
# Final Bachelor Project

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# Prologue

After three years of Industrial Design, having done many different projects and subjects, I had a clear idea of what kind of product I wanted to develop during my graduation project.
In my first and third project, I got to work and design a lot for children, aged 4-12 and 12-18. Designing playful interactions for this demographic was something that I enjoyed the most from those projects. It was something I saw myself continuing in during and after my studies.
At the same time, an interest in education started developing as well. Through side jobs and enrolling into the educational minor at the ESoE during my bachelors, becoming a teacher after my bachelor suddenly did not seem to be a farfetched plan.

For me as designer, play, education and children briefly summarize what and who I want to design for. It does not yet define what kind of products I want to make within this design scope.

Looking back at the products I designed during my second and third project, I see that in both the products serve as a bridge between digital technologies and physical product design. Seeing both the value of physical product design and the potential of digital technologies, these projects are still very relatable to me now.

I further developed this with electives like Creative Mechanical Engineering, Creative Apps and Educational Sciences 1 and by following a minor in Programming / Coding at the University of Amsterdam.

With this in mind, I looked at in which squad and project, I could fulfil the goals I had for my graduation project. One project from the Games and Play squad quickly jumped out as being a combination of all the different elements I wanted my graduation project to entail. The project focused on making a physical product that let's children play with data. Either for the sake of play and them getting some kind of grasp on the data, or for the sake of collecting data about children's play without interrupting their interactions while playing. Incorporating education into this project as well seemed like a very natural thing to do.

Excited to start this project, very little other projects and squads spoke to me. For my second option, I chose the Sensory Matters squad since out of all other squads – which I simply did not see myself working in –, designing through senses and material explorations attracted me the most as something I could develop more in.

Since students are assigned squads based on a lottery system, with students choosing their first, second and third option, I was unfortunately drawn out of the squad I wanted to do my graduation project in.

This affected my project mostly in the first half of the semester, as I was trying to find ways incorporate my previously set goals and interests in this squad. In the end, I am satisfied with to what extent I was able relate my project to my previously set goals and interests.

# Process

# First Exploration

## *Burger Lunch Kit*

Starting the design process, the decision was made to focus on children, the school / educational context, and food; in line with the topic of the squad. The exact age group of children was yet to be defined, but for this exploration I looked into research on primary school children specifically. I looked into what the current state of school lunches were among this target group, and if there were any opportunities to design for.

In almost all primary schools in the Netherlands, children get two breaks during the school day in which the students eat together with their classmates. In almost all cases, the children are expected to bring their own food. Given their young age, the contents of their lunchboxes are most often decided and prepared by their parents.
A problem arises however, in the fact that children today do not eat enough vegetables, fruit and whole wheat products (Van Rossum et al. 2016) (Rongen et al. 2019) (Volksgezondheid, 2019). The contents of children's lunch boxes are also very uniform among children, with 98% of children bringing sandwiches to school. Only 5% and 7% of children bring fruit and vegetables respectively (Vingerhoeds and Rongen, 2017) . This combined with the fact that children in the Netherlands move and exercise too little, has made being overweight or obese a growing problem in the country. This not only affects their physical health, but also their mental wellbeing and hinders them in daily activities (Vos, Kiefte-de Jong, Van der Velde, 2020). Tackling this problem at a young age can be especially beneficial, since 80% of overweight children carry these problems with them into adulthood (NJi, 2021).

The school environment can be a great place to change the dietary habits of children nation-wide, being a place that all children attend. But is there interest among children, parents and schools to have programs facilitating lunch at the schools itself? According to large-scale research done by the Dutch Ministry of Health, Welfare and Sport, there is (Van Giessen et al. 2020). In their research, multiple programs were evaluated where school lunches were provided by the schools themselves. Acceptance among schools, children and parents of these programs was reported to be high. And because the contents of the lunches were controlled, and made to be inline with dietary recommendations, children ate more heathy foods during these lunches. Another interesting point was that the cost parents reported to be willing to pay for these lunches was around €1.75 per child per day.

After having explored the current state of school lunches among primary schools in the Netherlands, I was inspired by a popular lunch food item originating in the US: Lunchables.
In short, Lunchables are food items targeted towards children, containing separate components of known meals like pizza, nachos and crackers. They also often contain candies and sweet drinks. The child is then able to assemble the meals themselves with the given items.

Having more than $1 billion dollars in sales in 2018 (Pinsker, 2018) and having more than 60 varieties, Lunchables have become a staple food in the US over their 34 years of existence. According to the company itself, their success lied not solely in the content of

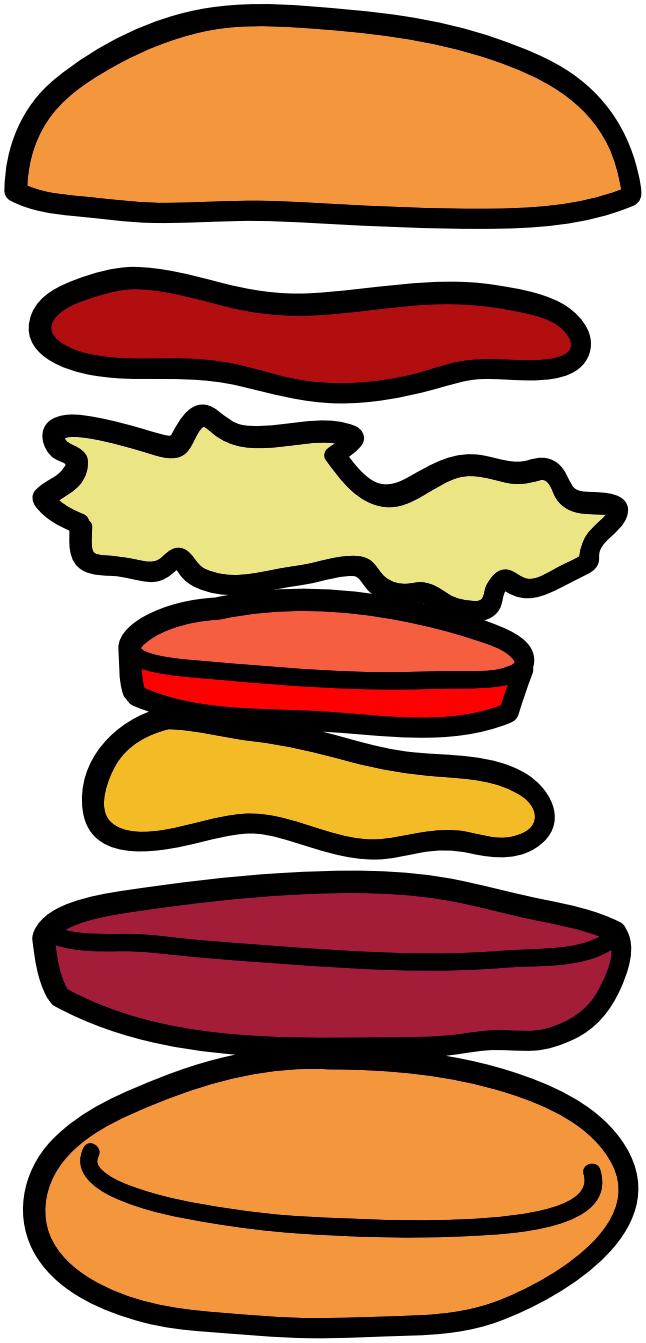
their food products, but mostly in the autonomy it gave children about their food. On dietary terms however, the products has its drawbacks. Some Lunchables are reported to have an entire day's worth of trans fats, salt and 65 grams of sugar in one serving (Moss, 2013).
The company did mention trying to improve the nutritional value of their food items and using fresher products, but doing so was paired with a decrease in sales and a shorter shelf life (Moss, 2013).

**Exploratory prototype**

The goal for my first exploration was to create a lunch kit similar to Lunchables, possibly able to incorporate into school lunch programs, while taking into account the dietary shortcomings of children's diets today. Just like with Lunchables, the idea is to have a multitude of different healthy lunch kits for the children to choose from and assemble themselves during school lunches.
I first chose to recreate a burger, replacing its conventionally unhealthy components like meat and oil-based sauces with healthier and vegan alternatives. The ingredients and proportions were decided on with the help of online recipes and through experimentation. The lunch kit consists of six parts:

- The burger, made from chickpeas, red beets, onion, garlic, binding agents like flour and oats, and flavourings like paprika, pepper and yeast flakes.
- A whole wheat bun
- A tomato flavoured sauce with chickpeas, oil, water, tomato paste and vinegar
- A cheese flavoured sauce with chickpeas, oil, water, yeast flakes, vinegar and sugar
- Raw tomato and white cabbage as vegetable toppings
- An apple cut into matchsticks to imitate fries.

To increase shelf life, I thought of the possibility of vacuum packing each individual component in plastic foil, similar to how a lot of food items already on the market are packed. These could then be stored in the fridge for 3-5 days, and possibly longer with the use of sterilization.
The concept got the critique of the coaches of not being novel enough and offering children autonomy on their food only on a surface level. Additionally, to try looking into incorporating different, more novel food sources like insects or algae into the lunch kit, to make it more innovative. The suggestion to vacuum pack the different components in plastic foil was met with the critique that single use plastic packaging create unsustainable waste.
Agreeing with the critique of it not being novel enough and too surface level, I began looking wider in the ideation process, instead of going deeper into this exploration. The idea of developing recipes or food items as a graduation project was also not something that tied to my vision and identity as a designer.
The idea of incorporating novel foods, insects in particular, greatly interested me however, and became a source of inspiration moving forward with the ideation process.



# Second Exploration

## *Buggy Puddy*

Continuing the design process, the idea arose to develop a product aiding children in getting used to eating insects. Insects are a very sustainable food source, especially when consumed as a meat-alternative (Smetana et al. 2015). Growing insects requires less land, water and resources while also releasing less greenhouse gases. The energy needed to produce a kilogram mealworms, surprisingly, is not that different from the energy needed to produce a kilogram of pigs meat (Oonincx, De Boer, 2012). Combined with the increase in demand for animal protein as population and global wealth have been growing, the need to transition from eating meat to insects becomes more apparent (Vlaar, Schaap, De Kruiff, Hol, 2015).

In very recent developments, the European Commission has approved the consumption of yellow mealworms in the EU (ipiff, 2021). Making it the first insect that has been approved as a "novel food" in the EU. Though this opens up a new market of insect consumption in the continent – one that is estimated to be worth $3.01 billion by 2027 (Meticulous Research 2020) – insect consumption is still very unpopular in most western countries (Schuurmans 2014).

The lack of entomophagy in western countries is a complex phenomenon that can be attributed to a lot of different factors. Notable reasons are neophobia and the negative associations people have with insects (Schuurmans 2014). Insects are often met with negative associations like disgust, disease and plagues. And though there are plague and disease causing insects, edible insects are rarely seen as separate animals from these.

In addition to dismantling negative associations towards insects, positive associations like health, sustainability and cultural identity need to be built through learning, education and exposure. Not only that, but neophobia in animal products is generally higher than for non-animal foods (Schuurmans 2014). And even for widely integrated animal products like beef, pork and poultry, westerners generally do not want to recognize the animal on their plate.

It is not uncommon for novel foods to be incorporated into new markets though. The most famous example being sushi, that was first introduced to the American market in the 1960s. From there reached it European mouths as well (House 2018). To introduce insects to the western market, a few things have to be done beforehand though.

Learning from sushi, insects could be integrated through popular subcultures and fine dining as well, where the taste is adjusted to the western cuisine. Insects would also need to become more accessible. Looking at my own experiences and knowledge before and even while doing this reason, I have no idea where I would be able to buy insects nearby or how to prepare them in a meal.

Incorporating insects using these methods proved be successful in a study done by the UWE Bristol in collaboration with Bug Farm Foods. By presenting the insects as familiar food items like burgers and Bolognese at a school cafeteria lunch, students were open to eating it. Informing the students about the environmental and health benefits of insects, made them even more willing to eating insects as part of their daily diet (Jones 2020).

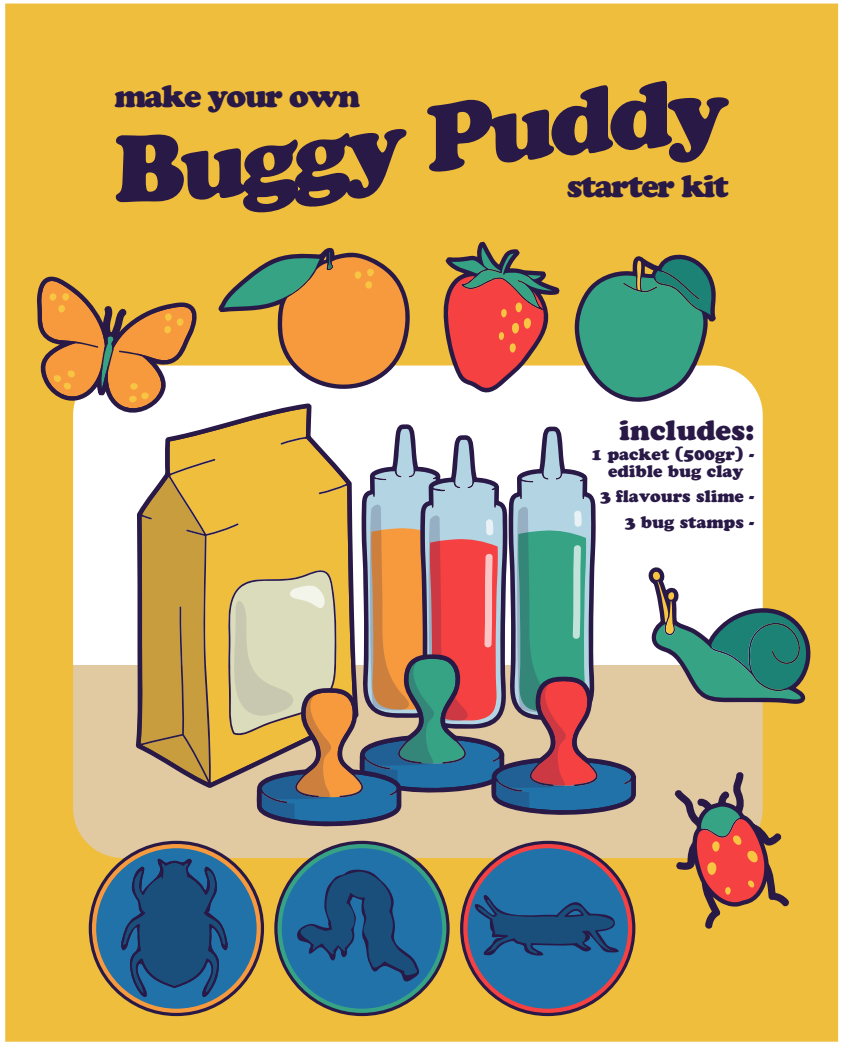
Coming back to the target group for this design process, an interesting study was done to measure neophobia in children (Loewen and Pliner, 2000). During this study, children aged 7-9 and 10-12 were exposed to novel foods, both good and bad tasting. Interestingly, exposure to the novel foods decreased neophobia and increased willingness to try more novel foods in the older age group, while for the younger age group, the results seemed the opposite.

**Exploratory prototype**

For my second exploration, a product concept was proposed with which children get to prepare and eat insect food items on their own. They do this with a puddy or clay that is composed for the majority out of insect meal. With the help of stamps, they are able to shape the puddy into different insect shapes. After decorating and flavouring their creations with colourful and sweet flavoured gels, they are ready to be consumed. The goal of the product is to create positive associations with insects like play and sweet flavours and making eating insects more accessible to children.
To validate whether this could be the case, and to gain more insight into the relation between children and food, I arranged a semi-structured interview with a paediatric dietician who has worked as one for 6 years as of yet. The full interview can be read in Dutch in appendix B.

A key takeaway from the interview was that she was not sure whether the product would help children eat insects given the end product would not actually taste like insects. When asked whether she has ever recommended insects to her clients, she mentioned she did not as of yet, but she does expect it to be eaten more in the future. Regarding the proposed age group of 10-12, she mentioned that it is easier for her to include their needs and wishes in her dietary advices but also that their older age meant that it can become harder to change their habits than that of a younger child.
The importance of having children experience the actual taste of insects was very interesting to me and led me to my next exploration.

*Buggy Puddy*



# Third Exploration

## *Feeding Mealworms*

While doing research into insects as part of my previous exploration, I became especially interested in mealworms as edible protein due to them being very easy to grow, even at home. As mentioned before, insects need very little land, water and resources. I had not realised how little until I came across multiple blogs of people reporting their methods and experiences of growing mealworms at home. A blog mentioned only needing a mealworm colony the size of an aquarium, to produce 100 grams of fresh mealworms each day (Bugible, 2018). With the only other needed resource being regular oats and the occasional vegetable for water intake (The Happy Chicken Coop, 2021). A product has also already been developed that let's consumers grow their own mealworm colony at home (LIVIN farms, 2020). Its small size makes it especially approachable to consumers.

Delving deeper into home grown mealworms, I came across a blog of someone claiming to being able to change the taste of their mealworms through their diet (EntoMove Project, 2016) (Ground to ground, 2013). By changing the type of flour the mealworms eat, or giving them a diet solely consisting of cinnamon for example, the mealworms were reported to take on the flavour of their feed.

Relating back to the comment of the paediatric dietician, altering the flavour of the insect to familiar spices and flavours, while letting children experience the taste of actual insects, seemed like an interesting concept to make further explorations in.
To do this, I repeated the process the blog posts mention on changing the flavour of mealworms through their diet.

**Experimentation**
Having bought 500 grams of live mealworms from Grislee BV, located in Boekel, NL, the mealworms were divided into eight batches. Seven of those, each containing 50 grams of mealworms, were each given a diet of different spices, herbs and other food items. Namely, dried rosemary, fresh basil, roasted and unsalted peanuts, cinnamon sticks, raisins, orange peel and margarine. The selection was decided on to have both sweet and savoury flavours to potentially incorporate the mealworms in both types of dishes. Margarine was included in the hope that by giving them food consisting mostly of fat, the prepared mealworms would take on a more fatty quality. The remaining mealworms were not given any food. This – known as purging – is done to rid the mealworms of their digestive contents before preparation (Ground to ground, 2013). This batch were to be used to try different mealworm preparation methods, as described in the following chapter.

The mealworms were given the diet for around four days, as was recommended in the aforementioned blogs. Each day, the mealworms were examined to see whether they accepted the food items. They were then purged for two days.
Afterwards, half of the mealworms were made ready for preparation by freezing them overnight, putting them in a dormant state. The following day, they were boiled for at least five minutes, making them safe to eat. No other preparations were done to these batches to ensure a taste most true to their actual taste, without preparation methods like frying or baking having an influence on the flavour.

Surprisingly and unfortunately, none of the batches of mealworms were found to have any flavour resembling the diet they were given.

The experiment was repeated with a few alterations: the period in which the mealworms were given their unique diet was extended to six days and they were not purged before preparation. With the idea that this might be the reason they lost their flavour before being eaten.

Sadly, these mealworms were also not found to have any flavours resembling their diet. A notable result was that the mealworms given the peanuts were found to be noticeably bigger and fuller than the others. At first it seemed that this might have given the result I was hoping to get by giving the mealworms margarine. But examining closer and noticing that more of the mealworms had pupated, it is more likely that these mealworms benefited from the high nutritional content of peanuts compared to the other food items, making them grow and develop faster.
After having barely any promising results after two weeks, I decided to stop the experiment and look for other areas for ideation.

*Mealworms with different food types*

# Fourth Exploration

## *Preparing mealworms*

The vast majority of insect food products sold on the market use (freeze) dried insects. These are for example processed into a powder to be used as ingredient like in Chirpsies (Nimavert, 2022), or flavoured with spices as a snack or topping, as sold by Jiminis for example (Jiminis, 2022). According to a coach of the squad, this process reduces the insects to a papery husk, removing the distinct tastes the different insects have from each other. Since taste is an important factor in promoting insect-based foods (Frontiers, 2018), not embracing the actual taste of the insects felt like a step in the wrong direction towards incorporating insects into the western diet.

Working with live mealworms myself, I could make explorations in preparing the mealworms differently from what seems to be most commonly done at the moment. By boiling the mealworms instead of drying them, I noticed the mealworms having a completely different texture and taste than those that were freeze dried. While the dried mealworms were light, papery and had a roasted flavour, the boiled mealworms were still meaty inside with a slight nutty taste. Their hard shell stayed intact a lot better, making it harder to chew on than their dried counterparts.
Working with this different product made preparing them further a logical step.

At first I pan fried them in some oil for a few minutes. Their shells started browning, making them crispy instead of chewy. Their nutty flavour was complemented by a roasted flavour. Adding some salt made them into a snack very similar to roasted peanuts or a topping similar to grilled onions.

*Process of boiling, grinding and frying mealworms*

Then I experimented with blending the boiled mealworms into a paste. The paste had a similar taste to liverwurst which, after adding a little bit of salt, could be used to be spread on crackers for example. The paste did contain small slivers of the mealworms' shells. The texture of these slivers was comparable to that of the hulls that can get stuck in your teeth eating popcorn. Trying to combat these slivers could be done by using a more high powered blender to produce the mealworm paste.

Since this paste could be described as ground meat, I shaped it into a patty and tried pan frying it like a regular meat burger. Once fried, the mealworms did not hold their shape and disintegrated into coarse powder. It tasted similar to toasted breadcrumbs, that you would find on top of a gratin. Not becoming the burger that was intended was assumed to be due to the absence of binding agents in the ground mealworms. Taking inspiration from the way meatballs are commonly prepared, oatmeal, flour and an egg was added to the ground mealworms along with salt and pepper. Their loose consistency transformed into a dough that held together better. These were then shaped into balls and pan fried. The binding agents made the balls hold its shape even after frying to produce intact mealworm meatballs. The balls had a taste similar to meat, though distinguishable from common cow, pig or chicken meat. The distinctive flavour of red meat from beef was not present for example. The browning imparted a taste similar to toasted bread as well.

All in all the experimentations lead to some interesting results, with enough aspects to elaborate further on. But at this point I started to reflect on how these explorations could be used towards my goal of introducing insects to children.

*Mealworm burger*

*Mealworm ball*

# Conclusion Explorations

Having done these different explorations and midterm demo day being only a few weeks away, I felt at somewhat of a crossroad. The concepts all explored different aspects of integrating insects to the western diet, but at the same time it felt like the problem was too complex and multifaceted to tackle effectively with only one exploration (or rather a further development of one). Additionally, on a personal level, the concepts, especially the last two, did not match my vision and identity as designer. Thinking further about what developments could be made with the explorations, did not lead to concepts that I saw myself wanting to work on for my graduation project.

At this point, I started looking into one of the yet unexplored aspects of integrating insects into western diets: building positive associations with insects through learning and education on the environmental benefits. Teaching children the benefits of cultivating insects through play started to look like a design case I was generally interested in and lined up a lot more with my identity as designer. Within this concept, the complexity of integrating insects into our diet could also be incorporated.

# Final concept

**Prototype**

Since the concept of creating an educational product to teach children the importance of cultivating and insects came not too long before midterm demo day, a prototype was created almost immediately of what this product could look like. The prototype represented a board game targeted towards children of the ages 10-12.

The prototype consists of a wooden board, wooden board tiles, playing cards and coins. The board consists of two parts: a playing field representing a city and its neighbouring land used for agriculture, and a dashboard that keeps track of four parameters with LED lights. The parameters are: consumer happiness, energy use, water use and land use. The board tiles each represent a farm, either a traditional meat farm in orange, or an insect farm in yellow. Each containing data about their energy use, water use and emissions. Two additional tiles represented a "meat supermarket" and "meat restaurant, while two others represented an "insect supermarket" and "insect restaurant". These would have an influence on consumer happiness. The cards and coins were there to represent the prototype as board game, and suggested towards how the game would be played were it developed further.

Being targeted towards children aged between 10 and 12 years old, players of the game would play as the major of "Arthropolis", a fictional city. Arthropolis is in the process of transitioning from growing and eating meat to growing and eating insects. The players can perform actions like swapping farms and employing


*Midterm prototype*

campaigns or subsidies to achieve this, while keeping maintaining consumer happiness. Doing so, they would see energy use, water use and greenhouse gas emissions change, learning about the benefits of insect cultivation through their own experience playing the game.

The game could be played alone or with multiple children, in which case they would collaborate with each other to decide on what moves to make next.

Being an early prototype, it did not contain any electronics or functional elements. It's purpose was to convey the product concept well enough to receive meaningful feedback during the midterm demo day. The prototype was made mostly out of MDF wood, which was hand measured and cut at the workshop in the Vertigo building. Since this did not produce a very clean result, with visible gaps between the individual wooden pieces, a different production method would need to be used for the final prototype. The LEDs were represented with coloured paper. The other details on the prototype were also printed on paper and glued on.

**Midterm**

For the midterm demo day, I presented my new concept and prototype, while relating back to my previous explorations with small pamphlets glued on cardboard.
The feedback I received during the demo day was overall very useful and motivating to continue developing this concept as a final product. Notable feedback included looking into other board games targeted towards this age group and using their complexity as a guideline for the complexity of this game. Concepts like subsidies and campaigns could be too complicated for children aged 10-12.
Furthermore, the context in which the product is used should also be elaborated on. Whether it is intended as a consumer product or to be sold to primary schools for example would drastically change the design perspective going into the final product.

*Midterm setup*

# Background research

Regarding the scope of the product, the choice was made to design the product as part of a primary school's curriculum on sustainability. Increasing awareness and teaching is one of the primary goals of the product, Schools are considered as a fitting place to use the product. Considering the target group, parents would have a large influence on the buying decision were this product to be offered on the consumer market. As aforementioned, entomophagy and the attitude towards insects is low among western consumers. With this in mind, a product that teaches about the importance of insects and their sustainability might not be a popular choice for consumers, when it is offered next to more thrilling and already widely popular board games like Catan.

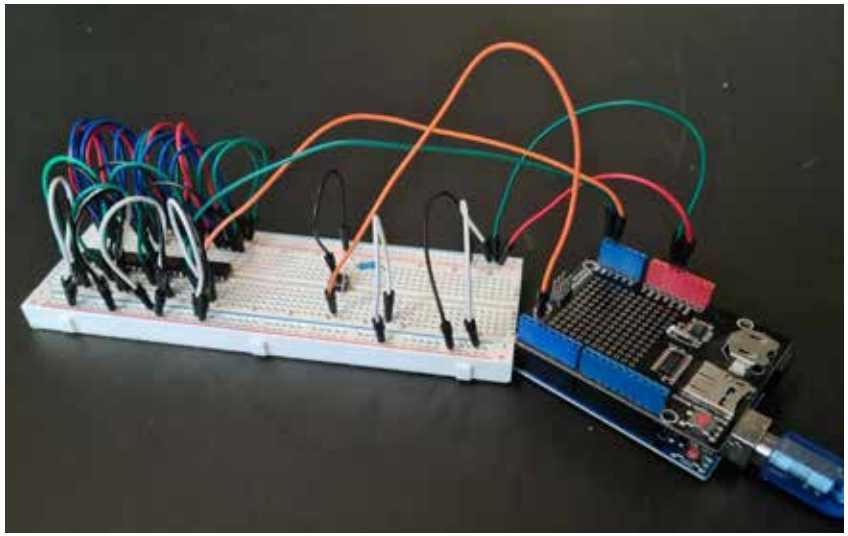
Going into designing the final prototype, large parts of the midterm prototype were kept the same. It would still have a board with swappable tiles, a dashboard displaying the four aforementioned parameters, playing cards and coins.
Since the board and board tiles were a crucial function of the product, I looked into how I could make this out of electronics. The board needed to be able to recognize whether a tile was placed on the board and distinguish each tile from each other.

To do this, the tiles needed to be able to hold digital information and a way to communicate this information to the board. EEPROMs (Electrically Erasable Programmable Read-only Memory) seemed like a good fit to do this. These chips are, depending on the type, able to hold up to 1 megabit of information. Since the board tiles could make do with only

To do this, the tiles needed to be able to hold digital information and a way to communicate this information to the board. EEPROMs (Electrically Erasable Programmable Read-only Memory) seemed like a good fit to do this. These chips are, depending on the type, able to hold up to 1 megabit of information. Since the board tiles could make do with only containing an ID number for the board to recognize, this was more than enough. The chip has eight pins with which it can be connected to a circuit. To facilitate the tiles being connected and disconnected repeatedly, eight pin IC sockets could be incorporated into the board. These are then soldered to the circuit inside, leaving the chips free to go in and out of the sockets. The EEPROMs have a binary numbering system integrated into the chip. Because of this, the Arduino can address each chip with a binary number between 0 and 7, being able to connect eight EEPROMs to the Arduino at once. Having eight sockets with eight pins each for a total of 64 different connections would seem impossible to connect to one Arduino at first glance without the use of a port expander.

Looking more into the complexity of using RFID with pin expanders compared to EEPROMs, the decision was eventually made to use EEPROMs for the final prototype. This will have to be accommodated for accordingly in the final design, especially so that the chips could not be connected wrong or break during use.
To test whether the EEPROMs would in fact work for this application, a small circuit was made connecting four EEPROMs and a button to an Arduino. Since the EEPROMs only have a set amount of reads and writes before the chip would

degrade – namely around 100 000 (Microchip Technology Inc. 2009) -, the Arduino could not be programmed to for example read the data from the EEPROM every millisecond, as this would wear the chips out quickly. By only having the Arduino read the EEPROMs when the button is pressed, the chips would last much longer. Assuming during one play session the button would be pressed between 10-100 times, the game could be played between 1000 and 10 000 times,



**Data research**

With this in mind, research was done towards creating the educational game for which the product will be used. As mentioned before, the goal of the game is to teach children aged 10-12 in a playful manner about the environmental and health benefits of transitioning from producing and eating meat to producing and eating insects.

To do this, a clear idea of how a city would go about incorporating insects into their agriculture and the population's diet. Not only this, but also the environmental benefits of doing so need to be known.

Starting with the latter, data about the current state of meat agriculture in the Netherlands to use in the game was retrieved. The three most common meat types were considered for this.

This data can be seen in table 1.

| **Meat type** | **Production** (CBS, 2021-a) (10^9 kg) | **Energy usage** (Moerkerken et al. 2014) (MJ / kg) | **Water usage** (L / kg) | **Greenhouse gas emissions** (Rijksdienst voor Ondernemend Nederland 2018) (kg CO2 / kg) | **Total amount of animals** (CBS, 2021-b) (CBS, 2021-c), (CBS, 2021-d) | **Average land usage per animal** (Van der Peet et al. 2018) (m2) | **Total land usage** (10^6 m2) |
|---|---|---|---|---|---|---|---|
| Cow | 0.424 | 5.5 | 845 | 7.1 | 11456833 | 1.7 | 1.9 |
| Pig | 1.6 | 23.7 | 660 | 4.26 | 1046503 | 0.8-1 | 12.5 |
| Chicken | 0.997 | 17.4 | 252 | 1.9 | 47 084 423 | 0.05 | 2.4 |

*Table 1*

| **Meat type** | **Amount of farms** | **Energy usage** | **Water usage** | **Greenhouse gas emissions** | **Land usage per farm** (10^6 m2) | **Board tile dimensions** (cm2) |
|---|---|---|---|---|---|---|
| Cow | 1 | 1 | 4 | 4 | 1.9 | 12 |
| Pig | 3 | 4 | 3 | 2 | 4.17 | 25 |
| Chicken | 2 | 3 | 1 | 1 | 1.2 | 7.2 |

*Table 2*

The data was transposed and simplified to be used in-game. For each parameter, the farm type that had the highest usage was given a score of 100%. The two remaining farm types were given a percentile score related to their usage compared to this higher number. In the case for energy usage for example, pig meat had the highest reported usage with 23.7MJ / kg. This was set to 100%. The remaining two farms, with an energy usage of 5.5MJ / kg and 17.4MJ / kg were given a score of 25% and 75% respectively. These percentile scores could then be converted into single digits. So pigs meat, gets a 4/4, cows meat a score of 1/4 and chicken meat 3/4. For production, since there were six tiles, each meat type would get an amount of farms relating to the amount of meat produced. Since in total, around 3 billion kg of meat is produced in the Netherlands each year, each farm represents around half a billion kg of meat production. For land usage, the total land usage was first divided into the amount of farms for each type. This could then be converted to corresponding dimensions for the board tiles. This process was repeated for the different parameters. This can be seen in table 2.

Regarding how this data would be used in game, the energy, water and emissions parameters are to be written on the EEPROM chip of each farm tile. The Arduino can then read this data and display the parameters accordingly on the dashboard using the LEDs. The last parameter will be visualised by changing the size of the board tile accordingly.

The process of defining the scores of these parameters for the insect farms was slightly different. Since insect farms are not common in the Netherlands at the moment, comparable data was hard to find. Let alone having different data for each different farm.

To combat this problem, research was looked at that compared the water use, energy use and carbon emissions of insect farms to meat farms (Oonincx, De Boer, 2012) (Hinder 2016).

Similar to the animal farms, this data was simplified to be used in-game. Since too little data was found that distinguished between different types of insect farms, all the insect farms were to receive the same scores for the parameters. This can be seen in table 3.

Regarding the data about land usage: to prevent the tiles becoming too small the insect farms were decided to have the same size as the chicken farm. As these were the smallest of the three meat types. In this way, it could still become clear to the player of the game that land usage would decrease when converting to producing insects.

With the research completed, the process of making the prototype continued

| Meat type | Energy usage | Water usage | Greenhouse gas emissions |
|---|---|---|---|
| Insects | 3 | 1 | 1 |

*Table 3*

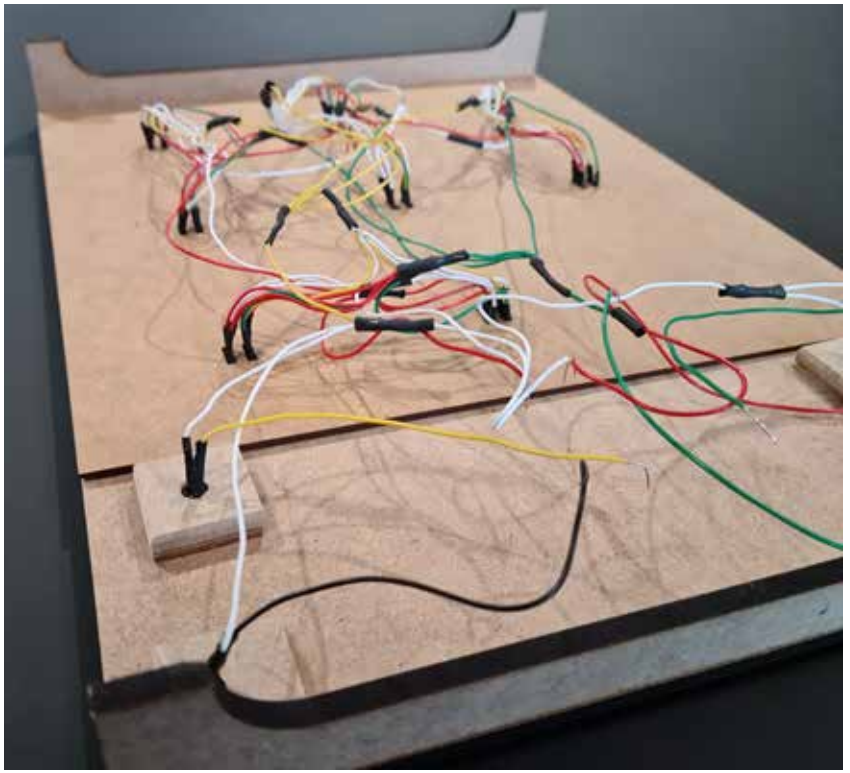
# Final Prototype

Firstly, the circuit was made by soldering wire to all eight pins of the eight sockets and securing it with heat shrink. These were then connected to the right pins, after which the buttons and LED strips were soldered and glued in place as well.

While testing the circuit, some sockets did not seem to be properly connected with the circuit and could not read the EEPROM chips when they were inserted. While this problem was fixed by resoldering the pins for two sockets, two other sockets seemed to have gotten solder in the holes where the pins of the EEPROM chips are supposed to be inserted. Trying repeatedly to get this out did not lead to the desired results. For this reason, the final prototype was to contain six sockets instead of eight. Since the presence of six farms being on the board at all times was already accounted for and supported by research, it was decided to remove the supermarket and restaurant tiles from the prototype. These were reincorporated as cards instead.

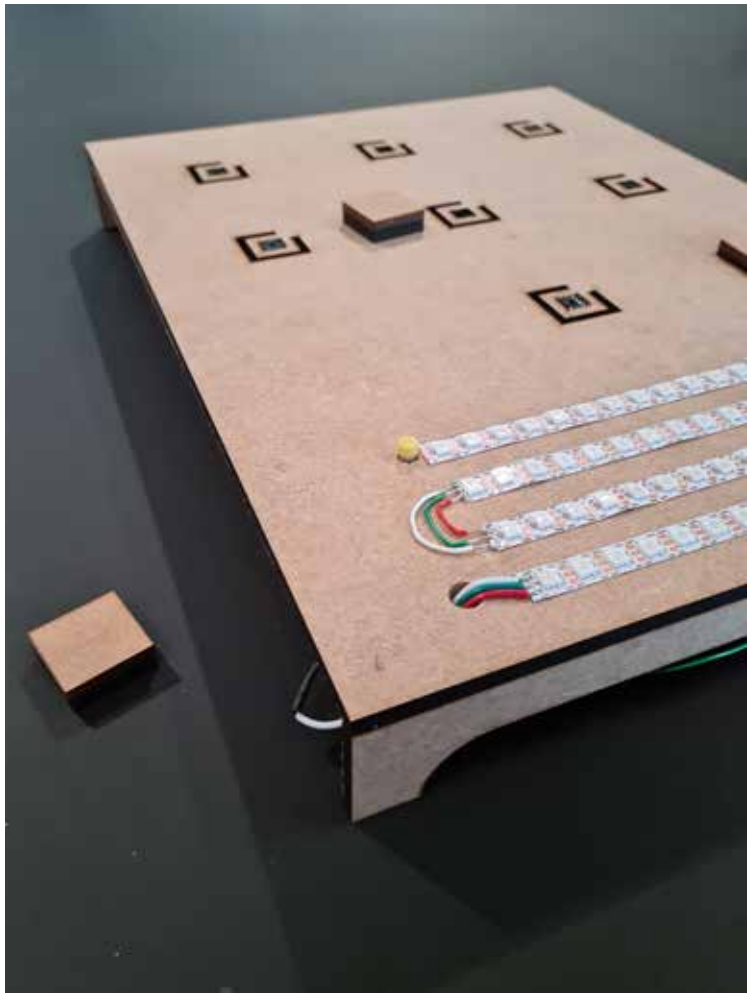
The body of the prototype was made in two parts. An inner body housing all the electronics and a outer one containing all the non-electronic visual elements of the board.

The inner body was made by laser cutting four pieces out of MDF wood. The first being the board, containing slots to hold the eight pin sockets and the board tiles. Second to that a backplate, containing slits for the pins of the sockets to go through. The backplate was glued to the board after the sockets were soldered in place, after which the sockets were glued to the backplate with hot glue. Two plates were also cut and glued to the sides of the board to hold it above the ground. These would eventually turn out to be too short to fit all the electronics, but this problem was later solved when making the outer body.

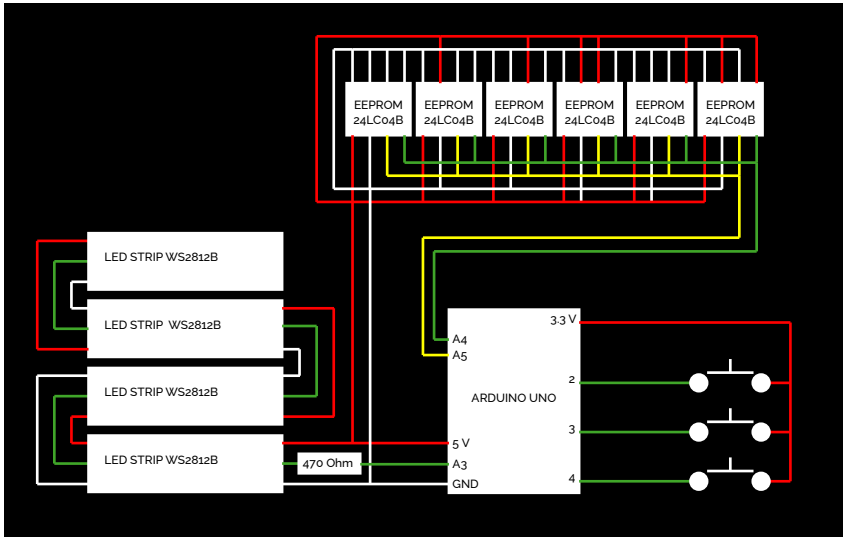


*Inner body with circuit*

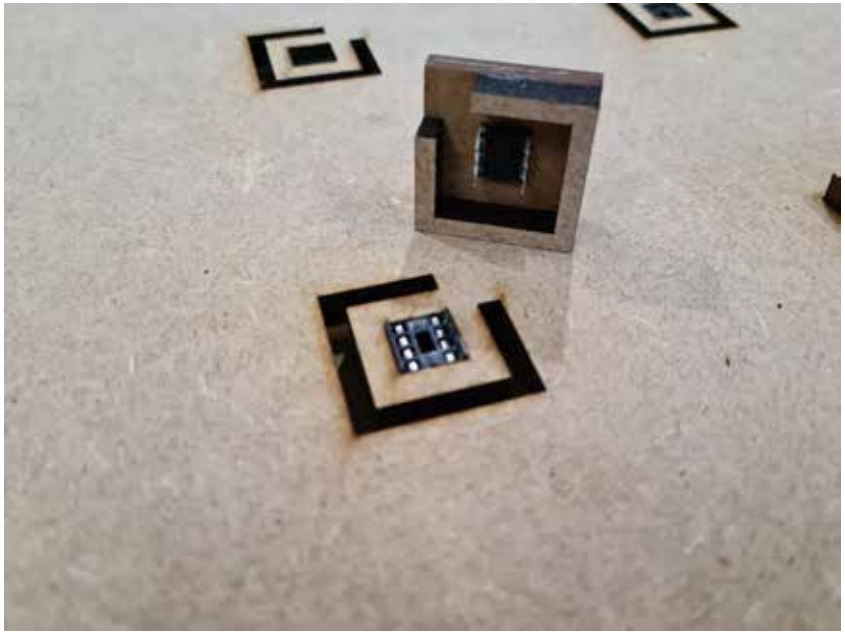
The tiles consist of three different pieces of MDF. The first being a top plate, with a thinner plate glued underneath with a slot to hold the EEPROM chip in the right place. Lastly the tiles contained a foot that was exactly the same size as the slots in the board plate. Because these feet were made to be thicker than the chip's pins when glued to the tiles and being able to only fit the tiles one way into the board, it is impossible to insert the tiles incorrectly on the board.



*Inner body*




*Schematic of circuit*



*Board tiles*

The outer body is mostly made out of plywood, being a higher quality wood type than MDF. The plywood was measured and cut by hand using the machines in the Vertigo workshop, painted white and glued in place. The faceplate of the board's dashboard is laser cut out of MDF. This would preferably have been made out of plywood as well. The laser cutter at Vertigo does not support cutting plywood however. So to ensure precision regarding the faceplate's measurements and slots, the decision was made to make it out of MDF. Four pieces of semi transparent plastic were cut to fit the faceplate's slots and diffuse the LED lights coming from underneath. These were connected to the faceplate using transparent tape, from underneath. Lastly, illustrations were made for the board and tiles and glued on.

For the illustrations, a clear, cartoonish, colourful and cohesive style was developed to complement the young target group. Inspiration was, among others, taken from the style of Pokemon games. The style and form of the board was kept flat and simple as to not overload the player with visual elements. With the goal of not distracting them from the game and its learning points.


*Final Prototype*

The decision was made to change the parameter of consumer happiness to meat and insect consumption. With both being displayed on the same LED strip in different colours. This was done since “happiness” is a concept too complex to be determined by the board and to concretise by the players.

Consumption is calculated by the board using the following formulas:

[Meat consumption] = [Amount of meat farms] * [Meat consumption factor]

[Insect consumption] = [Amount of insect farms] * [Insect consumption factor]

With these formulas, consumption will rise according to the amount of farms (production) of either meat or insects. The consumption factor symbolises the popularity of the corresponding food type. Through actions, these popularities could shift. Imposing a meat tax for example, would make meat less popular and consumed less. While serving insect lunches at school, would increase the insect consumption factor and the consumption. The effects of these campaign would degrade over time unless they were repeated each turn by the player: a popularity decrease in meat through a meat tax would slowly return back to normal when the meat tax is removed. The full code can be seen in Appendix C.

With six meat farms on the board, the default meat consumption factor was set to three, for a total meat consumption of 18 (thus not exceeding the 20 limit of the LED strip). The insect factor was set to one as default. Making insects a lot less popular than meat as default.

Next to the board tiles the game also contains playing cards, telling the player which options they have for the meat-to-insect transition. For this, the previous research done for the Buggy Puddy exploration was used as inspiration to create different action cards.

It was decided on to add two extra buttons to the board. One on either side of the board. Each would affect one consumption factor. Since in game, actions only decrease the meat consumption factor, or increase the insect consumption factor, each button corresponded with one of these actions. Pressing each button changes each factor by a half.
By doing some short playtesting myself, rules were set up to play the game. Making sure players would be able to win the game and adding a losing condition.

The rules and an explanation of the product and the game were written down in a game manual.

## Rules:

- You start the game with 20 coins.
- You can use these coins to perform the actions on the cards. The cost of each action is described on the card.
- Each turn, you get an amount of coins equal to the amount of yellow and red lights on the board.
- You may use as many cards per turn as you can afford.
- The blue cards only have to be bought once.
- Orange cards and green cards can be used multiple times.
- The orange cards let you change the tiles on the board.
- The green cards tell you how often to press the yellow buttons on the board.
- At the end of each turn, press the grey button to stat the next turn.
- You win the game if all insect farm tiles are on the board.
- You lose the game if the amount of yellow and red lights is 9 or less at the start of your turn. If this happens don't worry! Just try again :)

# Game manual

Arthropolis

Ages 10-12

## Materials

- 1 electronic board
- 12 farm tiles
- 11 action cards
- 50 coins

## The board

The board is divided in 2 parts:

1. The playing field containing 6 slots to put the farm tiles in.
2. The dashboard containing four light bars and three buttons.

The four light bars display consumption, energy use, water use and greenhouse gas emissions.
Insect consumption is displayed with yellow lights. Meat consumption is displayed in red. The use of the buttons is explained in the rules.


**To start the game, insert all the orange meat farm tiles on the board and plug the cable in an outlet.**

*"Welcome, Mayor of Arthropolis! So good to have you. You're here to help us transition from farming and eating meat, to farming and eating insects.*
*In Arthropolis, we only have pig, chicken and cow farms at the moment."*

**Press the grey button on the bottom right corner of the board.**

*"But as you can see, these produce tons of greenhouse gases! They also cost a lot of energy and water to maintain. Some of these farms are really big, leaving less room for nature.*
*Because of this, we need to turn all these meat farms into insect farms! They use less resources and produce the same amount of food."*

**How much less you ask? You'll see by playing the game!**

The goal of the game is to have all the mealworm, cricket and snail farms on the board.

*Game ManualAction cards*

**Meat Tax**
*Increase tax on meat.*
Press the left button 2x each turn this card is active. When active, you get 2 coins for each orange light per turn.
Cost: 0 coins per turn

**Insect Farm**
*Demolish a meat farm to build an insect farm on its place.*
Replace a meat farm tile on the board with an insect farm tile.
Cost: 20 coins

**Insect Campaign**
*Invite celebrities to dine at the insect restaurant.*
If you have an insect restaurant, press the right button each turn this card is active.
Cost: 5 coins per turn

**Meat Farm**
*Demolish an insect farm to build a meat farm on its place.*
Replace an insect farm tile on the board with a meat farm tile.
Cost: 20 coins

**Insect Restaurant**
*Open an insect restaurant.*
To perform this action, at least one insect farm must be on the board.
Cost: 10 coins

**Insect campaign**
*Put commercials online for the insect restaurant.*
If you have an insect restaurant, press the right button each turn this card is active.
Cost: 5 coins per turn

**Insect Supermarket**
*Open an insect supermarket.*
To perform this action, at least two insectfarms must be on the board.
Cost: 15 coins

**Meat Campaign**
*Teach people about the damage meat does to the environment.*
Press the left button 1x each turn this cardis active.
Cost: 5 coins per turn

**Insect Campaign**
*Put commercials online for the insect supermarket.*
If you have an insect supermarket, press the right button each turn this card is active.
Cost: 5 coins per turn

**Insect Campaign**
*Give insect lunches at schools.*
If you have an insect supermarket, press the right button each turn this card is active.
Cost: 5 coins per turn

**Insect Campaign**
*Teach people about benefits of eating insects to the environment.*
If you have an insect supermarket or restaurant, press the right button each turn this card is active.
Cost: 5 coins per turn

*Action cards*

**Final demo day**

To present the product on demo day, some extra resources were developed to support the product and its use. A poster was made displaying the product and all its elements in full. A video showed what the product is used for and how. A pitch gave a brief description of the product and its relevancy in text. Two additional posters were made to further explain the different elements of the product. These were all handed in for the online demo day. For the physical demo day, the last two posters were combined into a table spread, on which the product rested. The video and poster were displayed as well. During and after pitching the product, live demonstrations showed how the product is used and how it reacts to user interactions.

During demo day, the coaches and other students gave feedback on the product and project. The visuals, of the product, the illustrations and the presentation were met with very positive feedback. They were described as polished, consistent and fitting for the target group. The products context was also presented appropriately, whereas in previous design critique sessions, this was still lacking for the coaches. The functionality and technological quality of the product was appreciated. One coach also mentioned how the use of real life data and research behind the product gave it an extra layer of complexity and made it tie well to the User and Society.

Critical feedback included how the different design elements did not complement the interactions well enough. The three environmental parameters for example, were not distinct from the consumption parameter, even though they visualise very different parts of the game. The interactions tied to the action cards were also not explained well through the design of the product, but were instead only explained with text. Another important thing that needed to be done was to validate my product with an expert in the field. To see for example whether the product would be appropriate to be used by primary schools. Another proposed method of validation was to compare the complexity of the game to that of popular board games targeted towards the same age group.

*Demoday setup*

# Post Demo day

**Complexity Benchmark**
To compare the complexity of Arthropolis to that of board games for the same age group, Catan and Monopoly were chosen.
Monopoly has become the best-selling board game in history since it was first sold in 1935 by the Parker Brothers in the US (Britannica, 2022). In it, the player's goal is to buy and develop property, while bankrupting their opponents. The game can be played with two to eight people and is marketed to children and adults ages eight and up.

The board game consists of eight different elements like action cards, property cards, dice and money bills (Hasbro, 2022). The booklet containing the game's rules is 7 A5 sized pages. Not only that, but the player needs to understand terms like mortgage, auctions, rent and bankruptcy, and be able to make calculations with numbers up to 1500 at least (this is the amount of money each player starts with) (Hasbro, 2017).

Catan is a popular board game first published in Germany as Die Siedler von Catan in 1996. Since then, the game has sold more than eighteen million copies worldwide. (Raphel, 2014) Numerous expansions and spinoffs have been developed as well. The base game can be played with three to four players and is targeted towards children and adults ages ten and up (999 Games, 2022).

In Catan, players race to be the biggest settlers on an island full of resources. Players need to manage and spend resource, trade with others and strategize multiple turns ahead. The rulebook containing its rules is four A4 pages long (Teuber 2020). The almanac, containing more detailed descriptions of the games elements spans eight A4 pages.

Arthropolis is a game consisting of four five elements: board tiles, action cards, coins, an interactive playing field and dashboard. It can be played with one person, or multiple people working together as one player and is targeted towards children ages ten to twelve. The game manual is three A5 pages, with only one page dedicated to the rules of the game. To play the game, players need to understand terms like campaign, tax, water use, energy use, greenhouse gas emissions and consumption.

From this comparison, it can be assumed that Arthropolis is not more complicated than existing games like Monopoly and Catan and certainly not too complicated for its demographic. But this could be researched further by doing user tests with its target demographic.

**Redesign**

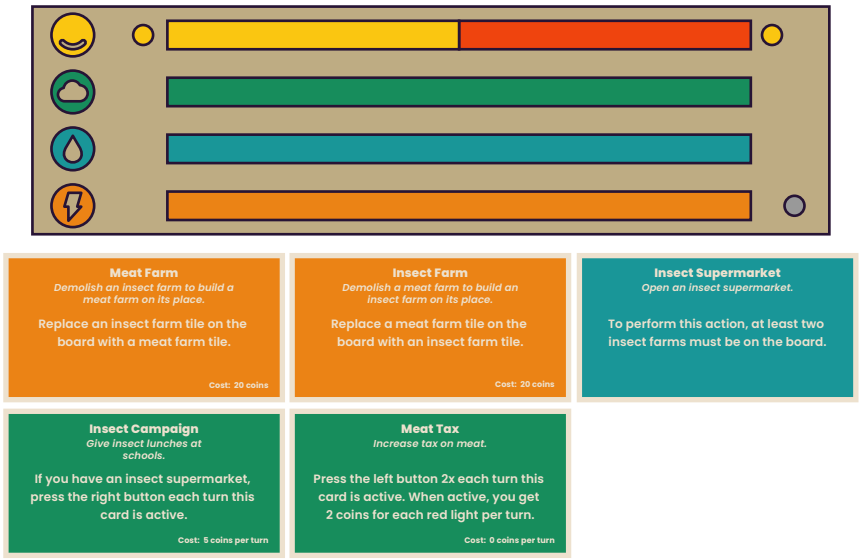
Following the feedback from demo day, the boards dashboard and the action cards were redesigned. The colours of the parameters and action cards were reconsidered to be used more consistently throughout the product.

The colour for meat consumption is changed to orange, in line with the colour of the meat farms on the board tiles. The colour for energy use, which was orange at first, is thus changed to red. The action cards for meat campaigns (e.g. the meat tax) are changed to orange as well. At the same time, cards for insect campaigns are changed to yellow just like the colour of the insect farms on the board tiles.

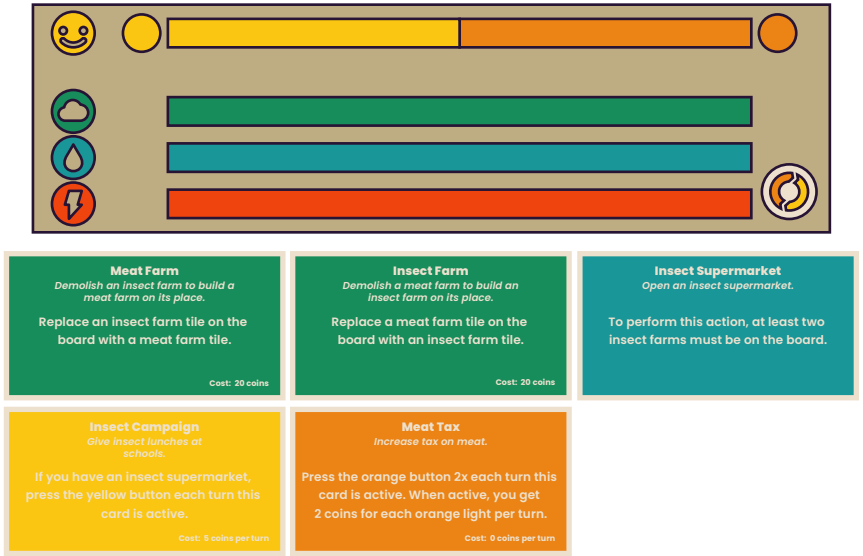
The colours of the buttons that need to be pressed when using the campaign action cards are changed accordingly as well, with users having to press the yellow button to perform insect campaign actions, and the orange button for the meat campaigns. The buttons' size is increased as well.

The four parameters are visually divided into two groups. One group containing meat and insect consumption. The other being the three environmental parameters. This helps the user distinguish from the parameters, as they have different implications in-game.

The 'end-turn' button's size is also increased and it's colour is changed to white. Since it's a button that's used every turn, the appearance should complement its importance. It also contains an icon that illustrates a rotating movement. The two arrows have a slight nod to the meat-to-insect transition, by being orange and yellow in colour.




*Old design of dashboard and cards*




*Redesign*

**Talk with expert**

Since the product is designed to be used by primary schools, it was important to talk with someone working in the industry to gain insights about my product and its marketability. To do this, a semi structured interview was conducted with a portfolio manager and former product developer of Malmberg. Malmberg develops educational materials for primary schools, high schools and MBO schools in the Netherlands. Since its inception in 1885, it has grown to be the largest catholic educational publisher in the Netherlands (Malmberg, 2022).

The goal of the interview was to gain an insight in the process within Malmberg to develop new educational products, how the learning goals of these products are validated during development and whether my product would fit a primary school's curriculum and be marketable. A summarized transcript of the interview can be read in Dutch in Appendix D.

A design process at Malmberg starts by looking at within which subjects there's a need for new materials, based on the current market and its trends. The needs of the customers (schools) and the government also play an important role in this. Since a large investment is needed to develop a curriculum, subjects are chosen based on their commercial viability.

For a new product, a didactic method is chosen based on literature and research. Throughout the process, tests are done with schools, teachers and students. Ranging from teacher panels, to small scale tests with schools and later on a large scale test period with multiple schools and hundreds of students. This last phase erases the finer details and makes the product ready for distribution.

The products reach the schools via large distributors like Heutink, Reinders and De Rolf Groep. They advertise and sell the materials to schools. Malmberg approaches schools as well for marketing purposes and functions as close contact partner when schools have in-depth questions about the products and materials. But in the end, sales are always done via the aforementioned distributeurs.

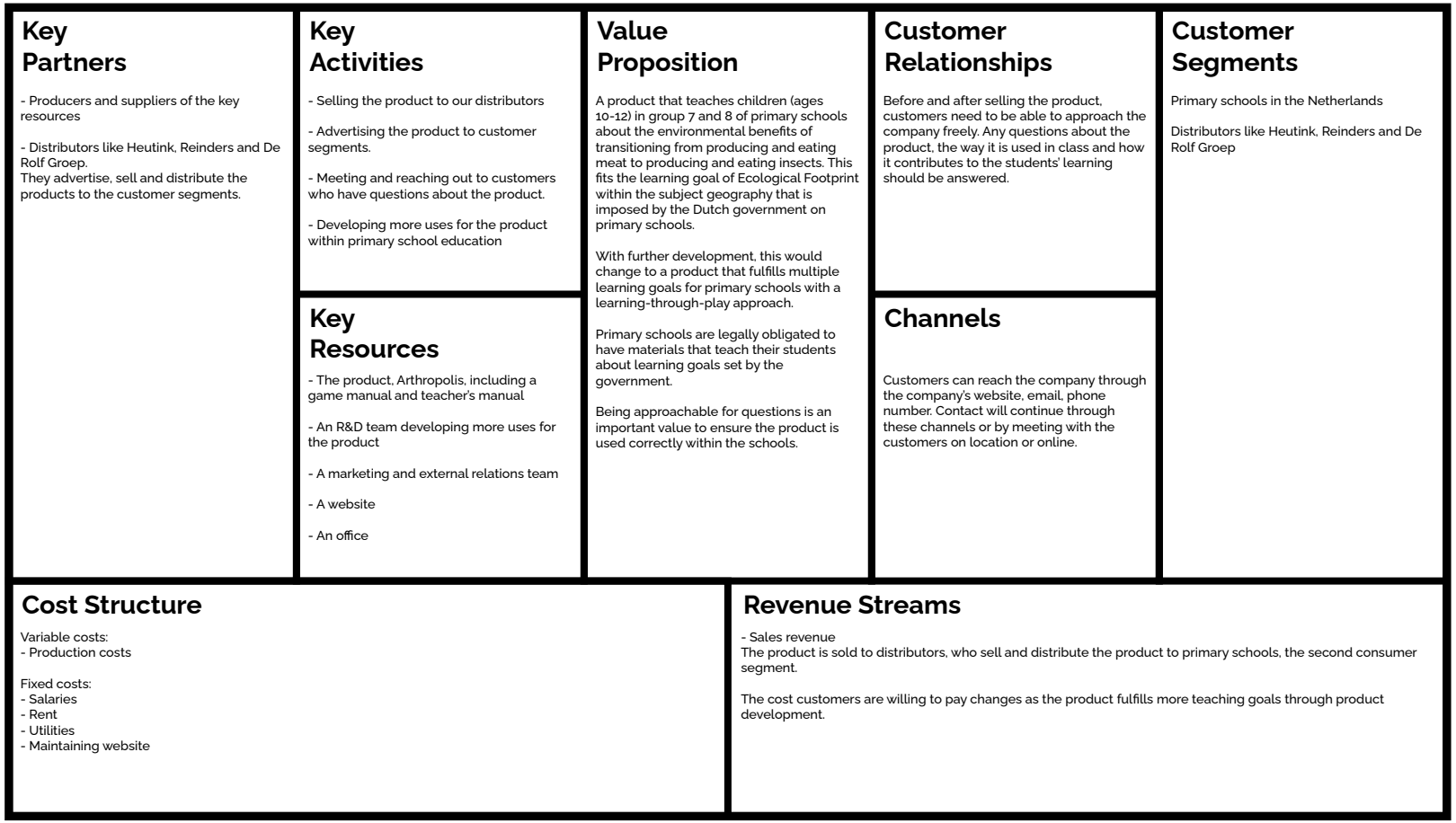
Malmberg's products are offered to schools and teachers only. The reason being that people without a teaching background can possibly use the materials incorrectly, negatively affecting the student's learning.

Since Malmberg only produces educational materials in the form of books and software, Arthropolis would not fit the product portfolio of the company. Companies like Heutink do offer products that are comparable to Arthropolis. Sustainability is a topic that is covered by primary schools. Though not as a specific subject, the topic is integrated in subjects like Technology and Physics (Natuur en Techniek), Geography and History.

Regarding the marketability of Arthropolis, the product would fit the learning goal Ecological Footprint of the subject Geography very well. This is a learning goal for group 7 and 8 in primary schools. So for children ranging from the ages 10-12, similar to the product's target group. The product is made for one specific learning goal however, limiting the value it offers to schools. Most likely, further development should be done to make the product usable in some way to more or all age groups. Or the product should be adaptable to fit different learning goals. Doing so, a school could allocate 70 euros for the product, though this was purely a guess.

Next to a game manual, the product needs to contain a teacher's manual as well. This should contain in fine detail what learning goal is being met, how many children can partake in it, how long it takes etc. Doing so, makes it easier for the product to be used by the teacher.

Based on the insights of the interview, a Business Model Canvas (Osterwalder et al. 2010) was filled in.




*Business Model Canvas*

# Discussion & Conclusion

**Discussion**

To validate whether the product validates the design case, there are some steps that need to be taken.

Firstly, the product's game should be further developed by play testing with children and revising the games rules. Creating a balanced board game that's fun and with the appropriate complexity for the target group should be aimed for.

Secondly, the product should be tested with its intended target group, preferably in the school context as well. These user tests can measure the product's ease-of-use and whether the design elements are understood. And whether the product's learning goal is achieved. For these tests, not only children aged 10-12 are needed, but teachers as well, since its their decision to incorporate the product into their teachings. To do this, a teacher's manual needs to be created as well and tested for usability.

Thirdly, research can be done in increasing the product's value to schools. This can be done by making the product usable to different ages, for different learning goals or a combination of both. With its current state, the product is probably too extensive for the very specific learning goal it's catered to. This limits the amount of money schools can afford it. By widening the product's value proposition, the amount schools can spend on it increases. Doing so does not guarantee that the product will deliver enough value for schools to afford it. In this case, other contexts or economical structures (like renting out the product or it being part of a workshop) should be considered.

For the prototype, the use of EEPROMs were chosen . To make the product more durable and fail-proof (especially considering its target group), RFID technology can be considered to replace them. EEPROMs were chosen for this prototype since they were more feasible to work with the Arduino module at hand. Given more time and effort, a more complex circuit can be created that implements RFID scanners and chips.

**Conclusion**

Over the course of one semester, a design case was proposed and a product was designed to try to fulfil this design case. The design case is:

to create a product that makes children aware of the environmental benefits of producing and consuming insects over producing and consuming meat.

The product took the form of an interactive physical board game, designed to be used in primary schools by children the ages of 10-12.

Validation on whether the product fulfils this design case is still needed.

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# Appendix A

## *Reflection*

Coming into the squad and my graduation project, I had a fairly concrete idea in mind on which topics and expertise areas I wanted to focus on and develop myself in. Given that I was really excited to start a specific project from a different squad, I took some inspiration from that project's focus into this. At first – I'd say during the first quartile – I noticed myself struggling to find a topic that really interested me, and that I saw myself continuing in. During this period I discovered that when I don't fully stand behind the work I'm doing, I find it hard to find motivation to continue working. This feeling was confirmed around the midterm, when I was able to find a design problem that I was really excited for. Creating an educational game for primary school children is something that really fit my vision and identity as designer. It also enabled me to work on skills within the Technology & Realisation and Math, Data and Computing expertise areas that I wanted to develop myself further in for this project. For me, this marked a turning point in the project where I was a lot more motivated to work on my project.

For the prototype, the use of EEPROMs were chosen . To make the product more durable and fail-proof (especially considering its target group), RFID technology can be considered to replace them. EEPROMs were chosen for this prototype since they were more feasible to work with the Arduino module at hand. Given more time and effort, a more complex circuit can be created that implements RFID scanners and chips.

The final prototype I made allowed me to learn a lot about how to incorporate different elements into a cohesive product. Through materials, form, illustrations and use of colours, the board, board tiles, dashboard, action cards, coins and game manual all look like a cohesive package. I learnt a lot in how to achieve this while making the prototype. Relating to this, I decided to make a package design to communicate the Buggy Puddy product concept to the coaches and other students. From this, I learned that there are different ways to communicate ideas to others than prototypes or simple sketches. I feel like with this, I was quickly able to get interesting feedback from others, since the packaging made it easy for them to envision the product, its use and context.

I am proud of the functionality and electronics the prototype has. Over the years and through different courses and projects, I had become quite comfortable with working with electronics and Arduino code and it allowed me to take on a project like this. Something I would have done differently, however, if I were to repeat the project is to put more thought into the prototype and its interactions and functionalities before realising it. They were not fully thought through yet before making the prototype. Had I done this, I feel like I could have incorporated more aesthetically interesting interactions in the product. I was very eager to create the prototype after the midterm and with the limited amount of weeks left until demo day I felt a sense of hurry to complete in time.

Though I was struggling to find a topic that suited me before the midterm, these weeks did lead me to a lot of insights that really shaped my project. Very early on, I knew I wanted to focus on making a product to get children to eat insects (which later evolved into making children more aware of the benefits of producing insects). While doing research and making very different explorations, I tried to tackle different ways insects can be incorporated into the western diet and children more specifically. Additionally, the interview with a paediatric dietician gave me some insight in the relation children have with food. Through this, I gained a lot of knowledge on society's view on entomophagy, the current state of both meat and insect agriculture and its future prospects. I learned to find a relevant design case with the use of secondary research and incorporate key findings into my concepts. Given that I focused on a difficult demographic during my project, I did not get to do user tests with my product and its target group. Having done this in two of three projects in the past, I know how much value and insights it give to your design and I regret not having had that. In my opinion, it remains one of the necessary steps of a complete design process and its definitely something I would do in future projects. I do, however, think that the use of societal research allowed me to use and develop skills in the User and Society expertise area that I hadn't done before.

I am glad I got the feedback to meet with an expert in education during the demo day. The interview with a portfolio manager and former product developer of Malmberg gave me a lot of insights in the role business plays when designing a new product. I wish I had had this conversation before starting my prototype, since it would definitely have affected my design. It could have allowed me to design product with the customer's (primary schools) financial needs and limits in mind. And design a product that offered more value to the customer. Not only do you need to create a product that the customer needs, but you need to create a product that the customer can afford. Mine being a quite extensive product for a very specific learning goal, it is likely that primary schools cannot afford to purchase this product, knowing that they have tons of other learning goals to fulfil. The interview also gave me insight in how a company like Malmberg reaches its customers, both involving them extensively in the design process to validate their products, and supporting them in their buying decision.

To conclude, I am very satisfied with the skills I was able to develop during my graduation project and the process I went through. Of course, in hindsight there are a lot of things I would have done differently and I will use these as learning points going forward. By staying true to my identity and vision as a designer, I developed these further in the direction that I wanted. Going forward I know I want to keep developing myself in the areas of education, play, children and the combination of digital technology and physical product design.

# Appendix B

## Introductie:

Hallo L, ten eerste bedankt voor het meedoen aan dit interview. Het doel van dit interview is om een beeld te krijgen hoe een jeugddiëtist te werk gaat en welke stappen die onderneemt om de eetpatronen van een kind aan te passen. En hoe deze kennis gebruikt kan worden om een product te ontwerpen om kinderen gewend te laten raken aan het eten van nieuwe voedselsoorten (bijv. insecten of algen).

## Interview:

Zou u uzelf kort kunnen introduceren.

Werkt 6 jaar als jeugddiëtist bij Zorgboog en het Laurentius ziekenhuis in Roermond

Hoe zit een standaard traject eruit dat een kind volgt bij een kinderdiëtist?

Ligt aan de aandoening zoals overgewicht, ondergewicht, allergieën etc. Over het algemeen komen ze voor een eerste consult waar medische gegevens worden gevraagd en wat ze allemaal eten op een dag. Daarmee geeft de jeugddiëtist adviezen die passen bij het kind. Bij het eerste consult zijn de ouders bijna altijd mee. Op jonge leeftijden zijn de ouders er sowieso altijd bij, maar oudere kinderen kunnen ook zelfstandig op consult.

Wat zijn daarin de nodige stappen om het eetpatroon van een kind aan te passen?

Vooral kijken waar de ouders tegenaan lopen, en vooral beginnen bij de basis en kijken wat er wel al goed gaat.

Op welke leeftijden focust u als kinderdiëtist?

0-18

In hoeverre is de aanpak anders bij jonge kinderen in vergelijking met oude kinderen?

Bij jonge kinderen spelen vooral de ouders een belangrijke rol. Bij oudere kinderen speelt ook een stuk zelfstandigheid een rol. Bij jonge kinderen werk je met kleinere stappen dan met oudere kinderen. Maar dat is voornamelijk bij overgewicht. Verder afhankelijk van de aandoening.

Zijn er leeftijden die er qua gedrag bovenuit springen?

Pubers hebben heel erg een eigen wil. Je kunt ze wel adviezen geven, maar het opvolgen gaat lastiger. Bij baby's is het juist dat je heel erg op de ouders focust.

Ik wil mijn project waarschijnlijk focussen op kinderen tussen 10 en 12 jaar oud. Wat zijn daarin dingen die opvallen qua gedrag of openheid voor nieuw eten?

Wat opvalt is dat het dan lastiger is om het gedrag te veranderen. Ze hebben dan al redelijk wat van hun gedrag geleerd van hun ouders, en dat gedrag hebben ze al een tijd

aangehouden. Je kan wel een actiever gesprek hebben met deze kinderen en ze betrekken in de adviezen die je aan ze geeft. De ouder is er overigens wel bij.

Hoe balanseer je de wensen van de ouders met de nodige stappen die nodig zijn voor het kind? Ontstaan er wel eens botsingen?

Met name door gewoon goed met ze in gesprek te gaan. Soms zijn er botsingen in wat wetenschappelijk nodig is en praktisch uitvoerbaar is.

Zijn er meer van dat soort botsingen, naast wetenschap versus praktijk zegmaar?

Vaak zijn er onderliggende problemen bij het kind en de ouders. Ook bij een scheiding, dan heeft de ene ouder bijvoorbeeld heel andere verwachtingen dan de ander.

Zijn er ook andere invloeden op het dieet? Zoals vriendjes en vriendinnetjes of de school etc.

Ja bij kinderen op de middelbare school kan de schoolkantine bepalend zijn in wat ze eten ivm wat ze aanbieden. Dan gaan ze ook met anderen naar de supermarkt wat een groot probleem kan zijn. Daarbij speelt groepsdruk een grote rol. Op de basisschool is er bijna nooit een kantine aanwezig.

Zijn adviezen over de schoollunch ook een groot onderdeel van je consult?

Dat valt mee. Grootste onderdeel is vooral als ze eenmaal thuis komen in de avond. Het blijft wel een ding, vooral op de middelbare. Op de basisschool zijn de lunch meestal normale boterhammen, dus daar ligt het grootste probleem niet.

Wat zijn de problemen qua voeding en dieet bij kinderen die u het vaakst tegenkomt?

Met name onder- en overgewicht. En daarna koemelkallergie en kinderen die moeilijk eten.

Bij kinderen die moeilijk eten, wat is er daarbij aan de hand? Moeilijk eten op het gebied van groente en fruit, in het algemeen of over het introduceren van nieuw voedsel?

Allemaal eigenlijk. Soms eten kinderen heel weinig, of te eenzijdig of inderdaad te weinig groente en fruit.

Wat zijn daarbij de strategieën die je gebruikt om kinderen verschillend voedsel te laten eten?

Met name in het ziekenhuis werken we met een multidisciplinair team, en dan kijken we samen wat een effectieve behandeling is. Dat kan bijvoorbeeld zijn met een huisbezoek, om meer inzicht te krijgen op de thuissituatie en hoe we die anders kunnen inrichten. En we kijken wat voor hulp het kind nodig heeft om toch aan te gaan eten. Soms moeten we daarin heel creatief zijn. We werken bijvoorbeeld met een bord waarbij kinderen aan een rad moeten draaien en het eten waar de pijl op te recht moeten komen moeten eten, met de ouders. Dan zitten er bijvoorbeeld leuke dingen op, maar ook minder lekkere dingen. Of we belonen de kinderen voor het eten van nieuwe dingen. Stickers werken ook heel erg goed, voornamelijk bij jonge kinderen.

En bij oudere kinderen?

Dan hoop je eigenlijk dat het probleem al eerder is aangekaart. Een collega gaat wel eens wandelen tijdens het consult met kinderen met obesitas. Tijdens het wandelen komt vaak meer informatie los, ben je in een andere setting en beweegt het kind ook gelijk.

En gaat het ook wel eens om specifieke voedselproducten?

Dat maak ik niet heel vaak mee. Wel dat er geen gevoel van noodzaak is om het gedrag van een kind te veranderen op het gebied van gezond eten. Die hebben niet altijd door wat gezonde voeding is.

Bij koemelk allergie merk je dat ouders terughoudend zijn in het opbouwen van koemelk eten. (Koemelkconsumptie wordt bij allergie opgebouwd om te voorkomen dat de allergie erger wordt).

Hoe zorg je ervoor dat de ouder en het kind zich aan het nieuwe eetpatroon houden?

Een jeugd diëtist wordt maar 3 uur per jaar vergoed door de zorgverzekering. Dus vaak heb je maar 3 uur om een heel eetpatroon te veranderen. Als de adviezen niet worden opgevolgd is het een kwestie van goed in gesprek gaan. Zodra ze vertrouwen in je hebben, gaat het eigenlijk steeds beter.

Dus het is vooral een kwestie van het geven van meerdere consulten, totdat er vooruitgang wordt geboekt?

Ja eigenlijk wel. En vooruitgang bijhouden en nieuwe doelen stellen. Uiteindelijk is het maatwerk. Veel mensen weten wel wat gezond is en wat niet, dus dan hoef je minder informatie te geven, dan ga je meer zitten op gedragsverandering.

Zijn er producten, gereedschap of overige materialen die u gebruikt als kinderdiëtist? Zo ja, welke?

Meetlint om lichaam mee op te meten. Medische-, drink-, of sondevoeding wanneer een kind heel slecht kan eten. Sondevoeding in overleg met een arts.

Bespreken concept. Wat zijn dingen die volgens u goed zijn aan dit product. Wat werkt niet?

Leuk over het algemeen. Omdat de smaak nu niet overeenkomt met de smaak van insecten is het de vraag of het uiteindelijk echt helpt. Positief over het kinderen laten spelen met eten. Vaak wordt bij kinderen afgeraden om te spelen met eten, maar bij kinderen van 0-1,5 jaar kan het spelen met eten ze meer gewend raken aan het eten en zijn ze minder bang om het te eten.
Zou zelf niet per se insecten aanraden aan kinderen/ ouders. Denkt wel dat het in de toekomst meer gegeten moet/ zal worden, maar voor nu is ze al blij als kinderen normaal eten leren eten, en dan zijn insecten eigenlijk te ver van de bed show. Misschien is dat over 20 jaar weer anders.

Vaker terugkomen / klant zijn van project

Staat er open voor. Meeting 1x per maand zou kunnen, en verder mail contact.
Interessante casus kan zijn om met een product kinderen met onder- of overgewicht nieuwe producten te laten ontdekken en proeven.

Appendix C

```
#include "Wire.h"
#include <FastLED.h>

#define BUTTON_PIN1 2
#define BUTTON_PIN2 3
#define BUTTON_PIN3 4

#define LED_PIN     A3
#define NUM_LEDS    96

CRGB leds[NUM_LEDS];

int buttonState1 = 0;
int buttonState1_last = 0;

int buttonState2 = 0;
int buttonState2_last = 0;

int buttonState3 = 0;
int buttonState3_last = 0;

// adres of EERPs
const byte ADRES[] = {0x50, 0x51, 0x52, 0x53, 0x54, 0x55, 0x56, 0x57};

// energy total, water total, emission total
int PARAMETER_TOTAL[3];

// value between 0 and 19
int PREFERENCE = 0;
int externalPreference = 0;
```

```
int readVal = 0;
int pointer = 0;

void setup()
{
  Wire.begin();
  Serial.begin(9600);

  FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);

  pinMode(BUTTON_PIN1, INPUT);
  digitalWrite(BUTTON_PIN1, HIGH);

  pinMode(BUTTON_PIN2, INPUT);
  digitalWrite(BUTTON_PIN2, HIGH);

  pinMode(BUTTON_PIN3, INPUT);
  digitalWrite(BUTTON_PIN3, HIGH);
}

void loop()
{
  buttonState1 = digitalRead(BUTTON_PIN1);
  buttonState2 = digitalRead(BUTTON_PIN2);
  buttonState3 = digitalRead(BUTTON_PIN3);

  // check if the pushbutton is pressed. If it is, the buttonState is HIGH:
  if (buttonState1 != buttonState1_last) {
    if (buttonState1 == LOW) {
      for (int i = 0; i < 6; i++)
      {
        for (pointer = 0; pointer < 3; pointer++)
        {
```

```
    readVal = readAddress(ADRES[i], pointer);
    if (readVal != 255)
    {
      PARAMETER_TOTAL[pointer] += (int)readVal;
      Serial.println(PARAMETER_TOTAL[pointer]);
    }
  }
}
// preference
int supermarket = (int)readAddress(ADRES[6], 0);
int restaurant = (int)readAddress(ADRES[7], 0);

PREFERENCE = supermarket + restaurant + externalPreference;

for (int i = 0; i < 20; i++)
{
  if (PREFERENCE < 9)
  {
    if (i >= PREFERENCE && i < 10)
    {
      leds[i] = CRGB::Green;
    } else {
      leds[i] = CRGB::Black;
    }
  }
  if (PREFERENCE > 9)
  {
    if (i <= PREFERENCE && i > 9)
    {
      leds[i] = CRGB::Green;
    } else {
      leds[i] = CRGB::Black;
    }
```

```
  }
}

// energy
for (int i = 20; i < 40; i++)
{
  if (i < PARAMETER_TOTAL[0] + 20)
  {
    leds[i] = CRGB::Yellow;
  } else
  {
    leds[i] = CRGB::Black;
  }
}

// water
for (int i = 40; i < 60; i++)
{
  if (i < PARAMETER_TOTAL[1] + 40)
  {
    leds[i] = CRGB::Blue;
  } else
  {
    leds[i] = CRGB::Black;
  }
}

// emission
for (int i = 60; i < 80; i++)
{
  if (i < PARAMETER_TOTAL[2] + 60)
  {
    leds[i] = CRGB::Red;
```

```
      } else
      {
        leds[i] = CRGB::Black;
      }
    }
  }
  delay(50);
 }

 if (buttonState2 != buttonState2_last) {
  if (buttonState2 == LOW) {
    externalPreference--;
  }
  delay(50);
 }

 if (buttonState3 != buttonState3_last) {
  if (buttonState3 == LOW) {
    externalPreference++;
  }
  delay(50);
 }

 buttonState1_last = buttonState1;
 buttonState2_last = buttonState2;
 buttonState3_last = buttonState3;

 for(int i = 0; i <96; i++){
  leds[i] = CRGB::Black;
 }
 FastLED.show();
}
```

```
void writeAddress(byte i2cAddress, int pointer, byte val)
{
  Wire.beginTransmission(i2cAddress);
  Wire.write((int)(pointer >> 8));   // MSB
  Wire.write((int)(pointer & 0xFF)); // LSB


  Wire.write(val);
  Wire.endTransmission();

  delay(5);
}

byte readAddress(byte i2cAddress, int pointer)
{
  byte rData = 0xFF;

  Wire.beginTransmission(i2cAddress);

  Wire.write((int)(pointer >> 8));   // MSB
  Wire.write((int)(pointer & 0xFF)); // LSB
  Wire.endTransmission();


  Wire.requestFrom(i2cAddress, 1);

  rData =  Wire.read();

  return rData;
}
```

Appendix D

**Kunt u uzelf kort introduceren en hoe u werkzaam bent binnen Malmberg?**

Ik ben portfolio manager bij Malmberg, wat inhoudt dat ik verantwoordelijk ben voor het inventariseren van klantwensen, van scholen. En deze communiceer naar de product developers. Ik moet ervoor zorgen dat de methodes goed gepositioneerd zijn in ons portfolio waardoor ze als methodes voldoen aan de wensen in de markt.

**Hiervoor bent u ook product developer geweest.**

Ja klopt, en ook uitgever. In de organisatie hebben we de uitgevers opgesplitst in product developer en portfolio manager. De portfolio manager kijkt naar de markt en inventariseert de klantwensen en staat boven het proces, en de product developer maakt de oplossingen.

**Vanuit welk beginpunt ontwerpt Malmberg hun nieuwe producten?**

Het is altijd een vak waar een aanbod voor nodig is. We kiezen hierbij de vakken die commercieel interessant zijn. Er moet heel veel geïnvesteerd worden in een methode, en die wil je terug verdienen. Wij richten ons daarom niet op kleine methodes als levensbeschouwing, maar alleen grote als taal, rekenen etc. Hierbij kijken we naar trends in de markt, bijvoorbeeld projectmatig werken, onderzoekend leren, burgerschap, digitale geletterdheid etc. We kijken ook naar wat scholen vragen en wat de overheid vraagt en wat hun kerndoelen zijn voor het basisonderwijs.

**Hoe valideer je of je product leerzaam is en aan de doelen voldoet?**

We kiezen altijd een didactiek die bewezen effectief is. We baseren dit op literatuur en of op basis van onderzoek van universiteiten. De Radboud Universiteit heeft bijvoorbeeld aangetoond dat als je doelen betekenisvol maakt, dus als je bijvoorbeeld weet waarom je een bijvoeglijknaamwoord nodig hebt, je dit beter gaat leren gebruiken en het doel gaat leren begrijpen en uiteindelijk weet wat een bijvoeglijknaamwoord is. Dit soort theorieën passen we toe tijdens het ontwerp proces.

**En is er hierbij ook een test proces met kinderen en leraren?**

Ja. We maken eerst een blauwdruk van onze methode. We kiezen waar we ons op willen richten, kijkend naar wat de klant en de overheid wil. Dat toetsen we met leerkrachten in panels waar we scholen bij elkaar roepen en onze ideeën bespreken en laten we vaak ook al wat mock-ups zien. Klanten reageren dan daarop. Je moet hierbij erop letten dat de methodes vaak pas 3 à 4 jaar hierna pas op de markt komen. Dan gaan we het verder ontwikkelen en hebben we tijdens het ontwikkelen verschillende fases waarin we het testen met een kleinere groep scholen. Zodra we een werkend lespakket hebben testen we het een maand op bijvoorbeeld 20 scholen met 400 leerlingen. Dan halen we de kleinere fouten eruit en gaan we door met de realisatie.

**Hoe worden producten van Malmberg uiteindelijk aangeboden aan scholen?**

Heutink, Reinders en de Rolf Groep zijn hele belangrijke klanten, ook wel educatieve dienstverleners. En die gaan namens ons naar scholen om onze producten aan te bieden en te verkopen. Maar we gaan zelf ook naar scholen toe. Die schoolboek handels weten wel iets van onze methodes, maar willen ze echt de diepte in kunnen ze ons benaderen om onze producten in de diepte te bespreken. Het begint eigenlijk bij interesse opwekken bij scholen over een nieuwe methode. Dan kunnen ze vanaf volgende maand een opzicht versie aanvragen en met iemand van ons de methode te bespreken. Dan vergelijken ze onze methodes met andere en maken ze uiteindelijk een keuze.

**En de verkoop gaat dan altijd via een bedrijf als Heutink**

Ja.

**Zijn er ook andere klanten die in contact komen met Malmberg producten, naast de basisschool, middelbare school en MBO?**

Ook andere partijen hebben ons product zoals de PABO-s en onderwijsadviesdiensten.

**Dus de producten blijven altijd in school context.**

We hebben heel hoog in onze visie staan dat we hulpmiddelen maken voor de leerkracht. En we vinden het niet goed als die materialen bij ouders zonder didactische achtergrond terecht komen. Die gebruiken het materiaal mogelijk verkeerd waardoor het kind niet de goede dingen leert.

**U vertelde net dat producten vanuit een bepaalde theoretische achtergrond worden ontwikkeld. Is spelenderwijs leren hierbij een overkoepelend thema voor Malmberg producten of komt dit alleen aan bod bij sommige producten? Of misschien helemaal niet?**

Dit is een voorbeeld van een trend die niet uit de overheid komt maar van scholen zelf. Zij horen, lezen daarover en geven aan dat ze dat willen. Er zijn ook onderzoeken die ondersteunen dat spelenderwijs leren werkt. We doen dit bijvoorbeeld bij rekenen en concurrenten zijn hier ook mee bezig.

**Uitleg product**

**Vanuit een eerst oogopzicht, is dit een product dat binnen Malmberg zou passen?**

Nee, niet omdat ik het niet leuk vindt maar omdat Malmberg zich alleen focust op het distribueren van boeken. Onze producten moeten voldoen aan standaarden zoals A4 formaten etc. We maken eigenlijk alleen boeken en software. In hoge uitzondering bieden we andere producten hierbij aan.

**Kent u een onderwijs ontwikkelaar waar dit wel binnen zou passen?**

Studio Tast maakt meer dit soort educatieve producten voor scholen. Die zijn vind ik wat vrijer in vorm dan dit specifieke doel waar je je hierop gericht hebt, duurzaamheid. Je zou

kunnen kijken op de schoolboekhandels als Heutink en je kan kijken welke bedrijven hiervoor verantwoordelijk zijn.

**Wordt er door Malmberg lesmateriaal ontwikkeld over duurzaamheid?**

Ja, maar dat is dan onderdeel van een methode. Dus dit zou bijvoorbeeld perfect kunnen passen bij het doel “ecologische voetafdruk”. Dat is een doel uit de bovenbouw van het basisonderwijs dus groep 7, 8. Deze hebben we ook in onze methode zitten. Hoe wij het aanbieden is we hebben een filmpje als introductie waarin we er een les over geven, met bijvoorbeeld een uitdaging zodat ze er zelf over gaan nadenken. Maar het is eigenlijk allemaal gestuurd vanuit papier of software. En kinderen gaan dan zelf met materialen in de klas aan de slag.

**Een doel als ecologische voetafdruk, hoort dat doel bij een bepaald vak?**

Ja bij natuur en techniek, aardrijkskunde maar ook geschiedenis bijvoorbeeld. Als we het hebben over de industriële revolutie komt ook duurzaamheid aan bod.

**Ja dus in die zin is duurzaamheid verwikkeld in de vakken en komt het aan bod wanneer het relevant is, in plaats van een los vak.**

Ja. Leerkrachten hebben een heel vol pakket, dus dit soort thema’s bieden we liever aan binnen de vakken die ze al hebben.

**Gebeurt het binnen Malmberg dat een product wordt ontworpen als aanvulling van een bestaand curriculum?**

We maken eigenlijk altijd een volledig nieuwe methode. Er komt bijvoorbeeld niet een nieuw apart boekje duurzaamheid, of burgerschap. We willen een totaal verhaal en leerlijn.

**Als Malmberg een product als dit zou aanbieden, zou je een schatting kunnen geven van voor welke prijs ze dit aan scholen willen aanbieden.**

Hoe het eruit ziet, ziet het er hartstikke leuk uit maar het is maar voor een leerdoel geschikt. Terwijl er heel veel leerdoelen zijn. Je zou moeten kijken of je je product kan verbreden naar meerdere leerjaren. Dan is het breder inzetbaar en zijn scholen bereid er meer aan uitgeven. Of dat je er andere doelen mee kan vervullen. Dat je bijvoorbeeld in plaats van die boerderijen, er voorzieningen in een stad van maakt. In groep 5 leren kinderen bijvoorbeeld bij aardrijkskunde dat een stad eigenlijk een heel ecosysteem is van allemaal dingen, kantoren, winkels, huizen etc. Als je dus meer doelen erbij kan betrekken kunnen scholen er ook meer aan uitgeven.

Als je er meer doelen aan toevoegt en je maakt het breder inzetbaar dan is het voor sommige scholen 70 euro waard. Maar dat is puur een gok eigenlijk.

Wat er nog bijkomt is dat je een hele duidelijke handleiding aanbiedt voor de leraren waardoor ze weten voor welk doel ze het kunnen inzetten, hoe lang het duurt, voor hoeveel kinderen etc. Dat het super hapklare blokken zijn en het snel inzetbaar is. Anders blijft het liggen op de plank.