

The Influences of Infinite Thing-Centered Learning on Everyday Practices

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ABSTRACT

Considering automated artefacts as co-performers in practices can bring insight to the relation between objects and people in practices. Taking a thing-centered perspective has similar aims in understanding the relation between objects and people, however the interplay between these two topics has not been a topic of research yet. Through creating a research product showing the thing-centered perspective and discussing implications for practices in a focus group with designers, the study has brought insights into factors that influence practices. The results provide four different aspects that show influences of automated thing-centered learning artefacts on practices in a future everyday environment. These four aspects are recommended to be taken into account by designers when adopting a thing-centered perspective to design artefacts that continuously learn. Doing this has potential to understand more about the relation between objects and people, and can lead to new ways to frame and solve problems.

Authors Keywords

Co-performance; practice theory; thing-centered design; embodied learning; automated artefacts.

INTRODUCTION

The technical advancements of the past centuries has led to the connected society we live in today. A society in which humans, and human practices are constantly in touch with automated artefacts. Automated artefacts are defined as “due to access to energy supply, are capable of performing actions in the absence of people, and, due to their being equipped with sensors, actuators and computing power can make decisions about how to proceed in specific, situated circumstances” [7]. The paper “Automated Artefacts as Co-performers of Social Practices: Washing Machines, Laundering and Design” by Kuijer [7] also tells us that it is possible to consider artefacts as performers of practices. Recognizing that automated artefacts are co-performers can offer a better understanding of the role of automated artefacts, and offers a new perspective on how automation changes practices over time. In contrast to ‘smartness’, which focuses on a supposed autonomy of artefacts, co-performance considers artefacts as capable of learning and performing next to people [4].

This raises questions about a future world in which feedback from humans and objects are valued equally, and where objects can learn infinitely from each other as well as humans in the object’s ‘language’. To further explore this future world, in a future everyday research, a ‘what-if’ question is formulated: “what if, in a future everyday scenario where

humans and artefacts are equal in performing practices, objects can learn functionalities in an embodied way through a thing-centered perspective?”

By giving automated artefacts the chance to learn certain behaviours and how to perform tasks in the household based on the behaviour of humans and other objects, a future world can be envisioned with a multitude of artefacts that stretch the boundaries of co-performance.

This pictorial describes the research process and sketches a future world, in order to answer the following research question: “What are the influences on practices when automated artefacts learn through a thing-centered perspective in a future everyday environment?”

To answer this research question and to discuss what this future world could look like, a first version of this world is presented to our target audience of designers during two separate focus group sessions. In these sessions, a video sketches the scenario of the future world, with infinite learning objects situated in a specific home context, which is meant to provoke questions. In this way, insights are collected on how participants, with their perspectives as designers, believe thing-centered learning objects change practices. This, through asking questions related to learning, human response, impact on human/practices and boundaries of infinite learning in an incremental societal and spatial scale.

The results of these focus groups allow us to define themes that show the influence of automated artefacts, that are constantly learning, through a thing centered perspective on human (in-home) practices.

Insight in this is important because it helps designers to adopt a thing-centered perspective in the design of artefacts that continuously learn. This is valuable because taking this perspective can help in understanding the gap between 'things' and 'us' [15], and can lead to new ways to frame and solve problems [3].

RELATED WORK

Objects as co-performers

Designed artefacts influence and are heavily influenced by the context that they are in, and practice theory can contribute to gain a better understanding of this [4]. Practices are the mundane everyday acts that are a large part of people's everyday life, such as showering, washing clothes, cleaning and cooking [9]. A practice-oriented view in relation to design which can be taken is viewing objects as co-performers of practices [7, 8]. Taking this perspective of co-performance means to consider artefacts "capable of learning and performing next to people" [8]. This increases the responsibility of artefacts within a practice, emphasizing that the tasks are shared between artefacts and humans. Highlighting the learning capability of artefacts within co-performance is central to the notion of infinite thing-centered learning presented in this paper. The aspect of embodied learning as part of co-performance [8] poses just that it can learn, rather than providing guidance on how to implement it into a design. What it does make clear is that practice-specific learnings can be embodied in an artefact as a result of repeated co-performances over time [8].

Within the perspective of co-performance, the learning can be a result of the artificial agency of objects. What this means is that it shifts the perspective of design being performed by the designer to being performed within the practice by the object and user. This shift in control can be a solution to the existing power imbalance that occurs when a few designers or engineers decide the way a product is used, and as a result form the practice [8]. Changing the power balance could also result in new dimensions of use and raise questions about

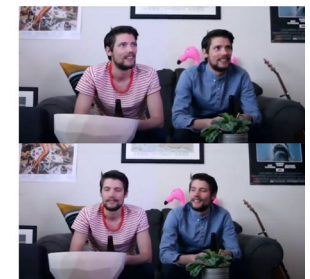
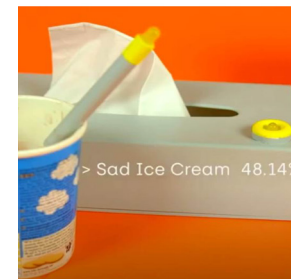
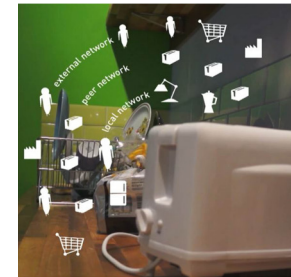
ownership of objects. Through co-performance, there is potential for designers to move away from human-centered narratives of smartness and autonomy [8]. Putting objects on the same level as humans also allows for a shared vocabulary between these two entities [8]. This could be beneficial for designers as designing with a thing-centered perspective can become more accessible.

Thing-centered perspective

Taking a thing-centered perspective means to approach a situation from the point of view of an object, rather than from a widely used human-centered perspective [5]. Taking this thing-centered perspective can help in understanding how people relate to things [15] and can lead to new ways to frame and solve problems [3].

Taking a thing-centered perspective has been used in ethnography [2] and human-computer interaction research [15]. Within the context of ethnography, it has been used to literally look from the perspective of the object by placing sensors and cameras on the object itself, learning about its situation and the people using the objects. The notion of thing-centeredness can be considered an addition to co-ethnography by using objects as co-ethnographers, which suggests an ontological symmetry between people and things [3]. This method of ethnography can be considered quite invasive, as it requires recording the situation not just in use, but also recording when it's not in use. In the other example of HCI research [15], a thing-centered approach was used to gain new insights into the relation between humans and objects, and what it would be like living with an object created from this perspective.

Taking this thing-centered perspective also seems to relate to notions of object-oriented ontology (OOO), a school of thought that suggests that objects have their own distinct realities, separate from human use [11]. There are several cases of an OOO perspective being discussed in design research [11, 1, 10]. OOO has potential to help in deconstruction of a design problem but also in forming possible solutions to it. However aside from these claims being made by researchers, widespread implementation of this philosophy to inform design practice is still not apparent. Through taking a thing-centered perspective, this gap in knowledge can be partially filled to inform design practice.



To get familiar with our thing-centered design (research) space and current proposed thing-centered future scenarios we explored similar (research) products in the field, see the figure above.

Firstly, the project 'Brad the toaster' by Simone Rebaudengo [14] shows a first glimpse of a rather provoking future everyday scenario working from a thing-centered perspective within a practice context, "toasting bread". In this scenario the internet of things does not lead to harmoniously interconnected gadgets within the practice. Instead it leads to a house full of objects who are desperately wanting to be used, having their own will. Rebaudengo explains how the research into this object behavior started from a "what if" question, a useful approach framing future everyday research. Namely, what if, smart objects being connected to and benchmarked against their peers, their relationships with each other start to inform their relationships with us?

Another project presented in the chapter by Giaccardi, Speed, Cila, and Caldwell explained some of the implications of a thing centered perspective for design anthropology [3]. In their research data was collected through interviews and information gathered by intelligent cameras (Autographers) attached to three key material objects in the home (kettle, cup and refrigerator), as well as to four individuals participating in home-based activities to reveal insights about their relationships with each other. They tell us how, as opposed to a human-centred perspective, a thing centered perspective brings unique insights about the relationships between objects and human practices. “It ultimately presents new ways of framing and solving problems collaboratively with ‘things’, which have skills and purposes different from those of humans [3].

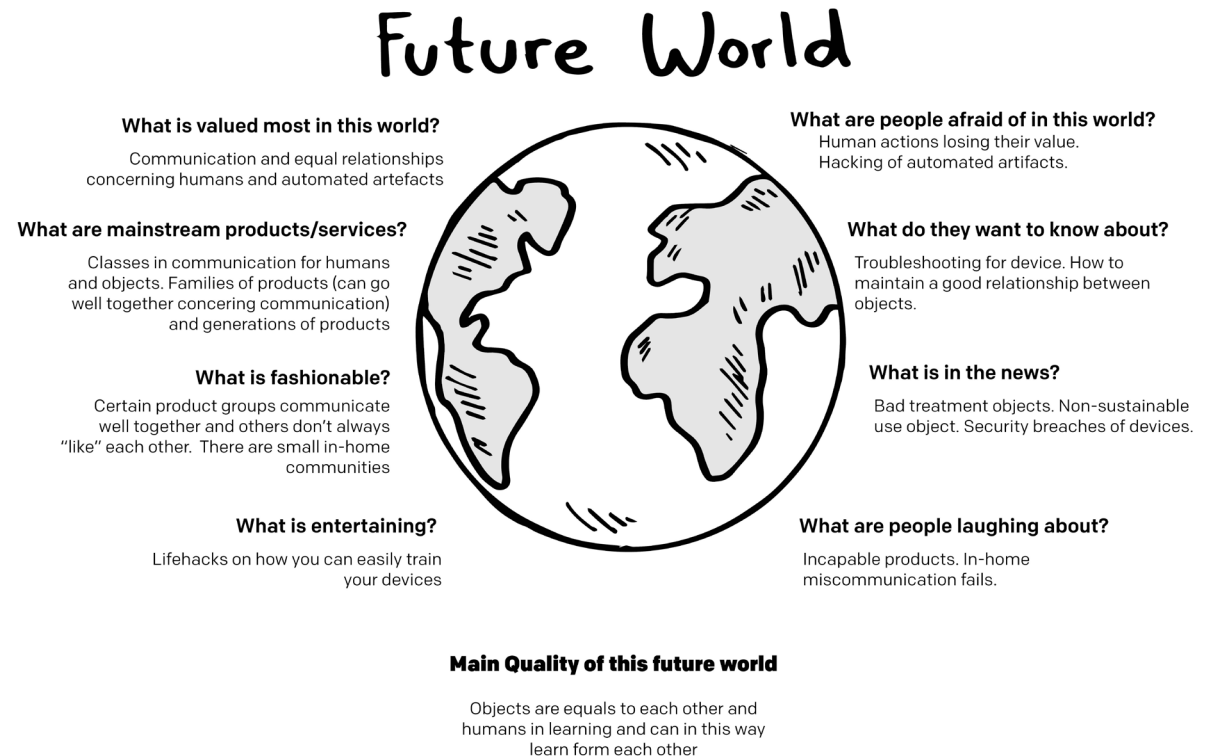
Other ways to research future everyday thing-centered perspectives, include the use of videos as research artefacts. In the research about “Everyday Entanglements of the Connected Home” the researchers use a video as a research artefact to explore more complex interrelationships, using a thing-centered design perspective [12].

Next to this, ‘Videos of things: speculating on, anticipating and synthesizing technological mediations’ by Oogjes and Wakkary also seem to relate to this. Their videos portray the mediated, and lived world of computational artefacts informed by post-phenomenology. In a post-phenomenological understanding, humans and things are interdependent in a way that they mutually shape each other. They also show how as a whole, technology or designed things mediate the relations between us humans and our world. The study emphasizes how challenging this can be for designers [15].

In this future everyday design research we explore automated thing-centered learning artefacts, and also look beyond these objects, exploring their influences on practices in future everyday environments. We aim to see the impact on design and design practice in a future scenario in which co-performance in practices, embodied learning and a thing-centered perspective are combined.

METHOD

For the purpose of this future everyday research, a future world scenario was created based on a combination of the thing-centered perspective concept [15] and the notion of co-performance [7]. In this future world, objects were imagined to be equal to each other and humans and can in this way learn from each other. This allowed for a broad futuristic perspective on thing-centered learning technology, which focussed on all aspects of society. This future world is shown in the figure to the right.



From this, the following question emerged: “What if, in a future everyday scenario where humans and artefacts are equals in performing practices, objects can learn functionalities in an embodied way through a thing-centered perspective?” This question was used in order to create the research product, in our case a thought provoking video, and formulate questions for the two online focus groups, to answer the research question.

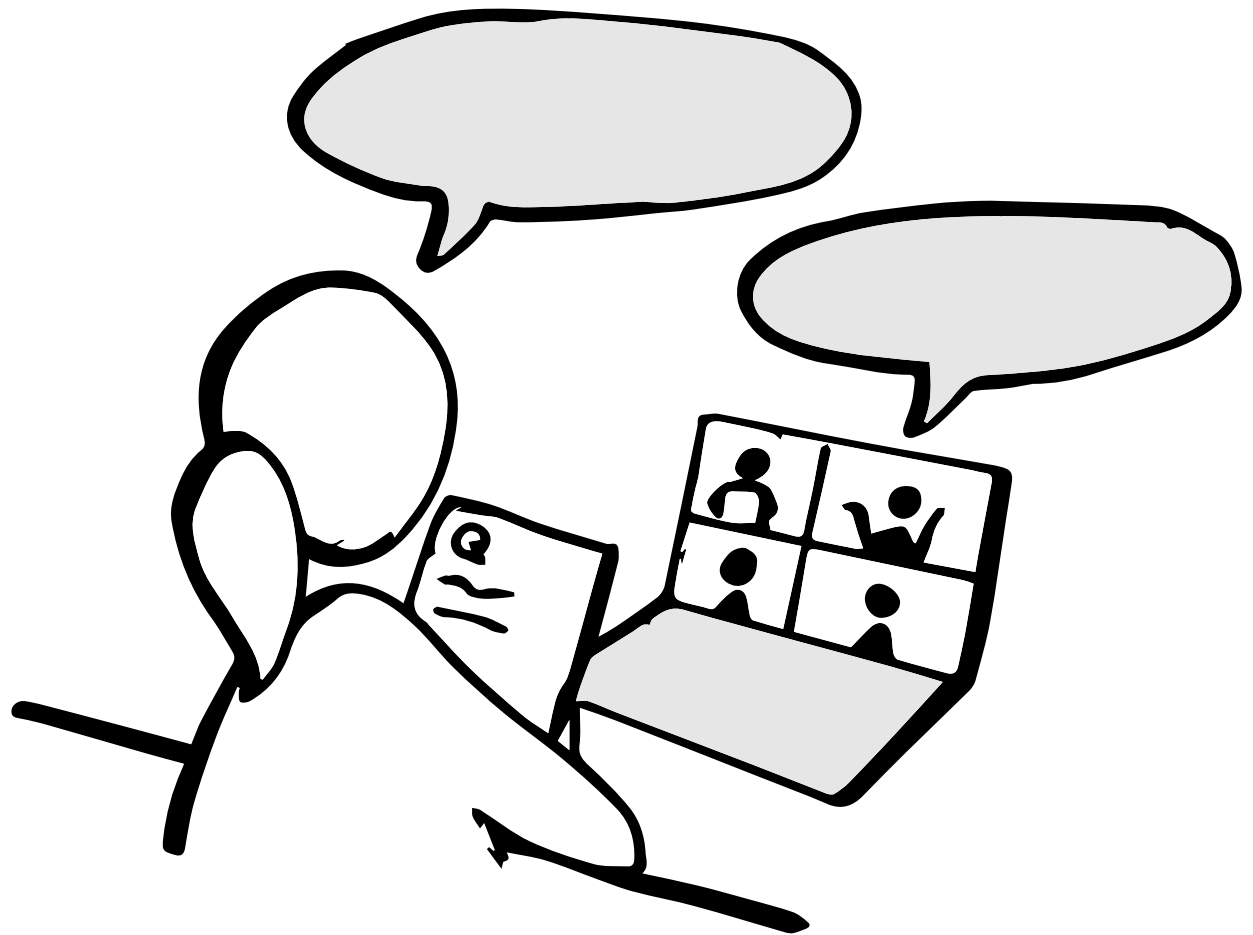
In this study it was aimed to find the influences on practices when automated artefacts (infinitely) learn through a thing-centered perspective in a future everyday environment. Qualitative data was gathered during two iterative online focus group sessions to assess thoughts and opinions on this topic, and to trigger thoughts about the proposed future scenario. This methodology would allow our participants to feel safe and comfortable, while allowing them to give their honest views and perspectives. Especially, due to the online Microsoft Teams environment used for the focus groups, which has also been approved by the ethical review board of the university.

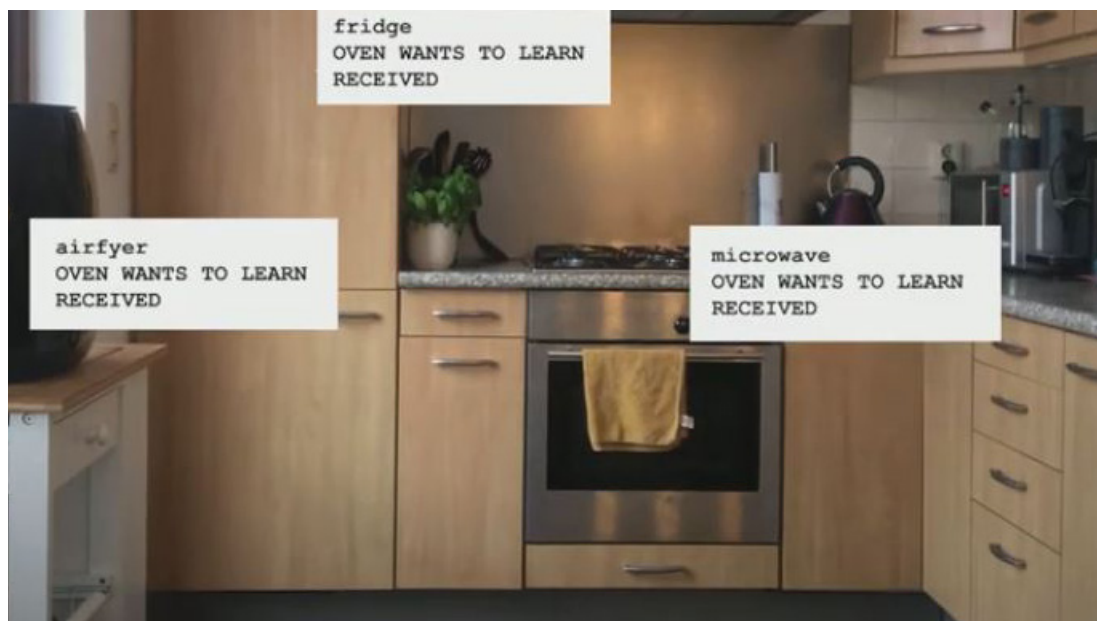
Both focus groups were audio recorded for analysis purposes, in order to better analyse similarity in discussion responses, contrasting quotes and opinions from the participants, and to more clearly create an overall analysis putting data from the two different focus groups together. In order to safeguard the participant’s privacy, an ethical procedure for the Eindhoven University of Technology (TU/e) was completed before the start of the study. Therefore, upfront of the study, an ethical review form was submitted to the ethical review board within the university and approved. This form guaranteed the protection of the privacy, data and wellbeing of the participants and ensured the storage of anonymized data not being able to trace back to an individual. Furthermore, participants were asked to read and accept a consent form before participating in the focus group. This consent form can be found in Appendix A: Consent Form. Participants were assured that all of their information would be treated with care and that their data would remain fully anonymous.

The target group for this future everyday research consisted of designers. In this way, participants (designers) were recruited via the personal and professional network of the design researchers, so in this way purposeful sampling, using the criterion of being Industrial Design students. Therefore,

singularly Industrial Design students from the TU/e were involved, and aged 18 years or older. It was not required for participants to reside in The Netherlands, as the focus group was fully conducted via online means. Furthermore, within the recruitment of participants it was emphasized on diversity within these Industrial Design students, gathering different perspectives on design, human/thing-centeredness and creation of societal impact. This to prevent a one-way designer’s perspective on the presented future scenario.

Moreover, in total 6 participants were recruited and divided over the two focus groups. So, the first focus group consisted of 3 participants (n=3), just as the second group (n=3). In the first group, diversity was created through the designer’s different interests in fields of design, such as digital UX, business and Internet of Things. As for the second group, the participants varied by consisting of two more digital and data-centered designers, and one highly human-centered designer.

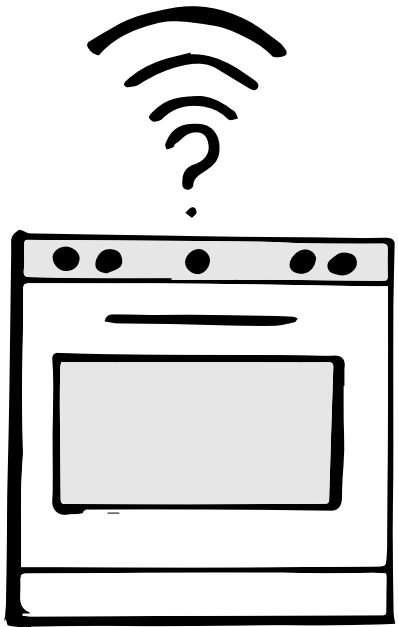




The procedure of the focus groups was aimed to gather qualitative discussion responses from the participants, centered around the above mentioned future scenario presented in the research product. The presentation used for these focus groups can be found in Appendix B: Presentation Focus Groups. As the first phase, the focus group participants were presented with a research product in the form of a short thought provoking video, see Appendix C: Research Product (Video). This video was created for the purpose of this study, and showed participants an example of a future scenario where automated artefacts learn (infinitely) through a thing-centered perspective. This specific scenario was in a kitchen, where participants could see these infinite thing-centered learning artefacts communicate with each other from the object's perspective, and in this way infinitely learn from each other and the wider global network of objects or internet. The video provided participants with the necessary background information on thing-centered learning and inspired the follow-up discussions, provoking questions. This was done in order to clearly convey the specific future scenario to the focus group participants, inspire the reflection on the object perspective used and to safeguard answers from unnecessary comments or confusion regarding the topic.

As a second phase, after watching the video, participants were asked to share their first impressions and express their first questions, thoughts and opinions that were provoked. The follow-up focus groups discussion was semi-structured, and consisted of open-ended questions that were asked related to "what can be learned", "human response", "impact infinite thing-centered learning objects on human/practices" and "boundaries of infinite learning" in incremental spatial scenarios. This meant discussion responses related to these topics slowly grew more towards answers on our research question, regarding the larger perspective of influences of these objects on practices. The first scenario to be discussed was that of a single object, such as a 'stove', what it could learn going from a thing-centered perspective, what the impact would be and what boundaries its learning would imply. The next scenario contained a group of objects in a house or room, such as a kitchen. Final scenarios consisted of thing-centered learning objects in a neighbourhood or beyond, such as the entire world. This allowed for open discussions, follow-up questions, and gave participants ample time and incentive to think and share thoughts or perspectives on this future scenario and influences on practices.

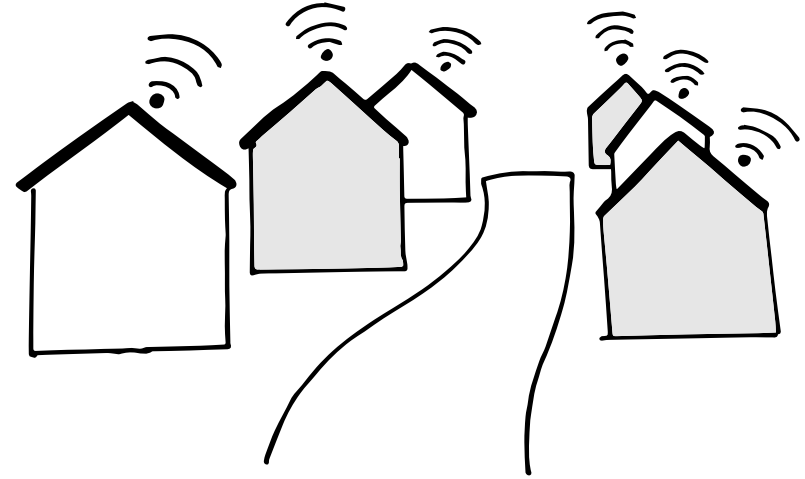
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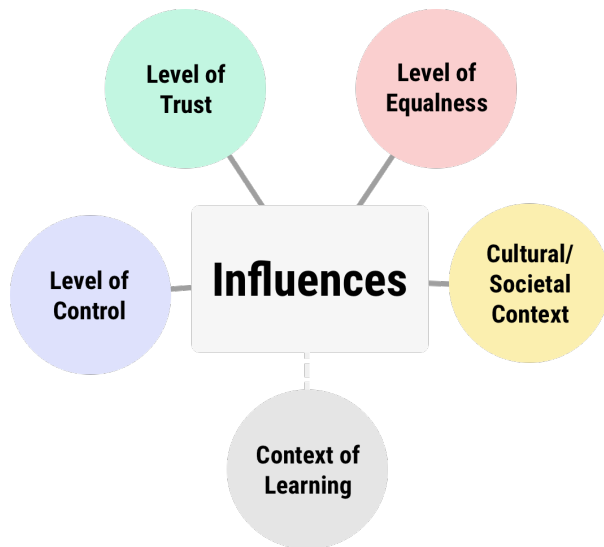
The figure above visualizes the questions asked in the focus group as they were phrased in incremental spatial scenario

FINDINGS

Results are based on a combination of two focus groups. In these groups, a future scenario about (infinite) thing-centered learning artefacts in a home environment was discussed. It was focused on incremental perspectives, namely: An object perspective, a room or house perspective, and a neighbourhood and beyond perspective. The results mainly provide insights into the influences of thing-centered learning automated artefacts on practices in a future everyday environment. These are divided into four sub themes of level of trust in automated artefacts, human levels of control on practice, level of equalness automated artefacts and humans, and cultural and societal influence on practice. Furthermore, secondary findings are provided which center around the sub theme of context of learning.

Influences on practices

All four sub themes are centered around the influences of thing-centered learning automated artefacts on (in-home) practices. All are of interest to this study, giving insight into important values and elements related to automated artefacts, learning processes, and practice-as-performance that indirectly influence practice-as-entities in a future everyday environment.



Level of Trust

System needs to gain user's trust, easily lost	Trusting the machines plays big role in the impact and learning process
If there is more trust towards the infinite learning objects, humans are more willing to give away their privacy	If there is a sense of trust in the objects, humans would allow objects to have more authority in learning process
Communication between AAs and humans important for trust in learning process	Machines don't care about ethics

Level of trust in automated artefacts

When the future scenario around thing-centered learning objects was introduced, in both focus groups, it was clear the levels of 'trust' in relation to automated artefacts, their learning processes, and performances of practices would be influenced. One participant from group 2 stated the importance of 'trust' with thing-centered learning objects in the learning process influencing the cooking practice, *"I would immediately lose trust in my smart kitchen tools if they would make a mistake, like with the Google Home. I think I would never use them again."* (P5,G2). Just as the assumed level of trust in thing-centered learning objects and lack of empathy for these objects and their learning process in kitchen practices, *"I see my smart stove more as, for example, a cook I hired. I hired him so I want him to do his job. I would give objects like that less opportunity to grow and improve."* (P5,G2). Moreover, a participant from group 1 indicated that trust is easily lost, but also needed, *"Systems need to gain the user's trust, which is easily lost again."* (P3, G1). In order for humans to gain trust in automated thing-centered learning artefacts being part of in-home practices, participants from both groups made it clear that object-human communication is key. A participant from group 1 said the following: *"Users need feedback in a learning system, for trust in learning."* (P2,G1). In the same way, a group 2 participant stated that object-human communication creates comfort for humans in practices which involve thing-centered learning, *"Communicating that's happening makes humans feel at ease."* (P4, G2). Interestingly, in group 2, it

was questioned if future thing-centered learning objects will have accountability for human safety, any sense of ethics or considerations of privacy within practices influencing the human level of trust. It was mentioned objects should have accountability for human safety, to trust these objects with performance of practices, *"Machines have a bigger responsibility because they can predict dangerous situations much more than humans would have to."* (P4,G2) and *"Yeah I agree, if you have humans in the mix, I think the machine's top priority should be to keep the humans at least in a safe situation."* (P5,G2). But within object-object learning, it was believed automated artefacts do not care about machine privacy or ethics, and the level of trust that's possible in these thing-centered learning objects was questioned, *"I don't think machines are in any way affected by their data sharing. If they don't feel anything or are in any way influenced by the sharing of their data or privacy, then I think it doesn't matter."* (P5, G2).

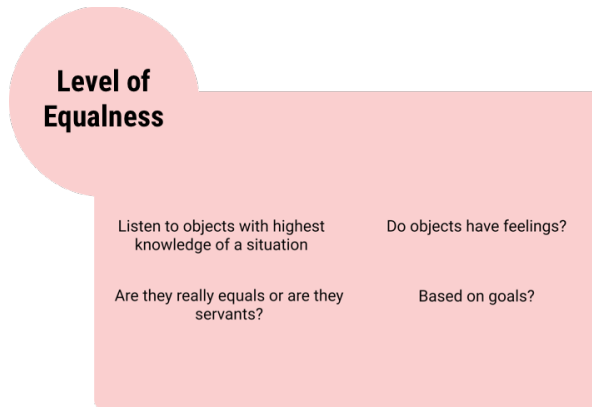
Level of Control

Manual override is necessary	Transforms kitchen into an experiment
Background process	Artefacts should go along with wishes of user
Awareness on level of control	When there are humans in the mix, objects have to put them in safe situations
Laws on robotics and their boundaries in human serving functioning	Impacts practices itself
"I do think machines should have some sense of accountability"	Autopilot

(Human) levels of control on practice

The influence of automated thing-centered learning artefact on levels of trust is highly related to their influence on (human) levels of control and authority within practices. Especially in group 2 this was highlighted, *"If there is more trust towards the infinite learning objects, humans are more willing to give away their privacy."* (P4, G2). and *"If there is a sense of trust in the objects, humans would allow objects to have more authority in the learning processes."* (P5,G2).

Furthermore, participants of both groups mentioned scenarios in which the authority or control of objects would go out of hand, and how this could impact practices. Participants in group 1 called the object's level of control into question, *"It's weird if you entered your house and your stove was already on, cooking something."* (P1,G1), and *"Objects steer people into a certain direction, being aware of how much control these objects have is important."* (P3,G1). Another participant in group 2 stated that high authority of thing-centered learning objects could turn the kitchen and the practices within a kitchen into an experiment, *"It transforms the kitchen into an experiment, so you become part of an experiment in your kitchen and the kitchen is testing stuff out on you. Like switching on the oven when you don't want the oven to be switched on, and then seeing how you react."*(P4,G2). Especially in group 2 the boundaries of control between humans and objects in practices was discussed. One participant in group 2 seemed more hesitant towards automation of artefacts, *"Not everything needs to be smart, I don't like to have it all automated, I want to do my own thing."* (P6,G2). Another participant in this group commented on the relation of control and convenience, *"The stove shouldn't control life too much, it has to work for convenience. If I am really hungry, I just want the stove to be a stove, and I will be happy if the stove has those added bits of intelligence, but not if it tries to control my life too much."*(P4, G2). However, it was also discussed that in future everyday life participants might accept giving more control to these objects in practices, similar to how the mobile phone was integrated into society, *"It's the same as with phones and cars, people didn't feel the need for it back then as well."* and *"As soon as it's better than normal kitchen tools, old ones will always be replaced, especially with thing-centered learning, they will always be smarter."*(P5,G2).

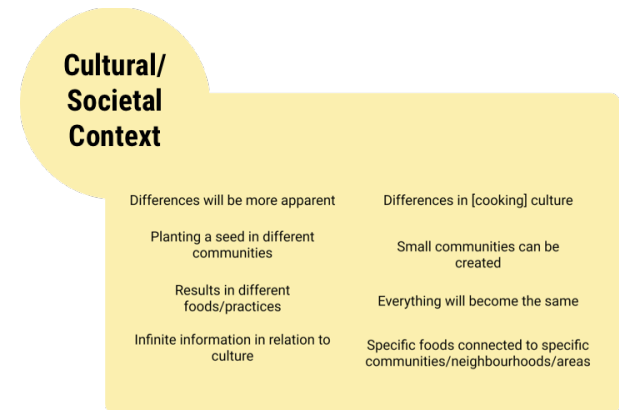


Level of equalness between automated artefacts and humans

From the focus groups, it was clear that the boundaries in equality between automated artefacts and humans go beyond questioning human and object levels of control in practices. Although, in our future world feedback from human and object is valued equally in the learning process and practice, participants questioned equality based on situational object, and human knowledge, skills, object's goal-orientation, or emotional intelligence. For example, group 1 participants made it clear that situational skills and knowledge determine equality in a practice, *"The object should listen to that which has the most knowledge on the subject."* (P3,G1). In the second group, it was mentioned that it should be more dependent on the goals objects have; if they are more object- or human-centered. One group 2 participant mentioned that what objects need to learn within a practice is based on what humans have as a goal, for example, *"If the human would say, sustainability is an important factor for them, that the object sees that more as a learning goal."*(P6,G2).

On the other hand, another group 2 participant stated that the objects could have their own learning goals to which the humans have to adapt, *"If their goal is to preserve themselves the best as possible, they probably learn how to use themselves the least as possible. Because if they are used, they wear down, they break. So if humans say 'I want something', the objects can say 'okay use that machine', and in that way they are safe."*(P5,G2).

An interesting comment made in group 2 was about equality in practices based on the level of emotional intelligence. This participant indicated having the need to be served by automated artefacts, but did not want it to have too much human emotions, so it would feel like a slave, *"It's just here to work and do its job. But even if the automated artefact had more feelings, I wouldn't want to buy it because I don't want to buy a slave."*(P5,G2). In this way participants questioned multiple ways to consider human-object equality within practices.



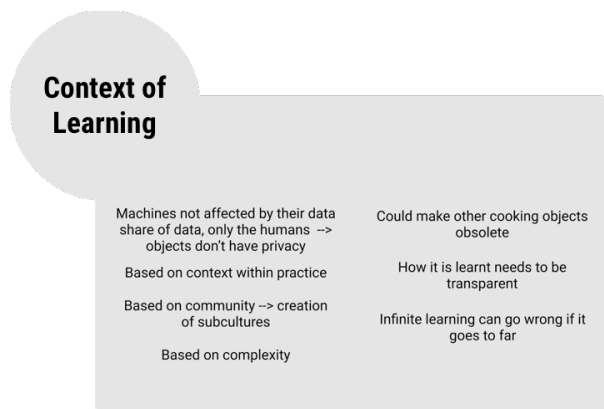
Cultural and societal influence on practice

In the first focus group it was clear that the use of thing-centered learning objects in in-home practices would have the ability to influence the creation of subcultures. Participants from group 1 stated that *"devices can learn from others in their proximity"* (P3,G1) which could support creating communities, *"Just like camping, as an example for a small community. Within this community it can be decided who is allowed to cook and who isn't based on energy allowance."* (P1,G1). Participants also mentioned that they think communities will get more flexible through practices that involve thing-centered learning objects, *"You can plant a seed in another community by performing a certain behaviour with a certain object."* (P3,G1). Furthermore, integration of these objects could make cultural differences more visible, as stated by a participant from group 1, *"It could result in different food and different practices, and show differences between cultures like with cooking in the Netherlands versus*

cooking in Africa.” (P2,G1). On the other hand, group 2 had a contrasting view on the cultural and societal impact, and they stated that possible consequence could be that cultures could get undermined, and that it could make (performances of) practices more equal on a global level. *“At some point the kitchen will discover a meal that is the best all around, over any other food. In taste, health, cost, etc. Would everyone in the world be eating the same thing over and over again then?”* (P4,G2).

SECONDARY FINDINGS

These findings are relevant for results and discussion to contextualize the above mentioned influences of automated thing-centered learning artefacts on practices.



Context of learning

Discussions in both focus groups showed a variety of contexts in which thing-centered learning with automated artefacts in the future could evolve. In group 1, it was imagined that these automated artefacts could learn through connections based on task complexity, as stated by a participant, *“It could be based on complexity of actions, looking at other products that are connected which are in a different practice but share the same level of complexity.”* (P3,G1). On the other hand, these artefacts could learn through connection based on proximity, as explained by another group 1 participant, *“It can be based on proximity, related to the time aspect of practice, like when heat needs to be applied.”* (P1,G1). Furthermore, especially in

group 2, it was emphasized how the learning process of a group of these automated artefacts could proceed in the context of a practice. For example, one of the participants stated that in regards to the practice of cooking, the automated artefacts would become *“a kind of company, in which the objects are hired cooks or experts, participating in the practice.”* (P4,G2). And how they could create variation in the practice through switching around objects related to a goal in the practice, *“If the goal of the group of objects was to produce interesting food, then maybe it will switch around the objects, and users will get different kinds of pastas. It could be interesting for the user to have this brand of products that interact with each other.”* (P4,G2).

As an opposing idea, another participant in this group imagined learning within a group of objects in a practice to be more software-centered, *“I think objects learn more through software than through other objects in their surroundings. Any time a new machine would be bought, the system would get smarter. But this can also happen faster through software.”* (P5,G2).

Aside from the ways automated thing-centered learning artefacts could learn or behave within a practice, the boundaries to infinite learning were discussed by participants in the focus group. As stated by a group 2 participant, *“From a machine perspective, is there anything that stops them from learning, and can they unlearn things?”* (P4,G2). Various perspectives on how far the learning should go were discussed, in which the main shared opinion was, *“If there is no room for human feedback, you would have unsupervised learning which could turn into the entire situation spiraling out of control very quickly”* (P5,G2). Participants in the first group had similar views, and stated the importance of transparent learning, both related to processes going on and object connections in the systems, *“It goes hand in hand with the feedback from the object.”* (P1,G1). Moreover, imagining a context full of automated artefacts involved in practices, it was discussed these *“could make other cooking objects obsolete [...] such as a sous vide”* (P3,G1). This in relation to the future, where the pan could, for example, inform the stove on the correct temperature to maintain. On the other hand, in group 2, participants imagined the use of a mix of thing-centered learning objects and non-smart objects working together in a practice, in which *“automated artefacts try to*

find ways to communicate to the human, on how to use a non-smart object, like a knife.” (P4,G2) within performance of a practice.

DISCUSSION

Our findings suggest that there are several factors that influence practices when automated artefacts learn through a thing-centered perspective in a future everyday environment. We find that the level of trust in automated artefacts, the human level of control on the practice, the level of equalness between automated artefacts and humans, and the cultural/societal context influences the practice.

The level of trust can influence the practice itself as this can change the dynamic between the object and the person. To perform a practice with an automated artefact, the person needs to trust the object to reliably complete the task which is something slowly gained but quickly lost. Communication between user and object is found to help increase this trust, and makes users feel at ease. This feeling of being at ease is important in relation to the safe operation of an artefact, as machines gain an increasing responsibility to run practices smoothly. Not being able to do so can be dangerous, according to the participants.

This requirement for trust correlates to other findings which show that the level of control people would experience when interacting with these artefacts is important. Participants stated that when the level of trust increases, the need for control would decrease. A certain level of control is always desired, regardless of the ability and skills of the automated artefact. This could be to avoid the object taking too much control and users not being able to regain this control. Even though participants have stated as such, there is a possibility that the level of control that is desired is influenced by current perceptions of how much artefacts can be trusted. In reality a lower level of control can be provided. Participants could envision this decreased need for control as a likely scenario.

The level of equalness automated artefacts have in relation to its users is linked within co-performance to an equal division of tasks, but what the study found is not just about a division, but also about the status and general relationship between these two entities. Participants desired equalness because they did not want artefacts to be slaves, calling into question

aspects of emotions within objects. However, the comments made by the participants were still very human-centered in relation to the boundaries of equalness. Even though participants were tasked to adopt a thing-centered mindset, they still had strong human-centered ideas of what equalness is, such as it was considered that humans would still always be in control and thus be superior.

This relates to the general experience of the focus group, as the participants struggled to adopt the thing-centered mindset. Not surprisingly, as taking a human-centered perspective is prevalent among designers [5]. This reluctance to fully adopt a thing-centered perspective was also shown when participants discussed the broader impact when these thing-centered devices are connected. Immediate reactions from participants were to think of human sub-communities that would be formed because of objects learning from their environment. Creating human sub-communities could result in making the differences between each community more visible, if the differences are also reflected in the artefacts. On the other hand, it could also lead to undermining small differences and homogenizing the cultures into a single 'optimal' way a practice needs to be performed. This shows that a different approach needs to be taken to impart a thing-centered mindset on designers.

Through the creation of the research product (the video) some boundaries were set to the ways of thing-centered learning, although these were also questioned by the participants. Participants questioned how exactly and through which devices these objects would learn, how this would differ in various practices, and how this would bring variety within a certain practice. These can be considered as suggestions designers need to take into account when designing automated thing-centered learning artefacts for future everyday life within the context of practices. Most interesting was the fact that participants highlighted how the organization and combination of different automated learning artefacts within a practice was seen as important. It was imagined that this group of objects would form a sort of ecosystem, in which these objects switch around tasks while learning from each other in order to create variation within a practice, such as ways of cooking pasta. From a designer's perspective, it was suggested this could offer new opportunities, offering a collection of thing-centered learning objects to users that

interact with each other in certain practices.

Furthermore, boundaries of infinite learning were discussed. This could be interesting for designers when creating the mechanics of how these future automated artefacts should learn. In both focus groups, dystopian scenarios of infinite learning were discussed. Participants imagined the consequences when human control would be lost. According to the participants, this would create some form of unsupervised learning which raised questions on how some learning capabilities of these automated artefacts can be removed by the object itself, the designer, or the user in the practice. Moreover, questions were raised about the amount of objects with thing-centered learning that should be integrated into practices. A combination of non-smart objects and learning objects was proposed, since singular use of learning objects would make some of these objects obsolete within a practice. However, when combining non-smart and learning objects, communication on how to use these non-smart objects is key, and was imagined to be done via the automated learning artefacts. For designers, it could be a challenge to create interesting thing-centered interplays between these objects to support humans within practices.

Limitations

Participants for the focus groups were all design students rather than experts in thing-centered design. Therefore, adopting a thing-centered perspective was a challenge for the participants in both focus groups. Having participants take on this perspective was difficult during the sessions, which limited their imagination of the future scenario, and also asked for the researchers to intervene more into the discussion. This meant that researchers implemented more of their own perspectives in the discussions, which could have led to biased responses. Moreover, although the research product in the form of a video immersed the participants in a future scenario and provoked questions, the discussions still mostly contained speculation from designers on these future scenarios. This questions the reliability of the research results. Another limitation that needs to be acknowledged is the fact that within the research artefact that was presented to the participants, the researchers shared their vision of thing-centeredness. This could have led to less informed discussion responses. A final limitation includes the recruitment of the participant base. As mentioned in the methods section, participants were selected

from the researcher's network through purposeful sampling based on the criterion of being Industrial Design students. Although, the diversity within these TU/e Industrial Design students was emphasized, having designers with interests in different fields of design. All participants still were from only one university, which could limit the variety in perspectives available for discussion. Furthermore, since the participants knew some of the researchers that were present during the focus group sessions, this could have led to some 'pleasing' responses. However, to prevent this as best as possible, it was explicitly mentioned to the participants in the introduction of the focus groups to be honest. Researchers emphasized that there were no wrong answers, in order to best support the research.

CONCLUSION

In this research four themes were defined that show the influences of automated artefacts that are constantly learning through a thing centered perspective on human (in-home) practices: The level of trust in automated artefacts; human levels of control on practices; the level of equalness between automated artefacts and humans, and; the cultural or societal context.

These four themes are based on the results from multiple focus group sessions in which a future world scenario was presented through a research artefact in the form of a video. All themes give insights into values and elements related to automated artefacts, learning processes and performances of practices that indirectly influence practices as entities in a future everyday environment. These four aspects are recommended to be taken into account by designers when adopting a thing-centered perspective to design artefacts that continuously learn.

Insights in this are important as they could help designers to adopt a thing-centered perspective in the design of artefacts that continuously learn. This is valuable because taking this perspective could help in understanding the gap between 'things' and 'us' [15], and can lead to new ways to frame and solve problems [3].

ACKNOWLEDGMENTS

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Appendices

Appendix A: Consent Form

Subject information for participation in scientific research

Infinite thing-centered learning

Official title: Infinite thing-centered learning.

Introduction

Dear Sir/Madam,

You are asked to take part in a scientific study.

Participation is voluntary. Participation requires your written consent. Before you decide whether you want to participate in this study, you will be given an explanation about what the study involves. Please read this information carefully and ask the investigator for an explanation if you have any questions. You may also discuss it with your partner, friends or family.

1. General information

Situation	Example passage
- Course DCM170 'Researching the Future Everyday'	This study has been designed by By Rick Buijs, Kyara Fasen, Melvin Sterk and Veerle van Wijlen and is being carried By Rick Buijs, Kyara Fasen, Melvin Sterk and Veerle van Wijlen within their Master of Science at the University of Technology Eindhoven. There is no commercial party involved in this study.

For this study 6-8 designers with large diversity, e.g. different cultural backgrounds or design perspectives, are required. Since, designers are the ones that in the future are going to give the limitations to these automated artefacts and determine their new roles in co-performance within in-home practices. Furthermore, designers have the background knowledge to say something useful about the future of automated artefacts and are accessible in the research's time-frame. Therefore, in order to answer the research question, we are planning to involve Industrial design students (human participants). We will conduct the online focus group sessions from our homes in the Netherlands. The participants do not need to reside in the Netherlands and will be conducted via Microsoft Teams.

In this study in we would like to obtain your impressions of a future everyday scenario where humans and automated artefacts are equals, and objects can learn functionalities in an embodied way through a thing-centered perspective, including emerging challenges this future world can bring. Around 2 of the researchers will show you a video portraying the above mentioned future everyday scenario and

will lead a follow-up discussion about possible future implications of this scenario in which you are asked to participate.

2. Purpose of the study

The paper “Automated Artefacts as Co-performers of Social Practices: Washing Machines, Laundering and Design” by Lenneke Kuijer tells us that it is possible to consider artefacts as performers of practices [1-4]. Recognizing that automated artefacts are co-performers can offer a better understanding of the role of automated artefacts, and offers a new perspective on how automation changes practices over time [4]. This made us wonder about a future world in which feedback from human and object is valued equally, and where in this way objects can learn infinitely from each other and humans, in their own ‘language’. This brings us to the following question: “What if, in a future everyday scenario where humans and artefacts are equals, objects can learn functionalities in an embodied way through a thing-centered perspective?”

By giving automated artefacts the chance to learn certain behaviours and how to perform tasks in the household based on the behaviour of humans and other objects, we can envision a future world with a multitude of artefacts that stretch the boundaries of co-performance.

By sketching an idea of this world we want to answer our research question: “How can automated artefacts learn via communication with other objects through a thing-centered perspective in the future everyday environment in relation to co-performance?”

3. What participation involves

During the study, the following will happen:

- One of the researchers will send you a link to the online Microsoft Teams focus group session
- Here you will see 1-2 researchers and 2-3 other participants of the focus group session
- You will be asked to watch a future everyday scenario video about infinite thing-centered learning and asked to discuss first impressions
- You will be asked to imagine infinite thing-centered learning in relation to automated artefacts in incremental future scenarios (e.g. what if kitchen appliances can also learn from bathroom appliances or what if automated artefacts in your house can learn infinitely from the neighbour’s automated artefacts?)
- Finally, you will be asked to engage in a conclusive open discussion
- These discussions will be audio recorded
- The insights from the discussions during the focus group will be transcribed and reported in the research paper by Rick Buijs, Kyara Fasen, Melvin Sterk and Veerle van Wijlen

The focus group will last for approximately 60 minutes.

4. What is expected of you

In order to carry out the study properly it is important that you follow the focus group instructions given by the researchers during the session, actively engage in the discussions, answer questions and share opinions/perspectives on the presented topic.

It is important that you contact the investigator(s):

- if you no longer want to participate in the study.

5. If you do not want to participate or you want to stop participating in the study

It is up to you to decide whether or not to participate in the study. Participation is voluntary.

If you do participate in the study, you can always change your mind and decide to stop, at any time during the study. You do not have to say why you are stopping, but you do need to tell the investigator immediately.

The data collected until that time will still be used for the study.

If there is any new information about the study that is important for you, the investigator will let you know. You will then be asked whether you still want to continue your participation.

6. End of the study

Your participation in the study stops when

- you choose to stop
- the end of the focus group has been reached

The study is concluded once all the participants have completed the study.

7. Usage and storage of your data

Your personal data will be collected, used and stored for this study. This concerns data such as your voice from the audio recordings. The collection, use and storage of your data is required to answer the questions asked in this study and to report the results. We ask your permission for the use of your data.

Confidentiality of your data To protect your privacy, your data will be given a code. Your name will be pseudonymized and other information, as audio recording data, that can directly identify you, will be anonymized after transcripts. Through the use of explicit consent forms, any of your contributions in the conversation shared amongst participants and researchers in the discussions will be safeguarded and not shared outside the focus group. Data can only be traced back to you with the encryption key. The encryption key remains safely stored in the local research institute. The data cannot be traced back to you in reports and publications about the study.

Access to your data for verification

Some people can access all your data at the research location. Including the data without a code. This is necessary to check whether the study is being conducted in a good and reliable manner. Persons who have access to your data for review are Rick Buijs, Kyara Fasen, Melvin Sterk and Veerle van Wijlen: the researchers. They will keep your data confidential. We ask you to consent to this access.

Retention period of your data

Your data must be kept for 5 years at the research location of the University of Technology Eindhoven.

Withdrawing consent

You can withdraw your consent to the use of your personal data at any time. This applies to this study. The study data collected until the moment you withdraw your consent will still be used in the study.

More information about your rights when processing data

For general information about your rights when processing your personal data, you can consult the website of the Dutch Data Protection Authority.

If you have questions about your rights, please contact the person responsible for the processing of your personal data. For this study, that is:

Chief Information & Security Officer, the Privacy & Security Officer and/or the Data Protection Officer of the Eindhoven University of Technology via privacy@tue.nl or contact the Dutch Data Protection Authority.

If you have questions or complaints about the processing of your personal data, we advise you to first contact the researchers: Rick Buijs, Kyara Fasen, Melvin Sterk and Veerle van Wijlen. You can also contact the Data Protection Officer of the institution or the Dutch Data Protection Authority as mentioned above.

8. Any questions?

If you have any questions, please contact Rick Buijs (r.c.h.f.buijs@student.tue.nl), Kyara Fasen (k.r.fasen@student.tue.nl), Melvin Sterk (m.t.sterk@student.tue.nl) and Veerle van Wijlen (v.s.v.wijlen@student.tue.nl). If you have any complaints about the study, you can discuss this with the investigator. If you prefer not to do this, you may contact the lecturer of the course, dr. Lenneke Kuijer (s.c.kuijer@tue.nl).

9. Signing the consent form

When you have had sufficient time for reflection, you will be asked to decide on participation in this study. If you give permission, we will ask you to confirm this in writing on the appended consent form. By your written permission you indicate that you have understood the information and consent to participation in the study. The signature sheet is kept by the investigator. Both the Investigator and yourself receive a signed version of this consent form.

Thank you for your attention.

Subject Consent Form

Infinite thing-centered learning

- I have read the subject information form. I was also able to ask questions. My questions have been answered to my satisfaction. I had enough time to decide whether to participate.
- I know that participation is voluntary. I know that I may decide at any time not to participate after all or to withdraw from the study. I do not need to give a reason for this.
- I give permission for the collection and use of my data to answer the research question in this study.
- I know that some people may have access to all my data to verify the study. These people are listed in this information sheet. I consent to the inspection by them.
- I **do**
 - do not**
give consent to researchers to audio record my voice during the focus group session. I am aware I will be pseudonymized in the report and my audio data will be anonymized after transcripts.
- I **do**
 - do not**

consent to not share any sensitive content shared amongst the participants and researchers in the focus group discussions. I am aware this is important to guarantee the privacy of the researchers and fellow participants of the focus group.

- I want to participate in this study.

Name of study subject:

Signature:

Date: __ / __ / __

I hereby declare that I have fully informed this study subject about this study.

If information comes to light during the course of the study that could affect the study subject's consent, I will inform him/her of this in a timely fashion.

Name of investigator (or his/her representative):

Signature:

Date: __ / __ / __

Appendix B: Presentation Focus Groups

Focus Group session

WELCOME!

Rick Buijs, Kyara Fosen, Melvin Sterk, Veerle van Wijlen

Thing-centered perspective

Beyond the human perspective

'What does the world of objects look like?'

Thing-centered learning

Researching the Future Everyday

Veerle van Wijlen
Rick Buijs
Kyara Fasen
Melvin Sterk

'What-if' question:

"What if, in a future everyday scenario where humans and artefacts are equals, objects can learn functionalities in an embodied way through a thing-centered perspective?"

ONE OBJECT

The stove

- What can an object learn from other objects (what is relevant for themselves)?
And which information is relevant for this object to learn and use?

ONE OBJECT
The stove

- How do people respond to this?

ONE OBJECT
The stove

- What is the impact of this on the use of the stove?

Room/House
Groups of objects

- What can groups of objects in the practice cooking pasta learn from other objects (what is relevant for themselves)?

Room/House
Groups of objects

- How do people respond to this?

Room/House

Groups of objects

- What is the impact of this on the practice of cooking (pasta)?

Neighbourhood and beyond

- If there was a limit to the object's learning where would it be?
(related to 'infinite learning' in the video)

Neighbourhood and beyond

- What is the impact of objects learning this way on our society?

What we want to know:

How do thing-centered learning objects change practices on a societal scale?

Appendix C: Research Product (Video)

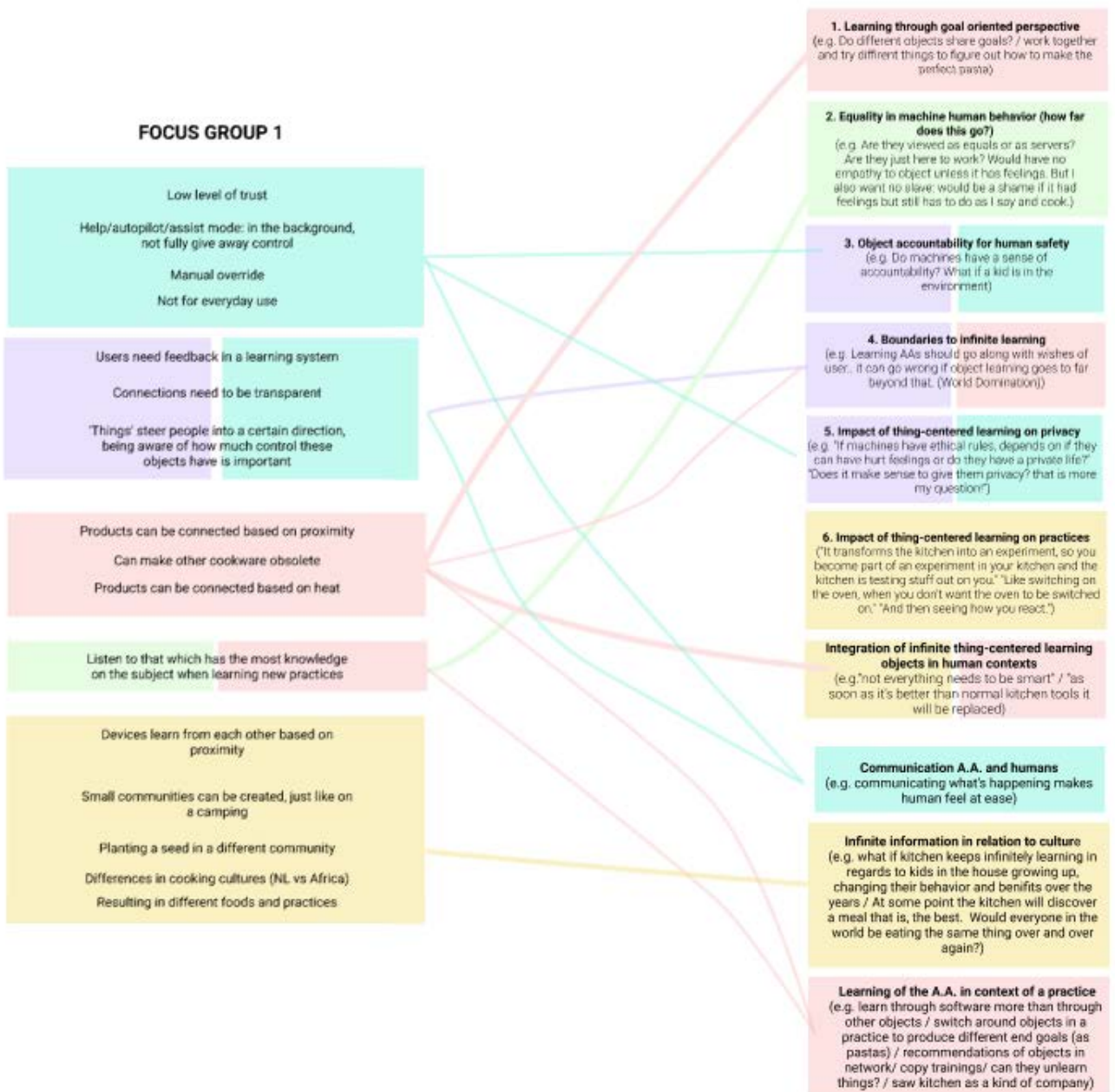
<https://www.youtube.com/watch?v=GkkAsK29Ulk>

Appendix D: Thematic Analysis

Here the combination of the key insights from both focus groups into the final themes can be found. Insights that belonged to the same overall theme were connected with lines and given a color corresponding to the overall theme, to create useful overview.

FOCUS GROUP 2

FOCUS GROUP 1



Final themes creation out of the separate key insights.

Context of Learning

Machines not affected by their data share of data, only the humans -> objects don't have privacy

Based on context within practice

Based on community -> creation of subcultures

Infinite learning can go wrong if it goes to far

Could make other cooking objects obsolete

How it is learnt needs to be transparent

Based on complexity

In regions without GDPR, machine can collect whatever it wants, give very good automated systems

Level of Equalness between AA and human

Listen to objects with highest knowledge of a situation

Do objects have feelings?

Based on goals?

Are they really equals or are they servers?

Humans level of Control on practice

Autopilot

Manual override is necessary

Background process

Awareness on level of control

Laws on robotics and their boundaries in human serving functioning

"I do think machines should have some sense of accountability"

Impacts practices itself

Transforms kitchen into an experiment

Artefacts should go along with wishes of user

When there are humans in the mix, objects have to put them in safe situations

Machines have bigger responsibility because they know more, are smarter

Level of Trust in AA

System needs to gain user's trust, easily lost

If there is more trust towards the infinite learning objects, humans are more willing to give away their privacy

Communication between AA's and humans important for trust in learning process

Trusting the machines plays big role in the impact and learning process

If there is a sense of trust in the objects, humans would allow objects to have more authority in learning process

Machines don't care about ethics

Cultural/Societal Context (influence on practices)

Differences will be more apparent

Planting a seed in different communities

Results in different foods/practices

Infinite information in relation to culture

Differences in [cooking] culture

Small communities can be created

Everything will become the same

Specific foods connected to specific communities/neighbourhoods/areas

Organization of the final themes into a narrative around the research question, to report the results.

**RQ:
What are the influences on practices when automated artefacts learn through a thing-centered perspective in a future everyday environment?**

1

Level of Trust in AA

System needs to gain user's trust, easily lost	Trusting the machines plays big role in the impact and learning process
If there is more trust towards the infinite learning objects, humans are more willing to give away their privacy	If there is a sense of trust in the objects, humans would allow objects to have more authority in learning process
Communication between AA's and humans important for trust in learning process	Machines don't care about ethics

3

Level of Equalness between AA and human

Listen to objects with highest knowledge of a situation	Do objects have feelings?
Are they really equals or are they servants?	Based on goals?

2

Humans level of Control on practice

Manual override is necessary	Transforms kitchen into an experiment
Background process	Artefacts should go along with wishes of user
Awareness on level of control	When there are humans in the mix, objects have to put them in safe situations
Laws on robotics and their boundaries in human serving functioning	Impacts practices itself
"I do think machines should have some sense of accountability"	Autopilot

4

Cultural/Societal Context (influence on practices)

Differences will be more apparent	Differences in [cooking] culture
Planting a seed in different communities	Small communities can be created
Results in different foods/practices	Everything will become the same
Infinite information in relation to culture	Specific foods connected to specific communities/neighbourhoods/areas

Context of Learning

Machines not affected by their data share of data, only the humans -> objects don't have privacy	Could make other cooking objects obsolete
Based on context within practice	How it is learnt needs to be transparent
Based on community -> creation of subcultures	Infinite learning can go wrong if it goes to far
Based on complexity	