# SMART ENVIRONMENTS PROJECT

## DOCUMENTATION REPORT

## THE DISASTROUS SEVEN

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# Chapter 0: Introduction

**0.1 Introduction to the team members**

Introducing the seven members of The Disastrous Seven.
The team consists of one team leader, two explorers, two innovators and two analysts. The team leader is Floor Lieverse and she has shown she fits her role very well. Her listed skills contributing to her role are organizing, planning and presenting. Other listed skills, being writing and designing, are also valuable for the project.
One of the two explorers is Sil Dijkman. Her listed skills are designing, sketching and prototyping, all being very important for the creation process. The second explorer is Seokho Jeong. His listed skills are software and programming, invaluable skills for the technological aspect of the project. One innovator of the team is Patrick Botz. His listed skills are design, creativity and music production. Creativity is key to a good end result for the project and design will obviously also be an important factor. The other innovator is Victor Ploeger. His listed skills are hardware and programming. These skills also have a clear correlation with the project and can prove very useful. The first analyst on the list is Jesse Strijker. His listed skills include writing reports and creative thinking, excellent for the ideation and research phase. Also hardware and programming, important for the creation phase. The last member and second analyst on the list is Roel Kneepkens. His listed skills are analyzing and critical thinking. Great attributes for the ideation and research phase.
This concludes the summary of the seven members of The Disastrous Seven.

**0.2 The main theme**

The main theme of this project is disasters. Before, during and after disasters there are loads of problems that may occur. Some are related to infrastructure, some problems are related to the collapsing buildings, others are related to the climate and some problems that occur during and after disasters are related to health issues. And that is exactly where this project group focuses on. The health issues that may occur after having experienced a disaster. Health problems that may occur during disasters may be related to injuries that people get due to being stuck under debris. Another health related problem that may occur is during wildfires that people breathe in the smoke, which affects their lungs. These examples are all focussed on physical health, which is of course important. However, mental health is often overlooked. Both natural and infrastructural disasters can cause severe mental damage to people. This fact, however, is not looked at often enough. Therefore, this project group will focus on the mental health aspect of this project. Both adults and children can suffer from mental health issues after a disaster happened. However, young children are more vulnerable and therefore they are more likely to deal with traumas and anxiety. The problem that will be focused on during this project will, therefore, be young children who experience anxiety due to disasters.

### 0.3 Subject of the project

Everyone involved with the disasters will be affected by them. When a disaster occurs, most adults can process it by either talking about it or going to therapy. For children this can be more difficult. Most children, especially when they are younger in age, have a hard time grasping what is going on or what has happened to them. They do not understand the term ‘terrorist attack’ and they know what an earthquake looks like, and thus they do not know how to cope when their home collapsed because of it. When talking about disasters, mostly discussed is only the prevention of it, but never really the mental impact it has on people, and especially children. It is hard for children to talk about their feelings with a therapist, since they don’t know this person. That’s why there has to be a way for parents to understand when their child is having anxiety and how they can help.

### 0.4 The chosen solution

The chosen solution to this ever growing problem is a device that can objectively measure stress levels to avoid the subjectivity of talking about one’s feelings, which can be even more difficult for children. A watch-like device will be made that has multiple sensors such as a heart-rate sensor, hormone sensor measuring cortisol and/or adrenaline if possible, an oxygen in blood sensor and a blood sugar sensor. All of these sensors will measure simultaneously and will note averages and peaks of stress levels over time, this can be connected to a smartphone app to make others aware of one’s mental state and make it easier to talk about that. By having multiple sensors all measuring different things at once it will be more likely to get more accurate readings, but if these measurements aren’t up to the team’s standards, a simple three button setup could be installed on the watch where the user could indicate whether he feels good, neutral or bad.

By measuring the stress levels (using the different data gathered from sensors) the child is able to be monitored in case it is experiencing anxiety or discomfort of such sort. When this happens a parent (f.e.) will receive a notification on their phone and is able to help and support their child. Even if they are unavailable they can call somebody to check up or talk to them at the end of the day about it.

The initial idea with this problem was to tackle the actual trauma. The team soon realized that this was beyond everyone’s scope and decided to focus on making a smart device aiding and providing information to the right people that are able to take the right action (therapists, hospitals, etc).

# Chapter 1: Literature Review

### 1.1 Lists of disasters

During a short brainstorming session there has been came up with the following disasters classified in the categories natural disasters, infrastructural disasters and disasters caused by humans.

#### 1.1.1 Natural disasters:

1. Tsunami
2. Earthquake
3. Floods
4. Landslide
5. Meteor impact
6. Volcano eruption
7. Hail storm
8. Wildfires
9. Food security
10. Pandemics
11. Heat waves
12. Swarms
13. Ozone layer hole
14. Hurricane
15. Sinkholes
16. Thunder(storm)
17. Blizzards

#### 1.1.2 Infrastructural disasters:

1. Car/bike accident
2. Building Collapsing
3. Power outage
4. Internet down
5. Plane crash - sil
6. Boat sinking
7. Nuclear meltdown/explosion - Victor
8. Fireworks explosion

#### 1.1.3 Human caused disasters:

1. Mass violence / terrorist attacks - Victor
2. Failed government
3. War
4. Economical collapse
5. Violation of human rights - Victor

### 1.2 Existing publications on disasters

Next there has been a search for 20 publications concerning the disasters mentioned above. Of each publication there has been added a summary.

#### 1.2.1 Tsunami

About the personal disaster management of a tsunami:
Get as far away as possible, ideally 2 miles inland or 100 feet up. (3,2 km or 30 meters)
If the wave is in sight, take action to enlarge the distance.
When a tsunami warning is issued evacuate immediately
If possible bring some supplies for the evacuation
If you are safe register yourself on the save and well site (disaster management)

#### 1.2.2 Earthquakes

Common natural disasters are earthquakes. Earthquakes consist of intense shaking of the earth's surface, caused by movement in the earth's most outer layer. They can happen at any time and anyplace yet there are certain areas on the earth more prone to earthquakes due to the structure of the earth's plates.
There's no way of preventing an earthquake so the solutions come into play once it is starting. Find a safe place to hide under; When earthquakes happen, buildings and furniture might collapse and potentially hit someone, so seek a safe place with cover.
Things like strong tables or desks, or any wall away from any furniture that could potentially hurt when collapsing or falling.
Other hazards one might encounter during an earthquake are fires. Fires often erupt due to broken gas lines or damaged electrical lines / devices. Buildings should be checked once the earthquake is safe to ensure there's no remaining hazards.

#### 1.2.3 Landslides

On page 9 to 12 of the file can be found the example of Andorra. The way they are trying to prevent accidents regarding landslides there is through very precise mapping. During the mapping on various scales and based on various materials, they identified certain areas that are higher risk than others to build or live. Furthermore they identified different types of landslides that influence these risks as well. A gravel slide, for example, has less impact than an entire mass slide. Thus depending on the hazard level, “builds or events must set up necessary stabilization or protective measures.” In order to be allowed to do things in those areas, so this article talks about damage prevention and damage control in the case of a landslide.

#### 1.2.4 Meteor impact

This seems like a very science fiction like event, and not probable at all, but it is in fact a very real possibility to happen at any moment. There are different ways of preventing a large meteor impact. Large is specified here, since people are hit by meteors constantly but they burn up in the atmosphere. The larger meteors however can have a very big impact on the planet. Here are some risk assessment against meteors:
Mapping and cataloging all the meteors/asteroids and comets and their orbit, to have a better risk assessment.

Disaster prevention of asteroids falls into two classes, fragmentation and delay. Fragmenting being focussed on fragmenting the asteroid and thus missing the earth or being small enough to burn up in the atmosphere. Delay uses the fact that earth is in orbit of the sun, and delaying the asteroid can lead to it missing the earth. These classes can both of course be further worked out, but won't be of value for this summary.

### 1.2.5 Volcano Eruption

With Millions of people around the world living around the remaining 1,500 active volcanoes, volcano eruptions are one of the possible natural disasters of today.
Volcano eruptions cannot be “prevented” but the disaster can be controlled. To do this all volcanoes are under constant moniterization. Over the years, volcano exports have developed their knowledge and patterns and can monitor the volcanoes to know when they will erupt. This allows for evacuation and measures to prevent the lava flow from hurting anybody. The damage can't always be controlled as the lava flow will often overflow any barriers.

### 1.2.6 Sinkholes

A sinkhole is a collapsed area of ground that is formed when a void under the ground creates a sinking effect where the material around it will drown into. There are two types. The first is a cover-subsidence sinkhole, where the soil will go into a nearby cave, so the ground slowly subsides. Not catastrophic.
The second kind is a cover-collapse sinkhole, mostly occurs with clay where the clay also leaches into the cave below creating a void that moves upwards. Here the bridge on top of the void can’t hold the surface and collapses. Humans can induce sinkholes by drilling into the ground, building parking lots and buildings. Some areas in America are prone to sinkholes, but mostly China is. One can sense a sinkhole is forming by cracks in the house, building or on the ground. As prevention, the void can sometimes be filled with concrete and large pieces of rock. The sinkhole in Guatemala in 2010 was really big. When nothing is done with the sinkhole it will just become a pond.

### 1.2.7 Airplane crash

Peter Grant and his research team from the Faculty of Applied Science & Engineering were asked by the U.S. Federal Aviation Administration to develop a new methodology to make sure new pilots were also able to learn what to do when their plane goes into an aerodynamic stall, thus having less control over their plane. When new pilots learn flying through simulation they can’t practice what to do when their planes go into an aerodynamic stall. To make a new methodology they had to get trained pilots to fly a plane into a stall in a wind-tunnel to see the behaviour of the plane. After they obtained this, they made a representative model which they tested and that was later implemented into the official new pilot training program.

### 1.2.8 Wildfires

This research has been executed to indicate the health risks of exposure to wildfires, focussing on the United Kingdom. The article tells the reader that there have been many wildfires in the USA and Australia already, due to climate change wildfires are emerging in Europe as well. Therefore, it is important to look at the health risks of these fires.

There are four ways through which people's health can be affected by wildfires. First all, through direct exposure to heat and flames. Second, through exposure to smoke that arises when a wildfire occurs. The smoke is diffused through the air. Thirdly, when soil or land is contaminated with chemical products of the wildfires. Lastly, it affects people's health by water that is contaminated water.

The health effects of wildfire include both physical and mental difficulties. Examples of physical difficulties include: respiratory symptoms such as deteriorating lung functioning, burns that arise due to direct contact with wildfires, heat induced illnesses, heart diseases and eye irritation. Examples of psychological difficulties include: depressions, Post Traumatic Stress Syndrome, somatization and anxiety.

With the risk of more wildfires in Europe and considering the information that was found during their research, the conclusion of the research is that wildfires can cause severe health damages. There should be raised more awareness to these effects and health care workers should know more about these health risks.

### 1.2.9 Thunderstorm

The pollen gains on ground are carried by the lower level (descending air current) into cumulus type clouds. In regard to the thunderstorm outbreaks, the gathered pollen spreads by raining in the whole place. But thunderstorms with pollen outbreak are not frequent. By this phenomenon, people get asthma and they suffer from allergies. Patients that suffer from asthma die or their condition becomes worse. In effect, in Australia, there are many patients with asthma caused by thunderstorms.

### 1.2.10 Building Collapse

The collapsing of buildings can often be triggered by earthquakes or by flaws and errors in the design/structure. Often it can be a combination of both that sets off this disaster.

The most obvious thing to do when finding oneself in a collapsing building is to leave the building. If possible, the safest way to survive this disaster is to leave the building and take the appropriate distance (incase of collapse, rocks falling).

In most cases it will be difficult to do so. If trapped in the building, remain calm and follow earthquake like instructions; duck and cover. Find a hard desk or sofa (etc) and cover under it but not completely placing the item directly above oneself.

### 1.2.11 Floods

This research has been written in response to a severe flood in Bangkok, Thailand, from July to November 2011. With this paper the researchers wanted to look into the causes of the flood, the lessons that they have learned from the flood and the future management of floods and a new flood management system.

The main causes of the big flood can be summarized in the following points: the big volume and the pattern of the rainfall, the existing irrigation systems and their water management, due to the long and heavy rainfall the main structures were damaged, a poor flood warning system and lastly the flood was caused by the a poor communication and rescue system.
After this big flood, the government of Thailand came up with a strategic flood committee who came up with a short term and long term plan to control the floods. The short term plan includes the following concepts: providing adequate draining capacity in lower areas, providing supportive measures, repairing the damaged flooding system and coming up with a functioning warning system. The long term plan focuses on an upstream, midstream and downstream plan. It also focuses on the social (facilitate understanding, prediction and warnings) and administrative plan (organization, database etc).
The conclusion of the research is that the flood is caused due to heavy rainfall. And the short term plan in combination with the long term plan need to make sure that such a severe flood should not happen again.

### 1.2.12 Food security

This research is executed because farmers in the area of southern Africa suffer from food insecurity. According to the research “food security exists when all people, always, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. The farmers in this particular area have bad access to food and experience multiple difficulties with farming due to the climate change.
One of the solutions that the paper discussed to prevent food insecurity is conservation farm management. This entails amongst other concepts minimum tillage and crop rotation with legumes. The result of conservation farm management is a more fertile soil and the soil has more nutrients. Another solution is germplasms. With the help of germplasms, there can still be produced a high yield under stressed conditions. Lastly, the availability of quality seeds in a local community also helps with a better harvest and crops of a better quality.
Even though there still are some negative factors, such as pests and water stress, the solutions mentioned above will, according to the research, help the people in communities to achieve food security.

### 1.2.13 Hailstorm

Hailstorms are a big hazard for vineyards. That’s why there’s a new system created to protect the crops at a vineyard from the hail. When the system is opened up it has an umbrella-like shape. It covers and protects the crops and thus withholding impact from the hail. It can also be retracted, so that the vineyard looks normal again and can obtain the sunlight as usual. Every row of the vineyard is controlled by a local electronic card which detects if there is any chance for hail by checking temperature and humidity etc. When there is hail detected, the system automatically opens the umbrellas.

### 1.2.14 Nuclear meltdown

Nuclear meltdowns cause a lot of damage, not just for a moment, a lot of years after the meltdown there will still remain a lot of damage that requires management. You would think that

evacuating all of the population living close to the meltdown as fast as possible should be one of the first things to do but it actually turns out to be way more dangerous than staying in the one for a bit. The most important things to manage a meltdown disaster are staying inside as much as possible and checking all food and drinks for radiation.

### 1.2.15 Terrorist attacks

There are four main solutions for preventing terrorism that are all still being studied and improved till this day but conclude to this. The people need to be stopped from radicalizing and becoming terrorists for the next generations. Buildings and places need to be as good as immune to attacks so there can never be a humongous disaster. Get in the head of terrorists and follow their communication and plans to stop attacks before they happen. Always be prepared for the aftermath of an attack, enough medical supplies for example.

### 1.2.16 Violation of human rights

To stop the violation of human rights there needs to be close monitoring on all “PeAcE oPeRAtIoNs” and the maintaining of that peace. There also have to be good justice systems for when there have been violations and good plans to stop future possibilities of violations. Support each other's forces to stand strong together and check on each other.

### 1.2.17 Pandemic

The article entails details about the actions taken against the Coronavirus in the form of vaccines by (e.g.) companies all over the world. The purpose of this article and the work behind it is to help those companies to coordinate easier with each other. With better communication, the process of developing a vaccine can be sped up significantly. The article illustrates the Research & Development landscape for a COVID-19 vaccine, it gives insight to the diversity of technology platforms used during the development and it gives the profiles of the vaccine developers.

### 1.2.18 Heatwave

Heatwaves have numerous severe consequences for health and safety. The article highlights the prevention and heatwave recognition systems implemented in European countries.
It looks primarily at the HEWS set in place (Heatwave Early Warning Systems) by those countries and comparing them with each other.

### 1.2.19 Power outage

Summary of “Hurricane-induced power outage risk under climate change is primarily driven by the uncertainty in projections of future hurricane frequency”:
Power outages can lead to severe economic and social health & safety problems and are not something to be scoffed at. Understanding the causes is important. The main cause of power outages are hurricanes. This article cannot only give insights to climate scientists on the implications of hurricanes in respect of power system management, it can also propose a framework for electric utility planners and others to base their investment decisions on and improve prevention methods.

### 1.2.20 Ozone layer hole

Over a few years, the ozone is collapsing by greenhouse gases. Therefore, there is the ozone layer hole in the southern hemisphere. The main cause is gas called Chlorofluorocarbons (CFCs or Freon gas). This gas is necessary in the atmosphere, however if there is much CFCs in the atmosphere, it is caused by the ozone layer hole. Mostly, the Freon gas is detected from items like an air conditioner. Therefore, the amount of the Freon gas increases in the atmosphere. Chlorine decomposed in freon gas causes ozone layer destruction. In other words, freon gas is the main cause to let chlorine decompose in freon gas and is a dangerous element to being ozone layer holes. By the ozone layer hole, the temperature of the earth increases slowly, and global warming and climate change occur frequently.

# Chapter 2: Identification of General Problems and Challenges

**2.1 Deciding on a disaster subject**

In order to come up with general problems and challenges, there has been selected the top three favourite disasters of all members who were present during the team meeting. Victor's top three disasters: Heatwave, floods and wildfires. Jesse's most interesting disasters: Earthquake, floods and pandemic. Sil's preferred disasters were: Nuclear meltdown, heatwave and pandemic. Roel's top three disasters: Food security, wildfires and earthquakes. Seokho's most interesting disasters: Sinkhole, wildfires and pandemic. Lastly, Floor's top three disasters: Pandemic, wildfires, earthquakes/tsunami/floods

**2.2 General problems and challenges**

After, there has been concluded that the interesting disasters are: Earthquake, floods, wildfires and pandemics. There has been a short brainstorm session to come up with problems and challenges that occur within these areas.

For earthquakes the following problems were identified: Buildings collapsing, furniture falling over (health hazard), people missing after a big collision, providing food and first aid, people losing their homes.
For floods the following challenges were selected:  Water damage, people drowning and infrastructure isn't usable anymore.
For wildfires the next problems were identified: Encountering health problems, insufficient knowledge of the possible health damages, damaging nature and climate and hazard to surrounding animals and organisms.
Lastly, for the pandemic the next challenges were selected: Loneliness, anxiety, depression, death, overworked hospital staff, bad for the economy, digital learning/working, toilet paper shortage, societal collapse.

With the specified problems mentioned above, there have been ten nine general problems and challenges:

1. Infrastructure being unusable (Because of floods the roads aren't usable,
2. Loss or damage of (valuable) items
3. Food shortage
4. Economical damage
5. Environmental damage
6. Mental and physical health hazard(people & animals)
7. Loss of living environment
8. Discontinuation of school and job
9. Insufficient knowledge about the disasters

# Chapter 3: Identification of New and Relevant Problems

In this chapter there was looked at 5 problems that are relevant, interesting and urgent. In order to do so, the nine existing problems, from chapter two, were divided into smaller subproblems that come into existence when looking at that larger problem. This way there are more precise defined problems to work with when thinking of a solution to them. This gives a bounding box to make thinking of a solution easier and more efficient.

**3.1 Dividing disasters into sub-problems**

1. Infrastructure being unusable (Because of floods the roads aren't usable)
    - People and animals aren't easily accessible.
    - No information what roads are still usable
    - Rebuilding the infrastructure
    - There isn't any material available quickly for other ways of getting from point A to point B when the roads are flooded.
2. Loss or damage of (valuable) items
    - Scavenging for belongings
    - Keep belongings safe before disaster
    - Cars get water damaged and become unusable.
    - Belongings being broken, like closets falling over or tables breaking during an earthquake.
    - Houses in poor areas get destroyed easily because of poor engineering.
3. Food shortage
    - Equal amounts of food distributed for everyone.
    - When a disaster occurs and there comes a food shortage in a most of the time third world country, because of extra food distribution the economy collapses in that said country since they don't grow enough food. These countries don't have the knowledge that more advanced countries do have about agriculture, so maybe a product that sends or gives that knowledge or something? idk.
4. Economical damage
    - People lose their jobs
    - Families don't have enough money for the basic necessities*
    - Companies go bankrupt
5. Environmental damage
    - The homes of wildlife gets destroyed
    - People can't cultivate and save items like fruits and vegetables
6. Mental and physical health hazard(people & animals)
    - Teenagers don't exercise enough (don't go outside enough) when they have depression/anxiety.
    - When people are stuck in debris and injured no one can find them.

- Old people are in greater danger when there is an earthquake since there are falling objects and they can't quickly move to a safer place.
- In a heat wave old people are more prone to fatality.
- Children can be traumatized after a disaster has occured
- Loss of family can have a big impact

7. Loss of living environment
    - People need to get a new place to live for the time being
    - Rebuilding houses and other buildings
8. Discontinuation of school and job
    - With zoom university & zoom jobs people don't have much contact with other peers & colleagues
    - In 3rd world countries the discontinuation of school is a big problem after a disaster because a lot of times female students don't come back to school.
    - With zoom university & zoom jobs people get a bad posture due to sitting behind a computer all day
    - Increase of domestic violence
    - Education may be of lower quality and thus educating students insufficiently
    - Less chance for students to get a job after they have graduated
9. Insufficient knowledge about the disasters
    - Wrong decisions make the disaster even worse
    - Little time to learn about the disaster while it is happening
    - Making important choices without enough knowledge

**3.2 Most relevant problems**

So after having divided all these problems into sub-problems, there were five problems identified as the most interesting, urgent and relevant ones. The list indicates the problems, and an explanation of why they are interesting, urgent and relevant.

1. **No information what roads are still usable**

    One of the reasons this problem is urgent is because there are a lot of situations (disasters) where this problem comes into play. For example when there is an earthquake, some roads might be blocked due to debris from buildings. Then it is urgent for the emergency services like firefighters and ambulances, to know which areas are reachable and how they can reach them. Next to all this it's an interesting problem because there is a lot to improve, and there aren't a lot of existing solutions for this problem. Besides that there is also the factor of climate change which will make this problem a lot more relevant/prominent in the future. (possible solution: an information detection system which will relay the information to an app or website) *

2. **Keep your belongings safe before disaster**
   This problem is an urgent problem because loss of items is quite annoying and a relevant occurrence in these situations. This is especially important for people that have items that are trivial for their living situation, like people in wheelchairs, diabetic patients with epipens, people with colostomy bags, people on grudges. There isn't any solution for what people do when they are stuck in a collision or a flood and they can't survive without their medical necessities. Whenever a big disaster occurs nobody talks about what these people go through and their struggles aren't picked up by researchers. Therefore this problem is very relevant and urgent.

3. **Teenagers don't exercise enough (don't go outside enough) when they have depression/anxiety.**
   Nowadays many teenagers suffer from depression and anxiety. Especially during the pandemic of COVID-19, many more teenagers suffer from mental illnesses and have symptoms like insomnia. When people experience depression or anxiety they are less likely to go outside and exercise. Therefore, this problem is relevant and urgent. Also, it is found to be an interesting problem because it is relevant for the age group, peers and friends.

4. **When people are stuck in debris and injured no one can find them.**
   When the explosion occurred in Beiroet there was a big problem of finding all of the workers that went missing during the explosion. After the explosion in Beiroet it was seen that it did take a lot of time to find the people that were missing. This has always been a big problem in collisions or earthquakes, basically when there is a lot of debris where people go missing. Other countries often have to send volunteers that search for the missing people which isn't the best, fastest or cheapest option. That is why this problem is relevant and urgent and there has to be a solution for this problem.

5. **Children can be traumatized after a disaster has occured**
   This problem is relevant for many children and many families. Since children are very vulnerable and easily affected, children are likely to be influenced by disasters. Trauma's can be one of the effects of experiencing a disaster as a child. Therefore, this problem is relevant and urgent. Also, it is an interesting topic.

# Chapter 4: Problem Selection and Motivation

After having brainstormed, the most interesting, relevant and urgent problem turned out to be the fifth problem: children can be traumatized after a disaster has occured. The reasoning for this is because a lot of disasters have a big impact on people, but also on children. Losing their homes or their family, for example, is a lot to deal with for a child. There has to be a way for them to deal with this in a manner that is suitable for children. For the time being, there is not a lot of information about what disasters, such as a refugee situation, do to a child on a psychological level.

An example is the refugee crisis. Now there is a crisis where a lot of refugees need to flee from their country of origin due to wars or an unstable situation in that country. The refugees are taken into different countries, but there isn't a lot done for them getting the psychological help that they might need. Because fleeing from an unsafe situation might be traumatizing for people, especially for children who are in general more vulnerable.

This is an urgent/relevant problem because there are a lot of situations where children can be or will be traumatized. Also, this is an interesting problem because there are a lot of potential ways to look at solving this problem. For example, looking at toys that can be manipulated technologically to make them more suitable for mental help for children. The following chapters look more into possible solutions for this particular problem.

# Chapter 5: Possible solutions

For this chapter there were several different ways of solving problems regarding child trauma. There aren't a lot of ways of preventing the trauma, but there are possible solutions to help the child cope with the situation or calm them down. For instance, children experience right after a disaster/accident a lot of stress and other unpleasant feelings, including in some situations, pain. Or a while after it has happened the child needs to accept what has happened, to cope with the trauma. Below here are several solutions to be found for the situations mentioned above, and explained why these solutions could work.

### 5.1 Possible solutions to stress among children

- Using familiar items for them, to calm them down right after a traumatic event
- Talking bear (recorded voice of a loved one)
- Game that introduces traumatizing events and responds accordingly
- Interactive TV-series (like Dora but actually interactive)
- Karaoke song installation
- YouTube crash course about emotional expressions
- Bracelet that tracks one’s heartbeat and plays some sort of music when the heart rate goes up? (Pou)
- Interactive art installation, in which the children can express their feelings
- Racetrack for children who have been in a car crash, to relive the experience and work through it like a game.
- Link their heartbeat to their room, so when they get stressed the room will change colors and start playing a movie**.**
- Online app / game which functions as a diary
- A Xylophone that gets used during therapy so children can mix music with mental help to process a trauma with more fun.
- Technically altering their favourite stuffed animal by making a screen in them and displaying an app in which they can draw, hear their family and listen to calming music.
- VR chat (AR talking buddy)
- Hopscotch that children can do, whenever they hop on a block, a video or challenge starts playing on a screen which is linked to how they feel about their trauma or something.
- Indoor exercises
- Interactive gardening tool where one talks to his or her plants

Of course for the scope of this project, the solutions need to be based on a smart environment solution, this eliminates some of the solutions written above, because they don't use smart environments to solve the problem. The term smart environment is to be interpreted as “The use of an environment or surrounding to improve or detect the current situation.” Next to that an environment does not have to be solid, it can also be different items that are familiar in that surrounding/environment. After having eliminated the ideas that didn't seem to use smart environment and were the preferred 5-8 solutions, all that was left were these ones: (the explanation on why they are smart environment solutions and what they entail can be found below them)

### 5.2 Solutions including a Smart Environment element

- Talking bear:
  *What does it entail?*
  There are multiple options to implement in the bear. The function of the bear would be to calm the child or in some cases make them cope with the situation. This can be achieved by implementing certain things. Some options are using a screen inside the bear. In this way the children can use the touchscreen. Also adding speakers inside the bear, will make it possible for the bear to make music and stream the voices of the parents. Another option is to add the function that the children can actually talk back to the bear, the bear in his turn will respond to the child and in this way an actual conversation can take place between the bear and the child. The bear can even be connected to other devices such as a smart bracelet for example.

  *Why is it a smart environment?*
  As mentioned above a smart environment is defined as the usage of the environment to detect or improve a situation. This applies to this specific problem in the sense that the use of a home environment includes certain items, including stuffed animals. The use of items in an environment to improve/detect the situation is still a smart environment. So the use of a stuffed animal to improve a child's mental/emotional state falls under a smart environment.

- Interactive TV-series (like Dora but actually interactive):
  *What does it entail?*
  The idea here is to make a TV-series which is interactive, people will get to answer about personal things. It will start out with simple questions that don’t really change the rest of the plot but will grow more and more to get the child to be more open about their emotions and feelings. The answers of the child will change the reactions of the TV-series.

*Why is it a smart environment?*
Kids generally love watching TV-series and enjoy them, but they are not specifically designed to help traumatized children over their issues. It is understandable that kids may not want to participate in normal therapy. By moving the therapy to something they enjoy (e.g. a TV-series), they will probably be considerably less hesitant to cooperate.

By taking something (therapy) out of the existing environment of traumatized kids and altering it so it is not only beneficial to the kid's wellbeing, but also more accessible and interactive, a better environment can be created for the child.
This can also be approached from another angle by focusing on the fact a TV-series that previously only had one goal (enjoyment), now, by altering it to include therapeutic aspects, will have a second benefit (therapy). Therefore improving upon the current situation. By altering and improving something in a child's environment (in this case a TV-series) to create a better environment, it becomes a Smart Environment.

- Bracelet that tracks one's heartbeat:
  *What does it entail?*
  The main function of the bracelet is to trace the heartbeats of the children. This means that children will wear a bracelet that looks very appealing for a child, by making it fun colored. The bracelet will be worn by children, and when they wear it the bracelet will also track the heartbeat of the child with a sensor that can track the vibrations of the pulse in their wrist. When the child becomes stressed, the heart rate will go up, thus the bracelet will detect more vibrations in their wrist.

  *Why is it a smart environment?*
  The bracelet is a smart environment, mainly because it uses the environment to to detect a situation and improve the situation. In this case, as mentioned above, the bracelet traces the heartbeat of the children. Thus, it uses the environment to detect something; it detects the heartbeat. When the heartbeat is unusual, especially if the heartbeat is higher than usual, it indicates that a child may be anxious and/or even relive the traumatic event. The bracelet can also improve the situation by then distracting the child with the options mentioned above.

- VR chat (AR talking buddy):
  *What does it entail?*
  By the VR chat, the children can communicate and play with buddies randomly. During this activity, the children will get fellowship and friendship with each other. This means that they trust each other. Due to the fellowship and the friendship, they can get out of the depression and the anxiety because the fellowship and the friendship help to cure the depression and the anxiety by trust. In other words, they are advised and helped by their friends when they are in a hard situation.

*Why is it a smart environment?*
The VR Buddy is a smart environment as it uses new VR technology to allow random kids from all over the world to become friends and play with each other.
The VR Buddy focuses on the positive effects kids get from meeting and playing with other kids, and using smart technology to increase the range and variety of the experience. Although VR doesn't fully replace real life contact, the smart technology allows for endless real buddys around the world and provides extra entertainment inside the digital world in which anything is possible.

- Interactive gardening
  *What does it entail?*
  Interactive gardening is a way to talk to one's plants in a way to make talking about feelings easier. One would be gardening so something will be done on the side whilst actually expressing oneself. This would be a small greenhouse with microphones and speakers. Gardening has become really popular for children in the Netherlands due to Albert Heijn's action to get little plant seeds, so gardening is a good exercise for children. The idea is to grow emotionally while the plants are growing in size.

  *Why is it a smart environment?*
  Interactive Gardening is a smart environment because it focuses on the positive and therapeutic aspects of gardening whilst implementing smart interactive technology allowing the children to talk to their plants (linking smart devices to everyday tasks / environments).
  The interactive technology aids to direct the conversation whilst the main focus remains on the gardening and the plants, putting the kids at ease.

# Chapter 6: Solution Selection

**6.1 The selected solution**

After some received feedback from Andreas and Antoine, it has been concluded that it is necessary to look again at the problems that were formulated in Chapter 3. After looking at the problems again, it has been decided that it is still interesting to focus on the mental health of children, despite the risks that it brings with it. Possible risks that may be encountered concern how the product can be tested and to what extent it will really help to solve the problem. Also, obviously the final product will not make all the anxiety that the child experiences disappear. The end product will help to let people know that their child is suffering from anxiety. Therefore, the product will not solve the anxiety of the child.

The selected solution is a bracelet that measures the heart rate or other physical properties of a child that is suffering from anxiety or PTSD caused by a trauma or accident. This bracelet is connected to the phone of one of their guardians, so when a spike in heart rate is detected, a message will be sent to said phone, alarming them of an anxiety attack their child might be having. The parent can now act directly to help or comfort their child, instead of waiting for the child to go to them for help, which can sometimes be much later or never. The objective is not solving their anxiety or trauma, but simply creating a way of communicating their anxiety attacks to their guardians, so they can get support immediately, which otherwise often is not the case. This will make the process of dealing with a trauma much more sufficient.

This problem has been selected over the other candidate solutions mainly because it is the most realistic solution. After the discussion with both Andreas and Antoine it became clear that it is not possible to come up with a product that makes the anxiety go away completely, therefore the solution should make the situation easier to deal with. The solution that has been chosen makes it easier for both the parents and the child to cope with the anxiety. Also, this solution was preferred because it is the easiest to indicate whether a child is experiencing anxiety or not. The other ideas did not really give the opportunity to measure the heart rate etc of a child. Therefore this solution is the best because it is the easiest to validate. With validate defined as knowing whether the product is effective or not. Lastly, this solution was chosen over the other ideas because young children are having a hard time with talking about their feelings. Besides, the children probably do not even know what a panic attack entails, therefore it may be challenging for them to talk about it. When the parents are notified about the fact that their children are having a panic attack, then the parents can start a conversation about it and talk with their kid about it. In this way the child learns how to talk about their feelings, which may come in handy during their life later.

### 6.2 Distribution of the tasks

The approach that will be taken for this project is a modular approach. The following modules are divided:

- Sensors: decide which sensors are necessary and order the sensors
    - *This will be done by everyone*
- Design: visualizing the product, making thumbnails, making sketches
    - *This will be done by Sil, Patrick, Floor*
- Software: get accurate readings, reading out data, connect the data to an app
    - *This will be done by Jesse, Victor, Seokho*
- Hardware: Making the sensors work with arduino
    - *This will be done by Victor, Floor, Seokho*
- Making the actual bracelet: combining everything into one product)
    - There will be two prototypes made; one functional one with all the hard- and software that works properly. And one that looks nice, clean and how the bracelet should look in the end.
    - *This will be done by Sil and Roel*
- Testing: Testing the product and making sure that the product actually works on children
    - *This will be done by Sil*
- Documentation: Finishing the documentation, updating the file and making sure that everything that is done is documented
    - *This will be done by Roel*

# Chapter 7: Methodology

**7.1 Anxiety and panic attacks**

After having worked out the idea more precisely, there is decided that there are sensors necessary in order to achieve the goal of the project; sensing if children are suffering from panic attacks and/or anxiety attacks.

The “How to recognize an anxiety attack”, published by MedicalNewsToday, talks about anxiety; the symptoms, causes, lifestyle tips and treatments. The article defines the difference between anxiety (attacks) and panic attacks. Anxiety or anxiety attacks are mainly caused by one specific trigger. Besides it is not easily diagnosable and it is also less severe than panic attacks. Usually it develops in the person within a certain period of time. A panic attack on the other hand is more severe. Usually it is not caused by one specific trigger and can thus happen all the time. A panic attack is likely to last between an hour and a few minutes. The aftermath of such an attack, though, lasts way longer. Also a panic attack may be a symptom of more severe medical conditions such as a panic disorder, therefore it is more easily diagnosable than an anxiety attack.

Since this project is focussing on both anxiety and panic attacks, there will be looked at the symptoms of both of those conditions. Anxiety and panic attacks are very personal, the symptoms of both of these attacks can differ per person. However, generally speaking anxiety attacks have the following symptoms: being worried about a specific event, being unable to rest and thus having trouble with sleeping. Also being unable to concentrate on (simple) tasks and work belong to the symptoms of anxiety. Furthermore, people tend to feel sad and they are easily irritated. Also, people who suffer from anxiety feel more pressure and feel like they are hurried. Lastly, a pounding and/or racing heart is also one of the symptoms. The symptoms of panic attacks also include changes in heart rate. Also the muscles are more tense, especially in the head or the neck. Headaches, nauseousness and diarrhea are symptoms. Furthermore, being sweaty and sweating in general is caused by a panic attack. A dry mouth, having difficulty with breathing, a tightness in the throat and feeling faint are also symptoms. Lastly trembling and/or shaking also belongs to the symptoms of a panic attack.
With this information, there can be looked at which sensor will be needed for the bracelet. The bracelet should be able to detect if a child is suffering from anxiety or from a panic attack. A combination of sensors that focus on the symptoms mentioned in the paragraph above should, therefore, be able to detect a panic attack.

### 7.2 Useful sensors for the project

The following sensors (which are based on the paragraphs above) could be useful for this project: A heart rate sensor which is placed at the fingertip or wrist. A blood pressure sensor, that is placed around the upper arm or wrist. An adrenaline and/or cortisol measurer that is placed at the fingertip or at the wrist if it is measured through sweat. A sensor that measures the amount of oxygen in blood which is detected at the fingertip or the wrist. Lastly a sensor that measures the amount of blood sugar, which is measured at the upper arm or at the wrist.

#### 7.2.1 Adrenaline/Cortisol

The technology to actually detect hormones is very complicated and is not really available for purchase right now. Although the technology has been developed recently to measure these variables in a way that corresponds to the team's objective, there are no actual sensors up for purchase as of now.

#### 7.2.2 Blood Pressure

Older technologies for measuring blood pressure consisted of larger equipment usually placed around the upper arm or elbow. These technologies would require pressure on the arm, certain time intervals and sometimes even a catheter inserted into an artery.
For the product of this project, these older technologies could not be taken into consideration as the team's aim is to observe and monitor the blood pressure throughout the whole night and while the child is sleeping.
Luckily, the development of new micro technology has allowed for wristwatch sized technology able to measure blood pressure. Recently, there's been an increase in fit / smart watches that contain a blood pressure sensor, able to measure one's blood pressure at all times. The accuracy of these sensors have been a little less accurate compared to larger equipment but they still provide a decent measure.
Especially in this case, where the objective is not detecting a slight increase in blood pressure, but a drastic one, which a child would experience when having a panic / anxiety attack. The options to purchase of these micro sensors is limited but there are options.

#### 7.2.3 Blood oxygen level

Blood oxygen means how much oxygen is contained in the body. Depending on the amount of the blood oxygen, one's current condition can be known.
Recently, the blood oxygen can be checked whenever by using an app which is for the blood oxygen sensor and a smart watch. It means that the mobile phone and the smartwatch contain a sensor to measure blood oxygen. And the measurements are shown in the screen for the results. In the mobile phone, one puts his or her finger on the sensor, the mobile phone measures the percentage of the blood oxygen. And in the smart watch, the watch is put on the wrist and the results appear after a few seconds.
Because the majority of the people have a mobile phone, everyone can easily measure.
When children have anxiety, they are going to breathe incorrectly. Therefore, due to incorrect breathing, they have a low blood oxygen level. In other words, anxiety gives indirectly the low blood oxygen level.

How is it measured? Blood oxygen level can already be measured by existing bracelets/watches. The Apple Watch is a very well known example. It measures the oxygen levels in the blood by shining an infra-red and a red light through one's wrist. Deoxygenated hemoglobin absorbs more red light, while oxygenated hemoglobin absorbs more infra-red light. That means that if more red light is absorbed by the blood cells, the oxygen levels are too low and if mostly infra-red light is absorbed, one does not lack oxygen in his or her blood.
The Apple Watch is however not very accurate in this area. There are two main reasons why it is not as accurate. On the one hand because it is measured at the wrist instead of the much better spot; the tip of the finger. This could possibly be solved by moving to the lights to a different spot, so one can lay the fingertip of his or her other hand on the device and it can be measured from the fingertip.

The reason for this difference in accuracy counts two factors. One, the blood gathers much more densely in the fingertip than at the wrist and two, the blood is much closer to the surface at the fingertips. On the other hand, instead of measuring the light itself , the Apple Watch measures the refraction. This is simply a less accurate method.
If those two main problems are worked out, it is much more accurate, but it is still not as accurate as going to the doctor. Therefore, if one would have legitimate concerns, he or she is advised to contact their doctor, instead of trusting the results from the bracelet/smart watch. For pulse oximeters to be considered reliable, it first has to be rigorously tested to get the label '*for medical use' (FMU).*

### 7.2.4 Blood sugar level

Blood sugar is often measured by diabetic patients. This used to be done by taking a little bit of blood from the tip of the finger. Now there are much more simpler ways to get the blood sugar level. A lot of blood sugar sensors are little machines that have to be clipped on the tip of the finger or chips that would go under the top layer of the skin.
The link in the sources is a paper on a self made smart glucose meter system, also made with an arduino. The only problem here is, that the sensor used is placed under the skin. Since the idea is to make a bracelet, a sensor that is placed underneath the skin will not be useful.

## 7.3 Sensors bought for the project

In the end there is decided to order the heart rate sensor, a sensor that detects the amount of oxygen in the blood, a blood pressure sensor and a water/humidity sensor which detects the amount of water and could be used to measure the amount of sweat of the child.
These sensors can be find at the following shops:

- Sensor for the heart rate and the amount of oxygen in the blood:
  Bought at Kiwi-Electronics.nl
- Sensor for the blood pressure:
  Bought at Distrelec.nl
- Water sensor:
  Bought at Conrad.nl
- Between 0 and 1023

### 7.4 Materials needed for the creation

For the creation of this bracelet multiple materials and information will be needed, below here a list of everything that is needed can be found.

- Arduino
- Arduino IDE
- Laptop
- Heart rate sensor, oxygen sensor, blood pressure sensor, water/humidity sensor
- Bluetooth module
- Breadboard
- Jumper wires
- Materials for the material of the bracelet itself
- Fitbit for testing purposes
- Websites/books with information regarding arduino and the sensors

### 7.5 Testing

After the bracelet is made, the testing phase will start. The bracelet detects heartbeat by the sensors. To check working on the results, a test for the results will be done with Patrick's fitbit. During the test, there will be checked whether the result that is detected from the fitbit matches with the result that is detected from the bracelet, and one of the children of Sil's boss is going to be tested with the bracelet to check the heartbeat. If it doesn't work, the faults will be sought out and improved for better results. A check needs to be done to ensure the result from the bracelet matches with the result from the fitbit.

### 7.6 Time planning

In order to achieve making the bracelet, a time plan is needed to see what should happen every week. Therefore, there are two plannings; one planning that is basic and more realistic and one planning that is very ambitious, with more tasks that will lead in the end to a more complex product. For the ambitious planning, the plan is to make an additional teddy bear. If it is sensed that a child is suffering from anxiety then the bracelet senses this, a message will be sent to the phone of the parents. Then the teddy bear is additional help to lessen the anxiety of the children.

**7.6.1 Time planning basic:**

| **Week (date)** | **Task** |
|---|---|
| 11th of December | - Do research on which sensors that will be used & order the sensors.<br>- Start working on the design.<br>- Software: start working on connecting arduino to one's phone<br>- Work on documentation |
| 18th of December | - 11.00 - 13.00 in Smart XP Lab<br>- Start working on the sensors & hardware<br>- Finalize the design<br>- Work on the 'visually good looking' prototype and finish the design of it<br>- Software: continue on working with connecting it to a phone. Work on reading the data.<br>- Work on documentation |
| 8th of January | - Finish hardware<br>- Work on software<br>- Finish the 'visually good looking' prototype<br>- Work on documentation<br>- Start working on the 5 minute presentation<br>- Testing: if it is possible test the product |
| **15th of January** | **5 minute presentation of the group's first prototype**<br>- Start on combining everything into the final prototype<br>- Finish the software |
| 22nd of January | - Do some fine tuning<br>- Improve the thing that went wrong during the 5 minute presentation<br>- Finish the presentation for the final demonstration (think about a proper way to to present everything) |
| **29th of January** | **Final demonstration** |

**7.6.2 Time planning ambitious:**

| **Week (date)** | **Task** |
|---|---|
| 11th of December | - Do research on which sensors that will be used & order the sensors.<br>- Start working on the design: start working on the design of the bracelet and the design of the teddy bear.<br>- Software: start working on connecting arduino to one's phone and start programming a programme that will be displayed on the screen of the teddy bear (ability to listen to music, hear parents talk and ability to draw with touch screen)<br>- Work on documentation |
| 18th of December | - 11.00 - 13.00 in Smart XP Lab<br>- Start working on the sensors & hardware<br>- Finalize the design of both the bracelet and teddy bear.<br>- Work on the 'visually good looking' prototype and finish the design of it<br>- Finish the design of the bear<br>- Software: continue on working with connecting it to a phone. Work on reading the data. Work on the programme of the teddy bear<br>- Work on documentation |
| 8th of January | - Finish hardware<br>- Work on software<br>- Finish the software of the teddy bear<br>- Finish the 'visually good looking' prototype<br>- Work on documentation<br>- Start working on the 5 minute presentation<br>- Testing: if it is possible test the product both bracelet and teddy bear |
| **15th of January** | **5 minute presentation of the group's first prototype**<br>- Start on combining everything into the final prototype both for the teddy bear and the bracelet<br>- Finish the software |
| 22nd of January | - Do some fine tuning<br>- Improve the thing that went wrong during the 5 minute presentation<br>- Finish the presentation for the final demonstration (think about a proper way to present everything) |
| **29th of January** | **Final demonstration** |

# Chapter 8: Design

As for the design of the bracelet, there are two designs. One design that visualizes an ideal bracelet. The ideal bracelet, as the name suggests, visualizes the perfect bracelet like the designers would design it if there were no limitations with money, time and hardware etc. There is also a realistic design, which visualizes the bracelet in the way that is realistic and the way this bracelet is probably going to look like in the end.

## 8.1 Sketches

The design team (design module) consists of three members: Patrick, Sil and Floor. In order to come up with the best designs for both cases, each member will make thumbnails in 3D for both designs. The sketches can be seen down below:

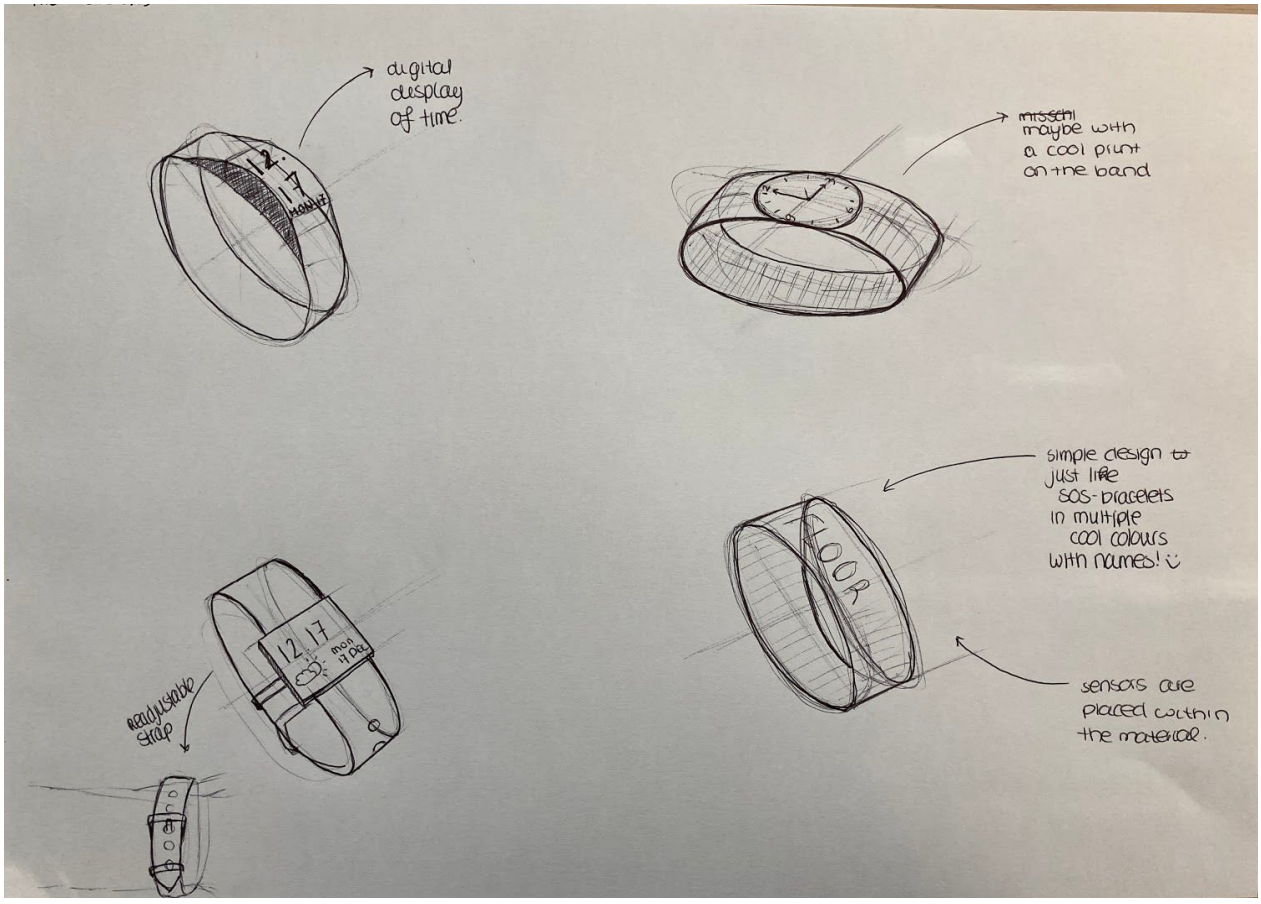


Figure 8.1.1 Concept sketches design

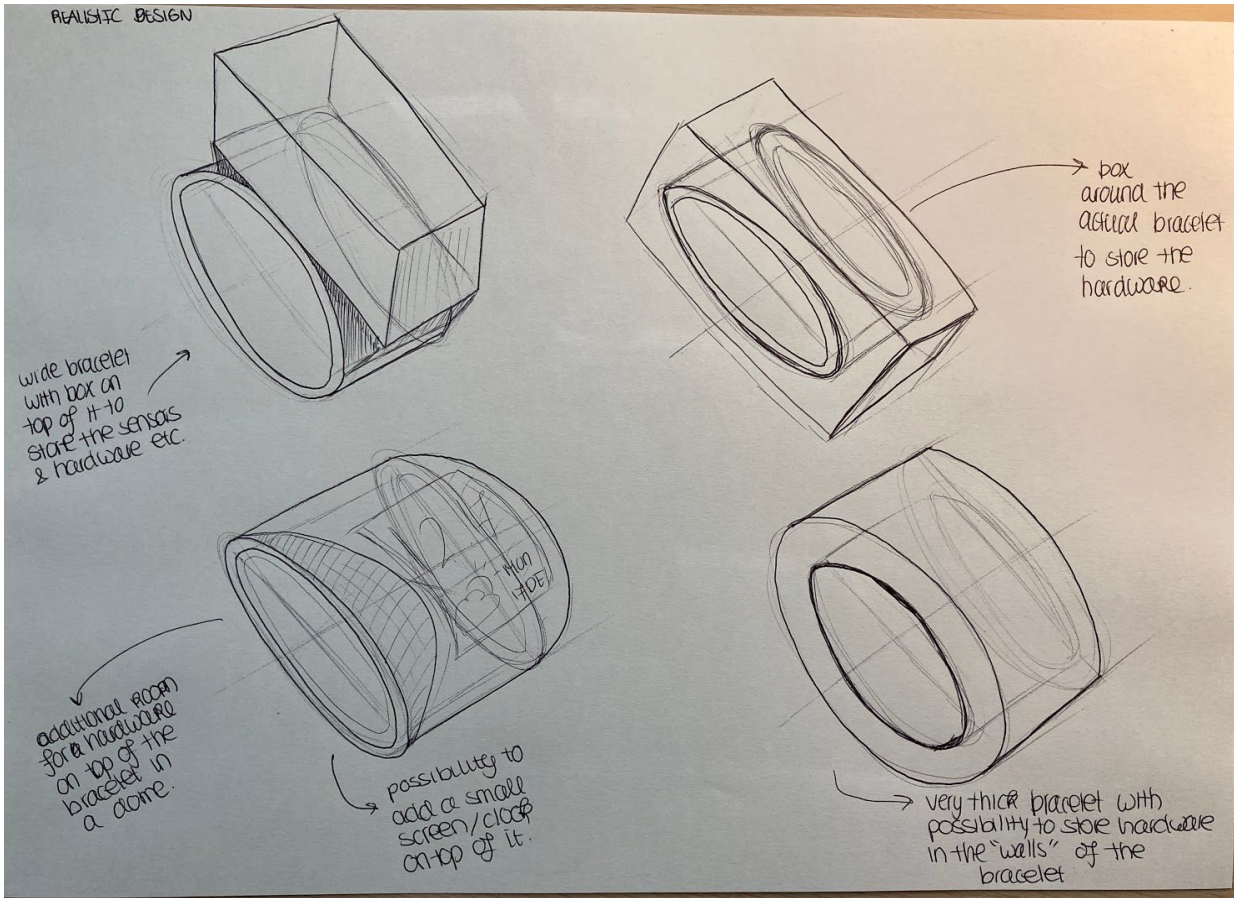


Figure 8.1.2 Concept sketch hardware placement

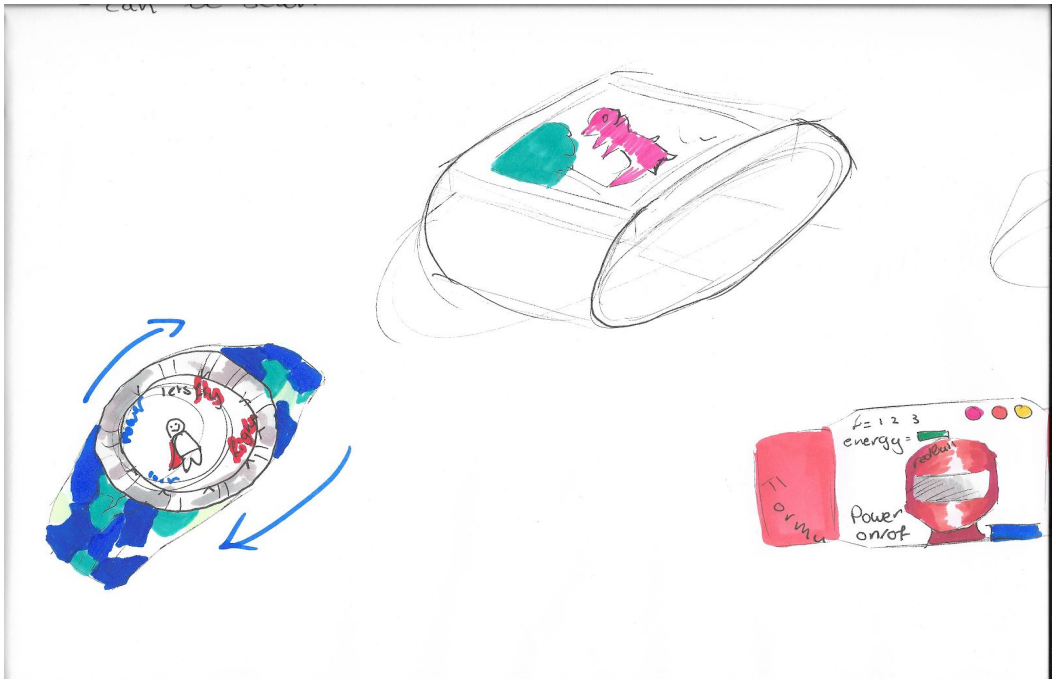


Figure 8.1.3 Concept kid-friendly design

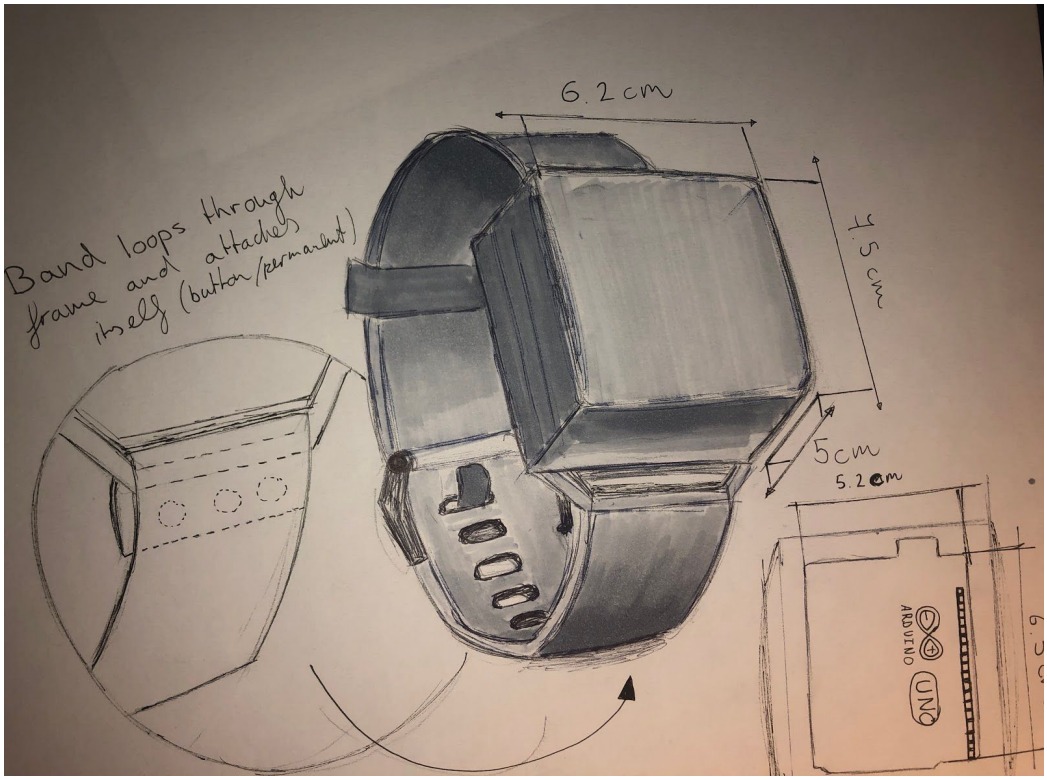

Figure 8.1.4 Concept practical design prototype

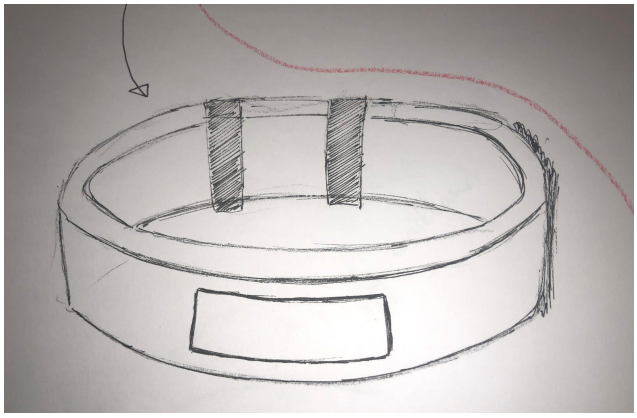
Figure 8.1.5 Concept design potential end result

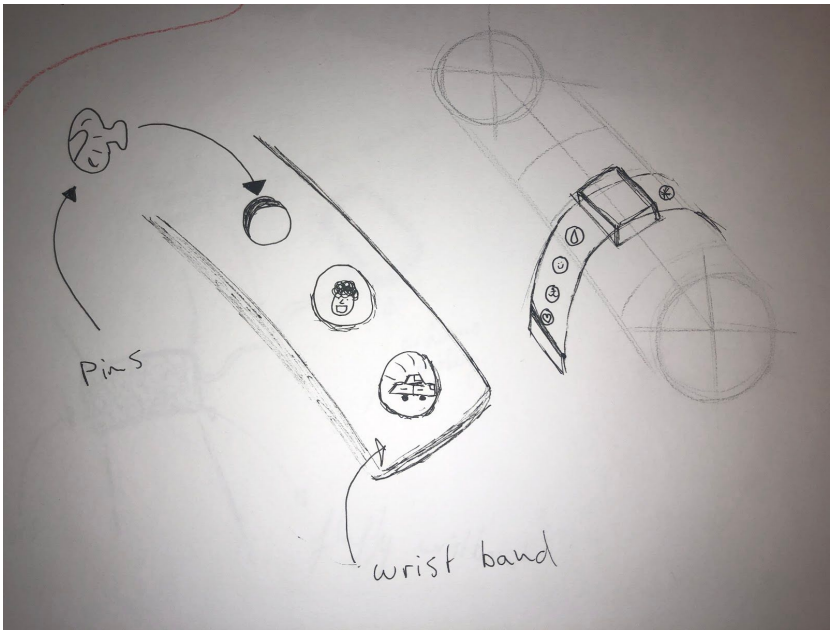


Figure 8.1.6 Concept accessories for kids

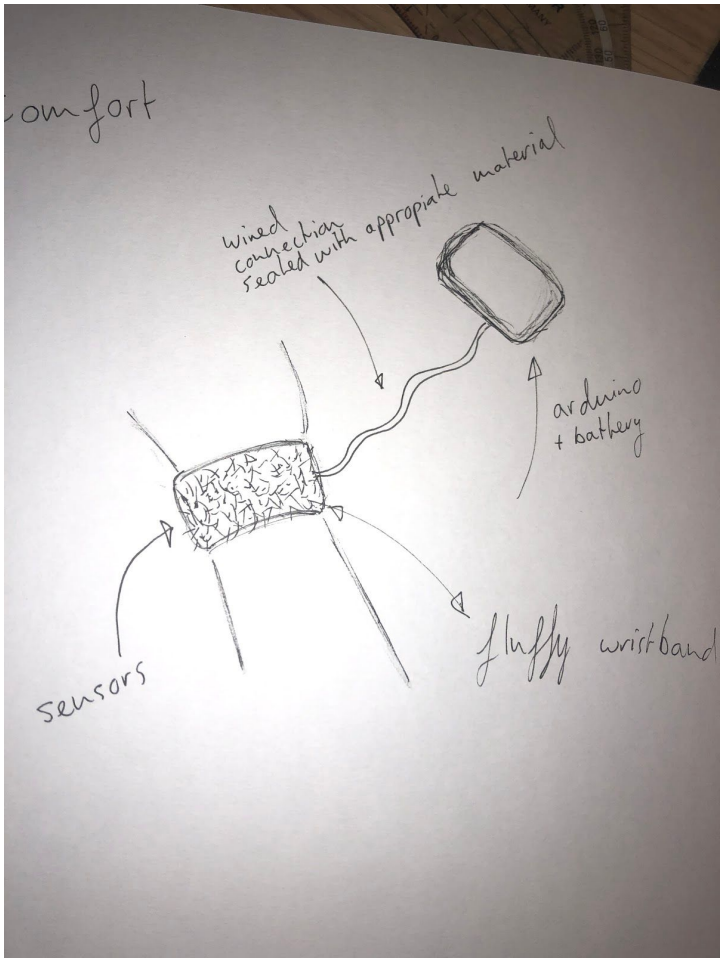


Figure 8.1.7 Concept build sensors

## 8.2 Materials

As for the material of the bracelet there should be looked at certain points of attention. For example, the bracelet should be strong and flexible. The target group of this project are children, children play outside and are still very playful. Therefore the bracelet should be suited for this and should not break quickly. In order to achieve this there are three possible materials for the bracelet: fake leather, silicone rubber and hard silicone.

**Silicone rubber**

Silicone rubber is a high-performance elastomer. An elastomer is a synthetic material that is very elastic. Silicone rubber is thus very elastic and quite high functioning. It is made of several chemical groups, which results in being able to carry both organic and inorganic properties. (The chemical structure of silicone rubber is visualized next to text). The main chemical group of this material is silicon, it is connected with other chemical groups such as oxygen, carbon and hydrogen. Silicone rubber has a great variety of properties, those properties also depend on the chemical structure of the chemical structure. It mainly depends on the way the material is ordered; organic structures (methyl, vinyl etc).

There are three points to keep in mind if this material will be suitable for the bracelet. First of all the design freedom; also known as how easy this material is to work with etc. Rubber silicone rubbers enhance options for part integration and it reduces the weight in products. Also it is very flexible and elastic. Also it is heat resistant, meaning that it can ‘survive’ in a very large temperature range. The second point to look at is the durability, how long can this material last. As mentioned above, it has a very high temperature resistance, it can survive above 1500 degrees! Besides it has UV light resistance, meaning that the material will not deteriorate under the influence for example of the sun. And lastly it has a micro crack resistance. The last point is production, because the material should not harm the environment. Silicone rubber has an excellent processability for injection and compression moldability. And the process of producing silicone rubber can be improved by minimizing the cold runner based LSR injection process. Considering all these facts, silicone rubber could be a very suitable material for the production for the bracelet, since it is very strong, it does not fall apart easily, it is resistant to many problems and it is very elastic.

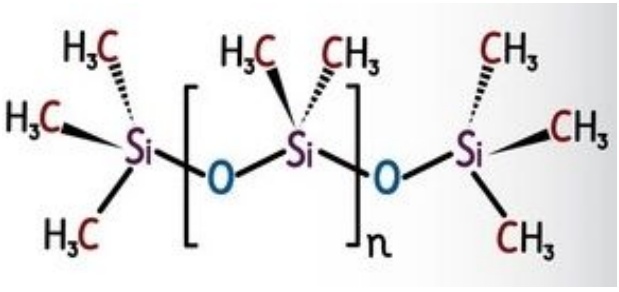


Figure 8.2.1 Chemical structure Silicone Rubber

## 8.3 Connecting the product to an app

As for connecting the product to an app to relay the information to the parents of the child or a potential psychologist, there are 3 things that need to be worked out. Firstly there needs to be figured out what data exactly needs to be sent to the app. Secondly how the data needs to be sent to the app, and thirdly how is the app going to look.

### 8.3.1 What data is going to be sent to the app?

So there will be multiple data detected as discussed before. The data of the following sensors will be received in the arduino: The data of the Heart rate sensor, oxygen sensor, blood pressure sensor and water/humidity sensor. So 4 different values. The question would be whether to send all the raw data to the app or to send a conclusion out of the data to the app. If the data sent to the app is raw there are 2 options to be discussed. Either the raw data is shown to the app user, to let the user draw their own conclusions (this has both advantages and disadvantages) or the app draws a conclusion on its own out of the data and shows that conclusion to the user. The other option is to already draw a conclusion in the arduino and just send that one piece of data to the app. Each of these options has their own advantages and disadvantages. So below here is a list:

1. **Sending raw data - displaying raw data :**

| Advantages | Disadvantages |
|---|---|
| Computers are set to make their conclusion on very set boundaries and cannot alter their conclusion based on extra factors. Next to that a human user might have extra circumstantial data the computer might not be aware of. The user of the app, mostly the parent, might however be aware of circumstances and therefore be able to draw more accurate conclusions. For example the parent can be aware of something that might have stressed the child that day, while the product cannot. | However, humans can often make mistakes and the raw data might also very quickly be misunderstood or an extra factor for overprotective parents to watch their child on every level. How privacy sensitive would this be? |
| In the view of how much storage and usage, sending raw data will require less space on the arduino since the arduino does not need to “calculate” the conclusion, and receiving raw data on the app takes a tiny bit more storage, but for an app that would be negligible. | However in the view of usage, 4 different sensor datas sent over bluetooth of course costs a bit more power then just one conclusion. This can however be considered negligible as well, since there are a lot of workarounds for minimizing whatever data will be sent. |

2. **Sending raw data - displaying a conclusion**

| Advantages | Disadvantages |
|---|---|
| The advantage from a user perspective in just displaying a conclusion would be that, that there is a clear answer on whether something is detected or not, people are not left to guess, but the computer knows what's up. This is more user friendly, since a conclusion speaks more for itself. | The disadvantage would be the missing data, for someone with a better understanding, raw data might be a better representation of what is going on then just a conclusion, since the person might not know where the conclusion came from. |
| In the view of storage and usage, all raw data is still being received in the app, but it is processed into a conclusion, since in an app that processing barely takes any power or storage this solution would be neutral in usage and storage | Disadvantage would be the tiny bit of more storage or processing power used to turn the raw data into a conclusion |

3. **Sending a conclusion - displaying a conclusion**

| Advantages | Disadvantages |
|---|---|
| In the view of a user the advantage for this would be the same as option 2 | This one also corresponds with the disadvantage mentioned in option 2 |
| The advantage in usage would be that sending a conclusion can ensure that less power and processing power is used, since less data needs to be sent. Since a conclusion could just be one letter, and that one letter is then used in the app to display a message, based on the letter. | Disadvantage is that the raw data needs to be turned into a conclusion on the arduino, since an arduino has very limited storage and processing power as less code on the arduino as possible is wanted. It is however important to mention here, that an arduino could probably easily read out 4 different sensor data and send a conclusion to the app without trouble. |

**Conclusion**

All options have their own advantages and disadvantages. The conclusion drawn from everything mentioned above would be that in all of the options processing nor storage power really is that much of a problem, so if looked at just the user's point of view, it is clear that both sending the raw data and the conclusion are beneficial in different ways. So the solution that has been come up with is that both the raw data and the computer suggested conclusion are shown, but the raw data is a bit more hidden, as in with the click of a button, or just accessible to anyone with a code. This code would then be available to anyone with client-doctor confidentiality or to someone with more experience in the meaning of the data. Most likely being a psychologist. However since this project group is not capable of storing or protecting data on a data encrypting level or with locks, for the project and prototype both the raw data and the conclusion will be displayed. The conclusion will however be drawn in the app, so that the

arduino only has to send the raw data from the sensors to minimize power usage and processing power.

### 8.3.2 How is the data going to be sent to the app?

So as mentioned above there will be a separate app to receive and process the data, earlier the option was of potentially using an sms to alert the user of the data, but this was deemed out of the scope of this group rather quickly, next to that, an sms would of course cost money. So the question as mentioned above in the title is more about what kind of connection is going to be used to send the data from tha arduino to the app. There are 2 options to be discussed here, bluetooth and internet. For the internet it would require the arduino to have internet access and send the data there via either a web server or via the local host to the app. The local host can however cause a lot of trouble since firewalls can be a bit tricky regarding sending data on one's local network. Regarding a web server, there would need to be a web server that can safely receive the data and send it through to the app, an advantage would be that the app user has access to the data wherever the user is with internet or data connection, the disadvantage is the lack of knowledge/skill the members of this group have regarding this specific solution. And however that is not an excuse to explore the possibility, it is far out of the scope of this project, since having a web server to support the collected data is not the main objective of this project. This solution would simply be too large of a problem to tackle within the boundaries of the given time.

The last remaining solution but not necessarily a bad one is sending the data over a bluetooth connection. This is easily in the scope of the abilities of the group and this project. The advantages of this bluetooth connection would be that it doesn't take a lot of power, makes it easy for the arduino to connect to the app and is very cheap. However, cheap isn't the biggest priority, is it however an advantage since the objective still is to make a product that has to be sold, and a lower production price either means more profit or a lower selling price, depending on the sellers goal.

*How will the data be sent using bluetooth?*

Arduino has a lot of premade usable modules for different things, including a bluetooth module. The image to the side here (figure 8.3.2.1) shows the bluetooth module called "HC-05 bluetooth module".

This is also the module that will be used for this project. It needs a Vcc and Gnd and 2 pins for Tx and Rx to send and receive data. This module costs about 7 euros each but this price is of course scalable when buying on a larger scale.

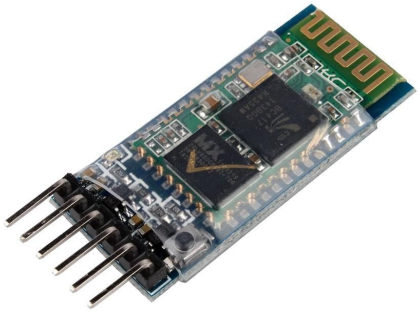

*Figure 8.3.2.1 Bluetooth module HC-05*

### 8.3.3 How is the app going to look?

The main purpose of the application is to be functional but an app design is also a part of the app. The functionality is discussed above but here the design of the app will take place. Below a design will be shown on how the app could look like. The design will be constructed based on existing app designs. So existing research/designs will be used to base the design on. Note: these existing designs wont be stolen, but the design will be 'inspired' by these existing designs. This will be looked at closely to ensure there won't be any copyright issues.

First some light sketches. The app needed to be direct and not confusing so the design is as simple as possible.

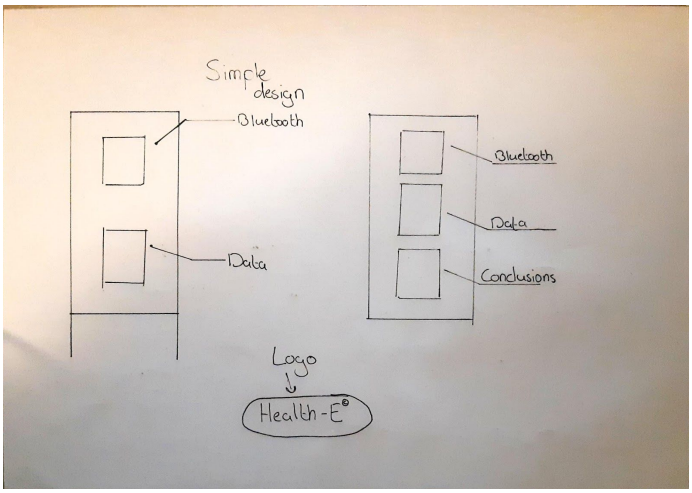


*Figure 8.3.3.1 First Sketches of the App*

After these sketches this is the final design. The color palette is mainly green after a medical aesthetic. So the app is simple and therefore easy to navigate in, also in case of emergency.

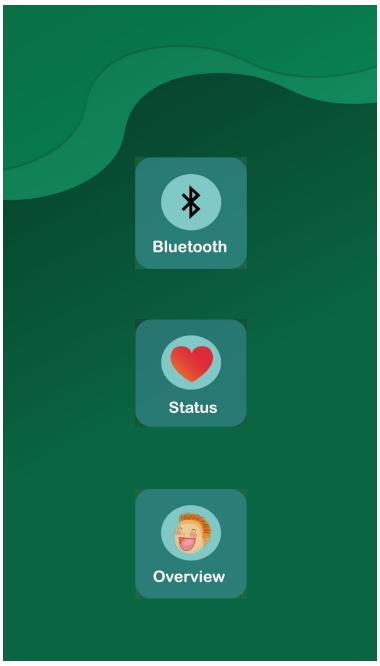


Figure 8.3.3.2 Layout of app

- Below the bluetooth icon the user will be able to connect to the watch when opening the app.

- When clicking on the status button the user gets to see all the raw data being sent in. A possible password could be implemented for this to make it just available to experts, as mentioned above, but for the prototype it's just available at all times.

- Below overview a conclusion can be drawn from the data read in status.

So after having implemented the design in the app it looks like the following screenshots:

The second screen still needs to be altered and will display different values, but since the making of the prototype is 1 day after the deadline of this report are these the results for now.

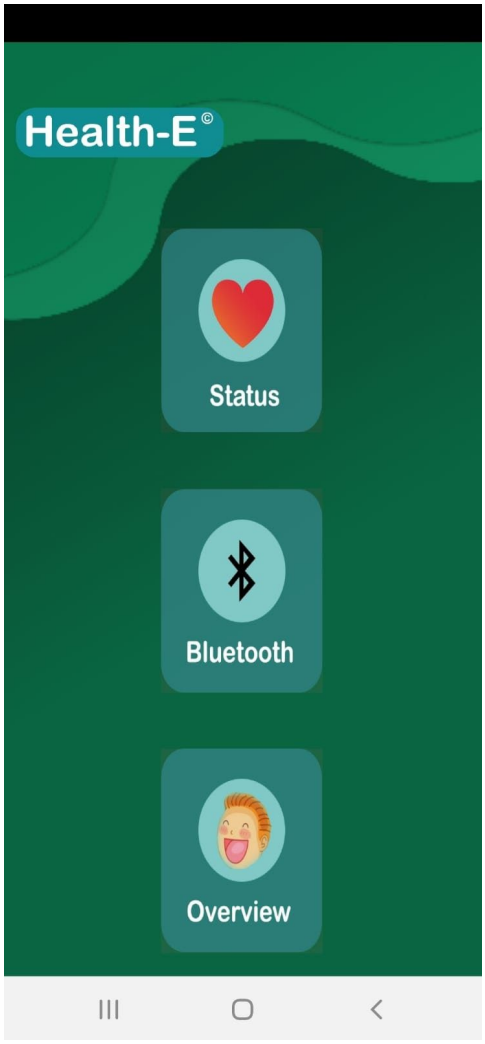


*Figure 8.3.3.2 The First Screen on the App*


*Figure 8.3.3.3 The Second Screen on the App*

# Chapter 9: Sensors

To achieve the goal of this project, several sensors are used: a heart rate sensor, water sensor and a temperature and altitude sensor.

### 9.1 Heart rate sensor

Figure 9.1.1 Heart rate sensor

The heart rate sensor, as the name suggests, measures the heart rate of a person. The sensor consists of a sensing material, which is encapsulated by a cover of plastic. On the plastic a white heart is visualized and, when it is connected to the arduino correctly, a green LED is visible.
There are three wires attached to the sensor. The red wire for the power supply, which goes in the 5V, the black wire for the ground and lastly the purple wire for the analog pin. For this project, the purple wire is attached to the A0 pin.
The minimum value of the sensor is 0 and the maximum value 1023. Realistically the values vary between 500 and 600. The peaks that are visible on the Serial Plotter thus vary between 500 and 600.
The sensor can be attached to a finger by means of a small band that is usually provided with the sensor. The band helps by providing the sensor with a constant pressure. However, one point of attention is that one should not put the band too tight around one's finger, because otherwise it blocks the blood from flowing through one's veins in the fingers, resulting in no heartbeat at all.

### 9.2 Humidity sensor

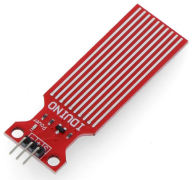

Figure 9.2.1 Humidity sensor

The humidity sensor is a surprisingly big sensor with some metal strips at the top which conduct really well through water so when the sensor gets moist it will send more voltage to the analog pin that reads it out. When the sensor is not in contact with any water it will just read 0and when the sensor is fully covered in water it will read 1023, this will give the Health-E a sense of how sweaty you are. Realistically it will only read between 0 and 600 when you're wearing the bracelet so we tuned it to take that into account.

### 9.3 Temperature, Pressure and Altitude sensor

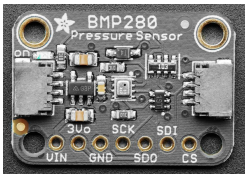


Figure 9.3.1 Temperature, pressure and altitude sensor

We have a sensor called bmp280, it senses temperature, pressure and altitude. It needs two libraries to actuate. The sensor reads the minimum value 0 and the maximum value 1023, and when someone is wearing a bracelet, each value is measured. Realistically, the value of temperature measures between 10 to 30. Blue and green wires are connected to A4 and A5.

# Chapter 10: Circuit Design

Visualized down below, one can find the final circuit design with the heart rate sensor, bluetooth module, water sensor and temperature sensor connected and attached to the Arduino Uno. The code for the Arduino Uno and the app can be found in the attachments.

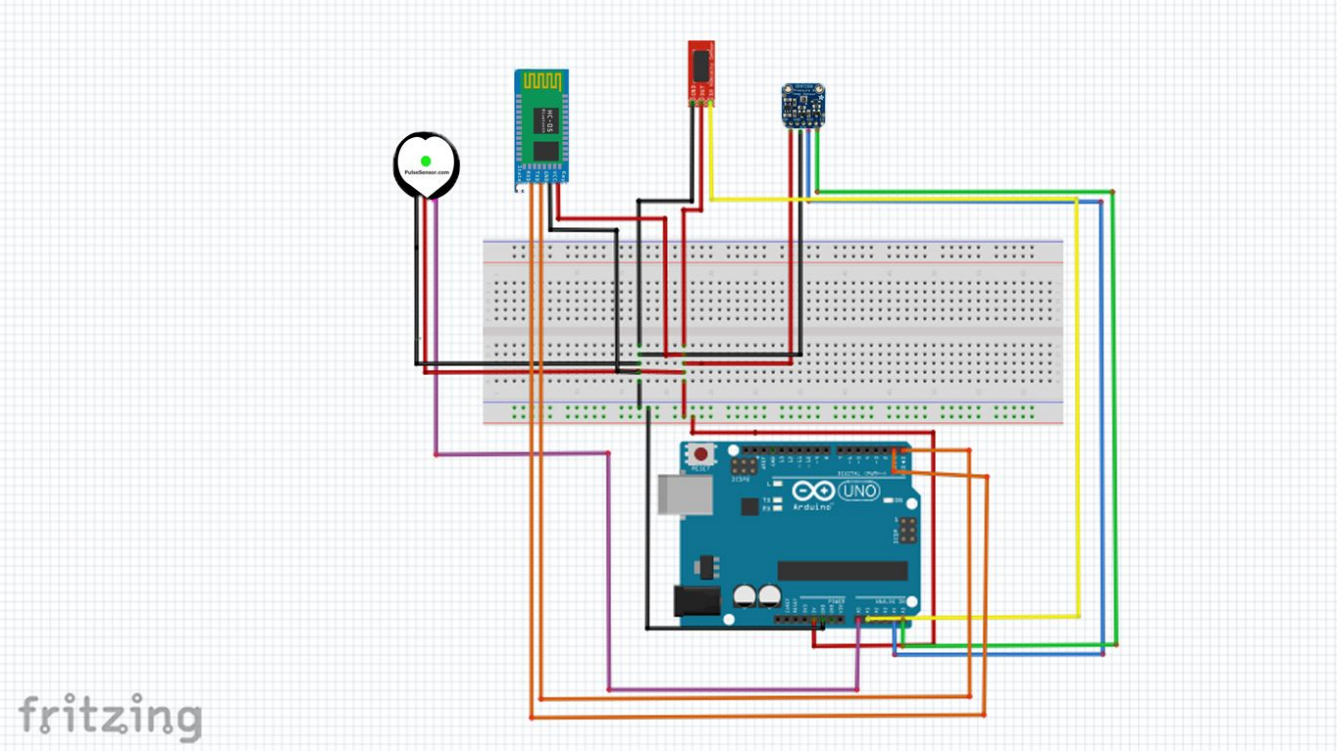


Figure 10.1 Final circuit design

# Chapter 11: Conclusion

To conclude, in this paper, there has been research on how to solve problems that are caused by disasters.
First of all, there has been done research on the different kinds of disasters that can occur. With that information nine general problems have been identified, which may occur during, after or before a disaster took place. By dividing these nine general problems in sub-problems five new urgent, relevant and interesting problems have been identified. From those five problems, one problem was selected as the problem that this project would focus on: children can be traumatized after having experienced a disaster.
After having identified the main problem there were stated many possible solutions to this main problem. Next, the final solution has been selected: a bracelet that tracks some physical features of a child to conclude whether the child is experiencing anxiety or not. If the child is experiencing anxiety and/or panic attacks, then a message will be sent to the app of the parents.

The physical part of this project had to be split up into many small tasks because of COVID, there was a team for hardware, software, design and documentation. The hardware team made the sensors work with the arduino, software made the app, the design made some ideal sketches of the bracelet, some realistic ones and also designed the look of the app.
For the design a lot of inspiration was taken from already existing child watches. Three separate materials were chosen to further experiment with to find the most suitable solution for the finished product. The first material was thick silicone. This material is often used for cheap bands, so production cost would be very low. One big downside is that people often experience sweaty wrists from them. Since there is a water sensor being used, this isn't convenient. The second choice would have been thin silicone, since that is lighter than thick silicone, so more comfortable for a child to wear. Sadly, this material also has the same problem as the thick silicone. The last and final material is fake leather, and this material is also the one that was chosen for the final product. Fake leather is also very comfortable for children to wear, just like light silicone. The sweaty wrist problem also doesn't occur here, since leather is more absorbent. Ultimately, we decided to use an already existing watch wristband.

Because of COVID the usage of the SmartXP Lab wasn't available for a long time. The wristbands are detached from the watch, and reattached to a self made plate with the sensors. There were some difficulties with ordering the right sensors because not all sensors are available for purchase or at a really high cost so little sacrifices had to be made. A blood sugar sensor, blood pressure sensor, blood oxygen sensor and hormone sensor would have been great. The result was a heart rate sensor, a humidity sensor, a temperature sensor and a pressure and altitude sensor for calibration. The altitude and pressure sensors don't give accurate readings or even workable readings but there was no time to change them for better ones.

The software for the app has been made using “MIT app developer” which had a more reasonable learning curve for writing an app in the time we had for this project. This receives the serial prints of the arduino via bluetooth and displays it in the app. The received data also includes a conclusion that displays what the raw data might mean. So an elevated blood pressure will display a message saying that it indicates the following...and then display a message. The data in the app will get updated every 10 seconds in a state of rest, but when an elevated value is detected the app will update every second.

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# Attachments

**Arduino code**

```
#include <Adafruit_Sensor.h>
#include <Adafruit_BMP280.h>
#include <Wire.h>
#include <SPI.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_BMP280.h>

#define BMP_SCK 13
#define BMP_MISO 12
#define BMP_MOSI 11
#define BMP_CS 10

Adafruit_BMP280 bme;

const int pulseSensor = 0;
const int liquidSensor = 1;

void setup() {
  Serial.begin(9600);
  if (!bme.begin()) {
    while (1);
  }
}

void loop() {
  Serial.print("Heart rate (BPM) = ");
  Serial.println(analogRead(pulseSensor));

  Serial.print("liquid level (%) = ");
  Serial.println(analogRead(liquidSensor));

  Serial.print("Temperature (C) = ");
  Serial.print(bme.readTemperature());

  Serial.println();

  Serial.print("Pressure (Pa) = ");
  Serial.print(bme.readPressure());

  Serial.println();
```

```
  Serial.print("Approx altitude (m) = ");
  Serial.print(bme.readAltitude(1013.25));

  Serial.println();
  Serial.println();

  if (analogRead(liquidSensor) > 300 && analogRead(pulseSensor) > 400 &&
bme.readTemperature() < 30 && bme.readPressure() > 80 && bme.readAltitude(1013.25) <
1200) {
    delay(1000);
  }  else if (analogRead(liquidSensor) > 300 && analogRead(pulseSensor) > 600 &&
bme.readTemperature() < 30 && bme.readPressure() < 80 && bme.readAltitude(1013.25) >
1000) {
    delay(1000);
  } else {
    delay(10000);
  }
}
```

**App code**

In this code the app only receives 2 datasets, but the newer code is not written yet since the prototype was not yet connected to the app at the moment of handing in the report