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School of Design Engineering

Design of a game for children to encourage environmentally friendly thinking and recycling using Artificial Intelligence as the primary tool.

Master's Thesis

Master's Degree in Design Engineering

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DESIGN OF A GAME FOR CHILDREN TO ENCOURAGE ENVIRONMENTALLY FRIENDLY THINKING AND RECYCLING USING ARTIFICIAL INTELLIGENCE AS THE PRIMARY TOOL.

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Abstract

This work examines the impact of artificial intelligence on the design industry and demonstrates the application of various AI tools to create a determinate graphic game, both as a physical and virtual game, highlighting the advantages and disadvantages of using AI in design. The goal of the graphic campaign will be to encourage environmentally friendly thinking and recycling.

Keywords:

Artificial Intelligence; AI tools; graphic design; education; responsible consumption

Resumen

Este trabajo examina el impacto de la inteligencia artificial en la industria del diseño y demuestra la aplicación de varias herramientas de IA para crear un juego gráfico determinado, tanto físico como virtual, destacando las ventajas y desventajas del uso de la IA en el diseño. El objetivo de la campaña gráfica será fomentar el pensamiento ecológico y el reciclaje.

Palabras clave:

Inteligencia artificial; Herramienta IA; Diseño gráfico; educación; consumo responsable

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Statement of originality

I, Sebastian Jans, born on December 14, 1996, hereby confirm that I have written the accompanying thesis by myself. The work contained in this thesis has not previously been submitted for a degree or diploma at any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published except where due references are made.

Declaración de originalidad

Yo, Sebastian Jans, nacido el 14 de diciembre de 1996, confirmo por la presente que he escrito la tesis adjunta por mi mismo. El trabajo contenido en esta tesis no ha sido presentado anteriormente para la obtención de un título o diploma en ninguna otra institución de enseñanza superior. A mi leal saber y entender, la tesis no contiene material publicado anteriormente, salvo en los casos en que se hacen las debidas referencias.

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1. Introduction

Artificial intelligence is an emerging technology that is revolutionizing industries across the board. Traditionally used for data analysis, robotics, and automation, it is now gaining more and more traction in new sectors, such as the education and entertainment industries, as well as the design industry (Aggarwal, 2022). While this progress seems to offer endless possibilities, it is also causing fears among many designers about the future of their profession. There have been many headlines proclaiming the imminent obsolescence of designer jobs, amplifying concerns within the design community (Ernst et al., 2019).

Recently, many new AI-based tools started emerging, offering to solve daily challenges that designers face or even offer similar services in a quicker and more precise fashion (Altavilla & Blanco, 2020). But as a designer, one always strives to create new ways to express creativity and make the world a better place by creating novel, innovative products. By embracing AI as a tool to empower workflows, designers can harness its capabilities and push the boundaries of creativity.

Motivated by this belief, I have chosen to dedicate my thesis to exploring the potential of AI technology and understanding how it

can enhance my role as a designer. To achieve this, I investigated in what ways I could integrate AI into my design work and which tools would be most fitting for which tasks.

In this research, rather than coming up with the design idea myself, I allowed myself to be inspired by AI tools, acting as the decision-maker and executor. This approach led me to the topic of this work—creating a product centered around the sustainable development goals of quality education (Goal 4) and responsible consumption and production (Goal 12). The objective was to develop a product that educates people while promoting responsible consumption and recycling. Throughout the creative processes and executions, I employed AI tools whenever possible.

The subsequent chapters of this thesis will dive into the literature review, explaining the impact of AI on design. I will detail the experimental design approach, outlining the AI tools selected and their applications in the creative process. I will create a children's game using this experimental design approach and then present and discuss the results and insights gained from this work.

This research holds significant relevance in the context of AI's influence on the design industry. By exploring the integration of AI in design practices, we can gain a deeper understanding of its implications, opportunities, and challenges. It is important to incorporate the transformative possibilities AI offers while preserving the essence of human creativity and design expertise.

2. Objective

Artificial Intelligence (AI) continues to advance in various fields, making it essential in every field of expertise. Therefore, it is only fitting to analyze the impact that AI has and will have on the Design Industry as a whole. This is precisely what this work is about; it serves as a case study to see how well it integrates into the daily work of a Designer. The main objective is to

Showcase the power of Artificial Intelligence in the design process.

By integrating AI tools into traditional design methodologies, this objective aims to demonstrate how AI enhances the entire design process, from the initial concept to the finished product. This showcases the transformative impact of AI on design outcomes. In the process of showcasing the main objective, two secondary objectives were determined:

1. Provide a practical guide for designers utilizing Artificial Intelligence tools:

This objective focuses on offering a concise and accessible guide for designers seeking to incorporate AI tools into their workflow. The objective is to provide a tool guide that enables designers to leverage AI effectively in their design work.

2. Explain the functionality and significance of Artificial Intelligence in the design industry:

This objective aims to provide a concise overview of the historical development of AI, emphasizing key milestones and advancements. Understanding the fundamentals of AI will enhance efficiency and reliability when working with AI in design.

By addressing these objectives, this work aims to thoroughly examine the impact that AI has on the design industry. It explores the historical development of AI, showcases its transformative power in the design process, and offers a practical guide for designers. The goal is to provide design professionals with the necessary knowledge and tools to effectively use AI.

This will be shown by creating a children's game, starting out only with an objective, and then employing AI tools every step of the way in order to create something innovative and unique.

Ultimately, this work seeks to bridge the gap between AI and design, empowering designers to harness AI as a valuable tool that enhances creativity, efficiency, and innovation in their work.

3. The theory of AI

In this section, we will dive deeper into the world of artificial intelligence (AI). It can be a complex and overwhelming field of study, which is why it is important to understand how it works. We will explore different classifications of AI and the underlying technologies. We will also take a look at the history of AI, including the notable moments and milestones that have shaped its development. Lastly, we will examine the current state of AI, from the most recent advancements to the future possibilities that this technology holds.

In this chapter

- 3.1. *What is artificial Intelligence?*
- 3.2. *How does AI work?*
- 3.3. *History*
- 3.4. *The current state of AI*
- 3.5. *Ethical and Societal Implications of AI*
- 3.6. *What does the AI future look like?*

3.1. What is artificial Intelligence?

When trying to define the term Artificial Intelligence, or AI, scientists from many areas have taken very different approaches. Some scientists tried to define it from a human-centered perspective, while others took a more logical and rational approach. From the human perspective, AI technologies are systems that attempt to mimic behavior, which would usually require human cognitive capabilities. From a rational standpoint, AI systems are computational models that use algorithms to create digital agents capable of reasoning and acting in complex situations (Russell & Norvig, 2010).

Considering these definitions, I want to relate them to the objective of this work. The goal is to develop a workflow that fully leverages the capabilities of AI. This means that for us, it is less important what it does than what it can do. Today, AI is being employed in nearly every field of expertise, from essential sectors such as healthcare and agriculture to enterprise sectors like finance and retail, as well as creative fields such as architecture and design (Tai, 2020).

AI is known for its ability to perform a wide range of tasks, including pattern recognition, natural language processing, image and speech recognition, machine learning, and robotics (Tai, 2020). However, AI can be an intimidating and confusing topic for many, so it would be best to define the most common terms and explain the inner workings of AI to clarify the subject.

3.2. How does AI work?

We now know what Artificial Intelligence is and what it can do. First, I will introduce the classifications and terminology of AI, and then I will dive deeper into the inner workings of this modern technology.

3.2.1. Classifications

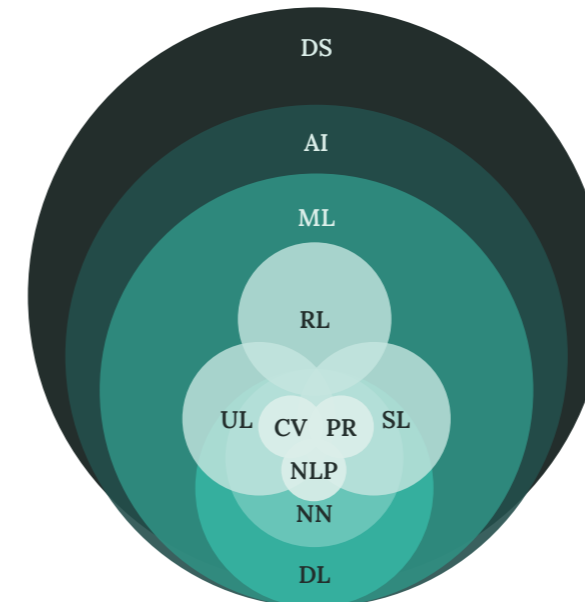
As previously mentioned, Artificial Intelligence works by using algorithms to train computational models to perform specific tasks. In order to help understand the scope and limitations of AI, researchers declared three main classifications of AI with different purposes (Kanade, 2022):

1. Artificial Narrow Intelligence, also known as weak AI (ANI), is a system that is designed to perform specific tasks. Their goal is to mimic human behavior and aid with simple and automatic tasks such as chatbots, automated customer service systems, or image recognition.
2. Artificial general Intelligence (AGI), or strong AI, is designed to act human-like. These Systems can be capable of learning from their environment, making decisions, and adapting to new situations. The most advanced examples of these systems include facial recognition and self-driving cars.
3. Artificial Super Intelligence (ASI) is designed to surpass the human mind, it is designed to learn independently without human intervention. Their goal is to be able to perform any

task that a human is given, or even tasks that humans are unable to do. But, if even possible, the science is still far from achieving this goal.

It is important to note that every AI that is currently in existence is considered an ANI. The current state of AI research and development is focused on improving ANI systems and developing AGI, which is a system that can perform a wide range of tasks across different domains. One of the most advanced models would be GPT-4, which is still not a true AGI system and still has limitations, but it is a step towards creating more advanced AI systems that can perform a wider range of tasks and potentially approach human-level intelligence.

Fig. 1: A Diagram showing the correlation of many of the AI terms shown in table 1.



3.2.2. Key Terminology

Having gained insight into the various types and objectives of AI, it is now appropriate to introduce and explain some of the complex terminology of the field. This will enable us to develop a deeper understanding of the topic and better understand the following chapters. However, it is important to note that this list is not exhaustive in explaining the vast landscape of the AI field.

In order to further explain the correlation between these terms, a Venn-diagram will be shown.

Short Term	Description
DS Data science	The Science of extracting knowledge and insights from data using statistical and computational methods.
ML Machine Learning	Machine Learning is a type of Artificial Intelligence that allows computer systems to learn from data without being explicitly programmed to do so.
SL Supervised Learning	A model is trained on labeled data, meaning that the desired output for each input is provided.
UL Unsupervised Learning	A model is trained on unlabelled data, meaning that there is no provided output for each input.
RL Reinforcement learning	A ML method that learns from experience through feedback signals of rewards or penalties.
DL Deep Learning	A subfield of machine learning that uses artificial neural networks to model and solve complex problems.
NN Neural Network	A computational model that can learn to recognize patterns
NLP Natural Language Processing	The ability of computer solutions to understand and interpret human language naturally.
PR Pattern Recognition	Pattern recognition is the automated recognition of patterns or irregularities in data.
CV Computer Vision	Similar to human vision, the goal is to enable machines to understand and interpret digital images
CB Chatbot	A computer program designed to simulate an intelligent conversation on a text or verbal basis.

Table 1: The most important terms for Artificial Intelligence and their abbreviations (Expert.AI, 2023).

3.2.3. How does it work?

Figure 2 provides a visual representation of the basic mechanism underlying AI algorithms, which can be further explored in the following explanation.

Most AI algorithms work in a similar manner. Relevant data is being gathered; for example, many pictures of trains and cars. The collected data is then preprocessed and prepared for training. That could include removing irrelevant things like people or trees, or it could be organizing the data.

The model is then trained with Machine Learning algorithms that learn from the data by identifying patterns. In our example, it would learn to distinguish between a train and a car by analyzing the different features between them.

Once the training is complete, the performance is evaluated using new test data that it has not seen before; in our example, new labeled images. Parameters such as accuracy are then measured.

If the model does not perform well, there are various approaches to improving it, such as using different models, adjusting parameters, or increasing the learning dataset. If the model performs well, it can be deployed for new, unseen data.

Lastly, the model can be fine-tuned to further meet the requested features using feedback and real-world performance data (Tableau, 2023).

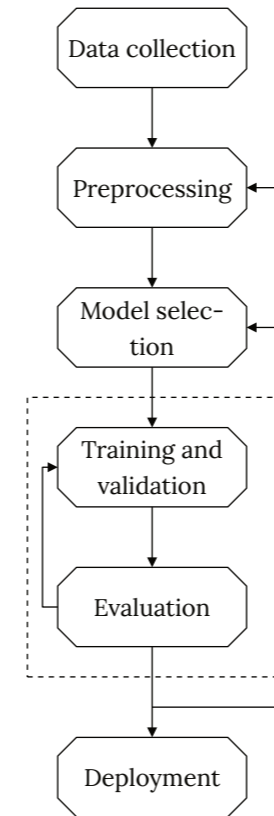
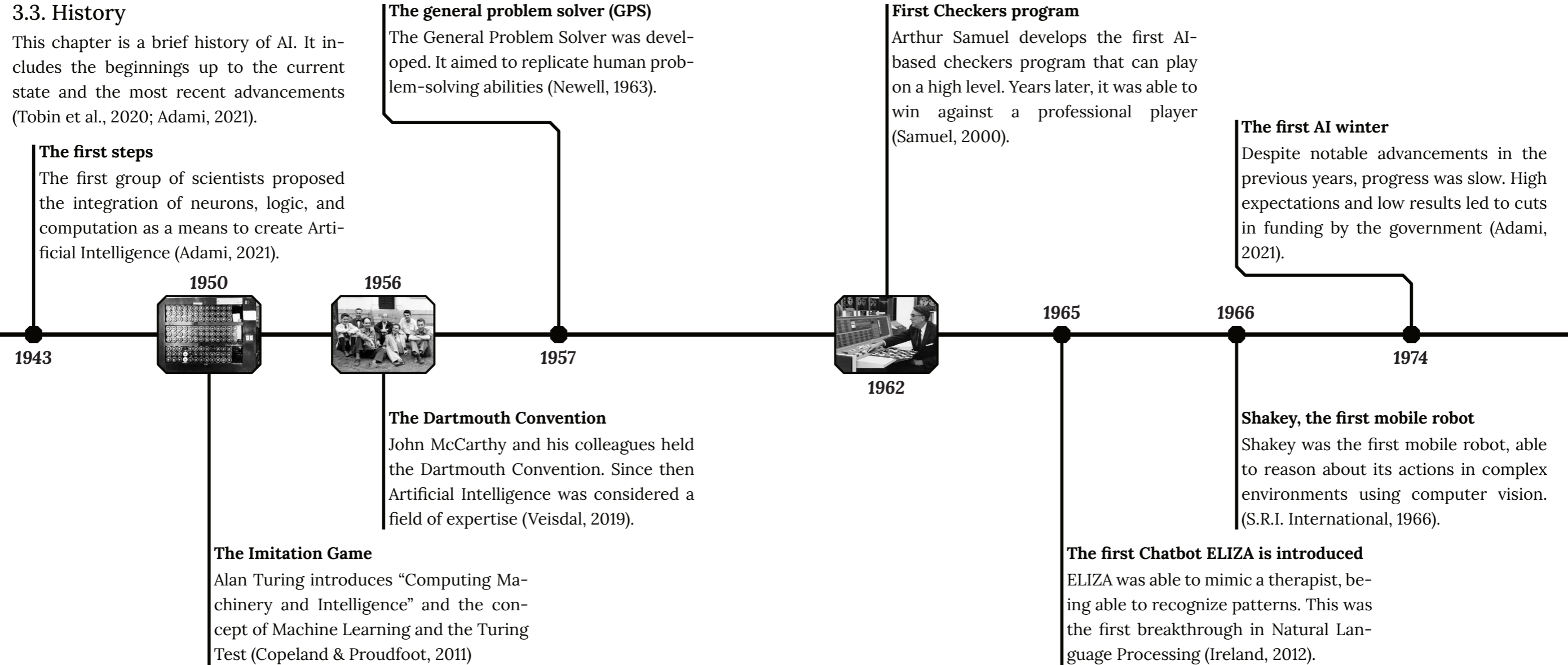
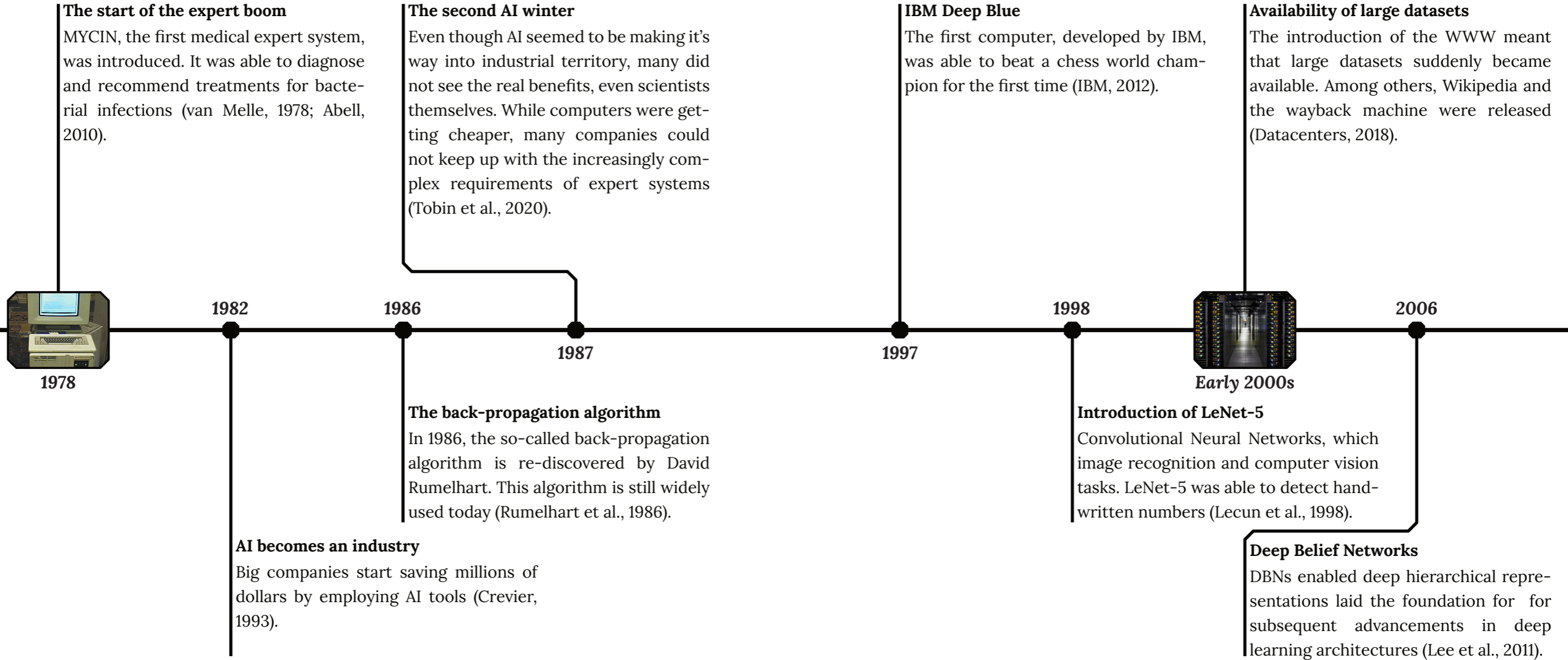


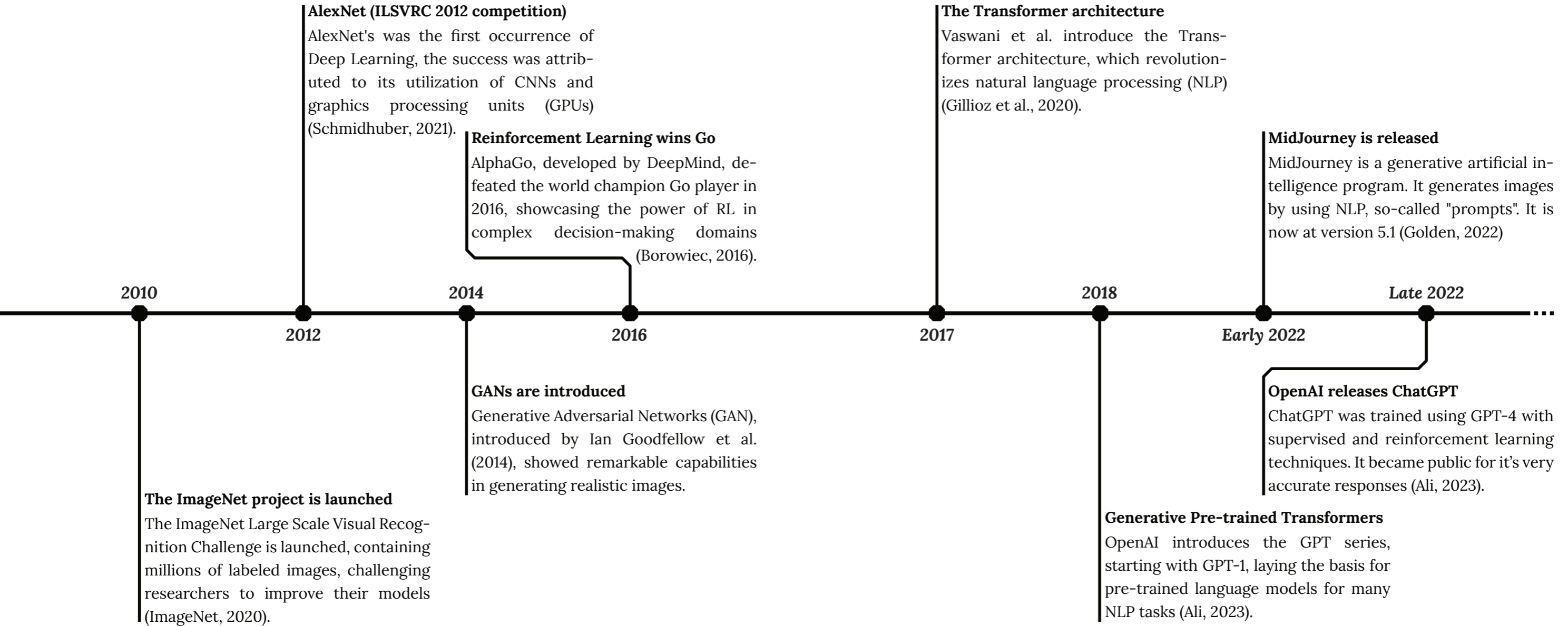
Fig. 2: Flowchart of a basic Machine Learning algorithm. The step with the training and validation is repeated until the algorithm is good enough for deployment (Ng et al., 2020).

3.3. History

This chapter is a brief history of AI. It includes the beginnings up to the current state and the most recent advancements (Tobin et al., 2020; Adami, 2021).







3.4. The current state of AI

Currently, AI is rapidly advancing, with new developments being made daily. It is already being integrated into many aspects of daily life, from healthcare and finance to transportation and education. The main objectives of AI are to improve efficiency, accuracy, and decision-making, which have significant potential benefits for individuals and society as a whole.

While progress in AI seems fast, there are still many challenges that this technology must overcome. One of the most pressing concerns is the impact on employment, as many jobs that have been introduced by earlier technologies are now at risk of being replaced by robots or AI-powered machines. This raises questions about the future of work and the need for new approaches to job creation and workforce training.

Another major challenge is the ethical and responsible use of AI. As a powerful tool, AI has the potential to perpetuate and amplify existing biases and inequalities, both in decision-making and in its impact on society. This raises concerns about the implications of ethical bias in the usage of AI as well as its impact on privacy, security, and human rights (UNESCO, 2022).

To ensure a successful transition to an AI-driven world, it is essential to have an arsenal of workers with diverse roles. As shown in figure 3, there are five groups of workers that play a critical role in this transition.

The first group are the innovators and researchers who are re-

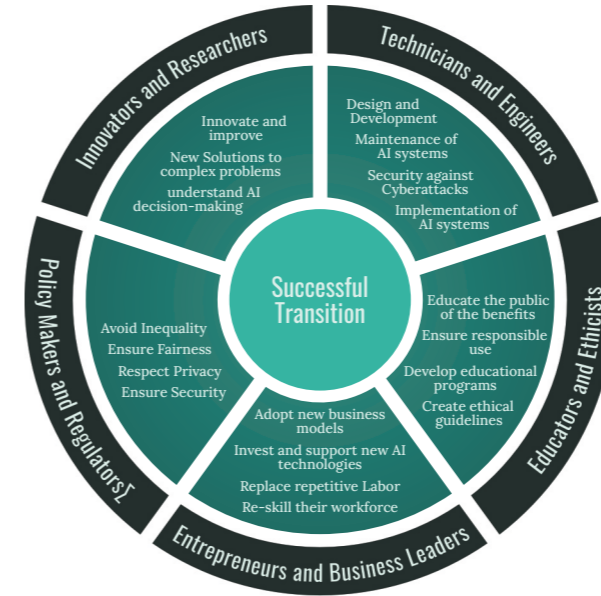


Fig. 3: The required groups for a successful transition into an AI driven world.

sponsible for driving progress in AI technology by continuously improving and innovating AI technologies and creating solutions to new problems (Hager et al., 2017).

The next group on the list are the policy-makers and regulators who bear the responsibility of ensuring ethical and responsible usage of AI (Scherer, 2015).

Next, business leaders and entrepreneurs will adopt new business models centered around AI and make investments in new technologies. Their role is to drive the integration of AI across different industries (Soni et al., 2020).

Fourthly, educators and ethicists have a crucial responsibility to raise public awareness about the advantages and risks of AI technology. Their function is vital in making sure that the public is informed about the possible benefits and drawbacks of AI (Burton et al., 2017).

Finally, technicians and engineers are responsible for developing software and ensuring the security of AI systems. Their role is essential in ensuring that AI systems operate efficiently and effectively and that they are protected against malicious attacks (Morel, 2011).

3.5. Ethical and Societal Implications of AI

As the development of artificial intelligence (AI) progresses, it becomes more and more important to address the ethical and societal implications of its use. Among these concerns is the potential for bias, which can result in discrimination and unfairness. An AI system's impartiality is limited to the data on which it is trained, meaning that if the data contains biases, the AI will only intensify and replicate them. This poses a significant challenge in the creation of responsible AI (UNESCO, 2022).

Furthermore, AI does not understand the concept of ownership, which raises questions around copyright and intellectual property laws. The recent AI art theft debate highlights the need for clarity around these laws and how they apply to AI-created content (Brittain, 2023; Appel et al., 2023).

Job displacement is another concern with AI, as automation can replace jobs that were previously performed by humans. While this can lead to increased efficiency and productivity, it can also have negative consequences, potentially replacing millions of workers (Vallance, 2023).

In addition to these concerns, there are also questions around liability and trust. Who is responsible when an AI system makes an error or breaks the law? How do we demonstrate that AI is safe to use and avoid biases being built into these systems from the outset?

To address these challenges, responsible AI frameworks have been

developed that prioritize fairness, reliability, safety, privacy, transparency, and accountability. Explainable AI (XAI) procedures and methods are also being developed to improve the user experience by being able to verify the results generated by machine learning algorithms (Microsoft, 2023; Google, 2023).

Overall, as AI continues to evolve, it is crucial to consider the ethical and societal implications of its use and develop responsible AI frameworks and practices to ensure that it is used in a fair, safe, and transparent manner.

3.6. What does the AI future look like?

The future with AI is an exciting prospect. As the technology advances, it will overcome the challenges that are still ahead of us, and society as a whole can harness the benefits. Many areas of life have the potential to be completely transformed once the technology is ready for mass adoption.

In the coming years, AI will revolutionize the design industry by streamlining workflows and enhancing efficiency. Designers will witness a significant reduction in the time and effort required to manage projects. With AI-powered tools and algorithms, the optimization and refinement of designs will become faster and more accessible than ever before. Furthermore, AI will enable designers to unlock deeper insights and understand user needs on a more profound level. By analyzing vast amounts of data and user feedback, AI-powered design systems can provide designers with guidance and recommendations (Philips, 2018).

4. AI in Design

This chapter is directed towards exploring the capabilities and possibilities that AI has today for Designers. The objective here is to compile a sort of catalog that can aid designers in integrating AI tools into their workflow while showing the strengths and weaknesses of AI.

In this chapter

- 4.1. *Why is AI such a valuable tool?*
- 4.2. *Traditional vs. AI Process*
- 4.3. *Overview and types*
- 4.4. *Finding the right tools and workflow*

4.1. Why is AI such a valuable tool?

As for other industries, AI can be beneficial in various aspects of a designer's daily life, including product design, graphic design, and other workloads. The landscape of tools is constantly evolving, from chatbots to branding tools and typography finders. An emerging market like this attracts many start-ups and competitors, making evaluating the validity and effectiveness of singular tools difficult to measure.

This vast landscape of AI tools also opens up a multitude of possibilities for designers to explore, enabling them to accomplish their work with unprecedented speed and innovative workflows.

As mentioned in Chapter 3, AI is already extensively used in data analysis. Tools such as Google Analytics already provide important data on how users interact with programs or interfaces, enabling them to extract meaningful insights such as market trends or customer preferences. This helps with design decisions and leads to more effective outcomes.

For designers, tools such as Rytr or ChatGPT can serve as copywriters, providing example texts that can replace the classic “Lorem ipsums”, that usually serve as placeholders. OpenAI DALL·E can create images that fit the designer’s imagination so they can envision their products easier. It also allows automation of repetitive tasks and faster iteration between versions. This results in more personalized experiences and better communication between designer and customer.

4.2. Traditional vs. AI Process

Product design is the process of creating a product that meets the needs of its users. In order to develop an efficient product design, there are several stages that need to be completed. While the approaches differ, most of them include the following stages (Gastaldello, 2021; Carter, 2023):

- 1. Idea Generation:** This initial stage revolves around generating creative and innovative ideas for the product.
- 2. Research and Analysis:** This stage involves researching the needs of the users and analyzing the current market to identify any potential opportunities or gaps.
- 3. Conceptualization and Product Definition:** This stage involves coming up with ideas for the product and developing a concept that meets the needs of the users.
- 4. Design and development:** This stage involves designing the product and its components, including both hardware and software.
- 5. Prototyping:** This stage involves creating a prototype of the product that can be tested and refined.
- 6. Evaluation and Testing:** This stage involves testing and evaluating the product in order to determine its effectiveness and identify any potential problems or issues.
- 7. Production:** This stage involves producing the product and making it available to the users.

With the help of Artificial Intelligence, most of these steps can be altered and made more efficient by saving time and resources. Table 2 displays a comparative table of traditional methods and modern AI tools that can be used for every step of the design process.

Stage	Traditional methods	Modern AI methods
1. Idea Generation	Ideation, Brainstorming, Google Storming, Mood Boards	Text generation, ChatBots, Mind maps
2. Market research and analysis	Market &, Competitive Analysis, Scientific re-search	AI research assistant, AI persona generator, ChatBots, SEO research
3. Conceptualization & Product Definition	Evaluation matrix, User research, Iterative design	Text generation, ChatBots, Mind maps
4. Design & development	Sketching, UI/UX Design	Image generation, Logo design, Typography combination, Color palettes, Website builder, UI designer
5. Prototyping	Physical, Digital, Rapid, Wire-framing,	Image manipulation, Image enhancing, Audio generator, Automated Prototyping
6. Evaluation & Testing	Analytics & Metrics, Iterative Design, Expert Evaluation	AI insights tool, Automated tests, Accessibility tests
7. Production	Manufacturing, Assembly	Optimized Supply chain, System optimization

Table 2: Comparative table, showcasing traditional methods (Patil et al., 2017; Mächler, 2022) and AI-based solutions for each step of the design process.

4.3. Overview and types

The range of tools available in 2023 for creative workers has expanded significantly, leading to a competitive market with a few standout options. Whether you're a writer, video editor, musician, or designer, there is an abundance of tools that can revolutionize your workflow and enhance your creative process like never before. Innovations such as ChatGPT and MidJourney are poised to reshape the way creatives work and transform the entire industry.

Not every tool serves the right purpose for everyone. With limited monetary resources, it is difficult to form a conclusive opinion about the best tool for every category. There are many tools that offer to “do it all,” and there are ones that are very specialized in certain areas. Very few of them come free of charge and most are based around a monthly subscription. This is mostly due to running server costs and Machine Learning requiring a lot of computing power (Dhar, 2020). While some modern approaches consume less power, this remains one of the biggest limitations of AI today.

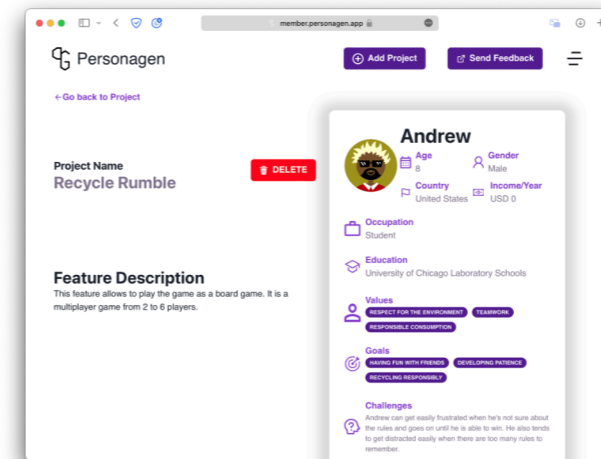
4.3.1. Exploring and comparing the tool types

Incorporating AI into the creative field offers numerous benefits across various aspects, including ideation, accessibility, inclusive design, and sustainability. AI-powered tools facilitate idea generation, make designs more accessible to diverse audiences, promote inclusivity in design practices, and contribute to sustainable design practices.



Fig. 4: Screenshot of whimsical, a mind mapping and project organization tool.

Fig. 5: Screenshot of PersonaGen, providing a user persona when giving it with a description of the project.



The first types of tools to explore are directed towards **idea generation**. There, methods like brainstorming and googlestorming can be immensely enhanced with AI tools. Machine learning is being integrated where it makes sense, such as by suggesting new nodes for a specific topic, as seen in figure 4. Singular sentence inputs can also lead to entire mind maps. Text-generation tools can also help provide guidelines to follow and enhance ideas.

In the step of **market research and analysis**, there are various tools. Such as research assistants that aid in scientific research, market analysis, identifying the target audience, and much more. Scientific research tools use NLP to understand natural language to find relevant papers and books to deliver the best possible research results. Market research tools can analyze large amounts of data to predict trends and competition by crawling websites. They are directed towards enterprises and feature complex user interfaces. Tools like PersonaGen can help in creating user personas to better define the target market (Figure 5).

Conceptualization and product definition are crucial stages in the design process, and AI-powered tools offer valuable support in these areas. During conceptualization, AI tools can assist designers in generating innovative ideas and exploring different concepts. They can offer outlines and project timelines to aid designers in keeping track of their project progress. Figure 6 shows a possible use case with Taskade.

The **design and development** step is where generative AI can be at its most powerful. There are many tools for branding (see figure 7), color combinations, typography, image generation, and more. Usually, AI can deliver ideas and insight about a particular project. For example, a certain placeholder might fit perfectly into a design, but a stock image is nowhere to be found. Using AI, this image can now be easily created and used.

In the **prototyping** phase, AI-powered tools can streamline the process and enhance efficiency. Prototyping tools equipped with machine learning algorithms can analyze design inputs and automatically generate interactive prototypes (see figure 8), saving

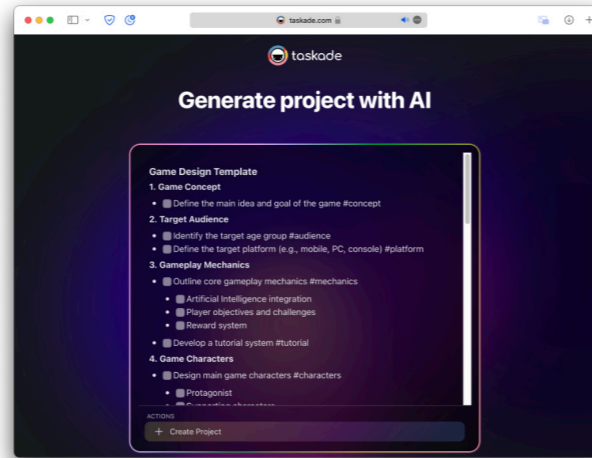


Fig. 6: Screenshot of Taskade, providing an outline for a design project upon entering a single prompt.

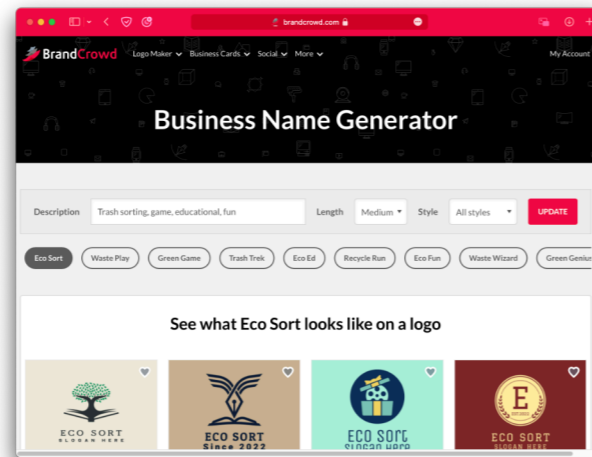


Fig. 7: Screenshot of the website brandcrowd.com, creating potential business names and logos.

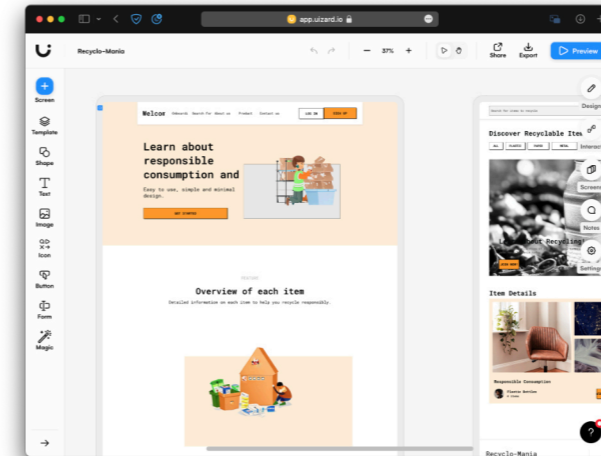


Fig. 8: Screenshot of the website uizard, testing the functionality of automated prototyping.

designers valuable time and effort. These tools can also assist in user flow optimization, offering suggestions for improving the user experience based on data-driven insights. Additionally, AI can simulate user interactions and provide real-time feedback, allowing designers to rapidly iterate and refine their prototypes. In the physical world, AI is still in the early phases of generating valuable 3D assets that can be used for 3D printing or similar methods.

Testing and evaluation are critical steps in the design process, and AI plays a pivotal role in providing valuable insights and analysis. AI-powered analytics tools collect and analyze user data, offering actionable metrics for informed decision-making. Machine learning algorithms deepen insights into user preferences, trends, and pain points, enabling designers to refine and tailor their designs accordingly. AI also aids in sentiment analysis by analyzing user feedback and social media data, helping designers understand the overall perception and sentiment towards the design product. Furthermore, AI augments traditional testing methodologies with automated simulations of user behavior, issue detection, accessibility testing, and A/B testing for evaluating different design variations and determining the most effective solution.

In the **production** phase, AI-powered tools contribute to streamlining and automating various aspects of the design process. For

instance, AI can automate repetitive tasks like image editing, formatting, and asset generation, significantly reducing manual effort and increasing productivity. AI-driven design systems can also assist in maintaining visual consistency across different deliverables, ensuring cohesive branding and design elements. Furthermore, AI algorithms can optimize file sizes, enhance compression techniques, and improve loading speeds, thus optimizing the performance of the final product.

4.3.2. Evaluating the Tools

I have identified five key categories for evaluating the usability and cost-efficiency of AI tools. These categories are based on functionality and are compared using the following criteria:

- 1. Quality:** How accurate is the AI tool at those tasks?
- 2. Ease of use:** How user-friendly is the AI tool?
- 3. Versatility:** How adaptable is the AI tool across different tasks and contexts?
- 4. Speed:** How fast does the tool perform the tasks?
- 5. Cost:** What is the cost of the AI tool, and is it worth it?

By comparing AI tools based on these criteria, we can develop an overview of their strengths and weaknesses. The cost is judged by the first two tiers of pricing that make the most sense for an individual user. The ease of use is determined by first impressions and how well-made the UI and UX are. The quality is determined by how well the tool performs and its versatility, as to how wide the

application field is. The speed is determined by the time until the tool gives the desired output.



Fig. 9: Comparison of the three best-rated AI tools for image generation. All of them were given the same prompt “A dog with a funny hat, playing video games”. From left to right: Dreamstudio AI, OpenAI Dall-E, MidJourney.

First of all, the cost of the tools is examined. Then, the ease of use and versatility are subjectively tested by exploring each tool. The tools are then given a task and, if possible, the exact same parameters to make a fair comparison, which can be seen in figures 9 and 10. Then the quality of the results is judged subjectively, and the speed is then examined and related to each tool in the category.

Fig. 10: Comparison of the three best-rated AI tools for text generation. All of them were given the same prompt “provide me with a list of waste items that children encounter in every day life”. From left to right: Bing AI, ChatGPT, Huggingchat.€

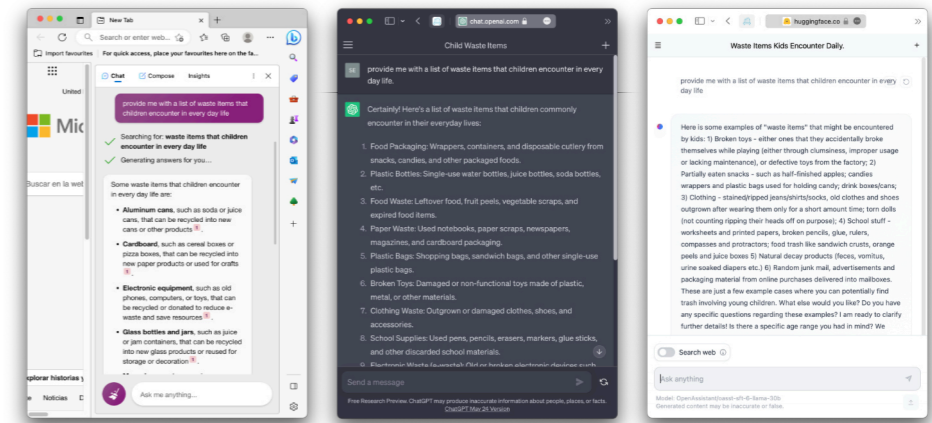


Table 3 presents a comprehensive compilation of different tool types along with tested scores based on the aforementioned criteria. It is important to note that this evaluation focuses on a selected group of top AI tools, and there are numerous other tools, both free and paid, that couldn't be included in the assessment. However, the tested tools showcased notable performance and characteristics that provide valuable insights for designers.

Analyzing the table, we can draw conclusions about the AI tools and their characteristics. The evaluated AI tools demonstrate high-quality performance and varying levels of ease of use, versatility, speed, and cost. Tools like Elicit and ChatGPT stand out for their accuracy and ease of use, while also being adaptable across different tasks. They offer fast results and come at no cost. On the other hand, tools such as Taskade, MidJourney, and OpenAI Dall-E provide high-quality outputs but may require some learning and come with associated costs. Overall, these findings highlight the potential of AI tools to enhance design workflows, but further research and evaluation are necessary to make informed decisions based on specific project requirements.

In addition to the established categories of AI tools discussed earlier, there are also emerging tools that hold great potential for designers but are not yet ready for widespread use in the mass market. These tools include vector creators and 3D model creators, which are still undergoing development and refinement.

Tool type	Name	Quality	Ease of Use	Versatility	Speed	Cost
Research assistant	Elicit	High	Easy	Moderate	Fast	Free
	Semantic Scholar	High	Moderate	Moderate	Fast	Free
	ASReview	High	Difficult	High	Fast	Free
Project organizer	Whimsical	High	Easy	High	Fast	Moderate
	Taskade	High	Easy	High	Moderate	Low
	GitMind	Moderate	Easy	Moderate	Fast	Low
Persona generator	User Persona	Moderate	Easy	Low	Fast	Free
	PersonaGen	High	Easy	Moderate	Fast	Free
	GetItOut	Moderate	Difficult	Low	Moderate	Free
ChatBot	HuggingChat	Moderate	Easy	Moderate	Fast	Free
	ChatGPT	High	Easy	High	Fast	Moderate
	Bing	Moderate	Moderate	Moderate	Moderate	Free
Content writer	Rytr	High	Easy	High	Fast	Low
	Jasper	Moderate	Moderate	Moderate	Fast	High
	AI Writer	High	Easy	High	Slow	High
Image Generation	MidJourney	High	Moderate	High	Moderate	Moderate
	OpenAI Dall-E	High	Easy	Moderate	Moderate	High
	StableDiffusion	Moderate	Moderate	High	Moderate	Free
Color palette	Huemint	High	Easy	High	Fast	Low
	Eva Design System	Moderate	Easy	Moderate	Fast	Free
	Khroma	High	Easy	High	Slow	Free
Logo Generation	Looka	Moderate	Easy	High	Fast	High
	Makelogo.ai	Moderate	Easy	Moderate	Slow	Moderate

Tool type	Name	Quality	Ease of Use	Versatility	Speed	Cost
Name Search	Onlycoms	Moderate	Easy	Low	Fast	Free
	Namelix	Moderate	Easy	High	Moderate	Free
	BrandCrowd	High	Easy	High	Fast	Free
Presentations	Slidemake	Low	Easy	Low	Fast	Free
	Tomeapp	Moderate	Easy	High	Fast	Low
	Wepik	Moderate	Easy	Moderate	Moderate	Free
Typography	Opentypeface	High	Easy	High	Fast	Free
	Mixfont	Moderate	Easy	Moderate	Fast	Free
	FontJoy	High	Easy	Moderate	Fast	Free
Image enhancing	FreeScaler	High	Easy	Moderate	Slow	Free
	Vectorizer.AI	High	Easy	High	Moderate	Free
	Remove.bg	High	Easy	Low	Fast	Low
UI design	Durable co	Moderate	Easy	Low	Moderate	Free
	UIzard	High	Moderate	High	Moderate	Moderate
	DesignMaker	Moderate	Easy	Moderate	Fast	Moderate
Coding	Replit	High	Moderate	High	Fast	Low
	Github Copilot	High	Moderate	High	Fast	Moderate
	ChatGPT	Moderate	Easy	High	Fast	Moderate
Sound & Music	Clip Audio	Moderate	Easy	Low	Moderate	Free
	Evoked Music	Moderate	Easy	Moderate	Fast	Moderate
	Soundraw	High	Easy	High	Moderate	Moderate

Table 3: Selected AI tools, sorted by tool type and compared for quality, ease of use, versatility, speed and cost.

4.4. Finding the right tools and workflow

After a thorough analysis of numerous tools spanning various aspects of a designer's work, it is now time to establish a workflow. For designers, it is essential to find the right kind of tools to leverage AI technology in their work.

4.4.1. The right workflow

Not every designer follows the same approach for their projects, but the underlying methodology is generally similar. As shown in Table 2, there are various types of tools available to assist with different steps of the design process. It is crucial to identify the key stages and activities involved in the design process early on. Once this is established, designers can customize and adapt their workflow to align with the unique requirements of their project.

4.4.2. Crafting effective prompts

One of the key concepts of using Artificial Intelligence is prompting. Prompting involves giving specific instructions to the tool at hand to generate a response based on the given input. It is also important to understand that GPT-based AI tools understand questions and provide answers by piecing together "tokens" that fit well together according to the system they are trained on. It is crucial to consider that, while they can understand written text well, they do not always get the desired results. This is why it is important to craft effective prompts. There are a number of tools and presets that allow for more effective results.

Technique	Ineffective prompt	Effective prompt
Be clear and specific	“Tell me about renewable energy and its effects”	“Please provide a detailed analysis of the impact of renewable energy on the global economy, focusing on job creation and environmental sustainability.”
Use contextual information	“Write about elves”	“In the context of a fantasy world, describe unique characteristics and culture of the elven race”
Experiment with Different Prompts	How can I manage my time better?”	What are some effective strategies for improving time management skills?
Use Prompts as Examples	Describe a beach scene	Provide a paragraph describing a serene beach setting with vivid sensory details, similar to: "The sun-kissed sand caressed my bare feet as the gentle waves whispered secrets along the shoreline.
Incorporate Constraints	Give me an overview of AI history.	Write a concise, 100-word summary of the history of artificial intelligence, focusing on key milestones and breakthroughs
Iterate and Refine	Sticking to the same prompt without making adjustments based on the initial output	After receiving an initial response: "Can you please provide more specific examples to illustrate your point about the benefits of exercise for mental health?"

There are many techniques for crafting effective prompts. Table 4 demonstrates efficient techniques and examples for efficient and inefficient prompts. Additionally, it is worth noting that every AI tool has its own restrictions, and it is reasonable to understand the specific prompt formats and syntax supported by different tools.

Overall, by implementing effective prompts and understanding the capabilities of different AI tools, designers can maximize the potential of AI technology in their creative workflows.

Table 4: Techniques and examples for ineffective and effective prompts.

4.4.3. Evaluating the results

When evaluating the results of AI tools, there are some important aspects to consider. One should always use personal judgment and compare the generated outputs to the expected human-authored content. That way, one can get a feel for how reliable and accurate the outputs are.

AI systems can inherit biases present in the data they were trained on. That means that often times they may provide the user with results that may incentivize extremist beliefs. This is especially concerning for content creators, who may not be aware of this issue. AI tools are also bound to hallucination, which means that they sometimes "imagine" information and provide the users with plainly wrong information. Some AI tools, like Bing AI, are known for being very insistent on giving the wrong information.

If these conditions are met for the desired information, users should further evaluate the outputs for factors such as coherence, consistency, and relevance. Coherence refers to the logical flow and organization of the generated content, ensuring that it makes sense and follows a coherent narrative or structure. Consistency involves assessing whether the AI tool maintains consistency in style, tone, and terminology throughout the generated outputs. Relevance is a critical aspect, as it determines whether the AI-generated results align with the specific information or context the user seeks.

5. Design of the game

This chapter's focus is on the creation and the design of game. Designing a game involves carefully crafting its elements to create an engaging and immersive experience for the players. This chapter explores various aspects of game design, including the selection of AI tools, project setup, prototyping, creating the application, and evaluating its effectiveness. By combining the power of modern technologies and AI-driven tools, we aim to develop a dynamic and visually appealing game that captivates both children and parents. Join us on this journey as we unveil the creative process behind bringing the game to life.

In this chapter

- 5.1. Choice of AI Tools and Project Setup
- 5.2. Idea generation
- 5.3. Market research and analysis
- 5.4. Concept development and Product definition
- 5.5. Creating the Visual Identity
- 5.6. Creating the assets
- 5.7. Creating the application
- 5.8. Prototyping

5.1. Choice of AI Tools and Project Setup

The selection of AI tools and project setup were crucial in shaping the direction and execution of this project. After thorough testing and evaluation, a curated list of tools was assembled to meet the specific needs and objectives of the project. Table 5 provides an overview of the tools chosen for the design process. Additionally, alongside these AI tools, dedicated manual labor was applied using dedicated programs.

It is worth noting that while some tools were not deemed the best overall, they were chosen for their exceptional value and efficiency in meeting specific project requirements. This careful consideration allowed for the optimization of resources and ensured that the project remained within budget constraints without compromising on quality or functionality.

The thoughtful selection and setup of AI tools and supporting programs formed the backbone of the project, providing the necessary framework to successfully realize the project objectives and deliver a high-quality end result.

Step	Tools used	Purpose
1. Idea Generation	ChatGPT	Ideation
2. Market research and analysis	Elicit,	Scientific research
	PersonaGen	User personas
	Bing AI	Market research
3. Conceptualization & Product Definition	ChatGPT	Product definition
4. Design & development	Rytr, ChatGPT	Content Writing
	MidJourney, Affinity Designer	Asset creation
	FreeScaler, Vectorizer.ai	Upscaling
	Huemint	Color palette
	ChatGPT, Brand Crowd	Brand name
	Looka, Affinity Designer	Logo design
	MidJourney, Svelte	UI design
	Opentypeface	Typography
	Clip.Audio	SFX
	ChatGPT, Github CoPilot, VS Code	Coding
5. Prototyping	Laser cutting, printing	Physical prototypes
	Uizard	Digital prototypes
6. Evaluation & Testing	PageSpeed Insights	Accessibility tests
	Interview with expert	Evaluation
	Play-testing with children	Play-testing, refining

Table 5: All the steps that were taking in the project together with the tools used. In cursive the tools that are not AI-powered.

5.2. Idea generation

When I started this project, I had two primary objectives in mind: aligning with the United Nations' Sustainable Development Goals (SDGs) of Quality Education (Goal 4) and Sustainable Consumption (Goal 12) (United Nations, 2022a; 2022b). Following these objectives, I created two main goals for this project:

- The target audience of the product should be young children,
- The product should be environmentally friendly and teach about responsible consumption in the context of the SDGs.

Due to these objectives, the initial stages of the project involved exploring various possibilities for the product. At the beginning, it was uncertain whether the product would be a toy, a game, or another product, and it was yet to be determined whether the product would be physical or digital.

Question to ChatGPT

“I want to create a product, directed towards young children. It should be environmentally friendly and teaching about responsible consumption, for the SDGs 4 and 12. Can you give me ideas?”

The preliminary idea generation was done with ChatGPT. By posing questions similar to the example on the left, I received a range of suggestions and concepts to consider, including eco-friendly toy sets, sustainable storybooks, a trash sorting game, sustainable gardening kits, and many more.

By leveraging the capabilities of ChatGPT, I was able to explore diverse possibilities and gather inspiration for the project's direction. This enabled me to refine and narrow down potential concepts that would effectively meet the project's objectives.

5.3. Market research and analysis

For market research, there are three main areas where AI tools can assist. Firstly, Bing's AI search was used to research the product ideas that were previously generated. This can be seen in Figure 9 to the left. This helps in finding competition on the market and seeing business ideas that might be difficult to find otherwise. After researching the most fitting ideas, the one with the most potential was an educational recycling game.

Secondly, the target market has to be defined. To achieve this, the AI tool PersonaGen is used to create user personas (Figure 10). One of the six generated personas includes information such as

- Age: 4–10 years
- Occupation: preschool, primary school
- Interests: Environment, having fun, learning, nature
- Values: Responsibility, social activity, teamwork

These insights allowed for a comprehensive understanding of the target market and helped shape the product to cater to their specific needs and preferences.

Lastly, although SEO and market trend analysis tools are common in the market, their usage in this research was not conducted due to their prevalent availability and often high costs. However, it is worth acknowledging that these tools can provide valuable insights into consumer behavior, market trends, and competitive analysis.

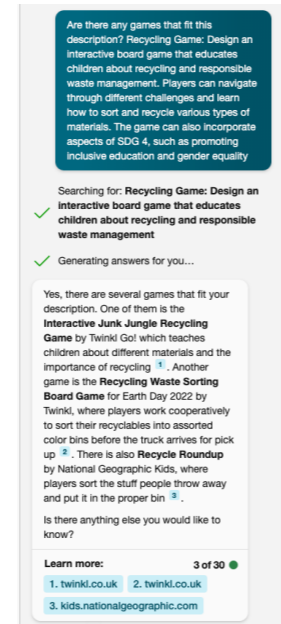


Fig. 11: Chat with Bing AI search, asking it about the ideas generated with ChatGPT.

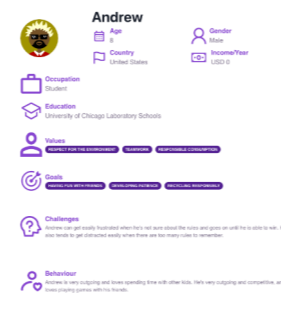


Fig. 12: Example user persona generated by PersonaGen.

5.4. Concept development and Product definition

To define the product and develop the concept, an efficient approach involved leveraging ChatGPT with pre-engineered prompts featuring a designated persona (Akin, 2023). The following example showcases the prompt engineering process:

"I want you to become my Prompt engineer. Your goal is to help me craft the best possible prompt for my needs. The prompt will be used by you, ChatGPT. You will follow the following process:

1. Your first response will be to ask me what the prompt should be about. I will provide my answer, but we will need to improve it through continual iterations by going through the next steps.
2. Based on my input, you will generate 2 sections. a) Revised prompt (provide your rewritten prompt. it should be clear, concise, and easily understood by you), b) Questions ask any relevant questions pertaining to what additional information is needed from me to improve the prompt).
3. We will continue this iterative process with me providing additional information to you and you updating the prompt in the Revised prompt section until I say we are done."

Using this prompt, the ideation process iterates as ChatGPT seeks clarification through questions like:

- What is the age range of the children you are targeting?
- What kind of game mechanics or activities do you envision being used?

After several iterations, ChatGPT generated a response that laid a solid foundation for a game concept. Building upon this foundation, further elaboration was done while simultaneously crafting a distinctive visual identity for the product.

This answer already provides a strong foundation for a game, which I elaborated on further, while also creating a visual identity.

Game Title: Recycle Rumble

Game Overview: Recycle Rumble is a fun and educational game for kids aged 5-10 that teaches them about different types of waste and how to sort them correctly. The game can be played with 2-6 players and lasts for approximately 15-20 minutes. Players learn about different types of trash through trivia cards and then race to sort various items into the correct trash bins.

Game Components:

50 items to be sorted (paper, cardboard, plastic, glass, metal, electronics, batteries, food waste, yard waste, hazardous waste, textiles, etc.)

7 trash bins (blue for paper and cardboard, green for organic waste and food scraps, yellow for plastics, red for hazardous waste, brown for yard waste and compostable items, grey or black for general waste, purple for glass bottles and jars)

100 trivia cards (10 for each trash category) with questions about trash sorting and recycling

Gameplay:

Shuffle the trivia cards and place them in a stack face down.

Shuffle the 50 items to be sorted and place them in a pile face down.

Each player takes a turn to draw an item from the pile and sort it into the correct trash bin. If they sort it correctly, they get to draw a trivia card from the corresponding category and answer the question. If they answer correctly, they get a point.

App Version:

The entire screen is filled with waste item icons that provide points when sorted into the correct bin.

The full conversation can be found in Appendix A.

5.5. Creating the Visual Identity

The general idea for the visual identity started out by asking ChatGPT questions like the one displayed here on the right. ChatGPT then returned 20 ideas, including hexagonal patterns or octagonal shapes.

Question to ChatGPT

“What are some unique visual elements or shapes that could be incorporated into a modern game targeted at children ages 4-6 to make it visually appealing and distinctive? Give me 20 suggestions”

5.5.1. The symbol

For my first logo inspiration, makelogo.ai provided me with the idea of incorporating bins into the symbol. Once the basic shapes for the letter "R" were established, the inclusion of the bins as negative space further refined the logo's design. The progression of this evolution can be observed in figures 14 to 17 below.

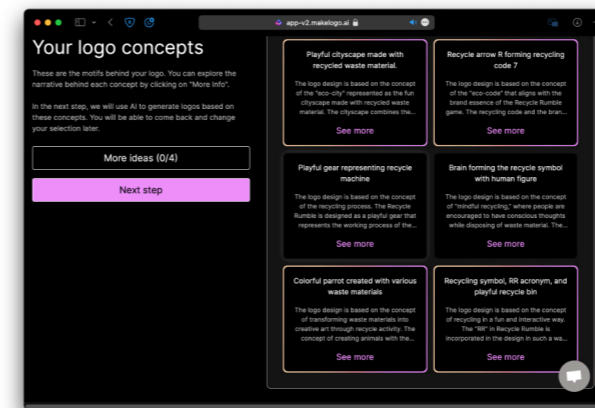


Fig. 14: Logo concepts provided by makelogo.ai



Fig. 13: The first logo idea, including two R's back to back with low-poly bins hidden in the negative space.

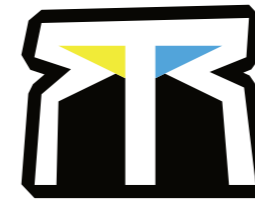


Fig. 15: The second iteration, already including the chamfered corners, it is child-friendly and playful.

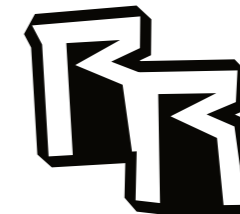


Fig. 16: In this version, the first R is turned around to make it more readable.

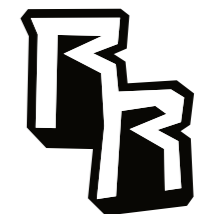


Fig. 17: In this final version, the first R is turned around to make it more readable.

5.5.2. The logotype

The logotype is based on the bin symbol. With multiple tries, the letters are following the same pattern as the symbol. This step was performed without the incorporation of AI, as the groundwork was already laid beforehand.

After a few iterations (seen in figures 18–20), the logotype incorporated a similar style as the symbol. The first iterations were too dark and difficult to read. After a few iterations, the logo ended up looking like the desired logotype. It features playful letters and a dark outline with relief.

5.5.3. Typography

Opentypeface was used to create a typeface. The tool creates typefaces using facial recognition to give the font various traits, such as thickness, slant, and many more. Afterwards, I searched for a similar font online. On this search, I found Andika, a font directed towards people who are beginning to read. As this game is directed towards children (SIL International, 2014), this seemed like a perfect choice.



Fig. 18: First iteration of a logotype. This version incorporates too much of the dark background which makes it difficult to read.



Fig. 19: This second version is more compact. The c and b still have too much negative space.



Fig. 20: This last version, the L's are adjusted, so the c and b can be made more compact. It also features a perspective shadow on the bottom side to add more dynamic.

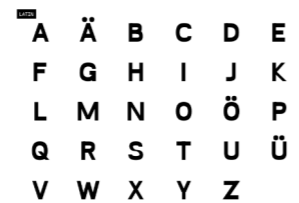


Fig. 21: Typeface offered by opentypeface.

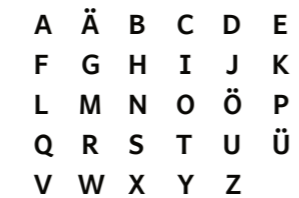


Fig. 22: Andika Typeface for comparison to the one provided by OpenTypeFace.

Question to ChatGPT

“I am creating an educative children's game, teaching about trash sorting, encouraging Responsible Consumption and Recycling, it is directed towards children of the ages 4-10. Provide me with color palettes of three colors that could fit for this age group”

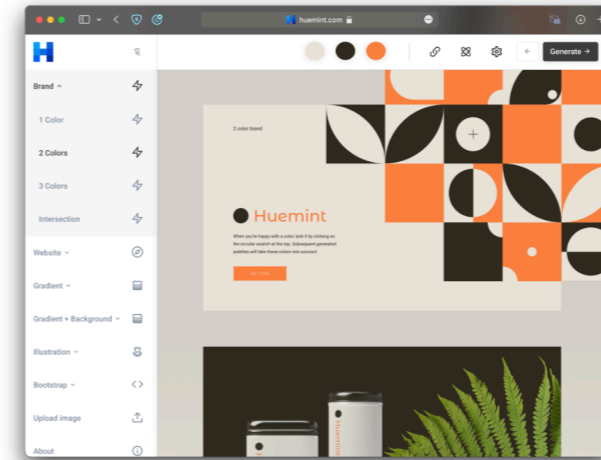


Fig. 23: A screenshot of huemint with the final colors for the game.

5.5.4. Colors

For the colors, I consulted ChatGPT to determine suitable colors for an educational children's game. Based on its suggestions, I considered green for nature and growth, yellow for happiness and positivity, orange for enthusiasm and creativity, and brown or beige for natural elements and the environment.

With these suggestions in mind, I used huemint, a tool that uses various parameters to randomly create color combinations. After multiple attempts, I selected orange as the main color and earthy tones as complementary colors. The resulting palette, shown in figure 23, consists of a light beige representing cleanliness and pu-

riety, a dark brown color associated with natural materials and providing contrast, and a vibrant orange color for excitement and energy, igniting enthusiasm.

With the main color palette now set, the secondary colors were later matched in the same way to represent the trash bin colors. This time, the given colors were blue (paper), yellow (plastic), grey (general), brown (organic), green (glass), and red (special).

5.6. Creating the assets

The first design element applied to all visually appealing elements was the addition of clipped corners, as illustrated in figure 24.

MidJourney was used for the asset creation. MidJourney has a bot interface and lives in the popular messenger app Discord. One retrieves results by sending the MidJourney-Bot a message with the desired output. MidJourney then returns four images. It is a perfect tool for inspirational use, and sometimes, with luck, it is possible to get the desired output on the first try; otherwise, one can retry or "remix" one of the images.

5.6.1 Waste items

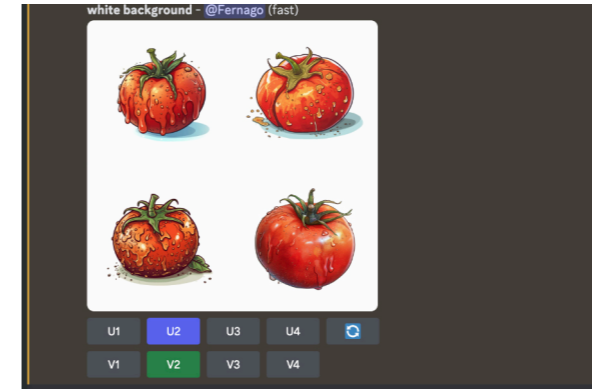
The waste items are supposed to be easily recognized while also looking old or rusty. To achieve that, a workflow of four steps was developed. The process was repeated for every trash item. The starting prompt would generally be of the same style as the one displayed on the right. This already refined prompt often led to good results. However, while MidJourney often returns good-looking results, it often misinterprets prompts, such as "egg carton", where it only understands egg or carton, which leads to inconsistent and unusable results. This meant that it was often necessary to adjust and refine the prompt to get the exact desired result.



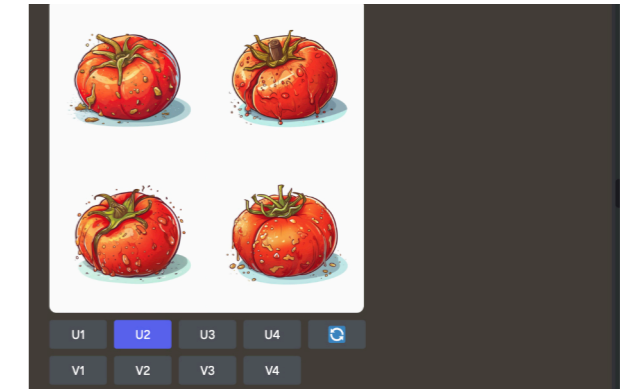
Fig. 24: The shape and background for a waste item tile.

Prompt for to MidJourney

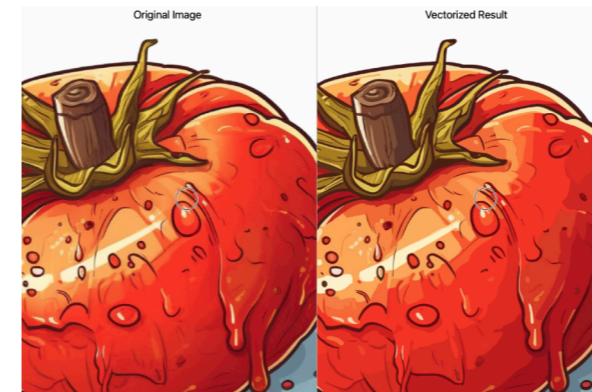
“Old rusty [Waste item name] in the style of tiny cute, highly detailed illustrations, flat shading, trashcore, top view from low perspective, vector icon a white background”



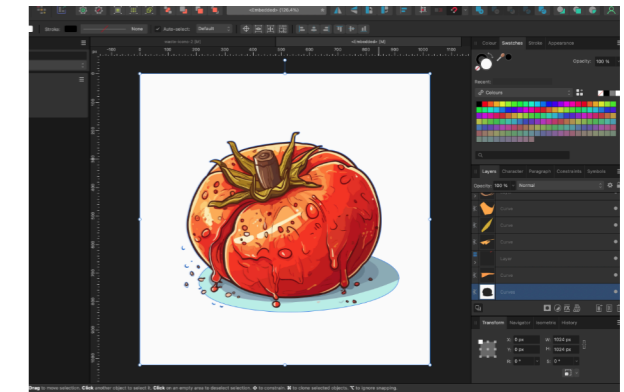
Step 1: Enter the prompt into the MidJourney chat. If you like one of the images, you can decide to upscale it or make variations.



Step 2: Select the most fitting image for the use case. If no image fits, continue searching until an image is found that serves the purpose. Upscale and download this image.



Step 3: Use the tool vectorizer.ai to upscale your image and export it to a vector file to obtain the best possible quality.



Step 4: Affinity Photo, a graphics design tool, is used to clean up the image and make sure it meets the desired needs.

Following this procedure, the waste icons were placed on tiles (see figure 25), so there is a visual consistency between the physical and digital versions of the game. By placing them on tiles, they are also easier to distinguish. The size of the physical card is 30x30x3mm.

5.6.2. Waste bins

The waste bins are different in the physical and app versions. For the app version, MidJourney was used to create trash bins with the same technique as for the waste items. The only difference is that instead of a perspective view, the prompt included “top-down aerial view” instead of “low perspective”.

For the physical version, I wanted the waste bins to be three-dimensional. In order for them to be easy to produce and simple to assemble, a system similar to the one used in the strawberry box, pictured in figure 26, is needed. They are created using a singular material and laser cutting.

As AI is not advanced and precise in the creation of vector assets, this part was conceptualized by myself. They feature a clipping mechanism, and the parts are designed to fit together. Alone, they are fragile, but together they form a strong wooden bin. Figure 27 shows the design of the bins with "teeth" that interlock and form a solid base. The design consists of four side panels, one top panel, and one bottom panel to form a bin.



Fig. 25: Design of a finished waste item card.



Fig. 26: A picture of a strawberry box.

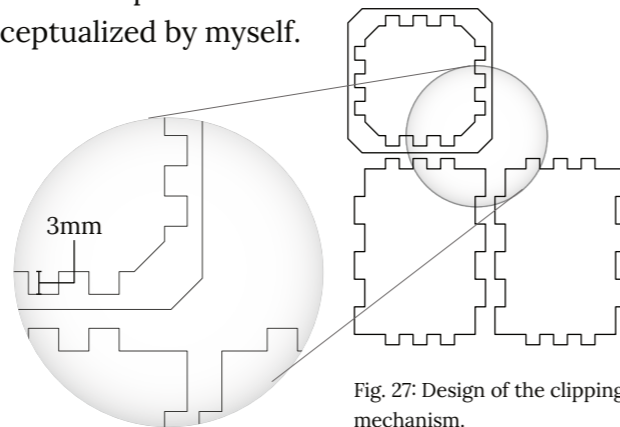


Fig. 27: Design of the clipping mechanism.

5.6.3. Playing fields

The playing fields were created with MidJourney using a similar technique to the one that was used to create the waste items and waste bins. Only this time, sample images were used to feed MidJourney inspiration images. Additionally, some parameters were used for better results; the syntax is as follows:

“*[Images] command --parameters*”

The command can be broken down into three parts, which best describes MidJourney's structure. Some important parameters include the ones displayed in Table 7. Figure 28 shows an example of a visual breakdown for the prompt.

Table 7: Parameter guide with the most used parameters for MidJourney (2023).

Parameter	Description	syntax	value range
Aspect Ratio	Adjust the size of the image	--aspect --ar	1:1 (Default), 2:1, 16:9, etc.
Tiling	Used for creating seamless patterns	--tile	-
Seed	Used to keep the same starting value	--seed	0 - 4294967295
Stylize	The higher the value, the more creative and artistic it is	--stylize --s	625 - 60000
Quality	The higher the value, the more detail is in your image	--quality --q	0.25 - 5
Chaos	This value encourages the prompt to create very versatile results	--chaos --c	0 - 100
Text weight	Gives words in your prompt more or less weight, add them after a word.	::	-10000 to 10000
Exclude	Exclude certain elements	--no	

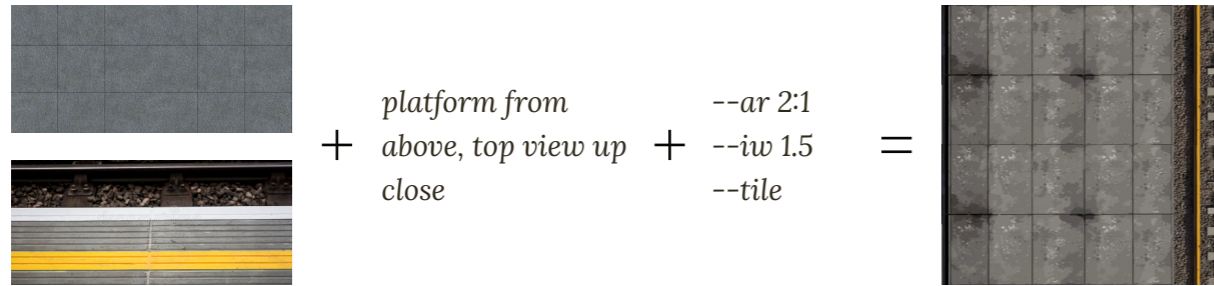


Fig. 28: Platform background created with MidJourney, created using images from (iStock, 2023; Sketchup Textures, 2023)

The first part defines inspirational images; the second part defines what MidJourney is supposed to create; and the third part specifies certain parameters that can enhance the result—in this case, the aspect ratio, the image weights, or whether or not the result should be a repeating pattern. There are many more parameters that can help further define the resulting images.

The digital version uses the resulting playing fields as seamless backgrounds, filling the entire screen. The physical version has big playing fields. In order to keep a compact form factor, the playing fields are created using another interlocking tooth mechanism (see figure 29). They also feature big, clipped corners to maintain a child-safe appearance. The size of the boards is 300 x 300 x 3 mm.

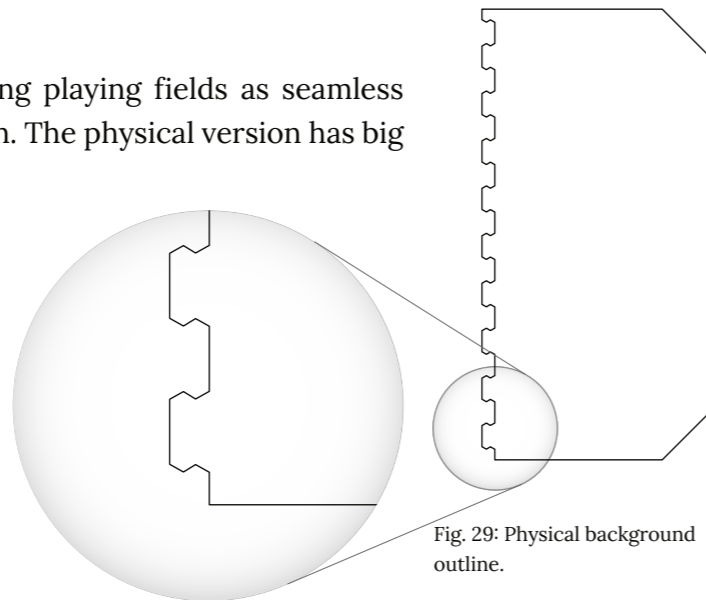


Fig. 29: Physical background outline.

Question to ChatGPT

“I am creating an educative children's game, teaching about trash sorting, encouraging Responsible Consumption and Recycling, it is directed towards children of the ages 4-10. Provide me 20 questions with two or three possible answers that could fit for this age group.”

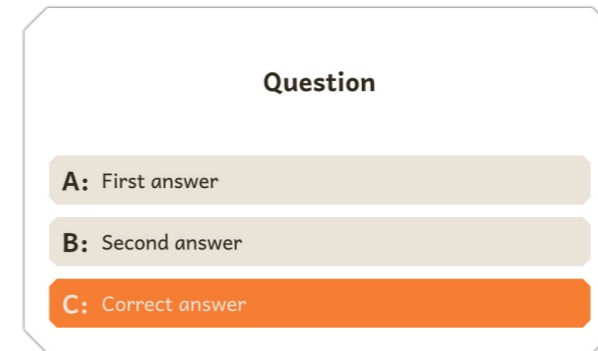


Fig. 30: Template for the A-B-C question card, the correct question is highlighted.

questions or True or false questions. The proposed size for these cards is 72 x 42 mm (see figure 30).

5.6.4. Trivia cards

The trivia cards were meticulously crafted using a combination of ChatGPT and Affinity Designer. The goal was to create engaging and visually appealing cards that are not only compact in size but also designed for effortless interaction.

With the assistance of ChatGPT, a wide range of intriguing trivia questions was curated to ensure an enjoyable experience for players. These questions were thoughtfully selected to cover various topics and levels of difficulty, catering to a diverse range of interests and knowledge levels. The questions include two types of questions: A-B-C

5.6.5. Developing the master sheet

The development of the master sheet for the designated player serving as a juror or judge was a straightforward task, as it only needed to include all the trash items, together with the trash categories and a description, on a piece of paper. The sheet would be the size of the playing field.

Fig. 31: Two templates for the categories paper and plastic, including all ten items per color.



5.6.6. Packaging

The packaging has been meticulously crafted to not only provide convenience but also prioritize sustainability in its production. Drawing inspiration from the practical design of pizza cartons, the packaging aims to minimize waste and utilize eco-friendly materials. By using a single sheet of carton and incorporating cutouts that can be efficiently produced using various methods, the packaging process is optimized for sustainability.

Furthermore, the packaging features a simple inlet design. This design element ensures that all the components, including the trivia cards and waste items, are neatly organized and secured within the packaging. This thoughtful arrangement allows for easy access to the contents while maintaining a clean and orderly presentation. The small section labeled “Playing Fields” only covers a small part of the area from the playing fields in order to maintain the shape of the inlet.

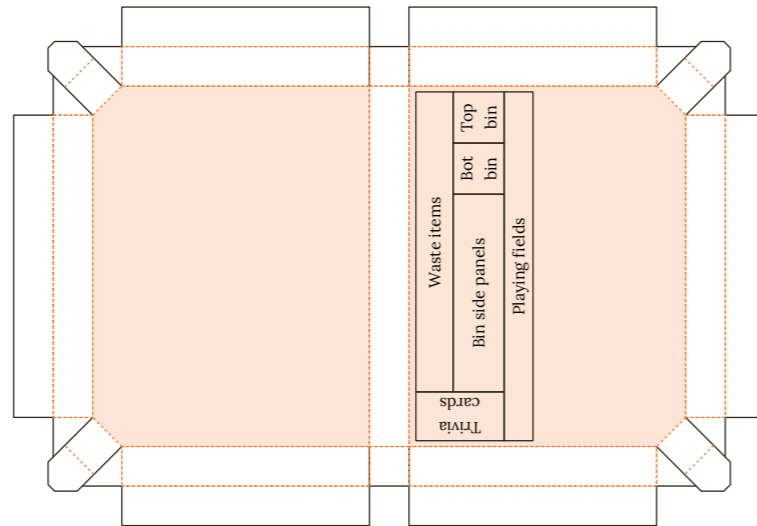


Fig. 32: Folding template for the packaging.

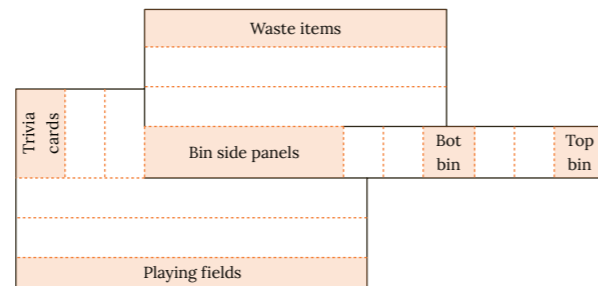


Fig. 33: Folding template for the inlet.

5.7. Creating the application

5.7.1. Project setup

To develop the application, I leveraged the capabilities of the modern JavaScript framework SvelteKit in combination with the versatile styling utility TailwindCSS. This powerful duo, complemented by the assistance of GitHub CoPilot and ChatGPT, provided a robust foundation for efficiently building a dynamic web application. In this project, the game needed to include a simple drag-and-drop mechanism and a trivia mode. Additionally, the game was supposed to include a score system and a global store that would keep track of the completed levels.

Throughout the development process, GitHub CoPilot emerged as an invaluable tool. Its seamless integration with coding programs, particularly Visual Studio Code (VS Code), fostered efficient collaboration and greatly facilitated the creation of various components. By generating code snippets, GitHub CoPilot accelerated the development of buttons and other crucial UI elements with accuracy and precision.

5.7.2. Execution

To ensure a cohesive and visually appealing user interface, I created a basic website layout with ChatGPT that served as a starting point for the game. By providing ChatGPT with a few prompts, it was already able to generate basic layouts with styling. Refer to figures 31–33 for visual representations of this process.

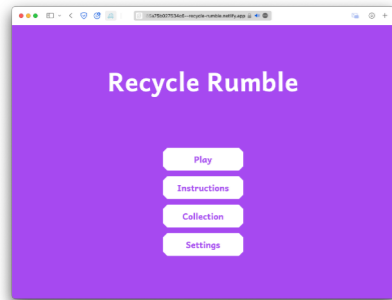


Fig. 34: Welcome screen created with ChatGPT.

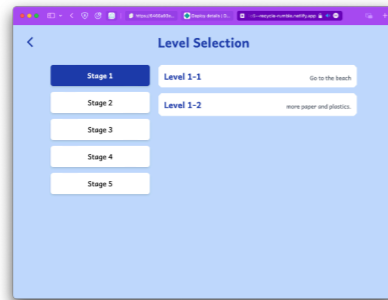


Fig. 35: Level selection page, created with ChatGPT.

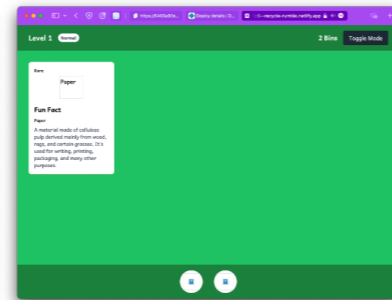


Fig. 36: Collection page, created with ChatGPT, it was later discarded.

The collaboration between ChatGPT and myself allowed for rapid iterations and refinements of the website layout, ensuring a user-friendly and engaging interface for the game.

In Figure 34, GitHub CoPilot's code suggestions are displayed within Visual Studio Code. It learns from the code inside the project and makes smart suggestions where necessary (GitHub, n.d.). In these examples, GitHub CoPilot suggests snippets that encompass the necessary logic. This greatly expedited the implementation process and ensured accuracy in handling the scoring calculations.

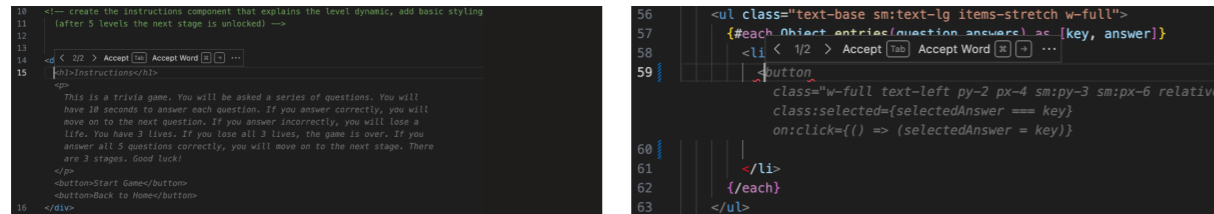


Fig. 37: Screenshots of VS Code suggesting complex code.

For general functionality, various stores have been programmed in order to maintain a score of the game progress and the settings, so that the user can continue playing the game even after he closes the window without the need to create an account.

For the actual gameplay, a drag-and-drop mechanism has been implemented. It detects whether an item is dropped on top of the correct bin or not. After that, the program either adds or discounts points or removes lives. It also detects if the player is running out of lives and then provides him with a "last stand", where the player has the option to answer a trivia question to regain a life and continue playing.

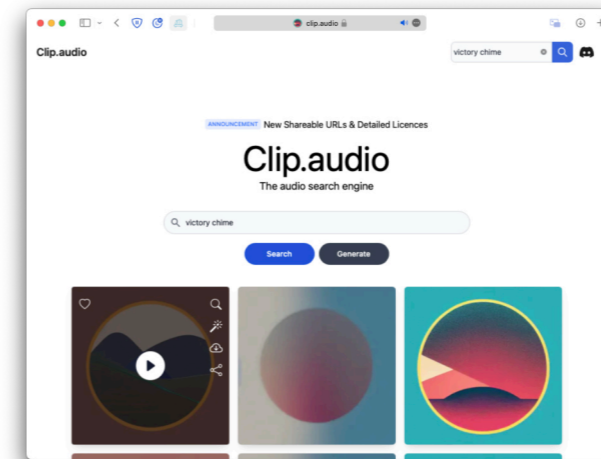


Fig. 38: Screenshot of clip.audio, suggesting sounds.

In order to create sounds for the game, the AI tool clip.audio was used. It is a search engine where one can search for specific sounds with natural language, and the tool then previews sound files that can be downloaded. In a future version, the tool will also offer to generate sounds from scratch, which sounds promising, but I was not able to test it. The sounds are played throughout the whole application, for example, when a player presses a button, wins a game, or throws a trash item into the correct bin.

In addition to the game and the application, the web presence showcasing the website was also created using the same methods.

5.8. Prototyping

Prototyping played a crucial role in the development process, allowing for the exploration and validation of ideas before moving on to the final implementation. The prototyping phase was divided into prototypes of the application and the physical version.

5.8.1. Prototyping the application

Prototyping the app was done with Uizard and ChatGPT. Uizard helped by analyzing hand-drawn wireframes and then converting them into editable layouts, as can be seen in figure 39.

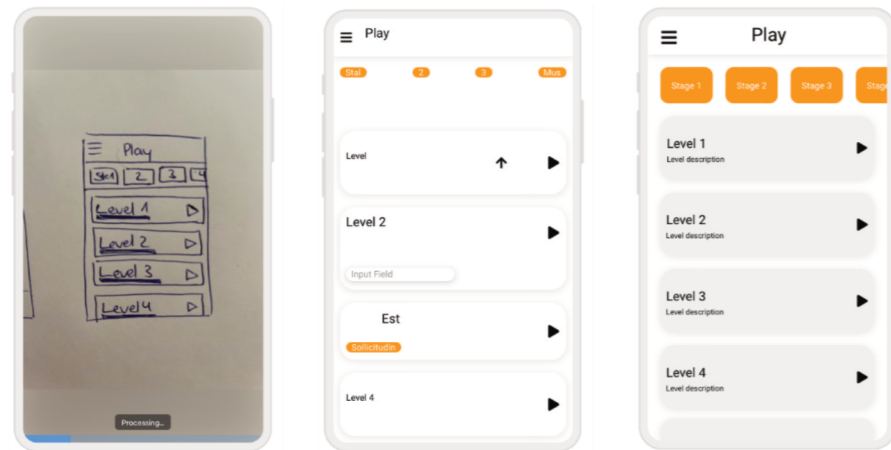


Fig. 39: Screenshots of the process of Uizard. It analyses hand-drawn wireframes and then generates an interactive interface. On the last screenshot, some parts of the interface were manually adjusted.

5.8.2. Prototyping the physical version

When creating physical prototypes, there aren't many AI tools that are ready for the market yet. Therefore, the first packaging concepts were created using paper cutouts, which were then folded into the desired shape.



Fig. 40: One of the first manually crafted paper prototypes.

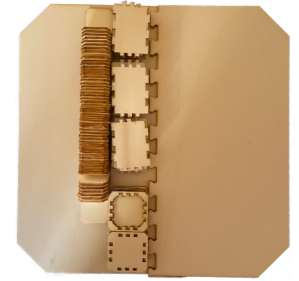


Fig. 41: Plywood laser-cut prototypes.

The game components were prototyped using laser-cut plywood and vinyl. This approach allowed for the creation of physical game components with greater fidelity and realism. The laser-cut plywood provided precise and consistent shapes, while the vinyl added visual appeal and durability to the game elements. By utilizing manual prototyping techniques, the design and functionality of the game were refined, ensuring a more tangible and engaging experience for the players.

5.9. Evaluation and testing

5.9.1 Talk with a child psychiatrist

During the evaluation of the game, it was shown to child psychiatrist Miriam Kaufman, who provided valuable feedback. Overall, the feedback was positive, highlighting the game's effectiveness in facilitating learning and child interaction. She mentioned that the game would encourage children to ask questions and spark their curiosity. She liked the illustrations, although some backgrounds were perceived as too busy, while simpler ones like grass, dirt, and the beach were preferred.

Miriam Kaufman identified the potential for future versions of the game with higher difficulty levels or more game items, suggesting opportunities for further engagement. It was recommended to avoid associating wrong answers with negative points, as this

could discourage children from trying and exploring. Instead, they suggested introducing a game master or tribunal sheet to enhance interactivity. This would allow for easier positive point allocation and provide one player with the leader's role. The game master sheet would also help to develop attentiveness skills and team-leading capabilities. She also proposed a game mechanism where, if someone answered incorrectly, other players would have the opportunity to answer.

Regarding the trivia questions, the format was considered effective, but for higher replay value, an alternative format was suggested. This format involved one side of the card featuring four different words with explanations for each, making it easier to find questions that are not too difficult, especially when players are unfamiliar with the category. The game "Bleff" was referenced as a potential source for inspiration in implementing this alternative format (Ruibal Games, n.d.).

The insights and suggestions provided by the child psychiatrist were invaluable in refining the game and ensuring its effectiveness in promoting learning, interaction, and engagement among children.

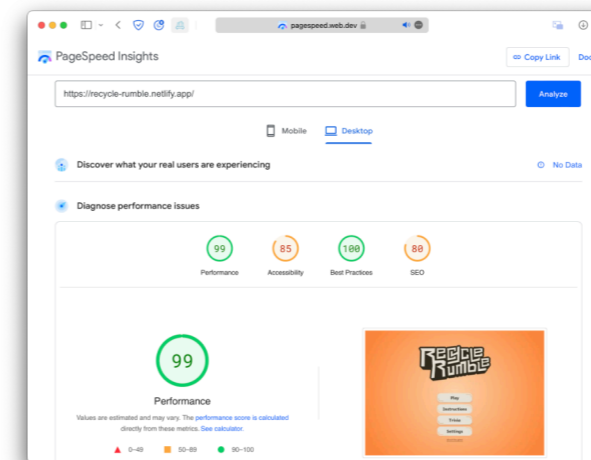
5.9.2. Play-testing the app

Play-testing with children (see figure 42) proved to be a valuable step in identifying areas for improvement. During the play-testing sessions, some UI errors were observed, with items appearing in unintuitive positions, affecting the overall user experience. Addi-



Fig. 42: A child play-testing the game on a computer.

Fig. 43: Result of the page analysis performed by PageSpeed Insights.



tionally, the static positioning of the trash bins was found to be less engaging, and the suggestion to add a more difficult mode with randomized positions was considered.

A notable outcome of play-testing was the spontaneous discussions among children playing together about where the trash items could come from, indicating active engagement and immersion in the game's concept.

The play-testing also revealed that there was a need for an introduction screen in the first level, which made it confusing in the beginning. As English was not the players' native language, they mentioned that the availability of their own language would be a good addition for this game. Therefore, for future possibilities, translating the game into more languages would increase the target audience immensely.

In addition to play-testing, the popular tool PageSpeed Insights was used to crawl through the website and check it for parameters such as performance and accessibility, which can be seen in figure 43.

Incorporating the findings from the play-testing sessions, adjustments were made to the user interface to make it easier to navigate. As more people get the chance to test the game, more fine-tuning can be done in the future.

6. Finished product

This chapter presents the results of this work. First, the concept of the game is explained, followed by the style guide, which includes brand assets such as the logo, the symbol, the color palette, and the typography. After that, the app version and the physical version of the game are presented, where all the different graphical assets are shown and explained.

In this chapter

- 6.1. Game concept
- 6.2. Visual identity
- 6.3. Physical Version
- 6.4. App-Version
- 6.5. Collage

6.1. Game concept

Recycle Rumble is a fun and educational game for kids aged 4–10 that teaches them about different types of waste and how to sort them correctly. Players get the opportunity to learn life hacks and expand their general knowledge by answering trivia cards. To adapt to modern times, the game is developed in two ways: as a physical version and as an app version. That way, it is possible to distribute the game to as many people as possible.

The physical version can be played with 2–6 players and lasts for approximately 10–15 minutes. It is created using vinyl for the graphics and plywood for the pieces themselves. The packaging is also made from vinyl for the graphics and cardboard for the structure, with a thin inlet to give the pieces their own place.

The app version utilizes a drag-and-drop mechanism, simulating the motion of sorting trash into corresponding bins. It presents a screen filled with waste icons, granting points when correctly sorted. With multiple stages and waste types, the game offers high replay value and progressive learning. Additionally, a trivia mode challenges players to continuously test their knowledge by answering questions.

The game features playful graphics and interactive gameplay that captivate young minds. By combining the physical and app versions, Recycle Rumble provides a versatile and accessible platform for children to learn about waste management in a fun and interactive way.

6.2. Visual identity

This chapter includes a complete style guide for brand assets, containing the logo, clear space, colors, and typography.



Logotype

The logotype is bold and playful and hides trash bins inside the R's. Each letter is unique and dynamic.

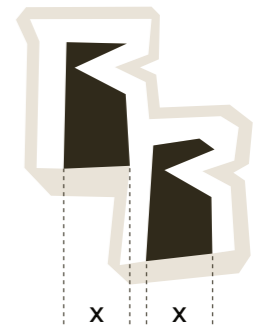
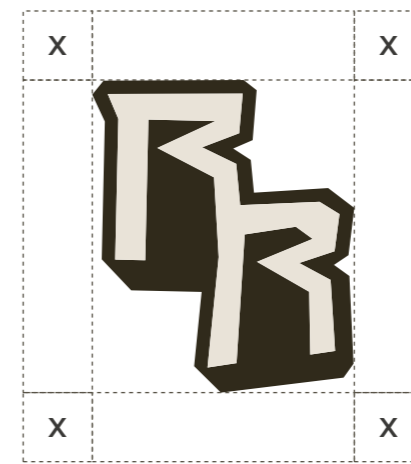


Symbol

The logo is the main focal point of the logotype, including the negative space bins inside the R's.

Clear-space

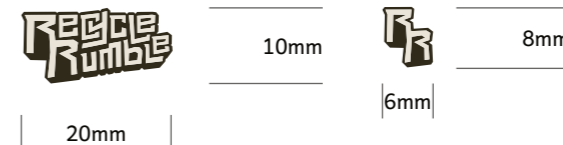
For it to look its best, our logo needs space to stand out. The minimum open space around the logo is defined by the maximum width of the negative space bins inside the R's.



x: maximum width of the negative bins inside the R's

Minimum Size

The logo remains legible at small sizes but should not exceed this limit.

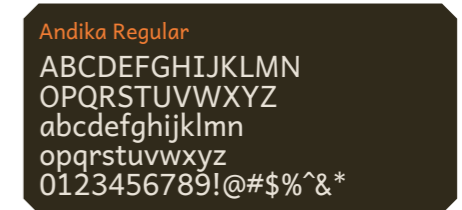
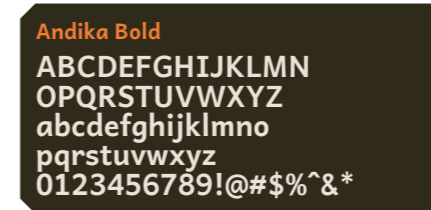


<p>White Coffee #E7E3D9</p> <p>RGB: 231.227.217 CMYK: 0.2.6.9 Pantone: 663 C</p>	<p>Pine Tree #302B1E</p> <p>RGB: 48.43.30 CMYK: 0.10.37.81 Pantone: Black 4 C</p>	<p>Crayola Orange #FF8031</p> <p>RGB: 48.43.30 CMYK: 0.10.37.81 Pantone: Black 4 C</p>
<p>Green Lizard #A2F439</p> <p>RGB: 163.245.57 CMYK: 34.0.77.4 Pantone: 367 C</p>	<p>Maximum Yellow #F5EF38</p> <p>RGB: 245.239.56 CMYK: 0.3.77.4 Pantone: 394 C</p>	<p>Picton Blue #39A9F4</p> <p>RGB: 57.169.244 CMYK: 77.31.0.4 Pantone: 298 C</p>
<p>Coral Red #F54238</p> <p>RGB: 245.66.56 CMYK: 0.73.77.4 Pantone: Warm Red C</p>	<p>Milk Chocolate #855747</p> <p>RGB: 133.87.71 CMYK: 0.35.47.48 Pantone: 7505 C</p>	<p>Granite Gray #666666</p> <p>RGB: 102.102.102 CMYK: 0.0.0.60 Pantone: Cool Gray 10C</p>

Primary Colors
The primary colors aim to excite children about learning. The sandy beige of the white provides a neutral background, and the dark brown represents the connection to earth and nature. The vibrant orange color adds excitement and energy to the palette, appealing to children.

Secondary Colors
The secondary colors possess a strong contrast and symbolize the typical colors employed for trash sorting. The aim is to help children associate these colors with the appropriate bins.

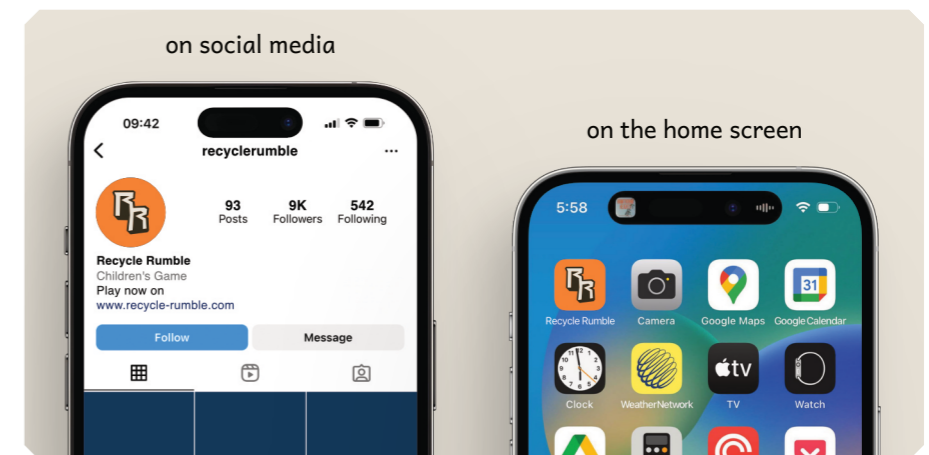
Typeface
The primary font is Andika. It was created to increase legibility for new Readers.



Color variations
The Logo can be used in three different variations.



Logo in Use
All elements are to have clipped corners to ensure a friendly aesthetic and convey safety.



6.3. Physical Version

The physical version of Recycle Rumble is designed to be an engaging multiplayer experience. The game includes a diverse range of 60 trash items, each with unique illustrations, representing different types of waste commonly found in daily life. The goal is to teach children to identify and sort these items correctly.

To facilitate sorting, the game provides six bins, each corresponding to a different type of waste. The bins are color-coded using a palette that aligns with the socially accepted colors for waste segregation in most countries. However, the colors in Recycle Rumble are specifically adjusted to be brighter and more vibrant, adding an element of visual appeal and playfulness to the game, as can be seen in figure 44.

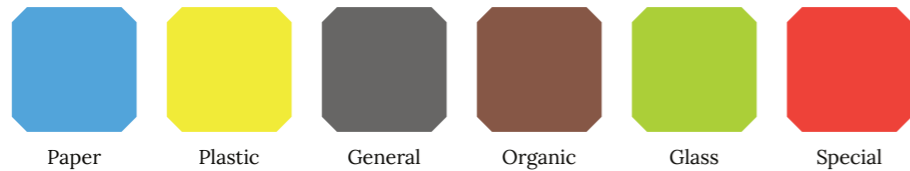


Fig. 44: Colors associated with the trash types.

Additionally, the game includes six playgrounds, each featuring stylized floors or grounds that children commonly encounter in their daily lives. This adds a relatable and immersive element to the gameplay, allowing children to connect the act of waste sorting with familiar environments.

Furthermore, the game features 80 trivia questions, each designed to teach general knowledge and tips for daily life.

6.3.1 Trash Items

The trash items are the centerpiece of the game. They have two sides: the front features an icon that represents a certain type of trash, which the player is supposed to recognize and then sort into the bins. Displayed on the back is the description and a clipped border with the color of the corresponding bin, which can be seen in figure 45. The back of the card serves as a hint and validation system for the players.

The illustrations are crafted to display a highly detailed style with flat shading. This makes it easy to associate the items with real-life objects. Displayed on the left is one example of a newspaper item with the corresponding color blue for the paper bin.

The cards are made in two parts. First, they are printed on vinyl and then cut out of plywood. The vinyl print is then glued with adhesive onto the plywood part.

Fig. 45: Mockup version of a trash item newspaper.



Fig. 46: One trash item per category. The illustrations made with MidJourney and in the bottom row the back sides, with the corresponding colors and descriptions.

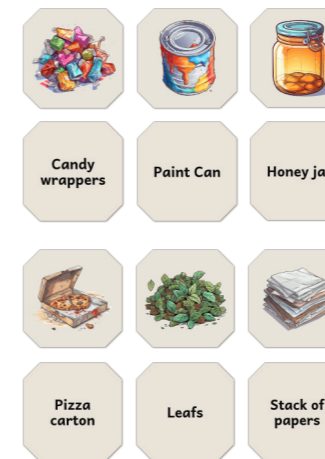


Fig. 47: A photo of a pile of the trash items

6.3.2 Trash Bins

The bins follow the design language with clipped corners. They are designed to be durable when assembled while also being easy to produce. Being made from plywood, the pieces are very fragile.

In Fig. 48, the vector shapes for the cuts can be seen; they are cut out and glued onto the plywood cutouts. They have teeth the width of the plywood in order to form a seamless surface. The following figs. 49 and 50 show renderings of the bins, while figure 51 shows the final result, the fully assembled version. Each of the bins features the appropriate color for the corresponding waste type.

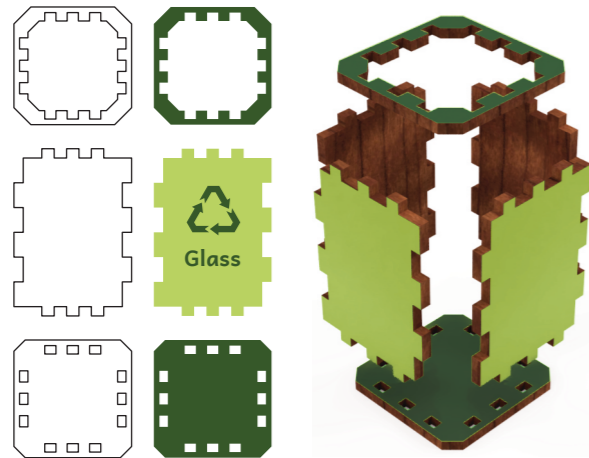


Fig. 48: Vector shapes that will be cut or printed. On left are the cuts and on the right sides the prints. The side parts are used four times and the top and bottom parts once.

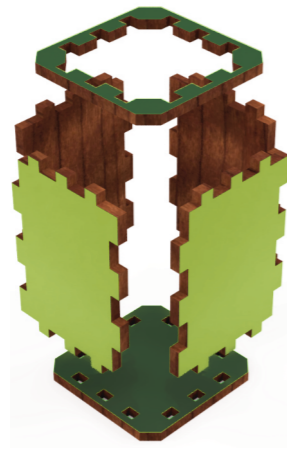


Fig. 49: Rendering of the exploded view of a bin. It is designed to be easily assembled and disassembled while being durable.

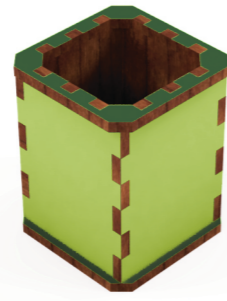


Fig. 50: Rendering of an assembled bin.



Fig. 51: Real version, printed on vinyl, glued on plywood. Fully assembled

6.3.3 Playing fields

The playing fields in Recycle Rumble are carefully designed to resemble real-life environments that children commonly encounter. By incorporating familiar settings into the game, such as a beach (Figure 52), a park (Figure 53), a forest, and more, the aim is to help

children relate the trash items they encounter in the game to situations they have experienced or observed in their own lives. This relatability enhances their understanding of waste management by providing tangible connections between the game and real-world scenarios.

The playing fields can also be included in the gameplay itself. At the beginning of the game, a playing field is chosen, and every player can place items on it that they have

seen before. That way, the game setup is already being done consciously. This can spark children's creativity by inspiring them to create stories and scenarios around the waste items and their respective environments. For instance, they could imagine a picnic at the park where they have to properly dispose of their waste or a cooking adventure in the kitchen where they practice recycling food packaging.

The integration of playgrounds creates a cohesive gameplay experience that not only educates but also empowers children to become active participants in their waste management journey.

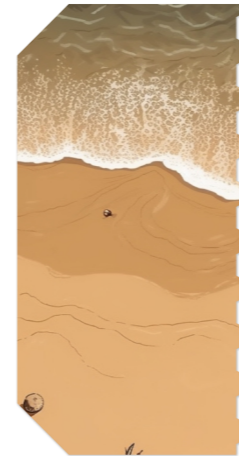


Fig. 52: The beach playing field with teeth to interlock.

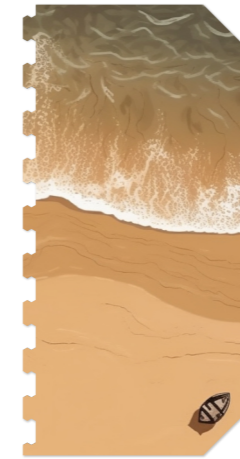


Fig. 53: Fully assembled grass playing field.

6.3.4. Trivia cards

There are two kinds of trivia cards: questions with A-B-C answers and true or false questions. The game offers a variety of ways to deploy these cards. By default, they are included in the standard game mode, where they can be used to recover negative points or enable a final showdown if there is a tie at the end of the game. They can also be used for a fun one-on-one trivia showdown.

As seen in figure 54, the cards feature clipped corners. There are 80 cards, for which there could be various expansion packages with more specialized questions.

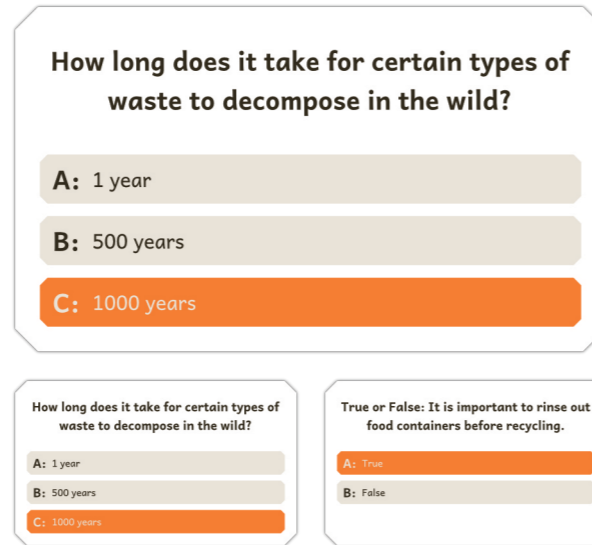


Fig. 54: A few playing cards examples.

6.3.5. Game Master sheet

The master sheet serves as a valuable resource for the designated player, providing them with a comprehensive tool to fulfill their role as a juror or judge effectively. The simplicity of the master sheet's design made it user-friendly and efficient (see figure 55). By presenting the trash items and categories in a clear and concise manner, it facilitated a smooth and seamless gameplay experience. Additionally, the sheet's size was optimized to be easily manageable and fit within the context of the game.



Fig. 55: The finished Game master sheet.

6.3.6. Packaging

The packaging of the game is designed to fit all the components and be easy to produce. It is made from thin cardboard. It features two clipped corners on the front. The design is inspired by a pizza carton and can be printed on thick paper and cut out. It consists of two parts: the outer carton and an inlet. Both are based on a cutout and then folded into the right shape.

The designs for the cover boxes are clean and simple, showing important information about the game at a glance. The basic instructions are on the bottom side of the box.

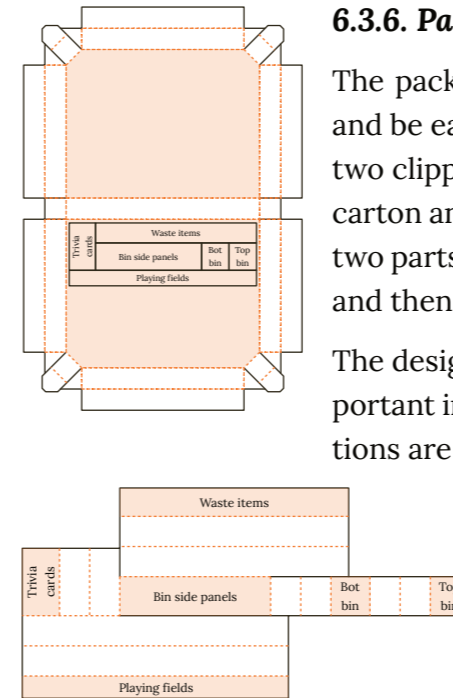


Fig. 56: The cutouts for the outside packaging and the inlet.



Fig. 57: Printing templates for the for the top and bottom packaging

6.4. App-Version

6.4.1. The welcome screen

The app version of the game features two modes: a normal game mode with fifty levels and a trivia mode with three difficulties. The main game mode consists of a certain amount of trash items per level, which get increasingly more per level and stage. It also offers the option to answer trivia questions to recuperate lives.

When you open the game, you are first greeted with this welcome screen. In cases where the player is idle, trash items start floating around on the screen to catch the user's attention.



It offers the option to play the game or the trivia mode, read the instructions, or adjust the settings. Clicking the buttons leads to various pages, which will be displayed and explained on the following pages.

Fig. 58: Screenshots of the welcome screen, both on the mobile version and the desktop version, featuring the logotype and buttons.

6.4.2. The general UI

The UI features colorful buttons with clipped corners and clean backgrounds. It is optimized for mobile devices and desktop computers, which makes it accessible for most people. On the settings page, the user gets to adjust settings such as volume or dark mode,

and it features sliders and buttons while also showcasing the hierarchy of the typography.

The Play page shows the level selection and shows the trophies achieved by the user upon completing a level.

Fig. 59: Screenshots of the level selection screen, both the mobile version and the desktop version.

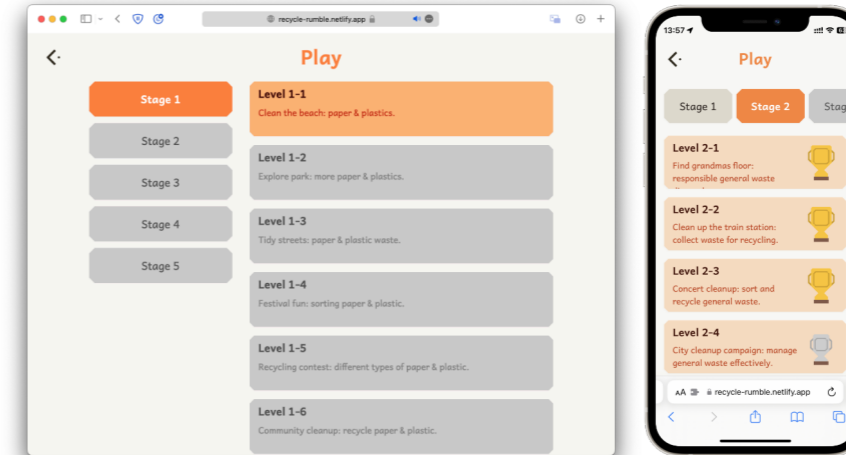
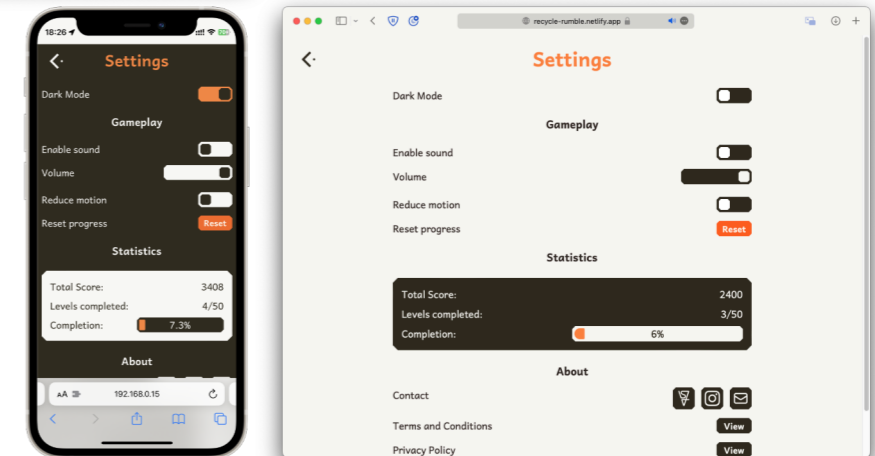


Fig. 60: Screenshots of the settings screen on both mobile and desktop, featuring various sliders and buttons while also demonstrating the hierarchy of the typography and the dark mode.



6.4.3. The level UI

This is the UI for the levels. It features a life indicator with a score, all the available trash items, and trash bins per level. The number of items increases with the level.

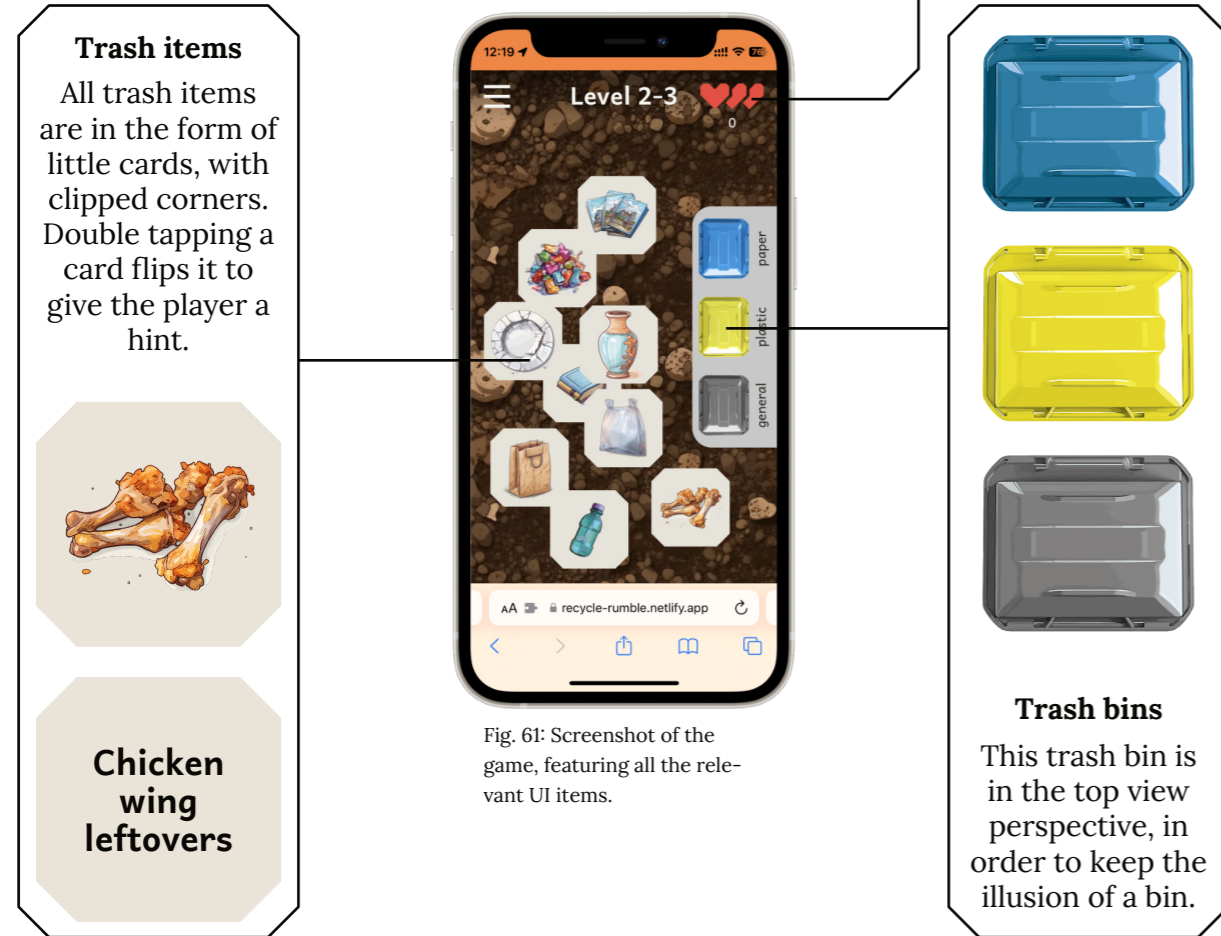


Fig. 61: Screenshot of the game, featuring all the relevant UI items.

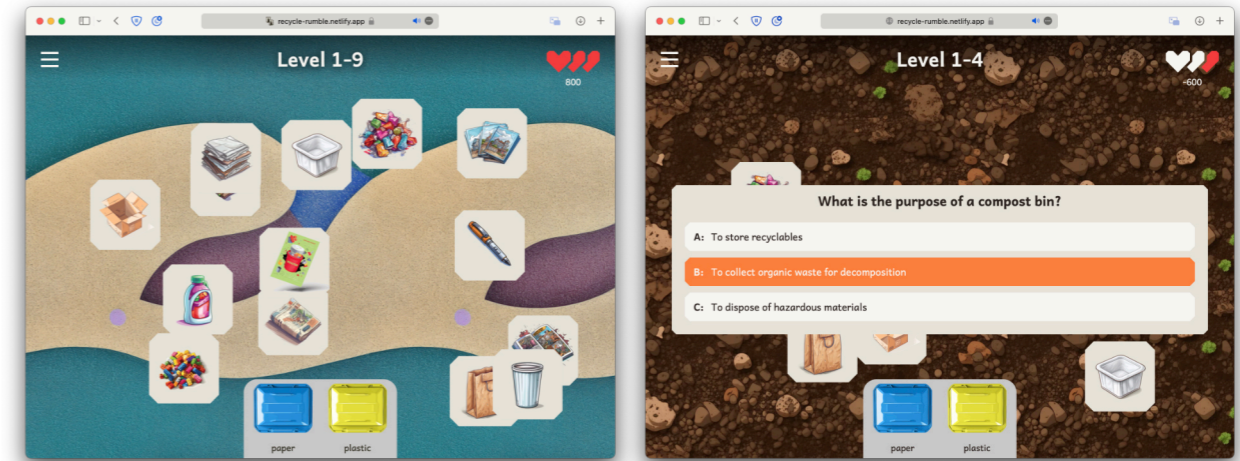
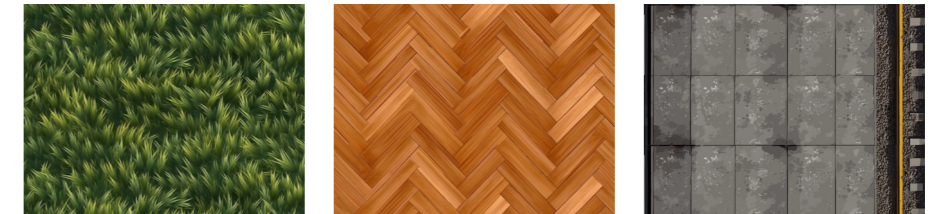


Fig. 62: Screenshots of the game on desktop, once just the screen and once with a recovery question.

The gameplay is as follows: At the beginning of the game, all the cards are distributed on the playing field. The player starts with three lives; if only one life remains, they are offered questions to regain a life. They get as many questions as they are in. For example, if the player is in stage three, they get three "bonus lives", but only if they answer all of them correctly.

The game offers a variety of different backgrounds in order to increase replay value and to allow children to associate the trash and the levels with the environments and develop their consciousness of the outside world.

Fig. 63: Some of the textures used in the game.



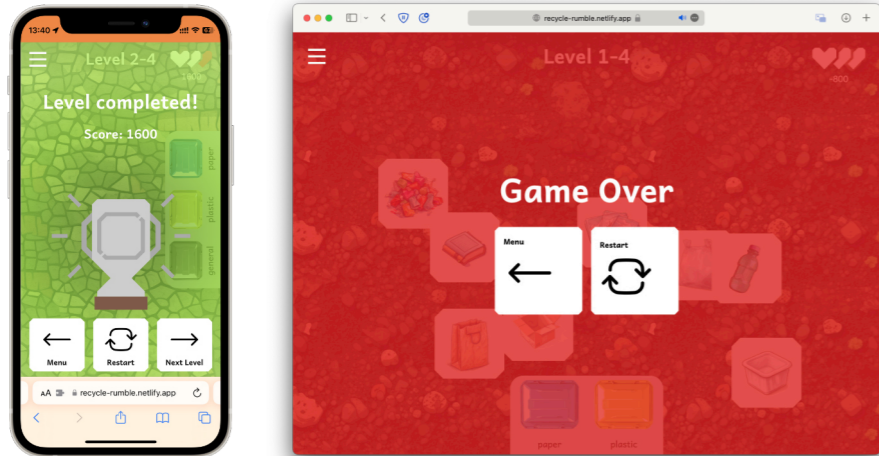


Fig. 64: The game won screen on mobile and the game over screen on desktop.

Upon completing a level, the player is presented with a screen such as the one shown in Figure 14. Depending on the maximum possible score, the user is rewarded with a trophy, which is later displayed in the level selection. There are three tiers, which are displayed with a simple animation to make it more rewarding.

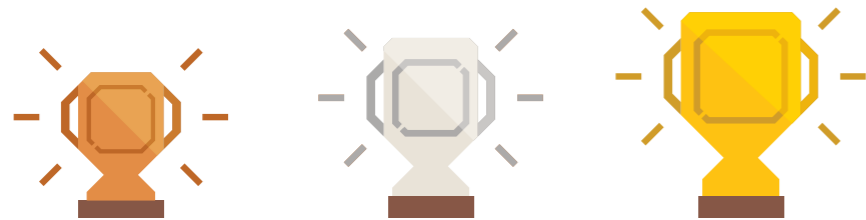


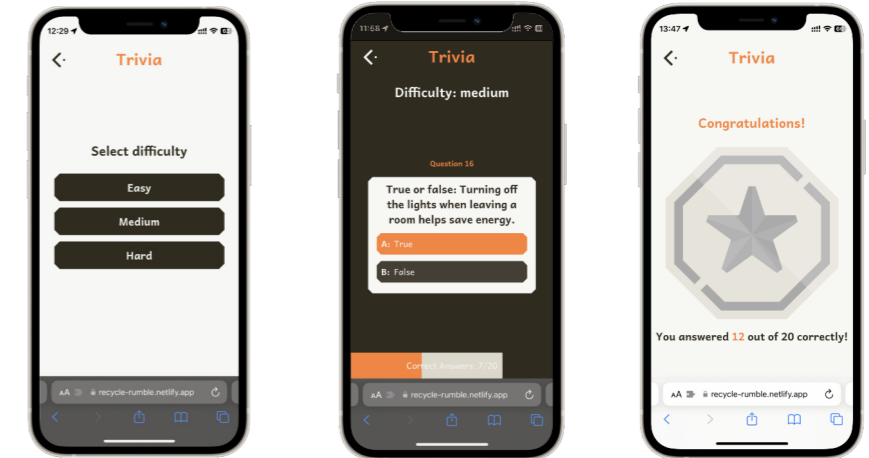
Fig. 65: The possible trophies that a player can earn per level.

That is the general gameplay. It starts out easy and gets more complex and challenging along the way. It also allows for easy expansion towards new types of trash or more levels per stage.

6.4.4. The Trivia mode

The trivia mode offers different amounts of consecutive questions in order to test the players' knowledge. The questions are picked randomly from a catalog. There are true or false questions and questions with A-B-C answers to provide variety. The game pro-

Fig. 66: Screenshots of the trivia mode, offering three difficulties with increasing amounts of questions. The last screenshot offers a glance at the end screen when finishing a level.



vides a progress bar to see how many questions he has answered and how many of them are correct. Once the player answers all the questions, he will be provided with an overview of how the game went and be awarded a medal. This mode is relatively basic, as it is meant for practicing.

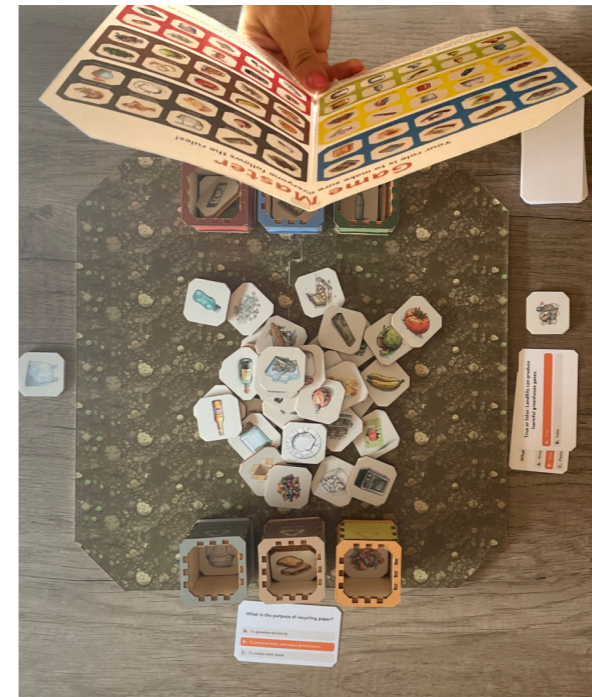
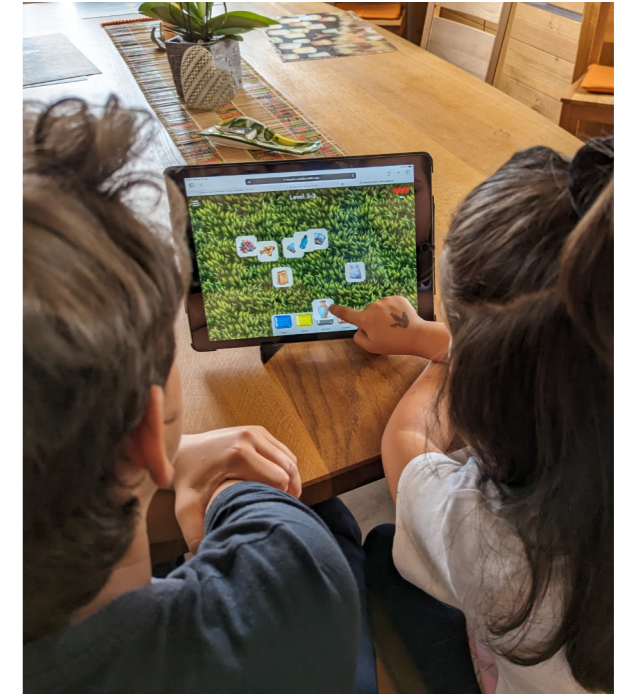
Fig. 67: The possible trophies that a player can earn upon completing the trivia levels.



6. Finished Product

6.5. Collage

Displayed here is a collage of the final prototyping results. It includes pictures of the packaging in both the physical and digital versions.



7. Quotation

The quotation is a fundamental part of the project, as the game needs a defined corporate identity and a well-executed game, both in a physical and digital version. Additionally, the packaging needs to be executed well to be appealing to both parents and children when they see it in a store.

7.1. Creation of the Brand identity

The creation of the brand identity incorporates a particular process that includes the logo and symbol design, brand colors, typography, and showcasing it in a visually appealing manner. See Table 8 for the details.

Service	Time in hours
Logo design	18
Visual identity	20
Packaging design	20
Website creation	12
Total hours	70
Hourly rate	25 €
Total cost	1750 €

Table 8: Quotation for the creation of the visual identity.

7.2. Creation of the game assets

The development of game assets involved harnessing the power of AI tools such as ChatGPT and MidJourney. These cutting-edge technologies enabled the creation of high-quality assets, ranging from captivating illustrations and graphics to engaging character designs. By utilizing these AI tools, the process of asset creation was optimized, resulting in efficient workflows and ensuring the timely delivery of visually impressive game elements. See Table 9 for the details.

Table 9: Quotation for the creation of the game assets.

Service	Prompts
Prompts (waste items)	800
Prompts (waste bins)	600
Prompts (playgrounds)	700
Trivia question creation	300
Total hours (2min per prompt)	80
Hourly rate	25 €
Total cost	2000 €

7.3. Creation of the app version

The development of the app version involved leveraging the power of modern technologies and frameworks such as SvelteKit and TailwindCSS. These tools enabled the creation of a dynamic and engaging user experience, incorporating features such as a drag-and-drop mechanism and trivia mode. See Table 10 for the details.

Service	Time in hours
UI design	30
Implementation of level mechanics	65
Implementation of trivia mode	25
Hours worked	120
UI design	25 €
Total cost	3000 €

Table 10: Quotation for the creation of the digital version of the game.

7.4. Creation of the physical version

The physical version of the game was meticulously crafted to provide a tactile and interactive experience for players. It involved designing and producing high-quality game components, including the game board, cards, and other physical elements. See Table 11 for the details.

Service	Time in hours
Creation of waste item cutouts	2
Creation of bin items + cutouts	20
Creation of playground cutouts	5
Packaging design	8
Packaging templates	10
Prototyping	5
Total hours	50
Hourly rate	25 €
Total cost	1250 €

Table 11: Quotation for the creation of the physical version of the game.

7.5. Total cost

The total cost analysis considered all aspects of the project, including brand identity creation, game asset development, app version, physical version, and production expenses. It provided a comprehensive understanding of the overall expenses for designing, developing, and manufacturing the game, guiding pricing decisions while ensuring quality standards.

Service	Time in hours	Cost
Brand identity	70	1750 €
Asset creation	80	2000 €
Physical game design	50	1250 €
App creation	120	3000 €
Total	330	8000 €

Table 12: Quotation for the total cost for the entire product and service.

7.6. Production cost

Determining the cost of the product involves calculating the approximate expenses associated with manufacturing one or 1,000 units. As you can see in Table 13, considering a 50% profit margin, the product could be competitive at around 12 euros.

Table 13: Approximate costs for the production of a unit

Service	1 unit	1000 units
Laser cutting	4 €	4000 €
MDF Plywood	1,5 €	1500 €
Packaging	0,5 €	500 €
Total	6 €	6000 €

8. Conclusion

The main objective of this thesis was to showcase the power of Artificial Intelligence in the design process by demonstrating it by creating a product and integrating AI into every possible step along the way, from the initial concept to the finished product. By integrating AI tools into traditional design methodologies, I have successfully achieved this objective. In the theoretical section, I was able to draw comparisons between traditional methods and modern AI-based workflows and show where AI can enhance certain workflows. With these comparative tables, I was also able to instigate methodologies that can be useful for many designers.

In the practical part of this work, I created a product that was not only well received by professionals and potential customers alike, but I was also able to finish the project in a short period of time. The entire product creation process was completed in only four months, in which an entire physical and digital game were created, together with a visual identity and web presence, making this work a proof-of-concept. The game "Recycle Rumble" complies with all the previously set conditions, as it aims to enhance the cognitive skills of children as well as create a conscience about the environment and waste recycling.

That said, the overall outcome is a game that works well on its own, has high replay value, and is easy to expand on by adding more items, increasing the difficulty, adding more specific waste types, or adding more game modes. Additionally, as the game is available both in a physical and digital version, its audience can be broad. While the digital version focuses more on the education and responsibility of a single child, the physical version aims to improve social skills such as leadership and communication.

However, not every workflow is very efficient. While most of the assets are of high quality, they show inconsistencies in style, perspective, and overall quality. Additionally, throughout this work, I created over 4000 images with MidJourney. This is because learning to "speak" to this program was a difficult process, as it sometimes misunderstands composite words easily. This led to around 90% of the created images being discarded.

Due to the nature of this project being in an academic setting, I had limited time and resources. With a market this lively, I was not able to completely explore every tool I would have liked to. Additionally, many tools are still in early access or are expensive. Therefore, sometimes the tools that might have been the best for the job are not the ones with the best value proposition.

This work also shows that while many AI tools show a lot of promise, there is still much work to be done both in the development and ethical aspects. Problematics such as ethical bias and hallucinations can be dangerous and impose the need for regulation and safe development.

This work marks a significant step in showcasing the power of artificial intelligence. It also shows that Designers shouldn't be afraid of technology but should embrace it. AI has proven to be valuable in many other industries, and the same will be true for the design industry.

This leads me to the next point: I recommend every designer start learning about how AI works and how to use it effectively. AI will create new markets, and just as with other significant advancements in our past, the people who are not willing to keep up with the progress are the ones that will be left behind. In our technological age, there are many resources to start learning to use and embrace AI.

In conclusion, this work serves as a proof of concept. Modern AI technologies have arrived in the world of design, and they are here to stay. As the market adapts to these new technologies, the need for progress will increase, accelerating it even more. Workflows will keep evolving, changing the landscape of design forever. Whether it will replace the profession of designers is still uncertain, but that is still far away. While Artificial Intelligence lacks ingenuity and creativity, it is the perfect tool for data collection and content creation, making it a valuable tool for designers.

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Appendix A: Ideation Process with ChatGPT

This is a conversation between me and ChatGPT, I will be referred to as SJ and ChatGPT as CB and will answer in cursive.

SJ: I want you to become my Prompt engineer. Your goal is to help me craft the best possible prompt for my needs. The prompt will be used by you, ChatGPT. You will follow the following process:

1. Your first response will be to ask me what the prompt should be about. I will provide my answer, but we will need to improve it through continual iterations by going through the next steps.

2. Based on my input, you will generate 2 sections. a) Revised prompt (provide your rewritten prompt. it should be clear, concise, and easily understood by you), b) Questions ask any relevant questions pertaining to what additional information is needed from me to improve the prompt).

3. We will continue this iterative process with me providing additional information to you and you updating the prompt in the Revised prompt section until I say we are done.

CB: Great! I'm happy to be your prompt engineer. What would you like the prompt to be about?

SJ: I want to create a game directed towards children, where they learn about all kinds of trash and how it can be reused or recycled.

CB: That sounds like a fun and educational prompt! Based on your input, here are the revised prompt and some questions to help us refine it further:

Revised prompt: Create an educational game for children that teaches them about different types of waste and how they can be reused or recycled.

Questions:

What is the age range of the children you are targeting?

Do you have any specific types of waste that you want to focus on in the game?

What kind of game mechanics or activities do you envision being used to teach children about recycling and reusing waste?

How do you want the game to be delivered to the children (i.e. online, mobile app, physical game, etc.)?

SJ: 5-10 years

The waste that is used daily, such as carton, plastic metals, but also more advanced types for an expansion pack in the future

The game mechanics would include teaching about the types of waste with some of info cards, and the main goal being to sort them correctly

I want the game to be delivered as a physical game but also be able to download it as a template so the children can DIY it, as well as an app version of the game

CB: Great, thank you for the additional information! Based on your input, here's a revised prompt:

Revised prompt: Create an educational game for children between the ages of 5-10 that teaches them about different types of waste, including common household waste such as cartons, plastics, and metals, and more advanced types of waste for a potential expansion pack. The game should include information cards that teach children about the waste and its recycling/reuse possibilities. The main objective of the game should be to sort the waste correctly. The game should be delivered as a physical board game that can also be downloaded as a template for DIY play and as an app for mobile devices.

Questions:

Do you have any specific ideas for the design or visual style of the game?

What kinds of rewards or incentives do you envision for children who sort the waste correctly?

How many players do you want the game to accommodate, and what is the ideal length of gameplay?

Do you have any specific ideas for the information cards or how they should be integrated into gameplay?

SJ: 1. the art style should be colorful and friendly

2. The person with the most correct items wins, but provide me with more ideas if you can

3. Between 2 and 6 players, As the children are young the game length should be around 15-20 minutes

4. I do not have any ideas yet, please provide me with some

CB: Great, thank you for the additional information! Here are some ideas for integrating the information cards into gameplay:

Each player draws an information card at the start of their turn and must correctly sort an item related to that waste type to earn a point.

Information cards can provide a bonus point if a player correctly sorts an item related to that waste type on their turn.

Players can trade information cards with each other, giving them an opportunity to learn about different waste types and potentially earn more points.

If a player incorrectly sorts an item, they must return their current information card to the deck and draw a new one at the end of their turn, potentially delaying their ability to earn points.

Let me know if you have any thoughts on these or if you'd like me to come up with any additional ideas!

SJ: use number 2

CB: Great, incorporating the second idea, here's an updated revised prompt:

Revised prompt: Create an educational game for children between the ages of 5-10 that teaches them about different types of waste, including common household waste such as cartons, plastics, and metals, and more advanced types of waste for a potential expansion pack. The game should include information cards that teach children about the waste and its recycling/reuse possibilities. The main objective of

the game should be to sort the waste correctly, with each player earning one point for each correctly sorted item. Information cards should provide a bonus point if a player correctly sorts an item related to that waste type on their turn. The game should be designed for 2-6 players, with a gameplay length of approximately 15-20 minutes. The art style should be colorful and friendly.

Questions:

Do you have any ideas for the name of the game?

How do you envision the app version of the game being different from the physical board game version?

Would you like to include any interactive elements or challenges in the game, beyond sorting items and using information cards?

SJ: 1. No, please give me ideas

2. The physics should be similar, in the app version the entire screen is filled with trash icons that provide points when sorted into the right bins

3. That would be fun, however i do not have any ideas. Can you provide me some?

CB: Sure, here are some ideas for the game name and interactive challenges:

Game Name Ideas:

1. Trash Tycoon
2. Waste Warriors
3. Eco Champions

4. Recycle Revolution
5. Garbage Games
6. Trash Talk
7. Waste Watchers
8. Eco Explorers
9. Recycle Rumble
10. Garbage Goals

Interactive Element/Challenge Ideas:

Memory Game: Players must flip over cards with different waste types and their corresponding recycling/reuse methods. If they match correctly, they earn a bonus point.

Trivia Questions: Players must answer questions about waste types and recycling/reuse methods. Correct answers earn a bonus point.

Recycling Relay: Players must race to sort a set number of items in the correct bins as quickly as possible. The first player to complete the challenge earns a bonus point.

Sorting Obstacle Course: Players must sort items while navigating a maze-like obstacle course on the board. Successfully completing the course earns a bonus point.

Let me know if any of these ideas sound interesting to you or if you'd like me to come up with more!

SJ: I like challenge ideas 2 and 3, they can be incorporated as more advanced game modes

CB: Glad you like the challenge ideas! Here are some suggestions for implementing them as advanced game modes:

Advanced Game Modes:

Trivia Challenge: In this mode, players take turns drawing trivia cards and answering questions about different waste types and recycling/reuse methods. Correct answers earn bonus points.

Sorting Sprint: This mode is a timed challenge in which players must sort as many items as possible in a set amount of time. Points are awarded based on the number of items correctly sorted within the time limit.

Recycling Relay: In this mode, players work together in teams to sort a set number of items as quickly as possible. The team that completes the challenge first earns a bonus point.

Maze Master: In this mode, players must navigate a maze-like board and sort items along the way. Successfully completing the maze and sorting all items earns a bonus point.

SJ: For the name i like number 2 and number 9

for the game modes i like numbers 1 and 2. However adjust number 1 so that whenever a player sorts an item correctly he gets the opportunity to draw a trivia card about the trash category.

CB: Great choices! Based on your preferences, here is a summary of the final game details:

Game Name: Waste Warriors or Recycle Rumble

Game Mechanics: Players learn about different types of waste through info cards and must sort them correctly to earn points. The player with the most points at the end of the game wins.

Game Modes:

Trivia Challenge: In this mode, players have the opportunity to draw a trivia card about the trash category whenever they sort an item correctly. Correct answers earn bonus points.

Sorting Sprint: This mode is a timed challenge in which players must sort as many items as possible in a set amount of time. Points are awarded based on the number of items correctly sorted within the time limit.

Art Style: Colorful and friendly

Number of Players: 2-6

Game Length: 15-20 minutes

Delivery: Physical game with the option to download as a template for DIY and an app version of the game.

Let me know if there's anything else you'd like to add or if you have any further questions!

SJ: Wonderful concept. Can you provide me with 50 potential items to be sorted and add them to the game idea?

CB: Sure, here's a compact format for the game idea with the 50 items added:

Game Name: Trash Trek

Objective: Sort various items into the correct bins to earn points and win the game.

Game Modes:

Standard Mode: Players race to sort as many items as possible in a set amount of time. Correctly sorted items earn points, and the player with the most points at the end of the game wins.

Trivia Mode: Whenever a player correctly sorts an item, they get to draw a trivia card about the trash category. Correct answers earn bonus points.

Challenge Mode: Players must sort items as quickly and accurately as possible, with increasingly difficult levels as the game progresses.

Items to Sort:

1. Plastic water bottle

...

49. Paper bag

50. Frozen food box

Delivery:

The game will be available in physical and digital format. The physical game will come with game board, trash bins, item cards and trivia cards. The digital game will be available for download on app stores and will be played on mobile devices or computers. Additionally, players can download templates and make their own version of the game.

SJ: Thank you. Now please provide me with trash bin

ideas with real-life sorting mechanisms

CB: Sure, here are some adjustments to the trash bins based on real-life sorting mechanisms:

1. Blue bin for paper and cardboard
2. Green bin for organic waste and food scraps
3. Yellow bin for plastics (bottles, containers, and packaging)
4. Red bin for hazardous waste (e.g. batteries, chemicals)
5. Brown bin for yard waste and compostable items (e.g. leaves, branches, food waste)

Grey or black bin for general waste (e.g. non-recyclable materials)

Purple bin for glass bottles and jars

Again, these can be adjusted based on the types of items you want to include in the game and the sorting mechanisms in your local area.

SJ: Wonderful, please add them to the game. They will from now on also be used as the trivia categories.

CB: Great, here's an updated version of the game idea with the new trash bin categories:

Game Title: Trash Trek

Game Overview: Trash Trek is a fun and educational game for kids aged 5-10 that teaches them about different types of waste and how to sort them correctly. The game can be played with 2-6 players and lasts for approximately 15-20 minutes. Players learn about dif-

ferent types of trash through trivia cards and then race to sort various items into the correct trash bins.

Game Components:

50 items to be sorted (paper, cardboard, plastic, glass, metal, electronics, batteries, food waste, yard waste, hazardous waste, textiles, etc.)

7 trash bins (blue for paper and cardboard, green for organic waste and food scraps, yellow for plastics, red for hazardous waste, brown for yard waste and compostable items, grey or black for general waste, purple for glass bottles and jars)

100 trivia cards (10 for each trash category) with questions about trash sorting and recycling

Gameplay:

Shuffle the trivia cards and place them in a stack face down.

Shuffle the 50 items to be sorted and place them in a pile face down.

Each player takes a turn to draw an item from the pile and sort it into the correct trash bin. If they sort it correctly, they get to draw a trivia card from the corresponding category and answer the question. If they answer correctly, they get a point.

Play continues clockwise until all items have been sorted.

The player with the most points at the end of the game is the winner.

Challenge Modes:

Time Attack: Set a timer for 5-10 minutes and see how many items players can sort correctly in that time.

Memory Match: Lay out all the items to be sorted on a table and allow players to study them for 30 seconds. Then, cover them up and see how many items players can correctly sort into the correct bins from memory.

Have fun playing and learning about waste and recycling!

SJ: Ok we are done for now, thank you.

CB: You're welcome! Don't hesitate to reach out if you need further assistance in the future. Have a great day!