8 CO-DESIGNING AND CO-SPECULATING *ON DIFFERENT FORMS OF DOMESTIC SMART THINGS*

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The interaction design community has long researched *the home* and applied diverse methods to these investigations. This trajectory of work has produced important contributions that have shaped how 'smart' computational objects can be designed to better support the tasks, routines, and experiences of home life (e.g. see Desjardins, Wakkary & Odom, 2015). However, conceptualizations of what the home is, how it is made and by whom have remained somewhat narrow in the interaction design community. Whether implicitly or explicitly, 'the home' is often characterized as a detached house and 'domestic life' cast as the social organization of collocated family members (e.g. heterosexual couples with children). This critique follows a strand of literature in science and technology studies (STS) that has shown how the design of technology often reinforces existing social roles and ideas of the home (Cowan, 1983; Martin & Mohanty, 1986). These works make clear that any change in social roles that seek to challenge emergent forms of home and promote diversity and difference ought to be mirrored by changes in technology.

There is a need for new approaches to co-designing and co-speculating on emerging smart objects and Internet of Things (IoT) technologies that challenge, rather than reinforce, social roles and narrow concepts of 'the home'. This need resonates with social theorist Ursula Franklin's notion of holistic technologies that

go against reinforcing "a culture of compliance" (1999, p. 24) and draw attention to the co-constitutive nature of technology:

> Technology has built the house in which we all live. The house is continually being extended and remodeled. More and more of human life takes place within its walls, so that today there is hardly any human activity that does not occur within this house. All are affected by the design of the house, by the division of its space, by the location of its doors and walls. (*ibid.*, p. 11)

For Franklin, technology is a pervasive social phenomenon that shapes our lives. Yet, in contrast to a technological determinist stance, which posits technology as a force that largely determines social phenomenon, the metaphor of a house reminds us of the critical and social roles that we, as designers and researchers, play as architects of technological systems.

A goal of this chapter is to offer a step towards expanding the interaction design community's approach to conceptualizing and designing for 'the home', domestic life and smart objects in this diverse context. This chapter describes and reflects on two design cases that offer different, yet complementary, approaches to designing domestic technology through involving a diverse set of people living in different kinds of domestic situations that exist largely outside of a 'mainstream' view of the home.

The first case focuses on *Different Homes* – a project that consisted of the use of cultural probes and design ethnography with people living in various kinds of home environments (e.g. in a boat, van, micro-loft, remote tiny house). Insights from these research activities inspired the creation of speculative design proposals that envision different ways that domestic technology could support a wider set of values, needs and desires by people living in different kinds of homes. The combined approach of conducting ongoing ethnographic work, crafting and deploying cultural probes, and generating design proposals produced new insights into and questions about how the interaction design community might conceptualize designing smart everyday things for a more diverse set of dwellers.

The second case focuses on *Loaded Dice* – a co-design toolkit that centres on the use of two 3D-printed cubes consisting of various sensors in one cube and various actuators in the other. The Loaded Dice toolkit was used to support generative activities with co-designers from a wide variety of backgrounds, abilities and domestic situations to better understand how future smart connected objects could be created to support their unique needs, values and desires. Findings from participatory workshops using the toolkit revealed that they were effective at enabling people from a wide variety of backgrounds to generate a range of idiosyncratic design concepts. The proposed design concepts offer an alternative vision of how smart objects could be designed for these specific people's everyday lives in and around the home.

Taken together, these two cases offer different accounts of how designers and researchers can approach co-designing and co-speculating with people in the service of envisioning new ways of designing smart objects. Through describing and reflecting on the benefits and limits of each approach, this chapter aims to expand the design space encompassing domestic smart objects as well as raise new questions to frame future research and practice.

Acknowledging and designing for different homes

Background

The Different Homes project is situated in the Vancouver, Canada Metropolitan area. Like many cities worldwide, Vancouver is facing numerous challenges in the areas of affordable housing and availability of space to accommodate growing population density. These issues and a range of social motivations have catalysed a growing number of citizens in the Vancouver area to adopt living situations that are smaller, mobile, temporary, self-made and/or collective. Our goals in this project are to (1) better understand the values and practices of people that embrace living situations that could be considered 'alternative' to mainstream domestic dwellings, and (2) to critically inquire into how such insights could inspire new ways of thinking about designing for 'the home' and what such a design practice might entail. Specifically, we were interested in several related questions:

- What would a 'smart home' be in the context of such alternative dwellings?
- What do connected objects mean if you frequently move between zones connectivity and disconnectivity?
- What kind of small luxuries are indulged in when there may be limited space for them?
- How do you build a record of home over time when home is not fixed to specific geographical location or set of household members?

Approach and method

Our design research inquiry across this multi-year project was divided into two stages: (1) a cultural probe (Boucher *et al.*, 2018; Oogjes, Odom & Fung, 2018) and ethnographic research (Odom, Anand, Oogjes & Shin, 2019; Shin, Sepúlveda & Odom, 2019) with people that adopted different living situations, and (2) developing speculative design proposals that responded to the values, desires, motivation, practices and experiences of our dweller participants (Oogjes *et al.*, 2018; Odom *et al.*, 2019).

For the first stage, we recruited a diverse set of participants that permanently lived in settings such as a van, boat, micro-loft, tiny house, urban condo, collective house and across many dwellings (as a house/pet sitter). To better understand their lives, we initially conducted a cultural probe study (Oogjes *et al.*, 2018). Cultural probes enabled participants to reveal to us their lives and ways of enacting domesticity on their own terms. To complement the breadth of the cultural probes study, we conducted an eight-month ethnographic study of dwellers living in three separate collective homes and dwellers living in three separate mobile dwellings (one van dweller and two boat dwellers) (see Odom *et al.*, 2019; Shin *et al.*, 2019). Mobile dwellers tend to live in vehicles where the interior of their home environment is relatively fixed, while the exterior environment surrounding their home is often changing. For collective dwellers, the physical location of the house is fixed, while the inhabitants (and objects) residing in the home may change over time. Our decision to conduct longer-term field research with collective and mobile dwellers enabled us to go deeper into understanding key overlaps and differences in their perspectives, values and ways of socially and materially organizing the home.

For the second stage, we drew on the returned probe materials and examples from our field research for design inspiration to speculatively engage with different considerations of the home and the role of technology within them. Our aim was to cultivate an attitude towards design for other, less considered forms of domestic life and to open up a dialogue about different ways that domestic technology could be explored in the interaction design community. We were particularly inspired by prior work that has focused on the creation of fictional products and product catalogues (e.g. Bleeker *et al.*, 2014). We were drawn to their capacity to catalyse a sense of familiarity at first glance through the styling of an advertisement, while then sparking critical reflection as the viewer recognizes, upon deeper inspection, a distinctly different technological future through the products and their attendant details.

We decided to embody the design proposals as various fictional products and services to think through how alternative domestic technologies might be used, designed and marketed. Our aim was to subvert and extend common tropes around domestic technologies. Our higher-level goal in developing these design proposals is to show that the proposed products do not exist in isolation but rather in relation to other services, products and systems within a sociotechnical world, and, in this, to question what this sociotechnical world might be like and for whom it might (or might not) be desirable.

Two speculative proposals: RoomiRoomba and Connectivity Clock

Next, we introduce and reflect on two speculative product concepts. These concepts aim to explore how insights from our cultural probes and field research

translate into design concepts that explore how technology might be envisioned to fit in such unique contexts and to question underlying assumptions in the mainstream consumer technology marketplace. Our aim is to use these concepts as proposals to raise questions with our dweller participants on the potential role of new technologies in their lives and, through this process, co-design new concepts with them.

RoomiRoomba

The RoomiBoomba (Figure 8.1) concept takes inspiration from collective dwellers and how boundaries of personal and shared space were negotiated in the home. These social practices are tied to the identity of our collective homes and reinforce their commitments to living cooperatively. They require collective dwellers not only communicate with each other but also for them to explore and reflect on what their personal boundaries are. Our dwellers' desires to live cooperatively were strong, but the nuances of socially signalling personal, shared and collective time and space could be challenging. This proposal explores how a smart product service might play a stronger mediating role in this process. As highlighted in the Product Reviews and Questions section, we aimed to explore what positive and negative consequences might emerge from delegating this type of labour an autonomous smart object. Further, this concept raises questions about how smart home technologies could be designed to support social configurations of domestic space that are in constant flux, while the physical house itself remains a long-term fixed entity.

RoomiRoomba reimagines familiar-looking smart home products through the unique social practices and dynamic boundaries of collective homes. RoomiRoomba offers an example of how the behaviour and presence of a smart vacuum cleaner could be extended to play a direct role in mediating the frequently changing configurations of personal, shared and collective space, thus serving as an extension of close-knit values of the collective. Its presentation within an Amazon advertisement with both positive and negative reviews provokes questions around the potential benefits and consequences of such technologies: Where do boundaries of acceptability lie when we extend practices tied to the sensitive and delicate social values of a household to a semi-autonomous smart home system? To what extent should we leverage the largely unseen individual data produced by household members' daily activities as a resource for mediating the social practices of a collective household (or any household)?

Connectivity Clock

The proposal of the Connectivity Clock navigation app (Figure 8.2) was inspired by our dwellers' descriptions of moving in and out of digital connectivity – which

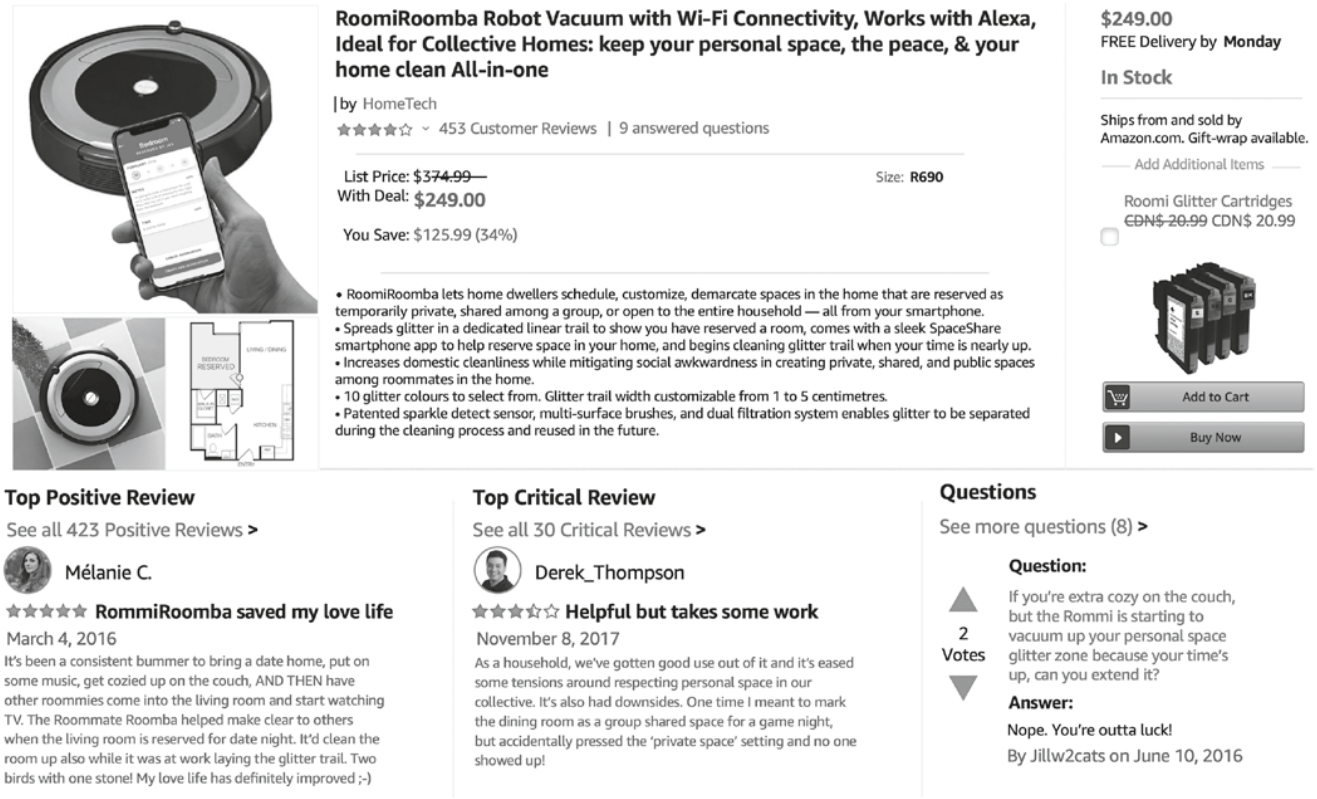

FIGURE 8.1 The RoomiRoomba is a vacuum cleaner that playfully embraces the social culture and practices of people living in collective homes.

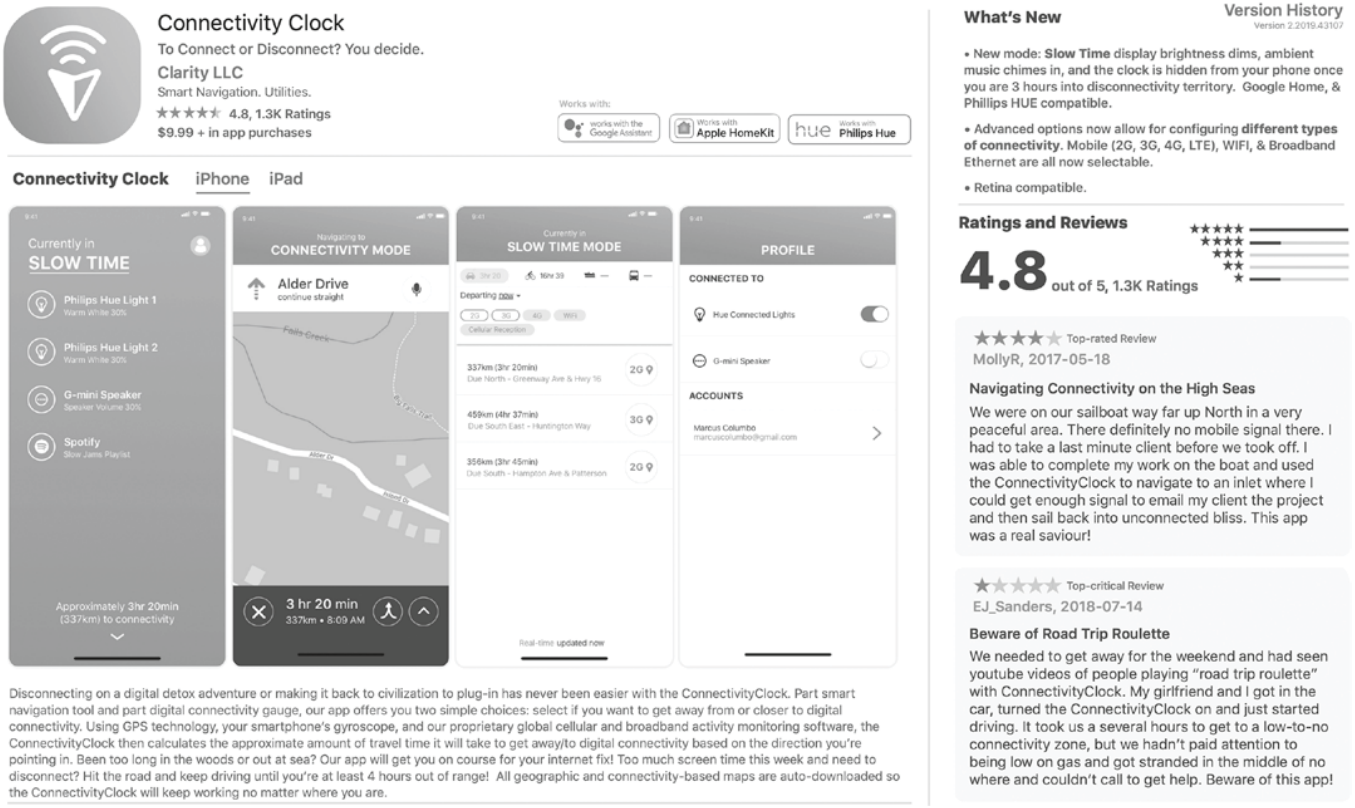

FIGURE 8.2 Connectivity Clock is a smartphone application that helps users navigate to differing levels of mobile internet (dis)connectivity.

projected 'connectivity' as a more porous, stratified and permeable concept. For example, a boat dweller mentioned how she had to sail farther north each summer to get away from smartphone connectivity. There were increasingly fewer zones that allowed her to truly get away from the connected world. Yet, she also enjoyed getting back to connectivity, the city and its infrastructure. Connectivity Clock provides information on how to direct oneself into different levels of (dis)connectivity, while not privileging one over the other. This provocation challenges the always-on ideal. Yet, it does so in a nuanced way by foregrounding freedom of choice to actively modulate one's (dis)connectivity desires across geospatial temporalities. Moreover, the Ratings and Reviews section suggests it may not be for everyone. New features such as slow time mode explore and question the desirability of enabling different levels of (dis)connectivity to open up new interactions with other locally connected devices and services (e.g. different kinds of smart light hues and music turn on once entering/leaving deep disconnectivity zones).

The Connectivity Clock proposal inquiries into the transitional qualities of our mobile dweller through a concept that leverages digital connectivity to amplify orientational awareness to changing conditions outside of the home – whether it is geographic directionality or spectrums of (dis)connectivity. Connectivity Clock recasts digital connectivity as a porous spectrum with possible richness in the stratified segments between totally connected and disconnected. This (dis)connectivity spectrum presents an intriguing space for designers to investigate in the future: How might different strengths and types of connectivity change our relation to objects, devices, people and the broader environment around us? For mobile dwellers and others alike? To what extent would this be wanted and why? The Connectivity Clock proposal open opportunities for co-design and co-speculation with dweller participants to explore how new designs could generate different kinds of geospatial awareness by considering connectivity along a wider spectrum, while still balancing people's agency and keeping them in the driver's seat.

Co-designing idiosyncratic smart objects with the Loaded Dice toolkit

Background

The Loaded Dice toolkit and workshop concept are influenced by the Scandinavian tradition of participatory design, which acknowledges that those that will be affected by a future technology ought to have an active say in its creation (Simonson & Robertson, 2012). Having people participate in designing future technology has the capacity to balance power distances between those that create and those that use technology. Designing together with people also has the potential to produce unique design outcomes that address and are aligned with the particular life worlds,

values, needs and desires of the people affected by it. The mixed materiality of smart objects, however, is a particular challenge for involving people in co-design. Grappling with the complexity of intertwining tangible objects with intangible services requires a technical understanding of sensors, actuators, networks and services. It also requires having expertise in abstractly envisioning and reflecting on potential future socio-technological assemblages of objects and services, and how they might shape people, their goals and the places they inhabit.

A variety of tools and methods have been proposed to address such complexity in the design process and support people in understanding the (in)tangible components of smart objects and services. An overarching goal of these tools and methods is to empower people to become co-designers of future smart objects and services. Some such tools are the Know Cards (http://designswarm.com/portfolio/know-cards/) and IoT Design Kit (De Roeck, Tanghe, Jacoby, Moons & Slegers, 2019) which provide *abstract representations* of IoT building blocks (e.g. sensors, actuators and networks) together with contextual concepts (e.g. places, people and goals). Such tools have been shown to be highly supportive in co-designing future artefacts for a variety of contexts and settings. Yet, a known challenge is that designing with them requires some degree of abstraction (Berger, Ambe, Soro, De Roeck & Brereton, 2019a). In contrast to this, purely technical co-design tools exist. They do not include contextual features but embody functioning IoT technology, so that people can tangibly explore the functionality of networked sensors and actuators. These tools raise the challenge that people may overly focus on the technicalities of the toolkits, while having trouble focusing on contextual concepts and socio-technological connections (Ambe *et al.*, 2019).

These challenges can be addressed with situated co-design workshops that take place in people's homes (*ibid.*; Berger *et al.*, 2019a) and carefully combine co-design approaches from both realms. One such approach is the Loaded Dice toolkit that we detail below. This toolkit combines a card-based workshop to explore problem-solution spaces in individual domestic settings with a functional IoT toolkit that makes networked sensors and actuators tangible.

Approach and method

The workshops conducted with the Loaded Dice toolkit take place in people's homes. They start with co-designers exploring and explicating a particular problem, goal or situation from their domestic lifeworlds with the help of a card set. This card set represents contextual concepts of places, people and goals as well as interaction properties. Co-designers first define an interaction goal through *Goal Cards* that help them to define a domestic problem-solution space. Subsequently, cards are used to refine this through *Actor Cards* and *Space Cards*, depicting the people and places involved in the problem-solution space. Following this, co-designers define input and output characteristics through the selection of

Property Cards representing sensor and actuator states. These *Property Cards* help to detail the particular functions, emotions and aesthetics of interactions within the problem-solution space; they define the *how* of sensor-actuator interaction. Co-designers start with a basic set of these cards but can create new cards when they find people, places or properties to be missing.

Only then, when the problem-solution space has been defined, co-designers engage with Loaded Dice that embody functioning networked sensors and actuators. Loaded Dice consists of one sensor cube and one actuator cube. On each face of the sensor cube a different sensor is located, while on each face of the actuator cube a different actuator is located. Both cubes are wirelessly connected and interact with each other: The upward-turned face of the sensor cube senses and communicates sensor data to the upward-turned face of the actuator cube. Turning different faces upwards activates the corresponding sensor or actuator. The sensor cube has one of six sensors on each face: potentiometer, microphone, infrared thermometer, lux-meter, passive infrared detector and ultrasonic transceiver. The actuator cube has one of six actuators on each face: Peltier element, vibration motor, LED bar graph, fan, loudspeaker and power LED.

Loaded Dice supports co-designers in tangibly exploring the functionality of and interaction between sensors and actuators. Co-designers can tangibly explore what it means, for example, to sense heat (infrared thermometer) and actuate it as heat (Peltier element), or to transform the same heat into movement (vibration motor) or sound (loudspeaker) by simply turning one cube.

Co-design workshop strategies

Both the Card Set and Loaded Dice support co-designers to first define a goal, be it problem, need, value or dream, they want to tackle with a smart object. Co-designers then tangibly explore the possible IoT functions and interactions through repeated turns between the Card Set and Loaded Dice. Following this rationale, we conducted Loaded Dice workshops with co-designers from various backgrounds, age groups and domestic living situations, paying particular attention to people's lifeworlds. Workshops have been conducted in the homes of co-designers to encourage them to take ownership of the co-design process and to actively explore problem-solution spaces within their home.

The Loaded Dice workshops enabled haptic, associative, functional and idiosyncratic strategies of relating IoT capabilities to their individual living situations, needs and desires. Often, these strategies merged into each other and represent different stages of fluency of co-designing future smart objects. Some such future smart objects are sophisticated engineering solutions for indoor-navigation systems, emotional connections over a distance or systems to automatically feed pets or water plants. Next, we detail two ideas for smart objects that explicitly follow idiosyncratic strategies. They are idiosyncratic in the

sense that they rely on particular sensible negotiations of emotional and sensory qualities and situated knowledge of lived experiences in domestic spaces. As such, they highlight how people associate unique goals with individual feelings of attachment, desires for well-being and dreams of how 'the home' is imagined. *The Whether Bird* and *The Inflatable Cat* depart from current norms in mainstream product design that focus on creating a more efficient domestic life. Instead, they shed light on how people imagine future domestic life with smart technology and relate computational smartness to their individual needs, as well as the 'sticky life situations' tied to their domestic routines.

Two idiosyncratic smart objects: The Whether Bird and The Inflatable Cat

The Whether Bird

The Whether Bird (Figure 8.3) is an idiosyncratic conceptualization of a smart object that emerged from a workshop with visually impaired students (Lefeuvre *et al.*, 2016). The student co-designers disapproved of speech assistants because using them might expose the user as 'needy and handicapped'. Simultaneously, they face the problem that their smartphone apps only provide weather forecasts with no way of knowing whether it had rained and the streets would still be wet:

Researcher:	"How do you know if it did rain overnight?"
P04:	"I ask a Weather App since I can't look out of the window. Otherwise I would notice when I feel that the street is wet."
Researcher:	"Don't you are at risk getting wet feet then?"
P03:	"Been there."
P04:	"You also can smell whether it did rain."
P03:	"Right!"
P02:	"I feel like the birds sing more melancholically when rain is approaching."

FIGURE 8.3 The Whether Bird sings more melancholically when rain is approaching.

In answering these two challenges, students envisioned The Whether Bird which we describe in a short scenario: Outside, on the windowsill, a weather sensor would measure the amount of rain over the past few hours. Inside, within the flat, a plush bird equipped with a hidden actuator would be wirelessly connected to the weather sensor. The plush bird would sing at the touch of a button, a tweak to the beak, or by stroking the birds' belly. Depending on whether it has rained, the bird would sing just a slight bit differently, so that only the blind student would know what this means.

The Loaded Dice workshop empowered the student co-designers to explore an issue from their domestic realm and to ideate a blueprint for future smart object. With the Loaded Dice toolkit, student co-designers did not just combine merely functional IoT building blocks to a smart object. Instead, they engaged in an immersive sensory-oriented exploration of goal and context, while simultaneously outlining the technical details of a future smart thing. The students co-designed a smart object that would not focus on deficits but instead foregrounds the extraordinary perception of blind people.

Many designs for people living with blindness stem from a deficit-based approach where assistive technology is engineered to make blind people better fit into the routines and capabilities of an able-bodied world. Our co-design approach enabled blind co-designers to voice their desire for technology that does not stigmatize them. It enabled blind people to ideate and then propose a technology that solves a problem form their life world by focusing on their innate abilities. The Whether Bird illustrates how co-designing artefacts with those that will be affected by them can lead to designs that support individual desires and capabilities. The Whether Bird also actively questions the normative, efficiency-oriented narrative of mainstream smart home technologies and advocates for a more situated, bottom-up approach to smart object design.

The Inflatable Cat

The Inflatable Cat (Figure 8.4) is a vivid example of how people co-designed a smart object for a 'sticky life situation' that they do not know how to solve well. It involves their cat within the context of their communal living arrangement (Berger *et al.*, 2019b). The aim of the smart object is to support the cat in 'what he actually desires'. Also, the communal house where the co-designers dwell has no cat flap. This has led to the cat being out in the cold and meowing in front of closed doors in hopes he would be let in. The co-designers envisioned a concept that would enable the cat to grab the attention of the communal dwellers. The smart object consists of a microphone outside the front door that could recognize the meows of the cat and distinguishes it from other cats to raise attention in the flat. Out of the several attention-grabbing and poetic ideas co-designers articulated, their final idea is particularly idiosyncratic: Within the communal home, a fan, instead of a

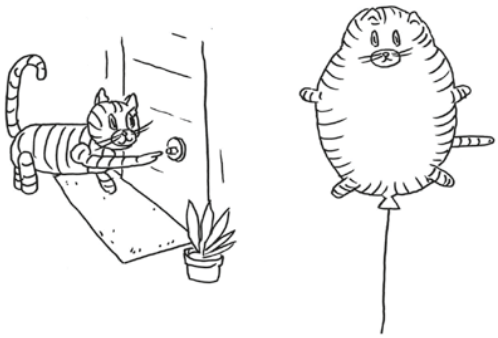

FIGURE 8.4 The Inflatable Cat supports a real cat in what he actually desires.

loudspeaker, would actuate the presence of the cat at the front door. To not disturb conversations, an oversized balloon-like version of the cat would be inflated by a fan, which would subsequently rise to the ceiling and vibrate.

The Inflatable Cat, as a co-design outcome, illustrates how the participatory workshop setup encouraged co-designers to reflect on poetic aspects of distributed communication while associating suitable sensors and actuators embodied by Loaded Dice. The Loaded Dice toolkit workshops enabled co-designers to explore problem-solution spaces closely aligned to their domestic experiences and to imagine smart objects that individually fit these contexts. The creative strategies exhibited here are idiosyncratic in the sense that the co-designers created ideas for smart objects that are specifically make sense within their housing situation. More generally, these co-design workshops and outcomes can help to better understand what people call 'the home' and what people consider to fit well into their very own, individually situated situation and socially constructed boundaries.

Discussion and conclusions

Designing interactive systems intended to support people's everyday lives and practices at home continues to raise opportunities and issues for the interaction design community. Design has long been regarded as an approach for framing, setting and solving human problems, and improving the conditions of people's everyday lives. Yet, design can also operate as an approach for critically provoking, imagining and questioning how we might treat such complex notions as 'the home' and the technologies designed in relation to it. A goal of this chapter has been to extend prior research by taking a step towards describing and unpacking two approaches to co-designing and co-speculating on the roles new kinds of technologies could play in different kinds of homes. These two approaches are different, yet complementary. They are both bottom-up approaches in the sense that they enable potential future users to co-speculate and co-design possible

futures with smart objects. In this way, they enable a conversation between designers and future users that connects present-day domestic life with individual potential futures. Both approaches illustrate alternative ways that technology could be designed for the home, embody different ideas of where home is located, explore how home is constructed, remade, curated and pursued, and question material, technological and social boundaries between it and the outside world. They generate knowledge about alternative ways of conceptualizing future smart objects in ways that often go unseen in commercial one-size-fits-all approaches to designing smart home technology.

These approaches differ in how they involve stakeholders and how they articulate the emerging design proposals. The Different Homes project combines empirical, inspirational and speculative approaches to challenge and expand what 'the home' is and whom the dwellers are that ought to be considered by designers. The Loaded Dice toolkit workshops offer examples of how a time-constrained co-design workshop method can lead to outcomes that open up people's imaginations of future smart technology design based on their own unique idiosyncratic values, desires and practices. Importantly, across the two projects, our aim is to not be prescriptive or conclusive. In line with this book's broader goal of establishing a research program for interaction design, our goal is to raise new questions that inspire, frame and expand future research in ways that move beyond narrow assumptions of a one-solution-fits-all approach for smart home design. Through our collective inquiry across the Different Homes and Loaded Dice projects, new questions have emerged that can be circumscribed into the following key areas and serve to guide future research.

Diversifying the home

How can the interaction design community better understand and acknowledge blind spots and implicit assumptions in design research and practice? How should we better recognize factors such as geographic location, gender, race, ableism, techno-solutionism and the unquestioned commitment to scaling up technology design? And in what ways can these factors be critically engaged with through design?

These questions provoke a number of considerations for diversifying smart object design through actively engaging with people into designing, questioning and rethinking possible futures. They generate openings in the design space to take seriously the need to design for difference and the obligations that come with co-creative and co-speculative approaches. There is a need for future research to recognize and embrace more different and diverse domestic living conditions, dwellings and dwellers. This will mean engaging with people from disadvantaged communities or geographic locations that are oftentimes overlooked by the

interaction design community. A starting point for these efforts will need to come with acknowledging that most co-designer and co-speculator participants, in research to date, come from a position in which they were able to choose to adopt the lifestyles they desire. Members of populations and communities that are affected by poverty, homelessness, physical/mental illness, discrimination and/or cultural annihilation (among other things) may have little choice other than to live in non-mainstream domestic conditions. Engaging with such populations represents crucially important opportunities for future research if we are to take seriously a broader, more inclusive call for diversifying the domestic and crafting new agendas for designing for a plurality of living situations.

Making it work

How can the interaction design community provide productive counter-narratives to normative assumptions of what the home is and what it entails? And how can design meaningfully 'scale-up' situated and diverse approaches to make them more available and inclusive?

The exemplars from the Loaded Dice and Different Homes projects provide a critical lens on how technology design can align with the ways that people envision their future domestic life. While these design exemplars rely on the unique values, desires, aspirations and practices of individual people and collective communities, they are not necessarily meant to be mass-produced for future use. For example, it is possible that relatively few homes might need an Inflatable Cat or RoomiRoomba. These exemplars work to concretely demonstrate that it is possible, and, in fact, sensible, to seriously engage the creative thinking of people and to trust their fluency in understanding their own domestic life. These approaches can be useful for 'making it work' in several number of ways. First, they question the ways we think about the smart home and also which 'smartness' aligns with the desires, goals and dreams of people. Second, they demand responses to the questions of what kind of 'smartness' we want and where we want it to be situated. In this way, creating concepts that might be far-fetched, critical, seemingly outrageous or even humorous help us collectively imagine and reflect on what kind of futures people want. Important in this is to take these concepts seriously enough in order to use them as design inspirations. This is well illustrated in work by Elisa Giaccardi and her colleagues on taking a thing-centred design perspective to critically question design decisions (Giaccardi, Speed, Cila & Caldwell, 2016). This work is in parallel to a growing interest in adopting and connecting co-speculative and participatory approaches in the interaction design community to engage individuals and communities in envisioning potential futures with technology and questioning if it is what they want (e.g. see Lyckvi, Roto, Buie & Wu, 2018; Desjardins, Key, Biggs & Aschenbeck, 2019).

Yet, the question remains as to what it would *mean* to make the ideas, emerging from such bottom-up approaches, work. We would need to envision new infrastructures and services to expand the notion of co-design and co-speculation to co-constructing and co-maintaining. In order to actually build the individual solutions co-designed with people, such new infrastructures would need the capacity to safely and efficiently produce and maintain smart objects as individual units or small batches.

Safeguarding and designing for the future home

How should the interaction design community ensure that the alternative futures envisioned in bottom-up approaches offer value to the people involved in their co-design and co-speculation? Is there a risk for the idiosyncratic outcomes resulting from co-design and co-speculation activities being co-opted into mainstream normative design? What kinds of unintended consequences could result? To what extent should we develop strategies for resisting against normative design?

The questions posed above highlight complex issues the interaction design community will have to face in future research. They prompt us to reflect on what kinds of 'problem-solving' we address with co-design and co-speculative approaches. They also are cautionary and make clear the need to critically consider who will benefit from the design, implementation and dissemination of such individually situated smart objects. In related research on IoT and do-it-yourself (DiY), the value of acknowledging different skills and different engagements in projects is important in order for a community to take ownership during a design process (e.g. (De Roeck *et al.*, 2012; Woo and Lim, 2015). For example, not all people are skilled at identifying valuable ways to use technology in their homes. As such, different methods and approaches are needed to critically reflect on the design proposals originating from co-design and co-speculation, to understand their effects on privacy, security and agency.

Acknowledgements

The Different Homes project acknowledges Doenja Oogjes, Sumeet Anand, Jo Shin, Peter Fung and Gabriela Aceves-Sepulveda for their important contributions to this project and the various publications and activities that encompass it. We also acknowledge that this research took place on the unceded traditional territories of the Coast Salish peoples of the Katzie, Kwantlen, Kwikwetlem (kwikwəƛəm), Qayqayt, Musqueam (xwməθkwəyəm), and numerous Stó:lō Nations. We thank our participants for generously sharing their experiences with us. This project is supported in part by the Social Sciences and Humanities Research Council of

Canada (SSHRC) and the Canada Foundation for Innovation (CFI). The Loaded Dice was made possible by Albrecht Kurze, Andreas Bischof, Sören Totzauer, Michael Storz, Teresa Denefleh, Mira Freiermuth and, most importantly, Kevin Lefeuvre. We are deeply thankful for the magnitude of support we received from Maximilian Eibl and we thank our co-designers for working with us. This project is funded by the German Ministry of Education and Research (BMBF), grant number FKZ 16SV7116.

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