Abstract

This bachelor's thesis examines integrating artificial intelligence, particularly Large Language Models, into the design process as a form of augmentation. Recognizing the significant role of design in navigating socio-technological changes, the study investigates how AI can support designers in addressing uncertainties. Reviewing existing literature, interviews, and prototype development, this thesis adopts an exploratory approach to understanding AI's alignment with contemporary design practices.

The complex nature of the design process, encompassing problem identification, framing, redefinition, and solution creation, is underscored. A designer's ability to manage uncertainties depends on mental models, biases, and the capacity to tackle the 'unknown unknowns.'

The study reveals that AI can inadvertently perpetuate societal thinking structures due to its probabilistic nature, which may limit its efficacy in solving problems that demand radical shifts in thinking. However, the thesis posits that AI can augment the design process by stimulating designers' reflections and helping them to challenge their assumptions and biases. This augmentation preserves the design process's complexity while mitigating the limitations of fixed thinking patterns.

The thesis identifies potentials and challenges of incorporating AI into the design process. It advocates for the responsible use of AI to enhance design, fostering innovation while critically engaging with ethical considerations. The study thus contributes to a growing field. It is directed towards individuals involved in the design or operating in uncertain environments, urging them to view design as an essential facilitator of innovative solutions through the cautious integration of AI.

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Approach and Methodology

The thesis utilizes an explorative approach to understand and investigate the Large Language Models and their potential. The background for this approach is based on the novel possibilities arising due to swift technological advancements and the sudden availability of Artificial Intelligence. The exploration becomes necessary as established conventions and best practices are still forming and must be comprehended.

The first step involved gaining a technical overview of machine learning to understand how Large Language Models operate, where the technology is currently used, and how potentials are determined and utilized today. This sense-building attempted to identify long-term developments and best practices in this rapidly evolving field. Later best practices for the design of AI and the design for AI were compiled and applied from guidelines provided by various companies and later implemented in prototypes.

The second step in the methodology involves identifying problems and complexities in the design process. Theories of creative and problem-solving approaches, like Horst Rittel's definition, an explanation of problem-solving in planning processes, and Lean Methodology for assumption-based work constitute the theoretical foundations. The thesis also reviews various popular methods and frameworks from professional literature to understand how problems are currently solved, and processes are organized in uncertainty. These observations should identify where most issues and complexities occur in these frameworks and the areas where Artificial Intelligence can provide support.

There were 14 in-depth interviews with designers conducted about their experiences with complexity in the design process. The interviewees were from diverse backgrounds in design. The goal of this qualitative research with field experts was to see how much AI is currently being used and where, in current processes, the potential for AI support could be found. All interviews were conducted one-on-one, either in person or via Zoom, and if possible, recorded and transcribed. Afterward, all transcriptions and notes were examined for overarching patterns and insights.

In the fourth step, prototypes were built, which allowed for validation of the perception of the inner workings and the feasibility and viability of the technology. During user testing, there was also an examination of the impact on the designer and the design process through in depth-interviews and questions about the perception of the interface. Various approaches for LLM prompting were also tested, which was one of the prototype's most developing fields and still has significant potential for improving the results.

The results of the prototyping and the theoretical basis of the work were presented to 7 interview partners in a later step. The new findings from the interviews led to further iterations of the prototypes.

In retrospect, the explorative approach effectively combined research, practical insights, and prototype construction, significantly facilitating the comprehension and demonstration of the research findings. The exploration of interaction design for applications with AI also opened an additional dimension in the design approach to AI. Due to the broad initial scope of the analysis, decisions took time, especially in the early phases of the project, where a narrower focus could have saved time. If there had been more time, collaborating and applying findings in real design projects would have led to many insights and more decision guidance.

AI

Artificial Intelligence is an expansive field with numerous technologies and functionalities. This work focuses on AI technologies used in text generation models, as these models have significant potential for augmenting problem-solving processes. AI technologies can be divided into two major categories: generative and discriminative. Generative AI systems produce new artifacts and can provide different outputs for the same input. In contrast, discriminatory AI systems focus on determining labels, classifications, and decisions and aspire to deterministic outcomes (Weisz et al., 2023).

Content-creating AIs, specifically in text and image generation, has been impactful. Optimizing outcomes has been ingrained in AI design from the ground up, with supervised learning, unsupervised learning, and reinforcement learning as fundamental types of learning (Engenhart & Löwe, 2022).

Supervised learning involves a scenario where the correct outcomes are known before training. The AI makes a prediction, then compares it to the actual result, refining the patterns on which future projections are based. On the other hand, unsupervised learning involves identifying statistical correlations without prior labeling. Lastly, reinforcement learning rewards correct solutions with a score, motivating the AI to explore and exploit the most successful pathways to still-unknown solutions (Engenhart & Löwe, 2022).

Predictions of AI systems can be categorized into classification, regression, and ranking. Neural networks, one of the foundational structures for AI, can undertake these various types of predictions and adapt based on complex relationships between neurons. These adaptations occur during the learning process through adjustments in the weights and biases of the neurons in the neural network (Engenhart & Löwe, 2022).

There are three main types of neural networks: Convolutional Neural Networks (CNNs), often used for image recognition and generation; Recurrent Neural Networks (RNNs), frequently employed in Natural Language Processing due to their capacity to handle semantic units; and Generative Adversarial Networks (GANs) that generate new images based on input data. Large models, such as GPT-3 and GPT-4, are Transformer Neural Networks (TNNs) that utilize concept-based neurons, allowing them to recognize and link concepts in various formats, such as photos, drawings, or language (Engenhart & Löwe, 2022).

Computers operate based on algorithms provided by humans. Conversely, AI leverages statistical learning methods to achieve desired outcomes by examining large amounts of data for potential patterns. This behavior is beneficial when the complexity of the desired results makes it difficult to codify the rules algorithmically because of large amounts of data or complex interrelationships.

The complexity of understanding how AI functions stems from the inability to trace processes within neural networks externally. AI's opacity in its functionality makes it challenging for researchers and developers to fully understand how much the AI can comprehend. In Interviews, it becomes apparent that even researchers at OpenAI are often surprised by the results and are continually investigating how much awareness AI systems have developed (Bubeck et al., 2023).

While the principles of neural networks have been around for quite some time, advances in server architecture and other technological developments have led to more recent breakthroughs in AI. Models such as GPT-3 have existed for years before the rise in popularity through ChatGPT. However, hardware developments, the coordination of processes in large language models, and an easy-to-understand interface have contributed to the fast development of LLMs.

For the remainder of this work, the term' artificial intelligence' will refer to Large Language Models unless specified otherwise.

AI Ethics

Implementing AI in design brings a host of ethical considerations and challenges that need to be addressed. A responsible integration of AI in design should adhere to eight essential criteria defined by the IEEE, as seen on the right. These include respect for international human rights, promoting user well-being, prudent access and sharing of user data, verifying the function to avoid harm, ensuring the basis for AI-driven decisions is transparent, and that the findings are unambiguous. It is also necessary to prevent misuse and risks associated with AI and educate users about its safe and effective usage.

Engenhart and Löwe (2022a) point out that AI systems are inherently biased as they cannot accurately represent reality but make predictions based on their data inputs. This bias manifests in technical and socio-political distortions. The data employed in widely used AI models, such as those from OpenAI, typically represent a specific segment of global society and do not equally account for all aspects.

Müller (2020) presents further debates regarding AI ethics in "Ethics of Artificial Intelligence and Robotics." These involve concerns about privacy and surveillance, with AI significantly increasing ways to collect and analyze data. The value of this data for companies has resulted in the growth of an attention economy where services aim to keep our attention as long as possible. Another ethical concern lies in AI's ability to manipulate behavior, as AI systems can tailor their efforts based on human input, possibly influencing behavior.

The opacity of AI systems constitutes another ethical debate. There is a limit to human participation in AI decision-making processes, and the methods through which AI systems arrive at conclusions often need to be made more transparent. These systems rely on the quality of their data, so biases in decision systems can amplify pre-existing prejudices within the data. Other ethical concerns include automation and employment, autonomous systems, machine ethics, artificial moral agents, and the concept of singularity.

It is crucial to note that AI is inherently discriminatory or biased due to the disparity between the environment and data and the discrepancy between data and statistical approximation. Therefore, while the application of AI in design can enhance the design process, we must be aware of these inherent biases and ethical considerations to ensure we use AI responsibly.

1. Human Rights - A/IS shall be created and operated to respect, promote, and protect internationally recognized human rights.

2. Well-being - A/IS creators shall adopt increased human well-being as a primary success criterion for development.

3. Data Agency - A/IS creators shall empower individuals with the ability to access and securely share their data, to maintain people's capacity to have control over their identity.

4. Effectiveness - A/IS creators and operators shall provide evidence of the effectiveness and fitness for purpose of A/IS.

5. Transparency - The basis of a particular A/IS decision should always be discoverable.

6. Accountability - A/IS shall be created and operated to provide an unambiguous rationale for all decisions made.

7. Awareness of Misuse - A/IS creators shall guard against all potential misuses and risks of A/IS in operation.

8. Competence - A/IS creators shall specify and operators shall adhere to the knowledge and skill required for safe and effective operation.

Fig 01

AI Application in Design

The following section will present some application examples of artificial intelligence for design. In an article from September 2022, the venture capital company Sequoia showed the potential of artificial intelligence. It predicted that by 2023 it would already be possible to generate mockups for product design and architecture through image generation, which later should become accurate. In addition, the company expects that final drafts will be created with artificial intelligence by 2025 and that these will be better than those of professional artists, designers, and photographers by 2030. The following examples will show the direct benefits of the current advancements in 2023 and the possible dangers of how the tools may impact the work of designers today.

Text	Code	Images	Video/3D/Gaming
Spam Detection Translation Basic Q&A	1-line auto-complete		
Basic Copywriting Second Drafts	Multi-line generation		
Longer forms Second Drafts	Longer form Better accuracy	Art Logos Photography	First attempts at 3d/video models
Vertical fine-tuning gets good	More languages More verticals	Mockups (product design, architecture)	Basic/first draft videos and 3D files
Final drafts better than human average	Text to product (draft)	Final drafts (product design, architecture)	Second drafts
Final drafts better than professionals	Text to product (final) better than full-time dev	Final drafts better than professional artists, designers	AI Roblox personalized dreams in videos

Fig 02

Autodesk Forma

Autodesk Forma, formerly Spacemaker, is an upcoming tool for the Architecture, Engineering, and Construction industry. The application uses artificial intelligence to transform and augment conventional design processes. This broad, data-driven approach should enhance urban planning and architecture optimization.

Forma's application extends beyond basic design by allowing users to input the entire solution space of architectural projects; it can optimize design problems through mathematical formulas and their relationships. The app can substantially enhance the quality of architectural designs, as it accounts for a broad range of parameters that can affect the viability and functionality of a proposed structure.

This feature enables Forma to drive data-oriented optimization in urban planning and architecture. For instance, the software can help design professionals model, verify, and optimize their design concepts by swiftly incorporating sunlight, noise, and air quality into the design process.

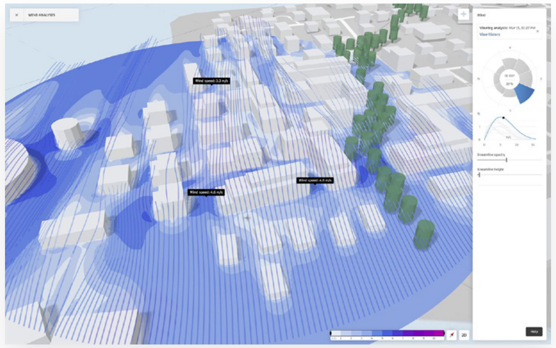

Fig 03

However, the quality of the results heavily relies on the data used, the mathematical models incorporated, and the assumptions made. Thus, it is essential to approach this critically, as simplifications and inaccuracies in these areas could lead to sub-optimal or misleading outcomes. Consequently, professionals should remain cautious to ensure the software's automated decisions align with real-world needs and constraints.

Vizcom

Vizcom, as an AI-powered tool, combines the simplicity of hand sketches with advanced AI tools for image generation. The blend of prompts, hand-drawn sketches, and sliders enables users to convert their initial ideas into photorealistic renderings. The platform offers a selective intervention into the AI-generated images. Furthermore, Vizcom's ability to create variations of the renderings directly adds a significant layer of convenience and versatility to the design process.

The benefits of using such an AI tool in design are various. Firstly, Vizcom enhances the efficiency of the design process by translating sketches directly into realistic renderings, minimizing the time and resources spent on multiple iterations and refinements. Secondly, integrating prompts and drawing tools opens up new creative spaces (Vizcom, 2023).

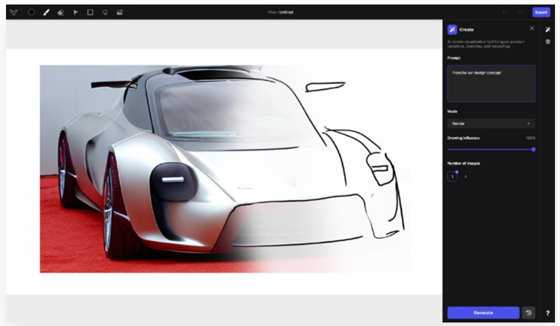

Fig 04

Despite these advantages, some potential risks and concerns are associated with using Vizcom. One significant concern is more transparency in the platform's documentation. It does not disclose the nature of the data it was trained on, nor does it specify the technologies utilized to achieve the results. This circumstance could lead to data privacy, security, and AI ethics questions. Proposals of the Artificial Intelligence model can increase biases and lead to results that look increasingly alike.

Adobe Firefly

Adobe Firefly is one of the most capable examples of how artificial intelligence can be integrated into current design processes. It seamlessly integrates with the popular Adobe Suite, enhancing productivity and creativity in design workflows. The tool primarily generates pictures, illustrations, artwork, and graphic designs based on user-provided prompts.

While Adobe Firefly is designed for ease of use, enabling fast results, especially in the beginner-friendly application Adobe Express. The accessibility allows immediate results even with little prior knowledge. However, it may lead to less influence over the final results, limiting the customization of the design outputs, thus posing disadvantages for advanced users seeking a high degree of control over their designs.

In terms of data privacy, Adobe Firefly provides a compelling solution. The AI models are trained solely on the data from Adobe Stock without utilizing user-generated outcomes for further training. This approach ensures brand safety and content originality. It is a brand-safe option for corporations and commercial design work, as it mitigates the risks of copyright infringement and unauthorized data usage.

Nevertheless, as with any AI tool, Adobe Firefly brings potential risks. Dependence on such a tool can decline human creativity and originality if overly relied on. Furthermore, while it ensures brand safety through its training method, it could also unintentionally promote a certain visual homogeneity due to its singular data source, potentially decreasing diversity and uniqueness in design because it is based on a limited data set in Adobe Stock.

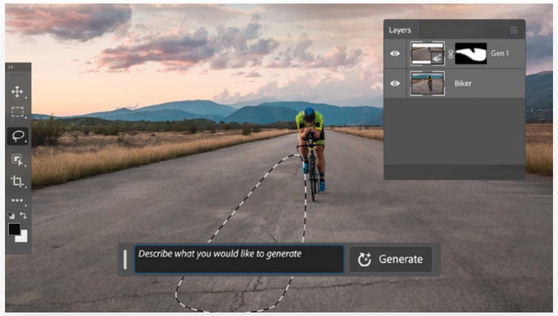

Fig 05

AutoDesigner

Autodesigner is a text-prompt-based tool that automatically generates user interfaces, providing a platform for outcomes to be customized after the generation. Its capabilities span from transforming screenshots and sketches into editable mockups to creating multi-screen mockups swiftly using simple text.

Autodesigner offers multiple customization options. The AI analyzes the design and converts it into a high-quality, adjustable template. This capability gives designers or non-designers a wide array of choices in terms of colors, fonts, and shapes before exporting the design to their preferred platform. App designs can be created and tested rapidly with minimal effort through a simple text prompt, facilitating a user-centric design process and a more efficient workflow (Antoshkin, 2023).

Possible issues could be the over-reliance on AI, which might lead to a lack of originality or uniqueness in design outcomes. As designs are generated based on pre-existing patterns and structures, the creative input from the designer could be undermined. This outcome could result in designs that, while functional and aesthetically pleasing, may need more individuality or brand identity that a human designer might incorporate.

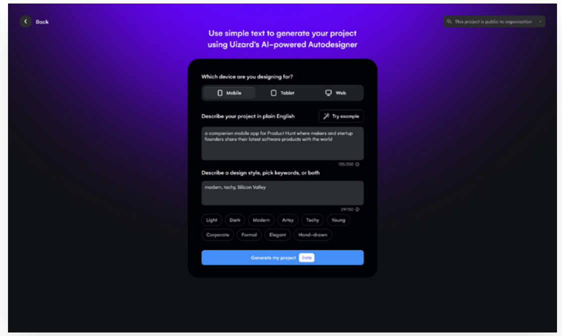

Fig 06

Accessibility may be another concern since the AI's knowledge is restricted to training data and does not include experience with sensation and actuation. This limitation prevents the AI from understanding human needs, for example, regarding interaction with applications and the overall user experience with an app. These risks can only be dealt with with the particular awareness of the designers.

Fermat

Fermat is an innovative tool that effectively combines artificial intelligence with design processes. This platform uses a canvas where ideation and image generation are gathered. Designers or users can prompt what they intend to design, even using sketches for enhanced representation, which are transformed into images through AI. The tool also facilitates interactive dialogues where users can ask questions, creating an environment for idea generation.

Fermat can enhance the overall efficiency of the design process. It offers an all-in-one platform for brainstorming, concept art, content creation, and scenario planning. The tool enables the visualization of relationships between concepts, thus fostering the generation of robust and innovative ideas. Moreover, the integration of generative AI within the product assists users in automating tasks and streamlining processes, enabling them to focus on the creative aspects of design.

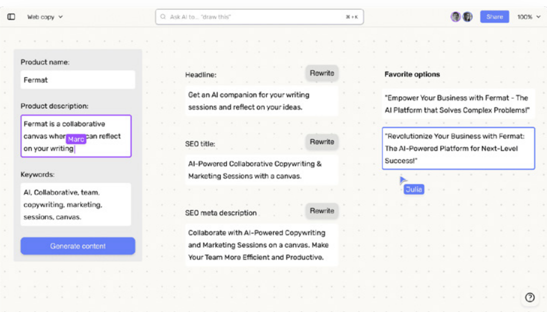

Fig 07

Despite these advantages, potential risks and challenges associated with Fermat's use must be considered. One significant concern is attributed to the dependence on AI for creative processes. While AI can generate numerous design options and streamline workflows, it could diminish the role of human creativity in the design process. Therefore, striking the right balance between automation and human involvement becomes critical.

In addition, the issue of AI bias is another risk to consider. The design outcomes generated by the AI are dependent on the training data used, which implicit biases can influence. These biases, if not carefully monitored, could limit the diversity of design ideas and even perpetuate harmful stereotypes.

Lastly, using AI in design processes like Fermat raises questions about intellectual property rights. When AI generates a design, it becomes unclear who owns the rights to that design. Additionally, there is the potential for unknowingly stealing ideas from other works and implementing them into their own.

Conclusion

The emerging AI tools like Autodesk Forma, Vizcom, Adobe Firefly, Autodesigner, and Fermat all signify the potential of AI in revolutionizing the design process by streamlining workflows and generating many design options. These tools can considerably enhance efficiency, productivity, and creativity by taking on tedious, repetitive tasks, sometimes leaving more room for human creativity.

However, these AI-powered design tools also pose significant risks and concerns. Primarily, the over-reliance on AI tools might reduce human creativity, originality, and individuality in design outcomes, as AI's proposals are primarily generated based on pre-existing patterns and structures. This fact raises the concern that AI might shape designs more by their capabilities and less by the designer's original vision, possibly leading to a lack of uniqueness and a potential homogeneity in design aesthetics.

Moreover, AI models depend heavily on their training data, which is prone to inherent biases. These biases can influence the design outcomes, perpetuating existing stereotypes and limiting the diversity and novelty of design ideas. The issue of data transparency, privacy, and security is also crucial, especially given that some AI design tools do not disclose the nature of the data they were trained on.

Furthermore, the potential implications for intellectual property rights must be considered. The blurred boundaries of ownership and the potential for unintentional copying of ideas in AI-generated designs can raise legal and ethical concerns.

OpenAI

OpenAI is a pioneering research company in the field of artificial intelligence. Established in December 2015 by Elon Musk, Sam Altman, and other founders, the organization aims to foster the development and application of AI that benefits humanity. Throughout its existence, OpenAI's contributions have significantly influenced the AI industry. The company's research output and open-source initiatives have empowered other organizations to develop AI-driven products and services. Furthermore, OpenAI's guiding principles and standards have been vital in promoting AI technology's safe and ethical development (O'Neill, 2023).

Dall-E 2 is an advanced generative AI tool that enables users to generate novel images from textual descriptions. Launched in April 2022, Dall-E 2 provides enhanced capabilities such as higher image resolution and improved image quality using a diffusion model. This model addresses previous image graininess and latency issues, making Dall-E 2 a powerful tool for generating high-quality visual content (OpenAI, n.d.).

The GPT series, including GPT-3 and GPT-4, are language models that utilize deep learning techniques to generate human-like text. Introduced in May 2020, GPT-3 has demonstrated versatility across several applications, such as generating code snippets, charts from text descriptions, and even Excel functions. GPT-4, the latest iteration, improves upon GPT-3 by incorporating multimodal capabilities, handling text and image input. GPT-4 exhibits enhanced factual correctness, decreased offensive or dangerous content output, and a higher input processing capacity (OpenAI, n.d.).

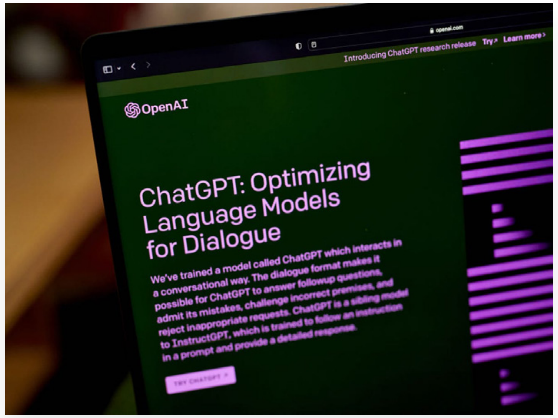

Fig 08

ChatGPT, launched on November 30, 2022, is the most consumer-oriented product of OpenAI that leverages the GPT models to provide detailed and articulate responses across diverse knowledge domains. With over 100 million users by January 2023, it has become the fastest-growing consumer application. Free access to ChatGPT has not only democratized the use of AI but also provided invaluable user feedback for the enhancement of future versions of the GPT models (OpenAI, n.d.).

Due to the substantial advancement of Large Language Models and the infrastructure they can run on, the decision was made to use OpenAI's API for the prototyping process. The excellent documentation and simple application examples made it easy to start. Another advantage was the choice between the high-speed and cheap GPT 3.5 turbo model and the GPT-4 model, which is much more expensive but provides higher-quality answers.

Graphologue

The paper “Graphologue: Exploring Large Language Model Responses with Interactive Diagrams” presents a novel interactive system called Graphologue, designed to convert text-based responses from Large Language Models like ChatGPT into graphical diagrams. The motivation for this system comes from the identified limitations of text-based mediums and their linear conversational structures, which can make it challenging for users to comprehend and interact with complex information (Jiang et al., 2023).

Graphologue employs prompting techniques and interface designs to extract entities and relationships from LLM responses, constructing node-link diagrams in real time. Users can interact with these diagrams to adjust their presentation and submit context-specific prompts for more information. This facilitates a visual dialogue between humans and LLMs, enhancing information comprehension (Jiang et al., 2023).

Graphologue allows the users to control the complexity of the diagrams, enabling them to toggle between sub-diagrams to show salient relationships, collapse branches of the charts to reduce presented information, and combine separate smaller graphs into one diagram to view all concepts as a whole. Users can also directly manipulate the graphical interface, translated into context-aware prompts for the LLM (Jiang et al., 2023).

Especially at the beginning of the topic identification of this bachelor thesis, the complexity and interconnectedness of the contexts in which we design played a significant role in the work. Initial hypotheses the interviews were led with similar opportunities for visually processing information. The paper was developed simultaneously with this bachelor thesis, but published interim results have steered this thesis’ approach away from pure visual information processing.

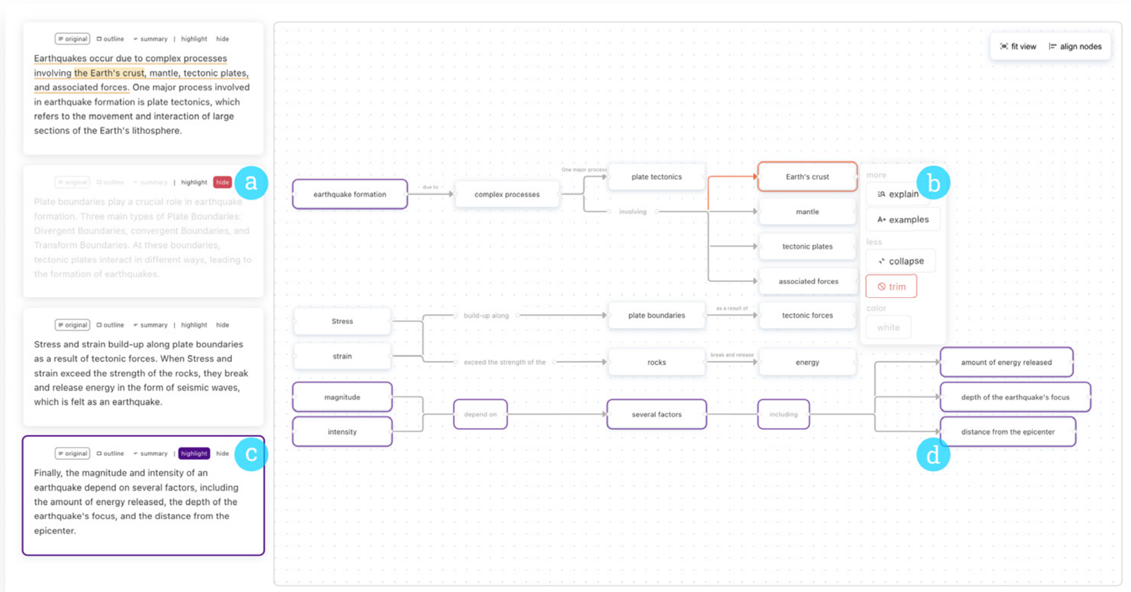

Fig 09

Riff

The article “Reflecting with AI: A Tool to Develop Human Intelligence” by Leticia Britos Cavagnaro discusses developing and using an AI tool called Riff for enhancing reflection. Riff is a conversational AI chatbot that uses a GPT 3.5 Large Language Model to generate dynamic questions based on user input, encouraging learners to delve deeper into their experiences (Cavagnaro, 2023).

Riff’s primary purpose is to augment individual reflection. It achieves this by asking questions that prompt the learner to elaborate on their experiences, contrast their current experiences with past or hypothetical ones, explores beyond their initial observations, and consider how their future actions might change based on their reflections (Cavagnaro, 2023).

Riff differs from other AI tools like ChatGPT in its interaction style. While users typically ask ChatGPT questions or request it to perform tasks, Riff asks users questions and continues to ask follow-up questions as they respond. This approach is intended to create an engaging conversation that should lead to reflection.

Riff’s interaction with the user will be an important parallel to this thesis. The use case is not meant to provide the user with answers or inspiration but to ask more profound questions encouraging them to reflect on their assumptions. In the following chapter, identifying personal beliefs and their reflection will become essential to the thesis.

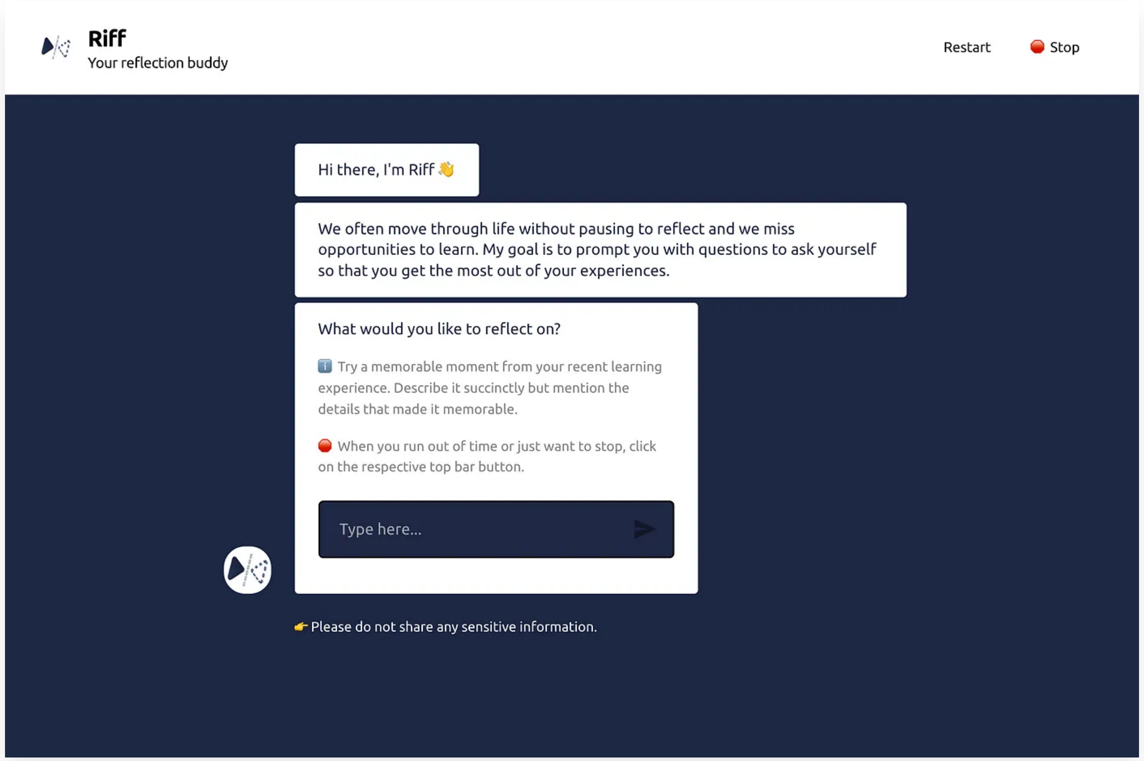

Fig 10

Conclusion

OpenAI's GPT models have proven instrumental in prototyping, thanks to their excellent documentation and the balance between cost and performance. The choice to use OpenAI's API has facilitated a smooth integration of AI capabilities into the thesis and set the foundation for the project to tap into the continuously evolving advancements in AI models, as seen in the transition to GPT-4.

The Graphologue paper, though developed simultaneously with this thesis, has provided valuable insights into transforming text-based interactions with AI into interactive diagrams, enhancing comprehension of complex information. This approach aligns with the initial hypothesis of this thesis regarding the value of visual information processing. Despite a shift from pure visual processing, Graphologue's principles continue to shape the explorations and developments in this thesis.

Furthermore, as detailed by Leticia Britos Cavagnaro, the Riff AI tool has offered a novel approach to AI interaction—promoting user reflection rather than simply answering queries. This reflective interaction style aligns with the goals of this thesis, influencing how AI can be leveraged not just for providing information but for encouraging introspection and critical thinking.

Design

“Design has too often been deployed at the low-value end of the product spectrum, putting the lipstick on the pig.” - Dan Hill

This quote was a guiding inspiration for the approach to design that this thesis is trying to investigate and augment. Furthermore, (Hill, 2012) adds in his book: “In doing this, design has failed to make a case for its core value, which is addressing genuinely meaningful, genuinely knotty problems by convincingly articulating and delivering alternative ways of being.” In the spirit of the quote and the book, this thesis will address the part of the design that deals with knotted but significant problems. Therefore, this part of the thesis explores how design frameworks and Design Thinking can support solving problems, especially in uncertainty.

To comprehend design and design processes more profoundly, the thesis turns to the definition offered by Herbert Simon in “The Sciences of the Artificial.” According to (Simon, 1970), “Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.” He adds, “Natural sciences deal with how things are; design deals with how things should be” (Simon, 1970).

These definitions are particularly relevant for this thesis as they weave together two significant concepts - the perception of the existing situation and the desirability of new conditions. They underscore the essence of design as a discipline that does not merely accept ‘what is’ but ambitiously navigates toward ‘what should be.’ Thus, by reframing our understanding of design, we can begin to value its power to influence and shape the world around us, embracing uncertainty as a platform for innovation rather than a limitation.

In the following chapters, different innovation and design frameworks are discussed, and their implications on uncertainty are considered. These will work as a foundation for the subsequent interviews with design professionals, which are being analyzed to provide insight into difficulties and complexities in applied design processes. Several design capabilities considered with uncertainty and AI emerged from these interviews.

“Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.” - Herbert Simon

Design Process

To gain an overview and to be able to classify different frameworks, two various overviews of design frameworks are used. The first overview on the right page sorts frameworks on a scale between Problem Focused and Opportunity Driven and the scale of External Focus to Internal Focus.

For the consideration and comparison of the design process, the thesis will concentrate primarily on the Problem and External Focused Frameworks since more representative design frameworks are placed here. Furthermore, this thesis will also borrow concepts from the Lean Startup and Futures Thinking frameworks, which are located adjacent.

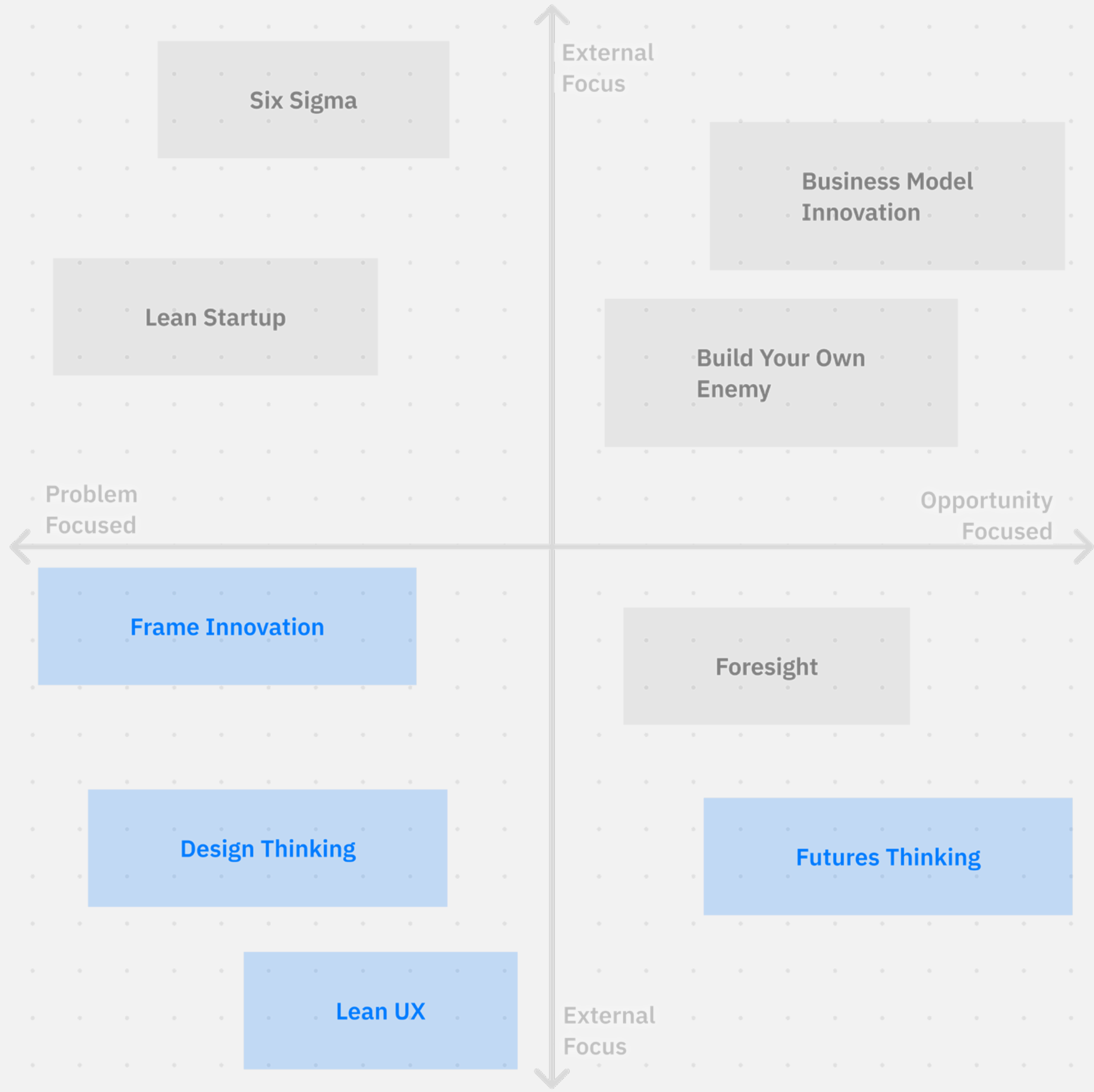

Fig 11

Another way of looking at the frameworks through the development process of a project is the diagram on the right by Dark Horse Innovation. This overview sorts the Problem Focused Frameworks, suggesting that Design Thinking is applied very early because of its external focus on problem identification. In the transition, Lean Startup is more involved when finding a problem-solution fit. Agile and Scrum are often used if the solution is found and needs to be made market-ready.

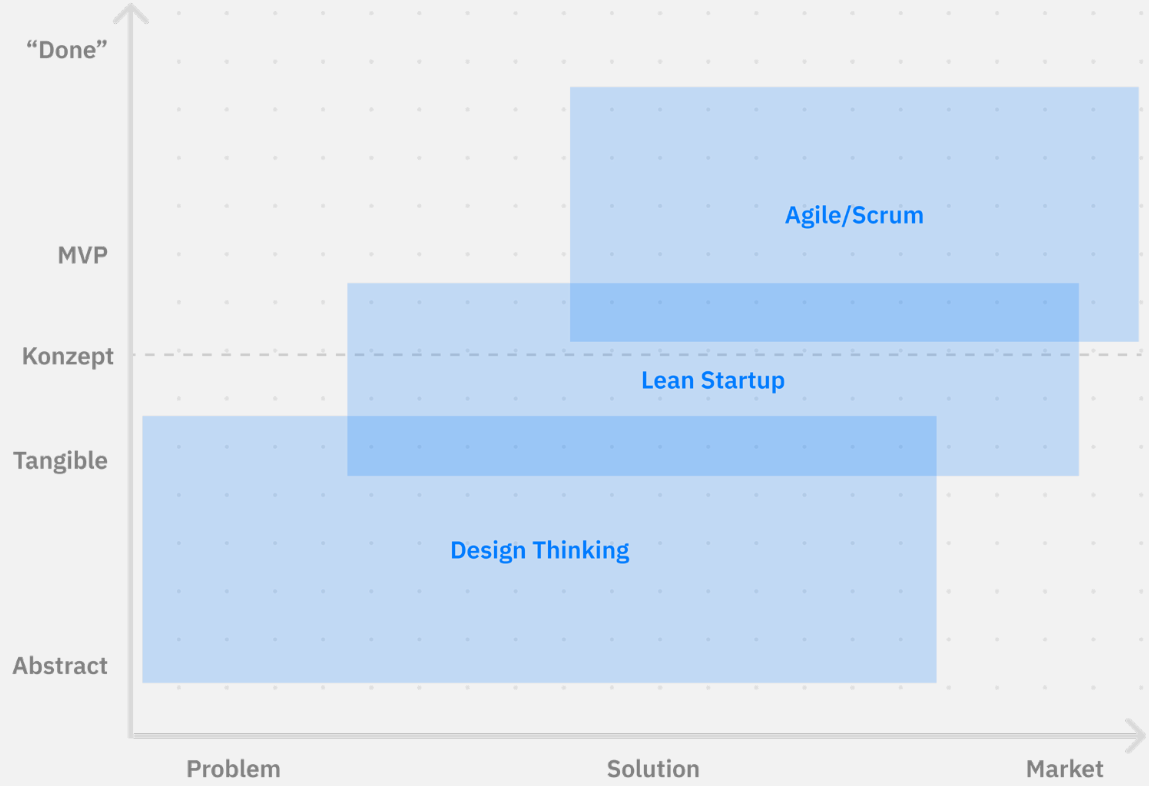

Fig 12

Design Thinking

Design Thinking was first mentioned by Herbert A. Simon in his book, The Sciences of the Artificial, later popularized by Nigel Cross, Tim Brown, and IDEO, is a non-linear, iterative process utilized to understand users, challenge assumptions, redefine problems, and create innovative solutions. This methodology contains five phases: Empathize, Define, Ideate, Prototype, and Test, as seen on the right (Interaction Design Foundation, 2022).

Design Thinking focuses on understanding human needs and reframing problems in human-centric ways. It encourages empathy, optimism, iteration, creative confidence, experimentation, and embracing ambiguity and failure. However, while impactful, it also has shortcomings.

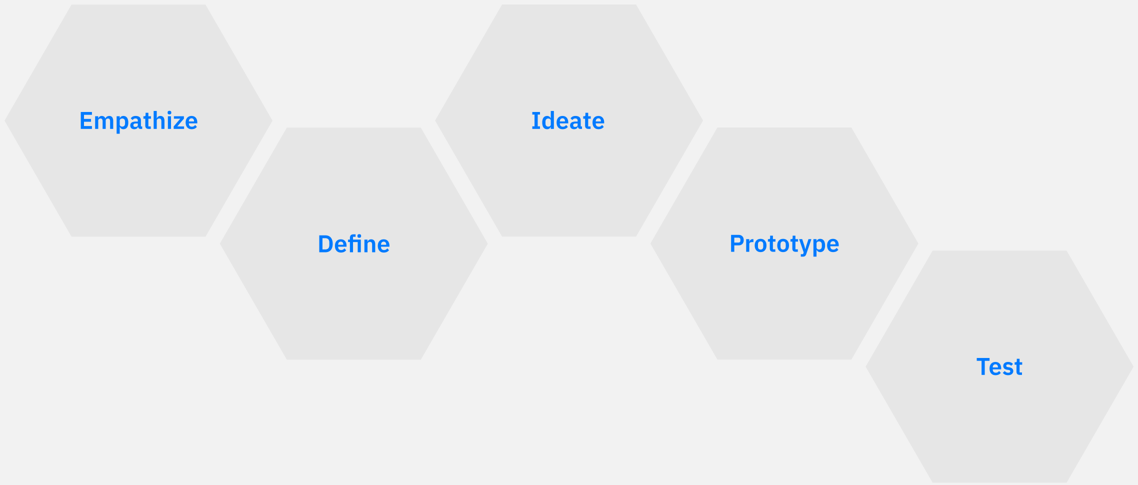

Fig 13

Design work often fails to account for potential impacts on people or the environment. It is suggested that such design processes tend to neglect the possible waste products that could result and the overall effect on people's lives (Norman, 2023).

In an interview with Dark Horse Innovation, Fabian Gampp, one of the co-founders of the System Mapping Academy, compares Design Thinking with systemic thinking, translated into English: "Unlike Design Thinking, system mapping is not (only) based on the needs of the users and does not per se claim to solve these needs. In applying system mapping, the focus is on the long-term health of the entire system" (Dark Horse Innovation, 2023). This quote describes one of the shortcomings of the user-centered design approach, in focusing too much on the needs of specific user groups.

Consequently, there has been a movement within Design Thinking to broaden the scope of consideration. This shift is demonstrated through the progression from user-centered to human-centered and eventually to humanity-centered design.

The user-centered design considers the user as a product statistic, whereas human-centered design sees beyond the user, empathizing with their needs and understanding their behaviors. On the other hand, the humanity-centered design considers humanity and the environment as a whole, addressing deeply rooted problems that affect us as a species (St Aïmond Banson, 2022).

Design Thinking has undoubtedly contributed significantly to developing empathy and understanding the contexts of target groups. Its initial focus on individual user groups and the resulting rapid insight and solution finding in the design process has led to great success. However, as Don Norman and Fabian Gampp pointed out, this mindset can also tend to ignore environmental influence. Especially in light of short-term thinking and climate change, thinking systemically and moving to humanity-centered design could provide a critical perspective for the design discipline. Thus, a thinking shift needs to occur in times of climate change to enable a more sustainable and environmentally conscious design direction.

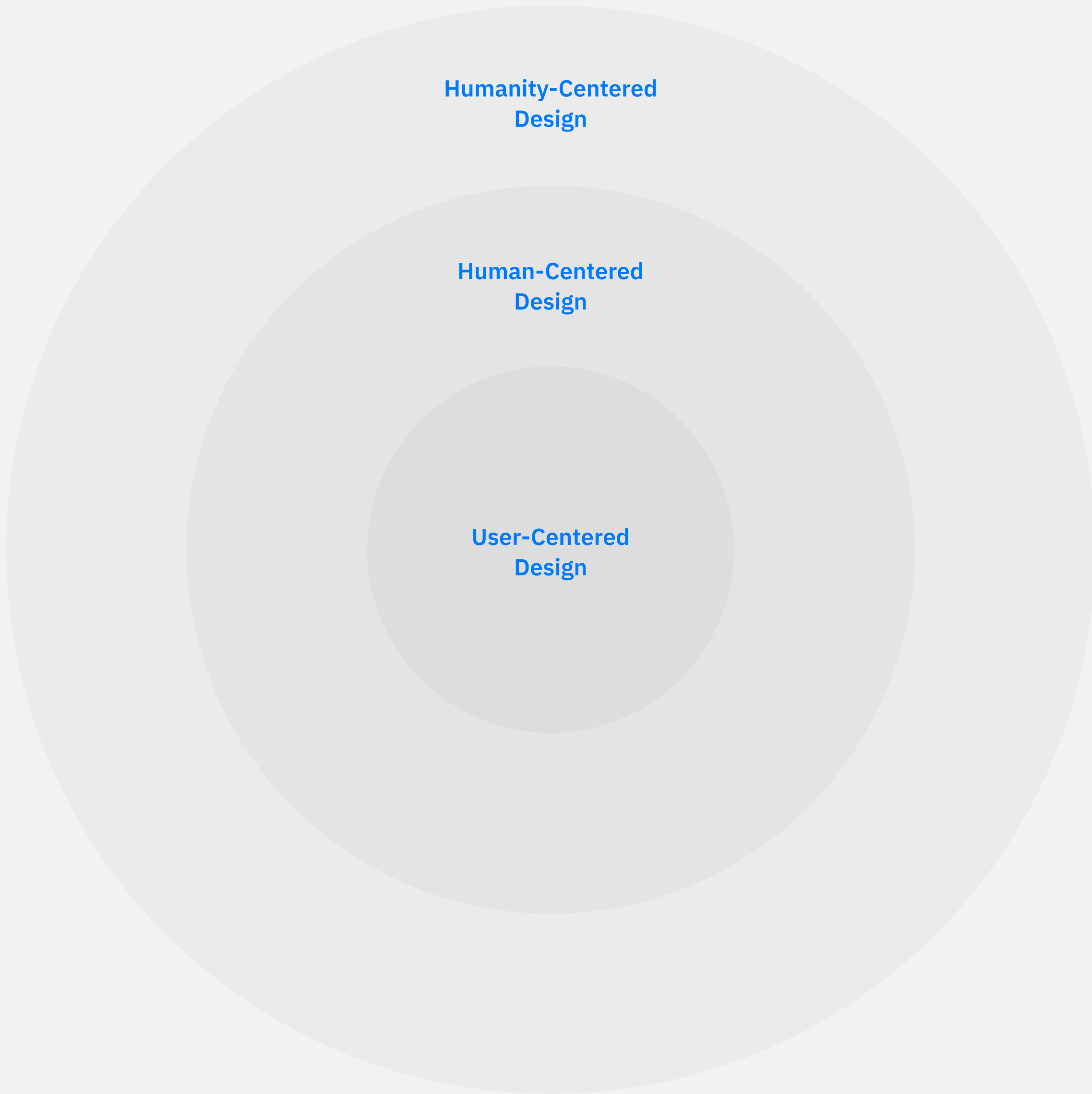

Fig 14

Futures Thinking

According to Groß and Mandir (2022), Design Futuring is a methodology dedicated to exploring, creating, and negotiating future scenarios. It provides designers with techniques and conceptual tools to systematically and efficiently propose various future scenarios. This methodology goes beyond forecasting, encouraging creativity to work towards the development of more "preferable" futures. Design Futuring holds a dual impact; it expands the toolkit and domain of influence for designers and establishes a shift in the design discipline toward more strategic and creative thinking.

A particular model integral to Futures Thinking is the Futures Cone developed by Joseph Voros, which can be seen on the right. Groß and Mandir (2022) describe this model as representing future possibilities as a cone rather than a linear timeline. The model can be envisioned as standing in a snowfall with a flashlight; here, each falling snowflake symbolizes a potential future event, while the flashlight's cone represents the spectrum of foreseeable future events. This analogy helps to comprehend that everything beyond the cone of light remains unknown, thereby uncertain. In the realm of Design Futuring, the Futures Cone serves as a model to categorize insights derived from exploring different future scenarios. The concept of the futures cone becomes relevant again in later considerations.

As mentioned by Nohr and Kaldrack (2023), speculation as an analytical-narrative method holds promise in challenging conventional thought patterns. It involves transcending established knowledge paradigms and uncovering the concealed genealogies of the present to envision new futures. However, this exploration must acknowledge the entanglement of one's perspective within power and knowledge regimes and an understanding of how they evolved, which emphasizes the necessity of critical reflection in Futures Thinking.

Larsen (2022) introduces in "What Is Futures Literacy and Why Is It Important?" the concept of the discipline of anticipation. It is about recognizing assumptions about the future and converting uncertainty from planning into a resource. Individuals can identify and foster their capacity to shape and invent new anticipatory assumptions by imagining different futures. Shifting this anticipatory ability from an unconscious to a conscious state is crucial to becoming future literate.

In summary, incorporating Futures Thinking into design processes is essential in steering design toward a more strategic direction. It allows for the addressing of more significant and intricate problems by engaging with assumptions and the desirability of the outcomes of the design process.

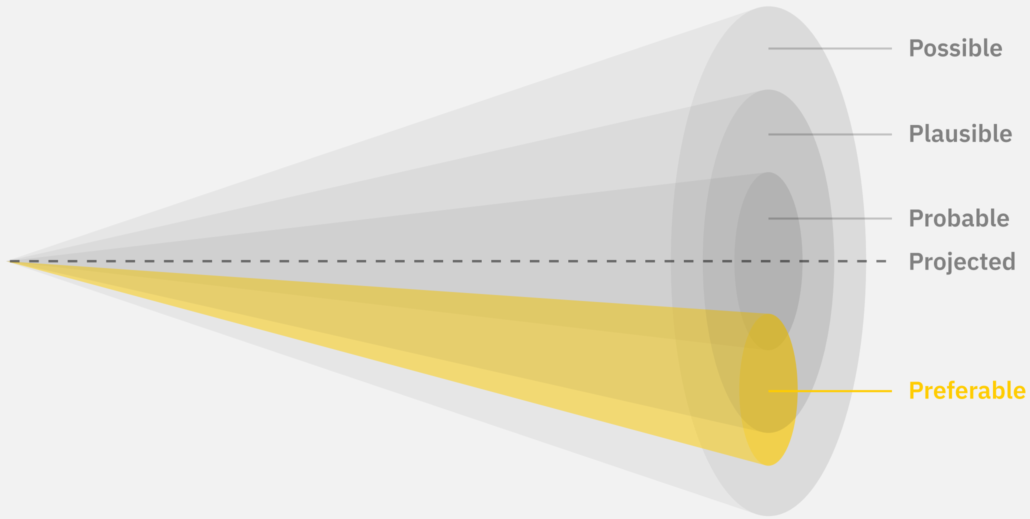

Fig 15

Lean UX

Lean UX focuses on the design process, team collaboration, and organization. It takes inspiration from Eric Ries' Lean Startup methodology, which encompasses a loop containing the "Build-Measure-Learn" cycle. This feedback loop minimizes project risk and fosters swift development and learning processes. In this context, every design is considered a hypothesis, and the smallest unit to test this hypothesis is introduced as the so-called Minimum Viable Product (MVP). The focus is to initiate the learning process by producing MVPs for different stakeholders as soon as possible (Gothelf & Seiden, 2016).

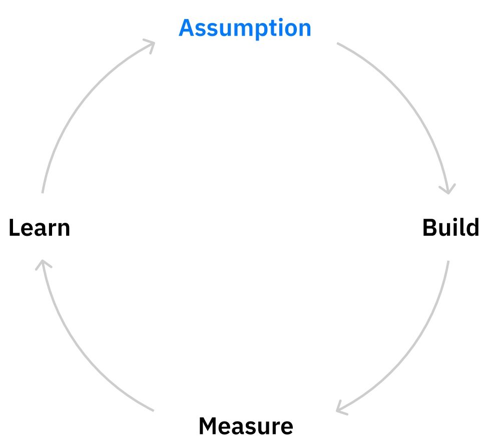

Fig 16

Assumptions are vital in the Lean UX methodology and are being added to the Build-Measure-Learn cycle of Lean Startup. At the beginning of a project, speculations range from the obvious to the ones that become only apparent when it is too late (Gothelf & Seiden, 2016). This approach also necessitates finding and doubting these assumptions and validating them systematically and comprehensively.

Gothelf and Seiden (2016) outline four main types of assumptions. The first type is business outcomes, which can be quantified as changes in customer behavior and act as market signals to verify or refute our hypotheses. The second type is users or personas, models of people we believe we are solving a problem for. The third type is results for users, containing the end goals of the people we are developing products and their emotional and long-term goals. Lastly, features are the products or changes expected to yield desired results.

The uncertainty inherent in startup environments makes the conscious formation of assumptions and the iterative Assumption-Build-Measure-Learn cycle pivotal to Lean UX. Lean UX provides the required methods to drive and structure the appearance of beliefs, making it an effective tool for startups navigating uncertainty.

Conclusion

Design Thinking, with its user-centric focus and iterative methodology, has been influential in fostering empathy and understanding toward target groups. Its core strength lies in its ability to define and solve problems in a user-centric manner. However, its shortcoming resides in its tendency to neglect the broader systemic and environmental impact, calling for a more humanity-centered design approach.

On the other hand, Futures Thinking acts as a transformative tool that enables designers to envision, negotiate, and shape the future. The model of the Futures Cone and the facilitation of anticipation encourages the exploration of different future scenarios and aids in developing more strategic, creative thinking. However, it also calls for high critical reflection to avoid getting entangled within existing power and knowledge regimes.

Lastly, Lean UX offers a process-oriented perspective emphasizing collaboration and swift learning. Inspired by the Lean Startup methodology, it focuses on making assumptions, testing them, and learning from the results in quick cycles. This iterative approach allows for a flexible and adaptive design process, making it a convenient tool for startups. However, emphasizing rapid iteration can sometimes overlook more profound user experiences and nuanced considerations, highlighting the need for a balanced, integrated methodology.

Expert Interviews

In the context of this Bachelor thesis, a series of interviews was conducted to identify critical issues within the design process. Based on personal experience and previous research, the initial hypothesis suggested that complexity often presents a bottleneck within this process. Initially, there was the idea that artificial intelligence could be employed to sort through large amounts of data, potentially facilitating more direct solutions with fewer unintended consequences. This thesis was tested in the following expert interviews in a non-suggestive way.

The interviewees consisted of a diverse range of designers, each operating within different contexts. One interesting divergence observed in the professionals' work was the level of uncertainty they faced with the level of conceptuality of their work.

The interview methodology and approach were laid out in the second chapter. This part focuses on the key themes that were addressed and the subsequent insights that were gained. Through the interviews, the thesis incorporates an understanding of the complexities and challenges faced in the applied design process. These findings from the interview are summarized in the eight following themes.

1. Managing Complexity and Unknowns in Early Stages

- Complexity arises when there is limited knowledge about the subject matter.
- The initial stage involves gathering numerous questions among stakeholders to eliminate unknowns.
- The collection of ideas, hypotheses, and potential problems plays a vital role in tackling the issue of finding unknowns.
- No methods were mentioned except for starting the process.

2. The Challenge of Problem Identification and Complexity

- In the design process, breaking down problems effectively, especially when the time for research is limited, can be a significant obstacle.
- It is common for users to acclimate to specific issues, making them hard to identify.
- While it would be beneficial to view problems from a systemic perspective, the complexity involved often makes this impractical.

3. Information Overload and Loss during Convergence

Handling large amounts of information, especially after diverging in the first diamond of the double-diamond model, can be daunting.

Important information can also get lost during the convergence stage, causing potential setbacks in the design process.

Many working methods and workarounds have been mentioned for solving this problem.

4. Need for Process Transparency and Visualization

Maintaining an overview of the current stage in the process is critical in the design journey.

Visualizing recent progress helps track the workflow, fostering understanding and collaboration among team members.

5. Balancing External Inspiration and Originality

Abstracting facts for problem-solving often filter out new inspiration, making it challenging to discover new design ideas.

Searching for inspiration from both within the company and externally, as well as analogies and solutions from other fields, can be beneficial but challenging.

6. Decision Making and Transparency

Making decisions understandable in presentations is crucial, but it was also considered time-consuming.

Summarizing issues effectively is essential for the design process.

Designers often facilitate decision-making for stakeholders by preparing and presenting information coherently.

7. Balancing Stakeholder Requirements and Personal Bias

Different stakeholders have varying requirements regarding the company's strategy.

Personal attitudes can significantly influence the design outcome and how problems are handled in the design process.

The challenge lies in maintaining an overview to prioritize and make decisions.

8. Navigating Stakeholder Relationships and Contradictions

Relationships with stakeholders form a vital part of the design process.

Clients often conceal problems to please agencies, and projects often start without an agreement between stakeholders, requiring the design to find a compromise.

Detecting contradictions in the design process and understanding what stakeholders genuinely want is a significant part of the design work.

Reflection on the Interviews

The interviews for this bachelor's thesis provided critical insights into the design process and its challenges. Initially, these discussions were approached with the premise that artificial intelligence could notably augment designers' work by reducing complexity. Ideas were sought that could aid in processing information within the design process.

Interestingly, the interviews revealed that established methods exist for summarizing and clarifying complex information. These methods mainly assist in the divergent and convergent approaches characteristic of Design Thinking. However, as the research progressed, it became increasingly clear that complexity arises less from the multitude of information, as designers can benefit from clustering and filtering processes that aid in their cognitive progression.

Uncertainty was identified as a substantial potential for facing complexity in design processes. Uncertainty often underlies the difficulty in understanding which pieces of information are essential and which are not. Particularly influential are the unknown elements - information that we are not even aware we do not know yet. Therefore, the augmentation of design processes through artificial intelligence holds significant promise in managing uncertainty rather than simplifying information comprehension.

In the following section, the thesis will use the findings from the interviews to explore essential skills and concepts in the design process that significantly impact the chosen problem statement of the idea.

Design Competencies

The following sections will explore various competencies essential to the design process. Understanding these skills can help understand how problems within the design process can be solved and how artificial intelligence could offer support within these problem-solving processes.

In Design for a Better World, Norman (2023) suggests a paradox in design practice, with its major weakness but also its greatest strength being the absence of specific domain knowledge. While design needs to gain content expertise for every project, this absence of preconceived notions and prior knowledge empowers designers. Such a lack of assumptions prevents designers from suggesting solutions to problems prematurely, allowing them to explore various possibilities thoroughly.

Expanding on this idea, Rittel (2013) offers in the book "Thinking Design" further insight into the intricacies of the planning process. He maintains that knowledge for a planning problem usually lies with the users rather than with the experts, and there are no real experts in solving complex issues except for the process of problem treatment.

Rittel (2013) underscores the difficulty of addressing complex problems through scientific methods alone, framing the process of tackling wicked problems as an argumentative one that requires intuition and rationality. The quality of a plan (or solution) is determined by the certainty with which the goal is achieved while avoiding side effects and consequences.

According to Rittel (2013), a solution is a sequence of operations and manipulations that transforms the current state into a desired one. This process of searching and constructing functions lies in the divergence and convergence of ideas. The implementation of plans always involves the use of resources and necessitates consideration of the irreversibility of plans. Models can help to assess the impact beforehand. They can range from sketches, cardboard, dynamic, and computer models to mental models, aiding this process. Models help make decisions more traceable and justifiable, fostering transparency in the planning process.

Integrating these perspectives, designers possess a comprehensive understanding of the creation process, which involves the ability to work analytically and creatively.

Context-Setting

The act of designing is often referred to as problem-solving. However, as underscored by Hill (2012) in his book Dark Matter and Trojan Horses, this terminology often brings with it the risk of a narrowed perspective that could hinder creative exploration and innovation. This view often restricts the design scope to addressing only known-knowns or known-unknowns while excluding the potential for identifying underlying systemic issues.

The design process is far more intricate and unpredictable than merely solving problems. Often, designers question the original problem they set out to solve, realizing they may have tackled the wrong problem altogether. This line of thinking has led to the understanding that the term 'problem-solving' might constrain the flexibility required to redefine the problem or challenge the original premise (Hill, 2012).

In this context, Hill (2012) proposes 'context-setting' as an alternative to problem-solving. In his perspective, by shifting the focus from merely problem-solving to setting the context, designers can make a more holistic and broad-spectrum impact, considering the predetermined issues and the broader context and assumptions underlying those issues.

Building on this, it is worth considering Simon's (1970) definition of design again, which frames the problem as an existing situation and the solution as a preferred situation. This definition provides a more flexible and broader perspective on design, emphasizing its transformative nature.

Fig 17

As mentioned before, Rittel (2013) in "Thinking Design," provides a theoretical framework to understand this concept of designing. The book "Frame Innovation" by Kees Dorst takes a step beyond the theoretical introduction and explores transforming into preferred situations. It offers insight into designers' thought processes and constantly underscores the need to challenge and redefine the design problem.

Frame Innovation

The traditional discourse around "Design Thinking" typically emphasizes a designer's capacity to produce solutions. However, an essential skill often overlooked is problem framing - the ability to conceptualize novel approaches to problem situations (Whitbeck, 1998). While valuable, the emphasis on solution generation can be seen as limiting because it implicitly operates within existing problem structures or "frames."

In contrast, Frame Innovation brings to the forefront the necessity of shifting away from predetermined "frames" that have typically been conceived to function within reasonably isolated, static, and hierarchically ordered environments. The real world, however, is a dynamically interconnected system, which underscores the need for more systemic design approaches (Dorst, 2015).

Fig 18

To delve further into the mechanics of problem-solving and design, we can refer to the typical basis for reasoning patterns in problem-solving, consisting of three components: "what" (elements), "how" (the pattern of relationships), and the "outcome" (observed phenomenon). These concepts are essential to various reasoning processes, such as deduction, induction, and abduction, adapted from Dorsts (2015) work.

The critical difference in design thinking emerges in what we term 'design abduction.' Unlike normal abduction, which starts with an observed phenomenon and works its way back to the elements and their relationships, design abduction begins with the known outcome and works backward within a particular frame. The choice of frame inherently involves certain assumptions and thus builds the ground basis for generating a preferred situation.

It is less about generating solutions and more about creating a bridge between existing and preferred situations. This critical shift underscores the idea that the creative moment in design is about establishing a connection between existing and preferred situations rather than the mere generation of solutions. This process can be done by iteratively adjusting the focus and finding the right frame (Dorst, 2015).

In this perspective, the "frame" does not merely concern itself with what can solve a problem but also how it can be solved, thus creating a bridge between problem and solution space. However, framing is still intricately tied to our perception of the environment and the assumptions we bring into the design process.

Fig 19

Creative Abilities of AI

Based on the model of Frame Innovation and the theoretical introduction of how the Large Language Models work, we will now consider how artificial intelligence could assist in design processes.

In the book "Design und KI," it is suggested that creative processes are often transferred into "systematically guided, often professionally operated and institutionally supported strategies" to be consistently applied (Engenhart and Löwe, 2022). In design, this expresses itself primarily through the rise of various frameworks and methods. It is argued that machines, especially AI, can participate in such processes, as they can operate systematically and methodologically. The underlying assumption is to understand creativity as a methodological approach rather than a serendipitous moment. As such, intelligent systems can indeed be creative, creating new, unexpected, and valuable outcomes, according to Engenhart and Löwe (2022).

Nevertheless, it is crucial to remember that a machine has no intrinsic creativity. It is the executive power, driven and designed by human intention (Engenhart & Löwe, 2022). The reflections on this point suggest that, regarding problem-solving strategies in Frame Innovation, AI still needs to possess the will or power of decision-making over the outcome of the design process.

Bubeck et al. (2023) in the paper "Sparks of Artificial General Intelligence: Early Experiments with GPT-4," provide some valuable insights on this matter: "The central claim of our work is that GPT-4 attains a form of general intelligence, indeed showing sparks of artificial general intelligence. This is demonstrated by its core mental capabilities (such as reasoning, creativity, and deduction), its range of topics on which it has gained expertise (such as literature, medicine, and coding), and the variety of tasks it can perform (e.g., playing games, using tools, explaining itself, ...)."

Despite some errors, large Language Models like GPT-4 have the capacity for deductive thinking. While induction and abduction are also possible, these processes do not occur to the same extent as in humans, showing that LLMs may be unable to reframe "problems" entirely (Bubeck et al., 2023).

Engenhart and Löwe (2022) conclude with an interesting proposition: viewing AI as an orthosis that enables designers to converge cognitively complex issues in design. AI is seen as a tool that aids and enhances the design process rather than replacing human creativity. As such, it acts as a tool that can augment the design process, leveraging its methodological approach to creativity to foster new, unexpected, and valuable results. The book "Design and AI" has listed some of the identified possibilities as seen on the right side.

Research	Ideation	Exploration	Conception	Realization
Design Strategy	Inspiration	Search	Low-Fidelity Prototyping	Optimization
Finding Needs	Brainstorming	Generation		Implementation

Fig 20

System-Oriented Design

As previously mentioned in connection with the criticism of Design Thinking, some insights from Systems-Oriented Design should now be drawn.

"Systems-Oriented Design," as elucidated in the book "Designing Complexity" by Sevaldson (2021), underscores the intrinsic interconnectedness and continual evolution of complex systems shaped by their components and environmental interactions. Emphasizing a perspective that surpasses a narrow focus on isolated elements, Systems Oriented Design points out that complexity is not a static feature but a dynamic characteristic that unfolds over time. This approach underlines the reality that complex systems are much more than the simple sum of their parts, producing unique and more significant outcomes than any single component could generate in isolation.

A key aspect of Systems-Oriented Design lies in its focus on adaptability and change. According to the principles outlined in the book, complex systems inherently adapt to their environments and evolve. Particularly in social systems, these complex entities frequently alter their rules, revealing an intricate web of interactions that we, as human observers, struggle to comprehend due to our cognitive limitations (Sevaldson, 2021). This complexity often reduces systems to simpler conceptual objects, such as archetypes, clichés, and schemas, for us to make sense of them.

The book further clarifies that understanding a system only sometimes requires knowledge of all its components. Instead, it encourages comprehension as the "Gestalt" of systems. It warns against the potential danger of addressing only the symptoms of a system, as this could worsen the situation, given the complex interplay between the various elements within the system (Sevaldson, 2021).

Masaki Iwabuchi outlines how the previously introduced Design Thinking process works in his Medium article. Here, user needs are considered in a context and translated via the five-step process into a "solution," which can take on different dimensions (Iwabuchi, 2021).

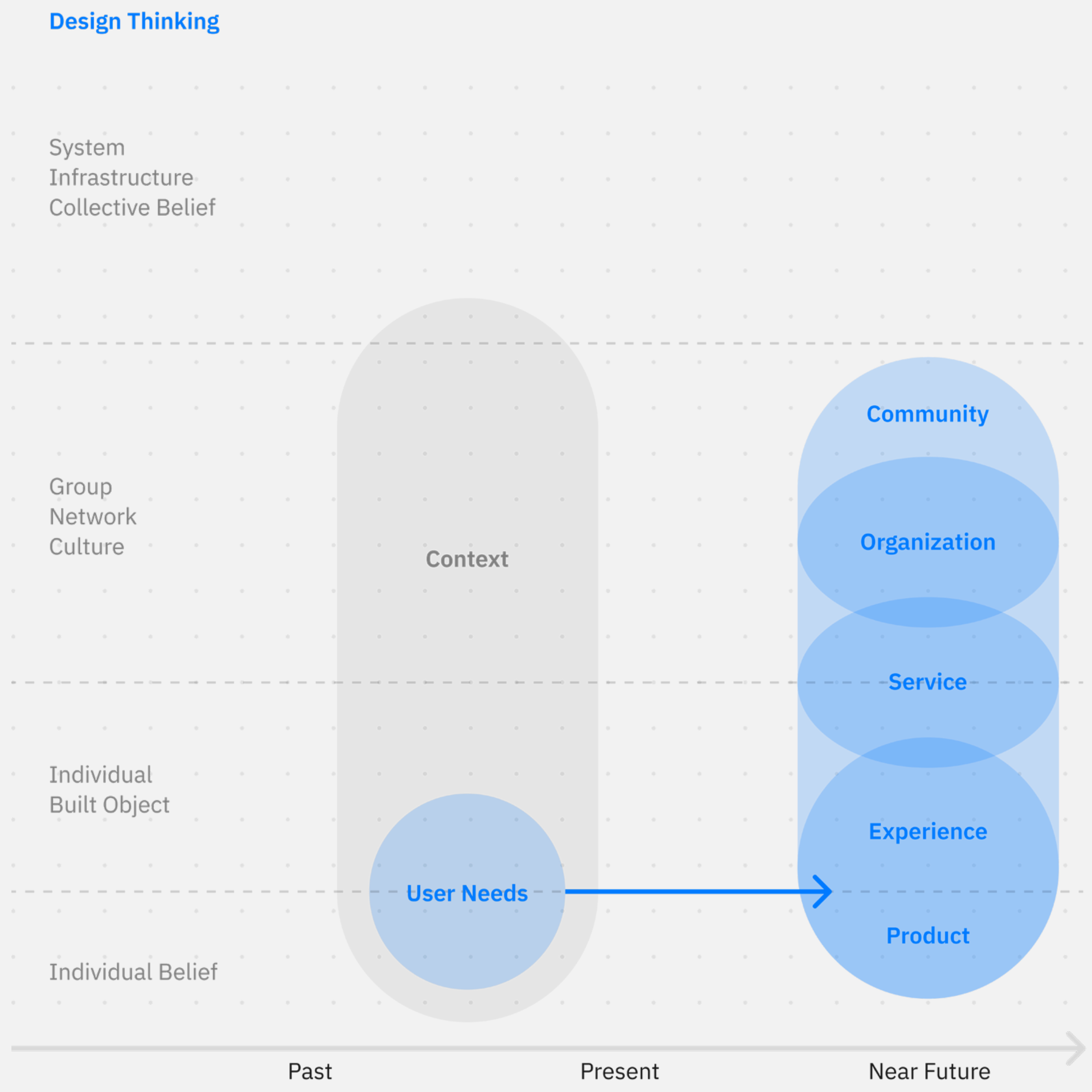

Fig 21

In contrast, the Systems Thinking illustration shows how the problem space can be addressed. It leaves out distinct groups of interest and focuses on understanding the dynamics between the system's entities. Iwabuchi also introduces the concept of the mental model, which circumscribes the comprehension of the situation and highly depends on the observer of the system (Iwabuchi, 2021). Both illustrations were abstracted and extended with the research results of this thesis. As such, the mental model covers only a particular part of the investigated system since our perception is limited to abstraction. The mental model and related implications on the design process will be significant for the further course of the thesis and therefore considered in more detail in the next section.

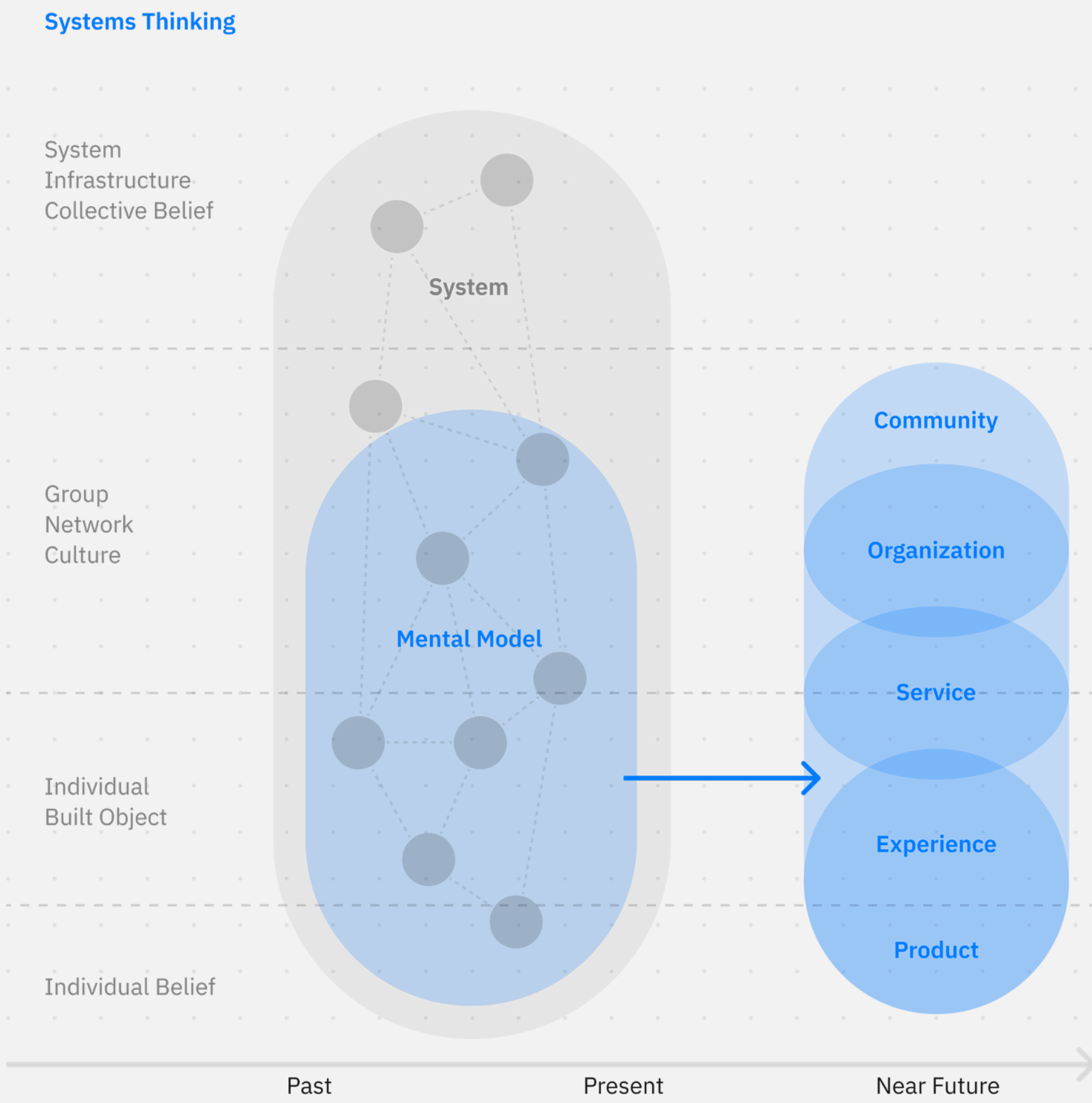

Fig 22

Mental Models

As we understand them, mental models are cognitive frameworks that provide a simplified representation of how the world operates. These frameworks underlie our beliefs and perceptions, thereby shaping our behavior and influencing our approach toward problem-solving and task execution. Derived not from facts but from individual or collective beliefs, mental models embody what users know, or perceive they know, about a system. As seen in the graphic to the right, some of these beliefs are in the conscious mind, but the majority are in the subconscious mind. Importantly, they possess a dual nature; they can either promote growth and innovation or hold back the same, contingent on their application.

Raworth (2017), in her work on the Doughnut Economy, amplifies this perspective on mental models. She articulates that these models not only shape our understanding of the world but can also limit it. Quoting the systems thinker John Sterman, she mentions, "The most important assumptions of a model are not in the equations, but what is not in them; not in the documentation, but unstated; not in the variables on the computer screen, but in the blank spaces around them." In essence, the challenge with mental models arises from what they do not account for, thereby making certain aspects of our world invisible.

The quote leads this thesis to another fundamental concept in the perception of problem spaces—the Unknown-Unknowns.

"The most important assumptions of a model are not in the equations, but what is not in them; not in the documentation, but unstated; not in the variables on the computer screen, but in the blank spaces around them" - John Sterman

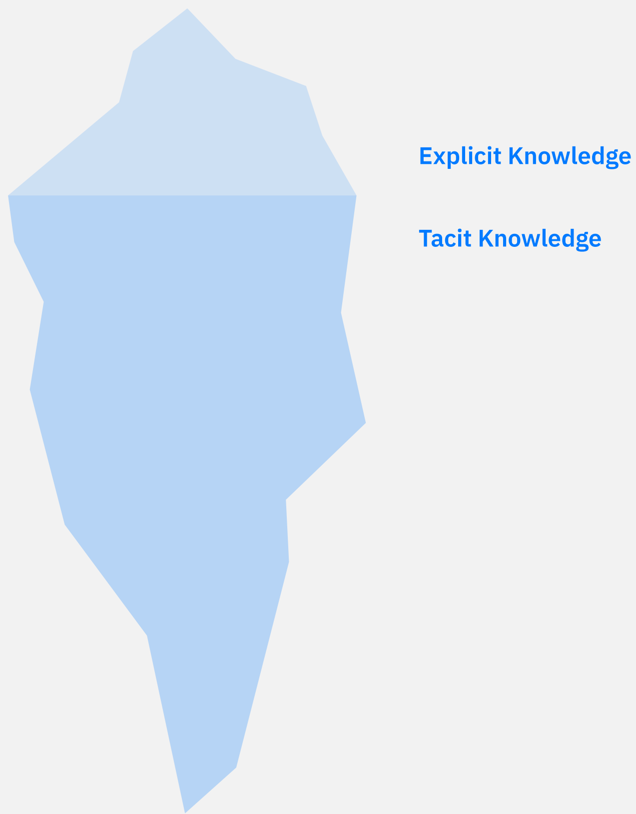

Fig 23

Unknown Unknowns

Unknown Unknowns refer to the unpredictable elements of a situation, those outcomes, events, circumstances, or consequences that are impossible to predict or plan for. It first gained widespread attention from former United States Secretary of Defense Donald Rumsfeld in a news briefing in 2002.

Unknown Unknowns play an immensely crucial role in design. They represent factors within the problem space that remain undiscovered until our ideas undergo testing. In the interviews with the designer, the concept was often associated with the chaos and uncertainty encountered, particularly during the early stages of the design process. This chaos and uncertainty are very well represented in the design Squiggle by Damien Newman. This insight may indicate that the experienced uncertainty and confusion can be partially attributed to the "Unknown Unknowns."

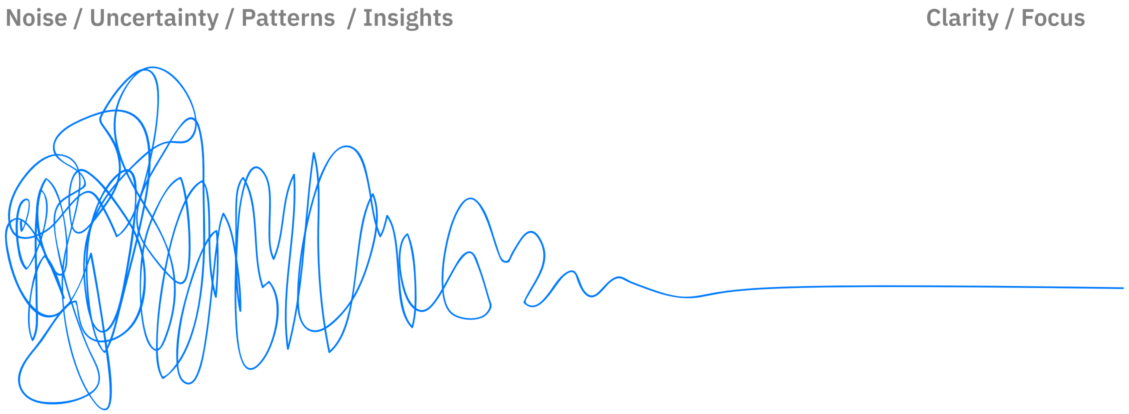

Fig 24

As John Sterman has already described, the most influential assumptions can remain outside our mental model and thus Unknown Unknown. The next part of the thesis will look at what assumptions within the mental model can also trigger.

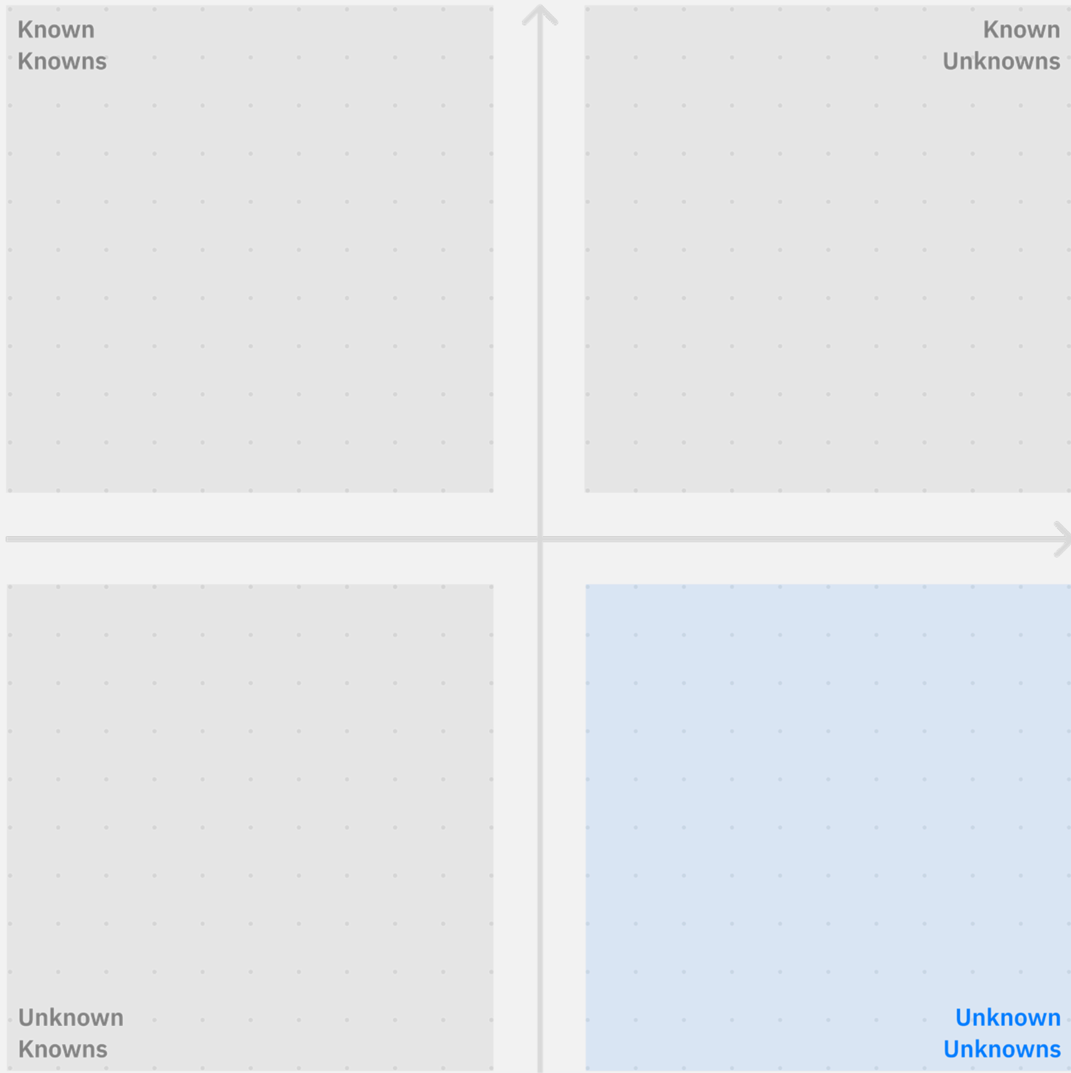

Fig 25

Assumptions in Design

As an integral part of the design process, assumptions and biases can influence the course and outcome of the design. Cognitive biases, defined as systematic patterns of deviation from rational judgment, can affect decision-making, problem-solving, and, subsequently, innovation outcomes.

Jeanne Liedtka's work is a good source in this regard, particularly her exploration of how Design Thinking can enhance the results of innovation processes. Her focus on cognitive biases and their impact on decision-making processes offers a comprehensive insight into the issue. Liedtka identified nine biases that can harm decision-making within the design process and summarised these in the table displayed on the right.

In her conclusion, Liedtka (2014b) articulates, "Humans often project their worldview onto others, limit the options considered, and ignore disconfirming data. They tend toward overconfidence in their predictions, regularly terminate the search process prematurely, and become overinvested in their early solutions—all of which impair the quality of hypothesis generation and testing".

Many current Design Thinking methodologies inherently support questioning and addressing these biases, as mentioned in Liedtka's paper. The investigation into design in this thesis has identified several concepts, such as mental models, unknown unknowns, and assumptions, as bottlenecks for innovation. The primary objective of this thesis is to explore how to expand upon current design methodologies and frameworks and address earlier-mentioned innovation bottlenecks.

Cognitive Bias	Description	Innovation Consequences
Projections bias	Projection of past into future	Failure to generate novel ideas
Egocentric empathy gap	Projection of own preferences onto others	Failure to generate value-creating ideas
Focusing illusion	Overemphasis on particular elements	Failure to generate a broad range of ideas
Hot/cold gap	Current state colors assessment of future state	Undervaluing or overvaluing ideas
Say/do gap	Inability to accurately describe own preferences	Inability to accurately articulate and assess future wants and needs
Planning fallacy	Overoptimism	Overcommitment to inferior ideas
Hypothesis confirmation bias	Look for confirmation of hypothesis	Disconfirming data missed
Endowment effect	Attachment to first solutions	Reduction in options considered
Availability bias	Preference for what can be easily	Undervaluing of more novel ideas

Fig 26

To further underscore the importance of this matter, this thesis will refer to the book "Preferable Futures." Nohr and Kaldrack (2023) propose that speculation, as an analytical-narrative method, promises to disrupt one's thought patterns, challenge basic assumptions and blind spots across knowledge regimes, explore hidden genealogies of the present, and envision new futures. This process, however, occurs under the condition of one's entanglement in power and knowledge regimes, as well as an understanding of their origins.

This perspective aligns with a quote from Albert Einstein referenced in "Preferable Futures": "We cannot solve problems with the same thinking that we created them with." The quote encapsulates the essence of this thesis - the need to challenge assumptions and biases in design thinking processes and innovate beyond them.

"We cannot solve problems with the same thinking that we created them with." - Albert Einstein

Conclusion

The exploration of various competencies integral to the design process, as discussed in the preceding sections, underlines that design is not merely a problem-solving exercise but a complex process involving identifying, framing, and redefining problems, followed by creating solutions. This process is influenced by various factors, including the designers' mental models, assumptions, biases, and their ability to handle the 'unknown unknowns.'

The concept of Frame Innovation brings to light the necessity of shifting away from established frames. It suggests that the creative moment in design lies in establishing a connection between existing and preferred situations. However, reframing problems is deeply tied to our perceptions and the assumptions we bring into the design process.

Artificial Intelligence's creative abilities, systematic approach, and capacity for deductive thinking can enhance the design process. However, it is crucial to remember that AI, at its core, is a tool driven by human intention and thus lacks intrinsic creativity.

The discussion on Systems-Oriented Design underscores the importance of adaptability and change in addressing complex systems. It emphasizes the need for a comprehensive understanding of the system as a whole, warning against the potential dangers of addressing only the symptoms of a system and leading to the exploration of mental models, assumptions, and biases in design. These factors can limit our understanding of the world and hinder innovation if not adequately addressed.

In conclusion, the need to challenge assumptions and biases in design thinking processes and innovate beyond them becomes more apparent. The following parts of the thesis will highlight how artificial intelligence can influence and assist in this design process.

AI in Design

In addition to the examples shown so far, the thesis will now address one by John Maeda. John Maeda is an American technologist and designer who has done significant work at the intersection of STEM subjects and the integration of art, including at the Massachusetts Institute of Technology. He works at Microsoft as Vice President of Design and Artificial Intelligence, where he and his team developed the Semantic Kernel, a lightweight framework for building applications based on artificial intelligence.

In one of his experiments applying the semantic kernel, he demonstrates AI's capability to partake in the first three phases of the Design Thinking process. In the empathize phase, an AI inputs a support log to generate sentiments and summarize the issues mentioned. These insights are used in the define phase, where the AI states specific customer problems. During the ideate phase, the semantic kernel, without any human intervention, brainstorms solutions to alleviate the customers' pain points. These solutions are then categorized into lower-hanging fruits and higher-hanging fruits (Microsoft, 2023).

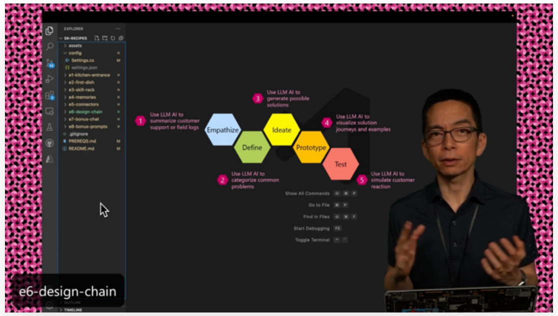

Fig 27

The book Human-Centered AI articulates the concept of automation and its benefits. Automation fuels greater demand by reducing costs and enhancing quality. This higher demand subsequently induces more job opportunities, thus producing a virtuous circle that benefits the economy and society at large (Shneiderman, 2022). The increased quality could also spark progress for humanity, enabling innovations and advancements.

The power of large language models is undeniably evident, particularly in their ability to automate the design process. This automation may appear very tempting; however, while beneficial, it can also be harmful. This risk is an important point that will be explored in the next section of the thesis. The chapter will conclude by discussing why this application and automation may not be desirable for design, society, and the environment.

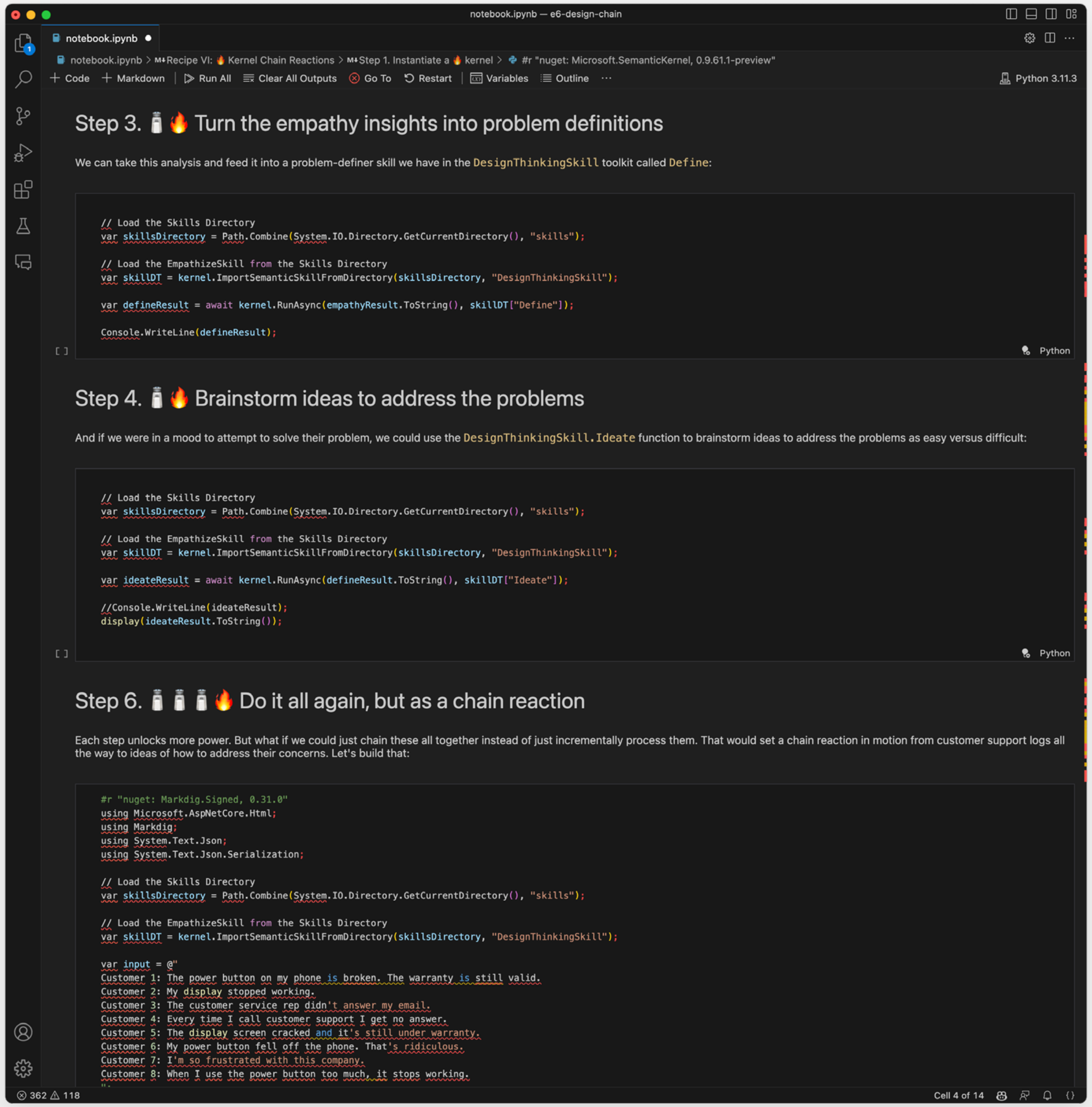

Fig 28

AI as Designer

Artificial intelligence can drastically transform our thinking and operation by augmenting the design process. The example provided by John Maeda highlighted how parts of Design Thinking can be automated with today's technology. However, one of the fundamental issues remains the inherent biases of AI.

These biases result from AI only approximating the training data it provides. The first problem arises because the large language models are always only an approximation of the data and are unlikely to represent 100% of the data's complexity. What happens when there are gaps in the data or the knowledge is not approximated accurately are hallucinations. These hallucinations are incorrect or exaggerated outputs of the models. AI, trained to provide satisfying and user-friendly answers, can hallucinate such missing information, leading to biased results and the AI's suggestion that this information is accurate.

Moreover, the biases arise from the data and the assumptions upon which the AI was trained. These data only represent human perceptions and interpretations, as explained in "Preferable Futures" (Nohr & Kaldrack, 2023). It notes that "data-driven AI exposes the prejudices and wishful thinking of those who feed it, thus stabilizing social structures and expectations." AI has been used in various contexts to limit uncertainties, whether in decision-making systems, training simulations, or full enterprise simulations. These applications share a common goal: controlling or making contingency controllable, leading to a rationality of "predictability.""

Business and economic simulations aim to mitigate uncertainties while simultaneously programming how our society functions. It is not only about predicting futures scientifically but suggesting, directing, manipulating, and designing futures based on a belief in continuity, thus stabilizing trajectories and path dependencies (Nohr & Kaldrack, 2023).

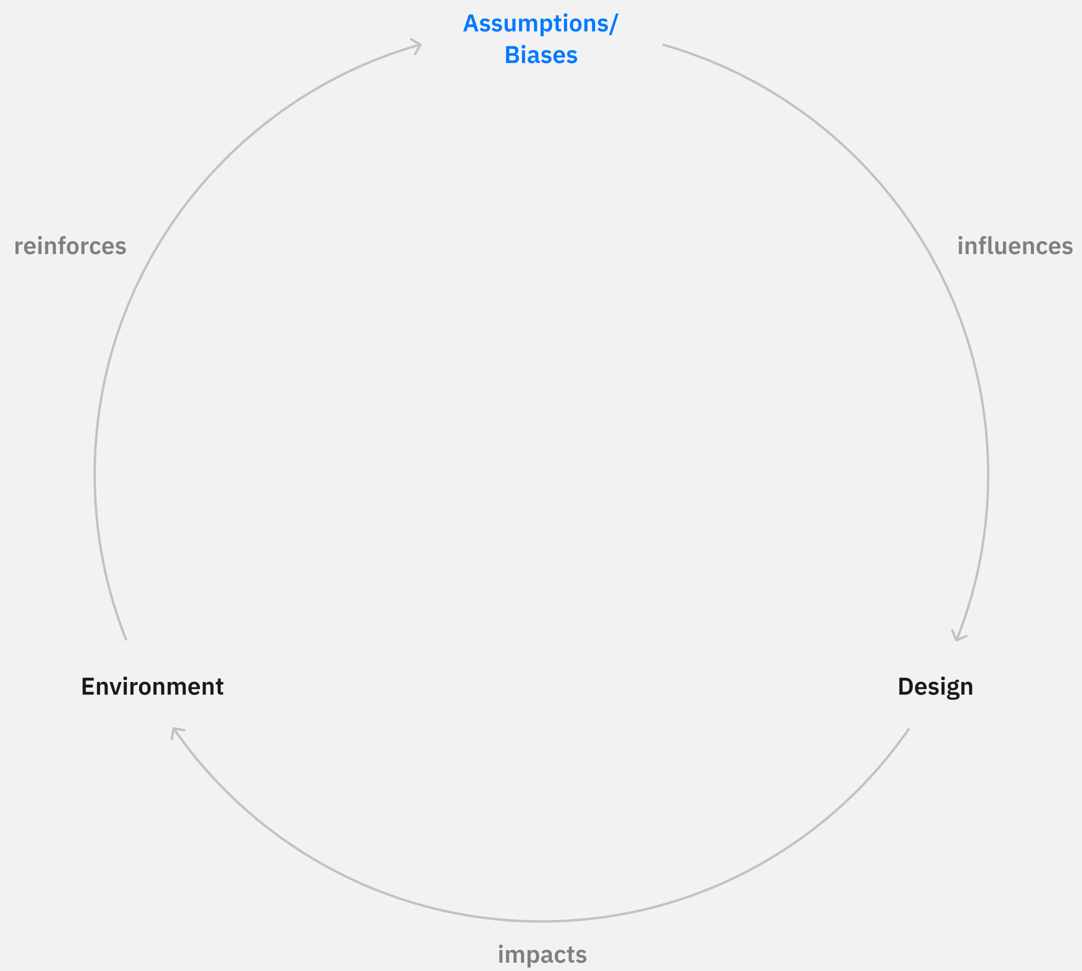

Fig 29

This manifestation of thought structures becomes even more apparent with the image of self-reinforcing feedback loops on the right page. In these loops, an action influences the environment in such a way that this action becomes more and thus develops into positive or negative loops. Activities that lead to loops with harmful effects must be recognized.

This behavior manifests itself, particularly in the thought structures, which in turn have an effect on behavior in societies. If, for example, we think that the car is the best means of transport, new governments build more roads based on this general assumption. The advanced development of road infrastructure also leads new generations to think that car is a practical means of transport. Our actions, therefore, solidify the initial thought structures.

If we aspire to implement more profound societal changes, we must question our thought structures to tackle climate change or species extinction. In the book Transformationsdesign, the authors write about "change by design or change by disaster." As Sommer and Welzer (2017) also state, socio-ecological transformations involve external conditions and people's perceptions, self-images, emotions, and habits. Therefore, changes in these cultural-mental formations must primarily occur in practice, not just in cognitive work.

To summarize these complex matters more simply, there is a quote by Rolf F. Nohr: "Or to put it more bluntly: the (uncertain) future imploded into a kind of "feedback-effected present" in which tendencies are intensified or subdued. The future was hedged and immobilized". The fundamental idea is that we have no absolute independence of action since our decisions are based on the present thought structures.

"Or to put it more bluntly: the (uncertain) future imploded into a kind of "feedback-effected present" in which tendencies are intensified or subdued. The future was hedged and immobilized."
- Rolf F. Nohr

The requirements to act based on new thought structures arise from the will to create a wide-ranging preferred situation. However, as seen before, large language models are built based on data, which maintains the fixed thought structures of our society. From this emerges that artificial intelligence cannot solve problems that require a change of thinking structure. A further issue is self-reinforcing loops, with which artificial intelligence continues reinforcing the thought structures built into it, as described in Preferable Futures.

It becomes clear that the current limitations of AI rest heavily on its inbuilt structures, shaped by existing human knowledge and prejudices, which causes replication of our societal biases, sometimes even an amplification. This issue extends to the core of AI-driven applications aiming to control or foresee uncertainties.

These self-reinforcing feedback loops further solidify these societal thought structures, influencing actions and expectations that drive our societies. Consequently, these feedback loops reinforce existing systems and potentially increase societal norms. The demand for a more comprehensive societal transformation, as necessitated by crises like climate change and species extinction, requires a reassessment of these profoundly ingrained thought structures.

Thus, despite its considerable promise, AI, as it stands, may struggle to address challenges that require a paradigm shift, mainly because it operates within and potentially accelerates the established thought structures of our society. Future discussions should consider this critical aspect while evaluating the utility and potential of AI-driven solutions. A proposal for working around this problem presents the thesis in the next section.

Augmentation of the Design Process

In recent years, the conversation around design processes has turned increasingly toward integrating artificial intelligence and automation. This thesis aims to revisit and clarify why augmentation, not automation, is vital for such processes. This consideration is underpinned by a critical intent - leveraging design to solve intricate yet meaningful problems. The focus moves from the simplistic view of a problem-solution definition to a nuanced understanding of existing situations transitioning into preferred ones (Simon, 1970).

Various design frameworks, including Design Thinking, have been examined for their impact on the design process. We discovered that Design Thinking had driven a shift towards considering broader environmental factors. Additionally, frameworks like Futures Thinking underscored the importance of envisioning new potential futures. Drawing on the Lean UX approach, we also learned to work based on assumptions to manage the uncertainty inherent in the design process.

Additional insights were gathered through expert interviews, leading to themes revolving around complexity in design processes. We discovered that a broad scope of consideration in the design, while desirable, significantly amplifies the complexity of the process. Interestingly, not the quantity of information that adds to the complexity but the uncertainty about information that can complicate matters.

In the quest for problem-solving, a novel definition was found in Frame Innovation, focusing on how designers transition from current to preferred situations. We evaluated the capabilities of AI in this context and further delved into the topics of mental models, unknown unknowns, biases, and assumptions within the design process. All these factors, significantly when poorly managed, can adversely impact the design process results.

Therein lies the contradiction of the argument. Automation in design, primarily through AI, comes with its risks. AI might reinforce existing biases and influence decision-making, as it depends heavily on the data it is trained on. It needs a deeper understanding of context, intuition, and emotion. Moreover, in cases where data is absent, AI might 'hallucinate,' leading to even more concerning outcomes.

The investigation concludes that while AI has its role, it should be seen as an augmentative rather than an automated one. Due to entrenched thinking patterns, this approach prevents the future from becoming 'hedged and immobilized' (Nohr & Kaldrack, 2023). It allows us to maintain the design process's complex, nuanced, and deeply human aspects.

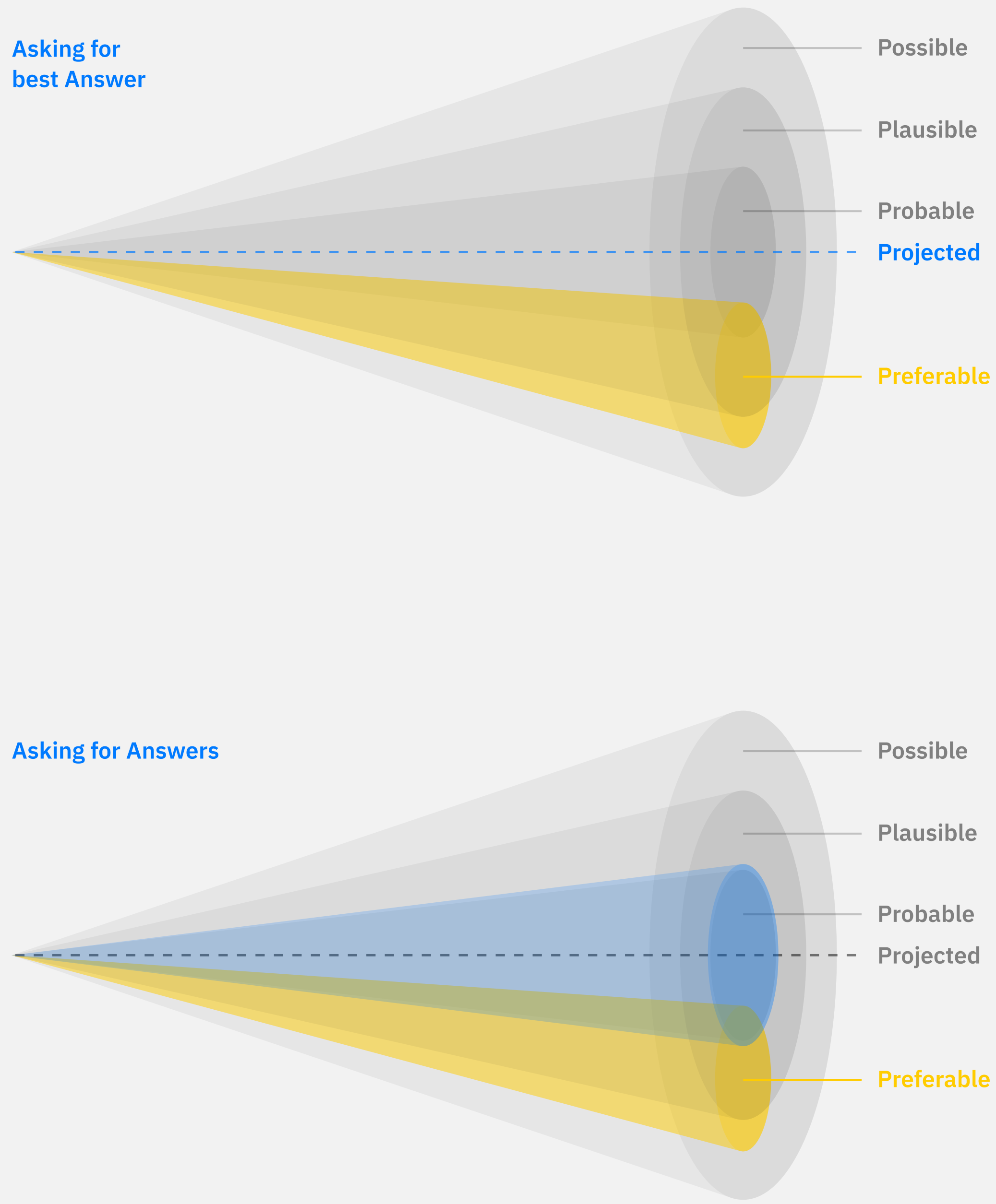

Fig 30

The thesis iteratively explored potential use cases for large language models that amplify the augmentation of the design process without influencing the design outcome. The generative capabilities of artificial intelligence were found to be advantageous for the design process. However, it was also recognized that increased data generation could again lead to complexity in the design process. Thus, the thesis aimed for a solution that, despite its generative and divergent capabilities, reduces the complexity of the design process.

Insights from the interviews underscored the importance of mitigating uncertainty in design processes. AI should not make decisions or generate ideas that can influence the designer, which led to the particularly relevant use case of AI stimulating reflection in designers.

The use case of stimulating reflection in designers emerged through an exploratory approach. In this context, designers' ideas or assumptions should be contemplated in collaboration with large language models. The intention behind this is to identify gaps in the design argument that can arise due to the mental models, assumptions, and biases of the designers. The broader goal of the application is the discovery of 'unknown unknowns,' which the designer inherently cannot recognize alone.

The responsible use of AI is thus ensured by not generating decisions or ideas but by providing stimuli for reflection that go beyond what the designer could consider unaugmented. This augmentation allows for a broadening perspective, enabling designers to challenge their inherent biases and assumptions. Reflection and questioning interrupt the manifested self-reinforcing feedback loops by exposing and questioning underlying assumptions before decision-making.

In essence, the augmentation of design processes through AI does not entail giving decision-making power to AI. Instead, it is about harnessing the generative capabilities of AI to help designers identify their biases and assumptions and illuminate 'unknown unknowns.' The focus is to reduce the complexity of the design process, not by filtering out valuable information but by enabling designers to manage uncertainty better, enhancing their capacity to transition from existing situations to preferred ones.

This approach aims to ensure that AI is implemented as an effective tool for augmenting the design process, providing stimuli for deeper reflection, and challenging existing biases and assumptions. By doing so, AI can play a positive and sustainable role in future design processes, not by seizing human designers but by augmenting their abilities and expanding their perspectives.

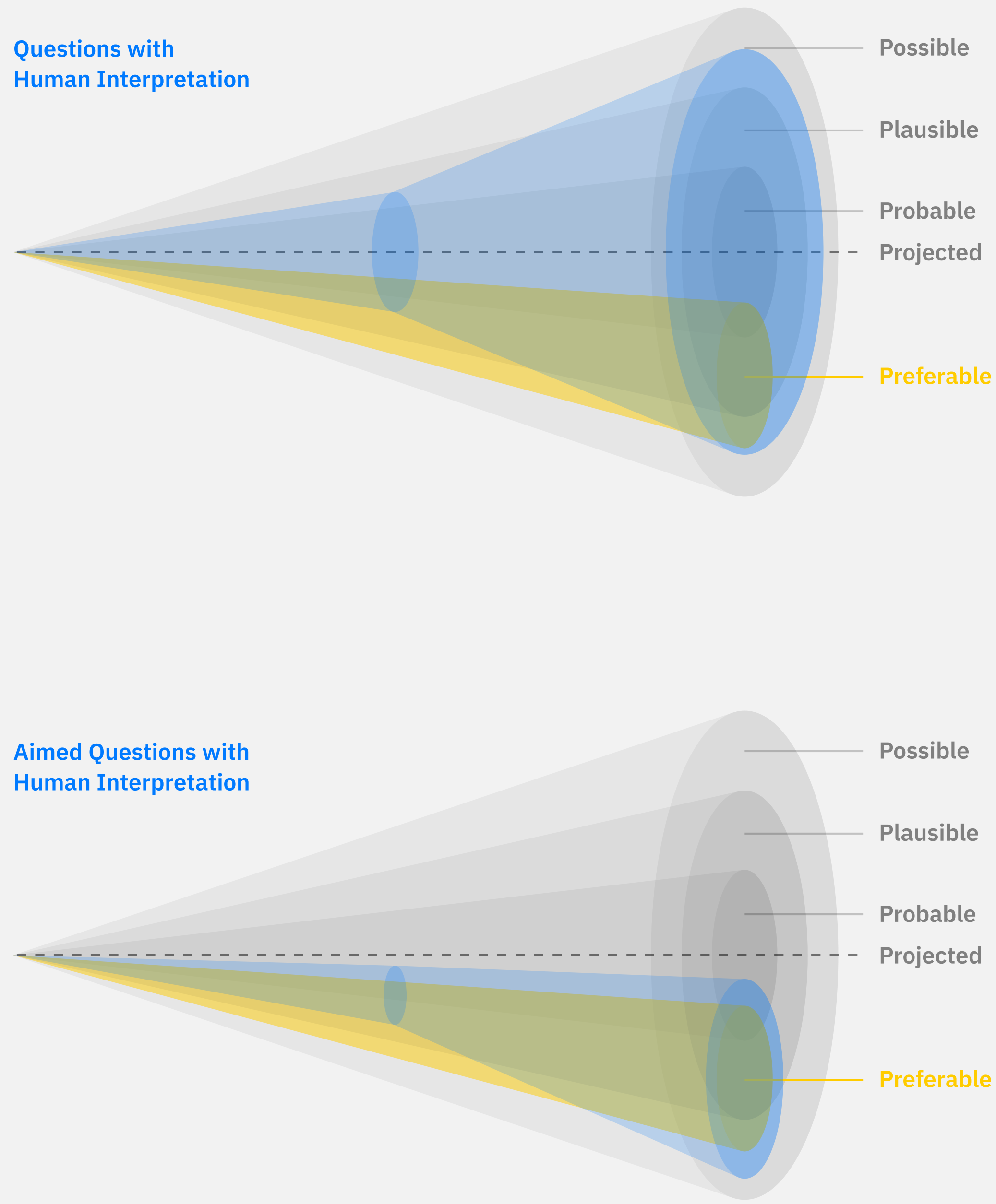

Fig 31

Design for AI

With the identified use case for augmenting design processes with artificial intelligence, we will further explore how Large Language Models can help designers identify their Unknown Unknowns and undiscovered Assumptions. For this purpose, the concept, importance, and methods of prompt engineering are explained first.

In the context of getting more and more out of the potential of large language models and understanding their functionality, prompt engineering, for example, for models like GPT-3 or GPT-4, becomes very important. The essence of prompt engineering lies in crafting an input, the "prompt," in a way that drives the AI model toward generating a desired response. The goal is to improve alignment and model steerability, acknowledging the direct relationship between the quality of the input and the output.

The process of prompt engineering can be undertaken through several approaches. One of these is the provision of clear instructions that help guide the model toward the anticipated output, allowing for better alignment with the task at hand (Suhridpalsule, 2023). Another approach involves few-shot learning, where the model is provided with a handful of examples of the desired input-output pairs, thereby assisting it in understanding the task at hand (Suhridpalsule, 2023).

More advanced techniques include the Chain of Thought (CoT) prompting explained by Foy (2023), where complex tasks are broken down into smaller steps, and the model is guided through a series of prompts. It keeps the AI on the desired path and maintains consistency in its responses. Self-consistency is another approach whereby the model is asked to verify its answers or generate multiple answers, comparing them for consistency. It helps the model verify its responses and ensure they align with the intended objective. Lastly, there is ReAct, a two-step process that has the model generate a plan or an outline and then complete the task based on that plan. This process helps ensure a coherent, structured output (Foy, 2023).

Insights from a detailed exploration of prompt engineering techniques have shaped the prototyping and validation of the feasibility. They have stressed the importance of carefully crafting the input to AI models to elicit the desired outputs, thus improving alignment with the tasks. The need for specificity, context, and iterations in a prompt design has generated more accurate and helpful responses from the models.

first prompt

name the top 5 assumption we have to validate to make sure that this is a better solution.

↓

fifth iteration

name all the assumptions that would have to be validated for this to be true. Focus on the alignment between the proposed solution and specific problem or pain point, without considering the market fit, feasibility and viability.

↓

twenty-seventh iteration

i want you to act as a critic. you will write a numbered list with all the assumptions that would have to be validated for this idea to be successful. you write only the assumptions that are critical to the idea and pose a potential threat to the idea. you will write the assumptions so specific that they can be tested, avoid general assumptions. you will think reversely of assumptions that have lead to the following idea. you will focus on the alignment between the proposed idea and potential problems and pain points that would be fixed. keep in mind the desirability and the user experience of the solution. do not focus on the viability and feasibility of the solution. write 5-20 words for each assumption. only write a list no introductory or summarization text in the beginning and end. don't write the word "assumption" or "assumptions":

↓

fifty-fourth iteration

I want you to act as a critic. Write a single thought-provoking assumption for this statement to be validated. Write the assumption so specifically that a test will prove the statement and will clarify uncertainty. Focus on the alignment between uncertainty and potential problems, pain points, and desirability. Do not focus on the viability and feasibility of the solution. Write 5-20 words for the assumption that should be at B1 English level. Do not write the word 'Assumption:'. Here is what is the statement:

Don't write anything adjacent in meaning to the following assumptions:

This is a description of the given project context and constraints that we can not influence:

Fig 32

Dimensions of Design for AI

It became essential for this thesis to introduce diverse perspectives and levels of artificial intelligence to place this evolution into perspective. These levels or areas can range from data to broader societal and environmental implications. The thesis will use a chart published by the dschool to open the scope for different dimensions.

Firstly, the data used for AI plays a crucial role in designing these technologies. The data's biases, origin, and privacy concerns surrounding its use must all be considered during the design process. Recognizing the potential issues in this area not only helps in creating AI that is fair and unbiased but also maintains user privacy and trust.

The technologies underlying AI, including Machine Learning (ML) and blockchain, form the next consideration level. Understanding these technologies and how they intersect allows for better comprehension and handling of the complex challenges that designing for AI might pose.

Moreover, the products themselves need to be considered, from their intentions to their context and end of life. These factors must be included in the design process to design beneficial and sustainable AI.

Experiences, avoiding exclusion, and adopting a human-centered approach are essential when designing AI. This ensures that the resulting products are accessible and beneficial to all users, thus promoting a more inclusive and empathetic use of AI.

At a higher level, we find systems and their related stakeholders and contexts. Understanding the interplay between these factors is essential for the design process in AI. A comprehensive approach can lead to the development of AI that is better integrated into its respective systems.

Finally, it is crucial to consider the far-reaching implications, from higher orders of effects to the impacts on health, society, humanity, and the Earth. The ethical dimension also plays a crucial role here. By incorporating these considerations into the design process, we can contribute to the development of AI that is not only beneficial in the short term but also sustainable and ethical in the long term.

This overview served as a helpful outline for the thesis for different levels of consideration. This integrative and comprehensive approach to AI design may lead to more responsible, ethical, and effective AI technologies.

Implications	Anticipation of side effects in design	Freedom to decide for preferable futures	
Systems	Mental Models of the users that get influenced	Teams and organizations that can work in different ways	Influence on design disciplines and processes
Experiences	Experience of reflection induced by artificial intelligence	Structuring implications and presumptions of ideas	Experience of conducting and influencing language models to promote reflection
Products	Interface to the applicability of the technologies	Visual representation and structuring of thought processes in uncertainty	
Technologies	Understanding of operation and potentials of the technologies	Exploration of use cases of the technology	
Data	Possible exploration of fine tuning the data and training		

Fig 33

Design Guidelines for AI

The following are suggestions from guidelines intended to support the design of products powered by artificial intelligence. Large companies create guidelines for designers to ensure a uniform and responsible use of the technologies on the companies' platforms. The following excerpts do not represent the entirety of the procedures but only the parts relevant to this work.

Apple Design Guidelines

This summarization focuses on Apple's design guidelines for integrating AI, specifically, the elements that need careful consideration in the designing process, as well as its potential pitfalls and benefits.

One significant challenge lies in the fact that the behavior of an AI-enabled app is based on the data received from the machine learning model rather than programmed reactions to specific scenarios. The role of machine learning can be critical (indispensable) or complementary (adding value but not essential to the app's functionality).

Further classification divides AI features into proactive or reactive, sensitive or non-sensitive, visible or invisible, and dynamic or static. These categorizations hinge on whether the AI offers unsolicited suggestions, the degree of personal sensitivity in the data, the visibility of the AI feature, and whether the AI's learning evolves. Each factor has significant implications for user interaction and perception of the app's reliability (Apple, 2023).

Feedback, both explicit and implicit, is another crucial aspect. The app can solicit detailed feedback on a particular response, and it should be requested only when necessary and voluntary. Negative feedback should be prioritized as it helps to improve the system. On the other hand, implicit feedback, inferred from user actions, can enhance the app's performance without additional effort from the user. However, it is essential to avoid allowing this feedback to decrease exploration space by merely reinforcing user behaviors (Apple, 2023).

The system should also provide users with an intuitive means of correcting machine learning results and ensuring that corrections feel rewarding. Such corrections serve as implicit feedback, enabling the system to learn and improve. However, it is essential to avoid confirmation bias, where users are restricted from exploring features due to skewed suggestions (Apple, 2023).

Handling mistakes in AI applications requires various strategies. These include managing expectations by communicating the system's limitations, offering easy ways to correct errors, and learning from these mistakes. Both explicit and implicit feedback play a role in this process. However, mistakes in proactive features may lead to decreased error tolerance, emphasizing the need for intuitive user interfaces and efficient error handling (Apple, 2023).

Lastly, to ensure the user's understanding and manage expectations, it is essential to communicate the limitations of the AI, provide feedback on user input, and suggest alternatives for achieving desired results. This can be achieved through placeholder texts, feedback on user inputs, and suggesting alternate ways to get the desired results (Apple, 2023).

In the application of these guidelines, striking a balance is critical. For instance, while feedback is essential for improvement, it should not restrict exploration. Also, while mistakes are inevitable, they should be minimized and easily corrected to maintain user confidence in the app.

Google Pair Design Guidelines

In terms of user needs and defining success, the primary objective is to determine if AI can enhance the user experience and identify where user needs overlap with AI capabilities. A critical decision involves the trade-off between automation and augmentation. Compared with augmentation, automation is often preferred for efficiency and safety improvement, reduction of tedious tasks, and enabling new experiences. Comparatively, augmentation can increase task enjoyment, provide higher control levels over automation, offer greater responsibility and fulfillment, and promote increased abilities and creativity (Google, n.d.).

Understanding the user's mental models is vital for a pleasant user experience. The user's perception must align closely with the actual functioning of the AI system. Several methods can be adopted to bridge this gap: setting expectations for adaptation, onboarding users in stages, planning for co-learning, and accounting for users expecting human-like interaction (Google, n.d.).

Explainability and trust are interconnected. The ability to adjust the mental model to accommodate the probabilistic nature of AI outcomes is essential. Maintaining a close relationship between action and explanation is equally important, demonstrating the AI's output's implications for the user. The explanations could be divided into general system explanations and specific output explanations (Google, n.d.).

Error handling and graceful failures are integral to AI applications. Errors can be classified into visible ones, such as context errors and fail states, and invisible ones, like happy accidents and background errors. It is crucial to assess the stakes of the mistakes, which could be rooted in model training, input quality, output relevance, or multiple AI agents without a clear hierarchy (Google, n.d.).

The above considerations and guidelines aim to maximize the benefit and user satisfaction derived from AI applications, aligning closely with Apple's design guidelines principles. The common underlying objective is to create an environment where AI enhances user experience without causing discomfort or confusion, fostering a continuous learning loop for system improvement.

Microsoft Design Guidelines

Due to their inherent nature, AI systems often exhibit unpredictable behaviors that can pose challenges ranging from confusion to potential danger. This unpredictability necessitates a shift in the traditional principles of human-machine interaction design, establishing new paradigms for successful integration and user experience (Natke, 2023).

In the initial phase of designing AI systems, it is crucial to communicate what the system can do. This involves demonstrating how outcomes can be manipulated and providing guidance on the acceptable input range. Transparent communication of system capabilities can help manage user expectations and reduce confusion (Natke, 2023).

During user interactions, the AI system should adhere to relevant social norms and work towards mitigating social biases. Adhering to social standards can make the system more relatable and user-friendly while mitigating social biases helps ensure fair and impartial functioning (Natke, 2023).

Several measures can be implemented when the AI system may be incorrect. These include supporting efficient invocation, dismissal, and correction of system actions. Additionally, the system should elucidate why it took a specific course of action, enhancing user understanding and trust in the system (Natke, 2023).

Over time, the AI system should retain a memory of recent interactions, allowing it to learn and adapt from past experiences. However, any updates or adaptations must be cautiously to prevent system instability. It is also essential to encourage granular feedback from users and provide global controls to maintain user autonomy over the system (Natke, 2023).

IBM Design Guidelines

This guideline aims to outline various key considerations for AI use in design, focusing on the characteristics of AI, aligning AI with societal norms and values, minimizing bias and improving inclusivity, and ensuring explainability.

AI design should be guided by explicit purposes, encapsulating the intended use and objectives of the AI system. The system's value, in turn, is influenced by how well it serves this purpose and offers solutions to users. Trust is fundamental in AI design, encouraging user engagement and fostering confidence in the system's output and decisions. It is crucial to maintain accountability for the AI system's outcomes, understand where the software's responsibility ends, and keep detailed records of design decisions and actions taken during the development process (Everyday Ethics for AI, n.d.).

Aligning AI systems with societal norms and values is another essential aspect. The system should consider value systems, ensuring a broad understanding of users. Consequently, these understandings should be reflected in the AI design, allowing the system to cater more accurately and empathetically to diverse user needs (Everyday Ethics for AI, n.d.).

Bias is a widespread concern in AI systems, potentially influencing the system's decisions and user interactions. Unconscious biases, such as availability bias, base rate fallacy, and congruence bias, can detrimentally impact the system's impartiality. Self-interest biases, such as ingroup/outgroup bias and status quo bias, can further skew the system's operation. Minimizing these biases and improving inclusivity by performing real-time analysis to uncover intentional or unintentional biases, ensuring design considerations are free from such biases, and implementing feedback mechanisms to allow continual system refinement (Everyday Ethics for AI, n.d.).

Ensuring the explainability of AI systems is vital for creating trust in AI's reasoning process. Users should understand why an AI system makes specific decisions or recommendations. This transparency fosters trust and enhances user confidence in the system's capabilities and decisions.

In summary, the design and use of AI systems should prioritize clear purpose and value, promote trust, align with societal norms and values, and ensure high inclusivity. The presence of unconscious biases should be minimized and continuously checked. Lastly, the AI system's explainability should be assured, fostering user trust in the AI's reasoning process.

UX of AI

Integrating Artificial Intelligence in design processes has been widely discussed, providing unique opportunities and challenges. According to Engenhart and Löwe (2022), there are three primary criteria to consider when assessing AI's User Experience (UX). First is the usefulness and added value of the function provided by AI. For a user to consistently engage with an AI system, the effort required to use the system must be less than the perceived value gained from it. The UX must convey a clear advantage in using AI over traditional methods (Engenhart & Löwe, 2022).

The second criterion is the reliability and usefulness of the AI's results. Users need to discern a clear connection between their interactions with the AI system and the problem they are attempting to solve. Users who cannot understand how their input correlates with the AI's output may feel disconnected from the process, leading to lower engagement and trust in the system (Engenhart & Löwe, 2022).

The third criterion focuses on the usability of the AI's interface. Users need to trust the system and feel that their interests are prioritized. An AI's interface can significantly impact user trust and its perceived usefulness. The more intuitive and user-friendly the interface, the more likely it is to be adopted and trusted by users (Engenhart & Löwe, 2022).

Designers are pivotal in shaping the interaction between users and AI systems. Knowledge about statistical learning methods, prototyping skills to test the interaction between users and AI, and understanding how users perceive AI systems are essential abilities in designing for AI. These skills correspond directly to the designer's role in the process, enabling them to create more effective AI systems.

“We need ideas to guide us to progress, as well as tools to implement them [...] machines only manipulate numbers; people connect them to meaning.”
- Arno Penzias

As Engenhart and Löwe (2022) describe, this model of designer abilities and UX criteria allows for a cycle of iterative learning. Designers need to be aware of these loops as they work to ensure that AI solves problems and provides a positive user experience.

Moreover, a human-centered approach to AI emphasizes supporting users in their responsibility of using AI. Providing direct feedback and opportunities for user control, such as interruptible and understandable processes, are critical aspects of this approach (Shneiderman, 2022).

The application of AI should focus on designing an interface that can genuinely support the user. This involves examining the cognitive effort required for different tasks and aligning these within the application. Consistency, predictability, and controllability of interfaces can further support users. Interestingly, less adaptive and autonomous interfaces might be preferred by users as they can provide more direct control and predictability (Shneiderman, 2022).

As Shneiderman (2022) cites Nobel laureate Arno Penzias: “We need ideas to guide us to progress, as well as tools to implement them [...] machines only manipulate numbers; people connect them to meaning”. No matter how technologically advanced, AI applications should always facilitate a sensemaking process for users. The ultimate value is created by aligning these technological capabilities with human vision and meaning.

Generative AI Applications

An essential resource in my research has been the work titled “Toward General Design Principles for Generative AI Applications.” This paper extensively discusses the principles and strategies for effectively integrating generative AI technologies into design processes.

A central aspect of using AI in design that Weisz et al. (2023) emphasize is the communication of generative variability to the user. It suggests that users should understand the range and limits of potential outcomes that an AI can generate. Furthermore, the paper poses several pertinent questions about the user’s role in the AI-enabled design process.

Additionally, the paper lays out a comprehensive set of strategies for managing multiple results from generative AI applications. These include “versioning,” which allows users to revisit old results despite the generation of new outputs; “curating,” a process encompassing the collection, filtering, sorting, selection, and organization of creations; “annotating,” which involves assessing the outcomes; and “visualizing differences” to discern subtle changes between similar results (Weisz et al., 2023).

Beyond the usage strategies, Weisz et al. (2023) also delves into a critical aspect of AI application – designing against harm. It outlines several potential risks associated with AI usage, such as discriminatory, exclusionary, or toxic results; misuse of sensitive data from training sets; and the danger of AI overconfidence leading to user misconceptions. Other risks highlighted include deception, impersonation, manipulation, copyright, intellectual property concerns, illegal misuse of AI, and the potential replacement of human labor instead of augmenting it.

Reflecting on these insights, the paper provides an invaluable perspective on generative AI technologies. While previously examined guidelines and principles related to AI integration in design, the strategies for multiple results and design against harm add new layers of consideration. They foster an understanding of the practical aspects of integrating AI into design processes and underscore the importance of caution and responsibility in AI usage.

Conclusion

In conclusion, each design guideline from Apple, Google, Microsoft, and IBM highlights the intricacies and sensitivities of integrating AI into our environment. They all emphasize the need for a carefully crafted, user-centered approach to AI system design. This entails understanding users’ mental models, defining clear system objectives and functions, incorporating feedback mechanisms, managing mistakes effectively, and maintaining transparency and accountability.

While Apple stresses the significance and categorization of AI features, Google’s priority lies in comprehending users’ needs and the trade-off between automation and augmentation, specifically emphasizing error handling and maintaining trust. Microsoft underscores the importance of transparent communication, adherence to social standards, efficient error handling, and memory retention. Meanwhile, IBM emphasizes purpose clarity, trust, societal alignment, inclusivity, bias minimization, and explainability.

In Human-Centered AI, Shneiderman (2022) offers a comprehensive model, adding to these guideline principles. It articulates the importance of AI functionality, results reliability, and interface usability to create a positive user experience. Furthermore, it discusses the constant learning loops and emphasizes the significance of having a human-centered AI approach.

The insights of Weisz et al. (2023) in Toward General Design Principles for Generative AI Applications on AI integration into design reinforce the complexity and multi-faceted nature of the task. It points to the necessity of communicating with users about AI’s capabilities and allowing them to understand the variety and scope of AI-generated outcomes. The paper underscores the importance of being wary of potential harm that could arise from AI applications, emphasizing the need to design responsibly.

These reflections, gathered from a comprehensive analysis of various guidelines and principles, will provide a solid foundation for the design strategies outlined in the next chapter. They bring forward essential aspects to consider, like balancing user needs with AI capabilities, understanding users’ mental models, designing intuitive user interfaces, managing errors, and fostering a learning loop for constant improvement. They all underline the need to design responsibly, ensuring that AI systems enhance user experience and remain beneficial and accessible.

Sacrificial Concepts

In the advanced stages of the research phase, a significant potential was identified in aiding designers against uncertainties. This discovery emerged after a substantial portion of the research had been concluded. It is well-documented that designers often grapple with ambiguity and uncertainties in the early stages of the design process. This ambiguity can arise from various sources, such as evolving client needs, technological constraints, or market demands.

In light of this, several potentials were identified where artificial intelligence could assist designers in navigating these uncertainties. Sacrificial concepts were developed to make this process tangible and open for discussion. These concepts were designed to represent various ideas exaggeratedly intentionally. This approach ignored the feasibility and economic viability boundaries to attribute almost magical qualities to the different images. The rationale behind this was to stimulate out-of-the-box thinking and to foster an environment where conventional constraints are temporarily set aside.

These sacrificial concepts were intended to serve as a basis for discussion with interviewees, highlighting the prioritization and implications of certain features.

Moreover, the concepts are subtly indirect to AI applications' negative aspects and consequences. The intent was to test how the interviewees perceived these nearly magical promises and where they started to show skepticism. Still, also it aimed to understand what negative consequences they were already aware of and could recognize.

Through discussions, it was possible to collaboratively evaluate which negative attributes significantly impacted the design process or society and which had lesser consequences. This evaluation was critical in understanding the trade-offs when implementing AI in design processes.

The Map

The first concept, "the map," symbolizes a comprehensive guide that helps designers traverse the often ambiguous landscape of a project. Like a geographical map, it shows the uncovered areas representing the unexplored or unfamiliar aspects of the project. It provides orientation by depicting the overall context within the design process. This context might include the project's objectives, constraints, stakeholders, and dependencies.

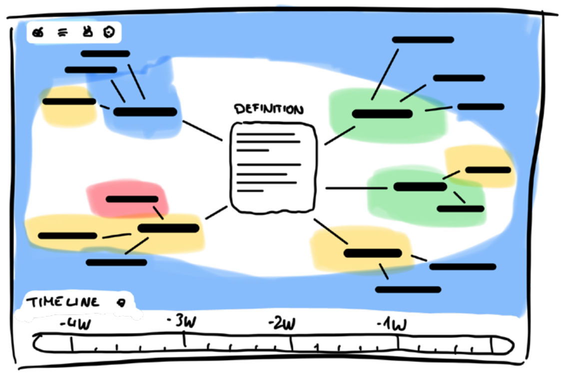

Fig 34

A critical aspect of this map is that it's not a static entity. It is constantly updated, reflecting the evolving nature of the project. As new information is uncovered and the context changes, the map is revised to remain current and relevant. The map is a single source of truth, meaning it can be relied upon for accurate and up-to-date information. In the face of uncertainty, it offers guidance by helping designers visualize the bigger picture, understand their current position, and determine their directions.

The dangers presented by this concept lay primarily in the suggested completeness that a map should otherwise provide. However, this exhaustiveness is impossible in uncertainty and cannot be provided by the AI application, as shown before.

The Magnifying Glass

The second concept, “the magnifying glass,” represents a tool that aids designers in scrutinizing the details of their work. Picture a designer with many post-its and notes - these often contain various assumptions and ideas. The magnifying glass metaphorically “glows” at unvalidated beliefs, making them apparent. This allows designers to recognize when a hypothesis hasn’t been tested or validated.

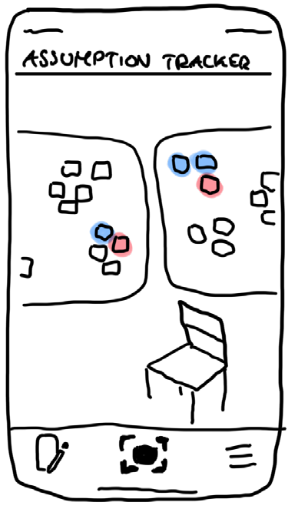

Fig 35

Moreover, looking closely through this magnifying glass, all the risks associated with these assumptions become visible. It guides the designer’s attention to areas that require reflection and critical analysis. This is particularly valuable because it is easy to overlook the nuances and risks of certain decisions in the excitement of creative processes.

The difficulties indicated here are that the tool itself cannot understand the effects and implications of the assumptions and, therefore, cannot give a valuation. The evaluation is also problematic, as will be seen more strongly in the next concept.

The Search Dog

The third concept, “the search dog,” embodies a guide that helps designers find the right path through their projects. Like a rescue mission search dog, it has an innate sense of direction and can see what’s important. It highlights the assumptions that should be the focus and pulls the designer through the project.

This concept represents a source of strong guidance. Unlike the map, which provides a broader orientation, or the magnifying glass, which focuses on detail, the search dog offers operational advice. It helps determine which aspects of the project are crucial and should be prioritized.

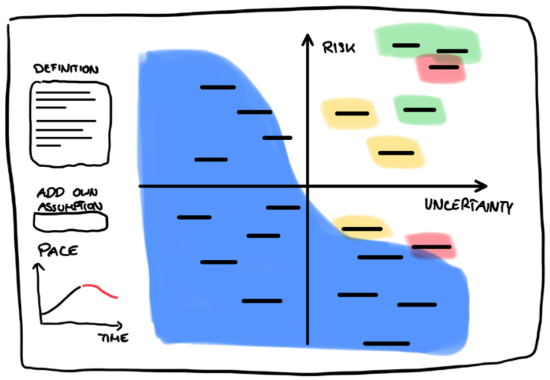

Fig 36

The dangers of this concept lie in the automatic scoring and prioritization of tasks. This could lead the user into a dependency that makes it easier to be guided through the search dog despite the designer’s ability to intervene.

Outcomes

While analyzing the outcomes of the interviews regarding the sacrificial concepts, several key insights and reflections emerged. The participants recognized and highlighted some potential dangers and the usefulness of the sacrificial concepts.

Firstly, “the map” was acknowledged as an effective tool, but some participants were apprehensive about its potential to create dependency. Similar to how individuals rely on Google Maps for navigation, there was a concern that designers could become overly dependent on “the map” for orientation. This reliance could hinder designers’ ability to think independently or creatively without the tool. However, participants found “the map” tangible and usable despite this concern. The metaphor of the map guiding one through a path of uncertainty was well-received, as it depicted the map’s ability to provide clarity and direction amidst the complex landscape of a design project.

Next, “the magnifying glass,” with its glowing assumptions, was considered particularly intriguing by the participants. They found value in its ability to highlight vague ideas, as these could be more innovative. The magnifying glass’s capacity to draw attention to assumptions and risks was seen as empowering, allowing designers to evaluate and refine their ideas critically.

Regarding “the search dog,” participants noted its representation of automation in the design process. However, this was a double-edged sword. While the search dog was seen as powerful due to its ability to see and sense things that might not be immediately perceptible to humans, there was criticism regarding the lack of genuine participation in the design process. The automation that the search dog symbolizes could potentially alienate designers from the hands-on aspects of their work.

One overarching theme that became particularly prominent through the development and discussion of the sacrificial concepts was the influence of these systems on the designers themselves. The way these tools might shape not just the design output, but the thinking and working patterns of the designers, was a recurring topic. This aspect was crucial and was considered throughout the further development of the concepts.

Prototyping

In the initial stages of my project, a Wizard of Oz prototype was employed. This method helps to test elaborate functions and features without the implementation effort.

During the first step, there were short discussions with interviewees about current work cases, where situations and the context were explained in detail. After gathering the necessary insights from the interviews, the information was incorporated into the language models with the according prompts. During this testing process, the prompts were also adapted to optimize the outcomes for the interviewees.

Approximately 10 to 20 assumptions were generated on each idea during the first stage. 3 to 5 further hypotheses were developed for each of these assumptions, which also needed to be verified for the primary assumptions to hold.

After a few days of working on inputting and refining the data through the language models, a follow-up interview was conducted with the participants. During these meetings, we thoroughly discussed the results generated by the language models for gathering feedback and insights on the effectiveness and accuracy of the outcomes.

To keep the data organized and easily accessible, a Notion Board was used. This enabled categorizing the assumptions based on the explanations to make it easier to analyze.

During the follow-up interviews, the participants engaged more interactively by independently categorizing the assumptions into the predefined categories on the Notion board. This collaborative approach ensured that the data classification was done with the insights and expertise of the interviewees, adding an extra layer of validation and accuracy to the categorization.

User Testings

To ensure a comprehensive understanding, interviews were conducted, during which the list of assumptions that still needed to be categorized was first reviewed. One of the significant difficulties during this process was the color coding used for the different categories, which proved problematic and confusing. Furthermore, the applicability and comprehensibility of the classes themselves presented challenges.

It was noted that the categories chosen for the classification of assumptions did not aid in gaining a holistic view of the entirety of the premises. Instead, the presentation on the Notion board was found to be strenuous due to the nature and volume of the hypotheses, partly attributed to the overwhelming sight of all the statements presented simultaneously. In addition, the language used in the assumptions was very advanced English, which lowered the participants' ability to immerse themselves in the statements and understand their implications. The reading process was also found to be disjointed, as the sentences addressed serious issues but varied significantly and focused on different aspects of the project.

During the testing phase, it became apparent that the tool could be handy in the early stages of the project. However, this observation could also be because the project descriptions given were rather superficial and still needed to contain current problems from the course of the project.

But even in projects that were in more advanced stages, new assumptions were discovered that had previously been made unconsciously. These findings referred to as "unknown unknowns", could potentially impact the design and, in turn, affect its functionality during application.

Outcomes

Based on the evaluation of the first prototype, it became evident that significant revisions were necessary in several areas to improve the functionality and user experience. Among the key areas that required overhauls were the categorization system, the mode of interaction through which the inputs were created and reviewed, and the visual representation, which needed enhancement for better theme allocation and navigation.

Furthermore, it was necessary to refine the prompts to generate language and statements that were more accessible to users, especially when acquainting themselves with new themes. This step was crucial in ensuring the users could efficiently comprehend and engage with the information.

One of the prominent issues was related to the interaction model that was initially used. It involved entering extensive prompts, followed by a comparatively lengthy waiting period for a comprehensive response. Subsequently, the users would have to spend an extended time reading through the material, which left them with limited and delayed opportunities to react to the responses of the language model. This mode of interaction was found to be impractical for the application's intended purposes.

In addition, there were challenges in addressing and delving into specific AI-generated assumptions. The prototype treated all beliefs equally and sought to explore them uniformly. This approach resulted in a vast volume of new information that overwhelmed the users. It was not feasible to handle this amount of data effectively, and it detracted from the user's ability to focus on pertinent assumptions that might require more in-depth examination.

These findings resulted in the prototype's following iterations incorporating a more streamlined and adaptive interaction model. This could include shorter, more focused prompts and faster response times. The visual presentation should also be intuitive, facilitating easy navigation and association of themes. Lastly, developing a method for users to selectively target specific assumptions for more profound analysis without being flooded by excessive information is essential.

Interaction Prototype

The development of the application was initiated based on a programming example from React Flow. This foundation ensured that the components, nodes, and edges were already available, facilitating the beginning of the project. React Flow Library proved an essential asset in this development as it provided fundamental interactions with the canvas and the nodes, which were adaptable.

A significant contribution to the structuring and organization of nodes was through the D3 hierarchy tree. It automated the arrangement of nodes, ensuring a systematic structure, which was critical in effectively managing the application components.

As the development progressed, React built additional parts of the prototype interface. These components were designed to make the testing of interactions within the application more manageable and streamlined.

At the heart of the application was the 'generate' function. This function aggregated different aspects of the project into a prompt for the language model. The prompt was fundamentally built around the parent node from which a new assumption was to be generated. It was positioned first to emphasize the significance of the parent node and its premise and included the most detailed instructions.

The objective description of the project was an integral part of this application. It was imperative to specify the goals that were to be aligned with the idea being processed. Doing so made it easier for the language model to identify and fill in gaps in the responses based on the goals.

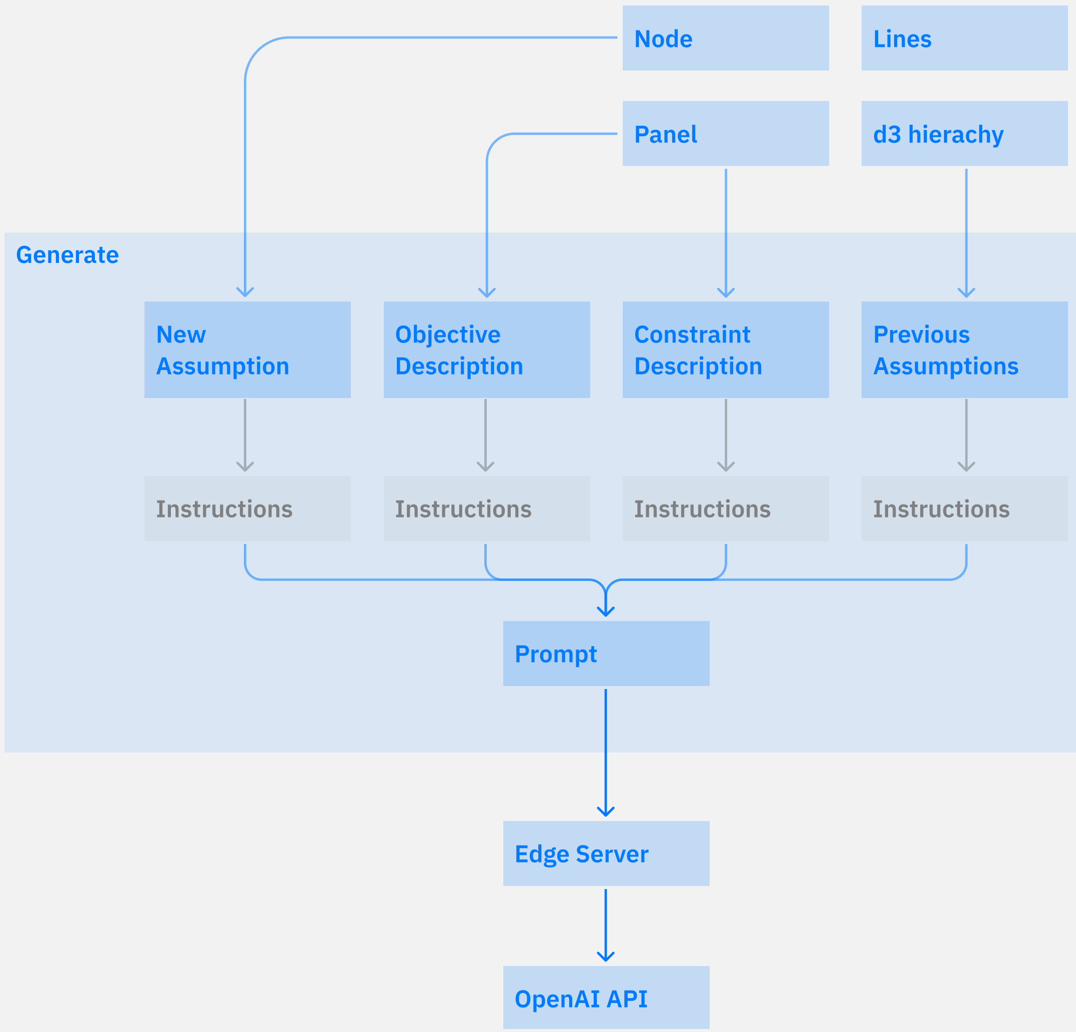

Fig 37

Furthermore, the constraint description allowed users to describe constraints that would prevent the language model's responses from considering elements that could not be altered within the project's scope.

One of the critical aspects was reading all the existing nodes and their assumptions from the entire tree and sending them to the language model. This was particularly important as, unlike ChatGPT, the OpenAI API does not store conversation history, leading to repeated responses. Depending on the categorization of nodes, assumptions had varying impacts on the language model's response.

Default nodes were designed not to be repeated in the language model's responses but had no further influence on the answers. Hidden nodes were marked as unimportant for the project, further narrowing the scope of influence within the project. Nodes marked as critical had the most substantial impact on the language model's responses. They were designed to provoke further 'unknown unknowns' in the language model, and over extended use, they may reveal more significant patterns in the designer's thought process and the project. This could potentially enable the identification of unknown unknowns with greater certainty.

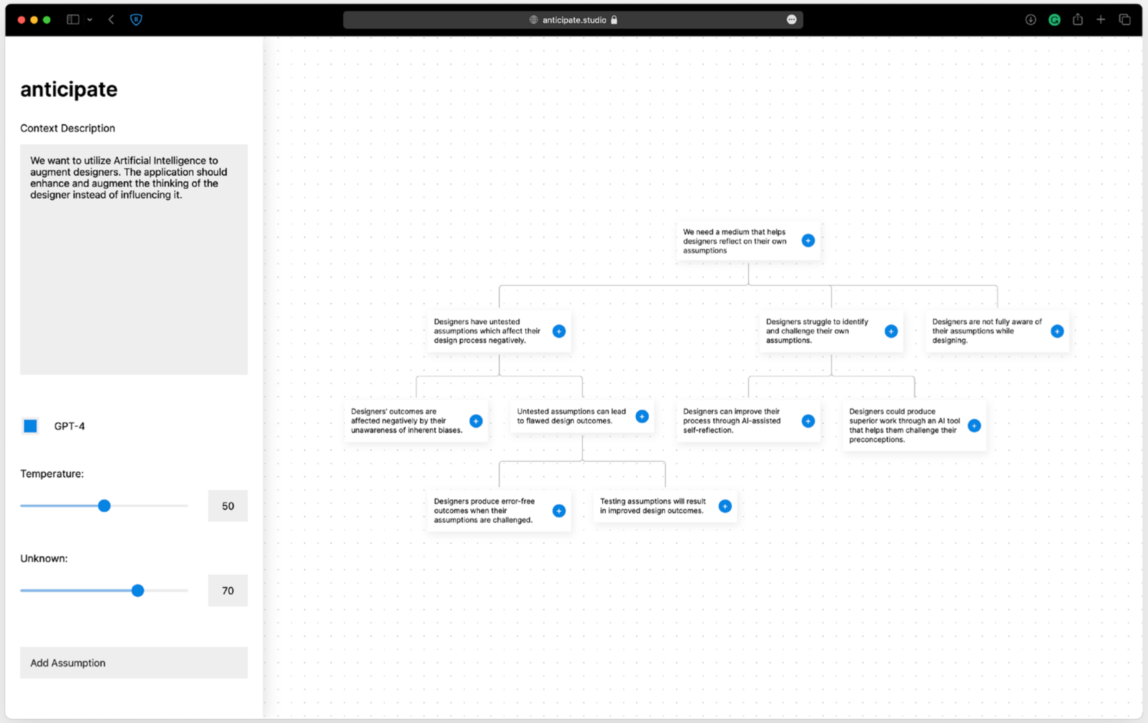

Fig 38

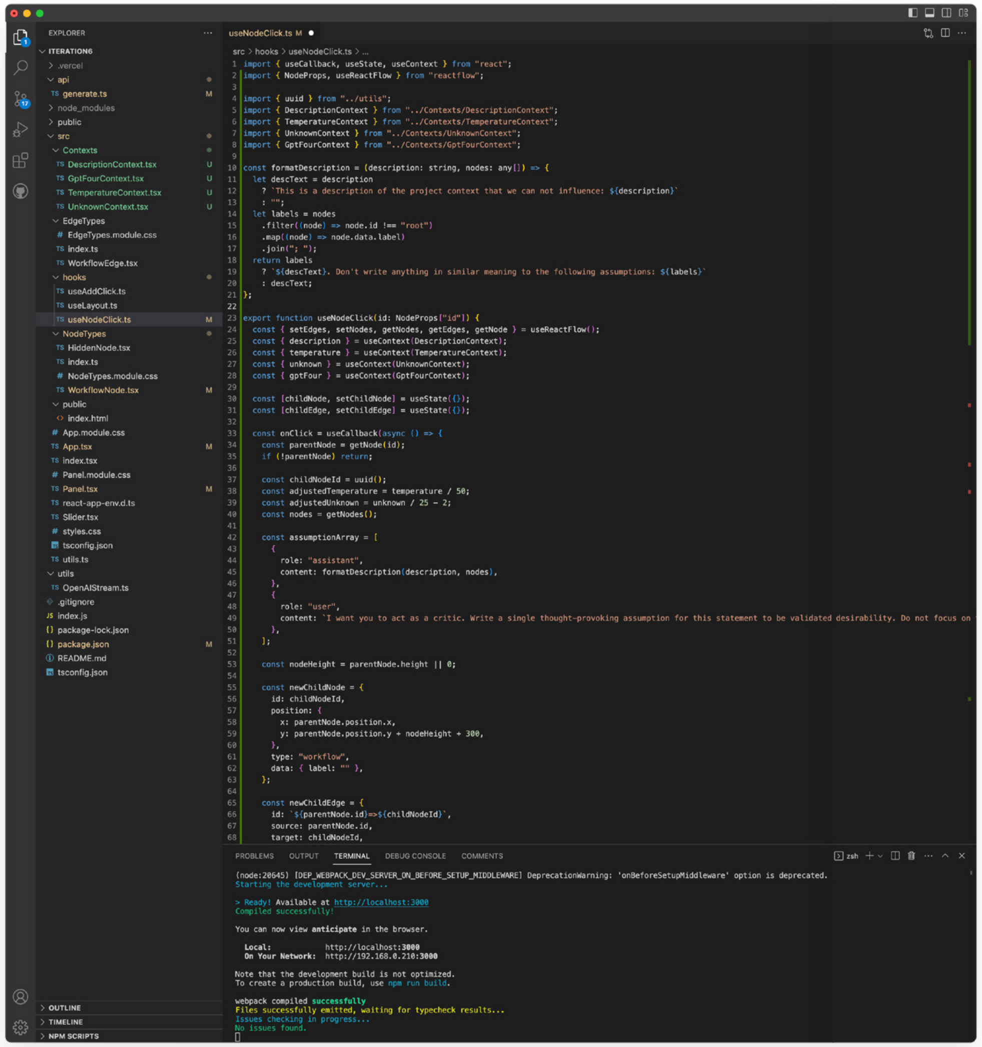

Fig 39

Conclusion

The primary purpose of the prototype was to validate the concept functionally and make the idea more accessible to explain and test for others.

Users could input their ideas and evaluate whether the results were relevant to their thought processes. This immediate interaction and feedback were beneficial in understanding and adapting to user needs and expectations. There was also a distinct shift in the discourse regarding the content of the thesis. The applicability of the results became more verifiable, allowing for a more in-depth and meaningful discussion.

The insights gained through the prototype were in a favorable ratio concerning the time invested in its development. Although there was no previous knowledge of developing such a prototype, the implementation was smooth, with only minor problems. It provided valuable information without requiring excessive time in its creation.

The prototype presents an opportunity for further enhancement, primarily through integrating findings from the development of the interface. This integration would yield additional insights into its usability and can further optimize the prototype.

Moreover, it would be exciting to continue examining the utilization of language models. In this context, it would be beneficial to fine-tune a large language model to refine the results further. The fine-tuning process would allow the language model to be more aligned and calibrated with the specific requirements and objectives of the application.

Additionally, a more intensive examination of the prompts would be advantageous in improving the results of the functional prototype. A thorough evaluation and optimization of the prompts can ensure that the language model receives the necessary information and context, resulting in more relevant and accurate responses.

Concept

To introduce the concept, the information architecture will be discussed first. In the application, the information was sorted by the different projects of the user. This structure should make the accessibility and allocation of information more accessible for users to understand and share.

An additional feature that was conceptualized but needed to be implemented was the ability for designers to maintain personal statistics and notes regarding their assumptions and biases. This feature aimed to improve the reflective process through this medium. By allowing users to keep track of their beliefs and prejudices, the tool would foster an environment for self-evaluation and improvement.

Within each project, all ideas and assumptions were intended to be placed on a canvas. This design choice aimed to render the information visually and functionally easily manipulable. By arranging data and ideas on a canvas, users can more effectively interact with the knowledge, modify it, and perceive it as adaptable rather than fixed.

The application employs overarching panels for information relevant across multiple projects, such as the description of objectives, constraints, and the description and customization of the language model. This hierarchy supports and visualizes the cross-project impact and manipulability by the user. It ensures that critical information across the entire project is easily accessible and can be altered for the user's requirements.

Another feature regarding the nodes is that information within a node can be directly adjusted. This includes toggling the node's status via a single click at the marker. Such a feature enhances the user's interaction and control over the data points. The text on the node can also be adjusted by clicking the text field.

Furthermore, users can directly provide feedback on the generated assumptions on the node. This function is positioned next to the author "anticipate," which helps in clarifying that the feedback is meant for the language model.

Additionally, nodes can be effortlessly deleted using the backspace key. But the node remains existent even after deletion in the hidden view. This feature is significant as it ensures that users retain valuable information and can retrieve it when necessary.

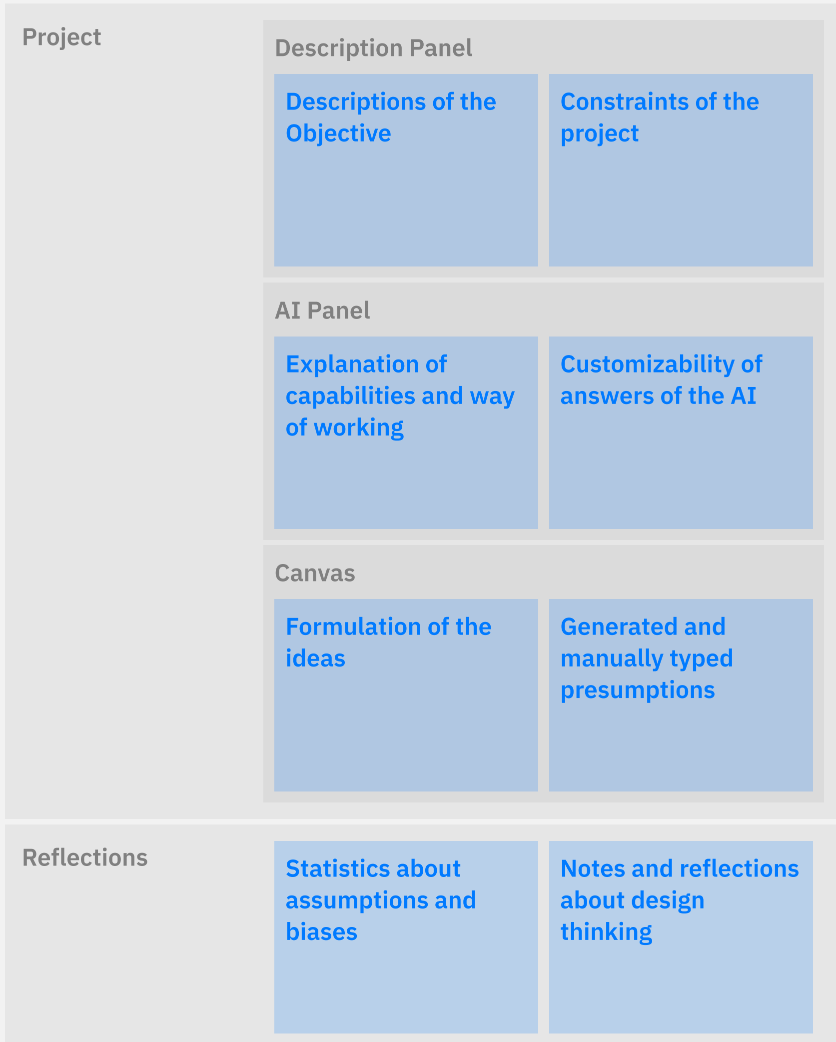

Fig 40

User Flow

Central to the user flow is the explanation of the tool for new users. The goal of this explanatory process is not only to introduce individuals to the various functions of the medium but also to highlight the relevance and responsibility associated with using the tool. By doing this, the medium aims to ensure that users recognize the significance of the results they obtain and develop a realistic set of expectations. This is believed to facilitate the tool's more straightforward and sustainable usage.

In the user flow, an example project is initially used to describe the concepts of objective and constraint description. This helps users understand what these terms mean and how they are implemented within the context of the tool.

Following this introduction, the users are guided in creating their first node by inputting an idea into the first node that is supposed to achieve the previously defined objective. This hands-on experience is instrumental in familiarizing users with the fundamental operations of the tool.

Subsequently, the introduction demonstrates how to generate new assumptions for the idea entered to let users comprehend how the tool can augment their initial input with additional insights.

The new users are then guided on adjusting the results of the AI in the AI panel, where the output can be fine-tuned to align with user-defined goals and preferences.

Users are also shown how to manually write and delete their nodes and are introduced to various canvas visibility settings. It is pointed out that even a deleted node is still present in a hidden view.

The user flow also includes a brief introduction to the customizable views of the canvas. However, this segment is relatively short, as these views are separate from the application and are generally more relevant to those with extensive experience with the tool.

Upon completion of the tutorial, new users can create their first project via the button in the project panel. With the knowledge acquired through the user flow, defining, generating, and customizing elements within the project should be seamless and straightforward. This introduction is integral to ensuring that users not only understand the mechanics of the tool but are also aware of the relevance and responsibility that accompany its use.

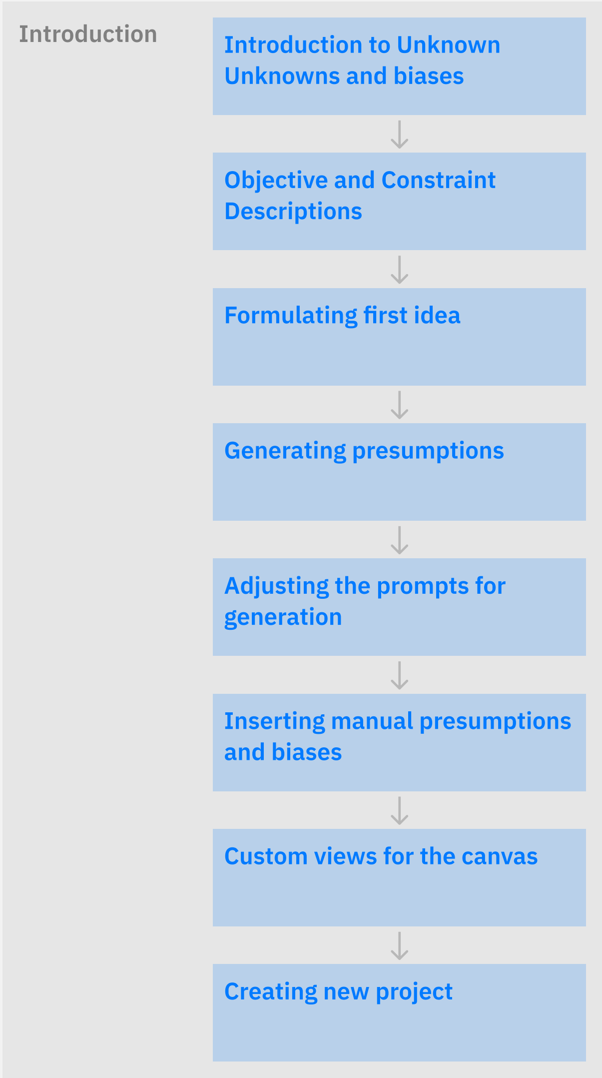

Fig 41

Mental Model

The testing of different stages has revealed numerous challenges in the application, resulting in the mental model's rework. Initially, the term "assumption" was mainly used; however, it was found that this term is not commonly employed and posed difficulties for even skilled designers in formulating their assumptions.

For this reason, the initial assumption was rephrased as "idea" as it proved more accessible for various groups to be expressed. Typically, the idea is documented once the objective (goal) and constraints of the action scope are defined. This approach is intended to simplify the articulation of ideas and create a coherent overall picture for the language model.

Subsequently, the AI generates presumptions based on the formulated idea, which the user can validate for the concept to work effectively. Here, the term "generate" is used to highlight the contribution of the language model, while the instruction to type signifies the possibility of manual input from the user.

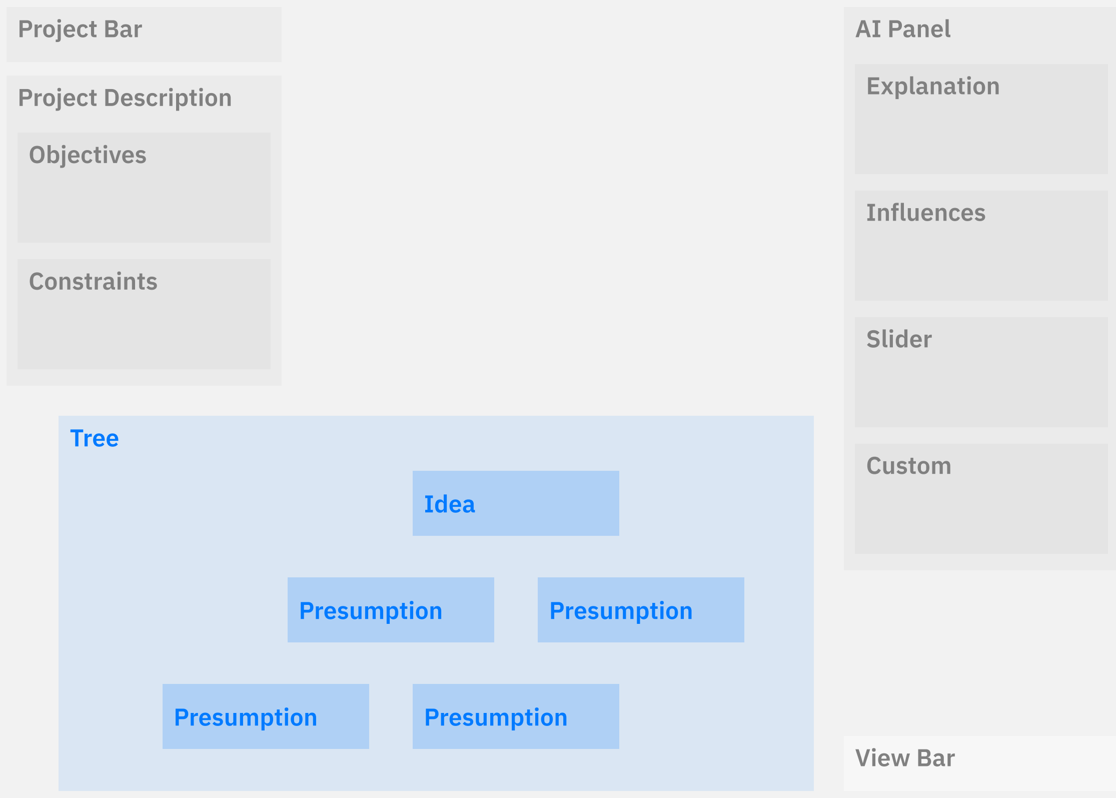

Fig 42

Views

The concept incorporates views and a tree structure to establish a hierarchical organization of assumptions like a decision tree. The initial ideas are distinctly visible and navigable on the canvas. As one explores these ideas, the increasing level of detail in the tree's nodes becomes apparent and easily navigable.

Efficient navigation is facilitated on the canvas, with significant space efficiency simultaneously due to the compressed but flexible trees. This layout yields a clear overview, benefiting newcomers and aiding in the tree's construction, as one can navigate from top to bottom through the tree.

Employing tree structures as a medium is prevalent for making decisions or organizing thoughts, making this highly relevant for practical application. The tree branches can be easily minimized or hidden without affecting the functionality of the tree.

In addition, custom views can be created for personal mental integration of assumptions into the design process. These adjustable views may include matrices where nodes can be sorted and prioritized according to individual metrics.

Furthermore, different visibility options for nodes enable users to hide or show nodes they have created, nodes generated by the AI, or nodes that have been deleted. This flexibility in managing visibility supports a more tailored approach to organizing and analyzing the information within the tree structure.

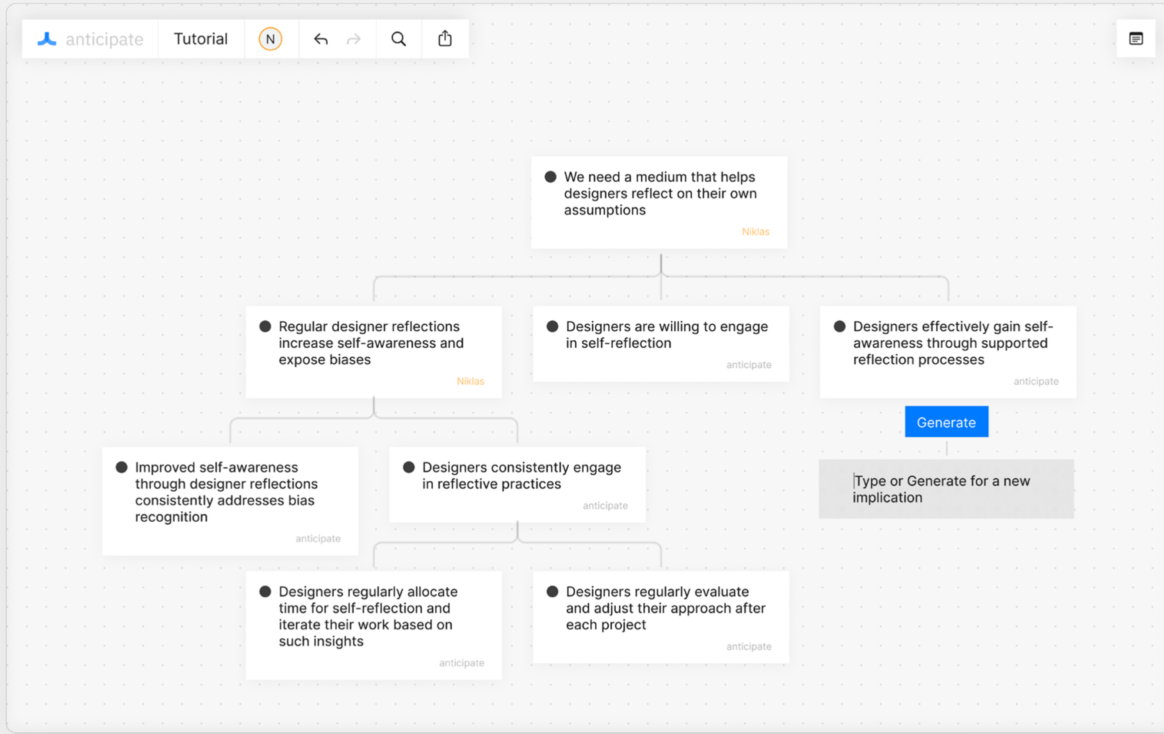

Fig 43

Project Description

In the concept, the project description is pivotal in providing artificial intelligence with the necessary context for generating assumptions. Initially, this contextual description was general and could encompass any information. However, it was later understood that the context description could also assist users in capturing their intentions, making it easier to respond with an initial idea.

Furthermore, the general field was divided into two segments: objectives, which represent the goals the project aims to achieve, and constraints, which mark the boundaries of what is feasible within the project. The purpose of defining these constraints is to prevent the AI from suggesting options that are not relevant to the project.

A critical aspect of this process was finding the right balance between providing guidance for valuable results and keeping the outcomes open-ended. This balance is essential not to confirm pre-existing notions but to allow unexpected and surprising elements to emerge.

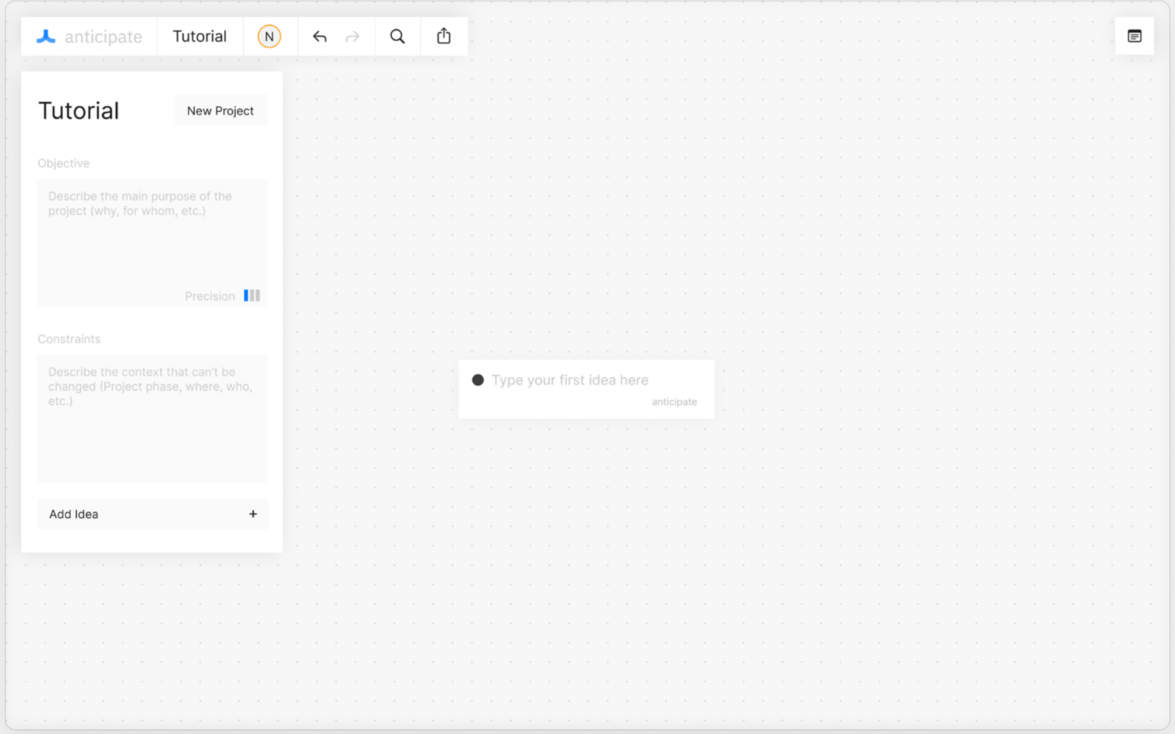

Fig 44

AI Explainability

The AI Panel is a feature that allows users to adjust their expectations of the AI's capabilities through detailed explanations of the inner workings. This is also accomplished through a control board that changes the functionalities of large language models to the specific purpose. The AI Panel aims to make the influence of implicit feedback more transparent and understandable to the user.

One of the key features is the option to experiment with various AI models, which aids in achieving cost efficiency. Further experimentation is facilitated through sliders that encourage users to guide the AI-induced reflections in a desirable direction. Moreover, explanations for each slider, including information on their significance, impact, and functionality, are provided to offer users a thorough understanding of how the sliders operate.

Additionally, users can define their objectives at the bottom of the AI Panel. This feature is designed to influence the AI's behavior and responses directly.

The AI Panel is supplemented with detailed descriptions for all parameters. This is intended to enhance transparency and allow users to comprehend better the workings and implications of the various elements within the panel. Through these features, the AI Panel enables users to have more control and customization in their interaction with the AI, adapting it to suit their specific needs and goals.

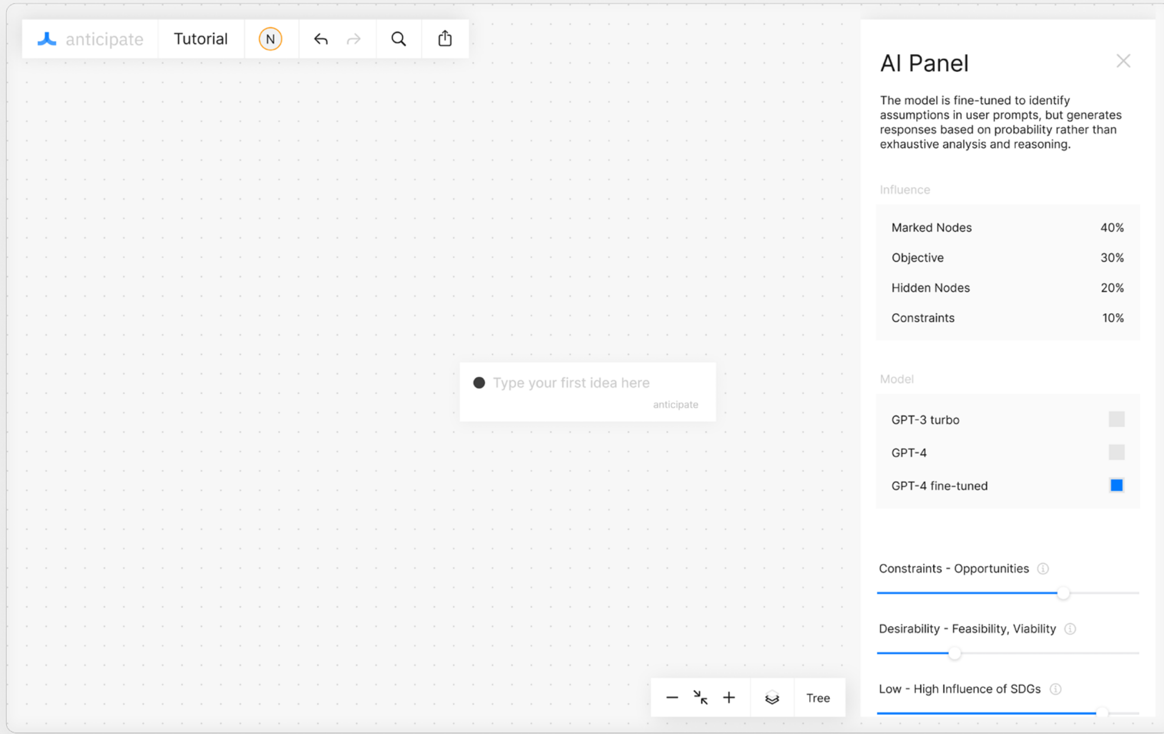

Fig 45

Classifications

The concept incorporates a system of categorizing assumptions through markers. Initially, assumptions were marked as default, validated, critical, or irrelevant. However, experiences drawn from utilizing the prototype indicated the necessity for alterations. Default and validated categories were merged, as a validated assumption was found to have an equivalent level of influence on the idea as a default node. In both instances, it is presumed that the idea remains validated.

Furthermore, the irrelevant marker evolved into deleting the node, where only hidden nodes remain accessible under a specific view. This adaptation is intended to foster a more streamlined and organized tree structure. Additionally, this alteration ensures the retention of nodes that would otherwise be discarded, and deeming them irrelevant becomes a more traceable decision.

This reclassification of assumptions is designed to optimize the clarity and organization of the tree while preserving the critical elements that contribute to the evolution and functionality of the idea.

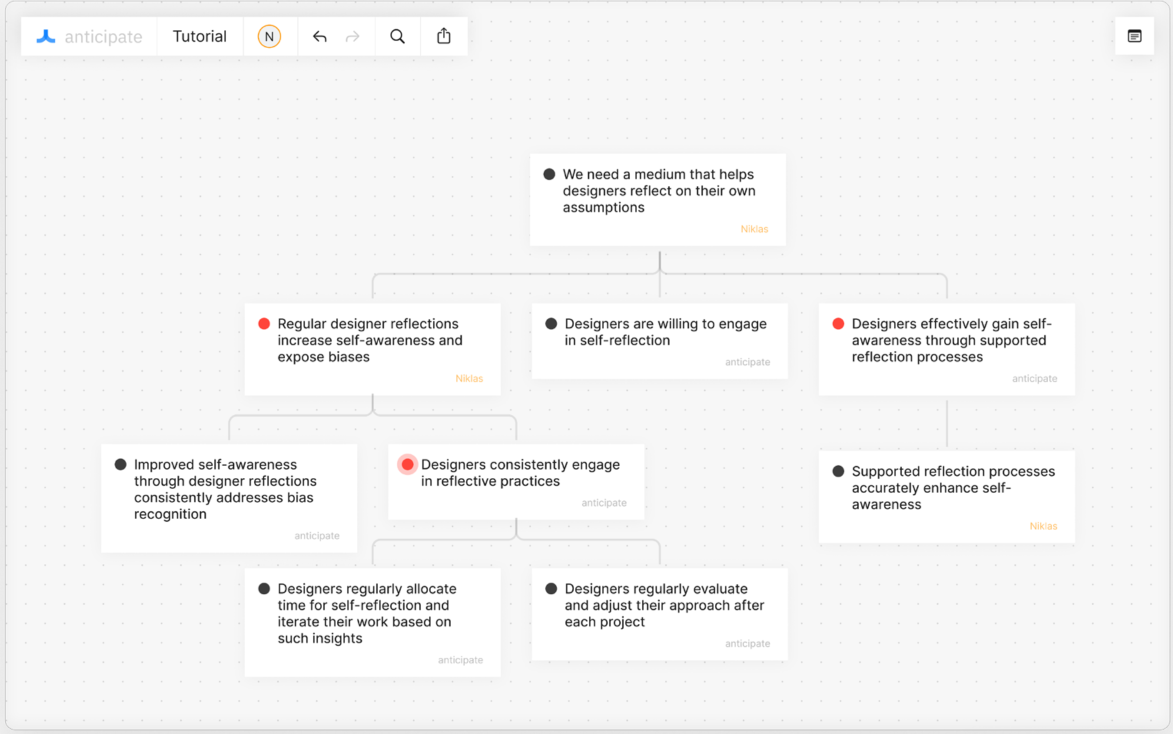

Fig 46

Feedback

The concept incorporates explicit and implicit feedback mechanisms to influence the training and improvement of the AI's language models.

Explicit feedback is designed to impact the AI's training to improve language models. However, this type of feedback should only be employed in exceptional circumstances that could potentially influence other users. Explicit feedback should not be incentivized, as it is reserved for extraordinary cases and is not meant to be used frequently.

On the other hand, implicit feedback build on the fact that users categorize nodes for their insights. This process involves conveying to the language model how nodes are organized so that the following generated assumption can better align with the user's intentions. The deeper the engagement with the project, the more refined these generated assumptions become, as they are progressively tailored to the user's specific needs and objectives.

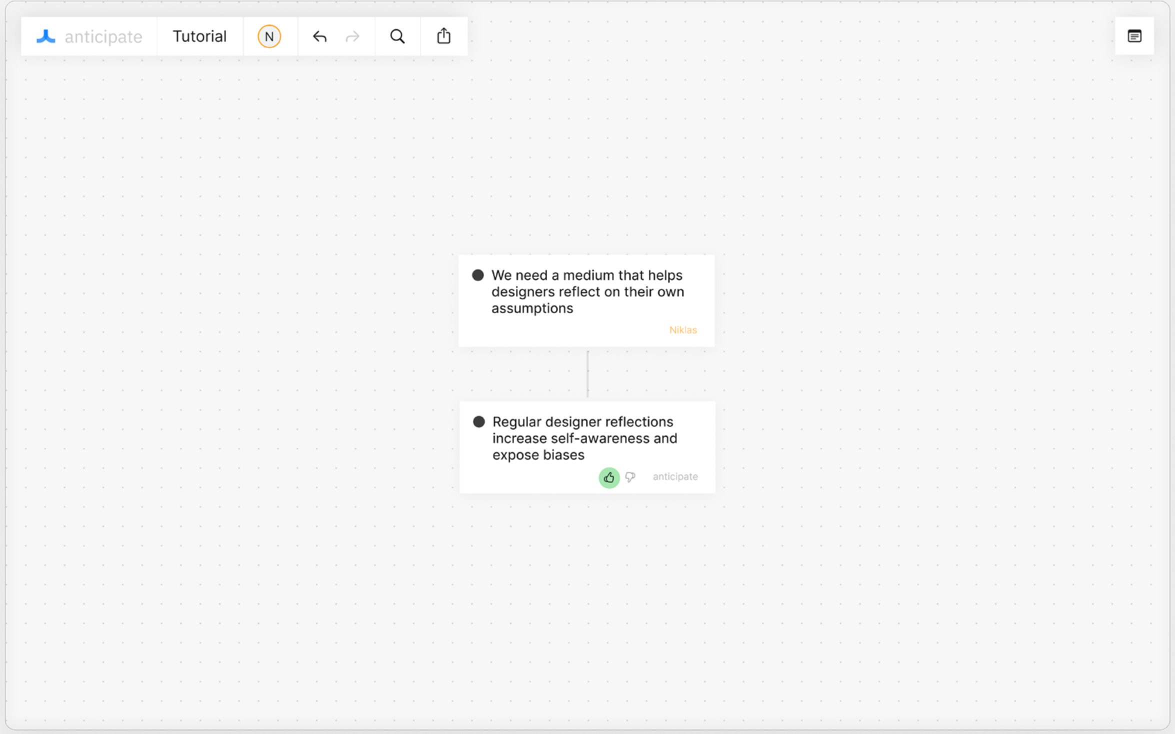

Fig 47

Collaboration

The insights gathered from interviews identified a substantial opportunity for improvement in collaboration with stakeholders. Uncertainties often challenge this collaboration, and the tool aims to alleviate this issue by facilitating stakeholders in articulating their diverse ideas and discussing the associated presumptions and implications.

By enabling this, the concept fosters collaboration among stakeholders from various backgrounds. It creates an environment where ideas can be discussed more openly and sincerely. This, in turn, contributes to a more efficient and cohesive decision-making process, allowing for the collective input and expertise of all stakeholders involved.

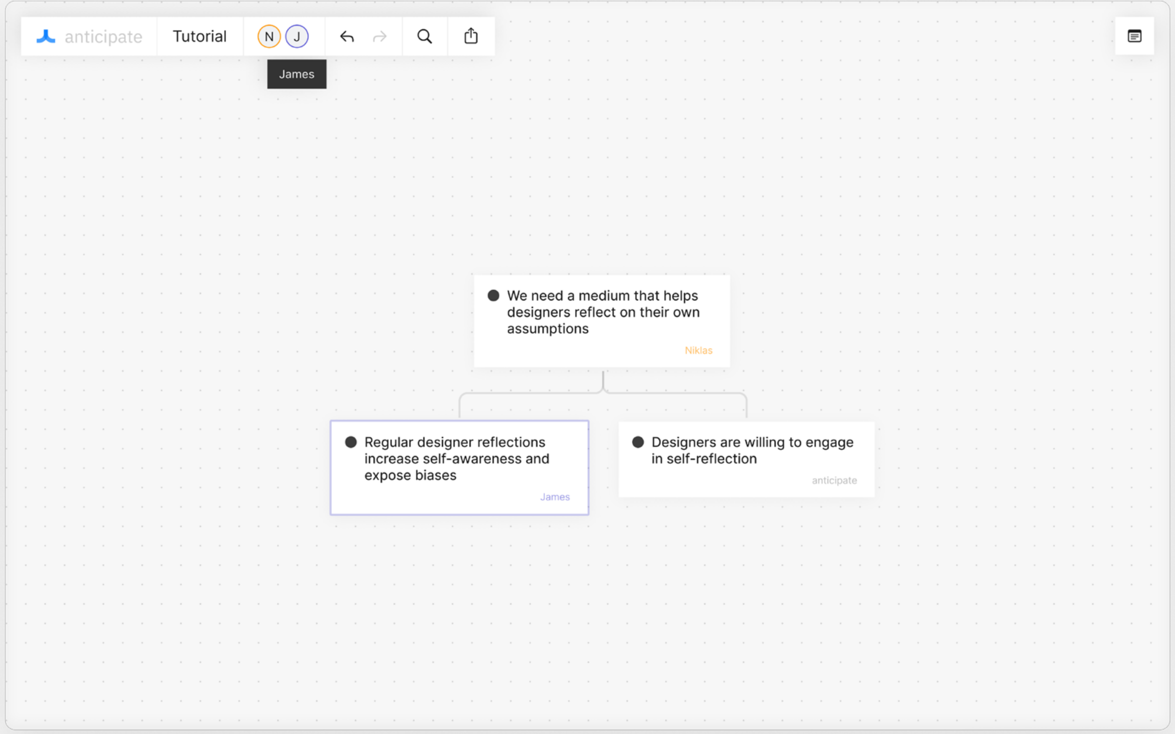

Fig 48

Integrability

The concept emphasizes integrability into the design process using embed functions from various information tools. Widely-used tools such as Notion, Miro, and Figma offer features that enable web interfaces to be embedded into other interfaces. This decision was made because it allows the information, views, and editing options from anticipate to be utilized without switching between different tools.

Initially, the idea was to expand the interface into a stage where assumptions derived from the exploration process could be converted into tasks and be more deeply documented. However, this initial idea was abandoned, as many interviews revealed that introducing an additional task tool could lead to conflicts with current methods and was not currently needed.

Additionally, there was no need for exporting or reusing the information in other applications. This is because anticipate primarily provides an overview, identifies unknowns, and only indirectly organizes and structures the process. The concept aims to streamline the design process and help users efficiently manage and analyze information by focusing on seamless integration and avoiding redundancy.

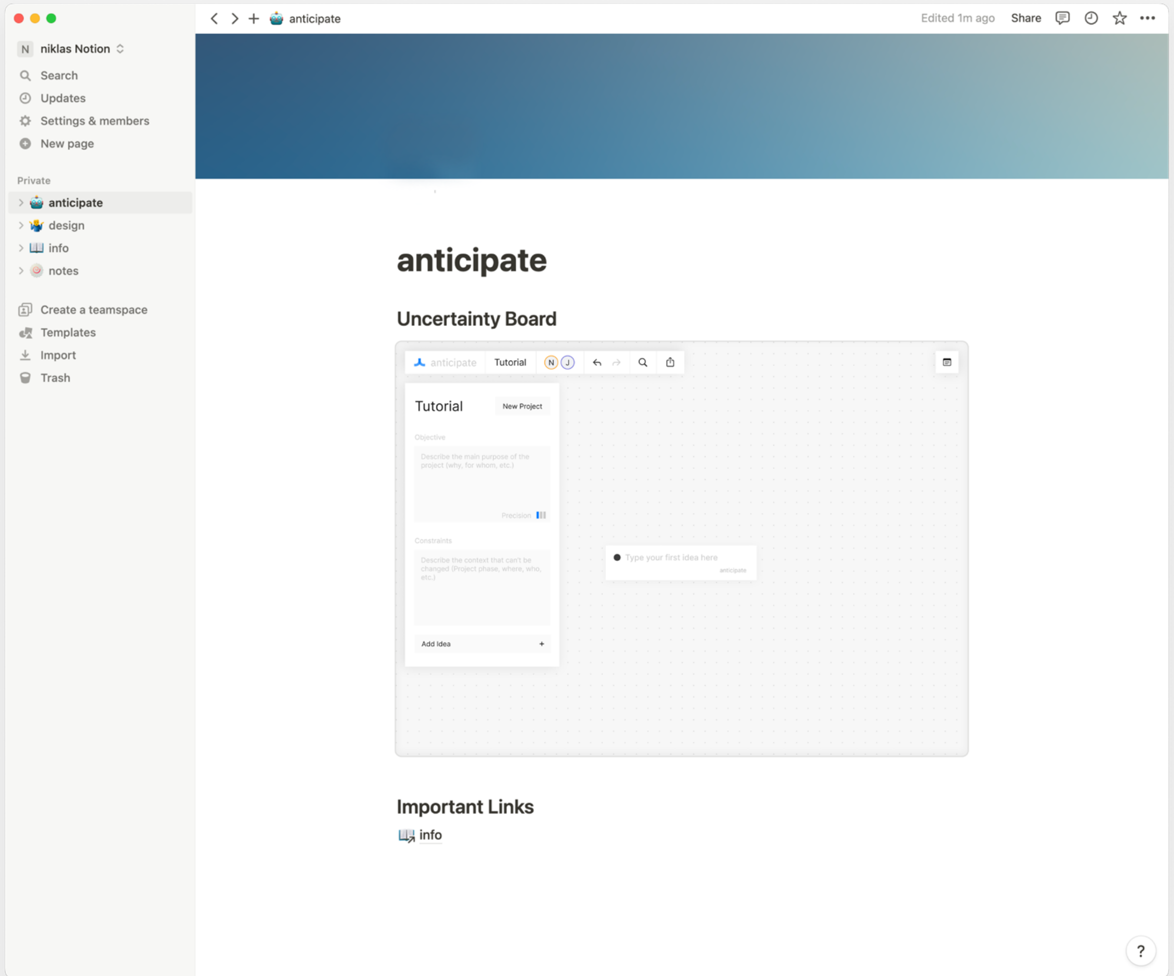

Fig 49

Appearance

In the concept, the visual appearance is designed with a focus on letting the brand and interface fade into the background. This is to highlight the research findings from literature and interviews primarily. The potential use case identified in the thesis is intended to be rendered credible and tangible through the interface and the brand rather than overshadowing the research.

By taking this approach, the concept aims to gather additional insights for integration into the design process. Additionally, it seeks to enhance approachability, making it easier to understand and discuss the use case and research findings. This emphasis on research and conclusions, rather than the brand and interface, ensures that the focus remains on the substance and potential applications of the concept, encouraging a more in-depth engagement with its functionalities and possibilities.

Conclusion

During the interface's development, it was paramount to ensure that the core idea of the thesis remained distinctly visible. This led to the realization that the interface should recede into the background.

Usability and comprehensibility of the application of the concept were at the forefront of the elaboration. This focus enabled testing the ideas that were developed through interviews and prototypes. The investigation primarily aimed to ensure that users were minimally influenced by the use of the concept in their design process.

The results obtained from user tests with prototypes for the interface and its functionality have consistently led to numerous improvements in both prototypes. As a result, there have yet to be any standardized user tests involving various users that can provide consistent and relevant results for the success of the interface and its interactions.

Reflections

The thesis build on the rising trend of artificial intelligence, creating an interest in the technology, its developments, and its implications. This interest greatly influenced the choice of topic. Upon examination of current applications, disturbing aspects could divert the course of design undesirably.

Further interest was delved into design processes, methods, and the inherent decisions, examining different frameworks and their approaches to uncertainty in design. Essential factors were identified, forming the strengths of the design process that must correlate with the impacts of artificial intelligence. This led to the formation of the research question on how artificial intelligence, particularly language models, can augment the design process.

Risk potentials for negative developments were highlighted, especially in light of existing applications and their impacts on design. Identified were problem fields in design that include uncertainty, inherent assumptions, and biases that designers may unintentionally possess, and their implications on the design process were investigated.

Studying the potential of designerly thinking and the design process in conjunction with artificial intelligence was essential. Key points included the desirability of developments and how we, as designers, can influence them. The restrictive impact that Artificial Intelligence presently has on development was a significant consideration.

The discovery that artificial intelligence always results in the most probable, while design aims at directing the future into something more desirable, was the central finding. Concerning application, differentiation was developed between automation and augmentation, which informed potential uses and the implementation of this potential.

In conjunction with interviews and testing, Iterative development processes were essential for the outcome and its applicability in the design process. Function prototypes confirmed expected potentials. Measures were employed in designing the concept to ensure responsible and understandable use of the application.

The thesis's outcome examines and identifies potentials within design stemming from technology. The likelihood of finding an overlap between the problem and solution space was unlikely but still met to an extent. The theoretical basis and the concept for integrating artificial intelligence in the design process represent a portion of all possibilities.

The research proposes and illustrates the potential for a responsible and beneficial use of artificial intelligence in the design process. It provides a basis for discussion in which further insights can be gathered on how we can self-determinedly influence our future and achieve desired goals. It is a singular demonstration in the vast array of possibilities and benefits artificial intelligence offers to the design process when used responsibly.

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Picture References

Fig 01 - Responsibility criteria
Own Illustration adapted from IEEE

Fig 02 - AI potential
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Fig 03 - Autodesk Forma
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Fig 12 - Frameworks Time
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Fig 14 - Humanity Centered Design
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Fig 16 - Assumption Learn Measure Test
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Fig 17 - Frame
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Fig 18 - Frame What + How
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Fig 19 - Deduction Induction Abduction
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Fig 21 - Design Thinking Scheme
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Fig 22 - Systems Thinking Scheme
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Fig 27 - John Maeda
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