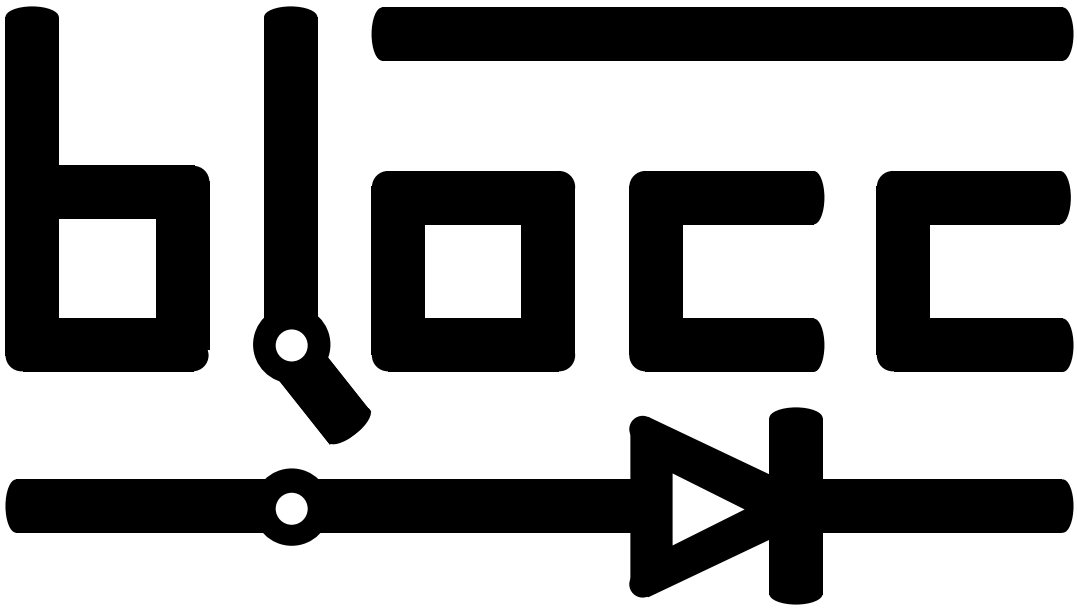

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Squad: Playful Learning

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Abstract

For the last semester, we have been working on a project in the theme of playful learning. Technology keeps popping up with different implementations all around us, making it more and more important that there are people who know their way around electronics and know how to maintain them. Having all kinds of electronic devices is nice, but without the basics of knowing how to work with and how to fix them, they can be short lasting luxuries.

With the resource shortage we see that nowadays, products are designed to be repaired. Therefore, we consider it important for the users willing to understand the hardware they make use of every day. And with the understanding of hardware, these user will be able to make repairs themselves and thereby repair their own products and those of others instead of replacing them.

As learning is easier when you are younger, we are focusing on children. Existing electronics kits and basic programming software are either too hard for children and beginners to understand or limited and non-intuitive. This being the case, we are dedicated to design a product where the user will learn by doing and by engaging with the product, with the intension to educate them in regard of general electronics and to inspire them in the future.

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Summary

With the digital age we are in with electronics everywhere, learning about electronics and coding seems like an absolute necessity for everyone in the future. As learning goes best at a young age, we are designing a product where the user will be introduced to several sensors and actuators found in modern circuitry. The user will learn by doing and by engaging with these parts, with the intension to educate them in regard of general electronics and to inspire them in the future.

Nowadays, there are already products with a similar concept on the market. However, these tend to be limited or non-intuitive, focusing on either circuitry or coding but never both. They cover a rather small aspect in a way that over a longer period, bores the user.

In conversion with experts, we produced a prototype which will introduce children to circuitry and coding in the way mentioned before. The prototype allows the user to build their own circuits using specific modules and wires. The circuits can range in complexity from a simple lamp turning on to a game controller. The circuit is linked to a computer on which the user uses block coding to send inputs to and receive outputs from the circuit.

When the user has built a game controller for instance, they can select a game, made by other users on an open source platform, to play on the laptop with the controller, giving them a direct and mostly fun way of knowing if their circuit works.

Project Goal

For this project, our objective is to introduce the user of our product to circuit building and programming with the intended goal to teach them more about technology in general. We have done so by creating a physical-digital hybrid learning module. With the physical product, the user is able to build circuits, and with the digital product, the user is able to assemble their own programs which will be able to receive inputs of the circuit the user built themselves. The user will learn by doing and by engaging with the product, we intend to educate and inspire them.

Our target user group are primary school children, aged 10-12. We chose this target audience, because we felt like this is an appropriate age to start learning about this complex subject. After conversing with primary school teachers about our chosen age group and objective, they agreed that it was appropriate.

We intended to make the design approachable for all children, even those who don't have an interest in technology themselves. We therefor simplify it and ask for professional insight of teachers and caregivers to determine how to enhance its approachability. The exact extend to which we simplify the circuit-building part will be investigated further as well.

At the end of this project, we wanted to have produced and tested a digital and physical product. The digital component, the programming part, should be able to work alongside the physical component, the circuit building, with both of them interacting.

Also we wanted to have several digital outputs for the circuits to demonstrate what you will be working towards as a student.

Research

In this section, we will cover our findings from different areas of research which were used in the development of Blocc.

Theoretical Research

There are two main aspects in this project which we wanted to research before starting with the rest of the project. First, we wanted to research playful learning, especially what it entails and in what ways it might help people. The other aspect we wanted to research was the relevance of tech. We felt like technology was growing more and more important in our everyday lives, but we do want to find out whether this is the case or not.

Playful Learning

As we are in the playful learning squad, we first want to define playful learning. This soon turned out to be not as straightforward as we might have thought.

"Learning depends on the child's engagement in planning their own course of action based on their understanding and being able to follow through and make comparisons between their expectations and their observations of real-world manifestations thereof" (S. T. Baker et al., 2021, p2). Developmental psychology describes learning as an active process. According to Daniel Reisberg (Wilson & Keil, 2001), learning "can be understood as a change in an organism's capacities or behaviour brought about by experience." The Oxford Companion to Philosophy defines it as "the acquisition of a form of knowledge or ability through the use of experience."

Now that we have a definition of learning, we looked at part of playful learning that covers play; According to E. M. Murtagh et al. (2022) it is quite challenging to compare their work to other studies, as there are various ways in which "play-based learning" is defined in literature and operationalized in practice. "Play is an extremely difficult phenomenon to define and, perhaps because of its essential spontaneity and unpredictability, has presented significant challenges to researches" (David Whitebread et al., 2009). Zosh et al. (2018) proposed a definition of play that creates a spectrum ranging from free play (no guidance or support) to guided play and games (including purposeful adult support while maintaining playful elements.

This leads to the following question: In what ways can play support learning?

Playful approaches can be an effective way for educators to support young children's learning and skill development (Sylva et al., 1976; White and Carlson, 2016). According to S. T. Baker et al., playful learning makes space for children to engage with their learning trough question-asking, exploration, curiosity, persistence, engagement in discussion and sharing interests between the classroom and the real world (2021). They emphasize they use 'makes space' as it is not the provision of the activity itselthatf that exercises the psychological mechanism for learning. Rather, it is the way the child engages with their learning that matters. What is important, according to both Bustamante et al. (2020) and Habgood and Ainsworth (2011), is the guided interactions with the teacher or caregiver during the learning process to bring about learning. Zosh et al. contend that guided play achieves best academic outcomes because it harnesses the features of an optimal learning environment as well as joy (positive affect) and iteration "more so than any other types of play" (Zosh et al., 2018, p4).

The main points we take from this is that it is of importance to us to keep in mind that we only provide the tools for education, meaning that the children still have to do their 'learning' themselves. We will also have to consider the teachers or caregiver in our design process, as they play a key feature in the learning process.

There is an overall conclusion that learning through play seems to be beneficial in development of skills, creative thinking and overall understanding of a subject. However, due to this spectrum in the definition of play, the exact way in which we will apply this principle remains open to our own interpretation. During our process, we will therefore stay in contact with educational professionals to receive feedback and further investigate our options.

A lot of research regarding playful learning focused on younger aged children. This led to the question whether older children of primary school age would also benefit to this approach to education. "Much of the research thus far has focused on early childhood setting, this paper therefore augments the body of evidence regarding the association between play and academic achievement in the primary school setting" (Elaine M. Murtagh et al. 2022). The study argues that a lot of research regarding this subject that has been conducted is based on children in their very early childhood and aims to shine this subject in a different setting. The conclusion of this study, a study focusing on a playful approach to math in primary school children, is that there seems to be a link between play-based learning approaches and academic achievement (Elaine M. Murtagh et al. 2022).

Based on this research, we will be able to use this playful education style with our chosen age group. The study does however emphasize that a controlled trial or pragmatic evaluation is warranted to confirm effectiveness of the program.

Importance of technology

The next thing for us to research is the importance of technology in our everyday lives.

One of the first sources we came across was OurWorldInData.org/technology-adoption. Hannah Ritchie and Max Roser have combined data regarding the distribution and adoption of technologies from a large number of sources in several clear graphs.

The graph above displays the rates of diffusion and adoption of a range of technologies in the United States, measured as the percentage of US households with access or adoption over time. This graph displays a growing share of households using specific technologies. This growth is quite strong for may of the specific technologies.

As this source suggests, technology has gained a huge share in US households over the last years. This source does not confirm the importance of technology. However, we would argue that technology is increasingly important over the past years, as it gained such a share, and would argue that there are no immediate signs of this share of technology dropping.

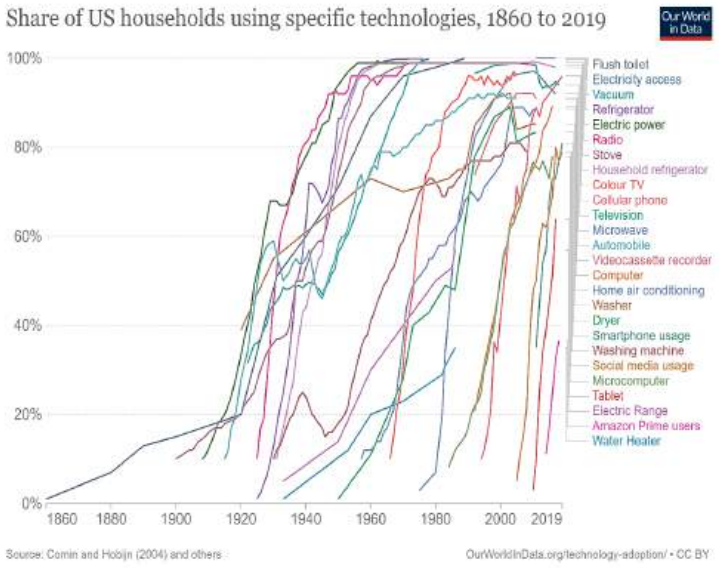


Figure 1: Graph distribution of technology adaptation in US households 19. (Ritchie, H. (2017, October 2)).

Market Research

Circuitry

After realizing we had to conduct research to which products were already on the market we started research on products bearing the same concept as our product. In this research we focused on both the method of teaching or familiarizing, and the complexity of the circuits linked to the freedom in exploring circuitry.

Snap circuits®

The Snap Circuits arcade offers plenty space for exploration, having a breadboard layout on which components can be placed. The components can be connected by both rigid and moveable wires. The design uses bright colors indicating the type of components which are exposed on top of the plastic together with their schematic appearance. Giving it a professional impression.

Figure 2: Snap circuits®.

Circuit maze™

Circuit Maze is a puzzle game where the player makes circuits to turn on several LED's. They make use of a grid to place components and wires on which are all the same size. The puzzles are motivating for the player to continue playing. The wiring of the LED's is hidden in the bricks giving a clean minimalistic look.

Figure 3: Circuit maze™.

LogiBlocs

The Logiblocs Smart Circuit kit allows the user to create electrical circuits by connecting blocks to each other. The blocks are brightly colored to indicate their function, also they are transparent revealing the circuitry underneath giving it a visualization of the technology inside the components. Using the blocks allows the user to create toys on conductivity and audio recording and

Figure 4: LogiBlocs.

Animate

The Animate cardboard electronics kit allows the user to create their own circuits which they can integrate in projects. The idea of the product is to give the user as much freedom as possible allowing great exploration. The electronics are pre-programmed making it more accessible for younger users or users which have no coding experience.

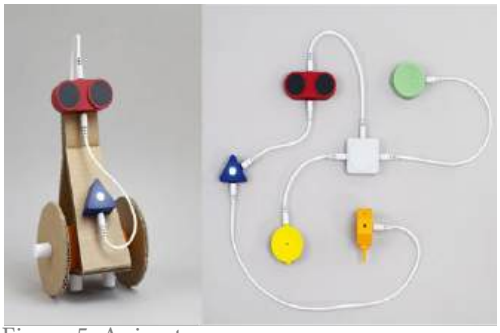


Figure 5: Animate.

Electronics Playground™

The Electronics Playround kit offers a broad amount of electrical components up with several complex components. The board is also equipped to work with several outputs. It offers a great base to explore circuitry on on a higher level.

Figure 6: Electronics Playground™.

Programming

As coding will be part of our product and teaching experience, we researched existing services breaking coding down to an easier, more accessible level. One of the first ways to achieve this, was by using block coding. Block coding is a coding environment where the user is able to write code by dragging and dropping blocks of code. The blocks often have a certain shape to make it clear for the user which coding lines work together. When a piece is able to follow up another piece of code where the syntax of the resulting code is correct, it will fit in or next to the other piece. This makes starting to learn programming very accessible. This approach to coding can be seen in quite a lot of programming environments focusing on teaching coding. Two very well-known examples are Scratch and ArduBlock.

Scratch

Scratch is a software designed for users new to coding, it presents it in coding in a form of puzzling where the user can create both animations and games in a digital environment. There are almost endless possibilities in scratch, at least digital that is. Furthermore, it is regarded by teachers and reviewers as easy to use and learn with.

Figure 7: Scratch.

ArduBlock

ArduBlock is the block coding interface for working with Arduino. It provides a simplified version of coding in a digital environment with the possibility to expand to a digital environment. It is built for people with novice experience in coding language, since the blocks don't really have understandable language on them. Instead they have the coding language, but written on the blocks.

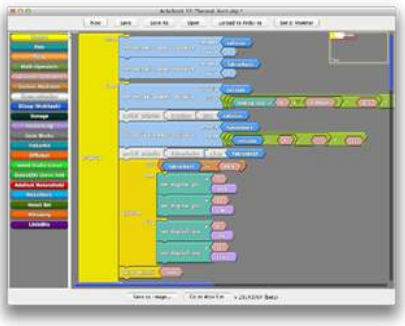


Figure 8: ArduBlock.

Both types of software have their benefits. Scratch works well, being easy to use, with lots of possibilities, while ArduBlock can communicate with hardware. A combination of these two programs would thus lead to the best program for our application.

Business Research

For the business aspect we used our knowledge from Business Design to create a business model canvas, which can be found in the third appendix.

The business model canvas is used as a tool to help visualize what is important when putting a product or service on the market. It forces the person or group who makes it to focus on what the key areas are for the business plan and what the relationships with the customers are going to look like. In short, the business model canvas is a big canvas with multiple blocks in it which cover and represent necessary thinking steps for a product to thrive on the market.

While defining our customers, the business model canvas made us realize that our customers differ from our target group. This is because our target group consists of children between the age of 10 to 12 years. And apart from the target group, our direct customers are primary school teachers or primary schools in general.

The main business concept is that our customers can either buy or lease our product in large amounts via our website. The website includes general information about our product and a video that explains what our product is about, it also highlights our vision and how the product works in its context. We maintain an indirect relationship with our customer via the website, since this is self-service. Furthermore, parts of the product will be able as open-source which allows users to tweak designs to their needs. This will be unlocked after a purchase by of one of the two payment methods. The open-source part, which will work via the website, will give the user the possibly to help design new components for the extension of the component collection. The option to buy the product is available for everyone. However, the option to lease the product in large amounts is meant for the primary schools, so they are able to have our product with the learning module. The learning module will provide the children with a self-directed learning experience.

We will work together with electronic supply shops and 3D-printing firms for the production. Furthermore, we will collaborate with existing delivery services for the delivery of our products. Lastly, if this business grows to a higher level in the future, we could do collaborations with toy selling brands and educational brands or become their key partners.

Process and Iterations

In this section, we will describe our design process. It will include original thought processes, sketches, prototypes and our design choices.

Our process started with a brainstorm session. In this session we communicated everyone's interests and started making a list which contained target groups, everyday problems we faced and personal interests. The main goal of computing this list was to get everybody to start thinking about the project and possibilities coming with it. After the session, the idea of teaching children about electronics and programming turned out to be a major favorite.

First sketches

To follow up on this idea, we agreed to start making sketches and concepts of what we thought our product might look like. One of the images that stood out was the idea of a chessboard on which individual components would stack on a grid like surface, an idea that comes back later.

From these sketches we quickly realized that there were a lot of options in regards of what kinds of product we could produce. We did learn that most of us were interested in a product that is a physical digital hybrid where inputs on a modular physical circuit would be able to communicate with an educational programming software.

Also, we realized that apart from these sketches, we would have to conduct research into our problem statement to build a legitimate case as to what goal we could contribute to. We also started to research into other product which were already on the market.

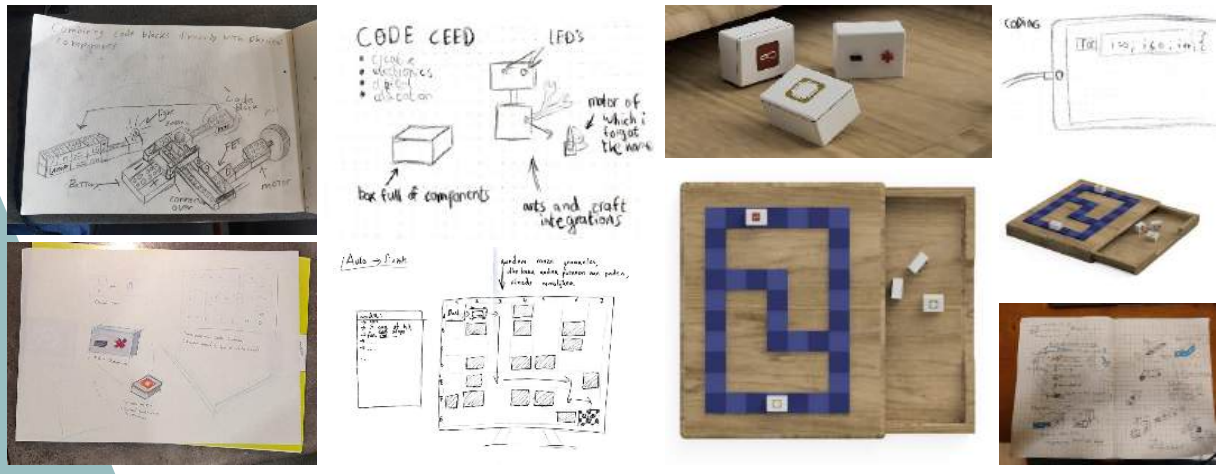


Figure 9 to 17: The sketches and conceptual renders made to illustrate how we saw our product take shape.

Prototyping workshop

After discussing our ideas, we started prototyping. We agreed that during our project we wanted to interview (educational) professionals to receive feedback on our own prototype iterations and other products which were already on the market. This would steer us during the process of making our project.

After a quick and dirty prototyping workshop, we ended up with some useful results which made us think in regards of how we could connect individual components in a safe way.

Figure 18: The prototyping workshop.

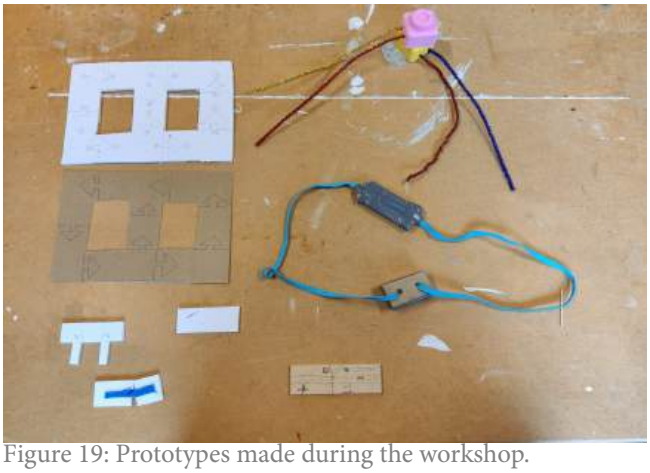


Figure 19: Prototypes made during the workshop.

Lo-Fi prototyping

This is where our first prototypes came in. We agreed that there were four global structures of how our product could work.

Grid

The grid layout is the most simplified version of creating circuits. Introducing circuitry as a type of puzzle whilst still being able to explore up to some complexity. However with the grid style you are bound to a specific shape.

Blocks

The blocks style removes the standard grid and allows for more exploration and more complexity. The wiring in this style will still be done by placing similar blocks after each other like in Circuit Maze.

Wired blocks

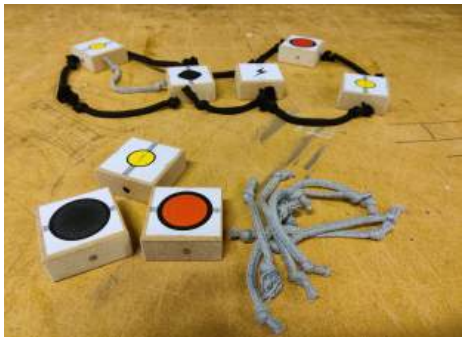
The wired blocks version is very similar to the blocks version, however here all the wire blocks are replaced by actual wires. This allows for more space efficient circuitry and so a higher level of complexity. The wiring also allows the user to integrate their circuitry into weirdly shaped objects like in Animate.

Fully wired

The fully wired version will fully expose electrical components as done in Electronic Playground and Snap Circuits. Giving a advanced and professional experience. This version can either be used as the Wired Blocks version with exposed circuitry or as the grid version in a breadboard like platform.

To receive feedback from a professional, we wanted to make a prototype with which we could convey all these different ideas. This is when we developed our wooden prototype, a chess board with loose blocks. This allows us to convey all our ideas to a professional.

To do so, we set up an interview in which we would be able to receive feedback on existing products, as well as on our prototype, with the aim to get a sense of direction in regards to which of our ideas would be best, if any were good at all. For this we approached different primary school teachers and PABO students and teachers.



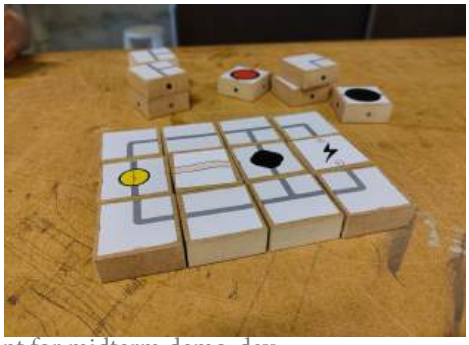


Figure 20 to 22: The wooden prototypes meant for midterm demo-day.

Midterm demo-day

After our first interview with a PABO student, we decided that for the mid-term demo day our prototype would be based on the loose blocks which were magnetically connected to each other. Next to this prototype we would also present our wooden prototype together lo-fi prototype of our digital environment and a prototype in which you could play a game with a soldered controller, allowing the user to experience the digital aspect of our product. The reason we did this was to receive feedback on all the parts of our project.

After midterm demo-day we increased our N-value which at that time was 1. We conducted several interviews with both parents and one with Rong-Hao Liang. All the interviews together gave us an N-value of 13.

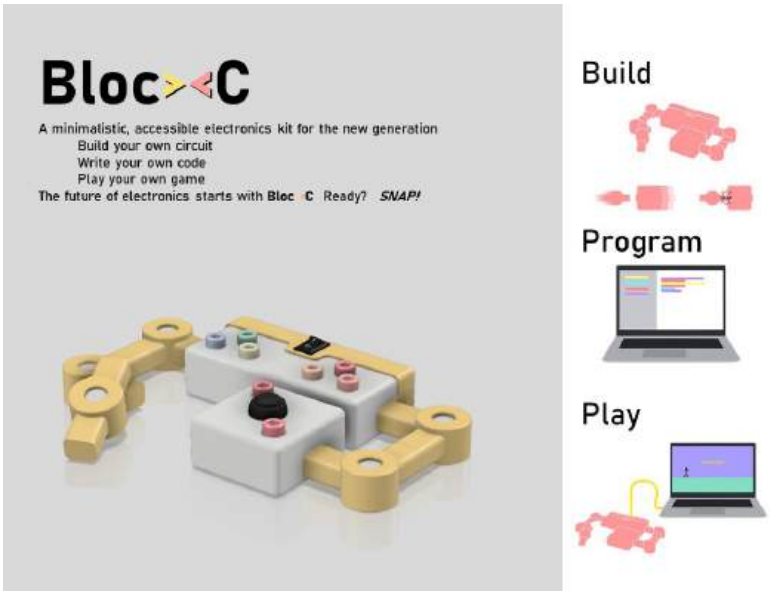


Figure 23: The midterm demo-day poster.

Figure 24: Our stand at midterm demo-day.

Rehaul

With more interviews conducted, we continued the project with a new vision. We wanted the learning process to be gradual and rewarding. To do so we started designing several new games which would be playable with self-made circuits. To help children get to the point on which they were able to create the necessary circuits themselves, we started the creation of a learning module and a component manual which students and teachers could use.

It also became clear to us that the blocks representing the wires were both confusing and made the product seem inaccessible. Because of this we decided to rid ourselves of the blocks and use actual wires. We did this to make our product more accessible, create the feeling of building an actual circuit and to add a playful element of plugging wires in to and out of the modules.

As a result of the changes we had to make and the new aspects of the product we had to include, we decided to rebrand ourselves with a new color palette and design structure. Wanting to make our products seem approachable and gender neutral we made several moldboards illustrating masculine; feminine and gender-neutral designs. After evaluating these mood boards we made our palette consisting of pastel colors mostly found on wooden toys meant for children and decided that our designs had to be round edged and fresh.

Figure 25 to 28: The moodboards and the new colour palette.

Redesigning modules

With a new list of components to implement which were based on the interview results, and a clear view on what our product should look like we started sketching again. While sketching we concluded that both the color and shape of the modules had to be representing the modules function. We did this to make the products more accessible and more interesting to play with. Also, the shape would help the children to better understand the function of the module by shapes they already recognize.

We started designing the modules to be coherent and as we mentioned, self-explanatory. After completing the designs and deciding we wanted to go further with this style, we started working on the interior of the modules. As we want to have people repair their own electronics, we added the possibility to replace every single component in a module, requiring them to be easy to disassemble and reassemble.

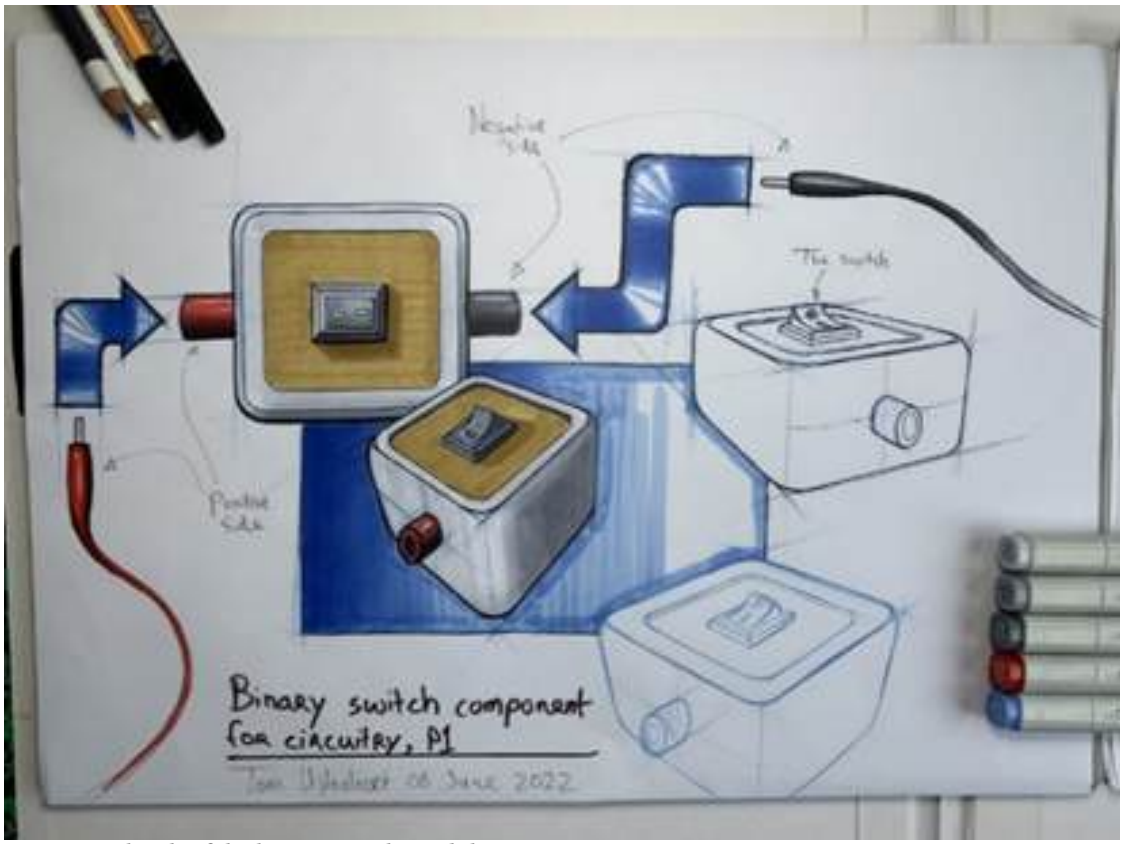


Figure 29: Sketch of the binary switch module.

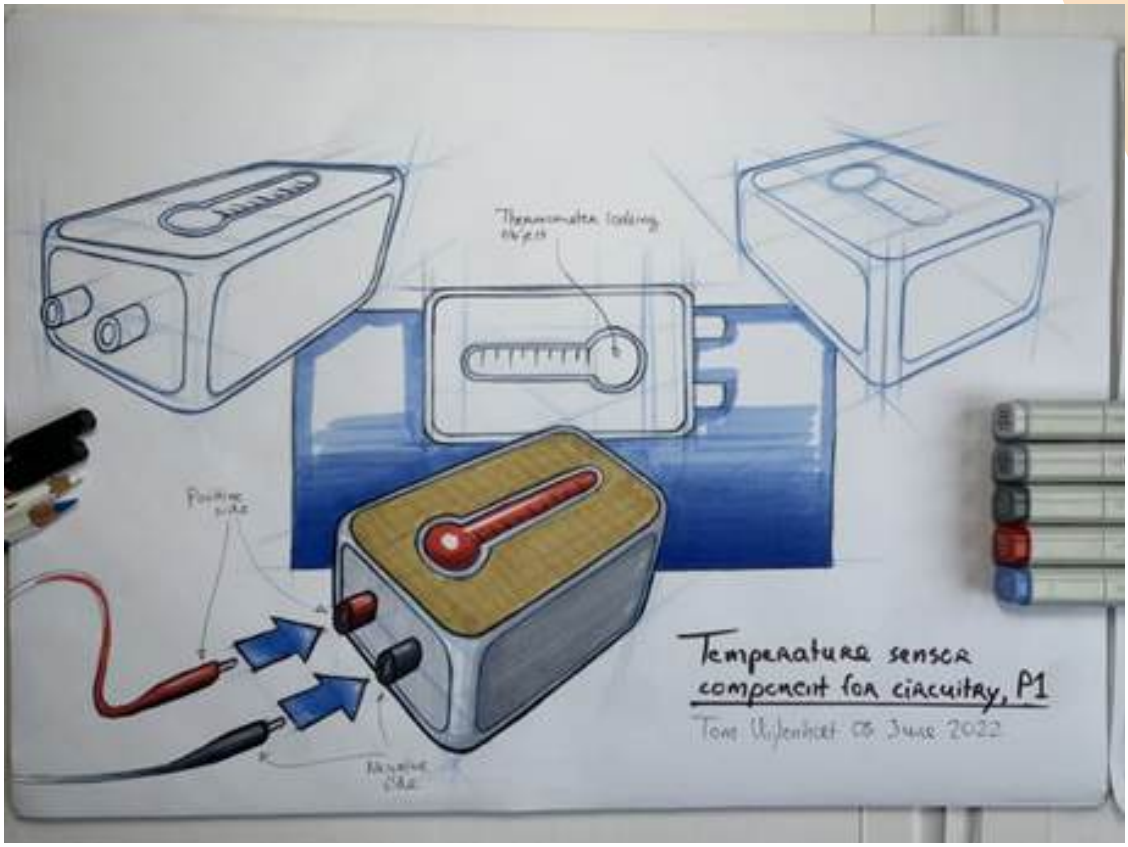


Figure 30: Sketch of the temperature sensor module.

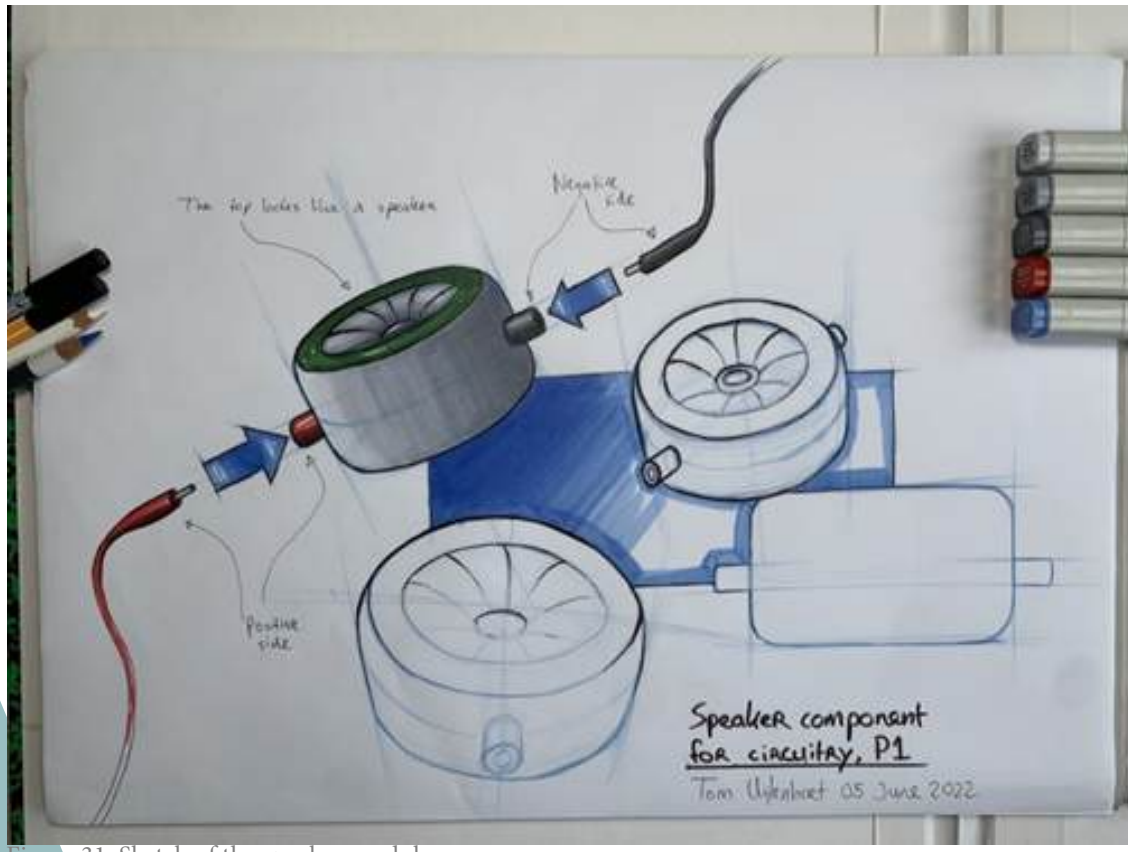


Figure 31: Sketch of the speaker module.

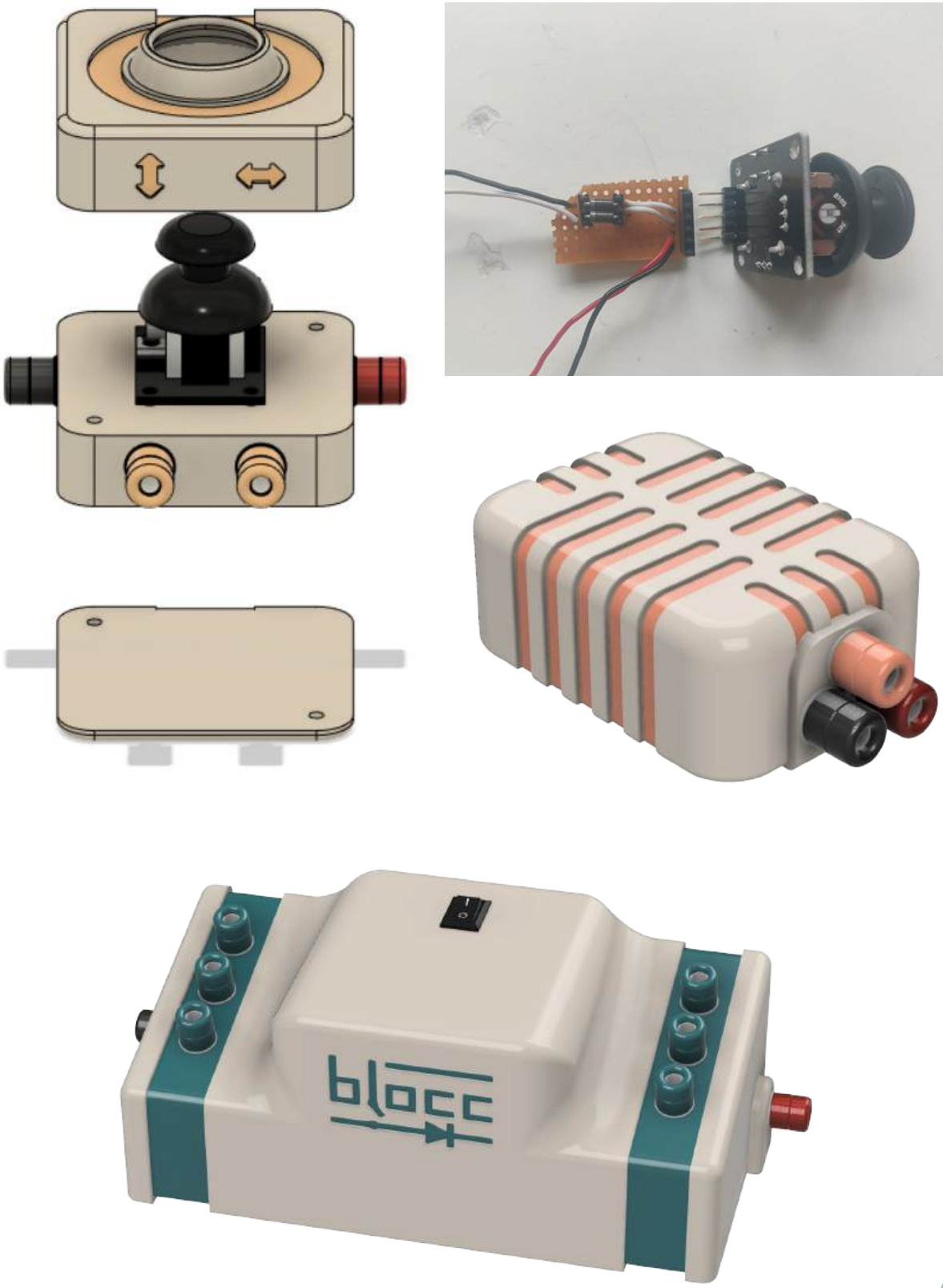
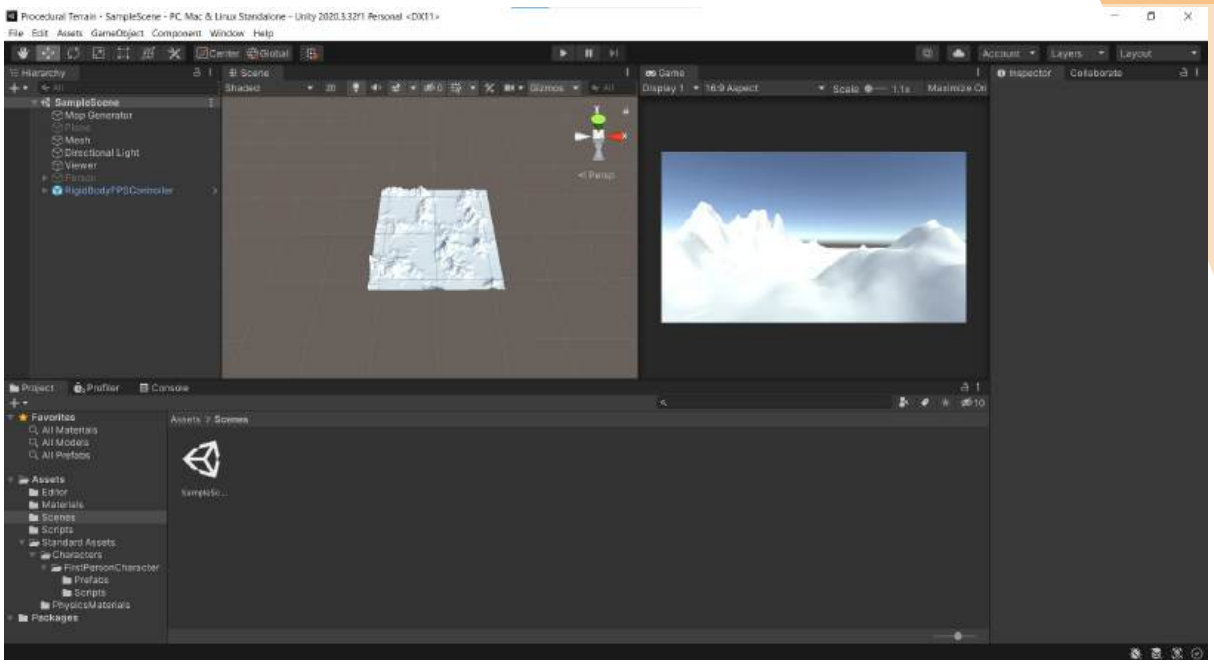


Figure 32 to 35,: the new generation of modules, these modules express their purpose and all components are individually replacable.



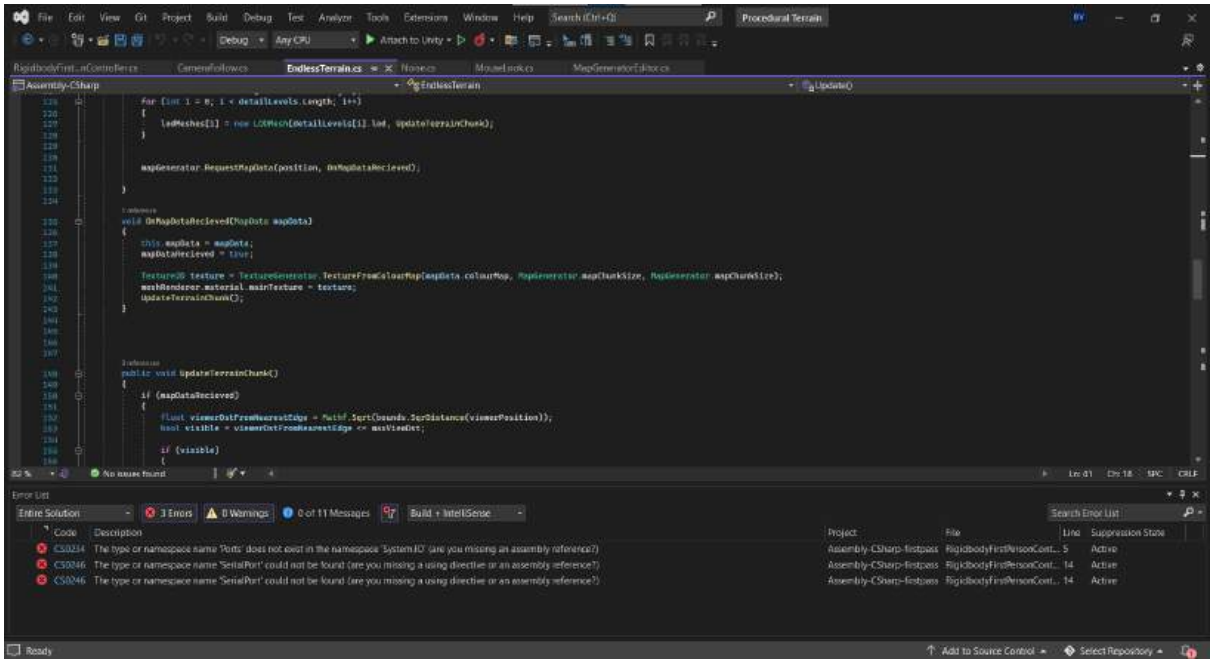


Figure 36 and 37: The creation of the new games.

For the development of the games we first did some research as to what sources we could use in the development of the games. We had no significant prior experience in game design, but as we were planning on developing our own games, we relied a lot on these sources.

On looking for sources, we came across two very useful YouTube channels. The first being Impheza (1111, November 11) a channel dedicated to basic game design and 3D modeling. One of the tutorials on the channel covers a step by step tutorial for the development of a Low Polygon Type racing game. This game would fit with our product, as it would be easy to implement basic controls with Arduino and the overall aesthetic fit our vision.

Development of this game went smoothly, largely thanks to the amount of information which could be found on the channel mentioned above. When the basic game was done, it was time to implement the Arduino code with the game. We wrote an easy code to print the readouts of the components and using another tutorial by the YouTube channel Comet's VR (2020, 12 november), in which a serial connection between Unity and Arduino is established, we were able to finish our first game.

The second game would be more complicated, as a reflection of the higher difficulty of the lesson associated with this game. We stumbled upon a YouTube channel named Sebastian Lague (n.d.), in which the producer tries to realize programming and game developing ideas he has. The video's range from basic visualizations of how a computer works to Procedural Terrain Generation, the latter of which we were interested in.
Having a player roam a procedural terrain means that there are no boundaries as to where the player would like to go, as new terrain will always be generated around the player. This would be a more complex game to develop, but by consulting the video's on the channel, we were able to develop the games. Just like the previous game, we would have to change the control input from basic mouse and keyboard controls which are covered by the original tutorials by our own Arduino implementation.

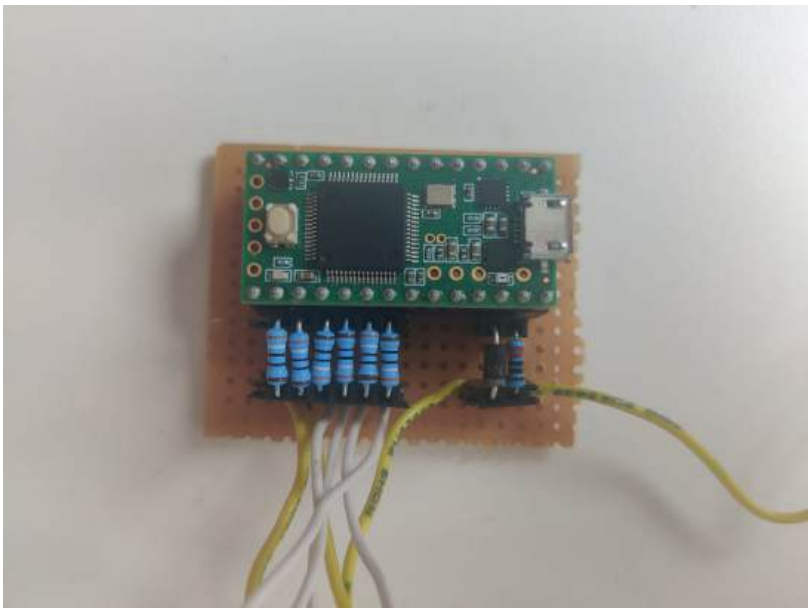
After this, the only task was to combine both projects in one file, allowing the user to switch seamlessly between both games and the code to run the different circuit.

Safety Measures

As the physical product of Blocc works on electricity, we need to make sure it is safe to engage with by the user. We do this by working with a voltage of 3.3V and an by having an amperage not exceeding 250mA.

All the components have diodes in them, these ensure current is only allowed to flow in one direction no matter how the component is plugged in. Also several components contain resistor, these are there to protect the PCB's and extend the products lifespan.

The resistors next to the microcontroller inside the hub were adjusted to the maximum current input/output of the positive and signal ports. The maximum current on a teensy 3.2 input pin is 9mA. Since it runs on 3.3 volts, the resistor needed to be at least (3.30 V)/(0.00900 A)= 370 Ω. The first resistor in the E12 resistors above this resistance is 390 ohms, so these were used between the input pins and the cables.



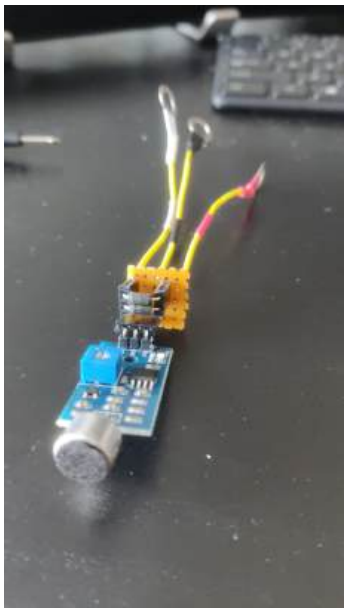


Figure 33 and 39: The improved interior of the modules.

Interviews

Interview setup

We found user research to have an important part in how a product should function. Therefore, we wanted a lot of interviews throughout the prototyping stage to inform our decisions.

Since interviews on children are both hard to conduct as well as hard to get through the ethics committee, we opted for people who work closely with children instead. This led us to thinking of primary school teachers and PABO students, who are either educated to know children and how they work or are learning this.

After finding a group to interview, the guidelines of the interview needed to be written. We opted for an open interview since we planned to interview a few teachers, and this would lead us more to their opinions on which they already have existing knowledge and/or practical experience.

Our interview should of course start with an introduction of ourselves and the product we want to make. We will then show a few pictures of various products on the market, as well as our prototypes, and gauge their opinion on approachability and what children would like and dislike about them. In this the specific design features seen in the product will be mentioned to make it clear what kind of information we are looking for.

For the question about our prototypes, it was most important to find out which one would be the most promising to reiterate further upon. This is done by asking questions about a few different aspects:

- How intuitive should our final product be?

- At what point is our product durable enough?

- Will anything get lost and how do we prevent it?

- Is it self-explanatory how it works?

Our written guideline for the interview can be found in the appendix.

The first interview

The first interview was the only interview conducted before midterm demo-day. It was conducted together with a PABO student from the HAN in the Netherlands.

The coloring on Snap Circuits is very interesting, making it more approachable. In general, it is confusing but with proper instruction it seems usable. The LED screen could be interesting to the users.

An execution like in Circuit Maze seems too simple for the user, making them lose interest over time. The coloring is nice, and it is esthetically pleasing.

Revealing the circuitry adds interest for the product. Also, the use of speakers and microphones seems very interesting to children.

Using preprogrammed sensors seems great for a workshop but will not keep children interested for too long.

Exposing the electronics creates interest for the product. The complexity is great for students who participate in special projects. The wires will probably get lost or break after a while.

The use of schematic like drawings for the components seems nice as it introduces the user to higher level schematics and forms a professional trait.

After discussion, the following components were recommended to make use of:
- LED screens
- LED lights
- Microphones
- Speakers
- Buttons

Out of the review session of our prototypes came that we could best go with a hybrid between the block and wired version. Where we will make least use of wires to make them more unique, creating a sense of value and to keep the product from becoming too complicated. The blocks version is most similar to real circuit making whilst keeping things straight forward enough. The grid version seemed too simple and limited.

Later interviews

After conducting more interviews we had an N-value of 13. Here we will describe the main findings from these interviews.

In the interview, we directly asked them feedback on what they liked and what they disliked about the products that already exists on the market.

Starting with the feedback given on the first product called Snap circuits®, the product seemed too chaotic for children. Also the breadboard made the product seem limiting and the combination of wires and wire blocks caused confusion. The coloring in the product added some sense of structure. Although limited by the breadboard the product featured interesting outputs such as a clock and an LCD screen.

The second product, Circuit Maze, was esthetically nice. The color palette made the product seem very professional. The game was less challenging as it was an adaptation of a puzzle solving game. The puzzles make the product approachable and motivating, however you will not learn that much about circuitry.

The LogiBlocs kit brought mixed feelings, whereas some interviewees thought this product added a lot of freedom with the modular blocks; Others thought it was too limiting as there were so many amount of ports. The coloring added to the experience as it categorized the products. Also, the product did not match our target group as it was too simplistic.

Animate received most positive feedback on aesthetics, the shapes resembled purpose and the wires added structure. The fact that the user would build its own creation with cardboard and these blocks was very well received. However the product limited imagination as all the components were pre-programmed. Few interviewees mentioned that the cardboard made the product seem rickety.

The circuit-lab does offer a lot in a nice, colour coded manner. This product however is a bad tool to introduce children to coding with. The product was too overwhelming, it was in an educative setting, which could be holding children back when engaging with the product. The product seemed very accessible to parents and teacher as it is designed in a similar style as toys from the past.
On coding, it was mutually agreed that Scratch was better for our purposes. However, the colouring in Scratch was still slightly confusing and the general layout was confusing.

We also conducted a later interview with a teacher. This open interview mostly led us to discuss diverse ways of learning. To make children interested in learning, they adopted an inquiry learning method, which includes asking questions and trying to let the children solve the problems themselves. If they are not able to understand, scaffolding is used to make the question gradually easier. Some children, however, cannot work with this and would rather work with a recipe method, giving them all the information they need so they can do the exercise. Other options are to frame the exercise within a house for example. Make a lighting system within a house or design a game controller. But elementary school is not only to learn hard skills, but also to learn basic skills like reasoning. This is also something to think about in a learning module. Regarding our primary product, the blocks using wires were seen as the best option, with similar reasoning to the parents. The color palette also should strive for a gender neutral appearance. From our interviews, we decided to change our direction in several ways.

Firstly, many noted that without working with real wires children would feel like they would not be working with electronics. Using real wires instead of blocks would also make sure children would not just think inside the box they are given with a board, but they are given freedom to explore and get more creative, since this boundary is taken away when using real wires.

Furthermore, we decided to rehaul our palette and the way our products would look.

Results

At the end of this project, we were able to display our final product at DemoDay. Blocc is an educational tool which can be used to teach children from 10 to 12 years old about electronics and programming. Blocc consists of learning modules ranging in difficulties three difficulties, a component booklet, two digital games and the electronics kit. It will be used in a classroom where the students can get their own learning module. In this learning module, several lessons can be found ranging from easy in the beginning to more difficult lessons later on.

Figure 40: Our product and all the elements.

The electronics kit consists of the following components: a hub, two splitters, two pushbuttons, one soundsensor, one potentiometer, two joysticks and ten wires. All components protected so there is no possibility of electrocution or short circuits.

Lessons focus on incorporating new components, and therefore start with an introductory paragraph introducing the basic function of the component followed up by some questions. Afterwards, the students can move on to integrating the component in a circuit. The amount of guidance in the assignments differs per module level, ranging from graphical step-by-step guidance to only hints towards the final results in the level-three module.

After assembling the circuit, the learning module aims to implement an interactive experience with the circuit which the student built to reward their effort and give extra motivation to understand the learning material. The first lesson of the learning modules only covers analog circuits, but from lesson three on, each circuit is linked with a small game which can be controlled by the circuit.

The two games included are a racing game which can be controlled with a potentiometer which functions as a steering wheel and with to buttons, gas and brake respectively. The second video game is a wandering game allowing you to roam in an endless world, while taking a block friend with you. The game is controlled with two joysticks, where one controls the movement of the player and one controls the camera.

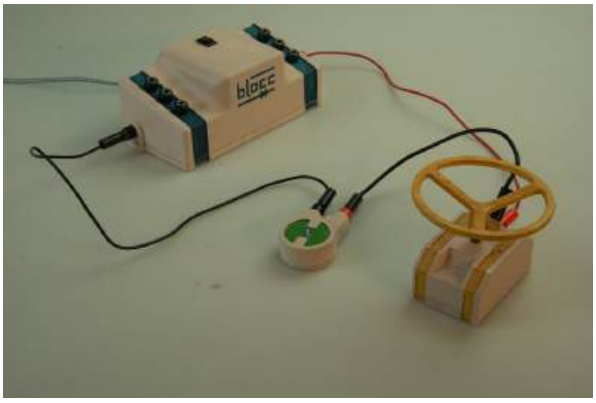


Figure 41: An analogue circuit built with Blocc.

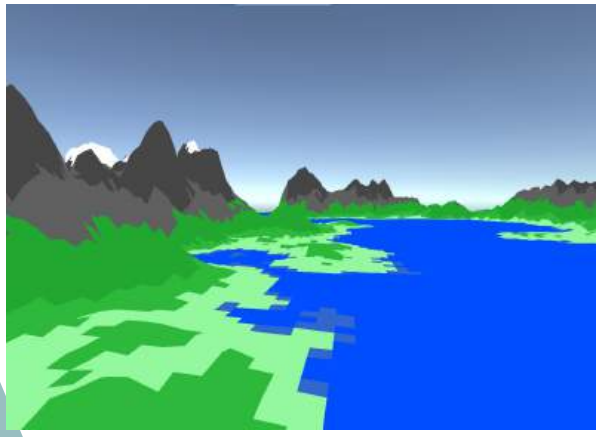


Figure 42: The world walker game.

Figure 43: The product packaging. Designed to resemble a power source with two ports like the ones on the modules.

If at any point a student gets stuck or want more information in general regarding a certain component, the teacher has a component booklet (Appendix 1) containing extra information for all components, including information about the schematics in case a repair has to be made.

To promote Blocc, a website has been published containing more information about the product (including a video) and contact information to get in touch with us. Furthermore, a concept for the coding environment has been produced.

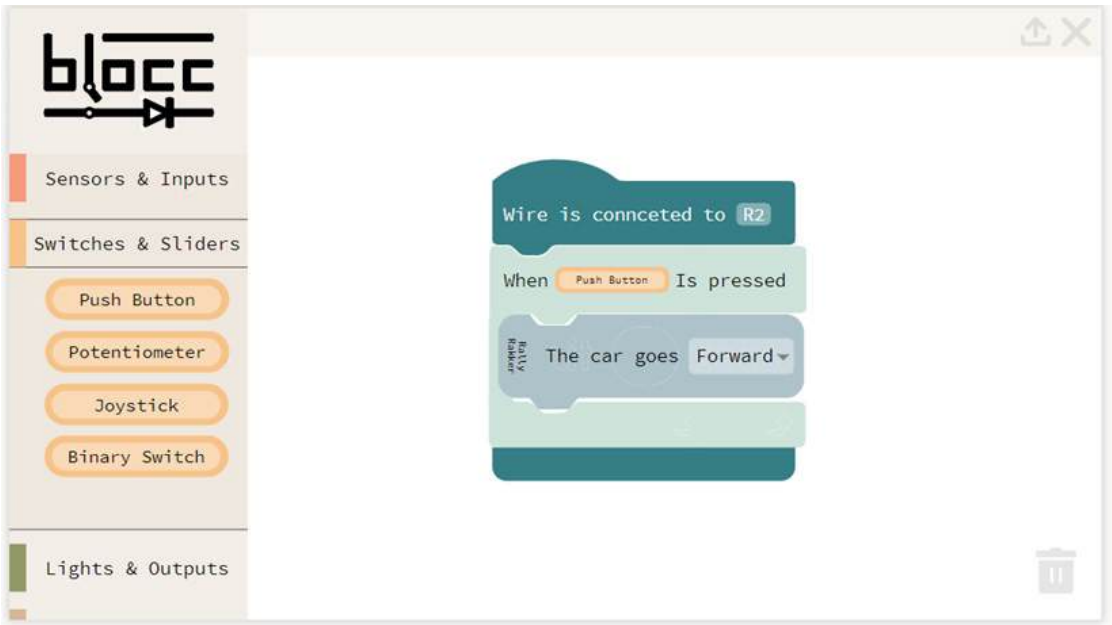


Figure 43: The coding environment.

Figure 44: The frontpage of the website. (Uijlenhoet, T (2022)).

User testing

Shortly after demo-day, we were able to make an appointment to test our product with a teacher and a technical assistant working at a primary school called De Driestam. Picking a date for the appointment proved to be difficult and it was a pity that we could not use the feedback from this session for DemoDay, but we are glad we were able to perform these user tests nonetheless.

At the beginning of the appointment, we introduced our project shortly and showed them our product. During the user test they were able to use our product, including the learning modules, electronics kit and component booklet, without any interference or guidance from us (unless asked for). In this section, we will cover the most important observations and feedback.

The product seemed very approachable and fun to use. The color labeling made it clear what category the components belonged to.

Feedback on the component manual was generally positive. Although, it was preferred that the students had access to it in medium of a poster on which they could easily find all the components.

Also the learning modules seemed too difficult, instead of the text based guidance we should consider doing this by illustrations demonstrating the assembly process. While testing the product we noticed there was a lot of scrolling through the booklet, to avoid this we could implement the same poster as mentioned before to have all the components in the same place.

A problem which did not occur to us before was that for several circuits, a black wire had to go in both a red and a black port. This seemed too confusing so in the future we will introduce a new colored wire which is for this specific purpose.

Figure 45: User testing.

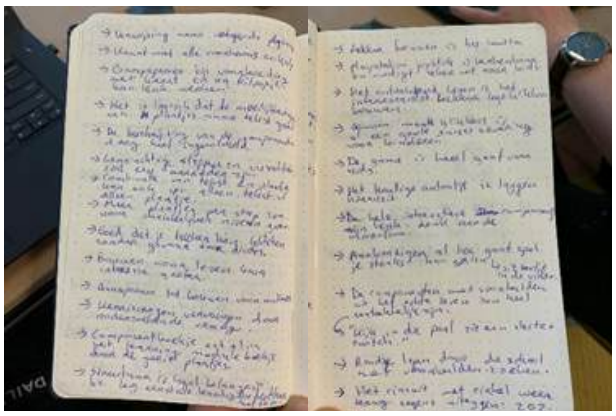


Figure 46 and 47: Notes taken during the user test.

Conclusion

Looking back at the design process, we have had our ups and downs. Eventually we were able to create a working prototype which was based on interviewee's input. However, as we were reliant on these interviews we suffered a delay. We spent too much time trying to get in contact with potential interviewee's causing unnecessary delays in the process.

We as a group are happy with the outcome of the project. We have spent a lot of time in researching, designing and manufacturing. We are particularly happy that everyone has had the opportunity to work on their personal development plan.

We reached our project goals partially. The user is able to build their own circuits and use the circuit in an interactive environment, in our case two games. They are not able to program their own games however, which is the main part that is missing to fulfill the project goal .

The latest user tests concluded that the blocks were very approachable, but the learning module was not, since there was too much text. The circuit enough is simple enough to be useful for teaching in our target group, but it was still understandable, so this goal was reached. Thus, we are happy with the outcome of the physical blocks with their approachability and complexity. We, however, did not focus on the programming environment since we found it hard to work on it alongside the blocks in the given time. However, computer interaction with the circuit was still possible with pre-written code and games.

Discussion

As concluded from the user test, in the future we would like to redesign our learning module and add a separate poster introducing every single component. Also, we want to add a set of video tutorials walking the teachers through the product and on its aspects. We would like to create videos for when repairing components and for specific lessons. If we were to continue our project we would go further with user testing, followed by a rehaul taking in the feedback and improving our product.
Also we would realize the digital environment, including the coding environment and the games library. If we were to take these steps, our goals would be achieved. Our main discussion point is that we spent too much time on finding interviewees, as we now know the importance of the interviews we will start this process earlier in future design projects.

Our Team

Bram van Duivenboden

Stef Klaassen

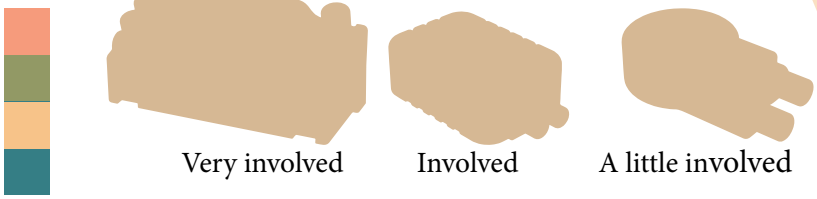
Teun Roetman

Tom Uijlenhoet

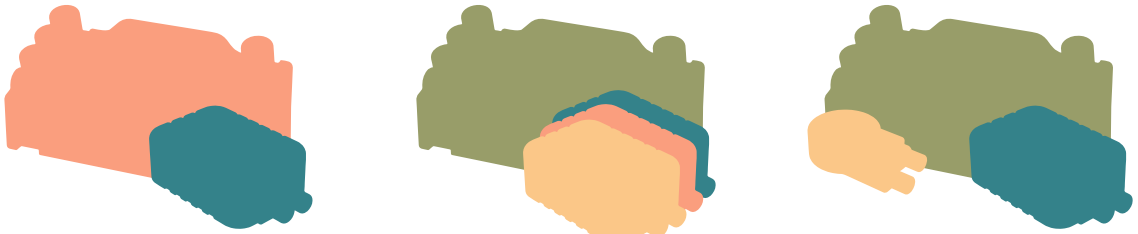
Work division

To visualize our work devision, we assigned a colour to each group member and use shapes to represent their involvement in specific tasks within the project.

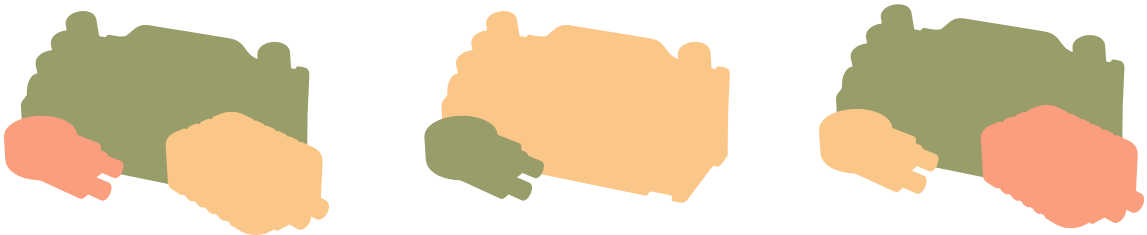
Bram van Duivenboden
Stef Klaassen
Teun Roetman
Tom Uijlenhoet



Theoretical Research | User research | Conceptualizing



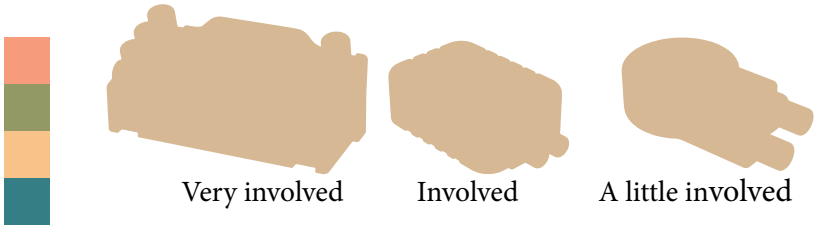
Playful learning research | Interviewing | Graphic design



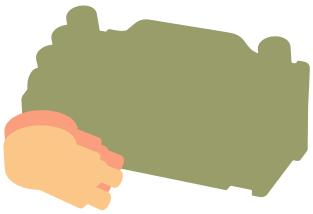
Market research | Electronics research | Designing prototypes

Business research | Colour palette | Sketching

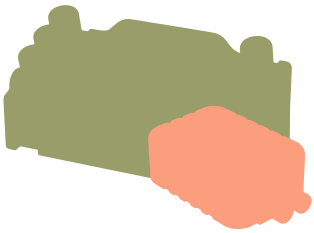
Bram van Duivenboden
Stef Klaassen
Teun Roetman
Tom Uijlenhoet




Learning module

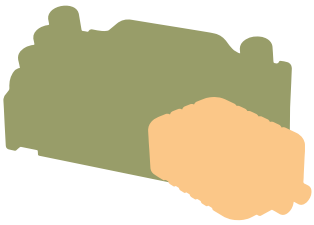

Casing

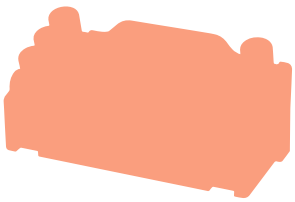

Lo-Fi prototyping

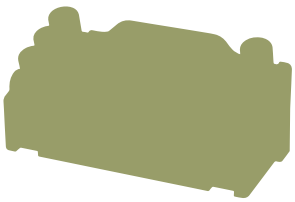

Component manual

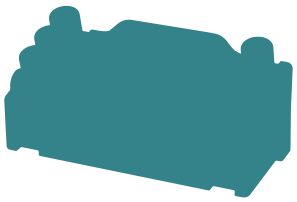

Assembling electronics

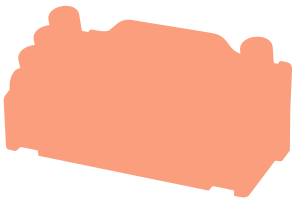

Video producing


Coding environment

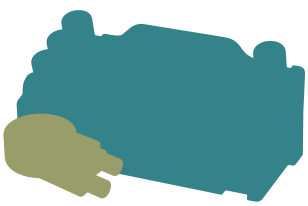

Making games


Video editing


Website


Integrating games


Midterm report


Poster

Packaging


Midterm report

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Reflections

Bram van Duivenboden – 1688235

During the last semester we, as first year Industrial Design students, were introduced to our first big design project. In this reflection, I will cover my experiences during this course and reflect on learning goals.

Starting of this course I was quite excited. It would be my first big project since starting with this study and I was able to join my favorite squad, Playful Learning. The start of a new project goes hand in hand with a new ideation phase, a phase where you introduce yourself to your group and start brainstorming about possible directions to explore within the project. This is where I hit my first obstacle.

Most other courses were very structured. They had clear guidelines regarding the direction your project should head in. Project 1 lacked this structure. The only guideline we got for this project was the general theme for the squad. I struggled with this freedom. I am aware that I am a problem solver and without a direct problem to solve, I felt like a fish out of water. This is something I feel like I need to work on, because as a designer, I believe I should be able to generate my own ideas.

In this project, I was able to challenge myself more often by taking on tasks I was not particularly confident in, as we as a group decided that we wanted to structure our workload not necessarily towards efficiency or overall results, but more with an emphasis on learning new skills. Our chairman was very well organized, which allowed me not to worry too much about the planning and organizing of the project. I am a control freak and being able to hand these tasks over to someone else was a mayor contributing factor with learning new skills.

During this project, I often took it upon myself to analyze papers to support our case. It is something I had done before in high school, but on a very basic level. I believe being able to use proper sources is key for understanding the problem space in a project and to be able to make a valuable contribution as a designer. The feedback we received as a group for the theory research in the midterm report was very good to my surprise.

I lack self-confidence when faced with tasks I have not done often, am new to or have not done for a long time. For me, this leads to procrastinating the task at hand which is quite frustrating. I was raised in a home where achievement and results were very important, and I believe this pressure to perform led to my habit of procrastination or a lack of perseverance. I took it upon myself to be as involved in the theoretical research as mentioned above because it is out of my comfort zone.

For the same reason, I took it upon myself to developing some games for the project. Game design is something I am keen to learn more about and was therefore one of my goals in my Personal Development Plan. It was quite intimidating and something I had been procrastinating for too long however, and to be able to finally overcome this mental block felt like a great achievement for myself. I really enjoyed reaching this goal to start developing my first games, and I am keen to try to make more and/or different games.

One thing I did struggle with throughout this course was deadlines. I often took too many tasks upon myself for deadlines like demo day or reports, which made for a lot of sleepless nights. I am aware that it is a habit of mine to continue working late. I have ADHD and at these late hours I finally get calm enough to sit down and put in some productive work. I plan on singing up for a sport where I can train early in the morning, to hopefully be able to tire myself enough to be able to sit down and take a breather, leading to a healthier sleeping rhythm.

To conclude, I want to continue challenging myself by diving into new subjects and I want to work on my struggle with productivity. I am proud of what my group and I have achieved during this project and I am proud that I have ultimately found a way to deal with my performance anxiety.

Stef Klaassen – 1694510

For the past semester I have got to work on a product with which children in primary schools get introduced to circuitry and coding. The product comes with a learning module and components manual.

During group meetings, I often had the role of chairman and notetaker. Preforming the tasks that came with these roles helped me keep overview on everything that happened throughout the project and allowed me to make sure everyone had their say. As I am a natural control freak, I encountered my strengths and weaknesses by doing so. The role of chairman gave me the opportunity in improving my leadership and remaining my objectivity and acceptance to all ideas during meetings.

When we arrived at the prototyping stage, I had an active role in both the designing and manufacturing of the prototypes. Up until this point in my career, this design process was one of the most evaluated ones. Every aspect was carefully chosen, from coloring to fillet diameters. Having such an elaborate design process helped me improve our products by questioning every design choice. This process helped me realize a coherent set of products ranging from physical prototypes to graphic designs. This design process further helped me implement my target groups desires into my design. As I got better at 3D modelling I also realized I also have a lot to learn, some of my designs weren't optimal resulting in unnecessary difficulty in the assembling stages. In the future, I will keep this in mind and put extra attention to such details. Also I will test and evaluate my products digitally before manufacturing to save time and production costs.

In my personal development plan, I mentioned I wanted to improve in report writing, by writing our midterm report with my team and receiving feedback on it I now know more about what is expected from me and what approach to the writing I can best use. I have put this approach to use by doing my part in the final report, I will use the feedback on this report to measure the process I have made in report writing.

Next to report writing I also mentioned that I wanted to improve in conducting interviews. In the later stages of the project we evaluated several designs with teachers and parents with the goal to further improve them. Conducting these interviews learned me to ask the right questions and steer the interview to get as much useful information out of them as possible. Having practices with conducting interviews really helped me as I can now efficiently conduct interviews in future projects.
Ultimately, I want to put all the things I have learned to use in future projects. I will further develop myself in product design focusing on making my products easy to assemble. I want to further improve in understanding the business aspect of a project as I realized that I have few experience in this area of expertise.

Teun Roetman – 1687484

In project 1 I worked in the squad playful learning. In this squad, me and my groupmates designed an ecosystem of a learning module, electronics, coding blocks and games to work together as an education package for elementary school. I learned how to iterate on prototypes using feedback gathered from user research, basic graphic design, implementing electronics and various other skills in the process of project 1.

The first point I want to reflect upon is my graphic design. It was one of the things I could not do before project 1 and it still is a weak point. Up until the mid-term I did all the graphic design for our project, like choosing colours and fonts and making templates for documents. I was not happy with the design however. It did give me the basics of adobe illustrator and Indesign, but these will require a lot more development for me to become competent at the programs. I tried doing everything by pressing buttons and seeing what they do. These programs are so complex that this strategy of mine really does not work anymore. To up my skill level in these I should watch and read guides on the programs. I feel like this is the same for my graphic design. I miss the basics of theory to experiment with the design. Thus, although I did progress a bit in graphic design, it was not as much as I would have liked. In the future I will take actual courses on these, since my old method does not work that well.

Including users in our design process went quite well, but should have gone smoother and faster than it did. We did a lot of interviews, as well as user testing for our project. We got a lot of useful information from the interviews, although later than we would have liked. This delayed our process as a whole and thus limited the amount of iterations. The user testing had the same problems. We wanted to test with teachers, but we had slow or no replies from most of them. This caused us to not be able to utilise the feedback we got from testing to improve our final prototype. To prevent this in the future, we should try to contact as many of our stakeholders as possible as soon as we know who these will be, to ensure user testing and interviews to minimise the delays they cause.

In the project I had some clear planning issues. Firstly, i planned a vacation in the middle of the semester, causing me to be useless for a week, and being out of the loop after returning. This was a strain on both me as well as my team. Looking farther ahead and making clear what I should do beforehand and afterwards would make a vacation possible, but the best recommendation for myself is to not plan vacations in school weeks.
There were more planning errors. The final report was written entirely the day before the deadline. I had time before this, but with no division of labour and no starting point on what we wanted to write, I could not start. This would have been solved by planning in advance who would write which part, or at least planning this at demo day.

There were also some teamwork issues. I noticed I worked differently from my other group members, which caused some friction. My concentration at meetings would slip away after half an hour, causing me to miss important choices and information. The best counter I found to this problem was to do easier project work while meeting. This would still make sure I would know the main points of the meeting, while also doing work on the side and keeping my concentration. An even better solution for me would be to have shorter, more concise meetings, but this would need group support.

To conclude, I learned some useful skills in this project, but there are also a lot of things to improve upon. My graphic design started with this project, but I am going to need to understand it and the programs needed for it better if I want to become capable at it. Thus I am going to follow online courses for this. User involvement went great for the first project, but we now learned contacting early is important to not cause delays. A clearer and more detailed long term planning would cause less stress and work being easier to do. Lastly, for me as a person I have problems concentrating, thus half concentration on meetings might be more useful for me, while the more ideal solution would be to have shorter meetings.

Tom Uijlenhoet– 1687484

We are now almost finished with project one in this first year of Industrial Design. After working on it for almost half a year, much has happened with our project, with my learning goals and with the teamwork. This project has been a rollercoaster for me and I have been gaining a large amount of experience and development. Halfway through our project, we had to write a reflection about the project until the midterm demo day. At that time I talked about my smart learning goals and how I went through changes in order to develop. These smart learning goals have also gone through a small change as well but not that much. The main smart learning goal is still that I want to improve on how to communicate my design ideas. In order to improve on this, I wanted to get better at pitching, sketching and prototyping. I feel like these skills are important to me since it helps me shape as a designer.

Last time, I talked about how I started with improving on presenting in front of a small crowd. The main learning experience I had then was mainly that it is important to do it as much as possible in order to gain confidence in presenting. Another important aspect is that it is not smart to memorize and put up your text for a pitch or presentation directly, because that comes across as very boring and unconvincing. It is also not wanted not to know what you are talking about, which is obvious. But the perfect balance is that you roughly know what you want to talk about in your pitch and then naturally try to explain it. About halfway between midterm demo day and now, we have had a pitching workshop. This workshop has helped me with improving on the technical aspects of my pitch and presenting skills a lot since the midterm demo day. During the workshop, we had to listen to other pitches and give feedback to them with things that went well and things that could be improved on. After this, the teacher talked about some important techniques to level up our pitches. For example, I've learned to take breaks in your pitch, to keep your intonation varied and to use emphasizing hand gestures for extra conviction.

Furthermore, I wanted to improve on my sketching skills. Before I started with Industrial Design this year I almost had no experience with sketching. My only real experience was with the school subject art that I had in high school. There, I learned some useful skills like drawing and getting your creative thoughts on paper. But with Exploratory sketching this quartile, I have already learned so much on how to sketch for exploration of an idea or design but also how to sketch for the communication of it. The skill to sketch your idea relatively fast on paper is a skill that I am focussing on a lot. I want to master it because it will help communicate

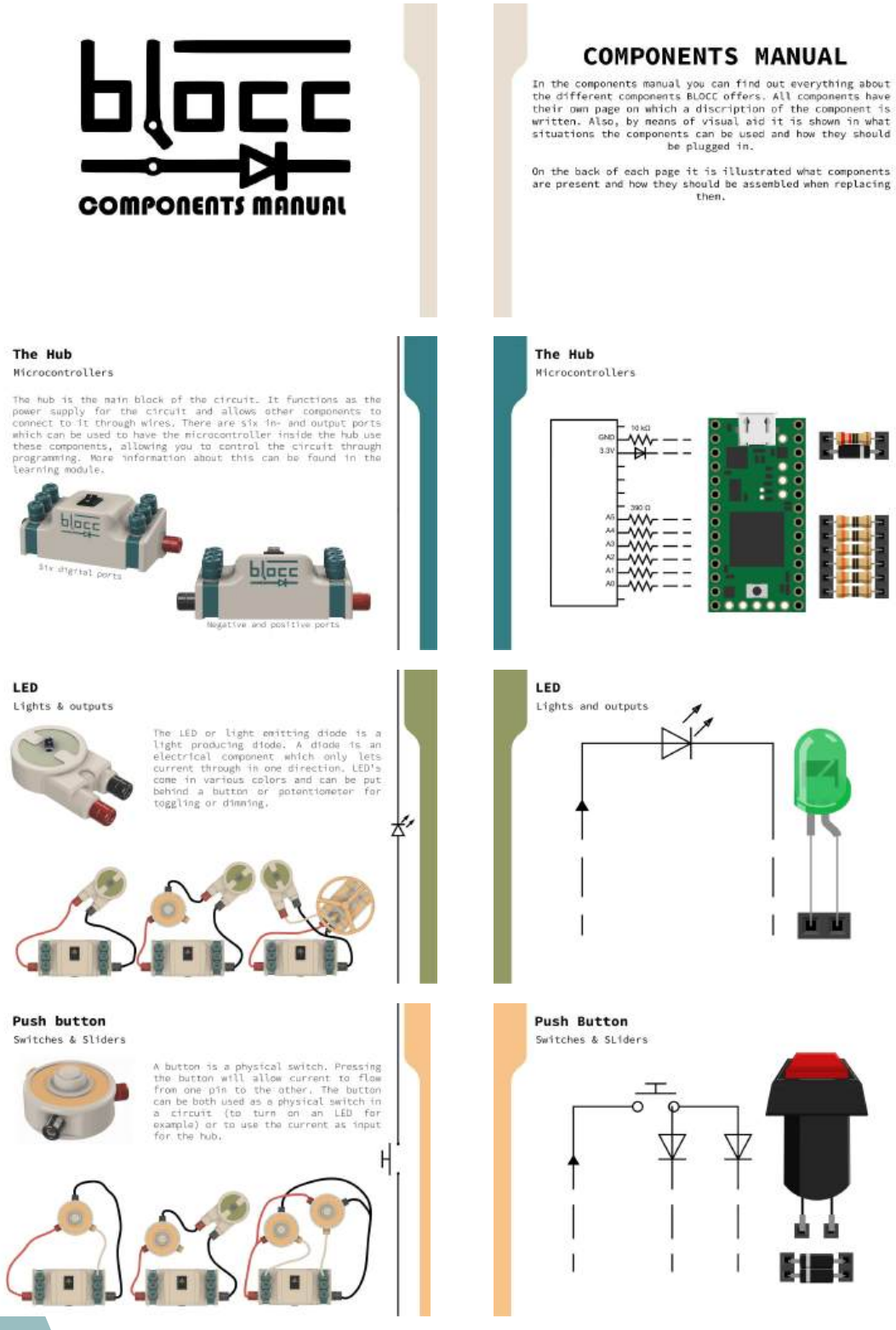
my ideas to others fast and it will improve design processes. Even though I am working on improving this skill a lot, I am not where I want to be yet. The teacher taught me that sketching fast is a key to a great sketch and if I had to make a design proposal for a client in the future, I would not have much time. So, to quickly explore many ideas in a short amount of time, I must improve on this aspect more by practicing on my pace of sketching. For project 1, I have been sketching different types of new components for our circuitry component collection. I first tried to explore different types of shapes for new components and afterwards I made loose but detailed communicative sketches of a speaker component, a temperature sensor component and a binary switch component.

Moreover, I tried to improve on prototyping last time. However, after midterm demo day, we divided our tasks so that I was not working on the prototypes too much. I took over other important tasks like building the website and the business model canvas as individual tasks. I used my learned skills from Business Design to build the business model canvas and learned how to use Wix to build the website.

Lastly, our teamwork has improved a lot lately. First, we were just working from week to week without any form of planning whatsoever. One of the group members was on vacation for a week and we did not have contact and did not discuss how to manage the situation. This was a small wake up call for all of us. After this, we tried to manage our meetings with preparations and made a document for our task division. This improved the situation already a lot, since we were making way more progress than before. However, about 6 weeks ago, we made a clear plan on what we wanted to have finished before the final demo day. In the planning we wrote all the tasks down, divided them and gave them clear timeslots with a small time buffer. This made it really clear and during these 6 weeks we communicated well via WhatsApp and managed to finish before demo day.

Appendix

Appendix 1, components manual



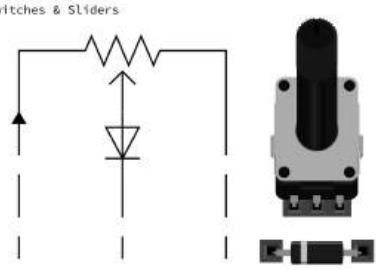
Potentiometer

Switches & Sliders

The potentiometer or potmeter is a voltage divider. It divides the voltage over the two output pins. The potentiometer can be used in a circuit to have an adjustable voltage input for another component or to use the adjustable output as an input for the hub.

Potentiometer

Switches & Sliders



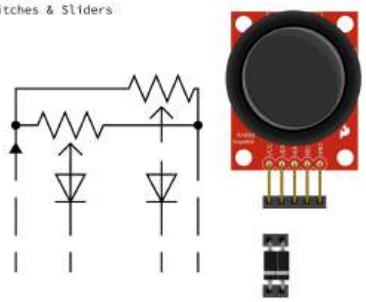
Joystick

Switches & Sliders

The joystick is closely related to the potentiometer. The joystick uses two potentiometer to track the position of the joystick along two directions. One potentiometer is connected to the x-axes and the other in the y-axes. The data from these two potentiometers will be send to and interpreted by the hub. This component can be used to move a character in a video game for example.

Joystick

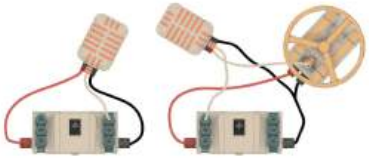
Switches & Sliders



Microphone

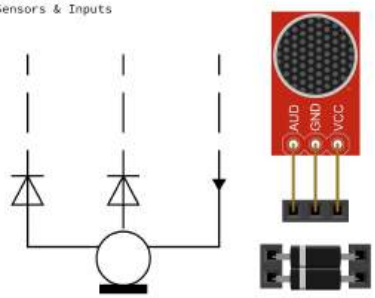
Sensors & Inputs

The soundsensor is a component that reacts to sound and is able to create a signal from that sound. This signal can be used as input for the hub, to in turn control an LED for or to be used in a game for example.

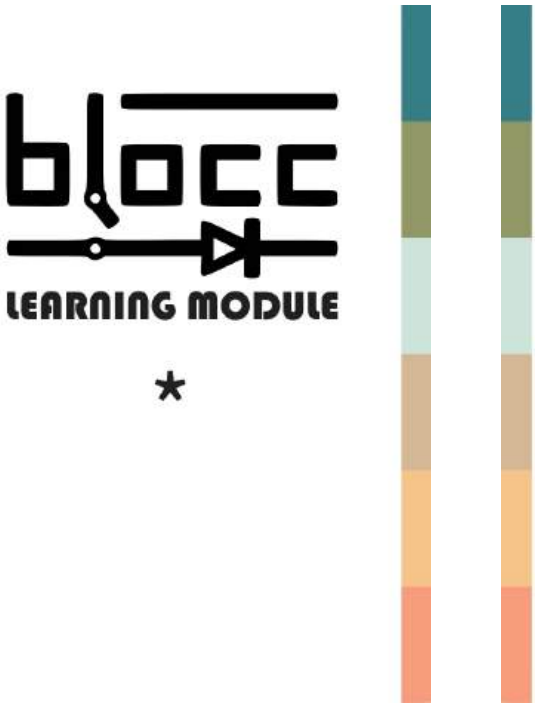


Microphone

Sensors & Inputs



Appendix 2, learning module



LESSON 1

Hi, welcome to your first electronics lesson. Throughout the learning module you are going to make your own circuits, write your own codes and play your own games!

But let us start with the basics of circuitry! In this lesson you will learn:

- How to connect a led to a hub
- How a connection piece works
- The difference between parallel and series

The hub is the central place where you connect everything. It has a positive and a negative port, where the electricity flows from one to the other. It also has 6 signal ports, which can be connected to various components to for example let you play games.

Then there is the light. You need to make sure positive and negative ports are correctly connected to the LED, so red to red and black to black, otherwise it won't light up.

The last component used in this lesson is the connection piece. This allows you to connect more than one wire to the negative and positive ports. Why do that when you can connect the components to each other? Come and find out!

LESSON 1

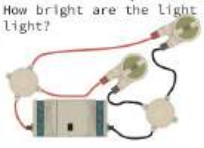
So, time to connect your first LED. Follow the schematic below to connect it.

Now take a good look at the brightness and add another LED using this schematic:

Notice anything about the brightness of the light?

.....

Connect them in parallel using the schematic below. How bright are the light now compared to a single light?



LESSON 2

In this lesson we are going to play our first game, Scream Flight. By screaming into a sound sensor, we can control our figure.
In this lesson you will learn
- How to send digital signals to a computer
- How to connect a sound sensor

A sound sensor picks up vibrations in the air and transforms this into a measurable value. The sensor has 3 ports. A positive port in red, next to it a negative in black. The orange is used to transfer data to the hub.

This is how you connect the sound sensor:

How hard do you need to scream to jump?

.....

Why do the positive and negative need to be connected to send a signal?

.....

LESSON 3

In this lesson you will learn:
- How you can play Rally Rakker with switches and a potentiometer
- The different signals potentiometers and switches send to a computer
- How you can connect the wires, so the computer receives the signal

Foreknowledge

The color red is used for the ..... port

and black for the ..... port.

The wires connect to the splitter and then the

single wire coming from the splitter goes to the

.....

The hub has 3 kinds of ports: Positive, negative

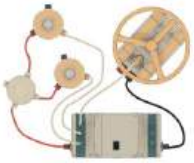
and .....

LESSON 3

The button is a type of switch which you can push on to allow current to flow through it. It can either allow all current to go through or none. The button doesn't need to be connected to the negative pole when used to send a signal, so this is different than normal. The button does need to be connected to the positive pole.

The potentiometer measures how much it has been rotated. This means it can send a lot of different signals, since it measured a lot of points. Using the computer, these numbers can for instance be used to control a car.
Just like the sound sensor, the potentiometer has three poles which are connected in the same way.

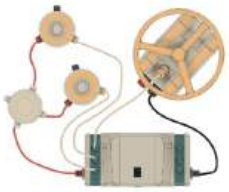
Build the circuit given by the illustration



LESSON 3

If you followed the instructions correctly, you should now be able to drive around in Rally Rakker. Steering with the potentiometer and going back and forward with the buttons.

Could you encircle the wires which lead the signals to the hub in the illustration?



If you want to see when the button is pressed using a LED, where would you have to connect it?

LESSON 4

In this lesson you will learn
- How to connect joysticks to navigate in a game
- How a joystick works

So today we look at the joystick, which actually isn't that new. It is very similar to the potentiometer, but also different. It is the first component with 4 ports.

Foreknowledge

Two of the ports you can probably already think of:

....., ...

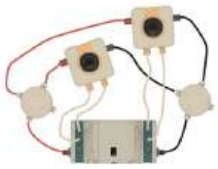
The third and fourth are also on a potentiometer,

these are the .....

But a joystick can move both horizontally and vertically, thus there are two potentiometers used.

LESSON 4

Let's build a circuit to walk around in a virtual world, using 2 joysticks.
First Build the schematic given below:



If you connected them correctly you can navigate navigate in World Walker, being able to look around and walk.

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LEARNING MODULE

★★

LESSON 1

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The hub is the central place where you connect everything. It has a positive and a negative port, where the electricity flows from one to the other. It also has 6 signal ports, which can be connected to various components to for example let you play games.

Then there is the light. You need to make sure positive and negative ports are correctly connected to the LED, so red to red and black to black, otherwise it won't light up.

The last component used in this lesson is the connection piece. This allows you to connect more than one wire to the negative and positive ports. Why do that when you can connect the components to each other? Come and find out!

LESSON 1

In this first exercise, we are going to connect a LED to the hub. To do this you need to connect the red port of the LED to the red port on the hub and the black port to the black port. You know you succeeded when the light is shining.

Now, we want to connect a second light. This is done by making sure the lights are ordered in the same direction, both red ports should pointing in the same direction. Now connect a wire between the black port of the first LED to the red port of the second one

Do you notice anything different about the light intensity?

.....

Now, disconnect the lights and connect a connection piece to both the black and red poles. Then connect each light to another port on the conncetion pieces like you would connect them to the 2 ports.

The lights are now **brighter/less bright**

LESSON 2

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In this lesson you will learn
- How to send digital signals to a computer
- How to connect a sound sensor

A sound sensor picks up vibrations in the air and transforms this into a measurable value. The sensor has 3 ports. A positive port in red, next to it a negative in black. The orange is used to transfer data to the hub.

To connect the sound sensor you need 3 wires. Where do you connect them?

..... -> .....

..... -> .....

..... -> .....

Now try to connect the sensor, did it work?

LESSON 3

In this lesson you will learn:
- How you can play Rally Rakker with switches and a potentiometer
- The different signals potentiometers and switches send to a computer
- How you can connect the wires, so the computer receives the signal

Foreknowledge

The color red is used for the ..... port

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LESSON 3

The button is a type of switch which you can push on to allow current to flow through it. It can either allow all current to go through or none. The button doesn't need to be connected to the negative port when used to send a signal, so this is different than normal. The button does need to be connected to the positive pole.

The potentiometer measures how much it has been rotated. This means it can send a lot of different signals, since it measured a lot of points. Using the computer, these numbers can for instance be used to control a car. Just like the sound sensor, the potentiometer has three ports which are connected in the same way.

We want to send a signal using the buttons. You need 2 wires for that per button: One for the signal and one for the positive pole. The red wire needs to be connected to both the positives of the buttons through which block?

.....

LESSON 3

The signal wire goes from the signal port on the potentiometer to the signal port on the hub.

Also, you want to send a signal from the potentiometer to the computer. For this you will need three wires. one wire to connect the negative port, one for the positive port and one wire from the sensor to the signal port.

Now that you know where the wires should go, can you draw the circuit out?

Use the schematic you drew to create the circuit and see if it works.

If you want to see when the button is pressed using a LED, where would you have to connect it?

LESSON 4

In this lesson you will learn
- How to connect joysticks to navigate in a game
- How a joystick works

So today we look at the joystick, which actually isn't that new. It is very similar to the potentiometer, but also different. It is the first component with 4 ports.

Foreknowledge

Two of the ports you can probably already think of:

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The third and fourth are also on a potentiometer,

these are the .....

But a joystick can move both horizontally and vertically, thus there are two potentiometers used.

LESSON 4

You want to connect two joysticks to the hub.

Thus, ... of the hub its signal ports are used.

You also need to connect the positive and negative ports. Since there are two of them, which extra pieces do you need?

.....

Now connect them and see if you can navigate in World Walker, being able to look around and walk.

LEARNING MODULE

★★★

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LESSON 1

COnnect your LED to the hub so that the LED lights up using the wires. Now try to connect two of them on after the other.

Do you notice anything?

.....

Now use a connection piece and connect both LED's to the connection piece.

Do you see any difference compared to the single LED's.

.....

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What would the third port send?

.....

So to which port on the hub should it be connected?

.....

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Build a circuit with which you can steer the car with the rotary sensor and go back and forwards with two buttons.
Hint: first draw the circuit including the wires. This will give you a better overview of what to do.

You should be able to control a car now.

If you want to see when the button is pressed using a LED, where would you have to connect it?

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Appendix 3, Business model canvas