Reimagining Recommender Systems

Reframing the future of personalised computational systems in the home

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Master Thesis

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ABSTRACT

At this moment in time, commercial corporations process large amounts of our consumer data through machine learning systems to create digital profiles. These highly individualised profiles are then sold and traded in what we may now consider Surveillance Capitalism. At the same time, experts are looking into possible future solutions in the direction of decentralised recommender systems, allowing users to own and train their own algorithm over entire lifespans. These devices would in effect secure, or at least obfuscate, the periphery of your digital footprint. This idea comes with social, design and technical challenges.

Designers find it hard to design for these types of ideas and technological experts in turn have difficulties giving shape to technological concepts. This project seeks to identify the research possibilities for this topic and is focused on speculating on the possible design imaginations, rather than providing a set of technological solutions. To explore this design space, it employs speculative futuring techniques in the form of so-called imagining machine workshops, collaborative ideation and in-home deployments. Research through design methods, like interviews, workshops and the deployment of both semi-functional and non-functional prototypes form the research interventions.

The project's outcomes provide a methodology for rethinking computational systems, encouraging speculative thinking among domain experts. This material serves as the foundation for speculative design guidelines for working with complex technologies, presenting future possibilities as a domain for translating novel technological concepts into foundational materials for research and design.

This Final Master project (FMP) project was in the making for over three four-month periods of time in the department of Industrial Design at Eindhoven Technical University and the Recommender system research group at TU Wien. During the earlier M1.2 project, the possible effects of Surveillance capitalism on a specific group of people was researched and a possible research program was developed. The research stay at Technische Universität Wien (TU Wien) gave insight into how recommender systems are built. This FMP project builds upon the insights gathered in these earlier projects.

INTRODUCTION

Surveillance capitalism and its methods have infiltrated the fabric of our daily lives, affecting our decisions and behaviour in both visible and invisible ways [40]. Commercial businesses process and sell a wide variety of our consumer data, from our browsing history to our purchasing patterns, to create highly personalised profiles. This phenomenon, known as Surveillance Capitalism, is frequently disguised as personalised experience or customised recommendations. These are tailored to users by recommender systems that essentially calculate how likely it is for a user to buy a certain product based on their past behaviour. These systems often work with sensitive data and sometimes have unforeseen consequences.

As designers, we have a unique opportunity to spark change and question the status quo. Our trade enables us to imagine, design, and launch things and systems that will change how people interact with computing devices. We have the potential to raise knowledge of, and accountability for, the ethical issues of recommender systems. However, to do so, we must first acknowledge the magnitude of problem and understand how the system works.

There has been an increase in study towards alternate alternatives, such as decentralised recommender systems because of the pervasiveness of recommender systems and their consequences for privacy [7]. These solutions let individuals to own and develop their own algorithms, giving them greater control over their digital fingerprint. Regardless of the potential benefits, such systems pose their own set of social, technological, and design issues.

This thesis presents a multi-pronged strategy for dealing with these challenges by engaging domain experts to reimage and rethink these computational systems in the home. Rather than proposing a specific solution, the purpose is to broaden the horizon of alternatives by investigating the complexities and subtleties of this design domain. The approach comprises the use of speculative futuring methodologies, collaborative ideation, and in-home deployments, as well as doing research using design methods such as interviews, workshops, and prototype deployment.

Furthermore, this thesis condenses the information and insights gathered into a set of guidelines and gives examples of how to implement them to assist designers in building products that respond to consumers' privacy concerns. It aims to bridge the gap between designers, design researchers, and data scientists. This could help to inspire discussion and raise awareness about the intricate network of Surveillance Capitalism.

THEORETICAL BACKGROUND

Surveillance capitalism

Through the utilisation of machine learning systems, commercial corporations process significant amounts of consumer data to develop digital profiles. The phenomenon of rapidly selling and trading highly individualised profiles may be investigated through the context of Surveillance Capitalism [40] Surveillance capitalism is an unprecedented phenomenon, which makes it difficult to make sense of, especially because we do not have a coherent vocabulary for it yet. Identifying and naming the ubiquitous digital instruments, that record and extract human experiences in everyday life, might be a way to start taming this phenomenon based on Shoshana Zuboff (2019) [41]. But creating a vocabulary is complex, especially for mechanisms that are invisible by design. Zuboff and others give some examples of how we could start to touch upon this complex topic.

Zuboff mentions some possible ways to combat Surveillance Capitalism [40].

- It is critical for legislators to devise effective tactics for disrupting and, in some cases, prohibiting the underlying mechanics of surveillance capitalism.
- Users often reject surveillance capitalism when they become aware of its underlying mechanics. They frequently seek protection and alternatives to this arrangement. Companies that efficiently cater to the true needs of individuals while adhering to the principles of market democracy could generate a global consumer base.
- Legislators must promote new forms of citizen involvement and collective action. This is reminiscent of the legal protection that workers won nearly a century ago, which secured them the ability to organise, bargain, and strike.

Recommender systems

A mechanism that is of interest in this research are recommender systems, which rank items/products for a user based on various assumptions about the person's interests. It could be based on previous interactions with a product, such as if a consumer previously purchased a similar or same product. To produce reliable customised recommendations, these systems require detailed user input. Examples include ratings, consumption histories, personal profiles, and company-gathered person-specific data such as location, phone kind, and gender [44]. This is handled by a machine learning algorithm and is utilised in services like as Google, Meta, Netflix, Amazon, and Spotify. However, because of the algorithmic complexity of these systems, people find it difficult to grasp how and why specific things were suggested [35].

Recommender systems are useful, but they also present privacy issues that are frequently overlooked. Many consumers are unaware of how much data is collected, sold to third parties, or safely maintained, and for how long [23]. To combat this privacy-protection mechanisms should be integrated into the system, although they should not interfere with the recommender system's operation. As mentioned by Jeckmans, et.al. [2013]:" the users and the service provider should not be overburdened, and the functionality and accuracy of the recommender system should not be hampered" [23].

Ethical implications of recommender systems [7]

The paper titled "Recommender systems and their ethical challenges" authored by Silvia Milano, Mariarosaria Taddeo, and Luciano Floridi [2020] provides a comprehensive examination of the ethical issues associated with recommender systems, based on a thorough analysis of existing literature [29].

The identified concerns are categorised into various ethical impacts based on a proposed taxonomy by the authors.

1) It is imperative for recommender systems to exhibit transparency and explainability to users. This enables users to comprehend the process of generating recommendations and the rationale behind them.
2) Privacy and data protection are important considerations for recommender systems. Personal data should be safeguarded, and the privacy should be respected.
3) It is crucial to prioritise fairness and avoid any form of discrimination. This can be achieved by designing the system in a way that ensures recommendations are not biased against any group of users.
4) When designing recommender systems, it is important to consider the autonomy of users and avoid any form of manipulation that may influence their behaviour.

5) In the realm of recommender systems, it is crucial to prioritise trust and responsibility. This can be achieved through the design of accurate, reliable, and unbiased recommendation algorithms.

6) It is imperative to consider the social and cultural impact of recommender systems during the design process. The design should aim to avoid perpetuating stereotypes or encouraging harmful behaviours through the recommendations provided.

The prime focus of this project is privacy and data protection, but rest of the taxonomy is considered.

Decentralised computational systems

A proposed approach to consider privacy and data protection in systems could be decentralised computational systems.

Bowles mentions in his book: "Future Ethics" the possibility for decentralised computation systems as a possible way around centralised processing in data centres far away [7]. The same theory was mentioned by two professors from TU Vienna, Peter Knees and Hannes Werthner [24,38]. As the hardware needed for these systems become cheaper, this might be a possible future. As Bowles puts it: "Combine this with a pocket AI approach that promises all AI training and inference is handled on the device, and this starts to look like a privacy campaigner's utopia. The user has complete control, with minimal data transfer and less risk of invisible exploitation. Not only that, but the resulting systems will have lower latency and work offline too" [7]. Of course, there are possible drawbacks.

1) Ownership of data is tricky due to outside factors, for example, the doctor or the tax authorities. CCTV footage and employers' files cannot be controlled by an individual person.

2) The impact of decentralisation on AI innovation is a topic of concern due to the significant processing power and time required for training algorithms in decentralised AI systems. This may hinder the development of such systems.

Federated learning

A possible solution for this might be federated learning, as Bowles, Knees and Huang mention [7,22,24]. Federated learning refers to the collaborative approach of utilising multiple personal computers to collectively train algorithms. The training data is sourced from the individual user and remains stored on their personal computer. The algorithm is being downloaded from a cloud and trained with a user's personal data. It is being encrypted and sent back to the cloud. The collaborative training process is repeated iteration after iteration until the model is fully trained [42].

Implications of decentralised systems

It is possible that individuals with the financial means to acquire such a system may choose to opt-out of targeted advertising, potentially leading to a decline in advertising rates. The implication is that individuals who lack the financial means to access this system are relegated to receiving personalised advertisements. The observation of a potential trend is evident in the case of the iPhone, which claims to offer enhanced privacy features. However, it appears that only individuals with higher socioeconomic status can afford such devices [7].

What do we not know?

While there has been research on the ethics of recommender systems, there is still a gap in comprehending their implementation in design practises. Starting this research project, I recognised the need for conversation about this topic between designers, design researchers and data scientists.

My primary goal as a design researcher was to explore into people's desires and preferences surrounding their coexistence with recommender systems. I wanted to know how people imagined living with these systems and how they imagined their devices protecting their data privacy.

Speculative future

Speculative futures, often known as design futures or design fiction, is a design research process that investigates alternative future situations through the creation of provocative and intriguing artefacts or tales. These speculative concepts are not designed to predict the future, but rather to promote critical thinking, conversation, and invention by exploring a wide range of possible possibilities.

The goal of speculative futures is to encourage debate and thought on alternate possibilities and their ramifications. It gives a sandbox in which to explore and experiment with ideas about how the future might appear to better understand our existing assumptions, values, and paths [15].

Experienceable invisible work and infrastructures

These projects have various characteristics, the most interesting of which is their involvement in the topics of privacy and control. The devices have access to a personal environment that is not always considered private, namely the home. All four projects debate the complexity of the human technology relationship and reveal hidden impacts of those.

Researchers are working on several projects to better understand the link between humans and technology. The phenomenon of "Automated Indifferences" is explained by Chatting [2023] in the Chatting project, which shows that technology prioritises efficiency and convenience over human emotions and needs [8]. This may appear straightforward, yet it has far-reaching consequences. Chatting is research that uses several types of speculative future methodologies. This essay discusses some of the interactional paradigms widespread in homes today from the perspective of Victorian country residences. It has been argued that there is frequently a design goal to conceal or ignore complexity, resulting in seemingly independent systems in which people and resources may be unknowingly abused. The exploitation of people and resources concealed by black boxing is particularly shocking in view of feminist framings of invisible labour and the ecological disaster [8].

This invisibility is related to an invisible data transfer in today's home environment. The use of an Amazon Echo Dot or Google Home is frequently associated with convenience and invisible data transfer. Desjardins et al.'s [2023] odd interpreters project develops new ways for relating with computing system data in the home [14]. The device emits a sound that should give the impression of a moving entity. This initiative is an example of work that raises awareness about the movement of data from the house to distant data centres. This invisible work and invisible infrastructure that surrounds home computing systems such as Amazon Echo Dot and Google Home is attempting to be made visible.

Lauren Lee McCarthy's project, LAUREN is a performative art installation that makes this invisible work visible [45]. The artist installs sensors in members' homes and is available for queries and requests 24 hours a day, seven days a week. The artist anticipates the demands of the participants and has control over the home through remote devices and switches. It's a great example of how much work and data devices like Siri and Alexa acquire.

Candle, a Dutch effort, aims to "research and accelerate the development of privacy-protecting smart home systems."[46] They set out to design examples of home devices that protect consumers' privacy and inspire the market to build more devices like it.

This research project

This research project aimed to explore potential futures by utilising speculative futuring techniques to investigate the questions "How might designers and design researchers contribute to the process of imagining and framing such a technology challenge? "

While the results from this project take the form of a set of design guidelines, the contribution of this work lies in its ability to generate topics for conversations between design researchers and data scientists and the collaborative imaging and reframing of technologies with domain experts.

Three designs were created based on the design guidelines as part of an effort to explore these topics. The analysis of the subject matter highlights its intricate nature and underscores the necessity for multidisciplinary investigation. The generated knowledge can equip corporations with design research methods to gain a deeper understanding of the distinct needs, concerns, and communication patterns of self-hosted computational systems in domestic settings.

METHODOLOGY

During the project, the research through design methodology was applied. The researcher created objects to investigate questions of inquiry and to identify new potential for design practises and designs [10,39]. Ways to imagine new futures were applied [25,27,28]. Because of the research's unique context, situated designs were required to investigate the topic [2].

Speculative futuring techniques were employed during the project, which describes methods that explore possible futures, often based on insight from speculative scenarios [3,43]. The topics discussed are often seen as wicked, connected and dynamic [34]. The prototypes created throughout the project are not proposed to be future objects but open discussions about what these objects should or could do [17].

Speculative futures are taking place in different futures that might be slightly different to ours. There are several futures that could be used for speculative futuring techniques, which can be seen in the Figure 1 [Fig. 1]. The small cone in the middle represents the likely future, which is the future in which most designers work. If nothing out of the ordinary occurs, this is the most likely outcome. The cone of plausible futures describes the futures outlined in projections and plans. The possible future cone is where links are created between today's world and the one that is suggested. Dunne and Raby believe that scenarios should be based on scientifically possible futures and that there should be a path from today to that future; otherwise, the scenario is fictional [15]. The research in this project is centred on a possible future, but there is a path to today.

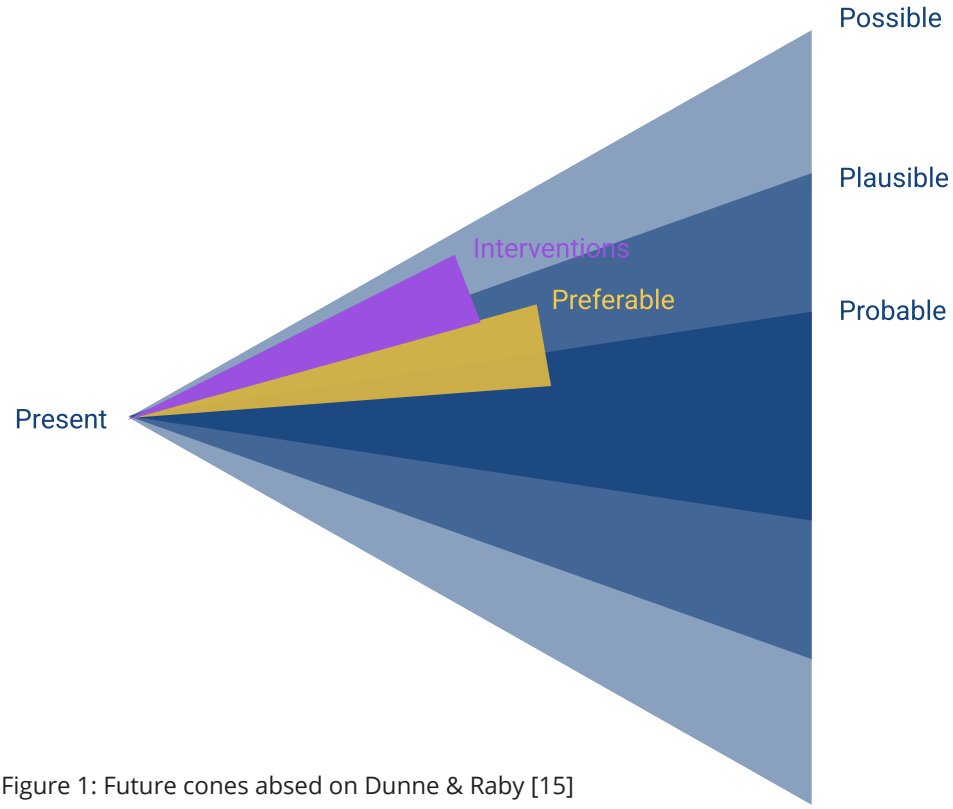


Figure 1: Future cones absed on Dunne & Raby [15]

Furthermore, the concept of adjacent possible was applied which refers to the possibility for new ideas and inventions to arise from existing ones [6]. These possibilities are linked to our present, in this case, possible technologies that exist or could exist but are not widely used. This adjacent possibility in this project is self-hosted computational systems powered by federated machine learning. The future scenario was chosen to investigate what people desire, fear, and require in those future systems. These findings were related to our reality, and design guidelines for designers, design researchers, and data scientists were developed. The adjacent future is possible because the technology that it would need already exists and there is a community around self-hosted computational system. In the image, the adjacent future and the present are shown. The bows show the processes that were performed during the study [Fig. 2]. The first one being the Imagining Machine workshop, in which the machines were created as part of the adjacent possible future. It is connected to the present because it triggered conversations about fears and desires that are experienced as well in the present but are mentioned as well in the future scenario. The insights were related to the present and three interpretations of embodiments were designed, which led to the next research intervention, the collaborative ideations with domain experts. This process overview ends with the 3 designs that were created to show how to apply the guidelines in a design process.

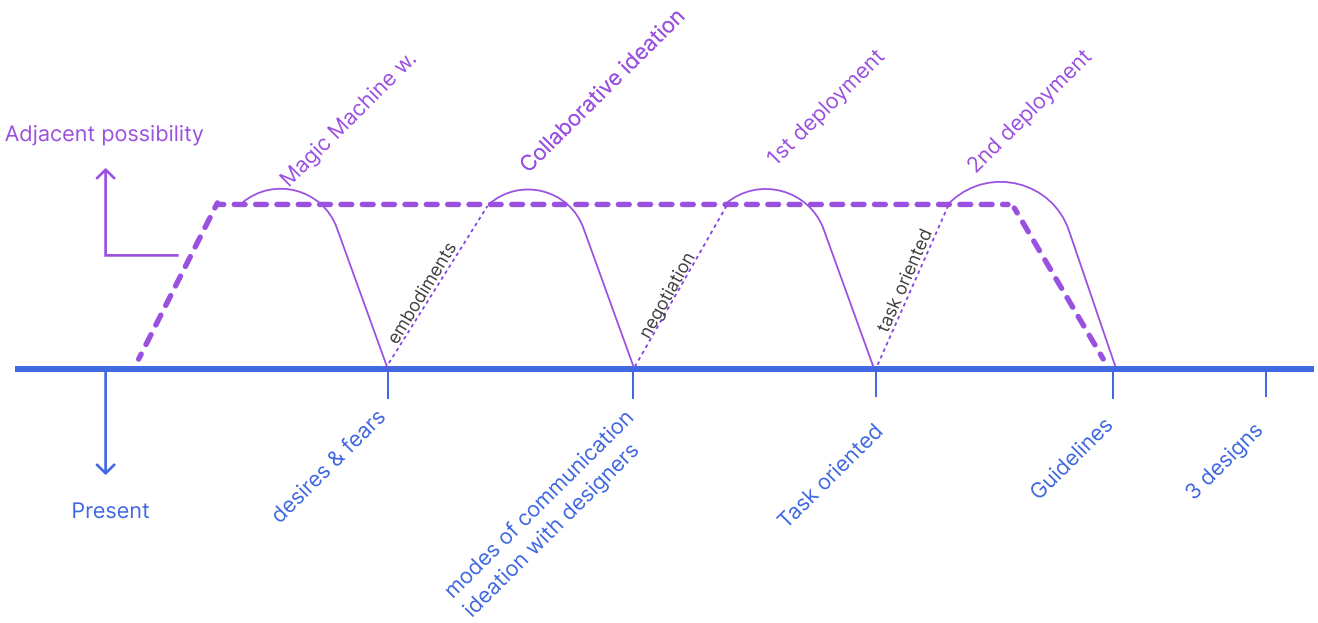


Figure 2: Process overview in which the adjacent future and present are shown. The interventions pierce through the present layer and create insights that are collected in the guidlines

Evaluations

How can speculative design be evaluated? Taking inspiration from the work of Rossi et al. [2022], which explores how to promote participatory design and foresight in the design of data protection measures [33].

Traditional legal design takes pride in being evidence-based, which leads us to question the appropriate standards for judging speculative ideas and foresight. Darby et al. [2015] identified methodological challenges surrounding reliability and validity, such as limited participant sample size and the struggle to collect meaningful data to effectively address research questions due to the highly subjective nature of 'imagination.' [11]. They also emphasise that speculative approaches lack the established legitimacy of other practises commonly used in policymaking.

To make matters more complicated, Baumer et al. [2020] stated that design fiction generates several types of information, implying that it should be examined via multiple lenses [4]. This emphasises the difficulties in quantifying the reliability and viability of speculative design because it deviates from the standard metrics used in evidence-based design, resulting in an ongoing dispute about how to successfully evaluate such interventions. In this research, the imagining machine workshop is the only one that will be analysed for validity and reliability and the other interventions are referring to the above-mentioned discussion points.

METHODS

Imagining Machine workshop

This method presents workshops that allow participants to engage in material discovery and think about new technologies that yet not exist [1]. The workshop is called Imagining Machine workshop and was adapted and repurposed to fit the research at hand. The original name is Magic Machine workshop.

The workshop is divided into four sections: prompt, material making, description, and group discussion [Appendix E]. The prompt encourages participants to begin the producing process; this is the stage at which "world making" occurs. Material making is the process by which participants build the machine that will assist them with the task stated in the prompt phase. Following the making process, participants are invited to explain and label what they created. The final section is a group conversation in which participants discuss the overall issue. During this section, participants can express their ideas, and it is frequently the section of the session where the most interesting conversations appear.

This workshop makes use of materials that are clearly identifiable and may be found in any home. The supplies used in the workshop include scissors, glue, rope, and paper.

Figure 3: Material on table forms the material for the Imagining Machine workshop.

Paper plates, Paper cups, rope, straws, yarn, hot glue, scissors, paper clips and tapes.

The method was used to study the desires and concerns associated with home-hosted computer systems. Because it encourages participants to think about technology. Making the materials allowed people to talk about their worries and desires without overthinking things.

The prompt used by the researcher was:

“You stand in front of your refrigerator at night, not knowing what to eat. Your stomach growls and your mind tries to find something satisfying and convenient to snack on. You feel a sense of frustration and indecision creeping in.

What if there is a machine that knows what you want before you know it?

This machine suggests you a snack.

Draw this snack on the piece of paper by using the paper and pen in front of you.”

After this, in the material making part, the participants were asked to build the machine that suggested the snack. The participants had 20 minutes to finish the machines.

In the description phase, the participants were asked to explain the machines they made, and the researcher asked detailed questions about the interactions, locations, relationships with these machines.

These questions were asked if the participant stopped the description, or they did not mention themes around ownership, location, interaction or relationship:

- What did you build?
- How does it make you feel? Comfortable / uncomfortable?
- What does it represent to you?
- Where does it live?
- Where is it situated?
- Is it portable or stationary?
- How do you live with it?
- What happens to it when you are gone?
- How old is the system?
- Can everyone own it? How do you get it?
- What does it mean to you that you own it?

In the final phase, the researcher was revealing their research and the motivation behind the workshop. The researcher discusses themes and patterns that they noted with the participants.

Expectation of workshop:

The researcher expected the participants to mention the following themes:

- Ageing
- Relationship
- Cohabitation
- Agency
- Symbolism
- Form
- Accessibility
- Value of technology

The workshop was mentioned to be successful if two were mentioned in all 6 sessions, which was the case.

Reliability of workshop [32]:

In this section, the replicability of the findings is being discussed.

Workshop consistency:

During each session, a list of questions was kept by the researcher. The session was not finished until the questions were answered. The researcher was open to new themes emerging. For example, in the last session a participant mentioned the need for an on/off switch, which was unexpected a never requested before. The researcher noted the theme down.

Researcher's role:

As a researcher, it is relevant to always try to ask questions in the same manner. Inconsistencies would lead participants into different directions. The role that was played is a very silent one. The participants must be able to share all their insights, so the researcher must give them space and just interrupt when the participant is struggling or is done.

Participants background:

In this specific workshop, 20 participants took part.

Background of participants	Count
Data scientist (practicing)	3
Design researcher (practicing	3
Designer (practicing)	3

Background of participants	Count
Designer (in education at TU/e Master level Industrial Design)	5
Design researcher (in education at TU/e Master level Industrial Design)	2
Bachelor student Industrial Design	1
None of the above	3
Men	9
Women	11

Table 1: Participant details

Replicability:

The list of tools was shown above and can be found in [Appendix E] as well as the original session guide.

Validity of workshop [32]:

In this section, the workshop outcomes are held against the claims of the workshop.

Participant engagement:

The participants were asked to participate based on their background but the 3 participants “None of the above” were asked to participate as a control group as they do not have a background as design or data science. The participants were recruited by convenience sampling [5], but the researcher is aware that the participants are not a complete representation of society. The sampling by background (design and data science) and the participants being available (researcher had access to without having to provide payment and were located in the Netherlands).

Expected themes:

The researcher had certain expectations for the topics the workshop participants would discuss. These themes, which included ageing, relationship, cohabitation, agency, symbolism, form, accessibility, and technological value, were deemed successful if at least two of them were addressed in all six sessions, which was the case.

Design and Execution of the Workshop:

The workshop design looks to be in line with the study objectives. It is divided into four sections: prompt, material making, description, and group discussion. The provocation establishes the context and encourages the creativity of the participants. The material creation phase allows participants to physically construct their imagined contraption. The description phase gathers qualitative information on the devices and their interactions with participants. Finally, the group discussion encourages interaction and a more in-depth examination of the broader topic.

Embodiments of insights

The creation of three embodiments that embody the desires and fears explored during the Imagining Machine workshops. They were made out of clay and PLA by the researcher. These embodiments and their stories sparked debate on the complexity of a self-hosted computing system and the qualities that people value in those systems. The archetypes arose from a personal drive to make sense. The Imagining Machine workshop proposed several ways to express desires, fears, and ideals. The archetypes aided in making sense of how some of these elements might work together. The findings from the Imagining Machine workshops were carried over to the next intervention using these archetypes.

The adventurer

Always up for an adventure. It disappears to unknown locations, but always reappears at the right time. Never useful for dietary recommendations, but excellent at picking tunes and tracking down lost items, and solving other daunting tasks.

Movement	**Solution orientated**
Uses its feet to go around.	Not at all.
Humor	**Trust**
Very funny.	You got it from a friend.
Situated	**Personality trait**
Everywhere.	Openess to experience

Figure 4: Embodiment of the adventurer

The wise

It can see into the future and reveal the exact meal you've been craving. Chatting with it might help you work through your problems. It won't disclose your private conversations to anyone and will keep them safe for you.

Movement	**Solution orientated**
It is stationary.	Depends on the task.
Humor	**Trust**
Humor is a waste of time.	Kickstarter project.
Situated	**Personality trait**
In one specific spot.	Introvert.

Figure 5 & 6 left & right: Embodiment of the wise and the kicker

The kicker

Its existence is to move the food that you want towards you. It will rotate its head and slide the products closer to the edge.

Movement	**Solution orientated**	**Personality trait**
It is stationary	Very.	Conscientiousness.
Humor	**Trust**	**Situated**
No humor.	You built it yourself.	Can be moved.

Collaborative ideation

A collaborative ideation session was conducted with two Industrial designer professionals to explore potential interaction scenarios between computational systems and users in a home setting. Card based tools can help to structure and guide the process of the collaborative ideation [31]. It supports the imagining of new futures and is a tangible ideation technique [25,26,27].

For the meeting, ideation cards were prepared, and archetypes were also presented. The insight from the Imagining Machine workshops was used to create the ideation cards, which touched on topics such as relationship, character, intention, negotiation communication, position, states, and movement. Each card featured a theme, a question, and an answer to the question. Participants were instructed to select three cards and brainstorm a computational system. After 20 minutes, a discussion began about the outcome of the brainstorm. Following the brainstorm, both designers were invited to collaborate on the design of one system, and the three embodiment figures were introduced.

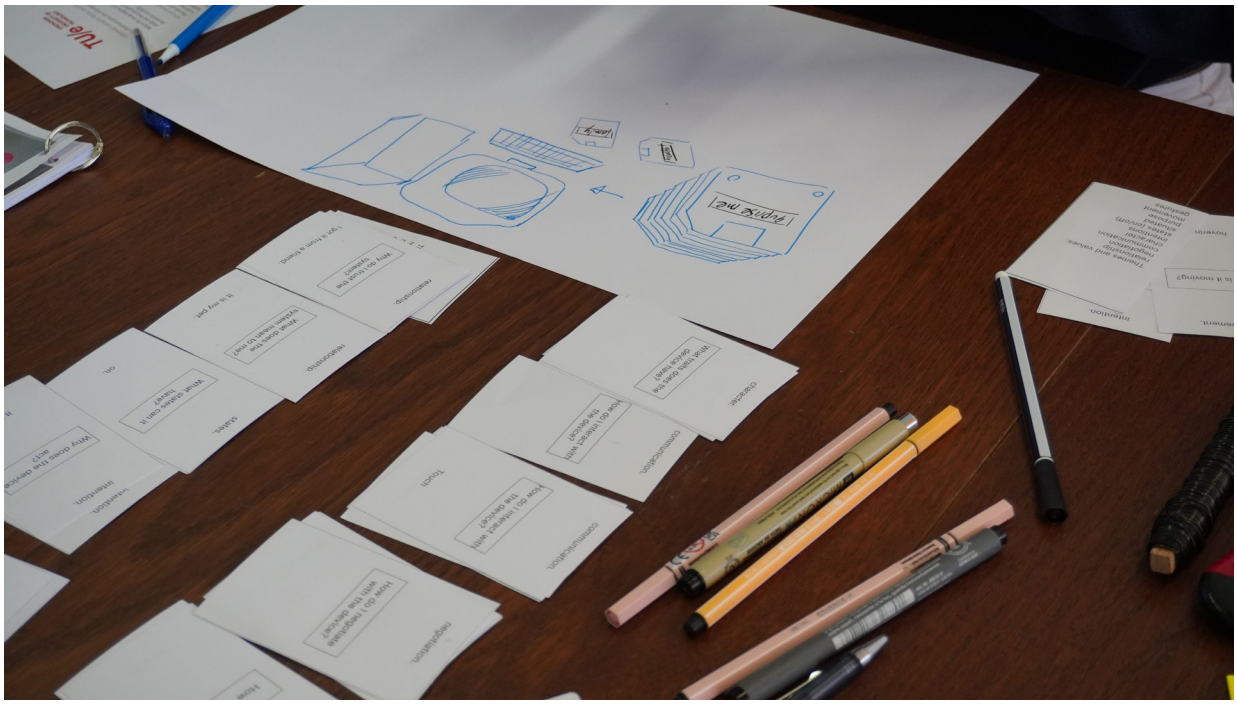


Figure 7: The ideation cards and the usage of the ideation cards during the collaborative ideation session

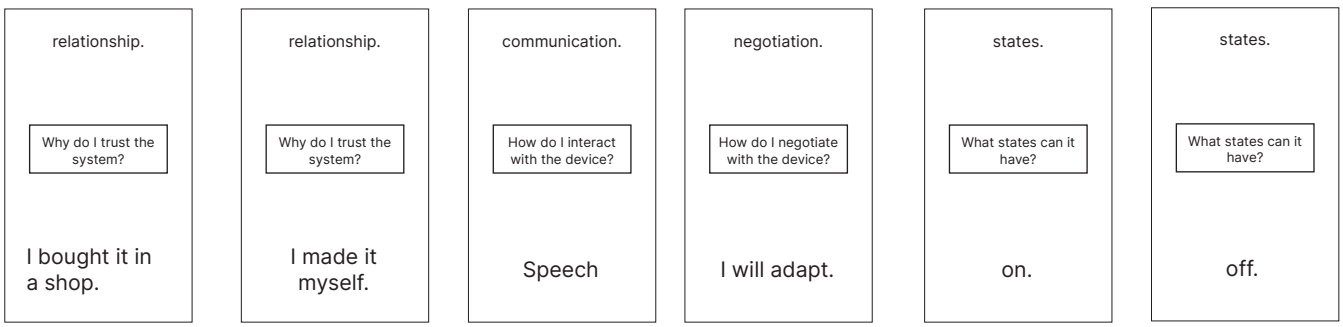


Figure 8: Six ideation cards

Home deployments

For both deployments, a speculative design method was applied in which the lo-fi artefacts were not created to be assessed as a future object (future truth) but as a possibility to discuss what these objects could or should do [17]. The artefacts "challenge how people think about everyday life." as Dunne and Raby describe it in their work Speculative Everything [15]. The research artefacts were created for the research and to imagine with the participants [19,36,37].

In both deployments, a bespoken booklet was introduced as part of the artefacts. The bespoken booklet method from Desjardin, is used to co-speculate with participants to envision an alternative future [13]. The booklets are situated, imaginary and personalized to the participants and their homes. This allows participants to talk about fears and desires for computational systems in the home in a speculative reality. The non-functional and semi-functional artefacts helped participants to imagine a future with these computational devices. Through conversation and diaries, the researcher was able to trigger reflection on the topic and unearth underlying fears and desires.

1st deployment

During the first deployment, a non-functional artefact was introduced to the participants, with which they lived for a week and kept a diary. The purpose was to imagine how a recommender system would interact with a participant and which kind of recommendations the system could provide.

An onboarding interview gave an idea about the participants current living situation, usage of IoT devices in their home and understanding of technology in general. Some questions were:" What does home mean to you? Do you have computational systems at home? Why do you have it?"

The offboarding interviews and the diaries, gave insights into different areas of computational systems that the researcher did not think about. The participants created worlds around those objects and noted their daily experiences in the diaries.

This method is inspired by Gaver's cultural probes [1999], in which the participants are given lo-fi tools to answer questions and start having reflection with the researcher and themselves [19]. Both participants took part in the Imagining Machine workshops and therefore were familiar with the topic of self-hosted computational systems. This was needed because this intervention was very open ended.

Figure 9: From left to right: Envelope with questions, the artefact Leila and the diary

The artefact above is called Leila. The basis of the prototype has a LED in it and lights up. The design of the basis gives the impression that the top object cannot fit on it. Giving the idea that it should be taken apart. The top object can be removed and carried with the participant. It was designed to be small enough to fit into a pocket. The diary was provided to prompt reflection and motivate the participant to keep track of their interactions with the artefact.

The artefact at the bottom is called Tom. This top object is the same design than in the previous artefact, but the basis is a ceramic object which is connected to a battery. It should give the idea of being a smart object, but it does not show what kind of smart object it is.

Figure 10: From left to right: Envelope with questions, the artefact Tom and the diary

2nd deployment

The researcher conducted this study to understand if participants see a need for personalization in their computational systems and to understand if a system should be task oriented. The research was used to imagine new forms of interactions between humans and systems.

The two research participants were chosen because of their cohabitation and professional backgrounds. The first participant is a designer who has spent several years working at a design agency, while the second is an academic designer who is involved in design research at a technical institution. Both have a great grasp on technology and its impact on society.

The semi-functional lo-fi artefact was influenced by Ron Wakkary's research artefacts [36,37] because they were made specifically for this research. The artefacts were semi-functional in order to allow participants to use their imaginations. The artefact interacted with the participants for one week and kept a diary during that time. An onboarding and offboarding interviews were held and a design workshop took place as well, during which participants drew their systems and explained how they wanted to see the product in the environment.

The artefact should provide the impression of a buddy while yet seeming like a computational device. The little legs should indicate how delicate it is, while the half-cube body should indicate that it is a frigid, cold house object. Its basic design was intended to blend into any home. The material was chosen due to its DIY look, being PLA.

Figure 11: A render of the artefact design

The artefacts were created by using an ESPS32 board, a servo motor and several cables. The artefacts are inspired by the Yo-Yo machines by Gaver et.al [20]. The ESPS32 are connected to the Wifi and can communicate with one another. [Appendix H] One version was placed at the participants home and one was placed at the researcher's home. The designs are created and printed by the designer.

During the starting interview, the participants were asked about their home situation, their experience with recommender systems, IoT systems and technological interest. The participants were asked when they want to interact with the devices during the day. They were introduced to the device and to the diary.

The diary consists of an introduction, in which the system is explained and how the diary is built up. Each day, there was a list of song with corresponding numbers. The participants had to read the prompt, refer to the recommender system for a number (if applicable) and listen to a song. Each day, they were asked to engage in a small reflection on the reflection page.

The role of the researcher was to change the dial each day accordingly and play out several personalities that the researcher wanted to research.

The end interview was a conversation about their experience with the artefact, their idea for a future with them and a collaborative reimaging of these systems.

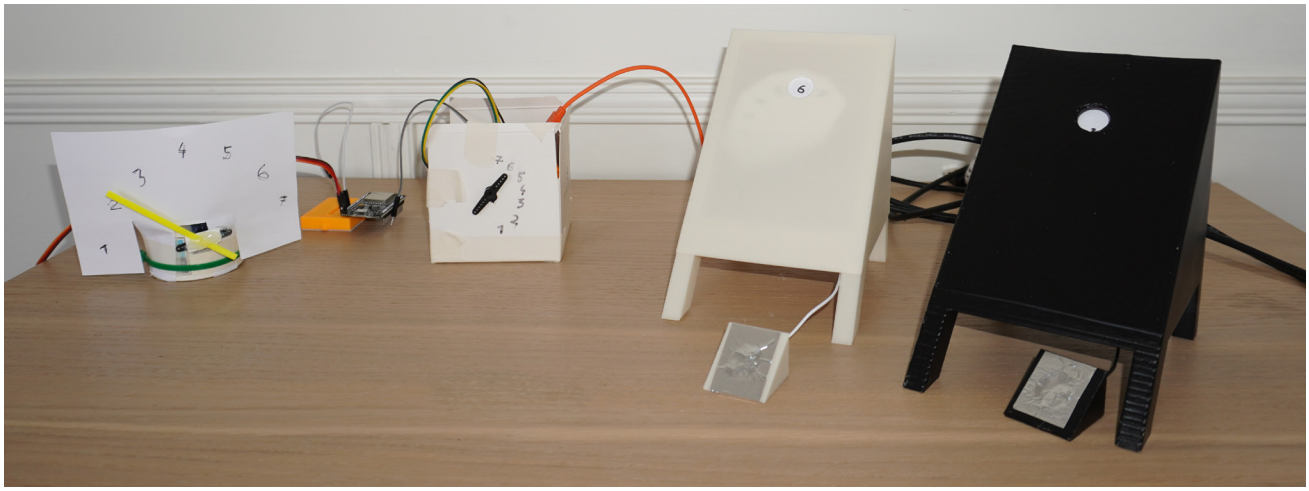


Figure 12: The two artefacts and their twins in the researcher's home

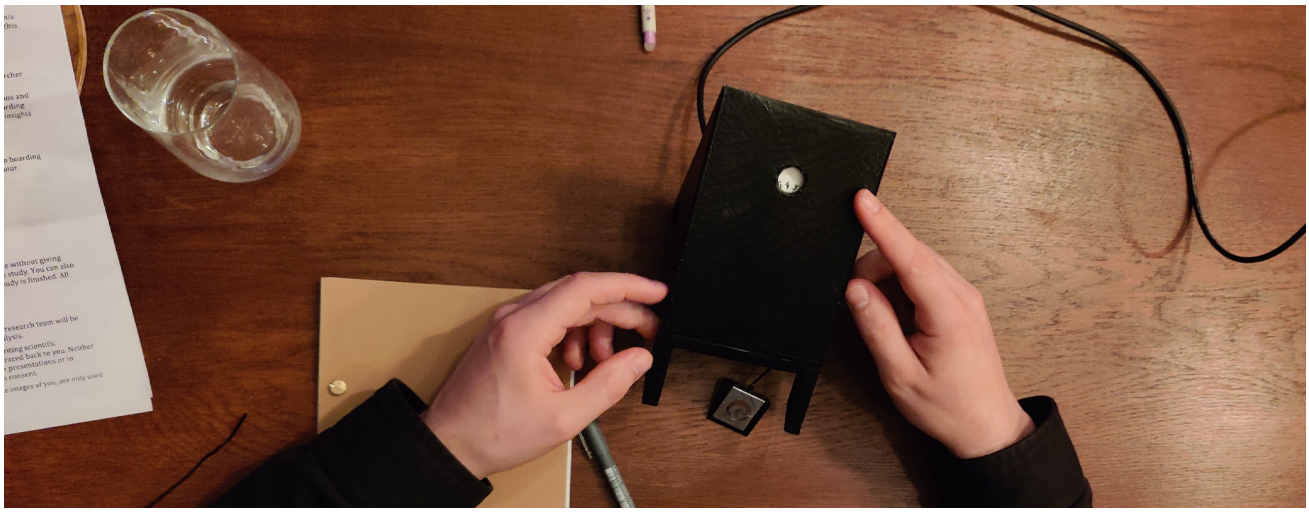


Figure 13: A participant engaging with one artefact

FINDINGS

Imagining Machine workshops

To analyse the workshops, a thematic analysis was conducted on the machines and the interviews were used as a reference point for them.

These are the themes that were discussed: mobility, personality traits, relationships, trust, humour, and solution-oriented objects yielded the findings.

These are the thematic pairs that derive from the workshops. All themes, except "No trust" were used for further developments of the following intervention, embodiments of insights.

Themes	Amount of times it was mentioned
Stationary - in kitchen	14
Free moving – not in kitchen	3
Free moving - in kitchen	3
Own personality	5
No personality	15
Companion	5
Tool	8
Pet	7
Anti solutionist	3
Solution	17
Trust	19
No trust	1
Humour	8

Table 2: All thematic pairs that were identified during the Imagining Machine workshop sessions.

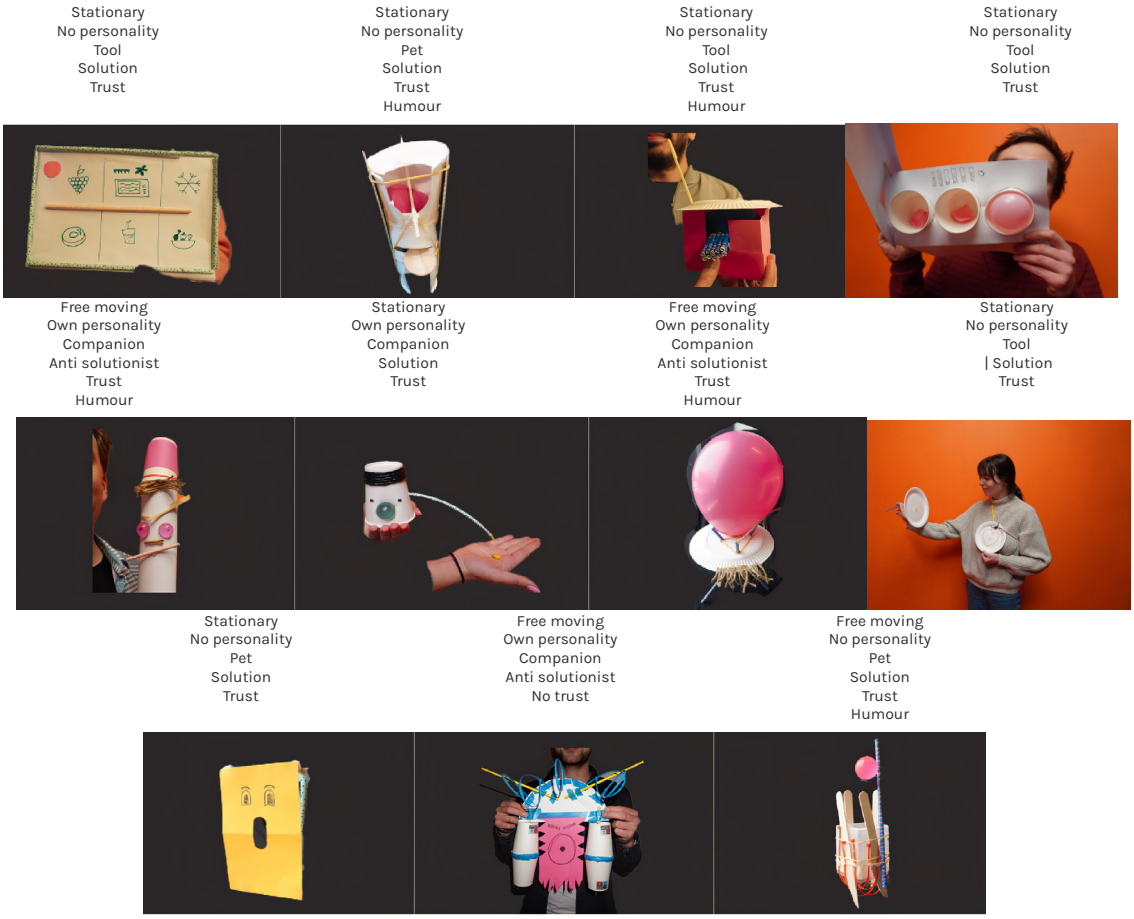


Figure 14: Thematic analysis based on Imagining Machine descriptions of participants during the workshops

Analysis of thematic analysis

1st themes: Trust

According to Robert Cialdini's [1993] book "Influence: Science and Practise, " machines fit within two of the six principles of persuasion introduced by Cialdini to persuade others [9]. The first is authority, because some machines are regarded as experts in their respective fields. These machines have become so familiar with the individuals that they have become experts in their fears and desires. This could be one of the reasons why participants trust the machines, as well as the fact that participants stated that they trust the system because it was purchased from a reputable company. Another reason given was that the machines were encountered as companions or pets, and the participants received them from family or friends or created them themselves. These imply that the participants trust it the principle of liking the machines.

2nd theme: States

One participant out of twenty mentioned the need for an on/off switch. All other devices seemingly would know when not to disturb the human. That participant was not from design, design research or data science and had troubles getting into the speculative environment. This might be the reason why they stayed with a concept that already exists, but they were the only ones that were questioning the necessity of these machines at all in the home.

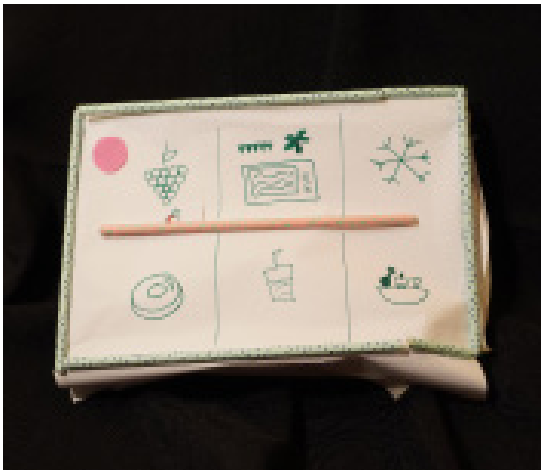


Figure 15: Machines with on/off button (pink circle)

3rd theme: Stationary / Free moving

The free moving machines came with their own stories, they were not just serving the participants but had often their own ideas in mind. This machines just came into view when the participant had their menstruation period, and they needed a perfect snack. The machine was already in the flat when they moved in, and they never engage for other topics with one another. The machine represents task-oriented recommendations and non-visible devices. The device can be visible if it is relevant for its task and makes sense.

This machine gives recommendations for anything other than food. It is moving with the participant and plays music, gives reading recommendations but it has its own will at times. The participant wanted a system that feels like an extension of themselves but at the same times should be portable and light. The participant adapted it themselves but the machines which built the machine, does not exist anymore. This machine is embodying the desire for personalised computational companions that are light and easily portable. They should as well fit into the lifestyle of the participant and have their own interaction style, which can be quirky and edgy.

Figure 16: Spider like machine

Figure 17: free moving companion (participant agreed to be shown here)

General

There is a trend towards stationary computational devices in the home which was mentioned by fourteen participants. They varied in size of being as big as a fridge to being as small as a butter holder in the fridge itself. Fifteen participants mentioned that the machines should not have a personality.

Two participants indicated that they were thinking about data privacy actively when they were designing their machines. One was creating a machine that is hovering over them and catching all data and another one wished for an on/off switch. The ones trusted that it did not have a malicious intend because they either got it from a friend, built the machine themselves or bought it from a respectable shop.

Embodiments of insights

We learn to see the world via stories. The archetypes represent how people would imagine interacting with computational devices in their homes. Perhaps we can use these visions to imagine a different interaction with future computing technologies in the house. It is vital to note that they do not depict how a system should appear and are not actual recommender systems. The archetypes were interpreted as recommender systems by some people. This created the discussion about a missing complexity of the devices. It seems important to some that the device looks technological sophisticated to that it embodies a complex recommender system. Furthermore, the shapes and the stories of the archetypes seem to fit well together because most people understood the connection immediately.

Collaborative ideation session

The cards were appreciated and were used for an initial brainstorm but seemed to be limiting to the complexity of the topic at hand.

The stories surrounding the figures sparked a debate about how these systems should be integrated into people's homes. The designers developed negotiation styles and forms for the imagined systems.

The session contributed to a better understanding of the significance of negotiation between the system and the human.

Designers found the stories and embodiments of the archetypes useful for product brainstorms. The risk of oversimplifying the complexity of living with a smart device creates the same issue as living with a current smart assistant device, like Alexa.

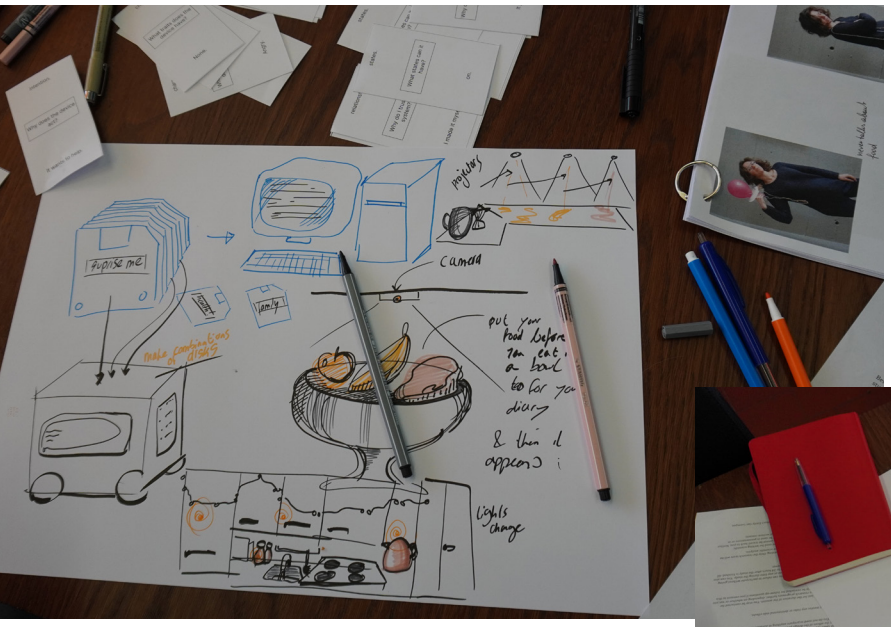


Figure 18: Brainstorm drawings after the usage of the ideations cards

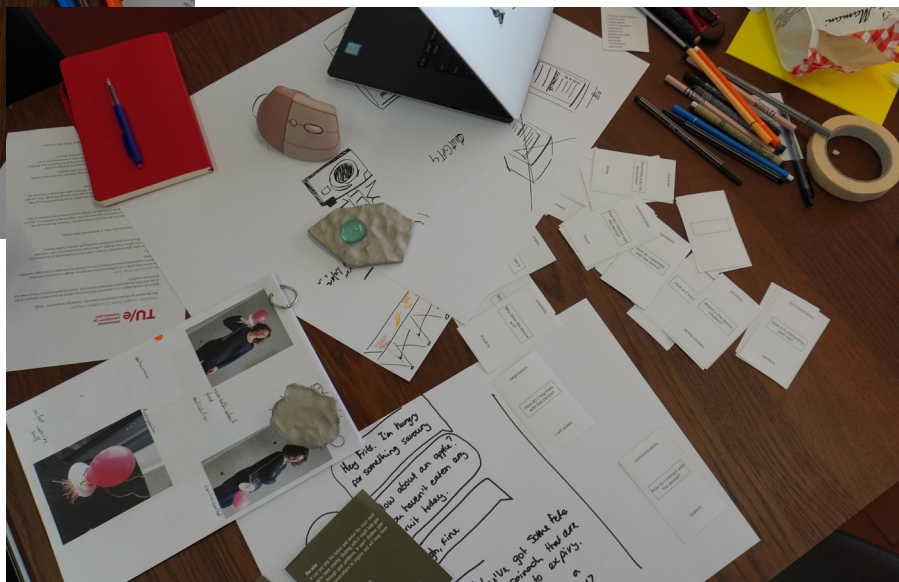


Figure 19: Reimaging computational systems post ideation cards with the embodiments

Deployments

1st deployments

Both participants do not refer to the artefact as artefact but by their names. Leila and Tom are the artefacts and are seen as systems instead of just objects.

Start interview

Participant who engaged with Leila

The participant who engaged with Leila, mentioned in the entrance interview their awareness of data tracking in phone application. An example of active data tracking was the tracking of the period that is used by some people and the implications it might have for them. As seen in the US, there are incidents in which the own data can become dangerous to oneself [18]. The participant mentioned that “you can sometimes also see your state of mind”, which means the photos that are on Instagram show how someone is feeling, which could be exploited by others.

Furthermore, the participant mentioned that they are living with 12 others in an apartment. This causes sometimes the algorithm to suggest odd things. The response of flatmates is to call people out on the shared group chat. When being asked if they would like to have one algorithm that is trained by all their friends and themselves, the participants reject the idea.

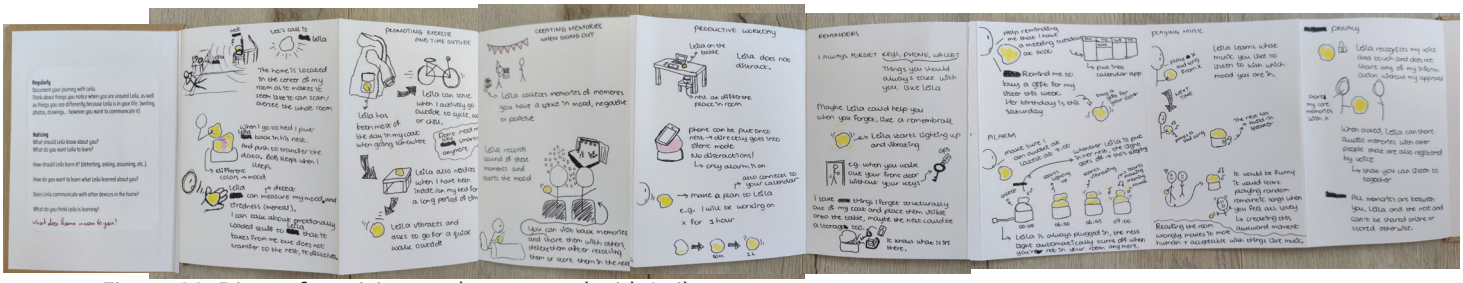


Figure 20: Diary of participant who engaged with Leila

Just one of the diaries (Leila) is being shown here. Tom's diary is more of a journal of the participant. Details are used that could identify the participants. The anonymised diary is added to the Appendix G and the insights from it will be discussed here.

The participant who lived with Leila, called the top object, Leila and the basis is called, nest. They lived with it for a week and positioned it next to their bed [Fig. 21].

Figure 21: Leila and the next was positioned next to the bed for a week [photo taken by participant - consent was given to include the image]

Modes and features that were imagined

Leila can detect and measure their mood and tiredness. The emotionally loaded things are being taken away by Leila.

- Leila collected memories of moment the participant has a spike in mood, negative or positive ones. Leila records sounds of these moments. The participant could visit back the memories and store them in the nest.
- The phone can be positioned on the nest to silence it. Leila can be used to make a time schedule. Lights in Leila count down until the time is up.
- The system of Leila and the nest could help to remember to take things with. The participant imagines Leila vibrating if certain things are not being taken with them.
- Leila would help to remember the participant to get presents before the birthday of a friend approaches or it functions as an alarm clock, by turning on its light after a while.
- Leila learns what songs the participant likes and in which mood they want to listen to it. The nest has speakers build in and plays the music from there. The participants mention the possibility of playing songs in wrong moments, would make it even more human and therefore, better, in their opinion. E.g.: Being with a crush and romantic music plays.
- The participant thought about privacy and the object being aware of the participant's voice. Leila would never share stories with others without consent. And "All memories are between you, Leila and the nest. And can't be shared online or stored otherwise."

Tom is a diary like device. The participant was writing in it each day of the week and trained a speculative algorithm with it.

- The participant was hoping for "surprising, serendipitous and perhaps a bit weird and strange" recommendations.
- On one point the participant asks if the diary has a recommendation for a pasta dish.
- The participant asks for a reminder to apply some medical crème every day.
- One prediction the participant is wishing for are record recommendations based on the genres they have at home and the bpm that certain songs have. The participant is making music and would need some help with songs because they cannot go from a "slow house track to a jungle track."
- The participant asks if there could be interesting predictions deriving from the little information that was mentioned during the week like: places, music, events, food, movies and books?

There are correlations between the workshop outcomes and this deployment. Probably because the participants were familiar with the project's topic and participated in the workshops.

Insights

- Both participants are asking for systems that are working on specific tasks.
  - Leila is a system that performs specific tasks which must be triggered. If there is a spike in excitement, sound is recorded, Leila awakens if the participant forgets something, and the nest plays music based when the participant asks it to.
  - Tom is recommending vinyls which would fit into the vinyl collecting of the participant
- Leila is more acceptable because it “reads the room wrong”. Mistakes makes it more human.
- The diaries and the questions were successful in triggering reflection
- The imagining worked better for Leila than for Tom, that is maybe due to the higher functioning prototype. It could be as well that the nest was bigger than the basis of Tom, which gave Leila’s participant the impression to take Leila with them. Tom’s participant never separated Tom from its basis.
- For Leila’s participant, it is alright if personal data is being collected if it is not shared with anyone or anything else. There must be rules for whom to share the data with.

2nd deployment

After a week of deployment, the end interview of 2 hours, gave insights into the participants experience with the devices, obstacles and understanding of the functionality of the artefacts.

While the designer envisioned a system built upon existing knowledge, the design researcher speculated about future possibilities, unconstrained by current technological limitations. The emphasis of the discussion was the importance of values in the design of hyper-personalized, home-based systems. Since technology can shape and influence our behaviour, it is crucial to clarify how a system might do this before it is installed at home or to ensure the system communicates its potential impact upon initial engagement. One key suggestion was that the system should excel at one specific function - in this case, the focus was on playing and recommending music. It was agreed that a system doesn't need to be omniscient, but it should excel at one thing. An exemplary scenario suggested was one where the system has an intimate understanding of the user's preferences, knowing when they are home, and selecting music based on upcoming concert attendance.

The discussion led to the idea that hyper-personalized self-hosted computational systems could be designed with different values in mind, such as efficiency versus playfulness. There was a debate about the trade-off between initially poor recommendations and eventually excellent recommendations.

The closing interview, initiated by the researcher, gradually evolved into a lively discussion among the participants. The designer (Participant 1) advocated for efficient systems and questioned the use of the low fidelity artefact. The design researcher (Participant 2), however, fantasized about the potential of the system beyond its current state.

Each participant offered valuable insights for improving the deployment. The collective reflection on the artefacts eventually sparked a philosophical conversation about the exploration of novel computational systems for the home. Participant 2 proposed a playful object with a built-in recommender system, like a speaker providing music recommendations. The envisioned object would be portable and have a unique personality reflecting the values deemed important by the participants, in this case, prioritizing playfulness over efficiency. On the other hand, Participant 1, who values efficiency, suggested an object like Google Home, which would explain the rationale behind each recommendation. They imagined a system that would allow them to adjust the significance of specific data points that recommendations are based on, providing a greater sense of control, which they currently feel is lacking. Despite acknowledging that a Google Home system could fulfil many of their needs, Participant 1 admitted they never had the time to set it up. The abundance of options was overwhelming, and they never found the time to read the manual. When asked how this problem could be resolved, they suggested a better onboarding process to provide a clearer understanding of the system's options.

DISCUSSION

Imagining machine workshop

At times, the Imagining Machine workshops are difficult to understand. Some believe that the new devices should be able to move because some participants mentioned that the machines should have feet. It's more of a desire for machines to have various embodiments and locations for interaction. Participants may prefer a device in the bathroom and kitchen rather than just the living room. There is a risk that companies or other researchers will take these insights literally and use them as design guidelines. The Imagining Machine workshops provide difficult to interpret insights that are highly contextual and personal. For example, if a company applied the insights from the Imagining Machine workshop literally, they would design a device that is in the fridge. It would move friendly every time someone opens the fridge to advertise certain products for consumption. The implication could be overconsumption of that specific product (probably based on the company that created the device) or, more likely, a rejection of the device and an early death for the product. In both scenarios, there is a direct implication on the human and on the environment. Therefore, caution in communication about how to use the methods is crucial.

Collaborative ideation session

As though the session was successful, the cards should be redesigned. The cards that were used during the session stated questions and answers. But to be actionable, the cards should have stated an action. For example, instead of stating:" What states can it [system] have?" it should state "Add a switch" Or "Create the possibility of different power states".

Deployments

1st deployment

Tom was not interactive enough. It could have helped if there would have been a bit more interaction in it. Or if the participant would have been provided with more modes of recording their days. Future research could be invested into finding different ways of investing people into engaging with these lo-fi nonfunctional prototypes.

2nd deployment

Placing the artefacts in the homes of data scientists could have provided valuable insight into how they would redesign these systems. The researcher chose designers and designers with a background in design research because they needed to imagine a new technological solution. This could be a disadvantage of the richness of the data, but it was deemed more relevant than a diverse set of backgrounds.

General findings

These following insights are based on outcomes of interviews, workshops and home deployments of non-functional and semi-functional prototypes.

The price for data privacy

Outcomes from the Imagining Machine workshop interviews revealed that participants are aware of companies collecting large amounts of data from them. However, shifting to a new manner of interacting with the internet would result in a loss of quality suggestions and experience, which most people are unwilling to make. This demonstrates that the cost of data privacy appears to be too high for many people. Efforts should be put into research and design to determine how a self-hosted recommender system may provide value to people's lives that is equal to or better than the current experiences.

The findings indicate that users appreciate the usefulness of the recommendations and the system's ability to leverage their existing information to provide personalised suggestions.

Furthermore, it is considered a loss to quit systems that have already acquired enough data about users to create well-defined user profiles. Certain subjects are not even questioned by participants, but they should be.

The presence of a conversation interrupter

Voice assistants such as Alexa and Google Home have become ubiquitous in many households. Based on the research conducted for this project, it has been observed that the inconvenience caused by the system's inability to comprehend commands or its tendency to disrupt conversations unintentionally outweighs the advantages for certain participants. During the study, three participants [deployments] expressed their dissatisfaction and lack of engagement with the devices. They also reported a feeling of annoyance when the device was accidentally triggered. According to the participants, there is a perception that Alexa or Google Assistant may be listening more frequently than necessary. Desjardin et.al. Broadcast object creates sounds when Alexa is sending data from the home device to the servers beyond the home. It shows how much the data is moving from the home to servers far away. It could be of interest for design researchers to create more projects in which the movement of data is made visible and explicit. A personal hypothesis is that participants possibly give their data more worth if they have more knowledge about the movement of their data. As per Desjardin's expert opinion, it would be worthwhile to explore the ways in which data privacy can be made more visible within the home [12]. Imagining the complex nature of data privacy and data in domestic settings via various scenarios could potentially facilitate people's understanding of the tensions.

What does it take to care for our wheatfield?

In 1982, Agnes Dene engaged in the cultivation and ongoing care of a wheatfield [30]. This environmental art piece was created as a comment on the climate change and the divide between the wealthy and poorer population in the United Sated of America. This artwork brought people together and made them discuss injustice and shed light on what connects us all. 1) The injustice of a colonisation of the internet by companies in the early days of the internet, should be made more visible. 2) Data connects us all. The way data is being gathered and translated into user profiles, is often the same for everyone. With the exception of individuals who have chosen to opt out or those who do not identify as digital natives, our research findings suggest that the majority of the population is highly engaged with digital technologies.

It would be interesting if more artworks would be created that connects people and creates visibility for the injustice but as well shows that we are all connected in a similar way.

Not a wizard of everything but a wizard for one

A recurring pattern was observed in the majority of the conversations with the participants. This pattern was that a recommender system that is hyper personalised and for a specific task, would be more appreciated than all-knowing machine. Research indicates that the trust that humans place in machines due to the presence of a human-like voice can be misleading and problematic. Alexa or Goggle Assistant are predominantly equipped with female voices, which is problematic from a feminist framing about invisible work and care work, that is often not being rewarded or seen [8]. During the research, female participants shared their annoyance with this topic, without knowing about this body of research. During the Imagining Machine workshops, the first and second home deployment, eighteen participants mentioned that they would prefer a hyper personalised recommender system and one that gives specific recommendations for one specific topic. Based on the findings of these studies, it appears that there is a prevailing sentiment against systems that are perceived as all-knowing and constantly active. Conversational systems are less appreciated than written systems, task-oriented systems or systems that play back specific audio upon request.

It would be of interest to research different forms of interactions between recommender system in the home. While speech has been a prevalent mode of interaction, it may not be the most sustainable option moving forward.

The arising issue here could be that task-oriented systems, need separate individual embodiments. This means that we would face a home with 5 different, separate embodied objects instead of one. We would have to research if the possibility of data privacy outweighs the possible environmental impact of yet another object in the world.

Your value is not my value

A house is a complicated place. It is a conflict zone. It is sometimes a place of abuse and discomfort. It can be a place of comfort and relaxation at times.

Most of the time, it is a gathering place for people with diverse backgrounds and values. During my research, I came across a couple who shared a Google Home. Because it was triggered by words that were not intended for it, this home assistant was interrupting the couple's conversations frequently. This caused distrust in the system because it appeared to be listening when it was not asked to. And one of the couples altered their conversational style in order to avoid being interrupted. Although these points caused irritations; these were not reasons for them to switch to a different product.

The same couple participated in the deployment of the lo-fi semi-functional recommender system. Following the end of the deployment in their home, they were asked about the values that the Google Home represents, which, in their opinion, is mostly efficiency.

One of the participants mentioned right away that they valued playfulness in a system. When asked how they wanted the recommender system to interact with them, they said they wanted an object that played music and had a playful personalised recommender system built in. It should be linked to other smart sensors in the home that detect whether they are at home or what type of concerts they are going to soon to play more of those songs to get them excited for the concert.

The interesting part was that a situated and personalised recommender system linked to home sensors is appreciated if it provides useful information and adheres to certain values that the user appreciates.

The second study participant stated that they appreciated the Google Home's efficiency because it aligned with their own values. They agreed that not all the functions that a Google Home can provide were relevant. And that a speaker with an integrated recommender system would suffice.

A topic to consider here is that if firms make products that represent distinct ideals, they create systems that are appreciated and highly individualised. The problem with this is that firms may create products that we blindly trust because we like them [9]. If firms propose products that we are not interested in, it will be tough to reject them because the company followed the concept of liking and consumers may accept it without questioning.

DESIGN GUIDELINES

These design guidelines are based on anecdotal stories as well as insights from study methods and interventions. These guidelines, along with the three examples shown below, are a toolset that designers and data scientists can use to iterate or design a product.

Transparent Data Practises:

Designers and data scientists should attempt to make data more transparent. This could be accomplished by making user data transfer clear and explicit. For example, a clear signal when data is being transported from the home device to the servers could help customers better understand their data privacy and value. This may also motivate people to take more control over their data.

Unobtrusive Design:

Voice assistants must be constructed in such a way that they do not disrupt conversations or accidentally trigger. This could involve things like bettering voice recognition algorithms or implementing a "do not disturb" mode or an on and off switch. It's also vital to consider how these gadgets are regarded in terms of privacy, as some users believe they're listening in more than necessary.

Art and Advocacy:

In the same way that Agnes Dene's wheatfield artwork connected people and brought attention to societal issues, designers might develop digital art or interactive experiences that highlight data privacy and data monopolisation by particular companies. This could ignite debate and raise user knowledge about data gathering practises and their repercussions.

Focused Functionality:

Rather than establishing all-knowing machines, design efforts may be devoted towards developing task-specific recommender systems. This may help to avoid the problems associated with overgeneralization of user profiles and the assumption of an all-knowing system.

Personal Values and Preferences:

It is critical to build systems that are compatible with the values and preferences of the users. Some users may favour humorous, amusing systems, whereas others may place a premium on efficiency. Designers should take these variances into account and maybe provide means for users to customise the system to their unique values and interests.

Transparency of Algorithms:

The recommendation algorithms should be transparent to users. This might involve explaining how the system creates recommendations and giving consumers options for customising the algorithm.

Context-specialised Recommendations:

In some cases, it may be advantageous to create recommender systems that deliver specialised recommendations for specific subjects. If a user is looking for music recommendations, for example, the recommender system might be incorporated within the loudspeaker to deliver contextual and tailored recommendations.

Modes of Interaction:

Research should be undertaken on various types of interactions between recommender systems and users. While voice has long been a popular means of communication, it may not be the most sustainable option in the future. Other types of interactions, such as written systems or systems that play certain audio on demand, should be investigated.

Diverse Voice Options:

Given the feminist framing of invisible work and care work, it's critical to provide voice assistants with a variety of voice options to prevent propagating gender stereotypes.

Potential Side Effects:

As we advance towards hyper-personalized systems, it's critical to think about potential side effects. Could these algorithms, for example, lead to people putting forth less effort to develop genuine human connections? How can we mitigate the risk of filter bubbles if we create hyper personalised systems? This issue should be researched to better understand and mitigate potential detrimental outcomes.

Minimal computational power:

To increase accessibility of this technology, it is important to consider how we can optimise computational efficiency with minimal hardware requirements.

To summarise, creating ethical recommender systems for the home requires balancing openness, privacy, customisation, and user values and preferences. It is critical to involve people in the design process and think about potential societal consequences and negative effects.

IMAGINING GUIDELINES: Strategies and Implementation of Guidelines in the Form of Examples

The following three design explorations are intended to help practitioners get started in their brainstorming session. **They are design thought experiment that follows a specific category of the guideline.** Having examples may help people understand the guidelines and think of possible implementations more easily. These three examples are based on my interpretation of the guidelines gathered above.

Transparent Data Practises:

A possible strategy following the guideline is to make collections of data visible. The strategy can be implemented using Netflix as an example. Next to Netflix could be explained which data was collected during the watching session m, but as well which data was gathered before a movie or series was chosen. This creates more transparency for the viewer and could create more trust as well. Visualize the practice of data gathering.

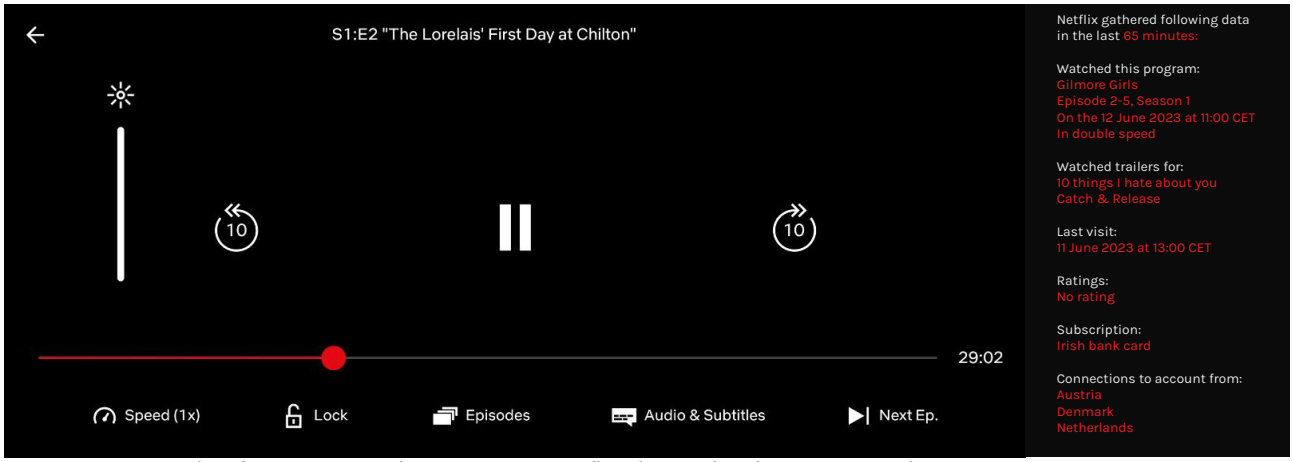


Figure 22: Example of transparent data practice: Netflix shows the data it was gathering

Screenshot of own Netflix application

Another example could be the Roomba, scanning the environment of the home. By making the scanning visible, the collection of data is being made visible as well.

Figure 23: Roomba scanning the environment of the home [21,47] [Photo origin: https://newatlas.com/author/ben-coxworth. 2021. Roomba j7 uses a camera to recognize objects – including pet waste. New Atlas. Retrieved June 13, 2023 from https://newatlas.com/around-the-home/irobot-roomba-j7/. green beam added by photoshop firefly]

Focused Functionality:

A possible strategy following the guideline is bring the recommendation to the place and situation where it is needed. The strategy can be implemented using fruit bowl as an example. Vitamin intake is being tracked and instead of getting a notification about which vitamins to take, the bowl shows which fruits to eat to get the vitamin intake needed. The recommendation should be localised.

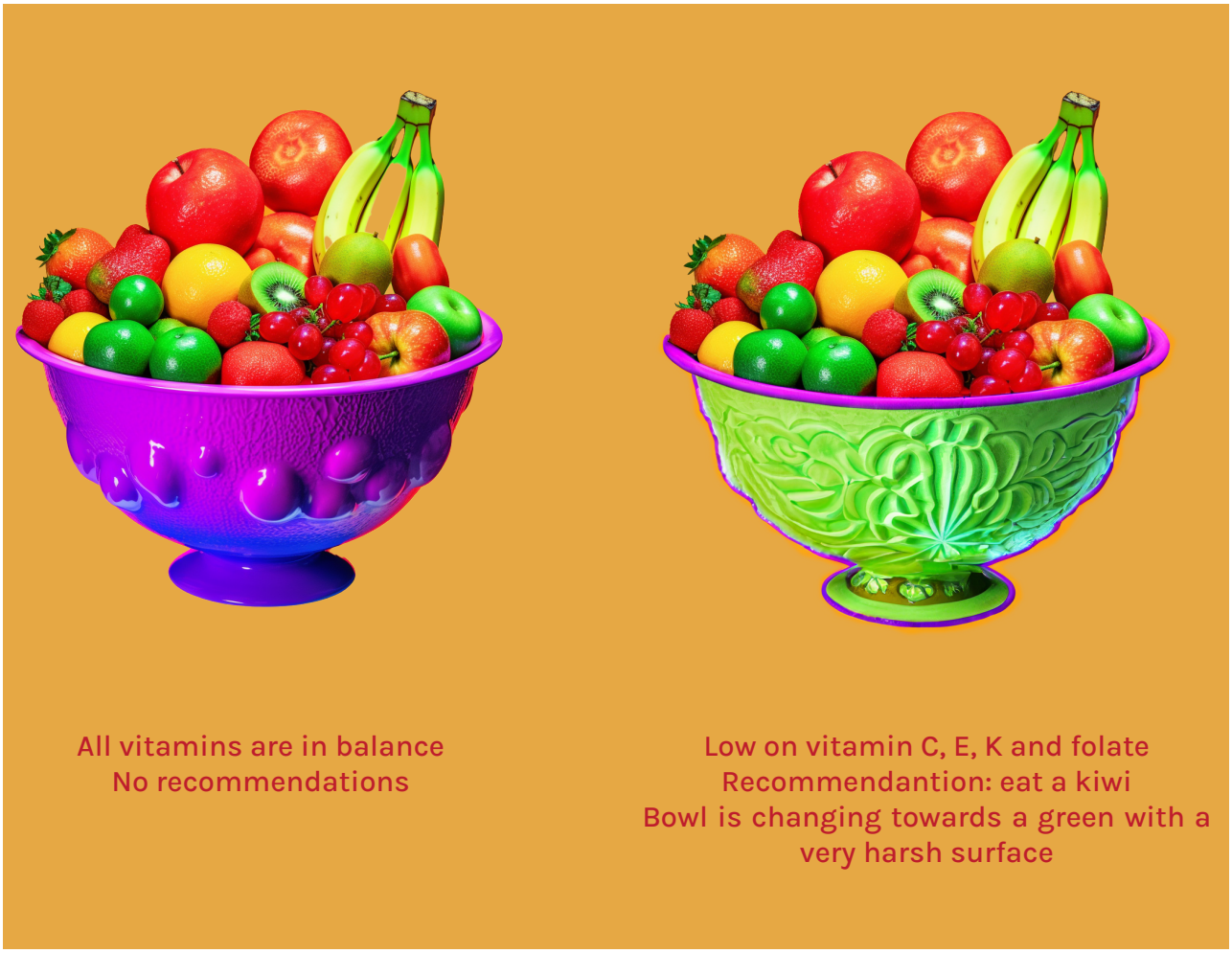


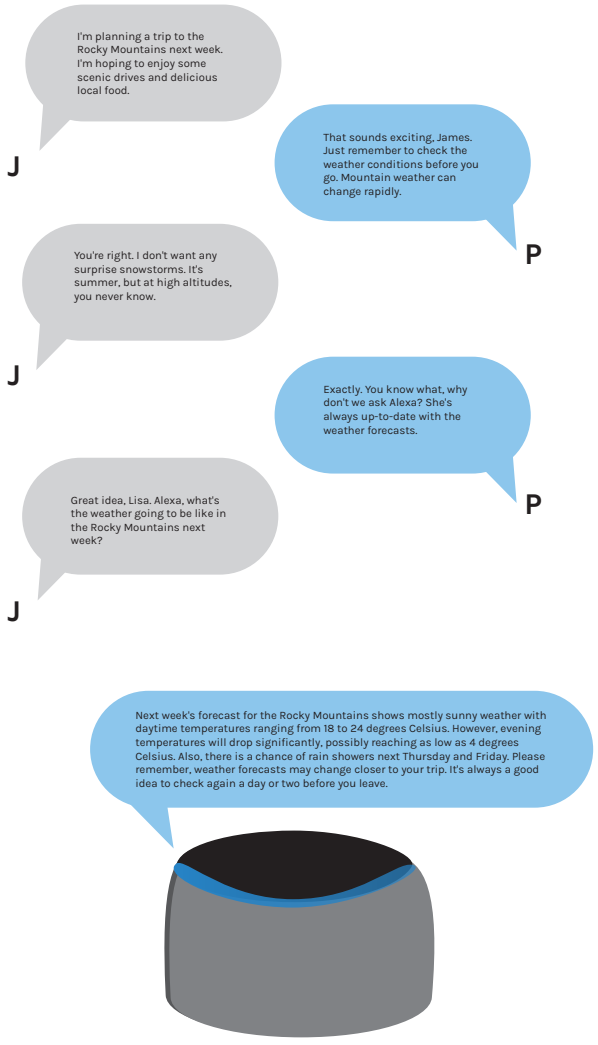
Figure 24: Two “smart” fruit bowls exemplifying how devices could be task oriented and highly situated [47,48]. Picture is created with Midjourney on the 14th June 2023 and edited with Photoshop Firefly.

Minimal computational power:

In this case, the strategy is to remove as much as possible from computational systems one by one . With each round, remove a different feature, observe how it works in a scenario, and then remove another feature.

In this example, information for Alexa was removed with each design step. Until Alexa is triggered by a random noise to make a specific recommendation. This way personal information can be removed, and designers can make sure that not too much information is gathered. Could tangible interactions instead of voice interactions work in this case?

Jenny and Paul have a conversation and want to know the weather forecast for a location from Alexa. Alexa was accidently triggered and is listening into the whole conversation.



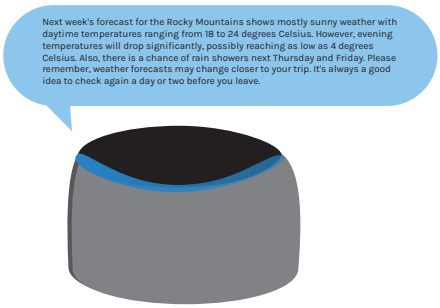
a

Figure 25 a,b, c: Squeaky chicken and different interactions with Alexa [49] Image source: 12.6 Inch Rubber Chicken /squeeze Chicken, Prank Novelty Toy. Fruugo. Retrieved June 13, 2023 from https://www.fruugo.nl/126-inch-rubber-chicken-squeeze-chicken-prank-novelty-toy/p-68857435-138458996?language=en.

The device is dorment until a loud noise is waking it up. The human can ask the question and the answer will be calculated.

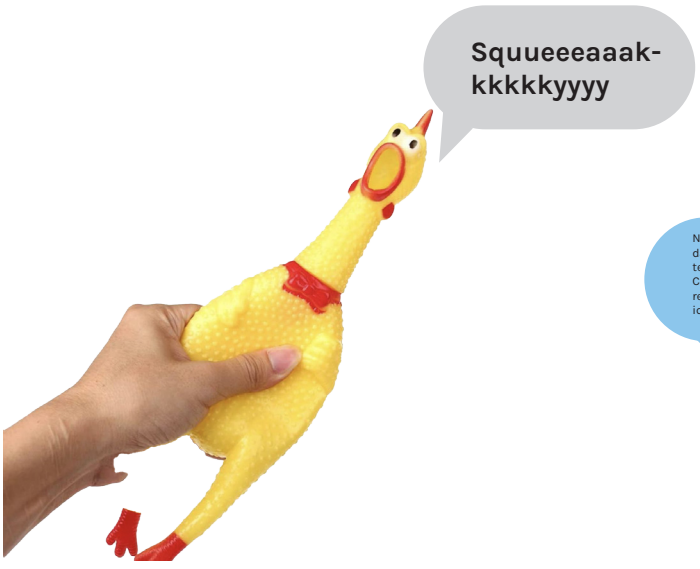
b

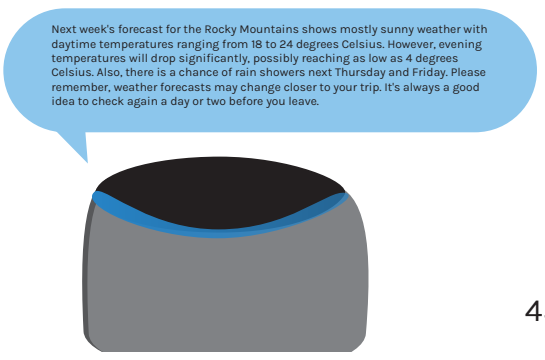
J



Alexa is not listening to anything anymore and cannot be triggered, but certain frequencies have certain recommendation features saved. The squeaky chicken frequency has the weather forecast saved.

c





DESIGNS BASED ON GUIDELINES

Minimal computational power & focused functionality

The 'Triad' is a cutting-edge system comprised of three streamlined computational units, each engineered for maximum efficiency with the smallest hardware footprint. The real magic occurs when the Triad comes together at its central hub, transforming into a single device with all three units' combined processing power and information.

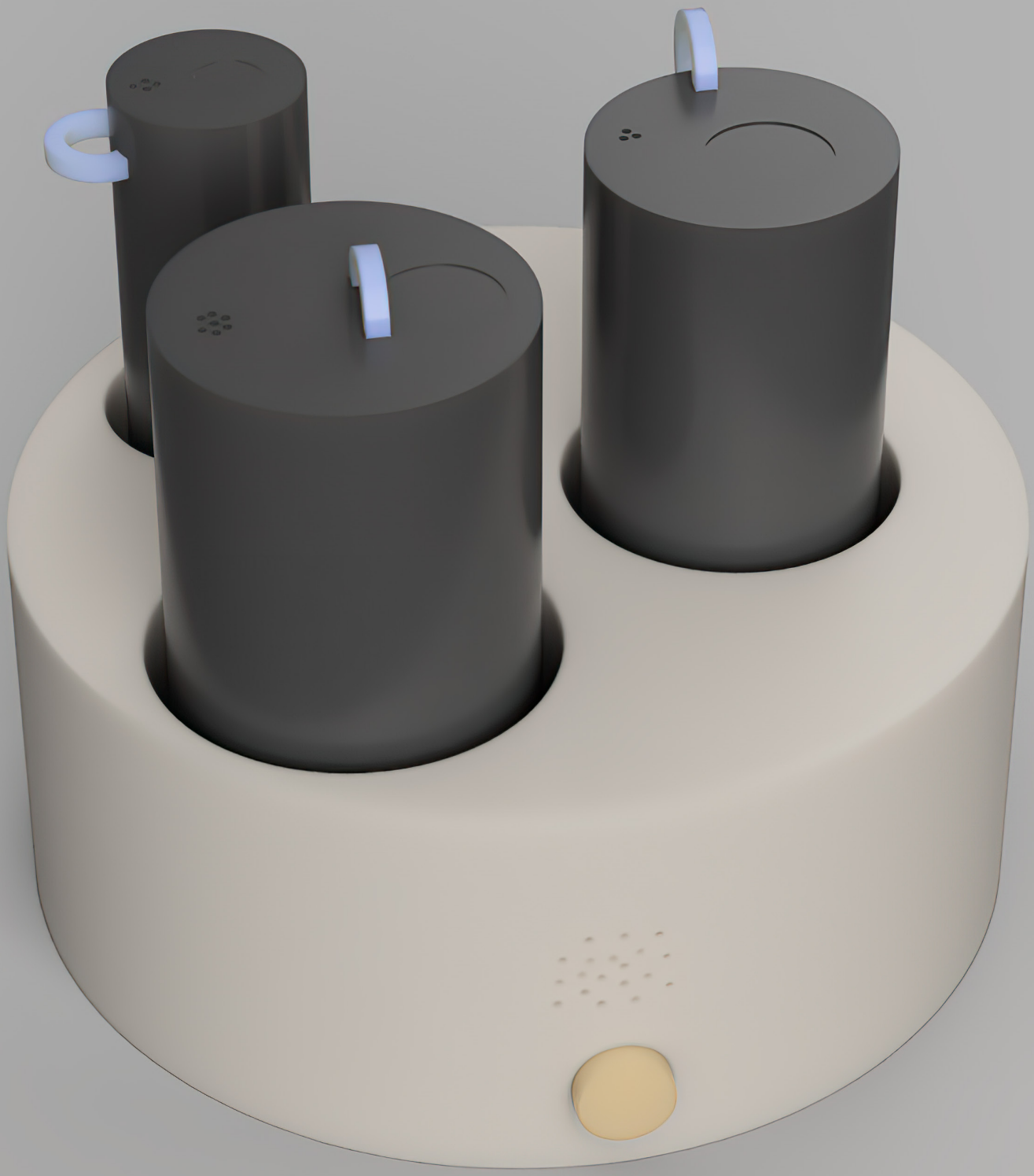
Each Triad component shines with its unique functionality, avoiding the pitfalls of overgeneralization while enhancing task-specific capabilities. Imagine having a personal weather forecaster in your bathroom, a culinary advisor in your kitchen and a dedicated sleep monitor in your child's room - that is the versatility of the Triad.

Despite their individual abilities, the Triad units recognise the value of collaboration. While they cannot access each other's data in different locations, they can connect via a secure link from the central hub with the owner's permission. This ensures that the minimalist design of the Triad does not limit its versatility.

Triad's design is centred on usability. Each unit has a ring mount for easy placement or portability, as well as a top button for power control. Small perforations at the top act as microphones, ensuring the Triad clearly hears your commands.

When docked at the central hub, a built-in knob allows you to easily control the volume of the speaker. A loudspeaker is hidden within the perforations of the microphone, demonstrating the Triad's commitment to minimalistic yet efficient design.

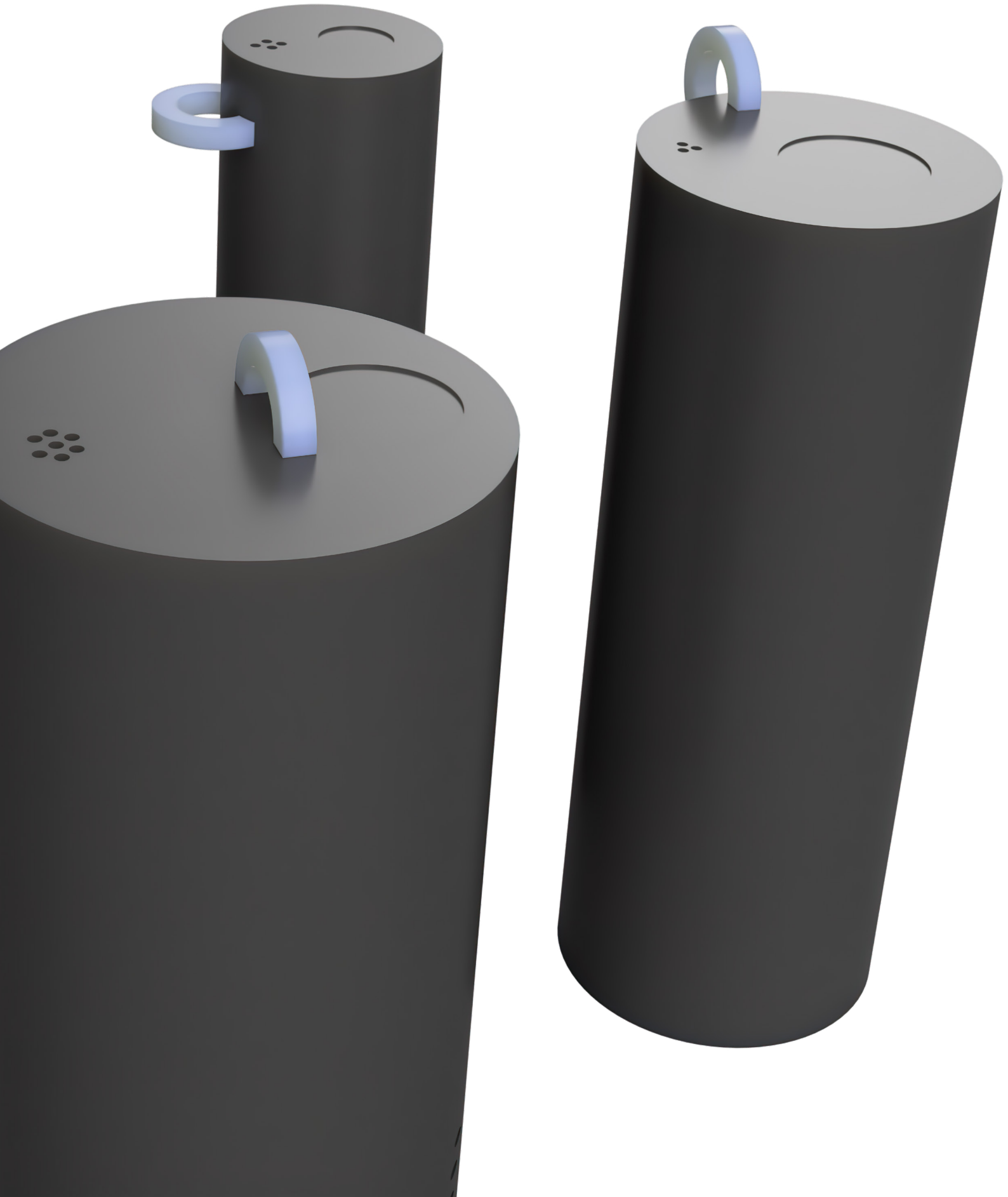
With the Triad, you can experience the future of computational units, where minimalistic design meets focused functionality for an unrivalled, tailored experience.



a

Figure 26 a,b: a: The three objects are in one base. b: all 3 objects are standing alone without the base. Rendered with Autodesk Fusion 360

b



Transparent Data Practises:

Introducing your culinary companion - the "Chef's TableTop", an interactive, smart table surface designed to revolutionize your cooking experience [Fig. 27]. Our tabletop seamlessly integrates with your fridge to identify its contents and propose tailored recipes based on that data.

Today, for instance, Christa is the only person at home. The smart system is aware of Christa's activity level, having noticed a low step count for the day. Based on the available food items - milk, yogurt, tomatoes, potatoes, leek, and eggs, and the food nearing its expiry - salad, potatoes, leek, tomatoes, it generates personalized, health-conscious recipes.

Recognizing Christa's low activity level today, it proposes a low-fat menu: a fresh salad with tomatoes and a comforting leek and potato soup, perfect for one person.

In an era where data privacy is paramount, our Chef's TableTop stands out. As we believe in transparent data practices, our design ensures you're always aware of when and where your data is being transferred. When information is transported from the TableTop to our servers, a clear notification is provided, enabling you to understand and control your data's privacy and value.

We invite you to experience the Chef's TableTop, where cooking meets technology, and transparency is a given.

Figure 27: Tabletop product with transparent data practice guideline in mind [47,48]. [image created with Midjourney on the 14th of June 2023, edited with Photoshop Firefly and Adobe Illustrator]

Modes of Interaction & Minimal computational power:

"Ruju" is a novel cat nibble dispenser that was created with simplicity and efficiency in mind [Fig. 28 a, b]. Unlike traditional models, Ruju keeps things simple by requiring no video or audio recording capabilities.

Ruju, with its semi-smart design, makes use of minimal computational power, making it highly accessible and affordable. Its main feature is an alert system for low food supplies, which illuminates a light indicator, ensuring your pet never goes hungry. Ruju uses a dependable timer for precise nibble dispensing, making it an ideal solution for those who are away from home for extended periods of time.

Ruju's interaction is refreshingly intuitive. It includes a touch sensor that allows pet owners to programme the food dispensing schedule with a single touch. One touch instantly releases the food, two touches set a 2-hour delay, and four touches set a 4-hour delay. Ruju is a versatile and approachable choice thanks to its touch-based interaction, which goes beyond traditional voice commands and embraces a more sustainable mode of communication.

Furthermore, in keeping with its minimalist design philosophy, Ruju stores no data, removing any privacy concerns. A small, efficient microchip controls the entire system, making it a compact and user-friendly solution for your pet feeding needs.

Choose Ruju, the efficient and interactive cat nibble dispenser that is designed to fit seamlessly into your life, and ensure that your pet's dietary needs are met with ease and precision.

Figure 28 a, b: a: Cat sits next the cat nibbler dispenser. The round touch screen on the top of the dispenser is off.

b

b: The touchscreen is lit up. The dispenser has a message for the user [47,48]. [image created with Midjourney on the 14th of June 2023, edited with Photoshop Firefly and Illustrator]

SECOND DISCUSSION

Design guidelines

Recognising the perceived complexity of the presented design guidelines, I acknowledge that they may appear to be anchored in a nearby potential reality, one that may initially challenge our current understanding of technology. If this recognition is not enough, I respect such reservations. My contention is that, in addition to the proposed methods, this framework provides a fertile ground for designers and researchers to engage in discourse about the potential manifestations of these technologies in various realities.

Consider the examples based on the guidelines, even though they are light-hearted these enable us to delve into topics that would otherwise be difficult to articulate.

Based on my belief that social reality is a linguistic construct, I find that the research approach fits in perfectly with my vision. I attempted to devise a method for investigating a subject that, despite its existence, remains elusive due to a lack of sufficient technological lexicon. A significant takeaway from this endeavour was the ability to create my own realities to investigate a topic that is intricately woven into our reality. Sharing the results of my research with my peers and hearing their reactions provided much-needed motivation.

How can companies use the framework?

The framework built through this research is aimed for influencing people's perception of data privacy and how they build systems for the homes. The approaches employed could assist corporations such as Google or smaller enterprises on the market in researching their users' needs and wishes before developing a device.

If a corporation came to me with a design brief for a new IoT system that is put on the wall and regulates air quality, they could check up the methods used in the research and choose the method that would investigate that topic. In this scenario, the Imagining Machine workshop would be useful because the researcher may describe where a machine should be located and what it should measure in the prompt. The participants would design machines that would be shown on the wall and how obtrusive the machines would be. Furthermore, they should apply the guidelines of: Transparent Data Practises and Minimal Computational Power. The object just needs to record certain amount of data and the company should be open about which data was gathered and for what purpose.

Another example: a company requires assistance in designing objects that comply with digital privacy regulations while remaining appealing to users. The design team and data scientists could get design inspiration from the examples of the design guidelines. When they created some lo-fi semi-functional prototypes, a home study with experts could help them understand the impact the interactions could have on users. Using the prototype with experts could provide a more comprehensive understanding of the benefits and drawbacks of a human-machine interaction.

Self-hosted systems

Self-hosted computational systems were a significant vehicle for this project's speculative inquiry, but as one can see, they were not specified in the guidelines. Throughout the project, the focus was always on data privacy and ensuring that humans were not overburdened by technology [23] I don't have the answers to how we can safeguard privacy in recommender systems while not overburdening users and service providers, but I believe we could think about imagining new way to frame the way our community create systems.

CONCLUSION

With this project, I present a method for rethinking and reimagining computational systems through engaging domain experts into speculative imaginations. This material forms the basis of design guidelines for designing with complex technologies. In that sense I am proposing futuristic possibilities as a site where novel technological concepts can be translated into material that is usable as starting points for research and designs.

These insights are qualitative in nature and created through speculative futuring approaches with participants. Ultimately, I translated the insights back to the present situations and distilled a set of design guidelines. For three of those guidelines, I created examples which are implemented in the final designs. Together they illustrate an approach and a framework for discussing and re-considering computational systems for designers, design researchers, and data scientists.

I propose that the study methods and interventions can assist us in conducting innovative designs of computational systems through involving qualitative and creative approaches in the imagination of future computational systems.

Researchers may use my workshop formats to examine the implications of engaging with computer systems in both the near and distant future.

Meanwhile designers may use them to design for technologies that are adjacent possibilities of our current state of the art.

And finally end users may use these methods to arrive at more detailed understanding of how these technologies might impact their lives.

In moving forward, the aspiration is to utilize our acquired vocabulary and the proposed framework as tools to mold computational products that not only safeguard privacy but also bring enjoyment.

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AI tools used:

Photoshop Firefly was used to add generated content to images. This was done on the 13th June 2023 on the following images: 23, 28, 27

ChatGPT was used to check if my writing is understandable and sometimes to rephrase a sentence. GPT 4 was used for this and it was done during the time period of: 1st May - 15th June 2023.

Quillbot was used to rephrase self-written sentences at times. It was done during the time period of: 1st May - 15th June 2023

Midjourney was used to create images on the 12th, 13th, 14th June 2023 and it was used for the following images: 28, 27

Vance.ai to increase the quality of some images on the 14th June 2023 and it was used for the following images: 26, 27, 28

All photos are taken by myself (if not otherwise stated or stated that an image was taken from the internet)

APPENDICES

For any of the appendices, please refer to the ZIP file that was delivered with this report. This is the entire list of appendices:

Appendix A M12 research project report
Appendix B Final Master Preparation report
Appendix C Final Master Project Proposal with edits
Appendix D ERB Approval User studies
Appendix E Imagining Machines workshop
Appendix F Collaborative ideation sessions
Appendix G First home deployment
Appendix H Second home deployment
Appendix I Demo Day stand
Appendix J Publication at ACM CHI Conference
Appendix K Poster for Salone di Mobile Milan exhibition