Wearable Arduino Components

CLIP ON

BY CHRISTINA ZHOU

Designed with Young Girls' Interests in Mind

LUND UNIVERSITY

Clip On
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Degree Project for Master of Fine Arts in Design, Main Field of Study
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Master Degree Project 2021

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ABSTRACT

This 30 credits master degree project focused on creating a product design with the aim to expand Arduino's maker community to reach young girls. The goal was to design a wearable merchandise for Arduino #include, which would inspire girls to explore STEM and learn about technology and programming. Arduino is a open source hardware company and Arduino #include is an inclusivity programme to celebrate Arduino's inclusivity values. Extensive research, via one survey and multiple interviews, was conducted in order to understand the interests of young girls and their thoughts on technology and programming. During the course of this project the target group changed to instead cover pre-teens and teens who are interested in exploring STEM. Although the design concept was still executed with girls' interests in mind. The result is a component system and online platform for crafting your own wearable technology.

BACKGROUND STORY

Back in February 2020 I was at my brother's apartment in Stockholm. Our class was exhibiting at the Stockholm Light & Furniture Fair and I stayed at my brother's place in Odenplan. One evening I was sitting on the sofa in his studio looking for summer jobs or internships. This would be my last summer before graduation and I was therefore searching for opportunities to gain more design related experience in my CV. As I was scrolling LinkedIn on my phone, I stumbled upon the Visual Design Internship announced by Arduino in Malmö. I saved the link and applied a week later when I had returned to my home in Lund.

Shortly after my application I was contacted for an interview at Arduino. The following weeks I received emails from other companies I had also applied at, telling me they had to cancel their jobs because of COVID-19. I was a bit worried the same might happen at Arduino. Luckily everything went well. I was accepted for the internship, which played out during the summer of 2020.

By the end of the internship in August I asked to continue at the company alongside the final year of my MA studies. When trying to figure out a topic for my MA thesis in December 2020, I wanted to combine technology and Arduino in my project somehow. And that is exactly what happened.

To be honest I have very little technical knowledge. I know nothing about coding. But I've always been interested in technical products, in particular consumer items. The world I'm living in is getting ever more digitised, and I want to take part in that development. Here's the documentation of my master thesis project 2021. Happy reading!

ABOUT THE COMPANY

As this thesis project is designed for Arduino I will dedicate this page to present the company. The following paragraphs are quoted directly from Arduino's official about-page on their website. I believe this text gives a good overview of the company and their products:

"Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

(...)

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide (Arduino, 2021)."


ARDUINO

BRIEF

In 2021 Arduino launched their #include programme, a long time initiative for the community and the corporation. Arduino #include is “a program to celebrate Arduino inclusivity values, by supporting and giving visibility to people and initiatives that use Arduino as an inclusivity tool”. The long term goal is to ” create positive role models across the tech communities” (Arduino, 2021).

My thesis will focus on the issue that is the lack of girls’ interest in technology, a subject part of STEM (science, technology, engineering, mathematics). Studies show that between the age of 11 and 16 girls lose their interest in STEM. The Arduino initiative is about inclusivity on all scales, but as this project will be my thesis the target group will be limited to the minority group of young girls in technology. I want to address this problem in my thesis by designing merchandise for Arduino #include. This should show how Arduino as a tech company is representative and cares about inclusivity. The outcome should be merchandise that will empower and encourage girls to pursue technology. I see potential for the merchandise to have functional and learning details, and be more than just non essential items. Merchandise in this project will be limited to wearables such as clothing, aimed for young girls to wear.

Throughout the project research will be conducted on why young girls lose interest in technology and STEM, but also what motivates the young girls that stick with their tech interest. What makes tech not interesting and what makes it interesting? This data will be collected in order to find a solution to designing the merchandise, which will creatively address the issue of girls’ lacking interest in technology.

WOMEN IN STEM

“Att vara teknisk eller att gilla teknik är ord som är mer förknippade med pojkar och män än med flickor och kvinnor (Stople et. al., 2018).” (Translation: To be technical or to like technology are words which are more associated with boys and men rather than girls and women).

I read the Swedish article *Teknikdidaktisk forskning för lärare*, published in the paper Naturvetenskapernas och teknikens didaktik by Karin Stolpe, Gunnar Höst and Jonas Hallström. The quote above is from their text. I could see their point, we as humans tend to categorise things and some things in our society are perceived as either masculine or feminine. But I also believe our prejudice and misconceptions always need to be challenged for a more equal and inclusive world.

Not only is the idea of technology more associated with masculinity, but studies show that girls lose their interest in STEM during their teenage years. In 2017 Microsoft released the results of their study in the report *Why Europe’s Girls Aren’t Studying STEM*.

”Most young European women become attracted to science, technology, engineering and math between the ages of 11 and 12. But that interest then drops off significantly between 15 and 16, with limited recovery (Microsoft, 2017).”

Why don’t more girls choose to pursue a science career? by PISA in Focus #93 2019 highlighted how factors such as confidence and interest, as well as academic strengths, affect one’s career choice (PISA, 2019).

At the same time a report presented at the *STEM Gender Equality Congress 2017* by the European Institute for Gender Equality show that there is a growing demand for STEM professionals. By 2025 the expected growth is 8%, which is higher than the 3% for all other occupations. The report points out that women participation in STEM studies is low in EU. The consequences of these issues are that they can affect the economic growth (European Institute for Gender Equality, 2017).

ARDUINO#include

INCLUSIVITY INITIATIVE

Speaking from my own mind I see the need for more diversity in STEM. I think we need women represented in order to develop an inclusive society. Our world today is getting more digitised and technology is all around us. If technology is the future, then women should also be part of that future.

As mentioned earlier in the brief I aimed at designing wearable merchandise for Arduino #include. In my brief I presented Arduino #include as ”a program to celebrate Arduino inclusivity values, by supporting and giving visibility to people and initiatives that use Arduino as an inclusivity tool”. The reason behind the existence of this program is because the company believes technology should be easy for everyone to use, people and projects using Arduino as an inclusivity tool should be given visibility and lastly this is a commitment to breaking down inclusivity barriers.

Since my project is only a thesis project conducted by myself, I am limiting my inclusivity to teenage girls, who I believe to be young women that should be included in the world of technology and Arduino. If they want to of course. I do keep in mind that technology and Arduino is not of interest to all girls. The group teenage girls is a very broad target. But my hope with this thesis is that the girls who might find technology interesting or are already interested, should be offered the opportunity to pursue this interest and feel included in the Arduino and maker community.

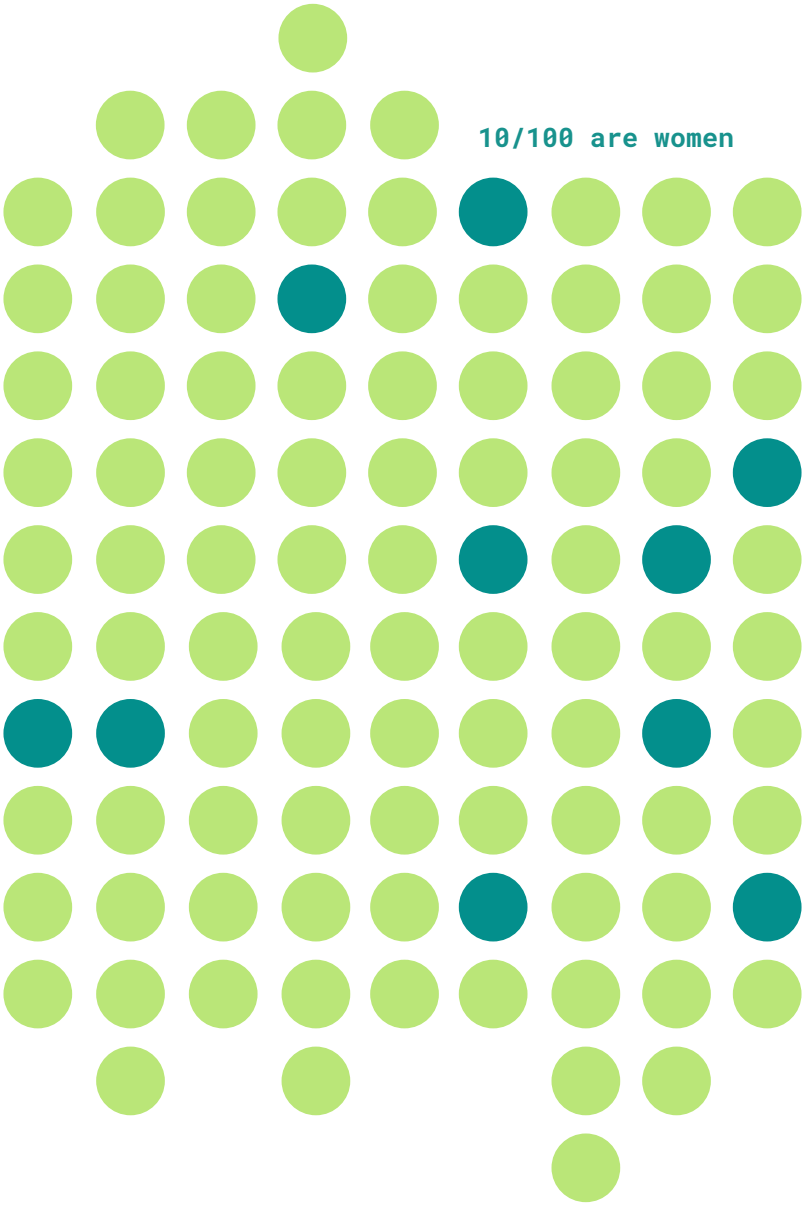
MAKER COMMUNITIES

I have mentioned the maker community in context with Arduino without defining what it is. Wikipedia's page about maker culture introduces the culture with the following definition:

"The maker culture is a contemporary subculture representing a technology-based extension of DIY culture that intersects with hacker culture (which is less concerned with physical objects as it focuses on software) and revels in the creation of new devices as well as tinkering with existing ones. The maker culture in general supports open-source hardware. Typical interests enjoyed by the maker culture include engineering-oriented pursuits such as electronics, robotics, 3-D printing, and the use of computer numeric control tools, as well as more traditional activities such as metalworking, woodworking, and, mainly, its predecessor, traditional arts and crafts (Wikipedia, 2021)."

Arduino's core concept is open-source hardware and Arduino is mentioned on this Wikipedia page about maker culture.

I wondered how many women are involved in maker culture. Based on personal experience from seeing Arduino forums and Discord channels, I knew the community and customer base of Arduino to be dominated by men. One place I do think it is equal is at schools which use Arduino as a learning tool. But school is obviously not the place for students to always make their own choices on what tools to learn and use. So when I look at the forums and Discord channel of Arduino I will make the assumption that the majority of members in these forums are those that have it as their self chosen interest or hobby.


10/100 are women

FACEBOOK MAKER GROUPS

As part of my research regarding women in maker communities I joined four Arduino groups and two Raspberry Pi groups on Facebook. Half of the groups were Swedish and half were international. All groups were currently active. I checked how many were women of the 100 recently joined members based on their profile pronoun, photo or name. Any profiles I could not determine a gender for were skipped in the count.

- Arduinobubblan (SWE): 4000 members, 1 woman out of the 100 recently joined members
- Arduino Sverige (SWE): 3000 members, 1 woman out of the 100 recently joined members
- Arduino programming/coding: 40 000 members, 1 woman out of the 100 recently joined members
- DIY Arduino/HERO projects and guides: 22 000 members, 10 women out of the 100 recently joined members
- Raspberry Pi and DIY Projects: 79 000 members, 2 women out of the 100 recently joined members
- RaspberryPibubblan (SWE): 4000 members, 1 woman out of the 100 recently joined members

The statistics between the groups were similar, except for one group that had a slightly higher percentage of women than the rest. Either this group did have a larger percentage of women or it was a coincidence that might have leveled out if I kept checking more than the 100 most recent members. Or women are less likely to use Facebook for group activity. There could be many factors in play.

At its best there were 10 women out of the 100 recent members in the maker groups. But most groups only had 1-2 women out of 100. Keep in mind that these groups are not fully representative for teenage girls today, who are using other social media platforms. But I do believe these numbers can provide a general overview of the gender diversity in the Arduino and maker community.

COMPETITORS

I had a look at some competitors to Arduino, what they are selling and if they are addressing the issue of inclusivity in STEM. Some of these competitors, such as Raspberry Pi and Adafruit, are also resellers of Arduino products or sell their own hardware that is based on Arduino's open-source.

Adafruit is a company selling both their own electronics brand as well as other known brands. They actively present themselves as a female founded business.

Imagilabs often also introduces themselves as a female founded company, and their target group is even teenage girls. Although I consider Imagilabs to rather be an indirect competitor to Arduino due to their small scale start up position and the fact that they are selling a finished product rather than open-source hardware. But as they are targetting the same group as me they are of interest.

Sphero is also interesting, because they are mainly targeting a younger audience; children and teenagers. Their products look colourful and well designed and even I would like to try them out. For me, someone who is not an expert in technology, their products give the appearance of being easy to use and learn.

Raspberry Pi had some blog posts where they discuss inclusivity and diversity.

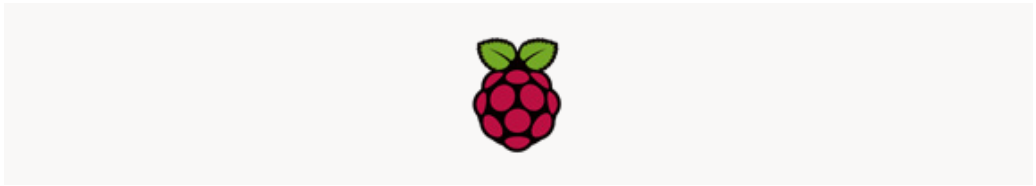
Sparkfun, Seeed and Beagle Board are all selling electronics that are similar to what Arduino offers. None of these stand out in anyway in terms of product lines or brand presentation.

Overall my final conclusion was that the competitors that are adressing inclusivity in STEM are Adafruit, ImagiLabs, Sphero and Raspberry Pi. But more can always be done and the fact that these companies are activity working with the issue is a good step forward.


adafruit


sparkfun
ELECTRONICS


sphero




seeed
studio


beagleboard.org


imagi

PHYSICAL

INSPIRATIONAL

EDUCATIONAL

Girls in STEM

Tjejer Kodar

DIGITAL

MARKET RESEARCH

When focusing on companies targeting teenage girls the results are limited. I therefore expanded the research a bit to include companies and organisations targeting girls of all ages or women. The chart displays examples of what I found on the current market. These companies, organisations or products are based either in Sweden or Europe.

The X-axis displays inspirational versus educational products. I defined inspirational as things that are addressing STEM in some way, but with the goal to inspire girls or women rather than teach. Educational was defined as things with the main goal of teaching STEM, such as offering coding classes. The Y-axis displays physical products versus digital services. Products are items in the shape of objects, there are things you could interact with and use. Digital services could be things such as online workshops or communities.

The physical and inspirational thing in the top left corner is a book called The New Girl Code. The story revolves around a girl who starts a career in the tech industry and the book is aiming to inspire other girls. I got my hands on the Swedish translation of this book to understand what it was about. One interesting aspect is that all translations have adapted the character names and places to the country it is translated for. Reading this in Swedish I could therefore picture the life of the main character and the environment in Stockholm very well. The book featured some snippets of code here and there, which was fun, and ended with real life suggestions on products and organisations you could use or join to learn more about STEM.

ImagiCharm by ImagiLabs in the top right corner is a physical product that I would consider to mainly be educational, although there are definitely inspirational aspects to it as well. The company is Swedish and teenage girls Sweden is currently one of their main targets. I was not familiar with the company until this research, but as I found them to be very exciting I reached out and interviewed one of their employees later on in this project.

Hello Ruby in the middle are books and activities by Finnish Linda Liukas.

I positioned it in the middle because a little bit of everything is offered. Physical books, online content, inspiration and learnings. Although the target group of Hello Ruby is young children and not teenagers nor girls specifically.

Below the center I placed Pink Programming. This is a Swedish non-profit that offers events and courses in programming for women. As a student myself at a technical university I have seen this organisation before. A lot of the events are online, but they do also arrange real life meetings. My overall feeling is they are targeting women or young women, as all the events I have seen do not really feel adapted for teenagers or children.

Girls in STEM in the bottom left is a non-profit network founded by three girls while they were in school. The network has then expanded over Sweden. They offer digital and some physical events for connecting with other Swedish girls who are also interested in STEM. I joined their Discord channel as part of my research. The channel has hundreds of members, who are mainly girls and young women in Sweden. Girls in STEM's Discord is used for asking questions or discussing STEM topics. Occasionally events are organised and I participated in a digital event, later on during this project, meant for practising giving presentations and feedback in a safe environment. I signed up to present and gave the participants an overview of this current project and my concepts on Zoom. As the network is run by volunteer girls and young women it is a really nice community for those who are the same age, and even if you are older or younger the network is very welcoming and open.

Tjejer Kodar is a Swedish organisation. They offer courses in programming, networking events, mentor programmes and list job offers within technology. Women are the target group of their business.

WHAT MADE YOU INTERESTED IN STEM

While I was figuring out how to reach my target group of girls age 11-16, I contacted the groups I where already had connections. Those who are close to my own age. Personally I do not have any friends or family under age 18, nor am I old enough to have adult friends with teenagers.

I talked to women that were either working or studying in STEM, most of them were working, and asked them what sparked their interest in the field. 29 women age 16-34 answered and told me their stories of how they ended up in STEM. These women were from Europe, North America and Africa. They were reached either by me directly as we were friends or via online forums.

The following points were found to be motivators to why the women became interested in STEM:

- events introducing STEM
- female characters in STEM portrayed in media
- support from teacher or parents
- parents working or interested in STEM who encouraged
- practical experience from childhood
- defying gender stereotypes
- the wish to make a good impact on environment / society / world
- enjoyed taking things apart as a child
- computer games

I believe these are still valid motivators to my target group today. My findings were confirmed by the study *Why Europe's Girls Aren't Studying STEM* (Microsoft, 2017), which lists similar things in the report. Note that I reached out to women outside of Europe and factors such as culture and school systems might affect situations.

SURVEY FOR TARGET GROUP

I created an anonymous survey to better understand my target group of girls age 11-16 within the topic of technology and programming. At the point of the survey I decided to define the target group as girls and non binary. This was because I had seen how men were clearly in majority in maker communities and I wanted to open up for anyone outside of this mainstream group. Being well aware of how the younger generation is very open about gender identity I did not want it to seem as if the survey only knew of the binary genders. The survey was made anonymous to keep the process and saved data safe, as I was reaching out to minors. It was conducted in Swedish as I was reaching out through Swedish online channels. The survey was shared through Facebook groups with parents, teachers, Discord channels and my social media profiles. It generated 50 responses during the first week it was active. A survey version in English was also made, but it only received 2 answers. Later on throughout my research I continued collecting information from Swedish people or companies. Therefore it did not make sense to expand the project outside of Sweden for now and I did not push for the English survey to be filled in.

The survey had obligatory initial questions for getting to know the responder:

- Do you identify as a girl or non binary? (Yes/No)
- How old are you? (Multiple choices. 11/12/13/14/15/16).
- Do you have a parent working in technology and programming? (Yes/No/Don't know).
- What are your interests? (Free text answer)

It was followed by obligatory questions about the definition of technology and programming as well as the interest in the subjects:

- What is your definition of technology? (Free text answer)
- What is your definition of programming? (Free text answer)

- Do you find technology interesting? (Yes/No/Don't know)
- Why do you find technology (not/maybe) interesting?
- Do you find programming interesting? (Yes/No/Don't know)
- Why do you find programming (not/maybe) interesting?

The last question was optional to answer with free text:

- Do you have any suggestions on how to make technology and programming more interesting for young girls and non binary?

Some Facebook groups and other forums do not allow sharing of surveys and marketing. Therefore this survey was shared in many spaces where the topic of STEM was already relevant, such as in groups with women in STEM where I shared the survey and asked if anyone had children or knew children fitting my target group. When it came to sharing it in my own social media channels there were no additional rules to obey and I could share my own survey however I wished. But keep in mind that the survey result is biased to some extent due to the fact that the responders might be children of parents working in STEM. According to the result over 40% had a parent working in STEM and some of these numbers might be due to the specified groups the survey was shared in.

One of the main takeaways for the continuation of this thesis was the question about what the target group do in their free time. The free text answer allowed for the responder to write as little or as much as they wanted. Some responders listed several hobbies and others just wrote one. I went through the results manually and sorted them into the categories shown in the chart. For example if a person answered ”football, horse riding and dance” this was sorted as two counts in the sports category and just one for dance. One single person with several listed free time activities therefore affects the results according to the number of activities they mentioned. With this in mind, the result might have differed if I instead presented free time activity categories for the responders to select, rather than being able to list several activities that I sorted as several counts in the same category.

The questions regarding the definition of technology and programming were in order to have a basic understanding for the target group's definition, and to better understand the answers in the following question about their interest in technology and programming.

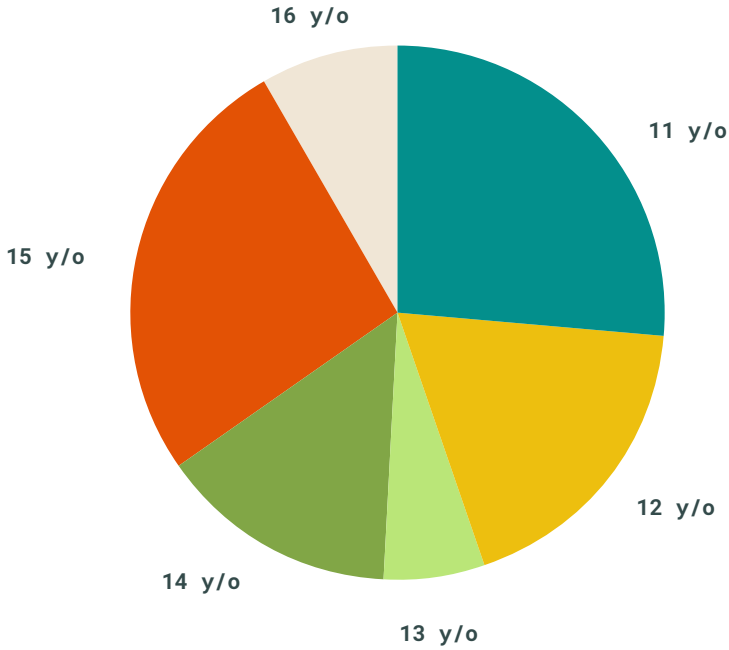
The results revealed that the responders had a good understanding of technology and programming. Technology was by the majority defined as a way of problem solving and something that is in everything around us. Coding was by the majority defined as coding to make something happen.

Among the 50 responders there was a mix of those who had an interest in technology and programming and those who did not find it interesting. The group that found it interesting was motivated by the fact that technology and programming is part of our future and our current reality. Many things would not exist otherwise. It was also mentioned that they were curious about the topic and that they believed programming was a way to be creative. One responder wrote in the question about their interest in programming that they did not know many girls who program and therefore felt that it was important to break the norms. The responders that did not find technology or programming interesting believed that it was too hard, complicated and boring. Some mentioned that they were not good with computers. A small number responded that they did not know if they found technology or programming interesting. For example these responders said that they sometimes felt that it was complicated or that they had never tried to program themselves and did not really know what it was.

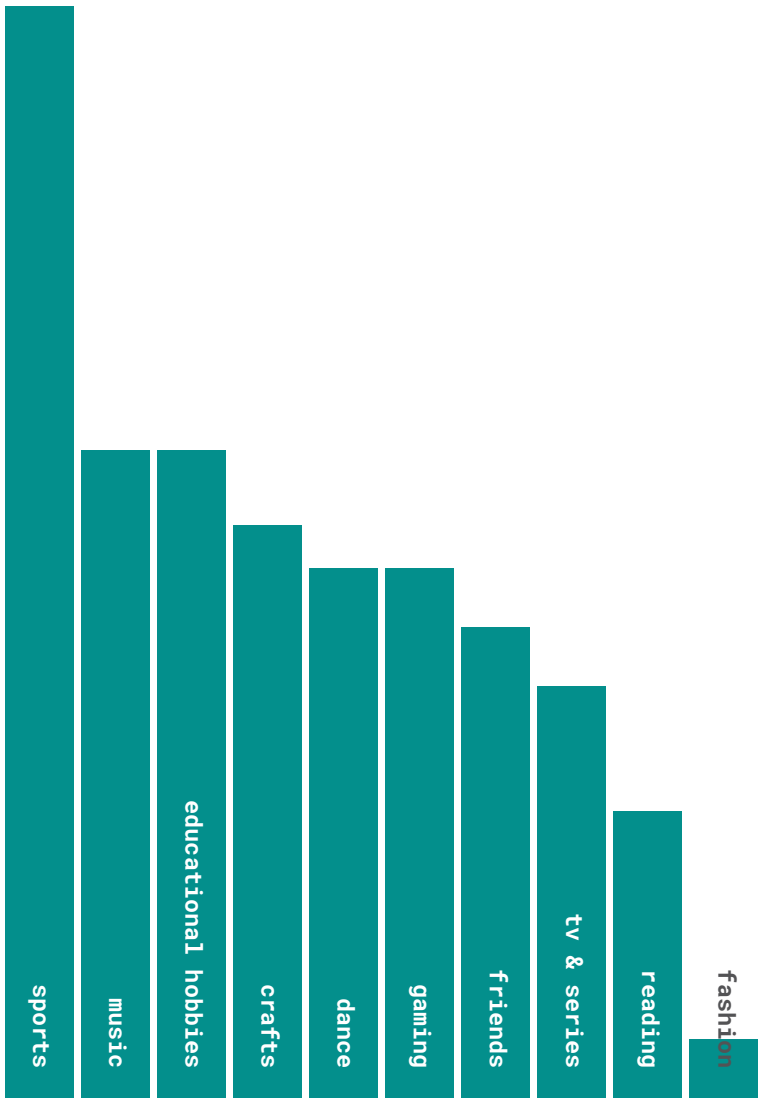
As the results showed that there is an interest in technology and programming I saw the opportunity to target this group and nurture their interest before it drops off. Additionally the responders who did not know about their interest or were not interested might potentially be convinced otherwise. But the main goal would be to encourage an interest that already exists.

The following pages illustrate the data from the survey.

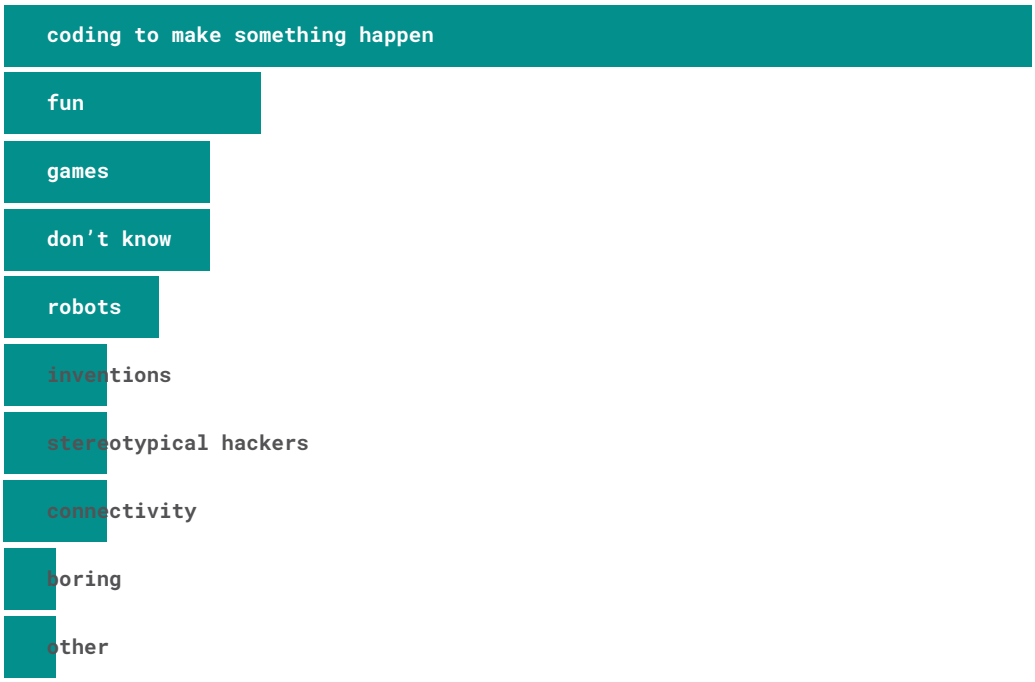
HOW OLD ARE YOU? DO YOU HAVE A PARENT WORKING IN TECHNOLOGY OR PROGRAMMING?



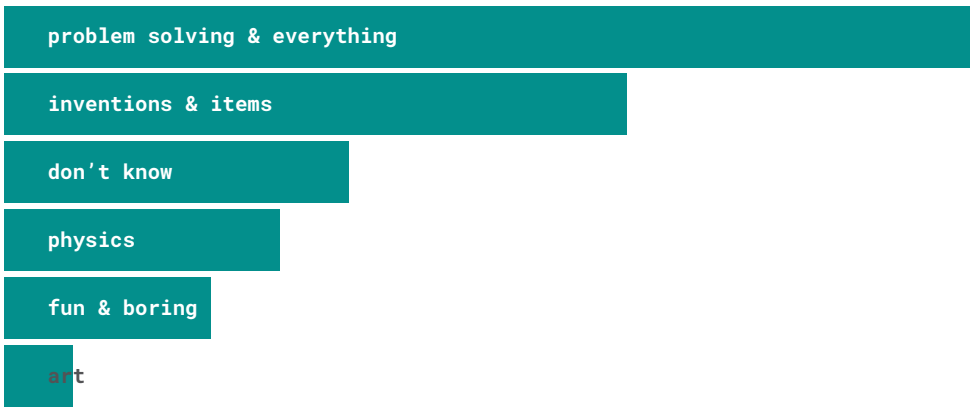
WHAT DO YOU DO IN YOUR FREE TIME?



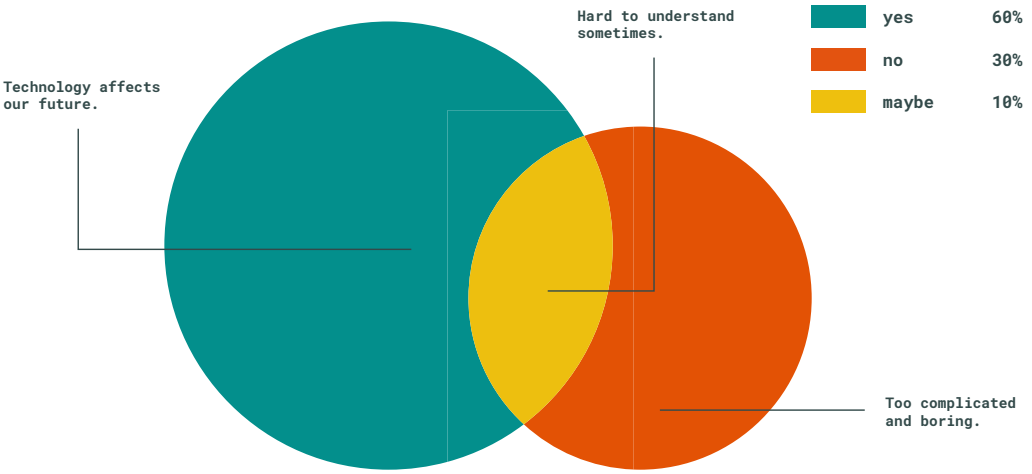
WHAT IS YOUR DEFINITION OF TECHNOLOGY?



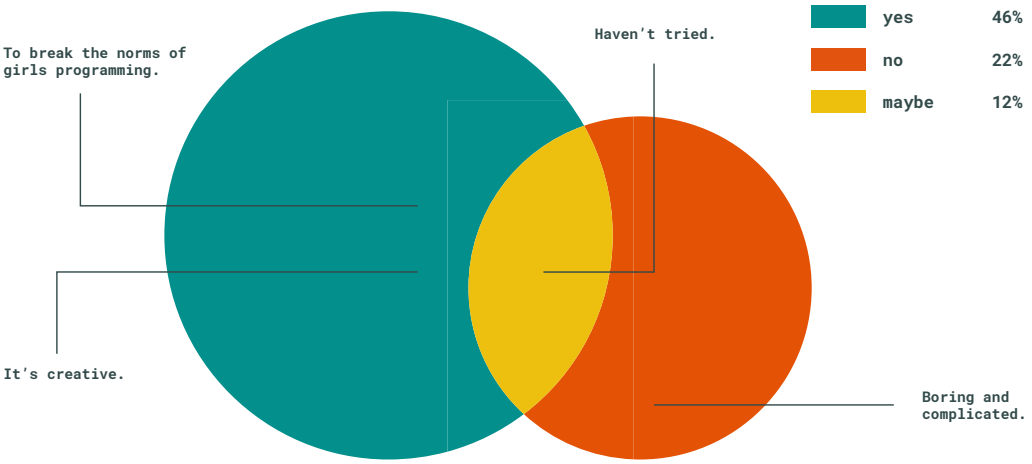
WHAT IS YOUR DEFINITION OF PROGRAMMING?



DO YOU FIND TECHNOLOGY INTERESTING? WHY?



DO YOU FIND PROGRAMMING INTERESTING? WHY?



DO YOU HAVE ANY SUGGESTIONS ON HOW TO MAKE TECHNOLOGY AND PROGRAMMING MORE INTERESTING FOR YOUNG GIRLS AND NON BINARY?

Offer the chance to try it out.

Make the education in the field focused on other things.

Normalise it wihout making it cringey. Show that it's for everyone.

More time in school to build things.

Avoid talking about job quotas, that scares girls off rather than engourage.

Blinking shoes, rollerskates, sequin sweaters you can change the look of.

Activities for girls and non binary.

Tech the basics and then allow for freedom to explore. You could for example program Among Us.

Show that it’s not only for men. Inclusive education at school.

More jobs within the field for girls and non binary. So others see them and get inspired.

More constructions.

Write about it and highlight what you can create.

Normalise it. I’d feel better if more girls studied it.

More technology and programming at school.

INTERVIEWS WITH PROFESSIONALS

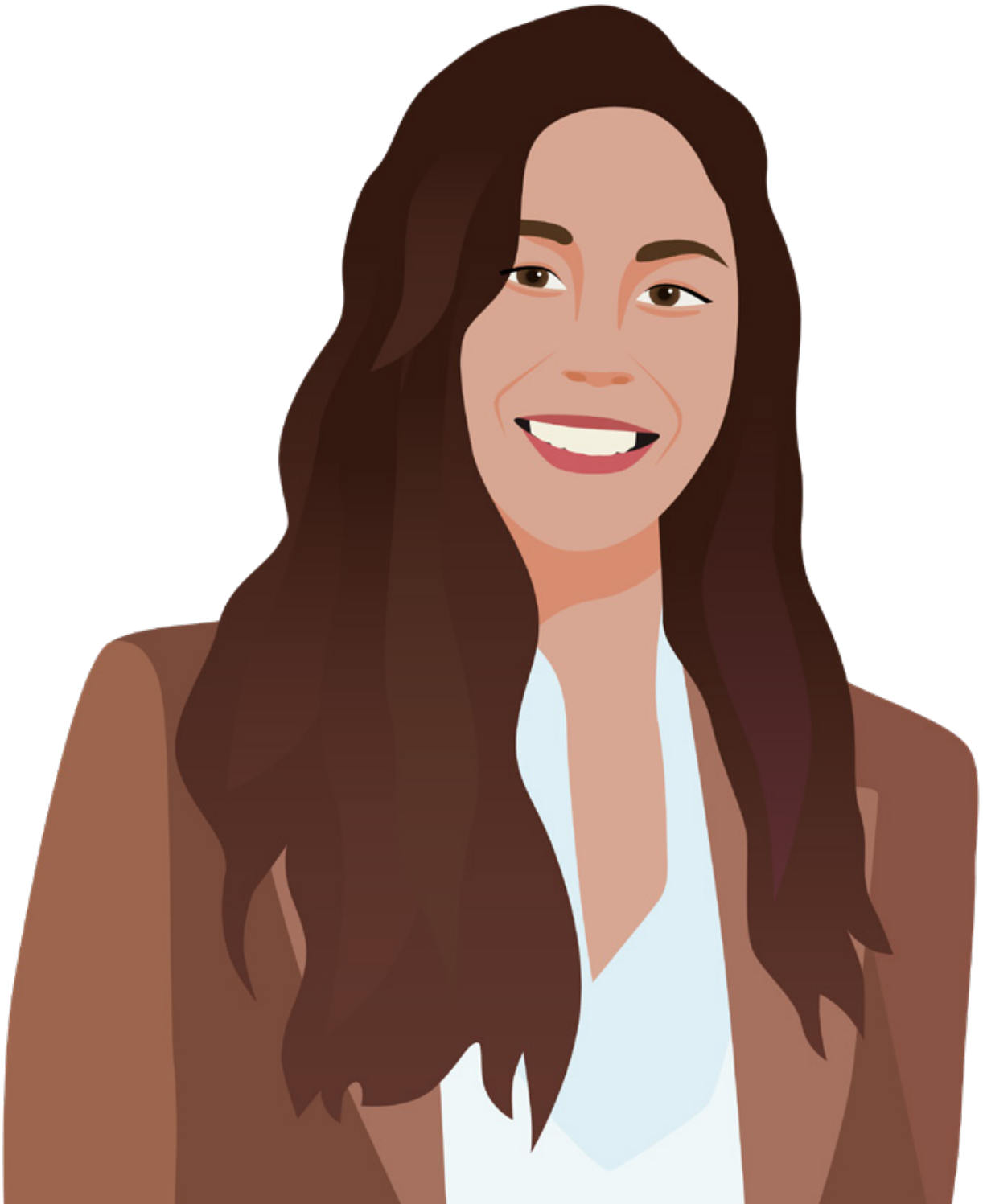
To better understand the topic and difficulties of technology, programming and young girls in STEM I reached out to professionals in Sweden who work in the field or are involved in some way. I did not specifically target women professionals, but everyone I got in contact with happened to be women. It does make sense that it is women who are passionate about questions regarding girls and women in STEM. In total I interviewed four professionals through video call or phone call. The interviews were casual conversations revolving around the theme girls, technology and programming. Questions were adapted to the background I had previously gathered about the professionals. I had planned for the interviews to last 20-30 minutes and all but one stayed within this time frame. One conversation drifted away to 1 hour as I was told a lot of personal anecdotes.

The following professionals were interviewed:

- Nadia Garfunkel. Partnerships Manager at ImagiLabs.
- Marielle Sterner. Manager at Cool Minds.
- Harriet Aurell. Technology educator for children and adults.
- Sophie Landwehr Sydow. PhD candidate at Södertörn University.

These people were either found by me while conducting market research or I was suggested to contact them when I tried to reach other people.

imagi



NADIA GARFUNKEL

The first professional I spoke with was Nadia Garfunkel from imagiLabs. Her position at the company is as Partnerships Manager. ImagiLabs is a new technology start-up business based in Stockholm. Their main product is the imagiCharm with LEDs which you can program using Python and their app. ImagiLabs' target group is exactly the same as mine. The following is quoted from the FAQ page on their website imagilabs.com:

"We are focused on inspiring and teaching programming to girls between the ages of 9 and 15. However, both the imagiLabs application and the imagiCharm have a low barrier to entry and provide endless opportunities and challenges – meaning they can be enjoyed by everyone (imagiLabs)."

"Our mission is to empower and inspire girls to become interested in technology, a field that women currently represent only 18% of. We are not here to create a product limited to girls, we are here to expand tech to include more girls (imagiLabs)."

Personally I really like their statement about not creating something limited to girls, but expanding the field. That is a valid disclaimer to keep in mind for my own project brief.

I talked to Nadia for 30 minutes at a Zoom video meeting. She gave me an introduction to imagiLabs' free app and the imagiCharm. Their app is community based and allows the user to share their code and use code written by others. Besides the in app community imagiLabs also has an ambassadors programme, a Discord channel and is very active on social media.

I asked if they knew how many were boys in their community, if a boy could be an ambassador and whether boys would potentially feel excluded because of their gender. Nadia told me she thinks "there's a conscious choice about making this girl dominated. Because there is no such tech digital space that is girl dominated. So we're happy to do that for them". Regarding the question of whether or not boys would

feel excluded Nadia told me she truly did not know, but had brought up the question with the team, being the closest person to potentially be the ”head of boys” as her position involves working with schools where genders are often mixed.

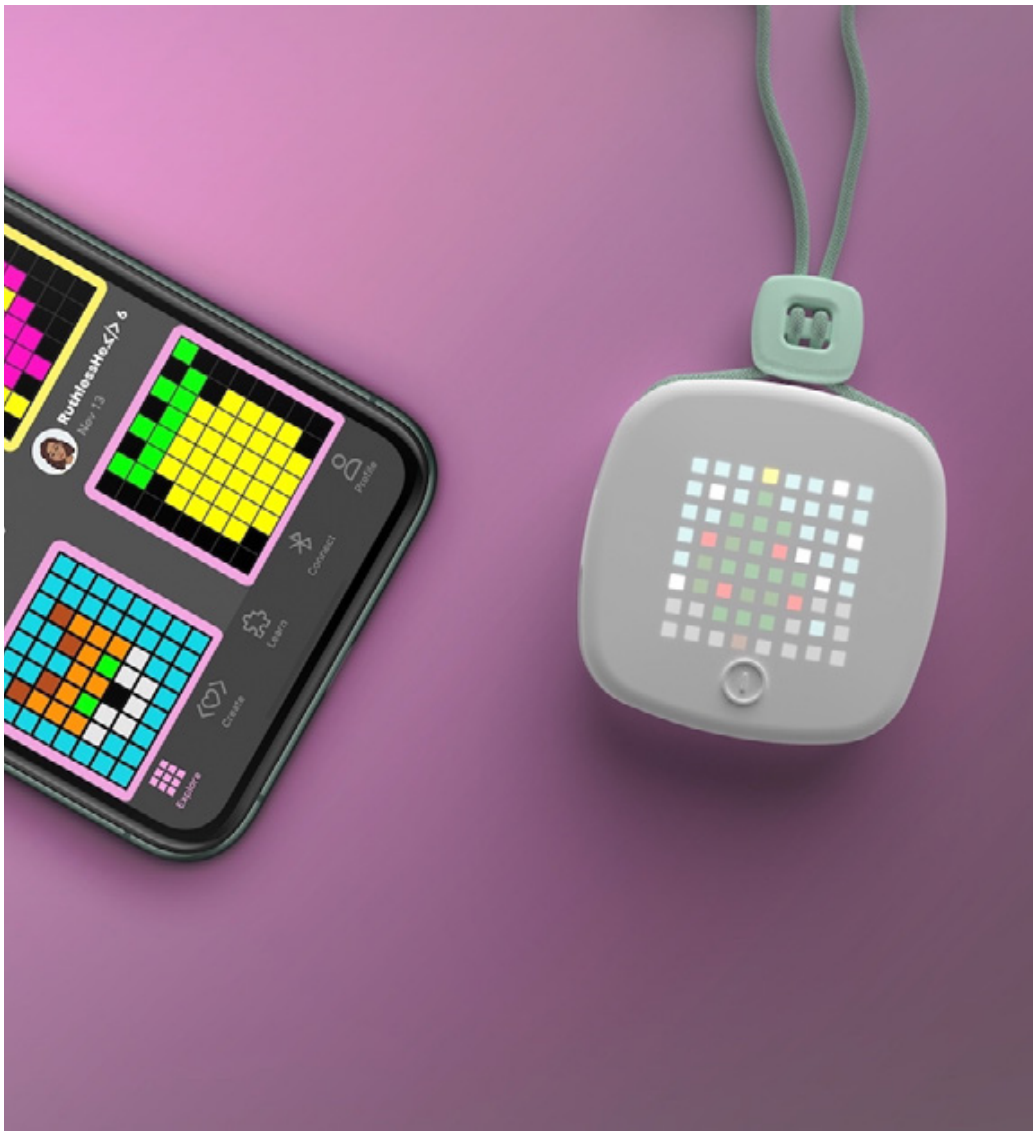
When their imagiCharm is presented at for example schools with only the packaging box as the context, it is a bit harder to tell that this the charm was designed for girls. Nowhere on the box does it say anything about girls, only their website does. Although I have reflected over the fact that their logo features a pink background. As does a lot of their marketing material and their website where pink is used as a signature colour. The ambassadors are also called imagiGirls, which is an additional reminder of their target group. Perhaps the fact that they refer to their ambassadors as girls is already an excluding factor which discourages any potential boys to even apply. Nadia told me she is trying to get the team to be more careful with using the term ”girls”, explaining to me that the wording is not necessarily gender inclusive. As she works in contact with partners and schools she often just uses the phrase ”all kids” rather than ”girls”.

”We pitch to certain parents that it’s educational and then we pitch to the girls that it’s fun.”

As start up company Nadia expressed to me how she believes that they are ”actually just unique, that I can’t on the top of my head right now think of an organisation that’s doing what we’re doing, and that’s not necessarily a good thing”. There are very few companies like imagiLabs which directly targets young girls, a fact I had already found out while doing my previous market research. Many other companies or organisations out there are either targeting children or teenagers in general or simply women.

I was curious about how they reach their customers and Nadia explained that they normally pitch to parents that the imagiCharm is educational, and to the girls they present it as something fun and cute. I wondered if the price of the charm was an issue. My feeling of 68 EUR is that it is not a price a teenager would necessarily pay with their own money. Can all

parents afford items for this price for their children? Nadia's impression was that in relation to other huge technology companies that make hardware for children this age, imagiLabs places themselves in the middle when it comes to price. They are neither the most expensive, nor the cheapest. She questioned if one can even put a price on the value of encouraging their daughter or friend to feel confident in learning how to code.



Cool Minds

MARIELLE STERNER

The second professional I reached out to was Marielle Sterner. In the previous semester my teacher had recommended me about her when I wrote a paper of how it feels to be a woman in STEM. Back then she did not have time to set up an interview with me during the short time frame I had. But for this project I made sure to contact her ahead of time and we scheduled a meeting.

Marielle is the manager (or perhaps was by the time this documentation is finished) of Cool Minds in Malmö, which is a science centre for children and teenagers age 5-15. Since 2017 the centre has been run by Marielle after taking over from the founder. Before becoming the manager Marielle had worked part time at Cool Minds. A couple of years ago the business of running the science center was turned into a non profit association. By the time of our interview Cool Minds was unfortunately in the process of winding up the association, after 6 active years, due to the struggles that came with the pandemic.

The 30 minute Zoom video interview with Marielle centred around her experiences working at Cool Minds and meeting visitors. I wanted to get an overview of who visits Cool Minds and was told it is both private individuals as well as schools, especially since the center moved to the current central location in the city. A more homogenous group is seen when looking at the participants in paid courses, which Marielle believes is because the parents actively have to find the course and make the decision to sign up their child as well as afford the price. I was told the gender distribution of visitors is normally equal when schools are visiting, but when it comes to private individuals some difference is apparent. More boys are signed up for activities in technology and programming and more girls are signed up for slime and pottery.

Apart from her professional role Marielle is passionate about the topic of girls and women in STEM. Under her leadership Cool Minds has had some courses and events only for girls and non binary. Although putting extra focus on creating courses and events a certain group is limited by the available resources. But Marielle believed gender separated activities can make some girls feel more comfortable. Courses open for

anyone often end up with a majority of boys participating. This might not matter to some girls, but Marielle told me about one girl in a course full of boys led by a male teacher who experienced feeling like an outsider.

During ordinary courses for everyone Cool Minds has actively tried to highlight more women and innovations they believe girls will find interesting. Marielle explained that she believes it is important to broaden the understanding of technology. It is not just about cars, trains and robots. Some girls find this interesting, but others might like fashion or sustainability for example and she thought these areas might involve just as much technology as the cars and robots. I asked her if she has noticed a difference in interest between what technology girls versus boys express to like when visiting Cool Minds. The only answer Marielle could give with some certainty was:

”Children need to learn that it’s not just about cars, trains and robots.”

”I think many girls appreciate technology related to sustainability. (...) And maybe in general questions related to society, if you can draw connections between technology and society. In reality that’s done all the time, but it might not be a known connection.”

We discussed where you draw the line when using gender stereotypes to make STEM more interesting. Since fashion was brought up as an example in our conversation. Marielle believed this is a fine line to draw, it is nothing Cools Minds has discussed but Marielle has thought about it personally. On one hand you want to make more girls interested in STEM and participate in courses and events. But on the other hand the methods of making things interesting should not be perceived negatively from a gender perspective.

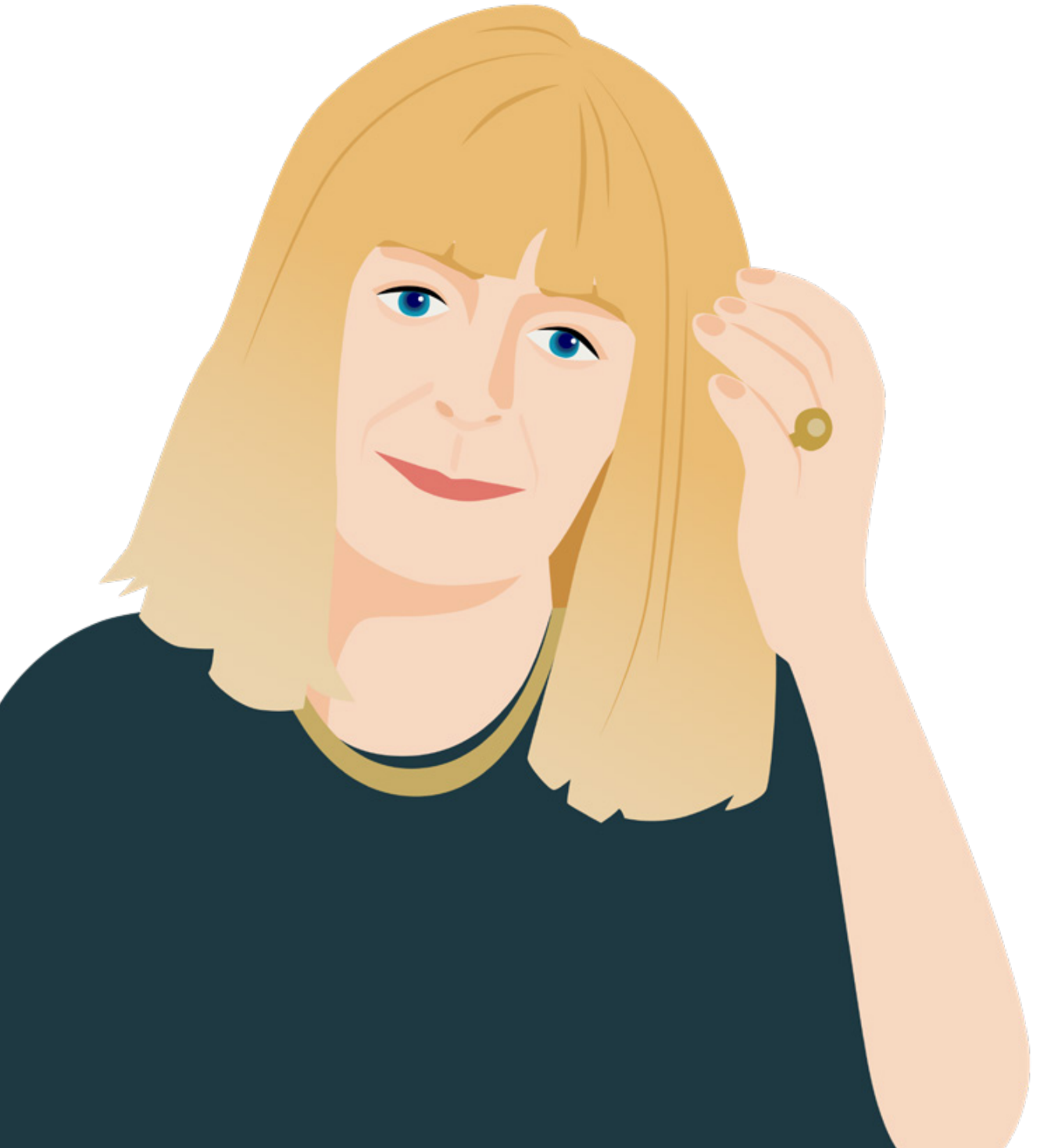
”Apart from not wanting to establish more gender stereotypes, there’s also the risk that the girls that do like technology will be discouraged. Because you create this image that they should have masculine interests, but they should also have feminine interests. They suddenly need to be everything at once. What we’ve done is that you need to balance what

is most important.

What has been most important for Cool Minds so far is to get girls to participate and sometimes you might have to use some tricks to target the girls' interests.

We talked about how hard it is to actually draw a line when it comes to using gender stereotypes in an enforced manner. Marielle brought up Pink Programming for example, which is a Swedish association for teaching women coding. They are simply named Pink Programming and use their signature colour pink in everything. Some might find the use of pink discouraging. What if you do not identify as a girly girl that likes pink? Is the Pink Programming's course then for me?

After the interview with Marielle I tried to reach Pink Programming. I asked if they had ever reflected over the use of pink and how this can be perceived. I received an automatic email answer when contacting the PR manager telling me she was on sick leave but would get back once she was back. I sent an email to the managing director and got no response. I did also email their general email managed by volunteers some days later and was told that they forwarded my email to the managing director, who they said would probably get back to me in a week. In the end I did not get an answer from Pink Programming about their decision to use pink as their colour.



HARRIET AURELL

The third professional I reached out to was Harriet Aurell. Initially I tried to get in contact with a makerspace network for women in Stockholm through email, but I was told by the former founder that the network no longer existed and Harriet was suggested as someone I should contact instead. So I emailed Harriet and got an immediate response to set up a phone call.

Harriet had been involved in teaching courses for this makerspace network amongst other things. She was truly a fascinating woman to speak with. To summarise it Harriet Aurell has working within teaching technology for over 40 years. In Swedish she calls herself a ”teknikpedagog”, a so called technology educator. She runs her own business and her target group for her courses and workshops is both adults and children. Harriet is also the founder of the concept of Komtek, a municipal after school programme for learning technology which now has schools all over the country. In Sweden it is very common to find municipal schools for learning how to play music instruments. I took piano and cello lessons this way after school during my upbringing. Komtek was founded based on the same idea, but with technology as the subject.

We ended up speaking for over one hour on the phone. Harriet had so much to tell me and so many stories from different times of her life.We spoke about the definition of technology and how it can be really broad and have different meanings to different people. During her workshops she normally defines technology as things that moves, lights up or makes sounds. This makes people associate technology with electronics and mechanisms.

We talked about how technology for a long time has been very masculine in the eyes of society and how little research has been done about technology from a female perspective. In many cultures men have been working and women have stayed at home, which means that most things in society have been built and developed by men. Harriet mentioned the construction of the Eiffel Tower as an example of this. The starting point of technology has for a long time been masculine.

“I’ve been doing this for many years and have had so much fun. Because I’ve seen how little research has been done from a female perspective. Our whole society, since a long time ago it’s been expected that the women stay at home and the men are out in the society. It’s like that in many cultures. So it’s the men that create the education, the schools and the contents. They make everything.”

Harriet gave me examples of when she first started teaching technology and she realised she did not teach it in a good way for the women. This made her reflect over how she had been taught. She told me the story of when she was young and studying to become a musical instrument builder. In the workshop she witnessed how the male classmate next to her carelessly blamed their mistakes with the machines and tools on something else. Harriet believes men grow up being taught to not take any blame for anything and instead blame it on the environment, while women often blame themselves. Of course this does not apply to all men or all women, but Harriet has noticed women tend to excuse themselves. When Harriet started studying psychology she learned that there are differences in how our brains work. Words can never be used on their own for teaching, we learn from words by making associations to previous practical experiences.

”What’s most sad, to me, is that men still have full control over technological development. Not women.”

According to Harriet, learning by making connections to practical experience is very important. Otherwise one will only learn the theory, but not be able to make connections on how to adapt the knowledge to make innovations. As an example Harriet told me she has noticed how many female civil engineering graduates often end up working as project leaders, but not as innovators. She told me about the gender distribution of patent owners:

”What’s most sad, to me, is that men still have full control over technological development. But not women. Ten years ago I reached out to the Swedish Patent and Registration Office. I asked how many patents were registered by women and men. 6% were by women. I

contacted them again recently and the number of women registered patents was 6%. Nothing has changed."

Her way of teaching today is therefore to present technology as something fun and something which can be explored. She puts a lot of weight into allowing participants to gain their own practical experience with technology by trying things out. Sometimes things work and sometimes it breaks, but either way experience is gained. In Harriet's workshops she tries to teach technology to girls and women by making connections to what she thinks they are familiar with and have experience of, apart from letting them try things out.

In the interview Harriet mentioned how back in the days some people believed that you should teach girls in very feminine contexts, such as making lipstick during chemistry and creating jewelry in technology. But Harriet thinks it should instead be made neutral. Otherwise you enforce this image of women being different from men, while the only difference is our upbringing and society's perception.

We ended our conversation about technology often being a masculine trait for men, while technology is not considered to make a woman more feminine. It can be a strange grayzone for women in technology. But on a personal note I do think our world today is slowly progressing to breaking down gender stereotypes. Technology should be for anyone and not have to be labelled as masculine or feminine. As Harriet said, it is best to keep it neutral.

SÖDERTÖRN UNIVERSITY
STOCKHOLM

SOPHIE LANDWEHR SYDOW

The last professional I interviewed was Sophie Landwehr Sydow. Sophie is a PhD candidate at Södertörn University in Sweden. I got in touch with her the same way I reached Harriet, through the no longer active makerspace network for women called Makertjej. I learned that Sophie had been an active member in the network while it existed.

I talked to Sophie on a Zoom video call for 30 minutes. She told me she intially joined the Makertjej as part her PhD research project and for observing the network from within. Our discussion revolved around inclusivity in the maker communities. Sophie believed that the maker community in itself is said to be welcoming to everyone, but in reality it is often somewhat closed workshops or you have to be very comfortable with yourself if you show up with a very different expertise. But she also thought that the issue is a matter of the individual communities and the people there. How open the makers are at a specific community will shape how open the community actually is.

”You have to reach your target where they are. And be inspired by those interests.”

We discussed the need for gender separated initiatives and Sophie’s opinion was that there is a need for these as long as it is not equal. On one hand certain communities can also be excluded. For example having a women only community could be excluding some groups. On a closing note, once this field and STEM is equal, there is no point for these to exist. For the time being Sophie’s view was that the maker community in Sweden is very masculine.

As a former active member in Makertjej Sophie has seen what works and what works less well when trying to make technology and STEM more interesting to girls. Activities where you build things that make lights or sounds are effective and participants value the tactile feedback.

Sophie’s tip was to use LEDs in projects. It is also good if projects have

a low entry level to keep it open for everyone. Preferably it should also allow advancement apart from being easy to start with, in order for the project not to get boring fast. Sophie believed that there are a lot of girls with an interest in technology, especially now when technology is a major part of our daily lives.

Regarding what works less well, the colour pink was brought up in our conversation. We talked about the cases where things are made pink when it is aimed for girls or women. According to Sophie using pink might work, but it all depends on your target group. It is important to reach the target group where they are at and be inspired by the interest they already have. If the target group is into pink then that could be the way to go. But both me and Sophie agreed that if the target group is not into pink, then pink can not be the only way of making something interesting. You have to design for where your target group is at and not what you assume. Besides, in my opinion it is also very gender stereotypical to make something pink just because it is for girls and women. Sophie told me something that was said by a girl when she was engaged in Makertjej:

”I have a quote I got from a 10 year old, ‘just because we’re girls we don’t want girly things, we just want to have space to be creative’. It doesn’t need to be girlified.”

To end our conversation Sophie expressed her belief in more makerspaces in the future. She thought that the world will use these places to create and repair items rather than to consume products.

COLOUR: PINK

The use of the colour pink has turned into a reoccuring theme by now. It has been discussed in interviews with professionals and I have encountered the colour while doing market research.

As a colour it has for some time been associated with girls. Therefore using it in the context of targeting girls or women will undoubtedly bring light to this association. Regardless of what the intentions of selecting the colour pink was from the start. It can either be interpreted as an empowering colour that is very clear with its target group. Or it can be gender stereotypical and seen as a cheap pink washing in order to reach girls and women.

The images show some examples of pink in use in STEM context, with focus on technology and programming. The Swedish association Pink Programming was mentioned as an example already in my second interview with Marielle Sterner. They use the colour pink in all marketing material and in their logo. Another example of pink use is the organisation Black Girls Code and the initiative Girls in STEM by Accenture.

One viral example of pink and gender stereotypes is the video campaign by the European Commission, the executive branch of the European Union, from 2012 called Science: It's A Girl Thing. The logo of the campaign was written in pink lipstick. In the video campaign women scientists in pink lipstick are portrayed using science to create cosmetics. It received a lot of critique after the release. Enough critique for the European Commission to remove the original video. The intention of the campaign, to encourage more girls to do STEM, was important. But the execution unfortunately became a bit too gender stereotypical.

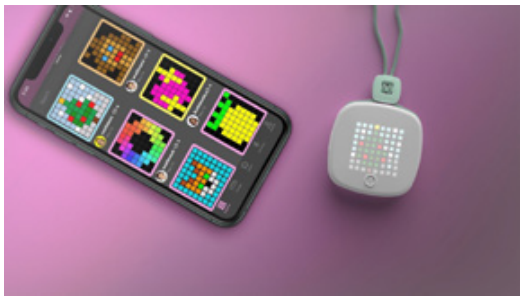
Apart from using pink all over the place there are examples of using pink as an accent colour or for details. Personally I do not have much against this type of use, pink is just a colour to be used like any other. It is all depending on the ratio of pink, one either starts making gender stereotypical connections or not.

ChickTECH

P I N K
{programming}

blackgirls
imagi


GIRLS IN
STEM




DARE TO
TINKER
EXPLORE


CODE
e. build. create.


#GIRLCODE
HACK 2021
BE PART OF THE REVOLUTION!
South Africa | Lesotho | Mozambique
Tanzania | Kenya | Zimbabwe
Rwanda| Egypt| Burundi | Ghana

DESIGN FOR INTEREST OF THE TARGET GROUP

KEEP IT GENDER NEUTRAL

PARENTS AS SECONDARY TARGET

FREEDOM TO EXPLORE

LIGHTS AND SOUNDS

SUMMARY OF RESEARCH

To summarie my research findings I will try to understand my target group. This was mentioned during all interviews, that it is of most importance to understand your target group and design for where they are at. It is easier to reach the target group if the design appeals to them because they already have an interest in part of the concept. Top interests found in the survey conducted are sports, music, crafts, dance and gaming.

Another important point is to consider parents as a secondary target group. Girls age 11-16 might not have their own economy to buy whatever they want, especially not when it comes to expensive products. Of course this will depend on the economic situation of the individual girl and the family.

The third takeaway is that technology and programming should be normalised as something for everyone. It was brought up by responders and discussed in the interviews. In order to normalise the subjects I need to consider what is coded as feminine or masculine activities and interests. The design does not in any way need to be girly just because my target group is girls.

Freedom to explore and learn is desired. The entry level for using the design can be low, but allowing for advancement in order to keep learning or making things will make the product less likely to become boring too fast. Lights and sounds are interesting to use as it gives a visible output. It connects the design with our physical reality, rather than creating a project that might only be about writing code and digital simulations.

MY POSITION ON THE MARKET

By this point I looked over the market research again to decide where in the chart I want to place my project. I knew that I wanted it to be a physical product, since I defined the outcome as a wearable merchandise in the design brief.

Arduino has a lot of physical educational products already and therefore I did not want my design to have the same characteristics, placing in the top left corner of the chart. For this project I wanted my outcome to be a physical product that was leaning towards being an inspirational source. The aspect of learning STEM was still important, but my first priority would be to create an interest for the topic which you then could dive deeper into and learn more about. My wearable merchandise might not be an advanced tool for creating your own smart watch, rather it would act as something interesting that opens your eye for technology. Hopefully it will inspire you, and your friends, to continue learning STEM and making technology projects. In that case Arduino has many existing advanced products and kits for sale, which can be used to further learn STEM.

As my design would be some sort of merchandise it made sense for it to lean towards the inspirational side. A merchandise is a product which promotes a company and therefore it will also aim to subtly inspire others to use their brand.

PHYSICAL

INSPIRATIONAL

EDUCATIONAL

HELLO RUBY

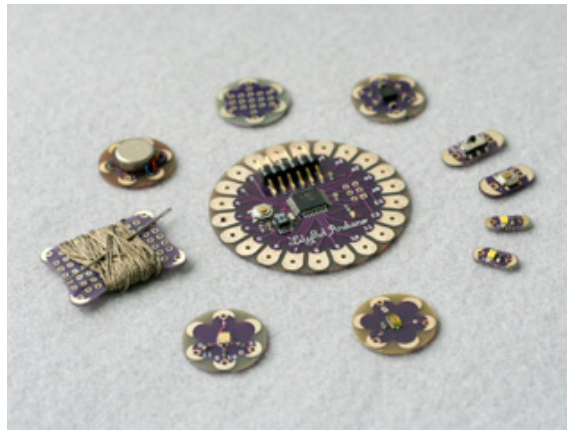
PINK {programming}

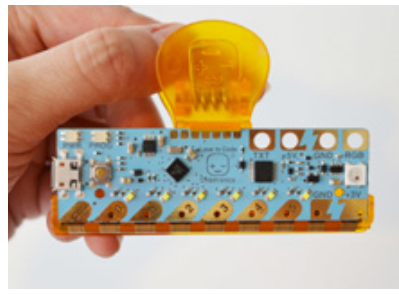
Tjejer Kodar

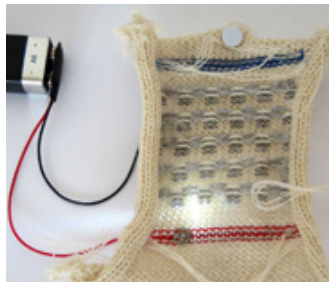
Girls in STEM

DIGITAL


CUTECIRCUIT







INSPIRATION

The inspirational moodboard of this project was made. One major inspiration from the very start was Lilypad Arduino created by Leah Buechley and designed together with Sparkfun. That was one of the early wearable microcontrollers available on the market. It was designed for making soft wearable textiles. Today it is no longer produced or sold in affiliation with Arduino due to different reasons. After Lilypad the market for wearable technology grew a little and today similar products can be found such as the Adafruit Flora.

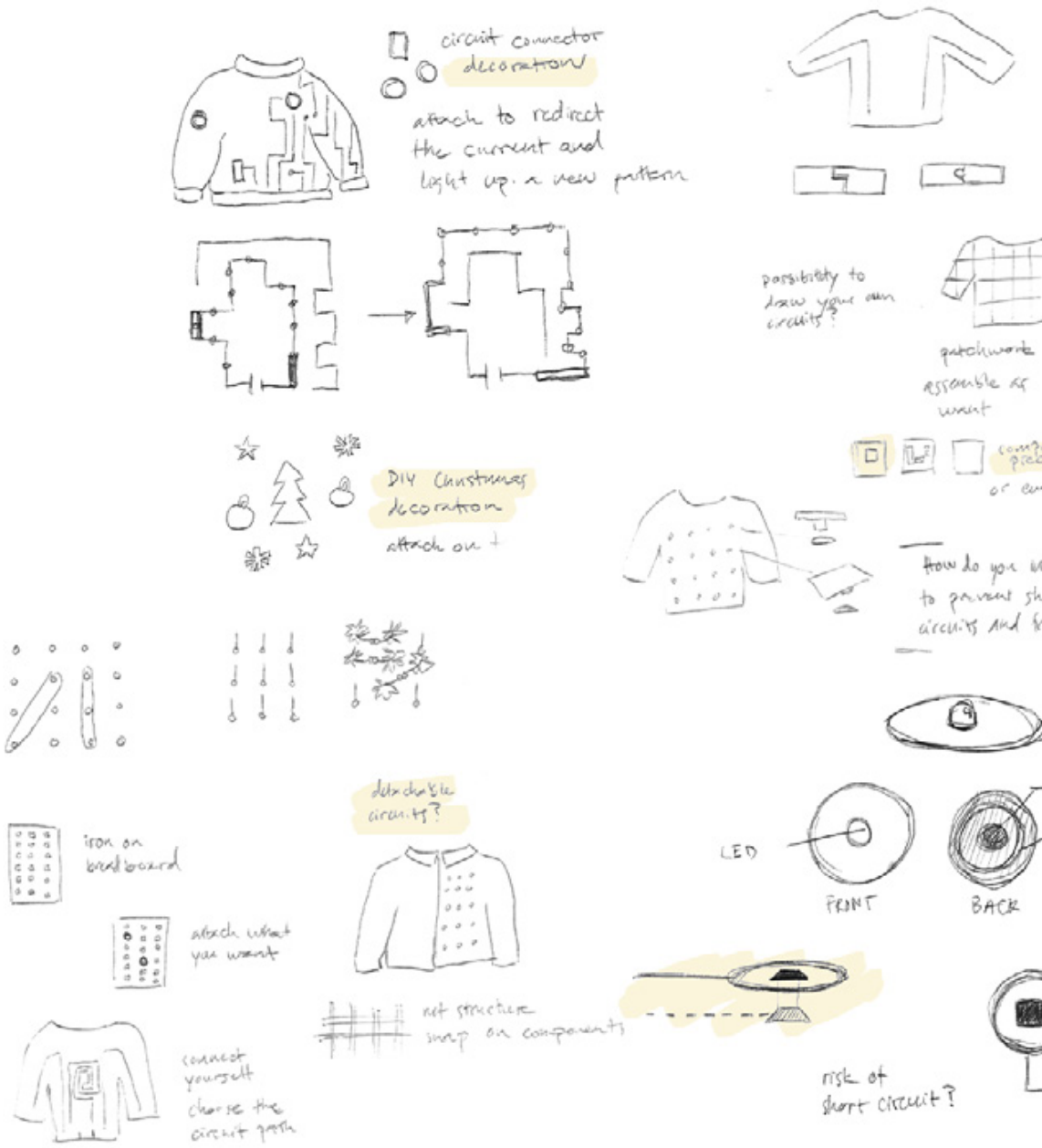
CuteCircuit is an interactive fashion company. They combine clothing with technology. Compared to Lilypad Arduino, or Arduino overall, they are selling ready made products and not products which you can use to make your own projects. For example if you bought the Lilypad Arduino you would use it to create your own e-textiles, but CuteCircuit is instead selling e-textiles clothes that are sewn and ready to use. The prices of CuteCircuit's products are relatively expensive and my understanding is that their target group is more high end, such as celebrities purchasing their fashion to wear on stage.

In fall 2020 Levi's collaborated with LEGO on a new clothing collection. It featured denim clothing with a LEGO base board you could build your own design on. This was also one of the early inspirations for this project before I even wrote the brief.

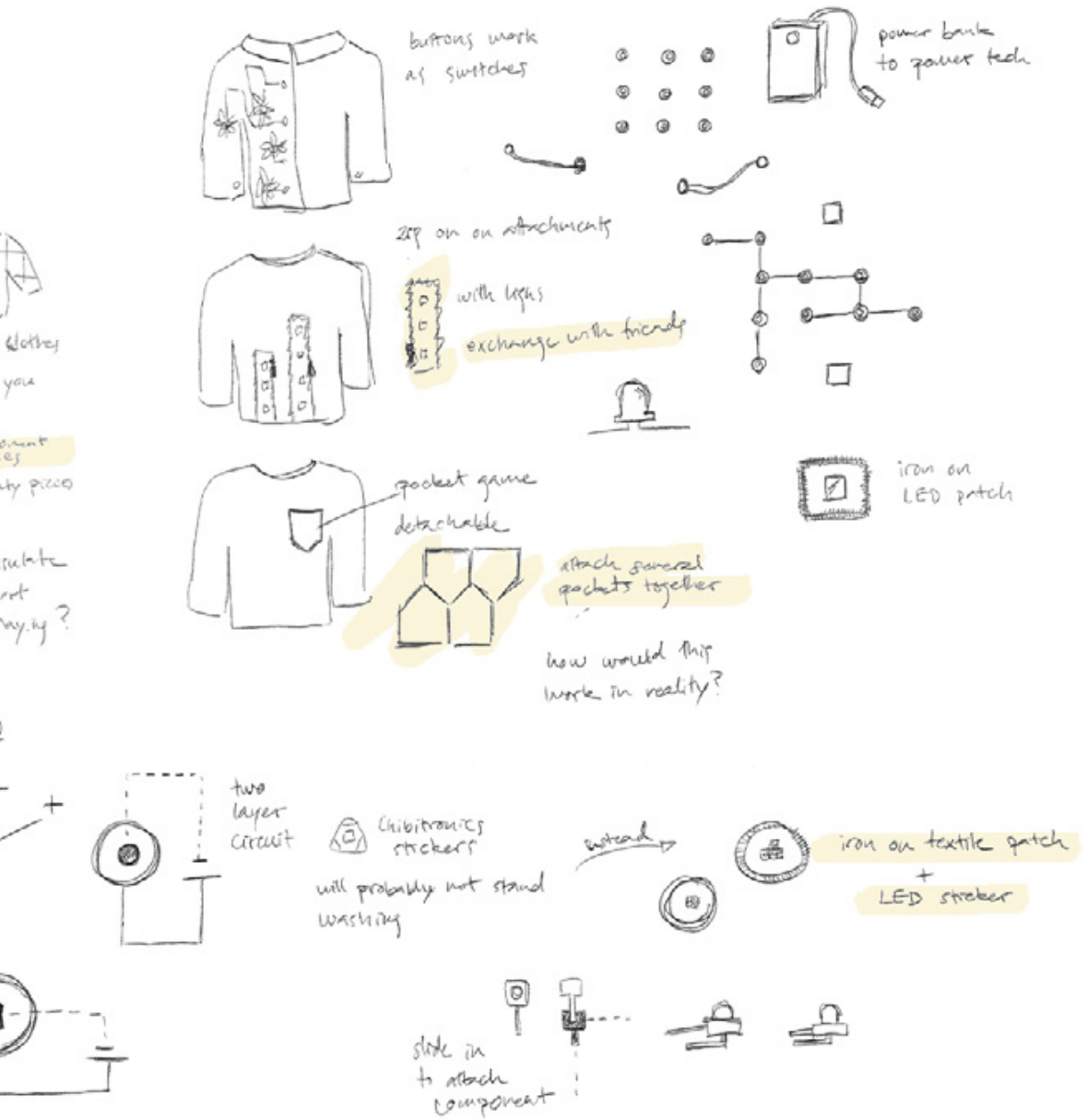
I went image searching to find even more inspiration for my design. I found that there are so many projects out there in the world. Either made by companies or individual people. In the time of Arduino and maker movements, technology has been made more accessible for anyone to create their own design. I found a lot of inspiration in the projects combining technology with soft things, because technology to me and many people is often hard objects such as a phone or laptop. But with the growing development technology in the future can be so much more I believe.

IDEATION

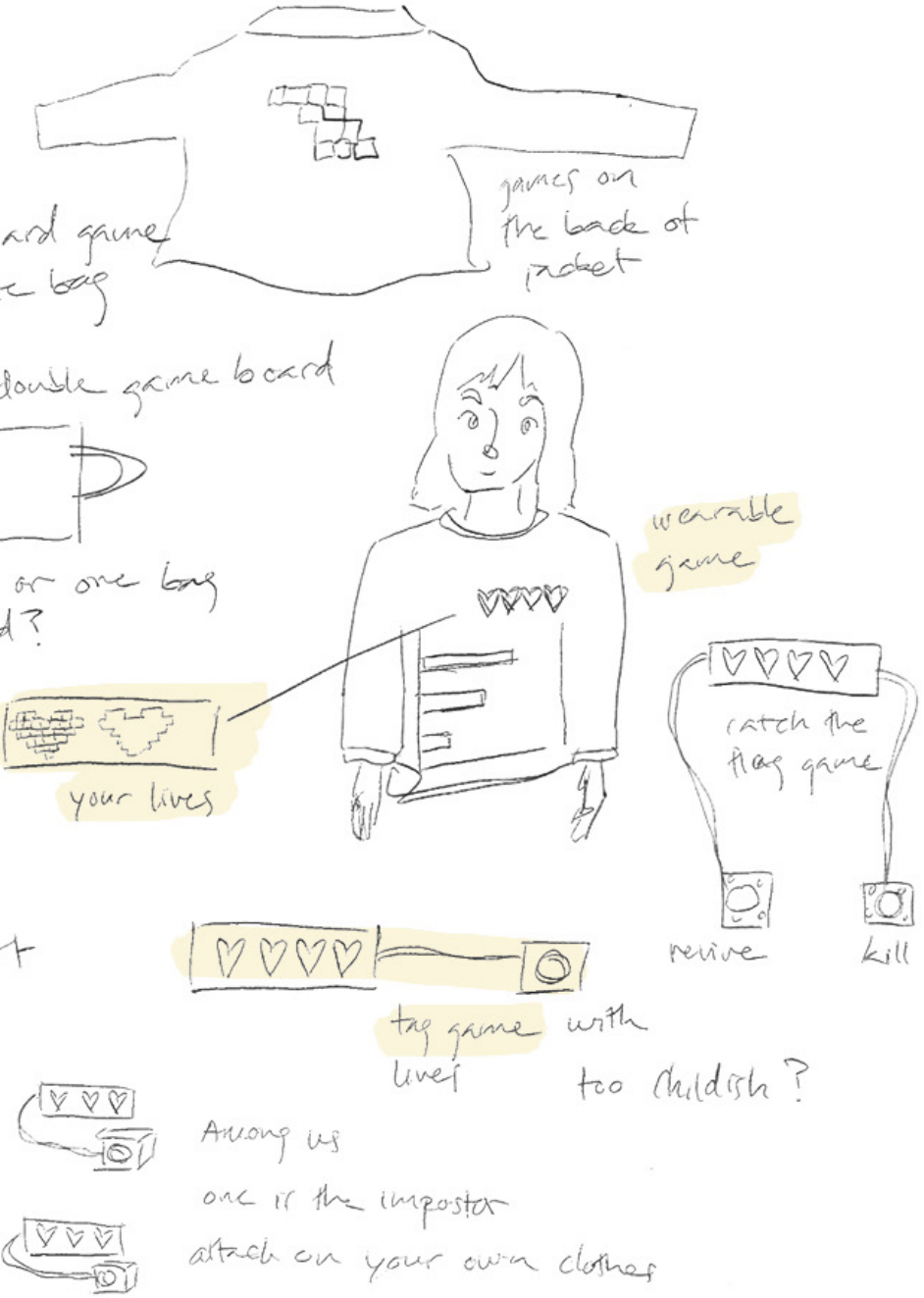
I started sketching based on the insights gained from my research, survey and interviews and with inspiration from the moodboard on the



previous spread. Part of the focus with the designs was to incorporate the top interests from the target group survey into the product.




GAMING
hat changes LED with brightness outside
digital pocket pet
only for this specific clothing?
pencil case pet aquarium
pencil case circuit
walk and draw socks

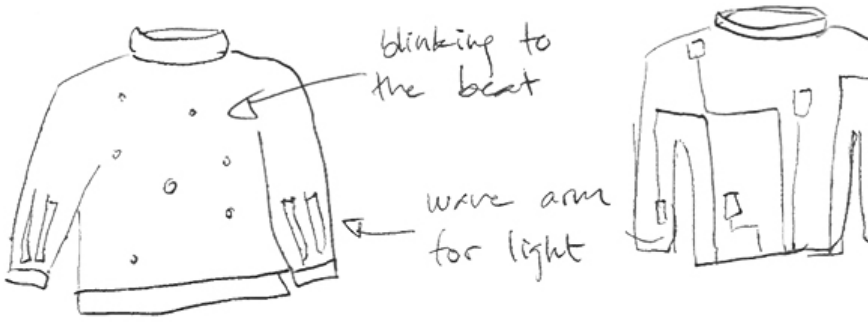

games on the back of jacket
double game board
or one bag
d?
your lives
wearable game
catch the flag game
revive
kill
tag game with lives
too childish?
Among us
one is the imposter
attach on your own clothes

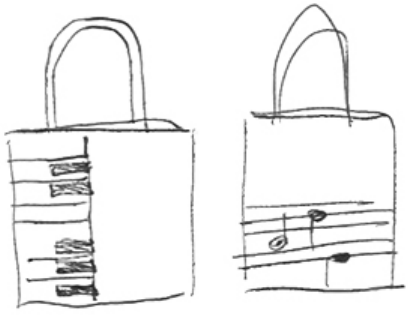

CRAFTS
DIY Christmas sweater kit
no sewing
make your own print with LED
make your own circuits
velcro
snap on LED
button
magnet clasp


soldering:
textile breadboard
no sewing
(looks like the strawberry dress)
connector points
how does it look inside?
inside out
wiring visible
conductive attachments
breadboard pocket
see the inside
you don't wash jeans that often
which is nice if you incorporate tech

MUSIC AND DANCE

LED outfit for concerts





turn
sock


piano scarf
you don't always wear scarfs
circuit connections when touching
LED beat hat
dance socks
LED
your
into dance socks
LED and movement sensor

SPORTS

- track speed
- track pulse
- track time

so many different sports
not everyone does sports

unable to use certain things
during competitions because of rules

zip up
for lights

n signal
or biking

s been done

t everyone bike

INTERVIEWS WITH TARGET GROUP

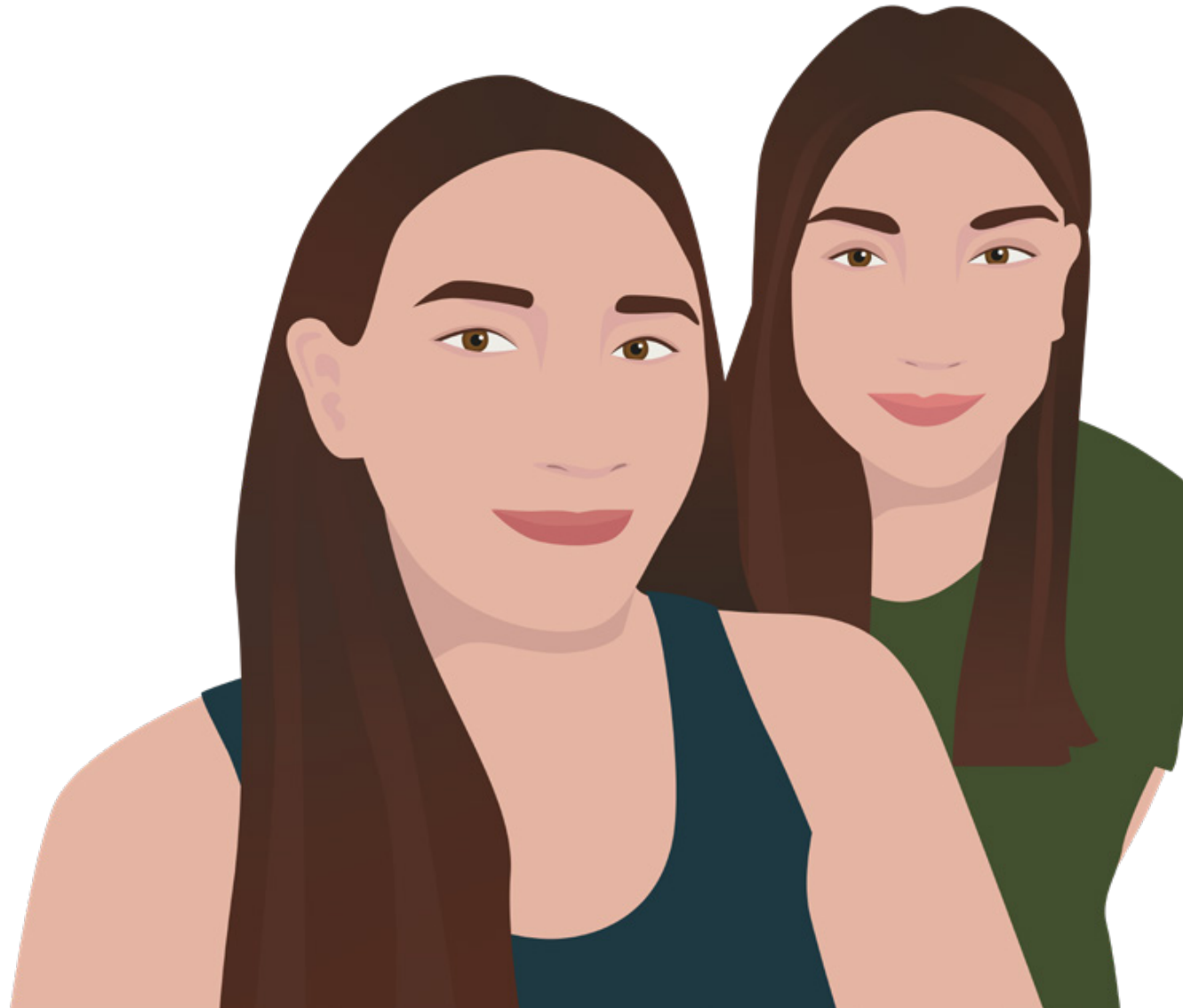
While sketching on ideas I talked to people in my target group. Girls with their parents. I did not purposely exclude the fathers, but all interviews just happened to be with the mothers. The main goal was to talk to girls 11-16 and have their parents along too, as they would be considered my secondary target group.

In the interviews I wanted to hear the thoughts of girls 11-16. What do they think about technology and STEM? I did ask for opinions already in the survey, but the answers submitted there were as I expected very short. When conducting these live interviews I did also get short answers in the case of the first interview, which was performed with only me and the interviewee. Conducting these interviews in smaller groups was the best solution. In those cases the girls could discuss with each other. This constellation made everyone more comfortable, but of course it is also a matter of personal preference.

SIRI AND RANI

The first people I interviewed was 14 year old Siri with her mother Rani. Siri was in 7th grade by the time of the interview and Rani is working as a designer and artist. I talked to Siri for 10 minutes on a video call and then talked to Rani for about 20 minutes.

Siri was interested in creating music and movies in various softwares. She also likes learning new languages using her iPad. When I asked Siri about the field of technology or programming at school I was told she



had not had either of the subjects yet. Schools in Sweden implement technology and programming into other subjects, such as mathematics or physics, and therefore Siri might not have encountered either yet as it is up for each school to fit technology and programming into their curriculum. I wondered if Siri liked the science subjects at school and she told me she did not. Partly because of the assignments not being interesting and partly because she personally does not find it interesting. Regarding the future and the future career Siri had not thought much about it.

”Her father had told her it is fun, and therefore she could consider working with it”

I knew that Siri’s father worked in computer science. Therefore I asked if she was familiar with what her parent’s occupations were, what she thought their tasks were and if she could consider doing the same thing. She told me she could consider both her parent’s professions, including programming which her father works with. Siri told me her father had told her it is fun, and therefore she could consider working with it during our conversation.

At this point of my project I had come across many initiatives and events specifically aimed at inspiring girls in technology or coding. I was wondering if the context of gender mattered to Siri. Siri told me she would consider participating in a girls only event, because she thinks it is more fun and she is more confident talking around girls.

Rani explained that the children, including Siri, had been given computers early on because their father thought they should keep up with technology. When this video call took place I had just encountered imagiLabs as one of the few companies targeting young girls that are selling a physical product, their imagiCharm. I brought their product up in our conversation to hear her opinion. The first impression of the imagiCharm was that it was rather expensive (820 SEK with lessons included) for only being a charm with lights.

Rani explained her experience raising her three children and their habit of collecting items. As an example her children would buy keychains

and similar items. One was not enough, but they would buy several. So what if they would want several items that are expensive? For Rani the imagiCharm was not convincing with only the function of being able to program the lights. To her personally she would want more functions to justify the price, such as the lights reacting to being close to a person you like and changing colour. When asked if the price could be justified if she knew it was meant for learning programming I was told her younger son has a microcontroller board with four lights, which he can program as he wants in different colours. The whole kit was apparently purchased for less than 100 SEK. The conclusion by the end was that she would consider buying the imagiCharm for Siri if it was for educational purposes and if she knew Siri really wanted it and would actually use it. But only if it would come to use.

”One was not enough, but they would buy several.”

EBBA, KLARA, SOFIA AND CHARLOTTE

For the second round of target group interviews I talked to my supervisor Charlotte and her children Ebba, Klara and Sofia. The 20 minutes long interview took place over a video call.

Our conversation began with an introduction of everyone. Ebba was 12 and the youngest child, Sofia was 15 and Klara was 17. I knew that Klara would be just a year older than my specified target group, but I

decided that this little deviation would not matter this time, as I believe slightly older or younger girls could still fit into my target group. I would also rather interview all three sisters together, as I realised after the previous interview with Siri alone, that people feel more comfortable in a group setting and in a group there will be more encouragement to discussions.

Ebba practised dancing in her free time and enjoyed hanging out with friends. Sofia played volleyball, liked to read books, spend time with her family and play piano. Klara would mostly be with her friends, study or watch tv series.

They were asked what they think when they hear the word ”technology”. I wanted to understand their definition of it. Klara immediately told me that technology for her was a school subject she had in 9th grade. Sofia agreed with that, saying that she was in 9th grade now. She told me she thinks it’s a hard subject because she is not so good at it. Ebba expressed that technology is really boring. All of them only connected technology with the school subject.

”It would not be enough if it was only something that looked cool without providing a function.”

As for programming Ebba continued to make the association with the school. Programming for her was something you did in the math classes and it was boring. Sofia countered that it could be fun if you understood, but it was not fun when the programming got more complicated and harder.

Klara thought programming was not introduced to her in an interesting way. She remembered that she did an exercise on the computer that looked like a children’s video game she played when she was 6. Charlotte asked Klara if she did not have a friend that liked programming. She did, but said that this friend was taking programming classes as his choice for the individual course. Klara believed that what this friend was doing was more programming for real compared to what she was introduced to. Sofia added to the discussion that she felt as if she had not gotten

a proper impression of what programming actually is. What do those who like programming do? To Sofia the little programming she did at school was not fun.

None of the sisters could imagine their free time interests combined with technology, as they believed their hobbies had nothing to do with technology. The discussion continued on its own about programming in combination with their interest without me having to ask the question. Here it was made apparent that their main idea of programming was in regards to computers and websites. As the interview progressed they did think of some scenarios where their interest could potentially be combined with technology. I asked if they would be interested in a product which would teach technology and programming in combination with their interest. The answer was yes, but it would also depend on how the product was presented. Klara also mentioned here that she understands how people might enjoy working with technology and programming to create a product, but she herself did not feel appealed by learning technology or programming.

”What do those who like programming do?”

At this stage in my project I was thinking of a product design which would use lights, perhaps as a piece of clothing. I asked them if they could consider using a product as such. Ebba said she would if the clothes looked good. Sofia and Klara argued that they would not buy clothes simply because it had technology on it. If it had electronics on that additional feature should also come with a functionality. It would not be enough if it was only something that looked cool without providing a function.

The interview continued about the value of being able to use an item for a long time and not only once. Klara and Sofia believed that the situation would depend on the paid price versus the value of a product. If something is cheap they might not think twice about how long they would use it before they grow tired. Sometimes they could also buy products spontaneously if they saw it while shopping, such as clothes. But when it came to more expensive buys the price did matter and it would have to be something that would be kept and used a longer time.

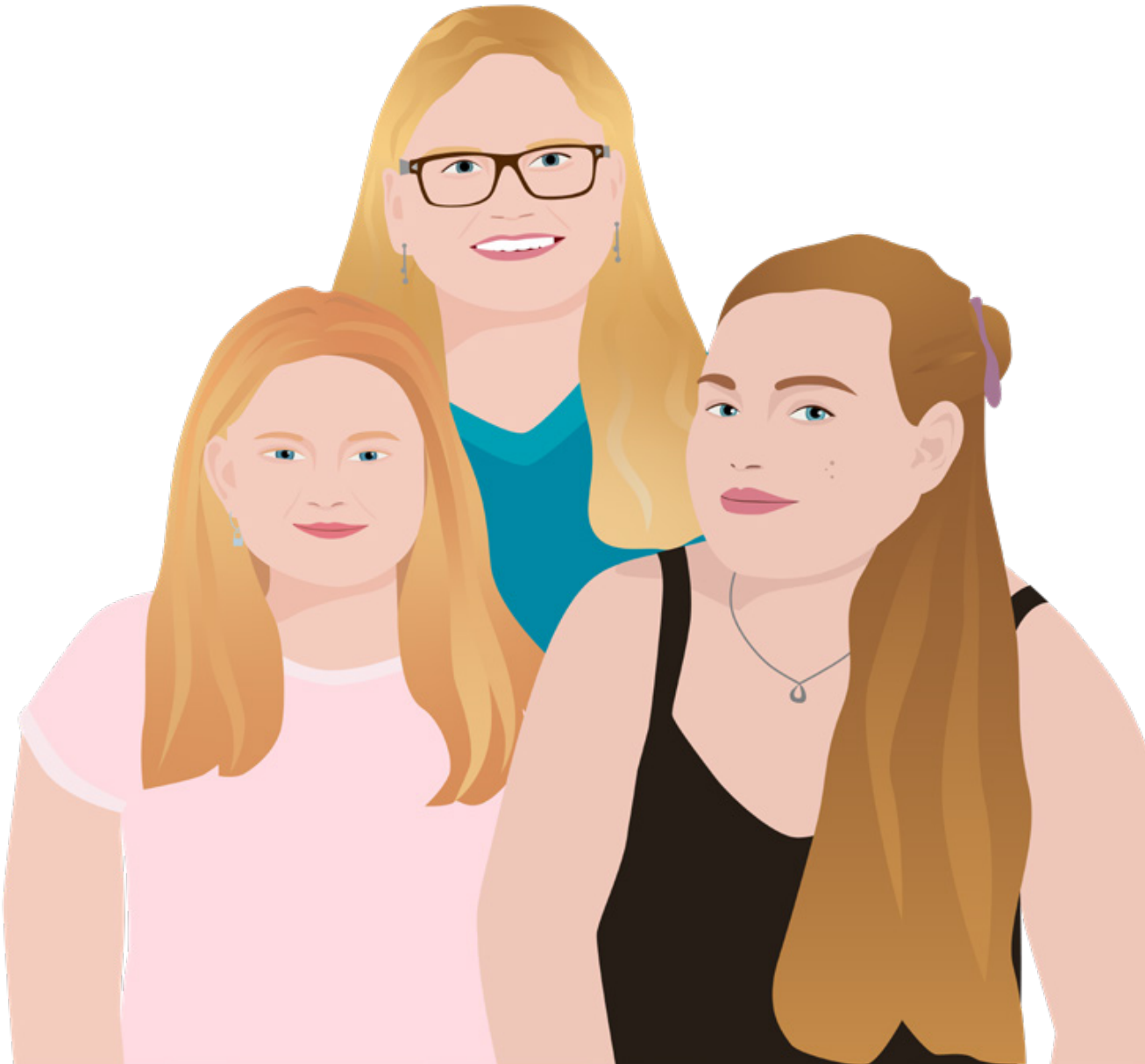
We discussed the aspects of DIY projects. Ebba, Klara and Sofia enjoyed doing crafts. Ebba said that she could get impatient if a project took too long, so preferably it should not take over two hours. They all prefered instructions for the DIY and thought that it was good if you for the moment did not have ideas of your own. A kit with instructions and examples of the finished project outweighed a kit with no instructions. On the other hand the idea of providing instructions, but allowing for some freedom to choose and experiment would also be okay. But there had to be instructions, otherwise you would spend your money on a DIY kit where you had no idea if the result would turn out good or not.

Lastly I asked Charlotte about if she as a parent purchased items for her children. I was told that Ebba, Klara and Sofia would deliver so called order lists for Christmas as an example. The parents did not really buy anything on their own initiative as the children had strong opinions on what they wanted. On the other hand, as parents they did have some influence when it came to buying more expensive items that would not be financed by the children's monthly allowance. More expensive purchases of course had to make sense for the parents to buy in the terms that it would last for some time. Other than that Ebba, Klara and Sofia seemed to have the main say in what products they wanted. The parents only had to be convinced too when it came to more expensive things.

"The children had strong opinions on what they wanted."

SARA, TYRA AND MALIN

The third and last target group interview was with Saga, Tyra and Malin. Malin was the mother of Sara and the aunt of Tyra, therefore making Sara and Tyra cousins. Saga was 11 and Tyra 15. Malin was working as an engineer. This interview was the only one not scheduled beforehand and conducted in person. I approached the for me unknown family at a ceramics workshop as they seemed to fit my target group. The conversation around technology and programming was discussed for



10 minutes. In the interview Tyra was the leading responder to most of the questions and Sara would often agree with her older cousin and sometimes add her own examples.

The cousins shared the same hobbies of dog agility and shooting with air guns. When asked about what they associate the word technology with, Tyra's answer was computers and mobile phones, which Sara agreed with. As for the word programming they thought of video games. Sara mentioned games where you program how the characters move. Both Tyra and Sara found technology and programming to be interesting subjects. Tyra told me she liked programming because it is fun at school and she viewed it as a way to be creative. Sara could not think of a good reason for why she liked the subjects, but simply said that she did enjoy technology and programming.

"She liked programming because it is fun at school and she viewed it as a way to be creative."

I asked them what their opinion was of learning technology and programming combined with their hobbies and interests. It could be such as combining the subjects with creativity and crafts, which I could see they enjoyed as we were sitting in a ceramics workshop. Sara and Tyra were asked if they would prefer a product kit and detailed instructions or a kit without instructions and just components for making whatever you want. Their immediate response was that they would choose the kit without instructions and have the freedom to make whatever they wanted. They were also onboard with the idea of a kit which would come with instructions, but still allow for freedom to make things on your own if you did not want to follow the instructions. Tyra pointed out that it could of course be good to have instructions to rely on in case you had no ideas of your own.

The process of buying a new product depend on the price. Tyra explained that things such as new clothes she would buy herself. But a new air gun for 20 000 SEK she would not be able without help from her father. For both Sara and Tyra the more expensive something is, the more important it is that is that it is truly an item they want and will use.

Tyra tried to always keep that in mind, even with less expensive buys. For her it was important that new clothes for example would come to use and not just hang in the wardrobe. Otherwise there would be no point in buying or keeping it.

From Malin's point of view, as the parent to Sara, she told me in their household the children would ask for things they wanted and then the parents would buy it for them if they believed it was something decent. Malin would sometimes buy things to the children without them asking for it if she believes it is something they would appreciate, something they have mentioned they wanted earlier or if it is something Malin herself thinks is fun. Malin also believed that a more important purchase should last for a while. The value of an item mattered.

"Things designed for girls was a cause she would like to support."

By the time of this interview I was still thinking of combining technology with clothing. Sara and Tyra agreed that they would buy clothes with technology if it looked good, the functionality of the technology part was less important. I was also told by Tyra that if she was to pick between two different products teaching technology and programming where one of the products was designed for girls, she would choose the one designed for girls. She thought that things designed for girls was a cause she would like to support.

DO IT YOURSELF

PRICE

AESTHETICS

CONCLUSIONS FROM TARGET GROUP INTERVIEWS

To conclude the target group interviews I learned that the opinions of parents do matter to some extent. Siri for example expressed that she could picture herself working with programming only because her father had told her it is a fun career. I also believe that Sara was affected at least a little bit by her mother Malin who worked as an engineer, a technical job. Tyra might have also been affected by Malin as her aunt, as I did not know what Tyra's parents' occupations were.

When it came to parents' opinions in terms of buying new items it differed among the families. For Ebba, Klara and Sofia the less expensive things they wanted would be bought on their own and their parents would buy them gifts after their exact wishes. The parents' only opinion would be that the purchases had to make sense to buy and come to use, in particular when it came to more expensive products which would not be bought with the children's own money. For Sara her mother Malin would still buy items for her sometimes if she believed it to be something Sara would like to have. Tyra mentioned that more expensive items would be bought by her parents, similar to how it worked for Ebba, Klara and Sofia. Everyone in these interviews agreed that the price mainly mattered if it is expensive. Something really expensive would also have to come to use for a longer time. For Rani yet another aspect was mentioned. Her experience was that her children sometimes start collecting several of the same items and in that case it would be good if the price is not too expensive.

Crafts were found to be fun, but it was mentioned by Ebba that if something takes too long you lose your patience. Ebba and her sisters preferred crafts with instructions whereas Sara and Tyra enjoyed making things with more freedom to do however they wanted.

The aesthetics of a technology and programming clothing product was the most important aspect for Sara and Tyra, which Ebba would agree on from the other interview. Klara and Sofia on the other hand questioned the functionality the technology and programming would

contribute with and for them it would not be enough with something that simply looked good.

A product designed for girls appealed to Tyra if she were to choose between two similar products. She wanted to support designs for girls.

The interviews conducted were with three very different groups when reflecting back. The first interview with Siri and Rani differed a bit from the last two, as I was in a much earlier phase of my project. That was also the only interview where it was not a group interview. Siri's mother Rani was not present when I interviewed her, and even in the other cases where the parents (or aunt) were present they were not participating so much in the interview discussion until I directed a question specifically to them in their parent role. The format of group interviews sparked more discussions and more elaborate answers compared to my one to one interview with Siri. I also imagine group interviews made the participants more comfortable and open to talk.

I would say that the first interview with Siri was rather neutral when it came to her opinion and interest in technology and programming. Ebba, Klara and Sofia seemed to strongly not have any interest in either technology or programming. Lastly Sara and Tyra both did have an interest for technology and programming and believed it was a way to be creative.

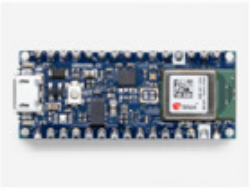
For the target group of my project I would consider Siri, Sara and Tyra to fit well into the frame of potential product users. Ebba, Klara and Sofia might be convinced depending on the execution of the project and the final design, but in general none of them had an interest in technology or programming.

Sort By FEATURED

SUMMER SALES
NEW PRODUCTS
MOST POPULAR

ARDUINO PRO
ARDUINO EDUCATION
WORKS WITH ARDUINO
STORE INFO
CONTACT US

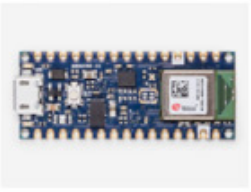
~~€27.90~~ €20.90
Arduino MKR WiFi 1010



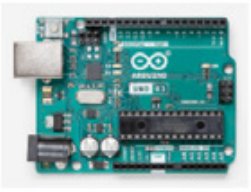
€19.50
Arduino Nano 33 BLE with headers

~~€18.00~~ €13.50
Arduino Nano 33 IoT with headers

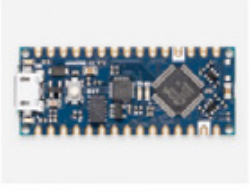
€20.00
Arduino Motor Shield Rev3



€17.50
Arduino Nano 33 BLE

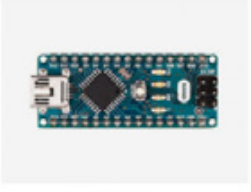


€20.00
Arduino Uno Rev3



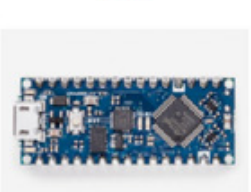
€9.00
Arduino Nano Every

€29.00
As low as: €27.10
Arduino Nano 33 BLE Sense with headers



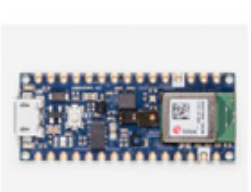
€20.00
Arduino Nano

€79.90
Arduino Starter Kit Multi-language



€11.00
Arduino Nano Every with headers

€18.00
Arduino Micro



€27.00
Arduino Nano 33 BLE Sense

€35.00
Arduino Mega 2560 Rev3

~~€16.00~~ €12.80
Arduino Nano 33 IoT

€35.00
Arduino MKR WAN 1300 (LoRa connectivity)

€35.00
Arduino Due

€22.80
Arduino Nano Every - Pack

ARDUINO'S STORE

After sketching ideas and interviews I had some product ideas in mind. Although many of my concepts were finished products in the sense that they would be purchased and ready to use directly. For example clothing with lights. I also came to the realization at this point that many of my ideas already existed as DIY projects made by someone else in the world. There are an incredible amount of maker technology projects out on the internet.

I took a step back and considered what Arduino is selling today. The image to the left is a screenshot from their online store. What Arduino is offering is hardware for people to use when making their own projects. They are not selling ready made items, but rather components which allow for creating something of your own.

A product which would offer greater freedom when it came to how and what to use it for also aligned better with what had been said in the interviews with the professionals and the target group. Learning through practical experience and allowing for freedom to explore.

By this stage I imagined the final design could be a kit of wearable components.

REVIEW OF BRIEF

I reviewed my initial brief based on the learnings I had come across so far in the project. I would still design merchandise for Arduino #include, but the target group could be expanded to be pre-teens and teens who are interested in exploring STEM. Those with no interest at all might not be the direct target group, but they could potentially be convinced by the friend who likes STEM.

The target group did not necessarily only have to be girls any longer. It would expand to cover pre-teens and teens of all genders. Though the outcome would be designed with young girls' interest in mind, with the goal to encourage pre-teens and teens to pursue technology and programming.

Further the wearable merchandise would be some sort of component system in a kit with provided instructions for making your own wearables.

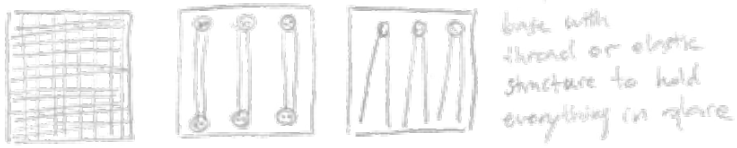
PROTOTYPES

I continued the project by making prototypes of wearable components rather than ready made products. The aim was a simple assembly, no soldering or sewing should be involved. Not everyone has tools for soldering at home or knows how to sew. Based on personal experience while making the prototypes I can also attest that it is a bit harder to sew with stiff conductive thread compared to ordinary thread.

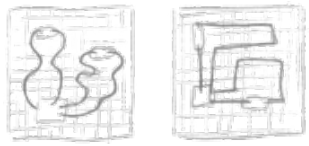
The ideas I had in the beginning were based on a two part system. Three examples of these are shown to the left and on the next spread. Components in these systems which would attach to a base. But the base itself would have to be attached in some way to your own clothing in order to make it wearable. Attaching this base would either be permanent by perhaps sewing or gluing, or it might be a detachable solution. Solutions such as sewing on a velcro strip or water soluble glue were considered. But in the end the detachable solution was preferred because it would offer more use for the design and not limit the use to the wearable the user first decided to attach it onto.

After more prototyping I decided to leave the two part system. If the components had to be attached they might as well be attached directly onto your clothes to make them wearable. The base was an unnecessary addition and could be skipped altogether. Instead I now focused only on how the component itself could be attached directly on wearables such as clothes. The main idea was to attach and remove it without damaging the textile. Methods such as pins and sticky glue were eliminated due to the risk of damaging textiles. Pins might not be that damaging, but on a personal note I would never wear pins on my delicate evening dresses with the small risk that the pin can get caught in a thread and perhaps destroy the dress. Same with glue, which could leave residue after removal.

Many prototypes were made with velcro as the way of attaching. The downside with velcro is that it can be caught at the wrong places and cause snagged clothes. Some rough functional prototypes based on the cardboard prototypes shown earlier were crafted. This was done to test if the concepts worked.



base with thread or elastic structure to hold everything in place



lead wire through the structure to secure in place

use wire to create designs

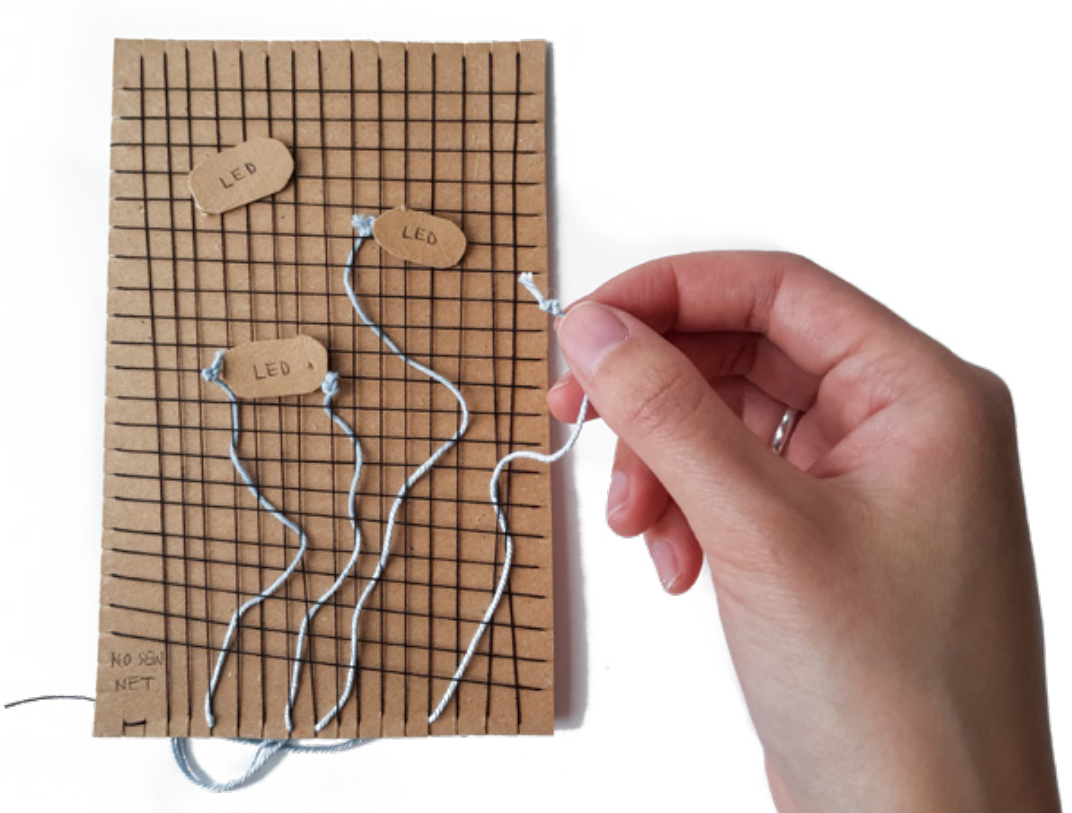
no sewing connections

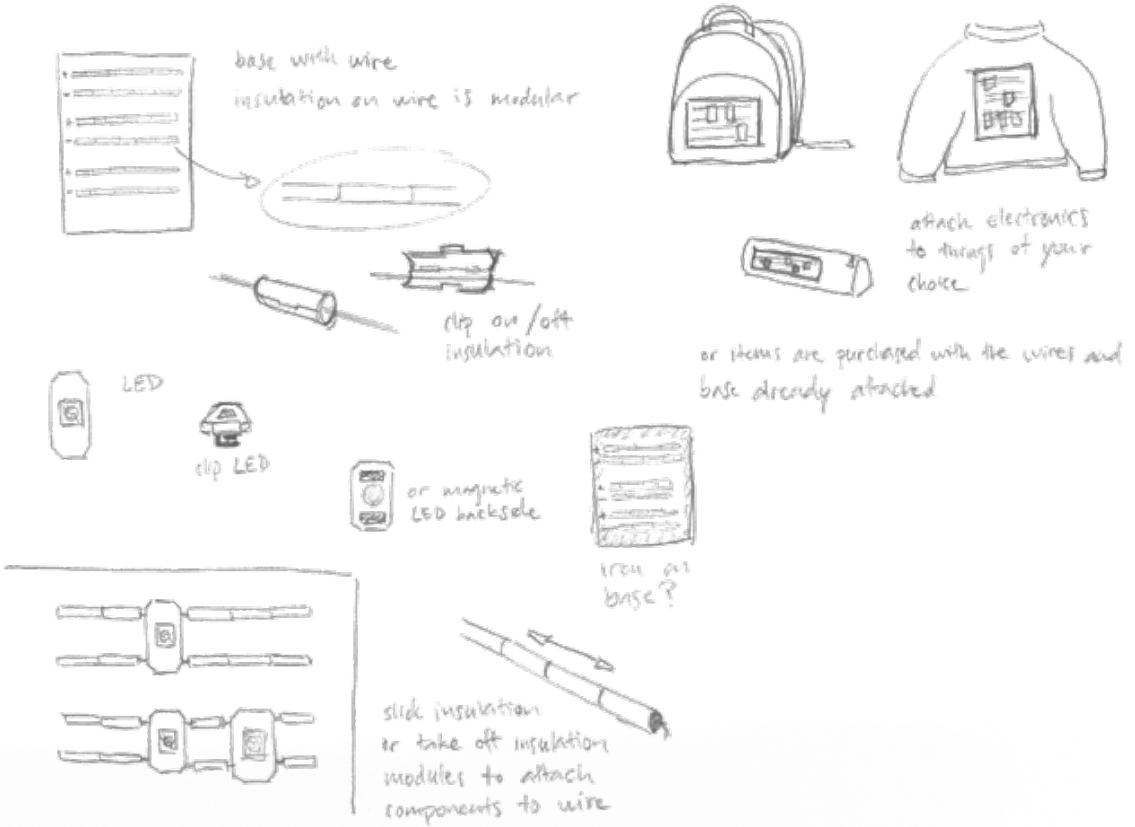
components attach with magnets or velcro

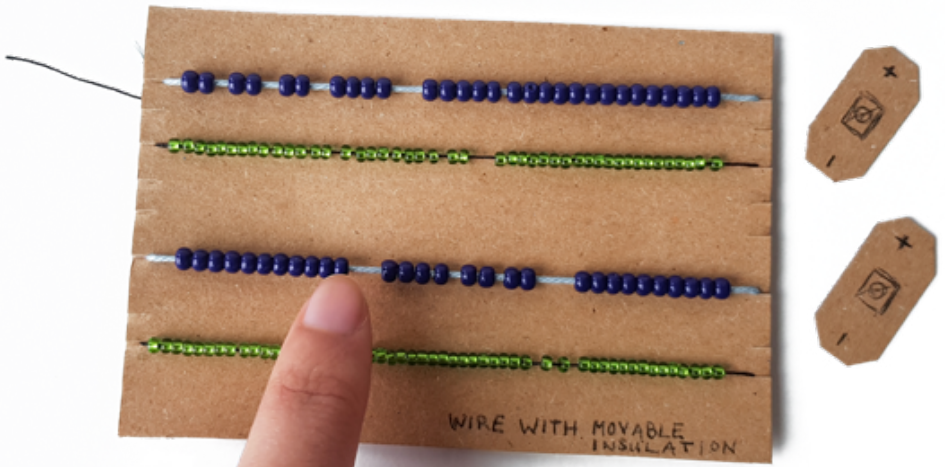
buttons?

attach piece of structure yourself on whatever

structure grown on item




base with wire
insulation on wire is modular
clip on/off insulation
attach electronics to things of your choice
or items are purchased with the wires and base already attached
LED
clip LED
or magnetic LED backside
iron on base?
slide insulation or take off insulation modules to attach components to wire


WIRE WITH MOVABLE INSULATION


velcro (?)
wire
velcro LED
velcro base
velcro decorative patches
use velcro patches to secure electronics and to create your own look
show wire as part of the design
wire
velcro patch
Christmas tree wire is optional
cut and make your own velcro patches!
wire inside velcro attachment?

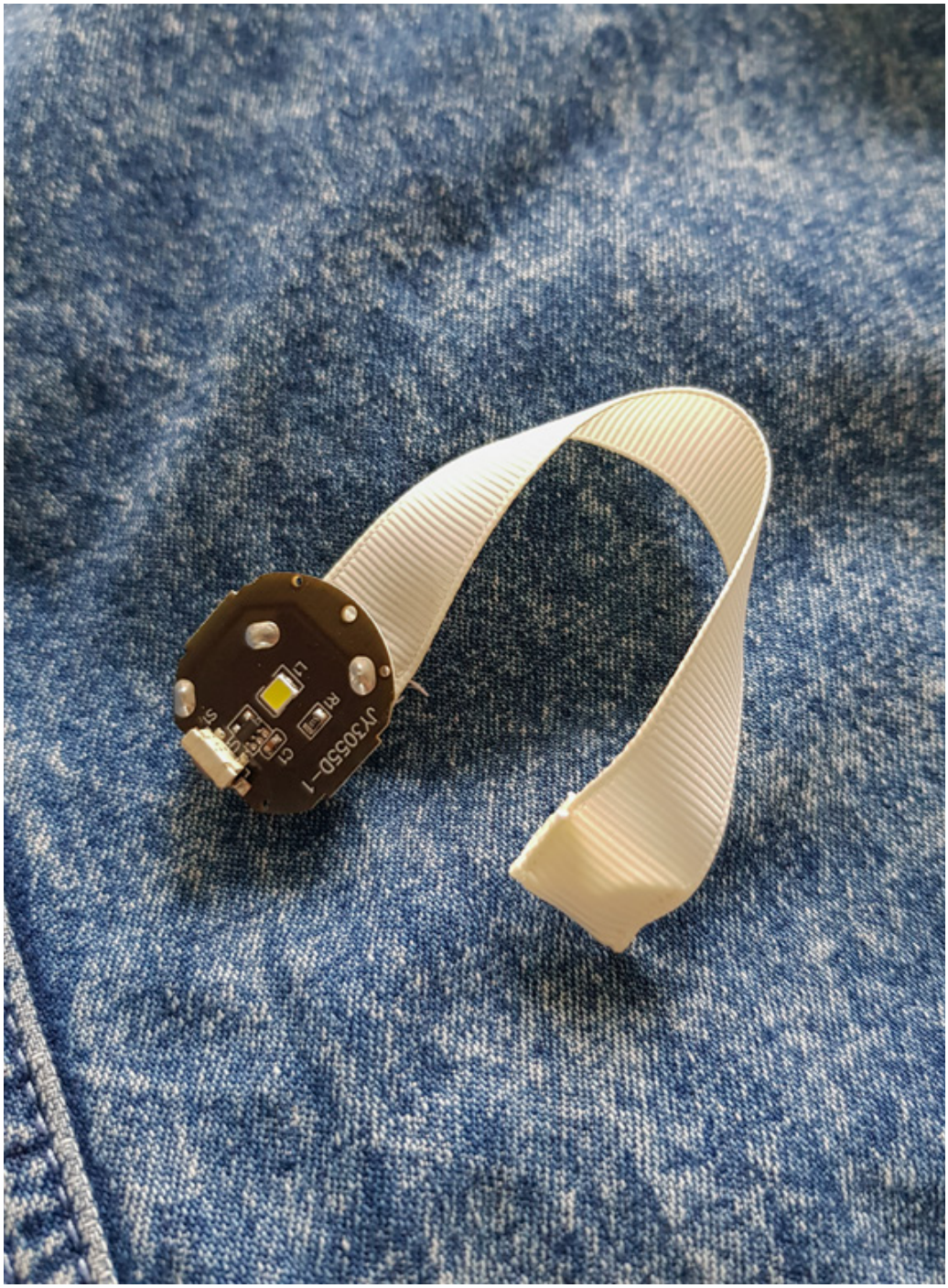

LED
VELCRO PATCH
VELCRO BASE
BATTERY


8/24
mes
Tapestry
apisserie bout rond
Finest Quality Needles

Electrical connections using velcro for easy attachment and removal. I learned that the connections were not secure enough and this solution would need extra help at the connection points.

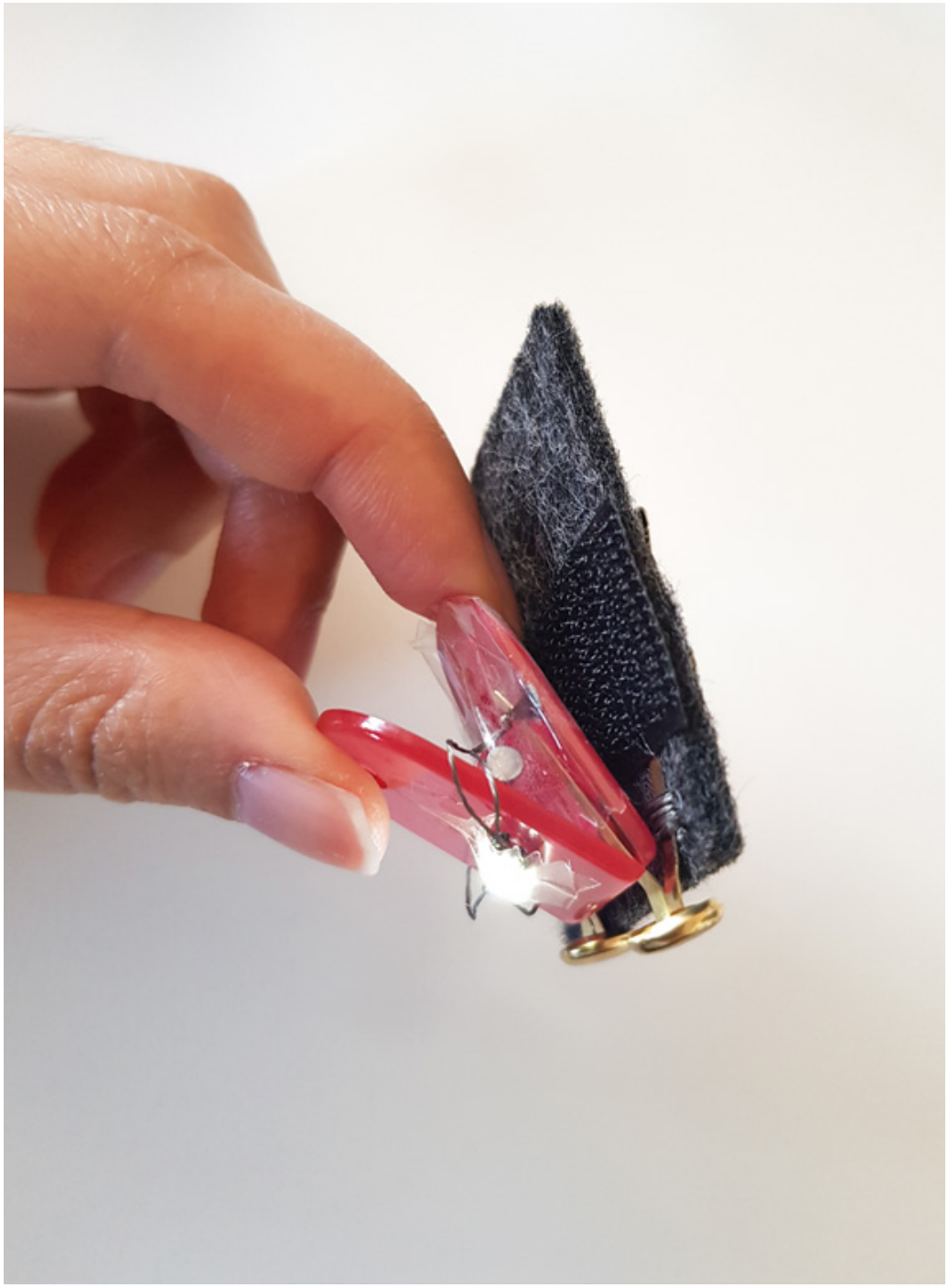
Movable insulation on the electric wires. It did work, but I was worried the risk of short circuits were too big in case one forgot to attach insulation where it should be insulated.

Magnetic clip on attachment similar to bookmarks. Worked without an additional base to attach onto. The downside is that it is restricted to attach on edges.



Magnets might interfere with the electronics that are sensitive to magnetic fields.

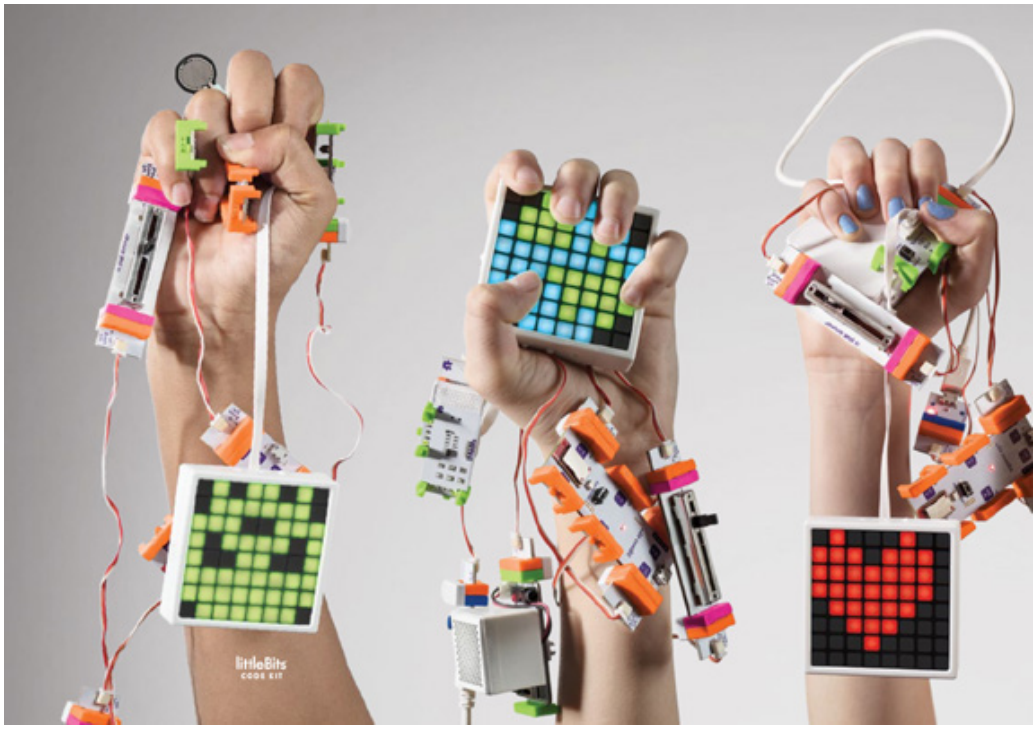
Attachment based on a clip. Worked well, but might be bulky depending on the clip design. Will definitely require a little finger strength to attach.



Overall this was a good idea with potential to be developed further. A clip would not damage textiles.

Evolvement of magnetic and clip solution. Magnetic clips for attaching on the edges of clothing. Simple securing and removal.

Magnetic connectors on the sides for connecting pieces to one another. Shown above is a battery piece and an LED piece.


littleBits
CODE KIT


LightUp
EDISON KIT
AGES 5+
APP INCLUDED
Discover new project ideas, get personalized hints, and share your creations with the community using the LightUp Learning app.
X-RAY VISION
Just take a picture and get X-ray vision with the LightUp Lens
Next Projects
Light Sensor
Alarm
You made a nightlight, see the electricity flow!
100 Best
DR TOYS
Winner
DISCOVER THE WORLD OF ELECTRONICS
Discover how things work • Learn about electrcity• Understand 100+ STEM concepts • Develop problem solving skills

OTHER COMPONENT KITS

As I continued along the path of designing a wearable component kit designed with girls' interest in mind, I researched the available kits on the market. Once again, there are extremely few technology or programming products on the market specifically targeting girls or being designed for girls. What is available is kits for pre-teens, teens and adults. I had an overall look at technology or programming kits offering components and open opportunities for what you can create. These kits should be of the kind which does not require any soldering nor are meant to use on the common breadboard. Similar kits are already sold by Arduino, as well as competitors, and if I were to design yet another product like this it would not meet the criteria in my brief.

Shown here are four examples of technology or programming kits. They are either targeting children, teenagers or anyone. Apart from these examples I did also find some interesting crowdfunding projects or individual projects, which never made it to the commercial market.

The first example, as seen on the top on the left side, is littleBits by Sphero. The company was found already in my early competitor analysis. LittleBits is a component system for learning technology and programming. Sphero offers littleBits in various kits with different themes and projects. The littleBits connect to one another by the magnetic sides and some kits provide a mounting board, similar to the LEGO boards. They do also have a variety of the board which is attached to a strap and can be worn on your arm as well as an accessory called shoes. The shoes are attached with magnets, adhesive or velcro which lets you attach littleBits on surfaces.

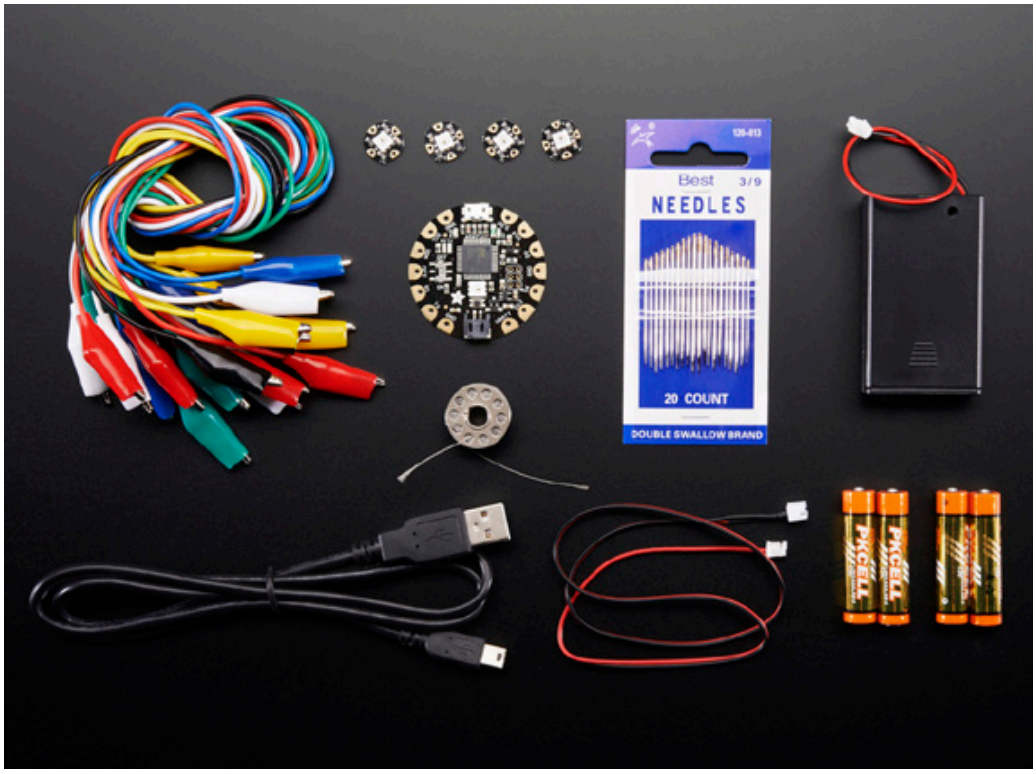
I was not familiar with these accessories until this point of my thesis, and when I did learn about them my first instinct was that I feared that my own design concepts were too similar. Upon further contemplation I could see that there were differences between my ideas and littleBits with accessories. The main distinction was the even though littleBits did provide the possibility of making wearables with their accessories, the arm strap mounting board only had room for very few components and the shoes accessory required a corresponding side to the magnet

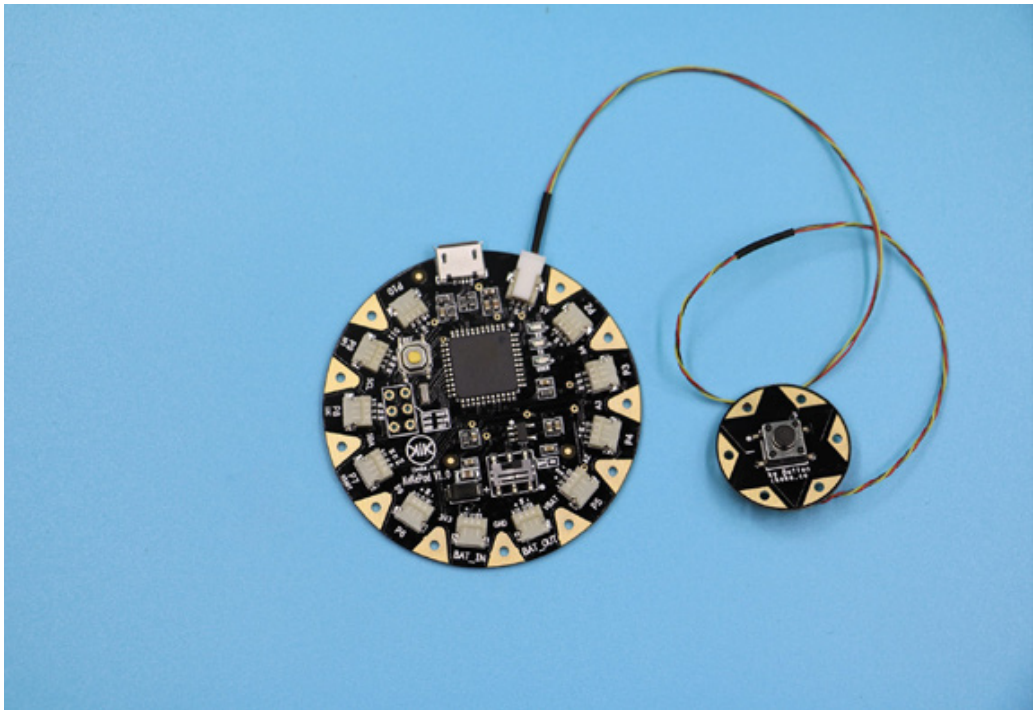
or velcro. This meant that the shoes accessory only upgraded the littleBits components, but in order to make use of the magnet shoes you would need a magnetic attachment surface and the velcro shoes needed an opposite velcro side. One one hand this did offer a wearable option, but you could also need to sew a piece of velcro or mount something magnetic onto your clothes themselves. As the littleBits were not designed to be used as wearables the accessories appeared later on in the product line.

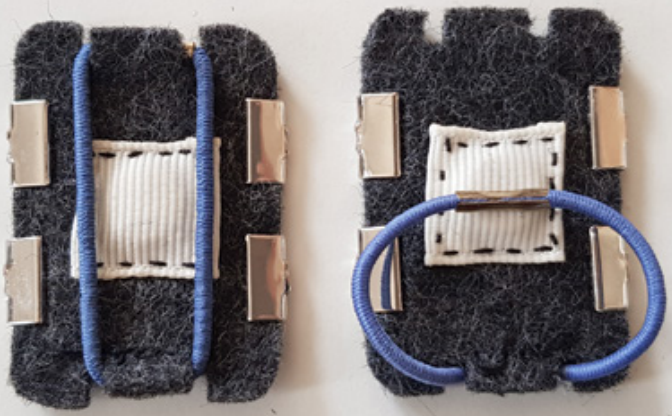
The second kit is shown as the bottom image on the previous spread. Light Up started as a crowdfunding project. I was unsure about whether the company was still active or not as parts of their website seemed to need an update and you were unable to purchase products. Similar to littleBits there are components in the Light Up kits which connect with magnets. Differentiating this from littleBits is that the kits also come with an augmented reality app, which teaches you about electronics through the lense of your camera.

The third example is a Flora kit by Adafruit. Flora is Adafruit's wearable microcontroller. It lets you connect to additional components by sewing with conductive thread. The Flora can also be used with alligator clips instead of thread as part of the prototyping process. It can be connected to your computer through the USB port for uploading code or accessing data. Wearable microcontrollers such as this one were one of my early inspirations. I only wished to simplify the process of building a project and avoid sewing as a necessary step.

The fourth and last example of a kit is KeKePad. This was a crowdfunding project, which I believe made it to the market for a short time before they disappeared. In principle it is just like Flora by Adafruit, a main microcontroller which can connect to other components. The difference is that KeKePad wanted to make the assembly easy and time saving. Instead of sewing with conductive thread you create connections with thin cables, which KeKePad claim to simplify the way wearable projects are built. This was exactly what I too wanted to achieve with my wearable design. In the earlier sketches I did have an idea of a similar solution, which I in the end did not continue with as my concept was a two part system that required a solution for securing the cables and components to a base.


Best 3/9
NEEDLES
20 COUNT
DOUBLE SWALLOW BRAND
PKCELL
PKCELL





FINAL CONCEPT

After different tryouts and more sketching it landed with this concept, which was prototyped after the previous tests on the last pages. The research on other component kits and in particular LittleBits served as great inspiration. My final concept combined the magnetic and clip attachment ideas. The frontside of the design would feature the electronics, the magnetic backside would allow for attachment to the metal part on the elastic band. The elastic band itself could additionally be used to create a loop, by hooking it to both sides, to slide the piece onto something. The magnetic sides are in order to connect to other pieces.

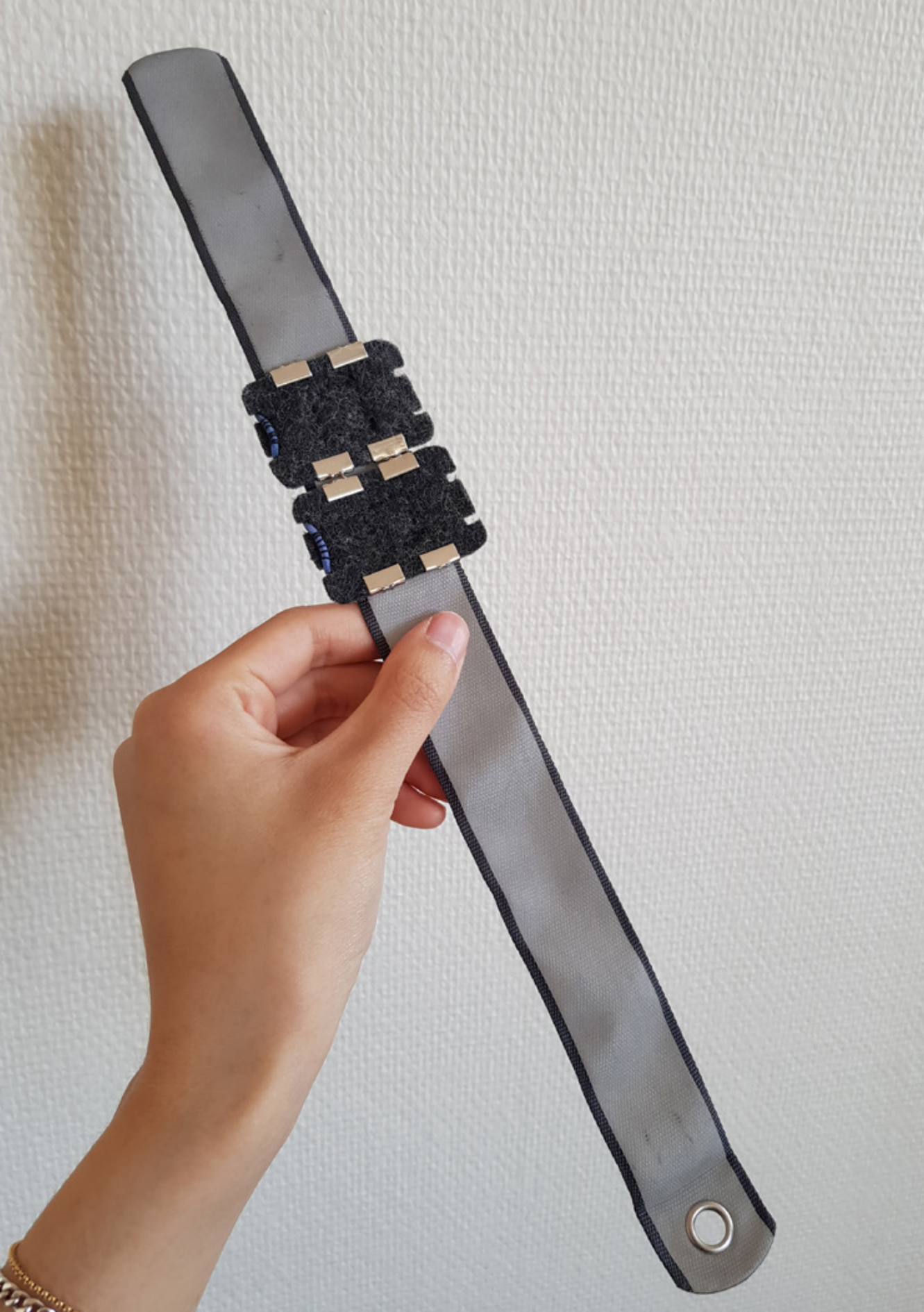
This concept opened up for a variation of wearing options. For example using the magnetic attachment it could be worn at the edge of your clothes. The magnets would not cause any damage to the fabric and stay on securely.

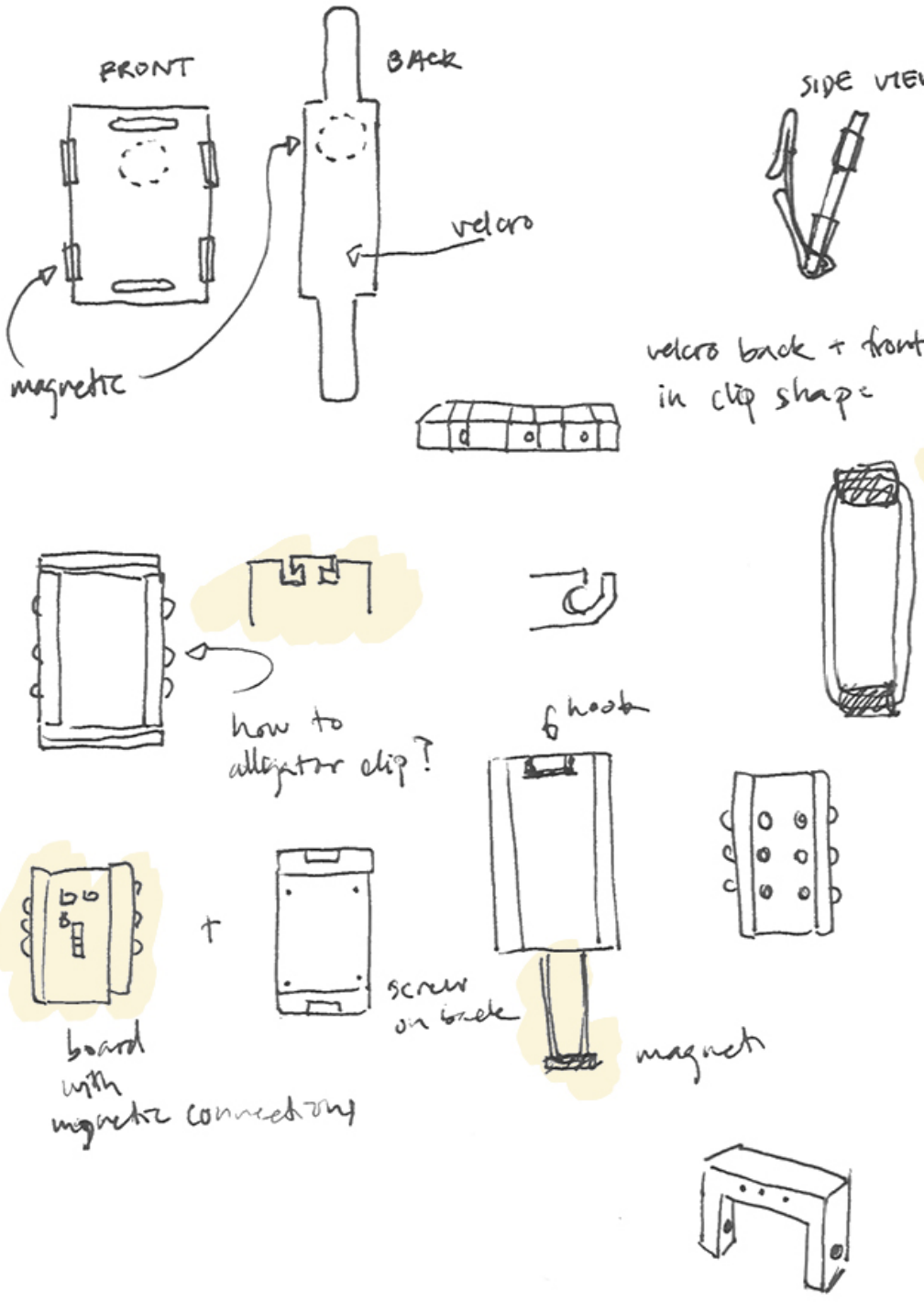
By creating a loop with the elastic band the piece can be attached to your backpack straps. One idea that came to my mind with this prototype was that it could be worn as a bracelet using the elastic band loop. For example snap-on reflectors are often magnetic due to the metal core, which means the pieces could be placed directly onto it by magnetism. The option of looping the piece onto something else would open up for possibilities beyond the edges of clothes.

All my prototypes in this project were created in soft materials, but after some consideration I decided it would be best with a hard design. Flexible electronic circuits printed on fabric are possible, but they might be less durable with all the stretching and I worried that the non flexible electronic components might detach from the stretchy circuit with bend and use of the piece. How would you create a soft circuit with LEDs and also make the LEDs completely soft? At this time it seemed impossible to make all electronics soft and bendy. E-textiles today often feature some hard bits, electronics which are not yet produced in soft versions. If it was possible to have completely soft circuits, which is not unlikely, another concern was that the manufacturing process might add to the price if it had to be a cutting edge technology and production process. I

did not strive for this to be an expensive product, but rather something affordable as the target was pre-teens and teens. Although final conclusions were very hard to draw. Ideally I would have liked to get my hands on some industrially manufactured soft circuits with different electronic components to see how they would stand repeated bending to the overall circuit they are attached onto.

I made the decision that it would be a hard product design. Partly because Arduino already has manufacturers within this area and partly because my research told me soft electronics would still need to use certain hard parts.

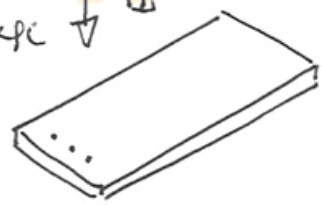



FRONT
BACK
velcro
magnetic
SIDE VIEW
velcro back + front
in clip shape
how to
alligator clip?
6 hooks
board
with
magnetic connectors
screw
on back
magnets

back and front
in loop shape

Limelights
shoes

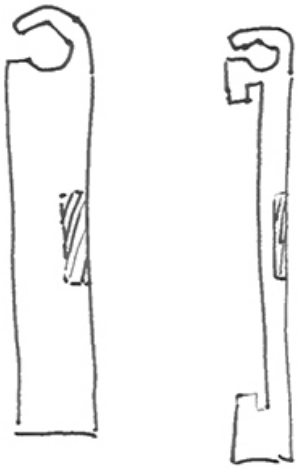
bitSnaps
available
for purchase

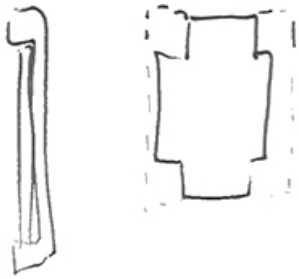


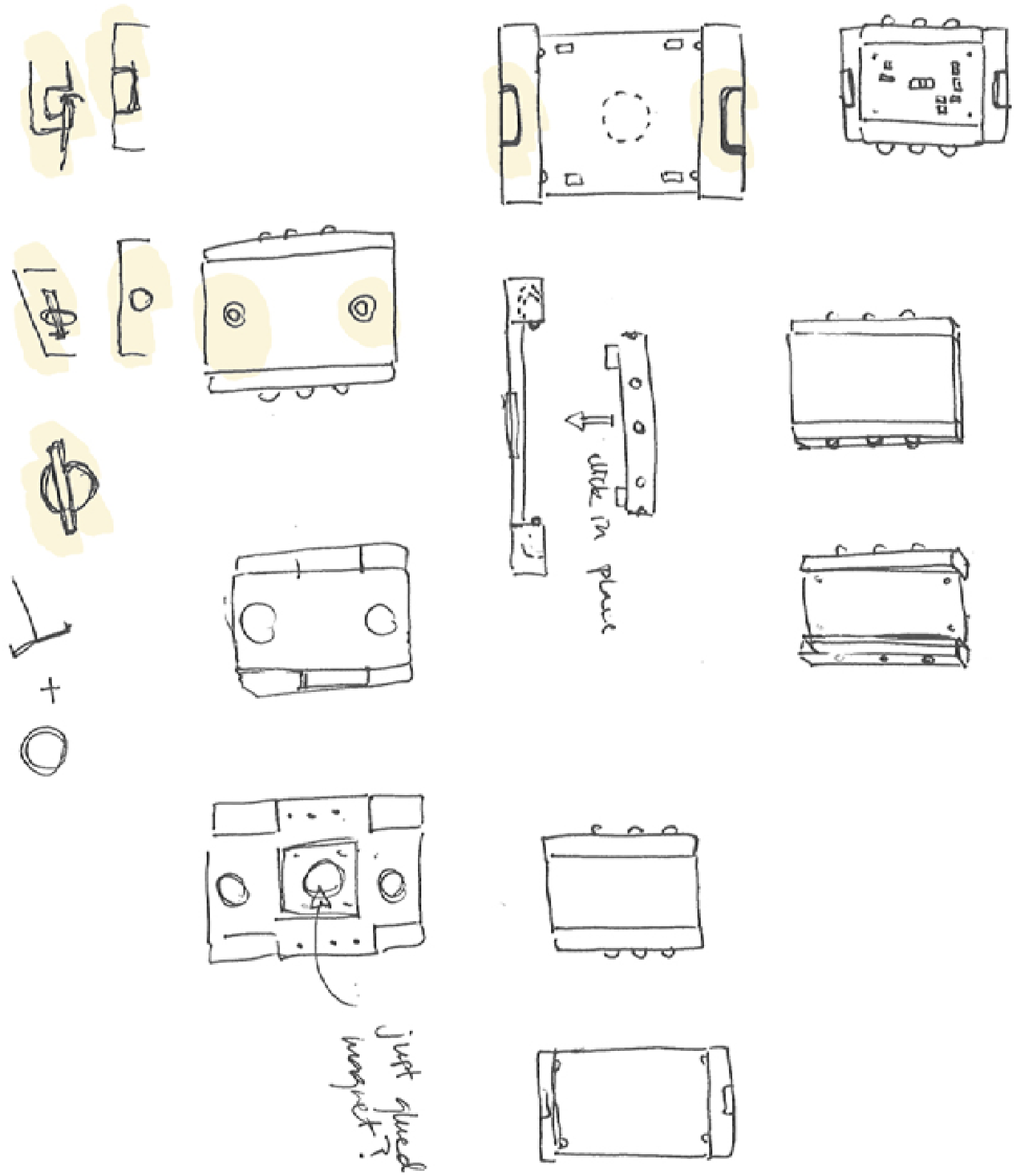
magnetic rod

silicone cover
for grip

which elastic
is the best?
most sustainable
and durable






stick in place
just glued magnet?

During my projects I felt stuck many times when I was trying to understand exactly how the electricity would flow through the product and how different components would connect in the circuit. When I started making prototypes I did make some that actually had electricity running through them and they functioned properly. By the end of the prototyping stage and when I tried to define the final concept I allowed myself to leave part of the technicalities undefined. Instead my main focus was to design how my product could attach to clothing. I did have enough proof of concept after my simple magnetic prototypes and enough products confirming that the idea worked, such as littleBits or magnetic chargers. What I did not know for sure, as I am not an engineer, was how close things could potentially be placed and soldered on the product. The exact placement and size of details on my design would therefore not be set in stone.

One detail I was uncertain about was if the magnetism would disrupt any of the electronics, as I also brought up in my prototype stage. To try what would happen I used one neodymium magnet, the same type I had used for prototyping which was strong enough to use for attaching something to your clothes, and moved it around in the vicinity of several Arduino microcontroller boards. I found that magnetism did not affect the electronics. A side note is that it would obviously have affected components which use magnetism, but in this test none of the boards had components of this sort. What did affect the boards was when I happened to place the magnet on top of different components and their metal connections, and the metal neodymium magnet in itself transformed to a conductor and risked short circuiting the board. This risk could be partially prevented by encasing the magnet and the connection points so that only the metal parts that need to be open for connectivity purposes are left exposed.

The final concept prototype was further explored through sketches by hand and in Illustrator. I searched for a good solution for anchoring the elastic band with the metal bar onto the component piece. The most important part of this was the metal part, as this attached to the magnet on the component backside. This metal piece did not require to be fastened to the main component, but having it hooked to the main component would lessen the risk of losing it with use. I sketched on how this hook for the elastic band would look like. You had to be able

to remove and attach the elastic, while it should also stay in place in the scenario when it is hooked at both short ends and used as a loop for sliding it onto something. The final design solution for this was an anchoring system with a hole and a rod, just like what is used as certain bracelet fasteners. This solution would stay secure in many scenarios and at the same time be relatively small and flat. As the elastic band with the metal rod could be fastened and unfastened this would also simplify the process of replacing the parts that are damaged. Replacing only the damaged parts would be more friendly to the environment and affordable compared to buying everything new.

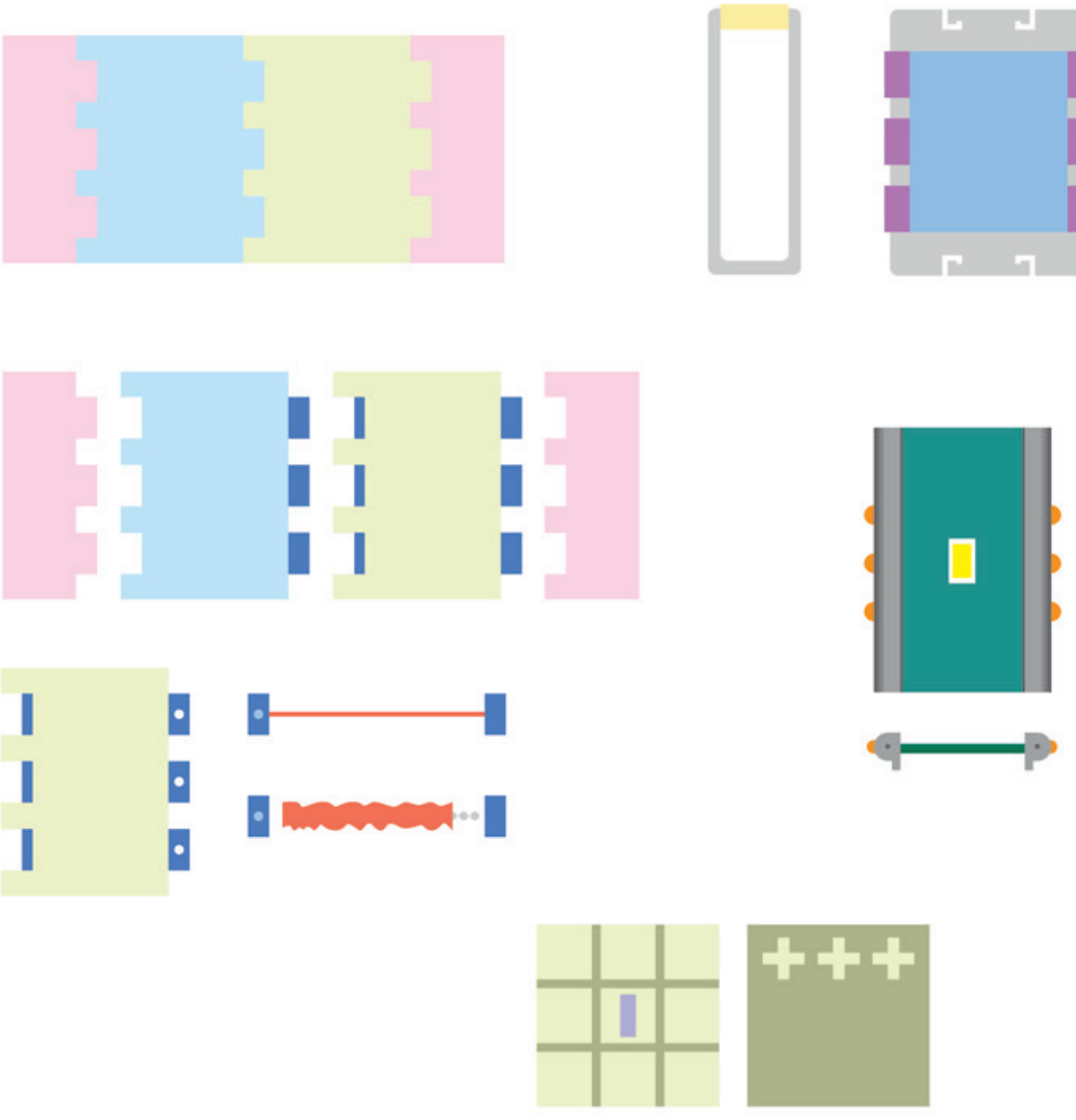
As the components in this final concept connected through points on the sides, they could only connect to each other in one direction and the components needed to be placed next to each other when building a project. This was a limitation and compromise made in order to not have tangly connector cables or oddly shaped connector pieces. The current concept could still imitate and give the perception of connectivity in several directions if multiple rows of sideways connected components were to be placed above or below one another. Although the rows would not actually be connected to each other and electricity and data could not be shared, it could provide a visual image of components being part of the same group even though they are not.

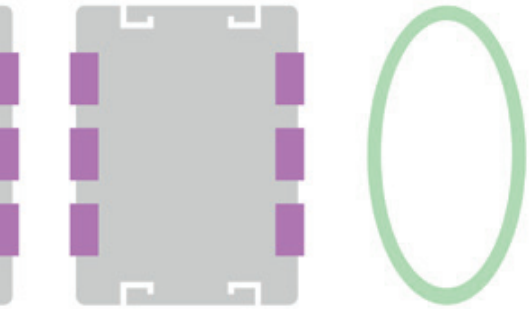
The component system would feature different electronics on the different pieces. Electronic components such as transistors, LEDs or sensors are very small. Therefore the size of the components would be determined by the size of the battery, the largest component. As different circuits and electronics required different supplies of capacity and voltage, the battery piece itself could potentially be of different sizes depending on what circuit it should power. If the size of the battery component piece was independent from the rest of the components pieces, the electronics components pieces could remain small in terms of size without having to adapt to the size of a larger battery. The potential solution of offering battery components in different sizes and capacity could be kept in mind for any further development of this project. But for the time being I wanted the design of the components to have a uniform aesthetics and the size turned out to be based on the required battery size.

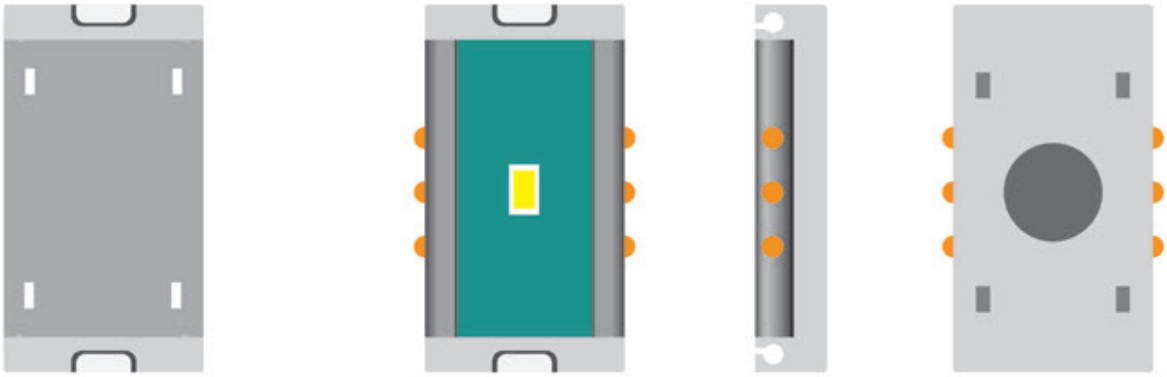
There is no way to determine the required battery power without knowing exactly what electric components are used, how they should function and how the whole circuit is connected. For this time I made a rough estimation of what I believe could work based on what is used in many wearable projects. Looking at tutorials of different wearables on the internet I found that lithium ion polymer batteries were commonly used to power projects and commercial technical products. Batteries for mobile phones are of this type for example. Lithium ion polymer batteries are generally small in comparison to what they offer and can be rechargeable. Continuing my search on the internet I drew the conclusion that 3.7v 500mAh was the smallest voltage and capacity used for powering simple wearables with a microcontroller and a few outputs, such as LEDs. It was a common battery size for many projects, even though there are even smaller batteries with less out there with less power.

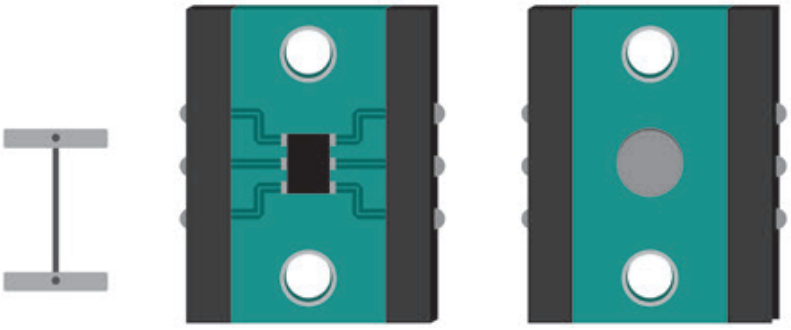
Keeping in mind that sports was the number one interest from the target group survey, I wanted to include this aspect. One way of approaching this was to have component pieces with motion sensors and show examples of the wearables in use in sports scenarios.

The following spreads show further concept sketches and a use scenario when skating.









FINAL DESIGN: CLIP ON

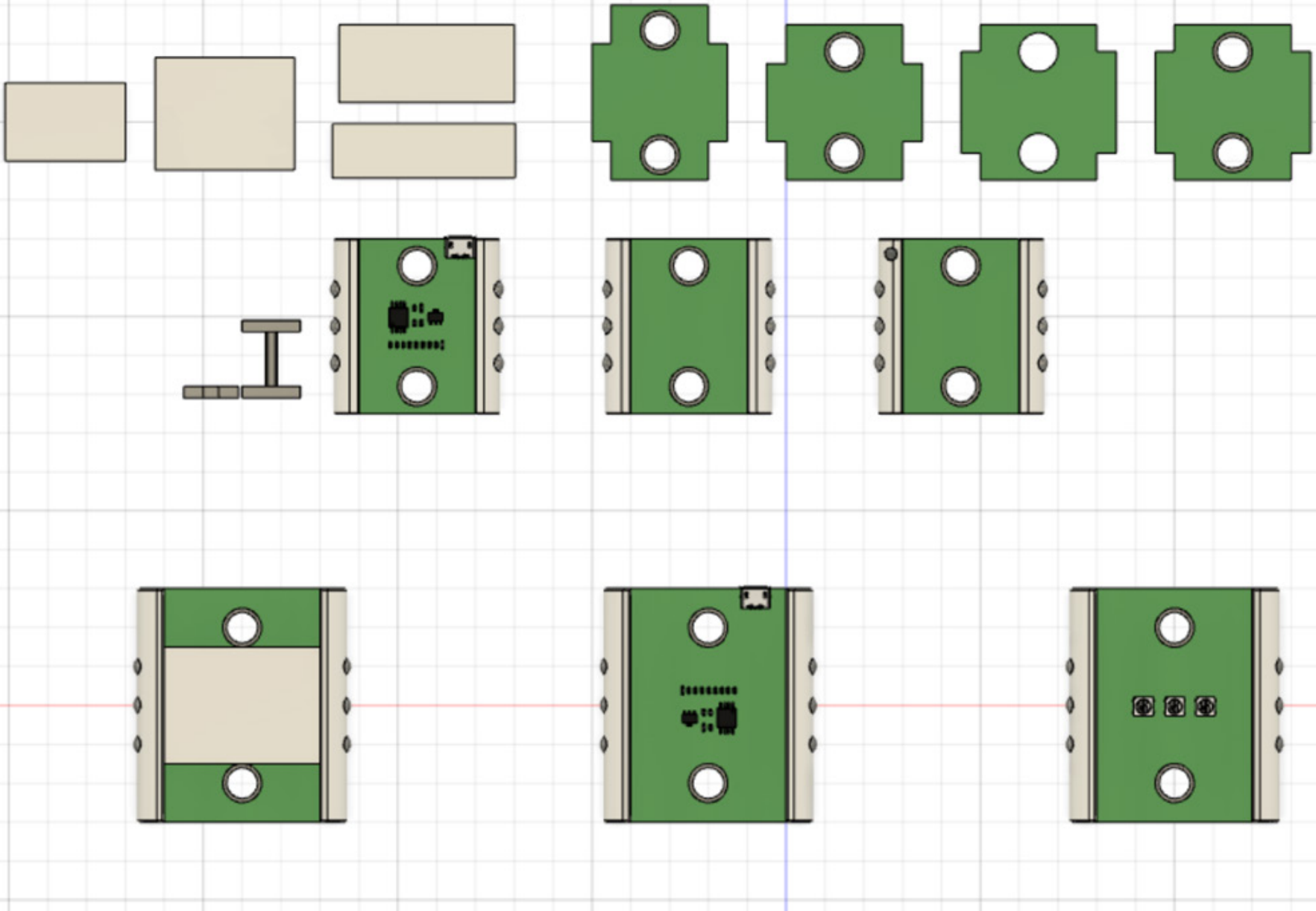
The final design of what I named Clip On was explored in 3D. Wearable component pieces were modelled and the dimensions were determined by the battery. These pieces would be part of a wearable component system which would be available in kits.

I would stick to a 3.7v 500mAh battery as a presumed battery size for my project. If a more powerful charge would be needed, the mentioned idea of having the battery component piece of the product design with its own design form is a potential solution. Another solution offering modularity would be to use series or parallel connections to increase either the voltage or capacity. These concepts could be kept in mind in case of further development. 3.7v 500mAh batteries can be manufactured in many sizes. For this project the battery dimensions measured 30.0 x 7.0 x 20.5 mm (Padré Electronics Co, 2021). With future innovation I believe it will be possible with even smaller and less bulky battery sizes.

The center part of the component product design would be a hard printed circuit board (PCB). As Arduino already sells products with PCBs the manufacturing of this wearable would follow the same process. An anchoring system for securing the magnetic closing with the elastic to the main PCB would be using the concept of a hole and a metal bar. The reason the metal end is secured to the elastic is to avoid having two separate pieces that might get lost from each other. This attachment hole would be made directly on the PCB, similar to how screw holes can be manufactured on PCBs.

The backside of this PCB should not have any metal sticks poking out after the electronics are soldered onto the board, as this could potentially damage textiles. As I was looking at the different Arduino boards I had at home, I saw that it was possible to manufacture PCBs with flat backsides with no sharp ends.

Magnetic sides would be soldered to the PCB and function as the magnetic connectors between the component pieces. These sides would be curved and feature rounded magnets in order for the pieces

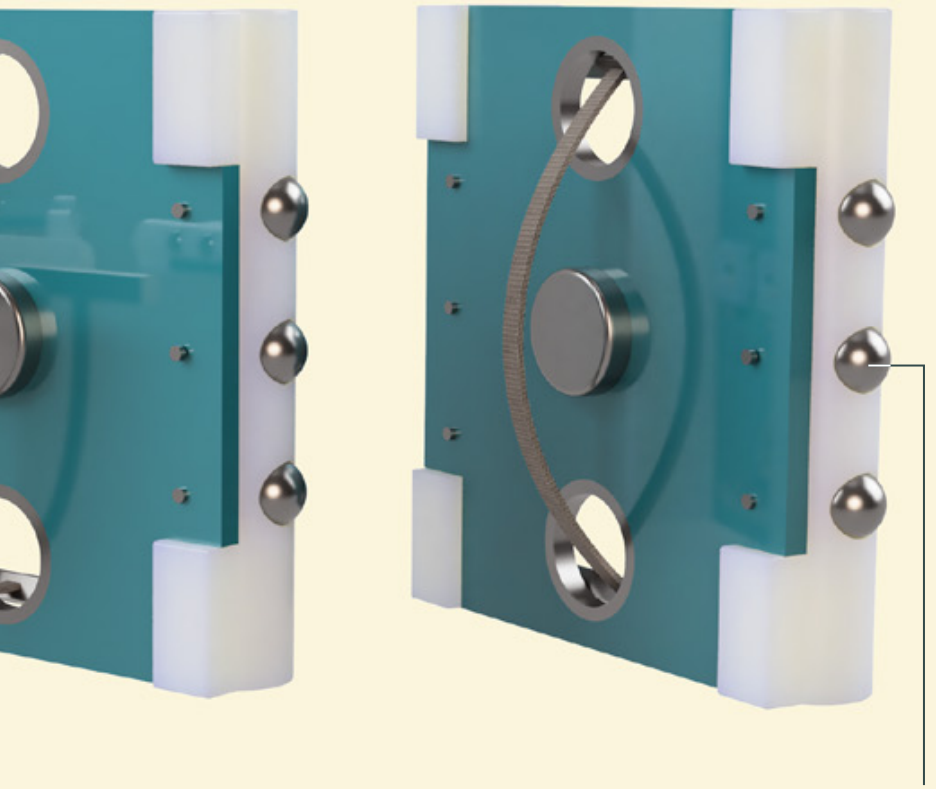


ATTACHMENT HOLES IN PCB

PCB WITH ELECTRONICS

ELASTIC WITH METAL

NEODYMIUM MAGNET



L ENDS

CURVED SIDES WITH MAGNETS

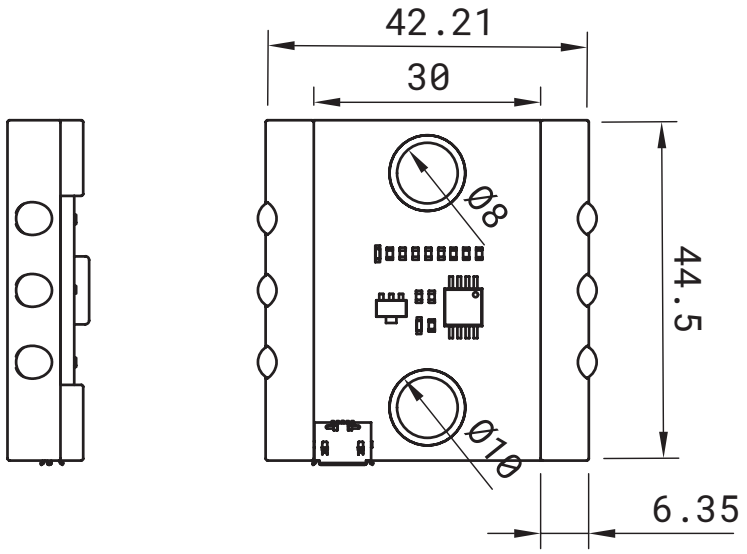
to remain connected next to each other, even if they are not perfectly aligned in a flat angle. As clothing and backpacks are normally soft this wearable component system should have pieces which can conform to the bends of textile.

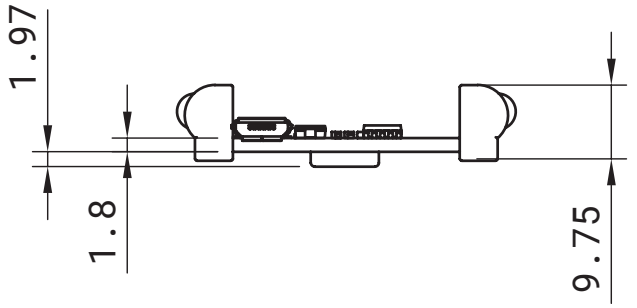
From an environmental aspect the manufacturing of Clip On should use as many sustainable resources as possible. The plastic parts could be made of recycled materials. I believe the elastic band will wear down the fastest. The elastic band with metal ends is therefore a separate element which can be removed and replaced if needed. In my design the elastic band and the metal ends are joined together. An alternative solution is to have the materials connected in a way so that the user themselves can replace the worn out elastic band at home. Replacements part could be sold on the Arduino webshop or instructions to the simple fix it yourself solution could be shared as an open source hack by Arduino.

I imagine that there could potentially be a recycle program for Clip On, in particular the PCB with the electronics, at the end of its life. You could return items to Arduino for either reuse or recycling. As a thank you one would receive a discount code for the next purchase. This would be an incentive to correctly dispose of broken electronics and also to stay as a loyal customer.

Another idea is to implement a repair service at Arduino's offices or official retailers. Customers who are living close by any of the offices or official retailers could bring their Arduino product with them and pay a visit to receive professional help. If the item is considered to be repairable this could be done for a service fee. If the item is beyond repair the customer could decide to leave it for recycling and receive a discount bonus code on their next Arduino purchase.

The last concept is to have do it yourself repair workshops at Arduino offices, which continues the idea of open source solutions. This could be organised as repair evenings, events the customers can attend in person. Materials and tools for repairing your Arduino products would be available and an instructor would be present for help. Repair workshops could in addition be a way to promote products and be a place for pre-teens and teens to meet like minded friends, while learning about electronics and extending the lives of their own products.


42.21
30
Ø8
44.5
Ø10
6.35


1.97
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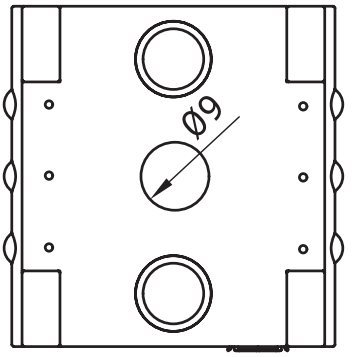
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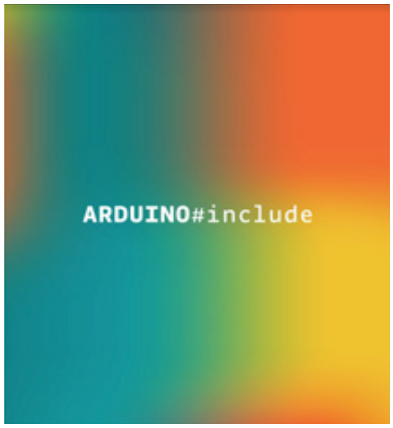

ARDUINO#include

COLOUR SELECTION

For the colours I was inspired by the design language of the Arduino #include programme, which uses the Arduino colours teal, orange and yellow blurred together. An image search on the word ”diversity” or ”inclusitity”, the core concepts of the #include programme and the background to my brief, will result in photos such as the one to the left. Many colourful images of people will show up. These images of people in turn made me think of friendship and friendship bracelets. For this thesis project I wanted to use my choice of colours as a subtle symbol for diversity and inclusivity.

My idea was to have the printed circuit board on Clip On in different colours. The colours could change with each new production batch.The image shown on the following page was found in an article about an Arduino workshop and the caption read: Arduino, even in girly colors (Mediamatic, 2019). For me there is no need to make anything “girly” or pink all over the place, but I aimed to make it colourful and appealing to most people, regardless of their favorite colour.

Producing the same printed circuit board for Clip On in different colours would require resources. Changing the colours for each new batch might be an additional fee to the overall production. Striving for an exact shade of colour is not easy. Proof of this is shown on Arduino’s official products with printed circuit boards, which comes in different shades of the signature teal blue colour.

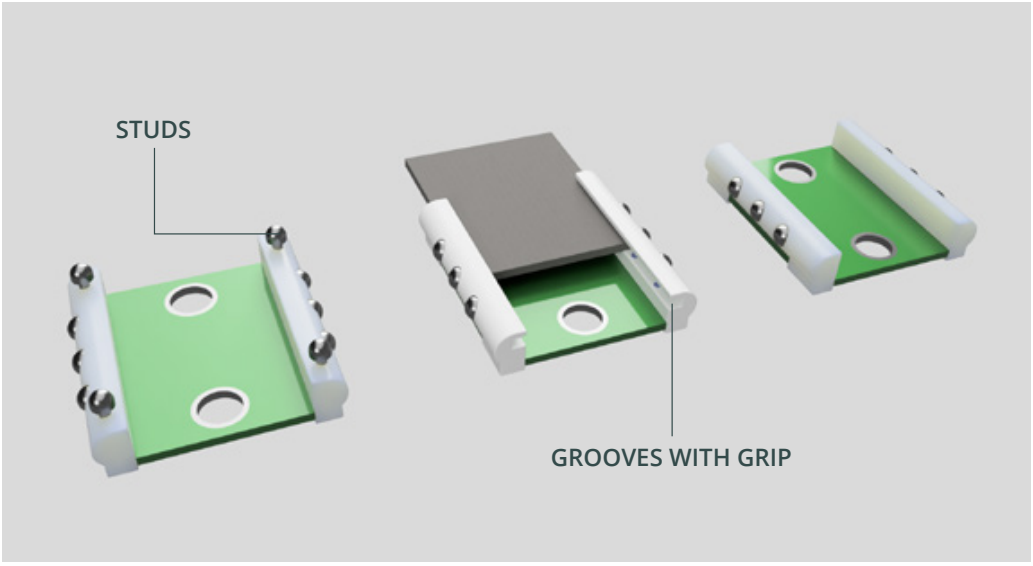
One alternative for colour variations was to use studs or groves in order to allow the user themselves to attach and change their own colours, by using pieces of paper or felt. This is shown in the image on the next page. Although this solution would also require extra steps in the manufacturing process. If the coloured decorative cover pieces were to be sold by Arduino or come with the Clip On, the pieces would need to be manufactured by the company.

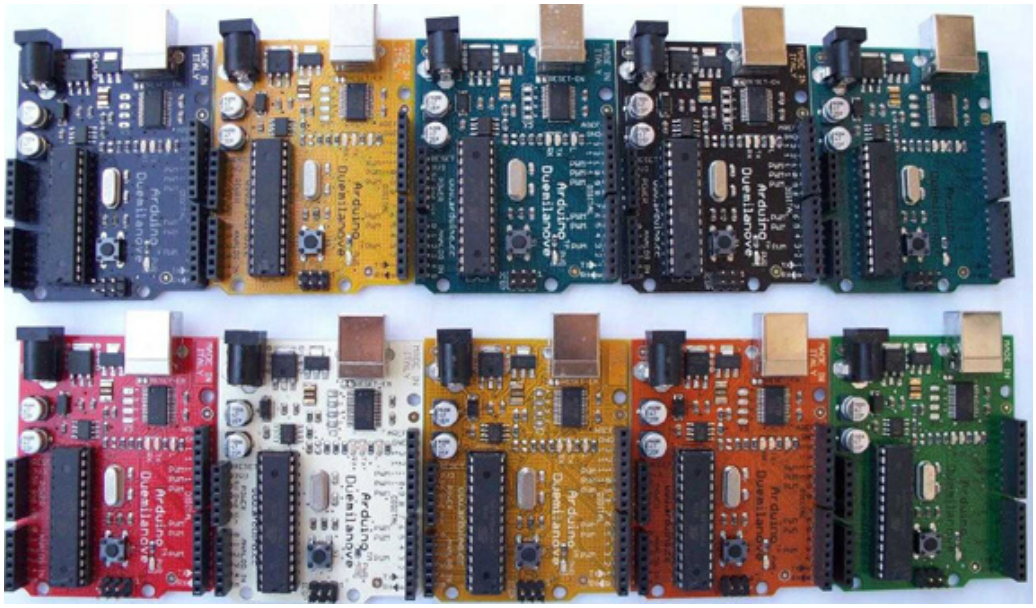
An open source solution is to provide the customers with instructions on how to create their own decorative covers at home. The version on the Clip On would then use studs or groves for attaching the covers. The

covers could be crafted using materials as paper or felt. They could also be made out of the cardboard packaging the Clip On is sold in. It would be an interesting concept if the Clip On was sold with ready to cut out cover pieces, making the packaging part of the product.

For now I settled with the idea of changing the colours directly on the printed circuit board. As any solution would require resources either way. The collections of different coloured Clip On could look like as shown on the next spread. There would be different electronics and different colours on the pieces of Clip On. The next spread shows a Clip On with a buzzer for making sounds, one with LEDs, a piece with a microcontroller which you can program by connecting it through the USB port and a battery piece which can be recharged through USB. The colours used for this image are Arduino's teal, orange and yellow. The palette for the Clip On colours is not set and the shades could expand beyond the main Arduino palette. Seasonal colours could be a way to implement new shades following the latest trends.

As Clip On comes in various colours with different electronics, friends could exchange pieces with each other similar to how friendship bracelets are shared. This way friends will encourage each other to explore new aspects of STEM by trying out new circuits and electronics. In addition collecting and exchanging Clip On could boost the sales.





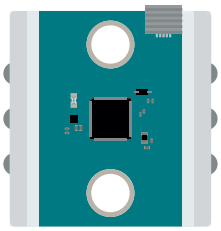
”Arduino, even in girly colors”

CLIP ON KITS

The Clip On component pieces will be available in themed kits on Arduino's web shop and at official resellers. Three examples are Motion Kit, Light Kit and Sound Kit. Clip On pieces featured in each kit will have electronics corresponding to the theme. The Motion Kit would for example use accelerometers, the Light Kit would have LEDs and light sensors and the Sound Kit would have buzzers. These are just examples of what can be featured and the opportunity to launch new kits remains.

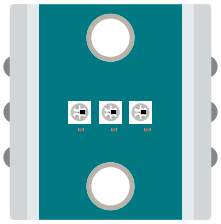
Creating new kits will continue to make the Clip On interesting. The customer who owns own kit might be intrigued to buy another to learn even more of STEM. Different kits and Clip On pieces can as mentioned also be exchanged or borrowed between friends.

Individual Clip On pieces could in addition be available as separate products. These could be purchased if one wishes to expand their kit with more pieces, but does not want to buy a whole kit. As the Clip On will be available in different PCB colours, the individual Clip On pieces could also be sold for the customer who wishes to collect more colors.



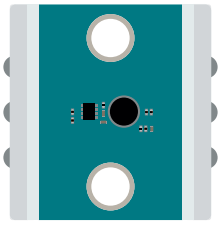
ARDUINO

CLIP ON
MOTION KIT



ARDUINO

CLIP ON
LIGHT KIT



ARDUINO

CLIP ON
SOUND KIT


coco


ABSOLUT
AHUS


BODY
CLEANSE

PACKAGING DESIGN

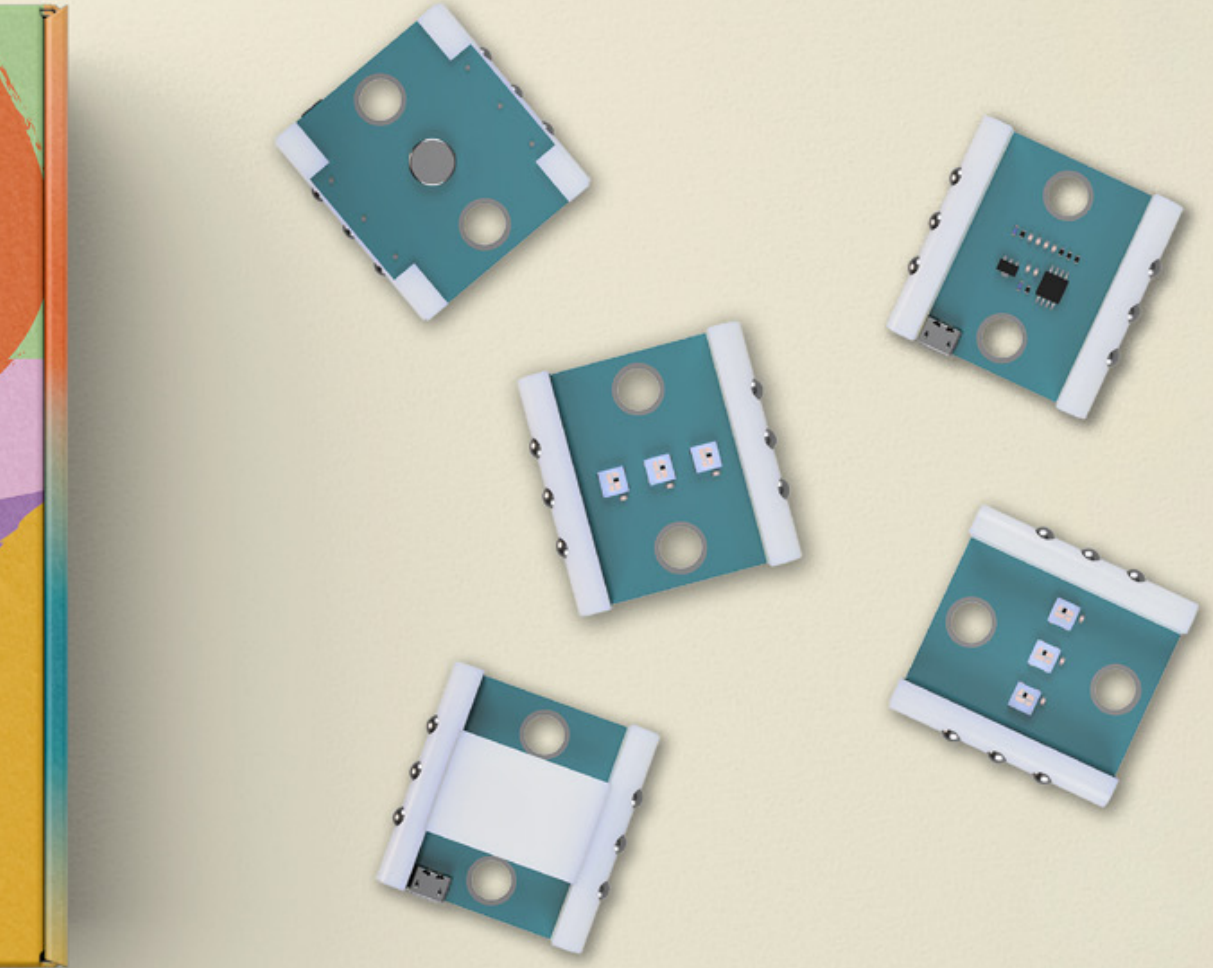
For the packaging I created this moodboard. I strived to continue using colours as a symbol for inclusivity and diversity on the packaging. Inspiration was found in products and packaging with vibrant colours in playful combinations.

I created a mockup, see the next spread, of a Clip On packaging that featured my own artwork. The colours and design were heavily influenced by the moodboard. I perceived the abstract artwork as yet another way to convey diversity, people look different and come in all shapes and colours.

This colourful packaging would stand out from the ordinary Arduino packaging, which are for example either in white and teal or black and lime green. This way would make it clear that this is a product created specifically for Arduino #include, the inclusivity and diversity initiative.

The basic elements of the ordinary packaging are kept to make everything look coherent in the Arduino product line. The front features an illustration of the product, in this case there is only one Clip On piece as the kit will contain several components. Beside the illustration is the official Arduino logo and the name of the product, elements which are found on all other existing packaging. The sides of the packaging, see more on page 160-161, will use the blended coluors already used for Arduino #include. Teal, orange and yellow in a soft mix. Keeping the #include colours and design language as part of the packaging will show a clear connection to the #include initiative.


ARDUINO
CLIP ON
LIGHT KIT



ARTIST COLLABORATIONS

To promote Clip On and reach a wider target group collaborations could be formed with artists. One idea is that the work of these artists address diversity or inclusitity. If the artists also happen to be well known for the potential Arduino customers that would be a nice bonus, as I believe that would work as a selling point for Clip On. By collaborating with external partners Arduino also widens their marketing channels.

Two examples of artists who could be featured are Aurelia Durand, to the top, and Amber Vittoria, to the bottom. Aurelia is a graphic designer who creates art about inclusivity with the focus on people of colour. Amber creates art which portrays abstract women and societal expectations on women.

Special edition Clip On packaging could be produced featuring these artists' art and the work of other potential collaborations. A beautiful packaging made together with a great artist will function as an incentive to keep the packaging box to reuse as storage for the Clip On pieces. Saving the box and reusing it with a purpose is a sustainable alternative compared to buying a brand new storage solution for the electronics. Special edition packaging might additionally nudge customers to buy Clip On just because it is a little more unique than the original packaging.

The next spread shows a mockup of three different Clip On kits. One uses my packaging design, the others feature illustrations by Aurelia Durand (kit to the left in pink and white) and Amber Vittoria (kit to the right in red and yellow).


ARDUINO
CLIP ON
LIGHT KIT
CLIP ON
MOTION KIT


CLIP ON
SOUND KIT
ARDUINO
CLIP ON
LIGHT KIT


ARDUINO
CLIP-ON
LIGHT KIT

LEARNING PLATFORM

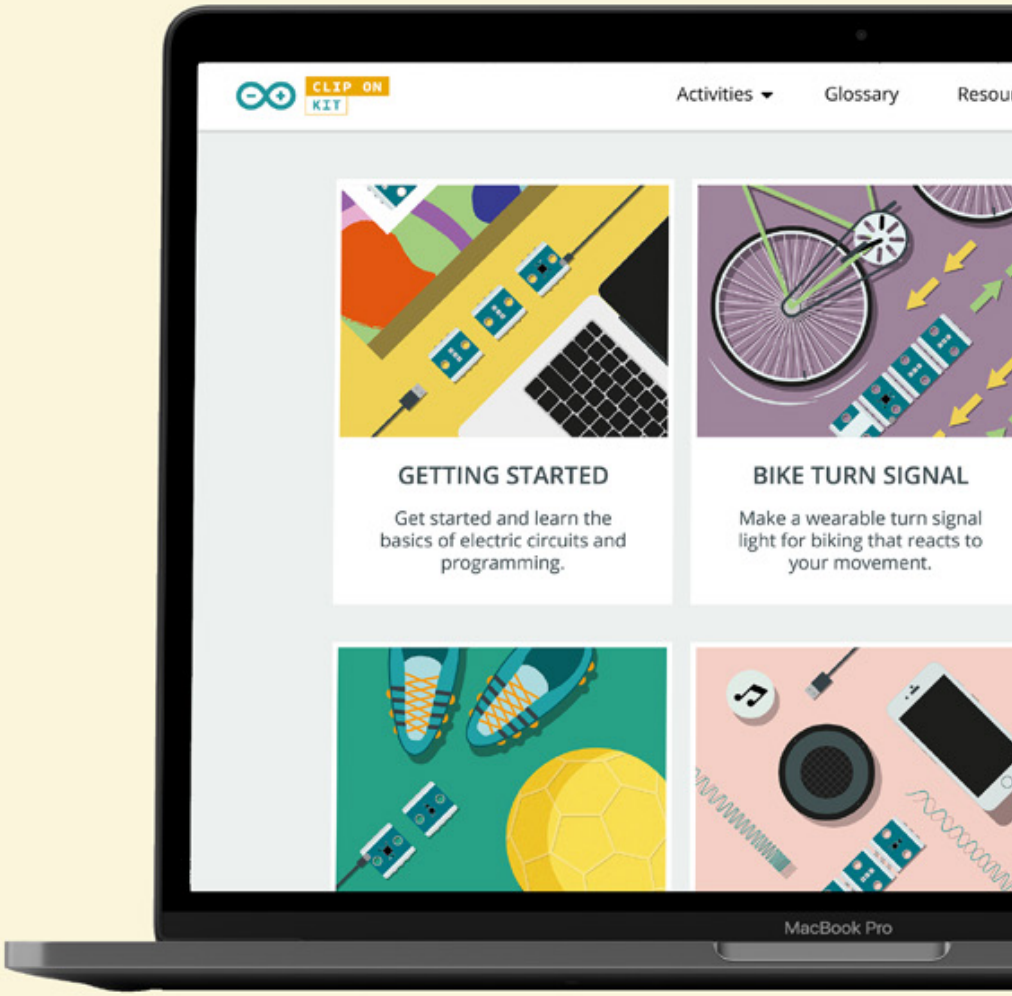
Arduino's product kits come with unique access codes to the online platform, where the customer can set up an account and then find lessons and activities for their electronics. The Clip On kits will follow the same concept and offer online material for getting started with learning STEM and exploring electronics.

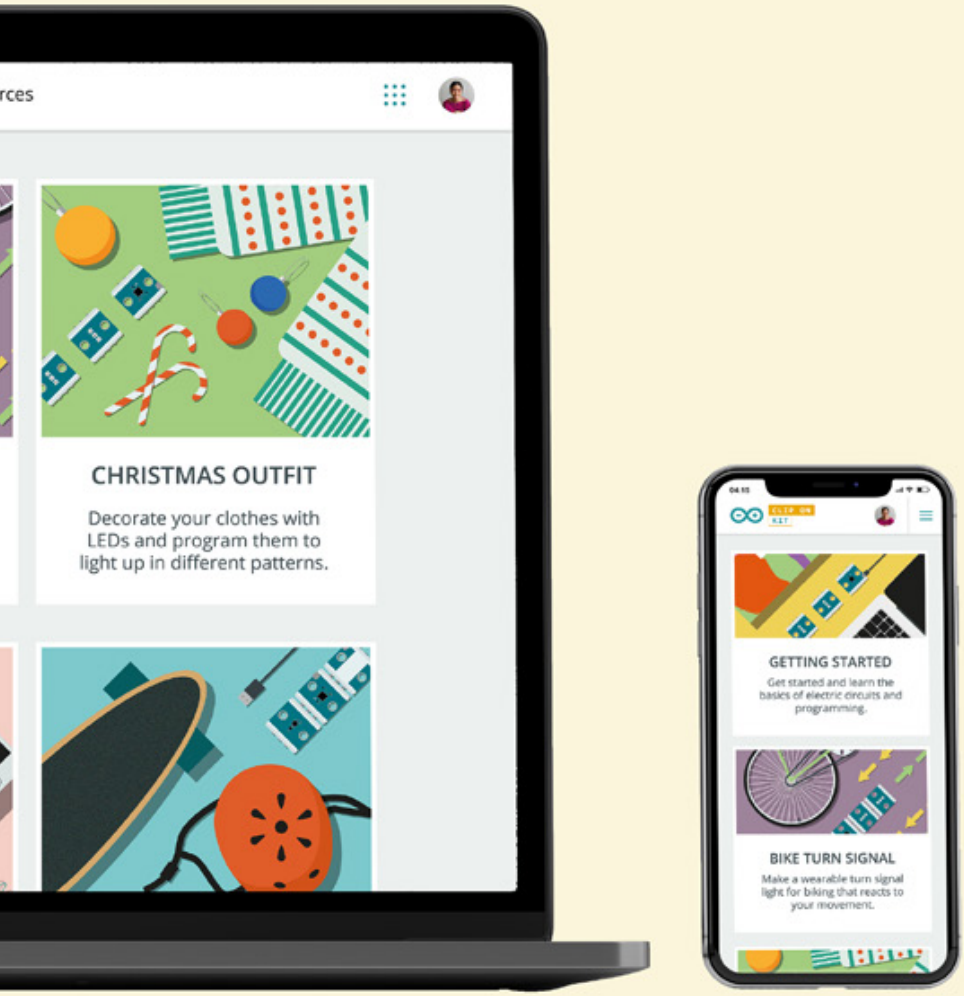
The activities for Clip On will be based on the interest of the target group. Grounded in my conducted survey and interviews I created examples of platform content that is focusing on activities within sports and crafts. The activities will contain instructions of the needed items and Clip On, how to connect the Clip On pieces, a code to copy and upload to the microcontroller Clip On and directions on how to execute the activity.

The learning platform will be available on both web and mobile. Having a mobile friendly online platform is especially important for this specific target group, pre-teens and teens who often prefer their phones before computers. Accessing the Clip On with the microcontroller, which you can program, to edit the code will however require a computer as this is done through a USB cable connection. For future upgrades of the Clip On could use wireless connectivity if this is feasible. If implementing a wireless solution can be done without increasing the price too much it would be a convenient upgrade. A potential wireless connectivity would allow the users to do everything through their phones, including uploading code to the microcontroller Clip On.

Following the design style of Arduino and the existing platforms, the Clip On platform homepage will feature illustrated cover images of the activities. These cover images display illustrated elements of some things that will be used in each activity.

The next spread is a mockup of the Clip On kit's learning platform, web and mobile version. To access the platform content one needs to be logged in.


CLIP ON
KIT
Activities
Glossary
GETTING STARTED
Get started and learn the basics of electric circuits and programming.
BIKE TURN SIGNAL
Make a wearable turn signal light for biking that reacts to your movement.
MacBook Pro


rces
CHRISTMAS OUTFIT
Decorate your clothes with LEDs and program them to light up in different patterns.

GETTING STARTED
Get started and learn the basics of electric circuits and programming.
BIKE TURN SIGNAL
Make a wearable turn signal light for biking that reacts to your movement.

ACTIVITIES AND WEARING

Here I will cover some examples of activities which could be accessed through the online platform. The Clip On could be used for creating a motion activated bike turn signal. Program the microcontroller to light up the LEDs when the accelerometer senses you extending your arm to show you will make a turn. Wear a set of Clip On turn signal lights on either sleeve to head both left and right.

Use Clip On when doing your favorite sports. Perhaps that is longboarding? Program the microcontroller to play a sound on the buzzer piece every time you reach a new highscore speed. Or have it play a sound once you have moved yet another 1 km to see how far you have transported yourself.

Use it when having fun with your friends. Who can do the best handstands for the longest? Wear Clip On and program it to alert you when you are in the perfect upright position.

Make your own wearable projects for every holiday. You can decorate your Christmas outfit using Clip On. Change the colours of the LEDs or make them blink in a festive light pattern. You could even use the buzzer to play a holiday jingle at the same time. Or adorn your Halloween outfits with some cool lights and sound to make the most amazing costume.

The colours of the Clip On should come in a variety as discussed in the earlier Colour Selection chapter. One marketing and sales strategy could be to produce a special colour edition holiday Clip On. These special holiday colours could be collected and exchanged with friends. Pre-teens and teens could put the holiday coloured Clip Ons on their Christmas wishlist and parents could gift these special edition pieces as additions to kits and encourage their children to learn STEM.

Clip On is not limited to being worn on the edges of clothing. Attach the pieces to a slap on bracelet, a strap or anything else that might work for a more versatile wearing experience. Wear your Clip On anywhere you desire.

The official Arduino blog could highlight customer projects which are using the Clip On in interesting ways, they could be called Clip On Hacks. This could be about the way Clip On is attached and worn or the activity one is using it for. Arduino is already featuring a lot of community projects on their blog and social media, and doing so also for Clip On would benefit the overall product image. Bringing visibility to Clip On would be a way to shed light on the product itself, but also on the programme Arduino #include. Showing real life community projects will encourage users to continue making their own wearables with the kits, their fantastic projects might even be featured in the official channels.

Clip On is for all pre-teens and teens who want to explore more of technology or STEM. Wear them on your clothes to inspire the friends around you. Use them together and exchange Clip On colours and components with each other to make new fun projects and learn STEM together.

Hopefully this is a small step along the way to encourage more young girls to pursue technology.

PROJECT REFLECTION

You finally reached the end of it (almost). In this last bit of text I will look back at my project. By the time this is written I have already made it through the official presentation of this thesis.

As a woman myself I was aware of how easy it would be to accidentally start making assumptions at the start of this project. My target group was young girls, and even though I would not define myself as a young girl today, I have also been a young girl age 11-16 earlier in my life. Therefore the research part of this project was very important to me. The data gathered from the survey and the interviews served as the core of this project. If it was not for the fact that this was conducted in the middle of a pandemic, when people are recommended not to meet, I would have liked to focus even more on the target group interviews and conduct more interviews in group settings or reach out to strangers at places in real life.

I admit I got a bit stuck in my creative process when I was sketching ideas and making prototypes, as it felt like everything had been done already (it's not the first time I got this feeling when designing). Although the prototyping stage was a lot of fun, I became so fascinated with e-textiles and soft circuits. If I were to redo this project I would return to the prototyping stage and challenge myself even more with creating a new product design. Perhaps it was possible to make a soft wearable, which would also be durable and low in price. If I were to explore this area again I would try to get my hands on real life soft circuits, take these apart and examine how it all goes together and functions. This would give me a greater understanding of the technology and possibilities.

Although I still believe the final product design fits well into the existing product lines at Arduino. The hard PCB and visible electronics convey the same form language as the other microcontroller boards.

As the final Clip On design was never really prototyped and tested this project is lacking the aspect of how a user would interact with it. Conducting a user test with functioning prototypes that represent the final design could potentially bring attention to what needs to be

changed. During the final presentation of this project I was asked if the sharp edges of the Clip On Components could be an issue. For the moment I do not believe the edges will cause any problems, as all other Arduino boards I have held in my hands also have straight sharp edges without feeling like they will cut me. But how design aspects like these edges would function in real life is hard to give a definite answer to without a proper prototype and user testing.

Another aspect which was questioned was the fact that the electronics on the PCB are completely in the open. There is nothing covering them. This was an aspect I thought of already when prototyping. Back then I wondered how some concepts would perform when it came to insulation. There is a larger risk of short circuiting electronics which are not properly insulated. That risk does exist in my design as the small places where the electronics are soldered onto the PCB will not be insulated. The magnetic connectors on the sides of the Clip On are not insulated either and will remain exposed during use. I abandoned the idea of Clip On covers due to the cost and extra production step. But if I were to continue this project I would explore more regarding covers. It would be a way to provide insulation and change the outer appearance of the Clip On in terms of colour, perhaps those properties are worth the cost. At the same time I really like the looks of the exposed electronics as you can see what the Clip On is made of and how it all connects. Hands-on experience and visuals are important when it comes to learning new things, such as STEM.

The most exciting part of this project has been the design research and designing all the graphic elements. The illustrated portraits for all people I interviewed were enjoyable to make, and as fun to share afterwards with the interviewee. I am really satisfied with the outcome of the packaging design, colour ideas and symbolism and the concept of artist collaborations. I have realised the past year that I really enjoy designing with the people in focus and embedd som symbolism in the design choices. I hope to continue with this and create more meaningful designs in the future.

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The Arduino official logo and #include logo are retrieved from the company's design recources.

The little icons used on page 16, 19, 23, 31, 34, 45, 62, 66, 82, 96 , 102 and 176 are designed for Arduino by Fabio Ferrero.

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