scale.
technology

Conclusion

In order to reference the insights from the chapters and establish links to the LCA conducted in order to calculate "Tattoo Session impacts", it is important to display a variety of solutions catered to the specific use case scenario of a product. Displaying feasible solutions rather than relying on technology not available or feasible at this point in time. The Work should clarify when a product's utilised materials should be re-evaluated and replaced by more eco-friendly materials. When a political incentive is necessary to utilise resources rather than incinerating in order to preserve resources, as well as providing education on why this topic is relevant, especially today, will play a major role in the development and improvement in the chosen industry. A Products EOL is often causing the greatest trauma to the environment we inhabit. The key message is to make consumers aware of impacts in order to understand complex topics through transparent visual concepts. Giving accessibility in order to conduct and translate real-life scenarios to one's own style of application with an open-access tool which is provided through the Thesis. Open source non commercial has the benefit of laying foundations, evoking collaboration and design thinking in order to solve one of the biggest problems of humanity at hand. Sustainable thinking and waste reduction , moving towards a reuse and reduce oriented society is a goal extending across the borders of this topic evoking change, for a society driven by low impact goals rather than financial incentive.

METHADOLOGY SM-13

Sustainable Minds 2013 Definition:

About the Impact Assessment Methodology
Sustainable Minds uses a single-figure LCA methodology for evaluating potential ecological and human health impacts from products used in North America. It uses TRACI1 impact categories developed by the U.S. EPA2, North American normalization and weighting values developed by the EPA and NIST3 respectively, and processes inventory data from the most credible sources worldwide. Continental and regional applicability Sustainable Minds uses TRACI characterization values based on conditions in the United States and per capita impact normalization values in the United States. This LCA methodology is most relevant for products consumed in the US, however, it can be applied in other regions of the world for which no explicit LCA methodology exists. The exception is in Europe, where LCA methods have been developed based on European conditions. Sustainable Minds can be reasonably applied in all continental regions outside of Europe.

J. Bare (2011) TRACI 2.0: the tool for the reduction and assessment of chemical and other environmental impacts 2.0. Clean Technologies and Environmental Policy. 13(5); United States Environmental Protection Agency (2012). Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) User's Manual. Document ID: S-10637-OP-1-0.
A. Lautier, et al. (2010). Development of normalization factors for Canada and the United States and comparison with European factors. Science of the Total Environment. 409: 33-42.
Bare, Jane; Gloria, Tom, and Norris, Greg, Development of the Method and U.S. Normalization Database from Life Cycle Impact Assessment and Sustainability Metrics, Environmental Science and Technology, / VOL. 40, NO. 16, 2006

Disclaimer by SM-13:

There is no such thing as a 'green' or 'sustainable' product.
All products use materials, energy, and create waste. The U.S. government has yet to define what 'green' and 'sustainable' means. Various industry groups and third-party certifiers are working on definitions and standards, but as of yet, there is no standardized set of metrics to qualify a product as 'green' or 'sustainable'. What we can do is to start making products greener than the ones we make now.
Environmental performance – the latest criteria for product development
Product development organizations deal with meeting design criteria in a number of categories: functional performance, aesthetics, safety, cost, and marketability to name a few. Environmental performance is increasingly being added to the list. Design teams have methods for obtaining quantitative data to support traditional criteria, but currently have few ways of estimating and presenting quantitative data to support eco-design decisions and opportunities.
Today, ecodesign is often practiced early in the process by implementing general strategies and guidelines, rules of thumb, and other qualitative approaches that fail in grasping the multi-dimensional, highly contextual, and often contradicting environmental impacts. Product concepts can therefore be numerous and loosely defined. Time, available data, and budgets limit the ability to create detailed models to conduct 'what-if' analyses. When asked which strategies or product system configurations produce the best environmental performance (or create the least impact) between various product concepts being considered, design teams have no way to quantify or support their recommendations.
Connecting ecodesign with LCA for greener product innovation
Ecodesign (or green design) enables new idea generation and opportunities for innovation. It does not guarantee that these new ideas will have superior environmental performance. The environmental performance of new concepts can be measured using LCA.

Suistainable Minds Impact Categories:

1.Ecological damage
-Acidification
-Ecotoxicity
-Eutrophication
-Global warming
-Ozone depletion

2.Resource depletion
-Fossil fuel depletion

3.Human health damage
-Carcinogenics
-Non carcinogenics
-Respiratory effects
-Smog

Approach:

This allows for in-depth analysis of the conducted LCA laying the foundation for future improvements and recommendations to lower the impact in three facets:

- **Prevention**
- **Sustainable Alternatives**
- **Redesign**

LCA

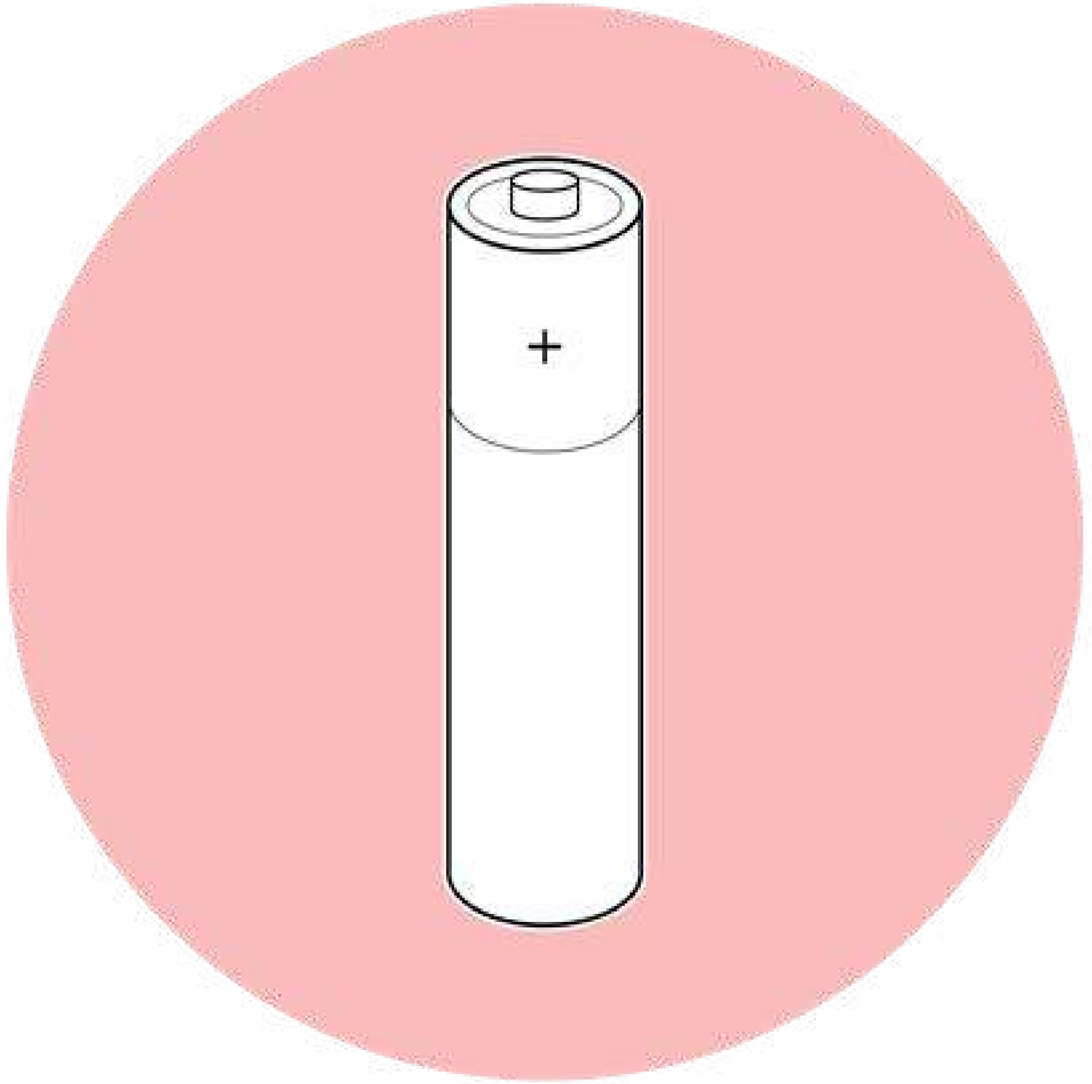
SM-2013

AAA Alkaline Battery LCA

Definition:

LCA Type:

Cradle-to-Cradle
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Native SM-13 Calculation therefore no composition data

EOL Impact unlikely - SM-13 Data Gap!

Product:

Battery: 11.4000g

Materials:
Nickel plated steel container & chemicals. nickel coated steel, manganese dioxide & graphite rods, alkaline electrolyte, zinc gel, brass nail, zinc coated steel lid Anode, laminated separator,plastic gasket.

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:
Printed Paperboard Box
3.900g

Surface Area of Packaging:
111.58cm²

Functioning Unit:
8 units & Retail Packaging

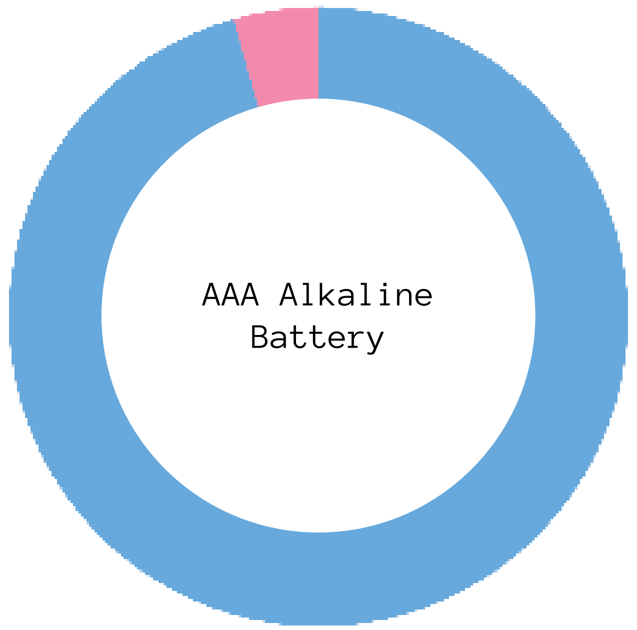
Ink Amount used for Packaging:
0.0007g

Transportation:

Belgium Factory - Logistics Centre Germany
Truck **106.460miles**
Logistics Centre Germany - Supermarket Cologne
Ship **414.281miles**
Supermarket Cologne - Studio Cologne
Bicycle **No Impact**

SM-2013

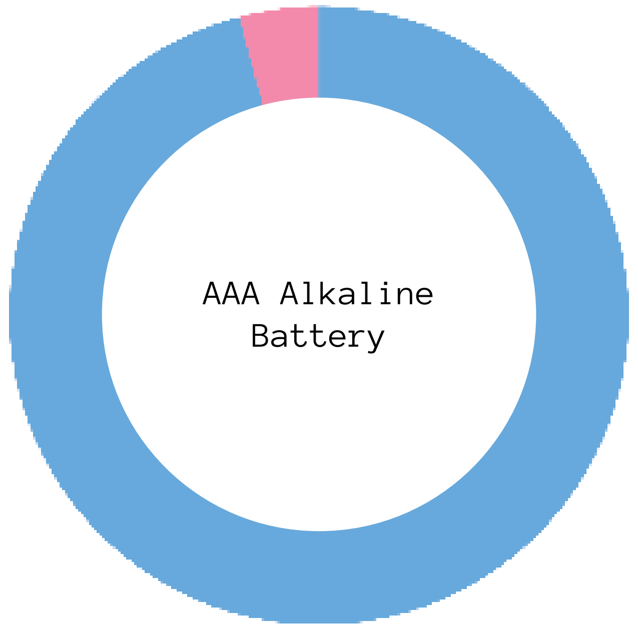
AAA Alkaline Battery LCA



95.59 %	Manufacturing	0.1330	CO^2 eq.kg
%	Use		CO^2 eq.kg
%	EOL		CO^2 eq.kg
4.41 %	Transportation	0.0061	CO^2 eq.kg

0.1391 CO^2 eq.kg emitted per functioning unit

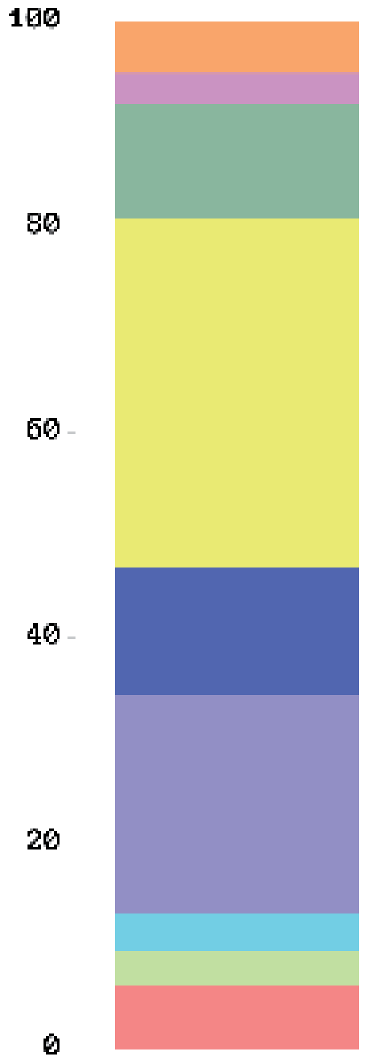
Greatest Impact:
AAA Battery – 0.1280 CO^2 eq.kg



95.93 %	Manufacturing	0.0090	mPts
%	Use		mPts
%	EOL		mPts
4.07 %	Transportation	0.0003	mPts

0.0093 mPts per functioning unit

Greatest Impact:
AAA Battery – 0.00862 mPts



6.29 %	Acidification
3.34 %	Ecotoxicity
3.53 %	Eutrophication
21.32 %	Global Warming
0.01 %	Ozone Depletion
12.43 %	Fossil Fuel Depletion
33.91 %	Carcinogenics
11.23 %	Non-Carcinogenics
2.94 %	Respiratory Effects
5.00 %	Smog

LCA based Insights*:*

The LCA Data shows significant data gaps in EOL handling. Although recycling was added to the LCA data, there is no impact shown in the data. This is a generic problem of SM-13 and its data gaps for recycling impacts. Hopefully data will be updated in order to make LCA calculations, especially those intensive in their EOL handling more precise.

Switching from a Head Lamp oriented setup towards a stationary light source could greatly improve impacts created during a tattoo session.

LCA

SM-2013

Bottle Sleeve Eco LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL - No Data
Transportation

Missing Information:

No EOL impact data aivailable - SM-13 data gap!

Modified starch film welding data not available. Manufacturing data missing in SM-13.

Product:

Bottle Sleeve: 1.8000g

Material:
Modified Starch

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:
Printed Paperboard Box bleached
35.412g

Surface Area of Packaging:
639cm²

Functioning Unit:
250 units & Retail Packaging

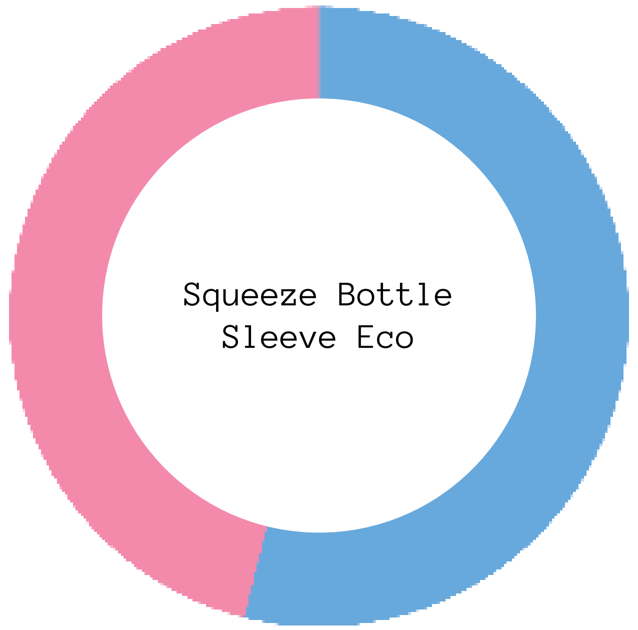
Ink Amount used for Packaging:
0.0045g

Transportation:

Shenzen China Factory I - Hong Kong Factory II
Truck **32.600miles**
Hong Kong Factory II - Hong Kong Port
Truck **9.260miles**
Hong Kong Port - Felixtowe Port UK
Ship via Suez **11138.390miles**
Felixtowe Port UK - Liverpool
Truck **263.000miles**
Liverpool - Liverpool Tattoo Supply
Van **11.130miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

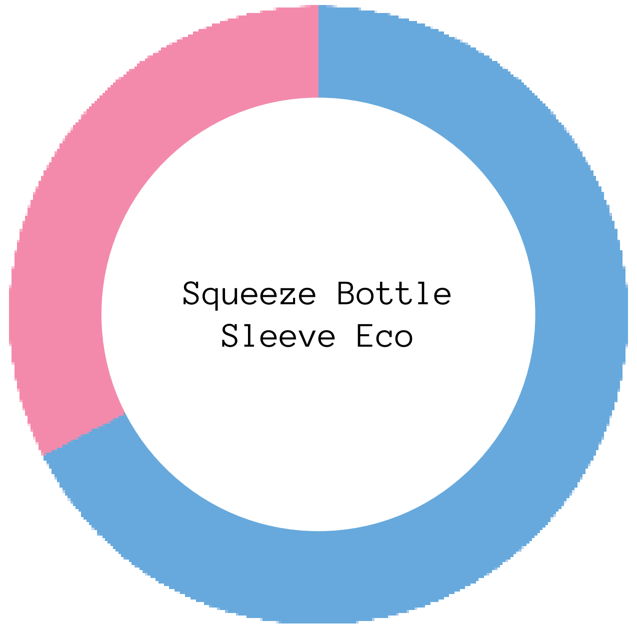
Bottle Sleeve Eco LCA



54.05 %	Manufacturing	**1.0600 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
%	EOL	**CO^2 eq.kg**
45.95 %	Transportation	**0.9010 CO^2 eq.kg**

1.9610 CO^2 eq.kg emitted per functioning unit

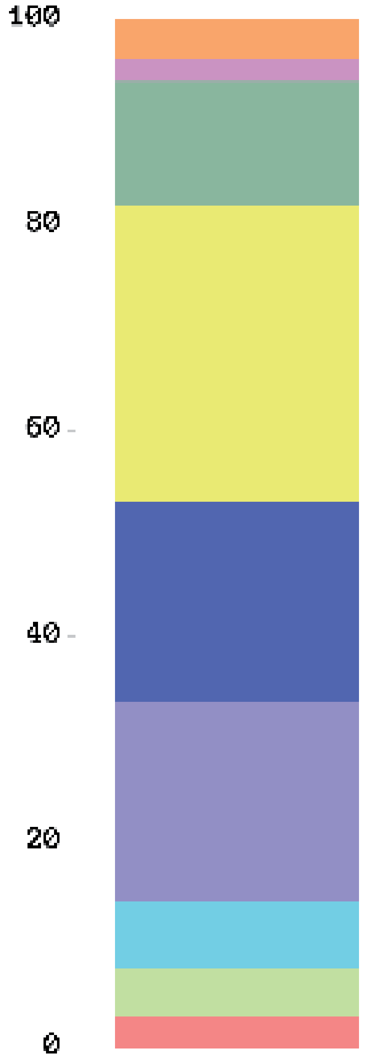
Greatest Impact:
Modified Starch – 0.7660 CO^2 eq.kg



67.57 %	Manufacturing	**0.0973 mPts**
%	Use	**mPts**
%	EOL	**mPts**
32.43 %	Transportation	**0.0467 mPts**

0.1440 mPts per functioning unit

Greatest Impact:
Modified Starch – 0.0820 mPts



3.13 %		Acidification
4.67 %		Ecotoxicity
6.31 %		Eutrophication
19.57 %		Global Warming
0.03 %		Ozone Depletion
19.47 %		Fossil Fuel Depletion
28.83 %		Carcinogenics
11.94 %		Non-Carcinogenics
2.30 %		Respiratory Effects
3.75 %		Smog

LCA based Insights:

The LCA Data shows significant data gaps in EOL handling. Since modified starches are fairly new materials, SM-13 lacks the data sets to calculate EOL Impact. Although the material is biodegradable, this approach will most likely not be used due to contamination of the material through direct or indirect contact to bloodborne pathogens.

Product redesign like adding tabs could allow for the displacement of microporous tape.

LCA

SM-2013

Bottle Sleeve PP LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

LDPE plastic film welding data not available. Manufacturing data missing in SM-13.

Product:

Bottle Sleeve: 1.4000g

Material:
LDPE

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:
Printed Paperboard Box
35.468g

Surface Area of Packaging:
639cm²

Functioning Unit:
200 units & Retail Packaging

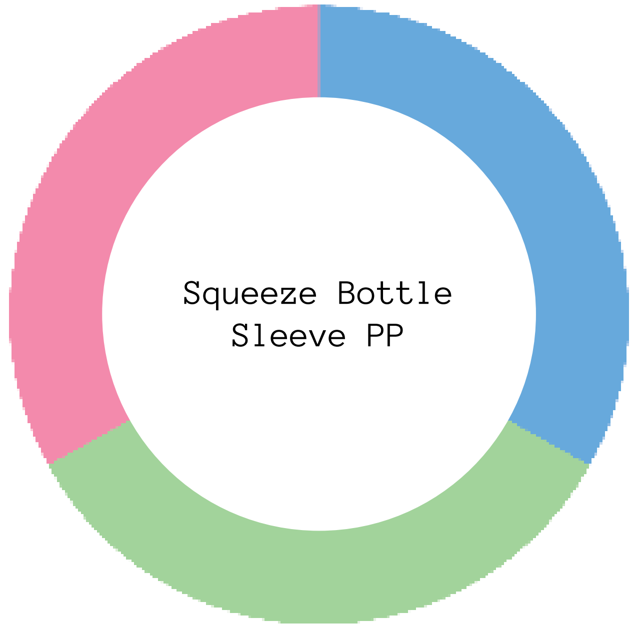
Ink Amount used for Packaging:
0.0045g

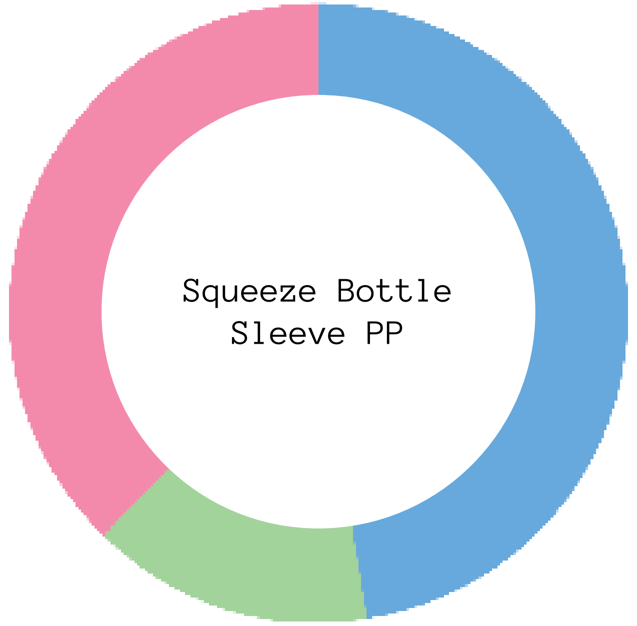
Transportation:

Hefei China - Shanghai Port
Truck **314.000miles**
Shanghai Port - Felixtowe Port UK
Ship via Suez **12032.550miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Bottle Sleeve PP LCA





33.23 %	Manufacturing	**1.0300 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
33.87 %	EOL	**1.0500 CO^2 eq.kg**
32.90 %	Transportation	**1.0200 CO^2 eq.kg**

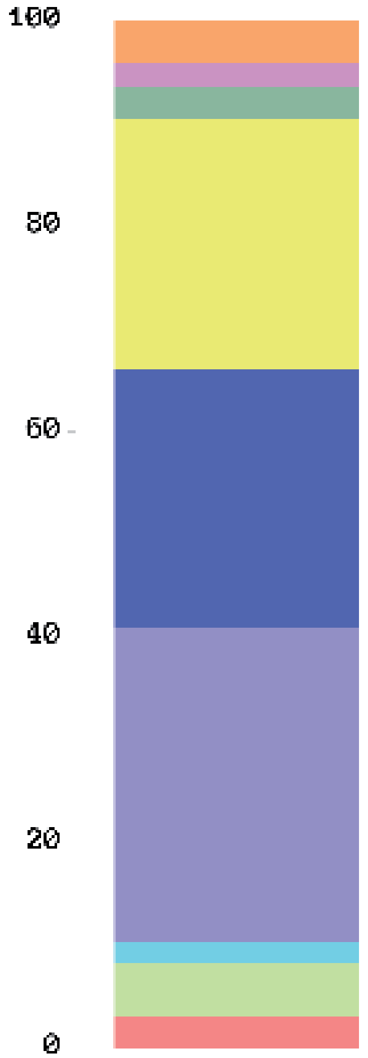
47.53 %	Manufacturing	**0.0693 mPts**
%	Use	**mPts**
14.88 %	EOL	**0.0217 mPts**
37.59 %	Transportation	**0.0548 mPts**

3.1000 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
LDPE Incineration – 1.0500 CO^2 eq.kg

0.1458 mPts per functioning unit

Greatest Impact:
LDPE Granulate – 0.0537 mPts



3.03 %	Acidification
5.35 %	Ecotoxicity
1.87 %	Eutrophication
30.58 %	Global Warming
0.02 %	Ozone Depletion
25.20 %	Fossil Fuel Depletion
24.31 %	Carcinogenics
3.21 %	Non-Carcinogenics
2.20 %	Respiratory Effects
4.23 %	Smog

LCA based Insights:

SM-13 shows data gaps in manufacturing processes. The impact is likely to increase further with added process data in the future. LDPE is the material that shows the most concerns towards sustainability, with the material being hard to recycle in general. The Exposure of Carcinogenics is a link to the common EOL practice of Incineration and also shows in the CO^2 eq. data.

The product should be avoided due to the alternative product having similar impact characteristics, the missing EOL data can be assumed to be of similar scope as PP incineration, with the benefit of leaking into the environment, decomposition is more likely to occur compared to petrochemicals.

Product redesign or adding tabs could allow for the displacement of microporous tape.

LCA

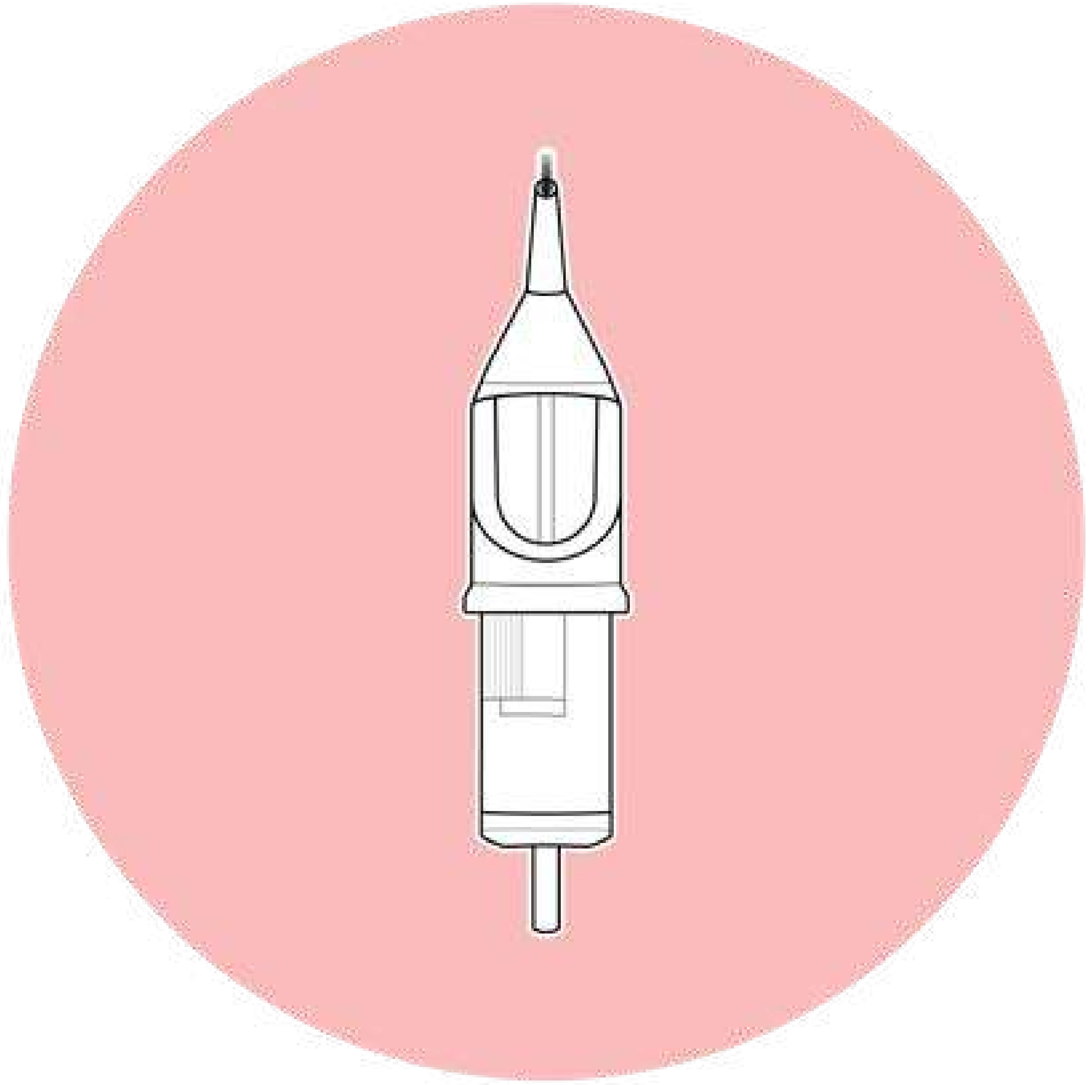
SM-2013

Safety Cartridge Needle LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Medical Grade Epoxy data missing - Epoxy Resin placeholder.

Manufacturing process data missing for Needle Grouping

Tyvek data missing - HDPE Placeholder.

Parts:

Body BLK	**PP:**	**1.7410g**
	PP:	1.6887g
	CB:	0.0523g
Body CPL	**PP:**	0.5650g
Shaft PP:		0.3160g
CAP PP:		0.3010g
Membrane TPE-S:		0.1380g
Needle SAE316:		0.0300g
Solder:		0.0400g
Epoxy:		0.0007g

Product Packaging:

Tyvek LID: 0.1970g
PVC Blister: 1.1940g

Retail Packaging:

Packaging:
Printed Paperboard Box
19.434g

Surface Area of Packaging:
593,78cm²

Functioning Unit:
10 units & Retail Packaging

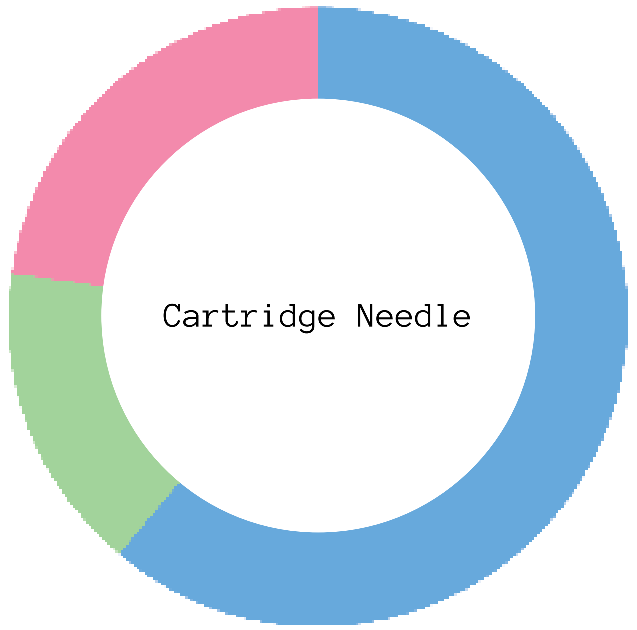
Ink Amount used for Packaging:
0.0042g

Transportation:

Berlin Germany - Hamburg Port
Truck **226.179miles**
Hamburg Port - Felixtowe Port UK
Ship **414.281miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

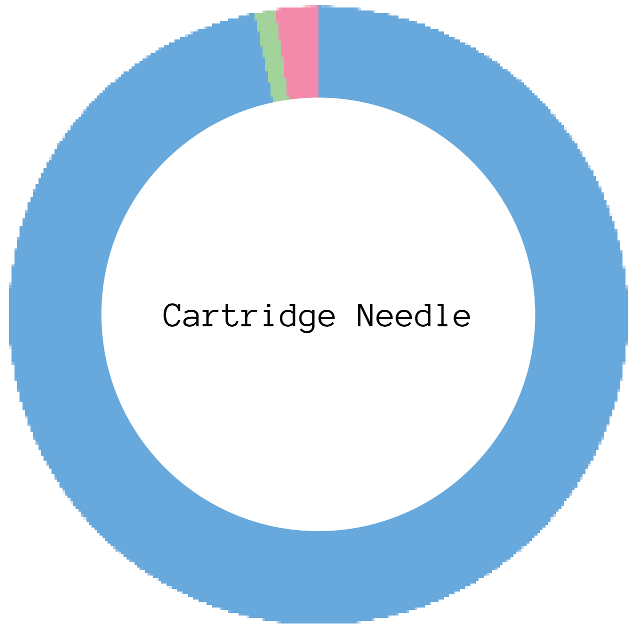
Safety Cartridge Needle



61.14 %	Manufacturing	**0.4090 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
16.14 %	EOL	**0.1080 CO^2 eq.kg**
22.72 %	Transportation	**0.1520 CO^2 eq.kg**

3.1000 CO^2 eq.kg emitted per functioning unit

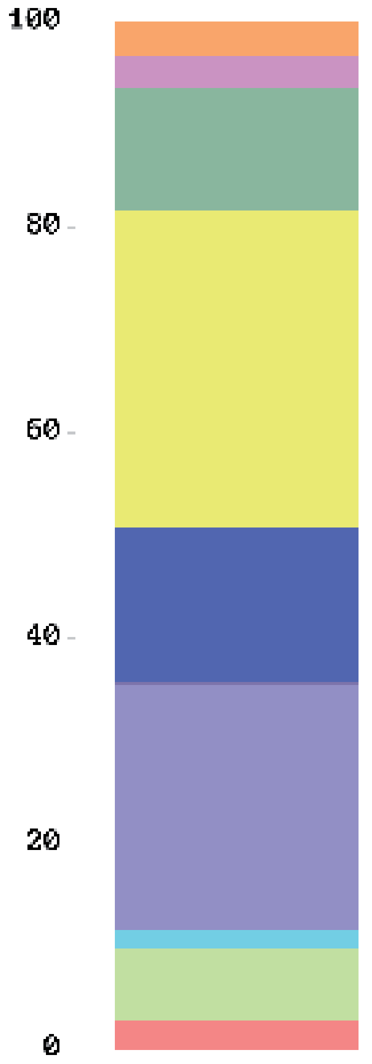
Greatest Impact:
PC – 0.1310 CO^2 eq.kg



96.91 %	Manufacturing	**0.0278 mPts**
%	Use	**mPts**
1.13 %	EOL	**0.0046 mPts**
1.96 %	Transportation	**0.0079 mPts**

0.0403 mPts per functioning unit

Greatest Impact:
PC – 0.0073 mPts



2.73 %	Acidification
7.09 %	Ecotoxicity
1.81 %	Eutrophication
23.94 %	Global Warming
0.02 %	Ozone Depletion
15.29 %	Fossil Fuel Depletion
30.88 %	Carcinogenics
11.85 %	Non-Carcinogenics
3.06 %	Respiratory Effects
3.33 %	Smog

LCA based Insights:

SM-13 shows data gaps in manufacturing for metal related processes. Grinding, decreasing, hardening and heat treating processes related to needle grouping manufacturing are missing.

From all materials used in the Cartridge Needle, the most toxic are Epoxy Resin and PVC since both materials expose humans to harmful fumes and chemical byproducts like furan and dioxin with especially high chances of forming aromatics during incineration. A strong focus should be laid on finding alternative materials or replacing epoxy resins by mechanical bonds rather than adhesives. The needle shaft could be injection molded around the needle grouping, which would also ease the EOL separation process in mechanical recycling approaches.

Transportation Route is routed via the UK; direct shipping would greatly decrease the impact of the product.

LCA

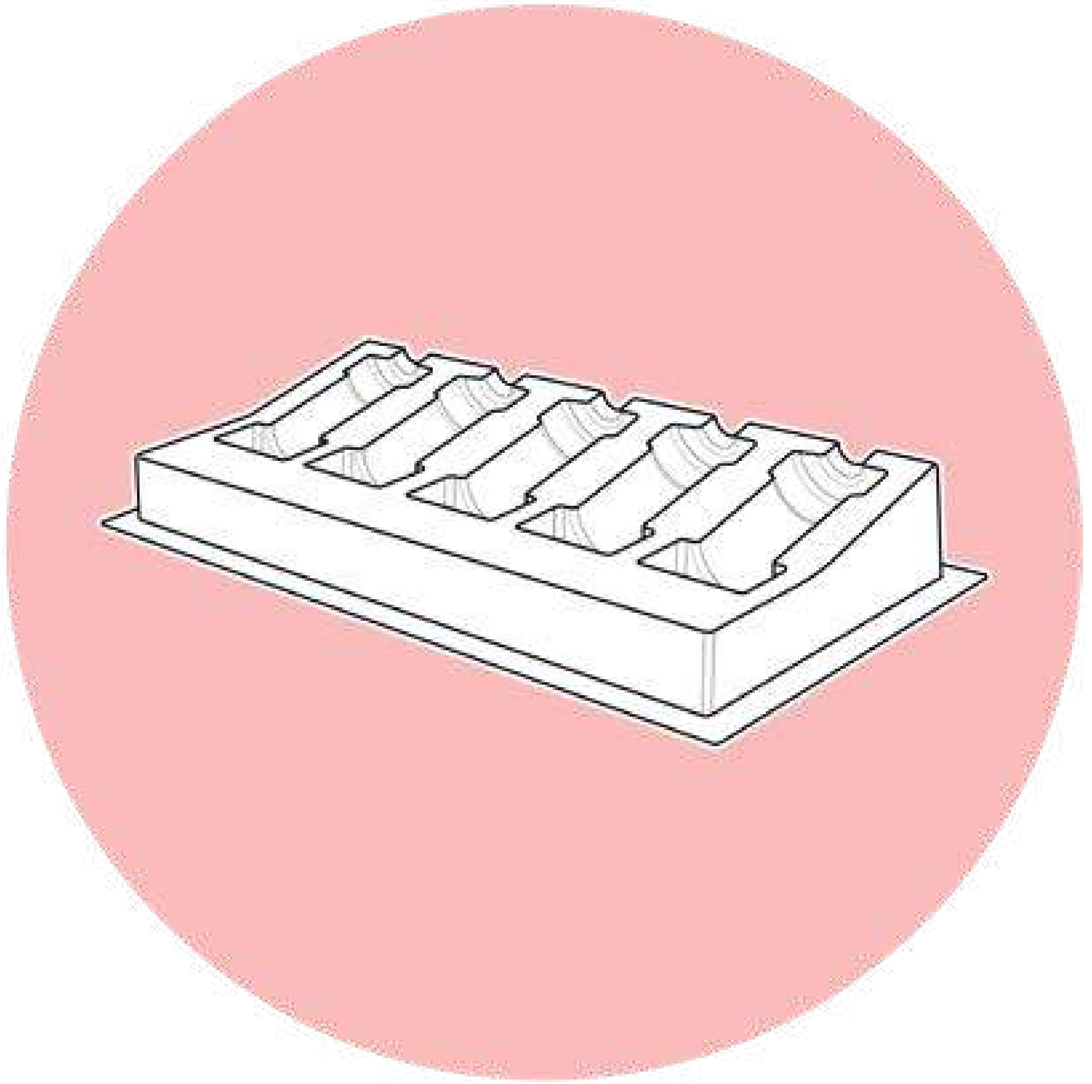
SM-2013

Cartridge Tray PP LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Parts:

Cartridge Tray: 6.3000g

Material : Polypropylene

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:
Printed Cardboard Box
114.000g

Surface Area of Packaging:
1868cm²

Functioning Unit:
50 units & Retail Packaging

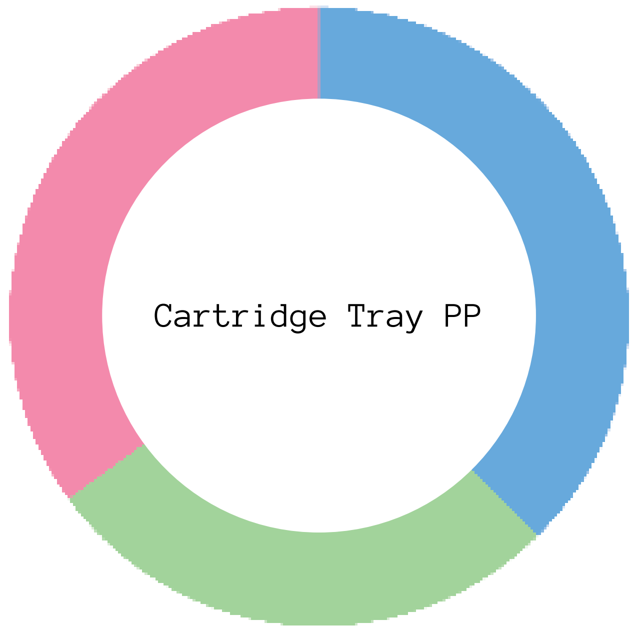
Ink Amount used for Packaging:
0.132g

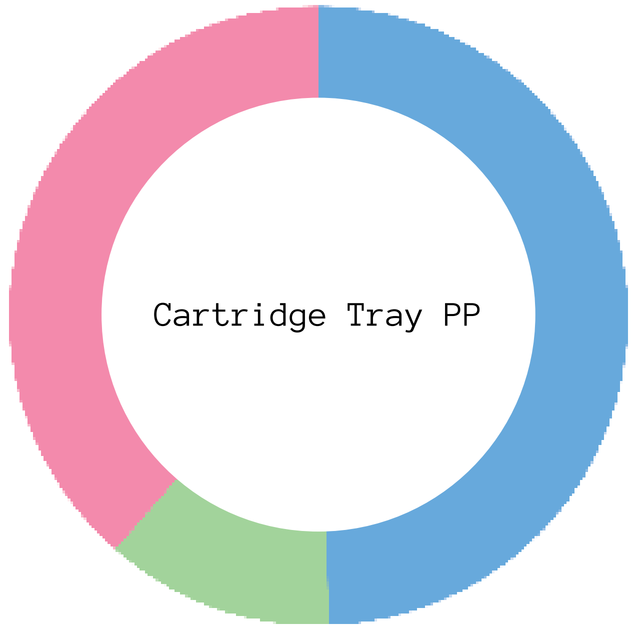
Transportation:

Jinhua Factory - Fuzou Port
Truck **327.660miles**
Fuzou Port - Felixtowe Port UK
Ship via Suez **11558.430miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Cartridge Tray PP LCA





37.68 %	Manufacturing	1.1000	CO^2 eq.kg
%	Use		CO^2 eq.kg
27.38 %	EOL	0.7990	CO^2 eq.kg
34.94 %	Transportation	1.0200	CO^2 eq.kg

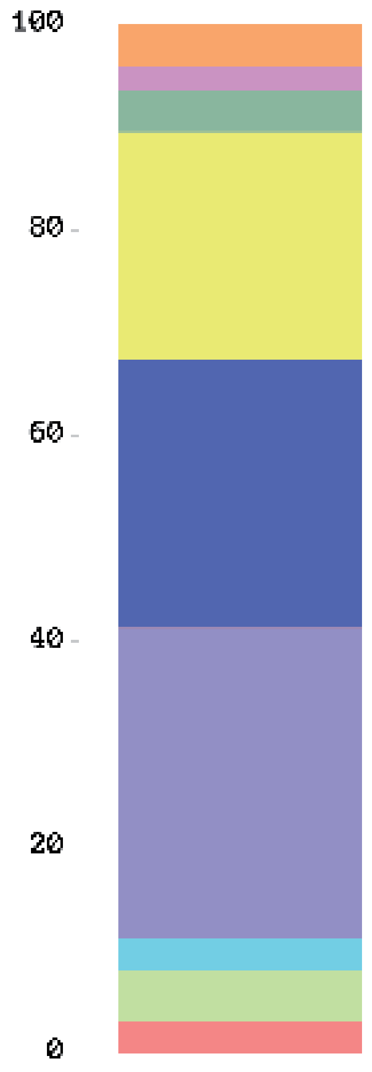
49.60 %	Manufacturing	0.0692	mPts
%	Use		mPts
11.90 %	EOL	0.0166	mPts
38.50 %	Transportation	0.0537	mPts

2.9190 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
PP Incineration – 0.7990 CO^2 eq.kg

0.1395 mPts per functioning unit

Greatest Impact:
PP – 0.0414 mPts



3.12 %	Acidification
4.89 %	Ecotoxicity
3.17 %	Eutrophication
30.17 %	Global Warming
0.02 %	Ozone Depletion
25.93 %	Fossil Fuel Depletion
22.25 %	Carcinogenics
3.99 %	Non-Carcinogenics
2.35 %	Respiratory Effects
4.11 %	Smog

LCA based Insights:

Highest concern is Polypropylene Incineration and the production of it. Impacts could be reduced by finding alternative materials. Plastic should be avoided at all costs when EOL is Incineration.

SUP Products should be replaced by alternative materials.

See Alternative Eco Product.

LCA

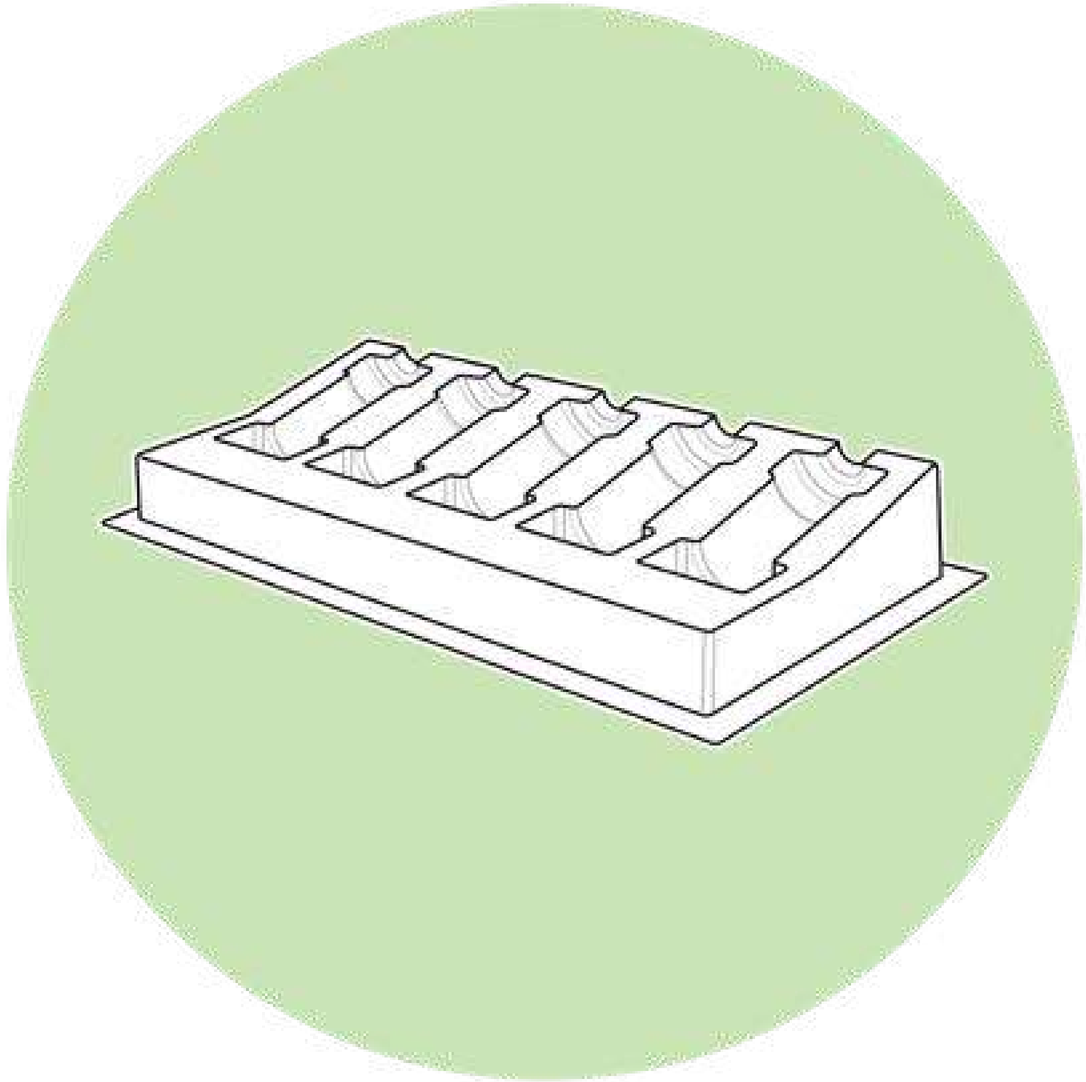
SM-2013

Cartridge Tray Eco LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Pulp Packaging Molding Process data missing.

Parts:

Cartridge Tray: 11.1000g

Material : Paper Pulp

Product Packaging:

No Individual packaging

Retail Packaging:

Packaging:
Printed Cardboard Box Bleached
114.000g

Surface Area of Packaging:
1868cm²

Functioning Unit:
50 units & Retail Packaging

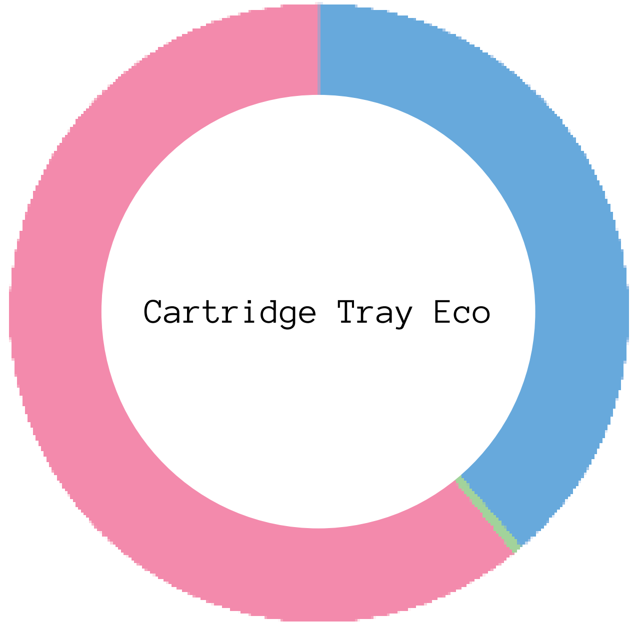
Ink Amount used for Packaging:
0.132g

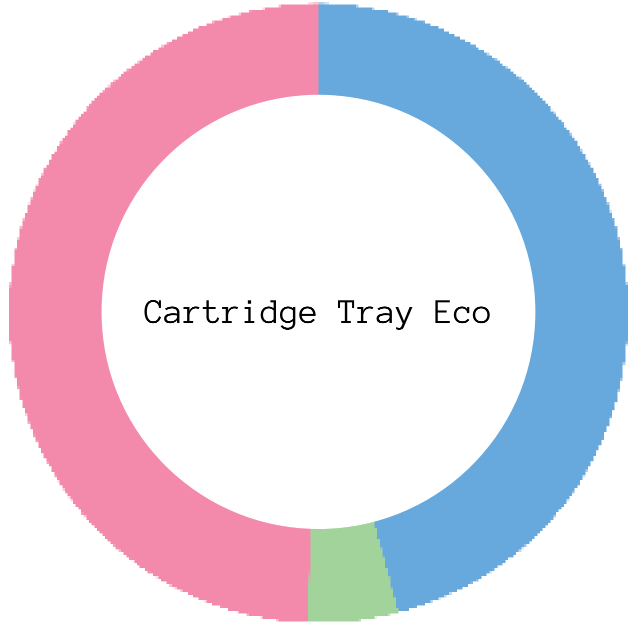
Transportation:

Guangdong Factory - Guangdong Port
Truck **38.230miles**
Guangdong Port - Felixtowe Port UK
Ship via Suez **11233.910miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Cartridge Tray Eco LCA





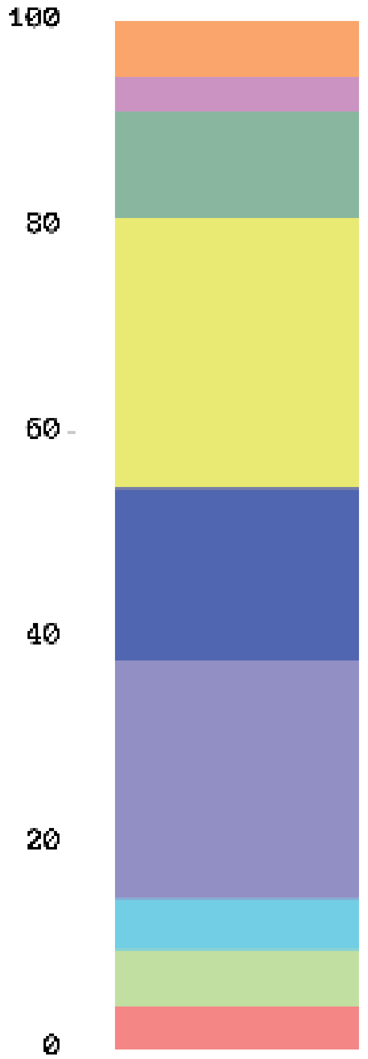
38.62 %	Manufacturing	0.8660 CO^2 eq.kg	46.08 %	Manufacturing	0.0645 mPts
%	Use	CO^2 eq.kg	%	Use	mPts
0.74 %	EOL	0.0166 CO^2 eq.kg	4.62 %	EOL	0.0065 mPts
60.64 %	Transportation	1.3600 CO^2 eq.kg	49.30 %	Transportation	0.0690 mPts

2.3821 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 1.1500 CO^2 eq.kg

0.1400 mPts per functioning unit

Greatest Impact:
Solid unbleached Board – 0.0547 mPts



4.07 %	Acidification
5.61 %	Ecotoxicity
4.95 %	Eutrophication
23.15 %	Global Warming
0.03 %	Ozone Depletion
16.74 %	Fossil Fuel Depletion
26.28 %	Carcinogenics
10.32 %	Non-Carcinogenics
3.45 %	Respiratory Effects
5.39 %	Smog

LCA based Insights:

Compared to its alternative product, the product shows a CO^2 Impact reduction of 18% with a 0.33% increase in mPts Impact. With Sustainable Minds 2013 having a 15% margin of error and the LCA Data of the Eco Product missing Processing Data, a conclusion cannot be made towards sustainability.

Although if the Product would be produced locally instead of Mainland China, significant transportation impacts could be reduced, especially air travel impacts, which are especially high in Eco Products due to their tendency to have increased product weight. This is especially significant when plastics are replaced by paper based materials. Paper in itself is also not infinitely recyclable as well as showing significant environmental and waste water impacts by material process nature.

LCA

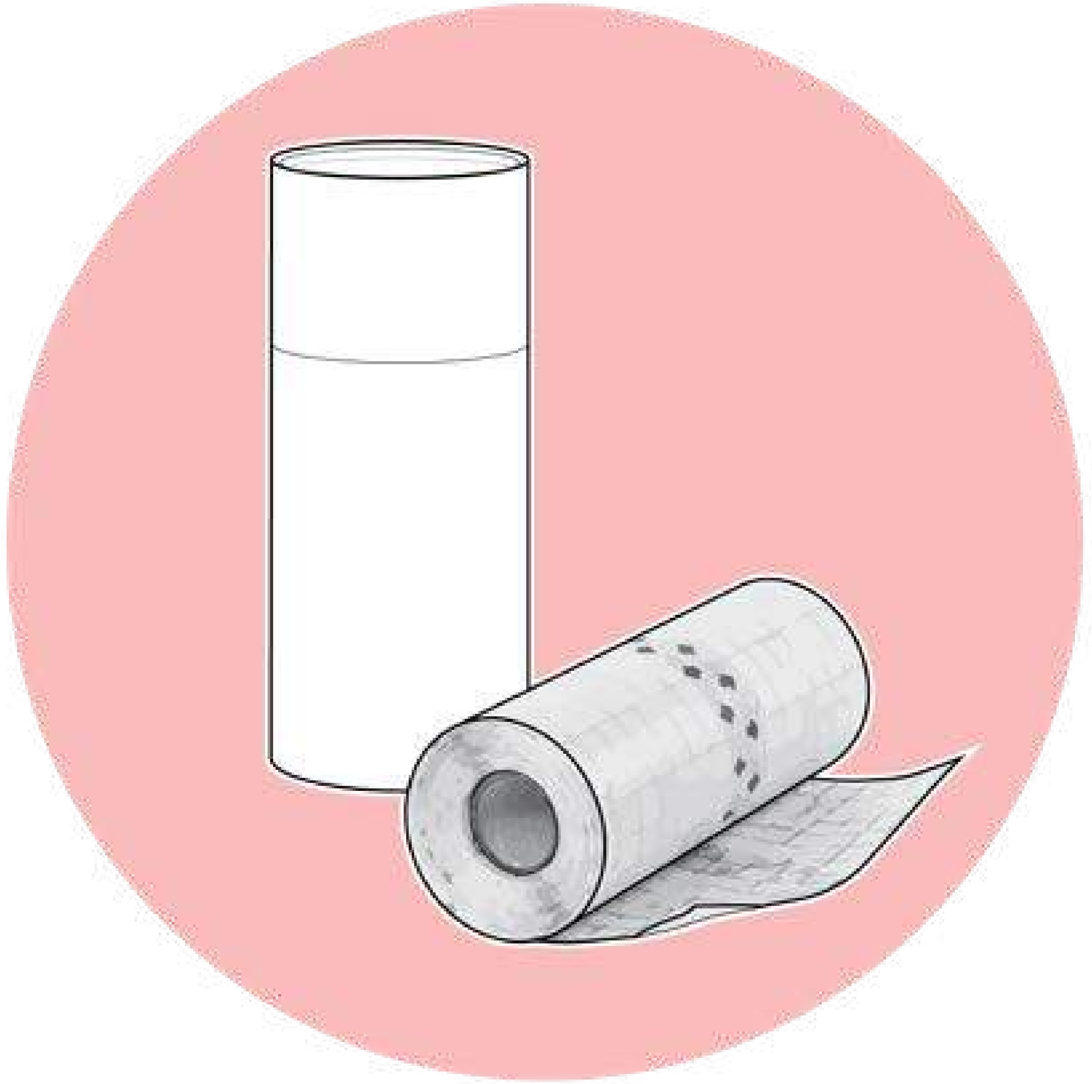
SM-2013

Polyurethane Tattoo Cover LCA

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Biocompatible Acryclic Glue Amount unknown.

Glassin Paper Data Gap - Material composition added.

Glassin Paper Print impact not included.

Polyurethane Film Data Gap - Polyurethane Foam Flexible Placholder.

Non Contact Deposition Data Missing.

Parts:

LDPE Protective Film: 1.7778g
Polyuretahne Cover: 1.3334g
Glassin Paper: 2.1112g
PET & Paper
84.78% & 15.21%

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

Printed Cardboard Tube
72g

Cardboard Core
15.375g

Surface Area of Packaging:
496.513cm²

Functioning Unit:
c.55 units & Retail Packaging
10cm x 18m

Ink Amount used for Packaging:
0.0353g

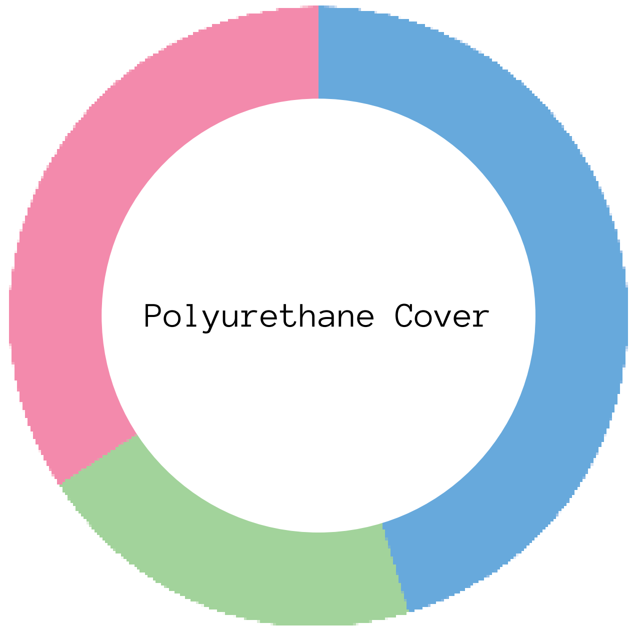
Transportation:

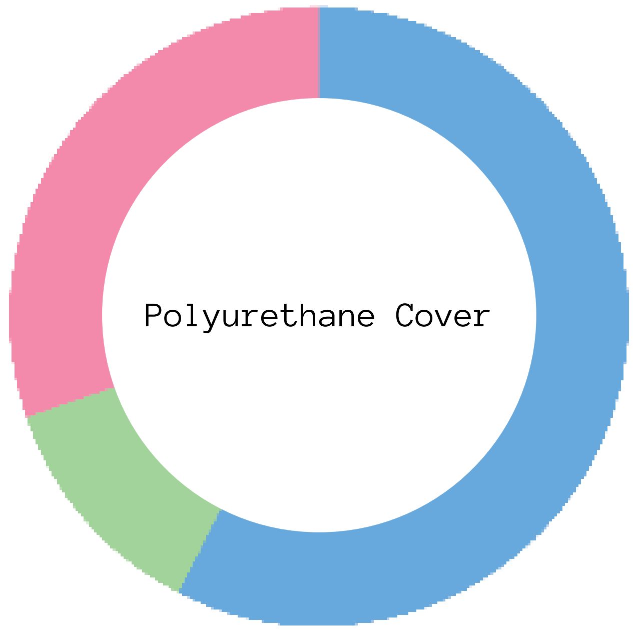
Ningbo Factory - Shanghai Port
Truck **158.000miles**
Shanghai - Felixtowe Port UK
Ship via Suez **12032.549miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

LCA

SM-2013

Polyurethane Tattoo Cover LCA





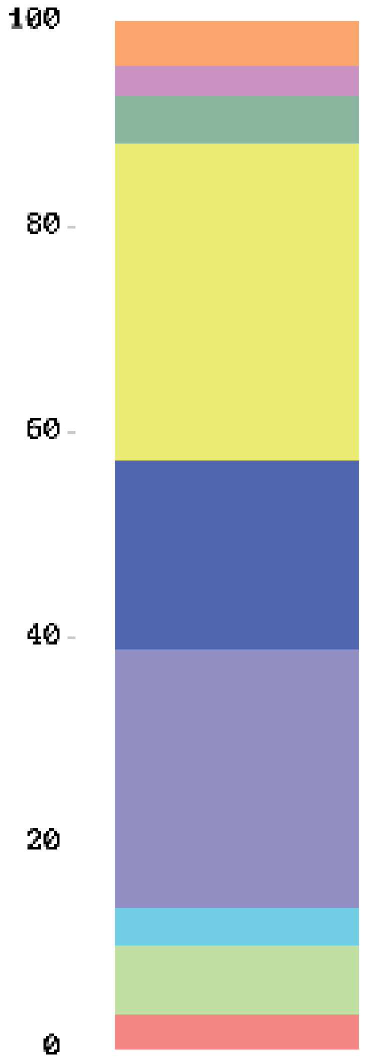
45.31 %	Manufacturing	**1.0200 CO^2 eq.kg**	**57.74 %**	Manufacturing	**0.0746 mPts**
%	Use	**CO^2 eq.kg**	**%**	Use	**mPts**
20.79 %	EOL	**0.4680 CO^2 eq.kg**	**12.15 %**	EOL	**0.0157 mPts**
33.90 %	Transportation	**0.7630 CO^2 eq.kg**	**30.19 %**	Transportation	**0.0389 mPts**

2.2510 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.5980 CO^2 eq.kg

0.1292 mPts per functioning unit

Greatest Impact:
Polyurethane Flexible Foam – 0.0286 mPts



3.27 %	Acidification
6.77 %	Ecotoxicity
3.58 %	Eutrophication
25.13 %	Global Warming
0.02 %	Ozone Depletion
18.61 %	Fossil Fuel Depletion
30.74 %	Carcinogenics
4.74 %	Non-Carcinogenics
2.88 %	Respiratory Effects
4.26 %	Smog

LCA based Insights:

This LCA shows significant Data Gaps in Manufacturing and Raw Material Data. The Product is patented and therefore lacks accessibility to information. The biocompatible acrylic deposition on the Polyurethane Film is performed with an inkjet printing technology which can be found in the Patent (Pub.No: US2006/0034899 A1).

Sustainable Minds 2013 is lacking data sets especially for niche materials like biocompatible Acrylic or the processing data of the deposition of biocompatible Acrylic glue with inkjet technologies like a XAAR XJ128-200 printhead. This Data will most likely be hard to obtain even in the future, LCA improvements are unlikely due to the patented technology associated with the data.

LCA

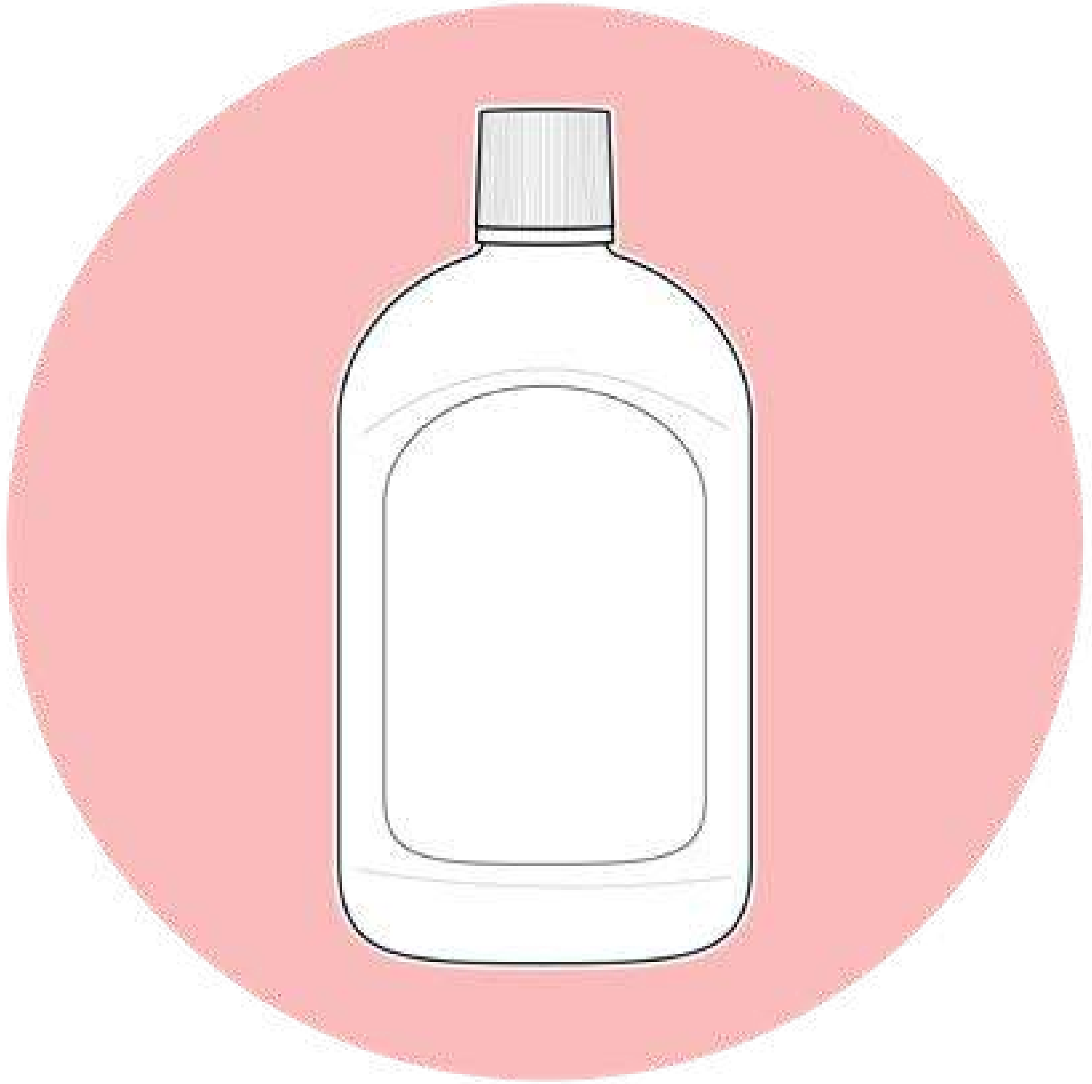
SM-2013

Floor Disinfectant

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Disinfectant Data Gap - Placeholder demineralized water.

- Substances are dissected with the help of external tools EWG.

Concentrate:

Aqua - Placeholder

Ingredients:
Chloroxylenol, Pine oil, Isopropyl alcohol, Castor oil, Caustic soda solution, Caramel & Water.

Product Packaging:

Bottle PP: 41.1170g
Bottle Cap PP: 4.8219g
PP & TiOx
97% & 3%
Cap Seal PS: 0.1550g

Retail Packaging:

Packaging:

Printed Paper Label:
1.4130g

Adhesive for Label:
0.2640g

Surface Area of Packaging:
158cm²

Functioning Unit:
33units / 500ml & Retail Packaging

Ink Amount used for Packaging:
0.0112g

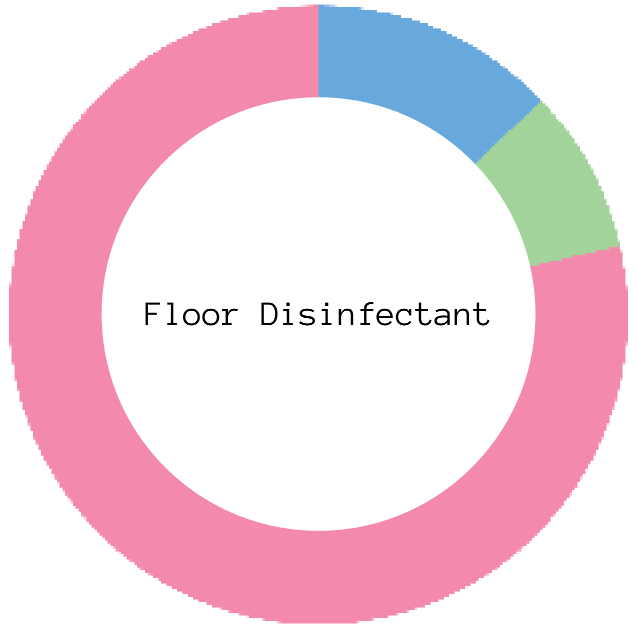
Transportation:

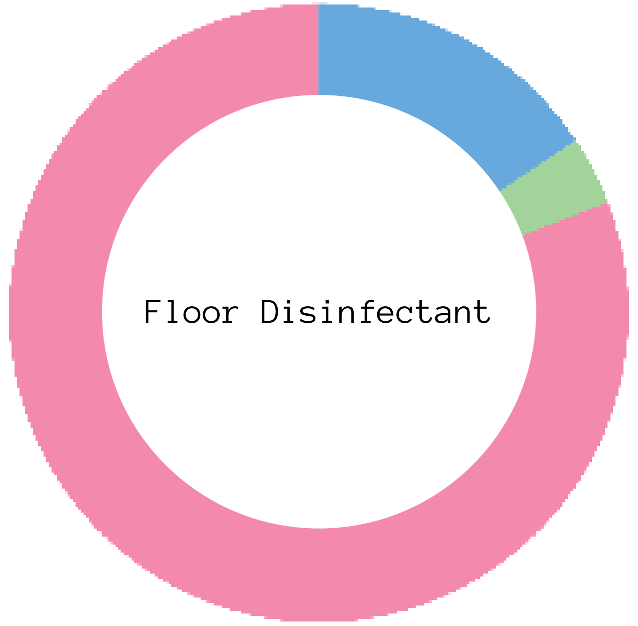
Bottle:
Guanzhou Factory - Guanzhou Port
Truck **58.950miles**
Guanzhou Port - Hull Port UK
Ship via Suez **11396.170miles**
Hull Port UK - Hull Factory
Truck **2.260miles**

Product:
Hull Factory - Liverpool Tattoo Supply
Truck **131.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Floor Disinfectant





12.81 %	Manufacturing	0.1730 CO^2 eq.kg
%	Use	CO^2 eq.kg
8.73 %	EOL	0.1180 CO^2 eq.kg
78.46 %	Transportation	1.0600 CO^2 eq.kg

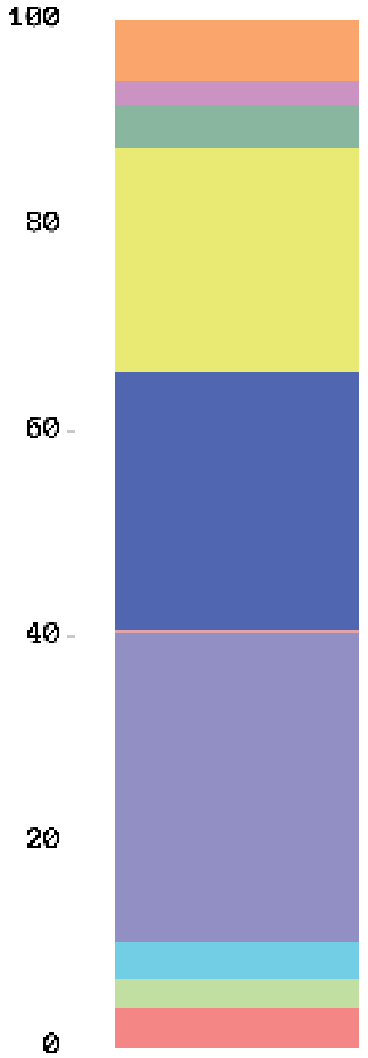
15.58 %	Manufacturing	0.0100 mPts
%	Use	mPts
3.86 %	EOL	0.0025 mPts
80.56 %	Transportation	0.0517 mPts

1.3510 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.9400 CO^2 eq.kg

0.0642 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0440 mPts



3.76 %	Acidification
3.01 %	Ecotoxicity
3.53 %	Eutrophication
30.24 %	Global Warming
0.04 %	Ozone Depletion
25.14 %	Fossil Fuel Depletion
21.82 %	Carcinogenics
4.18 %	Non-Carcinogenics
2.32 %	Respiratory Effects
5.96 %	Smog

LCA based Insights:

The LCA is inconclusive as the data for liquid calculations is limited within Sustainable Minds. Data Gaps will be explained through EWG (Environmental Working Group) data. The substance present in the dissected product contains Chloroxylenol and Sodium Hydroxide which show the most significant concerns in the chemical substances of the product. Organ System toxicity: industry recommendation for concentration restrictions as well as skin contact should be avoided for both substances. In addition Chloroxylenol is suspected to be a environmental toxin and work exposure restriction apply to handling the substance.

The scoring goes from 1-10 with one being the least dangerous and 10 the most dangerous. The score of Chloroxylenol is 3 and Sodium Hydroxide 1-4.

The Products impact could be improved by lowering the amount of water that is transported: this will show significant weight reductions and lower the impact created. The concentrate could be transported in water-soluble sachets instead of SUP Bottles. This would further reduce the product weight and impact.

LCA

SM-2013

Demineralized Water Refill

Definition:

LCA Type:

Cradle-to-Grave
Use - Not Applicable
EOL
Transportation

Missing Information:

Transportation Data missing.

Parts:

Distilled Water: 1l

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

Reusable Bottle :
HDPE Bottle & PP Lid
(Not included in this LCA)

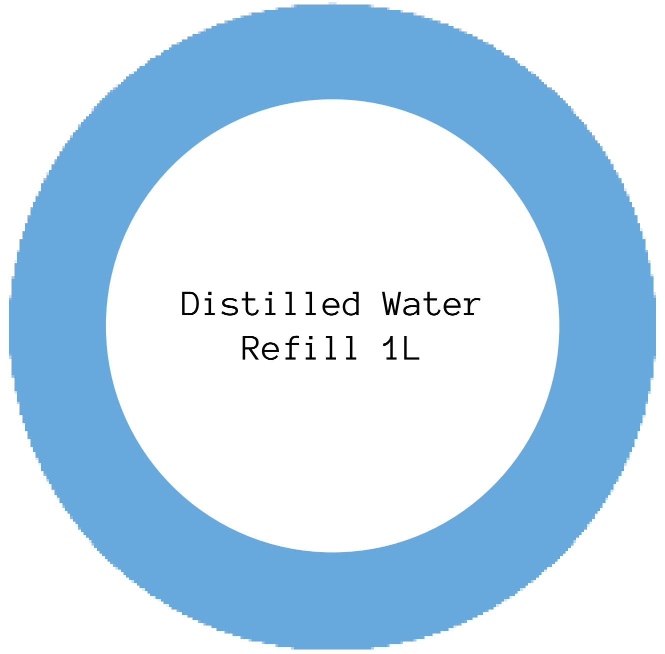
Functioning Unit:
1l Distilled Water Refill

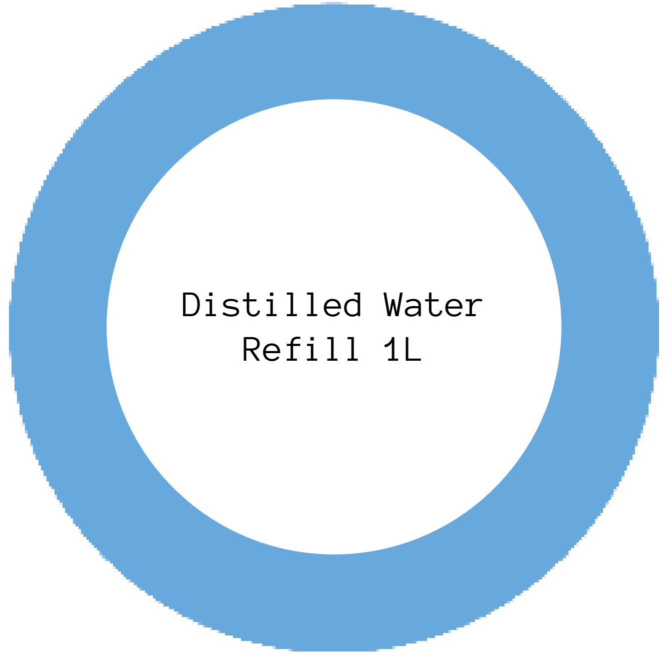
Transportation:

Data Gap

SM-2013

Demineralized Water Refill





100 %	Manufacturing	**0.0010 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
%	EOL	**CO^2 eq.kg**

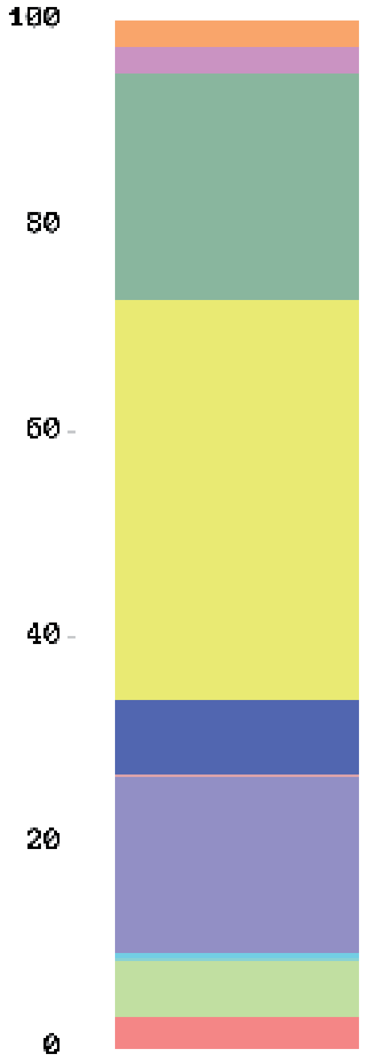
100 %	Manufacturing	**0.00008 mPts**
%	Use	**mPts**
%	EOL	**mPts**

0.0010 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Demineralized water – 0.0010 CO^2 eq.kg

0.00008 mPts per functioning unit

Greatest Impact:
Demineralized water – 0.00008 mPts



3.18 %	Acidification
5.44 %	Ecotoxicity
0.74 %	Eutrophication
17.15 %	Global Warming
0.12 %	Ozone Depletion
7.20 %	Fossil Fuel Depletion
39.11 %	Carcinogenics
22.02 %	Non-Carcinogenics
2.40 %	Respiratory Effects
2.64 %	Smog

LCA based Insights:

This LCA shows no potential for improvement in product optimization. The LCA shows data gaps in Transportation Data since then information was not provided by the Pharmacy that supplies the demineralized water. Since the transportation to the studio is done by bicycle no impact data was added. Research could help to establish a proposed transportation route in the future. Bulk packaging of demineralized water is not included in this LCA due to Data Gaps.

Carcinogenics are extremely high with 39.11% for unknown reasons. The reason should be researched in the future to gain further insights.

SM-2013

Demineralized Water Bottle

Definition:

LCA Type:

Cradle-to-Cradle
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Transportation Data missing.

Parts:

Bottle HDPE: 51.0000g
Bottle Cap PP: 2.9800g
PP & CB
97% & 3%

Product Packaging:

No individual packaging

Retail Packaging:

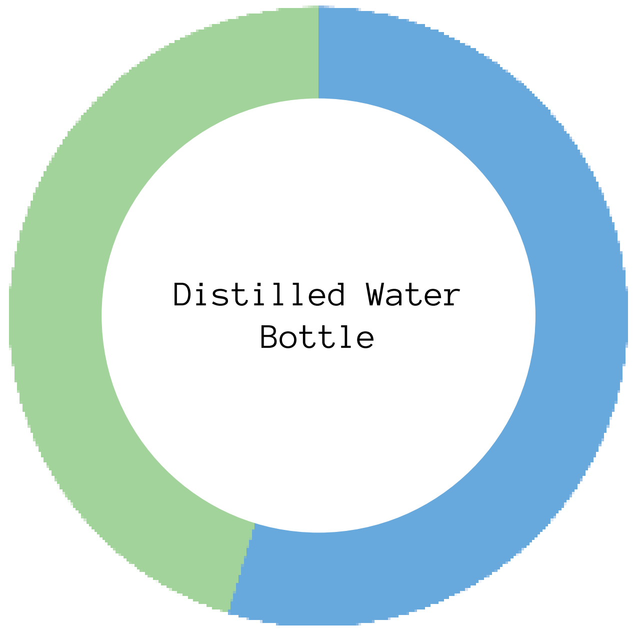
No Retail Packaging

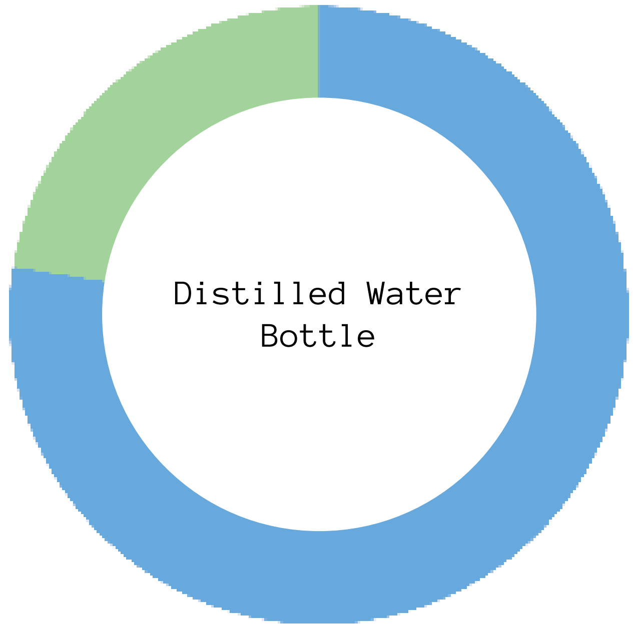
Transportation:

Data Gap

SM-2013

Demineralized Water Bottle





54.80 %	Manufacturing	0.1940 CO² eq.kg	
%	Use	CO² eq.kg	
45.20 %	EOL	0.1600 CO² eq.kg	
%	Transportation	CO² eq.kg	

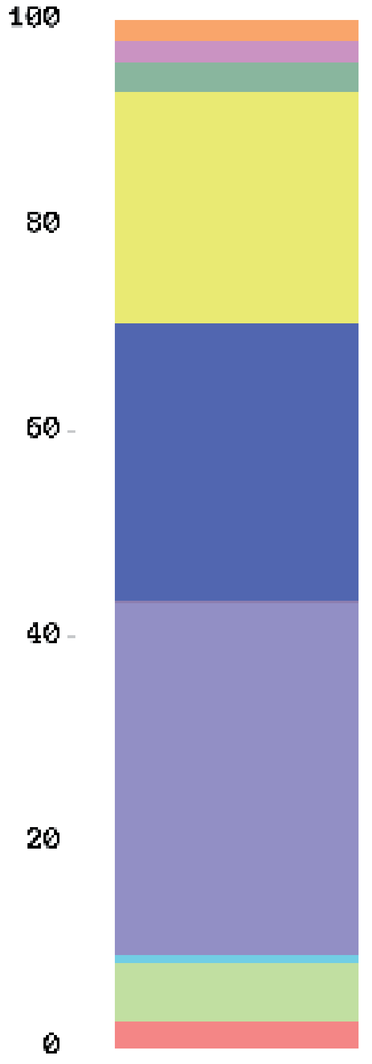
77.65 %	Manufacturing	0.0115 mPts
%	Use	mPts
22.35 %	EOL	0.0033 mPts
%	Transportation	mPts

0.3540 CO² eq.kg emitted per functioning unit

Greatest Impact:
HDPE Incineration – 0.1530 CO² eq.kg

0.0148 mPts per functioning unit

Greatest Impact:
HDPE – 0.0069 mPts



2.43 %	Acidification
5.79 %	Ecotoxicity
0.75 %	Eutrophication
34.38 %	Global Warming
0.01 %	Ozone Depletion
27.23 %	Fossil Fuel Depletion
22.52 %	Carcinogenics
2.83 %	Non-Carcinogenics
1.95 %	Respiratory Effects
2.11 %	Smog

LCA based Insights:

The Bottle being Reusable will result in a single impact per bottle and not per refill.This varies greatly from the traditional distilled water product where the bottle and content are bought together instead of refilling it from bulk packaging.

This doesn't mean that there is no waste associated with bulk packaging and much rather shows a data gap that has not been solved yet. The LCA shows data gaps in Transportation Data since the information was not provided by the Pharmacy that supplied the bottle. Since the transportation to the studio is done by bicycle no impact data was added. Research could help to establish a proposed transportation route in the future.

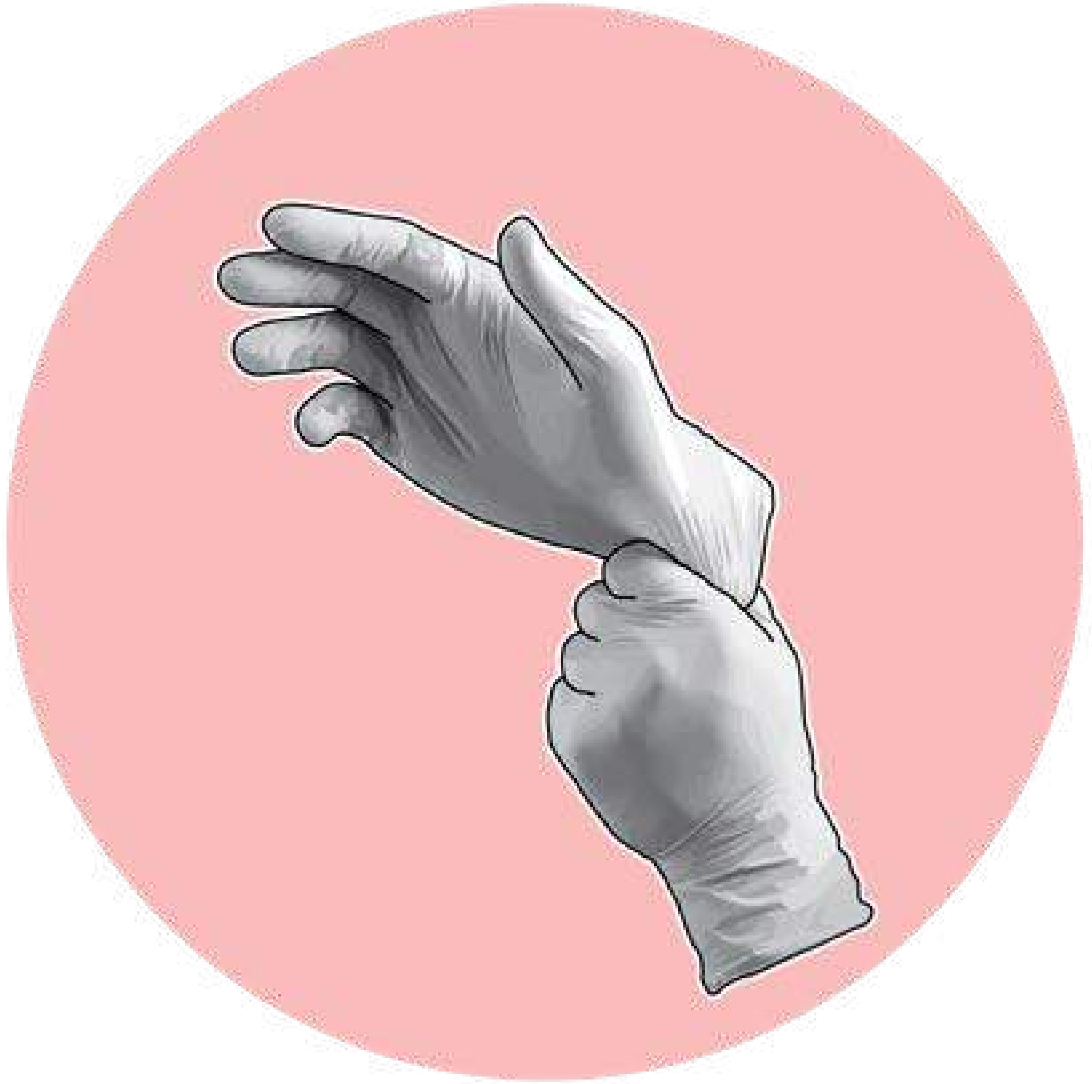
SM-2013

Nitrile Gloves

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Manufacturing Data Gap.
 -Nitrile Mold Dipping missing.

Parts:

Gloves (Pair): 8.8000g

Material: Nitrile

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

Printed Paperboard Box (bleached):
67.4060g

Surface Area of Packaging:
1546.60cm²

Functioning Unit:
100 Gloves (XL) & Retail Packaging

Ink Amount used for Packaging:
0.0110g

Transportation:

Gillingham Factory - Liverpool Tattoo Supply
Truck **168.180miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Nitrile Gloves

43.34 %	Manufacturing	**1.8200 CO² eq.kg**
%	Use	**CO² eq.kg**
33.10 %	EOL	**1.3900 CO² eq.kg**
23.56 %	Transportation	**0.9890 CO² eq.kg**

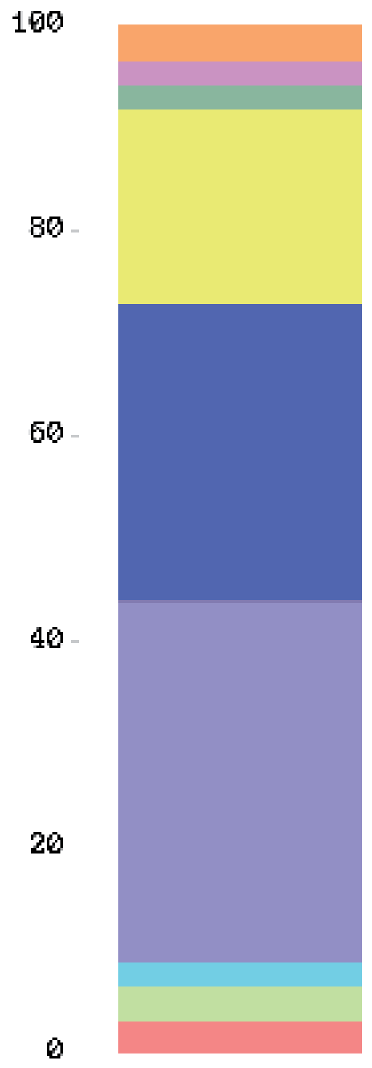
58.65 %	Manufacturing	**0.1010 mPts**
%	Use	**mPts**
13.18 %	EOL	**0.0227 mPts**
28.16 %	Transportation	**0.0485 mPts**

4.1990 CO² eq.kg emitted per functioning unit

Greatest Impact:
Nitrile NBR – 1.6200 CO² eq.kg

0.1722 mPts per functioning unit

Greatest Impact:
Nitrile NBR – 0.0916 mPts



3.04 %	Acidification
3.49 %	Ecotoxicity
2.23 %	Eutrophication
35.14 %	Global Warming
0.01 %	Ozone Depletion
28.87 %	Fossil Fuel Depletion
19.03 %	Carcinogenics
2.25 %	Non-Carcinogenics
2.29 %	Respiratory Effects
3.64 %	Smog

LCA based Insights:

Calculating the manufacturing process of nitrile Gloves is not possible due to process data gaps.

The Nitrile gloves are sourced through my regular tattoo supply shop in England. The company produces in England, but the HQ is located in Neuss, Germany, which is also a production facility. Buying the same product, but from the German production facility, will decrease transportation offset, especially the one listed under “Greatest Impact”. Airfreight impacts are always the biggest potential for CO² emissions, especially those of products with high weight.

The alternative product, Latex gloves, is preferred due its lower impact.

The LCA is only valid for XL sized gloves; calculations need to be adjusted to different glove sizes in the future.

LCA

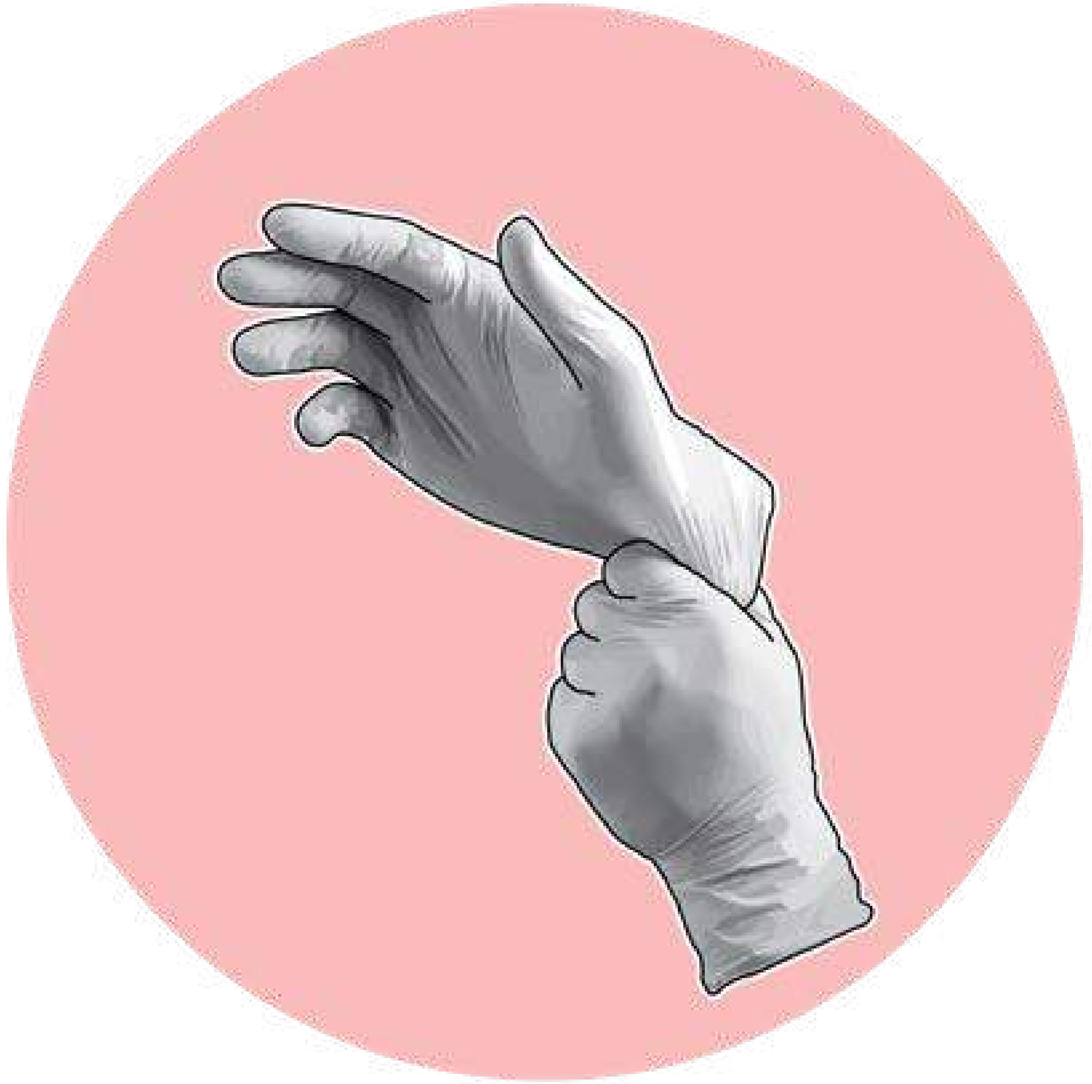
SM-2013

Latex Gloves

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Manufacturing Data Gap.
  -Latex Mold Dipping missing.
  -Vulcanization data missing.

EOL Data Gap. Incineration impact data missing.

Parts:

Gloves (Pair): 8.8000g

Material: Nitrile

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

Printed Paperboard Box (bleached):
67.4060g

Surface Area of Packaging:
1546.60cm²

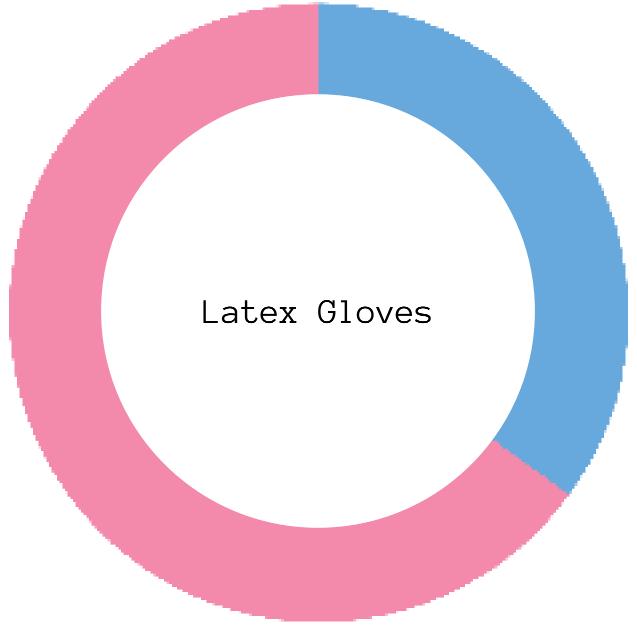
Functioning Unit:
100 Gloves (XL) & Retail Packaging

Ink Amount used for Packaging:
0.0110g

Transportation:

Gillingham Factory - Liverpool Tattoo Supply
Truck **168.180miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

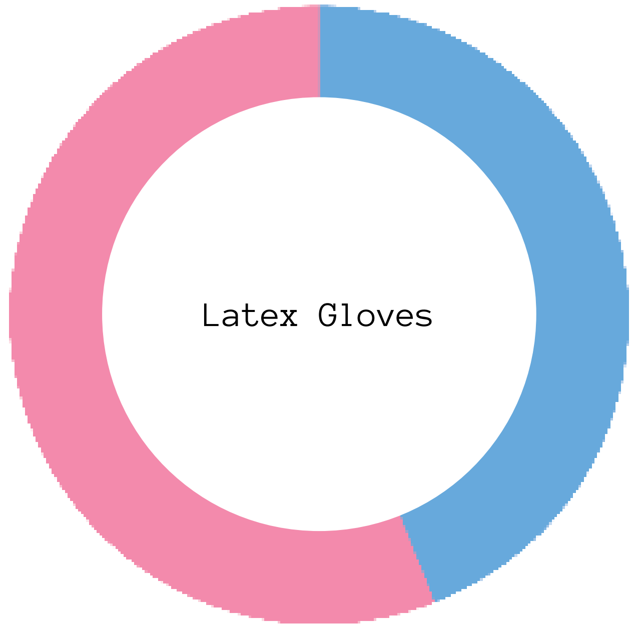
SM-2013
Latex Gloves



35.15 %	Manufacturing	0.5360 CO^2 eq.kg
%	Use	CO^2 eq.kg
%	EOL	CO^2 eq.kg
64.85 %	Transportation	0.9890 CO^2 eq.kg

1.5250 CO^2 eq.kg emitted per functioning unit

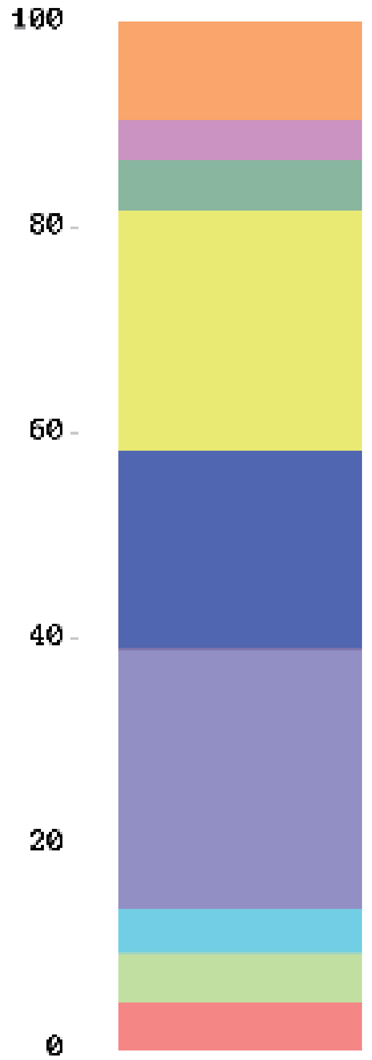
Greatest Impact:
Airfreight – 0.8710 CO^2 eq.kg



44.06 %	Manufacturing	0.0382 mPts
%	Use	mPts
%	EOL	mPts
55.94 %	Transportation	0.0485 mPts

0.0523 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0408 mPts



4.68 %	Acidification
4.74 %	Ecotoxicity
4.18 %	Eutrophication
25.34 %	Global Warming
0.03 %	Ozone Depletion
19.36 %	Fossil Fuel Depletion
23.26 %	Carcinogenics
5.01 %	Non-Carcinogenics
3.82 %	Respiratory Effects
9.56 %	Smog

LCA based Insights:

Calculating the manufacturing process of Latex Gloves is not possible due to process data gaps.

Latex gloves are sourced through my regular tattoo supply shop in England. The company produces in England, but the HQ is located in Neuss, Germany, which is also a production facility. Buying the same product but from the German production facility will decrease transportation offset, especially the one listed under “Greatest Impact”. Airfreight impacts are always the biggest potential for CO^2 emissions, especially those of products with high weight.

Latex Gloves would be the preferred product over Nitrile Gloves, due to the lower ecological impacts, but the Product should be avoided by tattoo artists, as well as customers with Latex allergies.

The LCA is only valid for XL sized gloves; calculations need to be adjusted to different glove sizes in the future.

LCA

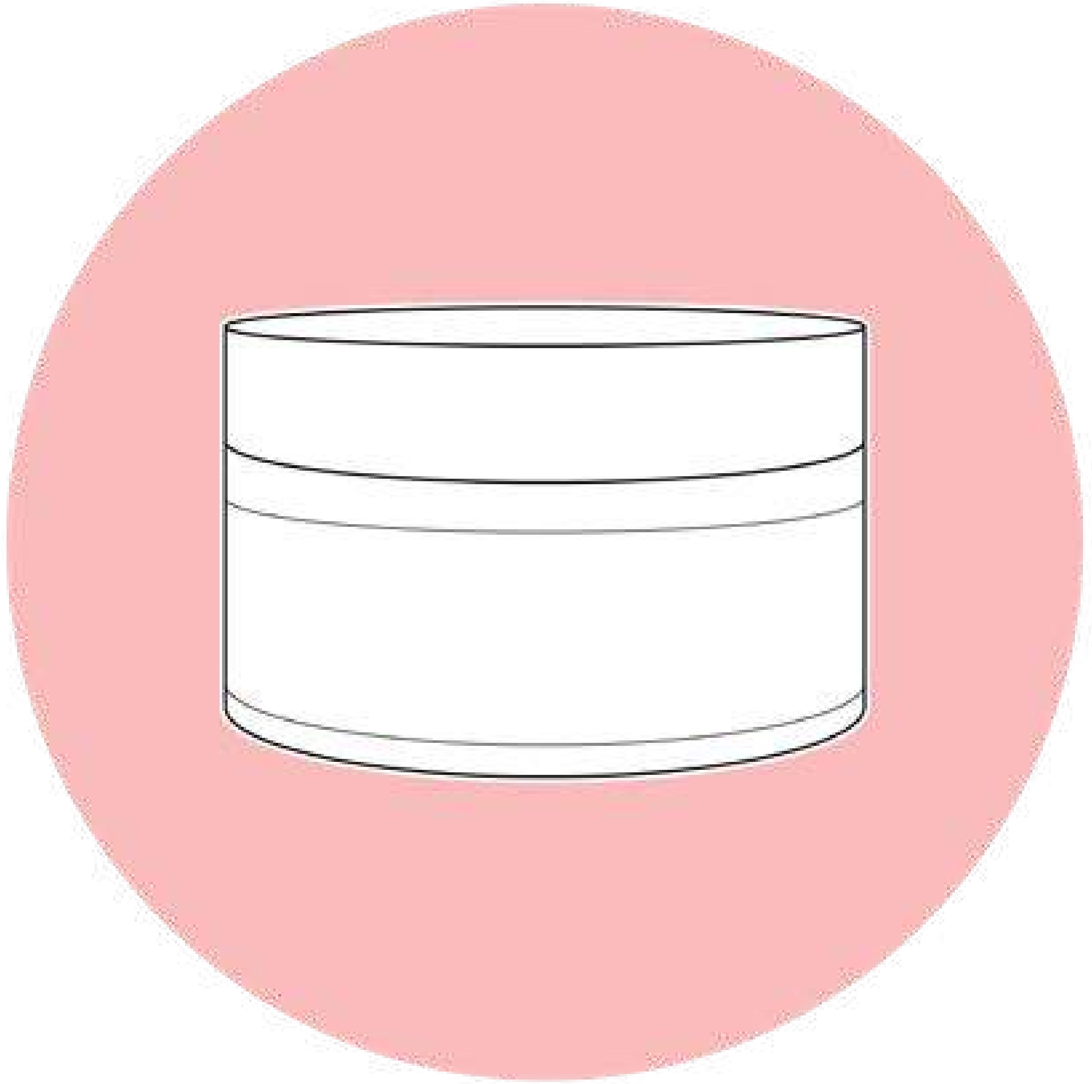
SM-2013

Tattoo After Care

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Cream Ingredients Data Gap.
-Sm-13 lacks data for Cream calculation - Coconut oil placeholder.
PVC Label Ink Data Gap - Offset Placeholder
Adhesive for Label missing.

Cream:

Coconut Oil - Placeholder

Ingredients:
Shea Butter, Mango Butter, Aloe Butters
Coconut Oil, Sunflower Oil, Rice Bran Oil,
Rosemary Oleoresin, Green Tea, Vitamin E Complex,
Mint Arvenis Essential Oil, Papaya Essence &
Coconut Essence.

Product Packaging:

Screw Tub PET (Frosted): 90.0000g
Seal Expanded PS: 0.2100g
Adhesive for PS: 0.4950g
Label PVC: **3.5000g**
PVC 97% - TiOx 3%

Transportation:

Product Packaging:
Guanzhou Factory - Guangzhou Port
Truck **58.950miles**
Guangzhou Port - New York Port
Ship via Panama Canal **12992.300miles**
New York Port - New York Tattoo Supply
Truck **27.200miles**

Product:
New York Tattoo Supply - New York Port
Truck **27.200miles**
New York Port - Felixtowe Port UK
Ship **3813.680miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

Retail Packaging:

Packaging:

PVC Label:
3.5000g

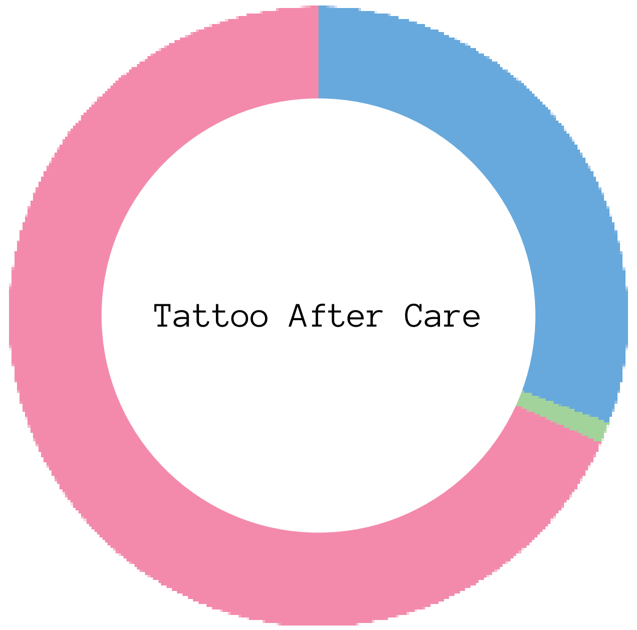
Surface Area of Packaging:
107.86cm²

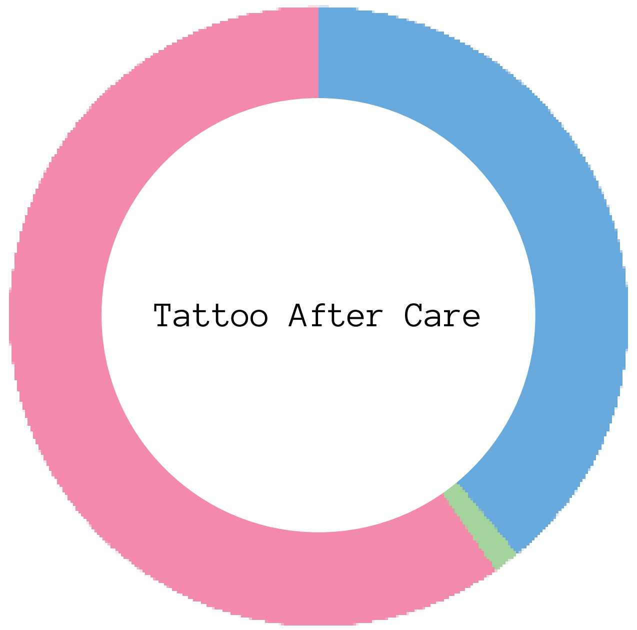
Functioning Unit:
150g & Retail Packaging

Ink Amount used for Packaging:
0.047g

SM-2013

Tattoo After Care





30.65 %	Manufacturing	**0.0256 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
1.23 %	EOL	**0.0103 CO^2 eq.kg**
68.12 %	Transportation	**0.0569 CO^2 eq.kg**

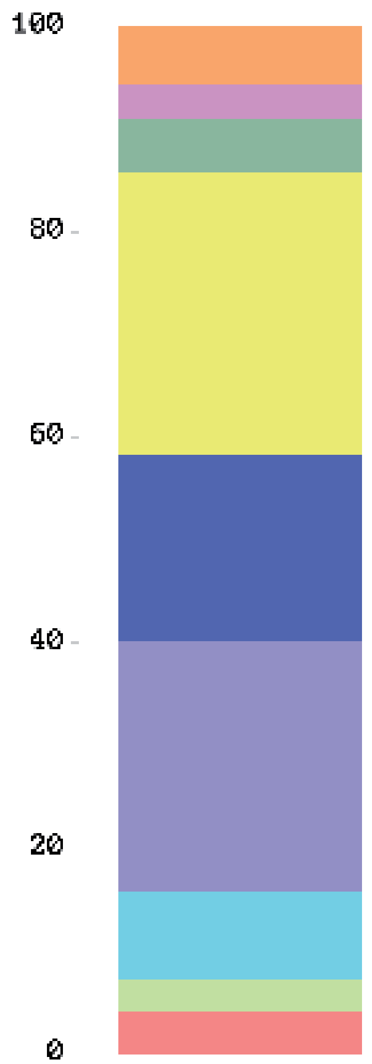
39.13 %	Manufacturing	**0.0194 mPts**
%	Use	**mPts**
1.15 %	EOL	**0.0005 mPts**
59.72 %	Transportation	**0.0296 mPts**

0.0928 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.4190 CO^2 eq.kg

0.0495 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0196 mPts



4.01 %	Acidification
3.26 %	Ecotoxicity
8.55 %	Eutrophication
24.30 %	Global Warming
0.05 %	Ozone Depletion
18.18 %	Fossil Fuel Depletion
27.49 %	Carcinogenics
5.18 %	Non-Carcinogenics
3.25 %	Respiratory Effects
5.72 %	Smog

LCA based Insights:

Product packaging is not produced close to the production facility resulting in added transportation impact. Overall, the transportation impact is the greatest impact by lifecycle stage. Airfreight being the “Greatest Impact” due to the product weight.

Data Gaps, like for most liquids and creams in SM-13, are leading to an inconclusive reflection. This requires the analysis of the cream through secondary sources like EWG. The data provided shows concerns for Rosemary extract with a Rating of 2/10. Rosemary extract shows strong evidence for human system toxicants or allergies.

The second ingredient of concern is Aloe Barbadensis Butter with a score of 1-2/10 with impacts showing growing concern to be a human carcinogen, causing cancer. The evidence is not yet conclusive but has increased from 2010 to 2013 & 2016 ,with the first study being declared as incomplete, the second suggesting strong evidence and the latest labeling it as possible human carcinogen.

At the current level of this LCA, the Plastic packaging and its impact reduction through local production or redesign for lighter or more sustainable materials would yield the greatest results.

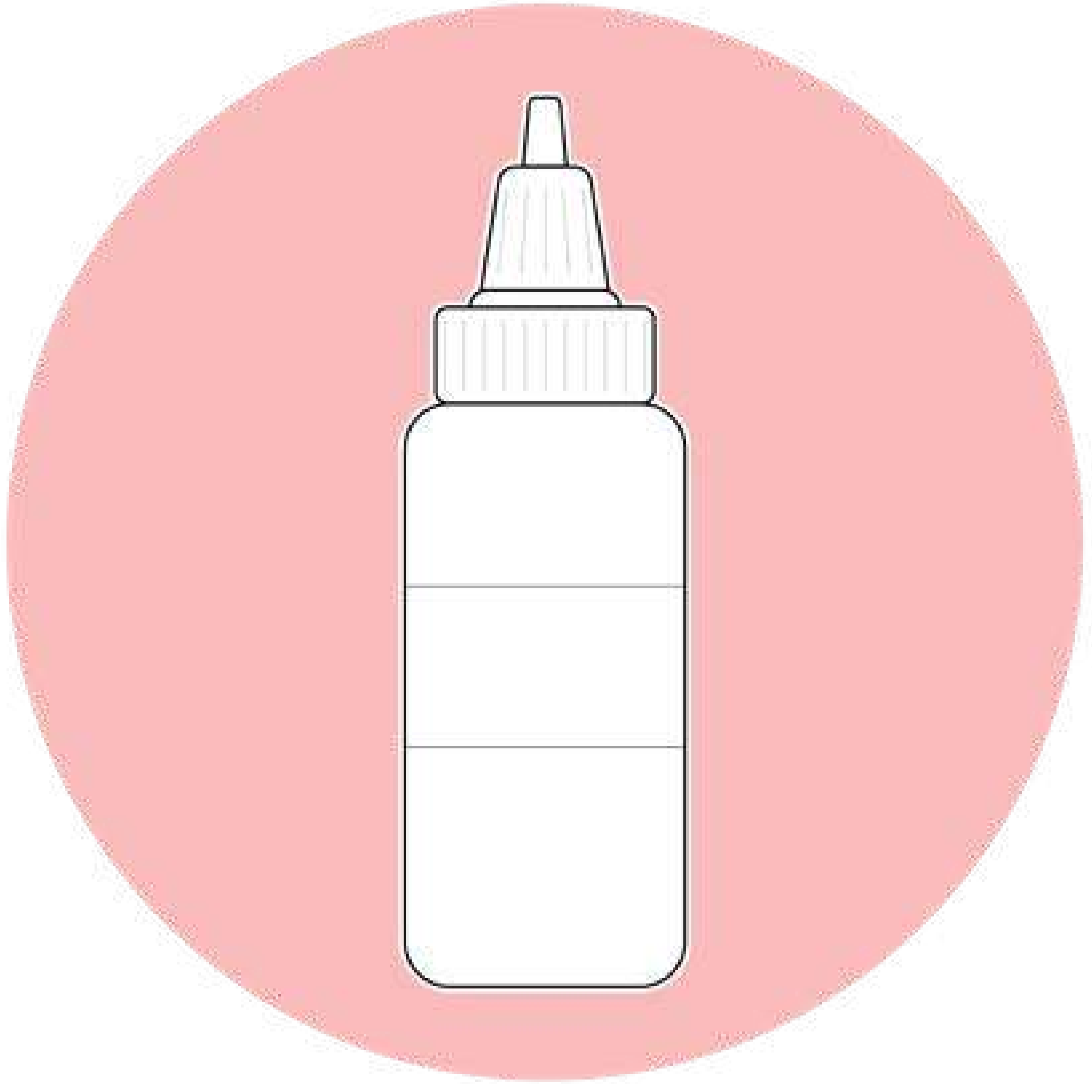
SM-2013

Tattoo Ink

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Tattoo Ink Ingredients Data Gap - Liquid Placeholder.
Glass Marble Manufacturing Data Gap.
PVC Label Print Ink Data Gap - Offset Placeholder.
PVC Label Adhesive missing.

Ink:

Aqua - Placeholder

Ingredients:
Carbon Black, Water, Glycerin, Isopropyl Alcohol & Hamamelis virginiana

Retail Packaging:

Packaging:

PVC Label:
0.7000g

Surface Area of Packaging:
40cm²

Functioning Unit:
60 ml & Retail Packaging

Ink Amount used for Packaging:
0.017g

Product Packaging:

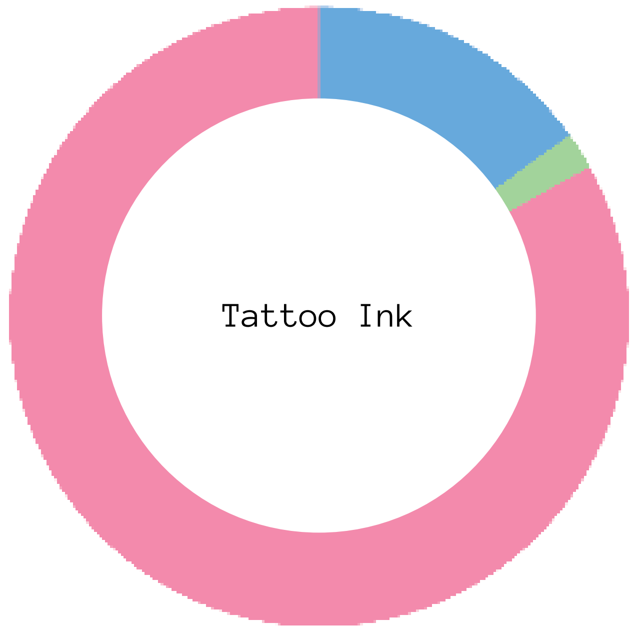
Bottle PET:	9.3000g
Cap PS:	2.8000g
Glass Marble:	3.6000g

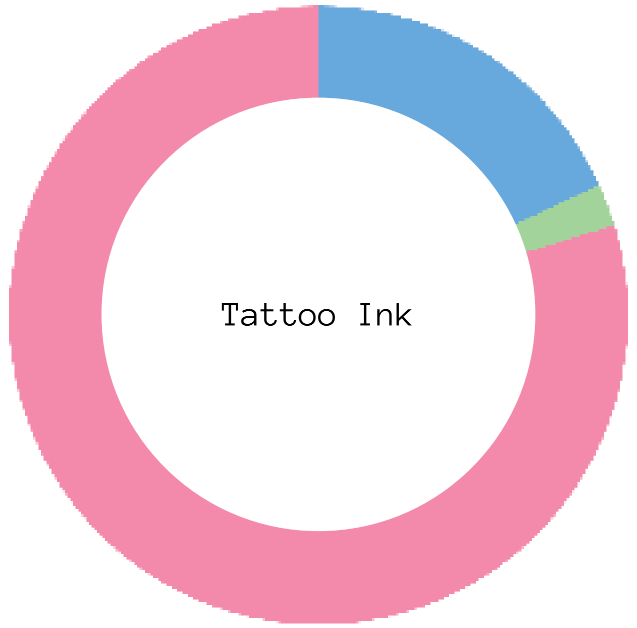
Transportation:

Yiwu Factory - Shanghai Port
Truck **204.330miles**
Shanghai Port - Long Beach Port
Ship **6568.649miles**
Long Beach Port - Tattoo Supply California
Truck **71.870miles**
Tattoo Supply California - Long Beach Port
Truck **71.870miles**
Long Beach Port - Felixtowe Port UK
Ship via Panama Canal **8841.438miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Tattoo Ink





15.02 %	Manufacturing	**0.1480 CO² eq.kg**
%	Use	**CO² eq.kg**
2.15 %	EOL	**0.0211 CO² eq.kg**
82.83 %	Transportation	**0.8160 CO² eq.kg**

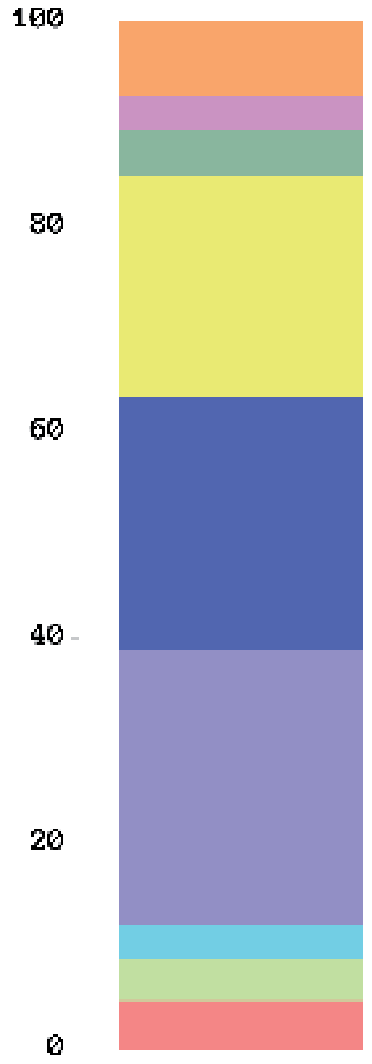
18.15 %	Manufacturing	**0.0097 mPts**
%	Use	**mPts**
2.32 %	EOL	**0.0012 mPts**
79.53 %	Transportation	**0.0425 mPts**

0.9851 CO² eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.5970 CO² eq.kg

0.0534 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0280 mPts



4.71 %	Acidification
3.90 %	Ecotoxicity
3.54 %	Eutrophication
26.60 %	Global Warming
0.05 %	Ozone Depletion
24.57 %	Fossil Fuel Depletion
21.75 %	Carcinogenics
4.34 %	Non-Carcinogenics
3.25 %	Respiratory Effects
7.28 %	Smog

LCA based Insights:

Various Manufacturing data sets are missing to complete this LCA, mostly energy-intensive ones like Glass Marble production would greatly increase the CO² eq. kg impact as well as added Ink data would be assumed to influence the manufacturing impact.

The Ink will be analyzed by using EWG. The color pigment (CI 77266) used in the analyzed ink with a score of 4/10, contains cadmium and is restricted since the REACH regulation has become legally binding .

The second ingredient of concern is Isopropyl Alcohol with a score of 2/10. It is especially a cause for concern when handled in large quantities as it shows to be an occupational hazard that can cause organ system toxicity and allergies.

Competing products are not likely to contain less Isopropyl Alcohol, but a strong focus should be put on an alternative with less concerning pigments. Testing of Ink quality and performance should be conducted before working on clients.

Transportation by airfreight results in a high CO2 impact. Alternative products should be sourced from German manufacturers and after testing, the current product in use should be displaced.

LCA

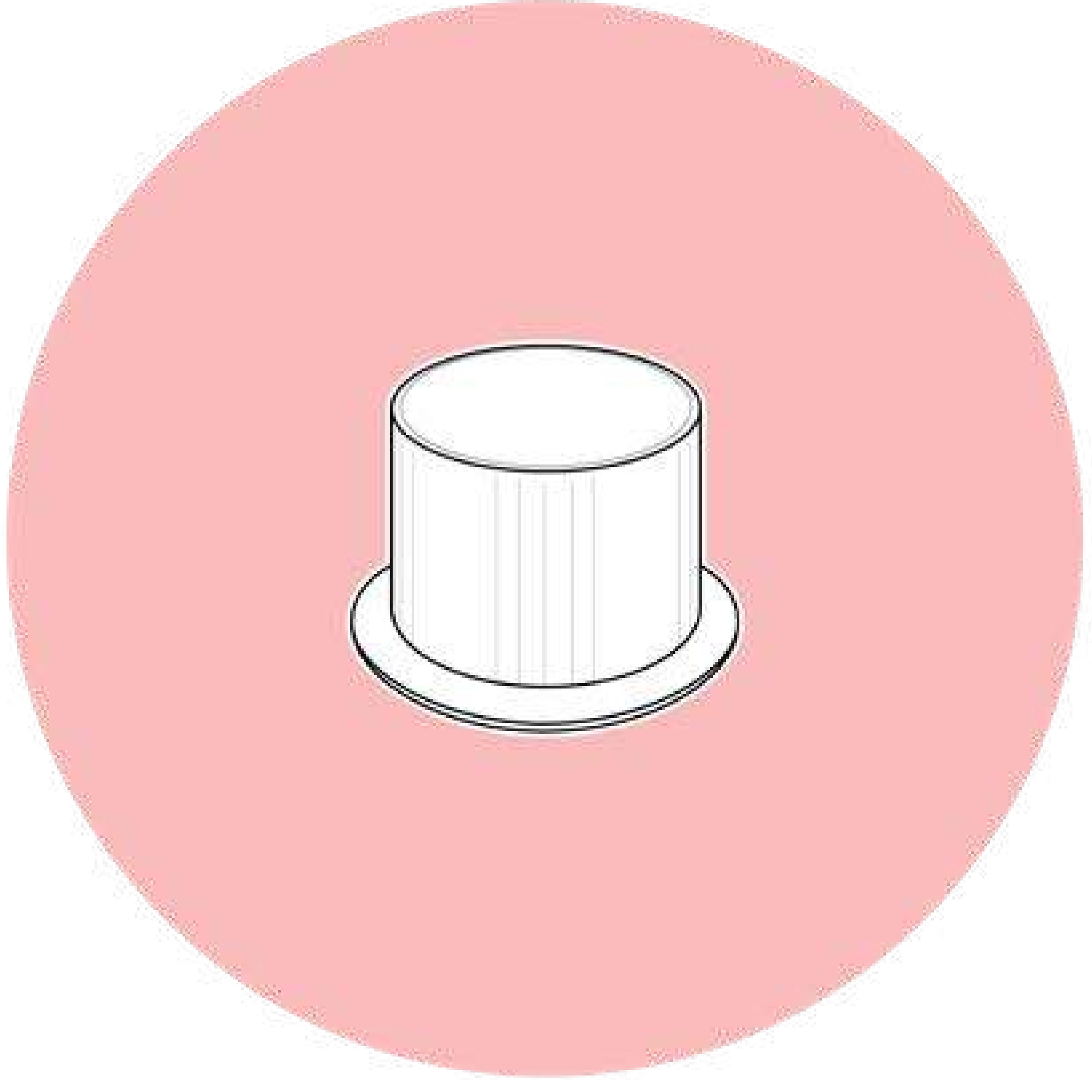
SM-2013

Ink Cap PP

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

LDPE Pouch Label Data Gap.
- Label & ink for printing not included.

Parts:

Ink Cap: 0.6000g
Material: PP

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

LDPE Pouch:
3.8080g

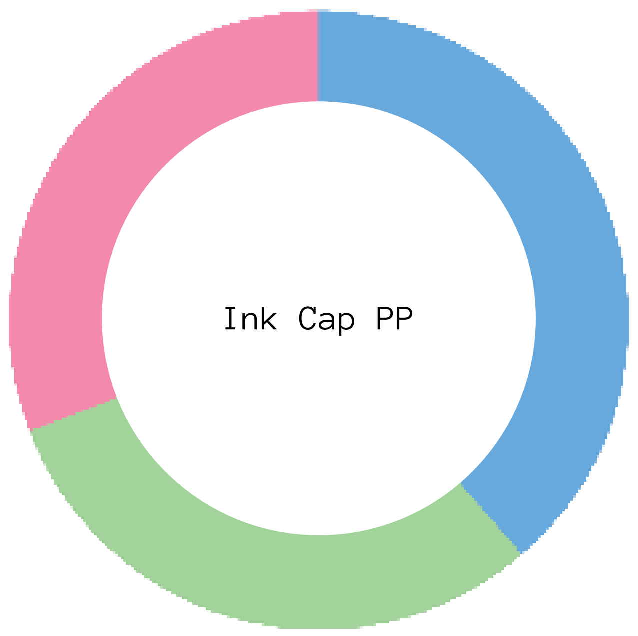
Functioning Unit:
100 units & Retail Packaging

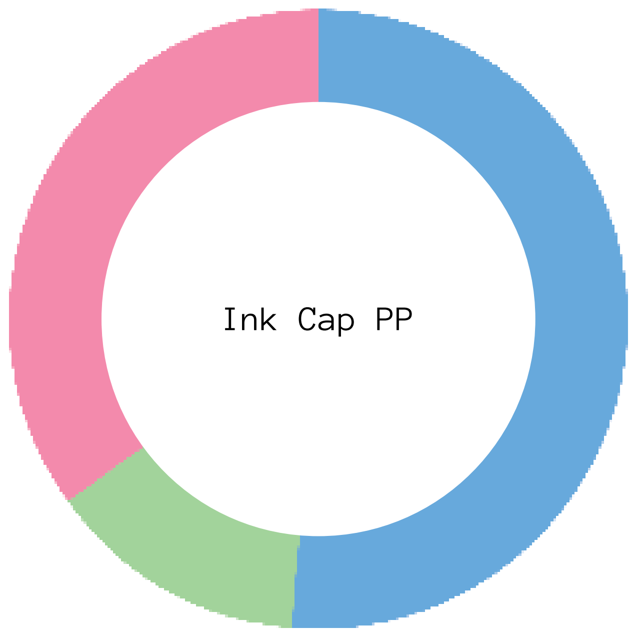
Transportation:

Zhejiang Factory - Fuzou Port
Truck **327.660miles**
Fuzou Port - Felixtowe Port UK
Ship via Suez Canal **11558.430miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Ink Cap PP





38.70 %	Manufacturing	**0.1920 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
30.65 %	EOL	**0.1520 CO^2 eq.kg**
30.65 %	Transportation	**0.1520 CO^2 eq.kg**

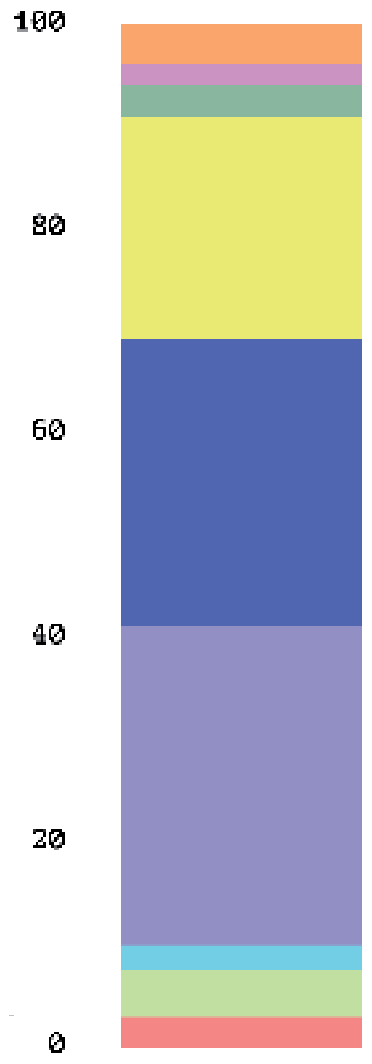
51.42 %	Manufacturing	**0.0118 mPts**
%	Use	**mPts**
13.77 %	EOL	**0.0032 mPts**
34.81 %	Transportation	**0.0080 mPts**

0.4960 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
PP Incineration – 0.1520 CO^2 eq.kg

0.0229 mPts per functioning unit

Greatest Impact:
PP – 0.0079 mPts



2.94 %	Acidification
4.59 %	Ecotoxicity
2.47 %	Eutrophication
31.13 %	Global Warming
0.02 %	Ozone Depletion
28.08 %	Fossil Fuel Depletion
21.78 %	Carcinogenics
3.04 %	Non-Carcinogenics
2.12 %	Respiratory Effects
3.83 %	Smog

LCA based Insights:

The separation of the label from the packaging was not possible, therefore the Label weight was not able to be calculated. Label printing data is also not included in this LCA.

When comparing the PP based product to its product alternative and the product unit is equal (200 units), the impact of the alternative is lower with 0.4359 kg eq. CO^2 emitted. Strong concerns for Plastic based materials and the EOL solution of incineration raises concern for toxic byproduct production, compared to paper based materials.

LCA

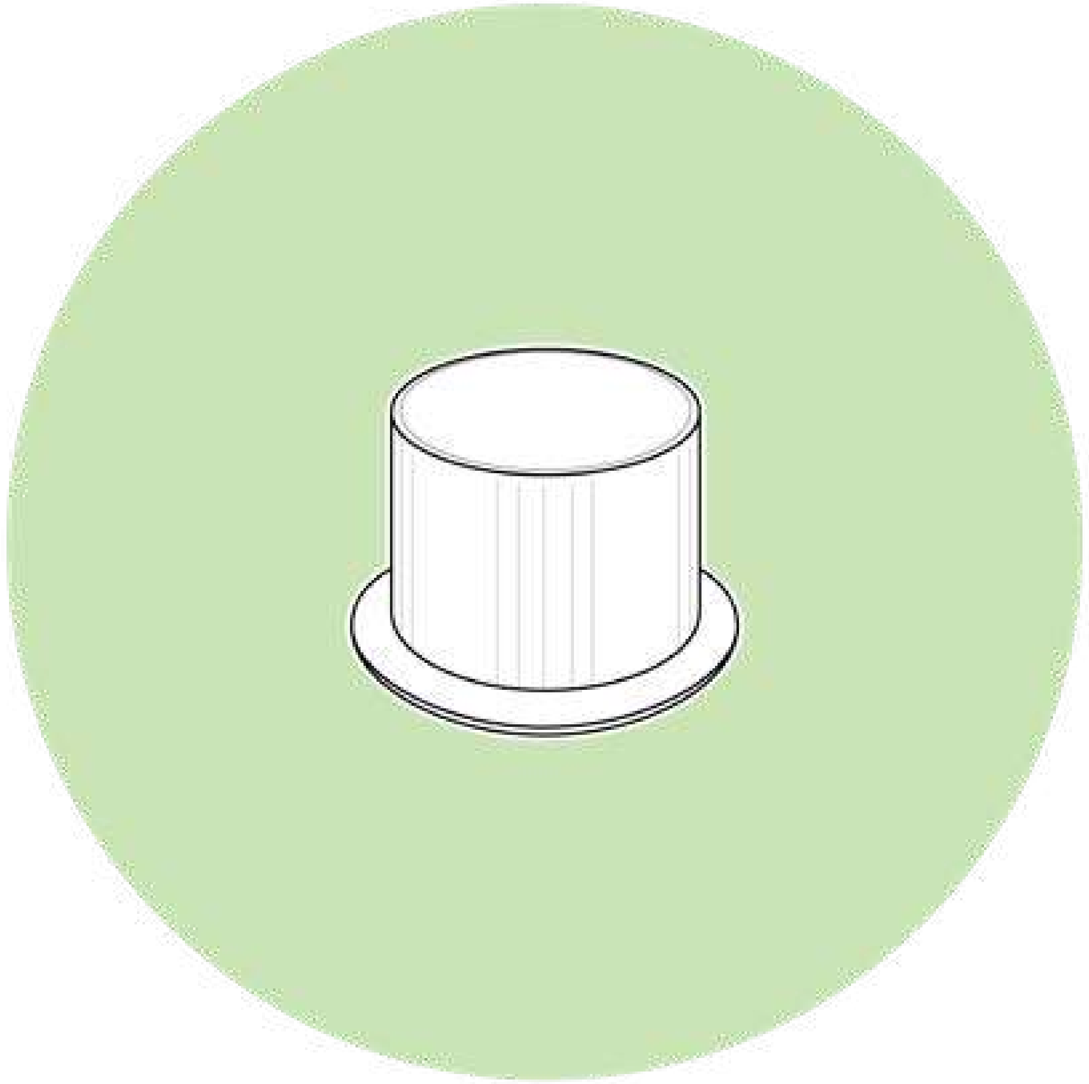
SM-2013

Ink Cap Eco

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Paper Pulp Molding Manufacturing data missing. Sm-13 Data Gap.

Parts:

Ink Cap: 0.5000g
Material: Paper Pulp

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

Paperbag:
12.7300g

Metal Wire:
0.7000g

Surface Area of Packaging:
132cm²

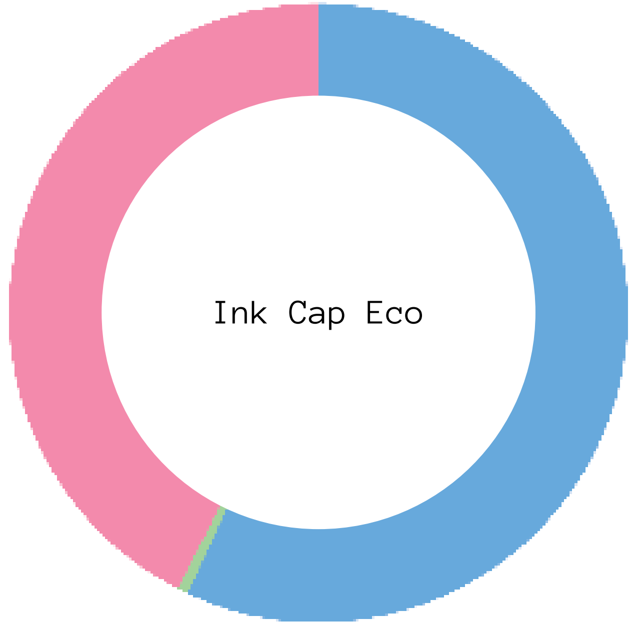
Functioning Unit:
200 units & Retail Packaging

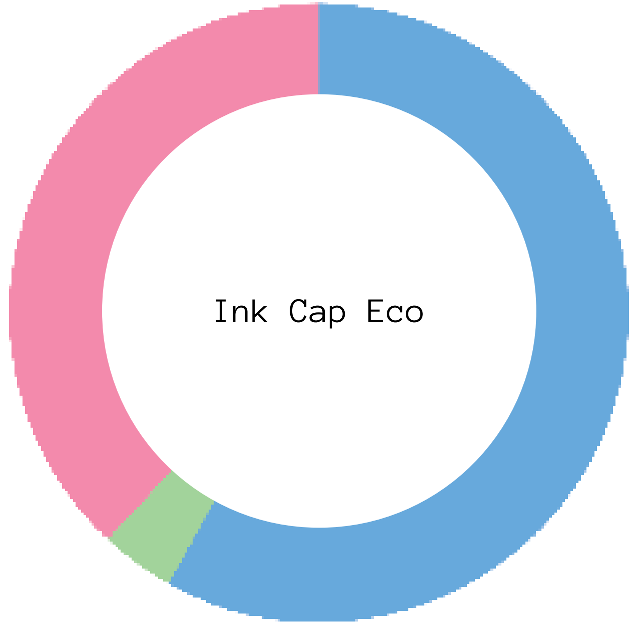
Ink Amount used for Packaging:
0.0009g

Transportation:

Guangdong Factory - Guangdong Port
Truck **38.230miles**
Guangdong Port - Felixtowe Port UK
Ship via Suez Canal **11233.910miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013
Ink Cap Eco





57.07 %	Manufacturing	0.3110 CO^2 eq.kg
%	Use	CO^2 eq.kg
0.54 %	EOL	0.0029 CO^2 eq.kg
42.39 %	Transportation	0.2310 CO^2 eq.kg

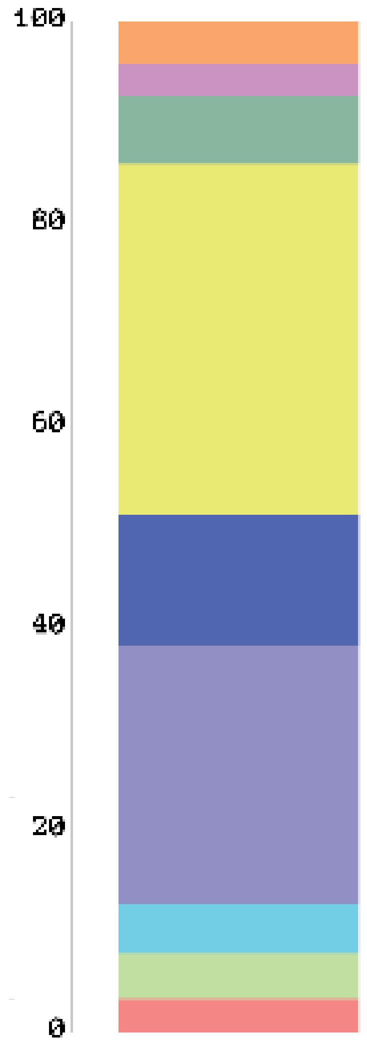
58.31 %	Manufacturing	0.0180 mPts
%	Use	mPts
3.79 %	EOL	0.0012 mPts
37.90 %	Transportation	0.0117 mPts

0.5449 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Paperboard Pulp – 0.2900 CO^2 eq.kg

0.0309 mPts per functioning unit

Greatest Impact:
Paperboard Pulp – 0.0136 mPts



3.24 %	Acidification
4.52 %	Ecotoxicity
4.97 %	Eutrophication
25.44 %	Global Warming
0.02 %	Ozone Depletion
13.05 %	Fossil Fuel Depletion
34.67 %	Carcinogenics
6.64 %	Non-Carcinogenics
3.13 %	Respiratory Effects
4.32 %	Smog

LCA based Insights:

The Product shows data gaps in Paper Pulp Molding due to missing datasets in SM-13. If the production of the cups is added in the future with the availability of new data, the impact will probably be similar to the one of the PP product. Percentage of improvement is not able to be conducted when LCAs are incomplete.

Local Production of the product shows the most significant impact reduction potential. The alternative Product shows lower impacts compared to its PP alternative when the Product unit is equalized. The use of the Eco Label Product is recommended. Especially with the EOL solution of Incineration and its strong concerns towards producing toxic byproducts when incinerating plastic-based materials.

LCA

SM-2013

Isopropyl Alcohol Swabs

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Ink for individual packaging print not included. Sm-13 Data Gap.
No Isopropanol Data. Sm-13 Data Gap - 1-Propanol Placholder.

Parts:

1-Propanol - Placeholder

Swap Viscose: 0.1000g
Isopropyl Alcohol 70%: 0.3000g

Product Packaging:

Composite Packaging: 0.3000g
Paper: 0.1373g
Alluminium: 0.0651g
PE: 0.0976g

Retail Packaging:

Packaging:

Printed Paperboard Box (bleached):
11.3600g

Surface Area of Packaging:
343.8cm²

Functioning Unit:
100units & Retail Packaging

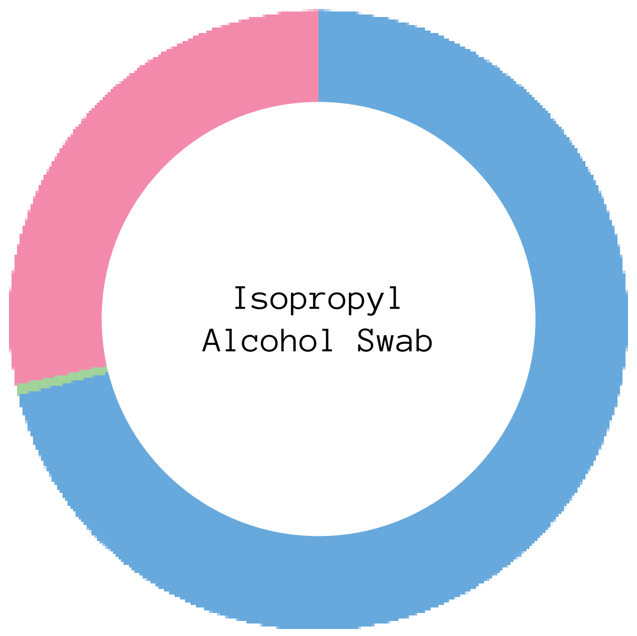
Ink Amount used for Packaging:
0.0024g

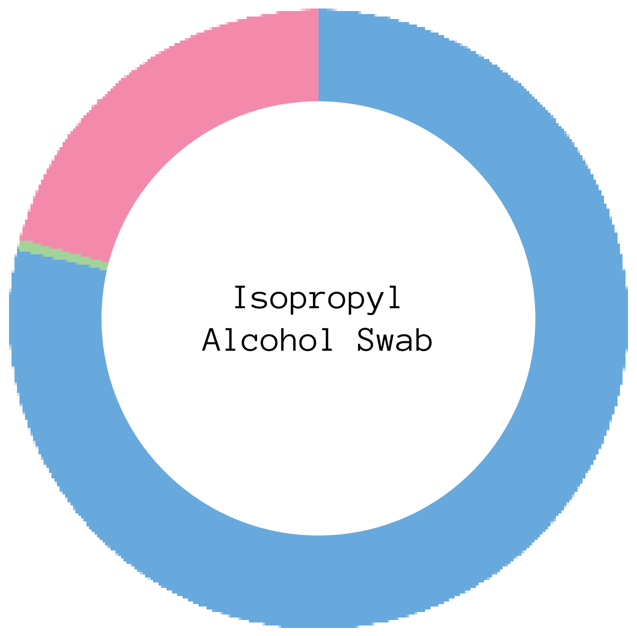
Transportation:

Gillingham Factory - Liverpool Tattoo Supply
Truck **168.180miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Isopropyl Alcohol Swabs





71.16 %	Manufacturing	19.8000 CO^2 eq.kg
%	Use	CO^2 eq.kg
0.56 %	EOL	0.1560 CO^2 eq.kg
28.28 %	Transportation	7.8700 CO^2 eq.kg

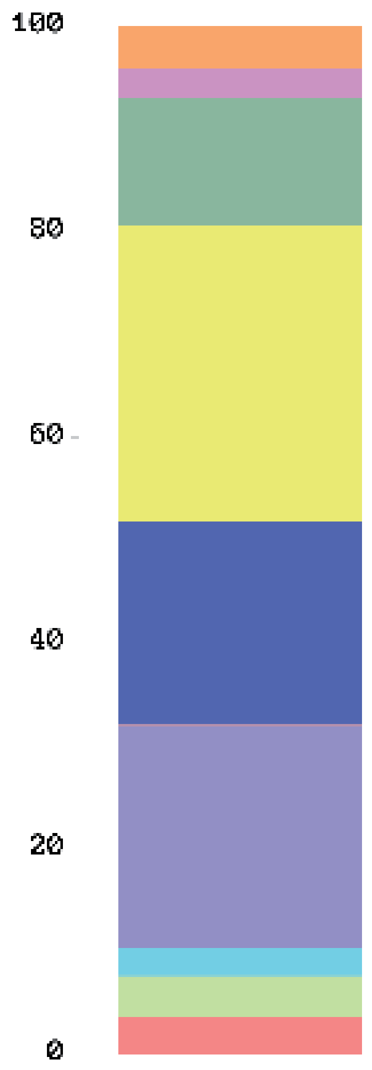
78.62 %	Manufacturing	1.4600 mPts
%	Use	mPts
0.59 %	EOL	0.0110 mPts
20.79 %	Transportation	0.3860 mPts

27.8270 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
1-Propanol – 13.5000 CO^2 eq.kg

1.8570 mPts per functioning unit

Greatest Impact:
1-Propanol – 0.8970 mPts



3.60 %	Acidification	
4.00 %	Ecotoxicity	
2.83 %	Eutrophication	
21.55 %	Global Warming	
0.03 %	Ozone Depletion	
19.94 %	Fossil Fuel Depletion	
28.67 %	Carcinogenics	
12.35 %	Non-Carcinogenics	
2.96 %	Respiratory Effects	
4.07 %	Smog	

LCA based Insights:

The product shows missing data for the print applied to the composite foil for the individual product packaging, due to SM-13 data gaps.

The most significant impact is the placeholder chemical compound 1-Propanol which is quite likely to stay the same when the actual compound, Isopropyl Alcohol, becomes available.
The concerns were previously reflected in the Tattoo Ink LCA with external data from EWG.

Since the composite material prevents recycling and the reclamation of resources, due to materials being fused together, an alternative may be Isopropyl Alcohol in bulk packaging and the use of Paper towels. This will prevent the composite material issue but likely not the impact of the chemical substance itself. The alternative product should be sourced from a German manufacturer to allow for the lowest impact in the transportation lifecycle category. This will significantly reduce impacts especially for tattoos of large areas or if multiple stencil transfer attempts are needed.

LCA

SM-2013

Green Soap Concentrate

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Liquid Substances Data Gap - Placeholder Liquid

Concentrate:

Aqua - Placeholder

Ingredients:
Aqua, Sorbitol, Aroma, Poloxamer407, Benzoic Acid, Methyl Salicylate, Thymol, Menthol, Sodium Sacharin, Sodium Benzoate, CI 116035, C(I) 142090, 15-30%, Anionic Sufricants,Parfume, Linalool, Limonene,5-15% Nonionic Suficants, Citronellol, Methyl Sothiozoline, Phenoxyethanol, Hexyl Cinammal, Disinfectants, Hamamelis Virginiana, Aloe Vera & Alcohol.

Product Packaging:

LID PP: 3.5501g
PP & TiOx
97% & 3%
Bottle HDPE: 39.1740g

Retail Packaging:

Packaging:

PVC Label:
1.5530g

Surface Area of Packaging:
132.2cm²

Functioning Unit:
500ml & Retail Packaging

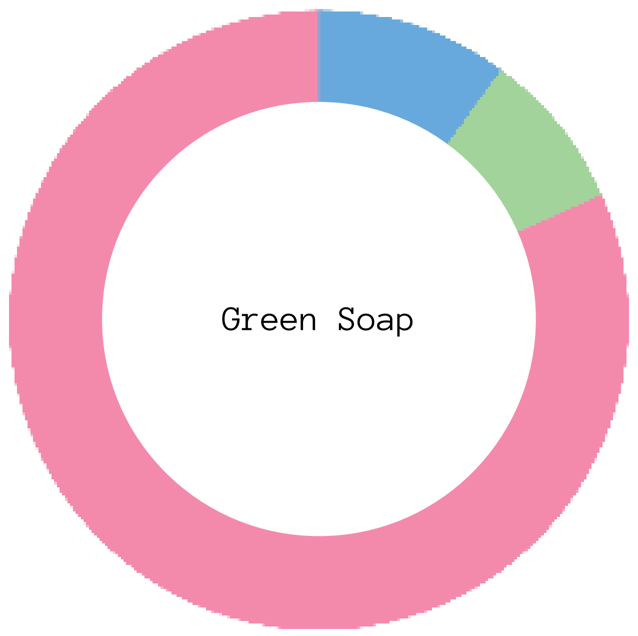
Ink Amount used for Packaging:
0.057g

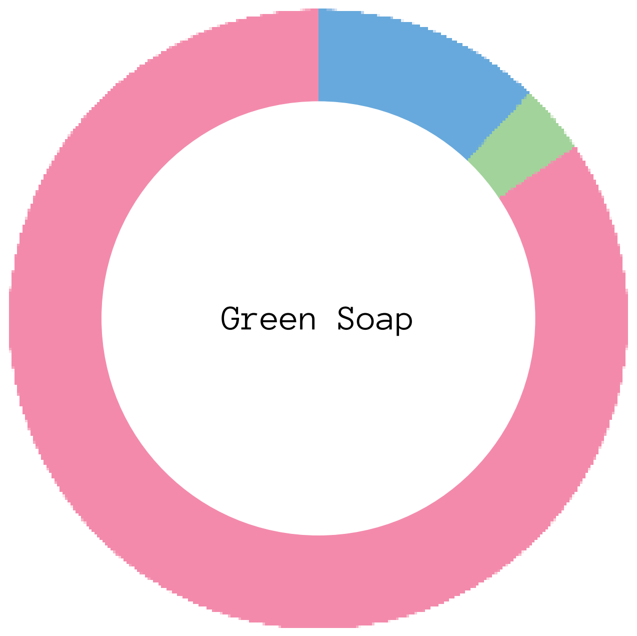
Transportation:

Guangdong Factory - Guangdong Port
Truck **38.230miles**
Guangdong Port - Felixtowe Port UK
Ship via Suez Canal **11233.910miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Tattoo Supply
Van **11.130miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Green Soap Concentrate





10.18 %	Manufacturing	0.1600 CO^2 eq.kg
%	Use	CO^2 eq.kg
8.34 %	EOL	0.1310 CO^2 eq.kg
81.48 %	Transportation	1.2800 CO^2 eq.kg

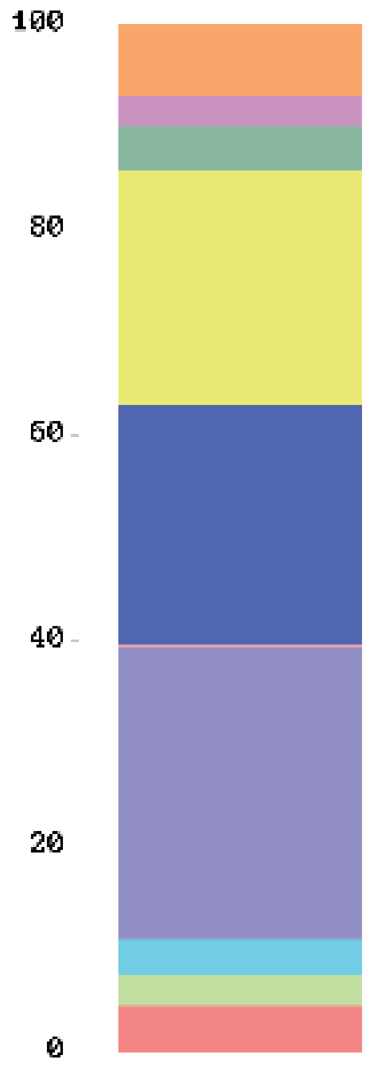
12.05 %	Manufacturing	0.0096 mPts
%	Use	mPts
3.59 %	EOL	0.0029 mPts
84.36 %	Transportation	0.0670 mPts

1.5710 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.9340 CO^2 eq.kg

0.0795 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0438 mPts



4.48 %		Acidification
3.05 %		Ecotoxicity
3.43 %		Eutrophication
28.54 %		Global Warming
0.04 %		Ozone Depletion
23.52 %		Fossil Fuel Depletion
22.75 %		Carcinogenics
4.28 %		Non-Carcinogenics
2.93 %		Respiratory Effects
6.98 %		Smog

LCA based Insights:

SM-13 shows Data Gaps in the liquid concentrate impact calculation. The Product shows the “Greatest Impact” in airfreight due to the product weight.

The LCA would recommend local sourcing of similar products with lower impacts due to transportation impact reduction potential. But for further reduction, a redesign of the packaging is recommended.
From Plastic packaging to water soluble packing in a paper box, this will reduce plastic use while the product concentration can stay unchanged. This packaging is already in use for cleaning products (window cleaner) and is a feasible solution that can be adopted. The minimalistic packaging would also reduce the products weight and therefore transportation impacts would be reduced. The Product would require the user to reduce the concentration of the product by dilution with demineralized water following clear instructions of the producer.

Analyzing the Chemical substances with EWG shows concerns for both pigments used, red (CI 16035) with a score of 3-6/10 as well as blue (CI 42090) with a score of 2-7/10, since both show significant concerns for Cadmium and Aniline contaminations, with red being prone to Mercury and 6-Methoxy-M-Toluidine contaminations in addition. Pigments in general cause concerns for Immune toxicity, causing allergies, cancer, skin irritation and being bioaccumulative. Since they have no purpose in the product except appearance, the elimination of these Products is feasible and should be considered due to the concerns they cause.

Other substances like Methylisothiazolinone with a score of 7/10 show significant concerns for high allergy and immune toxicity and therefore are already facing high use restrictions. Alternative Substances with lower concerns should be considered by the manufacturer.

LCA

SM-2013

Ultrasonic Tool Sterilizer Concentrate

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Liquid Substances Data Gap - Placeholder Liquid

Concentrate:

Aqua - **Placholder**

Ingredients:
Alkyldimethylethylammoniumethylsulfa, Polyhexamethylenbiguanidhyrochlorid, Cocospropylenguanidiniumdiacetat, Alkylbenzolsulfonaten,Benzyl Alcohol, Triclosan & Benzalkoniumchlorid.

Transportation:

Jinhua Factory - Shanghai Port
Truck **260.340miles**
Shanghai Port - Hamburg Port
Ship via Suez Canal **12403.100miles**
Hamburg Port - Retail Center Kempen
Truck **257.340miles**
Retail Center Kempen - Amazon DNW2
Van **46.170miles**
Amazon DNW2 - Studio Cologne
Van **11.960miles**

Product Packaging:

LID PP: 3.0620g
PP & TiOx
97% & 3%
Bottle HDPE: 32.9230g

Retail Packaging:

Packaging:

PVC Label:
0.7920g
Pigment PVC :
0.0238g
Adhesive Label:
0.1670g

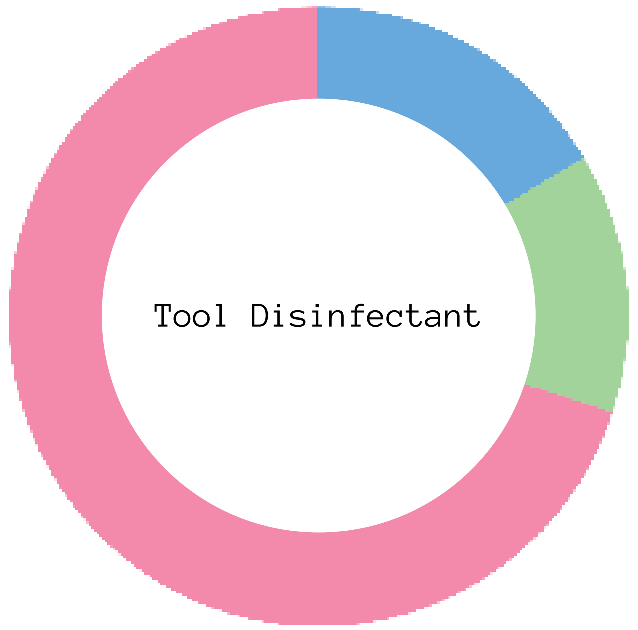
Surface Area of Packaging:
117.6cm²

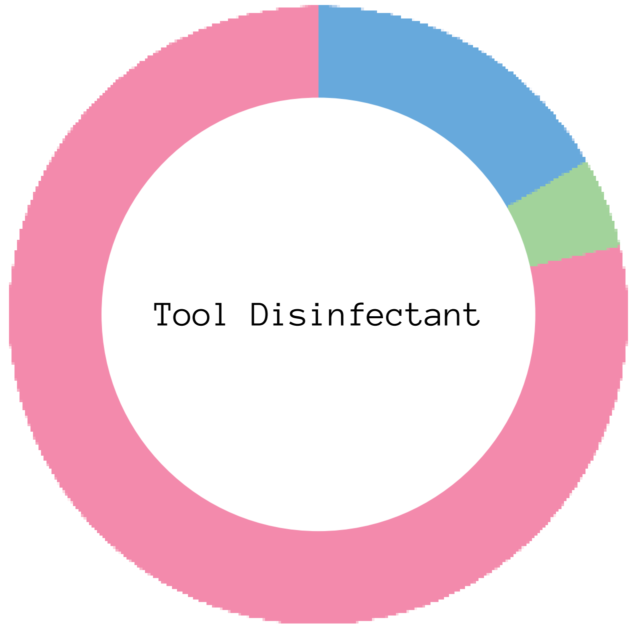
Functioning Unit:
500ml & Retail Packaging

Ink Amount used for Packaging:
0.051g

SM-2013

Ultrasonic Tool Sterilizer Concentrate





16.58 %	Manufacturing	**0.1330 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
13.59 %	EOL	**0.1090 CO^2 eq.kg**
69.83 %	Transportation	**0.5600 CO^2 eq.kg**

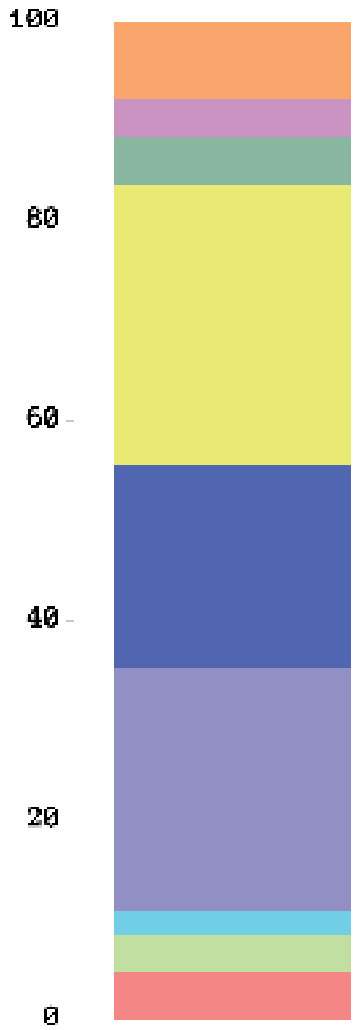
16.72 %	Manufacturing	**0.0079 mPts**
%	Use	**mPts**
4.91 %	EOL	**0.0023 mPts**
78.37 %	Transportation	**0.0372 mPts**

0.8020 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Truck – 0.1620 CO^2 eq.kg

0.0474 mPts per functioning unit

Greatest Impact:
Truck – 0.0105 mPts



4.83 %	Acidification
3.70 %	Ecotoxicity
2.46 %	Eutrophication
24.31 %	Global Warming
0.03 %	Ozone Depletion
20.16 %	Fossil Fuel Depletion
28.20 %	Carcinogenics
4.72 %	Non-Carcinogenics
3.84 %	Respiratory Effects
7.73 %	Smog

LCA based Insights:

The Tool Sterilization Concentrate shows data gaps in the area of liquid data due to SM-13 data gaps. The “Greatest Impact”nin the lifecycle is the transportation by truck, due to product weight.

The proposed packaging alteration to water soluble packing as recommended earlier would be the preferred approach in order to reduce product impacts.

Analyzing the chemical substances with EWG is not possible due to data gaps, the preferred approach is through the MSDS (Materials Safety Data Sheet) of the manufacturer. The concentrate shows significant concern in being a skin irritant, eco toxicant, and causes strong concerns towards affecting the respiratory system. Alternative Products should be considered that show lower concerns.

The artist is affected by these concerns and not the client. Alternative products would add operational safety for the Artist during the sterilization process. Disposal of waste Water shows the biggest concern for the ecosystem.

SM-2013

Surgical Face Mask KN95

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

SM-13 Production Data Gap.
- -Ear loop manufacturing - Polyester and Spandex
- -Ear loop ultrasonic welding
- -Plastic extrusion around metal parts. (Noseclip)
- -Spun bound Polypropylene
- -Meltblown Polypropylene

Parts:

Fabric PP (combined):
3.3080g
3 Layers
2x PP Spunbound
1x PP Meltblown

Nose Clip:
0.2280g
Steel & LDPE
58.77% & 41.23%

Ear-Loop (Spandex & Polyester):
0.4680g

Transportation:

Xiantao Factory - Shanghai Port
Truck **614.670miles**
Shanghai Port - Felixtowe Port UK
Ship via Suez Canal **12032.550miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

QC Label:

Paper Label:
0.7320g

Print Area:
$70cm^2$

Ink Amount used:
0.0049g

Retail Packaging:

Packaging:

LDPE Sleeve:
2.3300g

Printed Paperboard Box (bleached):
34.462g

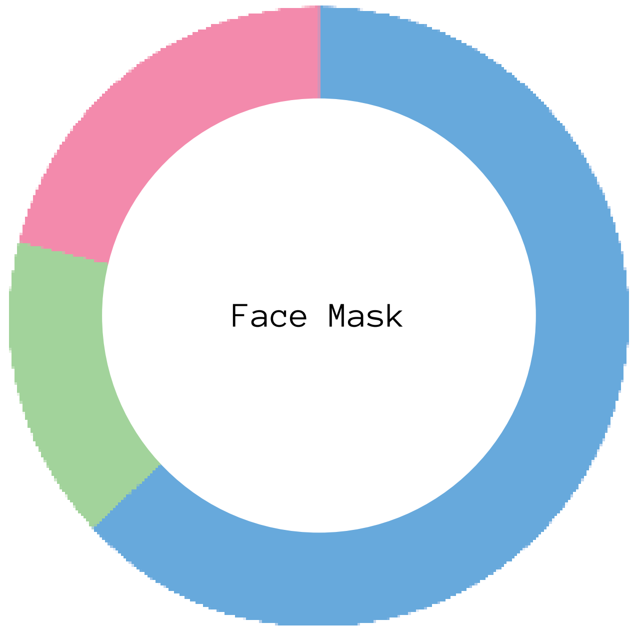
Surface Area of Packaging:
$1254cm^2$

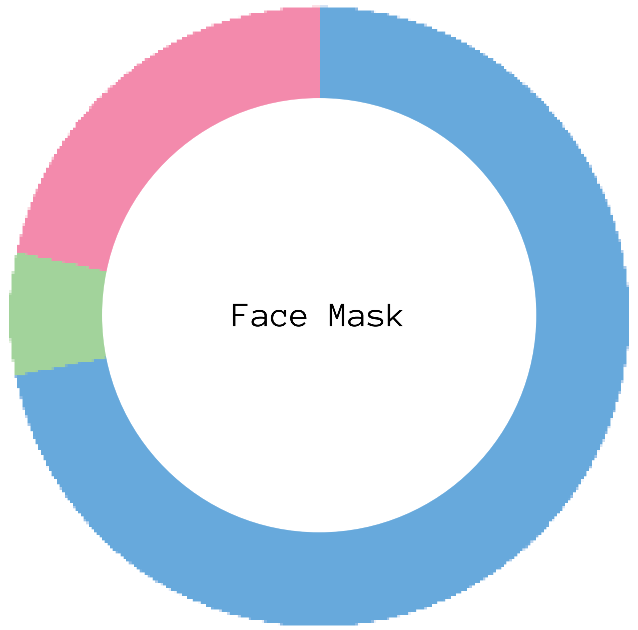
Functioning Unit:
50 units & Retail Packaging

Ink Amount used for Packaging:
0.0891g

SM-2013

Surgical Face Mask KN95





63.28 %	Manufacturing	1.7700	CO^2 eq.kg
%	Use		CO^2 eq.kg
15.77 %	EOL	0.4410	CO^2 eq.kg
20.95 %	Transportation	0.5860	CO^2 eq.kg

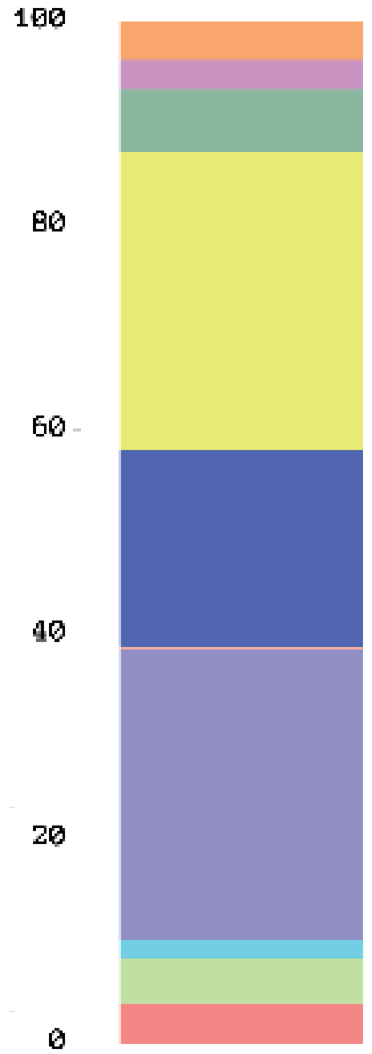
72.00 %	Manufacturing	0.1020	mPts
%	Use		mPts
6.47 %	EOL	0.0092	mPts
21.53 %	Transportation	0.0305	mPts

2.7970 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Fleece Production – 1.2700 CO^2 eq.kg

0.1417 mPts per functioning unit

Greatest Impact:
Fleece Production – 0.0539 mPts



3.80 %	Acidification
4.49 %	Ecotoxicity
1.88 %	Eutrophication
28.48 %	Global Warming
0.05 %	Ozone Depletion
19.43 %	Fossil Fuel Depletion
29.16 %	Carcinogenics
6.08 %	Non-Carcinogenics
2.85 %	Respiratory Effects
3.78 %	Smog

LCA based Insights:

The product shows significant data gaps towards the lifecycle of manufacturing due to production process data gaps in SM-13. Data for textiles, especially those categorized under tech. textiles are fairly limited and future updates to SM-13 datasets could compensate these data gaps.

The product weight being quite low shows low transportation impacts while manufacturing, even with significant data gaps showing the biggest impacts by lifecycle category.

The EOL calculated with SM-13 is quite unlikely due to plastic incineration data not showing up in the Scorecard. The process would produce toxic byproducts as described in the incineration chapter of this Thesis.

There are likely no product alternatives with lower impacts since FFP2 masks are more complex and therefore likely to have even greater impacts. In the future, the need for Masks might become obsolete again and therefore the account for this product might become obsolete too.

LCA

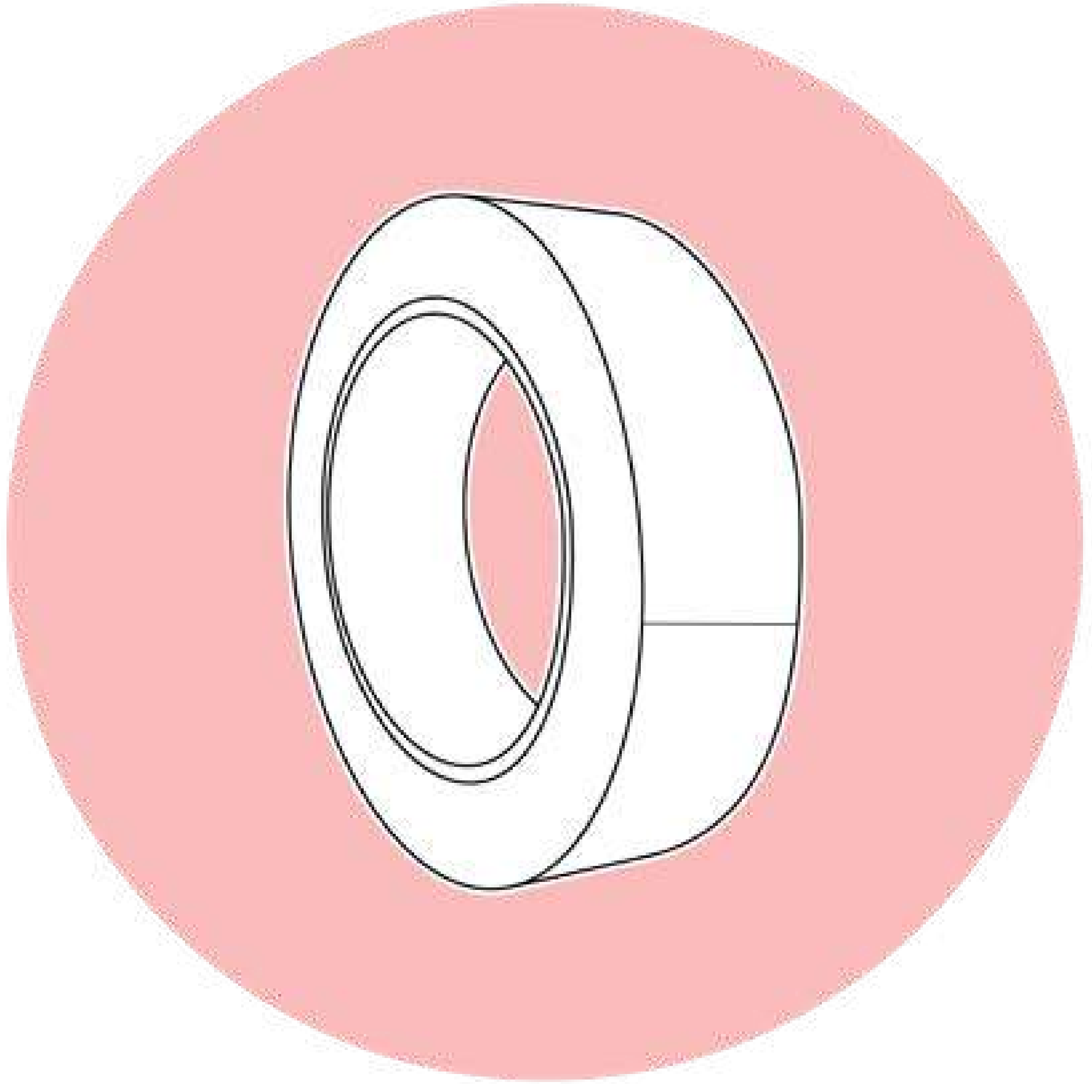
SM-2013

Microporous Tape

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Acrylic-Adhesive Data Placeholder. SM-13 missing Biocompatiple Acrylic.
Adhesive Application process data missing from SM-13.
Paperboard Core Printing data not included.

Parts:

Viscose Fabric (combined):
140g

Acrylic Adhesive:
10g

Paperboard Roll (Core):
13.795g

Product Packaging

No individual Packaging

Retail Packaging:

Not Applicable

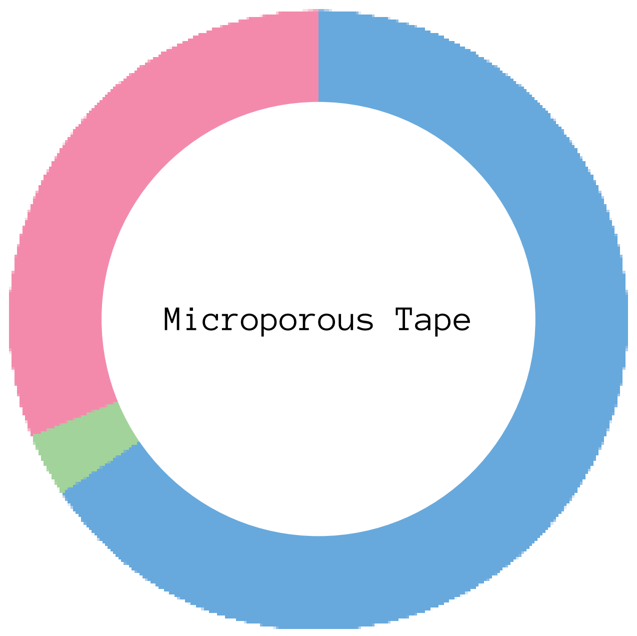
Functioning Unit:
50m per Roll

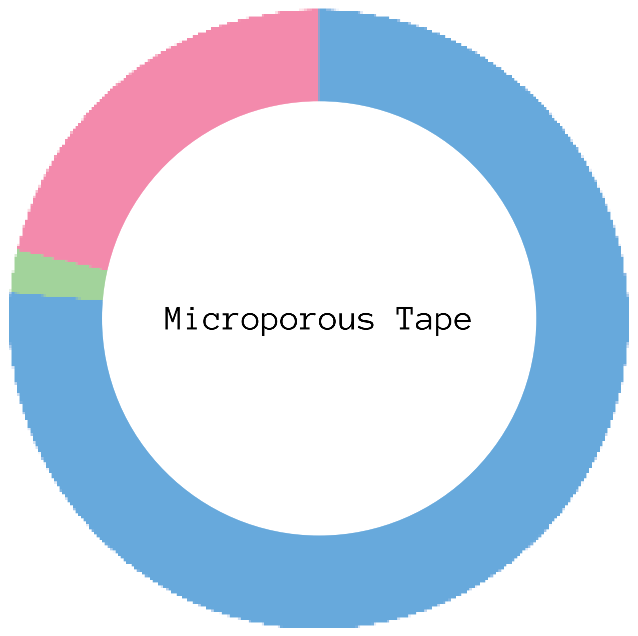
Transportation:

Jiangsu Factory - Shanghai Port
Truck **221.000miles**
Shanghai Port - Felixtowe Port UK
Ship via Suez Canal **12032.550miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Microporous Tape





65.58 %	Manufacturing	0.8790 CO^2 eq.kg
%	Use	CO^2 eq.kg
3.39 %	EOL	0.0454 CO^2 eq.kg
31.03 %	Transportation	0.4160 CO^2 eq.kg

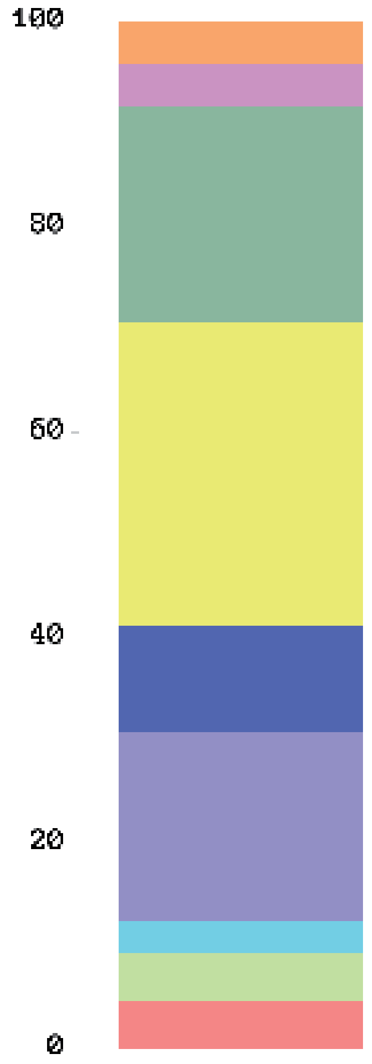
76.47 %	Manufacturing	0.0797 mPts
%	Use	mPts
2.33 %	EOL	0.0024 mPts
21.20 %	Transportation	0.0221 mPts

1.3404 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Viscose Production – 0.8460 CO^2 eq.kg

0.1042 mPts per functioning unit

Greatest Impact:
Viscose Production – 0.0773 mPts



4.59 %	Acidification
4.76 %	Ecotoxicity
2.96 %	Eutrophication
18.52 %	Global Warming
0.02 %	Ozone Depletion
10.28 %	Fossil Fuel Depletion
29.67 %	Carcinogenics
20.99 %	Non-Carcinogenics
4.17 %	Respiratory Effects
4.04 %	Smog

LCA based Insights:

The Microporous Tape shows significant data gaps in manufacturing processes like the application of Biocompatible Acrylic to the viscose fabric. Biocompatible Acrylic data is not listed as a material in SM-13, therefore Acrylic Adhesive is listed as a placeholder, the impact data will vary for the right adhesive, but data is expected to be similar.

The Papercore has OEM printing and is not included in this LCA due to difficulties in core separation to allow for calculation data availability. Alternative Products come without OEM branding and therefore the LCA still allows for insights.

The microporous Tape is used to fixate the Bottle Cover to the Squeeze bottle; alternatives could be investigated in the future but are unlikely to have lower impacts since adhesive tapes will always be made of composite materials. Tying of Bottle Sleeves could be considered when the Bottle Sleeve is redesigned with the intention of this feature.

LCA

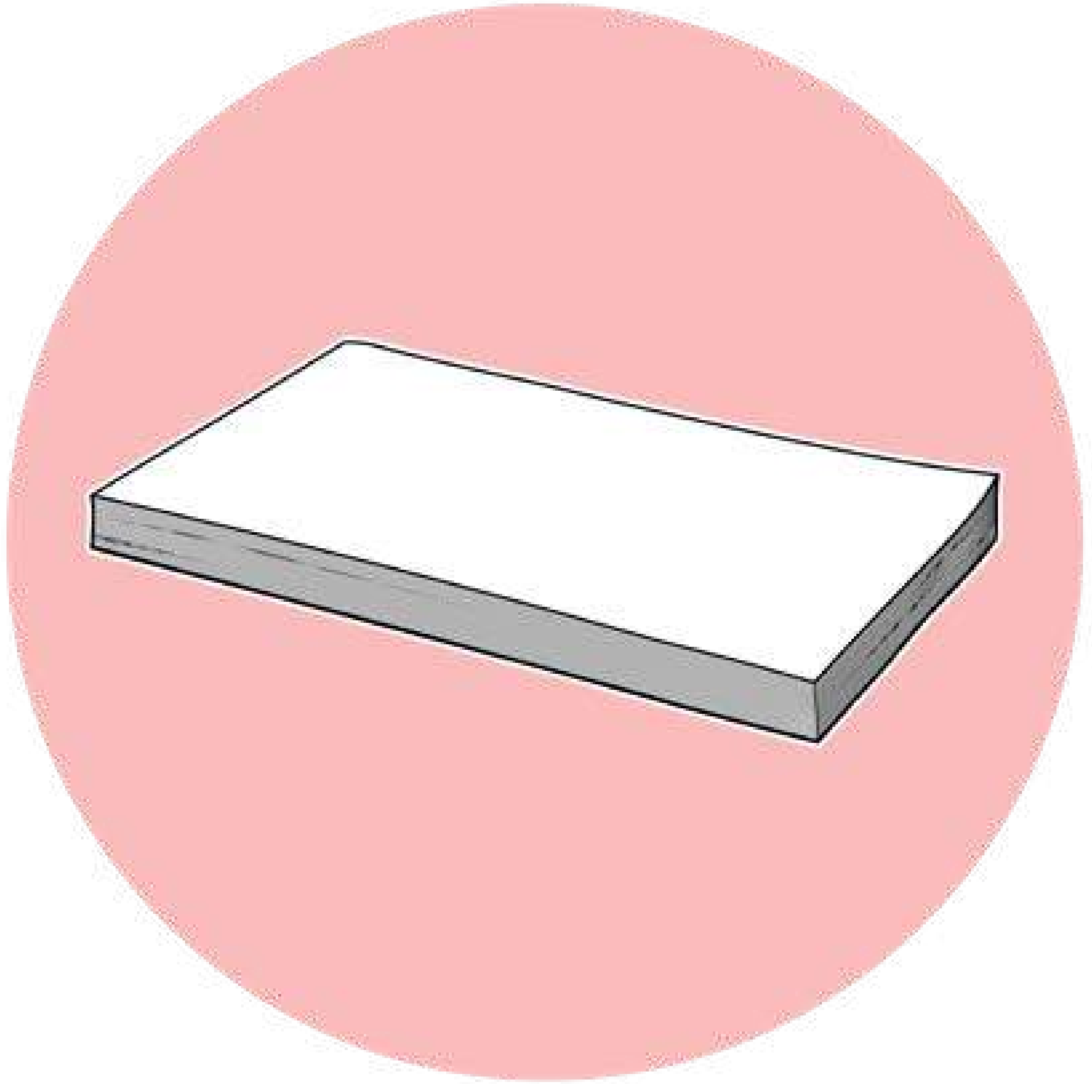
SM-2013

Stencil Paper for Inkjet Printing

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Paper Label Offset Ink use not included
Paper Label Adhesive Placeholder - EVA Acrylic - SM-13 Data Gap.

EOL for Stencil Paper does not include Incineration data. SM-13 Data Gap.

Parts:

Stencil Paper:
2.3g

Product Packaging:

No individual Packaging

Retail Packaging:

Packaging:

Carboard unbleached:
19.7080g

Paper Label:
0.3000g

LDPE Schrink Film:
2.4550g

Adhesive for Paper Label:
0.0830g

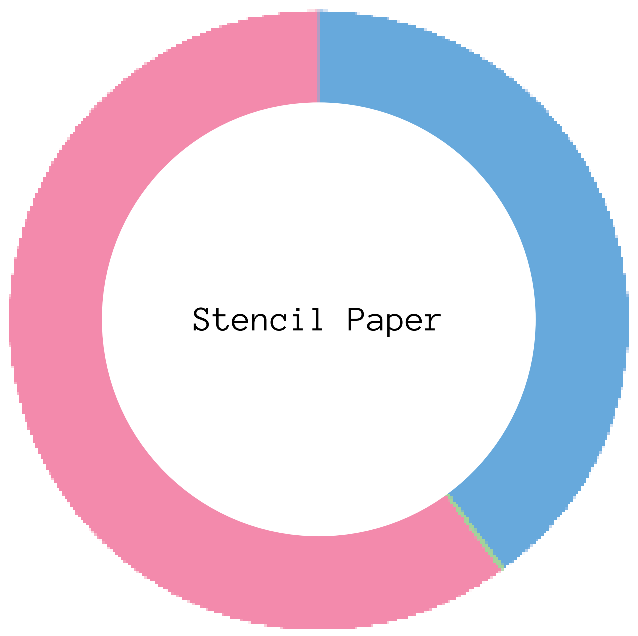
Functioning Unit:
500 Sheets & Retail Packaging

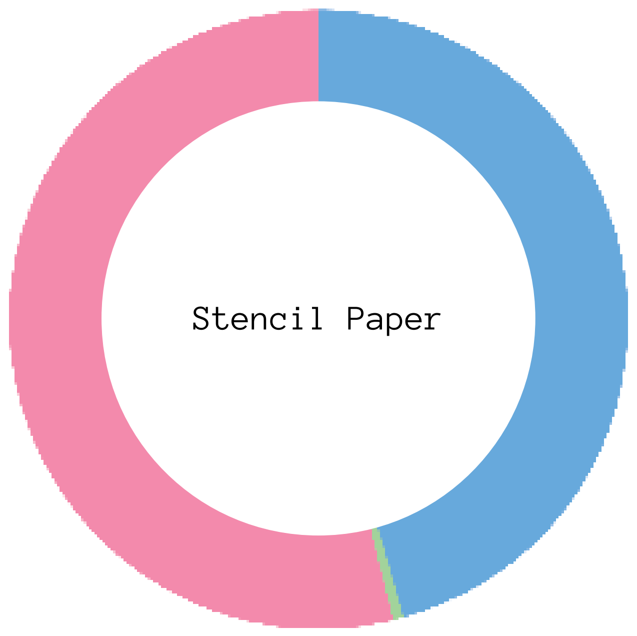
Transportation:

Elkhart Factory - New Orleans Port
Truck **998.000miles**
New Orleans Port - Felixtowe Port UK
Ship **5506.480miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Stencil Paper for Inkjet Printing





39.90 %	Manufacturing	**2.5900 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
0.17 %	EOL	**0.0109 CO^2 eq.kg**
59.93 %	Transportation	**3.8900 CO^2 eq.kg**

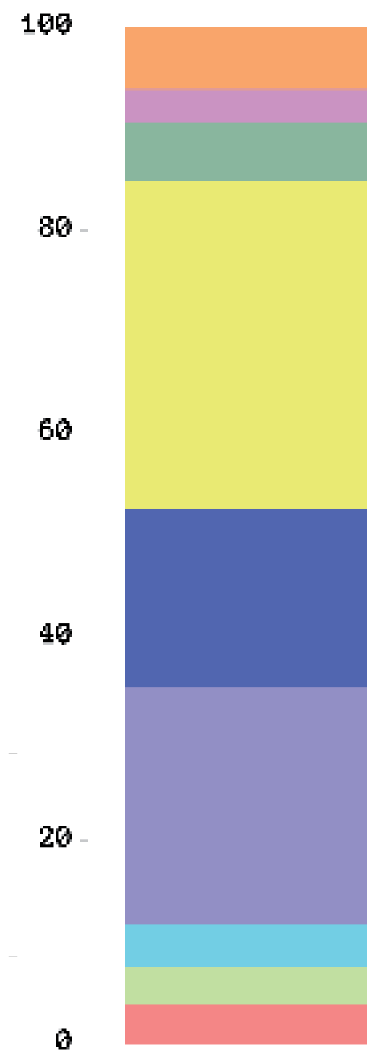
45.75 %	Manufacturing	**0.1850 mPts**
%	Use	**mPts**
0.59 %	EOL	**0.0024 mPts**
53.66 %	Transportation	**0.2170 mPts**

6.4909 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Kraft Paper bleached – 2.5600 CO^2 eq.kg

0.4044 mPts per functioning unit

Greatest Impact:
Kraft Paper bleached – 0.1830 mPts



3.85 %	Acidification
3.61 %	Ecotoxicity
4.36 %	Eutrophication
23.11 %	Global Warming
0.03 %	Ozone Depletion
17.63 %	Fossil Fuel Depletion
32.20 %	Carcinogenics
5.80 %	Non-Carcinogenics
3.30 %	Respiratory Effects
6.02 %	Smog

LCA based Insights:

The Product shows data gaps in manufacturing processes of the exact paper type. since SM-13 only allows for generic paper types to be calculated. Label and label ink use is not included due to difficulties in separation from LDPE shrink wrap and therefore calculations are not possible.

Paper incineration data missing. Paper is normally expected to be recycled by SM-13 but in the case of skin contact the paper is more likely to be incinerated with the general waste stream produced during application sessions.

The Product is already an Alternative to traditionally used Thermal Stencil Paper which is composed of one plastic film and four paper sheets. The reduction to a single sheet is already a great improvement especially when considering that an entire plastic sheet is coated with stencil ink in order to make the Thermal Stencil Paper process work, and therefore disposed of after each stencil printing.

LCA

SM-2013

SUP Safety Razor

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Manufacturing Data for Stainless Steel Blades missing. SM-13 Data Gap.

Parts:

HIPS Handle & Guard (combined):
4.3000g
HIPS & CB
97% & 3%

Stainless Steel Blade:
0.2000g

Retail Packaging:

Packaging:

Printed Paperboard (bleached):
73.0000g

Surface Area of Packaging:
1527cm²

Functioning Unit:
100 units & Retail Packaging

Ink Amount used for Packaging:
0.0108g

Product Packaging:

No individual Packaging

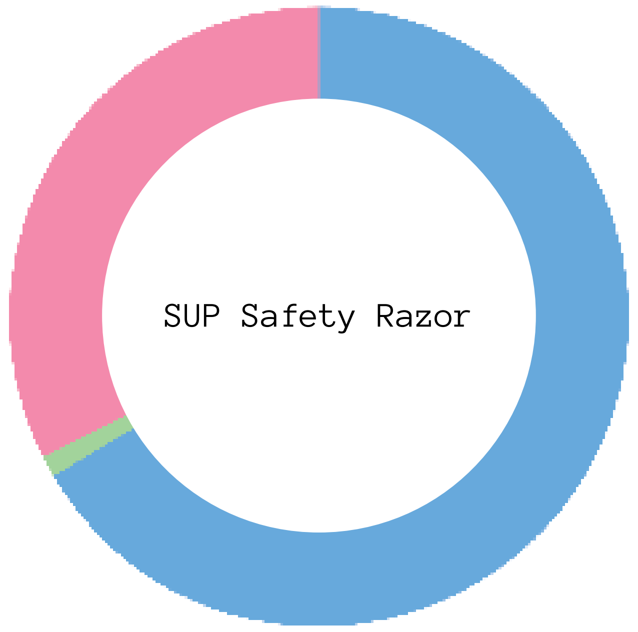
Transportation:

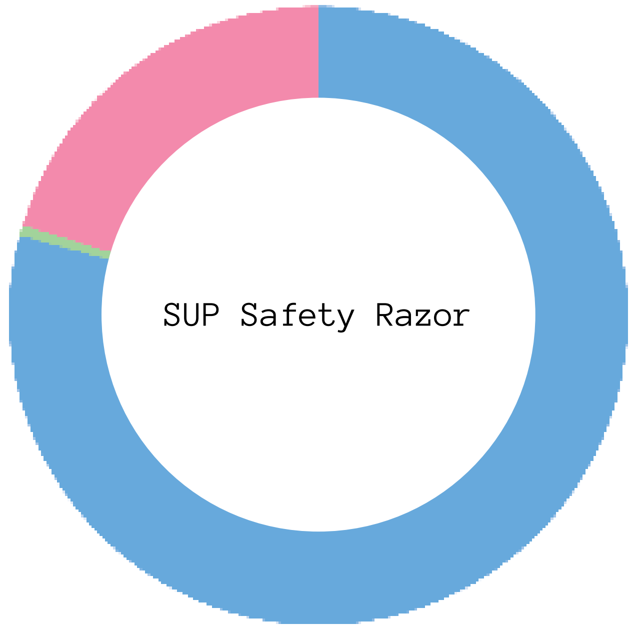
Swedish Razor Blades:
Munkfors Factory - Gävle Port
Truck **207.000miles**
Gävle Port - Shanghai Port
Ship via Suez Canal **13350.192miles**
Shanghai Port - Ningbo Factory
Truck **148.000miles**

Product:
Ningbo Factory - Shanghai Port
Truck **148.000miles**
Shanghai Port - Porto Port
Ship via Suez **11065.900miles**
Porto Port - Tattoo Supply
Truck **83.950miles**
Tattoo Supply - Porto Port
Truck **83.950miles**
Porto Port - Felixtowe Port UK
Ship **995.424miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

SUP Safety Razor





66.41 %	Manufacturing	2.5300 CO^{2} eq.kg
%	Use	CO^{2} eq.kg
1.31 %	EOL	0.0501 CO^{2} eq.kg
32.28 %	Transportation	1.2300 CO^{2} eq.kg

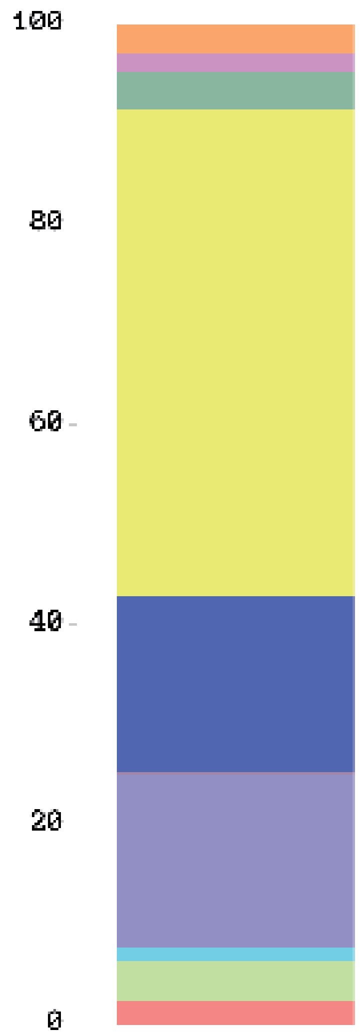
79.36 %	Manufacturing	0.2500 mPts
%	Use	mPts
0.39 %	EOL	0.0012 mPts
20.25 %	Transportation	0.0638 mPts

3.8101 CO^{2} eq.kg emitted per functioning unit

Greatest Impact:
HIPS – 1.4500 CO^{2} eq.kg

0.8892 mPts per functioning unit

Greatest Impact:
Stainless Steel– 0.1180 mPts



2.34 %	Acidification
3.95 %	Ecotoxicity
1.35 %	Eutrophication
17.43 %	Global Warming
0.03 %	Ozone Depletion
17.69 %	Fossil Fuel Depletion
48.79 %	Carcinogenics
3.52 %	Non-Carcinogenics
2.00 %	Respiratory Effects
2.90 %	Smog

LCA based Insights:

The complex manufacturing process of Swedish Stainless Steel Razor Blades is missing in the LCA calculation due to SM-13 manufacturing process data gaps. The CO^{2} eq. kg emissions is likely to increase further and with it also the “Greatest Impact” category.

The manufacturing in China adds additional Transportation Impacts to the product, which European production of the product could mitigate.

But as shown on the following two pages, the alternative product of a reusable razor could make the SUP Safety Razor obsolete with the downside of an added sterilization process. The importance of this practice should not be ignored due to customer safety, but is feasible when looking at barber shop safety practices and therefore can be performed responsibly.

SM-2013

SUP Safety Razor – Alternative Product

Displacement of SUP Products is achieved with initially higher production impacts of the product due to its material nature, but over extended use; the reusable product will show lower impacts. The Disposal of merely blades reduces the amount of waste significantly compared to SUP products, which are disposed of entirely.

The alternative product is a Stainless Steel Razor with disposable stainless steel blades, remaining impacts are: disposal of the blades and the impact of the sterilization process to ensure customer safety. Current tool sterilization procedures utilizing an ultrasonic cleaner and the tool disinfectant solution can be applied.

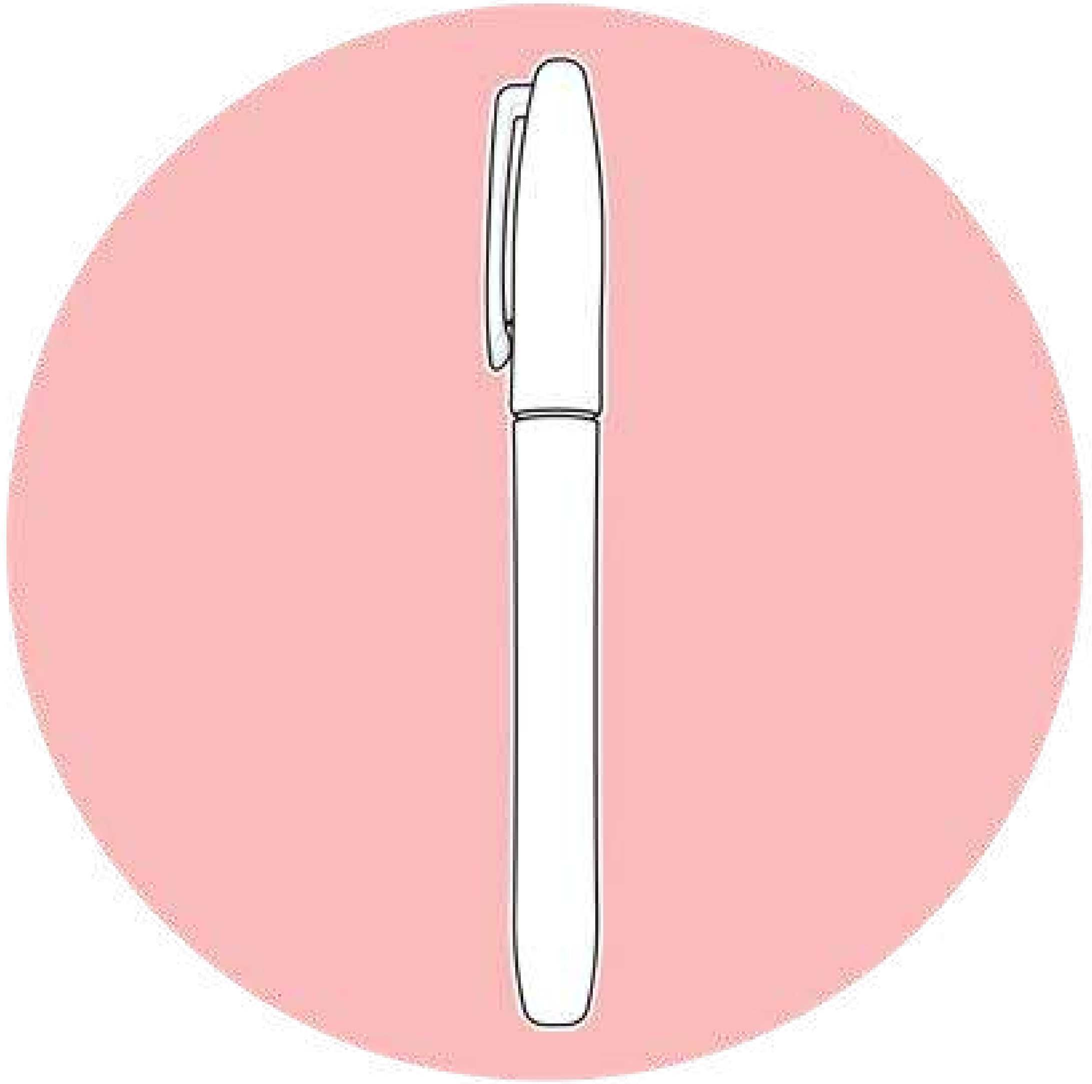
Neglection of sterilization can not be taken lightly, since a risk for infection or cross contamination from one customer to the other through bloodborne pathogens poses extensive risks.
Reusable products therefore should only be considered if implemented responsibly.

LCA

SM-2013
Skin Marker
Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Calculated
EOL
Transportation



Missing Information:

Liquid substances Data Gap.
Manufacturing Data for Tip and Reservoir missing.
- PE Sinthering for Tip
- Reservoir core PE Fibre Production with
- Reservoir exterior PE Cylinder extrusion.

Marker Screen Printing on PP Body & Baking not included - SM-13 Data Gap.
Marker Body Pigment - Grey not included - SM-13 Data Gap.

Parts:

Ink:
Pigment *(Carbon Black)*, Propyl Alcohol, Butyl Alcohol & Diacetone Alcohol.

Marker Tip PP *(sinthered)*:
0.2280g

Reservoir PE:
Inner 0.6850g
Outer 0.2600g

Marker Body PP:
3.1290g

Marker Grip PP:
1.9467g
PP & CB
97% & 3%

Marker Cap PP:
1.2540g
PP & CB
97% & 3%

Retail Packaging:

Functioning Unit:
Single Marker

Product Packaging:

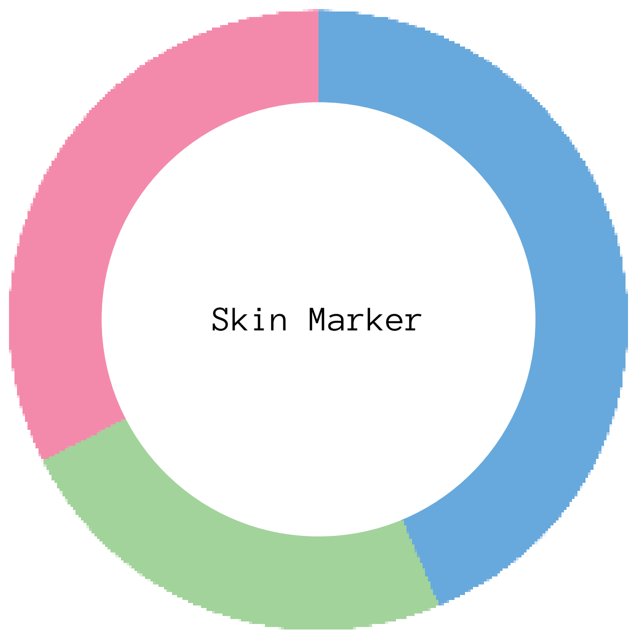
No individual Packaging

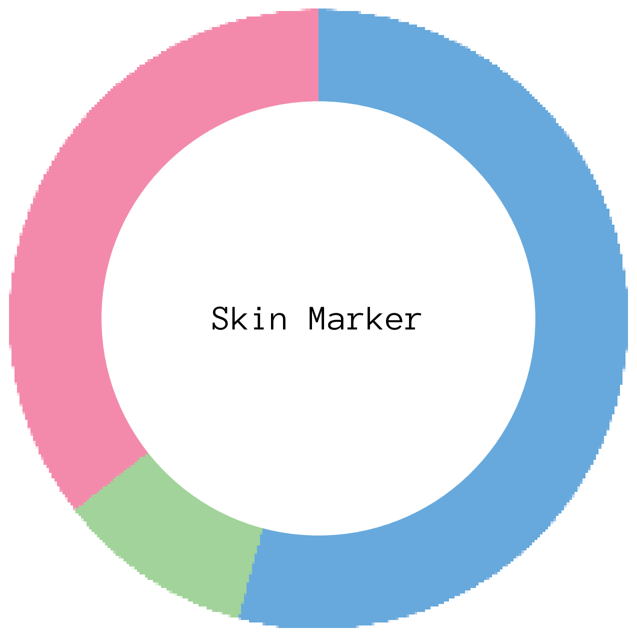
Transportation:

Wenzhou Factory - Shanghai Port
Truck **316.600miles**
Shanghai Port - Savannah Port
Ship via Panama Canal **11706.880miles**
Savannah Port - Atlanta Factory
Truck **270.500miles**
Atlanta Factory - Savannah Port
Truck **270.500miles**
Savannah Port - Felixtowe Port UK
Ship **4451.220miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Skin Marker





43.80 %	Manufacturing	**0.0318 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
23.83 %	EOL	**0.0173 CO^2 eq.kg**
32.37 %	Transportation	**0.0235 CO^2 eq.kg**

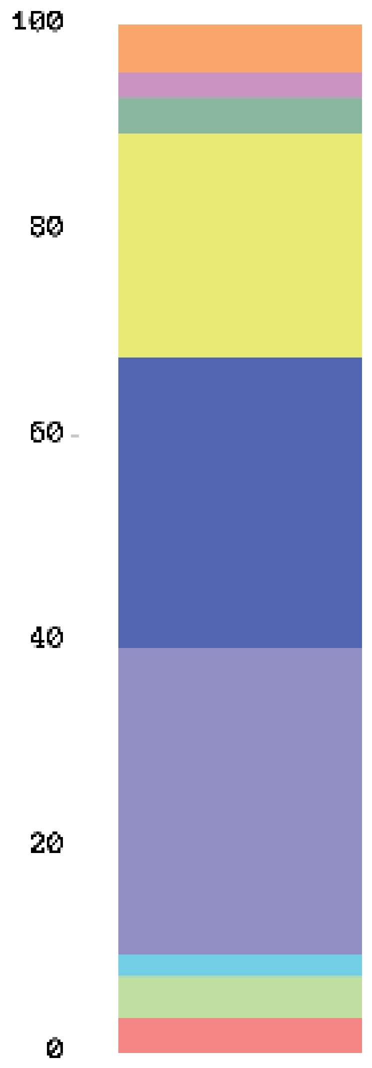
54.41 %	Manufacturing	**0.0019 mPts**
%	Use	**mPts**
10.17 %	EOL	**0.0003 mPts**
35.42 %	Transportation	**0.0013 mPts**

0.0726 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.0154 CO^2 eq.kg

0.0035 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0007 mPts



3.32 %	Acidification
4.04 %	Ecotoxicity
2.25 %	Eutrophication
29.66 %	Global Warming
0.09 %	Ozone Depletion
28.39 %	Fossil Fuel Depletion
21.70 %	Carcinogenics
3.45 %	Non-Carcinogenics
2.60 %	Respiratory Effects
4.50 %	Smog

LCA based Insights*:*

The Skin Marker LCA shows significant manufacturing data gaps due to the SM-13 manufacturing process being missing. The Technology associated with manufacturing like the sintering of the nib and manufacturing of the ink reservoir represent the biggest data gap concerns.
In addition, the printing on the Marker body which is performed with the process of screen printing is also missing in the LCA.

The Skin Marker could be avoided altogether by using other means of marking Stencil placement or making design choices in the tattoo design to allow for freestyle stencil placement. Altogether, this product does not foster my biggest concern since the product lasts over extended periods of time and can be reused since it doesn't come in contact with bloodborne pathogens due to the skin surface being sterilized before use.

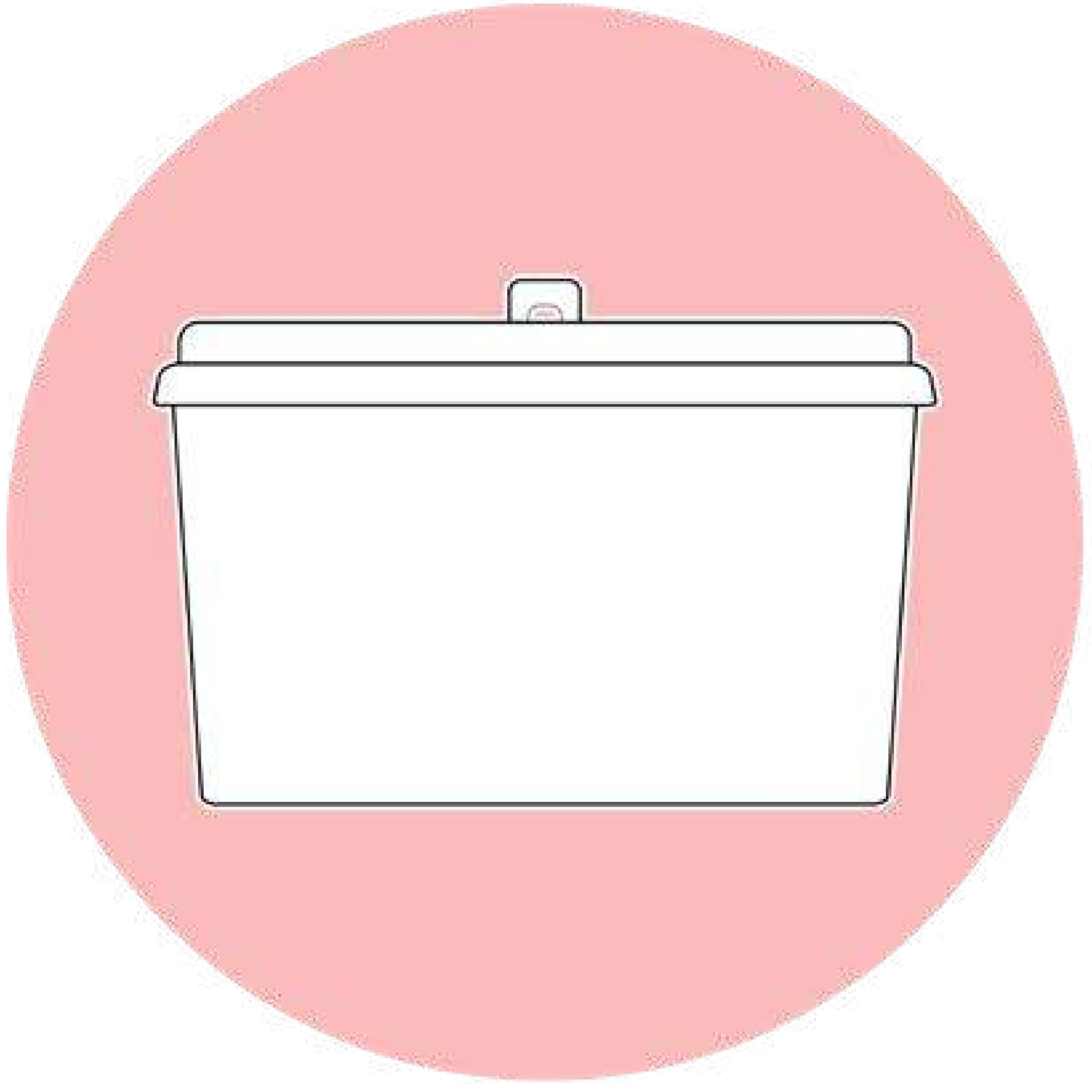
Even though the product weight is quite minimal, the "Greatest Impact" is still airfreight and could be reduced by sourcing markers from German manufacturers.

LCA

SM-2013
Biohazard Container
Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Pigment for PP Yellow & Red Data Gap.

Parts:

Sharps Container PP *(yellow)*:
184.0000g

Sharps Lid **PP** *(red)*:
104.2280g

Functioning Unit:

Single Container
(Disposes of ca.330 cartridges)

Product Packaging:

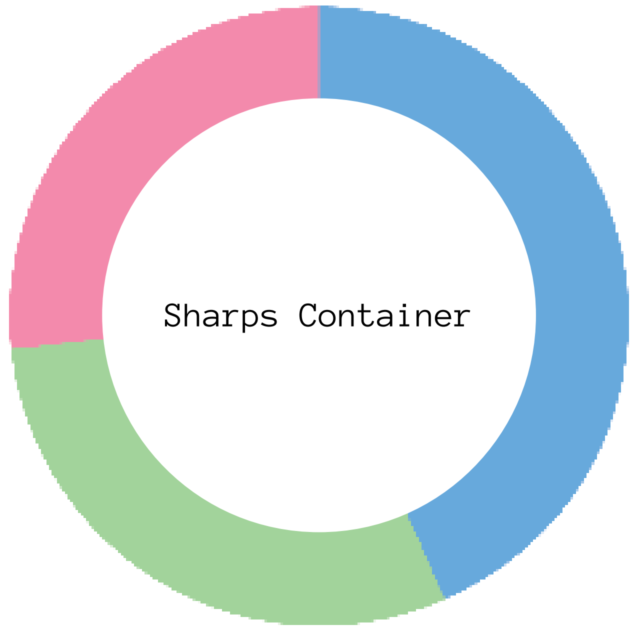
No individual Packaging

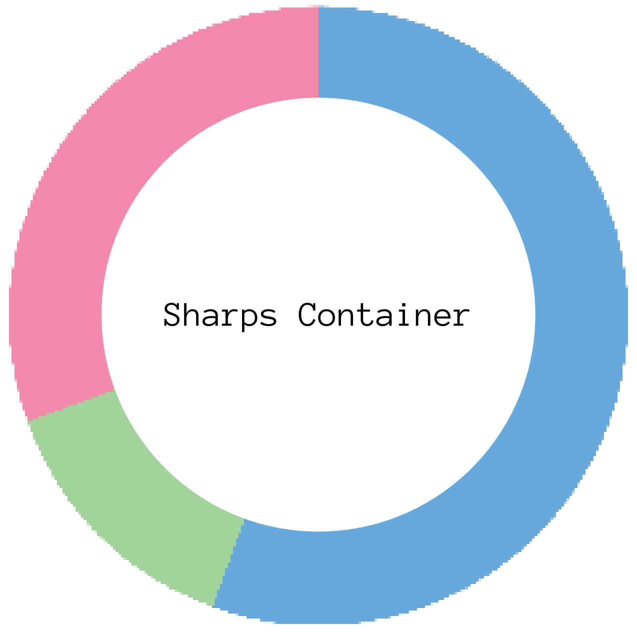
Transportation:

Ningbo Factory - Shanghai Port
Truck **148.600miles**
Shanghai Port - Amsterdam Port
Ship via Suez Canal **12144.175miles**
Amsterdam Port - Dronten Factory
Truck **56.750miles**
Dronten Factory - Amsterdam Port
Truck **56.750miles**
Amsterdam Port - Felixtowe Port UK
Ship **165.712miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Biohazard Container





43.46 %	Manufacturing	**1.0600 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
29.93 %	EOL	**0.7300 CO^2 eq.kg**
26.61 %	Transportation	**0.6490 CO^2 eq.kg**

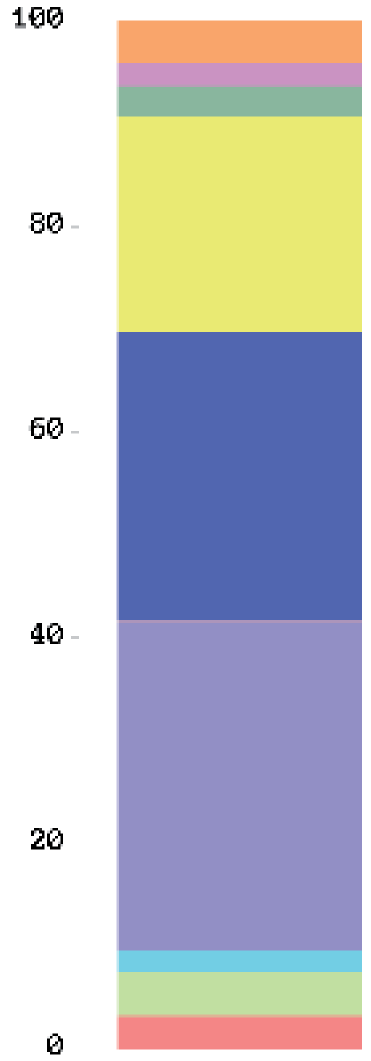
55.74 %	Manufacturing	**0.0612 mPts**
%	Use	**mPts**
13.84 %	EOL	**0.0152 mPts**
30.42 %	Transportation	**0.0334 mPts**

2.4390 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.4940 CO^2 eq.kg

0.1098 mPts per functioning unit

Greatest Impact:
PP – 0.0242 mPts



3.20 %	Acidification
4.33 %	Ecotoxicity
2.02 %	Eutrophication
32.02 %	Global Warming
0.04 %	Ozone Depletion
28.11 %	Fossil Fuel Depletion
20.95 %	Carcinogenics
3.06 %	Non-Carcinogenics
2.23 %	Respiratory Effects
4.04 %	Smog

LCA based Insights:

SM-13 shows data gaps in pigment calculation for PP components. The Pigment is internationally relevant for visual hazard identification of the product and its hazardous content in its EOL and therefore can not be displaced. Data set updates in the future could allow for their calculation.

The Sharps container in general only shows potential for improvement in wall thickness to the specific use case of tattoo sharp disposal when using safety cartridge needles; this is due to the fact that the needle is not protruding from its body. Therefore, the penetration of the walls of the sharps container present no hazard.

The “Greatest Impact” of the product is the material PP and an educated redesign to displace the material for more eco-friendly materials could show the greatest potential for impact reduction.

LCA

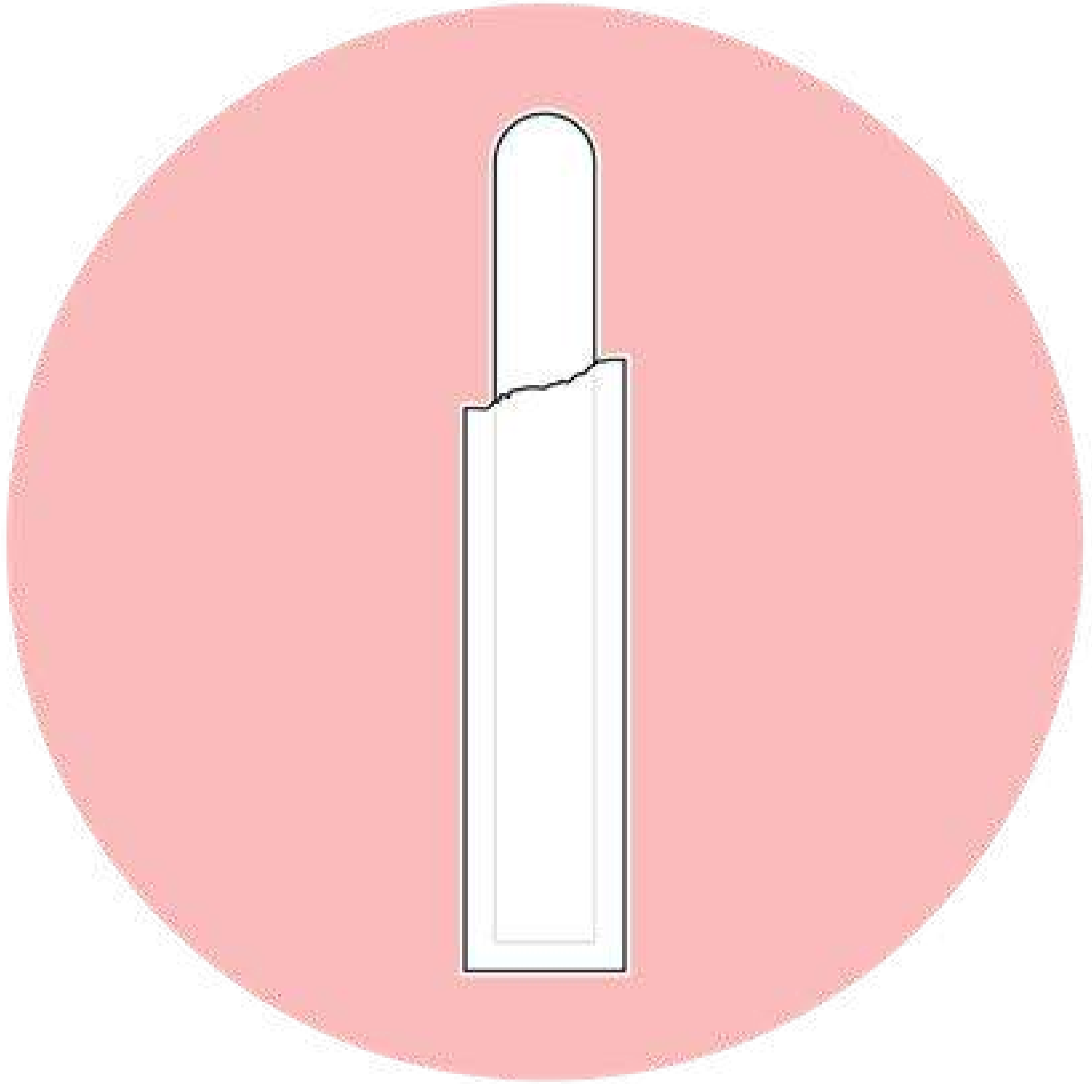
SM-2013

Tongue Depressor

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Ink for Paper packaging print not included.
Birch Wood Data Gap. Placeholder Ash.
Manufacturing for Spatulas not included, SM-13 Data Gaps.

Parts:

Ash Wood Spatula *(should be Birch)*:
2.1000g

Paper Packaging:
0.5000g

Product Packaging:

Paper Packaging

Retail Packaging:

Packaging:

Printed Paperboard Box:
37.3980g

Surface Area of Packaging:
937.56cm²

Functioning Unit:
100 units & Retail Packaging

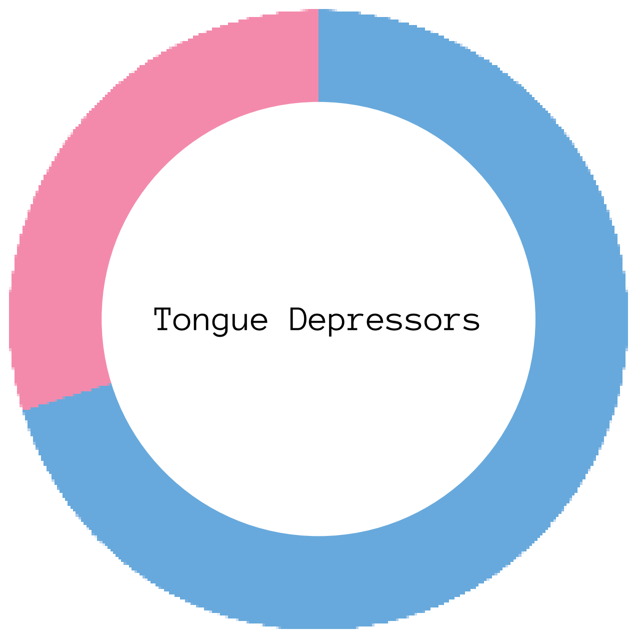
Ink Amount used for Packaging:
0.066g

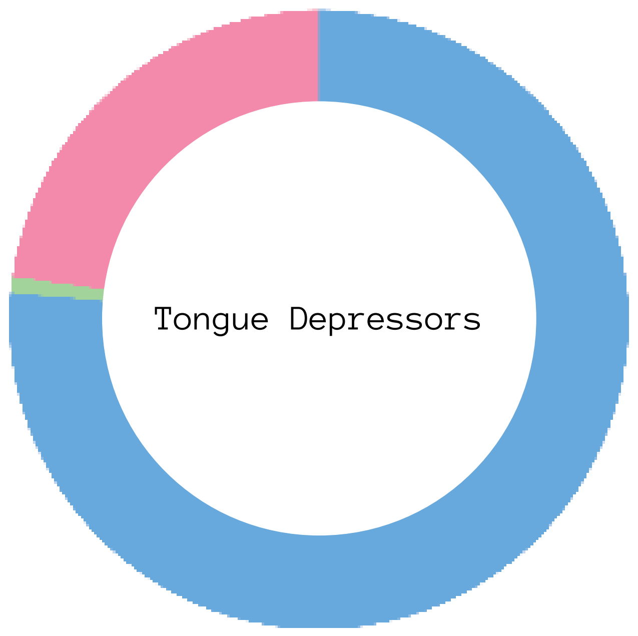
Transportation:

Guangdong Factory - Guangdong Port
Truck **38.230miles**
Guangdong Port - Felixtowe Port UK
Ship via Suez Canal **11233.910miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Tongue Depressor





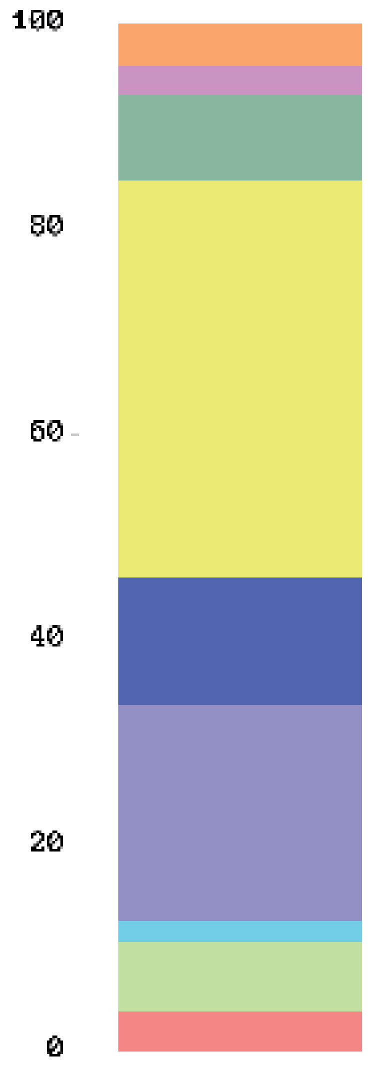
70.30 %	Manufacturing	1.6400 CO^2 eq.kg	76.52 %	Manufacturing	0.1220 mPts
%	Use	CO^2 eq.kg	%	Use	mPts
0.17 %	EOL	0.0039 CO^2 eq.kg	0.96 %	EOL	0.0015 mPts
29.53 %	Transportation	0.6890 CO^2 eq.kg	22.52 %	Transportation	0.0359 mPts

2.3329 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.5100 CO^2 eq.kg

0.1594 mPts per functioning unit

Greatest Impact:
Ash – 0.0245 mPts



3.73 %	Acidification
6.80 %	Ecotoxicity
2.07 %	Eutrophication
21.12 %	Global Warming
0.02 %	Ozone Depletion
12.32 %	Fossil Fuel Depletion
38.71 %	Carcinogenics
8.33 %	Non-Carcinogenics
2.72 %	Respiratory Effects
4.18 %	Smog

LCA based Insights*:*

Data gaps in SM-13 for woodtype, placeholder material Ash Wood instead of Birch. Print of paper packaging not included due to data Gaps. “Greatest Impact” is Ash Wood for spatula Manufacturing, this will likely remain the same, once data becomes available for Birch Wood. Manufacturing data for wood Manufacturing processes are not included, SM-13 data gaps.

For Lifecycle, the Manufacturing processes already make up *70.3%* by CO^2 eq. kg of emissions. This is likely to increase once manufacturing data becomes available for the spatulas. Changing the country of production from China to Germany would show the greatest improvement to the product’s impact.

The Alternative Product described on the following two pages would displace the need for this Product with minimal drawbacks due to the need of a sterilization process. The Alternative Product has no LCA as of now, but as seen with other products, Reuse will allow for the greatest impact reduction especially when the alternative product can be used to displace single-use products over extended use cycles.

SM-2013

Tongue Depressor - Alternative Product

A Stainless Steel Spatula is able to displace the wooden tongue depressor which is used to scrape cream from its container. This reduces the risk of introducing bacteria to the container when extracting cream. The Use of the alternative Product could displace the current Product in use therefore lowering the impact a tattoo session has.

After use, the Stainless Steel Spatula should be sterilized with an Ultrasonic Cleaner and a tool disinfectant solution.

The displacement of the current product in use allows for preserving renewable resources like wood. The reason for the material displacement is not the material itself but rather the fact, that wooden single use products should be avoided if possible. Wood shows greater potential in other applications and therefore there is no need for it being used to scrape cream once and then being disposed of.

LCA

SM-2013

Surface Disinfectant

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Calculated
EOL
Transportation

Missing Information:

Liquid Substances Data Gap - Placeholder Liquid
Stainless Spring Manufacturing Process Data Gap.
Material Data TPE-S (SEBS) missing. SM-13 Data Gap - SBR Placeholder.
PVC Label Printing Data Gap - Offset Printing Placeholder.

Concentrate:

Aqua - **Placeholder**

Ingredients:
Deionised Water, Didecydimethyl Ammonium Chloride, Alkyl Dimethyl Benzyl Ammonium Chloride, Alkyl Dimethyl Ethylbenzyl Ammonium Chloride, DMDM Hydation, Iodopropynyl Butylcarbomate

Product Packaging:

HDPE Bottle: 55.0000g

Sprey Head:
HDPE Parts: 1.2320g
PP Parts: 19.0340g
PS Parts: 0.2530g
TPE-S Parts: 0.2030g

Steel 304H: 0.6650g

Retail Packaging:

Packaging:

PVC Label:
2.537g
PVC & TiOx
97% & 3%

Adhesive for Label:
0.1269g

Surface Area of Packaging:
324cm²

Functioning Unit:
1L & Retail Packaging

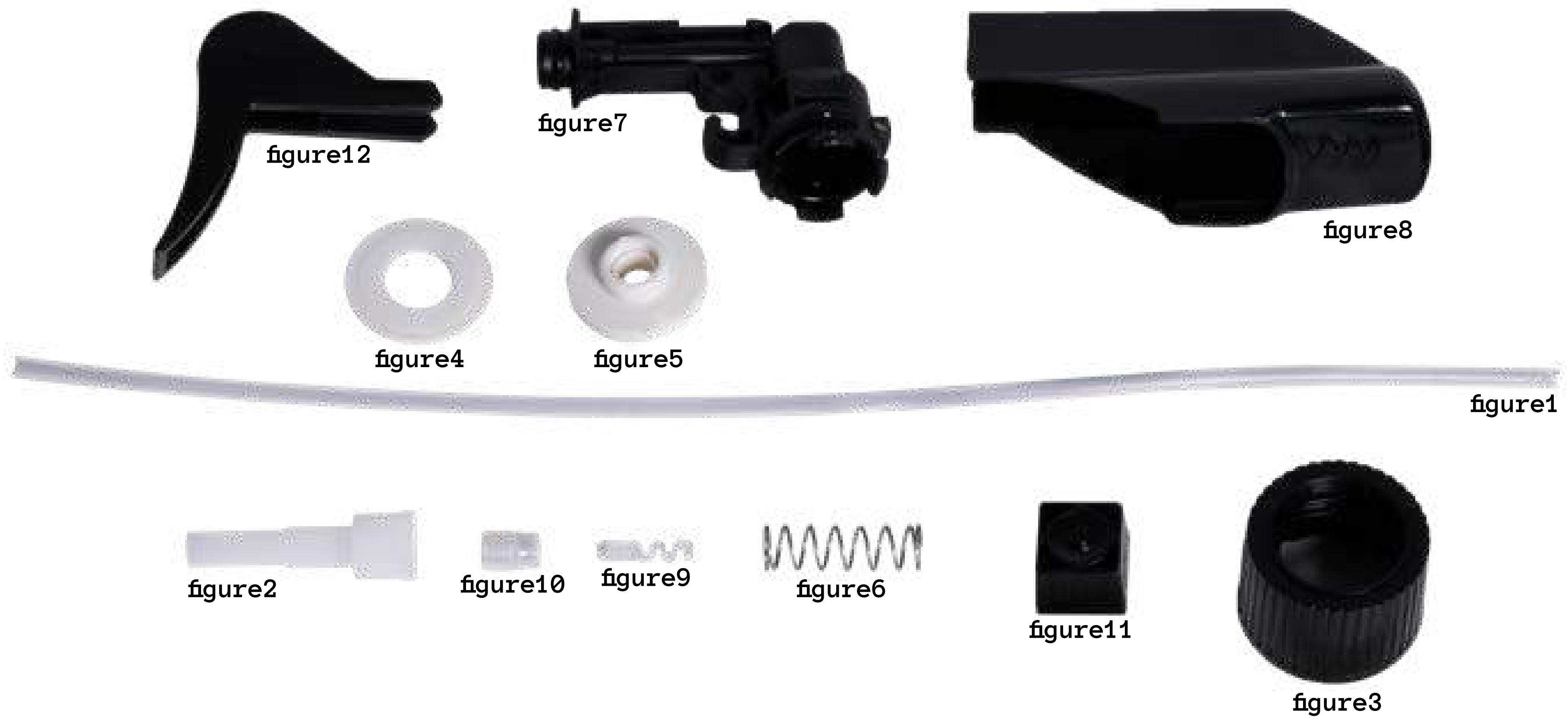
Ink Amount used for Packaging:
0.141g

Transportation:

Dezhou Factory - Tianjin Port
Truck **117.660miles**
Tianjin Port - Felixtowe Port UK
Ship via Suez Canal **12639.011miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Surface Disinfectant - Sprey Head



Parts:

figure1
Dip Tube:
1.2320g
Material: HDPE

figure2
Dip Tube Shalf:
1.0100g
Material: PP

figure3
Closure:
4.0180g
Material: PP & CB
97% & 3%

figure4
Gasket:
0.2530g
Material: PS

figure5
Cap Scall Ring:
1.3850g
Material: PP & TiOX
97% & 3%

figure6
Spring:
1.0100g
Material: Steel 304H

figure7
Inner Body:
3.6710g
Material: PP & CB
97% & 3%

figure8
Shroud:
5.2740g
Material: PP & CB
97% & 3%

figure9
S Valve:
0.0620g
Material: TPE-S

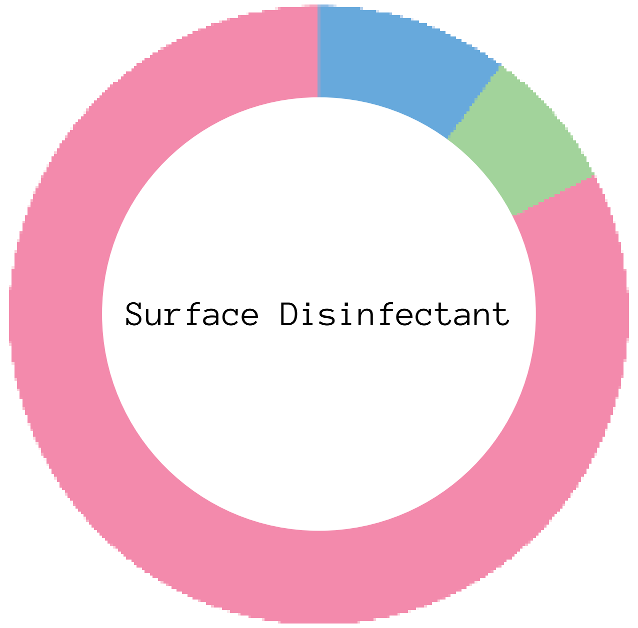
figure10
Spray Valve:
0.1410g
Material: TPE-S

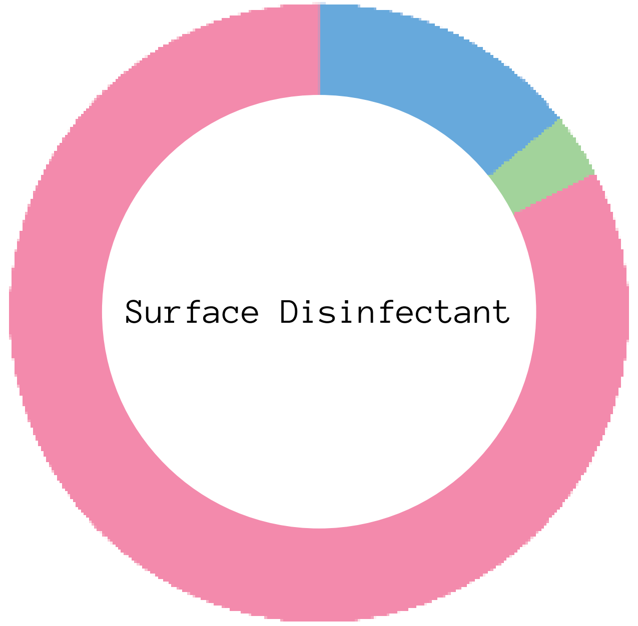
figure11
Sprey Nozzle:
1.101g
Material: PP & CB
97% & 3%

figure12
Trigger:
0.2530g
Material: PP & CB
97% & 3%

SM-2013

Surface Disinfectant





10.02 %	Manufacturing	0.2860 CO^2 eq.kg
%	Use	CO^2 eq.kg
7.64 %	EOL	0.2180 CO^2 eq.kg
82.34 %	Transportation	2.3500 CO^2 eq.kg

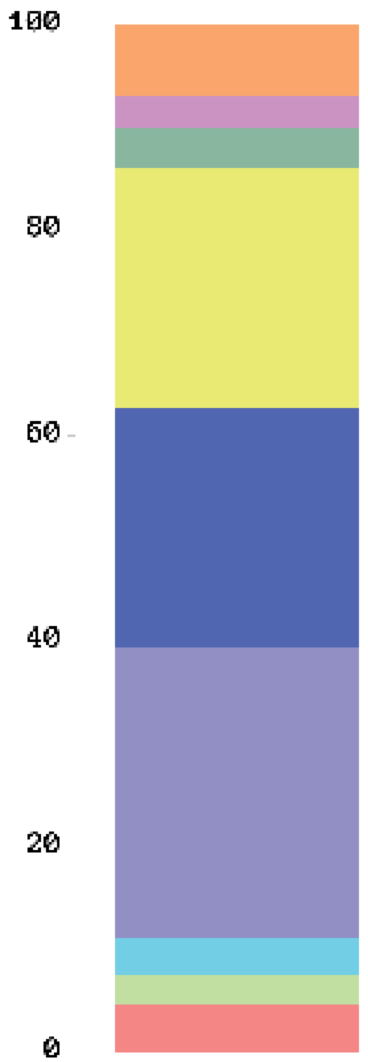
14.35 %	Manufacturing	0.0209 mPts
%	Use	mPts
3.26 %	EOL	0.0048 mPts
82.39 %	Transportation	0.1200 mPts

2.8540 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 1.8500 CO^2 eq.kg

0.1457 mPts per functioning unit

Greatest Impact:
Airfreight – 0.0867 mPts



4.64 %	Acidification
2.90 %	Ecotoxicity
3.53 %	Eutrophication
28.25 %	Global Warming
0.04 %	Ozone Depletion
23.38 %	Fossil Fuel Depletion
23.19 %	Carcinogenics
4.08 %	Non-Carcinogenics
2.93 %	Respiratory Effects
7.05 %	Smog

LCA based Insights:

The Product shows major data gaps in liquid calculation due to missing chemical substance data in SM-13; Distilled Water acts as the liquid Placeholder to allow for accurate transportation impact data. Calculation of PVC label printing was not possible due to data gaps for the process; offset Printing was added as placeholder until data becomes available. Manufacturing process data for steel springs shows data gaps, Coil Winding and Heat Treatment are not available at this point in time. The Material TPE-S SEBS is not available, therefore SBS was added as a Placeholder.

Liquid data was analyzed through MSDS to give insights for concern. The chemical substance Iodopropynyl Butylcarbamate is not recommended to be aerosolized but this is the case for surface sprays, therefore concerns for occupational hazards are given in addition to acute ecotoxicity. The three chloride substances are also raising concerns to act as skin and respiratory irritants. Alkyl Dimethyl Benzyl Ammonium Chloride shows significant concern for aquatic life: the liquid mostly evaporates during use, but during manufacturing or if disposed through waste streams still leaves potential for leakage into the environment before incineration.

There is no ingredient in this Product except the Deionised Water that doesn't show acute health or environmental concerns, alternative products should be considered to displace the currently used one. Furthermore the shipment of concentrate in Water soluble packaging and the use of a reusable spray bottle show potential for impact reduction.

SM-2013

Stencil Transfer Cream

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Calculated
EOL
Transportation

Missing Information:

Liquid Substances Data Gap - Placeholder Liquid
- Germaben II Placeholder.
- Stearic Acid Placeholder.

Stainless Spring Manufacturing Process Data Gap.
Stainless Ball Manufacturing Process Data Gap.
Material Data TPE-S (SEBS) missing. SM-13 Data Gap - SBR Placeholder.
PVC Label Printing Data Gap - Offset Printing Placeholder.
Adhesive Data Missing for PVC Label.

Cream:

Ingredients (Amount - Educated Guess):

Water	**142.881g**
Propylene Glycol	**63.389g**
Stearic Acid	**10.206g**
Fatty Acids Placholder	
Triethanolamine	**8.505g**
Germaben II	**1.815g**
PG, Formic Acid & Formaldehyde Placeholder	

Product Packaging:

HDPE Bottle: 24.3700g

Pump Spray:
PP Parts: 3.7060g
LDPE Parts: 2.4560g
TPE-S Parts: 0.0150g
PS Parts: 0.1680g

Steel 304H: 0.2190g
Steel 316H: 0.4170g

Retail Packaging:

Packaging:

PVC Label Cover - PP:
0.286g

PVC Label:
0.509g

Surface Area of Label:
100cm²

Functioning Unit:
240ml & Retail Packaging

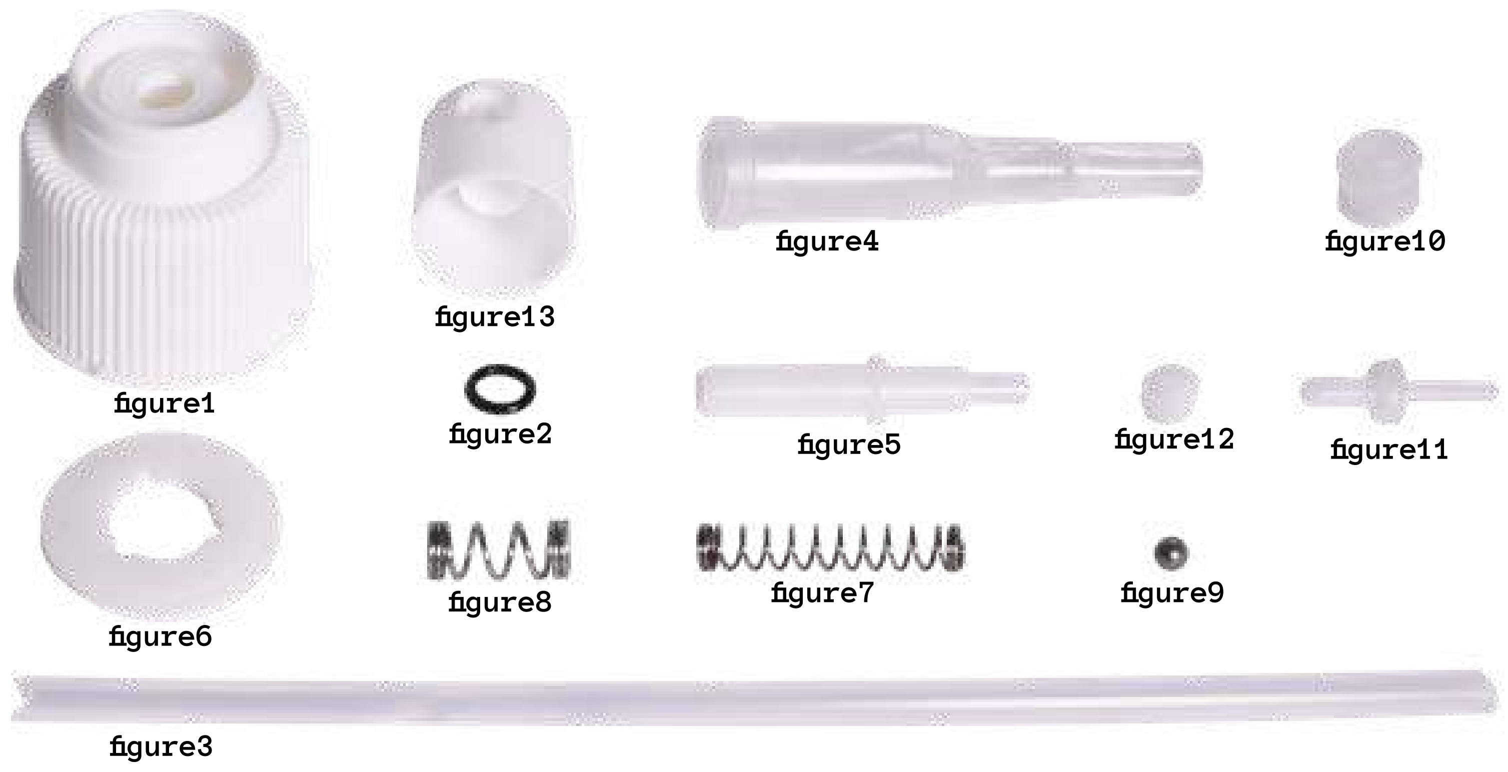
Ink Amount used for Packaging:
0.043g

Transportation:

Hefei Factory - Shanghai Port
Truck **314.000miles**
Shanghai Port - Philadelphia Port
Ship via Panama Canal **12147.628miles**
Philadelphia Port - Elkhart Factory
Truck **667.330miles**
Elkhart Factory - New Orleans Port
Truck **998.000miles**
New Orleans Port - Felixtowe Port UK
Ship **5506.480miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Stencil Transfer Cream – Pump Spray



Parts:

figure1
Closure:
2.9540g
Material: PP & TiOx
97% & 3%

figure2
Seal:
0.0150g
Material: TPE-S

figure3
Dip Tube:
0.8980g
Material: LDPE

figure4
Dip Tube Shalf:
0.1630g
Material: LDPE

figure5
Piston:
0.7530g
Material: LDPE

figure6
Gasket:
0.1680g
Material: PS

figure7
Spring:
0.2190g
Material: Steel 304H

figure8
Spring:
0.3030g
Material: Steel 316H

figure9
Metal Ball:
0.1140g
Material: Steel 316H

figure10
Inner Body:
0.0462g
Material: LDPE

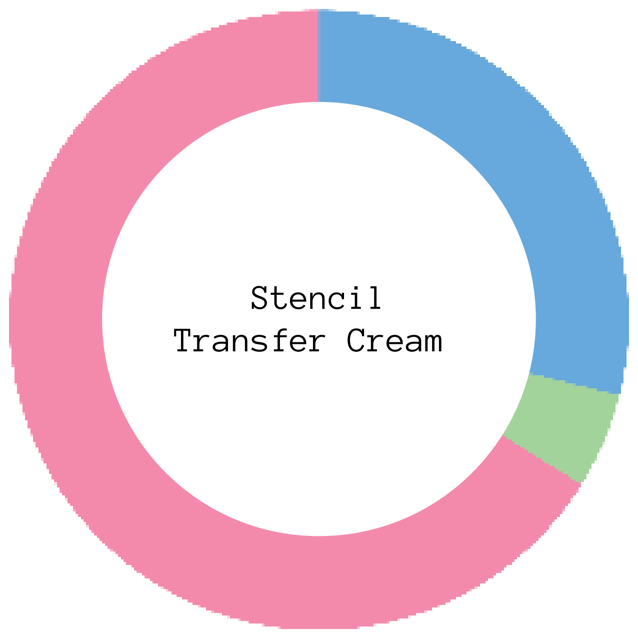
figure11
Valve:
0.1280g
Material: LDPE

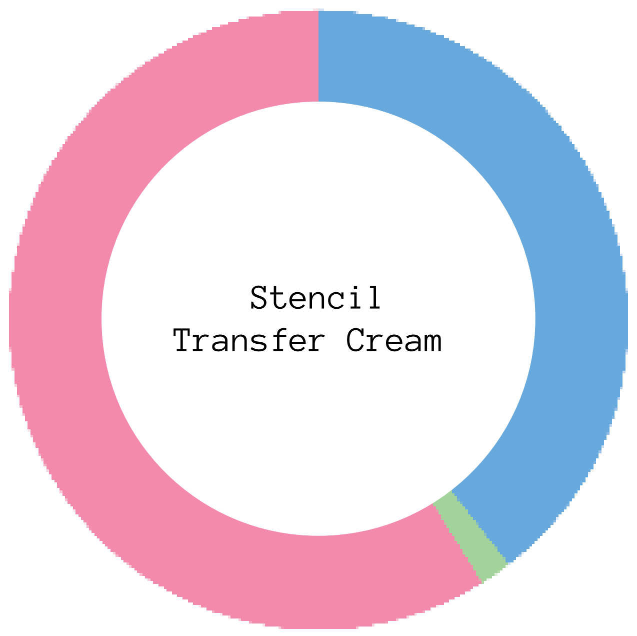
figure12
Spray Valve:
0.0052g
Material: LDPE

figure13
Spray Cap:
0.7520g
Material: PP & TiOx
97% & 3%

SM-2013

Stencil Transfer Cream





28.97 %	Manufacturing	**0.5310 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
5.04 %	EOL	**0.0925 CO^2 eq.kg**
65.99 %	Transportation	**1.2100 CO^2 eq.kg**

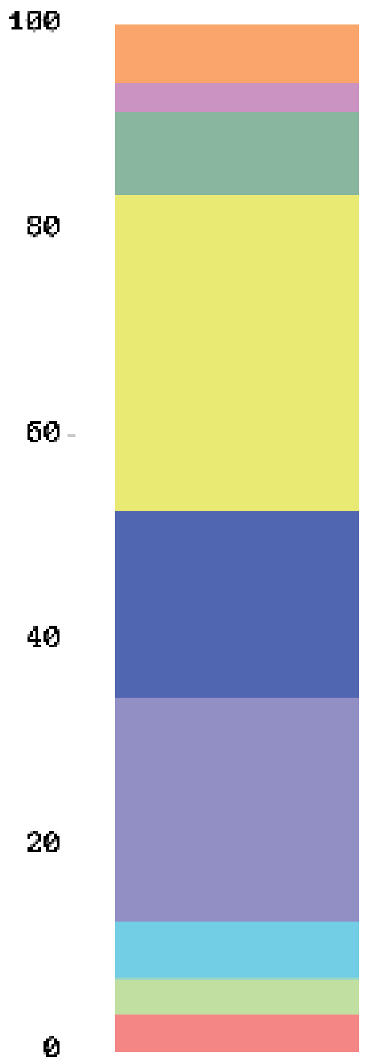
39.58 %	Manufacturing	**0.0479 mPts**
%	Use	**mPts**
1.58 %	EOL	**0.0019 mPts**
58.84 %	Transportation	**0.0712 mPts**

1.8335 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Airfreight – 0.4440 CO^2 eq.kg

0.1210 mPts per functioning unit

Greatest Impact:
Propylene Glycol – 0.0312 mPts



3.56 %	Acidification
3.52 %	Ecotoxicity
5.49 %	Eutrophication
21.85 %	Global Warming
0.04 %	Ozone Depletion
18.23 %	Fossil Fuel Depletion
30.82 %	Carcinogenics
7.99 %	Non-Carcinogenics
2.76 %	Respiratory Effects
5.73 %	Smog

LCA based Insights:

The product shows major data gaps in liquid calculation due to missing chemical substance data in SM-13; the product received multiple placeholder liquids to allow for accurate transportation impact data. Calculation of the PVC label printing was not possible due to data gaps of the process, Offset Printing was added as placeholder until data becomes available. In addition, Adhesive data was not able to be conducted due to difficulties in label separation when weighing components. Manufacturing process data for steel springs shows data gaps, Coil Winding and Heat Treatment are not available at this point in time. The Material TPE-S SEBS is not available, therefore SBS was added as a Placeholder.

The Liquid substance data was analyzed with EWG and shows concerns especially for Germaben II with a score of 3-4/10, which is classified as skin irritant by HazMap. Germaben II shows strong evidence to cause allergies and acts as Skin toxicant. Propylene Glycol with a score of 3/10 is also classified as skin irritant by HazMap. The chemical substance enhances skin absorption, and with evidence for Organ System Toxicity and provoking skin allergies in combination with the presence of Germaben II in the product, concerns are raised due to ease of skin penetration.

Product packaging could be improved by switching to less impactful packaging like squeeze bottles with fewer parts in order to reduce the product's manufacturing impact. Alternative Products without Germaben II and Propylene Glycol would be preferred and should be investigated in order to displace the currently used product.

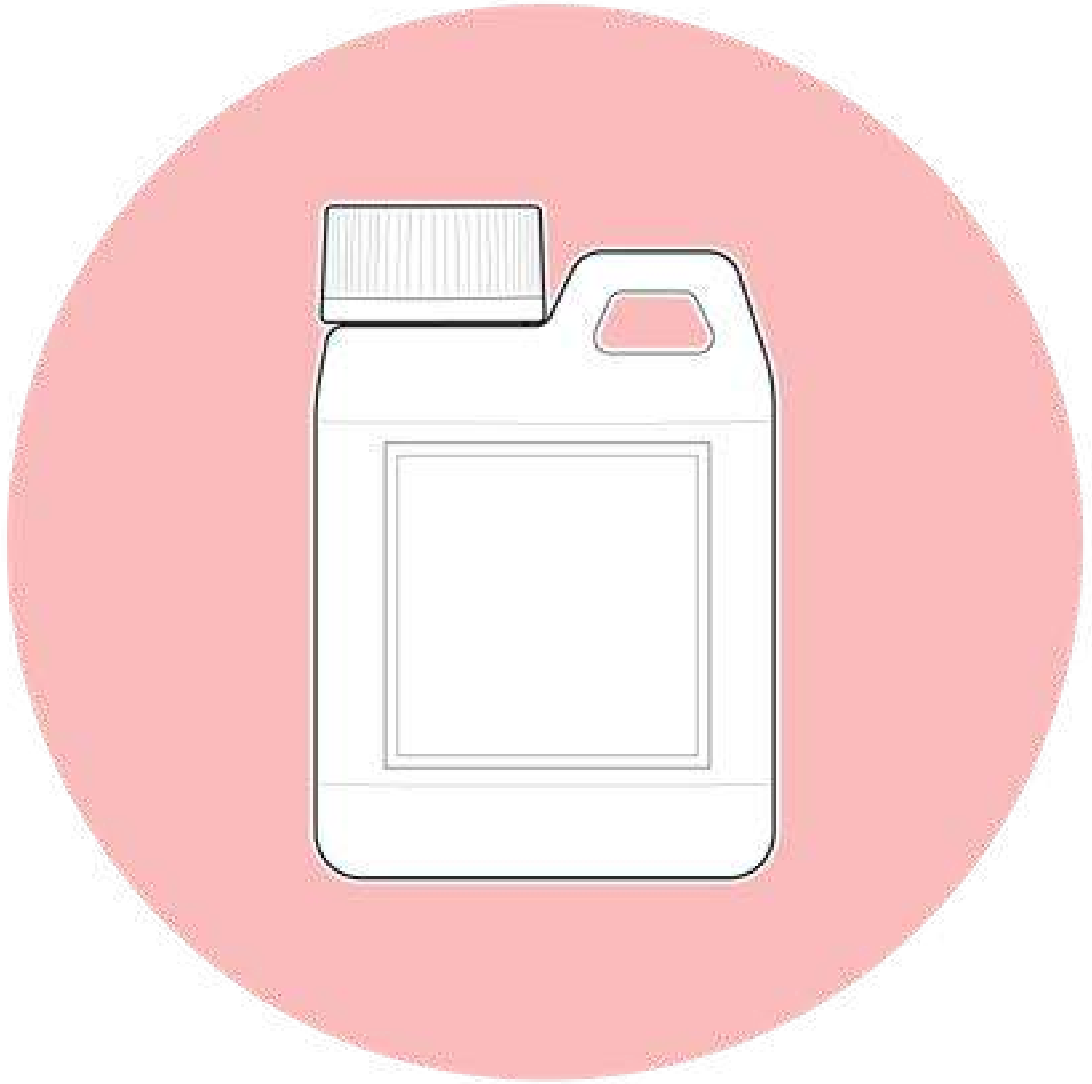
SM-2013

Stencil Ink for Inkjet Printing

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Calculated
EOL
Transportation



Missing Information:

Liquid Substances Data Gap - Placeholder Liquid - Water.
PP Pigment Red Data Gap SM-13.
Adhesive Data Paper Label not included.

Cream:

Water - Placeholder

Ingredients:
Water, Glycerin,
Isopropyl alcohol &
Methyl Violet *(pigment)*

Transportation:

Bottle:
Hangzhou Factory - Shanghai Port
Truck **141.000miles**
Shanghai Port - Philadelphia Port
Ship via Panama Canal **12147.628miles**
Philadelphia Port - Elkhart Factory
Truck **667.330miles**

Product:
Elkhart Factory - New Orleans Port
Truck **998.000miles**
New Orleans Port - Felixtowe Port UK
Ship **5506.480miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

Product Packaging:

Bottle HDPE: 17.0450g
PP & TiOx
97% & 3%

LID PP: 2.9800g
PP & TiOx
97% & 3%

Cap PP *(Red)*: **0.1980g**

Nozzle PP: 3.7920g

Retail Packaging:

Packaging:

Paper Label:
0.424g

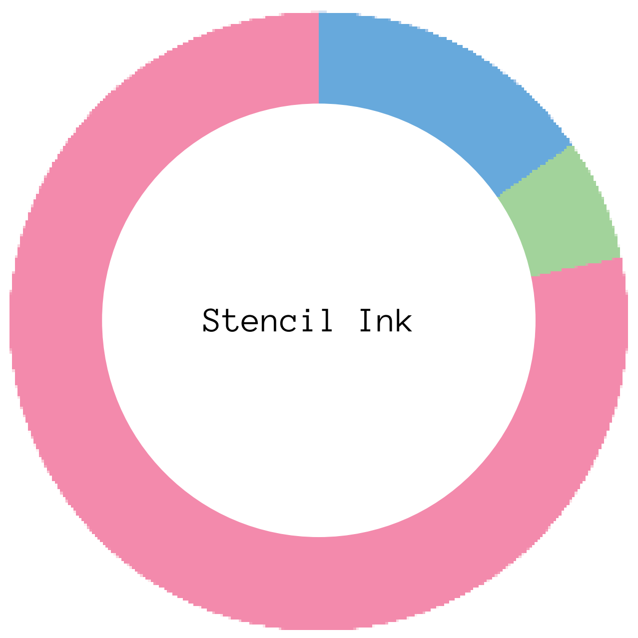
Surface Area of Label:
38.27cm²

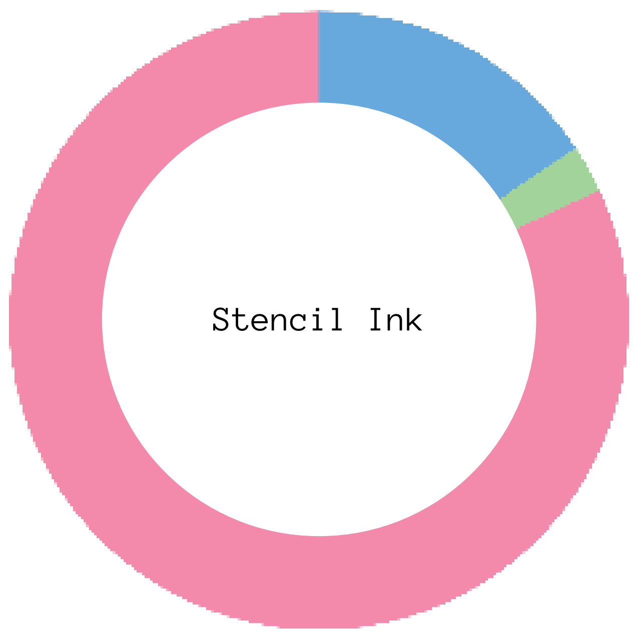
Functioning Unit:
ca.3000 pages (120ml)
& Retail Packaging

Ink Amount used for Packaging:
0.000275g

SM-2013

Stencil Ink for Inkjet Printing





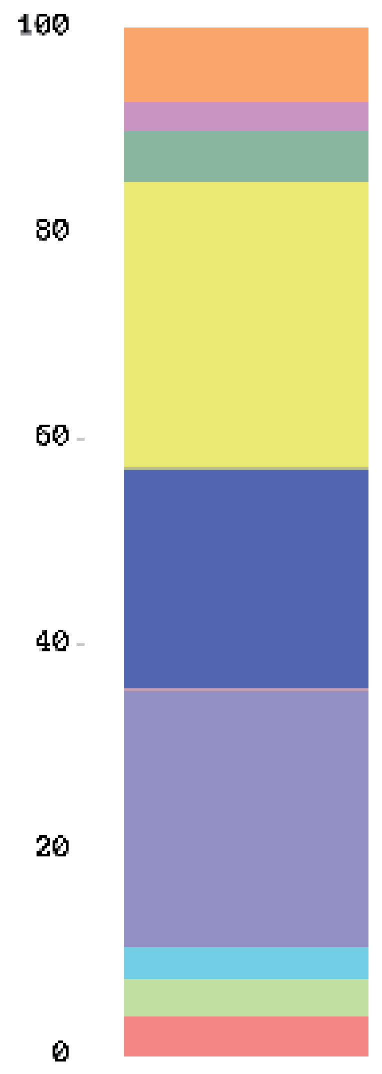
15.32 %	Manufacturing	**0.1560 CO^2 eq.kg**	15.81 %	Manufacturing	**0.0092 mPts**
%	Use	CO^2 eq.kg	%	Use	mPts
6.60 %	EOL	**0.0672 CO^2 eq.kg**	2.39 %	EOL	**0.0014 mPts**
78.08 %	Transportation	**0.7950 CO^2 eq.kg**	81.80 %	Transportation	**0.0478 mPts**

1.0182 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Truck – 0.2400 CO^2 eq.kg

0.0584 mPts per functioning unit

Greatest Impact:
Truck – 0.0156 mPts



3.73 %	Acidification
3.77 %	Ecotoxicity
2.99 %	Eutrophication
25.12 %	Global Warming
0.04 %	Ozone Depletion
21.48 %	Fossil Fuel Depletion
27.93 %	Carcinogenics
4.82 %	Non-Carcinogenics
2.96 %	Respiratory Effects
7.16 %	Smog

LCA based Insights:

Stencil Ink for Inkjet Printing shows data gaps in liquid data; therefore placeholder liquids were added to allow for accurate transportation data calculations with SM-13. Paper label and adhesive separation was not possible to be conducted due to disassembly issues. Furthermore the red pigment used in the product was not able to be calculated since SM-13 shows data gaps for this Pigment to dye the PP Cap.

Analyzing the liquid data through EWG shows significant concerns towards the pigment used to dye the skin in order to transfer the stencil. Methyl Violet, also known as Basic Violet 1, with a score of 4/10 has limited evidence for being Cancer causing. The pigment has significant use restriction and is classified to violate government use restrictions by Cosing as well as Canadian regulations. In addition, the pigment is suspected to be an environmental toxin. The product also includes Isopropyl Alcohol with a score of 2/10, which was discussed earlier in the Tattoo Ink LCA.

Alternative pigments like Safranin and Orange II could be considered to displace Methyl Violet in the same application method of Inkjet Stencil Printing. This recommendation is based on a scientific paper by Badaro et al., 2015 and is listed in the Bibliography. Further testing is needed, but not possible without a license for research chemicals.

LCA

SM-2013

Hand Disinfectant

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Calculated
EOL
Transportation

Missing Information:

Liquid Substances Data Gap - Placeholder Liquid - Water.

Cream:

Water - Placeholder

Ingredients:
Propan-2-ol, Propan-1-ol, Mecetroniumetilsulfat, Glycerol 85%, Tetradecan-1-ol, Fragrance, Patentblue V & Water

Retail Packaging:

PVC Label: 0.5240g
(Transparent)

PVC Label: 0.6350g
PVC & TiOx
97% & 3%

Adhesive:
0.123g

Surface Area of Label:
204.75cm²

Functioning Unit:
500ml & Retail Packaging

Ink Amount used for Packaging:
0.089g

Product Packaging:

Bottle HDPE: 32.4190g

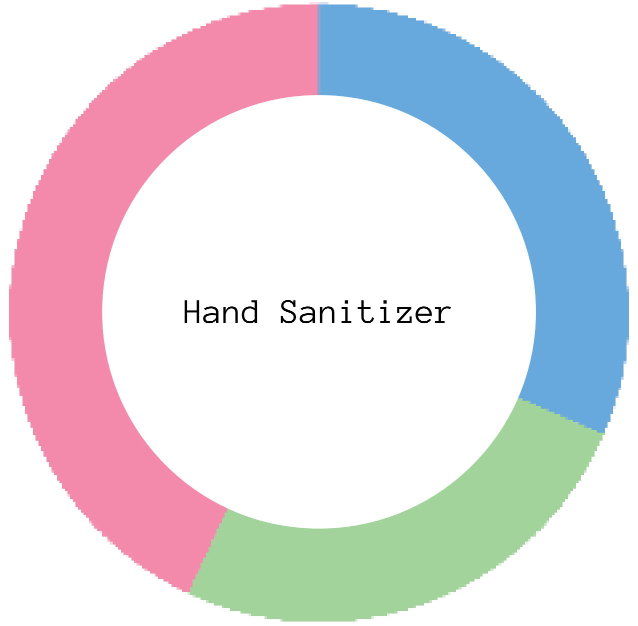
LID PP: 4.8200g
PP & TiOx
97% & 3%

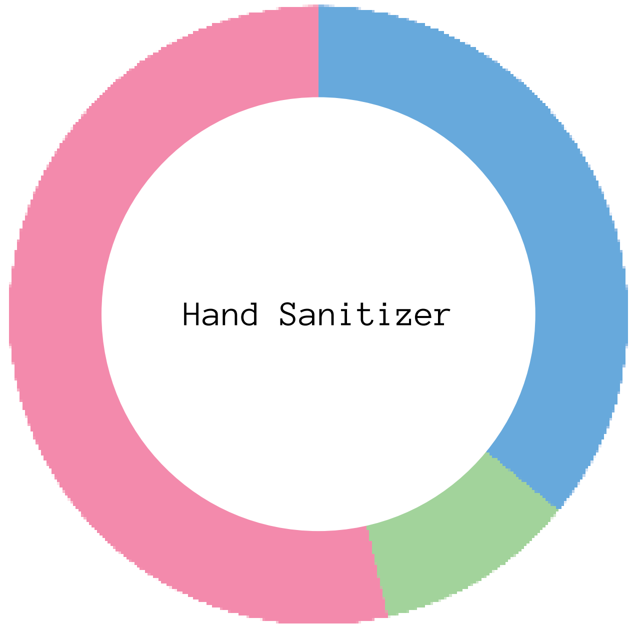
Transportation:

Hamburg Factory - Amazon DNW2
Truck **263.000miles**
Amazon DNW2 - Studio Cologne
Van **8.960miles**

SM-2013

Hand Disinfectant





31.66 %	Manufacturing	**0.1390 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
25.52 %	EOL	**0.1120 CO^2 eq.kg**
42.82 %	Transportation	**0.1880 CO^2 eq.kg**

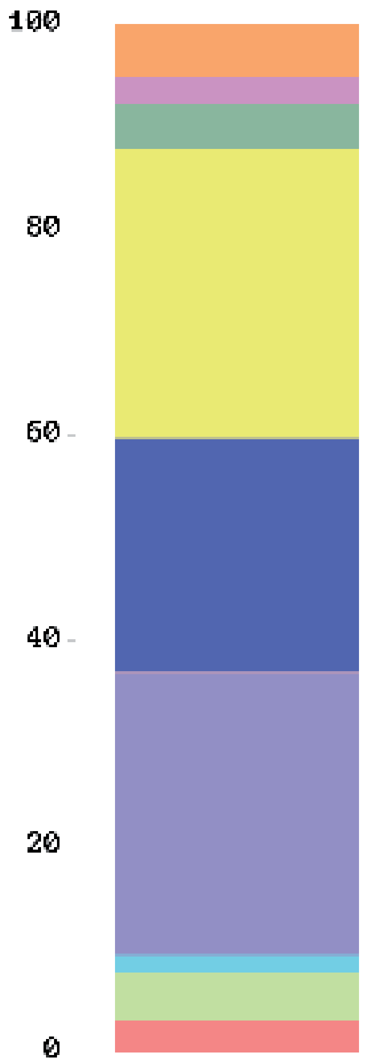
35.97 %	Manufacturing	**0.0083 mPts**
%	Use	**mPts**
10.60 %	EOL	**0.0024 mPts**
53.43 %	Transportation	**0.0123 mPts**

0.4390 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Truck – 0.1640 CO^2 eq.kg

0.0023 mPts per functioning unit

Greatest Impact:
Truck – 0.0107 mPts



3.03 %	Acidification
4.61 %	Ecotoxicity
1.76 %	Eutrophication
27.50 %	Global Warming
0.03 %	Ozone Depletion
22.77 %	Fossil Fuel Depletion
28.05 %	Carcinogenics
4.51 %	Non-Carcinogenics
2.54 %	Respiratory Effects
5.20 %	Smog

LCA based Insights:

The LCA shows data gaps for liquid based substance data in SM-13. To allow an accurate transportation Impact calculation, the LCA received Deionized Water as a placeholder liquid.

By analyzing the liquid data through EWG multiple chemical substances provoke concern. Patent Blue also known as CI42051 with a score of 3/10 has use restrictions and is banned for the reason of being unsafe for cosmetic use by Cosing. Isopropyl Alcohol with a Score of 2/10 was previously described in the Tattoo Ink LCA.

Propyl Alcohol and Mecetronium Ethylsulfate are not listed by EWG and analyzes are only possible through MSDS. Propyl Alcohol shows significant concerns for health hazards and shows concerns to be a possible mutagenic with strong evidence for ecotoxicity and reproductive toxicity.

The Product shows the greatest potential for hazard reduction by eliminating the Pigment Patent Blue from the formula. Additional harm reduction could be achieved by switching to alcohol based hand disinfectants.

SM-2013

Squeeze Bottle

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Parts:

Bottle LDPE:
25.3550g

Lid LDPE:
5.6030g

Dip Tube LDPE:
1.9600g

Product Packaging:

No individual Packaging

Transportation:

Hubei Factory - Tianjin Port
Truck **103.430miles**
Tianjin Port - Felixtowe Port UK
Ship via Suez Canal **12639.010miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

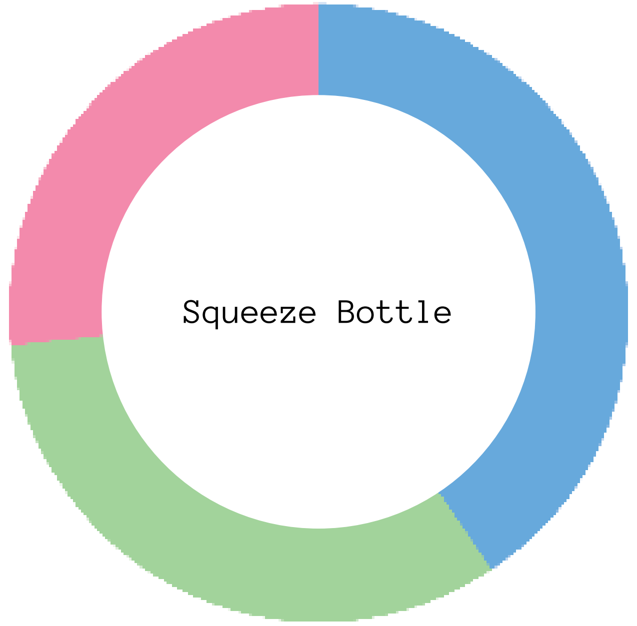
Retail Packaging:

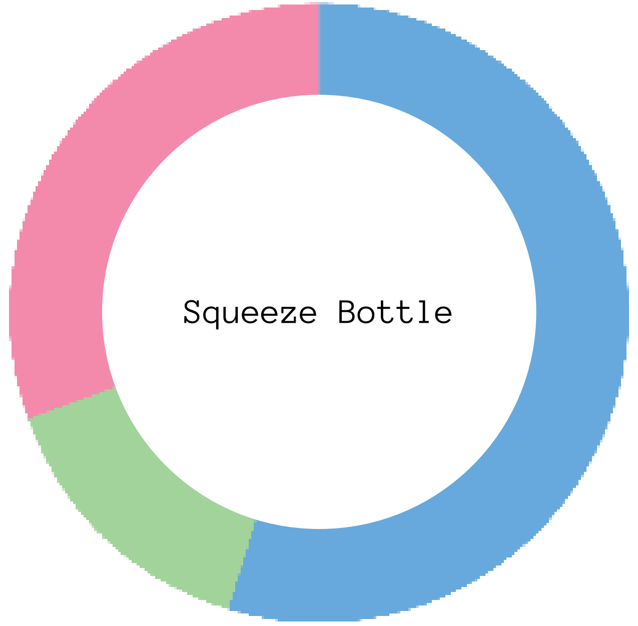
No individual Packaging

Functioning Unit:
one Squeeze Bottle 250ml

SM-2013

Squeeze Bottle





40.65 %	Manufacturing	**0.1220 CO^2 eq.kg**
%	Use	**CO^2 eq.kg**
32.89 %	EOL	**0.0987 CO^2 eq.kg**
26.46 %	Transportation	**0.0794 CO^2 eq.kg**

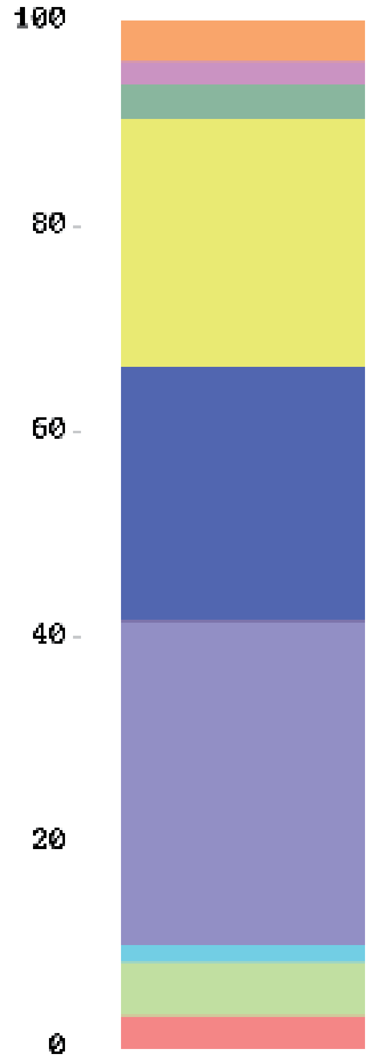
54.73 %	Manufacturing	**0.0075 mPts**
%	Use	**mPts**
14.85 %	EOL	**0.0020 mPts**
30.42 %	Transportation	**0.0042 mPts**

0.3001 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Incineration – 0.0760 CO^2 eq.kg

0.0137 mPts per functioning unit

Greatest Impact:
LDPE – 0.0039 mPts



3.20 %	Acidification	
5.21 %	Ecotoxicity	
1.67 %	Eutrophication	
31.46 %	Global Warming	
0.02 %	Ozone Depletion	
24.68 %	Fossil Fuel Depletion	
24.31 %	Carcinogenics	
3.22 %	Non-Carcinogenics	
2.29 %	Respiratory Effects	
3.93 %	Smog	

LCA based Insights:

The Product is complete by SM-13 standards and shows no significant potential for improvement. At the Products EOL, it is likely to be incinerated due to LDPEs difficulties in Mechanical recycling.

The “Greatest Impact” is LDPE by mPts and incineration for CO^2 eq. kg of emissions. The product can be reused over extended periods of time due to being a vessel to mix green soap and Deionized Water in order to clean the tattooed area as well as flushing needle modules.

The Product could show potential for impact reduction by changing LDPE to a bio-based material with lower impact in manufacturing or EOL impacts. Further Research is needed before making a claim.

LCA

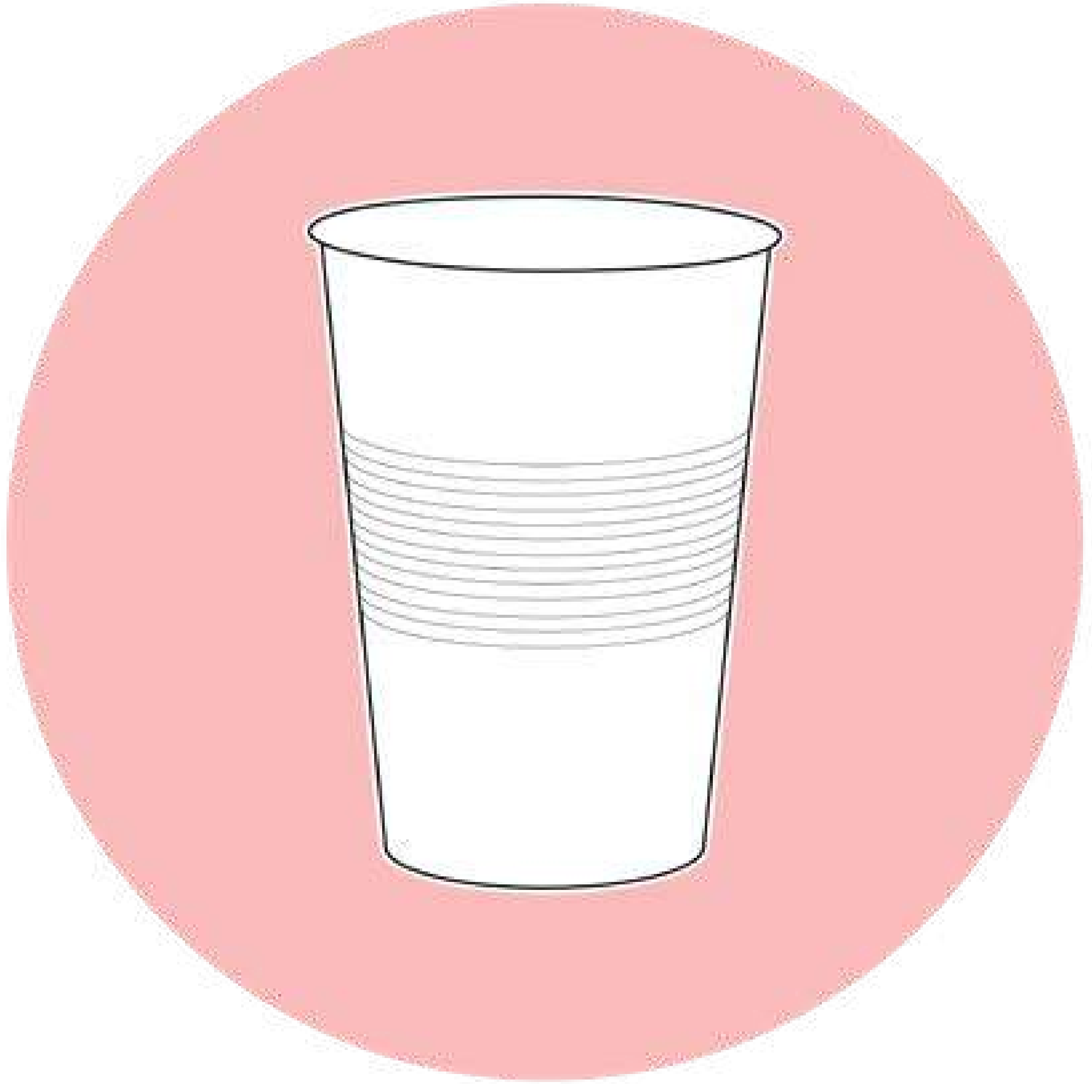
SM-2013

Wash Cup PP

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Parts:

Cup:
2.5000g

Material:
Polypropylene

Retail Packaging:

Sleeve LDPE:
2.8260g

Functioning Unit:
100 Cups & Retail Packaging

Product Packaging:

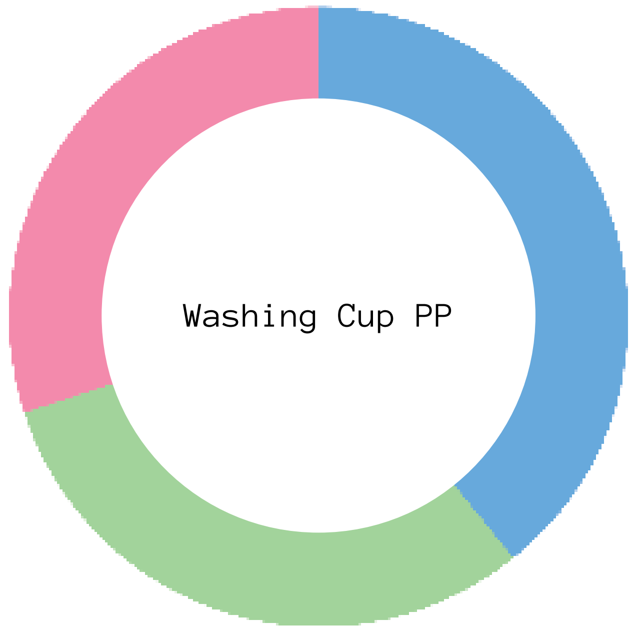
No individual Packaging

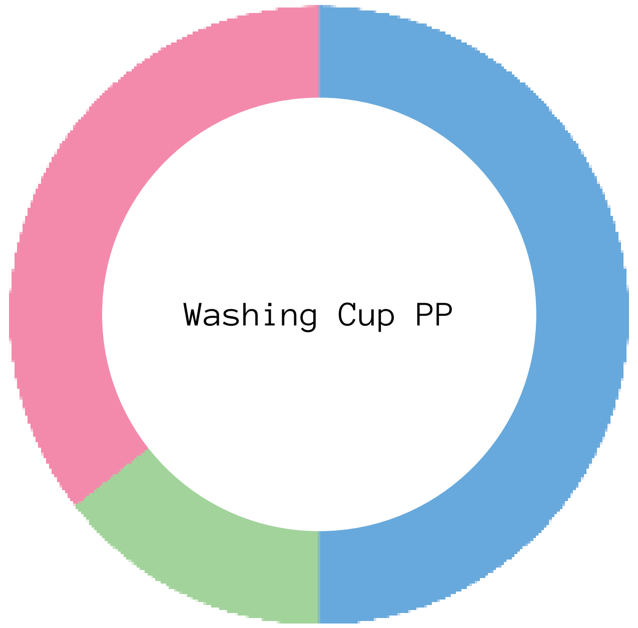
Transportation:

Jinhua Factory - Fuzou Port
Truck **327.660miles**
Fuzou Port - Felixtowe Port UK
Ship via Suez Canal **11558.430miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Wash Cup PP





39.32 %	Manufacturing	0.8230 CO^2 eq.kg
%	Use	CO^2 eq.kg
30.72 %	EOL	0.6430 CO^2 eq.kg
29.96 %	Transportation	1.6270 CO^2 eq.kg

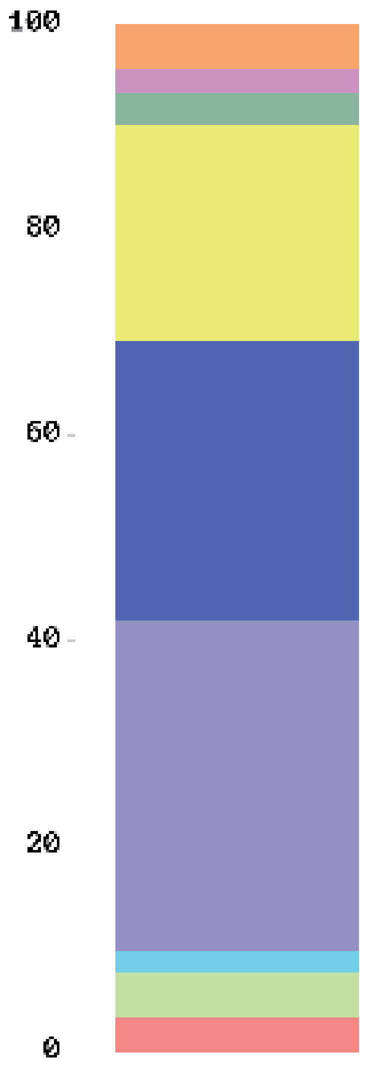
50.21 %	Manufacturing	0.0469 mPts
%	Use	mPts
14.35 %	EOL	0.0134 mPts
35.44 %	Transportation	0.0331 mPts

3.0930 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Incineration – 0.0634 CO^2 eq.kg

0.0934 mPts per functioning unit

Greatest Impact:
PP – 0.0329 mPts



3.36 %	Acidification
4.35 %	Ecotoxicity
2.00 %	Eutrophication
32.29 %	Global Warming
0.02 %	Ozone Depletion
27.24 %	Fossil Fuel Depletior
20.93 %	Carcinogenics
3.21 %	Non-Carcinogenics
2.32 %	Respiratory Effects
4.28 %	Smog

LCA based Insights:

The LCA data for The Wash Cup PP is complete and has no missing data. The “Greatest Impact” is the material PP with manufacturing being the highest impact by Lifecycle. The Scorecard shows high impacts in the categories of Global Warming and Fossil Fuel Depletion due to the material being crude oil-based.

The Product impact could be reduced by local production through transportation impact reduction. The alternative Product made from bioplastic cannot be considered to displace the PP product and rather a reusable product shown, following after the Eco product, should be considered to displace both product options.

LCA

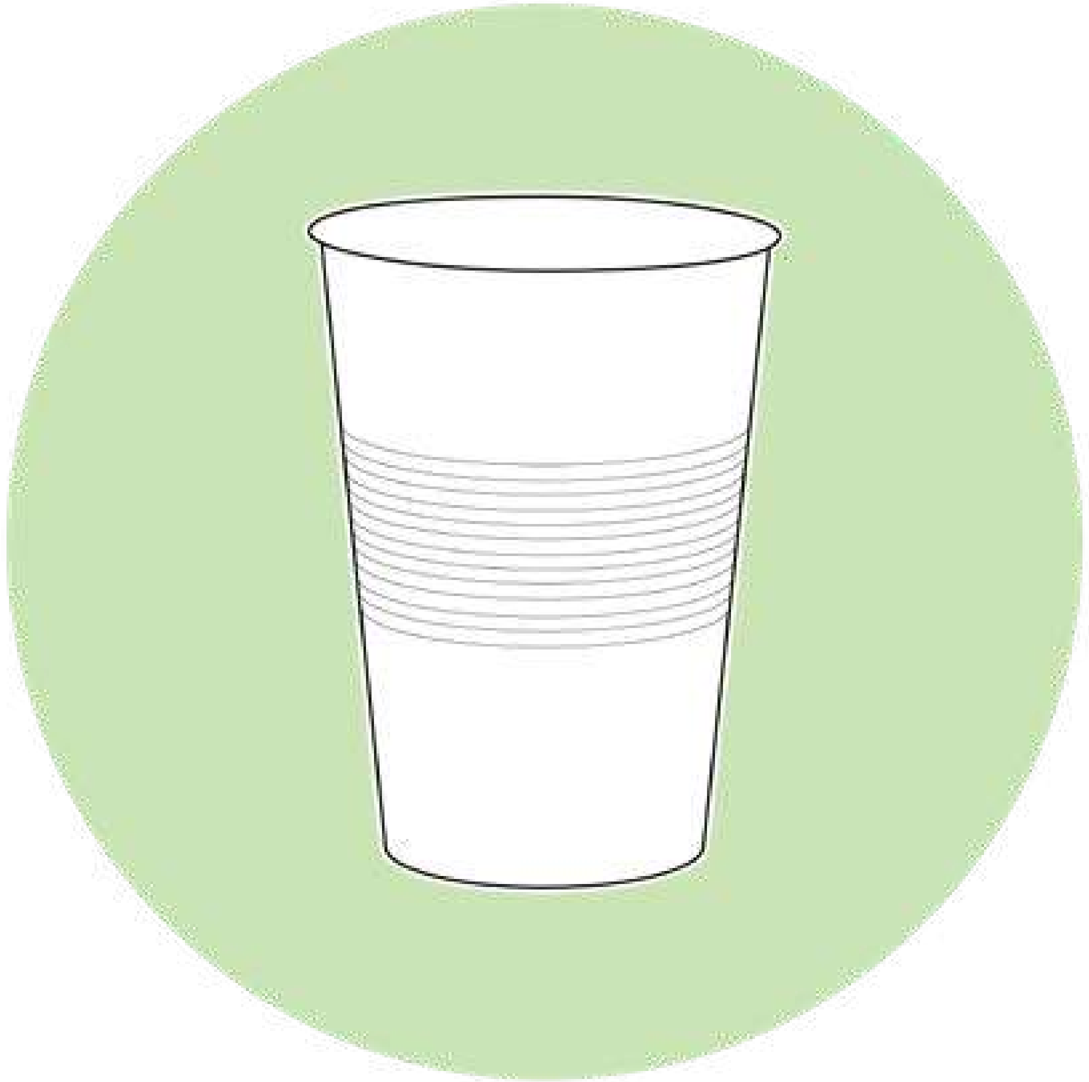
SM-2013

Wash Cup Eco

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

Parts:

Cup:
5.0280g

Material:
Corn Starch based PLA

Retail Packaging:

Sleeve Corn PLA:
6.7900g

Functioning Unit:
100 Cups & Retail Packaging

Product Packaging:

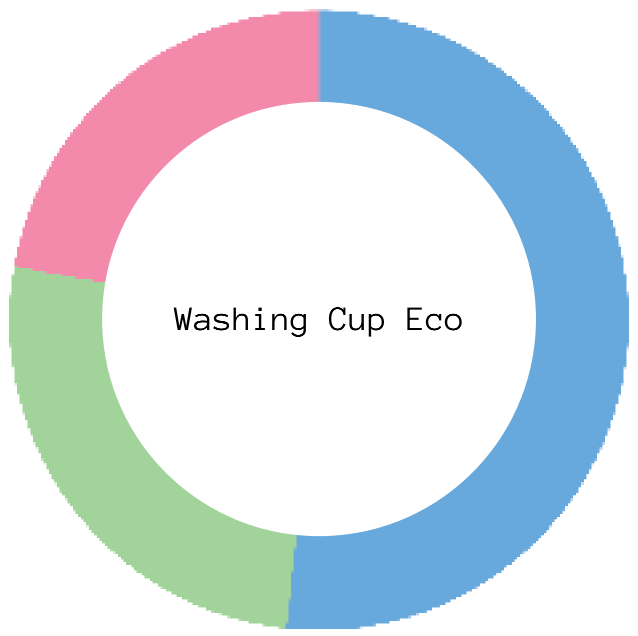
No individual Packaging

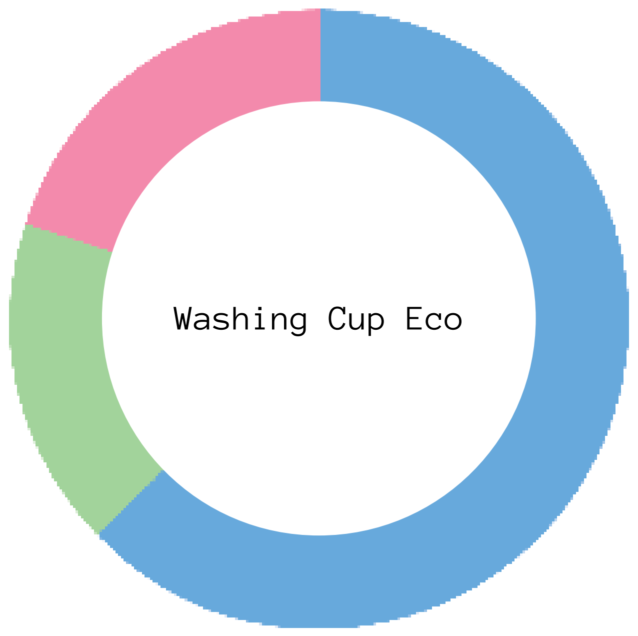
Transportation:

Shanghai Factory - Shanghai Port
Truck **21.300miles**
Shanghai Port - Felixtowe Port UK
Ship via Suez Canal **12032.550miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Wash Cup Eco





51.94 %	Manufacturing	2.4100 CO^2 eq.kg
%	Use	CO^2 eq.kg
25.86 %	EOL	1.2000 CO^2 eq.kg
22.20 %	Transportation	1.0300 CO^2 eq.kg

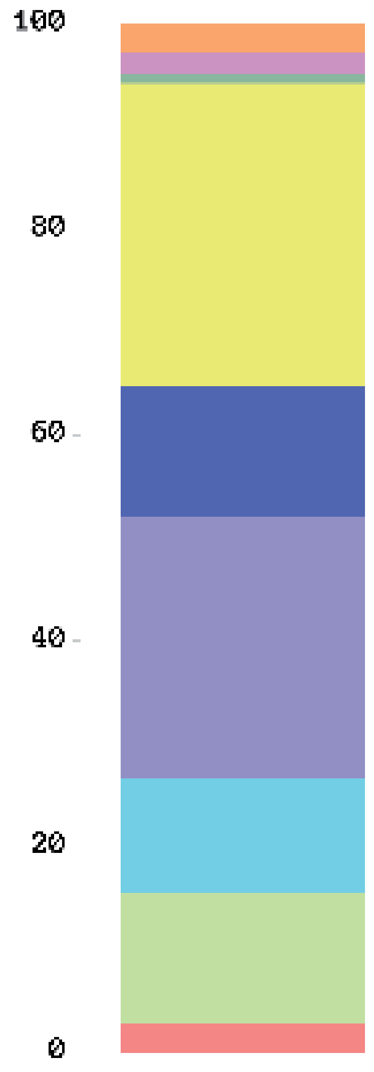
62.88 %	Manufacturing	0.1650 mPts
%	Use	mPts
17.23 %	EOL	0.0452 mPts
19.89 %	Transportation	0.0522 mPts

4.6400 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
PLA – 1.8500 CO^2 eq.kg

0.2624 mPts per functioning unit

Greatest Impact:
PLA – 0.1360 mPts



2.87 %	Acidification
12.56 %	Ecotoxicity
11.18 %	Eutrophication
25.53 %	Global Warming
0.02 %	Ozone Depletion
12.59 %	Fossil Fuel Depletior
29.46 %	Carcinogenics
1.03 %	Non-Carcinogenics
1.98 %	Respiratory Effects
2.78 %	Smog

LCA based Insights:

The LCA data for the Wash Cup Eco is complete and has no missing data. The “Greatest Impact” is the material PLA with manufacturing being the highest impact by Lifecycle. The Scorecard shows reduction in the impacts of Global Warming and Fossil Fuel Depletion compared to the crude oil-based product.

Product impact could be reduced by local production through reduction in transportation impacts.
The Product has higher CO^2 and mPts impacts, most likely caused by the energy use, manufacturing and resources needed in order to create the plant-based feedstock to produce bioplastics; this concern was also mentioned in the Thesis.

An Alternative to the Eco and PP product are Stainless Steel Wash Cups that need to be sterilized after use. There is no risk of cross contamination when the cups are sterilized. The initial impact of manufacturing is likely to be higher but will equalize over extended use when the traditional products are displaced. This will be explained further on the following two pages.

SM-2013

Wash Cup - Alternative Product

Stainless Steel Wash Cups show great impact reduction potential, with initially high production impacts due to the materials nature and being energy intensive, over extended use, the product will quickly surpass its current product or product alternative in use.

The product does not come in direct contact with the needle grouping that is washed, the needle grouping is washed with the help of the squeeze bottle, therefore its purpose is to collect the contaminated water.

Nonetheless Sterilization is recommended with an Ultrasonic Cleaner and tool disinfectant solution.

The use of this product, compared to SUP cups or eco labeled cups, leads to the preservation of resources and the avoidance of incineration in their EOL. This will not only reduce Carbon emissions due to the reduction of production impacts, but also reduce toxic emissions caused by Incineration of the previously used products.

LCA

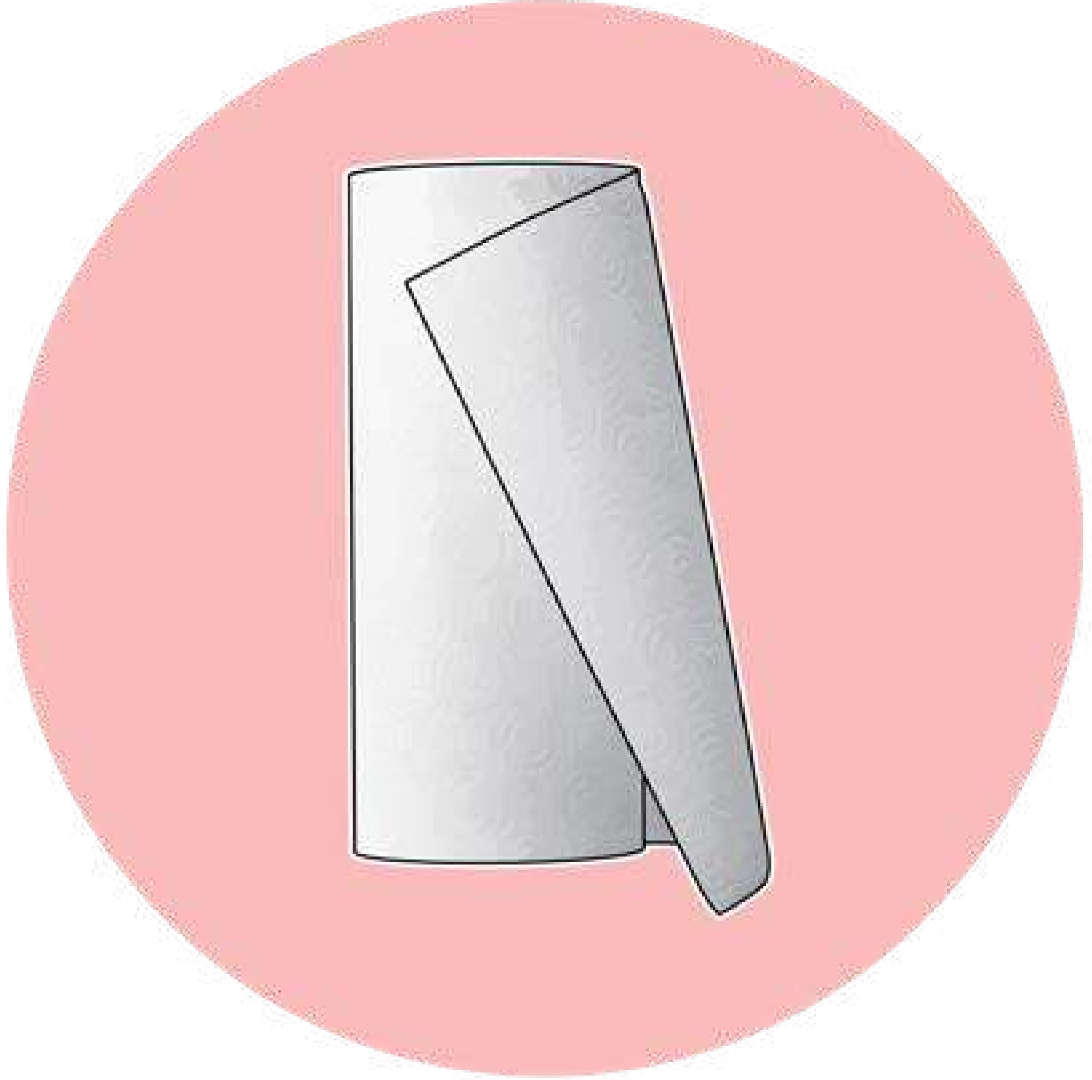
SM-2013

Paper Towels

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation



Missing Information:

SM-13 LDPE Printing Data Gap - Offset Printing Placeholder.
Paper Pulp as Material missing in SM-13. Kraft Paper bleached Placeholder.
Paper Pulp Processing Data Missing. SM-13 Data Gap.

Parts:

One Roll *(45 Paper Towel per Roll)*:

One Paper Towel:
2.6500g

Paperboard Core:
10.9670g

Product Packaging:

No individual Packaging

Retail Packaging:

Schrinkwrap Printed LDPE:
10.0270g

Surface Area of Label:
1645cm²

Functioning Unit:
4 Rolls & Retail Packaging

Ink Amount used for Packaging:
0.714g

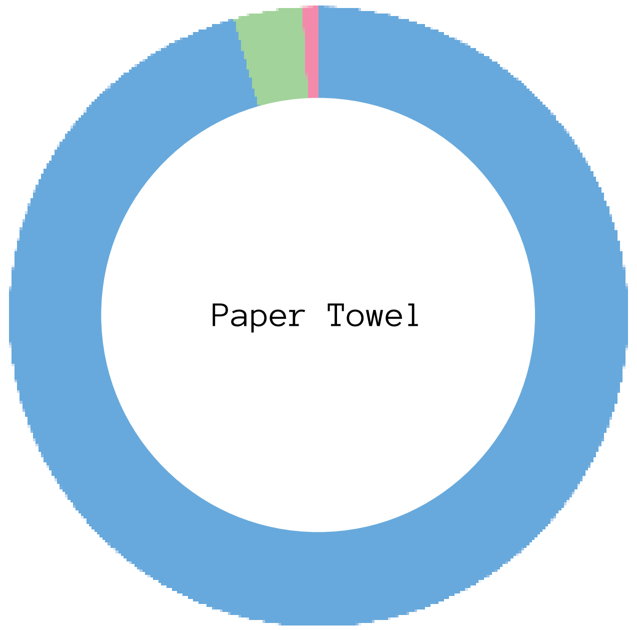
Transportation:

Neuss Factory - REWE Fulfillment Center 2.0
Truck **22.330miles**
REWE Fulfillment Center 2.0 - REWE Buchforst
Truck **10.000miles**

LCA

SM-2013

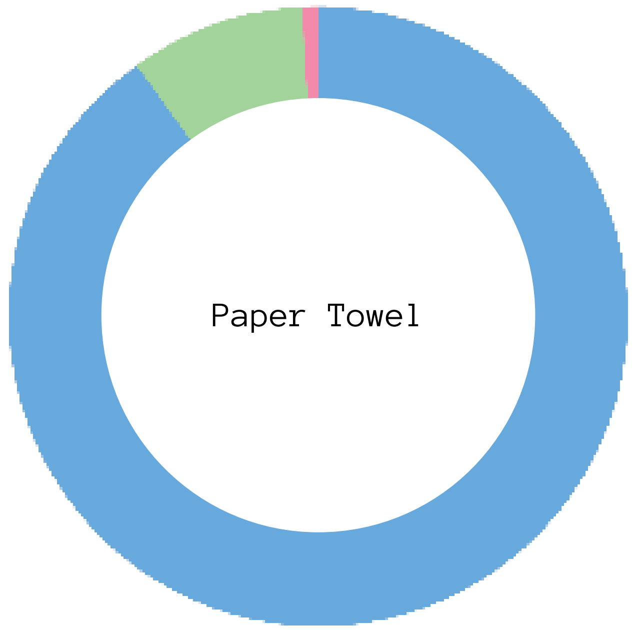
Paper Towels



95.74 %	Manufacturing	1.1500	CO^2 eq.kg
%	Use		CO^2 eq.kg
3.55 %	EOL	0.0426	CO^2 eq.kg
0.71 %	Transportation	0.0086	CO^2 eq.kg

1.2012 CO^2 eq.kg emitted per functioning unit

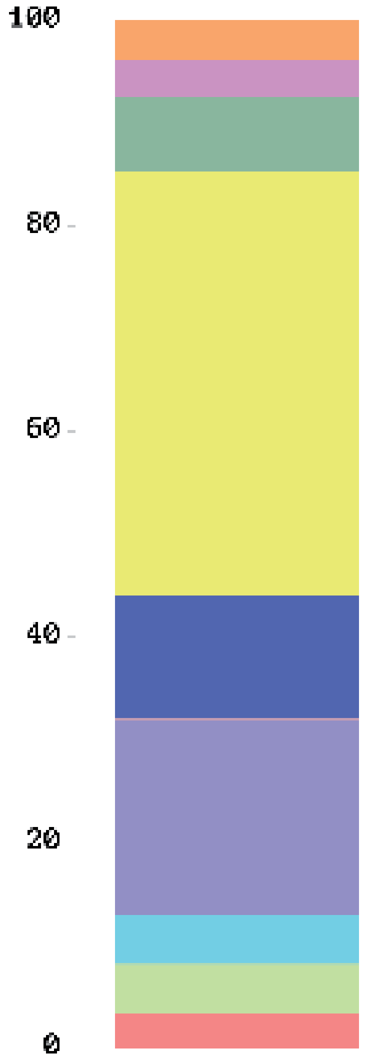
Greatest Impact:
Paper Pulp bleached – 1.0600 CO^2 eq.kg



90.06 %	Manufacturing	0.0822	mPts
%	Use		mPts
9.35 %	EOL	0.0085	mPts
0.59 %	Transportation	0.0005	mPts

0.0912 mPts per functioning unit

Greatest Impact:
Paper Pulp bleached – 0.0758 mPts



3.32 %	Acidification
4.83 %	Ecotoxicity
4.88 %	Eutrophication
18.95 %	Global Warming
0.02 %	Ozone Depletion
12.10 %	Fossil Fuel Depletion
41.22 %	Carcinogenics
7.31 %	Non-Carcinogenics
3.53 %	Respiratory Effects
3.84 %	Smog

LCA based Insights:

The LCA shows significant data gaps in the Lifecycle category of manufacturing. The product is missing LDPE printing data and has received placeholder Offset Printing data. The manufacturing of the right paper type was not able to be calculated accurately due to SM-13 data gaps and received placeholder manufacturing and material data. The “Greatest Impact” is paper pulp bleached and manufacturing by Lifecycle. When reflecting, the Scorecard Carcinogens show the “Greatest Impact” percentage due to paper production. The second highest impact in the LCA shows concerns for paper Incineration at the product’s EOL.

The product is sourced and produced locally, therefore no impact reductions can be recommended. The product packaging would therefore show the greatest potential for impact reductions, but this design change can only be put in place by the manufacturer. No Alternative Products were highlighted during research.

SM-2013

Workstation Cover Eco

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

EOL SM-13 Modified Starch Incineration Data Gap.
SM-13 Manufacturing - Modified Starch Film Extrusion Data Gap.

Parts:

Single Station Cover:
27.1000g

Material:
Modified Starch *(Compostable 7P0823)*

Product Packaging:

No individual Packaging

Retail Packaging:

Printed Cardboard Box:
70.0000g

Surface Area of Packaging:
1311.25cm²

Functioning Unit:
30 Covers & Retail Packaging

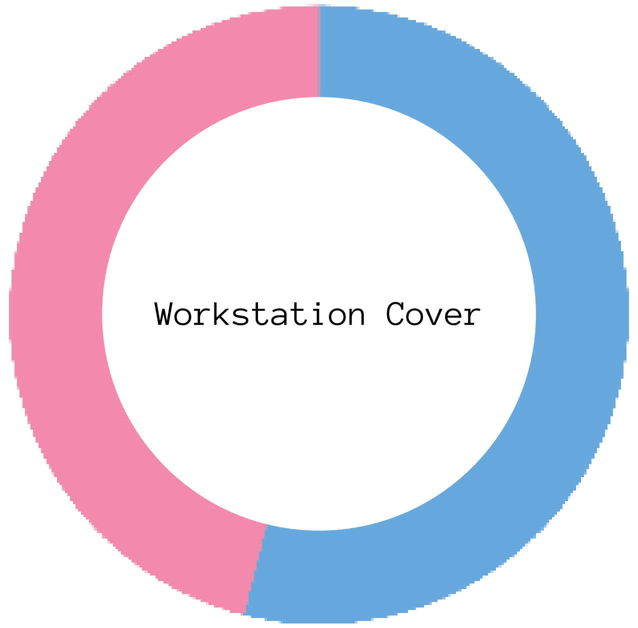
Ink Amount used for Packaging:
0.093g

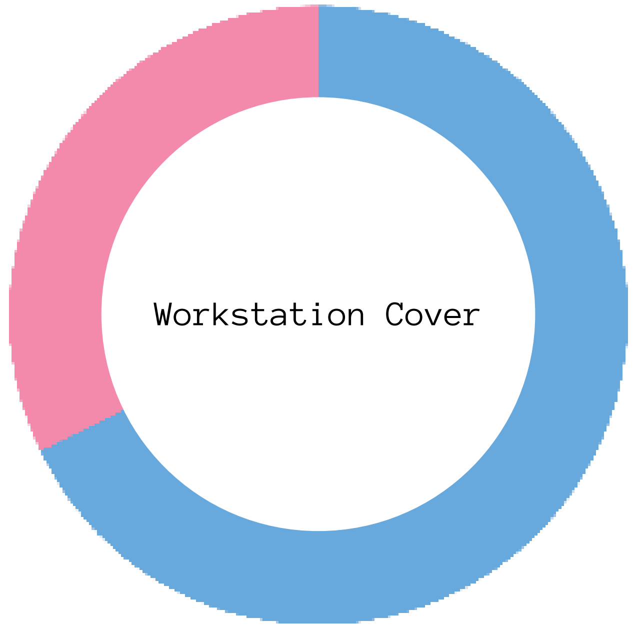
Transportation:

Shenzen Factory I - Hong Kong Factory II
Truck **32.600miles**
Hong Kong Factory II - Hong Kong Port
Truck **9.260miles**
Hong Kong Port - Felixtowe Port UK
Ship via Suez Canal **11138.390miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Workstation Cover Eco





54.11 %	Manufacturing	2.3700 CO^2 eq.kg
%	Use	CO^2 eq.kg
%	EOL	CO^2 eq.kg
45.89 %	Transportation	2.0100 CO^2 eq.kg

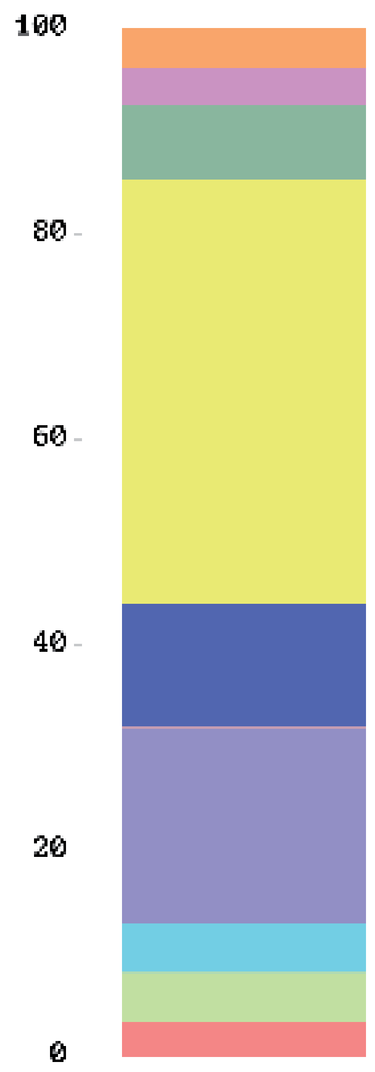
67.80 %	Manufacturing	0.2190 mPts
%	Use	mPts
%	EOL	mPts
32.20 %	Transportation	0.1040 mPts

4.3800 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Modified Starch – 1.7300 CO^2 eq.kg

0.3230 mPts per functioning unit

Greatest Impact:
Modified Starch – 0.1850 mPts



3.32 %	Acidification
4.83 %	Ecotoxicity
4.88 %	Eutrophication
18.95 %	Global Warming
0.02 %	Ozone Depletion
12.10 %	Fossil Fuel Depletion
41.22 %	Carcinogenics
7.31 %	Non-Carcinogenics
3.53 %	Respiratory Effects
3.84 %	Smog

LCA based Insights*:*

The product LCA shows data gaps for the EOL process of Incineration and is likely to be added in the future, since the materials are still quite new on the market. Incineration is likely to add 1.9200 CO^2 eq. kg to the product impact – data calculated through Plastic Incineration Mix, data by weight.

Modified Starch manufacturing data of Film Extrusion not available at this point in time, SM-13 data gaps. The “Greatest Impact” is the material (Modified Starch) which makes up the film.
The Product is used to cover the workstation in order to eliminate the risk of cross contamination from one customer to the other. Products to displace the Eco Workstation Covers are Aluminium Foil, Cling Wrap or Lab Cloths. All Alternative Products are unlikely to reduce impacts and therefore pose no solution. Surgical Trays made from stainless steel could be considered due to their potential to displace single-use products and offer reusability.

Product transportation shows potential for impact reduction when the packaging is manufactured in the same facility as the film. Even greater impact reduction would be possible through local production.

LCA

SM-2013

Rubbish Bag

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Parts:

Rubbish Bag:
6.9000g

Material:
LDPE

Product Packaging:

No individual Packaging

Retail Packaging:

Printed Paper Banderole:
2.3620g

Adhesive for Banderole:
0.1310g

Surface Area of Packaging:
234cm²

Functioning Unit:
25 Bags (35L) & Retail Packaging

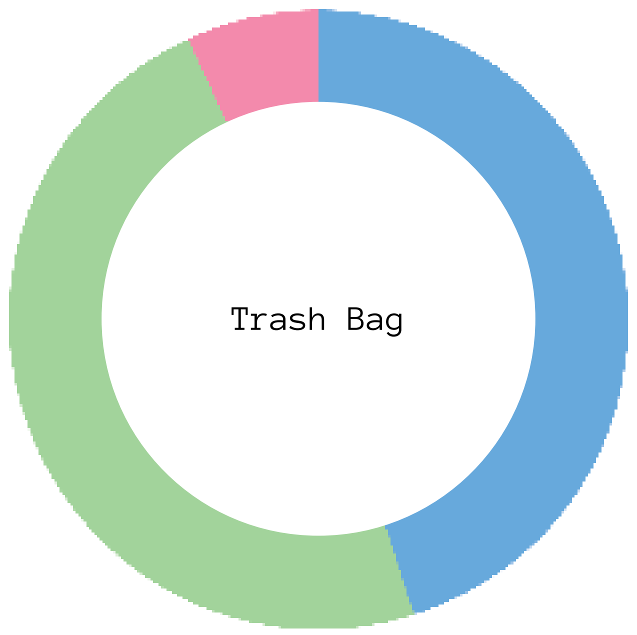
Ink Amount used for Packaging:
0.016g

Transportation:

Nangping Factory - Fuzhou Port
Truck **133.670miles**
Fuzhou Port - Hamburg Port
Ship via Suez Canal **11928.980miles**
Hamburg Port - Logistic Center ALDI Langenfeld
Truck **251.670miles**
Logistic Center ALDI Langenfeld - ALDI Kalk
Truck **17.900miles**
ALDI Kalk - Studio Cologne
Bicycle **No Impact**

SM-2013

Rubbish Bag



45.12 %	Manufacturing	**0.4860 CO^2 eq.kg**
%	Use	CO^2 eq.kg
48.00 %	EOL	**0.5170 CO^2 eq.kg**
6.88 %	Transportation	**0.0741 CO^2 eq.kg**

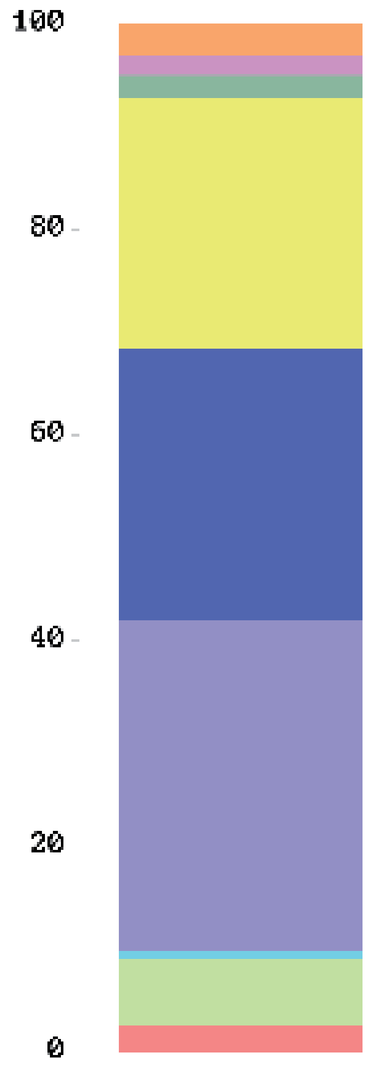
67.74 %	Manufacturing	**0.0328 mPts**
%	Use	mPts
22.10 %	EOL	**0.0107 mPts**
10.16 %	Transportation	**0.0049 mPts**

1.0771 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Incineration – 0.5170 CO^2 eq.kg

0.0484 mPts per functioning unit

Greatest Impact:
LDPE – 0.0265 mPts



2.60 %	Acidification
6.37 %	Ecotoxicity
0.81 %	Eutrophication
32.10 %	Global Warming
0.01 %	Ozone Depletion
26.53 %	Fossil Fuel Depletion
24.42 %	Carcinogenics
2.19 %	Non-Carcinogenics
1.99 %	Respiratory Effects
2.98 %	Smog

LCA based Insights:

Complete LCA by SM-13 Standards. The Product is likely to be the most sustainable solution available at this point in time due to product size. Smaller bags would be impractical and biobased alternatives would still be incinerated, defeating their potential for being compostable.
The highest impacts in the Scorecard are Global warming and Fossil Fuel depletion due to the materials' crude-oil based nature.
The "Greatest Impact" of the product is Incineration by CO^2 eq. kg emitted and LDPE by mPts.

More efficient or eco-friendly production shows the greatest potential for impact reduction, but no solutions can be recommended, further research is needed.

LCA

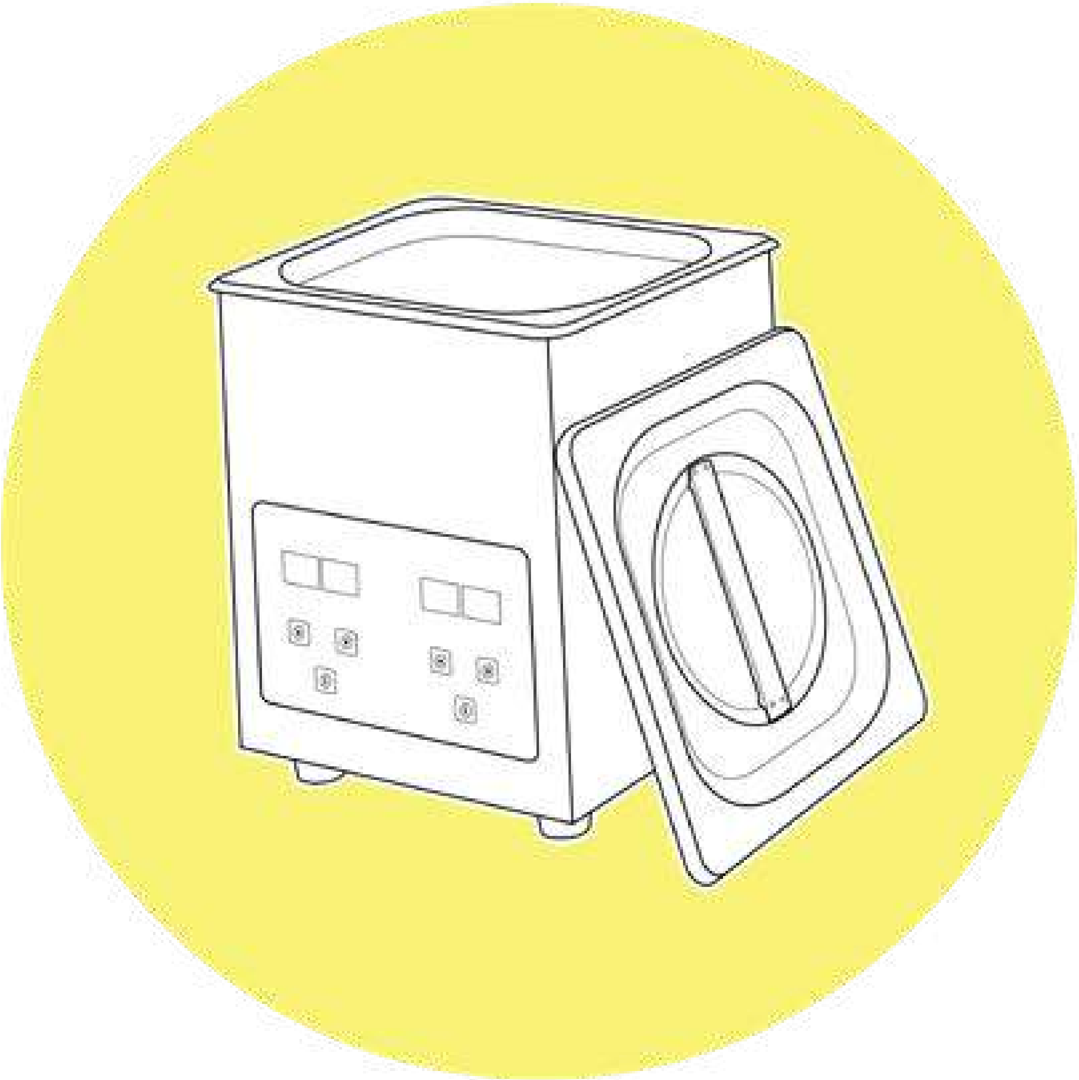
SM-2013

Single Tool Sterilization Cycle

Definition:

LCA Type:

USE CASE LCA
Manufacturing
Use
EOL
Transportation



Missing Information:

The Raw Materials, Production and Transportation Impact of the Ultrasonic Cleaner is not included in this LCA.
Only Impact of a single Tool Sterilization Cycle including its water, detergent and energy use is included.

Input:

Water and Detergent Solution:
300ml
Water & Detergent
95% & 5%

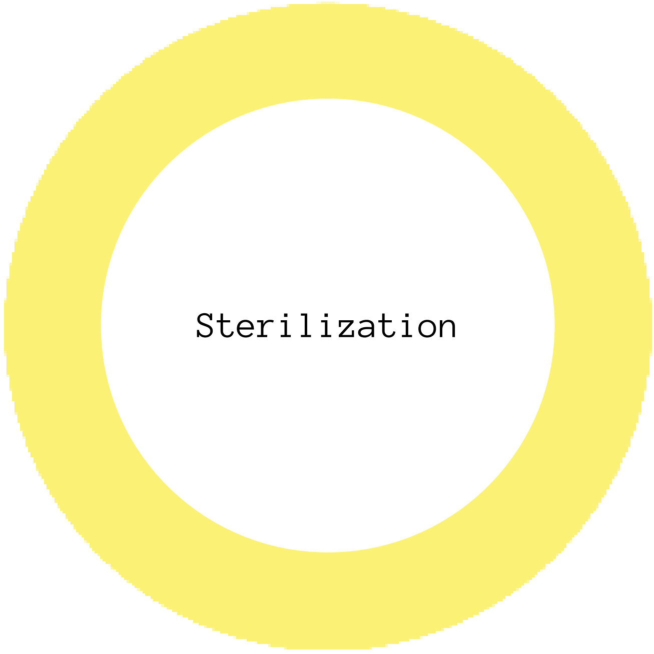
Energy Consumption:
106W

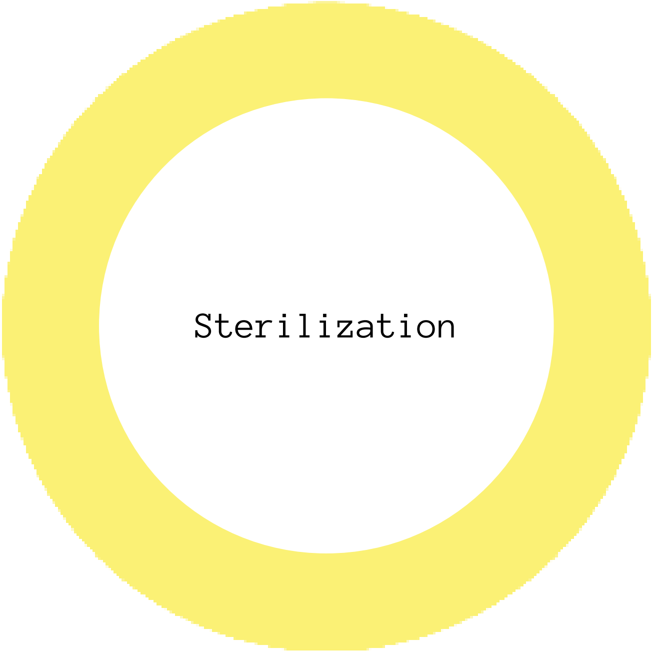
Functioning Unit:

Single Sterilization Cycle

SM-2013

Single Tool Sterilization Cycle





%	Manufacturing	CO^2 eq.kg
100 %	Use	0.0495 CO^2 eq.kg
%	EOL	CO^2 eq.kg

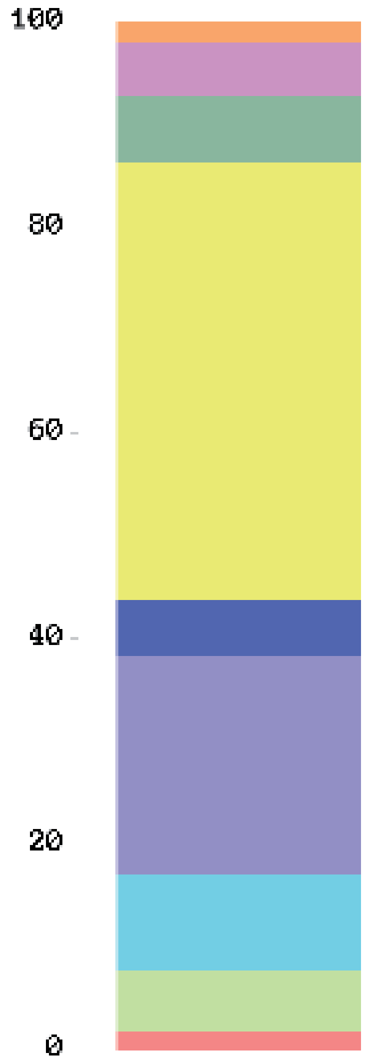
%	Manufacturing	mPts
100 %	Use	0.0036 mPts
%	EOL	mPts

0.0495 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Detergent – 0.0294 CO^2 eq.kg

0.0036 mPts per functioning unit

Greatest Impact:
Detergent – 0.0025 mPts



1.84 %	●	Acidification
5.98 %	●	Ecotoxicity
9.21 %	●	Eutrophication
21.17 %	●	Global Warming
0.01 %	●	Ozone Depletion
5.57 %	●	Fossil Fuel Depletion
42.54 %	●	Carcinogenics
6.38 %	●	Non-Carcinogenics
5.27 %	●	Respiratory Effects
2.03 %	●	Smog

LCA based Insights*:*

This LCA can not be compared with the other LCAs in this Thesis; the LCA type is Use only.
The LCA was needed in order to prove impact Reduction in order to compare the current tool set up of the HHP III compared to the Ekatā S. The “Greatest Impact” is the detergent used in the sterilization process with electricity being the second highest impact followed by the lowest impact of Deionized Water. In the Scorecard Carcinogenics show the greatest concerns.
Electricity having an CO^2 impact of 0.0198 CO^2 eq. kg emitted.

Deionised Water having an CO^2 impact of 0.0003 CO^2 eq. kg emitted.

The sterilization process would show the greatest impact reduction by displacing the detergent used in the process, as mentioned in the Tool Sterilization Detergent LCA; significant health and safety concerns apply to the current product in use. The process itself is needed in order to allow for customer safety by eliminating the risk of cross contamination from one customer to the other.

LCA

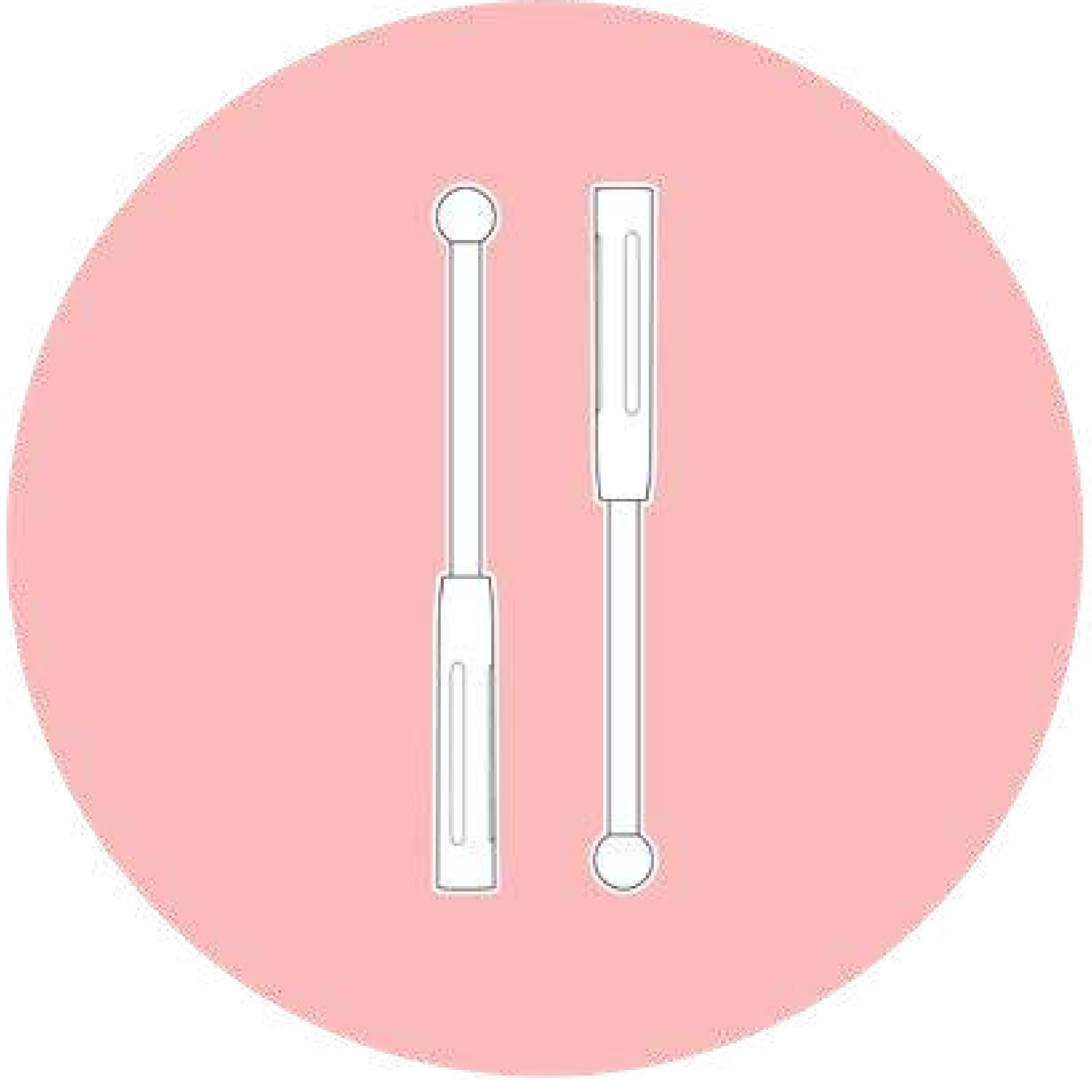
SM-2013

Drive Pins

Definition:

LCA Type:

Cradle-to-Cradle
Manufacturing
Use
EOL
Transportation



Missing Information:

Metal Manufacturing data gap.
-Alluminium Casting
-Thread cutting Stainless Steel

Parts:

Drive Pin: 0.6920g
Stainless Steel: 0.5120g
Aluminium: 0.1800g

Product Packaging:

No individual packaging

Retail Packaging:

Packaging:

LDPE Pouch:
1.1900g

Paper Label:
0.2650g

Surface Area of Packaging:
15cm²

Functioning Unit:
5units & Retail Packaging

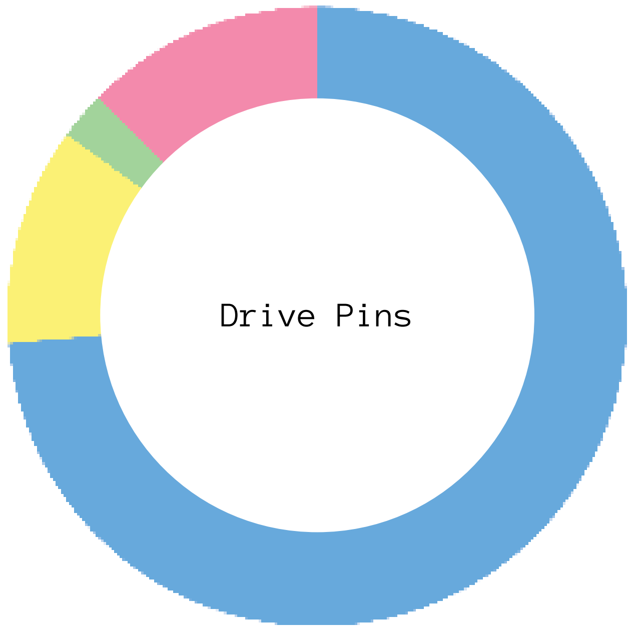
Ink Amount used for Packaging:
0.0011g

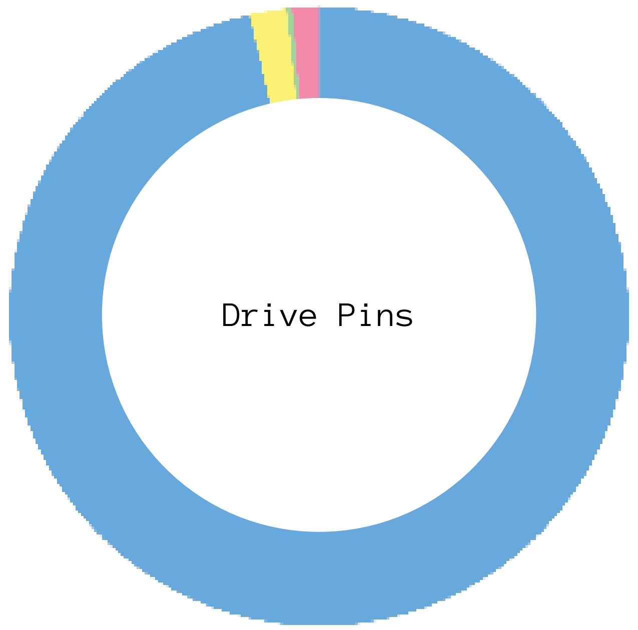
Transportation:

Florida Factory - Tampa Port
Truck **274.000miles**
Tampa Port - Felixtowe Port UK
Ship **5127.873miles**
Felixtowe Port UK - Liverpool Tattoo Supply
Truck **263.000miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

Drive Pins





73.80 %	Manufacturing	0.1050 CO^2 eq.kg
11.25 %	Use	0.0160 CO^2 eq.kg
2.51 %	EOL	0.0003 CO^2 eq.kg
12.44 %	Transportation	0.0177 CO^2 eq.kg

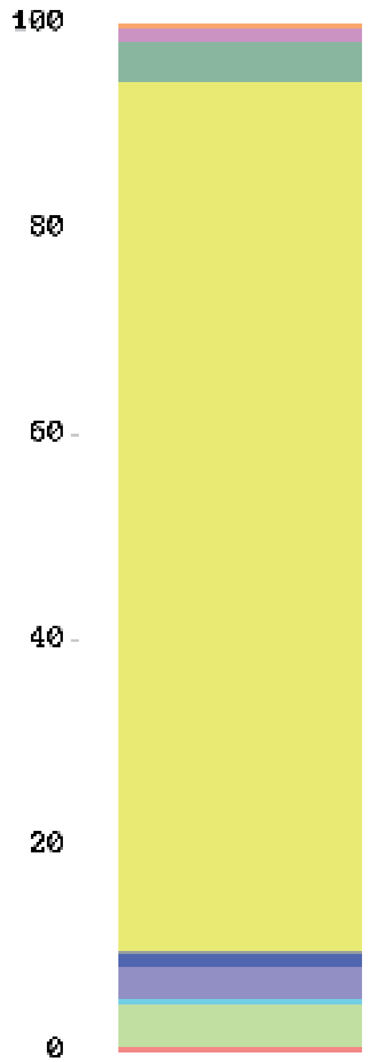
96.46 %	Manufacturing	0.0628 mPts
2.05 %	Use	0.0013 mPts
0.11 %	EOL	0.00007 mPts
1.38 %	Transportation	0.0009 mPts

0.2983 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Stainless Steel Milling – 0.0427 CO^2 eq.kg

0.0651 mPts per functioning unit

Greatest Impact:
Stainless Steel – 0.0301 mPts



0.47 %	Acidification
4.17 %	Ecotoxicity
0.43 %	Eutrophication
3.15 %	Global Warming
%	Ozone Depletion
1.47 %	Fossil Fuel Depletion
84.62 %	Carcinogenics
3.99 %	Non-Carcinogenics
1.26 %	Respiratory Effects
0.45 %	Smog

LCA based Insights:

The product LCA was conducted for the previous tool generation HHPIII and is no longer needed. Impact data will therefore be reduced in future setups. In general the product had low overall impacts since the Drive Pins could be reused after sterilization. The Drive Pins will be recycled through generic metal recycling systems once disposed of. The LCA data shows significant exposure to Carcinogens. This is due to the toxic mining associated with Bauxite which is needed in order to produce virgin Aluminium. The EOL data provided by SM-13 raises concerns of validity, since recycling metals should show significant impacts due to transportation impacts as well as energy intensive processes. But the upside is the ease of recyclability with metal-based materials.

SM-2013

HHP III

Definition:

LCA Type:

Cradle-to-Cradle
Manufacturing
Use
EOL
Transportation

Missing Information:

Metal Manufacturing data gap.
-Thread Rolling Stainless Steel

Parts:

Brass MS58 Adapter: 28.5670g
Stainless Grub Screw: 0.2800g

Product Packaging:

No individual packaging

Retail Packaging:

Non Commercial product.

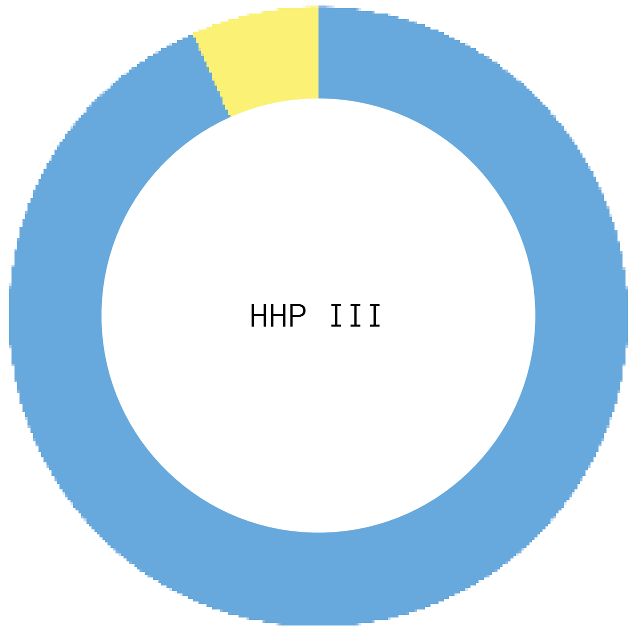
Custom Adpater for
SUP Cartridge Grips

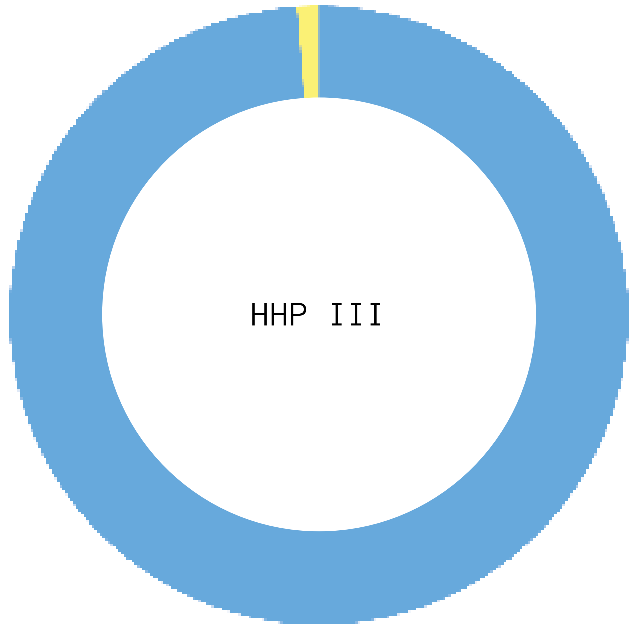
Transportation:

No Transportation

SM-2013

HHP III





93.47 %	Manufacturing	0.2290 CO^2 eq.kg
6.53 %	Use	0.0160 CO^2 eq.kg
%	EOL	CO^2 eq.kg
%	Transportation	CO^2 eq.kg

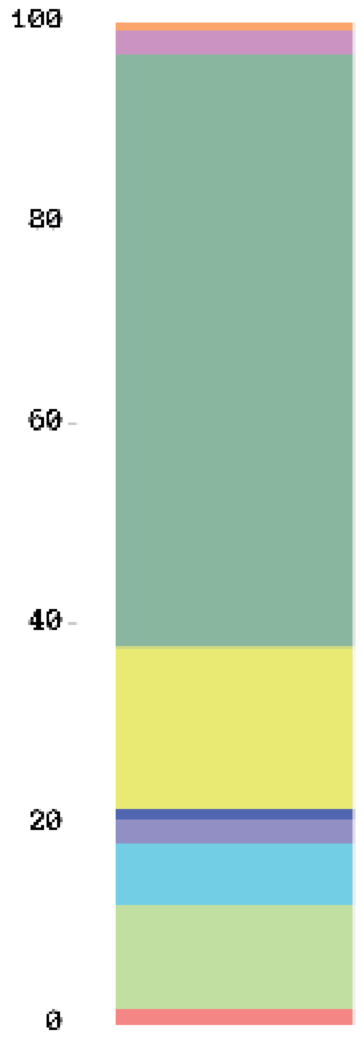
99.15 %	Manufacturing	0.1550 mPts
0.85 %	Use	0.0013 mPts
%	EOL	mPts
%	Transportation	mPts

0.2450 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Brass CNC Turning – 0.1530 CO^2 eq.kg

0.1563 mPts per functioning unit

Greatest Impact:
Brass – 0.0769 mPts



1.55 %	Acidification
10.30 %	Ecotoxicity
6.30 %	Eutrophication
2.26 %	Global Warming
%	Ozone Depletion
1.05 %	Fossil Fuel Depletion
16.18 %	Carcinogenics
59.16 %	Non-Carcinogenics
2.47 %	Respiratory Effects
0.73 %	Smog

LCA based Insights*:*

The Product LCA is conducted for the previous tool generation HHPIII and is no longer needed. Impact data will therefore be reduced in future setups. In general the product had low overall impacts since the Adapter could be reused after sterilization. The adapter could be recycled through generic metal recycling systems once disposed of.

The LCA data shows significant exposure of Non-Carcinogenics: this is due to the presence of Brass in the product. The EOL data provided by SM-13 raises concerns of validity, since recycling metals should show more significant impacts due to transportation impacts as well as energy intensive processes. But the upside is the ease of recyclability with metal-based materials.

LCA

SM-2013

SUP Cartridge Grip

Definition:

LCA Type:

Cradle-to-Grave
Manufacturing
Use - Not Applicable
EOL
Transportation

Missing Information:

Tyvek data missing - HDPE Placeholder.

TPE-S Data Gap - SBS Placeholder Material.

Parts:

Body Nylon 6:	21.8000g
Cartridge Grip TPE-S:	13.3000g
O-Ring:	0.1000g

Product Packaging:

Tyvek LID:	0.6000g
PVC Blister:	3.5000g

Retail Packaging:

Packaging:

Printed Carboard Box:
1.4130g

Surface Area of Packaging:
1345.5cm²

Functioning Unit:
10units & Retail Packaging

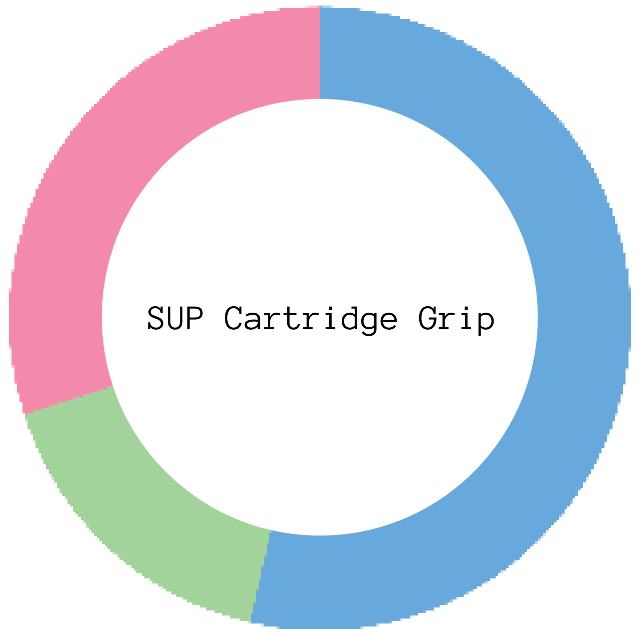
Ink Amount used for Packaging:
0.095g

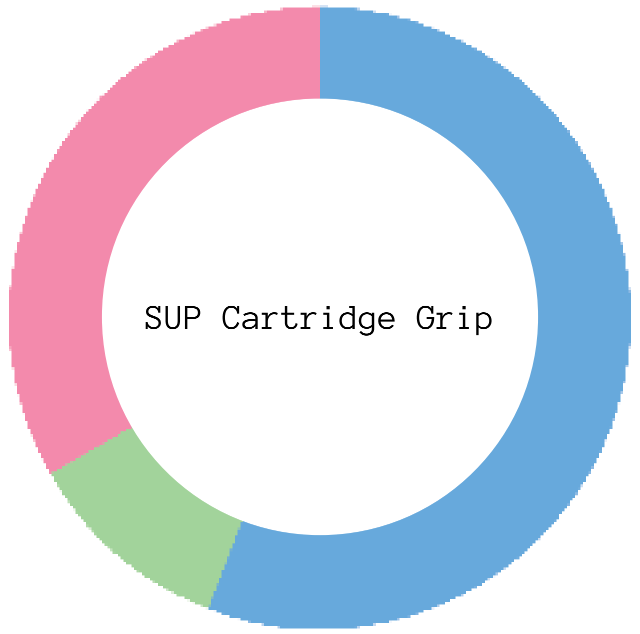
Transportation:

Suzhou Factory - Shanghai Port
Truck **79.970miles**
Shanghai Port - Rotterdam Port
Ship via Suez **12111.950miles**
Rotterdam Port - Erkelenz Retail
Truck **155.660miles**
Erkelenz Retail - Düsseldorf Airport
Truck **131.000miles**
Düsseldorf Airport - Liverpool Airport
Air **431.000miles**
Liverpool Airport - Liverpool Tattoo Supply
Van **1.500miles**
Liverpool Tattoo Supply - Liverpool Airport
Van **1.500miles**
Liverpool Airport - Cologne Bonn CGN
Air **458.000miles**
Cologne Bonn CGN - Studio Cologne
Van **8.960miles**

SM-2013

SUP Cartridge Grip





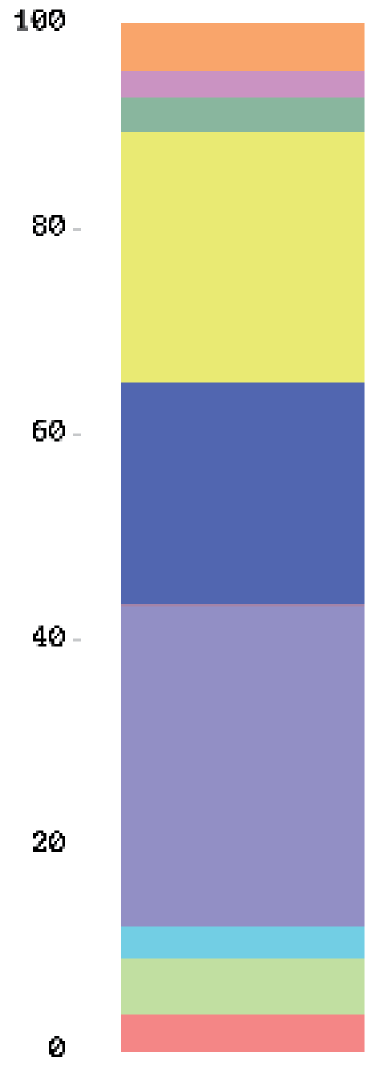
53.75 %	Manufacturing	3.4400 CO^2 eq.kg		56.05 %	Manufacturing	0.1650 mPts
%	Use	CO^2 eq.kg		%	Use	mPts
16.25 %	EOL	1.0400 CO^2 eq.kg		10.84 %	EOL	0.0319 mPts
30.00 %	Transportation	1.9000 CO^2 eq.kg		33.11 %	Transportation	0.0975 mPts

6.3800 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Nylon 6 – 0.0896 CO^2 eq.kg

0.2944 mPts per functioning unit

Greatest Impact:
Nylon 6 – 2.0100 mPts



3.55 %	Acidification
5.56 %	Ecotoxicity
2.95 %	Eutrophication
31.3 %	Global Warming
0.03 %	Ozone Depletion
21.72 %	Fossil Fuel Depletion
24.42 %	Carcinogenics
3.22 %	Non-Carcinogenics
2.61 %	Respiratory Effects
4.64 %	Smog

LCA based Insights:

The LCA shows data gaps for the tech. material Tyvek which is used for the Medical Blister Packaging, it is composed of HDPE and produced through trademark manufacturing processes which SM-13 does not provide data for. The TPE-S SEBS material received a placeholder material SBS since SEBS is not available in SM-13. The “Greatest Impact” of the product is the material Nylon 6.

The product is needed in order to utilize Cartridge Needles for hand-poke application in combination with alienated Rotary Machine Drive Pins and the HHP III adapter. In order to displace the product and its fairly high session-based impacts, the Ekatā S was developed which eliminates the use of SUP Cartridge Grips.

Product displacement shows the greatest overall potential in the LCAs conducted since single session impact reductions are extremely high with 0.6380 kg CO^2 eq. kg of emissions per Cartridge Grip.

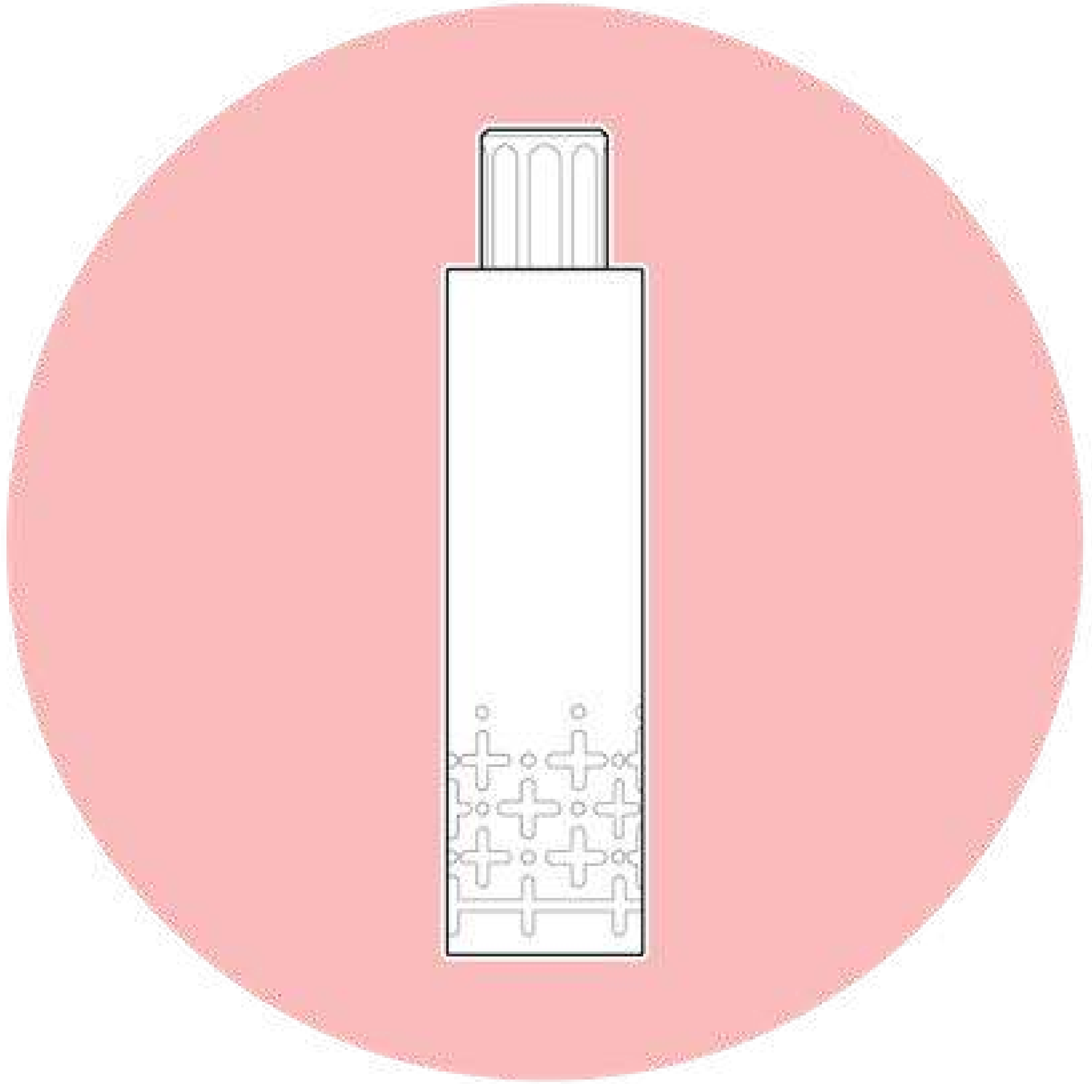
SM-2013

Ekata S

Definition:

LCA Type:

Cradle-to-Cradle
Use
EOL
Transportation



Missing Information:

Grub Screw Manufacturing Data Gap.
-Thread Rolling Grub Screw.

Parts:

Outer Shell MS58:	45.1679g
Inner Shell ALZNMGCU1.5:	32.5909g
Thumb Screw MS58:	23.7560g
Grub Screw SAE316(2x):	0.2780g
Total:	**102.0708g**

Product Packaging:

No individual Packaging.

Retail Packaging:

Non Commercial Product.

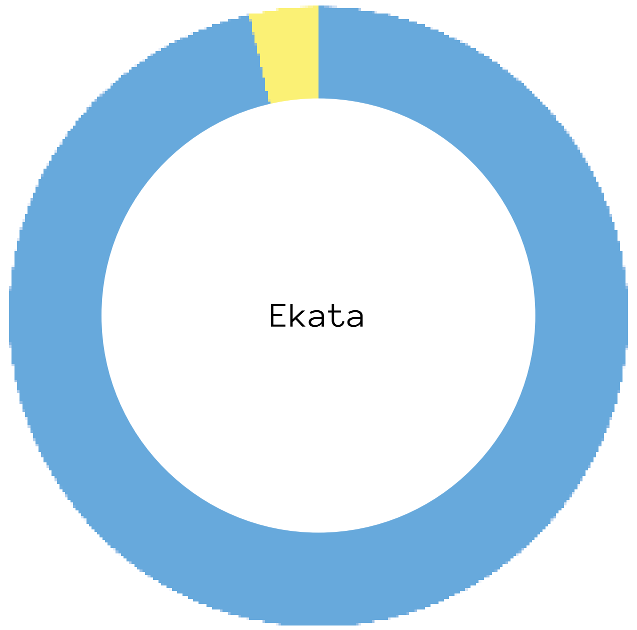
Packaging not included.

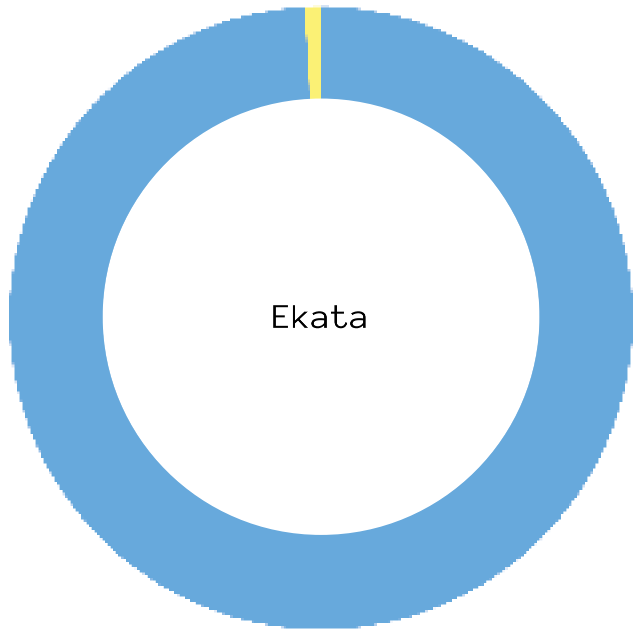
Transportation:

No Tranportation.

SM-2013

Ekata S





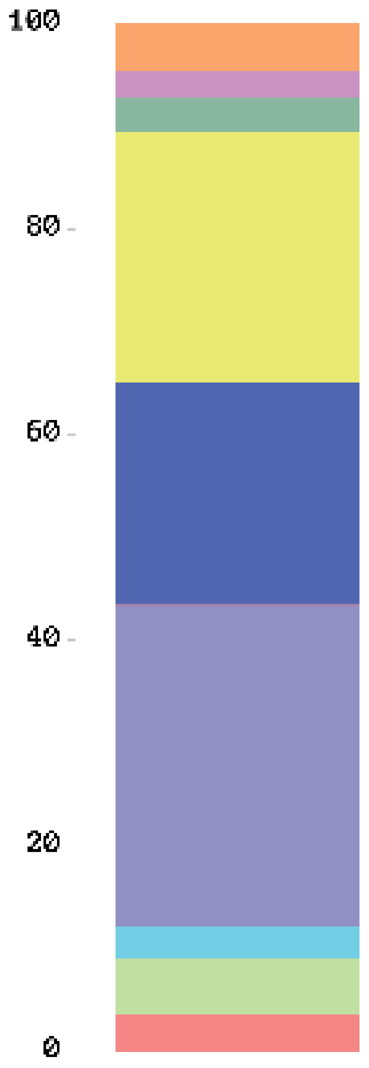
96.46 %	Manufacturing	**1.3500 CO^2 eq.kg**		99.28 %	Manufacturing	**0.4950 mPts**
3.54 %	Use	**0.0495 CO^2 eq.kg**		0.72 %	Use	**0.0035 mPts**
%	EOL	**CO^2 eq.kg**		%	EOL	**mPts**
%	Transportation	**CO^2 eq.kg**		%	Transportation	**mPts**

1.3995 CO^2 eq.kg emitted per functioning unit

Greatest Impact:
Alluminium – 0.4100 CO^2 eq.kg

0.4985 mPts per functioning unit

Greatest Impact:
Brass – 0.1220 mPts



- 3.55 % Acidification
- 5.56 % Ecotoxicity
- 2.95 % Eutrophication
- 31.3 % Global Warming
- 0.03 % Ozone Depletion
- 21.72 % Fossil Fuel Depletion
- 24.42 % Carcinogenics
- 3.22 % Non-Carcinogenics
- 2.61 % Respiratory Effects
- 4.64 % Smog

LCA based Insights:

The LCA shows minor data gaps in manufacturing lifecycle data of the M4 Grub Screws sourced locally due to manufacturing data gaps in SM-13. The LCA is conducted in the same manner as all LCAs in this Thesis; there is no product packaging and transportation since it does not apply to the product due to it being open source non-commercial and the materials are sourced locally as well as manufactured locally. See Sourcing Map.

The single point of concern is the way EOL is calculated by SM-13. The LCA data shows no impact since SM-13 does not apply impacts to products that are recycled. This is highly unlikely due to the material weight in transportation to recycling facilities as well as the energy intensive process of metall recycling itself.

The Product is able to displace the impact of the previous set up of the HHP III; within three single application sessions. This is due to the product's optimized weight compared to the earlier proof of concept (Ekata). Insights will be explained further and in more detail, on the following pages, the Ekata S chapter.

WHAT DOES SUSTAINABLE DESIGN FOR SATISFACTION, LOOK LIKE IN THE FIELD OF HAND-POKE TATTOO TOOL DESIGN?

"Not one great country can be named, from the polar regions in the north to New Zealand in the south, in which the aborigines do not tattoo themselves."
— Charles Darwin, The Descent of Man

An Homage to the history of tattoo art:

Nina Jablonski Notes that *"The oldest documented tattoos belong to Otzi the Iceman, whose preserved body was discovered in the Alps between Austria and Italy in 1991. He died around 3300 B.C., but the practice of inserting pigment under the skin's surface originated long before Otzi."* (Stevenson, 2008)

Improving tool availability in the industry of hand poke application from currently used medical spatulas or chopsticks with the old type of long needle bar fixated by microporous tape, to supplying a solution to skip the use of single-use cartridge grips with an adapter piece. The solution is a self-contained long-term sustainable and sterile cartridge grip that allows for adjustability while using a more precise needle type.

This report will show methods and reasons for the motivation to improve the tools I work with within a thorough approach, motivated by sustainability without sacrificing health and safety standards. Designing a tool that can reduce the impact, that can be repaired and replaced in parts.

Christianity, Missionaries & Colonialism

With the quest for European expenditure and the mission of spreading Christianity the European explorers have caused great trauma to the global remote tattoo practices. Even though tattooing played a great role in the early days of Christianity as early as the days of the Anglo-Saxon world, when the markings of the Jerusalem Cross marked the successful pilgrim to the holy land which would have been seen as incomplete without it. Around 787 A.C the practice was prohibited but like all prohibitions in human history, it didn't completely stop the practice.

With European missionaries exploring the world, we know today the practice in remote cultures like the Maoris, the native population of New Zealand, as well as Indian Americans from the Northern Territories of the nowadays United States, to the Polynesian Islands, the cultural heritage and the significant meaning of these cultural markings were suppressed by colonialism. In historic documentation, only a few cultures like the Samoans have successfully circumvented these suppressions, due to the missionaries not understanding the interlaced religious and ancestral history which is visualized within their tattoo design.

In the time between the 15th and 18th centuries, countless heavily tattooed indigenous people from different regions of the globe have been kidnapped and enslaved to showcase the proclaimed barbaric nature of these tribes, in order to make a profit. The consequences for their often short survival was a mixture of poor nourishment and foreign illnesses. As an example "The Painted Prince" (Sanders 2021).

The indigenous people that were enslaved often bared the most body markings. Baring markings over extensive parts of the body was a strong privilege since, in most cultures, extensive markings showed rank in the indigenous community. The bearing of tattoos showed spirituality, the history of the tribe, or the rank within the community. To avoid deportation, indigenous cultures in the example of the Indian community of North America have consequently avoided body markings and rather transferred their art from skin markings to jewellery and fabric patterns.

Consequently cultures like the Maori, Samoan, and Inuit are slowly recovering, by fighting for their right to display ancestral heritage and the right to wear body markings, without the stigma that is indoctrinated in society to this day, due to the missioning of Christianity and the act of marking slaves and criminals in various historical events.

The Oldest Tattoo style. More than just a trend!

With the rise of the tattoo machines, the art of hand poke has seen a significant decrease in active artists in addition to the rise of health and safety regulation and colonialism which further decreased the variety of traditional art and the history accompanying the craft. Two great examples are the indigenous communities of the Maori people from New Zealand and the Inuit people of Alaska.

The rise of the tattoo machine not only revolutionised the tattoo scene to this day with the earliest tattooing machine which has been patented in 1891 by S.F O`Reilly. The development of the Coil-operated tattoo guns to the latest development and widespread use of Rotary-operated tattoo guns have laid the base of the industry we see today.
But rather seen as addition the practice of application by hand has seen a decrease through slow and tiring application, limiting the amount of work that physically can be done, within a day of work.

In New-Zealand, established health and safety regulations made it difficult to use traditional tools composed of wood and bone like the indigenous Maori use them in the past. With the traditional style gaining popularity in recent years, the practice has been tolerated in its traditional way if the shop or artist obligates to Auckland Council "Traditional tools tattooing code of practice". (Auckland Council, 2021) This attitude towards the traditions and history of indigenous tattoo cultures has shifted in the last 15-30 years and the acknowledgment has led to the rebirth of traditional hand poke tattoo styles, of which I on the following pages.

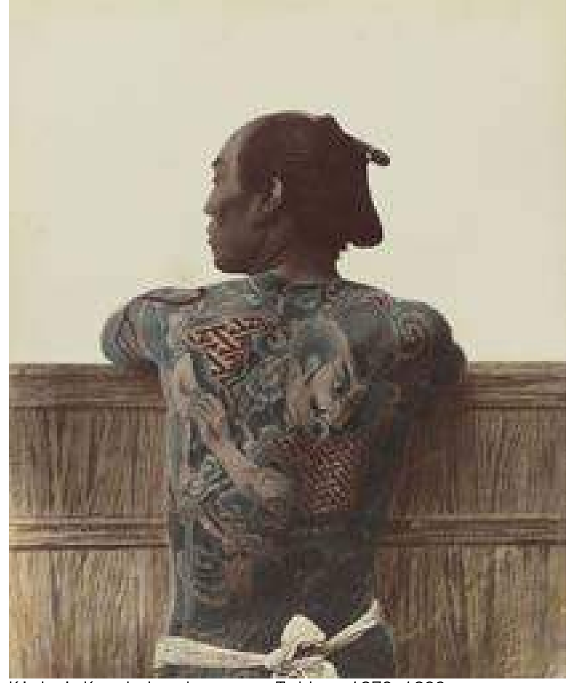
This Revival of plenty more tattoo traditions, as well as the different approaches to tattooing, lay the base of my passion and the motivation to create art and tools within the complex and diverse culture of hand poke tattooing. As the sensation of application of hand poke tattoos in modern and traditional studio settings is often described as spiritual, and a healing process due to the process of earning the markings on your body over extensive sessions, the fascination for this style has ever grown on me since I first discovered the topic through my Intermediate in 2017.

Greg Semu, *Auto Portrait with Pe'a*, 2017

Peninajoy Photography,
The Telesa Series, 2014

Joanna Clay, *Untitled*, 2006

Horace Bristol, *A Japanese tattoo artist works on the shoulder of a Yakuza gang member*, 1946



Kimbei Kusakabe, Japanese Tattoo, 1870–1899

Rooksana Hossenally, *Untitled*, 2013

Luang Pi Pant, *Sak Yant on Monk*, 2008

Nakhon Chai, *Sak Yant master makes traditional magic tattoo in Wat Bang Phra*, 2013

Burton Brothers, *Te Roro Tamati*, 1891

Destination Rotorua, Tourism New Zealand

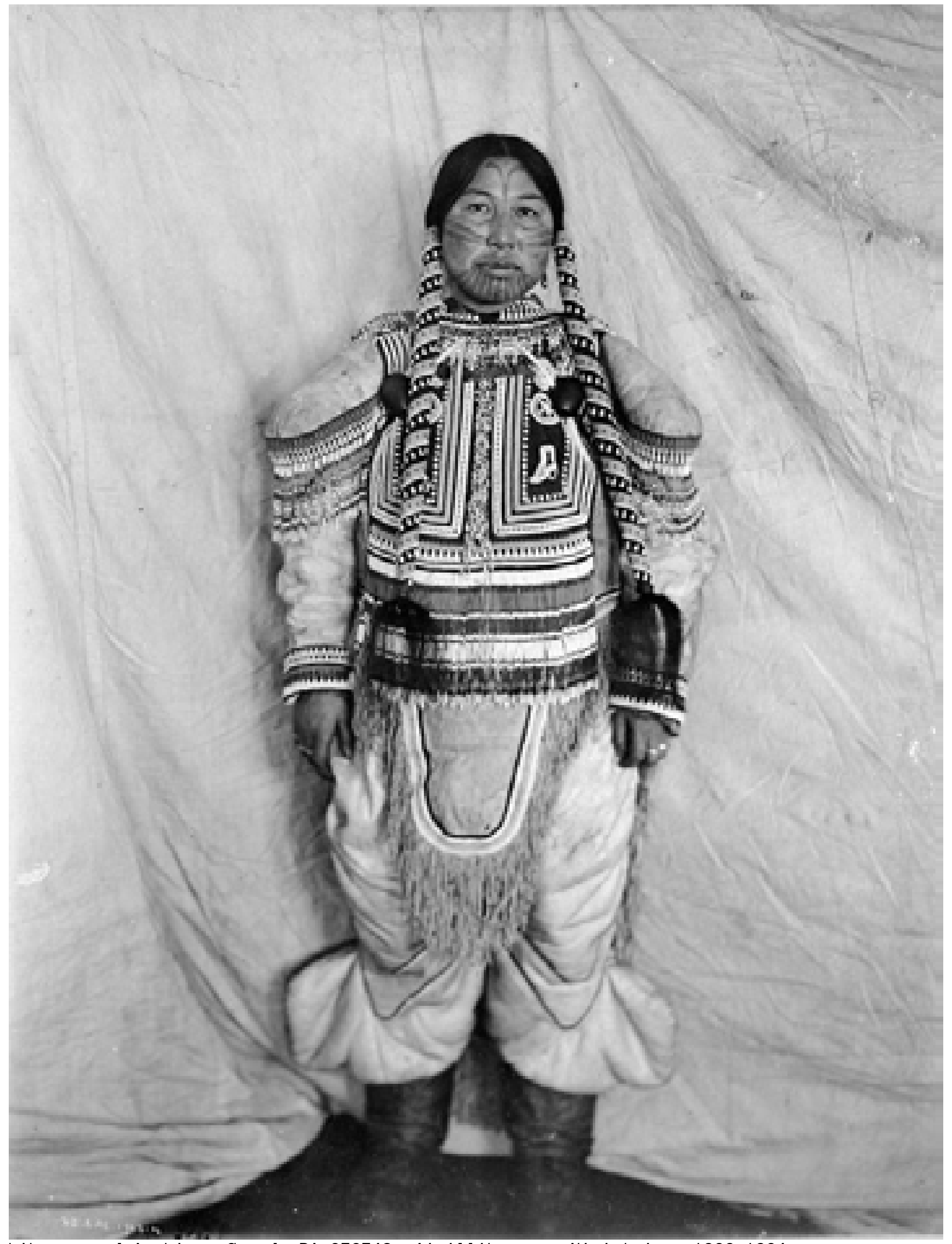
Lars Krutak,*Untitled*,2013

Fred Wissink,*The New Traditional*

Lee,*hopefully not...the last mambabatok*,2013

Angela Gzowski Photography, *Twice Colonized*

Claire Artemyz,*Mr. Dale demonstrating the art of skin-stitching on his arm*,2013



Library and Archives Canada PA-053548, *Aivillik woman Niviatsinaq*,1903–1904

The process of application in comparison to machine work is often described as being a more calm and spiritual one due to the technique having a slower rhythm of application as well as the lack of sound caused by the absence of an electric machine buzz. As I explored the process of spiritual tattooing in the past, my focus on this topic will be based on ease of application and pushing sustainability in an industry that is far from having adopted an attitude towards it.

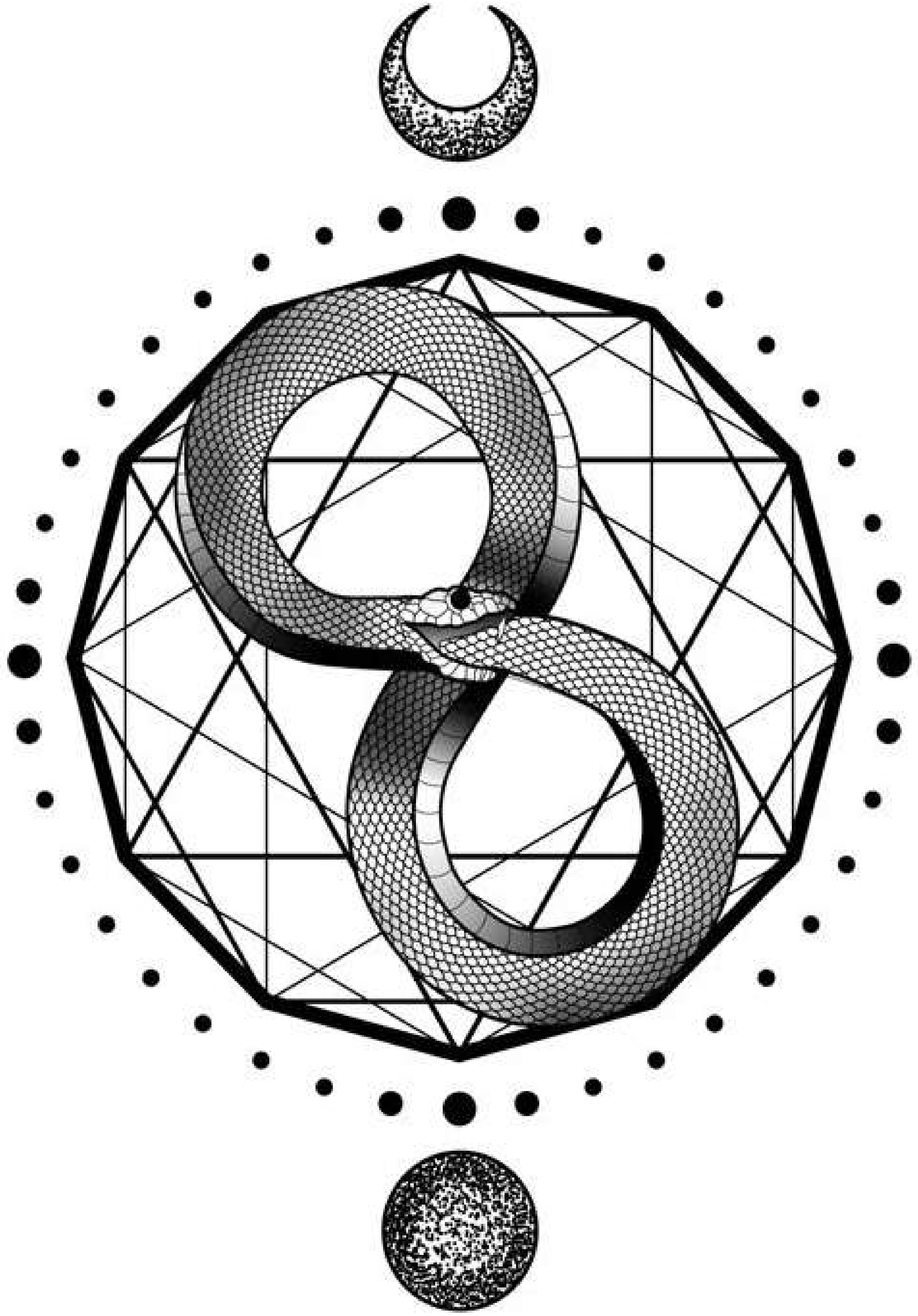
The topic is far more complex than it might seem since the artist preferences are as diverse as the art styles executed by individuals with the added complexity of industry standards that can not be ignored. To truly innovate within this industry, the need for sterility should be set as the highest priority. The changeover from long needle bars to safety cartridge needles is motivated by the precision and ease of use of the cartridge system. The first tools I have developed in my paper in 2017 were based upon the older long needle bar type and were quite primitive compared to the current motivation of creating a self-contained cartridge needle system for hand poke application. This will replace my current system (HHP III) in use which consists of a sterile single-use cartridge grip with a lathe machined adapter piece and a pair of stock machine drive pins that are alienated from a rotary tattoo gun.

The problem discovered in the current setup and the main motivation for future improvements to a self-contained system is the reduction of unnecessary single-use products within the tattoo process specific to my application, since the style of application as well as the product constellation varies with each artist. The motivation is to simplify the tool design in comparison to the complex tattoo machine grips. This is owed to the fact of moving parts that are driven by the Coil or Rotary motor of guns, which prohibits simplicity. The first version of the simplified mechanism of the hand poke self-contained tool will be abbreviated with “Ekatā”.

This tool design used Rapid Prototyping and a practical approach since there are no academic papers on the dos and don’ts of tattoo tool design. Although the research is mostly based on fields with similar requirements, decisions made were based on educated guesses and personal problem identification. A personal work methodology that has proven to be solution-driven with previous designs, which allows for greater insights through haptic feedback, being able to make adaptations on the fly, while staying cost-effective for the proof of concept stage.

Rather than putting the efforts into the visual design of the tool, the main focus of this approach is the proof of concept of the inner mechanism of chosen design, which in part will significantly dictate the outer appearance of the tool, due to complying with pre-existing parts like stainless steel grub screws and compression springs. This is a simple approach since the manufacturing of these parts could neither be economical nor be based on adequate justification for environmental impact. The retail of the product is not intended and building plans will be published in this paper under creative commons non commercial.This will allow other artists to adapt designs to personal likings in a market that is not seen as profitable even by major industry players. Once the concept was working, a temporary outer shell was designed.

This Proof of concept gave many insights for manufacturability, ease of use, and allowed for tool weight calculations that motivated a design change towards a more simple mechanic, in order to reduce tool weight to elevate strain on the artist’s wrist. Future concepts might pick up on the idea of the proof of concept again, but with close relations to manufacturability as well as sustainability.



PROBLEM STATEMENT

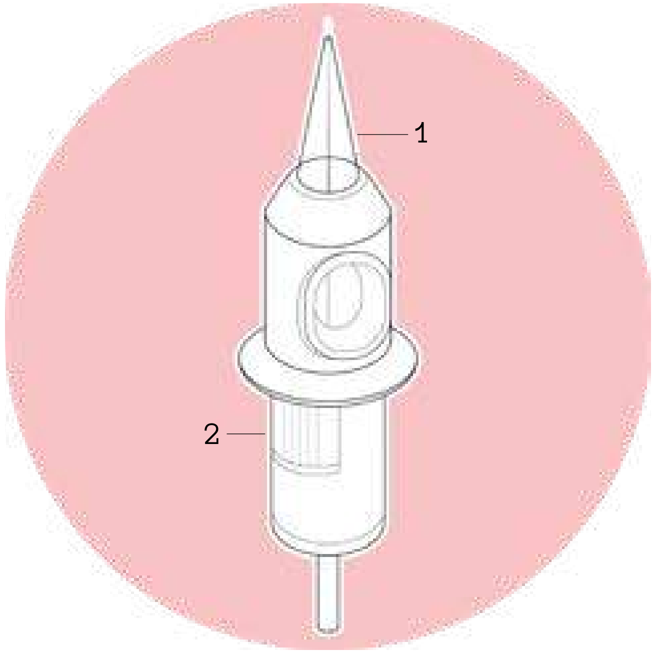
Improving tool choice in the industry of hand poke application from currently used medical spatulas or chopsticks with the old type of long needle bar fixated by microporous tape, supplying a solution to skip the use of single-use cartridge grips with an adapter piece. The solution should be a self-contained long-term, sustainable and sterile cartridge grip that allows for adjustability while using a more precisely guided needle type. This is due to the integrated needle enclosure and needle guidance found in cartridge needles (figure2). Needle-depth adjustability should allow for a versatile grip that can be adjusted for personal preference and exploit the capillary effect of the cartridge needle if adjusted correctly.

When Using the previous generation of needle Grips, the HHP II, there was the need for a grip for each long needle bar used. This meant that multiple tool holders were needed. With the HHP III this problem was solved by switching to the cartridge needle system which only requires a single grip in order to use multiple needle types: this is due to the bayonet-like fitting. While the HHP III has the downside of having to utilize a SUP product, the solution proposed should be reusable and not rely on any SUP Products.

The material choices should be based on their longevity, recyclability as well as their chemical resistance for their intended purpose. The self-sterilizing properties of copper-alloys on dry surfaces could be a complementing material property for the proposed tool. This results in added safety to the mandatory sterilization practice of medical devices that come in direct or indirect contact with bloodborne pathogens, but is a secondary safety net. It should not be seen as primary sterilization and sufficient safety measure on its own

Sustainability should be supported by the LCA conducted utilizing the Life Cycle Analysis tool SM-13.

figure2
1.Needle Guidance
2.Needle Enclosure



Aims & Objectives T

Analyzing and understanding previous tool design iterations, reflecting material choices or manufacturing processes as well as highlighting manufacturability to truly reduce environmental impacts that are applicable.
Changing the impact of a product by analyzing its Product design System for Sustainability, in which the satisfaction receives a superior role. Dissecting aspects of a product, its production, sourcing, use-case scenario, and end-of-life is only one aspect of the bigger coherence of its impact. To change the impact of a product, it cannot be seen as merely the product but rather a complex system of many fields of expertise. To enhance the product and change its impact to a more desirable outcome, analyzing each facet of the product to redesign the system as well as educating the consumer will aid to make sustainable decisions.

"If it can't be reduced, repaired, rebuilt, refurbished, refinished, resold, recycled, or composted, then it should be restricted, redesigned, or removed from production. "
(Seeger, 2008)

Goals & Insights

1. Reinforcing the suitability of copper and Copper Alloys as safety nets for tool sterility on primary surfaces that come in contact with bloodborne pathogens. The surface could have additional protection that prevents the survival of the COVID virus in the studio workflow. Utilizing the Oligodynamic Effect for tattoo tools.

2. Improving the performance of tool design by considering adjustability, increased safety, right to repair, recyclability, and transparent sustainability.

3. Gaining insights into which grip thickness minimizes fatigue to the hand. Since personally I have experienced traditional grip thicknesses being unsuited for my work style, causing fatigue when sessions are longer than four hours. Soft or hard grip material choices, which is suited the best, and should hard grips utilize increased surface areas to aid grippiness?

4. Improving the design and aesthetics of the tattoo tool. Considerations about the intended use, the inner mechanism, as well as the use of standardized components dictate the design of the tool in a way Louis Sullivan described by the phrase: "form follows function". The main goal is improving the usability of the tool by considering a simple but functioning inner working that is surrounded by a shell that suits the intended purpose. Developing solutions with the approach of an engineer.

By reaching the established goals the tool will not only solve problems in its facets of expertise but rather create intersections between coherent facets to display a more complete picture of the current status quo as of opportunities for future improvements.

LITERATURE REVIEW II

The succeeding literature review will examine three topics that are interconnected to the proposed thesis research question..

The first chapter will show methods of design for sustainability methodology and how they can be applied to the product.

The second chapter will take a look at the preselected metals and their properties justifying their suitability and potential beneficence to the product.

The third chapter reveals the medical industry status quo and why eliminating the use of plastics where possible is the preferable approach.

1. Design for Sustainability

The Following definition was given by ICSID in 2005:
"Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services, and their systems in whole lifecycles [...]. Design seeks to discover and assess structural, organizational, functional, expressive, and economic relationships, with the task of:
• Enhancing global sustainability and environmental protection (global ethics);
• Giving benefits and freedom to the entire human community, individual and collective;
• Final users, producers, and market protagonists (social ethics);
• Supporting cultural diversity despite the globalization of the world (cultural ethics);
• Giving products, services, and systems those forms that are expressive of (semiology) and coherent with (aesthetics) their proper complexity."
(ICISID, since 2015)

Only 40 years earlier Tomás Maldonado from the same Institution defined Industrial design in a much simpler way:
"By industrial design, we normally mean the designing of industrially manufactured objects."

Looking at the Industrial Design definition of the same institution 40 years apart it becomes evident that sustainability has truly found its way into all fields of design. The definition from 2005 does not only argue for more sustainability but an overall change in perception and consumption in the entirety of a product and its services.
This can be achieved by quantitative tools like LCA software which gives a greater overview of hidden product processes and therefore helps to establish the understanding for potential areas of improvement and in establishing a plan of action.

Areas for improvement that can be identified from the LCA are subdivided into six areas:

1. System Life Optimisation
2. Reduce Transportation
3. Resource Reduction
4. Waste Minimisation & Valorisation
5. Conservation
6. Toxicity Reduction

The main focus will be resource reduction, waste valorization, and reduction of transport since these factors have become quite apparent in the LCA I conducted for the previous tool design and will harness the biggest impacts without compromising health & safety for the proposed tool design.

Vezolli also argues for more environmental and socio-ethical solutions within the field of design, his key decision-making tool is the design system for satisfaction.
"The design of the system of products and services that are together able to fulfil a particular customer demand (deliver a 'unit of satisfaction') based on the design of innovative interactions of the stakeholders (directly and indirectly linked to that 'satisfaction' system) where the economic and competitive interest of the providers continuously seeks both environmentally and socio-ethically beneficial new solutions." (Vezolli,2014)

1.1 Defining Satisfaction

To gain greater insights into the product, its system and the stakeholder using the product, looking at the entirety of it is necessity. The demand for analysing these factors will help in laying down fundamental rules that will guide the design process. The need for clarifying a certain demand and therefore satisfying it. This approach is summarized by Carlo Vezolli
" The term satisfaction is proposed to emphasise the enlargement of the design scope from a single product to the system of products and services (and related stakeholders) that together meet a given demand of needs and desires: in fact a particular demand for satisfaction." (Vezolli, 2014)
This terminology is corroborated by Meadows with their well-known 30-year update on Limits to Growth commissioned by the Club of Rome which modelled the consequences of a rapidly growing population on a physically finite planet including its resources. (Meadows, 2004)

"Anyone who believes in indefinite growth on a physically finite planet is either mad or an economist." Sir David Attenborough

To further explain the definition of satisfaction it is important to understand the need in order to define a satisfaction unit, in the example of the Ekatā S (एकता) a unit could be defined to be the number of applications per unit, this would also allow for the possibility to compare reusable products with single-use products in order to compare their satisfaction for their intended use. Other satisfaction units could give a person more control over the reduction of impact by extending a product's lifetime.
Allowing people to identify with a product to promote change. Supporting the expression of traditional tattoo Art with modern health and safety standards. To full-fill the concept of satisfaction, it is important to select a concomitantly wider approach, accounting for product services, and stakeholder needs, but at the same time narrower by highlighting details.

1.2 Local Production

Local Production being one of two major areas I lay a strong focus on, in order to have greater control and transparency of production while in addition, creating a product with lower transportation-related impacts is an approach that is also described by Vezolli:
"Moving production of raw materials and manufacturing of the product closer to the end market reduces carbon emissions from transportation." (Vezolli, 2014)

The benefit of local production doesn't stop at the reduction of the impact of transportation but is associated with socioeconomic effects that allow for fair production and lower exposure to toxins due to local regulations of the European Union, resulting in credence of higher quality, ensuring the consumer of his tool decision-making through transparency.

1.3 Uniqueness & Achievement

Uniqueness adds value to a product from a consumer perspective, personalization, a story, characteristics, or values we like to connect to our self-image. Chapman explains how the personal connection to a product can extend its lifetime. (Chapman, 2005)

A further unique selling point of a product and its extended lifetime can be the sensation of a deeper understanding of the inner workings through the initial assembly of a product. Hence the likelihood of replacing parts, repairing, or reusing will be significantly increased.
"If the user builds the product herself, she acquires a deeper knowledge of the product and therefore will also be able to repair the product if needed. " (Papanek, 1995)

Stimulating a sense of self-making and presenting a deeper understanding of the mechanism trough schematics intends to promote user satisfaction and create an emotional connection which will encourage looking after it, and the willingness to repair instead of disposing of it.

1.4 Extended Service

If the product is of high quality and is expensive, it becomes worthwhile to take great care of, repair, modify it, or even redesigning its appearance. This adds value to the product and allows for additional services which will add satisfaction to the product.
It should be considered that the appearance of the product and the internal mechanism can be replaced or upgraded to one's personal liking. Possibilities of changing the appearance or adding different thicknesses of the grip which are possible through providing the tool design schematics. This will ensure that a wider user-base can be satisfied through adaptability to personal likings.

Chapman argues that new elements act as a stimulus to sustained interaction with a product. (Chapman, 2005)

1.4 Education & Co-Creation

Making the design process transparent and highlighting its true impacts will help to establish a base of trust, there is no such thing as a perfect product. Being transparent about sustainability is a more valuable approach than greenwashing facts. I believe there is a need and want for this change of displaying and promoting a product transparently and is indeed long overdue. The data presented is both in depth but also understandable due to the choice of relatable data like CO^2 impacts.

Co-Creation won't find its way into the thesis, this is due to time constraints. The projects outcome displayed are merely a milestone towards an educational open source approach of exchanging data and knowledge between artists in the future.

LITERATURE REVIEW II

2. Metal Properties

I utilized the technology of stainless steel laser sintering, a type of metal rapid prototyping in the past for the HHP II (figure3), which in hindsight was an unsustainable decision, due to its low corrosive resistance since a non-pure stainless composite powder is used to melt in order to create layers to shape the final design. The tool received an additional coating of 22-carat gold* to strengthen its resistance by lowering the probability of corrosion, without success.

After having used the HHP II for around 2 years before retiring the tool, with the rise of popularity in cartridge needles, the HHP III (figure5) - which is the current tool I am utilizing - was created. Brass was chosen for passive sterilizing properties and the transition to a more precise and self-contained needle setup while being able to utilize multiple needle types with the same grip. The long needle bar which was used in the HHP II was obligated to have a designated needle grip for each needle type used, thus creating more secondary waste during application compared to the proposed tool design Ekatā S.

2. Copper & Copper Alloys

“When microbes were exposed to copper surfaces, we observed contact killing to take place at the rate of tens to hundreds of millions of bacterial cells within minutes,” (Grass, 2011)
“This means that usually no live microorganisms can be recovered from copper surfaces after exposure.” (Santo, 2011)

Dry Copper and Copper Alloys have the property of being a natural biocide, the effect is called the Oligodynamic Effect and was described by Grass. The Oligodynamic Effect reduces any form of living organism on exposure. This property is known since ancient times and was recorded by the oldest medical document in history “Smiths Papyrus”. The knowledge was ascribed to an Egyptian doctor in circa 1700 B.C but is thought to be based on information that dates back as far as 3200 B.C. (Morrison, 2020)

Well-known uses in everyday objects are copper and copper alloy coins and brass doorknobs. As in medical devices or devices for intended medical use, the effect should not be considered as an excuse for lacking in sterility and the responsibility to tool sterilization before and after application, but rather act as an additional safety net for the surface that is prone to have the highest chance of cross-contamination due to its direct contact to the blood borne pathogens. The Tool’s outer shell, as well as the thumb screw at the end of the tool, ideally benefit from these material properties.
As the scientific paper “Brass Alloys: Copper-Bottomed Solutions against Hospital-Acquired Infections?” suggests the virus reducing properties have some limitations to certain strains of bacteria and viruses and therefore can not be seen as a primary sterilization process but rather as a complimentary one.

“Brass touch-surfaces should therefore be considered a complement to, not a substitute for, hand-hygiene practices, disinfection operations and other standard cleaning methods”.
(Dauvergne & Mullié 2021)


figure3

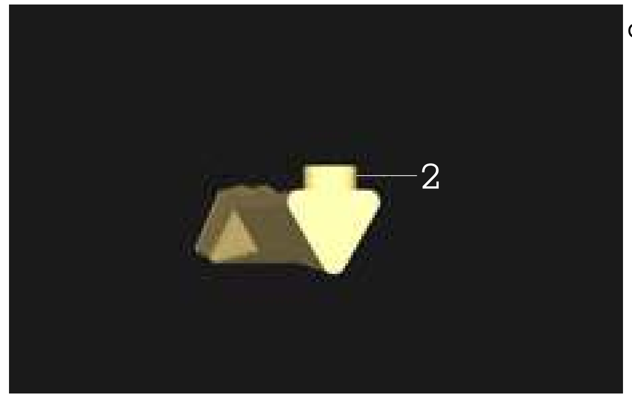


figure4

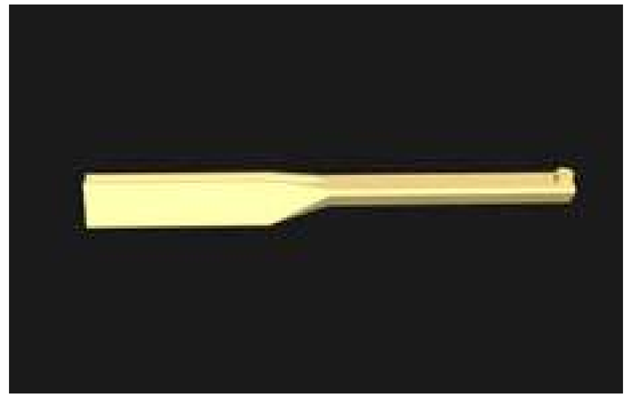


figure3 HHPII
1.Needle Bar Guide

figure4 HHPII
2.Bar Loop Male

figure5

figure6

figure7

figure8

figure5 HHPIII
3.Drive Pin
4.Adpater HHPIII
5.M4 Grub Screw

figure6
6.Single-Use-Grip

figure7
7.Cartridge Needle

figure8
8.Needle Grouping

3. Elimination of Single-Use Plastic

The sheer quantity of single-use plastics used in hospitals is alarming, which is why hospitals must adopt strategies that encourage the reduction of single-use plastics going forward.
"This is a worldwide issue as the AAMC found that globally 4.4% of all greenhouse gas emissions and over 5 million tonnes of waste come from hospitals. The NHS creates 133,000 tonnes of plastic annually with only 5% of it being recyclable."
(Davis, 2021)

Although the health care industry is not the tattoo industry, they are operated similarly and are facing the same problems that need to see a drastic change in the future. From the LCA I conducted for "Tattoo Session Impacts" the data provided shows ~50% of the waste created can be identified as single-use plastics. But as the health care system regulations on health & safety will never eliminate all single-use products, the attempt to minimise the impact is the highest priority until alternative, lucrative biodegradable materials with similar or equal properties can be a true substitute for petroleum-based materials. This research was displayed within the sustainability chapters of this thesis.

Topics on the meta-level of manufacturing, transportation, and the execution of the final tattoo tool are included in the LCA chapter and play a major role to display transparent design for satisfaction through all its facets and lay important foundations in benchmarking its properties to the current status quo.

4. Allow for Open Access

Allowing for open source, creative commons non-commercial use of the data provided not marked as quoted and with the exception of the tattoo illustrations allows for accessible transparent data to base future improvements upon. The open source approach furthermore helps to solve the complicated task of allowing for personalisation of artist preferences and local productions to mitigate impacts as discussed earlier.

The LCAs are provided under the creative commons non-commercial license, this means that artists can use the tool schematics and LCA´s in order to reduce impacts and foster industry education but they can not be resold or provided to third parties for profit.
The CAD Files will be happily provided through e-mail for requests sent to:
handwerk.stickandpoke@gmail.com.

In the future this approach could help foster interactions between artists, but also help clients and artists to develop further solutions by identifying problems within the industry.

The website provided through this thesis will be published under the same guidelines and can be utilized by artists in Cologne and Bonn in Germany, to provide insights for artists and clients alike.

Commercial replication to make profits from this tool is prohibited.

Ekatā S - एकता

The Schematic published under the name Ekatā S is the second alliteration of the design. The previous proof of concept, the Ekatā, turned out to be too complicated to manufacture as well as facing major problems with the product weight. When originally designed, the tool weighed around 313g due to size, material choice and its complexity, and would have not been viable to displace SUP cartridge grips since it would have caused great trauma to the wrist due to its weight. Therefore, the design was simplified in order to reduce material use and complexity, hence the name Ekatā Simplified. The Final Schematic has four components .

1.The inner shell, housing the needle depth adjustment as well as the bayonet fitting for the safety cartridge needle, which is made from aluminum (ALZNMGCU1.5). The part is tuned on the lathe to its final outer dimensions, and fittings for the thumb screw and the M4 pilot holes were drilled. The Component was then put into a 4-Axis CNC from Proxxon to fabricate the pilot holes for M4 Grub screws to hold the outer shell as well as the bayonet fitting. The Component then received a hand cut M4 thread to later receive the thumb screw to allow for depth adjustment. The final Step was polishing the tool to a mirror like finish and anodizing the surface to prevent corrosion.

2.The outer shell was manufactured from Brass (MS56) and was turned on the lathe to its final outer and inner dimensions in order to slide over the inner shell with a precision fitting. The blank was then put into the same 4-Axis CNC which engraved the surface enlargement into the shell and drilled the holes for the M4 grub screws. A M4 thread was cut in both pilot holes opposite of? each other. The burr of the M4 threads was removed with the help of a Dremel. The purpose of the M4 threads is to allow the assembly of the tool. This decision was made due to ease of manufacturability and not for aesthetic purposes.

3.The Thumb screw Brass (MS56) was shaped to its final dimensions on a Lathe to create the blank. It received surface enlargements with the 4-Axis CNC on the thumb screw to ease adjustability when wearing gloves that came in contact with blood, cream or ink. The Tool received an M4 thread to fit the inner M4 thread of the inner shell and was polished in its final manufacturing step to create a mirror like finish.

4.Two M4 grub screws were sourced from Schrauben Schwarz in Longerich, Cologne to make the assembly of the inner and outer shell possible. The Manufacturing of these parts would be possible but economically not viable as long as standardized components exist on the market.

The tool ends up weighing 102.0708g which is closely related to most industry standardized grips for rotary and coil guns that weigh between 95 - 150g, depending on material and grip thickness. This was a major goal to alleviate strain on the wrist of the artist to allow for extended application sessions of more than four hours.
The parts that will come in direct contact

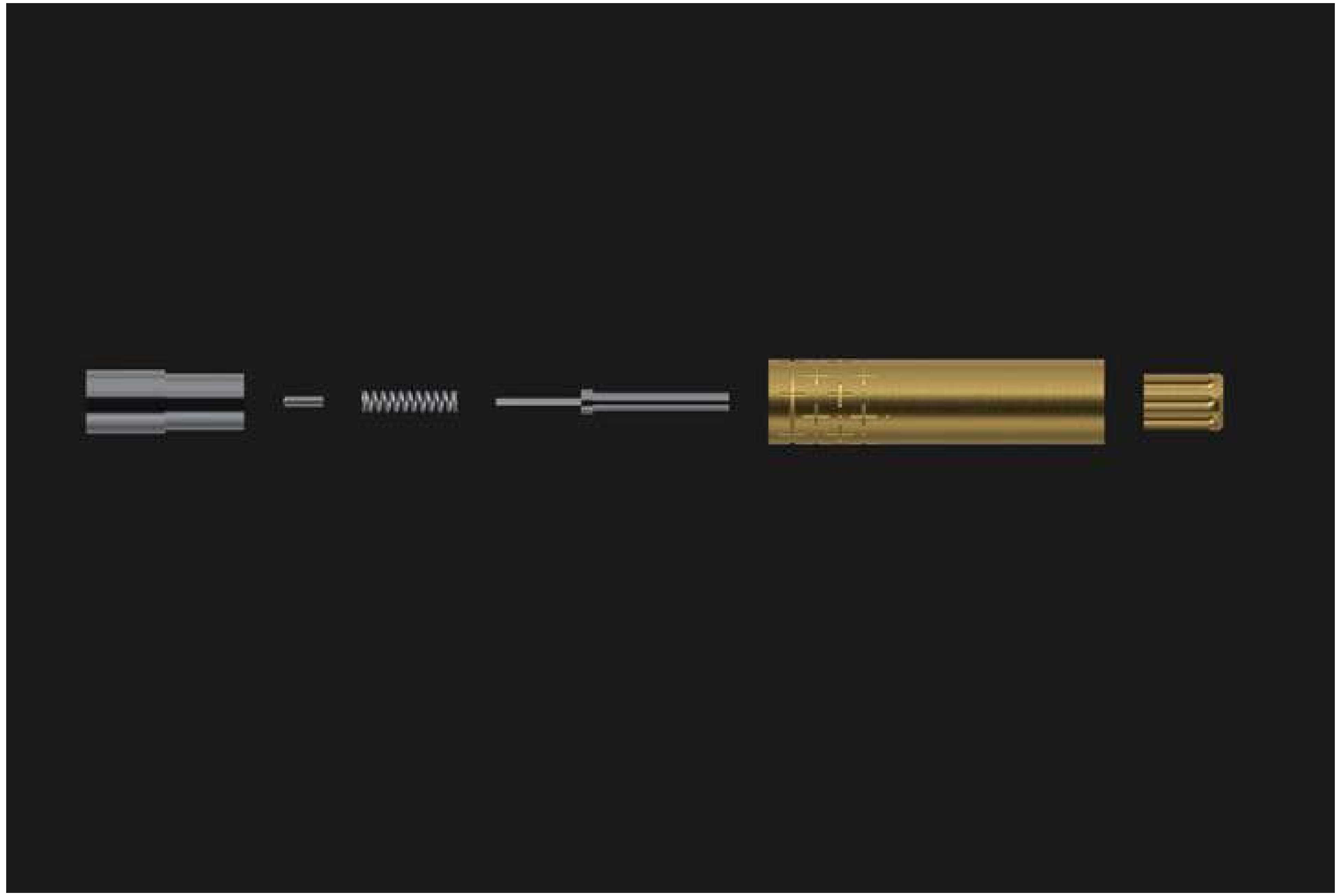
with bloodborne pathogens profit from the oligodynamic effect and the anodization which ease the sterilization process and thereby prolong the life expectancy of the tool. If single components are wearing out over time, the damaged component can be replaced to further prolong the tool's lifetime. If a new design of the outer shell or thumb screw is desired, they can be replaced, while reusing the original inner mechanic to reduce the impact created and prolonging the tool's lifetime. Due to this adjustability and right to repair, the personal attachment and appreciation for the tool should increase consumer satisfaction.

Future concepts could allow for artist insights when more tools have been manufactured and handed out for testing. The current goal of displaying satisfying products that consider EOL handling as well as right to repair and reusability have been achieved with great success. Components of a single material type follow the design goals of DFD and ease of EOL handling.

Future concepts could furthermore allow for ease of personalization as well as adding mechanisms to prevent needlestick injuries when the cartridge is locked in the grip while the tool is layed down on the workstation.

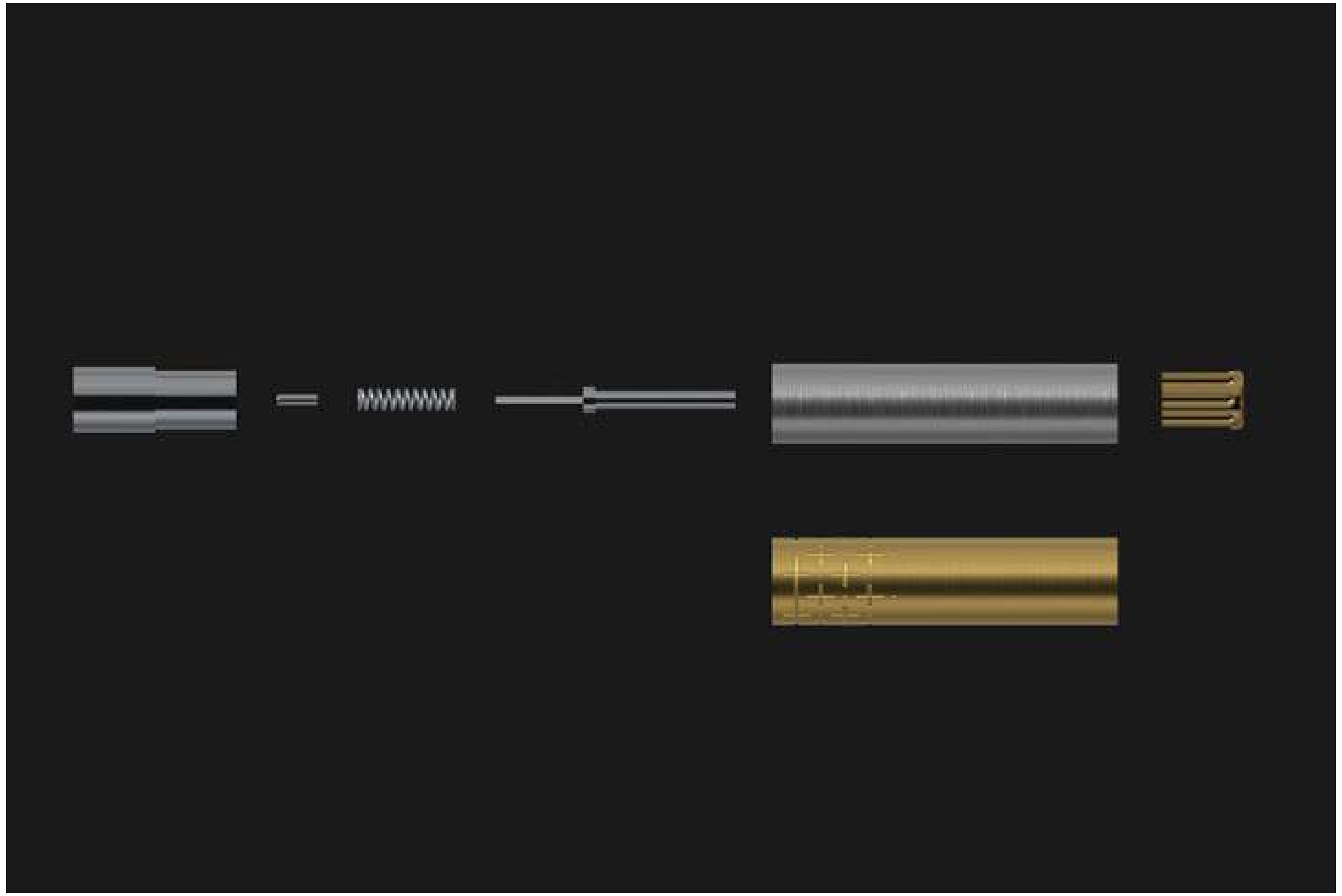
Until then, the cartridge needle is recommended to be ejected from the fitting when not in use, since the needle depth adjustment stays unchanged when reinserted.

For deeper insights or help for problem solving, personalisation as well as manufacturability, feel free to contact me.



Parts:

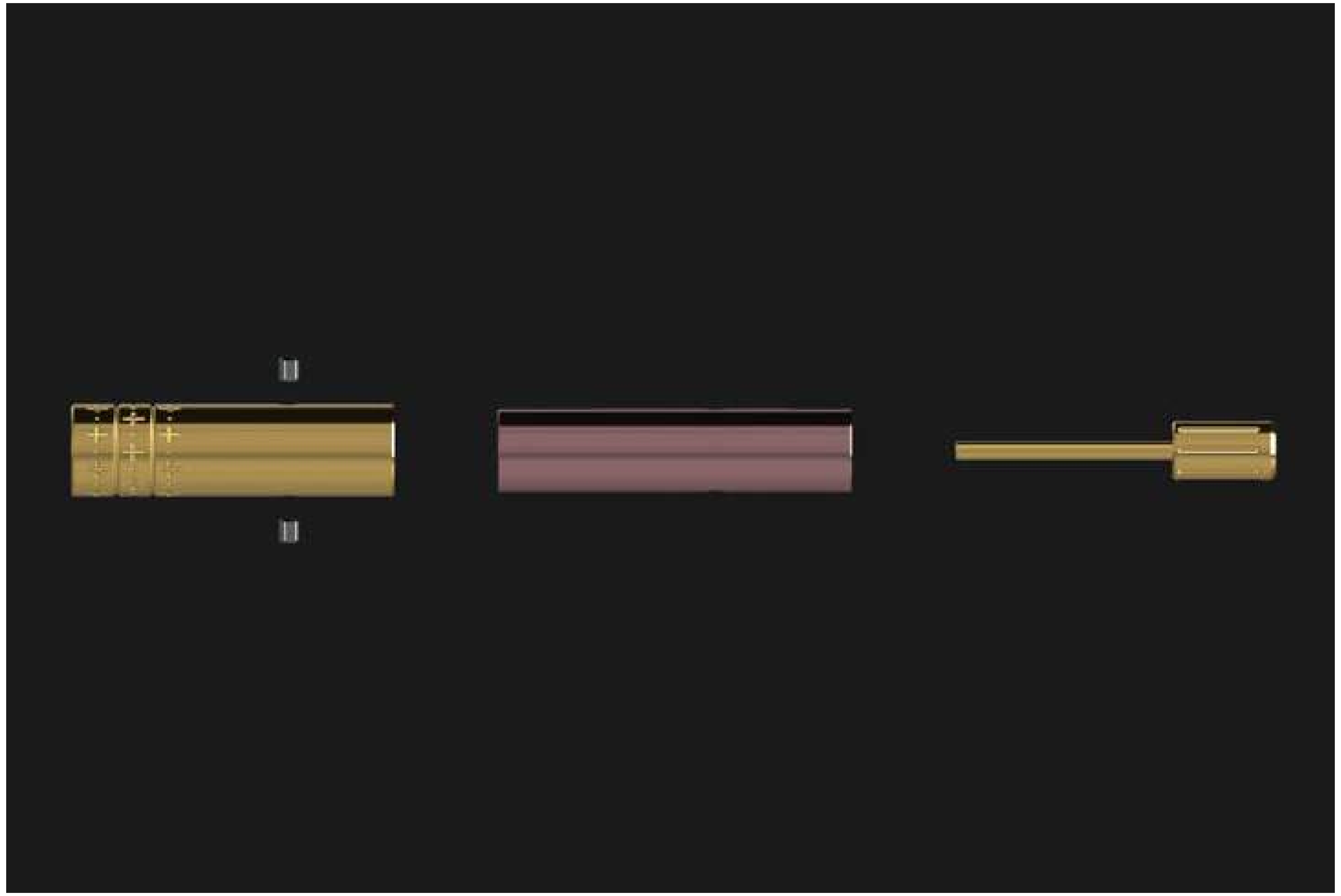
Cartridge Hub SAE316:	55.3106g
Grub Screw SAE316:	0.7550g
Compression Spring SAE316:	0.7930g
Key Assembly SAE316:	6.9647g
Ekata Shell Brass C36000:	225.2620g
Thumb Screw Brass C36000:	24.2032g
Total:	313.2885g



Parts:

Cartridge Hub SAE316:	55.3106g
Grub Screw SAE316:	0.7550g
Compression Spring SAE316:	0.7930g
Key Assembly SAE316:	6.9647g
Ekata Shell Inner AL Anodized:	56.2200g
Ekata Shell Outer Brass C36000:	50.2900g
Thumb Screw AL Anodized:	7.7760g
Total:	178,1093g

EKATA S



Parts:

Ekata S Outer Shell MS56:	43.6000g
Ekata S Inner Shell ALZNMGCU1.5:	34.0300g
Ekata S Thumb Screw MS56:	24.2900g
M4 x 5 Grub Screw Stainless Steel:	0.4300g
M4 x 5 Grub Screw Stainless Steel:	0.4300g
Total:	102.7800g

The Ekata which was developed as proof of concept showed significant downsides due to excessive product weight, this would have resulted in higher environmental impacts as well as strain on the wrist of the artist over extensive application sessions.

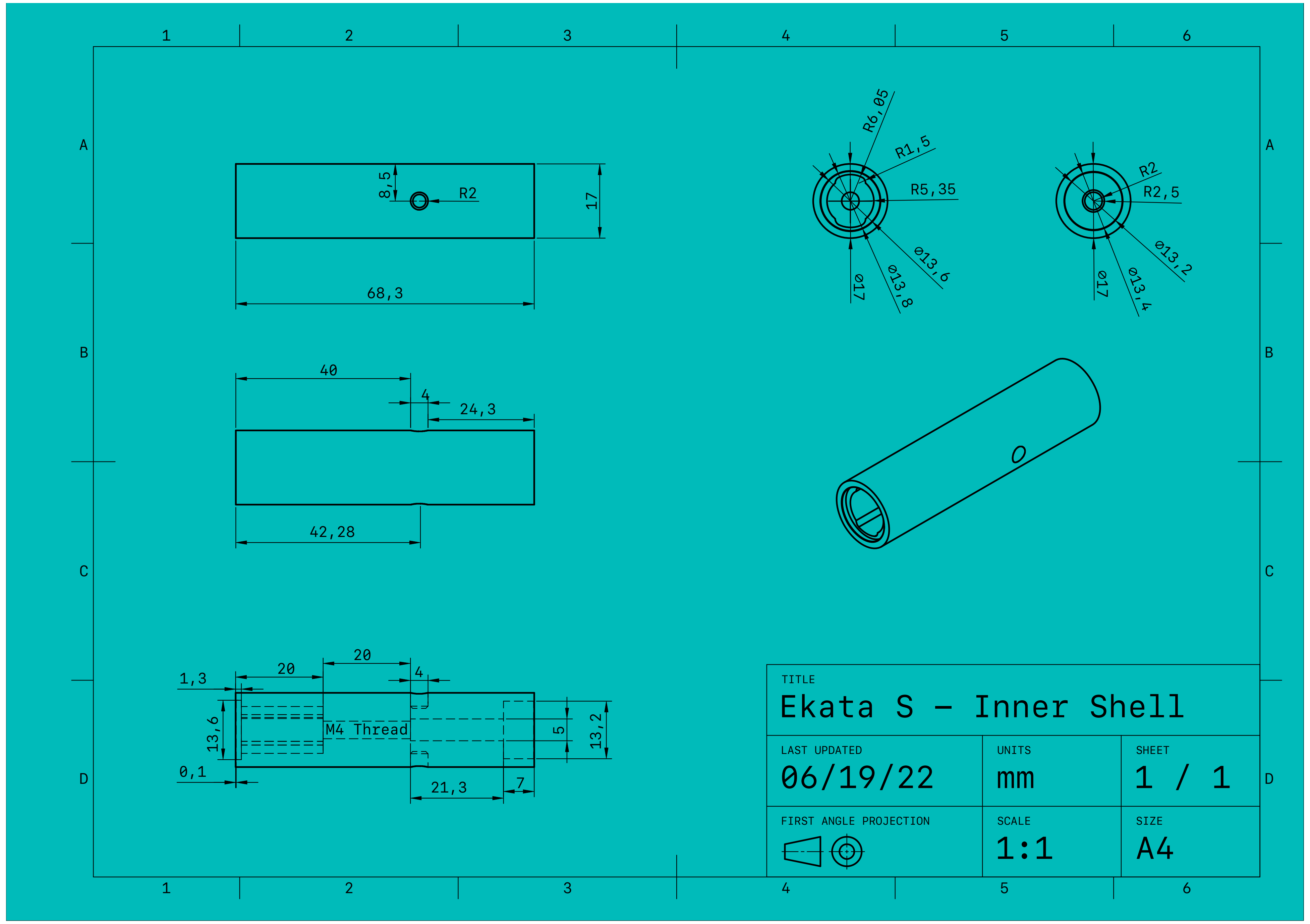
The concept of the Ekata was revised and material choices reconsidered in order to lower its weight by 44% with the downside of one more component that needs to be manufactured.

The Prototype proved that it is possible to build a tool that is able to displace the current tool in use (HHPIII) but also showed concerns for manufacturability. Therefore a third version took a much simpler approach, which is the proposed solution to the excessive amount of SUP disposed of in every tattoo session.

The Ekata S (Ekata Simplified) allows for the same adjustability as the HHPIII with lower environmental impacts, and the possibility to repair & replace the tool through open source access. This also adds the possibility of customization of the tool for artist preferences.

The reason for material choices is described in the Thesis. The materials can be replaced by other metals, but the weight of the final tool should be considered when making these changes.

The grip thickness is adjustable since the outer shell can be replaced if artists choose to prefer thicker grips.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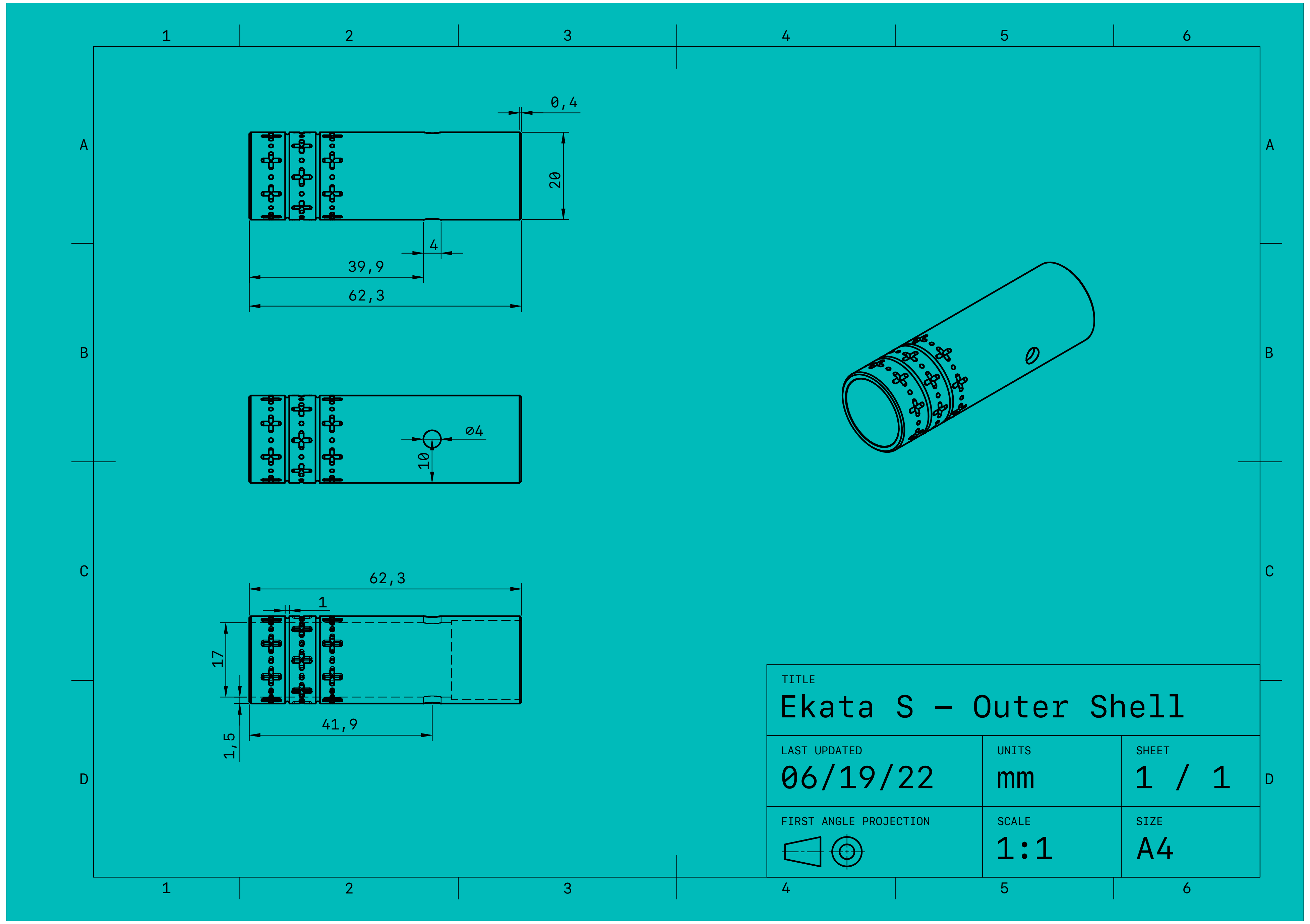
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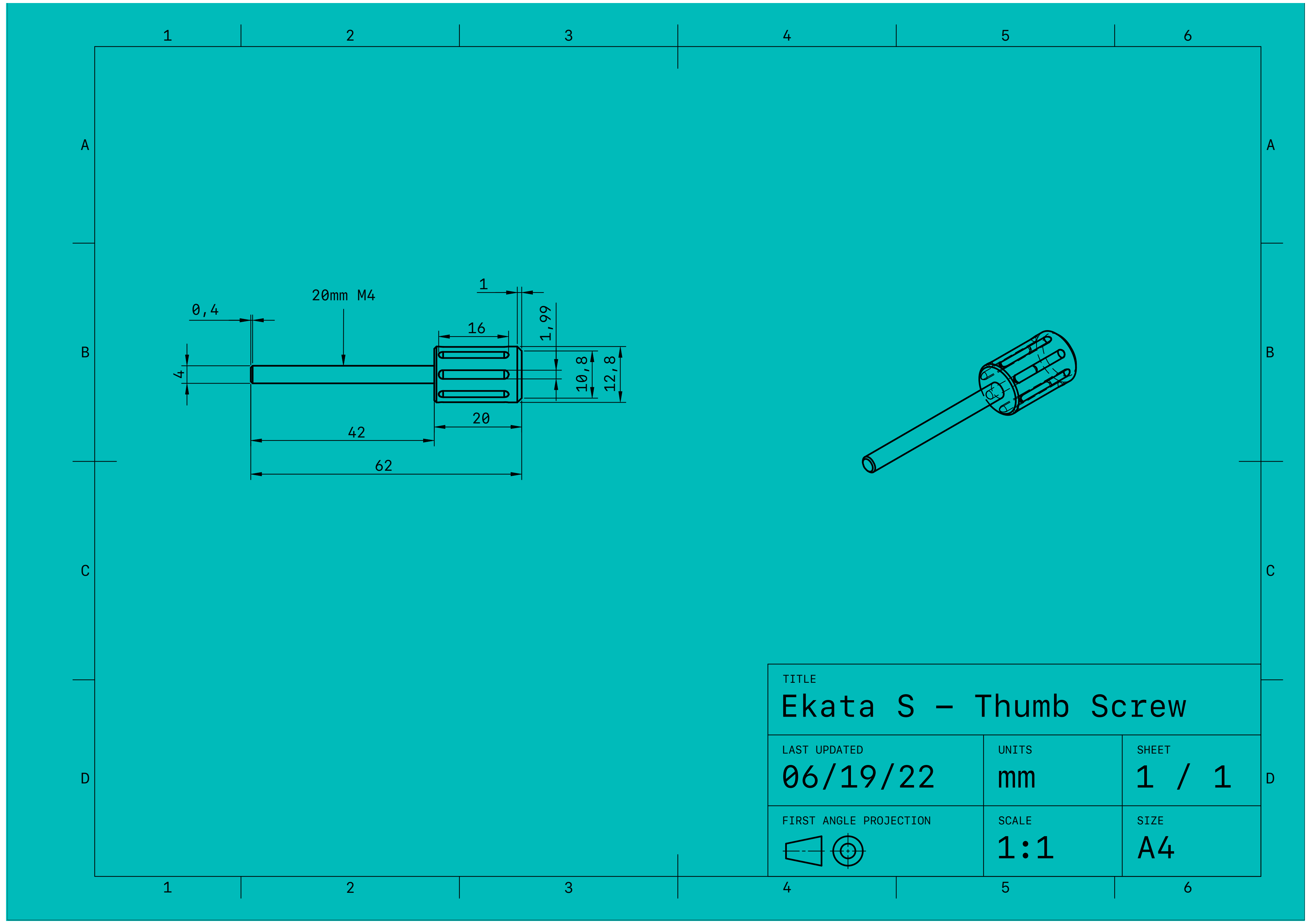
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Ekata S – Thumb Screw
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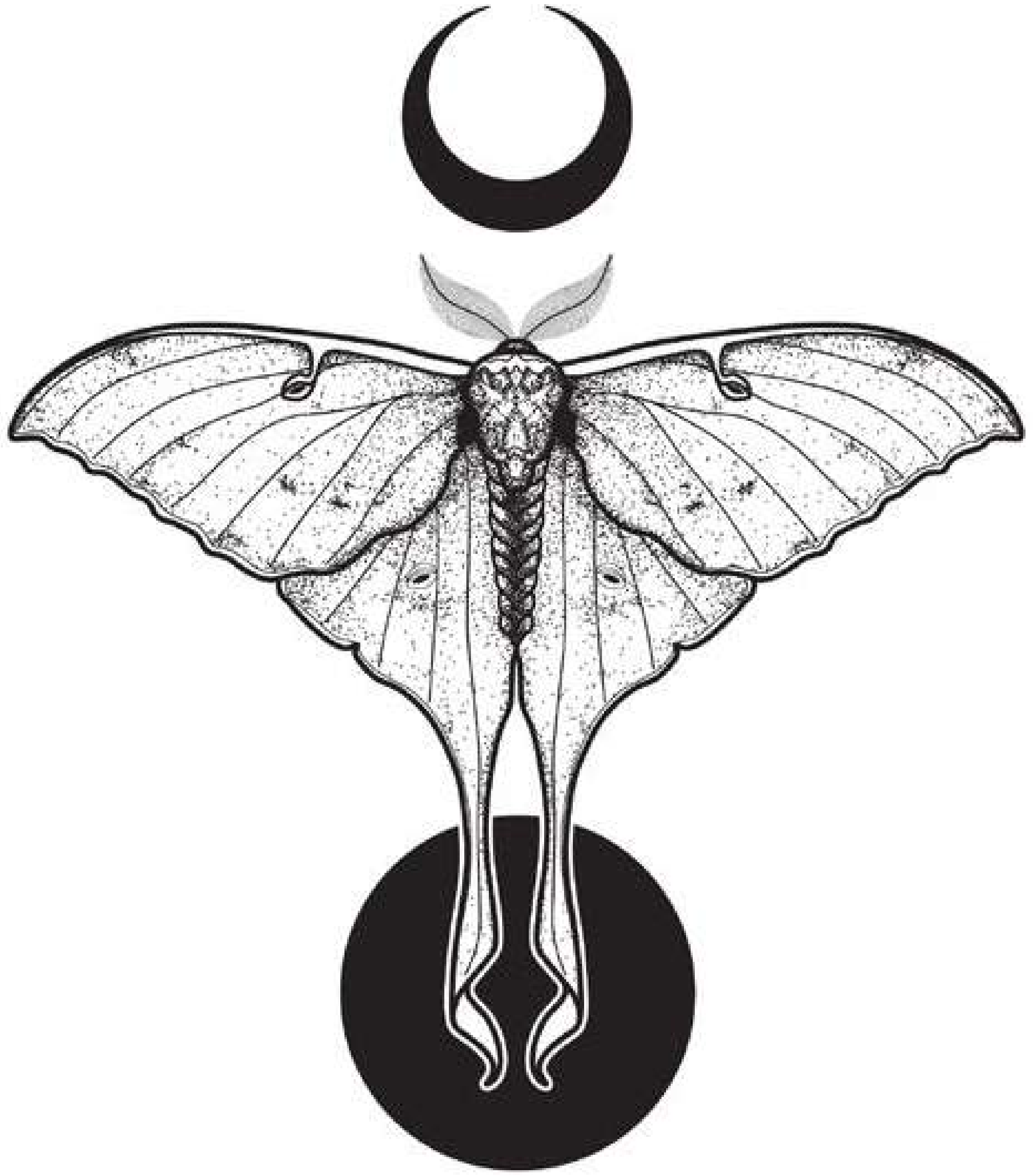
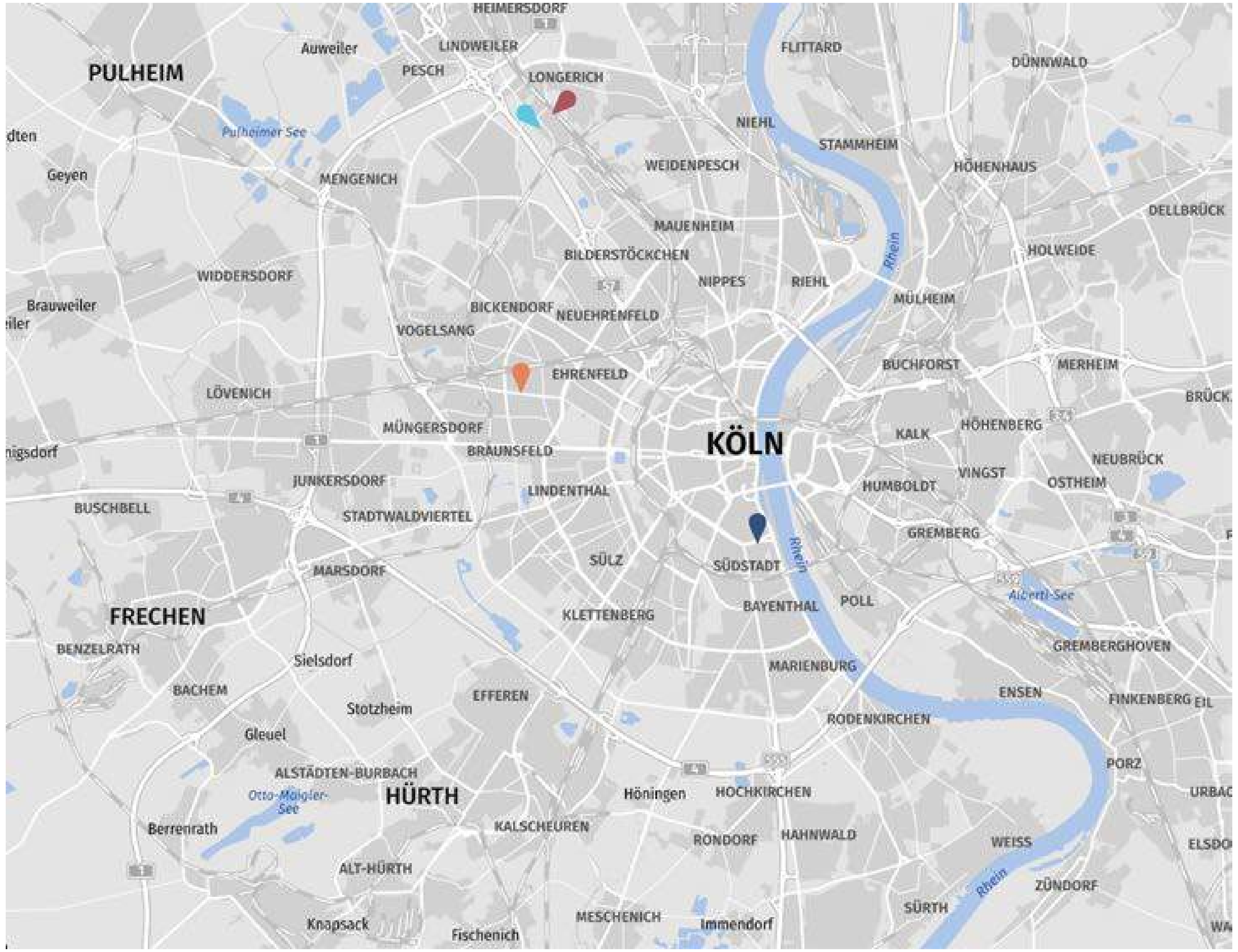


Sourcing Map & Production

The Sourcing Map shows the benefit of local sourcing and production of tools in combination with the Ekatā S LCA which displays no transportation impacts , since the sourcing was conducted by bicycle of which the use has no environmental impact. The LCA as described earlier might seem incomplete but was conducted in the same manner as all other LCA´s and, as displayed on the title page, no information is missing. The only concern as for most products and their EOL, reusable materials like metals never show impacts within SM-13. This is highly unlikely since the excessive weight of these materials and the energy intensive processes of recycling will always create an impact. This is due to Data Gaps by the chosen software and not intended to greenwash the product. In general, it is quite apparent that even a single retail box of cartridge grips has more impact than the entire manufacturing of a single Ekatā S tool even though metal products tend to have greater initial manufacturing impacts. But when adding up the sterilization process of the HHP III as well as the drive pins, in addition to each of the SUP cartridge grips used, the impact reduction becomes even more apparent.

If the Product is not produced & sourced locally, these insights will change significantly due to added transportation impacts. Also, traceability of socioeconomic factors will become less transparent when getting parts manufactured by third parties. Especially on a small scale and with the option of personalization, the concept of external manufacturing becomes unviable and is not recommended.



- Hoffmann Group – CNC Cutter
- KISD – Manufacturing
- Schrauben Schwarz – Grub Screws
- Wilms Metalle – Metal Stock

Conclusion

Improving tool choices in the industry of hand poke application from currently used medical spatulas or chopsticks with the old type of long needle bar fixated by microporous tape, supplying a solution to skip the use of single-use cartridge grips with an adapter piece. The solution is a self-contained long-term sustainable and sterile cartridge grip that allows for adjustability while using a more precise needle type. This is due to the integrated needle enclosure and needle guidance found in cartridge needles. Needle-depth adjustability allows for a versatile grip that can be adjusted for personal preferences of application and if adjusted, the capillary effect can be exploited. This effect occurs when the needle-depth is adjusted in such a way that the enclosure around the needle grouping will allow for ink to flow naturally from its reservoir in the cartridge to the tip of the needles, therefore reducing the need to re-dip ink and therefore reducing the time of application. Compared to long needle bars without a type of enclosure used by a majority of the hand poke community, the need to re-dip is a lot more frequent, caused by limited ink flow and increased exposure to air and therefore the evaporation of the ink filler.

Switching from long needle bars to capillary cartridge needles has the added benefit of reorganizing the workstation, without limiting the use of multiple needle types from RL (Round liners) to RS (Round Shaders) to RM (Round Magnum) needle groupings with a single grip rather than having individual grips for each needle grouping utilized.

The type of grouping used differs greatly from tattoo style to personal preference of the artist or the size of the application intended.

The Ekatā S adds the benefit of minimizing the waste of a single tattoo session through the reduction of SUP (Single-Use Plastic). The tool focuses on long-term sustainability through sterilization and sustained use with an initial higher impact compared to a single-use product. To show transparent design, the LCA of the current setup was compared to the Ekata S and shows that sustainability does not mean short-term reduction of impact but rather long-term solutions. Although the Cartridge system shows a higher impact to traditional long needle bars, the needle guidance would normally be an additional part (needle grip), which is nowadays most commonly single-use as well.

The material choices are based on their longevity, recyclability as well as their chemical resistance in addition to copper-alloys self-sterilizing ability on dry surfaces. This results in added safety to the mandatory sterilization practice of medical devices that come in direct or indirect contact with bloodborne pathogens.

Unintentional needle stick injuries are quite high in fields with similar exposure to sharps with the potential of infection through bloodborne pathogens.
"Currently, needlestick injuries (NSIs) are one of the most important occupational hazards among healthcare workers (HCWs) globally. According to WHO, more than two

million occupational exposures to sharp injuries occur among 35 million HCWs annually" World Health Organization (WHO)." (Bouya, 2020)
But the risk does not start in production and assembly, transitioning into the studio environment and ending in the sharps container. The highest risk much rather lurks at its end-of-life handling.
"Despite the implementation of preventive measures to reduce sharp injuries such as equipment design improvement and employee training, they continue to occur in every step of sharp device usage, disassembly, or disposal". (Alfulayw, 2021)
Therefore the use of SUP Safety Cartridge needles greatly reduces the risk of injury especially during application and EOL handling since the needle is retracted into its enclosure when it is not in use.

The Brass outer shell and thumb screw do not only add an aesthetically pleasing appearance but rather utilize the self-sterilizing properties of dry copper and copper-alloy surfaces through the Oligodynamic Effect which adds operational safety.

The claimed sustainability is supported by the LCA conducted utilizing the Life Cycle Analysis tool SM-13.

To understand our relationship to the impacts we create it is important to note:

The environment doesn't need us, but we need the environment. Therefore we should focus our energy towards change and preserving it through impact reduction practices.

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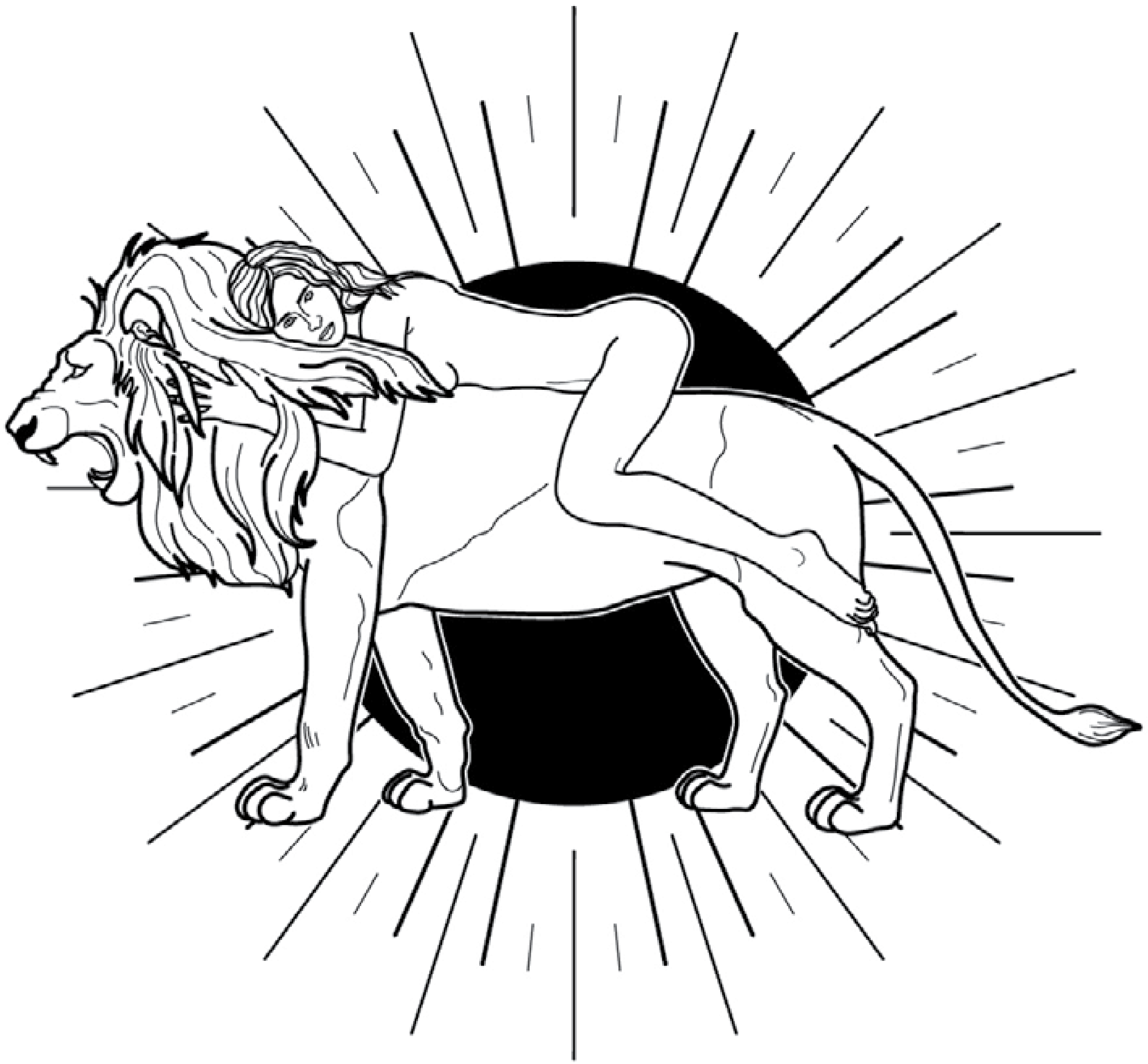
RL:
Round Liner, needle grouping for creating outlines.
RS:
Round Shader, used for creating dot-work or shading small areas or details.
RM:
Round Magnum is used to shade larger areas with a smoother gradient.
Application:
Describing the active process of depositing ink in the dermis. (Tattooing)
HHP III:
Handwerk Hand Poke Version 3.
Biocide:
Destructive to biological life. For example, viruses, bacteria, and fungi.
Oligodynamic Effect:
Describes the biocidal effect of metals in this case Copper and its alloys and occurs even in low concentrations.
Compression Spring:
Open-coil helical springs wound or constructed to oppose compression along the axis of wind.
Grub Screw:
A small headless screw.
Round Stock:
Cylindrical metal bar
Product Constellation:
The Product Constellation describes which products are included in the LCA.
एकता/ekatā:
Means unity in Hindi.
LCA:
Life-Cycle-Analysis
Industrial Design:
Definition from ICSID.
ICSID:
International Council of Societies of Industrial Design
WHO :
World Health Organisation
SM-13:
Sustainable Minds 2013 (LCA Software).
EOL:
End of Life.
Hydro Degradation:
Describes the property of certain bioplastics to brake-down in water.
Euthorictaion:
Describing the process of introducing harmful amounts of nutrients and minerals like phosphorus and nitrogen to a water body, this causes excessive plant growth on the body's surface changing the ecosystem for all inhabitants, depriving the body of oxygen. The numbers only reflect the activities of man rather than the natural process occuring in nature where a water body turns into a swamp.

Non-Carcinogenics:
Defining hormonally active agents (HAAs) which result in reduced immune responses and adverse effects on the reproductive system.
mPts:
Millipoints used as a measurment by SM-13. 1mPts = 1/1000th of a point.
SBOM:
System Bill of Materials. Used by SM-13 to define the materials and processes inlcuded in a products LCA.
SBOM Impact:
SM-13 definition of the Carbon or mPts impact of the claculated Product LCA.
EOL:
End of Life
SUP:
Single-Use Plastic
Cradle-to-Grave:
LCA type where the whole process from Raw Material, to Production and EOL including transportation, is analysed.
Cradele-to-Cradle:
Closed-loop Lifecycle, Products are recycled into the same product or products made up of the same material types.
MNPs:
Micro & Nanoplastics
Product Constellation:
The Product Constellation, describes complementary Products to fulfill a given task.
As an example: When making coffee, you need a coffee pot, a kettle, coffee, a coffee grinder, water…
It will include all products independent of personal preference.
Product System Boundary:
The System Boundary will define which aspects will be included in the LCA calculations and what is left out. It considers: life cycle stages, processes, and materials.
Macrophage:
A type of white blood cell that targets and kills microorganisms, removing dead cells and stimulating the immune system.
Epithelial:
Describes the tissue that covers the internal and external surfaces of the human body.
Cerebral:
Brain Cells
TiOx:
Titanium Oxide, a pigment used to dye plastics.
CB:
Carbon Black, a pigment used to dye plastics.
DFD:
Design For Disassembly.
EWG:
Environmental Working Group
MSDS:
Material Safety Data Sheet



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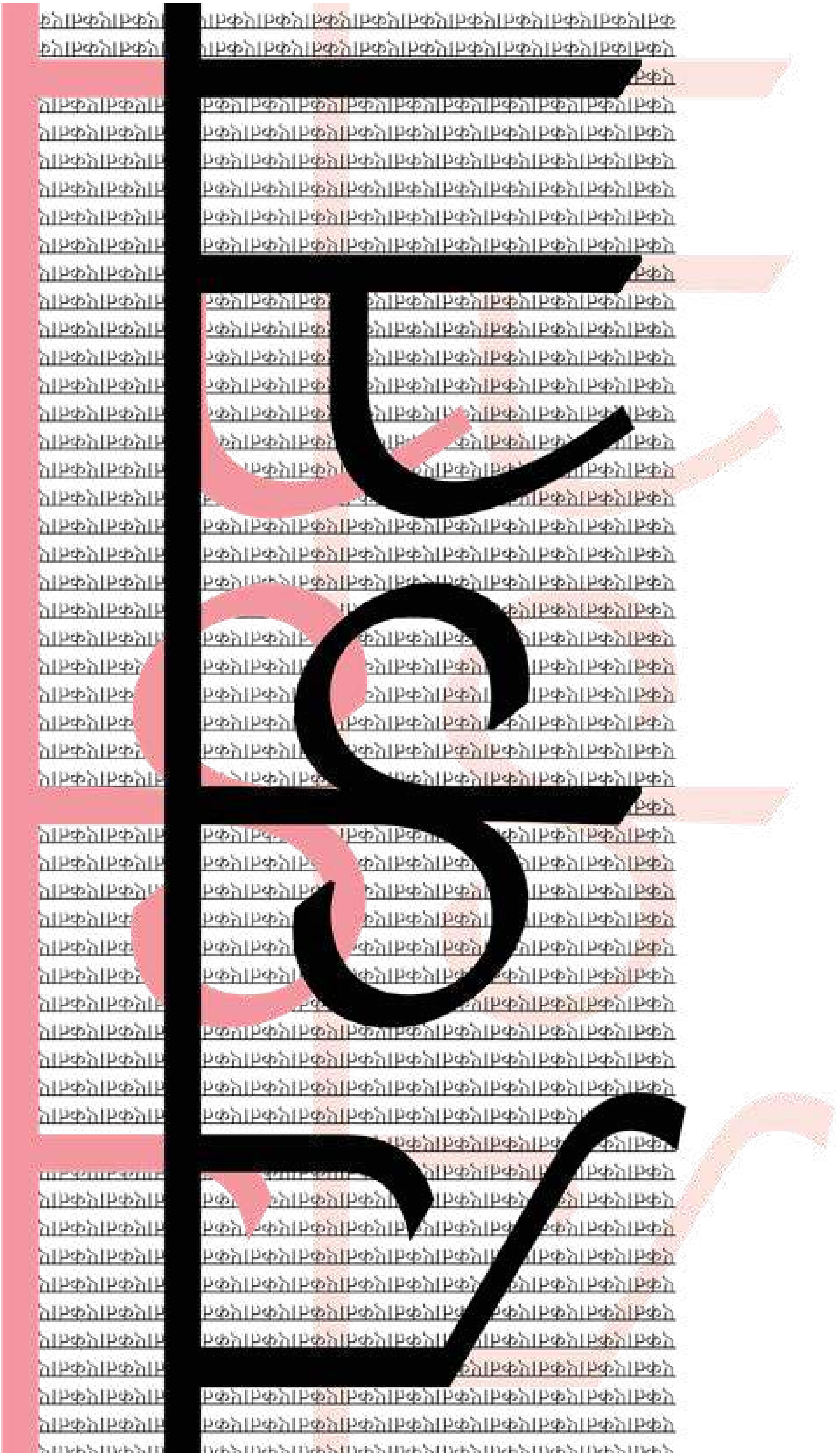
Versicherung

Hiermit versichere ich, dass ich die Arbeit selbstständig angefertigt habe und keine anderen als die angegebenen Quellen und Hilfsmittel genutzt habe. Zitate habe ich als solche kenntlich gemacht.

Köln, 20.06.2022

SIGNATURE



BA THESIS

EKATA

COLOGNE