HANDY

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Executive summary

For our project we aim to develop a physical-digital hybrid educational game that teaches the Dutch Sign Language (DSL) to children between the ages of eight and twelve, in a playful and fun way.

The ideation phase involved brainstorming sessions, evenly task division, and group collaboration to refine the concept. The decision to teach DSL was influenced by its recent recognition as an official language in the Netherlands and the lack of educational tools targeting children without hearing impairments.

We have done research on: DSL, the learning processes of children and already existing sign language courses in the Netherlands. By conducting interviews with experts from Kentalis and Het Nederlands Gebarencentrum we gained useful insights into teaching methodologies and the importance of integrating DSL with its cultural context. In the meanwhile, our technology research explored motion tracking options, leading to the selection of Pyxy3D, a Python package used on a Raspberry Pi Pico for 3D rigging.

Prototyping involved two stages: technical and physical. The card game prototype, iterating through analogue and wireframe versions, facilitated learning the DSL alphabet. And physical product design throughout iterations involved: research on figures from children movies, sketching and 3D modelling, designing a robot-like figure named Handy, chosen for its potential role as a teaching aid.

Testing involved playtesting the card game, wireframes, and crafting scale models for the physical designs to gather insights from peers and potential users.

Iterations refined the project, addressing challenges such as expensive hand tracking technology and the need for a correcting factor. The future project integrated Pyxy3D on a Raspberry Pi Pico, Arducams, and a nine-inch display unit, resulting in an estimated cost of €61.50. With the physical design, constructed from wood, which underwent several iterations to balance stability, attractiveness, and affordability. The product in the earlier established colours to create a positive user experience.

For short, the Handy project represents a comprehensive effort to address the gap in sign language education for children without hearing impairments. The game's affordability, accessibility, and incorporation of cultural aspects make it a valuable addition to language learning tools. The iterative process, including research, prototyping, testing, and design refinement, will ensure a well-rounded and user-friendly final product.

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Introduction

Sign language was banned in the Netherlands until 1980 and it was not until 2021 (Ministerie van Algemene Zaken, 2022) that it was recognized as an official language. So, it is still quite a novel and relatively unknown way of communicating. While people in for instance the USA, Germany and the UK have sign language classes in grade school, nothing like this exists in the Netherlands. Therefore, we, Megan, Sophie, Jeppe, Dante and Siebe, a group of first-year Industrial Design students, wanted to make a little robot that tutors children, who are not per se hard of hearing, between the ages of 8 to 12 the Dutch Sign Language. To create a more accepting and inclusive society for people who are hard of hearing. We went about this following a design-brief of this project called 'CBL project 1', namely: to make a physical-digital hybrid educational game for three or more players. The game must be playable in a collocated and dislocated setting or a combination of the two. Furthermore, the game cannot be insulting. We focussed on creativity & aesthetics and user & society. The following document is an overview of the work we did and the designs we made. It contains two main themes:

1. Research
2. Process

The first theme shows the research we did to make Handy who it is. It shows the literature research we did, the interviews we conducted and the why behind our design choices.

The second theme is about the processes we went through when designing Handy. From the game concept development to experimenting with different shapes, colours, and sizes. We investigated different technologies that we could use and how we would implement all this this into one product.

Process

Ideation phase

To make a product, you must first know what to make. All we had to go off was the design-brief: to “Design a physical-digital hybrid educational game.” The first sessions were spent on brainstorming, putting all our ideas onto paper. We put into practice the brainstorming theories we learned in lectures. We thought of all sorts of subjects for our game; a game that teaches people to cook a game using calculus or a program that teaches people how to fix their home appliances.

The session after, we democratically chose the ideas we liked most, with everyone refining them as we went. Taking parts from other ideas that we had, brewing, and adding them all together. Another session later, we as a group joined forces to turn this wide web of ideas into one single final idea. Taking aspects like social skill and teamwork, combining them with teaching about technology and languages. We finally decided to build a machine to teach people Dutch Sign Language (also referred to as DSL), in groups. Figure 1 is a representation of the ideation process we went through. We chose Dutch Sign Language over other ones for several reasons; our entire group is Dutch, so it was close to home, but Dutch Sign Language is also something that is quite foreign to most Dutch people. This is because it was only in 2022 that the first Dutch non-special education schools started offering a course in sign language (B. Crommentuijn, ‘*Eva leert gebarentaal op school: “Nu kan ik beter met mijn neefje praten”*’, 2022), which is different in other countries. In the USA for instance, it is less of a novelty; already in 1986 one percent of all American high schools offered courses in American Sign Language (ASLdeafined, ‘American Sign Language in High School’, 2019).

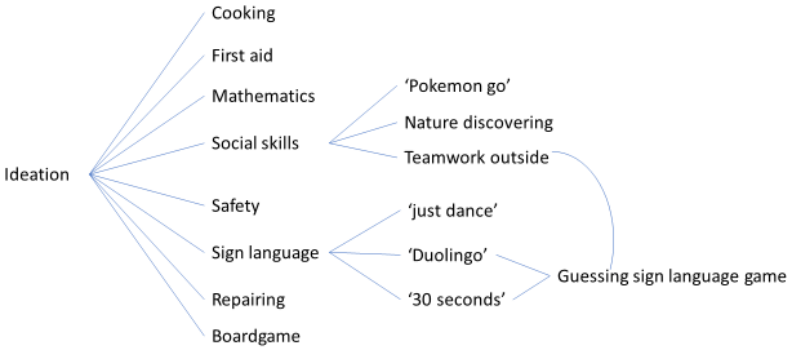


Figure 1: ideation

When building something for users, you first need to know who your users are. We spent a session on figuring out who our target audience was. Using techniques learned in our human-centred design course, we first narrowed our user group down to children, since we can make the biggest step towards our goal by teaching the clean slates who still have time to change things in the world. We then chose to make the game for Dutch children, since they are the ones that are most likely to learn DSL. But we would have translations to English available so that people who do not speak Dutch could also use our product. Having chosen the nationality, we could also narrow our target group down. From our own experiences and the stories of people in our surroundings, we concluded that children in ‘groep 5’ till ‘groep 8’ of the Dutch school system (eight to twelve years old) still learn a lot, while also having the required motor skills to learn sign language. They already know how to speak and write in at least one language. This way we can use that known language to teach DSL. So, our final target group would be children between the ages of eight and twelve. We want to create this game for both children that are hard of hearing and children that are not. This way we can ensure that these children can communicate with each other.

Figure 2: brainstorming session

Because we wanted to make the game for children, we also wanted to make the game accessible. To guarantee this, we wanted to make the game affordable (the aim was to stay below one hundred euros, this way it could be given as a big Christmas gift or even bought by schools to use in class). We also wanted it to be clear and obvious to use, so that anyone could pick it up and start learning sign language. Besides, we wanted the game to be fun, so children would enjoy playing it with friends and not feel like they are forced to learn this language.

All of us have experienced exclusion in our lives, so an important motivating factor for choosing sign language as the educational element in our game was to improve in inclusivity in society and to facilitate communication between people that are hard of hearing and people without a hearing disability at an early age. With a sizeable

portion of our team having experience with how society tends to treat people with a disability, improving on inclusion is an especially important motive.

Research

We benchmarked the available tools to learn sign language. Looking at courses provided by companies such as Kentalis and LOI. This also confirmed that our user group was a suitable choice: most sign language courses, whether Dutch or based on any other language, were designed for either adults or children who are hard of hearing. So, teaching kids who are not hard of hearing was a gap in the market.

We started doing research on the Dutch Sign Language to gain a better understanding of the language. We uncovered something that we all found bizarre; learning sign language was illegal in the Netherlands until 1980 (Hartman, 2021) and it was not till 2021 that DSL was recognized as an official language (Ministerie van Algemene Zaken, 2022). Because of this, DSL is still largely in development, with new signs being added every year. And schools do not really offer courses in it either, as said before: it was only in 2022 that the first Dutch non-special education schools offered a course in sign language (B. Crommentuijn, '*Eva leert gebarentaal op school: "Nu kan ik beter met mijn neefje praten" '*, 2022), which is different in other countries. In the USA for instance, it is less of a novelty; already in 1986, one percent of all American high schools offered courses in American Sign Language (ASLdeafined, 'American Sign Language in High School', 2019). This motivated us and provided us with a purpose to work towards: to make learning the Dutch Sign Language more fun and accessible for children (who are not hard of hearing) so Dutch Sign Language can become a bigger part of society in the Netherlands.

We also researched how children learn. For instance, we looked at studies by the department of English language of the university of Cambridge on how children learn a second language. They advise primary school children to play, sing and read in both their first and second languages to improve development in both languages (Cambridge Assessment English, n.d.). K. Vanitha, Associate Professor & Head, Department of Education Periyar Maniammai Institute of Science & Technology (2018) describes the process of learning a language for kids as a more elaborate system. They describe it as a three-part system: firstly, kids should become familiar with the sound (or in our case shape) of words. Secondly, the words they are familiar with should be associated with what they represent. Thirdly, they will be able to recognize the sounds (again shapes in our case) and the people or objects those sounds represent.

Having done literature research, we decided to reach out to experts. We interviewed an expert working for Kentalis (figure 3), a Dutch institute which aids people who are hard of hearing, blind or have a communication disorder. They provide education, healthcare, and coaching (*Over Kentalis | Kentalis*, n.d.).

We learned more about how sign language is taught. The expert gave us insights into the problems the companies faced in their lessons. We received information about how Kentalis teaches people sign language and how they develop the tools used to teach. We also explained our ideas and talked about if and how this would work according to the view of an expert in the field. The biggest insight we gained in this interview, something we completely overlooked at first, was the existence of deaf culture. Just like with every other language, there is an entire culture engraved in the fabric of the language. After this interview, we also did research into the culture of people who are hard of hearing.

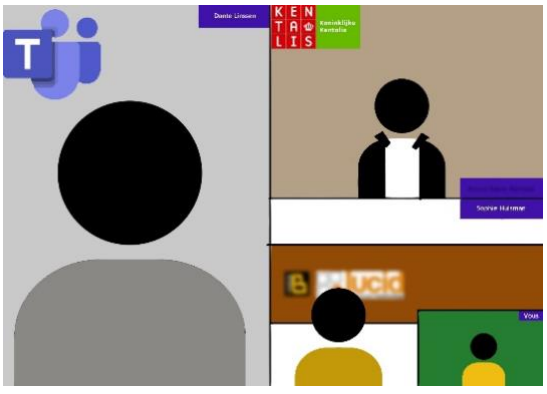


Figure 3: anonymized interview with Kentalis

We believe Carol Padden and Tom Humphries describe deaf culture beautifully in their book 'inside deaf culture' (2005): "… a group of people who did not have any distinctive religion, clothing or diet – or even inhabit a particular geographical space they called their own -could be called "cultural"" Deaf culture differs from what is normally considered a culture, but also had some similarities. It is not a grouping of people by nationality or religion, but it is similar in the sense that it groups by practices. Not being able to communicate with people vocally, like most do, leads to specific experiences and worldviews that can often be shared by other people who are hard of hearing. The language is also a big part of the culture, as we

were told at Het Nederlands Gebarencentrum: “You cannot learn the culture and language separate from each other, the two are inseparably interconnected.” (Nederlands Gebarencentrum, personal communication, November 21, 2023). Learning the language is learning the culture, like learning any other language, it is the gateway to understanding people.

We visited ‘Het Nederlands Gebarencentrum’ in Amersfoort, which is an expertise centre in the field of Dutch Sign Language. This expertise centre has created a dictionary for Dutch Sign Language and is continually updating this. They describe their goal as ‘the management and promotion Dutch Sign Language in all its manifestations.’ (*Nederlands Gebarencentrum*, n.d.)

They told us lots about the history of sign language and we were introduced to people who are hard of hearing for the first time. This was both remarkably interesting and eye-opening. Speaking with the people who we could aid with Handy, while also having a tough time communicating and having to rely on an interpreter because we were, and sadly still are, unskilled enough to conduct a conversation in DSL.

Like at Kentalis, we asked research questions and spoke through our ideas and plans. They told us that we should not aim to teach an entire language, but only to provide that beginning spark. To teach the utter basics, because basic knowledge ensures more understanding and openness for people who have a hearing impairment. This was also one of the goals of Het Nederlands Gebarencentrum: everyone should know basic words in Dutch Sign Language. (Nederlands Gebarencentrum, interview, November 21, 2023).

What was interesting at Het Nederlands Gebarencentrum, was that they were also developing a course for children to learn DSL. It was helpful to speak with people who were creating a similar product but who came from diverse backgrounds. We also confirmed lots of assumptions we had. For instance, that learning DSL in groups would be more effective than doing it individually. Additionally, they confirmed something that we had noticed in digital sign language courses, a crucial element that was missing most of the times online, the controlling factor. Where in a normal classroom a teacher can correct your mistakes, most online sign language courses do not have this controlling factor. They show video materials of the required sign and expect you to repeat it correctly. When learning sign language solely to understand what people are saying, this is sufficient. But if you want to converse, problems may occur. Therefor this would be a big part of our final game.

Figure 4: UltraLeaP

Figure 5: MANUS Metagloves

Because of this, and since we had to create a digital-physical hybrid game, technology would play a big part in our design. Most of the technology research was done for the controlling factor. How would a product know that the sign you are doing is correct? We looked at existing technologies and systems, such as motion tracking cameras and suits. Camera systems like ‘Ultraleap’ (see figure 4, using: *World-leading hand tracking: small. fast. accurate. | UltraLeaP*, n.d.), compact stereo camera systems with built-in software to build a rigging of your hands, or gloves like the MANUS Quantum Mocap Metagloves (see figure 5, using: *Motion capture gloves - finger tracking - MANUS*, n.d.). These are all emerging technologies that are very impressive, but there were some things that made them unsuitable for our project. There were budgetary constraints, but there were also a few technical shortcomings: DSL is more than just the movements of the hands, the hands are only half of the language. The position of the movement relative to the body and facial expressions also play a significant role in DSL. If we wanted to capture the position of the body and face, as well as the hands with technology like mentioned above, it would turn out to be expensive. Moreover, in case of the motion capturing suit, it would not be as comfortable. In case of the camera systems, they did not have the mobility we wanted. Later we stumbled on Pyxy3D, which is a python package used to create 3D rigging of

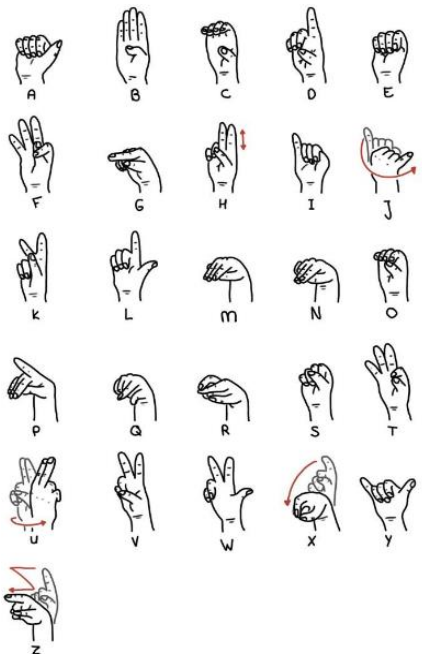


Figure 6: card game alphabet

an entire rigged body (*Pyxy3d*, 2023). Running this on a Raspberry PI Pico, a single-board computer, using two small cameras we could make Handy functioning.

Prototyping

Software development

The technical prototyping started with a complexly analogue version of what Handy would eventually become. It was a series of flip cards with the sign on one side and the corresponding letter of the alphabet on the other side. The players got five minutes to study the sign, shown in figure 6. After that, the gamemaster would start the game. In turns, every player would be shown a letter, and they would have to do the corresponding sign. After two minutes, the player whose turn it is, is eliminated from the game. This then repeats itself until there is a winner.

This was a quick and effortless way to gain many insights about how the project would function. We learned that the number of letters (the entire alphabet) was a lot to learn in such a short amount of time. So preferably, the number of words of letters will be decreased. We also learned that the game was a lot of fun to play, however, once players are eliminated, it is boring to not be a part of the game anymore. The elimination part should therefore be eliminated.

Later we made a wireframe version of our project. This was a drawn-out version of what the digital aspect would look like with all the interactions shown as arrows. Speaking about this with classmates and coaches, taught us new things about interactions and functions we were missing. This gathered information was all combined to build up our last version.

Product Design during iterations

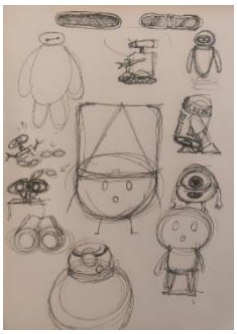


Figure 7: character sketches

Predevelopment phase: For the first step we began visualizing our ideas of what Handy could look like, by researching well-known figures that children can relate to, such as movie characters from children's movies. Then we implemented those ideas when creating multiple rough sketches (figure 7 and 8). After the sketches were done, we decided to let the product represent a robot-like figure for multiple reasons: it would house the technology required to have the correcting factor, while physically being a figure, like a teacher or a friend, whom children can empathize with. This was the start of the first iteration phase.

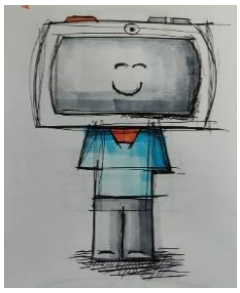


Figure 8: first Handy sketch

Iteration phase 1: We gave all our group members the task to make a sketch that would fit the design requirements we established in the predevelopment phase. After which we all selected our best sketches and presented them to the rest of the group. these sketches were placed side by side at the table and the best one was chosen as the current representation of Handy (figure 9).

Figure 9: second Handy sketch

Iteration phase 2: After some time, we wanted handy to have a softer and modern feeling to him. The first proper design concept was still too angular and clumsy. Because the learning-game takes place on a screen, the screen may well be his body. With that thought in mind, a new Handy design was created. Inspired by the little robot character BMO from the children's series “Adventure Time.”

Handy Design 2 was later 3D modelled, rigged, and rendered out, to get a realistic image and to experiment with different colouring. We chose a bright blue colour because we thought this would be the most appealing to children. Figure 10 shows the 3D model we made. The second Handy model was later used at the end of our demonstration video.

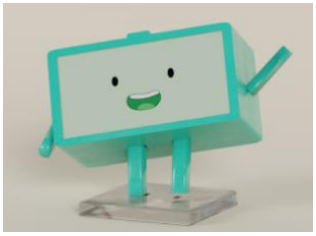


Figure 10: Handy model

Iteration phase 3: However, the second prototype was still too clumsy and fragile for children at early age, so we worked on the shortcomings of this design and made three last designs before building the prototype.

The third gen iteration-designs were designed in such a way that you could adjust their head (screen) so they could be used properly in allocated and dislocated places. Additionally, we did some calculations how big handy should be to support an iPad as its head. We made three scale models (see figure 11) made of PIR: polyisocyanurate on a one to two scale and presented them to family members and friends who are at younger ages. They chose which design they think was the best. And the design with the highest votes will be further developed.

Figure 11: Handy scale prototypes

Evaluating the concepts

Playtesting was done in the initial stages of development. We made a card game to learn the alphabet in DSL and assessed different quantities of words, the time needed for one game and if people would be interested in it.

The tests were done with peers, the group closest to our user group while still being allowed to participate in the tests (we were not allowed to experiment with people who legally were not able to consent to it). This gave us some great insights into how the final game would work and if the game seemed enjoyable. The card game proved to be a remarkable success, so we kept the concept for the digital game.

The wireframes were also evaluated with peers. Showing and speaking to them throughout the process so we could gather insights of people who were not involved in the project.

We also tested different version of our designs. (see Iteration phase 3 of the Product design) Showing them to people in our vicinity and having them image to be someone from our target audience. They would then tell us which version of Handy they preferred. While some like the minimalism of the leftmost design, the rightmost was the preferred one, confirming what we expected.

Branding

Because our product will help children learn the Dutch Sign Language, we thought it would a fun idea to design a logo that has something to do with hands. (figure 12)

Figure 12: first logo sketch

Because Handy is such a catchy name, we also wanted it to be displayed in the logo itself. We created multiple sketches that look like hands and experimented on how to implement it in the name. We chose for both human and robotic hands because our product is a robotic character.

Figure 134: second logo sketch

We wanted the logo to match with Handy's design, so we gave it a bright blue colour, which matches with the colour of Handy. These designs are shown in figure 13 and 14.

Figure 14: final logo

Because of the shape and character of our product resembling a retro futuristic robot, we decided to have those themes recur all throughout our designs, with icons and patterns paying homage to that theme of design. We also incorporated minimalistic shapes and designs, which would appeal to and catch the attention of our target audience. We picked the Nunito font to use for all our text, this font is clearly readable from a distance and resembles the same shapes that we use all throughout our visuals. For our colour scheme, we decided on calming but bright primary colours. This fits into our theming and easily catches the eye of young children amongst other toys on store shelves. The colour scheme, consisting of five shades, as well as the theming in our designs makes our designs easily recognisable and cohesive.

During this phase we also finalized the colour scheme we wanted to use for Handy, using multiple light blues to give a calming vibe, contrasting this with a yellow and pink to make it a bit more exiting. The complete palette is shown in figure 15.

Figure 15: colour scheme

Iterations

Iteration 1

For our first iteration, we created a low-fidelity card game prototype. With this card game, we can teach the alphabet in sign language. Figure 16 shows the cards we used for the tests, while figure 17 is the manual for the card game. The players have 1 minute to study all the signs, and then the game starts. The gamemaster shows a letter and the player whose turn it is must do the sign. If the sign is done incorrectly, the player gets to see the sign and must copy it. Then it is the next persons turn. The player whose turn it is after two minutes, loses the game, and is eliminated. Then the next round starts, until there is a winner. The goal is to create a quick and fun game for children to learn the Dutch Sign Language.

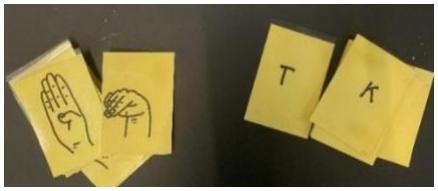
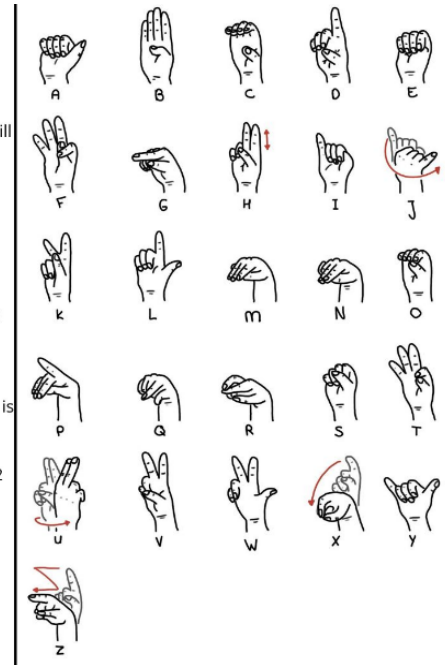


Figure 16: card game



Game summary:
A game of Handy consists of several rounds in which players will receive a letter/word of the Dutch Sign Language alphabet to sign as quickly as possible. During a process of several rounds, players will be eliminated one by one until two players are left standing. Those two will face off in a final round to determine the winner.

Game progress:
-opening (optional): for 5 minutes, players will be given the option to familiarize themselves with the cards and their corresponding signs, knowing these off the top of their heads will be an advantage during the game.
-round 1: for 2 minutes, one by one, players will be given a letter by the game master and must do the sign that fits the given letter/word. If after 5 seconds the player has not done the sign, the game master will show them the card with the sign. When the player has done the sign the turn will move to the next player. After 2 minutes, the player whose turn it is will be eliminated.
-round 2: the time is now reduced to 1,5 minutes. If the time passes, the player whose turn it is will be eliminated.
-round 3 onward: the time is reduced to 1 minute.
-final round: the final two players will play for 2 minutes. The player who is at turn once the 2 minutes pass is declared the loser, while the one who finished their turn will be the winner.

Required:
-1 game master
-4+ players
-sign cards

Figure 17: card game manual

After we had made the physical card game and set up some rules, we tested the game ourselves to correct major errors. After some corrections, we let other people play the game.

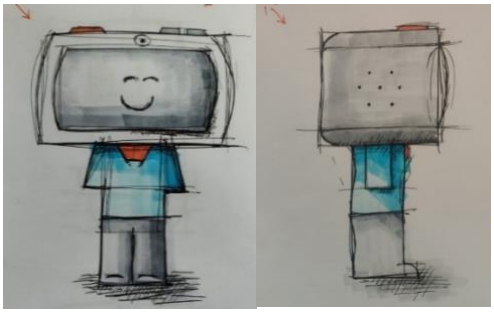


Figure 18: first Handy (front and side view)

During the playtests, we learned that the flip cards were an efficient way to learn the letters. Besides, it was helpful that another player could check whether a sign was done correctly or not. In half an hour, the players knew about three quarters of the alphabet. Trying it with multiple groups of players using different amounts of words or playtime, we dialled in the time and wordcount needed for the final game. We also found out that the game was a lot of fun to play, which is good, because children need to be willing to play the game in their spare time.

For the physical part, we all made sketches, (figures 18 and 19) comparing them and choosing the ones we like most, iterating on them to build a vision for our product.

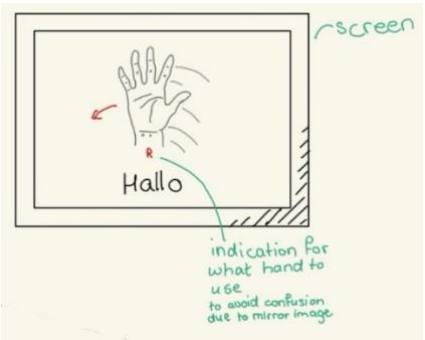


Figure 19: wireframe sketch

Iteration 2

For our second iteration we went on to incorporate the design brief more and more into our project. We turned our card game into a digital version and tried to digitalize the 'gamemaster.' (Figure 20, Handy our 'gamemaster')

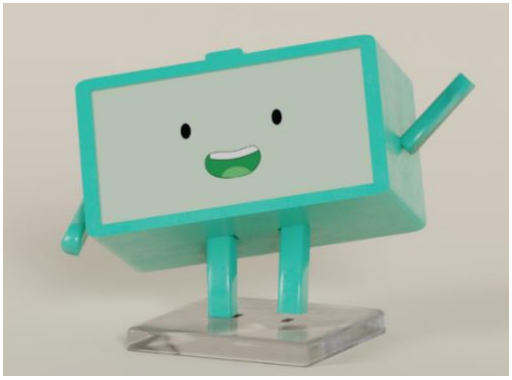


Figure 20: Handy model

As mentioned earlier in this document, the correcting factor is important to learn sign language properly (Nederlands Gebarencentrum, personal communication, November 21, 2023). This is why we wanted to be able to register and check the signs the participants were doing, to make sure they learn the signs correctly.

We wanted to give Handy this 'teacher' role. To give handy this controlling factor, we researched hand tracking camera systems. There were two things that made these systems unsuitable for our product. The first thing was that these systems were too expensive (with our target group in mind). The second problem with those systems was that Dutch Sign Language is not just the movement of your hands, it is also their position compared to your body and the movement of your face. So, a system that only tracks the movement of the hands is not enough to determine whether a sign is executed correctly.

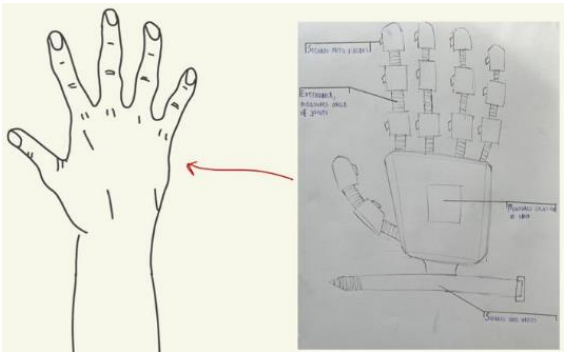


Figure 21: glove sketch

We also investigated using motion capturing suits, like gloves. This would give us an accurate rigging of the participants signs so we could compare it to the correct ones we modelled. There were a few problems with this iteration: to make the technology is demanding and therefore expensive (motion tracking gloves are expensive to make and even more expensive to buy, but figure 21 shows sketches we made to design them ourselves), since we wanted to keep it accessible for everyone this would not fit with our main goal. It also would be difficult to play it with multiple people in the period we imagined for the game unless everyone had their own glove. We were going to fix this in the following iteration.

Iteration 3

While doing technical research, we stumbled upon an Instagram account named python.hub (*Instagram*, Python.hub, n.d.) who demonstrated an open-source hand-gesture recognition software called “Pyxy3D”. This software could also be used to create 3D rigging of an entire rigged body. Exactly what we needed. We could use this software to do what we wanted to do in the second iteration, but cheaper and easier. We only needed to add two small cameras to Handy and it would we work. So, we tweaked our second iteration and generally improved it, dropping the glove idea and integrating Pyxy3D.

We also changed our design, using some more complicated shapes to give Handy some more character while also strengthening the entire product.

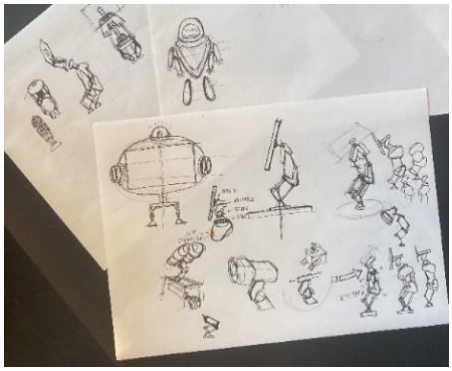


Figure 22: third iteration sketches

Figure 23: Handy scale prototypes

Figure 24: creating scale prototypes.

We built multiple versions of our design, testing out different shapes and constructions, this process is shown in the pictures above. These were made of polyisocyanurate blocks, a material we chose for its ease of processing and ability to take lots of shapes.

A decision was made to give Handy some more body, both to add stability and to make it a more attractive product for our target audience. We also built in some hinges so players could move around the figure to make it more interactive and add some adjustability, so the head, a lcd, would be visible for every player.

When we had the three designs we went and tested them, asking people in our surroundings to tell us which version they liked most, with the third one, shown in figure 23.

We also made the first version of the digital prototype. It existed of wireframes which were created in Figma Because of the prototype function in Figma, we were able to create an interactive prototype. While creating this prototype, we focused on the functions and less on the aesthetics, because we wanted to outline all steps of the gameplay clearly. Both creating the wireframes and testing it with peers, gave us a lot of insights about the game and the functions that were missing. With those insights, we made an improved version, which was the second version. This version was improved on the functions, so we had all the necessary functions included.

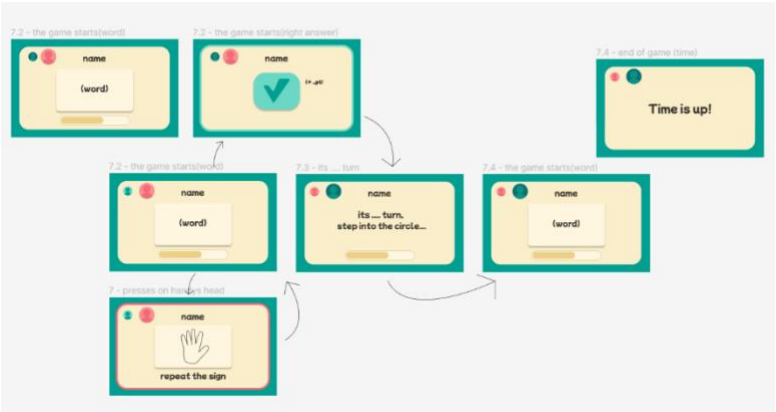


Figure 25: the wireframes for the Handy program

Future plans

In the future we would like to have to correcting factor working completely. We would use a raspberry PI PICO to run the code we have written using Pyxy3D. This would be connected with two 'Arducams' made to be run on a raspberry PI. This would give us the stereo vision needed to make full use of the Pyxy3D motion tracking. To display our game, we would use a nine-inch display unit. This size was chosen because it provides a right balance between readability and affordability. Using these components, we made a wiring diagram to show how we build this. (see figure 25) Below, we did some research into the costs of the electrical components; the prices are for consumers however, if we would realize Handy, we would be able to buy these components in bulk, causing the prices to drop. This would assure that we could keep Handy below the one-hundred-euro price ceiling we decided on.

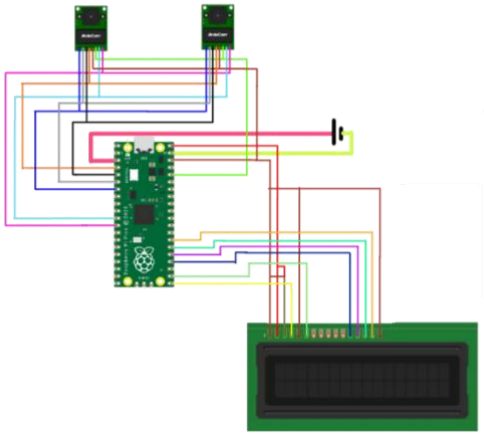


*Figure 26: The final wiring schematic, (*Documentation - Raspberry Pi Pico and Pico W*, n.d.))*

Product	**Price**
Raspberry Pi PICO	€3.50
ARDUCAM1	€24.50
ARDUCAM2	€24.50
Display unit	€9.00
Total price:	€61.50

Table 1: The price of all electronics needed to make a working Handy

The final design would also be made of plastic. This way the entire product would be lighter, cheaper to make and easier to produce, so it would make Handy both more affordable and handleable. We would like to iterate more on the design itself, doing research into how toys for children in our age group are made and interviewing specialists in this field of work.

In the future we would also like to make Handy more interactive. We would like to experiment with making the product motive, so that it could do the signs itself. This would make the interaction with the system more fun and more human. Something that we assume would make it more attractive to our user group.

Final Design

Physical design

We decided to make the definitive version of Handy out of wood, the material that worked best with the time constraints and the qualities we wanted Handy to have. We also simplified the design again, making it a bit more cuboid. Strengthening was done as well, by making it out of solid wood, but also by making Handy sit down instead of standing up. Figures 26 and 27 show the prototype in its raw wooden form. We also used sketching techniques to figure out sizes and rations, while producing this prototype. These sketches are added in the appendices. Technology integration was also an important aspect as we made sure the screen we wanted to use would fit in the demonstrator.

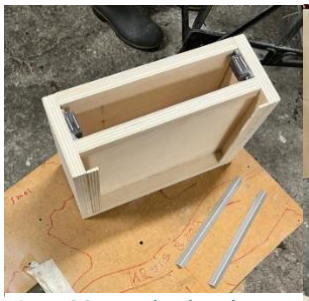


Figure26: wooden head

Figure 27: wooden body

When the figure was built, we used some spray paints to paint it (figure 28). We went for a blue head and body for its pleasant hues and calming properties (Valdez, P., & Mehrabian, A. (1994). Effects of color on emotions). The final prototype for this semester is shown in figure 29, on your left-hand side.

Figure 28: spray painting

Figure 29: the final Handy prototype

Digital design

After making the second digital prototype, we made a new version which was mainly improved on the aesthetics, which was the final version (appendices, overview of final wireframes). We integrated our chosen branding style into the wireframes. The font of our branding style has a good readability because of the open aperture and the x-height. We think this improved the overall experience of playing the game.

Gameplay

To set up the game, players must set down their Handy device on a level and stable ground. After doing so, they lay down the red circle on the floor. This serves to indicate to Handy whose turn it is, since that player must stand in the red circle. This helps the camera system not have to interpret all the hand movements it captures. The players then turn on the device and select the account of the main player, before selecting the accounts of the other players. They can then choose the time of their game session before starting the game. After watching an instruction video displaying the signs, players must take turns guessing the correct signs in the fastest time possible. If a player guesses a sign wrong, they are shown the correct sign and must repeat it. After doing so, they receive a new prompt to sign. If they guess it wrong again, the turn moves on to the next player. They have a time limit of 10 seconds, after which the turn will also move on. Based on the time taken to give a correct sign, they receive a score ranging from 1 to 10. The turns continue until the total time limit has passed, after which the leaderboard of scores will be shown and a winner is revealed. The players will then get to see a fun statistics screen, displaying statistics from the game such as the most wrongly guessed word. If any players are not in the same space as the others, they can join using their own Handy device and connecting via wireless play. Their Handy device will check their signs and compute the scores to send to the main player's device.

Manual

The game comes with a manual, designed using our signature colour scheme. On the back is a message from the team, wishing players fun with playing and describing the game in short. First, we create a long text explaining the rules and steps of the game as well as more minor functions such as the settings and fun facts displayed at

the end of each game. Since our game is targeted at young audiences living in the Netherlands who speak all sorts of different native languages, we added a Dutch translation of the manual after the English version. Since we want children to be able to play the game without much help beside the manual, we added a short step by step explanation of the gameplay at the start in both Dutch and English, so that children can quickly start playing, and kept the longer version, for parents to be able to understand the more complex part of the game. Visually, the manual uses similar shapes and colours to the other designs, like the packaging and visual interface. The entire manual is shown in the figure below, figure 30.

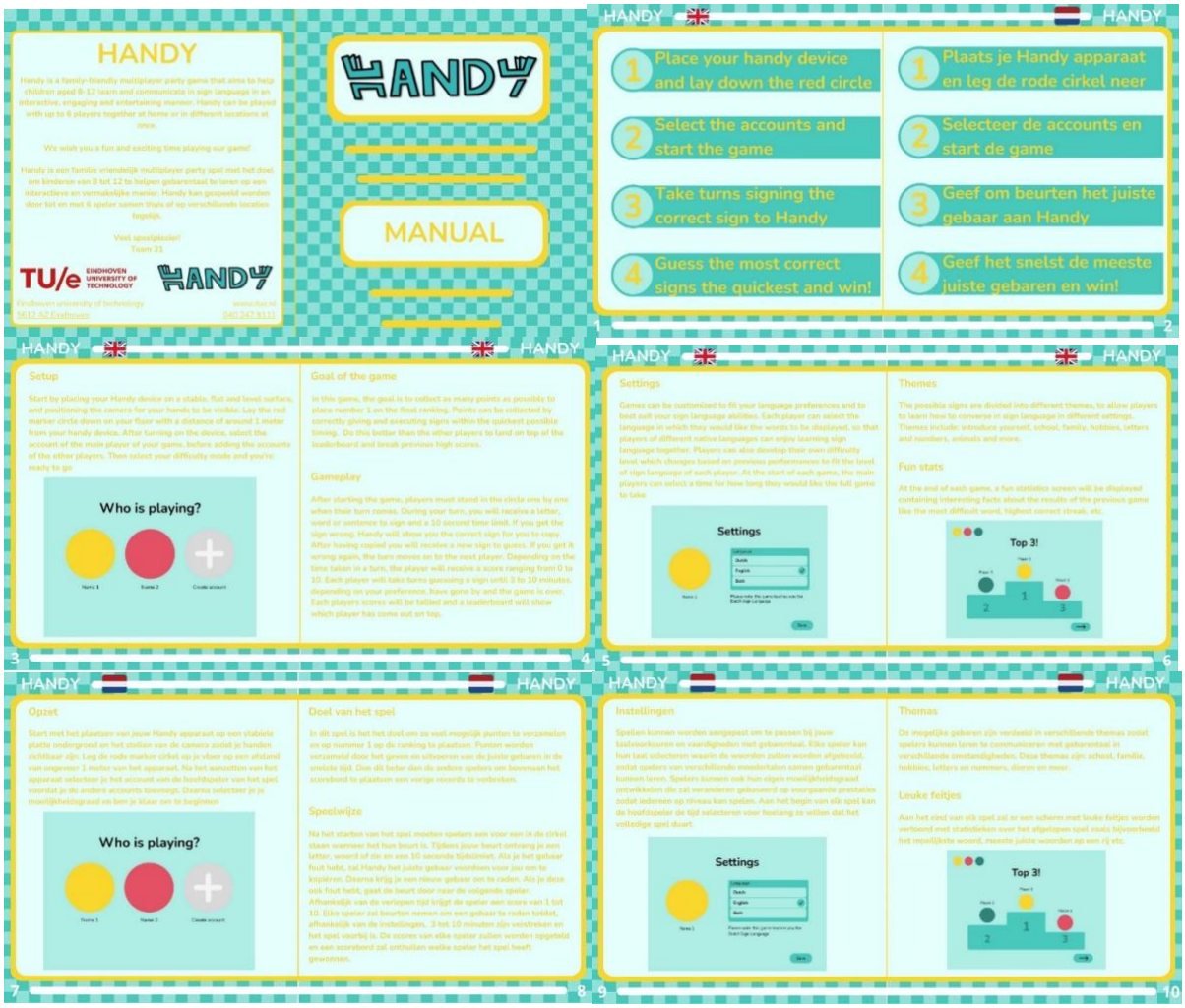


Figure 30: the Handy manual

Packaging

Our packaging is a fitted cardboard box which opens from the top. On the upper half of the frontside there is a cutout, where a thin plastic screen is placed, which makes Handy's screen clearly visible. When handy is still in the package, a paper cutout of the face will be placed over the screen to display his smile, since the screen will be turned off while packaged. The front features recognisable icons representing video game buttons to represent the brand by which fans can recognise Handy related media. The back features a short slogan to capture children's attention and illustrate the main goal of our game. The logo is featured on both the top and front, making for an easily recognisable product name on the packaging. The entire packaging is made up of the selected shades we decided on to stick to the brand that Handy would be known for. Since our target audience is children, the packaging does not feature an abundance of text, using visual features as the main attractor, with bright colours that attract the attention of young children among toys on store shelves. Inside the package are Styrofoam shapes to hold Handy in place, allowing for safe shipping and carrying from place to place. Figure 30 shows the template for the packaging, while 31 shows the packaging in its assembled form.

Figure 31: packaging

Figure 32: Handy packaging, assembled

Wrap-up

To conclude, undergoing an official design process for the first time was a fun and informative experience. Only having a design brief to go off of was a somewhat frightening but also freeing experience. It was nice to finally be left off the hook, something that could not be more different from the projects in lower education. Putting theories learned in different courses into practice was also an enlightening experience, as we were able to directly see how we would use these theories in projects. For instance: the brainstorming techniques learned in the second lecture of this course combined with the information we got on user groups in human centered design, was used to narrow down our goal and target group; creating a game to teach Dutch Sign Language (DSL) to kids without hearing disabilities aged eight to twelve.

We spent lots of time doing research, something we all enjoyed, it involved studying existing sign language learning tools, delving into the details of Dutch Sign Language, understanding how kids learn languages, and collaborating with experts at Kentalis and Het Nederlands Gebarencentrum. We did official interviews for the first time and gained lots of insights about Sign Language, like learning that it's not just about teaching the language but also understanding the unique culture embedded in Sign Language.

Technology was a big part of our project, researching into different methods of motion tracking and narrowing it down to a python library that we could integrate into our design. Looking at the technology available and having to choose the one perfect for our subject and requirements was a good experience and allowed us to have both the functionality and the affordability we wanted.

The designing phase was also a bewitching process. With every iteration Handy became more and more alive. This was aided by playtesting and testing for the aesthetics, looking at what works and what does not. The process as described was crucial for making our project into what it has become today.

The final Handy, a minimalist wooden structure with its calming color scheme was enriched with technology to bring it to life, finally becoming the teacher we designed it to be.

Reflecting on the process, shows how far we have come, and we feel like we can be proud of what we have made. The work done by our team, combined with the knowledge of experts and peers made our project into what it has become; Handy is not just a language course, we feel like it has become a stepping stone in making Dutch Sign Language more accessible and integrated into society, fostering inclusivity and understanding.

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Appendices

Summary of the interview at the Dutch Sign Language Centre (Nederlands Gebarencentrum)

Is learning sign language different for people that are deaf/hard of hearing as opposed to people who do not experience hearing issues? (For example, the course for parents of children that are deaf/hard of hearing.)

People with a hearing disability are in general much more visually coordinated than people without a hearing disability. It costs a lot more energy for people without a hearing disability to spend a long time concentrating on and looking at signs, since they are much more auditorily coordinated and, as a result, are not used to these types of learning activities. Thus, focusing on what you see will be something that these people will have to train more if they want to learn sign language. The need to learn sign language is also much smaller for people without a hearing disability compared to people with a hearing disability. Auditorily impaired people have usually already communicated with other deaf people through sign language out of necessity.

(Conclusion: learning sign language will be relatively easier for auditorily impaired people than for people without a hearing disability, mostly tied to the small "advantage" auditorily impaired people have. Apart from that, few differences in learning were mentioned.)

Are there specific things one should be cautious of while teaching sign language to children?

The most important thing is that the vocabulary fits the target group. Additionally, a form of gameplay helps keep the learning activities engaging.

->**How about motor skills?**

Young children, up to around 6 years of age (**Who do not fall in our target group**), do not always have the necessary motor skills to execute some signs. Often, a child will use a "simpler" version of the sign instead of the actual sign. This is comparable to how children learn to talk; some young children, for example, tend to replace an R-sound by an L-sound because they are not yet able to make and R-sound with their mouths. Both with learning sign language, as well as learning to speak, this will eventually develop itself. From this you can conclude that the underdeveloped motor skills of children up to 6 years old will not be a problem when learning sign language, as the skills will develop themselves eventually.

How do you teach sign language to people?

Our courses are in groups, with one teacher (preferably a teacher who themselves is also deaf). It is easier to see if you are executing the sign correctly in groups, since the other person has to understand you, in this way there are mutual checks between group members. The interviewees also named other advantages of learning in groups, such as that a group can help with motivation. Additionally, a group can help you practice communicating in sign language, through which you learn if you are executing a sign correctly and whether the other understands you. This is much harder to do on your own because there is no effective way to check your efficiency. For this reason, the Dutch Sign Language Centre only does courses in group sessions.

According to the interviewees, having a teacher who has a hearing disability helps you learn sign language because you will be "forced" to communicate in sign language, from which you learn a lot. If you had a teacher who is not auditorily impaired, you would not ask your questions in sign language as often.

How do the learning methods differ between children and adults?

De largest differences are in the themes of the words you learn, which are as much accustomed as possible to the daily life of the people you are teaching, which of course will be different for children and adults. Young children aged six or younger (**Not our target group**) do not yet have a fully developed set of motor skills, so some signs

will be difficult for them to execute. In those cases, they will often produce a simpler sign, like how they replace Rs with L's. Children also learn much quicker than adults.

We discovered that there is a whole culture that comes paired with sign language. What importance does this have when learning sign language in your view?

You cannot learn the culture and language separate from each other, the two are inseparably interconnected.

Do you think that learning sign language works and is useful for children? Why/why not?

It is very important that children learn sign language. Young children are quicker at learning it than adults (so it is also efficient). Having a basic knowledge of sign language helps you communicate with others, which is also great for the inclusivity of Dutch society.

(It would also be helpful if sign language would also be taught in middle/high school facilities, like in Belgium and Germany, which would help more people in the Netherlands achieve a basic knowledge of sign language, which then would make society more inclusive.)

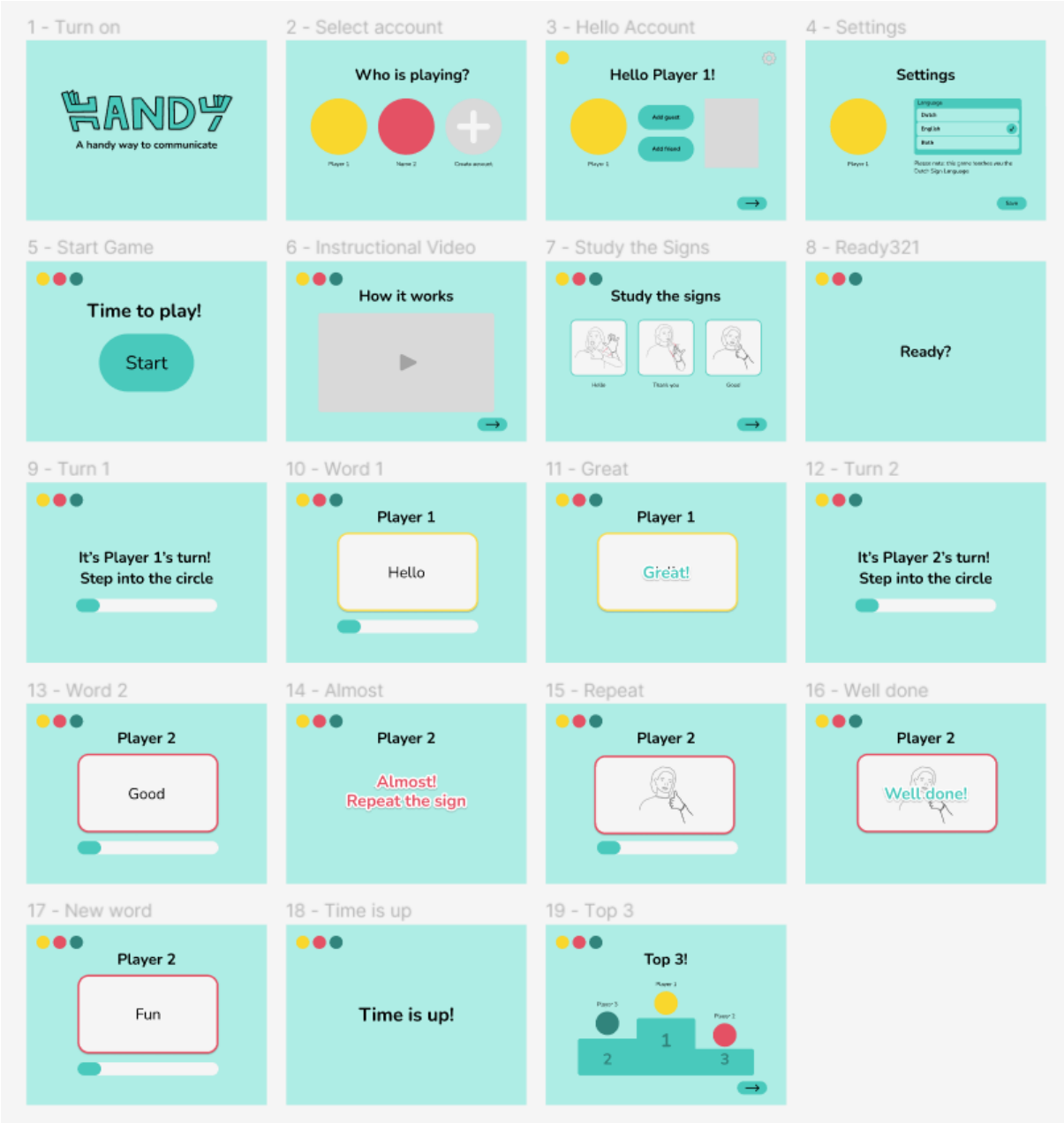
Important for our project:

It is important for us to teach children the basics of sign language, they do not have to learn the full language in a brief time period, but just building up a small level of understanding would help a lot.

Most teaching methods for language are for individual learning, how do you think methods for groups would impact the learning experience?

Teaching in groups has many advantages. You learn to communicate in sign language, and it is also more fun and motivating than working on your own. For this reason, the Dutch Sign Language Centre solely teaches courses in group settings.

Overview of final wireframes



Distribution of tasks

Jeppe van Broekhoven

- Final prototype
- Ideation
- Interviewer
- Report writing
- Research

Megan van Gerwen

- Graphic design
- Ideation
- Task division / agenda
- Report writing

Sophie Hulsman

- Head of communications
- Interviewer
- Ideation
- Report writing
- Wireframes

Dante Linssen

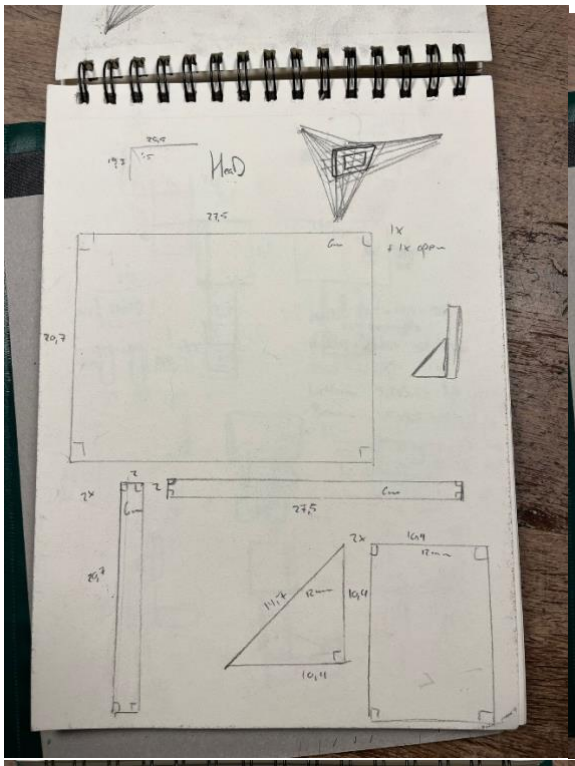
- Prototype designer
- Logo design
- 3D modeling
- Ideation
- Report writing

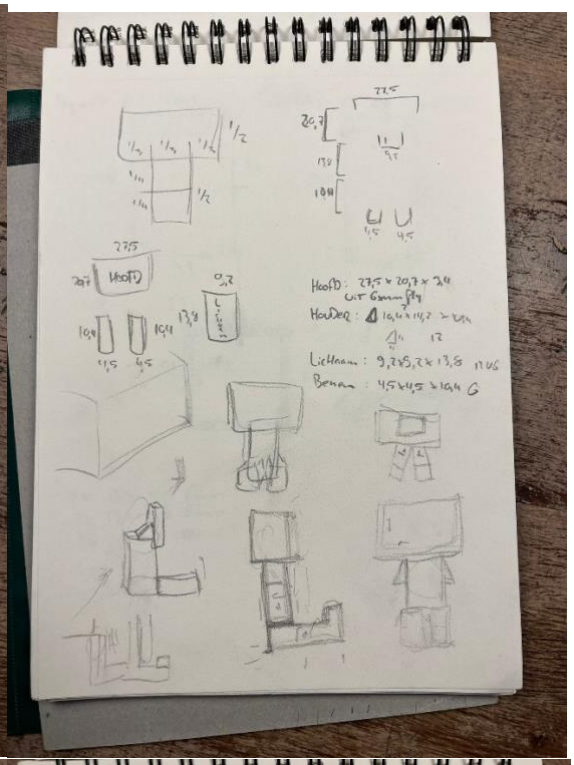
Siebe Nieuwhof

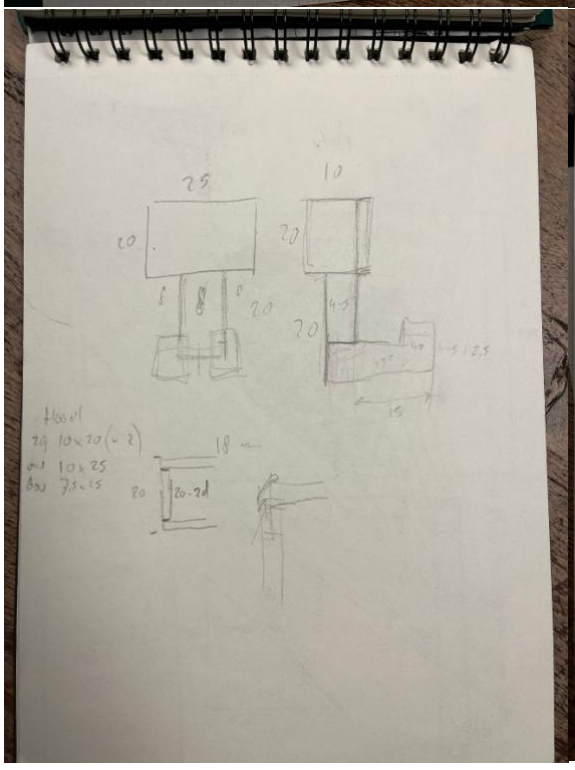
- Game manual
- Game packaging
- Game rules
- Ideation
- Report writing

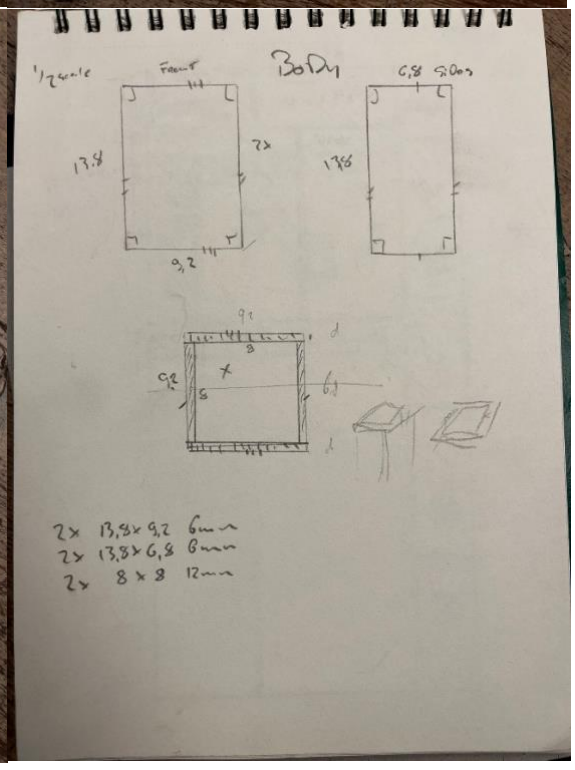
Technical sketches for the final Handy prototype

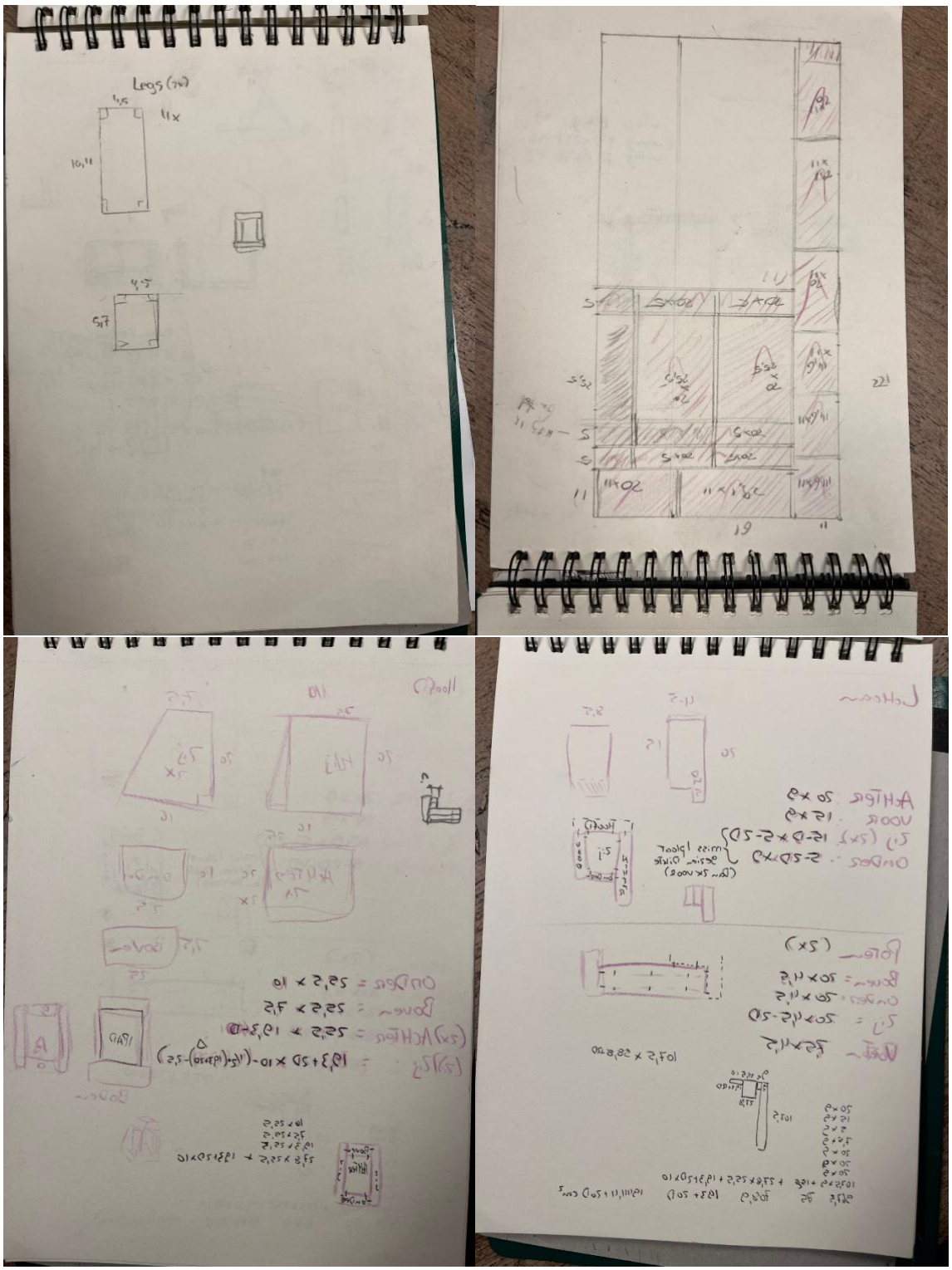
By Jeppe van Broekhoven







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5½
4½
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