# ECSense

## International Product Development Project Report


**And**


**Spring Semester, 2022**

# Inhaltsverzeichnis

## 1. Introduction „Inno.Space“ and DFGN

DFGN stands for„Design Factory Global Network“. It is a network of innovation hubs at universities on five continents [1]. „Inno.Space“ is the Design Factory of the Hochschule Mannheim which was established in 2017. Since then students from all faculties of bachelor and master studies contribute in a variety of projects to develop prototypes for different products and ideas. This report presents the work done by one of the groups participating in the IPDP (**I**nternational **P**roduct **D**evelopment **P**roject) course held by Inno.Space in summer semester of 2022.
The project is performed in teams of different faculties and nationalities. In this case the German half of the team consisted of a Medical Informatics student and a Mechanical Engineering student. The Finish side consisted of a Smart and Sustainable Design student from HAMK University of Applied Science of Hämenlinna.

## 2. Design Thinking and Human Centred Innovation

The Design Factory projects use a methodical innovation approach called Design Thinking. A common misconception about design is that it mainly focuses on the esthetical aspects of a product or a certain idea. In fact esthetics are a part of design but by far not the biggest or most important part. Design is a complex process that is both technical and creative at the same time [4]. Every design starts with the understanding of a problem. In the Design Thinking method this part is called **empathise.**

The designers have to become specialists and gather as much information as possible about the product or the specific challenge that they are given. This is done by defining the respective stakeholders of the problem that is supposed to be solved. It is crucial to get in touch with those stakeholders and interview them to find out about their routines and general contact points to the problem. It is very important not to be biased when doing interviews. For example not to ask questions that imply certain answers you might assume or expect them to give. Questions have to be very open and target the stakeholders true opinion and feelings concerning the problem [3].

With the information gathered in these interviews the second part of the **empathise** phase starts. Analysing the goals that stakeholders have is a way to define the actual “Innovation Space”. Those goals can be “Do -Goals” [3] so concerning what a user wants to do, or “Be-Goals” [3] concerning how a user wants to feel. There are several methods available to analyse the information. One possible way is creating a persona which would be a fictional stakeholder consisting of the synthesised information the interviews have given. Another feasible method is creating a User-Journey [Table 1]. This approach on finding out about possible innovations, places the human being in the centre of the process. Human centred design is not about creating solutions that are highly sophisticated or technical, but to meet the needs of the stakeholders and creating a pain relief for the problems stakeholders have.

In the **ideation** phase the synthesised information is creating the “Innovation Space” which sets the boundaries for a possible solution. In a brainstorming the team gathers the ideas from each team member and discusses them. With the synthesised information it can be helpful to create so-called “How might we…” questions which are supposed to precisely name the actual problem that is

desired to be solved. In the case of our project the question was “How might we implement pathways for a new approach on Liquid biopsy testing?. This part of the Design Thinking method can be quite short but is crucial for the next steps. After the ideation there should be as many solutions as possible to continue with the next step. The **prototyping.**

**Prototyping** doesn't necessarily mean to build a working product but to make something that gives users the opportunity to experience how the solution would feel and what the main innovation features are. It is a great way to verify the idea for the team itself. Not every idea that seems feasible on paper proves itself in prototyping.

With the prototypes in hand the **testing** phase gathers more information about the quality of the solution being developed. The idea embodied by the prototype has to be tested with the actual stakeholders. What is the opinion of those people about the prototype?

Although testing is the last phase of the process it is not the end of the method. Along the way it can always happen that the path a project has taken turned out to be wrong. This doesn't mean it is a failure! The Design Thinking method is based on iteration. One very important part of working with this method is not to get too attached to your idea. Being able to change course when needed and start over with the Ideation is common practice in Design Thinking.

This graphic shows the steps of Design thinking and visualises the iterations of the method. The first three steps were summarised in the Empathise phase.

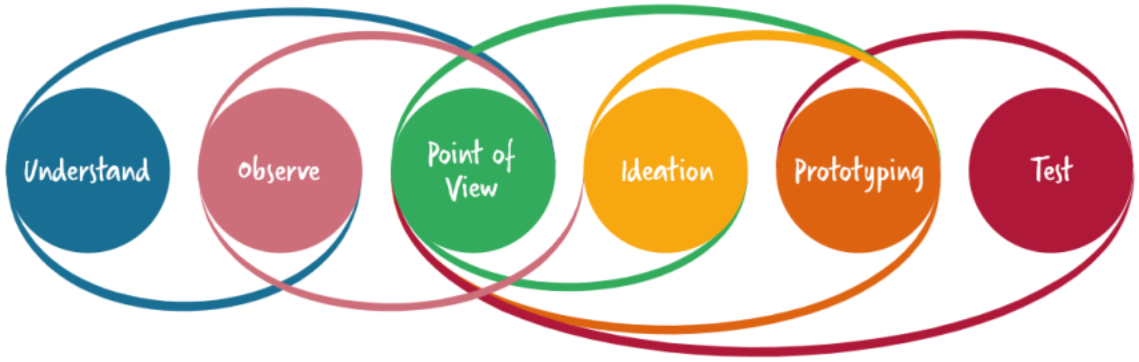


Figure 1: Design Thinking process graphic [10]

## 3. Project and sponsor introduction

### Challenge for iPDP 2022 - ECsens

With its Lab-on-a-Chip platforms [2] for liquid biopsies, the university spin-off ECsens [11] provides a nanoscale engineering solution that is extreme sensitive and selective in detecting parthenogen particles. This makes it especially well-suited to reinvent the process of diagnose/treatment of respiratory infections/diseases e.g. in context of COPD (Chronic Obstructive Pulmonary Disease) or Corona. The goal of this student project is to target the following question:

**How might we integrate the diagnostic value of the Lab-on-a-Chip technology into the process/service of diagnosis and treatment of patients by care givers e.g. in hospitals or at general practitioners.** This general information and “How might we…?”-Question was created by the Sponsor ECSens.

The IPDP is performed in interdisciplinary and international teams of students that are working with a sponsor company which is already established in the market or is about to launch a product to the market. To research and find out about opportunities to improve, or fully develop ideas concerning their product is the central goal of this cooperation.

In this case this sponsor is a Dutch university spinoff with the name ECSens. A high tech startup company developing in the field of nanotechnology and microfluidics to build a medical sensor device for liquid biopsy testing.

They first started to apply their knowledge to investigate ways for cheap, quick and easy to use cancer diagnosis over TdEV's (Tumour derived Extracellular Vesicles) found in the patient's blood. They learned to „coat" polished stainless steel surfaces in a way that antibody-like structures adhere to them [2]. When a particle of interest attaches to them, it causes the induced current in the sensor to change and can be measured through a highly sensitive readout device.

The first published paper on that achievement dates back to 2019 [2]. As the Covid-19 pandemic started, detecting viruses became an even bigger need that their technology was able to meet.

The current testing solutions being the very unreliable but cheap quick tests and the very precise but tedious and labour intensive Polymerase Chain Reaction(PCR) tests. It was obvious that a need for cheap, quick, easy to use and reliable testing existed.

Dr. Pepijn Beekman, the CTO of ECSens, explained to us that his company is applying on the SarsCov2 virus what they researched originally to detect TdEV's for cancer diagnosis and is going to be able to even beat PCR tests in reliability. PCR tests cannot be replaced entirely because of their accuracy and adaptability to any type of DNA. Its biggest strength though, the accuracy, becomes a weakness in the scenario of a pandemic. As the amount of tests being made rises, the control of environmental impacts on the results, becomes more and more difficult. The handling of the samples taking at least two hours, gives contaminants a big window to enter the sample and ruin the result.

This cleanliness during handling required for such a huge amount of tests is very expensive because of labour and special facilities needed. By reducing labour and time consumption to about the time and labour needed for Covid quick tests, ECSenses technology has the power to replace PCR in respiratory disease detection entirely.

They reached out to Inno.space to gather information about the possible ways to implement their product in an existing health care system with the digitalisation process in mind.

# 4. The project

## 4.1. Empathise

To learn about the challenge and the product of ECSens a brainstorming was done to build a Stakeholder Map [Figure 2]. Stakeholder is every person that could possibly get in contact with a certain product or idea. With the guidance of the Desing Thinking process we started to gather thoughts and ideas.

Collecting the information from our first meeting with the sponsor company combined with possible aspects that define the product and the goal of the product a list was created. We expressed those findings through questions that needed to be answered.

- How can we create a faster broader cloud-automated connection between all medical-device-related stakeholders?
- How can we create a data-privacy and secure respecting system that conforms to ISO-standard (HL7), GDPR (General Data Privacy Regulations)?
- How can we improve the on boarding process to include 100000s of hospitals?
- How to explain the virus detection outcome (yes/no, stages in cancer, etc...), and give suggestions (eat, medicines, clinics, lifestyle)?
- How to not replace doctors, but enhance their capabilities?
- How to reduce time getting a diagnosis (e.g. less time in bed)?
- How to raise the value of individual diagnosis in a shorter time?
- How to reduce stress for doctors, ability to handle more things (more subjects, research)?
- How to increase the capacity of the hospitals?
- How to ease communication around the world, and increase speed to research new therapeutics because doctors have more data access?
- How to increase likelihood of correlations for rare diseases?
- How can we confirm the accuracy of the results?
- How can we connect other devices together to get a diagnosis

The **benchmarking** was done to define which aspects could possibly affect the success of the product:

Benchmarks

- ISO (International Organization for Standardization)
- GDPR [General Data Privacy Regulations]
- Amount of connected medical stakeholders (defines the versatility of the product)
- Cloud connection (ready for the use with any digitalised database)
- Usability (easy and intuitive)
- Price (affordable)
- Number of positive/negative reviews from doctors
- (Pros and cons from doctors perspective)

A market research was done which brought up the following two companies that we considered competitors to ECSens.

Competitors:

- Breathomix [6]
    - SpiroNose (direct, breath testing that was FDA approved)

The SpiroNose is a diagnostic tool that detects viruses contained in the patient's breath. It is used by exhaling into it.

- Abbot [7]
    - Molecular Rapid Test
    - Molecular Lab Test
    - Antigens

Abbot is one of the world's biggest producers of healthcare consumables and devices and produces Sars-Cov2 tests.

At First we made sure no one else already did what ECSens is trying to do. It is only worth chasing an idea if it hasn't been done or hasn't been done properly yet.

In comparison to ECSens the two competitors found were mainly focused on the Sars-Cov2 Virus. Instead of liquid biopsy testing which requires a liquid sample taken from the patient, the SpiroNose approach detects the aerosols that an infected person exhales. Although this seemed to us more comfortable than taking a liquid sample the use cases are strictly limited to the particles that can be found in the micro droplets exhaled by a person. Therefore we came to the conclusion that the Spiral Nose would only be a competitor for Covid-19 or respiratory disease detection ECSens was researching currently. In the long run ECSens's technology had way more opportunities for further development. Abbot on the other hand focuses on the quick tests but with the financial resources of a global player like Abbot they should be kept an eye on anyway.

### 4.1.1 Healthcare Digitalisation Germany vs. Finland

The German approach to centralized storage of digital health data is called Gematik [12]. Gematik GmbH was founded in January 2005 by the German health care providers to promote the introduction, maintenance and further development of the electronic health card and its infrastructure in Germany in accordance with the statutory mandate and to ensure the interoperability of the components involved. The goal is a simple, secure and targeted exchange of data between insured persons, physicians, pharmacists and health insurance companies via the electronic health card. Gematik's shareholders include the German Medical Association, the German Dental Association, the German Federal Ministry of Health, the German Hospital Association, the German Pharmacists' Association, the National Association of Statutory Health Insurers, the Association of Private Health Insurers, the National Association of Statutory Health Insurance Physicians and the National Association of Statutory Health Insurance Dentists. Although Gematik

was established in 2005, the system is still in the processing phase. It has been in use since 2022 but still has many problems in its use.

The Finish approach to centralised digital Healthcare data storage is called Kanta [13]. In My Kanta Pages you have access to your health records and prescriptions. You are able request and renew electronic prescriptions, view records related to your treatment, laboratory tests and x-ray examinations.

You can also access the EU digital COVID-19 vaccination certificate, if you have had the vaccinations. As well as other vaccination records that have been entered by a healthcare unit joined with Kanta. In addition to this, through My Kanta Pages you can save your living will and organ donation testament, consent to or deny the sharing of your data, and consent to the disclosure of prescription information to a pharmacy in another European country. To be able to use My Kanta you need a Finnish personal ID code and means of identification such as, online bank IDs, mobile IDs or an ID card for online services. It is also possible to have access to My Kanta through an organisation card or social and health care professional card issued by the The Digital and Population Data Services Agency. My Kanta Pages is a nationwide service, whether you use private, public or occupational healthcare services. They all use the Kanta Services. The health records shown are:

- patient records and diagnoses
- critical risk factors
- laboratory tests and X-ray examinations
- referrals
- health and care plan
- medical certificates and reports.

When visiting the My Kanta Pages or, a healthcare or social services provider, you will be informed about the use of data recorded and the operating principles of the Kanta services. As well as, information on how to determine how your data is processed. You will be requested to submit your consent to data sharing, this ensures that all service providers involved in your care have up to date and sufficient information about you. You may also enter a denial of consent to patient data sharing and a denial of consent to prescription data sharing if you wish to restrict the use of your data stored in Kanta. The consent or denial to data sharing can be issued on the My Kanta Pages alternatively, it can be done when you visit your health care service provider .

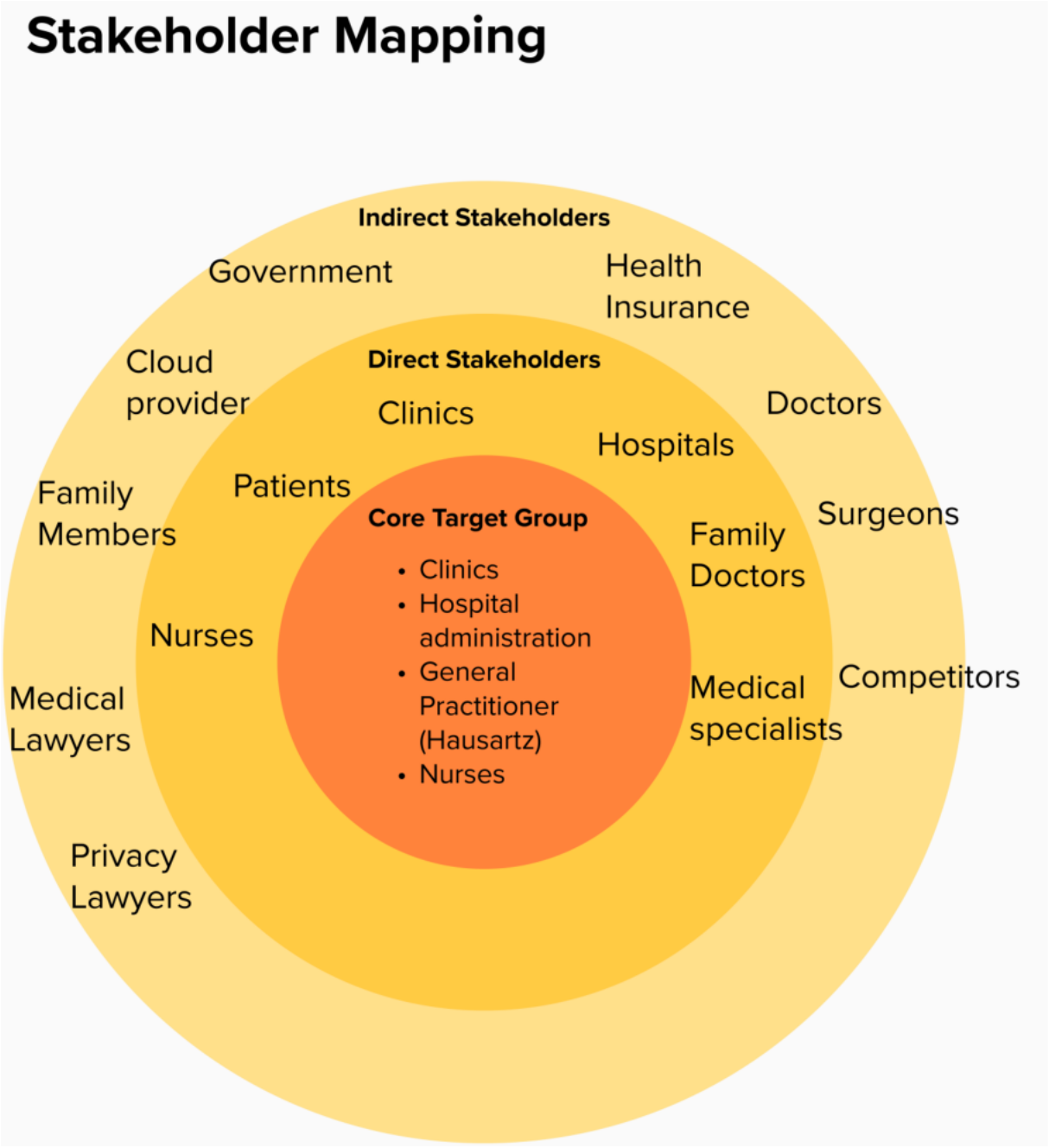


**Figure 2: Stakeholder Map**

The Stakeholder Map [Figure 2] is separated in three different areas. The outer ring represents the least important stakeholders and the closer to the centre you get the more important the stakeholders become. With this hierarchical order of the stakeholders the core target group of the product gets determined. This is important for finding the right interviewees for the project.

The core target group are those stakeholders that would have the most contact with the product and benefit or suffer the most from its features. At first the patient itself used to be one of our most important stakeholders too. But after a few Interviews we decided to put patients further out because we found out that patients generally accept technologies that the medical professionals accept. In our societies, at least in Finland and Germany we learned that there is a general trust in

doctors and medical professionals. The main goal for a new healthcare technology is to convince the medical professionals.

Finding interviewees from a medical professional background turned out to be difficult. Because of Covid it was not possible for us to walk into a hospital and ask the people working there. Neither could we go to General Practitioners for the same reason. They would only allow patients and employees entering their doctor's office.

We went on interviewing people in our own social environment. Friends and family studying medicine or doing apprenticeships in a medical context.

These interviews as our main source of information brought up some very surprising insights in the German healthcare system, especially concerning the existing structures of data sharing and the poor attempts of digitalising patients data and communication. In Finland in comparison a well working digital data system has been in place for many years.

In Germany a doctor that needs information from another has to make a phone call, then send a patient's consent by Fax. Then the information needed is sent hours or even days later, again by Fax. This is not only slow but a lot of unnecessary work for all involved parties. This process even turned out to be illegal by German GDPR but is still the most common way doctors share data with others in Germany. In Finland in comparison the patient opens his Kanta app, accepts sharing with the doctor and the doctor has full access to the needed information in seconds.

The information gathered was displayed in an Affinity Diagram [Figure 3] which combines all the interviews information onto a single page. With this kind of diagram a good overview is achieved and it is easy to work on as a team. With all the information collected the work on the Persona and User journeys [Table 1] began. The Persona didn't turn out to be the strategy for us because we had a limited amount of interview information so we decided to stick to the User Journey [Table 1].

The User Journey [Table 1] is done in a table which gets filled out with the specific findings from the interviews. It does not necessarily contain the answers of the interviewees but the conclusions that are drawn from them.

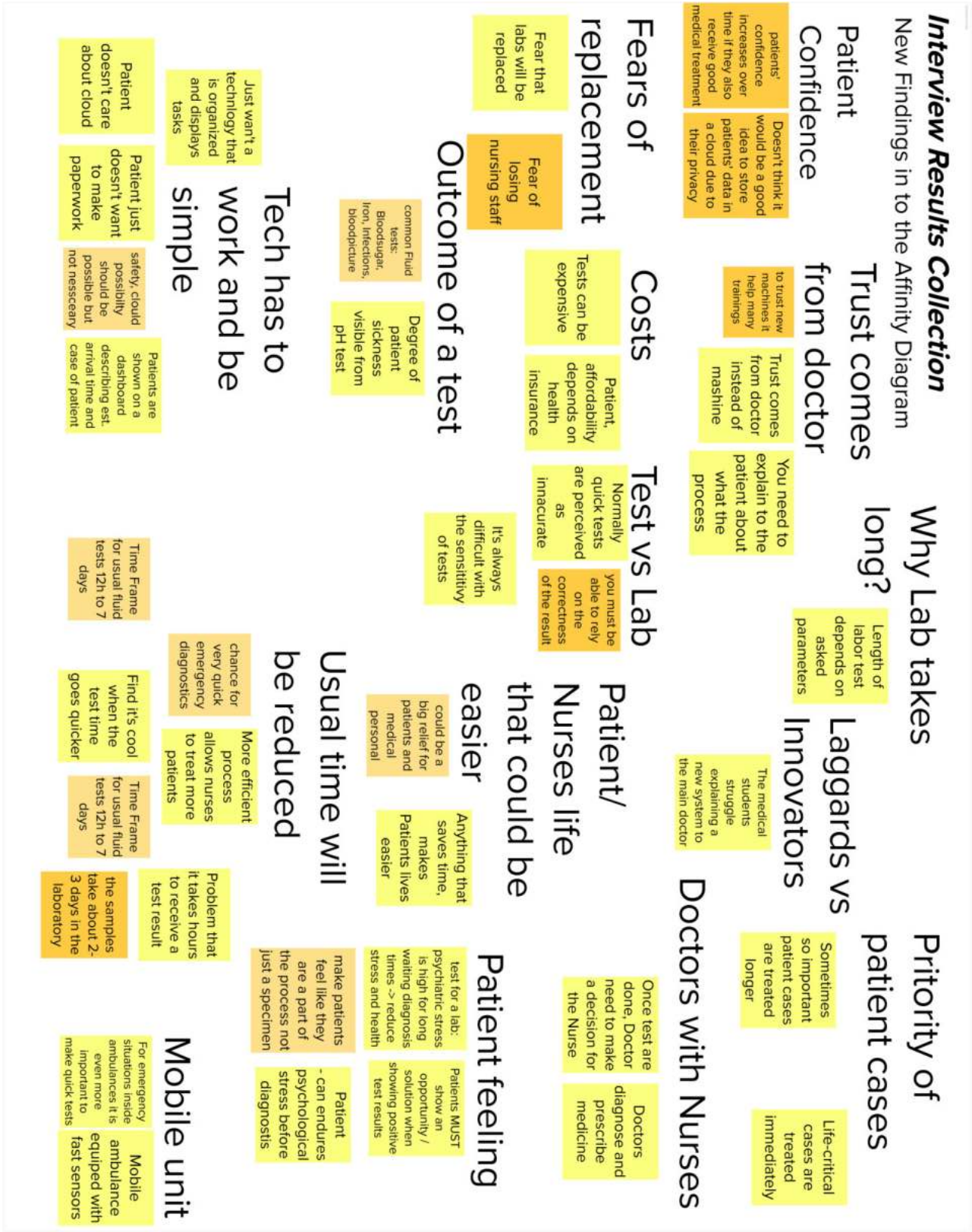


**Figure 3: Affinity Diagram**

| **Stages** | a patient needs medical help | patient arrives at doctor/hospital | samples are tested | sample results | patients data is saved | patients data is needed by a different doctor/hospital |
|---|---|---|---|---|---|---|
| **Steps** | patient calls doctor/hospital or ambulance - patients data collection: name, gender, age, address, insurance - patient gets advised what the next step will be I.e. going to the hospital, getting fetched by the ambulance.. | patients data gets double checked - samples are taken if needed for diagnosis - patients data is documented in datasheet | samples are sent to lab or if applicable quick tests are made - patient has to wait - if applicable pre diagnosis is made and general treatment started | doctor interprets results and advises treatment - results added to datasheet (in Germany usually by hand) | personal data and results are saved locally where the treatment happened - forms are filled out for insurance purposes | patient consent needs to filled out - asking for data by phone or fax - patients data is sent after hours or even days |
| **Positive Feelings** | making the patient feel calm and in good hands - being able to help someone who is in need for it | succeeding in making the patient calm and feeling in good hands - being able to help everyone who needs it | being able to provide appropriate treatment and diagnosis | having reliable tests - being able to treat patients in the best possible way | | |
| **Negative Feelings** | patients data transmission is very old fashioned (phone and fax) | documentation is very time consuming - a lot time spent not helping the patient | unable to do proper treatment during waiting times | data collection takes up too much time | spending a lot of time that doesn't help the patients | very slow and old fashioned - frustrating for patients and doctors |
| **Pain Points** | data transmission is slow and ineffective and spelling mistakes can happen | time spent with a lot of things in order of actual patients Treatment | waiting times | to many steps were spelling or other mistakes can happen | paperwork has nothing to do with helping people | slow and stressful process |
| **Opportunities** | automating data transmission | more time for better treatment | shorter waiting times can save lives | less mistakes | more time for helping people | save time and stress for doctor and patient |

Table 1: User Journey Map

## 4.2. Ideation

In the ideation, brainstorming about possible use cases of the ECSens device was done. To get a better feeling for the direction the project is going to, new “How might we…?” questions were thought out. The decision on two main questions was made:

- How might we implement pathways for a new approach on liquid biopsy testing?
- How might we integrate the device from ECSens into a digital healthcare data structure?

## 4.3. Prototyping

### 4.3.1 Cartridge recycling approach

This rendering [Figure 4] shows a design for the cartridge the sample is put into after its taken from the patient. It contains the sample well, the fluid lines, the sample is transported through, and most importantly the ECSens chip which is able to “catch” particles and therefore makes the whole system able to detect things. The Sample never leaves this cartridge. The cartridge has a QR code printed on it to identify each individual cartridge quickly and easily. The rendering [Figure 4] was the starting point for the physical prototyping that was done, mainly because there is a size estimation possible with the hand holding the cartridge at the bottom left.

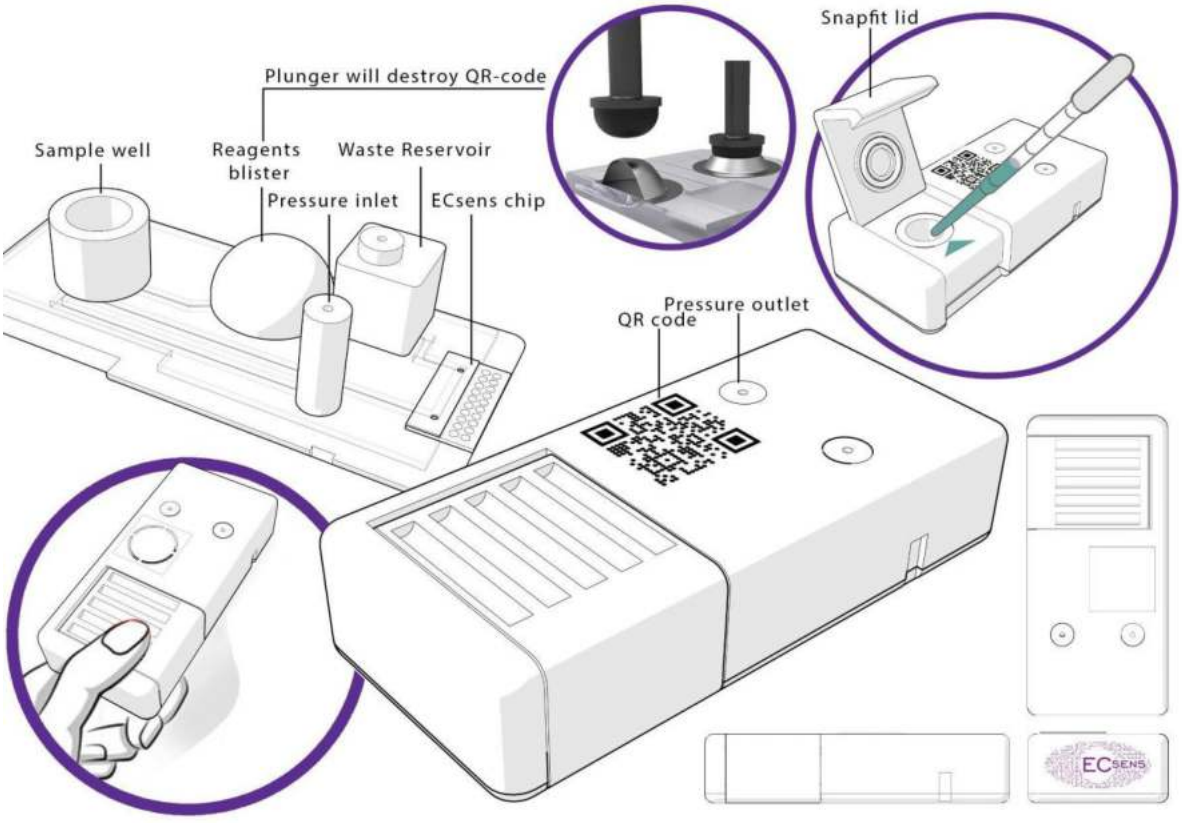


**Figure 4: Rendering of the ECSens cartridge design [provided by Dr. Pepijn Beekman - CTO ECSens]**

The “Version 1” of our prototype [Figure 5] was made from cardboard. The Cartridge that is seen on the rendering was made to have a quick physical sanity check for the direction the prototyping was taking. To have the full product in this cardboard state, a box with general dimensions ECSens officials told us was made as a prototype for the readout device. It was said that the readout device only is imagined to have a slot for the cartridge and an led ring to give a basic status report to the user. As a screen for displaying the data a tablet or computer is going to be used.


**Figure 5: First physical prototypes**

After this the main focus was put on the cartridge and to further develop how this part of the ECSens technology could be like a 3D model [Figure 6] was made in CAD and 3D-printed out of PLA in a FDM printer.

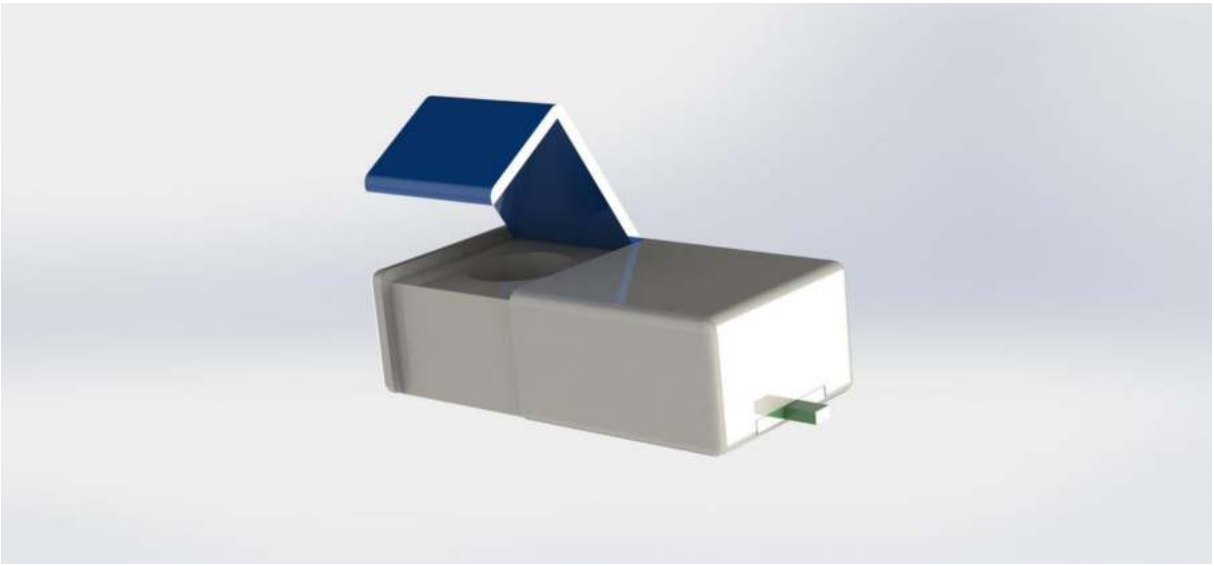

**Figure 6: Rendering of the 3D cad model of the cartridge**

The green part at the bottom right resembles the chip with a little fin to be able to take out the chip. This was meant as a first idea to try and make cartridges reusable. The chip, getting in contact with the sample, is the most delicate part so replacing just the chip seemed a way to make reusable cartridges possible. The 3D printed cartridge [Figure 7] made the need for further thoughts about this element of the ECSens Technology even more apparent.

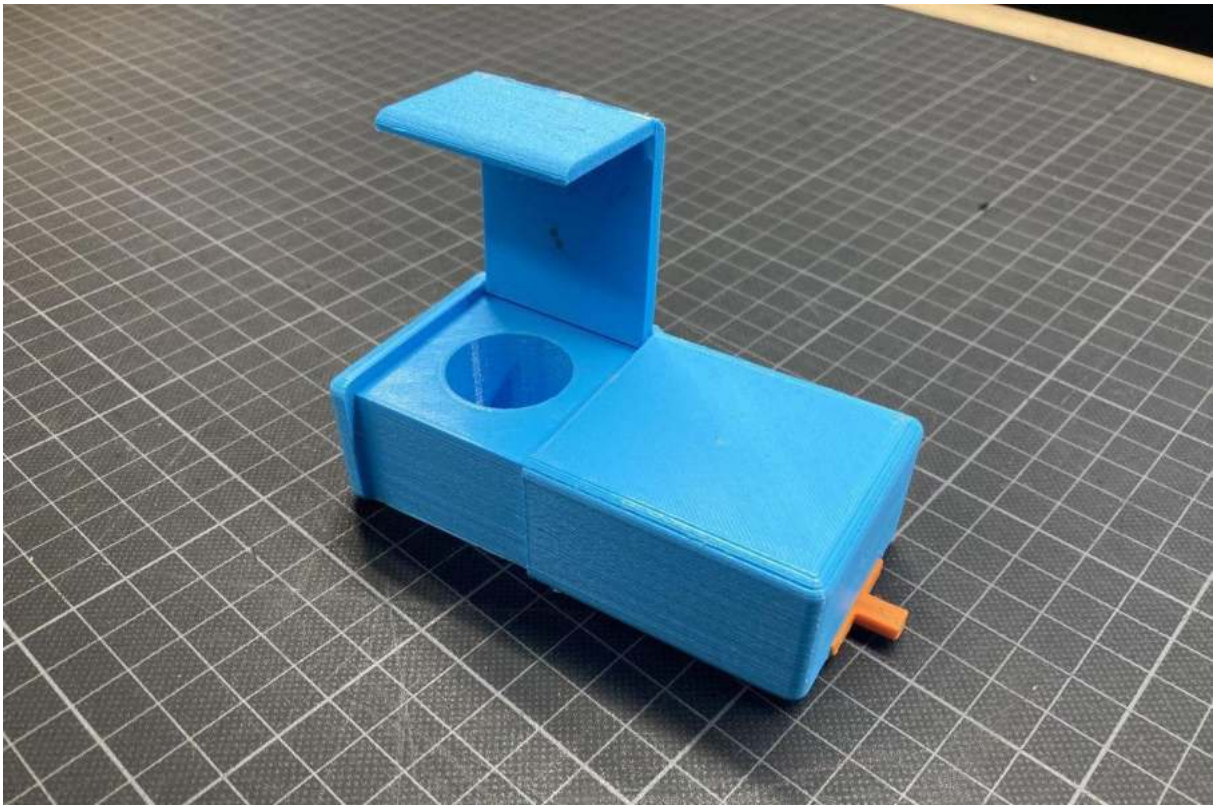

**Figure 7: 3D-printed cartridge model**

After making the cartridge, and thinking about the size and therefore the space a laboratory or hospital would need to store them it appeared to us there is a need for improvement. Either make the cartridge smaller or more versatile to use. We learned that recycling is a big issue. The body of the cartridge contains the fluid lines which are about 30 x 50 microns in square section, so cleaning after usage turned out to be impossible as well. In addition to the recycling issue the general size of the cartridge seemed way too large considering you would need one for every single test you wanted to make.

Discussions about redesigning the cartridge to be reusable in cooperation with the sponsor led to the realisation that due to the danger of affecting the accuracy of the testing, the idea of a reusable cartridge was dismissed.

At this point the general direction we were able to agree on was to make the cartridge as small as possible to make handling still easy and the ECSens chip fit in it. This would make collecting them after usage for a recycling purpose easier and might even reduce manufacturing costs. With the chip having a footprint of 1x1cm$^2$ this would be around the size of a standard portable USB-stick.

### 4.3.2 Stationary ECSens readout device and smartphone application

Parallel to this physical prototype a digital prototype in the form of an app design [Figures 9+10] was developed. The physical prototype trying to answer the first of our two “How might we” questions and the digital prototype being an approach on answering the second one. For the app design a tool called “Figma” [8] [9] was used. During further development and reviewing the interview data we gathered, the idea to create a second version of the ECSens readout device emerged.

This second version would change the original target group, the medical professionals and laboratories to every single person in range of the machine. A stationary readout machine built to withstand the weather and chances of vandalism, located at public places around town. It could be a replacement for the very unreliable Covid quick-tests almost every person did at least a dozen times before they met friends and family to be a little bit less uncertain whether they could pose a threat with infecting vulnerable people they might get in contact with. Cartridges wouldn't be at hand at a doctor’s office but could be bought in drug stores for specific diseases. Originally the idea to have a fully automated test and result handling was dismissed and so was the taking of the sample by an untrained person due to the fear the extremely high precision of the technology could suffer from it. In reality though this loss of accuracy wouldn't even come close to the inaccuracy current self-testing solutions have.

Every conscious human being has the need for a more reliable self-testing solution and will perform the test as cautiously as possible, to have the most reliable result they can achieve for their own interest in not posing a threat to the people they love.


**Figure 8: Model of the stationary ECSens readout device**

This led to the stationary and fully automated ECSens station [Figure 8]. Similar to a car park ticket machine.

This Prototype of the idea is about 1,2m metres high and has a footprint of about 35x35cm. It is made out of cardboard covered with a paper wrap and painted. The rectangle at the front resembles the cartridge intake. It needs an internet connection to send the processed data to the client.

When a person is approaching the station a cartridge is needed, the sample is taken by the person itself. Before inserting the cartridge into the station the QR code has to be scanned with a smartphone or tablet in the ECSens app shown below. After a few minutes the fully automated sample processing and testing is finished and the result is sent to the app and can be read.

Due to the uncertainties of this process this result cannot be used in any official context for example to use it as a confirmation for travelling. But it can be used to protect others from infections they might not handle easily.

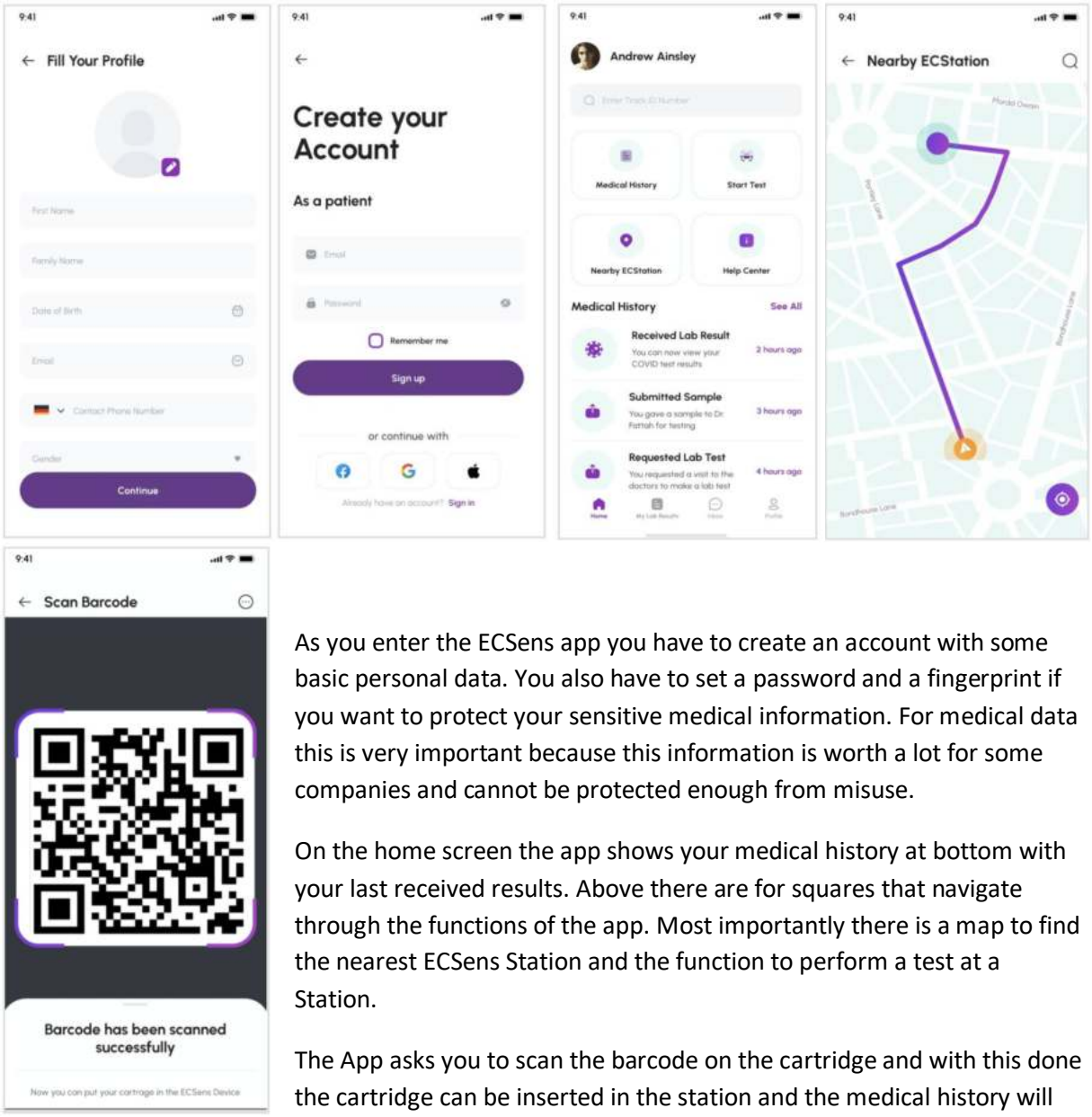


**Figure 9: App design of the patients view**

As you enter the ECSens app you have to create an account with some basic personal data. You also have to set a password and a fingerprint if you want to protect your sensitive medical information. For medical data this is very important because this information is worth a lot for some companies and cannot be protected enough from misuse.

On the home screen the app shows your medical history at bottom with your last received results. Above there are for squares that navigate through the functions of the app. Most importantly there is a map to find the nearest ECSens Station and the function to perform a test at a Station.

The App asks you to scan the barcode on the cartridge and with this done the cartridge can be inserted in the station and the medical history will show the result as soon as it is available.

This scenario is only applicable on “minor” diseases like Covid or other common respiratory diseases that need monitoring to keep our everyday life with public transport and social services running and safe while an infectious disease is roaming around. For an official situation or testing for more severe disease for example cancer, which will be possible in the future with the ECSens technology, the sample and result handling is way more delicate and needs to be performed by a medical professional.

### 4.3.3 Mobile ECSens readout device and smartphone application

The second prototype which is more in the direction of the original idea, ECSens approached us with, can fill this gap.

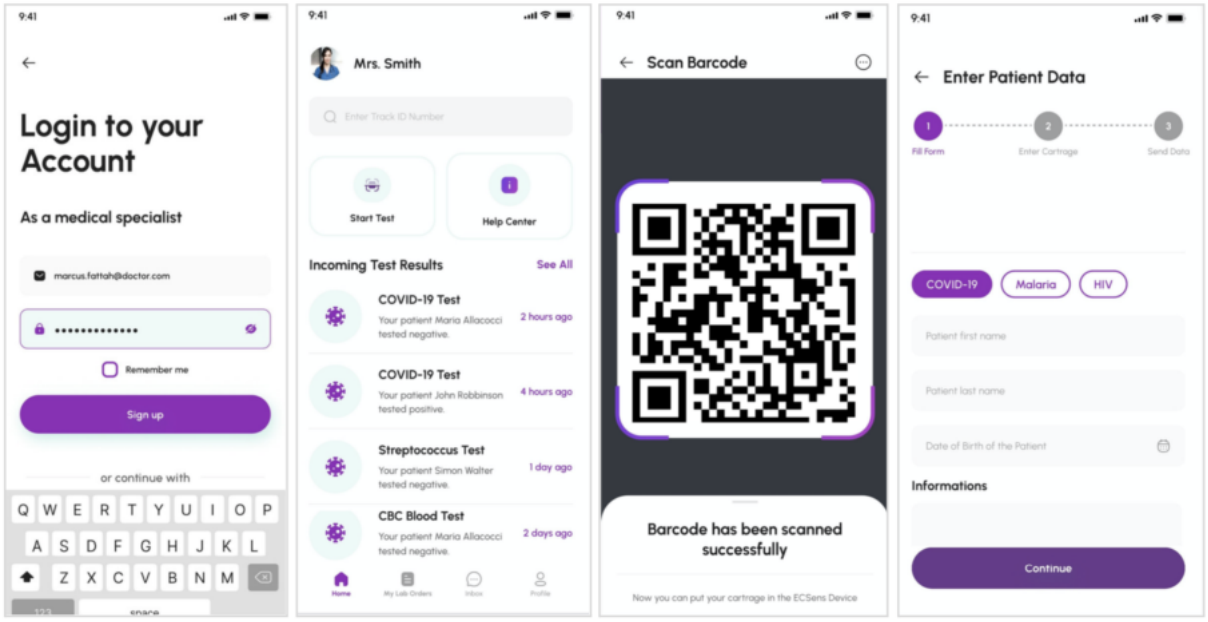


Figure 10: App Design of the medical professional view

For the medical professional the app minimises the functions to perform a test. The medical professional is taking the sample from the patient and scans the barcode. After the patient's data is entered you can wait for the result which at first is only visible for the medical professional. With this for example a doctor can check the results for plausibility and if there is a severe diagnosis behind the result the doctor can always decide not to submit the result to the patient via the app but to contact the patient to make an appointment and talk personally about what the result is and might mean. For this case we have a smaller readout device [Figure 11] in mind which is in the scope what ECSens was originally planning. It is about the size of a coffee machine and can be put on a desk or wherever it's needed. You could imagine one hanging inside an ambulance to make work for paramedics safer during high infectious seasons.


Figure 11: Mobile/Professional Use readout device model

Or use them at the entrance of mass gatherings like festivals or conferences. This version is supposed to be very versatile and make use of the speed and accuracy in any kind of scenario. No sample transport or lab procession is needed for accurate and reliable testing. Just the machine and a cartridge at the point of care.

### 4.4. Testing

To test the idea we showed the prototypes to the team members from the other groups and got quite positive feedback. The stationary testing solution had totally different stakeholders than we collected originally. In fact the stakeholders were simply everyone that was curious if he might be infected with some disease or not. So we were able to test this solution with basically any human being. Especially to provide accuracy as good as PCR in a self-testing scenario convinced everyone we showed the idea to.

## 5. Conclusion

Three months seems to be more time than it actually is. After our final presentation at the Design Factory in Hämenlinna in Finland we kept the feeling that we had just scratched the surface of what was possible. We had bad luck with contacting actual laboratories. Many sent emails stayed unanswered over the course of the project. In addition to those difficulties our team originally consisted of six Members and by Time we had to do the Final Presentation three had left the Project completely and one couldn't join the presentation because of health issues. Still developing an idea in this kind of scenario was very motivating though because it could have so much impact on all human beings because pandemics will occur more frequently in the future and the need for reliable and easy to use testing solutions will not fade. The digitalisation in German healthcare was a shockingly poor example for what actually is possible and how this immediately affects the well-being of the patients.

The research showed that Germany has to look into countries like the Netherlands or Finland to learn from them about digitalisation and the huge benefits that come with it. Not because digitalisation is comfortable or handy, in healthcare especially it can save lives because of Time saving aspects for patients and medical professionals. Nurses and doctors focusing on their patients' needs and don't waste their precious time with filling out insurance forms or datasheets by hand can be the result. A high tech testing solution like the one ECSens developed would improve medical safety in general even if there is no pandemic roaming the globe. The pathways to implement such a solution were pretty clear for our Finish counterparts. They just connect the “Kanta” system that is already in place. Servers and general Data security requirements are already met and can just be applied or used for ECSens. In Germany there is a lot to be done concerning digital healthcare. “Gematik” the German centralised system supposed to store patient’s data is not being used widely enough to unfold its potential. As a recommendation for a product in digital healthcare it would be fair to say, don’t try to roll out your product in Germany at first, Finland or the Netherlands are a better place to start.

# 6. Figures

# 7. References


[1] Design Factory Global Network Hompage: https://dfgn.org

[2] Beekman, P., Enciso-Martinez, A., Rho, H. S., Pujari, S. P., Lenferink, A., Zuilhof, H., ... & Le Gac, S. (2019). Immuno-capture of extracellular vesicles for individual multi-modal characterization using AFM, SEM and Raman spectroscopy. *Lab on a Chip*, *19*(15), 2526-2536.

[3] IPDP Lecture materials, Presentation Slides Attached.

[4] Bauer, R., & Eagen, W. (2008). Design thinking: Epistemic plurality in management and organization. *Aesthesis: International Journal of Art and Aesthetics in Management and Organizational Life*, *2*(3), 568-596.

[5] Grots, A., & Pratschke, M. (2009). Design thinking—kreativität als methode. *Marketing Review St. Gallen*, *26*(2), 18-23

[6] SpiroNose - Possible Competitor of ECSens: https://www.breathomix.com/spironose-2/ (27.09.2022, 10:16 Uhr)

[7] Abbott – Possible Competitor of ECsens: Our Contributions to the COVID-19 Response | Abbott U.S. (27.09.2022, 10:18 Uhr)

[8] https://www.figma.com/proto/lcsvhXKmwRc56lTLvqeQdt/ECSens-design?node-id=1036%3A36455&scaling=min-zoom&page-id=1036%3A35422

[9] https://www.figma.com/proto/lcsvhXKmwRc56lTLvqeQdt/ECSens-design?node-id=1034%3A26293&scaling=min-zoom&page-id=1032%3A20211

[10] https://hpi-academy.de/en/design-thinking/what-is-design-thinking.html (27.09.2022, 10:21 Uhr)

[11] https://ecsens.com (27.09.2022, 10:22 Uhr)

[12] https://www.gematik.de (27.09.2022, 10:24 Uhr)

[13] http://mykanta.fi (27.09.2022, 10:25 Uhr)

# 8. Attachments

- Only in the digital Version, which has been sent to Prof. Dr. Anna Luther.