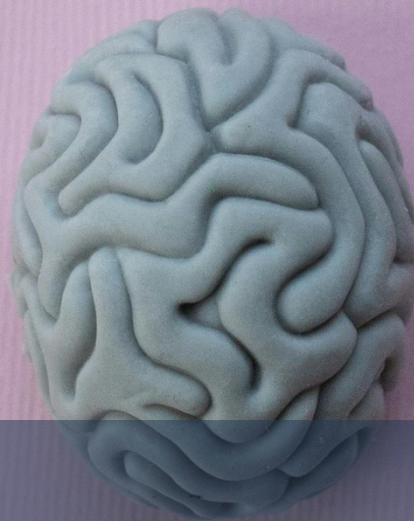


Management Innovation Lab @ HOST



Working Paper 02/25

AI in Design Thinking

Methodology | AI in DT Workshops | Trends

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1. Management Summary

This Working Paper examines the integration of Artificial Intelligence (AI) into Design Thinking (DT) workshops, a convergence poised to revolutionise problem-solving methodologies in management. It acknowledges Design Thinking's increasing importance as a human-centred approach to innovation and investigates how AI tools can amplify the effectiveness of Design Thinking in workshop environments.

The paper meticulously outlines the dual benefits and challenges of integrating AI into the Design Thinking process. On the positive side, AI tools can significantly boost creativity and ideation by generating a broader spectrum of ideas than humans alone. They accelerate research and synthesis through rapid, in-depth data analysis, offering insights that might otherwise be missed. AI also facilitates the creation of personalised user experiences through the development of detailed, data-driven personas. Generative AI enhances prototyping and visualisation, enabling teams to quickly iterate on design concepts and efficiently obtain feedback. Furthermore, AI-powered analytics streamline testing and iteration, ensuring data-driven design improvements.

However, the paper also raises crucial concerns about the potential pitfalls of AI integration. It cautions against over-reliance on AI, which could dilute the human-centric essence of Design Thinking, a methodology rooted in empathy and understanding of human needs. Ethical considerations are paramount, with the paper addressing the risks of biases embedded in AI systems and the imperative to protect data privacy. It highlights the need for vigilance to avoid simply mirroring existing biases, thus perpetuating inequalities.

The paper delves into the specific applications of AI within each phase of the Design Thinking process - Empathise, Define, Ideate, Prototype, and Test - providing actionable guidelines and showcasing AI tools that can be effectively employed in each stage. Examples include using Natural Language Processing (NLP) to analyse user feedback during the Empathise phase and employing generative AI tools like *DALL-E* for rapid prototyping.

The core recommendation is to adopt a balanced approach, positioning AI as a tool to augment human creativity and decision-making rather than a replacement for it. The paper stresses the critical importance of upholding ethical standards, continuously evaluating the impact of AI tools, and ensuring that human insight remains central to the Design Thinking process. This document targets academic researchers, design practitioners, innovation managers, and students, offering both theoretical foundations and practical insights for implementing AI-assisted design methodologies, thereby fostering more effective and ethically sound innovation strategies. Ultimately, the paper argues for a thoughtful integration of AI that enhances, rather than supplants, the human element in Design Thinking.

This management summary was generated by *perplexity.ai* and grammatically corrected by *Grammarly.com*.

Hope you enjoyed it anyhow.

2. Introduction

In a time of rapid technological development, the intersection of Artificial Intelligence (AI) and Design Thinking (DT) presents an area of innovation that could advance problem-solving in management. Accordingly, this Working Paper examines the **relationship between AI and Design Thinking**, focusing on their application in typical workshop settings.

Design Thinking, a human-centred approach to innovation, gained importance as a methodology for addressing wicked problems (Brown, 2008). Its iterative process, emphasising empathy, ideation, and rapid prototyping, proved efficient in generating creative solutions (Plattner et al., 2011). Concurrently, AI emerged, capable of processing large amounts of data, recognising patterns, and generating insights at high speeds (Russell and Norvig, 2020).

The integration of AI into Design Thinking workshops presents both opportunities and challenges. On the one hand, AI tools can **enhance the efficiency** of the Design Thinking phases, from data analysis in the Empathy phase to rapid Prototyping and Testing (Verganti et al., 2020). On the other hand, this integration raises concerns about **maintaining the human-centric nature** of Design Thinking and the ethical implications of **AI-assisted creativity** (Borenstein and Arkin, 2017).

This Working Paper addresses the necessity of **guidance on effectively incorporating AI tools into Design Thinking workshops**. While separate research areas exist on Design Thinking and AI, limited academic work bridges the two areas in a practical, workshop-oriented context (Cautela et al., 2019).

This paper aims to explore how AI can enhance Design Thinking workshops, providing both theoretical foundation and practical guidelines. Specifically, it seeks to:

- Analyse the potential benefits and challenges of integrating AI into each phase of the Design Thinking process,
- Provide an overview of various AI tools suitable for Design Thinking workshops and
- Address ethical considerations for responsible AI use in creative problem-solving contexts.

This Working Paper is aimed at a **diverse audience**, which includes academic researchers, design practitioners, innovation managers, and students. For researchers, it synthesises existing knowledge and highlights areas for further exploration. For practitioners and managers, it offers practical insights and tools to enhance their Design Thinking workshops. For students, it serves as an introduction to AI-assisted design methodologies.

The **methodology** used in the Working Paper comprises a literature review and an analysis of existing AI tools. By integrating academic research with practical applicability, the Working Paper seeks to bridge the gap between theoretical approaches and real-world implementation.

3. Basic Concepts

Design Thinking is a human-centred, iterative approach to innovation that integrates user needs, technology, and business objectives. This chapter briefly explores its five key phases - Empathise, Define, Ideate, Prototype, and Test (Jacobsen, 2024) - while examining how Artificial Intelligence (AI) can enhance each phase, from analysing user insights to generating ideas, prototyping and testing solutions, ensuring **synergy between human creativity and machine intelligence**.

3.1 Design Thinking: Empathy, Ideation, Prototyping, Testing

Design Thinking is a human-centred approach to innovation that draws from the designer's toolkit to integrate people's needs, technological possibilities, and business success requirements (Brown, 2008). At its core, Design Thinking is an iterative process that aims to understand users, challenge assumptions, redefine problems, and create innovative solutions to prototype and test (Jacobsen, 2024).

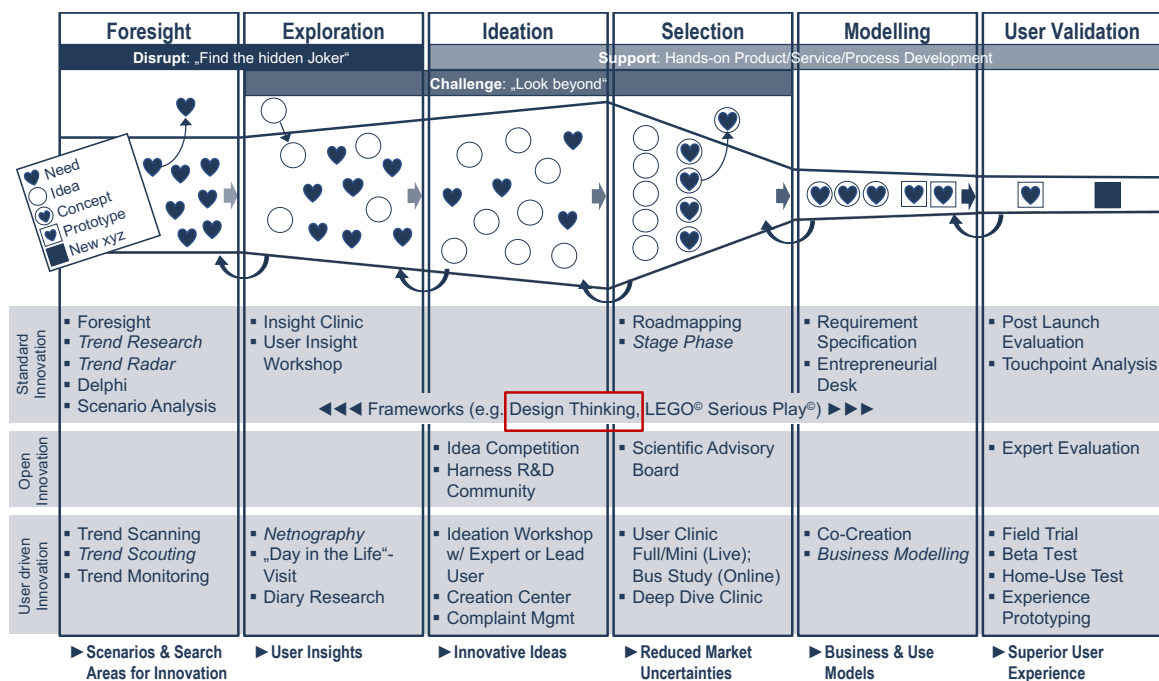


Fig. 1 - Design Thinking in the Innovation Management Framework (Jacobsen, 2025)

The Design Thinking process typically consists of **five phases**: Empathise, Define, Ideate, Prototype, and Test. These phases are not always sequential and can often be run in parallel, out of order, and repeated as needed (Jacobsen, 2024):

Empathise - The first phase focuses on an empathetic understanding of the problem one seeks to resolve. This involves consulting experts to gain further insights into the area of concern by observing, engaging, and empathising with individuals to comprehend their experiences and motivations (American Marketing Association, 2024).

Define - In this phase, the information gathered during the Empathise phase is combined. The observations are analysed and synthesised to define the core problems the team has identified. The goal is to create a human-centred problem statement (Jacobsen, 2024).

Ideate - The third phase involves generating ideas. With knowledge gained from the first two phases, one can begin to "think outside the box" to identify new solutions to the problem statement created (American

Marketing Association, 2024). Techniques such as brainstorming and brainwriting can stimulate free thinking and expand the problem space (Jacobsen, 2024).

Prototype - In this phase, the design team produces several inexpensive, scaled-down versions of the product or specific features. These prototypes may be shared and tested within the team, in other departments, or with a small group of people outside the team (Jacobsen, 2024).

Test - Testers utilise the most effective solutions identified during the prototyping phase. Although this is the final phase, it often involves an iterative process where the results are used to redefine one or more problems (Jacobsen, 2024).

3.2 AI Fundamentals: Artificial Intelligence, Machine Learning, NLP

Artificial Intelligence (AI) is the simulation of human intelligence in machines programmed to think like humans and mimic their actions (IBM, 2024a). The field of AI has some **key components**:

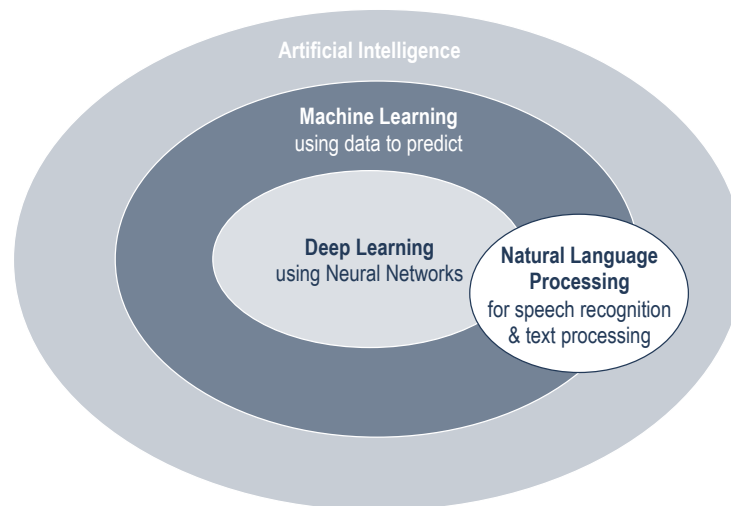


Fig. 2 - Relation between AI, ML and NLP

Machine Learning - Machine Learning (ML) is a subset of AI that concentrates on using data and algorithms to mimic the way humans learn, progressively enhancing its accuracy. ML algorithms create a model based on sample data, referred to as "training data," to make predictions or decisions without being explicitly programmed to do so.

Natural Language Processing - Natural Language Processing (NLP) is an area of AI that deals with the interaction between computers and humans using natural language. The objective of NLP is to read, decipher, understand, and make sense of human languages in a valuable way.

Generative AI - Generative AI refers to AI systems that can produce various types of content, including text, imagery, audio, and synthetic data. These systems learn the patterns and structures of their input training data and then generate new data with similar characteristics.

3.3 The Intersection of Design Thinking and AI

AI can enhance each phase of the Design Thinking process, from data analysis in the Empathise phase to rapid Prototyping and Testing.

In the **Empathise** phase, AI can assist in analysing large amounts of user data to uncover patterns and insights that human observers might overlook. During the **Define** phase, AI can aid in synthesising information and formulating more precise problem statements.

For **Ideation**, AI tools can produce numerous ideas based on specified parameters, broadening the solution space beyond what human teams may conceive. In the **Prototype** phase, AI can rapidly generate and iterate on designs, facilitating quicker testing and refinement.

Finally, during the **Test** phase, AI can analyse user interactions with prototypes on a large scale, providing detailed insights into user behaviour and preferences.

However, when integrating AI, it is crucial to **maintain the human-centred nature** of Design Thinking. AI should **augment** human creativity and decision-making, **not replace** it. Ethical considerations, such as potential biases in AI systems, must also be considered.

In the following chapters, the integration of AI into each phase of the Design Thinking process will be explored in detail, providing practical guidelines.

4. Methodology

This chapter briefly outlines the methodological approach employed in this Working Paper to investigate the integration of AI tools into Design Thinking workshops. The methodology consists of a literature review and an analysis of existing AI tools to establish a foundation for the recommendations.

A literature review was conducted to support the theoretical framework for integrating AI into Design Thinking processes. This review included peer-reviewed journal articles, conference proceedings, and industry reports published in the last five years. Databases such as *Google Scholar*, *IEEE Xplore*, and *ACM Digital Library* were utilised. The literature review focused on three **primary areas**:

- Recent developments in Design Thinking methodologies,
- Advancements in AI technologies relevant to creative problem-solving,
- Existing studies on the integration of AI in design and innovation processes.

To offer practical insights, an analysis of current AI tools applicable to various stages of the Design Thinking process was conducted. The **criteria for selecting** these tools included:

- Relevance to Design Thinking stages (Empathise, Define, Ideate, Prototype, Test),
- Accessibility and ease of use for non-technical users,
- Cost considerations.

Tools across different categories were evaluated, including:

- Natural Language Processing (NLP) tools for research synthesis and ideation,
- Generative AI for visual prototyping and concept development,
- Machine Learning algorithms for data analysis and user behaviour prediction.

Each tool was assessed based on its functionality and potential impact on the Design Thinking process.

However, it is acknowledged that the rapidly evolving nature of AI presents limitations to this Working Paper. The tools and techniques evaluated may become outdated, and new AI capabilities may emerge that were not considered. To address these limitations, **areas for future research** have been identified, including:

- Comparative analyses of different AI tools across various Design Thinking stages,
- Investigation of industry-specific applications of AI in Design Thinking workshops.

5. AI in Design Thinking Workshops

Integrating AI into Design Thinking workshops represents a step forward in innovation management. This chapter explores the **benefits** and **challenges** of incorporating AI tools into the Design Thinking process.

5.1 Benefits of Applying AI in Design Thinking Workshops

AI tools provide benefits when incorporated into Design Thinking workshops. This includes:

Enhanced Creativity and Ideation - AI can enhance human creativity by generating a wide(r) range of ideas. Tools like *ChatGPT* support brainstorming sessions by offering various perspectives and solutions that human participants might overlook (IDEO U, 2024b). This broadened ideation space can result in more innovative and breakthrough ideas.

Accelerated Research and Synthesis - AI-powered tools can rapidly analyse large amounts of data, helping teams gather insights during the Empathise and Define phases. Natural Language Processing algorithms can synthesise user feedback, market trends, and other relevant information, allowing teams to form comprehensive and data-driven problem statements (HPI d-school, 2025).

Personalised User Experiences - AI can create detailed and realistic personas by analysing large datasets of user behaviour and preferences. This leads to a deeper understanding of target audiences and enables the design of more personalised solutions (Design Thinkers Academy, 2023).

Enhanced Prototyping and Visualisation - Generative AI tools like *DALL-E* and *Midjourney* create visual prototypes from textual descriptions. This enables teams to rapidly iterate on design concepts, visualise ideas, and obtain feedback efficiently (Design Thinkers Academy, 2023).

Efficient Testing and Iteration - AI-powered analytics tools can process user interaction data from prototypes at scale, providing detailed insights into user behaviour and preferences. This allows for more rapid, data-driven iterations of designs (IDEO U, 2024b).

5.2 Challenges of Applying AI in Design Thinking Workshops

While AI offers benefits, its integration into Design Thinking workshops also presents challenges:

Maintaining Human-Centricity - One of the core principles of Design Thinking is its human-centred approach. An overreliance on AI tools could result in a disconnect from the human aspects of problem-solving. Facilitators must ensure that AI is used to support rather than replace human empathy and intuition.

Ethical Considerations and Bias - AI systems can amplify biases in their training data. This is concerning in the context of Design Thinking, where understanding diverse user needs is crucial. Teams must be vigilant in identifying and mitigating potential biases (IDEO U, 2024a).

Overreliance on AI-Generated Solutions - Teams might become overly dependent on AI-generated ideas or solutions, potentially oppressing human creativity and critical thinking. It is important to use AI as a tool for inspiration rather than a replacement for human ideation (HPI d-school, 2025).

Data Privacy and Security - The use of AI tools often involves processing large amounts of data, including sensitive user information. Ensuring the privacy of this data is crucial, especially when working with external stakeholders (Design Thinkers Academy, 2023).

5.3 Integrating AI Across the Design Thinking Process

To utilise AI in Design Thinking workshops, it is important to understand how these tools can be applied in each phase of the process:

Empathise - In the Empathise phase, AI can gather and analyse user data. Tools like natural language processing can help analyse survey responses, social media posts, and customer feedback at scale. For example, AI can identify common themes and sentiments in user comments, providing a more comprehensive understanding of user needs and pain points (HPI d-school, 2025).

Define - During the Define phase, AI can help synthesise research findings and identify key insights. Machine learning algorithms can cluster related ideas and help formulate precise problem statements. This can lead to a more focused and data-driven approach to defining the challenge (Design Thinkers Academy, 2023).

Ideate - AI tools such as *ChatGPT* can be powerful in the Ideation phase. They generate ideas based on the defined problem statement, assisting in overcoming creative blocks and broadening the solution space. It is essential to utilise these AI-generated ideas as inspiration rather than final solutions (IDEO U, 2024b).

Prototype - Generative AI tools can create visual prototypes from ideas developed during the ideation phase. Tools such as *Uizard* transform rough sketches into digital prototypes, speeding up the prototyping process. This helps to visualise and iterate on various design concepts (Design Thinkers Academy, 2023).

Test - In the Test phase, AI can assist in analysing user interactions with prototypes. Machine learning algorithms can process user feedback and behavioural data, providing insights into which aspects of the prototype are working well and which require improvement. This data-driven approach can lead to more effective iterations and refinements (IDEO U, 2024b).

5.4 Best Practices for AI Integration in Design Thinking Workshops

To maximise the benefits of AI while limiting its challenges, the following practices can be considered:

Maintaining a Human-Centred Focus - AI should enhance human creativity and decision-making, not replace it. Empathy and user needs must remain at the core of the process (Jacobsen, 2024).

Establishment of Ethical Guidelines - Guidelines for the ethical use of AI must be developed, addressing issues such as data privacy, bias mitigation, and responsible AI use (IDEO U, 2024a).

Encouragement of Critical Evaluation - Participants should be trained to critically assess AI-generated outputs and utilise them as inspiration rather than as definitive solutions (HPI d-school, 2025).

Balance of AI and Human Input - Workshops ought to be designed to incorporate a mix of AI-assisted activities and conventional human-centred exercises (IDEO U, 2024b).

By integrating AI tools into Design Thinking workshops, teams can enhance their creative problem-solving capabilities while maintaining the human-centred Design Thinking approach.

6. AI Integration Across Design Thinking Phases

Integrating AI into the five phases of the Design Thinking workshop can significantly accelerate the process. This chapter outlines the tools traditionally employed in Design Thinking workshops, typical AI applications in the various phases, sample prompts, along with opportunities and challenges. It covers the five phases: Empathise, Define, Ideate, Prototype, and Test.

6.1 Phase 1: Empathise

The Empathise phase is essential in Design Thinking as it forms the basis for understanding **user needs**, experiences, and **pain points**. AI can improve this phase by analysing large amounts of data and revealing insights that may be difficult for human researchers to identify manually.

Traditionally, designers utilise qualitative and quantitative methods to gather user insights (Jacobsen, 2024):

- User Interviews: Face-to-face or virtual conversations with target users.
- Surveys: Structured questionnaires to collect quantitative data.
- Observation: Direct or indirect observation of user behaviour in a context.
- Focus Groups: Moderated discussions with small groups of users.
- Ethnographic Research: Immersive study of users in their natural environment.

While these methods are valuable, they can be **time-consuming** and **limited in scope**. AI tools can complement these approaches, enriching the depth and breadth of insights obtained.

AI Applications in the Empathise Phase

❶ Natural Language Processing (NLP) for Interview and Survey Analysis

NLP tools can transcribe and analyse interview recordings and open-ended survey responses, identifying common themes, sentiments, and insights that human analysis alone might miss. For example, *IBM Watson Natural Language Understanding* can process unstructured data from interviews, social media, and customer feedback to provide a comprehensive view of user needs (IBM, 2024a).

❷ Sentiment Analysis for Social Media and Customer Feedback

AI tools can analyse social media posts, online reviews, and customer support logs to gauge user sentiment towards existing products or services. This offers a real-time understanding of user pain points and preferences. For example, (fee-based) *Brandwatch Consumer Research* analyses online conversations, providing insights into consumer trends and sentiments (Brandwatch, 2024).

❸ Computer Vision for Behavioural Analysis

AI-powered computer vision analyses video recordings of user interactions with products or services, identifying patterns of behaviour that may not be obvious to human observers. (Fee-based) *Tobii Pro Insight* uses AI to analyse eye-tracking data, providing insights into user engagement (Tobii Pro, 2024).

④ Predictive Analytics for User Persona Creation

AI can help create detailed, data-driven user personas. By analysing large datasets of user behaviour, AI can help identify patterns and characteristics that inform more accurate and nuanced personas. Tools like (fee-based) *Personas by Delve* use machine learning to generate data-driven personas based on qualitative and quantitative data (Delve, 2024).

⑤ Chatbots for Automated User Research

AI-powered chatbots can conduct initial screening interviews or gather preliminary data from users on a large scale. This helps researchers identify areas to focus on during subsequent in-depth interviews. For example, *Typeform's* (fee-based) AI-powered conversational forms can adapt questions based on users' responses, providing more personalised and engaging research (Typeform, 2024).

Example for Food Waste Challenge including Sample Prompts

To address this Working Paper's sample challenge of "**Redesigning food handling in a society where a third of food is wasted**", a combination of AI tools could be employed:

- A **NLP** tool like *IBM Watson* could analyse transcripts from interviews with consumers or food retailers to identify common themes and pain points in the current food handling system:

The image shows a dark blue background with white text. At the top, it reads: "For NLP Analysis - 'Analyse the transcripts from user interviews about food waste habits. Identify the top five recurring themes and provide relevant quotes for each theme.'" Below this, there is a white box containing a list of five themes with their descriptions and relevant quotes. The themes are: 1. Guilt and Emotional Response to Food Waste, 2. Financial Impact of Food Waste, 3. Strategies to Reduce Waste, 4. Food Expiry and Storage Challenges, and 5. Use of Alternative Waste Solutions. At the bottom of the white box, there is a small source URL: "Source: Data Source: https://border.bournemouth.ac.uk/33/1BA%20Lever%20Food%20Waste%20Interview%20Data.pdf?utm_source=chatgpt.com; Analysis by ChatGPT".

For NLP Analysis - "Analyse the transcripts from user interviews about food waste habits. Identify the top five recurring themes and provide relevant quotes for each theme."

- 1. Guilt and Emotional Response to Food Waste:** Many participants expressed guilt when throwing away food, often tying it to financial concerns or environmental impact.
 - "I hate throwing food away, so yes, we always talk to the kids about obviously there are people starving in the world, it's wrong that we don't finish food, and we throw food away, so morally I don't feel so comfortable with it."
 - "I felt really guilty because I come from a background where I grew up with this courtesy of food and it was almost like a crime to waste it when I was a child."
- 2. Financial Impact of Food Waste:** Many participants, especially those on tighter budgets, highlighted the financial loss associated with food waste.
 - "It is a waste of money because you think how long it takes you to earn that money."
 - "I don't like it because I pay for the food and I don't like to just throw it away."
- 3. Strategies to Reduce Waste:** Participants employed various strategies such as meal planning, freezing leftovers, and reorganising their fridges to minimise waste.
 - "I have a little organiser on the fridge with a menu for the week, so we know exactly what we need and don't have to do extra shopping."
 - "We check what's in the freezer before making a shopping list, and we try to use up what we already have first."
- 4. Food Expiry and Storage Challenges:** Decisions about discarding food were often based on visual inspection, smell, and use-by dates, but some participants were cautious about certain items (e.g., dairy and meat).
 - "I am really afraid of eggs and all the lactic products like milk, so I tend to throw them away sooner rather than later."
 - "I try not to rely on sell-by dates but rather check if food still looks and smells fine."
- 5. Use of Alternative Waste Solutions:** Some participants found ways to repurpose waste, such as composting or feeding scraps to pets.
 - "We don't waste much because we have chickens and I've begun composting."
 - "If something is nearing its expiry, I try to use it in a different recipe, like soups or stews, instead of throwing it away."

Source: Data Source: https://border.bournemouth.ac.uk/33/1BA%20Lever%20Food%20Waste%20Interview%20Data.pdf?utm_source=chatgpt.com; Analysis by ChatGPT

Fig. 3 - Empathise Phase: ChatGPT Prompt using NLP Analysis

- A **Sentiment Analysis** tool like *Brandwatch Consumer Research* could analyse social media posts and online discussions regarding food waste to understand public attitudes and behaviours related to food consumption and disposal:

For **Sentiment Analysis** - "Analyse social media posts containing #foodwaste from the past month. Provide a breakdown of sentiment (positive, negative, neutral) and identify the most common emotions associated with food waste discussions."

Analysing social media discussions over the past month using the hashtag #foodwaste reveals a predominantly negative sentiment. This negativity is often accompanied by emotions such as anger, fear, and disgust. These findings align with previous research indicating that food waste topics frequently evoke strong negative reactions.

However, it's noteworthy that positive emotions like joy and surprise also emerge in these discussions, albeit less frequently. This suggests that while the overarching sentiment is negative, there are instances where individuals share positive initiatives, solutions, or success stories related to reducing food waste.


In summary, the discourse surrounding food waste on social media is complex, characterised by a mix of negative and positive sentiments, with a significant emphasis on negative emotions. This highlights the importance of addressing the emotional aspects of food waste in public discussions and interventions.

Source: Analysis by ChatGPT

Fig. 4 - Empathise Phase: ChatGPT Prompt applying Sentiment Analysis

- **Computer Vision Analysis** of video recordings showing how individuals interact with their refrigerators can provide insights into storage habits and decision-making that lead to food waste.
- **Predictive Analytics** could develop detailed personas for consumers based on their food purchasing, storage, and disposal habits:

For **Persona Creation** - "Based on the analysed data, generate three distinct user personas representing different attitudes towards food waste. Include demographic information, key behaviours, pain points, and motivations for each persona."



The Conscious Planner

Demographics

- Age: 35-50
- Gender: Any
- Location: Urban/suburban areas
- Occupation: Middle-class professional, working parent, or financially savvy individual
- Income Level: Middle to upper-middle class.

Key Behaviours

- Regularly make meal plans and create shopping lists to avoid unnecessary purchases.
- Uses leftovers strategically (freezing, repurposing in new meals).
- Relies on personal judgment (smell, appearance) rather than strict expiry dates.
- Prefers fresh food over frozen but uses a combination to reduce waste.

Pain Points

- Occasionally overbuys, particularly for special occasions or guests.
- Feels guilty when wasting food due to ethical and financial reasons.
- Finds it frustrating when household members don't follow waste-reducing practices.

Motivations

- Financial savings and efficiency.
- Environmental and ethical concerns.
- A sense of achievement and control in household management.

Quote

"I hate throwing food away because it's a waste of money and resources. I try to plan our meals, but sometimes we still end up with extra food when plans change."

Source: Visualisation by DALL-E, Text by ChatGPT, Icon made by freepik from www.flaticon.com

Fig. 5 - Empathise Phase: ChatGPT Prompt applying Predictive Analytics (Only one Persona shown)

- An AI-powered **chatbot** could carry out initial surveys with a large number of consumers to collect quantitative data on food waste behaviours and attitudes.

While AI can enhance the Empathise phase, there are some **challenges** to consider:

- **Data Quality and Bias** - AI analysis is only as good as the data on which it is trained. Ensuring diverse and representative data sources is crucial to avoid biases.
- **Contextual Understanding** - AI may overlook nuanced cultural or contextual cues that a human researcher would detect. It is crucial to combine AI insights with human interpretation.
- **Over-reliance on Quantitative Data** - While AI is good at processing large amounts of data, it is essential not to neglect qualitative insights from direct human interaction.
- **Privacy Concerns** - When collecting and analysing user data, it is essential to comply with data protection regulations and ethical guidelines.

6.2 Phase 2: Define

The Define phase is essential for synthesising the insights gathered during the Empathise phase and articulating a **clear problem statement**. AI can enhance this process by helping to identify patterns, prioritise issues, and formulate more precise problem definitions.

Designers typically use several methods to **synthesise information** and **define problems** (Jacobsen, 2024):

- Affinity Mapping: Grouping and categorising insights from user research.
- Empathy Maps: Visualising user attitudes and behaviours.
- User Journey Maps: Charting the user's experience over time.
- Problem Statement Formulation: Crafting "How Might We" questions.
- Persona Development: Creating representative user archetypes.

While these methods are effective, they can be **time-consuming** and **influenced by cognitive biases**. AI tools enhance these methods, providing data-driven insights and minimising subjective interpretations.

AI Applications in the Define Phase

① Clustering Algorithms for Insight Synthesis

AI clustering algorithms can process large volumes of data from the Empathise phase, uncovering patterns and relationships that may not be evident to human analysts. *IBM's Watson Discovery* employs NLP and ML to analyse unstructured data and extract key concepts and relationships (IBM, 2024b).

② Natural Language Processing for Theme Extraction

NLP tools can analyse text data from user interviews, surveys, and social media to identify recurring themes and sentiments. Tools such as (fee-based) *Thematic* utilise AI to automatically analyse open-ended responses and extract key themes (Thematic, 2024).

③ Predictive Analytics for Problem Prioritisation

AI can prioritise identified problems by predicting their potential impact on user satisfaction or business metrics. For instance, *DataRobot's* (fee-based) automated ML platform can analyse historical data to predict the outcomes of addressing different user pain points (DataRobot, 2024).

④ Automated Persona Generation

AI can create more balanced and data-driven personas by analysing large datasets of user behaviour and characteristics. Tools like (fee-based) *Personas by Delve* use ML to generate detailed user personas based on qualitative and quantitative data (Delve, 2024).

⑤ AI-Assisted Problem Statement Formulation

Natural language generation (NLG) tools can assist in crafting more precise and impactful problem statements. For instance, *GPT-3-based tools* can produce multiple versions of "How Might We" questions based on synthesised insights (OpenAI, 2024a).

Example for Food Waste Challenge including Sample Prompts

To define the problem of food waste more precisely, a combination of AI tools could be employed:

- A **clustering algorithm** could analyse data from the Empathise phase, grouping insights into categories such as "storage issues," "over-purchasing," and "confusion about expiration dates.":

The image shows a dark blue background with white text. At the top, a prompt asks for a clustering analysis of household food waste issues. Below, the response lists five categories with their relative importance and a representative quote for each.

For **Clustering Analysis** - "Analyse the user research data and identify the top five clusters of issues contributing to household food waste. Provide a summary of each cluster and its relative importance."

- 1. Overbuying and Poor Planning:** Many respondents admitted to purchasing more food than needed, often due to impulse buys, bulk deals, or a lack of meal planning. While some planned meals carefully, others shopped without a list and later struggled to use everything before expiration.
 - Relative Importance: **High** - One of the most commonly cited reasons for food waste.
 - "I wouldn't say that I'm organised and buy what I need; I tend to think, 'Oh, well, that's a good deal, I'll buy that,' but then sometimes we don't get around to eating it."
- 2. Confusion Over Expiry Dates:** Many interviewees used "use by" and "best before" dates as strict rules rather than guidelines. Some were cautious and discarded food once it reached the printed date, while others relied on sensory checks (smell, texture, appearance) before discarding.
 - Relative Importance: **Medium** - Mentioned frequently but not as universal as overbuying.
 - "I sort of use the sell-by dates and use-by dates but only as an indicator... I hate wasting food, so I always try to use it."
- 3. Lack of Time or Motivation to Use Leftovers:** Many people planned to use leftovers but often forgot about them or lost interest. Some found leftover meals unappealing, while others simply didn't get around to repurposing them.
 - Relative Importance: **High** - A recurring issue in multiple interviews.
 - "We put some leftovers in the fridge to reheat, but we never did and forgot about them. They went in the bin sadly."
- 4. Storage and Freshness Management Issues:** Some respondents lacked proper food storage habits, leading to premature spoilage. Issues included overcrowded fridges, forgetting about perishable items, and improper storage techniques.
 - Relative Importance: **Medium** - A major issue but often linked to broader planning habits.
 - "Sometimes I buy too much fresh food, and it gets buried at the back of the fridge until I find it too late."
- 5. Portion Control and Cooking Habits:** Many people cooked more than needed, leading to uneaten food. This was especially common in households with children, where uneaten food from plates was discarded regularly.
 - Relative Importance: **Medium** - Less frequent than overbuying but still significant.
 - "My kids don't always finish their meals, and I don't like to eat their leftovers, so it ends up in the bin."

Source: Data Source: https://border.bournemouth.ac.uk/33/1BA/20Leverhulme%20Food%20Waste%20Interview%20Data.pdf?utm_source=chatgpt.com; Analysis by ChatGPT

Fig. 6 - Define Phase: ChatGPT Prompt applying Clustering Analysis

- **NLP tools** could analyse textual data from user interviews and social media to identify the most frequently mentioned pain points related to food waste.
- **Predictive analytics** could evaluate which aspects of food waste (e.g., financial loss, environmental impact, guilt) most significantly impact user behaviour:

For **Problem Prioritisation** - "Based on the analysed data, rank the identified food waste issues in order of their predicted impact on reducing overall household waste. Provide a brief rationale for each ranking."

1. **Overbuying and Poor Planning (Highest Impact):** This issue is the most frequently mentioned and has the most significant potential for waste reduction. Many participants admitted to *purchasing more than needed*, often without a shopping list or meal plan. Preventing overbuying at the source would *eliminate waste before it starts*, making this the most impactful area to address.
 - *Potential Solutions:* Meal planning, shopping lists, and awareness campaigns on impulse buying.
2. **Lack of Time or Motivation to Use Leftovers:** Leftover food is often discarded because of forgetfulness or lack of appeal. Since many households *regularly overcook and fail to consume leftovers*, improving leftover management could significantly cut food waste. Since food has already been purchased and cooked, *small behaviour changes (like meal prep habits) could have a significant effect*.
 - *Potential Solutions:* Encouraging creative use of leftovers, better labelling in fridges, and promoting batch cooking with planned reuse.
3. **Confusion Over Expiry Dates:** While not as prevalent as overbuying, many respondents discarded food prematurely due to *misunderstanding "use by" and "best before" labels*. Better consumer education on *sensory checks (smell, texture, colour) rather than strict date adherence* could help prevent unnecessary waste.
 - *Potential Solutions:* Public awareness campaigns, more evident packaging labels, and education on food spoilage indicators.
4. **Storage and Freshness Management Issues:** Many respondents *forgot about perishable food* due to disorganised fridges or improper storage methods. While this issue contributes to waste, it is *secondary to overbuying and planning* since better purchasing habits would naturally reduce the amount of food at risk of spoiling.
 - *Potential Solutions:* Fridge organisation techniques, proper storage education, and smart kitchen technology (e.g., freshness tracking apps).
5. **Portion Control and Cooking Habits (Lower Impact):** While *cooking too much and plate waste* contributes to food waste, this issue ranks lower because it is *more situational and varies across households*. Additionally, people who consistently cook too much often have habits (e.g., freezing leftovers) that already mitigate waste.
 - *Potential Solutions:* Education on portioning, strategies for repurposing uneaten food, and family-friendly meal - planning tips

Source: Data Source: https://border.bournemouth.ac.uk/33/1BA/20Leverhulme%20Food%20Waste%20Interview%20Data.pdf?utm_source=chatgpt.com; Analysis by ChatGPT

Fig. 7 - Define Phase: ChatGPT Prompt applying Predictive Analytics

- **AI-generated personas** could represent various consumer types based on their food waste habits, assisting in refining the problem definition for specific user groups.
- An **NLG tool** could produce multiple versions of problem statements, such as "How might we help busy families reduce food waste without adding complexity to their meal planning?"

For **Problem Statement Generation** - "Generate five 'How Might We' questions addressing the food waste challenge, focusing on the most significant issues identified in the analysis. Ensure the questions are specific, actionable, and user-centered."

1. **Overbuying and Poor Planning (Highest Impact):** *How might we help households make smarter shopping decisions to reduce impulse buying and over-purchasing of perishable foods?*
 - *Focus:* Encouraging better meal planning, grocery list usage, and mindful shopping.
2. **Lack of Time or Motivation to Use Leftovers:** *How might we make leftover meals more appealing, convenient, and easy to track so that households actually use them?*
 - *Focus:* Improving leftover visibility, reusing food creatively, and reducing the "out of sight, out of mind" problem.
3. **Confusion Over Expiry Dates:** *How might we help consumers better understand food expiration labels and reduce unnecessary waste due to date confusion?*
 - *Focus:* Educating users on "best before" vs. "use by", encouraging sensory checks, and improving labelling clarity.
4. **Storage and Freshness Management Issues:** *How might we help people store food properly and organise their kitchens to extend freshness and reduce forgotten waste?*
 - *Focus:* Smart storage solutions, fridge organisation tips, and reminders for soon-to-expire food.
5. **Portion Control and Cooking Habits:** *How might we help individuals and families cook just the right amount of food to reduce uneaten leftovers and plate waste?*
 - *Focus:* Right-sizing portions, batch cooking strategies, and making it easy to repurpose extra food.

Source: Data Source: https://border.bournemouth.ac.uk/33/1BA/20Leverhulme%20Food%20Waste%20Interview%20Data.pdf?utm_source=chatgpt.com; Analysis by ChatGPT

Fig. 8 - Define Phase: ChatGPT Prompt applying NLG to generate HMW Questions

While AI can enhance the Define phase, some additional **challenges** should be considered:

- **Maintaining Human Insight** - Although AI can recognise patterns, human expertise remains essential for interpreting them within the wider context of the design challenge.

- **Balancing Quantitative and Qualitative Data** - AI excels at processing quantitative data; however, qualitative insights derived from human observation and interpretation are equally important.
- **Preventing Overgeneralisation** - AI-generated insights may fail to capture the nuances of individual user experiences, potentially resulting in excessively broad problem definitions.
- **Data Quality and Quantity** - The effectiveness of AI analysis relies on the quality and quantity of data gathered from the Empathise phase. Insufficient or biased data can result in warped problem definitions.

6.3 Phase 3: Ideation

The Ideation phase is critical in Design Thinking as it aims to **generate** a wide range of potential **solutions to the problem** defined in the previous phase. AI can enhance this creative process by expanding the solution space and providing new perspectives.

Designers typically employ various ideation techniques to generate and explore ideas (Jacobsen, 2024):

- Brainstorming: Group sessions to generate a large quantity of ideas.
- Mind Mapping: Visual diagrams to explore and organise ideas.
- SCAMPER: A technique to modify existing ideas.
- Six Thinking Hats: A method to approach problems from different perspectives.
- Analogical Thinking: Drawing inspiration from unrelated fields or concepts.

While these methods are effective, they can sometimes be **limited by the team's knowledge, experience, and cognitive biases**. AI tools can complement these approaches by introducing new perspectives and expanding the scope of possible solutions.

AI Applications in the Ideation Phase

1 Generative AI for Idea Expansion

AI tools like *GPT-3* and its successors can generate many ideas based on the problem statement. These tools can provide unexpected combinations and novel approaches that human teams might overlook. *ChatGPT* can be prompted to create innovative solutions for specific challenges (OpenAI, 2024b).

2 Visual Ideation Tools

AI-powered visual generation tools such as *DALL-E 2* or *Midjourney* can create images from text descriptions, aiding in visualising abstract concepts. This can be useful for product design or user interface ideation (Midjourney, 2024).

3 Semantic Networks for Analogical Thinking

AI can create semantic networks that connect seemingly unrelated concepts, thereby facilitating analogical thinking. Tools such as (fee-based) *Dimensions.ai* utilise ML to map relationships across various research fields, potentially inspiring innovation across domains (Dimensions, 2024).

4 Collaborative AI Agents

Advanced AI systems can act as virtual team members during brainstorming sessions, providing ideas and enhancing human-generated concepts. For example, *Cogito's* (fee-based) AI collaborates with human agents in real time, augmenting their decision-making and creative processes (Cogito, 2024).

5 AI-Powered Idea Evaluation

ML algorithms can help evaluate and cluster generated ideas, identifying common themes and assessing their potential impact and feasibility. Tools like (fee-based) *Spigit* (now: *Planview IdeaPlace*) use AI to analyse and prioritise ideas generated during innovation challenges (Spigit, 2024).

Example for Food Waste Challenge including Sample Prompts

To generate innovative solutions for reducing food waste, a combination of AI tools could be employed:

- A **generative AI** tool could be prompted to propose solutions ranging from smart refrigerators to community-sharing platforms, producing hundreds of potential ideas:

For **Generative AI** - "Generate 50 innovative ideas for reducing household food waste, incorporating aspects of IoT technology, behavioural psychology, and community engagement. Ensure a mix of high-tech and low-tech solutions."

IoT & Smart Technology Solutions (High-Tech)	Behavioural Psychology-Based Solutions	Community Engagement & Social Initiatives
<ol style="list-style-type: none">Smart Fridge Assistant A built-in AI system that tracks expiration dates and suggests meals.IoT-Connected Food Storage Jars that change LED colours as food nears expiration.AI-powered Grocery List App Syncs with fridge sensors to suggest shopping lists based on food usage patterns.AR Expiry Scanner Users scan food with a phone camera to see expiration status and freshness tips.Voice-Activated Food Waste Tracker Logs discarded items via smart speakers (e.g., Alexa) to analyse waste habits.Smart Recipe Generator An AI-powered app that creates recipes based on expiring ingredients.Fridge Organisation AI Assistant Uses cameras inside fridges to recommend optimal storage locations for freshness.Food Expiry Reminders via Smart Home Integration Notifications sent via smart home devices when food is nearing expiry.Automated Portioning System Kitchen scale that suggests serving sizes to prevent overcooking.Blockchain-Enabled Food Sharing A decentralised app where neighbors can list surplus food items for pickup.	<ol style="list-style-type: none">Gamified Food Waste Reduction App Rewards users with points for reducing waste.Commitment Contracts for Smart Shopping Users pledge to buy only what they need and get reminders of their goals.Colour-Coded Fridge Sections Visual cues help prioritise food usage (e.g., "Eat Soon" section).Mood-Based Cooking Suggestions AI suggests meals based on available food and user mood.AI Nudges in Smart Kitchens Subtle prompts like "Would you like to use your spinach before it goes bad?"Psychological Anchoring for Food Expiry Dates Adjusting "best before" labels to emphasise usability over strict expiry.Plate Size Recommendations Based on Habits AI learns portion habits and suggests adjustment.Endowment Effect Food Tracker Reminders that link food waste to financial loss.Meal Planning Subscription with Pre-Portioned Ingredients A weekly meal kit that only provides the needed portions.Mindful Eating Journals Encouraging people to track food purchases and consumption for awareness.	<ol style="list-style-type: none">Neighborhood Food Exchange A local platform where people swap extra food.Community Fridges with IoT Locks Shared fridges that log who donates and picks up items.School & Workplace Food Rescue Challenges Local competitions to encourage food-sharing and waste reduction.Digital Leftover Matching Service Matches households with charities that need food items.Pop-Up Zero-Waste Cooking Classes Teaching how to use leftovers in meals creatively.Social Media Challenge for Food Waste Reduction Trend-based food-saving challenges on platforms like TikTok.Crowdsourced Best Practices App A community-driven app where people share creative food waste solutions.Grocery Store Food Waste Discounts Members get discounts if they commit to purchasing nearly-expired items."Rescue My Food" Pickup Service Neighbors list excess food, volunteers pick it up for donation.Food Waste Awareness Ambassador Program Community members trained to spread awareness.

Source: Text by ChatGPT; Icon made by freepik from www.flaticon.com

Fig. 9 - Ideation Phase: ChatGPT Prompt applied to generate 50 ideas (Only 30 ideas shown)

- **Visual AI** could generate mock-ups of proposed solutions, including user interfaces for food-tracking apps or designs for innovative packaging:

For **Visual Ideation** - "Create five visual concepts for a smart kitchen device that helps users track food freshness and suggests recipes to minimise waste. Include both *futuristic* and retro-inspired designs."



Fig. 10 - Ideation Phase: ChatGPT Prompt using Visual Ideation (Only "futuristic" concepts shown)

- A **semantic network** tool could identify potential solutions from other domains, such as how logistics companies optimise inventory and apply these concepts to the management of household food:

For **Analogical Thinking** - "Identify ten effective strategies from the field of supply chain management and adapt them into potential solutions for household food waste reduction."

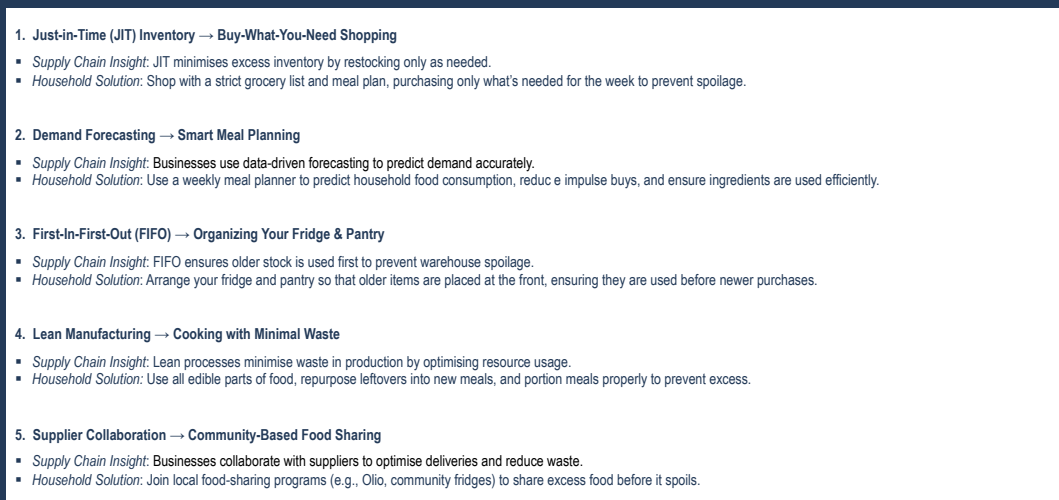


Fig. 11 - Ideation Phase: ChatGPT Prompt using a Analogical Thinking (Only five concepts shown)

- **Collaborative AI** could engage in virtual brainstorming sessions, providing ideas and assisting in the combination and refinement of concepts proposed by human team members.
- AI-powered **evaluation tools** could analyse the generated ideas, cluster them into themes, and assess their potential impact on reducing food waste.

While AI can enhance the Ideate phase, some additional **challenges** should be considered:

- **Balancing AI and Human Creativity:** Although AI can generate numerous ideas, it is essential to maintain human creativity in the process. AI should enhance, not replace, human ideation.
- **Quality versus Quantity:** AI can generate many ideas, but not all will be practical or relevant. Human expertise is needed to filter and refine concepts generated by AI.
- **Ethical and Feasibility Considerations:** AI may suggest ideas that are technically innovative yet could raise ethical concerns or prove unfeasible in practice.
- **Overreliance on AI:** There is a risk that teams may become overly dependent on AI-generated ideas, which could hinder their creative thinking.

6.4 Phase 4: Prototype

The Prototype phase in Design Thinking is where ideas take a **tangible form**. This phase involves creating low-fidelity representations of solutions to gather feedback and refine concepts. AI can enhance this process by accelerating prototype creation, enabling more iterations, and providing data-driven insights for refinement.

Designers typically use various methods to create prototypes (Jacobsen, 2024):

- Paper Prototypes: Quick sketches or paper mock-ups of interfaces or products.
- Digital Wireframes: Low-fidelity digital representations of user interfaces.
- 3D Printing: Physical prototypes for product design.
- Storyboarding: Visual sequences to illustrate user journeys or processes.
- Role-Playing: Acting out scenarios to test service designs.

While these methods are effective, they can be **time-consuming** and **limited by the designer's technical skills**. AI tools can augment these approaches, enabling rapid prototyping and more sophisticated representations.

AI Applications in the Prototype Phase

1 Generative Design for Rapid Prototyping

AI-powered generative design tools can produce numerous design variations based on fixed parameters. (Fee-based) *Autodesk's Generative Design* employs AI to investigate thousands of design options that satisfy specified criteria (Autodesk, 2024).

2 AI-Powered Sketching and Wireframing

Tools like *Uizard* use ML to transform rough sketches or low-fidelity wireframes into digital prototypes. This allows designers to turn ideas into testable interfaces (Uizard, 2024).

3 Natural Language to User Interface (UI) Generation

Advanced AI models can generate UI prototypes directly from natural language descriptions. For instance, *GPT-3*-based tools can create basic HTML/CSS layouts based on textual descriptions of desired interfaces (OpenAI, 2024c).

4 Virtual and Augmented Reality Prototyping

AI-enhanced VR and AR tools enable the creation of immersive prototypes. Platforms like *Unity's AR Foundation* use ML to improve AR experiences, allowing for interactive prototypes (Unity, 2024).

5 AI-Assisted 3D Modelling

AI can assist in creating 3D models for physical product design. Tools like (fee-based) *Siemens NX* use AI to automate aspects of the 3D modelling process, speeding up prototype creation (Siemens, 2024).

Example for Food Waste Challenge including Sample Prompts

To prototype solutions for the food waste challenge, a combination of AI tools can be employed:

- **Generative design** can create multiple variations of smart food storage containers, optimising for factors like air circulation and visibility:

For **Generative Design** - "Generate ten design variations for a modular food storage system that optimises for visibility, accessibility, and freshness preservation. Consider both refrigerated and pantry storage."



Transparent Stackable Containers with Expiry Date Indicators

- **Key Features:** Clear, BPA-free plastic or glass containers with built-in digital expiry date displays automatically updating when items are placed inside.
- **Use Case:** Fridge and pantry organisation, preventing forgotten food.

Rotating Shelf System with FIFO Mechanism

- **Key Features:** A pull-down rotating shelf system ensures older items move forward when new items are added, enforcing First-In-First-Out (FIFO) use.
- **Use Case:** Perfect for fridge storage (yogurts, sauces) and dry goods in pantries.

Slide-Out Transparent Crisper Trays with Humidity Control

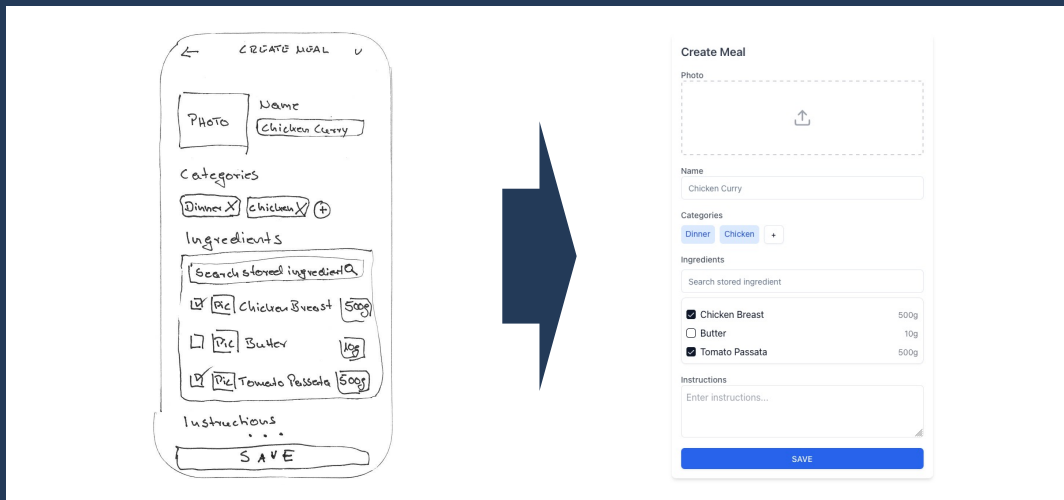
- **Key Features:** Fridge-compatible slide-out trays with adjustable humidity settings and anti-fogging transparent covers for easy visibility.
- **Use Case:** Preserves leafy greens, berries, and other delicate produce.

Source: Visualisation by DALL-E. Icon made by freepik from www.flaticon.com

Fig. 12 - Prototype Phase: ChatGPT Prompt for generating Designs (Only three concepts shown)

- **AI-powered sketching** tools could rapidly convert hand-drawn concepts of a food waste tracking app into testable digital prototypes.

For **AI-Powered Sketching** - "Convert this hand-drawn sketch of a food waste tracking app into a high-fidelity digital prototype. Maintain the core layout while enhancing visual design and adding standard UI elements."

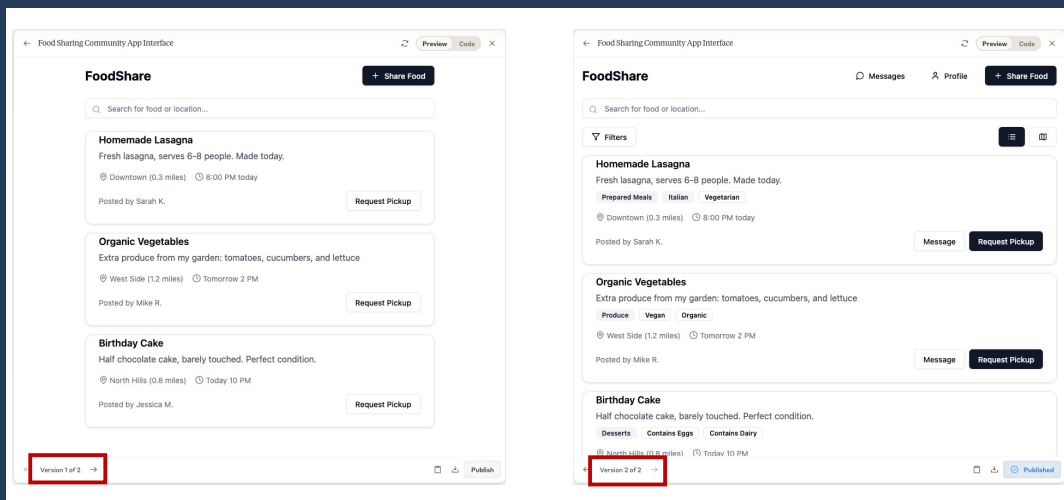


Source: Skitch, Jacobsen, 2025; Programmierung & Visualisation by ChatGPT

Fig. 13 - Prototype Phase: Using ChatGPT for AI-powered Generation of Food Waste App

- **Natural language to UI generation** could create a basic interface for a community food-sharing platform based on a text description of desired features.

For **Natural Language to UI Generation** - "Create a basic UI prototype for a community food-sharing app. Include features for listing excess food items, searching nearby offerings, and coordinating pick-ups. Use a clean, modern design style."



Source: Programmierung & Visualisation by CLAUDE

Fig. 14 - Prototype Phase: Using CLAUDE for UI Generation (Original and AI-suggested Improvement)

- **AR prototyping tools** can be used to visualise how a smart refrigerator interface looks and functions in a real kitchen environment.
- **AI-assisted 3D modelling** can help design and optimise physical prototypes of food preservation devices.

While AI can enhance the Prototype phase, several **challenges** should be considered:

- **Balancing Speed and Fidelity:** While AI can produce high-fidelity prototypes swiftly, it is crucial to acknowledge the significance of low-fidelity prototyping during the initial design phases.
- **Maintaining Design Intent:** AI-generated prototypes might not accurately embody the designer's original intent. Human oversight and refinement are essential.
- **Technical Limitations:** Certain AI prototyping tools may possess limitations regarding customisation or the implementation of specific features.
- **User-Centredness:** It is essential to ensure that the efficiency achieved through AI-assisted prototyping does not come at the cost of user-centred design principles.

6.5 Phase 5: Test

The Test phase validates ideas and **gathers user feedback** to **refine solutions**. This involves exposing prototypes to users and collecting data on their interactions and responses. AI enhances this process by enabling comprehensive testing, providing insights, and facilitating rapid iterations based on feedback.

Designers typically use various methods to test prototypes (Jacobsen, 2024):

- User Testing Sessions: Observing users interacting with prototypes in controlled environments.
- A/B Testing: Comparing two design versions to see which performs better.
- Surveys and Questionnaires: Collecting structured feedback from users.
- Heatmaps and Click Tracking: Visualising user interactions with digital interfaces.
- Focus Groups: Gathering qualitative feedback from small groups of users.

While these methods are valuable, they can be **time-consuming** and occasionally **limited in scale**. AI tools can enhance these approaches, facilitating more comprehensive and efficient testing.

AI Applications in the Test Phase

1 Automated Usability Testing

AI-powered tools can perform automated usability tests on a large scale. For example, (fee-based) *UserTesting's Intelligent Insights* utilises ML to analyse user sessions and identify key moments and issues (UserTesting, 2024).

2 Predictive User Behaviour Modelling

ML algorithms can predict user behaviour based on historical data and prototype interactions. Tools like *Contentsquare* use AI to forecast how changes in design elements might affect user behaviour (Contentsquare, 2024).

3 Sentiment Analysis of User Feedback

NLP tools can analyse open-ended user feedback to gauge sentiment and identify common themes. For instance, (fee-based) *Qualtrics XM* employs AI to analyse survey responses and provide sentiment scores (Qualtrics, 2024).

4 Eye-Tracking and Facial Expression Analysis

AI-powered computer vision can analyse eye movements and facial expressions during user testing, offering insights into user attention and emotional responses. (Fee-based) *Tobii Pro Fusion* integrates eye-tracking with machine learning to provide behavioural insights (Tobii Pro, 2024).

⑤ A/B Testing Optimisation

AI can optimise A/B testing by dynamically allocating traffic to more effective variants and proposing new variations to test. Tools such as (fee-based) *Optimizely* employ ML to accelerate experimentation and enhance results (Optimizely, 2024).

Example for Food Waste Challenge including Sample Prompts

To test solutions for the food waste challenge, a combination of AI tools could be employed:

- **Automated usability testing** could analyse user interactions with a food waste tracking app, identifying pain points along the user journey.
- **Predictive modelling** could forecast how different features of a smart refrigerator interface may affect food waste behaviour.
- **Sentiment analysis** may analyse user feedback on a community food-sharing platform, identifying areas of satisfaction and concern.
- **Eye-tracking analysis** may uncover which aspects of a food storage system prototype users perceive as most intuitive or confusing.
- AI-optimised **A/B testing** could evaluate various versions of food freshness indicators to identify which is the most effective at reducing waste.

For Automated **Usability Testing** - "Analyse user sessions with the food waste tracking app prototype. Identify the top five usability issues and provide recommendations for improvement based on observed user behaviour patterns."

For **Predictive User Behaviour Modelling** – "Based on historical data and current prototype interactions, predict how the implementation of a 'smart expiration date' feature in the refrigerator interface would impact food waste behaviour over a three-month period."

For **Sentiment Analysis** - "Analyse user feedback from the community food sharing platform beta test. Provide a sentiment breakdown and identify the top three positive features and top three areas for improvement mentioned by users."

While AI can enhance the Test phase, some additional **challenges** should be considered:

- **Interpreting AI-Generated Insights:** The insights generated by AI tools may necessitate interpretation and contextualisation by human experts to be meaningful.
- **Avoiding Bias in AI Analysis:** To prevent the perpetuation of biases in testing results, it is important to ensure that the AI models employed for analysis are trained on diverse datasets.
- **Maintaining Human Empathy:** While AI can provide valuable insights, it is crucial to maintain the human touch when understanding user needs and experiences.

7. Ethical Considerations

As AI becomes integrated into Design Thinking processes, the **ethical implications** of its use must be considered. This chapter explores key ethical considerations and provides hints for responsible AI integration in Design Thinking workshops.

One of the challenges in AI development is the potential for bias. AI systems learn from data; if that data contains **biases**, the AI will replicate and amplify them (Humane Design Thinking, 2024). In Design Thinking workshops, this could lead to insights that do not adequately address the needs of all users.

To reduce bias:

- A variety of datasets should be utilised to train AI tools.
- AI outputs should be regularly audited for potential biases.
- A diverse representation in user testing and feedback sessions must be guaranteed.

The "black box" nature of AI systems can undermine trust in the Design Thinking process (Humane Design Thinking, 2024). Maintaining **transparency** in how AI tools are used and influence decisions is essential.

Recommended practices include:

- Offering clear explanations of how AI algorithms function.
- Ensuring that AI-assisted decisions can be traced back to the underlying data.
- Human oversight in critical decision points is maintained.

As AI tools process large amounts of user data, **protecting privacy** is paramount. Design Thinking practitioners must ensure compliance with **data protection regulations** and ethical data handling practices (Parachute Design, 2024).

Key considerations:

- Consent must be obtained for the collection and use of data.
- Data should be anonymised whenever possible.
- Robust data security measures should be implemented.

While AI can enhance the Design Thinking process, it is essential to maintain a **human-centred approach**. The European Commission highlights the importance of "Ethics by Design," which entails considering potential ethical concerns while developing AI systems (European Commission, 2024).

Guidelines for human-centred AI in Design Thinking:

- User needs and experiences must be prioritised over technological capabilities.
- It must be ensured that AI tools enhance rather than replace human creativity and empathy.
- The impact of AI integration on the design process and its outcomes must be regularly evaluated.

By addressing these considerations, Design Thinking practitioners can use the power of AI while ensuring responsible and human-centred innovation. As the topic evolves, staying informed about ethical guidelines and best practices will be relevant for maintaining the integrity of the Design Thinking process.

8. Future Trends

As AI continues to integrate with Design Thinking, some emerging trends are shaping the future of innovation and problem-solving. This chapter looks at **key developments** likely to influence the intersection of AI and Design Thinking.

One promising trend is using **predictive AI to anticipate user needs** before they are explicitly expressed. This capability has the potential to improve the Empathise phase of Design Thinking.

Advanced ML algorithms are increasingly skilled at analysing large amounts of user data to identify patterns and predict future behaviours. This enables designers to proactively address user needs and develop more relevant solutions. For instance, AI could analyse user interaction data with a product and predict potential pain points or desired features before users even articulate them (Paul4innovating, 2023).

AI-powered **generative design** is set to transform the Ideate and Prototype phases. These tools can generate numerous design variations based on specified parameters, enabling designers to explore a much wider range of possibilities in a shorter time frame (Paul4innovating, 2023). As generative AI becomes more sophisticated, it can be expected:

- AI systems are capable of learning from designer preferences and adapting their outputs accordingly.
- Automated prototyping systems can produce physical or digital prototypes derived from AI-generated designs.

AI's capability to process and analyse individual user data facilitates a **new level of personalisation** in design solutions. This trend will likely influence all phases of the Design Thinking process, from user research to final implementation. Future AI systems might have the capability to craft highly personalised user experiences by:

- Customising prototypes for individual user testing.
- Adapting final solutions in real-time according to user interactions and feedback (Paul4innovating, 2023).

The future of AI in Design Thinking is likely to be **multimodal**, integrating text, image, and voice analysis to offer more comprehensive insights. This integration of multiple AI capabilities can enhance various stages of the Design Thinking process:

- In the Empathise phase, multimodal AI could analyse user interviews, facial expressions, and tone of voice to provide more profound insights into user emotions and needs.
- During Ideation, AI could generate ideas in various formats, including textual descriptions, visual concepts, and audio or video representations.
- In Prototyping, multimodal AI can create more immersive and interactive prototypes that engage multiple senses (IDEO U, 2024a).

AI systems are increasingly capable of **continuous learning**, adapting their outputs based on ongoing feedback and new data. This trend has implications for the Test phase of Design Thinking:

- AI could analyse user feedback in real-time during testing, recommending immediate adjustments to the prototype.

- Design solutions may evolve as AI systems continually optimise based on user interactions and changing needs (Paul4innovating, 2023).

The future of Design Thinking with AI will involve more **advanced collaboration** between humans and AI systems. This may include:

- AI assistants are capable of actively participating in brainstorming sessions by providing ideas and enhancing human concepts.
- Virtual reality environments allow designers to collaborate with AI in immersive 3D spaces.
- AI systems facilitate remote collaboration by synthesising ideas from distributed team members working remotely.

The **convergence of AI and IoT technologies** is set to create new possibilities for Design Thinking:

- IoT devices could provide real-time data to enhance the Empathise and Test phases.
- AI could analyse data from IoT devices to identify usage patterns and guide design decisions.
- Prototypes can be tested in real-world environments utilising IoT sensors and AI analysis (Kaplan, 2024)

While these trends offer exciting possibilities, they also present **challenges** that will need to be addressed:

- Balancing AI assistance with human creativity and intuition.
- Ensuring AI systems understand and honour cultural nuances in design.
- Addressing privacy concerns as AI systems handle increasing amounts of personal data.

When considering the future, AI will undoubtedly play a significant role in Design Thinking. Nevertheless, the fundamental principles of human-centred design will remain relevant. The most successful applications of AI in Design Thinking will enhance human creativity and empathy rather than attempt to replace them. The future of Design Thinking is one in which human insight and AI capabilities collaborate to address complex challenges and drive innovation.

9. Recommendations

The integration of AI into Design Thinking represents an improvement in problem-solving and innovation management. This Working Paper has explored the synergies between AI and Design Thinking, highlighting how this integration can **enhance creativity and efficiency** across all phases of the process.

The research has revealed some **key findings**:

- AI significantly enhances the **Empathise phase** by providing deeper insights into user behaviour and needs through advanced data analysis (IDEO U, 2024a).
- In the **Define phase**, AI tools help synthesise large amounts of data, resulting in more precise problem statements and personas (ISJTREND, 2024).
- AI enhances the **Ideation phase** by generating a broader range of ideas and concepts, pushing the limits of conventional thinking (Kaplan, 2024).
- **Prototyping** is improved by AI-powered tools that can rapidly generate and iterate on design concepts (ITONICS, 2024).
- The **Test phase** benefits from AI's ability to analyse user interactions on a large scale, providing more comprehensive feedback for refinement (ITONICS, 2024).

Based on these findings, the following **recommendations** are offered:

- **Small Start and Gradual Scale** - The process should start by integrating AI into one or two stages of the Design Thinking project. For example, AI can gather and analyse user data during the Empathise phase or generate initial design concepts during ideation (Appnova, 2024).
- **Fostering a Collaborative Approach** - Collaboration between AI tools and human designers should be encouraged. AI can handle data-intensive tasks, while human designers concentrate on creativity and intuition (Appnova, 2024). This synergy enables a nuanced approach to problem-solving.
- **Maintaining Human Oversight** - Although AI can generate options and provide insights, the ultimate decisions should be made by designers who can consider the nuances that AI might miss (Appnova, 2024). Maintaining a balance between AI-driven insights and human judgement is essential.

The **future** of Design Thinking with AI integration appears promising. The following **trends are to be anticipated**:

- **Predictive AI** for anticipating user needs before explicitly articulating them (ITONICS, 2024).
- More sophisticated **generative design tools** for rapid prototyping and iteration (ITONICS, 2024).
- **Enhanced personalisation** using AI results in more tailored user experiences (IDEO U, 2024a).
- **Multimodal AI** that combines text, image, and voice analysis for more comprehensive insights (ITONICS, 2024).

Although the integration of AI into Design Thinking offers advantages, it also presents **challenges and opportunities** that must be addressed:

- Balancing AI assistance with human creativity and intuition.
- Ensuring AI systems understand and respect cultural nuances in design.
- Managing potential job displacement as AI takes on more design tasks.
- Addressing privacy concerns as AI systems process more personal data.
- More data-informed decision-making in the design process.
- Faster iteration cycles, allowing for more refined final solutions.

- Ability to tackle more complex design challenges through enhanced analytical capabilities.
- Democratisation of design tools, making advanced design processes more accessible.

Integrating AI into Design Thinking represents a powerful synergy between data-driven insights and human-centred creativity, offering possibilities for innovation and problem-solving (ISJTREND, 2024). By combining the strengths of AI technology with the empathetic nature of Design Thinking, designers can utilise data analytics, automation, and predictive modelling to enhance the design process while prioritising user needs and experiences.

For students and practitioners seeking to incorporate AI into their Design Thinking workshops, the following recommendations are suggested:

- Familiarisation with AI tools relevant to each phase of Design Thinking.
- Experimenting with AI-assisted Ideation and Prototyping in the next project.
- Staying informed about emerging AI technologies and their potential applications in design.

By integrating AI into Design Thinking processes, more impactful, user-centred solutions can be created that address complex challenges in innovative ways. The future of Design Thinking is one where human insight and AI capabilities work harmoniously to drive innovation and create meaningful change.

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