Appendix A: Patient journey of autoinjector

Step 0: Collection & storage

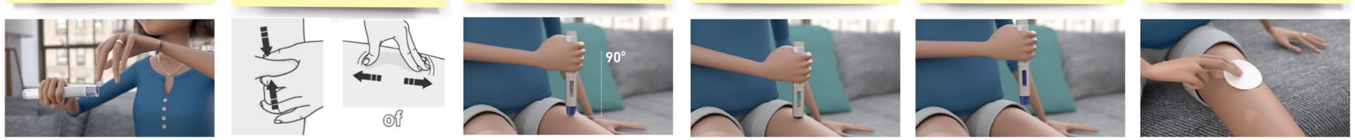
- Collect autoinjector at pharmacy
- Store pen in fridge

Step 1: Preparation

- Remove the autoinjector from the fridge an wait for 30 minutes till it is room temperature
- Wash your hands
- Inspect autoinjector and vaccine to make sure there is no physical damage and that the expiration date has not passed
- Prepare & clean injection site

Step 2: Injection

- Remove the cap
- Stretch or pinch skin
- Press the autoinjector firmly onto the skin at a 90 degree angle. You will hear a click to indicate that the injection has started.
- Keep pushing the autoinjector down on your skin till you hear an end click
- Remove the autoinjector from the skin by lifting it straight up.
- Use a cotton ball to gently press on the injection site for a few seconds.



Step 3: Disposal

- Throw autoinjector & cap away in sharps disposal container
- When the container is full, bring it to the pharmacy or a waste facility for disposal

Fig. 205: YpsoMate patient journey. Images from from Ajovy (2021)

Appendix B: Unintended use research

Autoinjectors, like any other product, are not always used as intended which can have consequences on the (re)design of the product. Since I have been using autoinjectors myself every month for the past three years, I did not find it necessary to interview people to understand the experience of using an autoinjector. However, I did conduct a small online survey (P = 5) and online research to find unintended uses that I might not be aware of. Unintended use can harm the autoinjector, such as dropping, scratching, drowning it or bending the needle. This has an impact on the possibilities for reuse.

Method

I conducted a small online survey with five participants who use different types of autoinjectors. Through Instagram stories, I asked the question: “How do you use/ handle/ transport your injection pen?” Through literature research, I found more uninteded use scenario’s.

Participants

- P1: Insulin autoinjector
- P2: EpiPen
- P3 & P4: Rheumatoid arthritis
- P5: Migraine

Different autoinjectors

The insulin, migraine and rheumatoid arthritis autoinjector should be stored in a cool place. Therefore, they often have a fixed storage place, such as a fridge at home.

The EpiPen does not have to be cooled and is often carried close to the user, so adrenaline can be administered in case of a serious allergic reaction. Thus the EpiPen does not have a fixed storage space but is stored in pockets and bags. This provides more options for accidental misuse. However, Ypsomed does not produce EpiPens, so these misuse scenarios are not relevant for the YpsoMate Refill redesign.

Results

The unintended actions below are divided into the steps shown in the use scenario.

Storage:

1. Not cooling the autoinjector while traveling. (P1, P2)
2. Dropping the injection before and/ or after use. (P1, P5)
3. Scratching the autoinjector during transportation (internet source)
4. Drowning the autoinjector (EpiPen) in a washing machine, after leaving it behind in worn clothing (McCray et al., 2020)

Injection:

5. Using an autoinjector (EpiPen) past its ‘use by’ date. (Rimler, 2020)
6. Unintended injection
7. Stop injection too early

Dispose

8. Not bringing the sharp waste bin with autoinjector back to the pharmacy, so the autoinjectors lie at home for years.
9. Disposing of the autoinjector into the general waste bin instead of the sharp disposals container (fixme source internet).

P3 and P4 mentioned no unintended use. They keep the autoinjector in a box in the fridge till they need to use it and then quickly dispose of it after use.

P2 mentioned that she always travels with her EpiPen in her bag. The EpiPen comes in a plastic protection box (figure fixme), which she stores in a small leather bag (figure fixme) inside her bag (figure fixme). Due to this protection box, she mentioned she is not afraid to scratch the EpiPen.However, this scenario of transportation is not relevant for YpsoMate, since Ypsomed does not produce Epipens.

Unintended use scenarios 2, 3, 4, 7, 8 and 9 have an impact on refilling the used autoinjector. These are important to take into account for the YpsoMate Refill.

The other unintended use scenarios do not impact the autoinjector. Thus, this report does not discuss these further.

Fig. 206: Figure fixme: P2 recieved EpiPen inside a plastic protection box.

Fig. 207: Figure fixme: P2 keeps EpiPen inside leather bag.

Fig. 208: Figure fixme: This leather bag is stored inside her backpack.

Appendix C: Autoinjector trends

The autoinjector market is continuously evolving, with new trends emerging in the areas of sustainability, connectivity, platform design for different drugs and volumes, and needle-free injections.

Sustainable autoinjectors

As described in the introduction, sustainability is getting more attention in the autoinjector industry. Pharma companies are working to develop reusable autoinjectors, use biomaterials, and implement recycling programs to decrease their environmental impact (Simpson, 2020).

Connectivity

Connectivity is becoming an increasingly popular trend in the autoinjector market, with devices such as the Philips Aria (Fig. 28), YpsoMate On (Fig. 29), and YpsoMate SmartPilot (Fig. 27) offering the ability to connect to a patient's phone. These connected devices can help with medicine management by providing reminders for when to take medication, tracking injections and adherence, and communicating this information to the patient's doctor to improve treatment outcomes. Additionally, these connected devices can easily track the expiration date of the medication and alert the patient accordingly.

While the YpsoMate On and the Philips Aria integrate connectivity into the autoinjector, the YpsoMate SmartPilot is a reusable add-on device that makes a single-use autoinjector smart (YpsoMate, n.d.). Via an NFC tag, the YpsoMate autoinjector can connect to the YpsoMate SmartPilot. This way, the disposable YpsoMate autoinjector does not require a battery.

Some autoinjectors now feature electronic screens and LED lights to enhance the user experience. For example, the Philips Aria has a user interface that provides feedback on the injection sequence and how to use the device, and the YpsoMate SmartPilot uses LEDs and audible feedback to communicate with the patient.

However, the increased use of electronics and batteries in these connected devices raises concerns about their environmental impact (Granta Edupack, 2022). To address this issue, some companies like Philips are developing reusable electronic autoinjectors, which can help minimize the environmental footprint of these devices (Fraenkel & Sørensen, 2021).

Fig. 209: Through LEDs, the SmartPilot communicates when the drug has reaches room temperature and is ready for injection.

Fig. 210: The Philips Aria has a screen-based user interface and can be connected to a phone (Phillips-Medisize, 2022).

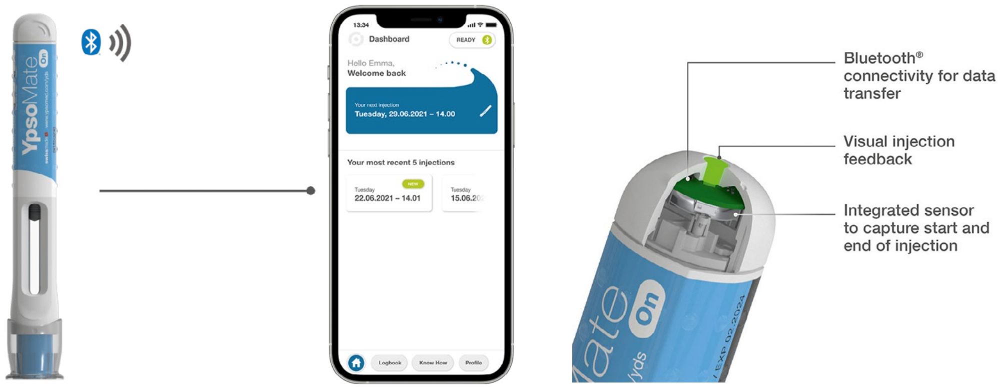


Fig. 211: The YpsoMate On can be connected to a phone (YpsoMate On, n.d.).

Platform for different drugs & volumes

The demand for autoinjectors that can accommodate a wider range of drugs and volumes is on the rise. This provides an opportunity for pharma companies to create versatile platforms for different medications. For example, Ypsomed has developed the YpsoMate 2.25 mL and YpsoMate 5.5 mL high-volume autoinjectors. These are equipped with a higher spring force to inject the large injection volume within the standard 10 seconds time frame (Ypsomed, 2022).

Motor-driven injection

Other companies, such as Philips and Recipharm, have chosen to use motors instead of springs to push the plunger down. This approach has several advantages, including the flexibility to tailor the motor force for varying drug viscosity, fill volume, needle size, and drug delivery time (Recipharm, n.d.). Additionally, if the patient accidentally removes the autoinjector from the skin, the motor-driven injection will automatically stop, preventing wasted medicine. This is not the case for spring-driven autoinjectors, which will complete the entire injection regardless of the device's position on the skin.

However, using a motor-driven autoinjector also has its drawbacks. The device battery needs to be charged to work, and the environmental impact of a motor-powered autoinjector is higher than a spring-powered version due to the addition of a motor and battery (Granta Edupack, 2022).

Takeaways

The following trens are emerging in the autoinjector market:

- ***Sustainability*** gets more attention with recycling programs, reusable autoinjectors and biomaterials.
- ***Connected autoinjectors*** can help with medication management, but adds electronic waste to the injector.
- Companies are developing v***ersatile autoinjector platforms*** that can accommodate a wider range of drugs and volumes.
- ***Motor-driven autoinjectors*** offer the ability to tailor the motor force for different drugs, but also have drawbacks such as the need for battery charging and higher environmental impact.

Needle-free injections

Another trend is the technological advancements of needle-free injections. These jet injectors shoot medicine into the skin at high pressure, eliminating the need for a needle (Appendix E). Needle-free jet injections have been around since the 20th century (Warren, 1955) and the improved technology is used in modern-day insulin injectors, such as InsuJet (InsuJet, n.d.). An advantage of needle-free injections is that they can decrease the pain and fear associated with needles (Insujet, n.d.).

However, the current needle-free injectors available on the market have a limited injection volume of 1 mL (Biojector 2000). Moreover, they do not provide sufficient precision in terms of dosage, depth, and location under the skin (University of Twente, 2022).

To address these precision limitations, researchers at the University of Twente in the Netherlands are developing a needle-free injection that uses a liquid jet that is heated and shot by a laser (Fig. 25). This technology promises to reduce the waste associated with injections since there would be no needle to replace (University of Twente, 2022). However, it could take up to ten years before this technology is market-ready (De Ingenieur, 2022).

Takeaways

- The University of Twente is developing laser-driven needle-free injections that have the promise of reducing waste (needles) and pain.
- It could take up to ten years before this technology is market ready.

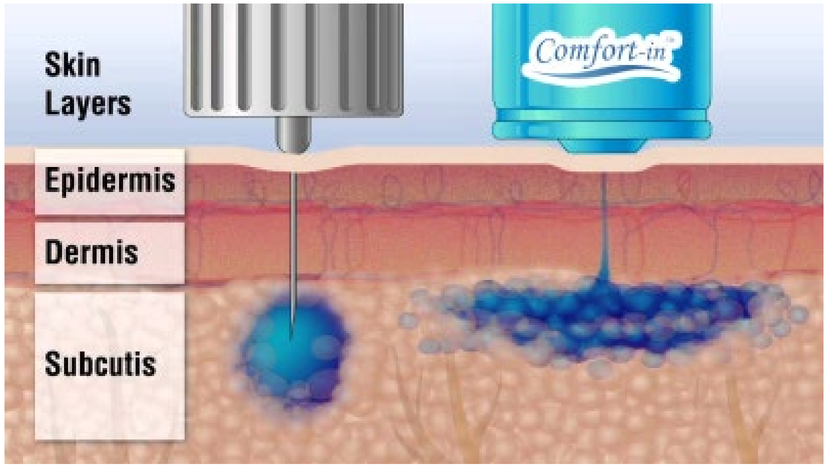


Fig. 212: Needle-free jet injections that are currently on the market push through the skin with a high-pressure liquid drug (Helcimon, n.d.).

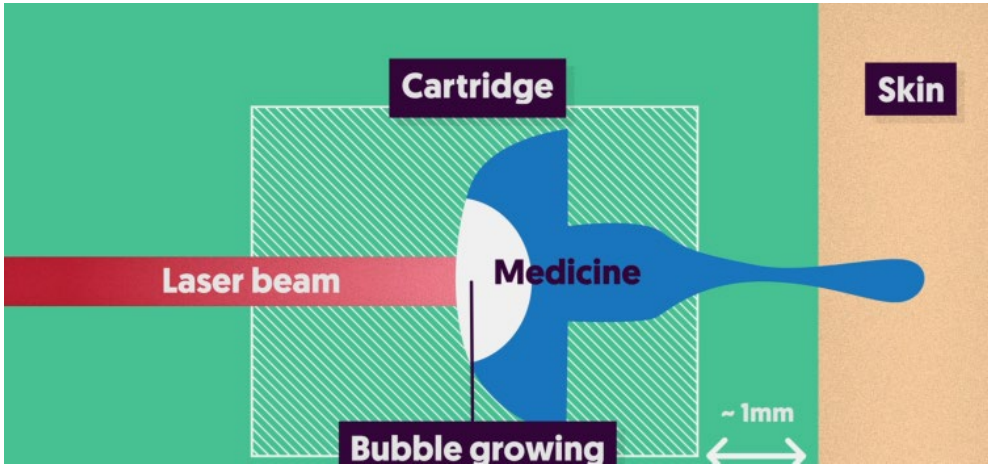
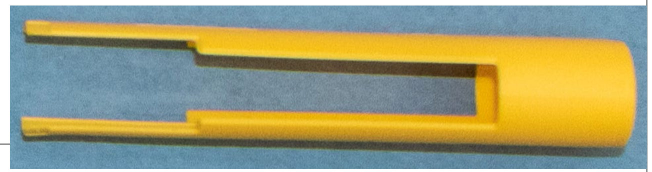
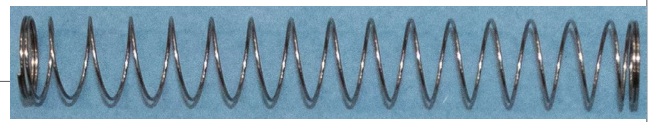


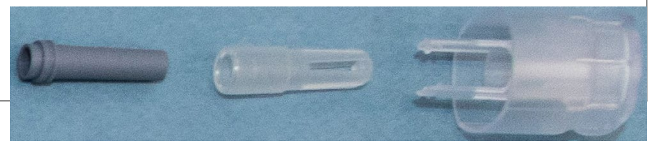
Fig. 213: The University of Twente is developing a needle-free injection that would penetrate the skin via a laser beam (4TU, n.d.).

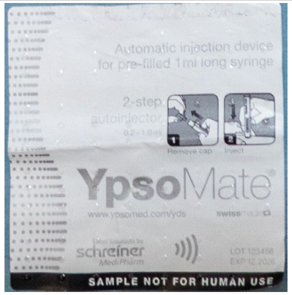
Appendix D: Functional Analysis single-use YpsoMate parts

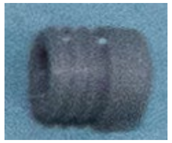
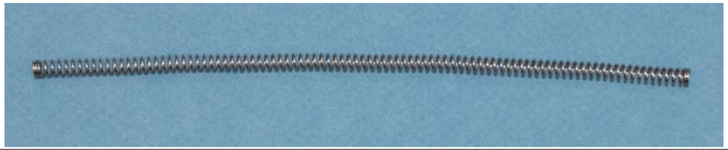
Part	Functions
Housing & end cap	• Ergonomic grip • Protects syringe & mechanism • Can hold spring forces • Creates end click sound • Viewing window provides clear view on syringe, medicine & progress of injection via coloured plunger rod
Cover sleeve	• Triggers injection when pushed • Comfortable platform on skin during injection • Blocks after injection to hide needle to prevent injuries
Cover sleeve spring	• Moves cover sleeve up & down.
Cap remover & needle shield	• Protect needle • Blocks injection from starting before cap is removed

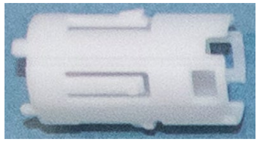
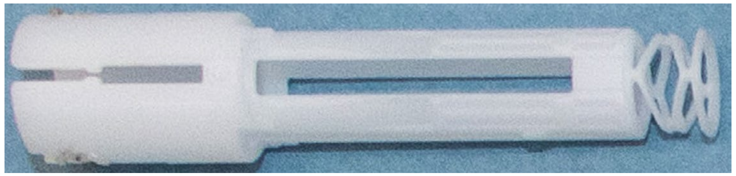
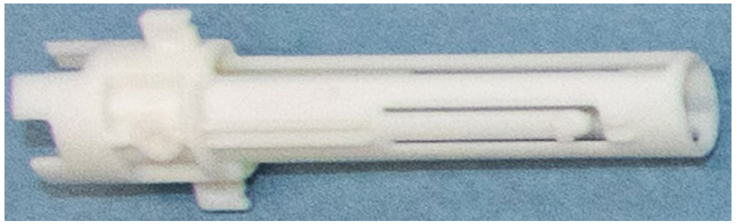






Part	Functions	
Label	• Communicates medicine specific info • Hides snapfits end cap	
Syringe	• Contains medicine	
Syringe holder	• Prevents that glass falls out of housing if syringe breaks. • Keeps syringe in place • Limits movement of cover sleeve • Transparency provides clear view on syringe, medicine & progress of injection via coloured plunger rod	
Needle	• Penetrates skin to inject medicine into subcutaneous fat layer	

Part	Functions	
Rubber plunger	• Pushes medicine through syringe	
Plunger rod	• Transfers spring injection force towards rubber plunger • The colour indicates the progress of the injection	
Injection spring	• Pushes plunger rod down to push medicine through syringe.	
Holding pin	• Holds injection spring in loaded position before injection.	

Part	Functions	
Telescopic lock sleeve (TLS) outer	• Slides over mechanic holder to move cover sleeve up and down	
Telescopic lock sleeve (TLS) inner	• Locks cover sleeve down after injection to hide needle	
Mechanic holder	• Keeps syringe in place • Spring dampens needle injection • Locks endcap in place • Keeps holding pin in place • Keeps click sleeve in place • Slider for telescopic lock sleeve	
Click Sleeve	• Creates the sound of the end click by smashing against the end cap.	

Appendix E: Supply chain of the YpsoMate autoinjector

Fig. 214 visualizes the supply chain of an YpsoMate autoinjector, based on a process map made by South Pole (2022). To declutter the image, I left out the import of raw materials and the intermediate and tertiary packaging.

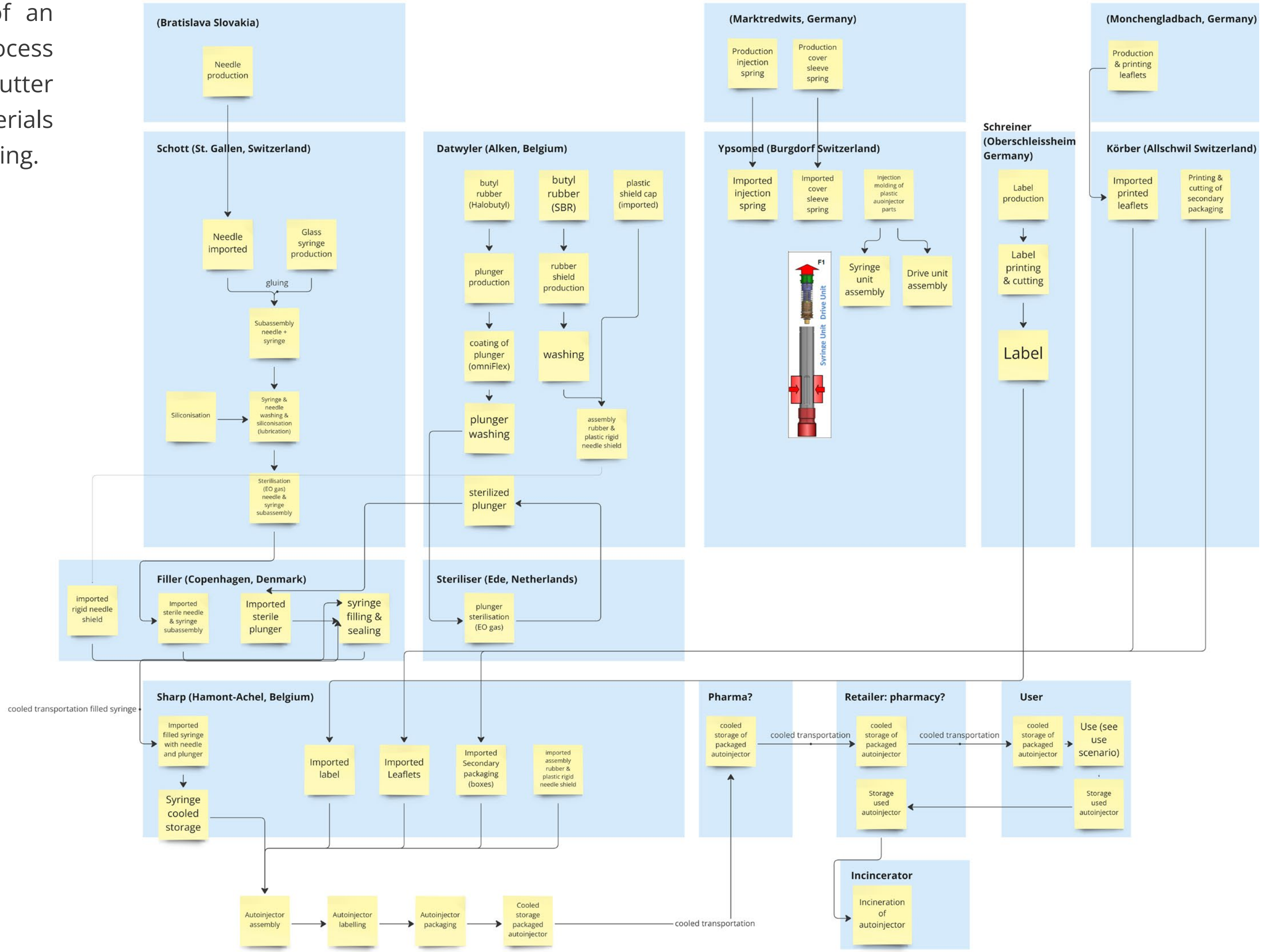


Fig. 214: Supply chain of a YpsoMate autoinjector based on the Life Cycle Assessment of South Pole (2022) commissioned by the Alliance to Zero.

Appendix F: High-level disinfection methods

The table bellow shows high-level disinfection methods, their advantages and disadvantages, environmental impact and compatibility with plastics and metals. The colors green, red and yellow indicate if a disinfection method scores good (green), medium (yellow) or bad (red) in a category. The information in the table comes from the following sources: (Rutala & Weber, 2013), (Center for Disease Control and Prevention, n.d.), (Chiu, 2015) (Plaskolite, 2020), (Yilmaz, 2020), (Centre for Disease Control and Prevention, n.d.), (Gill, 2021), , (IBL Specific, n.d.)

Disinfection method	Advantages	Disadvantages	Environmental impact	Compatibility with plastics	Compatibility with metal
Alcohol: Ethyl & Isopropyl (low level) (liquid)	• Fast acting • Evaporates quickly, leaving no residue • Used on wide range of surfaces • Effective against a wide range of microorganisms	• Does not kill spores. • Highly flammable	• Chemical free method • No chemical exposure for employees • Biodegradable	• Methyl alcohol can create cracks in polycarbonate • Compatible with	In high concentration corrosive (>500 ppm) to soft metals (aluminum) Safe to use on stainless steel.
Chlorine (liquid)	• Inexpensive • Fast acting	• Can cause respiratory problems • Harmful byproducts	• Can be harmful to the environment if not used or disposed of properly	• May damage polycarbonate (PC) & ABS • Compatible with POM	• Corrosive to metals in high concentrations (>500 ppm)

Disinfection method	Advantages	Disadvantages	Environmental impact	Compatibility with plastics	Compatibility with metal
Formaldehyde	• Effective against a wide range of microorganisms	• Toxic: can cause cancer. • Can cause respiratory & skin problems. • Irritating fumes & strong odor	• Can be harmful to the environment if not used or disposed of properly • Can be toxic to employees	• May damage PC & ABS • Compatible with POM	• Corrosive to metals in high concentrations
Hydrogen peroxide	• Does not coagulate blood or fix tissues to surfaces	• Can cause skin and eye irritation • Limited clinical experience	• Environmental friendly by-products (water, oxygen)	• Compatible with PE, PP and PTFE, etc. • Up to 3% Hydrogen Peroxide is compatible with POM. • Can discolour, brittle or cloud plastics (PC, ABS POM, PVC) in high concentrations or when left on the surface too long	• High concentrations can corrode metals, such as aluminum, copper & brass. • Compatible with stainless steel

Disinfection method	Advantages	Disadvantages	Environmental impact	Compatibility with plastics	Compatibility with metal
Glutaraldehyde	• Effective against a wide range of microorganisms • Long shelf live	• Toxic: can cause cancer. • Can cause respiratory problems • Expensive	• Can be harmful to the environment if not used or disposed of properly • Can be toxic to employees	• Compatible with most plastics • Can discolour, brittle or cloud plastics (PC, ABS and PVC) in high concentrations or when left on the surface too long	• High concentrations can corrode metals, such as aluminum, copper & brass. • Compatible with stainless steel
Ortho-phthalaldehyde (OPA)	• Effective against a wide range of microorganisms • Fast acting • Low odor	• Expensive • Harmful byproducts	• Byproducts can be harmful to the environment if not used or disposed of properly	• Compatible with most plastics • Can discolour, brittle or cloud plastics (PC, ABS and PVC) in high concentrations or when left on the surface too long	• High concentrations can corrode metals, such as aluminum, copper & brass. • Compatible with stainless steel
UVC	• Effective against a wide range of microorganisms • Chemical free • Fast	• Only disinfects non-obstructed surfaces that the UVC light can reach. • UVC light is harmful to human skin and eye	• Chemical free method • No by-products • Potentially high energy use	• Acrylics, PC, PVC and PS can become brittle, discolored or lose transparency when exposed to UVC light	• Yes

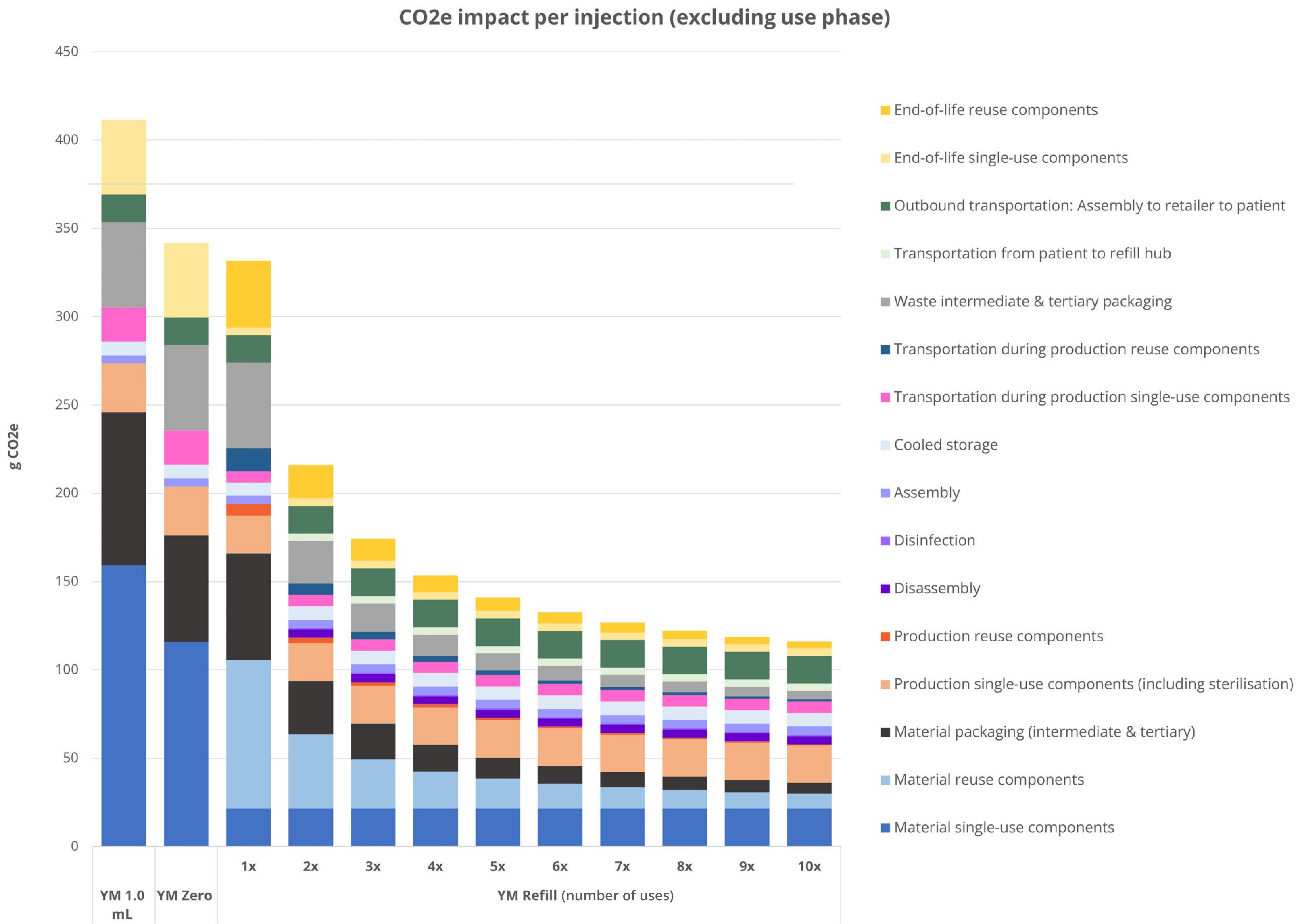


Fig. 215: The CO2e emissions (g) of the single-use YpsoMate 1.0 mL and YpsoMate Zero excluding the use phase in comparison to the CO2e (g) emissions of the YpsoMate Refill concept over multiple reuses. The parts are not recycled at their end-of-life, but incinerated/ landfilled.

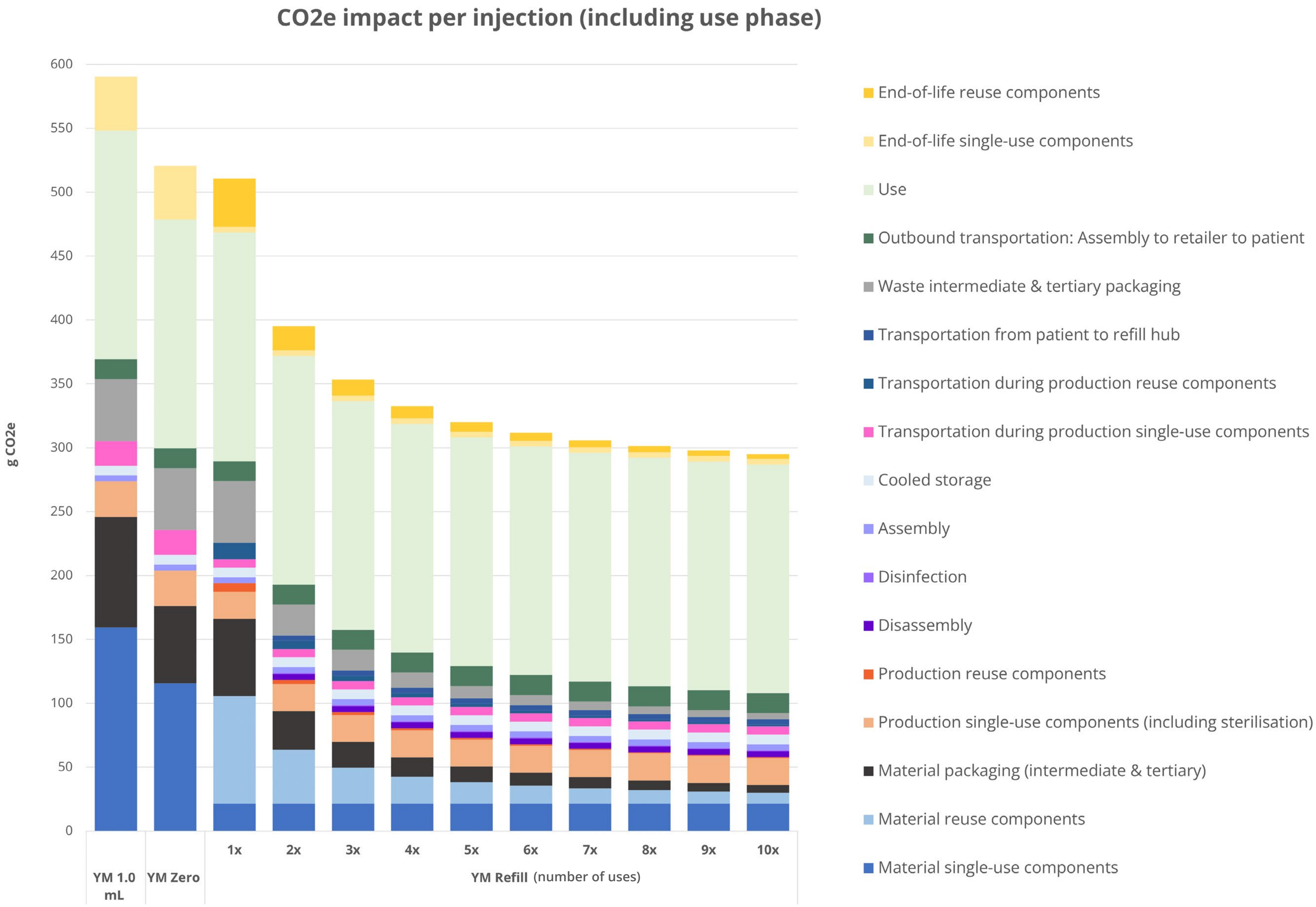


Fig. 216: Figure fixme: The CO2e emissions (g) of the YpsoMate 1.0 mL and the YpsoMate Zero including the use phase in comparison to the CO2e (g) emissions of the YpsoMate Refill concept over multiple reuses. The parts are not recycled at their end-of-life, but incinerated/ landfilled.

Appendix G: Project brief

Design of a refillable autoinjector product-service system | project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 12 - 09 - 2022 | 31 - 03 - 2023 end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Context:
If the global health care sector were a country, it would be the fifth-largest greenhouse gas emitter on the planet [1]. Health care's climate footprint is smaller than that of China, the United States, India, and Russia but larger than Japan's and Brazil's. By contributing to 4,4% of the global net greenhouse gas emissions and toxic air pollutants [1], the healthcare sector is jeopardizing its mission to protect people's health.

This graduation project focuses on reducing the environmental impact of a specific product in this healthcare environment: an autoinjector. Autoinjectors are used to self-inject drugs safely and conveniently in emergency situations such as anaphylaxis (severe allergic reaction), migraine and epileptic seizures or for chronic conditions like psoriasis, multiple sclerosis and rheumatoid arthritis [2]. These injectors are optimized for ease of use, administering the injection one-handed by pushing a button or placing the device onto the skin.[3]

More than 20 pharmaceutical companies have developed nearly 80 autoinjectors until today. Of the around 50 approved drug-autoinjector combinations on the market, 62% are disposable autoinjectors [4]. These disposables generate a large hazardous waste stream that ends up in landfill or incineration. The LCA in figure 1 shows that more than half of the CO_2 emissions of an autoinjector are generated during the production. By refilling the autoinjector, these emissions can be reduced since less autoinjectors will be produced.
Based on the research insights during this graduation project, an autoinjector will be redesigned to be optimized for refill by either the producer, pharmacy, or another suited stakeholder.

Stakeholders (see figure 2):
Currently, Johnson and Johnson is launching a takeback scheme for autoinjectors, to enable recycling. However, no system exists for taking back and refilling auto injectors. A complex web of stakeholders is involved in this system; pharmaceutical companies, packaging producers, assembly and waste managers, patients, pharmacies, doctors, etc.
The Alliance to Zero expressed that pharmaceutical companies feel the need to reduce the environmental impact of auto injectors, due to upcoming regulations, patient expectations and shareholder ratings [5].
The Alliance to Zero is a non-profit organisation for pharma and biotech supply chain companies that aims to facilitate the transition of the pharma sector to compliance with net-zero emissions, including waste reduction [6]. Together with the faculty of Industrial Design Engineering at the TU Delft, they have initiated a series of graduation projects to design an autoinjector that fits into the circular economy. This graduation project focuses on the 'reuse' loop of the circular economy by designing an autoinjector that is refilled away from the patient. This project will be done under the additional mentorship of npk design, a product design consultancy with valuable practical knowledge on sustainable and medical product design.

Sources:
[1] Karliner, J., Slotterback, S., Boyd, R., Ashby, B., Steele, K., & Wang, J. (2020). Health care's climate footprint: the health sector contribution and opportunities for action. European Journal of Public Health, 30, 165-843.
[2] R. Vijayaraghavan, Autoinjector device for rapid administration of life saving drugs in emergency, Def. Sci. J., 62 (2012), pp. 307-314 [3] Global Autoinjectors Market, 2016, Global Autoinjectors Market, 2016, (Accessed 8 August 2022)
[4] Roy, A., Geetha, R. V., Magesh, A., Vijayaraghavan, R., & Ravichandran, V. (2021). Autoinjector–smart device for emergency cum personal therapy. Saudi Pharmaceutical Journal, 29(10), 1205-1215. (see 'planning' for more sources).

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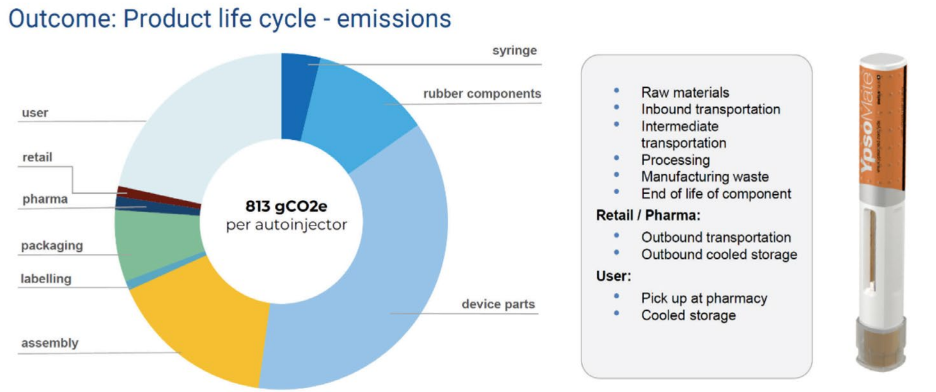


image / figure 1: LCA of autoinjector [6]

image / figure 2: Graduation support team & Research questions

Initials & Name E.M. Linders Student number 4545699

Title of Project Design of a refillable autoinjector product-service system

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Philips [7], Ypsomed [8], Jabil [9] and other companies launched reusable autoinjectors that can be refilled by the patient. However, refilling adds extra use steps that might be difficult in emergency situations or for infrequent or physically disabled users.

Therefore, the Alliance to Zero asked me to look into opportunities where the producer or other stakeholder, instead of the patient, is responsible for refilling the autoinjector. This could for example be an autoinjector as a service (e.g. access model [10]), where a stakeholder collects, cleans, and refills the autoinjector before delivering it to a new patient. So, one autoinjector could be used by e.g. fifty different patients to reduce waste, material, and energy use. From now on, this will be called the 'away-from-patient refillable autoinjector'.

The main focus of this graduation project will be on the product embodiment of the refillable autoinjector. The goal is to design a refillable autoinjector for a product-service system. Then, to compare this design to existing single-use autoinjectors and patient-refillable autoinjectors based on fast-track LCA's, safety, hygiene, comfort, ease of use and cost-effectiveness.

Since the refillable autoinjector will most likely be a part of a product-service system, the system should also be researched. However, my master, interests and learning goals focus more on product embodiment, so the service around it will get less priority. Therefore, the service will be worked out in less detail on a higher concept level.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

This graduation project aims to propose a redesign for an autoinjector as a service, which is refilled away from the patient. This includes redesigning the product architecture and service for ease of refill and cleaning (away from the patient) to decrease the waste and thus energy and material use. Meanwhile, the (needle) safety, hygiene, comfort, and cost-effectiveness of single use autoinjectors should be maintained.

This graduation project aims to design a product-service system of an autoinjector that is refilled away from the patient. The main focus is the design and embodiment of a refillable autoinjector, which results in the 'research questions autoinjector design' in figure 2.
To answer these research questions, my goal is to deliver a design of the autoinjector at Technology Readiness level 4 [11], which is defined as: "Proof of concept Prototype: testing done on core mechanisms and functions." This design will be used to conduct a fast track LCA, to compare the environmental impact to single-use and patient-refillable autoinjectors. A HotSpot analysis and disassembly map will be used to determine the ease of cleaning parts and reassembly. Moreover, the estimation of cost price, hygiene and safety will be compared to the mentioned status quo autoinjectors.
Furthermore, this design will result in an operational model, which "communicates how the product is used with the potential for ergonomic evaluation." [12]. This prototype will be used to do qualitative user testing to evaluate the ergonomics, ease of use and comfort in comparison to single-use and patient-refillable autoinjectors. Moreover, this prototype will be used in interviews with production & assembly experts (e.g. factory workers) to evaluate the ease of cleaning, refill, and reassembly.
As stated in the problem definition, the service-system around the product has less priority than the autoinjector embodiment. Therefore, the 'research questions service system design' in figure 2 are relevant, but will be researched in less detail, at a higher concept level.

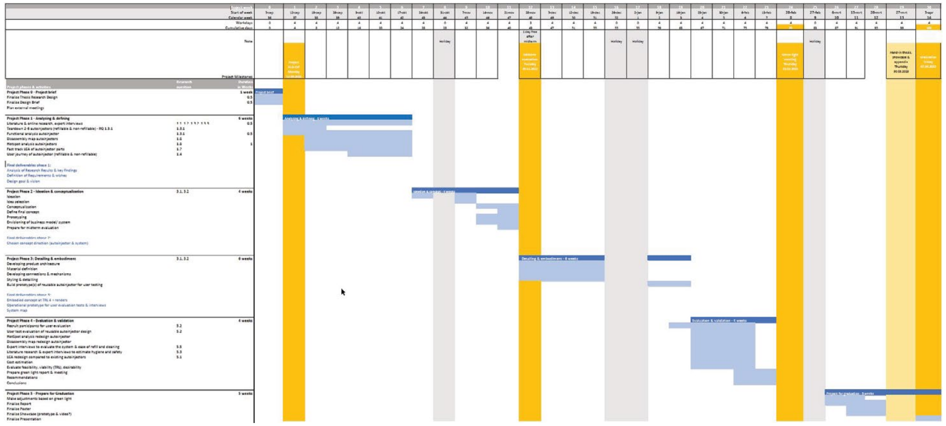
Initials & Name E.M. Linders Student number 4545699

Title of Project Design of a refillable autoinjector product-service system

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 12 - 9 - 2022 | 31 - 3 - 2023 end date



The graduation project is structured in 5 main phases, with a week of preparations before the kick-off meeting.
The project will extend to 31 weeks since I am also a student assistant at the TU Delft for 8 hours a week. Thus, I'll be working on the graduation project for 32h a week instead of 40h. There is also a Christmas holiday scheduled and two one week holidays to take some time to energize.

Main project milestones:
Kick-off meeting: Monday the 12th of September
Midterm evaluation: Day 41 - Tuesday the 29th of November 2022
Green light meeting: Day 81 - Thursday 23 February 2023
Presentation & graduation: Week 14 2023

Additional sources of previous chapters;
[5] alliance to zero ppt
[6] Alliance to Zero. (n.d.). Alliance to Zero - net zero emissions across the pharmaceutical supply chain. Retrieved August 20, 2022, from https://alliancetozero.com/
[7] Philips. (2022, May 5). Smart Autoinjector Platform | Phillips Medisize. Phillips-Medisize. https://www.phillipsmedisize.com/products/smart-autoinjector/

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

In the book 'Products that Last' (2010), C. Bakker et al. writes that for circular design, a business is needed that is "based on a credible challenge which is also exiting and fun to tackle." For me, this project provides such a challenge.
This project is close to my heart since I use an autoinjector monthly for my migraine medicine. The amount of waste I'm generating shocked me; I have over thirty autoinjectors pilling up in my closet.

Therefore, I am excited to look into ways to reduce this waste and specialize more in circular design. After following multiple courses about sustainable and circular design, I look forward to putting this knowledge into practice. During this project, I would like to use tools such as rapid LCA's, HotSpot maps and disassembly maps.

Moreover, the medical field is an area that I have never explored, thus this project provides many learning opportunities.

During this project, I aim to improve my project and time management skills. During previous projects and my internship at npk design, I did make plannings and kept an overview of my work. However, I sometimes have difficulties with estimating how long a task will take, therefore taking longer than expected in my planning.

My goal is to end this project with a Technology Readiness Level 4 design and performance prototype of a refillable autoinjector. Changing the single use autoinjector into an away-from-patient refillable one has consequences on the (embodiment) design. I would like to explore this among other things through rapid prototyping.

Further, I enjoy making visualisations to clarify designs and processes. I aim to use sketching and rendering throughout my project and would like to improve these skills.

I look forward to advising the Alliance to Zero on ways they could create a sustainable refillable autoinjector. I could envision a career in consulting companies on sustainable and circular product design, so hopefully this graduation project could be a step in that direction.

So, in summary, my learning objectives are;
1. Gaining in depth knowledge on sustainable and circular design.
2. Broadening my design field by learning about medical design.
3. Improving my project and time management skills.
4. Getting hands-on experience in embodiment design and rapid prototyping.
5. Improving visualisation skills through sketches and renders.

Additional sources from previous chapters;
[8] Ypsomed. (n.d.). FixPen – The easy-to-use fixed dose pen. Ypsomed Delivery Systems. Retrieved August 20, 2022, from https://yds.ypsomed.com/en/injection-systems/pen-injectors/fixpen.html
[9] Jabil. (n.d.). The QfinityTM Autoinjector Platform | Jabil. Jabil.Com. Retrieved August 20, 2022, from https://www.jabil.
[10] Bakker, C. (2014). Products That Last: Product Design for Circular Business Models. Laurence King Publishing.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Additional sources from previous chapters;
[11] Technology Readiness Levels (TRLs) in Design and Engineering. (n.d.). 4c. Retrieved August 30, 2022, from https://www.4cdesign.co.uk/blog/technology-readiness-levels/
[12] Evans, M. (n.d.). iD Cards | School of Design and Creative Arts | Loughborough University. Loughborough University