EMPOWERING OLDER PEOPLE

TO AGE RESOURCEFULLY

WITH THE INTERNET OF THINGS

TU Delft OPEN

RESOURCEFUL AGEING

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Edited by Elisa Giaccardi & Iohanna Nicenboim

RESOURCEFUL AGEING

Empowering older people to age resourcefully with the Internet of Things

Many thanks to our participants
Maria, Ida, Tina and Karen and their Things.
(All names changed to respect privacy)

RESOURCEFUL AGEING

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EXECUTIVE SUMMARY (EN)

Resourceful Ageing was a highly interdisciplinary project funded by the Netherlands Organisation for Scientific Research (NWO) under the Research through Design (RTD) program in 2016–2018. The project brought together designers, computer scientists, social scientists and professional practitioners from TU Delft, TU Eindhoven, Avans University of Applied Sciences and Philips Design with the goal of researching and designing Internet of Things (IoT) solutions that could empower older people to age resourcefully.

We developed a data-enabled Research through Design approach using a combination of designerly experimentation, machine learning and ethnographic fieldwork to create and prototype designs that could support older people in everyday practices of resourcefulness. In products designed specifically for older people, the inventiveness and resourcefulness of the elderly is often underestimated in favor of designs that overestimate the extent to which older people are in need of assistance. Instead, we wanted to focus on what older people can still do and the strategies they use to creatively compensate for ageing skills. Our motto was: »*Ageing is an achievement and should be celebrated!*«

In this book, we introduce the motivation behind this project and the reason we focused on resourcefulness rather than assitance. We also explain how we combined ethnographic research and machine learning to observe and analyse resourcefulness in older people, and then dive deeper into the stories we collected from both our human participants and their everyday 'things'. These results offer the reader a categorized set of strategies that can be used to support resourcefulness in older people's everyday lives. Strategies include, among others: the anticipatory stocking and arranging of physical and social

EXECUTIVE SUMMARY (NL)

Resourceful Ageing was een interdisciplinair project dat werd gefinancierd door de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) onder het Research through Design (RTD) programma in 2016–2018. Het project bracht ontwerponderzoekers, informatici, sociale wetenschappers en praktijkexperts van de TU Delft, de TU Eindhoven, de Avans Hogeschool en Philips Design samen met als doel het onderzoeken en ontwerpen van Internet of Things (IOT) oplossingen die mensen in staat stellen vindingrijk ouder te worden.

In het project hebben we een data-enabled Research through Design methode ontwikkeld. Dit is een een data-rijke methode voor ontwerpend onderzoeken die gebruik maakt van een combinatie van ontwerp-experimenten, lerende algoritmes en etnografisch veldwerk. We hebben deze methode toegepast en verfijnd door het ontwerpen, maken en testen van prototypes die oudere mensen kunnen ondersteunen in hun alledaagse vindingrijkheid. Eerder onderzoek heeft aangetoond dat producenten van technologieën die speciaal ontworpen worden voor ouderen vaak de inventiviteit en vindingrijkheid van ouderen onderschatten. Veelal impliciet gaan ze er vanuit dat ouderen hulpbehoevend zijn. Wij wilden daarom focussen op wat oudere mensen wél kunnen en de creatieve strategieën ondersteunen die ze zelf al gebruiken om de gevolgen van het ouder worden te compenseren. Ons motto was: »*Ouder worden is een prestatie en moet gevierd worden!*«

In dit boek introduceren we onze motivatie en de redenen waarom we ons concentreerden op vindingrijkheid. We laten zien hoe we etnografisch onderzoek en lerende algoritmes combineerden om vindingrijkheid in het leven van ouderen te observeren en te analyseren, om vervolgens dieper in te gaan op de verhalen die we verzamelden van zowel onze menselijke

RESOURCEFUL AGEING

resources; the spontaneous making and adjusting of objects; and using things in multiple instances or as assemblages to use as bodily extensions or to place markers.

We then move on to explore how 'things' can become active partners in data-enabled Research through Design (RTD) and, more importantly, in the process of doing design itself. In particular, we discuss how the first, second and third iterations of the Connected Resources we designed came about and how they built onto each other. These results offer the reader useful methodological considerations for embarking on data-enabled RTD, including the idea of disciplinary speed, the fluid infrastructuring of iterations and the creative role of machine learning. Design tools and techniques are described in detail and made available to enable students, researchers and practitioners alike to use them in other contexts.

Finally, the book discusses the impact that the project had on the disciplines and domains involved: gerontechnology, machine learning, social practice theory and professional design practice. We reflect on the lessons learned from our research and highlight opportunities for further exploration. We argue that the main takeaway of Resourceful Ageing is this: for older people, 'living independently' means that they can live independently — when desired — not only from the care of others but also from care technology. This suggests that we should design technology for older people as 'resource' not as 'intervention'. Designing for resourcefulness should not be understood as designing technologies that can predict all possible situations of use. Instead, it means designing technologies that are capable of enabling older people to situate and negotiate use in everyday life with a certain degree of freedom.

The design of Connected Resources reflects this way of thinking.

deelnemers als hun alledaagse 'dingen'. Op basis van ons onderzoek bieden we de lezer een reeks vindingrijke strategieën die onze deelnemende ouderen gebruiken in het dagelijks leven. Deze strategieën omvatten onder meer: het aanleggen en onderhouden van een anticiperende voorraad van fysieke en sociale middelen; het spontaan maken en aanpassen van objecten; en dingen gebruiken in meerdere situaties en samenstellingen, bijvoorbeeld als lichamelijke versterking, of voor het plaatsen van persoonlijke markeringen.

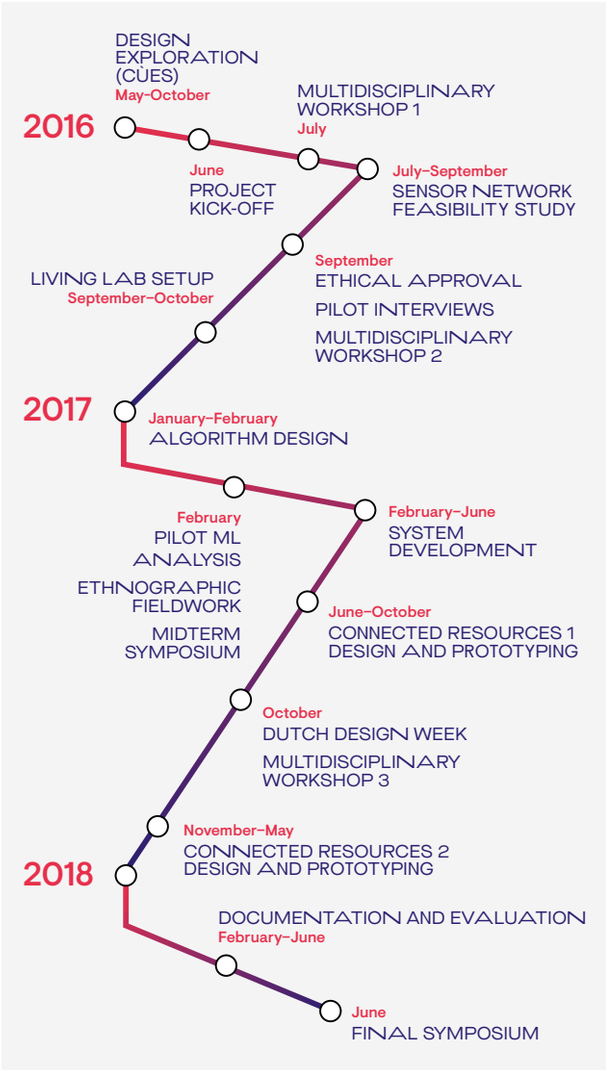
Vervolgens beschrijven we hoe 'dingen' actieve partners kunnen worden in data-enabled Research through Design (RTD) en, belangrijker, in het ontwerpproces zelf. In het bijzonder bespreken we hoe de eerste, tweede en derde iteraties van de 'Connected Resources' die we hebben ontworpen tot stand zijn gekomen en op elkaar voortbouwen. Deze resultaten bieden de lezer methodologische overwegingen voor het starten van date-rijke RTD, inclusief het idee van disciplinaire ritmes, de vloeiende infrastructurering van iteraties en de creatieve rol van lerende algoritmes. Ontwerphulpmiddelen en -technieken worden gedetailleerd beschreven zodat studenten, onderzoekers en praktijkexperts ze in een andere context kunnen gebruiken.

Ten slotte bespreken we de impact die het project had op de betrokken disciplines en domeinen: gerontechnologie, kunstmatige intelligentie, sociale gedragspraktijktheorie en de professionele ontwerppraktijk. We reflecteren op de lessen die we hebben getrokken en benadrukken de mogelijkheden voor verdere verkenning. Het belangrijkste leerpunt van Resourceful Ageing is: voor ouderen betekent onafhankelijkheid dat ze — indien gewenst — zelfstandig kunnen leven, en daarbij niet afhankelijk hoeven te zijn van de zorg van anderen, maar ook niet svan zorgtechnologie. Dit betekent dat we technologie voor ouderen moeten ontwerpen als 'flexibel middel' en niet als 'interventie'. Ontwerpen voor vindingrijkheid moet niet worden opgevat als het ontwerpen van technologieën die alle mogelijke gebruikssituaties kunnen voorspellen. In plaats daarvan gaat het om het ontwerpen van technologieën waarvan ouderen het gebruik in het dagelijks leven grotendeelszelf kunnen bepalen.

Het ontwerp van de Connected Resources belichaamt deze manier van denken.

RESOURCEFUL AGEING

TIMELINE



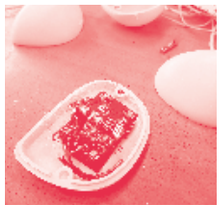
IMAGES

1 | **Workshop with the team of researchers.**

2 | **In home interviews with participants.**

3+4 | **Prototyping Connected Resources 1.**

5 | **Presenting results at the final symposium.**



RESOURCEFUL AGEING

We wanted to focus on what older people can still do and do better.

AGEING IS AN ACHIEVEMENT TO BE CELEBRATED!

2

INTEGRATING PERSPECTIVES

INTEGRATING HUMAN AND NONHUMAN PERSPECTIVES IN DATA-ENABLED RTD

SETTING UP A LIVING LAB OF PEOPLE & THINGS

USING MACHINE LEARNING TO UNDERSTAND RESOURCEFULNESS

INTEGRATING HUMAN AND NONHUMAN PERSPECTIVES IN DATA-ENABLED RTD

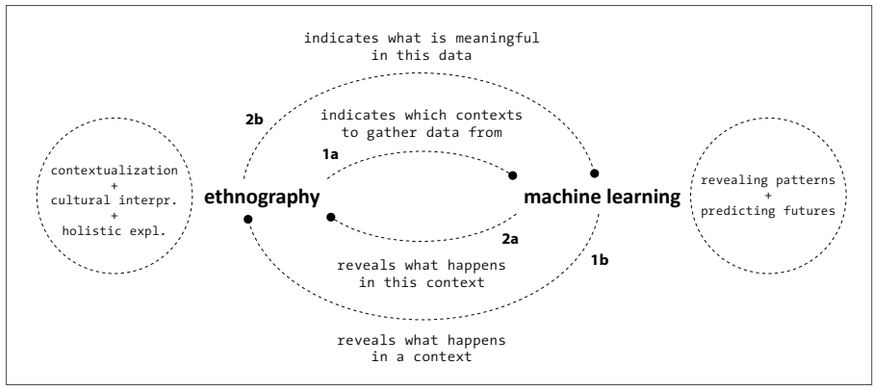
Elisa Giaccardi

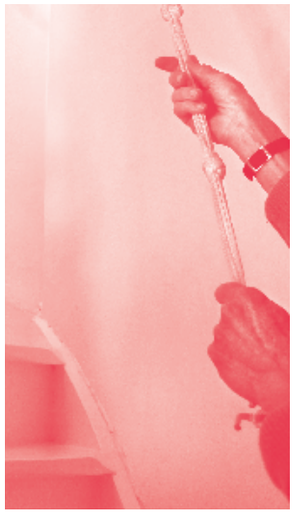
Experimenting with what objects can 'see' helped us integrate previously overlooked and unexpected perspectives about older people's everyday lives.

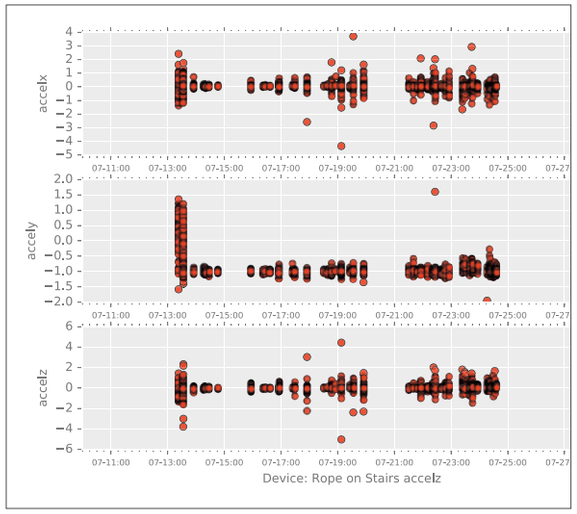
Since resourcefulness is a dispersed practice that is difficult for the human eye to observe and capture, we invited five households of people between 65 and 78 years old, as well as their domestic objects to take part in our field research. Human participants included four females and one male living independently at home, two of whom live with their spouses. Nonhuman participants included doors, fridges, chairs and remote controls, as well as unique assemblages such as a spider stick and a rope on stairs. Nonhuman participants were selected by the team together with human participants using a combination of sensitisation techniques and preliminary ethnographic fieldwork. We deployed a bespoke wireless sensor network infrastructure and instrumented with artificial sensing capabilities with eight objects per household for a total of 32 domestic objects. Over a period of two months, we collected 133 MB of sensor data from three of the participating households. Sensors sampled when objects moved in space and collected environmental data. We then used unsupervised machine learning techniques to discover structure from the data and assign meaning to it. The intention was to ask our nonhuman partners about routines developed within temporal patterns of day and night, and weekdays and weekends, which might suggest practices of resourcefulness too dispersed for a human observer (including our human participants) to discern.

GRAPH
1 | **Living Lab** shows a continuous feedback loop of qualitative and quantitative data by combining ethnography and machine learning. © Created by Nazli Cila

IMAGE OPPOSITE
1 | **Rope on stairs.** Karen demonstrated how she attached a rope next to the stairs to pull herself up when climbing upstairs.





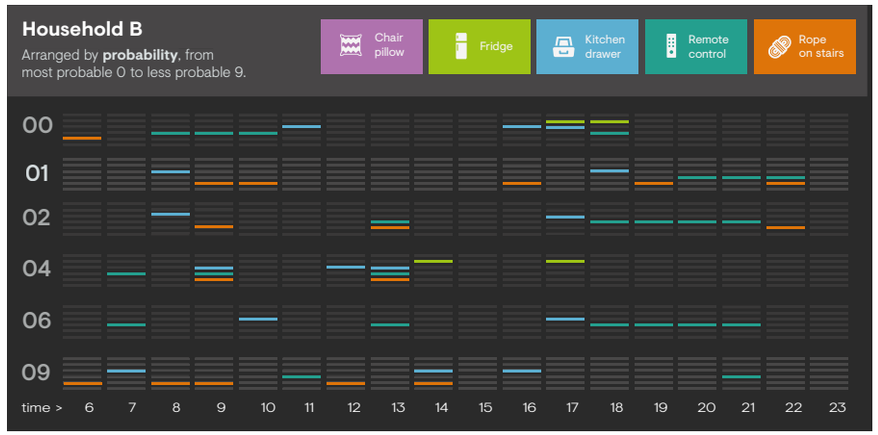


In our Living Lab, the resourcefulness witnessed by objects in older people's homes and captured by direct human observation looked like a magnet (for example) — a very mundane entanglement, central to the resourcefulness of one of our elderly, who uses the magnet to keep together small objects she would not be able to grab when flat on the table. But what the algorithms that we developed for this project were able to see is the probability of an object being handled at a particular time of day and the probability of clusters of objects being handled at the same time — a hint to the possibility that certain objects may be used together often as part of a dispersed-yet-established practice of resourcefulness that escapes human observation and normative sense of relevance.

As illustrated by the design iterations in Chapter 4, the unique perspectives that nonhuman participants brought to the RTD process through both 'thing-centric' ethnographic work and machine learning analysis informed different elements of our designs, from physical embodiment (directly observed material quality of affordances) to digital functionalities (inferred probabilities of resourceful behaviour).

GRAPHS
2 | **Raw acceleration events in time** recorded by a sensor placed on a rope on the stairs. Each dot indicates an event where the object moved enough to trigger the logging of acceleration on three degrees of freedom (x,y, and z).

3 | **Patterns uncovered by machine learning**. Common usage of objects and their temporal context extracted from a topic model. © Created by Benjamin Lopez (Philips Design) based on graph by Hayley Hung.



RESOURCEFUL AGEING

SETTING UP A LIVING LAB OF PEOPLE & THINGS

Ivo Maathuis, Iohanna Nicenboim

We enlisted both older people and their everyday objects as participants in order to explore practices of resourcefulness.

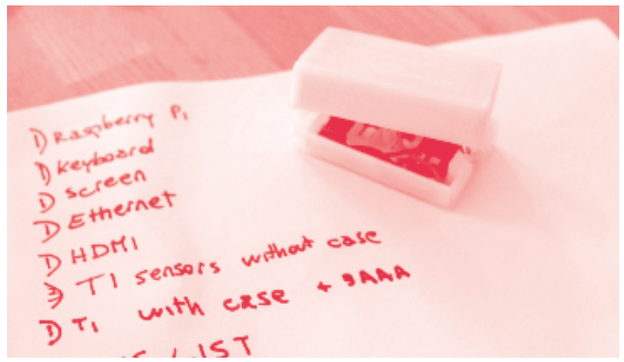
The Living Lab for this project enlisted a community of five households of both older people and the things they ordinarily use and 'misuse' as participants. Our assumption was that 'misused' objects — things already used as part of daily practices of resourcefulness — might hint towards other practices of resourcefulness too dispersed for a human observer (including our human participants) to discern.

Older people were recruited through the TU Delft Product Evaluation Lab (PEL), comprised of a panel of 1.700 households in the city of Delft in the Netherlands. The inclusion criteria involved people aged 65 and older living in their own home, either alone, with their partner, family members or cohabiting. Twelve participants were interested in joining the study, five of whom were initially included. Three people lived alone, two of whom lived with their partners. They either lived in a terraced house (n=4) or an apartment (n=1) in the inner city of Delft. Four-out-of-five participants were retired, while one was employed full-time. Their education varied from general secondary school to university and their (former) professions ranged from shop owner to housewife, lawyer, study adviser and nurse. All of them had Dutch nationality.

WE THOUGHT THAT 'MISUSED' OBJECTS MIGHT HINT TOWARDS PRACTICES OF RESOURCEFULNESS TOO DISPERSED FOR A HUMAN TO OBSERVE.

To select things that older people used and misused, we conducted several visits. After an initial interview, we asked participants to complete a workbook over the course of one week, identifying their most important and frequently used artefacts. These artefacts were discussed and photographed in a follow-up interview. The photos were analysed in a joint workshop with members of the research team and Philips Design. Next, the outcomes of the workshop were discussed in close collaboration with the team members involved in the deployment of the sensors. The selected objects were then discussed together with the participants. After agreement was reached, the sensors were attached to the objects and the sensor networks were installed in the homes of the participants. Characteristics of the people and things of the Living Lab are summarised in the Table.

HYPERLINKS
See **Strategies of Resourcefulness (Chapter 3)** [p.33] to read about how we envision things to become partners in doing data-enabled RTD.



IMAGES
1 | **Objects tagged by Karen.** A one-week home activity that asked participants to tag objects they use frequently in activities they value.

2 | **Setting up the sensing infrastructure.** The team attaching the sensors enclosed in cases to the selected objects.

3 | Participants helped us think of where and how to **attach the sensors**.

TABLE
Selection of objects to track for each household
The people and the things in the Living Lab.

	MARIA	IDA	ROBERT*	TINA	KAREN
AGE	69	76	65	70	74
GENDER	Female	Female	Male	Female	Female
HOUSING	Terraced House		Terraced House	Terraced House	Terraced House
LIVING	Living with partner	Alone	Living with partner	Alone	Alone
SELECTED OBJECTS	Kitchen chair Remote control Fridge Kitchen cabinet door Tablet Knitting needle	Kitchen chair Remote control Fridge Tray Garden door Spider stick	-	Kitchen chair Remote control Fridge Couch Kitchen cabinet door Secretaire Knitting basket Foot step	Kitchen chair Remote control Fridge Kitchen drawer Rope stairs Chair pillow

*Unfortunately, Robert decided to withdraw from the study after the first interview for personal reasons.

ETHNOGRAPHY

USING MACHINE LEARNING TO UNDERSTAND RESOURCEFULNESS

Hayley Hung, Yanxia Zhang

We used machine learning to understand how objects were used and combined resourcefully across practices.

Our use of pervasive sensors and computational tools in the Living Lab provides a novel approach to understanding how older people use and 'misuse' objects in everyday life. This method steps away from the typical use of sensors for monitoring and norming about older people's activities.

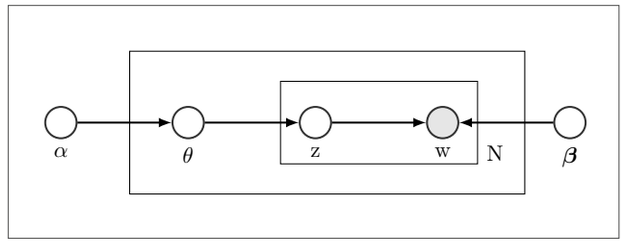
Traditional methods are based on human ethnography interviews, surveys, self-reporting and logging. These methods can suffer from subjective bias. In addition, they can only sample limited information from experiences recalled from the users' perspective. Similarly, data-enabled research methods using sensors for monitoring and norming about older people's activities express the unethical technology push we vowed to avoid in this project.

We wanted to uncover patterns of hidden, unexpected behaviour that would not be easily observed through conventional ethnographic methods or the monitoring of supposedly 'normal' behaviours. By equipping continuous passive sensing to households objects, we hoped to be able to discover routines such as daily or nightly, weekday or weekend patterns. This information is valuable in understanding the usage patterns of objects across practices, which can be useful for suggesting new design practices.

WE WANTED TO UNCOVER PATTERNS OF HIDDEN, UNEXPECTED BEHAVIOUR THAT WOULD NOT BE EASY TO OBSERVE THROUGH CONVENTIONAL ETHNOGRAPHY.

To address our research questions about older people, we used machine learning and leveraged sensor data to understand resourcefulness in parallel with ethnography. We focused on identifying situations where objects had been used in a creative and unexpected situation. For example, it can be when objects are either used together or at unexpected times during the day.

To record events of object usage with sensors, we used their movement as a proxy for objects being handled by the participants. Our first step was to examine raw events recorded by the sensor. These are a set of time series data that correspond to events triggered by object movement in chronological order. The time series data forms a digital trace of each object's behaviour. Ultimately, we wanted to see whether the detected events from the sensors were consistent with observations during ethnographic fieldwork.



GRAPHS

1 | **Latent Dirichlet Allocation** topic model, which was used to identify patterns from the object sensor data.

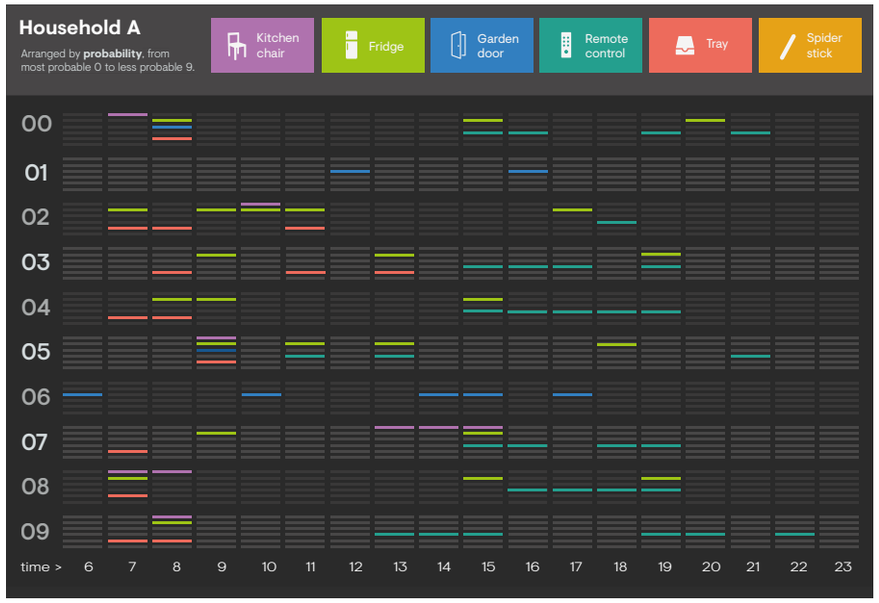
2 | **Plot of the topics** extracted by machine learning from the data of one household, separated into hourly intervals. © Created by Benjamin Lopez (Philips Design) based on graph by Hayley Hung.

We then further explored interactions between objects to uncover patterns of objects used together and their temporal context. To achieve this, we created feature representations to encode object movements for the entire group of objects per household. We extracted common usage patterns by applying a topic model: a mathematical model from machine learning that was first proposed for analysing text documents (see graph above).

We modified this model to work in the analysis of object behaviours. The benefit of topic models is that they are probabilistic, so they can provide quantitative metrics to rank how important these patterns are. We wanted machine learning to generate meaningful patterns related to resourcefulness and reduce the manual labour involved for humans to sift through all the data.

While machine learning can help us discover patterns in the data, what is found still needs to be interpreted by a human expert. These patterns may also have no sense or meaning to the trained human eye. To ensure that the discovered patterns are more meaningful, object usage data of tens of hundreds of people should be collected over long periods of time (months or even years). This is why a solid connection is needed to be made with the other disciplines in the project to ultimately create value for these results.

PATTERNS CAN ALSO BE FOUND THAT HAVE NO SENSE OR MEANING TO THE TRAINED HUMAN EYE.



MACHINE LEARNING

2

In this chapter, we discussed how we set up our research project, particularly how we combined ethnographic research and machine learning to observe, document and analyse resourcefulness in older people through the way everyday objects are used and 'misused'. In the next chapter, we dive deeper into the project and share our research findings both from a 'people perspective' and a 'thing perspective'. Based on observations from our ethnographic research and machine learning, we also define and categorise strategies of resourcefulness used by older people in everyday life.

WE WANTED TO BE ABLE TO DISCOVER PRACTICES AND ROUTINES THAT ESCAPED OUR NORMATIVE SENSE OF RELEVANCE.

3

STRATEGIES OF RESOURCEFULNESS

WHAT ARE THINGS

STORIES OF PEOPLE

STORIES OF THINGS

STRATEGIES OF RESOURCEFULNESS

DIMENSIONS OF OPENNESS AND VARIETY

WHAT ARE THINGS?

Elisa Giaccardi

In simple terms, we could think of a 'thing' as the designed artefact(s) plus the people (or other artefacts) that relate to it and how they relate to it.

A thing is not the artefact in its straight materiality but a nexus of relations that has the ability to shape 'ways of doing' and open up new futures. In simple terms, we could think of a 'thing' as the design artefact(s) plus the people (or other artefacts) that relate to it and *how* they relate to it. In design, we often think of this relation as one of use, though of course, 'use' is a simplification of the more entangled relation we have with things, and things with us (or with other things).

Attributing agency to things is not a new concept. In social theory, actor-network theorists discuss the ontological symmetry of humans and nonhumans, in which material forms take on the characteristics of humans: they judge, form networks, speak and work performatively. Similarly, anthropologists concerned with materiality have suggested that objects are dynamic and emergent entities that contain their own life forces, energies and histories. More recently, object-oriented philosophy suggests that things do not exist just for us; they can be many and various, but no matter their size, scale or order, they enjoy equal being.

CLEARLY, DESIGNERS MAKE THINGS. BUT CAN THINGS MAKE THINGS TOO?

Turning to the feminist reconceptualisation of performativity as 'making', we adopted a thing-centered perspective in this project to look at artefacts (elsewhere in this book referred to as 'everyday objects') in the context of practice, specifically dispersed practices of resourcefulness. We were interested in how artefacts — conceptualised as things — can participate next to people in the making of resourcefulness.

At the core of the project is the idea that things make things indeed. Enabled by data technologies, things not only perform social practices next to people, they 'make' things too. And so, we began to spend time with things and painstakingly work together with them to offer different ways of understanding what we know and what we do, and ultimately reframe and reconfigure older people's social and material relations with technology.

In this chapter, we discuss what we have learned about older people's strategies of resourcefulness with things and the dimensions of openness and variety needed to design the Connected Resources in Chapter 4.

IMAGES OPPOSITE

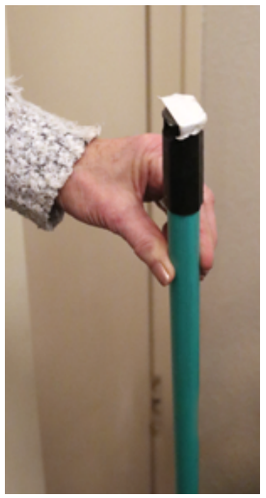
1 | **Ida's spiderstick.** In order to reach higher, she placed double-sided tape on a broomstick. She uses this to kill spiders on the ceiling.

2 | **Ida's self-defense table leg.** In case burglars enter her house, she keeps an old table leg under her bed.

3 | **Tina's cupboard sign.** Reminds guests to take care of the furniture that is old.

HYPERLINKS

See **Designing Connected Resources 1 & 2 (Chapter 4)** [p.70, 74] to learn about our design process and integrating insights from machine learning and ethnography.



OBJECTS ARE DYNAMIC AND EMERGENT ENTITIES THAT CONTAIN THEIR OWN LIFE FORCES, ENERGIES AND HISTORIES.

ETHNOGRAPHY

STORIES OF PEOPLE

INTERVIEWS

Ivo Maathuis

Older people showed creativity, courage and a sense of purpose in »making their lives work«.

The interviews and home visits gave us broad insight into the everyday lives of the participants and the objects they use. In their stories, they emphasised how they stay in control by doing what they value most in their lives and how they embrace the technologies, gadgets and tools that are available to them to continue to do what they think is important. All of them use 'popular' digital applications – some are surprisingly creative in using them – but also, they use everyday objects to deal with the challenges of ageing in place. Creating their own solutions, daily routines and seeking help from others are central in making their lives work.

CONTINUE TO DO WHAT YOU VALUE

ROBERT

All participants gained fulfilment from making their houses comfortable to live in. Robert shared how he single-handedly created a new heating system in his house to be able to warm up each room separately, instead of heating the whole house every time. He not only designed the mechanism for the boiler but also physically prepared his old heating system so that the workers from the energy company only had to change some valves in the meter cupboard for the new system to work. Although this was years ago, Robert had shared how he was planning to place solar panels on his roof to be energy self-sufficient in the near future. Tinkering with home-automation had always been his hobby, he explained:

»I AM ALREADY THINKING ABOUT HOME AUTOMATION [...] POSSIBLY ALSO WITH CAMERAS, BUT ALSO TO BE ABLE TO REMOTELY TURN THE LIGHTS ON AND OFF, OPEN AND CLOSE CURTAINS, AND SO ON [...]«

Robert

Although Robert admitted that home-automation was his hobby, he surely developed a lot of 'professional' knowledge over the years about the energy system in his house. He shared detailed information on being 'energy self-sufficient' in the Netherlands. Moreover, he was very fond of the apps he used on his iPhone to keep an eye on the energy consumption in his house.

KAREN

Karen had spent her whole life fixing her house and making it her own. With pride, she told us how she used to reconstruct her house all the time, how she single-handedly made a new wooden floor in the living room (»*I took three weeks*,«) and how she fixed old furniture she found on the street. As a result, she still owned a lot of professional tools. One of the things she restored was an old medicine cabinet she got from a retired pharmacist. Since the cabinet was quite heavy, she decided to attach wheels to it so it would be easier to move.

Additionally, she demonstrated how she attached a rope next to the stairs to pull herself up when climbing up the stairs. Apparently, 'making things' and doing things by herself is an important part of Karen's identity. However, because of incapacitating health complaints (rheumatoid arthritis), she is not able to do all these things anymore (»*I do not dare to climb into the trees anymore to shorten them*,«). Nevertheless, she refused to let go of her creativity, which she now expressed in sewing things for her loved ones, possibly helped by all kinds of tools. She also showed many examples of tools she had collected over time that helped her to live with her condition, like scissors with extra-large handles, a can of WD-40 to open jammed door locks and lots of handy gadgets she brought from her home country when she came to the Netherlands to marry her husband.

WITH PRIDE, KAREN TOLD US HOW SHE USED TO RECONSTRUCT HER HOUSE ALL THE TIME.

Nowadays, Karen still goes out to collect wood. Sometimes she brings home things she finds in containers down the street or she takes something with her from her daughter's farm. She uses the luggage rack of her bike to carry it home. While she does not make new furniture anymore, she uses the wood for her fireplace instead. She cuts it into pieces with an electric saw, and sometimes her daughter helps her if it becomes too heavy. Although used in a very different way, using wood still plays a key role in Karen's life, and she plans to keep it that way.

MARIA

Just like Robert, Maria also mentioned how much she liked home-improvement. During one of our visits, she revealed her plans for placing a new ceiling in the kitchen. On the second visit, we bumped into a pile of wooden slats in the hallway. The ceiling was almost finished, except for the lighting. When we asked her where she got the ideas for the lighting, she answered she used Pinterest (»*On Pinterest, indeed. Are you familiar with Pinterest?*«). And during the closing visit, she proudly showed us her kitchen with beautiful LED ceiling lights. When she was asked what activity she valued the most in her life, home-improvement was one of them and also the tools she used for this.

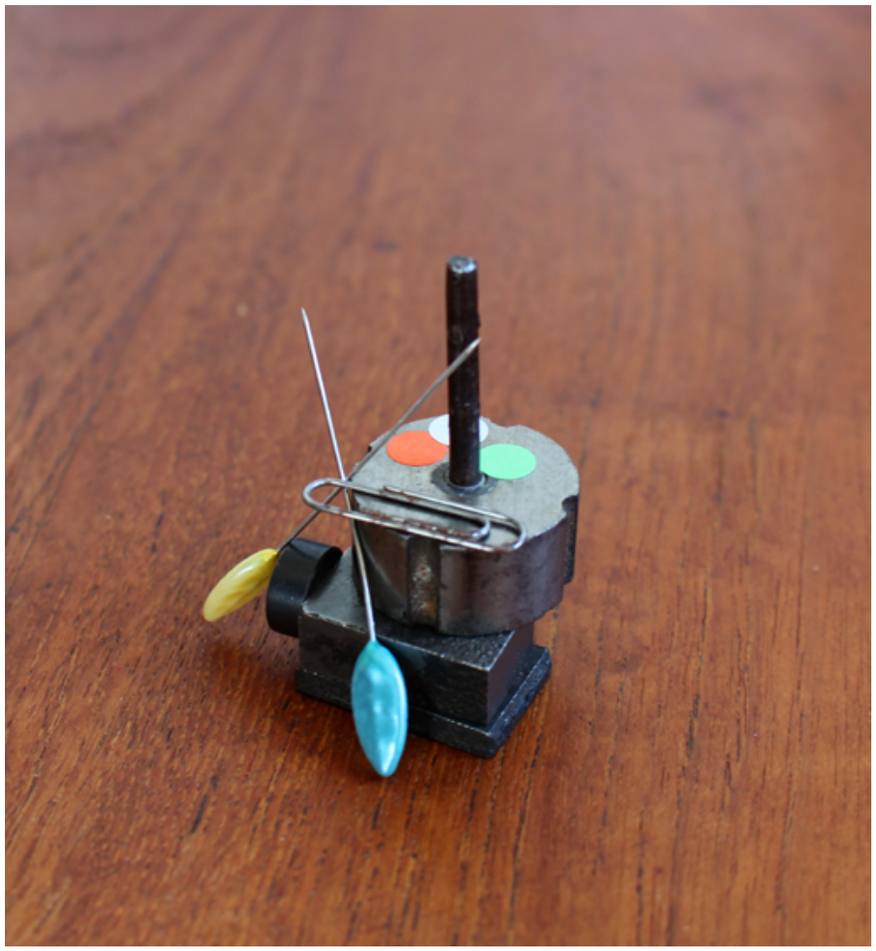
However, at the end of the home tour, Maria showed us the objects she used for the hobby she loved most. She loved to knit sweaters for her grandchildren and repair clothes or make them according to their wishes.

IMAGES

1 | **Karen's medicine cabinet.** She restored an old medicine cabinet she got from a retired pharmacist and added wheels so it would be easier to move.

2 | **Karen's tools.** She had collected over time several tools, which helped her to live with rheumatoid arthritis, like scissors with extra-large handles or a can of WD 40 to open jammed door locks.

ETHNOGRAPHY



ETHNOGRAPHY

»They sit on their knees when they slide from the slide, so their pants are always worn out. Then I sew nice things on their pants. But now they like it so much, they slide on their knees on purpose! Because then, their grandmother sews nice pictures on their pants«. (Maria)
The sewing machine, thread and needle were therefore important objects for Maria, as well as the yarn, knitting pins and other items.

IMAGES P.38–39
1 | **Karen still goes out to collect wood**. She uses the luggage rack of her bike to carry it home. She saws it into pieces with an electric saw, and sometimes her daughter helps her if it becomes too heavy.

2 | **Ida's wrapped pan.** She adjusted some of her pans by wrapping ropes around the handles against the heat just to get a better grip.

3 | **Karen's Magnetic Needle Pickup.** A piece of magnet helps her to pick up small metallic items, which she cannot grab with her hands anymore.

4 | **Karen's headlamp.** She uses it in her long walks in the woods next to home when it is dark.

»I STILL SEW. [...] I USE ONE PAIR OF PLIERS TO PUSH THE THREAD THROUGH THE NEEDLE AND THE OTHER PAIR TO PULL IT OUT [...] AS LONG AS I CAN DO THEM LIKE THIS, I KEEP DOING THEM.«
Karen

ON BEING DIGITALLY SKILLED

Contrary to popular belief, all of the participants mentioned that smart devices were very valuable objects in their daily lives. Some of them even said these were the most important 'objects' in their house. They were used for taking pictures, making videos and surfing the web, but most importantly, these devices allowed them to stay in contact with their friends and loved ones via e-mail, Facebook and/or WhatsApp. Sometimes they showed us how digitally skilled they were without even being aware of it. For example, on our first visit to Tina's house, she opened the door and asked us for the license plate number of our car. After we gave her this information, she took her iPad, opened a parking app and entered the information. She explained to us that the app was offered by the municipality for her guests to be able to park for free. Moreover, during the second home visit, she shared a video with us on her iPhone of her grandchild playing with furniture at a nearby IKEA, and she was very fond of the fact that she could synchronise all her material from iPhone to iPad and vice versa (see image right).

IMAGE
Tina's devices. She is a frequent user of her iPad and iPhone.

Also, Ida showed us pictures and videos of a choir concert she participated in, and while we visited Maria, she got regular WhatsApp messages from her husband and her granddaughter who were visiting the zoo.

While some of the skills described above might be quite common nowadays for people aged 65 and older, both Ida and Robert had developed their own digital competences. Ida had developed a rather creative way of using devices in her home. When she was asked about the devices under her TV, she answered that one of them was a VCR and the other a digital video recorder.

This way, she could record two programs at the same time without having to stay home to watch one of them. Additionally, she kept a video8 device in her bedroom, which she sometimes used to play old family videos. According to her, some of those videos were also transferred to VHS at one point in time to keep them up-to-date with the 'newest standard', which is already obsolete now. Hence, Ida was willing to embrace innovations in her life but is also perfectly capable of reflecting on technological trends and putting them in the right perspective.

Just like Ida, Robert developed a creative way of using digital devices in his house. As we talked about his hobbies, he mentioned he was interested in home-automation but also in music. For the latter, he was subscribed to Spotify, which he used to discover new music that could be of interest to him. He liked classical music but also rap, reggae and rock music. Occasionally, Robert will buy a CD at a flea market, but at home he always put the music on his own server. This way, he could draw upon the music on Spotify and he could use his own collection at the same time. In other words, Robert created his own hybrid of old and new ways to store and play music. And by streaming all his music, he could make it available throughout his entire house via the Sonos app on his mobile phone.

IDA IS WILLING TO EMBRACE INNOVATIONS IN HER LIFE BUT IS ALSO PERFECTLY CAPABLE OF REFLECTING ON TECHNOLOGICAL TRENDS AND PUTTING THEM IN THE RIGHT PERSPECTIVE.

USING EVERYDAY OBJECTS AS RESOURCES

During our visits, we saw a lot of examples of the (digital) tools participants used to make their everyday lives more comfortable. However, although creatively operated, most of these tools were used 'normally' and most of them were bought at regular stores for consumer electronics. Robert used the Spotify and Sonos apps to listen to his music. Karen used tools and gadgets to alleviate the effects of her rheumatism, and Ida used her video recorder to record extra TV programs. Nevertheless, during our visits, the participants also demonstrated how they use everyday objects in alternative ways to deal with the challenges of ageing in place.

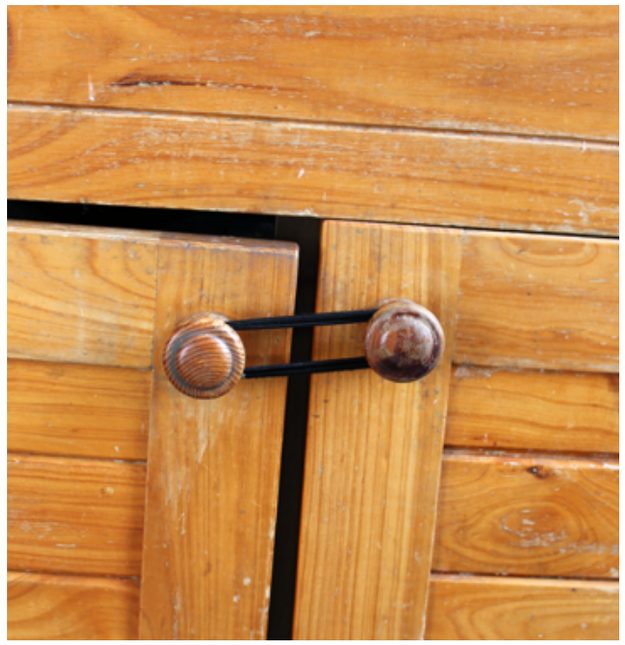
IMAGES P.42-43
1 | **Ida's newspaper.** She shares a newspaper subscription with her daughter and brings it to her every afternoon. In that way, her daughter also knows she is fine.

2 | **Tina's clips and bands.** She uses a lot of clips or elastic bands to keep curtains together, to keep cabinet doors closed and to prevent damaged furniture to fall apart.

3 | **Ida's homemade door lock** made by her with a small wooden block and covered with leather to prevent burglars from enter.

For example, Tina used a lot of clips or elastic bands to keep curtains together, to keep cabinet doors closed and to prevent damaged furniture from falling apart. Additionally, Ida mentioned how she used the newspaper in a resourceful way. She told us how she shared the newspaper with her daughter by bringing it to her every afternoon. Little by little, this became an important routine in Ida's life. By bringing over the newspaper every day, she communicated to her daughter whether she was fine or not. Or, as she explained: *»If she does not receive it, they know something is going on.«* Instead of using a high-tech surveillance system, Ida and her daughter had developed their own way of keeping an eye on each other. As such, Ida's newspaper became an important everyday object to communicate her well-being to her daughter in an informal way.

ETHNOGRAPHY



Ida also created her own additional way to secure her house from burglary. To prevent burglars from opening the sliding door to her garden, she attached a small wooden block between the door handle and the lock. For aesthetic reasons, she even decorated the wooden block with a matching piece of leather (see Image 3, p. 43).

BY BRINGING OVER THE NEWSPAPER EVERY DAY, SHE COMMUNICATED TO HER DAUGHTER WHETHER SHE WAS FINE OR NOT.

When she was asked whether she thought the wooden block truly secured her house from burglary, she said that she did not think it would really prevent burglars from entering her house. However, if they did try to open the door, the block would fall on the ground, which would definitely wake her to scare the burglars away. To support her in this endeavour, she kept an old table leg under her bed (see figure 5). Hence, it was not only the wooden block that secured her house. It was the combination of the wooden block and the table leg under the bed that made her feel safe at night. While engineers might have advised her to install a burglar alarm, for Ida, a wooden block and an old table leg did the job.

In a similar vein, Karen designed a creative solution to deal with her rheumatism. Since making clothes and sewing things like pillows or leather bags became quite a challenge for her, she used a pair of pliers and a magnifying glass for threading needles: »*I still sew, but sometimes I just can't succeed in threading the needle, and therefore I use pliers combined with a magnifying glass. I use one pair of pliers to push the thread through the needle and the other pair to pull it out [...] as long as I can do them like this, I keep doing them.*«

Moreover, she used a magnet from an old electric motor for picking up pins and needles that she dropped on the floor. Additionally, she showed us how she single-handedly adjusted some of her pans by wrapping ropes around the handles against the heat just to get a better grip. (see image 2, p.42).

WHILE ENGINEERS MIGHT HAVE ADVISED HER TO INSTALL A BURGLAR ALARM, FOR IDA, A WOODEN BLOCK AND AN OLD TABLE LEG DID THE JOB.

By creatively using and adjusting objects, they allowed her to deal with the challenges of an ageing body. They enabled her to keep doing the activities she valued in her life like sewing and cooking. She liked sewing because of it allowed her to be creative and to share this with her loved ones. The cooking enabled her to prepare her own meals and take care of herself despite her ageing body.

IMAGES

1 | **Ida's highlighter.** She made a red mark on her kettle to make the minimum water level more visible.

2 | **Maria's hidden cables.** She made a hole in some furniture cabinets to bring charging cables through them. She pushes them when she needs to use it.

FOCUSING ON RESOURCEFULNESS OPENS UP A DESIGN SPACE FOR INTERACTIONS BETWEEN PEOPLE AND 'THINGS' THAT ACKNOWLEDGES THE ROLE OF SOCIAL NORMS AND INVITES EXPLORING (OLDER) PEOPLE'S CREATIVE ENGAGEMENT WITH THESE SOCIAL NORMS.

In summary, the interviews and the home visits resulted in a varied overview of the activities the participants valued and the objects they used to deal with the challenges as they age. Most of them indicated that it was important to continue to pursue their hobbies for as long as possible. They also showed us how digitally skilled they were, not only by using popular applications that we all use, but also by using digital devices in a very creative way. Moreover, the participants of our research showed how they were capable of using everyday objects as resources to deal with the challenges of ageing.

HYPERLINKS

See **Setting up a living lab of people & things (Chapter 2)** [p.26 & 28] to read more about on how we integrated both human and inhuman perspectives in our research.

See **Thing-centric design tools – Analyse (Chapter 6)** [p.99] on how we used the insights gathered in our design process later on.

ETHNOGRAPHY

A day in the life of our participants – People.

4117

8.30 wakker worden
douchen en aankleden

9.00 Koffie zetten broodsmeren ontbijten + lezen

10.00 huis opruimen wegen of stofzuiger, bed opmaken
kleren ophangen, in tuin werken of
houtzagen voor de kachel opruimen

13.00 lunchen

13.30 wandelen in Delftse Hout

15.00 boodschappen doen eet op bezoek bij vrienden

17.30 eten klaar maken, eten – afwassen

20.00 op bezoek of telefoneren met familie en vrienden
in Denemarken – Nederland
• lezen of naaien en E mailen

22.00 Nieuws kijken TV

23.00 met het oog op morgen Radio

24.00 lezen en slapen

Dinsdag
Februari
20

Morning

8 8.30 wakker worden
douchen kleding ontbinden

9 ontbijten krant lezen

10 10.30 koffie Huishoudkarwijtjes

11 11.30 boodschappen

12

13 13.00 lunch

14 computer

15 crijptogram

16 pianospelen

17

18 18.00 eten

19 19.00 T.V kijken

Evening
11.30 naar bed lezen

24.30
slapen

ETHNOGRAPHY

FEBRUARI
20

7:00	wakker douchen aankleden
8:00	radio aan ontbijt
9:00	actiend gym t.v.
10:00	opfiets naar supermarkt
11:00	koffie drinken bij Ikea
12:00	lunch
13:00	Stofzuigen
14:00	Hele huis
15:00	Kringloop
16:00	lezen
17:00	
18:00	18:00 eten
19:00	lezen
20:00	

23,00 naar bed

Dinsdag Februari, 20

8	8.20 wakker koffie ontbijt douchen tanden poetsen aan
9	kleding gezicht reinigen
10	tablet tv stofzuigen
11	bed verschonen boodschappen
12	
13	Lunch
14	
15	planten
16	
17	
18	eten afwas tv tablet slapen

Notes

ETHNOGRAPHY

STORIES OF THINGS

PATTERNS

Hayley Hung, Yanxia Zhang

Instrumented with passive sensors and unsupervised learning algorithms, objects can help uncover patterns of hidden, unexpected behaviour.

To illustrate the identified patterns, we plotted 10 extracted topics from the data of Household C in the graph on the right, where each coloured circle corresponds to a different object as shown at the top of the graph. The kitchen cabinet door, knitting needle, fridge, tablet, remote control and kitchen chair were being sensed for use. Each row of the plot corresponds to a daily routine of some of the objects in the household separated into hourly intervals. Whenever a circle is seen at a particular hour, it indicates that the model found this object to be commonly in use at that hour of the day. The bigger the circle, the higher the probability of those interaction events occurring for that topic and at that hour of the day. The ordering of the circles in each hour is arbitrary and doesn't have any meaning. What matters is whether we see two or more circles within the same hour.

OBJECT CO-USE IN DIFFERENT ROUTINES

If we examine each individual topic, each of them appears to associate with different routine behaviours. Let us look more closely at topic #0. This topic consists of a repeated pattern of two combinations of object usage, including 'Kitchen Cabinet Door' with 'Fridge' and 'Remote Control' with 'Fridge'. This topic is associated with routines around 'Fridge', which indicates its significance in this household's daily activities.

COULD THE HIGHER NUMBER OF OBJECTS INVOLVED CORRESPOND TO A COMPLEX SITUATION WHERE SOMETHING RESOURCEFUL IS HAPPENING?

We observed the combination of 'Remote Control' with 'Fridge' usage at around 9:00–10:00. *Could this be a daily morning ritual: watching television while eating breakfast?* If more objects around this routine were being sensed, it would be interesting to verify this further.

The same combination appeared between 19:00–20:00. *Perhaps this indicates the routine of 'watching television while eating' in the evening?*

The use of the 'Kitchen Cabinet Door' with 'Fridge' occured at around 16:00–17:00. *Could this be indicating cooking activity?*

SALIENT COMBINATION OF OBJECT USAGE

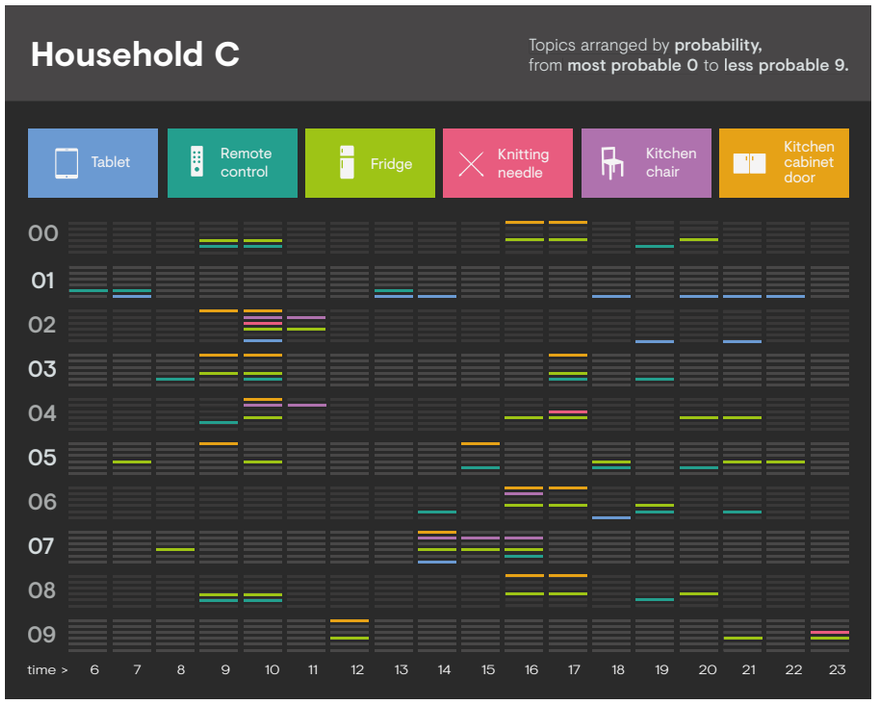
If we examine object usage occurring during the same one-hour period, we can observe a variety of configurations of object co-use combinations. It was very common that one or two objects are used. Are topics where we see one or two objects frequently used indicators of moments of resourcefulness?

On the other hand, topic #1 is mostly related to the usage of 'Tablet' and shows a less unique routine because it is used throughout the day. Are topics where we see mostly one object acting in isolation less indicative of resourcefulness? Or are there other objects that we need to sense?

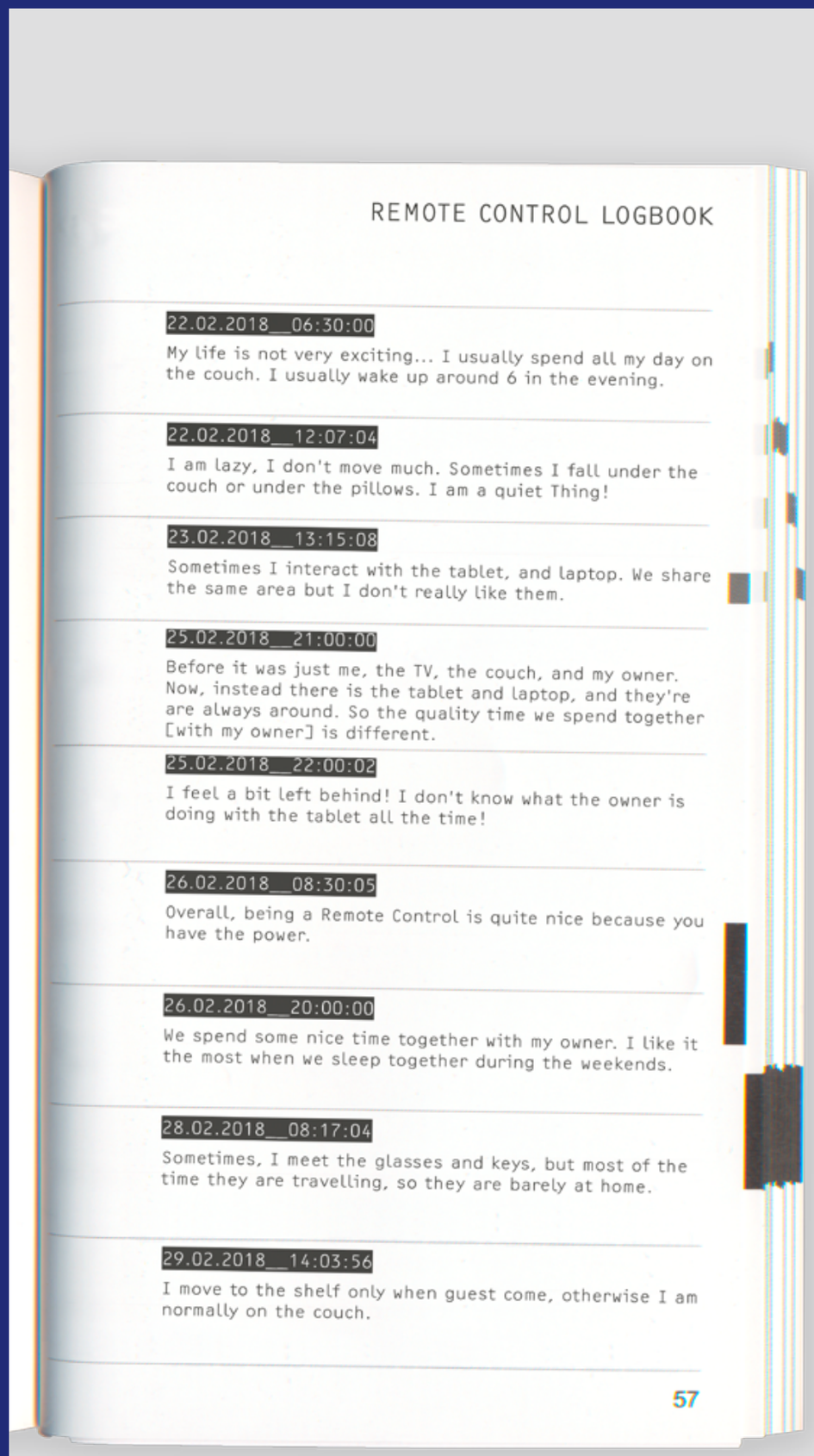
We also observed a few cases where three or more objects are co-used. Besides looking at the number of co-used objects, we also observed unexpected combinations of object usage. For instance, topic #2 shows a combination of five objects including 'Knitting Needle', 'Tablet' and other objects in the kitchen. The combination is preceded by using the 'Kitchen Door' and followed by two other objects ('Fridge' and 'Kitchen Chair') again in the kitchen. These cases are particularly interesting. Could the higher number of objects involved correspond to a complex situation where something creative or resourceful is happening with the co-use of the objects? For example, is the 'Tablet' being used to search for food menus? Why then is the 'Knitting Needle also important in this situation? To solve these mysteries, we needed a human expert to come back to the home and provide insights.

In this section, we used two examples to discuss ways to interpret the patterns by looking at shared object co-usage. We tried to associate those with situations where resourcefulness might have occurred. Nonetheless, our interpretation has limitations as they are entirely based on the continuous digital traces collected from the sensors attached to the household objects. To complete the circle, we needed to take these findings back to the participants and ask them to reflect on the data.

GRAPH
Patterns uncovered by Machine Learning. Common usage of objects and their temporal context extracted from a topic model.



MACHINE LEARNING



REMOTE CONTROL LOGBOOK

22.02.2018__06:30:00

My life is not very exciting... I usually spend all my day on the couch. I usually wake up around 6 in the evening.

22.02.2018__12:07:04

I am lazy, I don't move much. Sometimes I fall under the couch or under the pillows. I am a quiet Thing!

23.02.2018__13:15:08

Sometimes I interact with the tablet, and laptop. We share the same area but I don't really like them.

25.02.2018__21:00:00

Before it was just me, the TV, the couch, and my owner. Now, instead there is the tablet and laptop, and they're are always around. So the quality time we spend together [with my owner] is different.

25.02.2018__22:00:02

I feel a bit left behind! I don't know what the owner is doing with the tablet all the time!

26.02.2018__08:30:05

Overall, being a Remote Control is quite nice because you have the power.

26.02.2018__20:00:00

We spend some nice time together with my owner. I like it the most when we sleep together during the weekends.

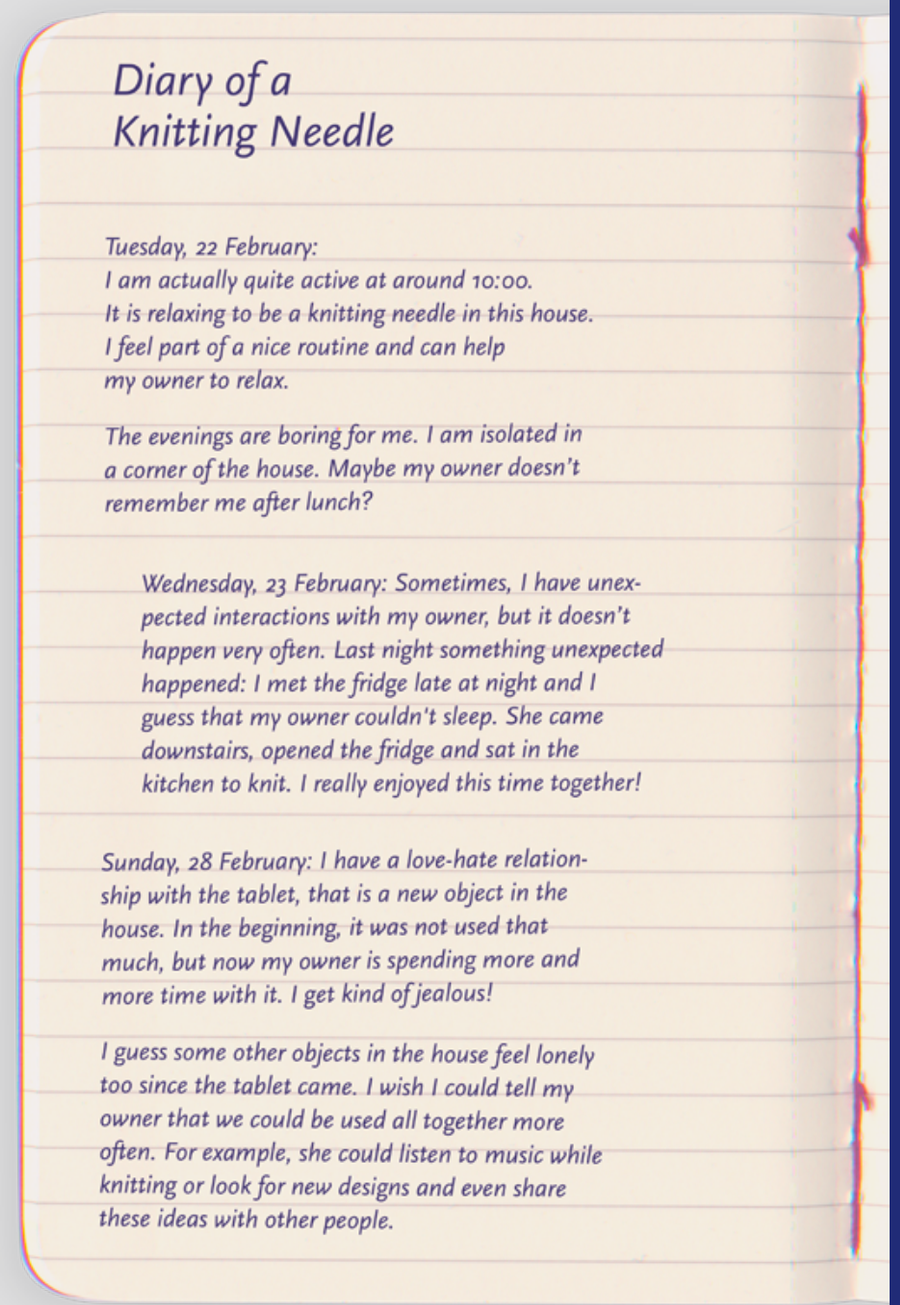
28.02.2018__08:17:04

Sometimes, I meet the glasses and keys, but most of the time they are travelling, so they are barely at home.

29.02.2018__14:03:56

I move to the shelf only when guest come, otherwise I am normally on the couch.

57



Diary of a Knitting Needle

Tuesday, 22 February:
I am actually quite active at around 10:00.
It is relaxing to be a knitting needle in this house.
I feel part of a nice routine and can help my owner to relax.

The evenings are boring for me. I am isolated in a corner of the house. Maybe my owner doesn't remember me after lunch?

Wednesday, 23 February: Sometimes, I have unexpected interactions with my owner, but it doesn't happen very often. Last night something unexpected happened: I met the fridge late at night and I guess that my owner couldn't sleep. She came downstairs, opened the fridge and sat in the kitchen to knit. I really enjoyed this time together!

Sunday, 28 February: I have a love-hate relationship with the tablet, that is a new object in the house. In the beginning, it was not used that much, but now my owner is spending more and more time with it. I get kind of jealous!

I guess some other objects in the house feel lonely too since the tablet came. I wish I could tell my owner that we could be used all together more often. For example, she could listen to music while knitting or look for new designs and even share these ideas with other people.

Fictional logbooks inspired by Things Interviews of four objects we tracked with sensors. The interviews are based on our interpretation of the movements observed in these objects in one household and the patterns uncovered by machine learning.

MACHINE LEARNING

Refridgerator RF22VACWA

Features (continued)

Door Alarm:
RF22VACWA prevents food spoilage by alerting you if the freezer or refrigerator door has been accidentally left open.

Power Freeze and Power Cool Options:
RF22VACWA adjusts the temperature quickly when the refrigerator or freezer compartments need to be cooled due to repeated door opening.

RF22VACWA Logdata

Page 1

22.02.2018	My average day could sound a bit boring because not much action seems to happen.
22.02.2018	I am not involved in a lot of activity in the household.
22.02.2018	I think I might have contact with the remote control.
24.02.2018	It feels lonely to be a fridge in this household.
26.02.2018	Maybe the owner likes to use something from me while she watches TV?
27.02.2018	My owner might be having snacks while watching TV or do anything else, like crushing frozen cookies

Entries

22

Tuesday 22	Where I feel most comfortable is on the living room table.
Wednesday 23	I try to help my owner by providing information. But I am not so portable... I can be a bit heavy.
Thursday 24	My owner uses me while knitting. She might be looking for instructions, or otherwise listening to music, or watching Youtube videos, or even talking with someone on Skype.
Friday 25	The remote control is a good friend. We have a complementary relationship: it helps my owner to reduce the volume of the TV so she can concentrate on me.

Fictional logbooks inspired by Things Interviews of four objects we tracked with sensors. The interviews are based on our interpretation of the movements observed in these objects in one household and the patterns uncovered by machine learning.

MACHINE LEARNING

RESOURCEFUL ARRANGEMENTS

Lenneke Kuijer, Iohanna Nicenboim

The shift from designing products to designing resources implies moving from solving problems to supporting people's strategies of resourcefulness.

In order to design for resourcefulness, we first had to understand what older people's existing competences of resourcefulness were and how to support these competences with new designs. We recognised the strategies by clustering photos from the ethnographic fieldwork into different categories and organising them into what we call a Resourceful Repertoire: a non-exhaustive collection of strategies, capabilities and materials that play a key role in shaping older people's resourceful arrangements. But since the practice of resourcefulness can be understood as an integration of elements which involves both objects and people, resourcefulness shouldn't be approached as a property of a person or a technology alone, but as something that emerges from the way people and objects work together in particular circumstances. Thus, the process of defining the resourceful repertoire demanded more than just looking at the pictures and was directly based on our conversations with participants.

In the same way, the resourceful repertoire elements are not just materials but are materials which were used as resources by our participants. For example, we have physical materials and everyday objects such as clips, elastic bands, or magnets but only because they were deployed by our participants to cope with crises of routine they faced in the past. Similarly, the category capabilities include both what people can do with resources (such as inserting) but also what resources themselves allow people to do (such as wrapping). Strategies demanded to look for know-hows, high level plans or emergent systems that were developed over time between things as participants in order to achieve a goal or just make do. Strategies also showed combinations with immaterial resources such as getting help from the family or their social connections.

RESOURCEFULNESS SHOULD BE APPROACHED AS SOMETHING THAT EMERGES FROM THE WAY PEOPLE AND OBJECTS WORK TOGETHER IN PARTICULAR CIRCUMSTANCES.

RESOURCEFUL STRATEGIES

Multiple Instances

A

Extensions

B

Sequences

C

Sharing / Communication

D

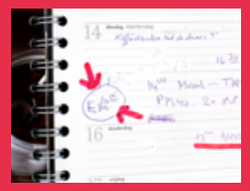
Material Adaptations

E

Proximity

F

Markers



G

Arrangements

H

SOCIAL PRACTICE THEORY

PHYSICAL RESOURCES

Clips

I

Magnets

J

Bands

K

PHYSICAL CAPABILITIES

Hanging

L

Inserting

M

Wrapping

N

PRACTICES OF RESOURCEFULNESS

Lenneke Kuijer, Iohanna Nicenboim, Louis Neven, Ivo Maathuis

Resourcefulness is about more than just responding to situations of crisis. It emerges from the way people and objects work together in particular circumstances.

When analysing the examples of resourcefulness that we identified in the fieldwork data, we realised that our participants had a wide range of strategies of resourcefulness that together form a complex process of closely related elements; from embodied skills, know-hows, anticipatory stocks and arrangements of potential resources to personal and unique solutions and their social justification. Below, we describe each element of resourcefulness and the strategies we identified using rich examples from our research.

PARTICIPANTS POSSESSED A CERTAIN SET OF EMBODIED SKILLS AND KNOW-HOW THAT ALLOWED THEM TO ACHIEVE RESOURCEFULNESS.

EMBODIED SKILLS AND KNOW-HOW

EVERYDAY DESIGN

From the examples we found, it was clear that our participants possessed a certain set of embodied skills and know-how that allowed them to achieve this level of resourcefulness. First, they showed the capability of following a design process by finding solutions to unique problems they encountered. This process includes identifying (or anticipating) problems, generating different ideas and implementing and evaluating a solution. A clear example of this is of Ida fixing her kitchen tap. When her tap broke, she needed something to keep the tube in place so it wouldn't spray over the edge of the wash basin. She tried different things from her kitchen to achieve this purpose and eventually found a perfect fit in a spare wooden spoon. Another example is Tina using an elastic band to hold a door closed [K] or Ida who used an electronic bracelet for the same purpose.

RECOGNISING OPPORTUNITIES

Another skill of resourcefulness is the ability to discover opportunities in the course of everyday life. Contrary to the relatively structured process of everyday design, these are situations in which something that is happening spontaneously or is already going on is recognised as a solution to a (latent) problem. For example, Ida's newspaper is primarily a habit put in place to save resources, but then it was discovered as a lowkey mechanism to let her daughter know that she is alright. Ida also used a magnet from a dynamo to pick up needles [B].

MATERIAL MASTERY

A third skill is material mastery. Resourcefulness in many cases involves material adjustments, i.e. the making and adjusting of objects. The confidence and skill to mend, adjust and make things is important for being resourceful. For example, Ida wrapped the pan handles with a thread that she knows won't burn or get hot to be able to protect her hands from burning when holding the handle close to the pot [E].

ANOTHER SKILL OF RESOURCEFULNESS IS THE ABILITY TO DISCOVER OPPORTUNITIES IN THE COURSE OF EVERYDAY LIFE.

ANTICIPATING FUTURE CHALLENGES

Finally, as we discovered, resourcefulness is also about anticipating future problems and challenges, and curating a stock of potential resources to deal with them as they arise. This skill is both about knowing oneself and one's own situation, and about being able to see particular affordances in objects that may not be their primary function. Knowing one's own situation particularly involves making one's valued activities clear, as well as an awareness of one's own (shifting) ideas about acceptable living circumstances. Examples of this are the choices our participants make with regard to which objects to keep stock of and where, which set of tools to have and what network to maintain. The following sections go deeper into the characteristics of the physical arrangements resulting from this.

ANTICIPATORY STOCKS AND ARRANGEMENTS

The skill of anticipating future challenges brings us to another aspect of being resourceful that we observed, which involves the presence of stocks and arrangements. These stocks and arrangements aren't resources in themselves because as long as they are not applied in a resourceful solution, they remain just stocks and arrangements. Together with skills of anticipating future situations (in which these might be needed) and of creatively repurposing things, they form potential resources, and to us, they can be seen as part of practices of resourcefulness.

STOCKS OF PHYSICAL RESOURCES

Within this aspect of resourcefulness, we observed a few types of stocks of potential resources. One is keeping stocks of relevant bits and bobs in case something is needed to make, adjust or fix something else. Ida, for example, is into sewing and keeps a broad stock of fabrics, other soft materials, thread, buttons and sewing equipment. Also, when she fixed her tap, she made use of her curated stock of objects from which she could take a spare wooden spoon to mend the tap.

STOCKS OF SOCIAL RESOURCES

In a similar way, we can say that the participants all somehow kept and maintained a stock of potential social resources — people in their surroundings who, next to being regular social contacts, could be seen as a stock of skills that they keep on hand by maintaining relations with them. Specifically, we see this happening in the form of doing things for them that lie within the particular capabilities of our participants (such as sewing or taking care of grandchildren). This is not to say that all these favours are calculated transactions, but a secondary effect of these social activities is the access it ensures to a 'stock' of human resources. Although our participants generally prefer to manage on their own, they maintain a network of people around them who can help them with all kinds of things, e.g. problems with their digital devices and heavy work. In the case of Ida, we see that she does things for her grandchildren, such as mending clothes and making textile craftwork for them, which keeps her in good contact with them and they are thus available to help her with things when necessary. With Maria, we see another function of her network as a resource, where she uses contact with peers to exchange ideas for dealing with the challenges of an ageing body. Social capital can be combined with particular 'production' practices of things some older people value and are particularly good at, for example taking care of grandchildren (they generally do not have work hours) and handwork such as knitting and sewing.

ANTICIPATORY ARRANGEMENTS

Anticipatory arrangements involve strategically placing objects together where they will be needed. These things can form tangible reminders in sensible locations and prevent older people from forgetting something or not having something needed at hand. Sequences is a specific form of anticipatory arrangement in which things are routinely done in a particular order, making it less likely that something important is forgotten. For example, Maria described her morning routine, which starts by turning on the radio and follows the same set of actions daily. [C].

A combination of both arrangement and stock is the practice of keeping multiple instances of something in strategic locations where they are anticipated to be needed at some point. Keeping a spare key at the neighbours' house, having multiple pairs of glasses or even various types of magnets in strategic spots in the house are some examples. Similarly, especially for activities that are highly valued, we saw several participants build-in some redundancies to make sure they can go on even in cases of unexpected circumstances. To repeat the example of the newspaper, if for some reason the newspaper is not brought to the daughters house, the daughter and mother can use their phones to get in touch with each other and communicate about their well-being directly [D].

PERSONAL/UNIQUE SOLUTIONS

All the strategies of resourcefulness discussed here require thorough understanding of personal and situation-specific circumstances and inherently contribute to personal, unique solutions. Nonetheless, we were able to see some general patterns in the different solutions that we found in our participants' lives. In our research, we specifically focused on creatively dealing with the challenges of an ageing body, and we found a number of strategies that could be seen as more particular for our group of older participants, but other strategies are expected to occur across age groups.

WE FOUND A NUMBER OF STRATEGIES PARTICULAR TO OLDER PEOPLE, BUT ALSO STRATEGIES THAT ARE EXPECTED TO OCCUR ACROSS AGE GROUPS.

Several of these solutions have already been mentioned. The following are actual examples of resourceful solutions rather than prerequisites or strategies that shape them.

MULTIPLE INSTANCES

Multiple instances is a solution in which certain specific items are used in several places, for example, multiple pairs of glasses, pens, calendars or toothbrushes. This solution is likely to be a response to situations where something was not at hand, i.e. the location of something was different from the place in which it was needed. For things that are easily replicable, a solution could be to make sure that there are multiple instances of that thing in all the places where it is normally used. This multiplicity is person- and situation-specific, and is likely to shape itself in unique ways over time as spare things »*are simply left where they are used*« [A].

KEEPING THINGS TOGETHER

This is a solution where specific items that belong to one practice are kept together in order to prevent losing or forgetting things. Maria, for example, mentioned that when she is knitting, she leaves the unfinished parts and needles together — normally on this decoration plate — so she can easily continue knitting later. Ida keeps all her tennis gear together in the tennis bag, including her tennis pass, and other things for going out in her handbag.

PLACING MARKERS

Another, highly person-specific solution is that of placing markers. Karen uses this strategy around the kitchen: she placed a red mark in her kettle to make the minimum water level more visible. She also showed us how, in order to avoid missing important events from the agenda, her system was to highlight them with a red marker [G]. This marking needs contextual knowledge because, for highlighting important visual signals over others, you need to be able to distinguish these signals in the situated circumstances.

OBJECTS AS SIGNS

We also saw a number of examples where objects were used as unique signs. The sharing of the newspaper between Ida and her daughter is a clear example of this. For them, the newspaper forms a sign to the daughter that the mother is okay. Over time, the newspaper has gained the function of forming a sign as a shared understanding between mother and daughter. Since it is implicit and unobtrusive, it forms a more acceptable form of communication for both mother and daughter than, for example, the mother sending a daily text message to say that she is okay. Another example is from Maria: she placed a sticker in a drawer to remind the guests to be careful with the old piece of furniture. In these situations, direct, verbal or telecommunication was found too troublesome, intrusive, disruptive or difficult to do because of spatio-temporal separation between two people. Once a shared meaning has been agreed upon, anything can become the carrier of a certain message.

THE NEWSPAPER HAD GAINED THE FUNCTION OF FORMING A SIGN AS A SHARED UNDERSTANDING BETWEEN MOTHER AND DAUGHTER.

THINGS AS BODILY EXTENSIONS

We saw a range of examples in which physical things are used in clever ways to compensate for changing bodily capabilities. In order to reach higher, Ida placed double-sided tape on a broomstick. She uses this to kill spiders on the ceiling. Karen also showed us how a magnet helps her pick up small metallic items, which she cannot grab with her hands anymore. Maria also gave an example of this: she noticed that because the force in her hands is reducing, she wasn't able to remove the coin from the shopping cart anymore. Now, she uses a keychain type of coin with a hole and a little hook to remove it and a little hook to remove it.

PERSONAL ADAPTATIONS

Lastly, related to this type of solution are personal adaptations. These solutions involve material adjustments of means to achieve a certain purpose. Karen adapted her pans by wrapping the handles with threads in order to avoid burning her hands. This adaptation is a direct response to a physical process of reducing force in the hands that is compensated by reducing the arm length of the pans to continue to be able to cook. Ida created a wooden cube wrapped with leather to block the garden door. This is her own 'low-tech' system to avoid theft and feel safe. A characteristic of these solutions is that it is unlikely for them to be commercially available. This is because these highly personal adaptations may be too situation-specific (market too small) or because they would not pass standard safety tests, for instance. Holding a pan so close to the hot part (and having to tread so close to the fire) would probably not pass safety standards. The block Ida keeps on the garden door handle is there as a burglary prevention system. It blocks the door handle and will make a distinct sound if it drops. It also provides easily understandable and trustworthy feedback in the morning that nobody has tried to open the door. The block forms a means to the purpose of continuing to live in her own home. There are of course, commercially available security systems, but these might emphasize a feeling of insecurity, while the block illustrates her capability to manage on her own.

DISCURSIVE SKILLS OF SOCIAL JUSTIFICATION

Finally, what we noticed when studying resourcefulness and viewing it as deviations from socially agreed ways of doing were the discursive skills of our participants in explaining their particular ways of doing as sensible, good and preferred. This makes sense because when being resourceful involves deviating from socially shared norms, talking about resourceful examples involves some kind of justification in relation to this social norm. What we saw in our highly resourceful participants was that they were generally proud of their skills, arrangements and solutions and had developed ways of explaining them that positioned their unique ways of doing as good and personally preferred. From this, we conclude that being resourceful involves having confidence in one's capabilities to find satisfactory solutions to personal and everyday challenges and owning up to the unique solutions found. These solutions may not be common, but they work for the specific circumstances in which they emerged.

This skill of social justification comes to the fore in the newspaper example. Ida and her daughter share the newspaper, not for the main purpose of communicating the mother's well-being to the daughter, which would foreground her vulnerability, but for the main purpose of being efficient with resources. Social justification is not just about solutions that work but also about the way solutions are perceived by others and, by extension, about the way older people think others will perceive them.

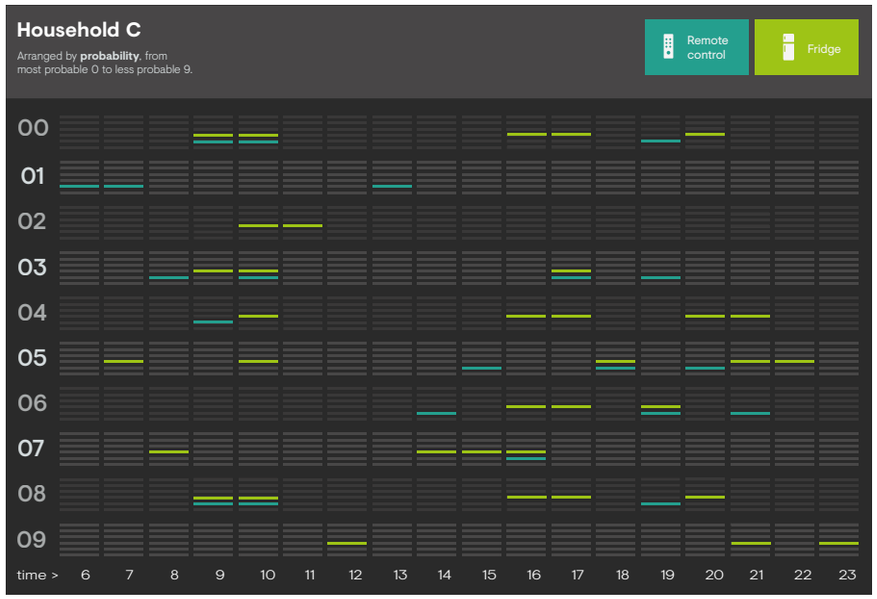
RESOURCEFULNESS INVOLVES DEVIATING FROM SOCIALLY SHARED NORMS.

SOCIAL PRACTICE THEORY

ML PATTERNS UNCOVERING AND PROVOKING RESOURCEFULNESS

This aspect of resourcefulness had some interesting resonances with our thing ethnography approach. Through the patterns of sensor data created with machine learning (ML), we were able to reveal additional examples of resourcefulness that may have remained hidden without them.

For instance, the resourceful solution of eating dinner at her daughter's home or microwaving a meal instead of having to cook on her own were revealed in the ML patterns by the absence of the use of the fridge around dinner time. When asked about this however, Ida showed a level of embarrassment about this 'anomaly'. Identifying these forms of resourcefulness is tricky because there is no single, commonly agreed way of 'doing' that applies in all situations. There is also some form of embarrassment that goes with solutions that participants enact and yet perceive as 'uncommon' or somehow 'out of the norm'. With the ML patterns as evidence on the table, participants were nudged to reveal a little more information about their everyday lives that might be considered slightly deviant from what is 'normal' or expected. In spite of this occurrence, Ida did not feel in any way embarrassed by the introduction of the ML patterns to the conversation.



A similar example is that of Household C having breakfast in front of the television, revealed by the simultaneous use of the remote control and fridge in the morning. There is an implicit 'norm' that eating 'should be done on a table and not on the sofa'. This norm was certainly present in our conversation with Maria because when we asked about this pattern, she told us that they normally have breakfast on the couch, immediately adding that this is because there is more light there and that they have kept a relatively old couch so it is no problem if the grandchildren spill something on it. Although acknowledging (with these additional explanations) that it is likely a bit uncommon to do this, she was not apologetic about this habit, but seemed proud that this is the way they do things.

GRAPH
Patterns uncovered by machine learning. Common usage of objects and their temporal context extracted from a topic model.
© Created by Benjamin Lopez (Philips Design) based on graph by Hayley Hung.

DIMENSIONS OF OPENNESS AND VARIETY

Masako Kitazaki, Iohanna Nicenboim

In order to design for resourcefulness, we shifted our focus from designing closed solutions to designing for a variety of possible solutions.

Connected technologies promise to assist older people with living more independently. However, as we argue in Resourceful Ageing, the mainstream approach does not always reflect the desires of older people and the variety of situations they encounter. Framing older people as passive recipients of technology and focusing merely on solving problems leads to conceiving technologies within narrow-scripted scenarios, which fail to address the variety of situations older people encounter and the variety that exists within this user group. For example, a medicine dispenser that is designed for indoor use only fails to address that many older people spend a lot of time outdoors. Instead, in another study, older people mentioned a free senior citizen bus pass and three pairs of sturdy shoes for different times of the year as key items to support their independence. Thus, the challenge for designers in gerontechnology is to bypass the tendency to begin the design with focusing on needs and physical decline, and instead, design technologies that can empower elderly people to retain their independence in a variety of activities they value.

Our approach steps away from scripted scenarios by shifting from products to resources. Resources, in contrast to products, can be deployed in a variety of ways according to older people's own desires. Thus, the shift from products to resources implies moving from designing for specific scenarios to supporting variety of uses, i.e. positioning connected objects as tools that can support use in various ways and for multiple purposes, even beyond the ones we designers envisioned. In order to design for resourcefulness, we needed to understand how to tune the dimensions of variety and openness of the technologies we design and explore how connected resources can be deployed in existing practices of older people. We will discuss these dimensions in Chapter 4, which is dedicated to our design work.

THE SHIFT FROM PRODUCTS TO RESOURCES IMPLIES STEPPING AWAY FROM FIXED SCENARIOS.

HYPERLINKS
See **Bridging First and Second Iteration (Chapter 4)** [p.72] to read about our design process and tuning the dimensions of openness and variety of the technologies we design.

3

In this chapter, we dived deeper into our findings both from a 'people perspective' and a 'thing perspective'. Based on ethnographic research and machine learning, we also categorised the strategies of resourcefulness used by older people in everyday life. In the next chapter, we explore how 'things' become active partners in data-enabled RTD and, more importantly, in the process of 'doing design' itself. In particular, we discuss how the first, second and third iterations of the Connected Resources came about and how they built onto each other.

WHILE ENGINEERS MIGHT HAVE ADVISED HER TO INSTALL A BURGLAR ALARM, FOR IDA, A WOODEN BLOCK AND AN OLD TABLE LEG DID THE JOB.

4 DESIGNING CONNECTED RESOURCES

THINGS AS PARTNERS

CÙES

CONNECTED RESOURCES 1

BRIDGING FIRST AND SECOND ITERATION

CONNECTED RESOURCES 2

THINGS AS PARTNERS

Elisa Giaccardi

Things 'make' things too. As such, they can play an important role as both co-ethnographers and co-designers.

For a long time, design and research have been regarded as separate endeavours. As illuminated by a recent survey of Research through Design (RTD), explicit theory about RTD is young, and as a community, we are still struggling to find the right words, framings and practices for what it is that we do.

The role played by artefacts in RTD is equally complex. Used as a manifestation, provocation or speculation, artefacts are utilised in RTD as a way to explore new design spaces, as exemplars to establish critical areas of concern and judgment, and even as a means to test hypotheses and build theory.

Since the artefacts in this project are data-enabled, their role is reframed in two ways. Firstly, we consider them as having perception and an agency of their own, so to speak. Secondly, we enlist them as partners in the design process to add a different perspective and to help us problematise the design space. Throughout the book, we consistently refer to them as things. Things in this project are the objects of everyday use, instrumented with sensors and software in the ethnographic research phase, as well as the connected devices we created and tested in our design iterations.

BY TAKING PART IN DESIGN NEXT TO US, THINGS MAY HELP US BROADEN AND BALANCE HUMAN AND NON-HUMAN PERSPECTIVES.

We explained the role of things in our ethnography in Chapter 3. Here, we want to explain how we envision things as becoming partners in doing data-enabled RTD and focus on the role they have been designed to play once they are released as **Cùes** (first iteration) and **Connected Resources** (second and third iteration). Before moving onto the actual things, we will briefly clarify this idea of things as partners in RTD.

WE MUST ACKNOWLEDGE THAT INCREASINGLY, THINGS 'MAKE' THINGS TOO.

Things 'make'. These autonomous judgments and performances establish connections among people and things, shape relations, give rise to new ways of doing, bring into being social practices and potentially open up futures. Data-enabled artefacts are things that increasingly do business with humans and with each other. We must acknowledge that increasingly, things 'make' things too. This problematises how things may take part in design next to us and how their uniquely artificial competence, their point of view and skills can be brought to bear on design work in ways that broaden and balance both human and non-human perspectives.

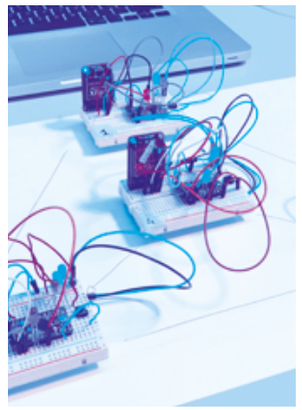
In a world where the complexity and scale of design problems has grown and where distinctions between design and use, subject and object, producer and produced have blurred, the challenge of design is not a matter of getting rid of the emergent and placing the human more firmly at the center. It is rather a matter of how to partner with things as both co-researchers (Chapter 3) and co-designers (this chapter) and to make this new partnership an opportunity for more creative and, hopefully, more sustainable solutions.

HYPERLINKS
See **Strategies of Resourcefulness (Chapter 3)** [p.33] to read on how we envision things to become partners in doing data-enabled RTD.

CÙES — A DESIGN EXPLORATION

Edoardo Fusaro

In the first exploration, we still thought that the 'things' of the Internet of Things should take care of older people.



In this first iteration, the design was still informed by a notion of cognitive decline. As a result, things were still 'in charge' (of a person's routine) and are still assistive in nature (designed to 'take care' of the older person).

In everyday activities, older adults can encounter difficulties and frustrations while attempting to remain independent. Ageing in place is a process that involves a continuous, dynamic interaction among the person, the objects and the surroundings in which they are located. The goal of the first design was to provide a connected system of everyday use objects that is able to adapt and support cognitive changes, allowing elderly people to remain independent and age resourcefully.

THE CHALLENGE FOR THE DESIGN WAS TO CREATE A NETWORK OF CUSTOMISABLE SENSORS EASY TO SET UP AND USE.

Cùes is a customisable system of everyday objects that are able to talk to each other and take care of the user. In the short-term, it helps to keep things together so that they are never misplaced or forgotten. In the long-term, it suggests new ways to rearrange the environment according to changing needs due to ageing. It is composed of a digital interface that is used to set up and manage the system and to visualise user's changing patterns. Machine learning will be used to collect proximity data among objects to see how these configure and reconfigure overtime.

The system will understand the objects that the user needs during different context. This will collect information about the user and it will support them in living independently at home for a longer period of time. The system knows its 'owner' through their objects and the environment in which they are embedded. Moreover, the system recognises the objects that the user brings with them when they leave home. Cùes takes care of the object so that they are not left behind. If this happens, it will give an audible feedback.

IMAGES
1 | **Prototyping.** Mid-fidelity prototypes created to test the main technological features of the concept.

2 | **Cùes.** The final concept consists of two different physical elements that are part of the system: an environmental node and an object node.

WEBLINKS
See **CÙES Video**
edoardofusaro.com/cues.html

The challenge for the design was to create a meaningful network of everyday use objects that is able to communicate with the user, provide maximum customisation and is easy to set up and to use. The aim was for the network to be able to support older people who are living independently at home, while tackling the problem of forgetfulness. The system allows for maximum flexibility of use and is composed of both physical and digital elements that work together.

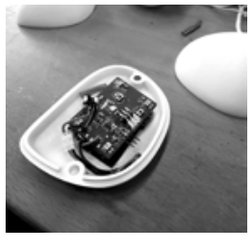
CONNECTED RESOURCES 1

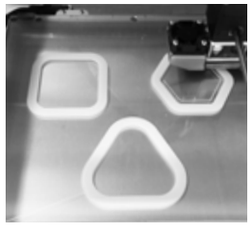
Iohanna Nicenboim

In the first iteration, we designed technologies that could support existing practices of resourcefulness.

Since our project aimed to position technologies as resources, we designed a series of artefacts to implement that approach. We call them Connected Resources. Designing Connected Resources implied supporting resourceful strategies instead of solving problems and tuning the dimensions of openness to allow variety of use according to personal circumstances.

WE WANTED TO ACHIEVE NOT ONLY VARIETY OF USES, BUT VARIETY IN USE.





ENVISIONING CONNECTED TECHNOLOGY FOR OLDER PEOPLE

We began by observing older people's existing practices of resourcefulness in an ethnographic study. From this study, we recognised different material elements of these practices then translated them into a generative design tool that we used to ideate new connected objects. Finally, we designed and prototyped three connected resources to better understand how we can support the resourceful practices we observed with connected technologies.

PROTOTYPES

Connected Stones: allow users to organise actions or things in a sequence by glowing one-by-one. Besides highlighting sequences and paths, they also support the strategy of keeping things together in a digital way by placing connected stones next to objects that one wants to remember, for example.

Connected Bells: play a recorded voice message when they detect movement, creating a relationship between content and the space where they are placed. For instance, if placed on a door, it will play a message when opened. The message can be recorded by calling a telephone number, and the sound can be intentionally or unintentionally triggered.

Connected Magnets: prompt a digital album on a device placed close to it, thanks to a near-field communication (NFC) tag. They help to access personal or shared images and videos in a situated way.

HOW TO DESIGN FOR OPENNESS AND VARIETY?

Since resources are not designed to solve specific problems but to encourage use in multiple ways, our focus was on allowing the resources to fit into different practices. That relates very well with the conceptualisation of resourcefulness as a dispersed practice — something that occurs across practices. While they often hold papers on the fridge, magnets are used by Maria to pick up small, metallic objects. Similarly, Connected Resources are not designed for one specific practice but can move across them.

One crucial step was to keep the purpose of these objects as 'underdesigned' or as 'open' as possible. However, designing resources is not simply about keeping all dimensions open: some dimensions needed to be 'closed' to make this object familiar and easy to use. This is especially the case since we wanted to achieve, not only variety *of* uses, but also variety *in* use, meaning the technologies can be easily repurposed without much planning ahead or reconfiguration.

IMAGES
1 | **Sketch** resulting from the design session by using the Coding Cards (Chapter 6), in which we combined the physical resource 'Stones', with the digital capability 'Helps you navigate', and the strategy 'Sequences'.

2 | **Prototyping.** Testing the electronics of the Connected Stones.

3 | **3D-printing Connected Stones.** We tried 3D-printing in different materials, including in PLA and porcelain.

IMAGES
Connected Resources 1
1 | **Connected Stones**
2 | **Connected Bell**
3 | **Connected Magnet**

DESIGNING CONNECTED RESOURCES IMPLIED SUPPORTING RESOURCEFUL STRATEGIES INSTEAD OF SOLVING PROBLEMS.

By positioning technologies as resources, we recognised new design spaces. For example, we observed that resources (such as clips and thread) are somewhere in-between products and raw materials. This property of resources is important because it is their mundane character that often helps people take the risk to appropriate them. Connected technologies are commonly expensive products, which makes it hard for older people to tinker with. This space in-between products and materials highlights a new range of properties we could use in the design of connected technologies to support resourcefulness.

Lastly, we also envisioned how the configuration of resources could be more explorative than available options in the market. Available technologies for configuration are still really complex or demand users to have digital skills. IFTTT (if this-then-that) is a framework to configure connected devices in a playful way. Although it is designed for people without programming skills, it does require users to have a predefined idea of what one wants to do and to have certain knowledge on sensors and actuators. IFTTW (if-this-then-what) considers to approach connected technologies in a more explorative way, where there is more freedom for the user to decide what and how the technology will be used.

HYPERLINKS
See **Dimensions of Openness and Variety (Chapter 3)** [p.65] to read on our research with participants to design open and closed dimensions.

See **Thing-centric tools (Chapter 6)** [p.95] to read on our co-design workshops with participants.

BRIDGING FIRST AND SECOND ITERATION

Iohanna Nicenboim, Masako Kitazaki, Elisa Giaccardi

By positioning technologies as resources, we recognised that we needed a new way of thinking about their affordances and configurability.

In order to move to the second iteration, we used the three initial prototypes of Connected Resources to conduct two studies. The first was a small study to understand the dimensions of openness. The second was a participatory session from which we recognised new practices beyond what we previously envisioned as designers.

DIMENSION	CLOSE		OPEN
Structure	Simple	⟷	Complex
Content	Limited	⟷	Various
Interface	Standalone	⟷	Expandable
Feature	Dedicated	⟷	Multifunctional
Signifier	Clear	⟷	Ambiguous
Self-Adaptation	Fixed	⟷	Various
Knowledge	Un-learnable	⟷	Learnable
Experience	Familiar	⟷	Novel
Quality of Learning	Serious	⟷	Playful
Mindset to newness	Timid	⟷	Courageous

= Recommended direction of openness for resourcefulness

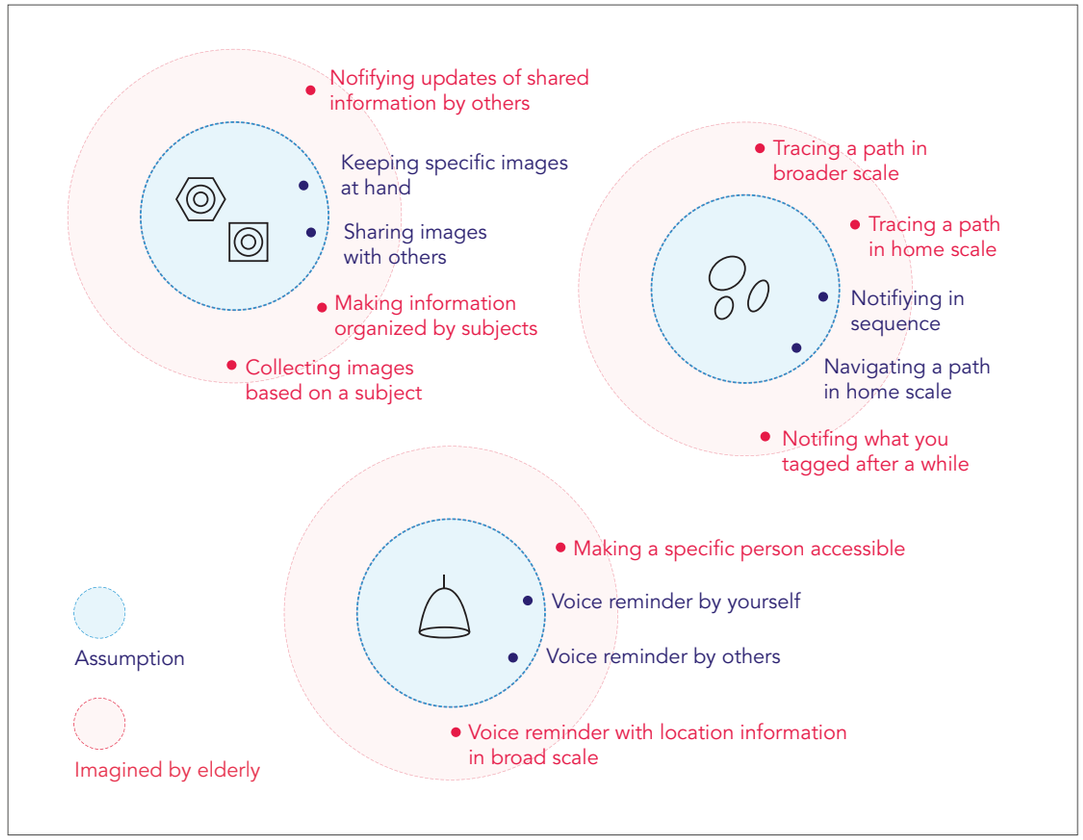
UNPACKING THE DIMENSIONS OF OPENNESS OF CONNECTED RESOURCES

With the three initial prototypes of Connected Resources, we conducted a small study to seek dimensions of openness necessary to support resourcefulness. For an object to become a resource, some dimensions of the artefact must be open to make it eligible for appropriation across several practices; others need to be closed to keep it familiar and easy to use. Resourcefulness emerges from the manner in which the artefact and human work together. Therefore, dimensions were researched according to two perspectives: the first concerns the artfact, such as material constraints and affordances, and the second concerns human capability, such as personal history and the ability to see beyond an artefact's prescribed functions. Each dimension was explored along two poles, 'open' and 'close'. The hypotheses were subsequently evaluated by ten participants using the three initial prototypes, as well as additional artefacts purposely selected for the study. Participants first rated the extent of openness they perceived each artefact to have, and then scored the extent to which each artefact was perceived to fit between the two poles (open-close) on each dimension.

The analysis concluded with the ten dimensions and their recommended poles as a design-guideline for openness of resourcefulness. Findings also revealed a correlative relationship between an artefact's simplicity, clarity of signifiers, playfulness and familiarity, and a human's courageousness and learnability. Moreover, the study revealed that the familiarity in the signifiers of an artefact gives people an entry point to explore its material and possible personal adaptations according to unique situations beyond its intended use.

GRAPH
1 | **Dimensions of openness** and their recommended direction. © Masako Kitazaki

IMAGE
2 | **Workshop image** shows participants and designers co-creating scenarios.



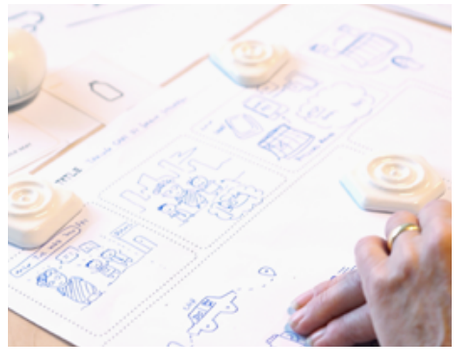
EXPLORING VARIETY OF USE WITH PARTICIPANTS

To explore how the initial prototypes of Connected Resources could be configured in older people's everyday practices in a variety of ways, we conducted a participatory session with four of our participants, two design students and two researchers from the team. Apart from having the three prototypes on each table, we created several materials, including sheets and cards, in order to facilitate the discussion.

GRAPH
1 | **Variety of uses**, beyond the ones we assumed, that we recognized during the workshop. © Masako Kitazaki

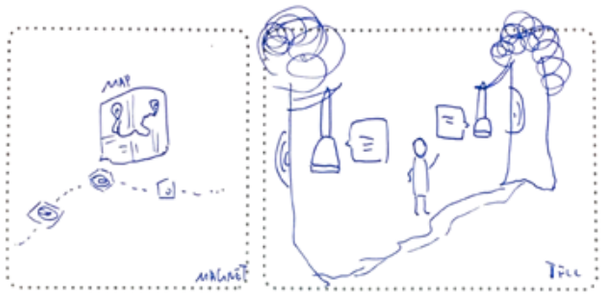
IMAGES
2 | **Connected Resources 1 prototypes** were presented during the session.

3 | **Outcome image** shows a scenario presented by one of the two groups.



Participants were asked, in two groups, to envision possible scenarios based on the first prototypes of Connected Resources. By analysing the scenarios created during this session, we recognised seven practices. We analysed these practices using the proto-practices framework, identifying meanings, competencies and materials of a valued practice and how it was reconfigured when introducing the prototype. The practices we analysed are: 'Walking independently', 'Sharing knowledge about routes while walking', 'Remembering what I was doing', 'Remembering important events', 'Collecting images to get inspired', 'Managing schedules to bring grandchildren to schools on time', and 'Keeping in touch with remote family members'.

This shows practices that were imagined around every prototype, mapping which of them were previously assumed by the designers, and which were not envisioned by designers. From these gaps between what was imagined in advance by designers and what was envisioned by participants, we expanded the range of variety.



CONNECTED RESOURCES 2

Masako Kitazaki

Building on the first iteration, we redesigned Connected Resources to be used with a higher degree of freedom.

The second iteration of Connected Resources are objects that can be used alone or in combination to cleverly pin, arrange and organise digital resources in a physical way around the home. Once in use, the objects begin to learn from the way in which they are deployed. Through an online platform, they encourage older people to learn from each other's strategies and find new uses.

EACH OBJECT HAS A DIFFERENT CAPABILITY AND CAN BE USED ALONE OR IN COMBINATION.

ONCE IN USE, THE OBJECTS BEGIN TO LEARN FROM THE WAY IN WHICH THEY ARE DEPLOYED.

REDESIGNING CONNECTED RESOURCES

We implemented the insights of openness, variety and independence in the second iteration. The insights were translated into design requirements such as using familiar metaphors of normal everyday tools as an entry point. Another requirement was the need for an application that could guide the configuration and reconfiguration of the resources, and thus help older people control their desired level of independence. Based on these design requirements, the redesign encompassed four Connected Resources and their online platform. Each object has a different capability and can be used either alone or in combination to cleverly pin, arrange and organise digital content in a physical way around the home. Once in use, the objects begin to learn from the way in which they are deployed. By connecting to the online platform, objects will use their accumulated learning for encouraging older people to learn from each other's strategies and find desired configurations.

IMAGES
Connected Resources 2
1 | **Messaging Bell**
2 | **Lighting Clip**
3 | **Linking Frame**
4 | **Navigating Compass**

PROTOTYPES

The four Connected Resources include:

Messaging Bell
which plays and records voice messages when moved – intentionally or unintentionally triggered.

Lighting Clip
which can be pinched to objects and glows in response to human proximity.

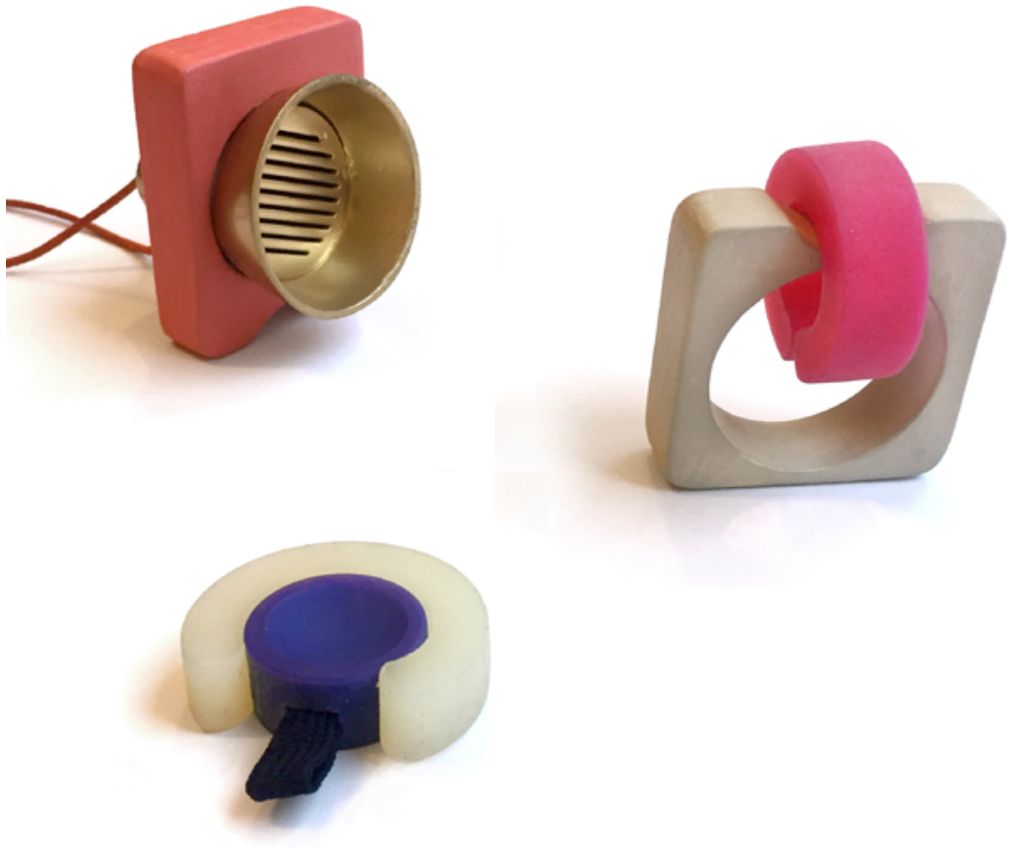
Linking Frame
which allows older people to keep videos and digital pictures and together, accessed by a phone or tablet placed close to them.

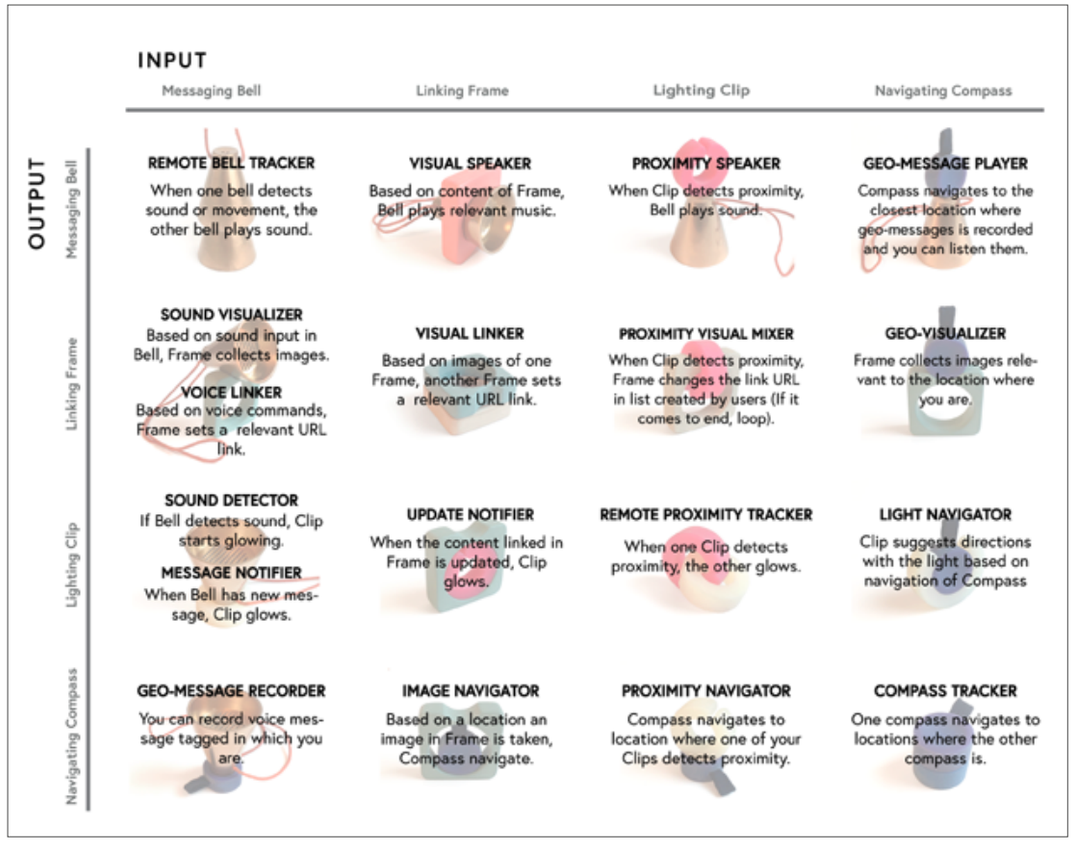
Navigating Compass
which records the locations where it has been and helps users trace back their steps.

Once two (or more) resources are physically combined, new capabilities are configured by connecting their input and output functions. For example, the combination of the Messaging Bell and Lighting Clip works as Sounds Detector. When the Messaging Bell detects sounds, the Lighting Clip starts glowing. Connected Resources and their online platform were designed with the principles of simplicity, familiarity and playfulness to fit into older people's homes and inspire everyday practices of resourcefulness.

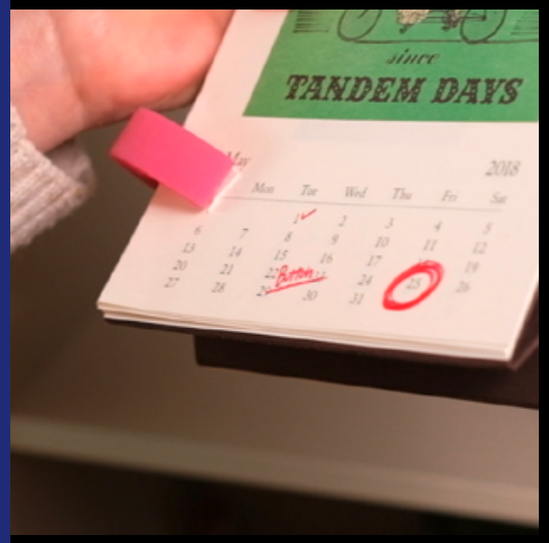
IMAGES OPPOSITE
1 | **Examples of combinations.** Once two resources are physically combined, the new capability is configured by exchanging their input and output functions.

2 | **Matrix of use.** Four Connected Resources create sixteen physical combinations.





OUTPUT \ INPUT	Messaging Bell	Linking Frame	Lighting Clip	Navigating Compass
Messaging Bell	**REMOTE BELL TRACKER** When one bell detects sound or movement, the other bell plays sound.	**VISUAL SPEAKER** Based on content of Frame, Bell plays relevant music.	**PROXIMITY SPEAKER** When Clip detects proximity, Bell plays sound.	**GEO-MESSAGE PLAYER** Compass navigates to the closest location where geo-messages is recorded and you can listen them.
Linking Frame	**SOUND VISUALIZER** Based on sound input in Bell, Frame collects images. **VOICE LINKER** Based on voice commands, Frame sets a relevant URL link.	**VISUAL LINKER** Based on images of one Frame, another Frame sets a relevant URL link.	**PROXIMITY VISUAL MIXER** When Clip detects proximity, Frame changes the link URL in list created by users (If it comes to end, loop).	**GEO-VISUALIZER** Frame collects images relevant to the location where you are.
Lighting Clip	**SOUND DETECTOR** If Bell detects sound, Clip starts glowing. **MESSAGE NOTIFIER** When Bell has new message, Clip glows.	**UPDATE NOTIFIER** When the content linked in Frame is updated, Clip glows.	**REMOTE PROXIMITY TRACKER** When one Clip detects proximity, the other glows.	**LIGHT NAVIGATOR** Clip suggests directions with the light based on navigation of Compass
Navigating Compass	**GEO-MESSAGE RECORDER** You can record voice message tagged in which you are.	**IMAGE NAVIGATOR** Based on a location an image in Frame is taken, Compass navigate.	**PROXIMITY NAVIGATOR** Compass navigates to location where one of your Clips detects proximity.	**COMPASS TRACKER** One compass navigates to locations where the other compass is.



WEBLINK
Watch the full video here:
https://vimeo.com/263320210
Filming, light and video montage by Andreas D'Hollandere - To The Heart Photography, Belgium for Masako Kitazaki

More specifically, these four Connected Resources were designed to resemble everyday objects and materials older people regularly use in their homes, as observed during the ethnographic studies of four households of participants between 65 and 78 years old. The familiar shapes of the objects are meant to improve older people's confidence while trying a new technology. Their aesthetics and clean forms also encourage older people to adopt them as part of the home, in contrast to how 'foreign' technological devices are often hidden. At the same time, the playful, geometric shapes of the objects also inspire users to try them out and combine them together. By sticking or hanging them to other objects — depending on the situation — older people can discover new configurations better suited to their changing needs and interests.

IMAGES
1 | **Online platform – Main uses of Messaging Bell.** Visualisation showing the way it has been used in relation to other resources.

2 | **Online platform – Frequency of Combination.** Data of combinations and other users.

3 | **Online platform – Data visualisations** including (1) Activity map: suggesting how you have extended areas that you use Connected Resources and (2) Correlations: interesting correlations between uses of Connected Resources and other crowd data sources, such as weather, number of tweets, etc.

FROM INDEPENDENT LIVING TO INDEPENDENT INTERACTION

Iohanna Nicenboim, Masako Kitazaki, Elisa Giaccardi

By redesigning Connected Resources, we understood that older people want technology that helps them negotiate their desired level of independence.

We understood that resourcefulness was driven by older people's motivation to »keep doing the activities they valued« even though they are confronted with crisis of routine. For example, Karen knows that walking is essential and indispensable for her well-being in everyday life. Therefore, she has a strong will to keep doing it even if her competence for walking (remembering the route, physical ability) and social connections (friends walking together to help each other) are changing. This strong motivation facilitates older people's resourcefulness, especially when deriving purposes from means. Therefore, she thought of a new usage for the pebbles as a route tracker.

»THE TECHNOLOGY IS ENOUGH TO TELL ME TO LOOK AT THE CALENDAR.« SHE WANTED TO REMEMBER IT HERSELF.

Although »keeping on doing what they enjoy« motivates participants to incorporate new technologies and reconfigure the elements of their current practices, they don't necessarily want technologies to take over their existing capabilities. As we saw in our study, participants only want partial help from technology. For example, Ida wanted the pebble to play a role as a trigger to remember someone's birthday. However, she mentioned that she would not like this device to tell her whose birthday is it. She said: »*the technology is enough to tell me to look at the calendar,*«. Although technologies could give her an explicit schedule of information automatically, she didn't want that because she wanted to remember it herself.

DESIGNERS SHOULD MAKE SURE THAT DEVICES CAN BE CONFIGURED TO SUPPORT INDEPENDENCE AS WELL AS TO NEGOTIATE IT.

We learned that, for our participants, living independently meant not only living alone but also performing independently from technology when desired. This suggests that designing dimensions of openness and variety should not be understood as designing technologies that can predict all possible situations of use; instead, it means designing technologies capable of enabling users to situate and negotiate use with a certain degree of freedom. In order to empower older people to live independently, designers should make sure that older people can configure devices according to their personal circumstances in a way that their independence can be supported and be constantly renegotiated.

HYPERLINKS
See **Stories from People (Chapter 3)** [p.33] to read about our ethnographic fieldwork with our living lab participants which informed the design iterations of Connected Resources.

DESIGN

4

In this chapter, we examined how 'things' become active partners in data-enabled Research through Design (RTD) and, more importantly, in the process of 'doing design' itself. We also described how the three iterations of our Connected Resources came about and built onto each other. In the next chapter, we summarize the impact of our research project on relevant disciplines and domains, including gerontechnology, machine learning, social practice theory and professional design practice. We also reflect on the lessons learned from our research and identify opportunities for further exploration.

WE SHOULD DESIGN TECHNOLOGY FOR OLDER PEOPLE AS 'RESOURCE' NOT AS 'INTERVENTION'.

5

MULTIDISCIPLINARY IMPACT

GERONTECHNOLOGY

MACHINE LEARNING

SOCIAL PRACTICE THEORY

PROFESSIONAL DESIGN PRACTICE

KEY INSIGHTS

GERONTECHNOLOGY

Louis Neven

Through an interdisciplinary, data-enabled RTD approach, Resourceful Ageing goes against the grain of what is currently occurring in the mainstream of gerontechnological innovation.

As we have described elsewhere in more detail, many innovation projects for older people explicitly or implicitly adopt a 'paternalistic stance' in which the engineers and designers assume they know better than older people about what is good for older people to use, what skills older people have or lack, and implicitly, what the lives of older people are like or what they should be like. Often, the underlying imagery of older people is one of a frail, dependent and lonely person with very little skills and very little ability to learn. It is the prerogative of gerontechnologists to intervene in this (imagined) situation. Gerontologists have long since known that the vast majority of older people do not fit this imagery, and indeed, problems with acceptance of gerontechnologies are accordingly prevalent.

In the Resourceful Ageing project, a group of designers, engineers and people from industry have teamed up with social scientists to look at ageing in a very different way. How do older people solve their own everyday life problems with technology or material/digital means? Looking at the resourceful solutions that older people come up with has allowed us to move away from the paternalistic stance and the interventionist logic that is so common in gerontechnology. For us social scientists, we were also very keen to be forced out of the role of a critical-but-marginal bystander and into a role of an engaged collaborator. It was deeply interesting and rewarding to learn from the different perspectives, methods and theories that all partners brought into the project.

Above all, the wealth of data we collected was stunning. While we had certainly expected older people to create resourceful solutions, we had not expected to hit such a rich vein of empirical material. There were so many beautifully creative, idiosyncratic solutions to specific, localised problems, often intimately intertwined with stories from the personal history of the people interviewed. It was both highly interesting and important to note that the older people we engaged with in the project did cope with the issues that popped up in their lives. Indeed, it went far beyond coping; many of the older respondents enjoyed coming up with resourceful solutions and took pride in and got satisfaction out of them. Their resourcefulness shows their creativity, their independence, their ability to engage social resources to fix problems and, most importantly, their technological literacy. While they may not be exactly the same skills younger people have, the older people we met are most definitely technologically and digitally skilled. If we know more about their technological literacy, that can be a good inroad to designing technologies that suit them better.

Indeed, the resourcefulness perspective as a whole carries this hope. Beginning with a positive view on older people, learning about their resourcefulness and, in its wake, their technological literacy may well provide us with useful cues for moving away from the problems that beset current gerontechnologies.

MACHINE LEARNING

Hayley Hung

Without knowing beforehand the nature of the problem, we had to be creative to make progress in this process. However, the interplay between mathematical models and human interpretation is a fascinating scientific topic that warrants further investigation.

In any interdisciplinary, collaborative process, there are many challenges to overcome. We were confronted with very different ways of working that affected the machine learning (ML) process greatly. Machine learning experts produce and work on ideas mostly in isolation, with occasional discussion with others. On the other hand, design ideas are generated mostly by talking and collaborating with others.

For much of domain-specific ML (that is, the branch of computer science that investigates how ML can be applied to solve specific problems), the skill is in understanding the nature of the problem to be solved in order to find the best solution. This means that we should know beforehand what the nature of the problem is. In this case, we had to be creative in this process to make progress; working on other data that we hoped would have similar properties to the data we were planning to collect.

Mostly, ML research occurs after the data has already been collected, and then, the work begins on using the data to validate methods. The success of a computer science researcher in this domain is dependent on showing how one mathematical model is better than others in interpreting or ordering data. For ML tasks known as supervised learning, a human expert decides beforehand what is in the data. Then a computational model can be trained to make predictions on unseen data. A human expert can then check if the model made the correct prediction or not. Repeating this test and validation process allows us to quantify exactly how well our method works.

There is another branch of ML known as unsupervised learning. In this setting, the human expert can only discover meaning in the data by using the ML approach to structure the data for them. This is the type of ML that was used in this project. It is not clear what the right answer of the mathematical model is. In this project, even though we were able to bring discovered patterns back to the participants and researchers from other disciplines, it was not clear how we could quantify whether the discovered patterns were good or bad. As we saw in the closing loop, sometimes the discovered patterns could be obvious and other times, they could be completely nonsensical. Therefore, the reliability of the data could provide some hints, but it really needed the weight of the stories behind them from the participants to really have meaning and value. This is something that is hard to quantify in a numeric sense. One positive point was that participants were able to interpret the data and recognised some of the routines.

However, perhaps what appears nonsensical to one person might be considered obvious or a complete inspiration to another. In other words, patterns identified by a mathematical model can only be evaluated subjectively. This brings up an interesting question: if the patterns are so subjective, could it be the case that — since humans are wired to see seemingly connected patterns, even in random events — these patterns can still be ascribed meaning? Perhaps these discovered patterns can play a strong role in triggering and questioning an individual's daily rituals as well as design practice in general, even if they are nonsensical (to some). If these discovered patterns trigger debate about which patterns are meaningful or not, they might already serve to reinforce our ideas of which object usage patterns are novel and which are more commonplace. This interplay is fascinating and warrants further investigation.

SOCIAL PRACTICE THEORY

Lenneke Kuijer

Reflecting on Resourceful Ageing from the perspective of social practice theory highlights how social practice theory has brought value to Resourceful Ageing but also that Resourceful Ageing brings value to social practice theory.

Integrating a social practice theory perspective into the Resourceful Ageing project has helped the team come to terms with the concept of resourcefulness and to generate new types of empirical data, insights and design solutions. Compared to existing notions of resourcefulness in design, a practice theory perspective expands the notion of resourcefulness from interactions between people and objects to include the role of social norms. This revealed the socially sensitive nature of resourcefulness. Moreover, it helped to see links between different practices and their associated objects and routines, and therefore opened up our design space to develop solutions without practice-specific purposes.

Conversely, Resourceful Ageing has brought and harbours further potential to bring new insights to social practice theory. Compared to mainstream research in social practice theory, Resourceful Ageing was exceptional in several respects. Rather than concentrating on general, collective phenomena that are often at the centre of attention in studies drawing on practice theory, this project focused on the highly personal and specific but still used a practices-oriented approach.

Our explorations of resourcefulness deepen our understanding of the relationship of individuals to practices. Resourcefulness, as we have defined it, exists in dependence of socially shared ideas of normal and appropriate conduct. Being resourceful involves creative engagement with these social norms. Our body of examples elaborates on and highlights the human skill playing with collective norms by reconfiguring practices in particular circumstances. It therefore contributes to the debate on the position of individual autonomy within theories of practice.

Also, unlike many other studies focusing on practices, we focused on a dispersed practice instead of an integrative one. Our discussions on resourcefulness form an example of how dispersed practices might be observed and described in studies drawing on practice theory.

Next, I believe that resourcefulness itself is interesting for the practice theory community. The concepts we developed in the project help to understand processes of change and flesh out the role of 'crises of routine' — as introduced by Reckwitz — in them. The creative solutions, shaped in resourceful ways, form reconfigurations of practices that work and make sense in particular situations. They form deviations from the norm and are therefore outliers and exceptions, but they can also be seen as seeds of change. If the reconfiguration spreads, the practice shifts and the reconfiguration becomes part of a new normal. Resourcefulness is not the only mechanism of reconfiguration though, and because it often involves highly personal solutions, certainly not every example of resourcefulness is likely to spread. However, looking at practices of resourcefulness is nonetheless a way of deepening our understanding of how change in practices happens.

Finally, an open question remains regarding what strategies are for practices. In the strand of theories of practice that I draw upon, practices are considered to consist of configurations of elements. How the idea of strategies fits into the conceptualisation is so far unclear but forms an interesting question for further research.

PROFESSIONAL DESIGN PRACTICE

Benjamin Lopez (Philips Design)

Planning for the right skills in the team at the right moments, as well as the right infrastructure, is perhaps the biggest challenge of data-enabled RTD.

Philips Design was involved from the beginning of the project as one of the industry partners and contributed to the project in different ways: by sharing knowledge with the team, helping to shape the research direction, support with developing the data collection tools and infrastructure as well as coaching and giving creative direction to the different design iterations and student projects.

At the same time, our involvement in the project gave us some takeaways that we can reflect on and explore for applicability within the context of our professional practice.

A. Relevant Knowledge generated for Philips Design

There are many research topics that have been discussed throughout the project that are relevant for the work we do at Philips Design. The key knowledge areas we are interested in developing new perspectives on are:

- Designing for resourcefulness in the Third Age principles, based on the Dimension of Resourcefulness report
- Digital resourcefulness: How do the insights we obtained from the home visits related to people, practices and strategies of resourcefulness translate to the digital world?
- From IFTTT (if-this-then-that) to IFTTW (if-this-then-what) approach
- Machine learning as part of the Research through Design process; considerations, challenges and recommendations
- Older people using technology as a co-creation tool. What were the lessons and considerations we obtained from involving Third age participants throughout the process to shape the research direction and co-creation sessions?

B. Methodology and tools

Although the methodology and tools used during the project are familiar to the work we do at Philips Design, it did help us to gain closer exposure to the Thing-ethnography approach and the process the team followed by moving from a theoretic method to putting it into practice. These are the main takeaways we obtained throughout the process:

- It is important to have a clear vision and goal created, communicated and agreed upon with the team to make sure everyone is on the same page. We created a blueprint that helped the team to visualise and agree on the steps to follow in setting up the study.
- It is important to plan for the right skills in the team at the right moments, as well as the right infrastructure to carry-out the research (data collection tools and access to participants).

We foresee that a couple of tools created by the team during this project, can be re-usable by the Philips Design community.

- **Data collection kit:**
  This includes the sensors for data access (TI sensors and Raspberry Pi) and the infrastructure.
- **Set of cards to design for resourcefulness:**
  These cards include strategies, analog affordances, digital affordances and collection of objects. This card set can be used as an ideation tool during creative sessions in a team.
- There is no clear applicability from the machine learning algorithm since we don't have enough evidence on the relevance of it, because it was not possible to iterate further on that track.

C. Learnings from the process and way of working

One of the bigger challenges we had during the project was to agree on the specific data we should be collecting and to work on the deployment of a system to collect data, rather than analysing that data and frame other iterations based on that analysis.
Based on discussions with team members and reflecting back on the impact generated by the project, we believe that, in order to carry out a research activity like this, an ideal team composition could include the following roles (beyond the project lead):

Service Designer
Helping the teams to consolidate the insights from the study and providing overall direction to:

- Create new Propositions coming from data insights
- Modify/optimise propositions through analysing data collected during testing
- Define new, emerging service touchpoints that might be related to machine learning, AI and big data

Design researcher
Defining main research questions and planning the overall research approach, as well as defining how and when observational and data insights should be combined

Data ethnographer
Looking at the data collection strategy and contextualising the quality and origin of the data; this person should also make sure the study meets the privacy and ethics protocols necessary depending on the research context

People ethnographer
In charge of carrying out the qualitative studies and analysing insights from those

Data and platform expert
With deep understanding of back-end data repositories and front-end tools to analyse the data

Data scientist
Doing analytics and possibly machine learning activities to discover patterns derived from the data exploration

Data visualizer
Looking into visualisation of the insights from data in a more explanatory way or developing tools and visuals that support data exploration

We will reflect this back internally within our team to develop new capabilities, acquire new talent for project planning and create awareness for our team leads to better allocate individual resources and teams when a similar Research through Design approach is needed.

KEY INSIGHTS

Elisa Giaccardi

Our main learning point is that 'living independently' has a richer meaning than assumed in the mainstream of gerontechnological innovation. To older people, 'living independently' means to be able to live independently — when desired — not only from the care of others, but also from care technology. Our results have indicated that we should design technology for older people as 'resource' not as 'intervention'. Designing for resourcefulness should not be understood as designing technologies that can predict all possible situations of use. Instead, it means designing technologies capable of enabling older people to situate and negotiate use in everyday life with a certain degree of freedom. In order to empower older people to live independently, designers should make sure that older people are able to configure technology according to their personal and changing circumstances in ways that support and help them negotiate their desired independence.

- **Gerontechnological innovation should be pursued on the grounds of a positive view of older people** (Chapter 1).
- **Older people's creative engagement with social norms should be at the centre of notions of resourcefulness in the design of gerontechnologies** (Chapter 3).
- **The human perspective of people and the nonhuman perspective of material objects and algorithms should be integrated and balanced in both research and design to offer a richer understanding of the world.** (Chapter 2 & 4).
- **Machine learning should be used for triggering, questioning, and sustaining creative opportunities, not just for detecting and monitoring** (Chapter 2 & 6).
- **Development of IoT technology should move from an IFTTT (if-this-then-that) approach to a IFTTW (if-this-then-what) approach** (Chapter 4).
- **A data-enabled RTD process should enable the fluid infrastructuring of iterations and keep the results of one's discipline permeable to the results of the others throughout the entire process** (Chapter 6).

5

In this chapter, we discussed the impact that the research project had on the disciplines and domains involved: gerontechnology, machine learning, social practice theory and professional design practice. We reflected on the key insights derived from our research and highlighted opportunities for further exploration. In the next chapter, we outline the methods and tools we incorporated throughout the research project and describe them more in detail to enable students, researchers and practitioners alike to use them in other contexts.

BY STARTING FROM A POSITIVE VIEW ON OLDER PEOPLE, RESOURCEFUL AGEING STEPS AWAY FROM THE PATERNALISTIC STANCE OF MAINSTREAM GERONTECH-NOLOGICAL INNOVATION.

6

DATA-ENABLED RTD

DATA-ENABLED
RTD PROCESS

THING-CENTRIC
DESIGN TOOLS:

EXPLORE
OBSERVE
ANALYSE
IDEATE
EVALUATE
REFLECT

DATA-ENABLED RESEARCH THROUGH DESIGN PROCESS

Elisa Giaccardi

Conventional RTD practices usually aim to support people in imagining, discussing and shaping future practices at design time.

In this project, we used the infrastructural collaboration of older people, designers and things powered by data technology and machine learning (ML) algorithms to support ways of understanding and designing that take place during, after and beyond the design work throughout the project. And so, we used RTD to look at how older people can live with things and be empowered to turn every 'use situation' into a potential design situation.

A shift from the 'projecting' of design activities to their 'infrastructuring' has been advocated for a long time. What is new, both in this project and in our process, is that we have not been looking at how designers can 'align' infrastructures and resources in a design project in order to move the object of design forward. Alternatively, we looked at how we could collectively dream of futures in which older people, as well as algorithms and artificial forms of intelligence, could actively partake.

MACHINE LEARNING WAS MEANT TO HELP US ASK INTERESTING QUESTIONS, NOT TO PROVIDE ANSWERS.

WE USED RTD TO LOOK AT HOW OLDER PEOPLE CAN BE EMPOWERED TO TURN EVERY USE SITUATION INTO A POTENTIAL DESIGN SITUATION.

FEEDBACK LOOP BETWEEN ETHNOGRAPHY AND MACHINE LEARNING

As mentioned in Chapter 2, we envisioned sensemaking and framing to be the result of a continuous feedback loop between what humans can see and what things can see, where 'seeing' here is understood both in terms of what can be observed and how this is interpreted. As speculated in previous work, ethnographic research and ML can be complementary. It is difficult for a human ethnographer to see patterns at large scales, whereas a machine (and the computer scientist writing the code) cannot see which patterns are meaningful. This is essentially a question of what inputs matter and why in a certain situation. We assumed that by looping qualitative data (from human ethnographers in the field) and quantitative data (from thing ethnographers via ML), we would have learned something new about how older people use things in everyday life. Unexpected patterns of use would have emerged within the data that was streamed through the interaction between people and things, and things and things, and these would have helped designers identify opportunities for resourcefulness.

GENERATIVE ROLE OF ARTIFICIAL INTELLIGENCE

Machine learning is a form of Artificial Intelligence. Traditionally, the ML field has focused on classification problems. These are important in fields such as the medical domain to answer how accurately we can automate a process.

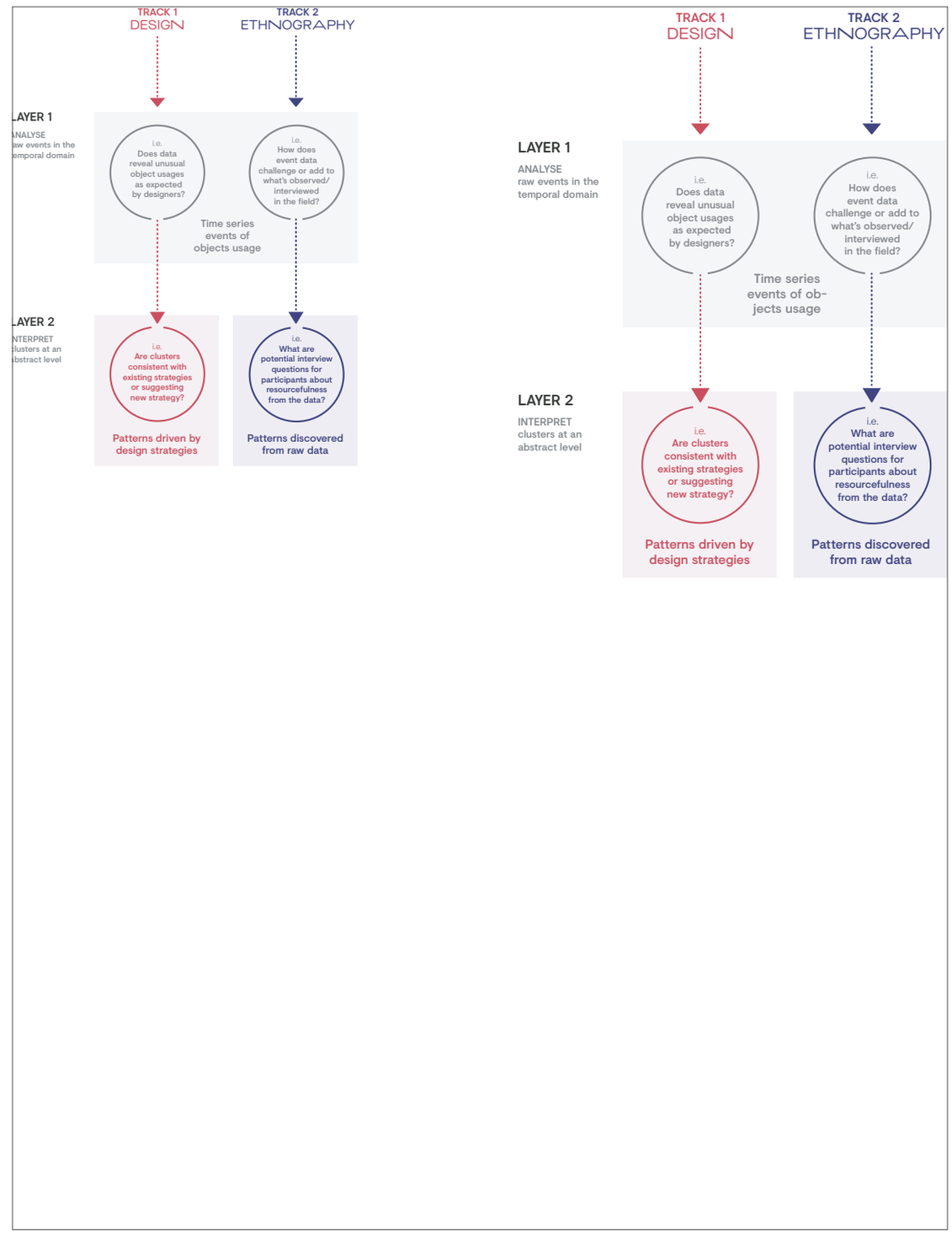
The generative topic models and adversarial networks that have been looked into for this project are answering a different set of questions in a very similar way to the sorting of photos collected during our thing ethnography. In ML, researchers would inform the algorithm with rules to sort the photos on the basis of their characteristics. The result is then further sorted into object categories, which are abstract and cannot be directly measured in pixels.

Our use of ML was meant to help us ask interesting questions, not to provide answers. By moving from raw temporal events to abstract clustering, we were concerned with whether the collected data could have been able to reveal unusual usage of things, and whether the clusters identified through ML analysis were consistent with the strategies observed by humans in the field or actually suggesting new strategies. The expectation was that, through sensors and algorithms, things would have given us access to previously unattainable trajectories of use and revealed patterns that could help us ask interesting questions to our human participants. The following diagram visualises the kind of questions ML helped us ask.

GRAPH OPPOSITE
1 | **Data Workshops Diagram.** Visualises the kind of questions machine learning helped us ask. It shows the process of discussing the data uncovered by ML within the group of researchers, including the disciplines of design and ethnography.
© Created by Peak15 from a concept by E. Giaccardi

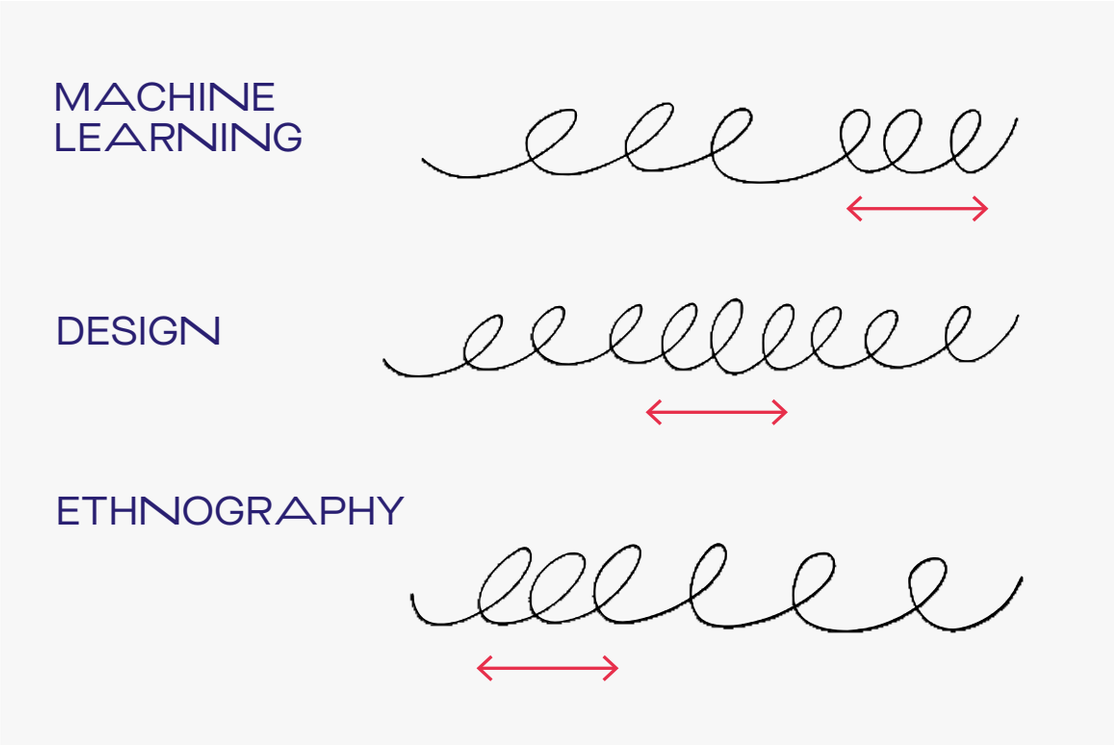
As the project moved forward, ML took on an even more radically generative role. We soon came to realize that there was another role for ML in this project besides expanding the processing of the data beyond human capacity and helping us identify unusual usage patterns within the data. Perhaps, an even more interesting role for ML was to suggest probabilities — openings for new strategies to be generated and exchanged among older people. Rather than revealing patterns as 'assumed-to-be-real facts' that designers could use to identify design opportunities and directly inform their design work, the probabilistic model used for the ML analysis was opening up patterns as 'possibilities'. These possibilities are 'objects of design' where those taking part in the design process — from professional designers to older people and algorithms — could all contribute to construct. This use and vision of ML has informed the final design of Connected Resources, where a particular combination of sensors in support of a certain strategy of resourcefulness is to be considered an 'object of design' shared among a community of older people.

AN EVEN MORE INTERESTING ROLE FOR MACHINE LEARNING WAS TO SUGGEST PROBABILITIES — OPENINGS FOR NEW STRATEGIES TO BE GENERATED AND EXCHANGED AMONG OLDER PEOPLE.

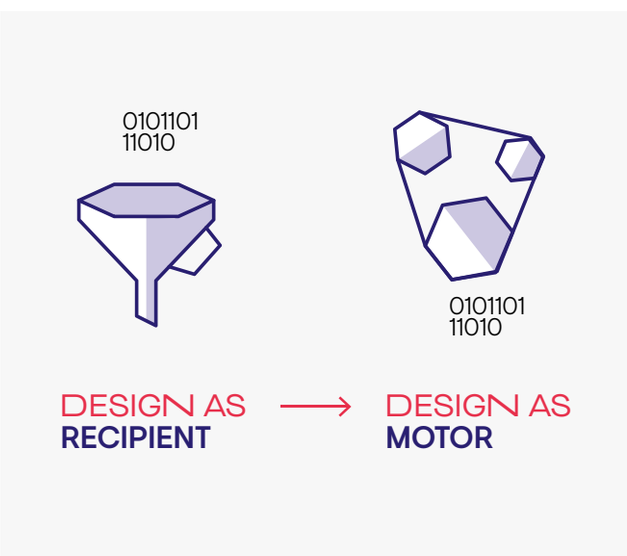


INFRASTRUCTURING RESOURCES AND ITERATIONS

When we started this project, we were initially determined to 'align' all our expertise and resources in a step-by-step process that would have soon led us to the best possible system for sensor data collection and would have directly informed our design. Having to create our own wireless sensor network for data collection, technology development soon became a bottleneck, and we started to go around in circles. Confronted with the reality of the limitations of currently available technology, ML, ethnographic fieldwork and design experimentation began to manifest at different speeds and accelerations, which could not simply be 'aligned' and 'looped' in the way we had originally envisioned. We simply could not wait for each other to make progress.



It was at that point when we decided to structure our design process as the real backbone of the project so that it could both drive ML strategies and fieldwork strategies and accomodate their insights at different points in time. In order to achieve the desired integration of trajectories and perspectives in our third and last phase of the project, we purposely misaligned resources and iterations. The 'infrastructuring' that resulted from this operation allowed us to productively work through the different speeds and capacities of different types of work (ethnographic research, ML analysis and design work). The diagram below visualises the type of infrastructuring that we configured as the project moved forward.



WE TURNED DESIGN INTO THE VERY MOTOR OF A CONTINUOUS, ALMOST OSMOTIC EXCHANGE OF KNOWLEDGE AND INSIGHTS BETWEEN DISCIPLINES.

In summary, we put design back into the lead in our RTD process. The loop remained, warped in the space-time of disciplinary collisions. But instead of relying on data as the engine of the process, with design as the recipient of scientifically informed insights — which, somehow we initially assumed to be the case —, we turned design into the very motor of a continuous, almost osmotic exchange of knowledge and insights between disciplines.

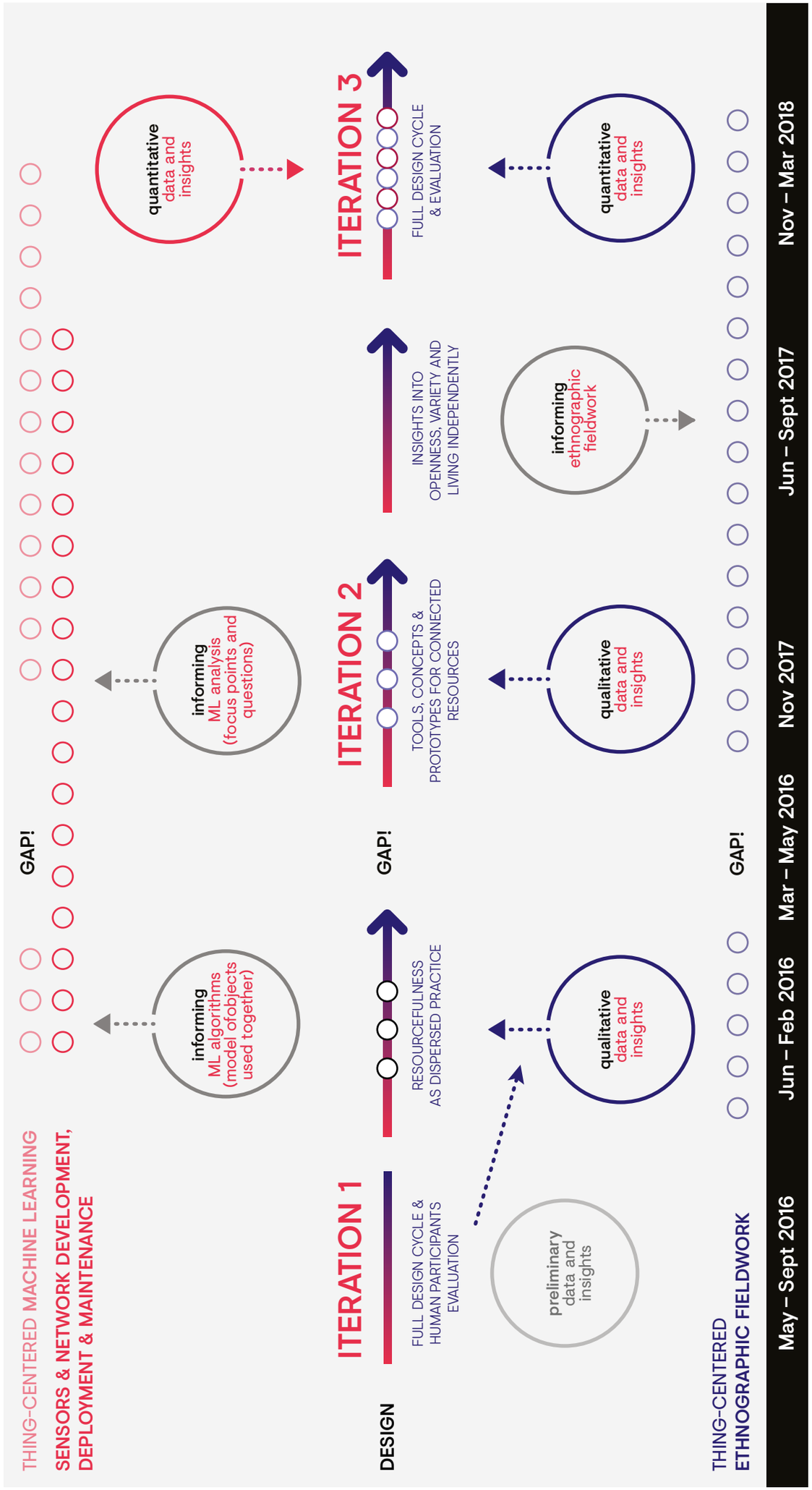
GRAPHS

1 | **Different speeds and accelerations** of machine learning, ethnographic fieldwork and design experimentation. © Elisa Giaccardi

2 | **Changing Role of Design.** Diagram by Elisa in her presentation at the final symposium. © Created by Peak15 from a concept by E. Giaccardi

GRAPH OPPOSITE

3 | **Structure of our design process.** A type of infrastructuring that we configured as the project moved forward, positioning design as the backbone of the project. © Created by Pattrasuda Partona from a concept by E. Giaccardi



THING-CENTRIC DESIGN TOOLS

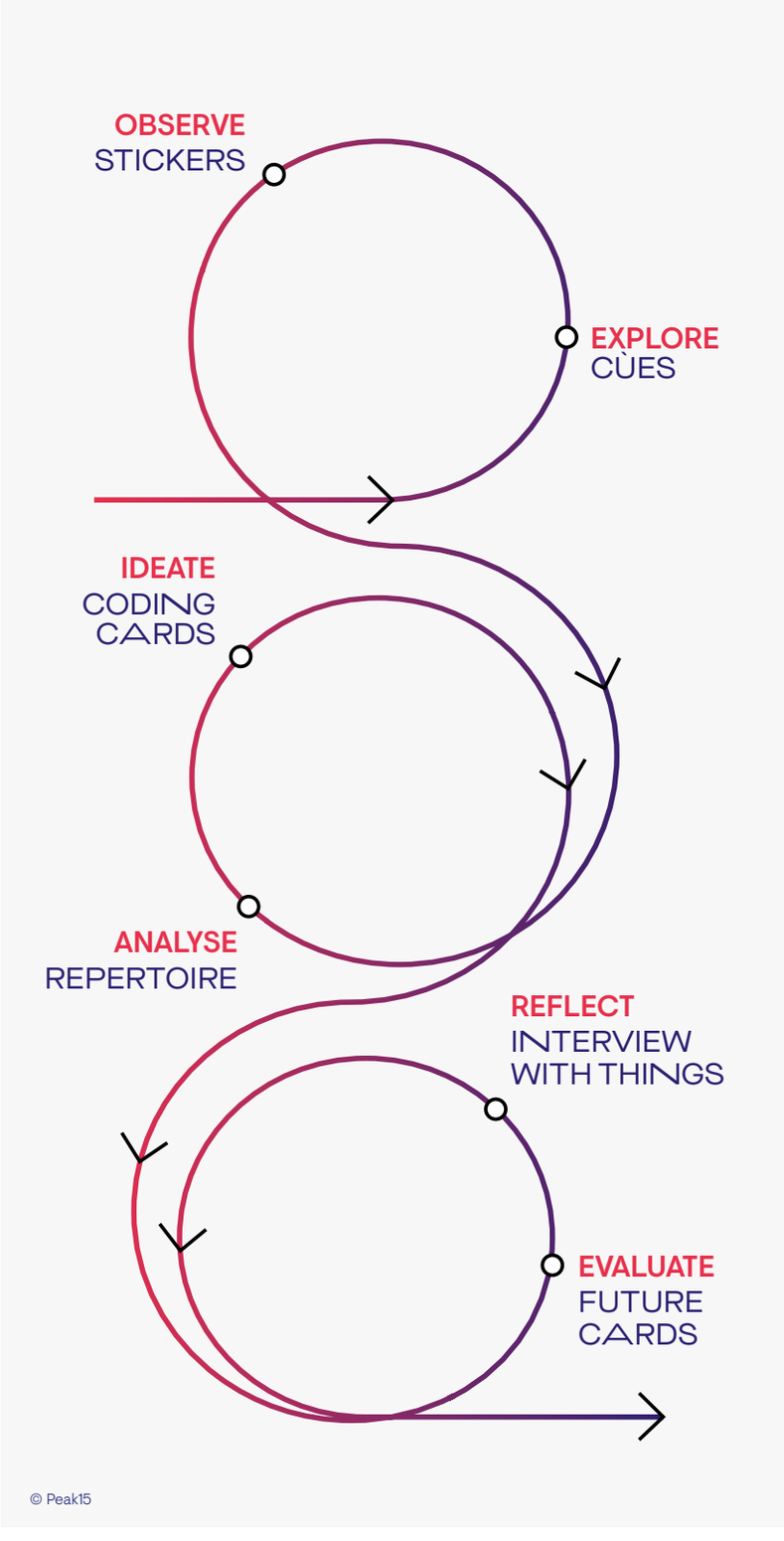
Iohanna Nicenboim

In order to apply a 'thing' perspective to both research and design work, we developed specific 'thing-centric' tools and techniques for this project.

We describe them here so as to make them available and useful to students and practitioners in other contexts.

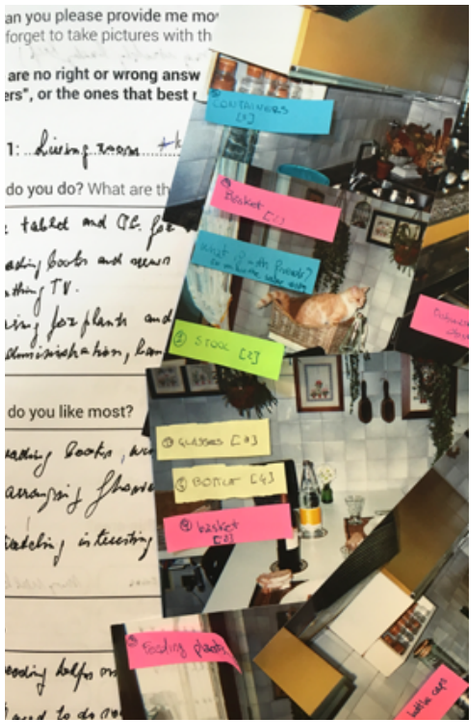
The tools fit into different phases of the project, which are:

- Explore (Cùes)
- Observe (Stickers)
- Analyse (Repertoire)
- Ideate (Coding Cards)
- Evaluate (Future Cards)
- Reflect (Interview with Things)



© Peak15

WEBLINK
More thing-centric tools can be found in the Thing-Centered Design toolkit, available for download at **www.tcdtoolkit.org**.



EXPLORE

CÚES SENSITISING KIT by Edoardo Fusaro

A kit with several items used to document activities and find correlations between objects and the areas of the house in which they are used.

WHY?

- To initially explore ageing through the things that older people use
- To find correlations between objects and the areas of the house where they are used
- To recognise opportunity areas for resourcefulness

HOW?

The kit contained a booklet with assignments, a disposable camera to report what was described in the booklet, and some coloured pens and stickers. As part of the assignment, older people were asked to:

- Document all the activities occurring in three main chosen areas of the house and list the main used objects (taking pictures of these areas while they were used and using stickers to identify the objects)
- Draw correlations between these objects and the areas of the house where they are used
- List the top 5 objects that they liked to use and the top 5 objects that they disliked to use

Data retrieved through the cultural probe / sensitising kit were analysed in two ways:

1) With an exclusive focus on things (experimenting with data visualisation)

2) With integration of insights from people

The steps were:

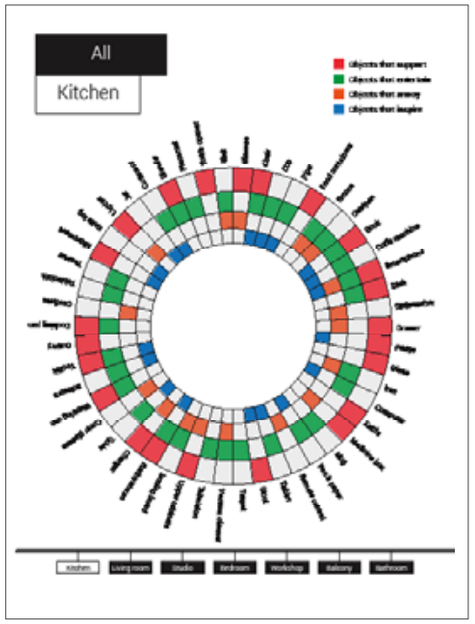
- Comparing the pictures and annotated notes in each booklet
- Semi-structured interviews and observation in the field were conducted, discussing what was previously reported through the booklet and pictures with the participant
- Coding all interviews, booklets and pictures together

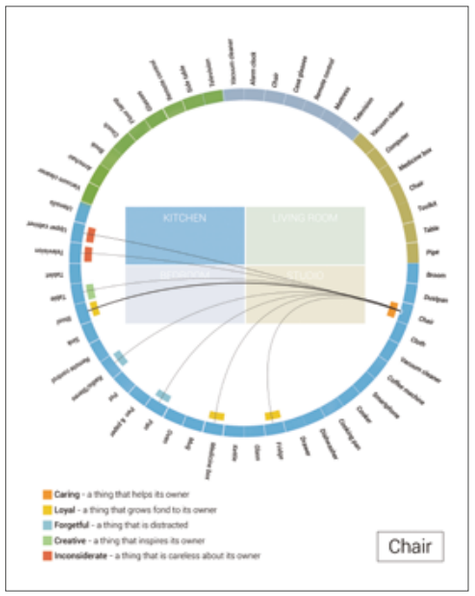
IMAGES

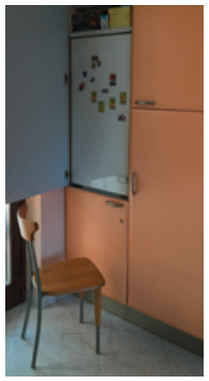
1 | **Cues sentizing kit** contained a booklet with five assignments to fill in for three days, a disposable camera to report what was described in the booklet and some coloured pens and stickers.

2 | **Analysis of booklets and pictures** with annotations before interviews.

3+4 | **Analysis and clustering** by area (living room and kitchen).







> I'm getting shorter with age, I can't reach the upper shelves anymore.
> W.W. (91)

> It's nice when I can see everything that I need at once and I don't have to spend time looking for it into drawers.
> J.W. (74)

After some preprocessing, the results were:
Aggregated in a sunburst diagram (first type of visualisation).
The diagram was subdivided into 50 equal slices (according to the number of objects identified and selected through booklets and pictures) and each slice was subdivided by four different rectangles (one on each ring) corresponding to the object's characteristics. Any time an object matched one or more of these features, the rectangle on the corresponding ring was filled in.

Interactive Circos diagram created with Processing (second type of visualisation).
The degree of relationship between objects is represented proportionally by the thickness of these curves. Therefore, thin lines refer to weak connections and thick lines refer to strong connections. For instance, by selecting the chair in the kitchen, it was possible to see at a glance all the uses and relationships with other objects (e.g. the chair used to reach the upper cabinets), called 'chair's social interactions'.

REFLECTION
Since this tool was used during an initial phase, many questions were not informed by resourcefulness but by general routines / needs / desires. A more resourceful framework for inquiry was better refined at a later time.

IMAGES
1 | **Sunburst diagram** showing the objects that were chosen according to pictures and booklets.

2 | **Circos diagram** showing the degree of relationship between objects, represented proportionally by the thickness of the curves. For instance, selecting the chair in the kitchen, it was possible to see at a glance all the uses and relationships with other ob-jects (e.g. the chair used to reach the upper cabinets).

3 | **Fieldwork images & quotes.** Analysis of the data collected through booklets with annotations before the interviews, as well as quotes from participants.

OBSERVE

COLOUR CODING STICKERS
by Ivo Maathuis, Tjeerd Stamhuis, Iohanna Nicenboim

A one-week homework assignment to tag objects that are frequently used by participants in activities they value.

WHY?
- To sensitise participants about resourcefulness
- To recognise frequently used objects to track with sensors
- To recognise resourceful practices
- To start from valued activities by our participants and not from problems

HOW?
After a first home visit, in which the ethnographer conducted a semi-structured interview, participants received a booklet. The booklet asked participants to tag the objects they frequently use with small stickers, especially in activities they value.

The results of the booklet were discussed with the ethnographer and one of the designers in a second visit. In this second visit, participants were asked to lead the researchers on a home tour, to point at the tagged objects and explain the reasoning behind their choices. We photographed the objects with the stickers, which they showed us.

REFLECTION
This method was particularly suitable to uncover resourceful strategies, as it revealed how things were used across practices in unexpected ways. The thing-centered approach allowed us to use objects as an entry point to discuss what practices are important for participants, while keeping it concrete. Furthermore, it helped us to establish a more positive view on ageing and move beyond impairments. Using the tagged objects as a starting point, we were able to recognize, together with participants, what resourceful practices could be, and they were able to show us additional examples.

This method can be used beyond the initial phase of a project. For example, in the user testing of the prototype from Cùes, as part of the exploratory phase, participants were asked to use and stick (pre-cut) sticky notes on objects that they would like to involve in the system.

IMAGES
1 | **Tagged objects** shows the result of the one week exercise we gave to participants, in which they had to tag objects they use frequently in activities they valued.

2 | **Selection of Objects.** Materials from the workshop to select the objects to track, according to the interviews.

3+4 | **Booklet** shows the different assignments participants had, for example, describing activities they like to do and which objects they use in an average day.

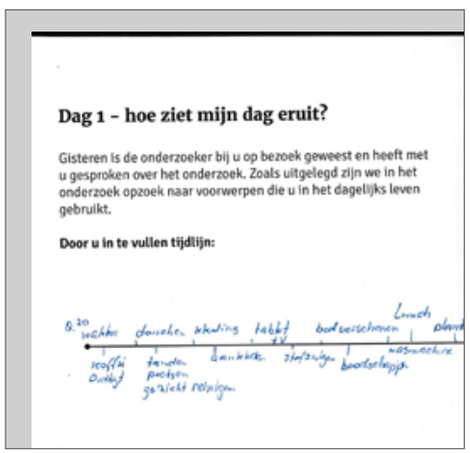
Dag 3 - belangrijke activiteiten

We hebben de afgelopen dagen gekeken naar algemene activiteiten die plaatsvinden tijdens de dag.

Vandaag willen we kijken welke activiteiten voor u belangrijk zijn. Wat zijn de activiteiten tijdens de week of maand waar u erg naar uitkijkt en welke u met veel plezier doet?

Vul hier in welke activiteiten voor u van belang zijn?
Bijv. het water geven van de planten.

tennissen
rep. zangkoor
bibliotheek
piano spelen
cryptogram oplossen
krant lezen
televisie kijken
computer
telefoon


Dag 1 - hoe ziet mijn dag eruit?

Gisteren is de onderzoeker bij u op bezoek geweest en heeft met u gesproken over het onderzoek. Zoals uitgelegd zijn we in het onderzoek opzoek naar voorwerpen die u in het dagelijks leven gebruikt.

Door u in te vullen tijdlijn:

ANALYSE

RESOURCEFUL REPERTOIRE by Iohanna Nicenboim

A non-exhaustive collection of elements that are present in resourceful arrangements.

WHY?

- To organise the findings from the ethnographic study in a visual way
- To better define the resourceful competences that older people have

HOW?

The photos were coded and organised into three categories: resources, capabilities and strategies.

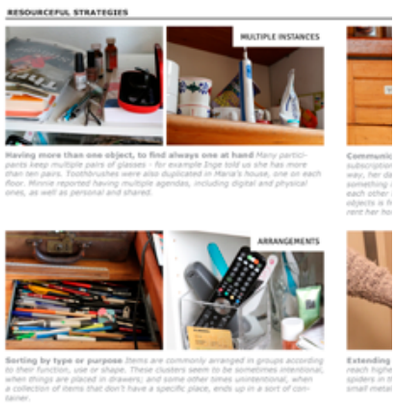
Resources: includes materials and everyday objects such as elastic bands, clips, etc.
Capabilities: includes abilities such as inserting, sticking, covering, etc.
Strategies: includes know-how, high level plans or emergent systems developed with time in order to achieve a goal or just make do. Strategies can also combine immaterial resources such as getting help from family members or their social connections.

REFLECTION

Resourceful Repertoire was inspired by the Resilient Repertoire research conducted by Dominic Furniss, Nick Barber, Imogen Lyons, Lina Eliasson and Ann Blandford in 2014. While the Resilient Repertoire focuses on efficiency and safety at work, we focus on creativity and resourcefulness at home.

This framework uncovered some resourceful strategies and allowed us to shift from solving problems to supporting strategies.

Since we understand resourcefulness not as a property of a person or an artefact alone, but as something that emerges from the way they work together, it was not enough to look at the pictures when defining the elements of the Resourceful Repertoire. We had to understand the meaning they have in participants lives. For example, we have physical materials such as clips, elastic bands or magnets but only because these were deployed by our participants in resourceful arrangements, mostly in practices they value. That makes the way in which resourcefulness was captured different from other types of Everyday Design. In Resourcefulness, special attention is paid to elements such as courage and socially accepted norms.



IMAGES
1 | **Resources** included physical materials and everyday objects.

2 | **Capabilities** included abilities that resources presented.

3+4 | **Strategies** were defined as know-hows, high level plans, or emergent systems that participants developed over time in order to achieve a goal or just make do.

IDEATE

CODING CARDS by Iohanna Nicenboim

A generative tool developed to inspire new designs by enhancing existing resources and strategies with digital capabilities.

WHY?

- To ideate on new concepts based on elements devised through a thing-ethnographic study; for example, strategies that are enabled through that thing or objects that come into contact with it
- To translate insights from an ethnographic study into the ideation phase of a design process
- To integrate insights from both a traditional and a thing-centered study; for example, interviews and sensor data analysed with machine learning
- To include design-in-use solutions into a new generation of designs by considering the user and how the thing it is used in a situated way as part of the design process

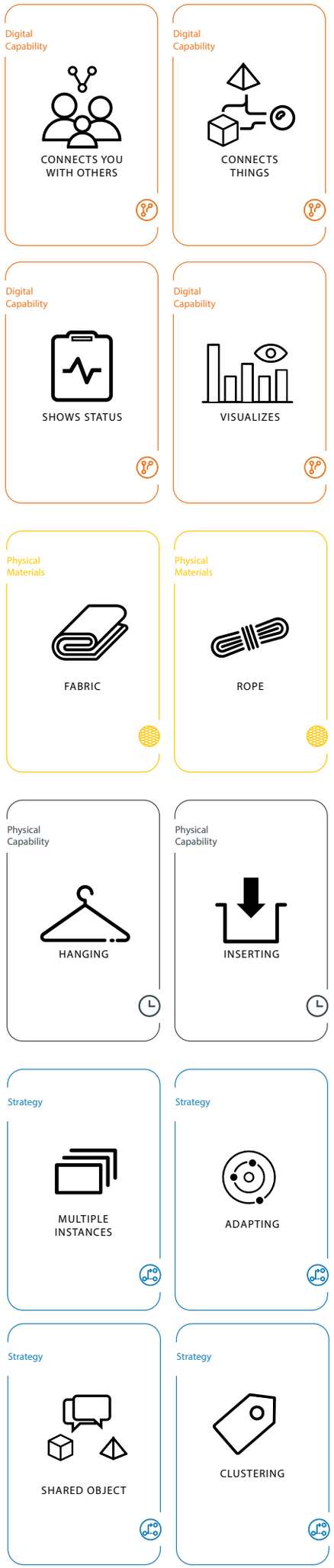
HOW?

Every item from the Resourceful Repertoire was represented by a card with its name and an icon. The cards were organised into three groups according to the categories we had in the repertoire (resources, capabilities and strategies) and had different colors. Since we wanted to create not only new resources but technological ones, we added a new category of digital capabilities, which included 24 cards. The items from this group were defined during the kick-off session. The card set was used in a series of workshops with a design team composed of one design researcher, three design master students and one computer science student. Then, the set was evaluated during two sessions with professional designers. We used this tool by choosing one card from each category and sketching ideas inspired by those cards. For example, in one design session, we picked the strategy 'Sequences', the capabilities of 'Helps you navigate' and 'Organising' and the resource 'Stones'. That inspired the idea of a set of stones that could glow in a sequence to help people trace a path at night.

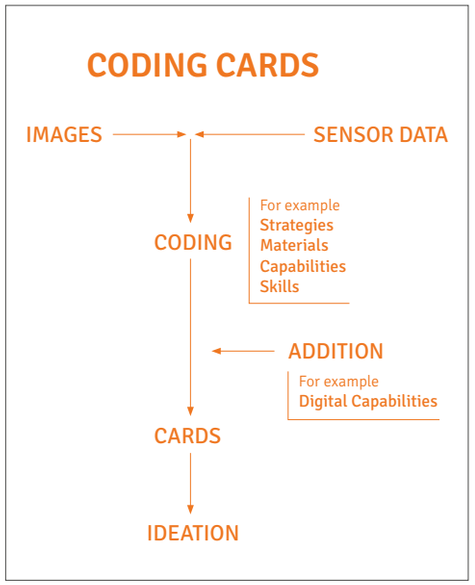
The tool was designed in a series of iterations:

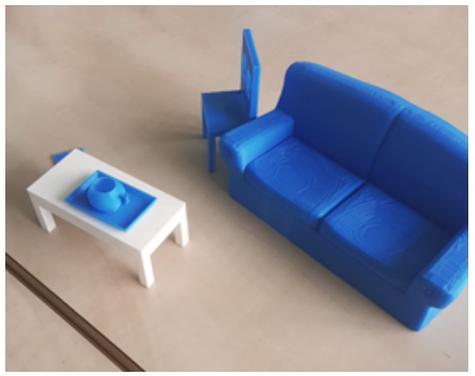
1 **Kick off session**

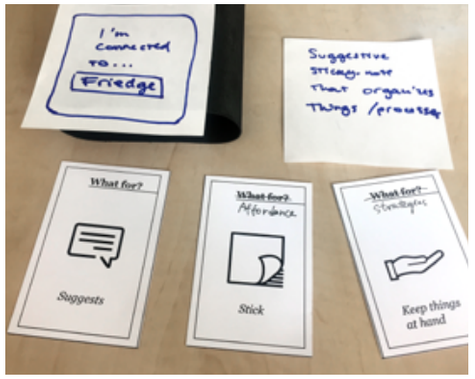
A design team (one design researcher, three design master students and one computer science student) brainstormed initial ideas of »*connected objects to empower elderly to age resourcefully*«. We didn't use the cards yet, but examples of strategies, resources and capabilities were presented before the brainstorming exercise. After presenting the concepts and clustering them into groups, it became clear that we were adding extra capabilities to physical resources, and thus, we made a list of what we called 'digital capabilities'. Later, this list was expanded by one of the designers and added as a suit to the card deck.

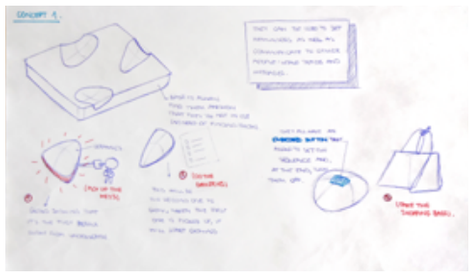


IMAGES
1 | **Coding cards.** A few examples of cards from the deck (88 cards in total).
© Iohanna Nicenboim









2 Design session

The card deck was printed in a draft version and used in a design session with the same team. We presented the following brief: »*Using the Resourceful Repertoire, design connected resources for elderly, that can be configured in their everyday practices, in a variety of ways*«. After the researcher introduced the card set and presented a brief, the team was divided into two groups and provided with a deck of cards and physical resources (such as clips, elastic bands, hangers, etc.). During every round, one person from the group picked a card from each suit and a physical resource. Inspired by the combination, everyone had to sketch as many ideas as possible. Several proposals were presented per group and discussed. At the end of the session, three concepts were selected according to the student's interests.

Since the deck was still a draft, it was incomplete (e.g. lacking the suit titles). After this session and based on what was discussed, the deck was improved, redesigned and printed. This sketch was one of the selected concepts from the design session. It resulted from combining the resource 'Stones' with the digital capability 'Helps you navigate' and the strategy 'Sequencing'.

3 Feedback session with professional designers

Lastly, the deck was used at The Incredible Machine design studio and at Philips Design (partners in the Resourceful Ageing project). In both sessions, we played some rounds and then reflected on the cards. The feedback focused around how the cards could be scaled, whether this tool was specific to resourcefulness and how to include more aspects of machine learning (the next step in the Resourceful Ageing project). Some changes we made after these sessions were refining the names of the strategies with terms from machine learning, like 'Sequences' or 'Instances'. Additionally, we decided to include a suit called 'Physical resources' in the set, although we used physical objects and materials in our design session for cases when materials were not available.

REFLECTION

Used as a generative tool, this card set helped us translate what we observed in the field directly into ideation, instead of using more general insights.

The connected objects we created were directly inspired by older people's competences of resourcefulness but also added digital capabilities. Some ideas were about supporting digital strategies in a physical way such as pinning digital images in a physical space. Others were about supporting physical strategies in a digital way, for example, keeping things together virtually.

IMAGES

1 | **Coding cards process** shows how the clusters from the ethnographic analysis were translated into the ideation tool. © Iohanna Nicenboim

2 | **3D printed models** were used to encourage thinking about how the new concepts connect with the objects we were tracking with sensors.

3 | **Workshop materials** used during the ideation.

4 | **Idea sketch** developed from coding cards.

5 | **Ideate image.** Development of one of the three concepts that was selected during the ideation session.

EVALUATE

FUTURE CARDS

by Masako Kitazaki, Iohanna Nicenboim

A simple tool for evaluating how our prototypes could be used as part of everyday practices or to create new ones. Cards were used to encourage discussion around the participants' future circumstances in a personal way, avoiding stereotypes about older age.

WHY?

- To support discussions about how our prototypes could play a role in participants' future lives in the way they envision it
- To avoid stereotypes or prescribed scenarios based on assumptions of how older people would like to live; instead, it helped us listen to how they envision their own futures
- To engage in a co-design activity with participants and share with them the prototypes we have created
- To imagine scenarios and collect feedback to inform a new iteration of prototypes

HOW?

The cards were developed for a participatory session with four older participants who were included in the previous ethnographic study. Participants had the role of 'experts on his/her life'. Additionally, two design students served as scenario drawers and two researchers who had visited the participants' homes served as translators between the participants and students. The moderation was done by two researchers.

Participants were divided into two teams. Each team had two participants, a design student and a researcher. Two tables were prepared with: three prototypes, A3-sized sheets for objects and actors mapping, A3-sized sheets for scenario drawing on which several panels were blank, Valued Activity cards (activities that the participants valued, discovered in the ethnographic research are illustrated), Actor cards (persons or group of people around the participants are depicted) and Object cards: (objects, tools, material, digital applications that were used and valued in the participants' activities are described).

We asked participants to follow the same steps three times. Each time, we incorporated a new aspect:

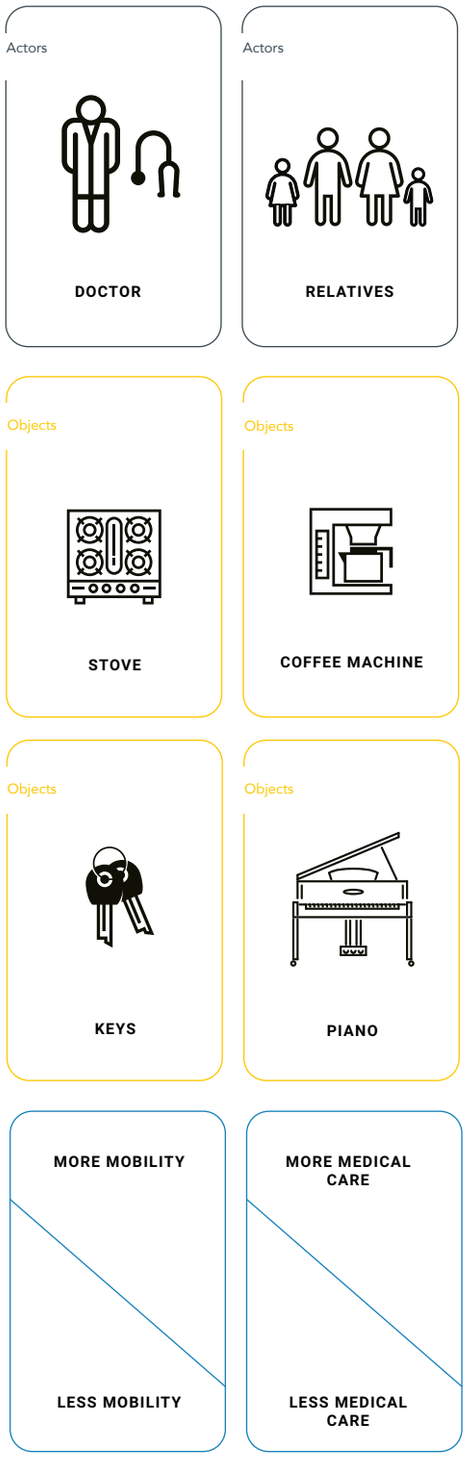
1. Your practice
2. Someone else's practice
3. Your future practice

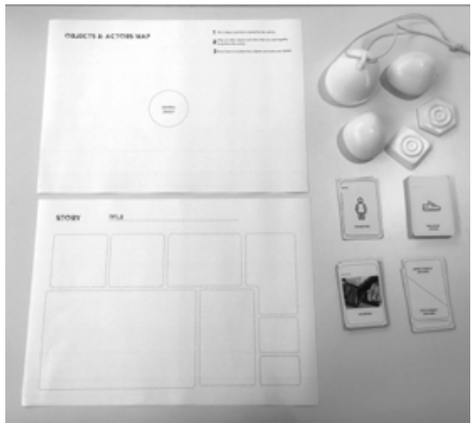
This was done to defamiliarise and encourage creativity, which could allow us to go beyond expected answers based on stereotypes of older age.

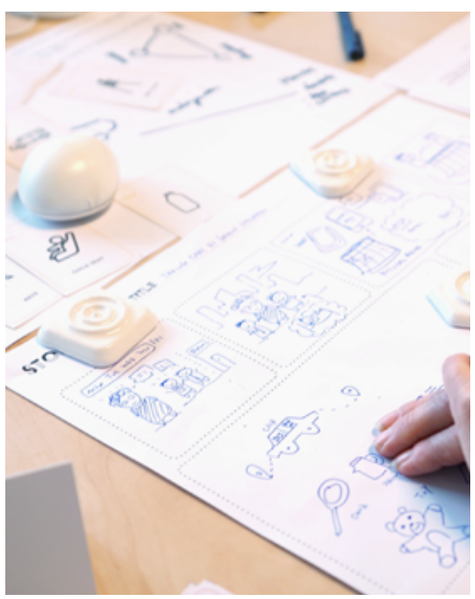
IMAGES

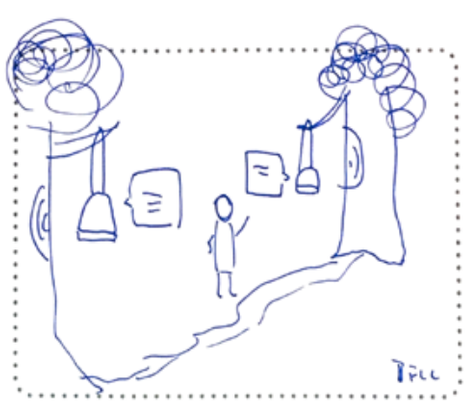
1 | **Workshop image** shows participants and designers co-creating scenarios.

2 | **Future cards** was one of the materials presented at the session to discuss personal futures.









Participants were asked to do a total of three iterations of these steps:

Reflect: By choosing a card, participants reflect out loud on which of these sides relates better to their future.

Envision future activities: Envision future activities: The team discussed which activities could affect the participants' future. For example, »*I might have less family around, as my daughter might move away. So I might need to contact her more through the phone*,« or »*I might have more family around while taking care of more grandchildren, so I might need to organise my activities accordingly*,«.

Ideate future scenarios: The team brainstormed on how the three prototypes could help them in the future activities. For example, »*If I cannot walk to my daughter's house, I could use this [...] to communicate with her in a gentle way*,«. The design students drew the envisioned scenario on the storyboard format. Then they reflected on new practices that digital resources could create.

REFLECTION

To improve the level of engagement of older people in the participatory design activities, part of the OASIS (Open Architecture for Accessible Services Integration and Standardisation) approach was used. This approach is based on creating of a friendly atmosphere with a common frame of jargon to scaffold participants to describe their own thoughts about the future by showing them a film that resonates with their experiences. Instead of films, we used a set of prototypes and 'future cards' with which older people could proactively choose the future direction they envisioned. This tools helped them to associate their current practices to new practices derived by new resources in a future daily situation.

To foster a creative atmosphere, it was stressed that there are no correct answers. All the ideas (even 'crazy' one) were allowed. With the actual working prototypes, the interactions were easily demonstrated.

IMAGES
1+2 | **Materials** for the participatory session.

3 | **Connected Resources 1 prototypes** were presented during the session.

4 | **Outcome image** shows a scenario presented by one of the two groups.

HYPERLINKS
See **Connected Resources 1** [p.70] to read about the first prototype iteration and **Bridging the First and Second Iteration** [p.72] which describes the insights we gained with the participants leading to **Connected Resources 2** [p.74]

REFLECT

INTERVIEW WITH THINGS by Wen-Wei Chang

It is a constructive and speculative approach for interpreting the data collected from a thing perspective, which uses a 'first-thing' point of view.

WHY?

- To emphasise and empathise with particular qualities and contexts of a thing's experience
- To gain a richer understanding about things' social lives

HOW?

1 Data Collection Stage:
Thing Ethnography
Multiple sensors are attached onto the thing to collect data from the thing's perspective

2 Data Organisation:
Preparing Materials for the Actors
The gathered data is prepared and organised for the benefit of professionals

3 Data Interpretation Stage:
Actors' Performances
The actors speculatively immerse themselves into the inner life of the thing and help make sense of it through performance

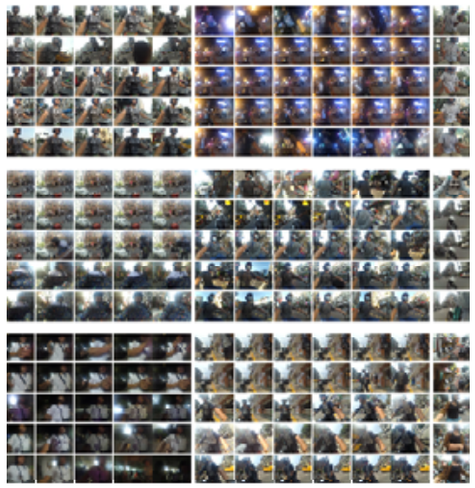
IMAGES
1 | **Thing-centered study** with scooterists conducted in Taipei. Cameras and sensors were attached to scooters, to collect data from a 'thing' perspective.

2 | **Time-lapse photos** were presented to actors.

3+4 | **Actors** interviewed as things.

All images © Wen-Wei Chang

WEBLINKS
More thing-centric tools can be found in the Thing-Centered Design toolkit, available for download at **www.tcdtoolkit.org**.



In this chapter, we discussed how data-enabled RTD turns every situation of use into a potential design situation, and illuminated the type of collaborative infrastructuring needed to make our process work. We also described the specific 'thing-centric' tools and techniques that we developed and made them available for use to students and practitioners in other contexts.

WE TURNED DESIGN INTO THE VERY MOTOR OF OUR DATA-ENABLED RTD PROCESS.

APPENDIX

ABOUT THE PROJECT

Resourceful Ageing is a highly interdisciplinary project that was funded by the Netherlands Organisation for Scientific Research (NWO) under the Research through Design (RTD) program in 2016—2018.

The project brought together designers, computer scientists, social scientists and professional practitioners from Delft University of Technology, Eindhoven University of Technology, Avans University of Applied Sciences and Philips Design with the goal of researching and designing Internet of Things solutions that could empower older people to age resourcefully.

resourcefulageing.nl
tcdtoolkit.org

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Edoardo Fusaro currently works as a UX Designer at Adidas with the experience design team. He works on the continual improvement of the consumer experience on the digital ecosystem. His focus is on creating effortless and meaningful user experiences, and he believes that the best solution is designed *with* people and not *for* people. He holds a bachelor's degree in Industrial Design and a masters in Design for Interaction at TU Delft, where he focused his final project on researching, studying and designing for resourcefulness. Prior to his experience in the Netherlands, he was an Industrial Designer in London, working on the design and production of digital musical instrument interfaces for people with varying physical abilities.

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Lenneke Kuijer is an Assistant Professor with the Future Everyday group in the Department of Industrial Design at Eindhoven University of Technology, where she joined in 2016. Lenneke obtained her B.Sc., M.Sc. and Ph.D. degrees from the Faculty of Industrial Design Engineering at TU Delft. Her Ph.D. explored the implications of social practice theory for sustainable design. After her Ph.D., she spent two years in the DEMAND Research Centre at the University of Sheffield in the UK. Lenneke is a leading expert in the area of practices-oriented design, a field within design and human-computer interaction research that draws on social practice theories. As a multidisciplinary researcher, she contributes within both the social science and design research communities. Her main interest lies in the relation between designing interactive systems and societal challenges of sustainability and inclusivity. She approaches these challenges using social practice theory and Research through Design.

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RESOURCEFUL AGEING

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Empowering older people to age resourcefully with the internet of things

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