INTRODUCTION

The increased integration of computation and networking capabilities into physical products is transforming many of our everyday objects into smart ones. Things such as domestic appliances, furniture, clothing and toys are gaining new capabilities and expanding their modes of interaction with their users. This prompts a series of questions concerning their role and agency: the way in which they may be perceived by the users and how their extended capabilities shape and inform the way they are designed. How are smart everyday objects ontologically different from their analogue counterparts? How are their new identities shaped by people's perceptions, experiences and imaginations? More crucially for the scope of our inquiry, how do we design them? What are the new frameworks, strategies and practices that can inform the design of smart everyday objects?

One of the recurrent themes anyone investigating smart objects has to contend with is the amount of debate (and hype) that has surrounded the Internet of Things (IoT) since its beginning. The expression 'Internet of Things' has been in circulation for two decades; the networked systems it describes were studied and experimented upon since the early 1980s (Sterling, 2005; Greenfield, 2006; Greengard, 2015). However, it can be said that the full potential of the interconnected world is yet to be reached. It is telling that the 'things' in IoT have been framed and described in varied ways including smart entities (Kuniavsky, 2010) and enchanted objects (Rose, 2014), or as non-human actors expressing a variety of possible personalities (Marenko & van Allen, 2016) and existences (Wakkary *et al.*, 2017).

For instance, when smart objects are perceived to have an autonomous existence, they might be experienced as well behaved, acting on our behalf, or as bossy, arrogant, mischievous or even incompetent when things don't go as expected. This variety of personalities can challenge the design of such objects. People are used to many contemporary everyday products responding to our actions, such as a kitchen mixer where we push a button or turn on a switch and the machine whirrs into action, blending or performing some other function. Yet,

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this scenario is considerably different once we consider smart kitchen appliances in the context of IoT (Atzori, Iera & Morabio, 2010) and ambient intelligent environments (Aarts & Wichert, 2009). What happens when our appliances talk back, take initiative and perhaps even advise us on what to eat? When they become more thoughtful, adaptive, social, suggestive and even capable to question our choices? How is their identity – and potential social roles – shaped, interpreted and designed for, considering ethical issues about responsibility, accountability and agency?

It is clear that when working with smart objects we have to consider their identity and character (Laurel, 1997; Janlert & Stolterman, 1997; Govers, Hekkert, & Schoormans, 2003), their qualities across a gradient of the human and non-human (Levillain & Zibetti, 2017), and the crossing of the virtual and physical they embody (Sterling, 2005). Thus, the proposition we put forward here is that smart objects in everyday life are a blend of tools and agents, a hybrid of the human and the non-human, possessing emergent properties and different forms of agency, and therefore demanding a different definition of 'intelligence'. Smart objects challenge interaction designers to grasp and creatively work with the new opportunities for design they can offer (Giaccardi, Speed, Cila & Caldwell, 2016), to use data or artificial intelligence (AI) as new materials in interaction design practice (Holmquist, 2017; Dove, Halskov, Forlizzi & Zimmerman, 2017; Odom & Duel, 2018) and to reimagine interaction as collaboration, coexistence and cohabitation with humans (Marenko, 2014; Marenko & van Allen, 2016; Rozendaal, 2016).

A further challenge for interaction designers is to envision smart objects from the perspective of their networking capabilities, therefore in terms of the wider ecologies in which they are embedded and in which they function, rather than from the perspective of a single entity (Funk, Eggen & Hsu, 2018). For instance, take smart kitchen appliances aware of their environment and of each other, and therefore able to act in concert. You can imagine a situation in which the blender knows that a third egg is not needed in a specific recipe you are using to make a cake. While you are unaware of this and attempt to take that additional egg from the fridge, the fridge (having received information from the blender) might decide to lock its door to prevent you from taking that egg. What may happen next? Perhaps, it is now the blender that issues a counter-order. One can begin to imagine how operational conflicts might emerge among machines that are, by design, enabled to be 'opinionated'. Likewise, one may wonder how far these networked ecologies may reach. Should the blender and the fridge be talking with your car too, now planning a trip to the supermarket? How do we deal with the distributed nature of an ecology of smart objects as designers as well as end users? To which extent do, could or should these ecologies reach? What might be the implications for the emergence and inherent unpredictability

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of responses in extended ecologies populated by multiple, active and potentially diverging agents?

The kitchen appliance example above shows how it is important, necessary and urgent to propose a shift from the conventional user-object relationship to wider ecologies of the human and the non-human where the actors engaged (whether they are people, objects or data) affect each other in negotiable, situated and intelligent ways. This landscape requires new design frameworks, perspectives, approaches and methods to help us (as designers, as well as users) consider, critically reflect on and rethink how smart objects are experienced and designed. Smart objects require innovative, hybrid and transversal methodologies to be contextually understood in their form, appearance and behaviour (Hoffman, Kubat & Breazeal, 2008; Hoffman & Ju, 2014; Vallgårda, 2014; Rozendaal, Ghajargar, Pasman & Wiberg, 2018), to be experimented upon and prototyped in everyday life (Chamberlain, Crabtree, Rodden, Jones & Rogers, 2012; Odom *et al.*, 2012; Desjardins, Viny, Key & Johnston, 2019), and, crucially, to be imagined and speculated about in their future possible manifestations (Auger, 2014; Wakkary *et al.*, 2015; Oogjes, Odom & Fung, 2018).

This is what the present book is about: a collection of insights, reflections and propositions to build a research agenda that, drawing on a multiplicity of perspectives, can shape, extend and evaluate interaction design practice and research for the current and near future landscape of smart everyday objects. This research agenda investigates and proposes alternative perspectives on intelligence, which, by underpinning new and thoughtful ways to design smart objects and the interactions we have with them, can open up design opportunities that can leverage the growing capacities of smart objects. A core goal of this research agenda is to propose new approaches to design that enable future smart objects to be imagined, to be given form and to be prototyped and situated in people's everyday lives. Finally, this research agenda puts forward careful consideration of the impact of smart objects on our individual, collective and social everyday lives, and is informed by critical reflection on their emergent agencies and their cultural, ethical, legal and political implications (Stolterman & Croon Fors, 2008; Redström & Wiltse, 2018).

Designing smart objects in everyday life

The notion of 'Agents' is a key lens to understand and frame objects as 'smart'. Following computer scientists Michael Wooldridge and Nicholas R. Jennings's definition of agents (1995), these are entities that are autonomous, acting without a direct intervention of humans; reactive, perceiving the environment and reacting to changes in a timely fashion; proactive, being able to exhibit goal-directed behaviour by taking the initiative; and social, having the ability to

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interact with other agents including humans. This lens allows us to describe and explore smart objects as technical infrastructures and to analyse their physical embodiment, software and networking capability.

To start with, the physical embodiment of smart objects allows them to be responsive. Embedded sensors, such as cameras, microphones and touch sensors allow smart objects to see, hear and feel the environment and allow us to interact with them through gestures, voice or by directly manipulating the physical object. Embedded displays, LEDs, physical controllers and speakers allow these objects to communicate back to us in a visual, haptic or aural manner. The way in which these objects communicate becomes more sophisticated when they can allow physical movement or change shape. This can be made possible by embedded mechatronics or smart materials. The rapid developments in engineering and material science will enable smart objects to display such novel forms of expression to be commonplace in the near future. Processors embedded in such physical artefacts enable them to collect, store and process data captured locally as well as elsewhere, and provide them with a 'brain'.

Software 'makes' objects 'smart' by allowing them to make sense of the environment (as picked up by its sensors) and to react in ways that can produce 'intelligent' behaviour. This might be very simple, for instance, when connecting the input from a sensor to the output of an actuator. Cyberneticist Valentino Braitenberg demonstrated that by connecting the light intensity (captured by a light sensor attached to a vehicle) to the speed of the motor driving that vehicle, rudimentary forms of intelligent behaviour can be achieved (Braitenberg, 1986). AI introduces more sophistication by enabling smart objects to learn by process, to be updated, to harvest data and to develop more advanced and refined models of the world as the system continues to learn. Different types of AI or machine learning (ML) exist that vary by their type of learning and knowledge representation (Michalski, Carbonell & Mitchell, 2013). For example, AI can learn through simple instruction, through evolutionary ways and by probabilistic inferences, and the knowledge of AI's may include rules of behaviour, problem-solving heuristics or classification taxonomies.

The networking capabilities of smart objects make them extend outside their immediate environment via connectivity protocols through which objects are connected to a network of other objects and systems (Kortuem, Kawsar, Sundramoorthy & Fitton 2010; Al-Fuqaha, Guizani, Mohammadi, Aledhari & Ayyash, 2015). Embedded processors and wireless communication devices such as WiFi combined with networking protocols, such as IP, enable smart objects to project distinct identities and to move beyond the confines of their physicalities. This can provide smart objects with connected services 'in the cloud'. For example, a smart car can tap into the live data about traffic generated by other objects and systems to gain updates about the preferred direction of travel. This can also enable smart objects to function in a collective; multiple objects can be part of a meaningful human activity, as we have illustrated with the smart kitchen example.

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Concerning their smartness, this networking capability also allows the intelligence of the object to be outsourced to another location or distributed across multiple objects as a form of a 'collective intelligence' (Mulgan, 2018).

If this illuminates smart objects as technical infrastructures that provide them with new capabilities, how do we understand them as being meaningful in everyday life? If we take the everyday as the sum of our everyday practices and day-to-day routines through which we humans accrue identity, relate to our environment and develop sense-making practices (Shove, 2007; D'Adderio, 2011), how might smart objects shape and transform it? Our starting point is that objects – whether analogue, digital or a mix of them – are essential to everyday practises, which are social and cultural, and they are profoundly enmeshed with objects (Kaptelinin & Nardi, 2006: Suchman, 2007; Kuutti & Bannon, 2014; Shove *et al.*, 2017) and therefore affect innumerable aspects of our working, social and intimate lives (Appadurai, 1986; Turkle, 2007). Deeply considering the everyday also requires framing it in the long-term and recognizing its repetitive cycles of use over longer periods of time which are stable and predictable but can also accommodate messiness, change and transformation (Kuijer, Jong & Eijk, 2013; Engeström, 1999).

To illustrate these notions with our previous example, kitchen appliances – whether smart or not – operate within the context of specific domestic environments, for instance, the kitchen, which possesses a situated cultural specificity conveyed by a variety of registers, from the spatial layout to the kind, size and number of various tools and appliances, as well as prevailing routines of use established by culture. Thus, any experience of, and interaction with, kitchen appliances can only be analysed in the interrelation with this environment and the other objects within it, as well as with the multiple human actors intersecting it. In other words, kitchen appliances are socially and culturally embedded. For example, as they are often available to many users, kitchen appliances tend to be socially coordinated. Furthermore, as they also embody traditions, histories and legacies that are both cultural and personal, kitchen appliances are inherently entangled with meaning-making practices and shared ways of knowing.

If our experience of the everyday is defined by socially embedded, meaning-making and culturally situated objects through which we develop long-term routines of engagement, then the experience of, and interaction with, smart objects should be wisely calibrated to fulfil these requirements – for instance, by striving to move beyond instantaneous gratification in user scenarios and embracing instead longer-term cycles of use and non-use. Succinctly, the presence of smart objects within wider environments ought to inform new modes of coexistence and cohabitation between us and them (Odom *et al.*, 2014).

To articulate how these may emerge (and be designed for), we now turn our attention to a discussion of intelligences, agencies and ecologies – the three key themes that underpin our framing of smart objects in everyday life. The next section explores how the *intelligence* of smart objects is shaped by a mix of the

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actual technical capabilities of an object as well as by human attributions of, and perception of, intelligent behaviours. Further, it discusses the *agency* of smart objects as a relational property emerging from our interaction with them. Lastly, it discusses how they are embedded in wider *ecologies* of the human and the non-human. To recognize the distributed, multiple and layered nature of smart objects in everyday environments we have chosen to use the plural terms – intelligences, agencies and ecologies. This underscores the idea that every time we engage with smart objects we are interacting with pervasive intelligent systems, with a multiplicity of coexisting (and not always aligned) agents, in wider ecologies of humans and objects.

Intelligences

As technological developments in AI and ML change the landscape of the design of interactive artefacts, intelligence becomes de facto a material to design with (Holmquist, 2017). Holmquist emphasizes that designers should be aware of the different types of ML and, in this, have a critical understanding of AI and the possibilities of what it can and cannot provide. Moreover, smart materials and mechatronic capabilities allow for new expressivities of smart objects through their material properties and the object's form(s). For example, smart polymers and shape memory materials have an inherent dynamic that can provide physical expressiveness in interaction design and more subtle, delicate and nuanced forms of physical interaction. Therefore, designing smart objects requires designers to have a broad understanding of what is meant by 'intelligent' objects. AI, ML and the technical infrastructures supporting networked smart objects are all crucial to this definition. So are the nuances of how humans perceive objects to be smart and attribute to them 'sentience'.

Humans have an innate tendency to attribute some kind of intelligence or sentience to inanimate things, even when we are perfectly aware that they are inanimate. As was shown as early as 1944 by psychologists Fritz Heider and Marianne Simmel, people would attribute intent to moving geometric figures and use anthropomorphic descriptions to explain the behaviour of abstract shapes – especially when objects appear to move by themselves and movement is not perceived to be caused by external forces. Brian Scholl and Tao Gao (2013) propose that this is hardwired in our perceptual system as an innate response to specific motion cues, such as self-propulsion, synchronous movements, patterns of approach or avoidance or coordinated orientation. Media theorist Cifford Nass introduced the term 'ethopoeia' to describe the attribution of humanness to computers that do not look human and are known not to be human (Nass, Steuer, Henriksen & Dryer, 1994; Reeves & Nass, 1996). More recently, cognitive and social scientist Leila Takayama (2009) explored agentic objects in the context

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of human-robot interaction, where objects that seem to have agency 'are perceived and responded to in-the-moment as if they were agentic despite the likely reflective perception that they are not agentic at all' (p. 239).

An understanding of animism – the attribution of liveliness to things – may be particularly useful as a perspective to interpret contemporary forms of human-machine interaction characterized by autonomous movement, environmental awareness and a range of expected (and some unexpected) responses. Developmental psychologist Edith Ackerman (2005) describes artefacts in the context of interactive toys as having an ambiguous nature, somewhere between the animate and the inanimate: 'the object's "aliveness" facilitates identification. At the same time, its "thingness" helps us keep a secure distance' (p. 1). Design theorist Betti Marenko (2014) introduced the notion of neo-animism to account for the 'new forms of cognition—embodied, sensorial, contextual and distributed—that are produced by ambient intelligence through mapping, tagging, and data gathering' (p. 223) and broadly in the wide networked entanglements of humans and digital things. Furthermore, Marenko and Phil van Allen proposed animistic design (2016) as a speculative and imaginative tool to rethink human-machine interaction 'neither from the perspective of the user, nor from the perspective of the object but from the ongoing modulation of their less-than-predictable interaction' (p. 2).

Philosopher and cognitive scientist Daniel Dennett's notion of 'intentional stance' offers an explanation as to why people's attribution of intention to objects is a fundamental aspect of human interaction with the world (1989). For Dennett, there is no difference between living or non-living things as long as using the intentional stance is an economical means to explain and predict complex behaviour. Adopting the intentional stance implies assuming that things have beliefs and desires and that things act rationally according to these beliefs and desires. How we arrive at these attributions of intelligence depends on the underlying metaphor that we adopt. Metaphors allow people to understand and communicate the workings of a system through a mental model (Lakoff & Johnson 1980; Norman, 1993; Janlert & Stolterman, 1997). A number of metaphors have been developed to understand how people make sense of and interact with different agents. For Instance, here we look briefly at biological and non-biological metaphors.

While biological metaphors are inspired by human, animal or plant life, non-biological metaphors have their origin in the expressiveness of cultural artefacts explicitly defined as 'enacted'. Human metaphors (i.e. anthropomorphizing) are apparent in the design and use of conversational agents and social robots that interact with human speech or use expressive body language (Allen *et al.*, 2001; Breazeal, 2003; McTear, Callejas & Griol, 2010; Følstad & Brandtzæg, 2017). However, when the humanlike appearance of robots prompts attributions of 'human' capacities (for instance, to feel, sense or express), this might conflict with the actual sophistication of the robot (Gray & Wegner, 2012) and induce a

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perception of 'uncanniness' – when they appear too lifelike (Mori, MacDorman & Kageki, 2012). This is also why animal metaphors that afford more-than-human perceptions of intelligence are often deployed for social robots (Breazeal, 2003).

As for non-biological metaphors, in conventional product design, objects are often perceived to have a personality that stems from the stylistic aspects in their design (Janlert & Stolterman, 1997; Laurel, 1997; Govers *et al.*, 2003; Boer & Bewley, 2018) or are 'enacted'. In other words, designed objects might appear to have an identity, their own social life (Appadurai, 1986) or 'objecthood' (Candlin & Guins, 2008). Alex Taylor refers to 'Machine Intelligence' (2009) as the lifelike quality of a machine's movement, autonomous interactions in and with the world around it, 'something "seeable", but also something enacted — emerging from those particular details of a setting' (p. 8). Marco Rozendaal (2016) introduced the notion of 'Objects with Intent' to describe agents that take advantage of the meaning of everyday things as the site for their intelligence and agency. These objects are approachable and intuitive in use, since their intelligence is made meaningful as everyday things with familiar uses, anticipated contexts of use and known ways of interaction.

The design of carefully calibrated interaction dynamics – accounting for human and non-human actors, and the networked systems that bind them together – can be achieved by acknowledging the ways in which technological innovation embedded in smart objects intersects how intelligence is attributed to objects. This may be achieved by sidestepping mainstream applications of human-like and animal-like metaphors in favour of more radical perspectives, such as animism. We contend that such an approach, by accounting for the wide spectrum of the animate and inanimate with no clear-cut division among them, can greatly contribute to the design of novel expressive forms and mental models, and to the production of narratives and fictions underpinning future interactions with smart objects. Thus, a question that emerges here is: Which animism-driven strategies can enable the creation of new kinds of interactivity and embodied relations with smart objects in everyday life by combining form-giving practices in product design and character animation?

Agencies

As much as intelligences and agencies are intertwined, it is useful to examine the notion of agency (or agencies) separately, to map key insights and literature on this topic as they feed into our proposed research agenda. Agency is taken here as a relational capacity that emerges through interaction or, following philosopher Karen Barad's argument, through what she calls intra-action. For Barad, while interaction assumes separate individual agencies preceding the interaction itself, intra-action acknowledges instead the emergence of distinct agencies *in* their act

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of coming together (2007, p. 33). This framing of agencies is particularly useful to understand complex ecosystems where humans and digital objects coexist and 'come together' in a variety of continuously modulated and 'live' ways – some overt, some invisible and happening in the background. For instance, social media status updates competing for our attention by actively prompting us on our smartphones, smart thermostats changing our home temperature depending on which dwellers are recognized to be at home, a lighting system adapting hues and tones to better suit our moods or refrigerators that automatically order more almond milk when it is predicted to be running out. These are all forms of interaction in which smart objects fed by environmental data manifest agency that respond to people's needs and wishes, all the while also informing our own human responses and reactions.

This ceaseless mutual calibration between human and non-human agencies calls for interaction models that are equally supple and negotiable. This means that, rather than understanding objects as tools that mediate our day-to-day activities, new models would see them instead as partners, companions or allies. The shift from tools to partners is an important one, as it raises questions concerning the ontological dimension of objects. If they are now active co-creators of interaction (rather than passive slabs of matter), extended throughout a live network of other connected objects (rather than a discrete singular entity), and partners (rather than servants or mere tools), then the traditional subject-object divide becomes distributed – and with this comes significant implications for the role of the subject, or user, or human in the equation. The questions are then how do such objects mediate interaction? What type of future partnerships can be envisioned in light of issues that include privacy, control, surveillance and accountability? How do different forms of intelligence lead to different modes of agency? And which roles might smart objects begin to play in our everyday lives?

The shift from tools to partners has been addressed by human-computer interaction literature, where the changing interactions between humans and computers-as-agents have been described initially as mixed-initiative user interfaces (Hearst, Allen, Guinn & Horvitz, 1999; Horvitz, 1999) and as symbiotic and integrative (Jacucci, Spagnolli, Freeman & Gamberini, 2014; Farooq & Grudin, 2016). With their growing autonomous and negotiable activity, smart objects can now be described as partners that 'construct meaning around each other's activities, in contrast to simply taking orders. They are codependent, drawing meaning from each other's presence' (Farooq & Grudin, 2016, p. 28). Similarly, the notion of co-performance, drawn from social practice theories, is also used to denote how new modes of human-computer relation develop through situated and evolving complementarity of capabilities and actions (Kuijer & Giaccardi, 2018).

Furthermore, different levels of agency that objects can display on the basis of the complexity of their perceived behaviour is described by the notion of 'Behavioural

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Objects' (Levillain & Zibetti 2017) – for instance, the level of 'animacy' denotes objects that move spontaneously and show a consistent motion and trajectory over time while the level of 'agency' denotes objects that seem to have goals and are able to deal with changing environmental constraints in a flexible manner. The level of 'mental agency' indicates objects that seem to coordinate their behaviour with others, displaying communicative actions and showing varied attitudes to other agents. Similar incremental levels of agency are identified in the behaviour of objects within IoT (Cila, Smit, Giaccardi & Kröse, 2017). Here, at the lowest level objects collect and aggregate data to visualize patterns of behaviours, as demonstrated by quantified-self technologies such as Fitbit, or domestic 'helpers' such as Google Nest as an object that learns to adapt to users' behaviour patterns. On the highest level of agency, however, objects may develop creative contributions. Describing machines that 'make' robots becomes a way to speculate on robots that might develop artificial forms of self-awareness.

From the perspective of Activity Theory – a cultural-historical view on human psychology and development (Rubinshtein, 1946; Leontiev, 1975; Vygotsky, 1978) – all objects are considered to have conditional agency, which simply means that objects produce effects because of their physical manifestation (Kaptelinin & Nardi, 2006). Some objects possess delegated agency – the agency delegated to them by someone or something. Finally, only certain entities, such as human beings or animals, have need-based agency. While objects cannot have a genuine need-based agency, they may however appear to have one. Considering objects as 'quasi-subjects' (Latour, 1993; Bødker & Andersen, 2005) or 'subject-objects' (Suchman, 2011) allows us to grasp smart objects as social and communicative beings, whose capabilities are other than ours. Susanne Bødker and Peter Anderson describe a ship's automated control system as quasi-subject to which actions can be delegated within the complex activity of ship navigation and control. Lucy Suchman (2011) talks about 'subject-objects' in her project to understand the identity of social robots from a feminist philosophical viewpoint. Drawing on Bruno Latour's notions of quasi-objects and quasi-subjects – real, collective and discursive elements underpinning human social bonds (Latour, 1993, p. 89) – these ideas suggest the growing hybridity of social actors and systems where the human encounters the technical.

Another approach to agency comes from post-phenomenology, which sees agency as the way in which objects mediate, shape and influence our experience and interaction with the world around us (Ihde, 1990; Verbeek, 2005). For post-phenomenology, what matters most is not agency per se but considering technologies as 'mediators of human experience' rather than merely functional, utilitarian or as symbolic objects. In this context, humans and technologies shape each other in a mutually constitutive way. These ongoing mediations give rise to the subjectivity and objectivity of a given situation in the world. Intriguingly, by looking at technological objects as designed artefacts (and not things that come

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in a 'raw' form), post-phenomenology offers an important lens for designers to work with, considering the mediating qualities of the smart objects that might be created.

To sum up this section on Agencies, and how it informs our proposed research agenda, a key issue concerns the acknowledgement of the partnerships that humans form with smart objects. For this reason, it becomes essential to discern how humans and smart objects' abilities, capacities and competencies can complement each other, as they are practised and performed in everyday life. For instance, what are the tools and know-hows needed to interpret correctly the level of agency smart objects exhibit? How can tasks be shared (and delegated) among humans and objects? Furthermore, What are the salient experiences that designers need to consider – issues of control, trust and accountability – and which range of acceptable roles may smart objects play when people start to coexist with them in everyday life? What remains to be seen, then, is the extent to which agencies (both human and non-human) might align or diverge, might recognize or misunderstand each other, might have common goals and expectations in terms of a desired state to achieve in the world, and what may happen in potentially antagonistic situations.

Ecologies

In this context we define Ecologies as the wider ecosystems where smart objects coexist and interact with humans and with other objects, actors and infrastructures – both analogue and digital. Broadly, we describe these ecologies as populated by various assemblages of humans and non-humans, and characterized as 'largely uncharted design territory, ridden with complexity, diversity, opaqueness, and intangibility' (Funk *et al.*, 2018, p. 1). Notably, the term 'ecologies' intends to emphasize the profoundly contextual and pluralistic nature of the entanglement of human and non-human, and, in the specific of smart objects, the multiplicity of technologies, materialities, users, outcomes and infrastructures at different spatial and temporal scales that shape ecologies as such.

Ecological theories acknowledge not only that we are embedded in the context we inhabit but also that our physical and cognitive abilities have evolved as a product of the environments in which we dwell. In such ecological theories, the notion of 'embodiment' is critical (Dourish, 2004). In evolutionary biology, for example, the intelligence and behavioural repertoire of a given species are said to have co-evolved within the habitats or milieus of that species (Darwin, 2004). In psychology, the ecological approach proposed by James J. Gibson (1979), understand the human perceptual system to be tightly integrated with the action system (and thus with our embodied intelligence). A similar view is expressed by Rodney Brooks (1991) in his work on robot development, where intelligence is

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understood as consisting of multiple layers of sensory-action feedback systems tailored to the environments in which they operate.

Social sciences' Actor–Network Theory (ANT) (Latour, 2005) is also illuminating how ecologies of smart objects can be understood. ANT is a distinctive approach to social theory and research which originated in the field of science studies. It is best known for its insistence on the agency of the non-human. It examines the complex interrelations of human and non-human actors as they interact within a largely horizontal landscape. It considers all human behaviour to arise by the agglomeration of multiple 'actants', which can be humans, things or even ideas. Unlike conventional assumptions that people make things and objects, ANT takes this idea and turns it around. What if it was objects that make people? This is the shift proposed by ANT: from the traditional distinction between humans and things to a new ecosystem of human and non-human actants. Briefly, everything that exists must be regarded as an actant: all entities, be them natural, artificial, human or non-human, objective or social are actants; thus, they exercise agency as they ceaselessly enter in associations, alliances and networks with each other. The first thing that strikes in this ontology is how utterly horizontal it appears to be. Not only are that blender, this fridge, our laptops and your smartphone very real and very likely connected to each other, but they are also engaged in alliances to assert themselves as social actors, with various degrees of agency that they exert in the world. This emphasizes how any discussion of ecologies is always also a discussion of agencies. Whether digital or analogue, animate or inanimate, these agents all participate in (and exit) complex ecologies of alliances and relations.

Now if we consider smart objects as participating in multistable ecologies of relations, we might ask what kind of relations these would be. Relations among artefacts that shape an ecology of things can be distinguished on the basis of their 'purpose' (when objects are related in terms of how they are a meaningful component of everyday activities). They might also be distinguished on the basis of their 'context of use' (when objects physically and temporally coexist in a specific setting) or even on the basis of the 'meanings' they have been given that express their significance in people's lives (Jung, Stolterman, Ryan, Thompson & Siegel, 2008). Similarly, the notion of 'product ecology' (Forlizzi, 2008) is useful to understand how systems of technology-based products are socially and culturally situated among specific communities of people. It also illuminates how products are effectively used and by whom, as it takes into account how different social roles and attitudes, each with their own temporalities and flows, will inform people engagement and patterns of use.

The notion of ecologies also casts light on the process of adaptation – whereby 'the introduction of a new artefact to an ecology can influence various aspects of users' daily behaviours as well as the use of other artefacts' (Jung *et al.*, 2008,

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p. 206). In a study on the introduction of a robot vacuum cleaner in the domestic environment, Forlizzi and DiSalvo (2006) found that the robot, by enabling new ways of cleaning, also altered established cleaning practices. Conversely, the robot also required assistance from the household inhabitants who had to intervene by rearranging and moving furniture for the robot to perform its tasks, or even helping it when it got stuck. The authors observed an 'unusual dynamic between the product, the physical environment, and participant' (p. 262), suggesting that the introduction of the robot in the household triggered multiple points of adaptation. The product, in other words, becomes an 'instigator for change — how it has an effect on people, place, and other products in use, effecting dynamic change on all of the factors in the Product Ecology' (Forlizzi, 2008, p. 15).

A final theme to consider in relation to ecologies concerns the emergent, and therefore potentially unpredictable, nature of the interaction. As multiple actors interact with one another as semi-autonomous entities, fed by live data picked up from different sources within their immediate environment and ambient networks, their interactions might become increasingly difficult to predict. If margins of unpredictability can be considered as an organic outcome of the emergent behaviours of complexity adaptive systems (Mataric, 1993; Callejas & Griol, 2005), the implications of 'digital uncertainty' in ecosystems populated by humans and smart objects can have dramatic consequences or, in a more mundane context, could lead to frustration, bafflement and a disruption of expectations. To go back to our initial example, think about the scenario in which your fridge refuses to be opened, or your blender decides (against your judgement) that your cake mix is now sufficiently done. A research agenda would need to consider ways to harness and maximize the creative potential of this type of emergent uncertainty to gain insights – for instance, on how to introduce elements of surprise, curiosity, wonder and delight in the design of meaningful everyday interactions.

To conclude this section on Ecologies, the key issues for our research agenda concern an enhanced sensitivity to the contexts within which smart objects operate, the assemblages they enter into with other objects and with users, and the type and nature of the relations they form. As embedded agents in wider ecologies, smart objects have to be examined (and designed) with an understanding of how their introduction in an existing ecosystem alters the equilibrium and changes existing relations. Furthermore, they have to be considered in their capacity to both adapt to and instigate mutual adaptability from other actors. Finally, the implications of emergent behaviours, such as the 'spontaneous' interplay between multiple intelligent actors, and the unpredictable scenarios that may arise must be taken into consideration, especially in their potential to supply creative elements to the design of surprise, delight and wonder in the everyday, and how to harness it.

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Towards a research agenda

The book is structured in four parts – Perspectives, Interactions, Methodologies and Critical Understandings. Taken together, these parts outline a coherent research agenda for interaction design. Said agenda has two key aims: to understand the way smartness is expressed and interacted with in the everyday, and to offer a roadmap for the conceptualization, design, prototyping and realization of smart objects that are considered as intelligent agents located in ecologies shared with humans and non-humans. A broad view of what can be considered as 'intelligence' allows this research agenda to eschew anthropocentric determinism and to embrace instead a multi-perspectivism that considers how more-than-human forms of intelligence may feed in, and inform, the effective design of smart objects, from the mental models they express to the interaction and partnerships they foster. The research agenda also aims at highlighting salient issues concerning the social, ethical and legal implications of smart objects, and how to design while offering responsible and sustained value to people in their everyday environments.

The variety of voices collected throughout this volume, each with its own distinctive perspective, epistemic culture and research methods, indicates the value of transdisciplinarity. Working across disciplines is nothing new for design, but the range of positions and concerns presented here makes a compelling argument in favour of transdisciplinarity. The multiple entanglements between human and non-human intelligences and agencies, and how they both constitute developing ecologies of multiple actors, appeal to developing transdisciplinarity knowledge that transcends the natural and the artificial, the biological and the cultural, and bridges the theoretical and the practical. Taken together, the chapters that follow offer insights, reflections, inspiration and concrete concepts to inform the generation of a research agenda to work with, and contribute to, the wide debate on how interaction design can move forward in its enterprise of designing future interactions and experiences with smart objects in everyday life.

The volume does not explicitly propose tools or toolkits ready for implementation but rather offers a range of insights that can help define, envision and inspire further design practices. Its ambition is that these insights, together with clear, useful and inspiring methodologies, can be used in the process of envisioning, giving form and prototyping smart objects, and the ever-evolving interactions we are part of in our everyday lives. The collective voices in this book further suggest that empowering people through the design of smart objects requires fostering democratization and fairness in their design and development. Finally, this volume should also be read as an accurate, albeit transient, snapshot of the state-of-the-art discussion on interaction design in the European and North American context in the second decade of the twenty-first century.

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Part 1: Perspectives

A significant conceptual area concerns the relationality between smart objects and how they embody and manifest 'intelligence'. Put differently, whatever definition we choose to adopt to describe intelligence, it will be a quality that emerges through the co-shaping relations between a smart object and its user. This first part of the book – Perspectives – offers ideas on fresh generative metaphors that can be used to think about and design smart objects as fungi, as actors in situated performances and as speculations on our hybrid and cyborgian futures by offering us different interpretations of machines. Rather than an intrinsic computational property or construed as a computing brain within the object, intelligence is enacted through multiple stabilities and relationalities. The work presented in this first part of the book explores alternative human-machine ontologies and perspectives on intelligence that make a practical contribution by helping designers envision, design and shape new morphologies for smart objects.

In Chapter 1, David Kirk, Effie Le Moignan and David Verweij examined how fungi, as living organisms, provide a powerful non-human metaphor for understanding smart objects. Interpreting smart objects by using fungal systems as an inspirational device allows conceptualizing them as hybrid entities part of, and generating, complex ecosystems of developing symbiotic relationships with human and non-human actors. Kirk and colleagues propose 'fungi' as a productive metaphor to imagine AI systems and ecologies of smart objects in a way that highlights slowness, otherness and coexistence. The chapter shows rather poetically how to look in unexpected places to generate new perspectives on functionality, application, human-AI partnerships and form factors. This perspective offers an alternative way of thinking about interaction with smart or intelligent interfaces, radically different from the usual anthropomorphic or zoomorphic metaphors.

Maaike Bleeker and Marco Rozendaal introduce the notion of a 'dramaturgy for devices' in Chapter 2, as a way to address interactions with smart objects as situated performances. In contemporary theatre, the term 'dramaturgy' refers to the totality of compositional principles that underpin the construction of performances. With their dramaturgy for devices, Bleeker and Rozendaal propose how smart objects can be understood not only through their technical computational properties but also through the relations they establish and transform within ecologies of people and things. As concrete suggestions for interaction design, they discuss how dramaturgical principles such as 'mise-en-scene', 'presence' and 'address' can help to guide designers to orchestrate such performances. Here the emphasis is on how to work with 'potentialities' and how through improvisations these potentialities might be actualized by means of design.

A satirical take on the imaginative potential of technology is present in the chapter that concludes this part. In Chapter 3, Tobias Revell and Kristina Andersen

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discuss how the notion of 'the machine' forges a cornerstone of our visions of the future. As humans, we dream and fear future machines as the true cyborgians we are; we fantasize through and with machines because they are more than simple tools and because we can imagine ourselves as one. The authors exhort us not to think in classifications (e.g. subject/object) but to remain open to the potential for new, evocative and alluring frameworks, to inform how objects and machines can be perceived and imagined. Put differently, the stories we tell each other about machines yet to exist tend to orient technological innovations. Likewise, we use innovations to forge new stories of futures that might (or might not) come to exist. Can 'better' machines be imagined, both in the quality of our imaginations and the machines therein? The chapter offers an answer by exploring speculative alternative machine ontologies.

Part 2: Interactions

The chapters in this part focus on how interactions between users and objects can be reimagined as an ongoing process of negotiation across multiple human and non-human actors, considering the multiplicity of identities, roles and embodiments they might assume. The same insight concerns the nature of agency as something that is distributed and emerges among networks and assemblages of people, objects and environments.

Notions of agency are introduced in Chapter 4 by Christopher Frauenberger, whose chapter draws on the work of Barad and Latour to develop a metaphysical position on the nature of the entanglements between humans and smart objects. To grasp the complexity of these relationships, the chapter argues, is necessary to portray them as a process of continuous negotiation for which appropriate spaces must be created and maintained, namely 'agonistic arenas' affording constructive conflicts over agency, power and morality with smart objects. To this aim, the chapter proposes the design of a new breed of smart objects: objects that are smart, honest and open to negotiate their relationships and material personalities with people around them, relationships that are co-developing by transforming the object in terms of its functionalities with the person's developing needs and interests.

In Chapter 5, Jelle van Dijk and Evert van Beek discuss the experience of smart objects from embodied and enactive perspectives, including the perspective of post-phenomenology. They illustrate how smart objects can display a dynamic kind of agency because of the multistable human-technology relations they can establish during interaction, that is, moving into the background or foreground of awareness and being perceived as tools or agents. Whether smart objects are seen as autonomous agents, or as social entities that we are in conversation with, often the underlying expectation is that these devices are 'in some sense like us'. By examining the ways in which smart objects 'can exist' as embodied

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agents in our everyday lived experience and 'dynamically mediate' human intentionality, the chapter offers insights on how their form and interactive behaviour can be designed accordingly. They conclude by suggesting design strategies that forefront ambiguity and openness to design for shifts in such emerging relationships.

To conclude this part, in Chapter 6 Nazli Cila and Carl DiSalvo conceptualize smart objects by examining delivery robots in the context of a smart city. They argue that ANT can help in critically revealing and explicating the actors and their qualities as sociotechnical contexts and networks, in which smart objects exist and operate. This perspective addresses objects and humans on a similar ontological level, thus with shared rights and responsibilities. Cila and DiSalvo propose that concepts from ANT can be mobilized by designers to help analyse and frame ecologies as expansive sociotechnical networks from the perspectives of all the actors involved, both human and non-human. This allows designers to 'see', identify and envision what is happening and hereby help them scope complex design spaces.

Part 3: Methodologies

This third part focuses on methods useful to the prototyping of smart objects and the form-giving typologies that may be exclusive to them. The expanding notion of smart objects as computational opens new ways to incorporate data and AI as a material to design with. It asks what kind of co-participatory methods will be needed in the near future, and examines how the design practice of prototyping can adapt to its particular emergent qualities and situatedness. We suggest that a research agenda should further interaction design practices where 'smartness' can be explored, questioned, sketched and prototyped. If it is true that interaction designers need to have a basic understanding of AI and ML, and of how these can be 'designed in' and incorporated into objects, it is also true that technical competence needs to be integrated by an understanding of ethics and the awareness that designing with data far too often reinforces existing social and cultural norms.

In Chapter 7, Philip van Allen explores how designers can approach the prototyping of smart things and contends that a paradigm shift in design practice is needed to adapt to their particular characteristics. Specifically, the craft of prototyping must adapt to new domains such as designing for unpredictability and emergence, contextual adaptation and animism, whilst accommodating key established design strategies – from sketching, rapid iteration, exploration and problem finding to user testing, participatory design and critical thinking. van Allen reviews some of the key techniques and methodologies to prototype with AI and ML, highlighting ways of carefully working with data sets that might have intrinsic biases and collaborating with data scientists as co-designers.

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In Chapter 8, William Odom, Arne Berger and Dries De Roeck propose how co-design approaches can be used in practice to explore interactivity together with individuals and communities in a way that is embedded in the uniqueness and diversity of their everyday living situations. They also discuss involving people with different abilities and socially marginalized groups directly as stakeholders in the design of smart technologies. In this way, people's specific and highly individual circumstances (as social, material and political contexts) help shape smart objects and their complex ecologies in personally relevant ways. An obvious focus of intervention is the smart home. Their chapter questions the somewhat narrow conceptualizations of 'home' (what it is and how it is made) found in the fields of human-computer interaction and design. The chapter aims to expand such a vision of 'home', and the everyday domestic life it contains, by describing and critically reflecting on two design cases that offer different, yet complementary approaches, to the design of smart domestic technology, addressing participation and alternative lifestyles largely outside the mainstream.

Part 4: Critical Understandings

The final part of the book focuses on a critical understanding of smart objects in terms of their impact as social, legal and political entities. It proposes critical standpoints through which smart objects could be situated and politically theorized, as well as examined in the light of issues of responsibility, accountability and liability. These chapters offer salient reminders of the need to avoid common traps and tropes in the design of new technology. The good intentions of shaping a new technology's design are often overshadowed by the negative and unintended consequences that they give birth to. For interaction design to move forward, we need to better understand how to address power distribution (and asymmetries) within systems while safeguarding human integrity in their design and use. This concerns not simply the agency of things that are now able to act independently, making choices for us, but also the impact of this distributed agency on extended digital networks where 'objects' gather information, share this information about us and, crucially, communicate with each other outside of what is humanly perceivable.

In Chapter 9, Betti Marenko and Pim Haselager investigate technological fetishism and techno-determinism. The promise of technology as a sort of magical solution is still too pervasive among the privileged part of society, scholars, academics and technologists, and this kind of thinking is put to the test when actually bringing technology into society. Marenko and Haselager draw on a Marxist critique to address technology-induced alienation, techno-fetishism and life captured by an exploitative technocratic system that needs to keep on extracting people's data to function. Simple conveniences are traded for data, and the social structures of people's everyday lives can become regimented by smart objects. In

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a philosophical fiction, Marenko and Haselager imagine Karl Marx himself sitting on the sofa of a smart home intent in taking notes – exactly as he did in his analysis of the Industrial Revolution – and imagine how the world of smart objects would appear to him as an ecosystem of alienation-inducing commodities. The aim is to highlight pervasive deterministic assumptions concerning the role of digital technologies and impart a critical stance on the design of smart objects.

Chapter 10 by Ann Light questions the dominant narratives and agendas around smart technologies from the standpoint of her own first-person account of engaging with people in co-designing and planning for smart connected futures. Through the discussion of three research projects about future network technologies from the early 2000s to more recent times, Light critically examines the challenges in dealing with envisioning the invisible infrastructures of data and the difficulties of operating in contexts still in the making, fraught with indifference and scepticism. The observation of people's sense-making processes related to future technologies by what these innovations may tangibly afford them reveals key difficulties in how people conceptualize the notion of networks. Light advocates for values centred around the notions of care and empathy to be embedded in the design of smart objects by enabling collective participation to make a bridge between academic research and people's everyday concerns, which ultimately facilitates interconnectedness with each other and our planet.

A consideration of the ethical, legal and societal implications (ELSI) of AI is discussed by Pim Haselager in Chapter 11. His chapter is a reminder that while smart objects ought, ideally, add their own smartness to that of their users so as to improve overall functionality and experience, in practice, however, such mixes of human and non-human intelligences might lead to unfavourable and unpredictable outcomes, and to increased risk of undesirable consequences. Worst of all, the use of smart objects might lead to users' uncertainty about agency, responsibility and liability, and a lack of clarity about who, or what, is in charge. Haselager makes a plea for the development of 'wise objects': smart objects that adhere to ethical, legal and societal constraints and minimize agency and responsibility confusions. This shift from 'smart' to 'wise' further opens up an imaginary space that, by envisioning smart objects that can go against the requests or actions of their users, that are responsible and that 'know when to quit', can inspire designers in prototyping increasingly protective, reliable and trustworthy smart objects.

A launch into the future

This book should be taken both as a snapshot of the present situation as well as an indication of the terms of a future research agenda, which we argue is transdisciplinary, process-oriented and relational. The research agenda that this book puts forward offers practical suggestions through design speculations,

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interventions and practices, aims to participate in future societal transformations and triggers reflection, dialogue and debate. This research agenda wants to enable the design and development of smart objects within technological and commercially driven environments and industries, while providing a robust critique to sustain such development. One thing is clear, a research agenda for interaction design demands practices, modes of thinking and ethical standpoints, as well as new vocabularies and images to think with. It centres on an understanding and design of smart objects that embrace their hybrid nature as shifting and blending tools, agents, machines and even 'creatures' that can enter into multiple kinds of relationships with us humans that are meaningful and empowering in the context of everyday life. It aims to illuminate hidden infrastructures behind the functioning of smart objects by stirring debates centring on technology, human values and impact on economy and ecology. We hope that reading this book will provide you, the reader, with inspiration on how to engage in this agenda as a scholar, design practitioner or activist. Finally, we want to hear from you on how these ideas resonate with your own practices in academia, industry or education, and engage in a dialogue that we hope can start as the book ends.

Bibliography

Aarts, E., & Wichert, R. (2009). Ambient intelligence. In *Technology guide* (pp. 244–249). Berlin: Springer.

Ackermann, E. (2005). Playthings that do things: A young kid's 'incredibles'! In *Proceedings of the 2005 Conference on Interaction Design and Children (IDC '05)* (pp. 1–8). New York: ACM.

Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of things: A survey on enabling technologies, protocols, and applications. *IEEE Communications Surveys & Tutorials*, 17(4), 2347–2376.

Allen, J. F., Byron, D. K., Dzikovska, M., Ferguson, G., Galescu, L., & Stent, A. (2001). Toward conversational human-computer interaction. *AI Magazine*, *22*(4), 27.

Appadurai, A. (Ed.). (1986). *The social life of things: Commodities in cultural perspective*. Cambridge: Cambridge University Press.

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer Networks*, *54*(15), 2787–2805.

Auger, J. (2014). Living with robots: A speculative design approach. *Journal of Human-Robot Interaction*, *3*(1), 20–42.

Barad, K. (2007). *Meeting the universe half-way: Quantum physics and the entanglement of matter and meaning*. Durham: Duke University Press.

Bødker, S., & Andersen, P. B. (2005). Complex mediation. *Human-computer interaction*, *20*(4), 353–402.

Boer, L., & Bewley, H. (2018, June). Reconfiguring the appearance and expression of social robots by acknowledging their otherness. In *Proceedings of the 2018 on Designing Interactive Systems Conference 2018* (pp. 667–677). New York: ACM.

Braitenberg, V. (1986). *Vehicles: Experiments in synthetic psychology*. Cambridge, MA: MIT Press.

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Created from ual on 2021-09-17 10:59:18.

Breazeal, C. (2003). Toward sociable robots. *Robotics and autonomous systems*, *42*(3–4), 167–175.
Brooks, R. A. (1991). Intelligence without representation. *Artificial intelligence*, *47*(1–3), 139–159.
Candlin, F., & Guins, R. (2008). *The object reader*. Oxford: Routledge.
Chamberlain, A., Crabtree, A., Rodden, T., Jones, M., & Rogers, Y. (2012, June). Research in the wild: Understanding 'in the wild' approaches to design and development. In *Proceedings of the Designing Interactive Systems Conference* (pp. 795–796). New York: ACM.
Cila, N., Smit, I., Giaccardi, E., & Kröse, B. (2017, May). Products as agents: Metaphors for designing the products of the IoT age. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 448–459). New York: ACM.
Darwin, C. (2004). *On the origin of species, 1859*. Oxford: Routledge.
D'Adderio, L. (2011). Artifacts at the centre of routines: Performing the material turn in routines theory. *Journal of Institutional Economics*, *7*(2), 197–230.
De Certeau, M. (2011). *The practice of everyday life*. Berkeley: University of California Press.
Dennett, D. C. (1989). *The intentional stance*. Cambridge, MA: MIT Press.
Desjardins, A, Viny, J., Key, C. and Johnston, N. (2019). Alternative avenues for IoT: Designing with non-strereotypical homes. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, paper 351 (pp. 1–13). New York: ACM.
Dourish, P. (2004). *Where the action is: The foundations of embodied interaction*. Cambridge, MA: MIT Press.
Dove, G., Halskov, K., Forlizzi, J., & Zimmerman, J. (2017, May). UX design innovation: Challenges for working with machine learning as a design material. In *Proceedings of the 2017 Chi Conference on Human Factors in Computing Systems* (pp. 278–288). New York: ACM.
Engemann, C., & Feigelfeld, P. (2017) Distributed embodiment. In *Hello, Robot! Design between human and machine*. Exhibition catalogue (pp. 252–259). Weil am Rhein, Germany: Vitra Design Museum GmbH.
Engeström, Y. (1999). Activity theory and individual and social transformation. *Perspectives on Activity Theory*, 19(38), 19–30.
Farooq, U., & Grudin, J. (2016). Human-computer integration. *Interactions*, *23*(6), 26–32.
Fogg, B. J. (2003) *Persuasive technology: Using computers to change what we think and do*. San Francisco: Morgan Kaufmann.
Følstad, A., & Brandtzæg, P. B. (2017). Chatbots and the new world of HCI. *Interactions*, *24*(4), 38–42.
Forlizzi, J. (2008). The product ecology: Understanding social product use and supporting design culture. *International Journal of Design*, *2*(1), 11–20.
Forlizzi, J., & DiSalvo, C. (2006, March). Service robots in the domestic environment: A study of the Roomba vacuum in the home. In *Proceedings of the 1st ACM SIGCHI/SIGART Conference on Human-Robot Interaction* (pp. 258–265). https://doi.org/10.1145/1121241.1121286.
Fromm, J. (2005). Types and forms of emergence. *arXiv*. Retrieved 21 March 2021 from https://arxiv.org/abs/nlin/0506028.
Funk, M., Eggen, B., & Hsu, J. Y. J. (2018). Designing for systems of smart things. *International Journal of Design*, *12*(1), 1–5.
Giaccardi, E., Speed, C., Cila, N., & Caldwell, M. (2016). Things as co-ethnographers: Implications of a thing perspective for design and anthropology. In R. C. Smith, K. T. Vangkilde, M. G. Kjaersgaard, T. Otto, J. Halse & T. Binder (Eds), *Design anthropological futures* (pp. 235–248). Oxford: Routledge.

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Gibson, J. J. (1979). *The ecological approach to visual perception: Classic edition*. Hove, East Sussex, UK: Psychology Press.
Govers, P., Hekkert, P., & Schoormans, J. P. (2003). Happy, cute and tough: Can designers create a product personality that consumers understand. In D. McDonagh, P. Hekkert, J. van Erp & D. Gyi (Eds), *Design and emotion, Episode III: The experience of everyday things* (pp. 345–349). London: Taylor & Francis.
Gray, K., & Wegner, D. M. (2012). Feeling robots and human zombies: Mind perception and the uncanny valley. *Cognition*, 125(1), 125–130.
Greenfield, A. (2006). *Everyware: The dawning age of ubiquitous computing*. San Francisco, CA: New Riders.
Greenfield, A. (2017). *Radical technologies: The design of everyday life*. London: Verso.
Greengard, S. (2015). *The internet of things*. Cambridge, MA: MIT Press.
Hearst, M. A., Allen, J., Guinn, C., & Horvitz, E. (1999). Mixed-initiative interaction: Trends and controversies. *IEEE Intelligent Systems*, *14*(5), 14–23.
Heider, F., & Simmel, M. (1944). An experimental study of apparent behavior. *The American Journal of Psychology*, *57*(2), 243–259.
Hoffman, G., Kubat, R., & Breazeal, C. (2008, August). A hybrid control system for puppeteering a live robotic stage actor. In *The 17th IEEE International Symposium on Robot and Human Interactive Communication*, RO-MAN 2008 (pp. 354–359). New York: IEEE.
Hoffman, G., & Ju, W. (2014). Designing robots with movement in mind. *Journal of Human-Robot Interaction*, *3*(1), 89–122.
Holmquist, L. E. (2017). Intelligence on tap: AI as a new design material. *Interactions*, *24*(4), 28–33.
Horvitz, E. (1999, May). Principles of mixed-initiative user interfaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 159–166). New York: ACM.
Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press.
Ihde, D. (1990). *Technology and the lifeworld: From garden to earth* (No. 560). Bloomington: Indiana University Press.
Jacucci, G., Spagnolli, A., Freeman, J., & Gamberini, L. (2014, October). Symbiotic interaction: A critical definition and comparison to other human-computer paradigms. In *International Workshop on Symbiotic Interaction* (pp. 3–20). Cham: Springer.
Janlert, L. E., & Stolterman, E. (1997). The character of things. *Design Studies*, *18*(3), 297–314.
Jung, H., Stolterman, E., Ryan, W., Thompson, T., & Siegel, M. (2008). Toward a framework for ecologies of artifacts: How are digital artifacts interconnected within a personal life? In *Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges* (pp. 201–210). New York: ACM.
Kaptelinin, V., & Nardi, B.A. (2006). *Acting with technology: Activity theory and interaction design*. Cambridge, MA: MIT Press.
Kortuem, G., Kawsar, F., Sundramoorthy, V., & Fitton, D. (2010). Smart objects as building blocks for the internet of things. *IEEE Internet Computing*, 14(1), 44–51.
Kuijer, L., Jong, A. D., & Eijk, D. V. (2013). Practices as a unit of design: An exploration of theoretical guidelines in a study on bathing. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *20*(4), 21.
Kuijer, L., & Giaccardi, E. (2018, April). Co-performance: Conceptualizing the role of artificial agency in the design of everyday life. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (p. 125). New York: ACM.
Kuniavsky, M. (2010). *Smart things: Ubiquitous computing user experience design*. Amsterdam: Elsevier.

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Designing Smart Objects in Everyday Life : Intelligences, Agencies, Ecologies, edited by Marco C. Rozendaal, et al., Bloomsbury Publishing USA, 2021. ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/ual/detail.action?docID=6643010.
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Kuutti, K., & Bannon, L. J. (2014, April). The turn to practice in HCI: Towards a research agenda. In *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems* (pp. 3543–3552). New York: ACM.

Lakoff, G., & Johnson, M. (1980). Conceptual metaphor in everyday language. *The Journal of Philosophy*, *77*(8), 453–486.

Latour, B. (1993). *We have never been modern*. Cambridge, MA: Harvard University Press.

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Laurel, B. (1997). Interface agents: Metaphors with character. In Batya Friedman (Ed.), *Human Values and the Design of Computer Technology* (pp. 207–219). Stanford: CSLI Publications.

Leontiev, A. N. (1975). *Activities. Consciousness. Personality*. Moscow: Politizdat.

Levillain, F., & Zibetti, E. (2017). Behavioral objects: The rise of the evocative machines. *Journal of Human-Robot Interaction*, *6*(1), 4–24.

Marenko, B. (2014). Neo-animism and design: A new paradigm in object theory. *Design and Culture*, *6*(2), 219–241.

Marenko, B., & van Allen, P. (2016). Animistic design: How to reimagine digital interaction between the human and the nonhuman. *Digital Creativity*, *27*(1), 52–70.

Mataric, M. J. (1993, April). Designing emergent behaviors: From local interactions to collective intelligence. In *Proceedings of the Second International Conference on Simulation of Adaptive Behavior* (pp. 432–441). https://doi.org/10.7551/mitpress/3116.003.0059.

McTear, M. F., Callejas, Z., & Griol, D. (2016). *The conversational interface*. Cham: Springer.

Michalski, R. S., Carbonell, J. G., & Mitchell, T. M. (Eds). (2013). *Machine learning: An artificial intelligence approach*. New York: Springer Science & Business Media.

Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & Automation Magazine*, *19*(2), 98–100.

Mulgan, G. (2018) *Big mind: How collective intelligence can change our world*. Princeton, NJ: Princeton University Press.

Nass, C., Steuer, J., Henriksen, L., & Dryer, D. C. (1994). Machines, social attributions, and ethopoeia: Performance assessments of computers subsequent to. *International Journal of Human-Computer Studies*, *40*(3), 543–559.

Norman, D. (1993). *Things that make us smart: Defending human attributes in the age of the machine*. New York: Basic Books.

Odom, W., & Duel, T. (2018, April). On the design of OLO radio: Investigating metadata as a design material. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (p. 104). New York: ACM.

Odom, W., Zimmerman, J., Davidoff, L. S., Forlizzi, J., Dey, A. K., & Lee, M. K. (2012). A fieldwork of the future with user enactments. In *Proceedings of DIS 2012* (pp. 338–347). New York: ACM.

Odom, W. T., Sellen, A. J., Banks, R., Kirk, D. S., Regan, T., Selby, M., *et al.* (2014, April). Designing for slowness, anticipation and re-visitation: A long term field study of the photobox. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1961–1970). New York: ACM.

Oogjes, D., Odom, W., & Fung, P. (2018, June). Designing for an other home: Expanding and speculating on different forms of domestic life. In *Proceedings of the 2018 on Designing Interactive Systems Conference 2018* (pp. 313–326). New York: ACM.

Pierce, J., Strengers, Y., Sengers, P., & Bødker, S. (2013). Introduction to the special issue on practice-oriented approaches to sustainable HCI. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 20(4), 1–8.

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Designing Smart Objects in Everyday Life : Intelligences, Agencies, Ecologies, edited by Marco C. Rozendaal, et al., Bloomsbury Publishing USA, 2021. ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/ual/detail.action?docID=6643010.
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Redström, J., & Wiltse, H. (2018). *Changing things: The future of objects in a digital world*. London: Bloomsbury.
Reeves, B., & Nass, C. I. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge: Cambridge University Press.
Robles, E., & Wiberg, M. (2010, January). Texturing the material turn in interaction design. In *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction* (pp. 137–144). New York: ACM.
Rose, D. (2014). *Enchanted objects: Design, human desire, and the internet of things*. New York: Simon & Schuster.
Rozendaal, M. C. (2016). Objects with intent: A new paradigm for interaction design. *Interactions*, *23*(3), 62–65.
Rozendaal, M. C., Ghajargar, M., Pasman, G., & Wiberg, M. (2018). Giving form to smart objects: Exploring intelligence as an interaction design material. In Michael Filimowicz and Veronika Tzankova (Eds), *New Directions in Third Wave Human-Computer Interaction: Volume 1-Technologies* (pp. 25–42). Cham: Springer.
Rubinshtein, S. L. (1946). *Foundations of general psychology*. Moscow: Academic Science.
Scholl, B. J., & Gao, T. (2013). Perceiving animacy and intentionality: Visual processing or higher-level judgment. In M. D. Rutherford and V. A. Kuhlmeier (Eds), *Social perception: Detection and interpretation of animacy, agency, and intention* (pp. 197–229). Cambridge, MA: MIT Press.
Shove, E. (2007). *The design of everyday life*. Oxford: Berg.
Sterling, B. (2005). *Shaping Things – mediawork pamphlets*. Cambridge, MA: MIT Press.
Stolterman, E., & Croon Fors, A. (2008). Critical HCI research: A research position proposal. *Design Philosophy Papers*, 1, 23.
Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions*. Cambridge: Cambridge University Press.
Suchman, L. (2011). Subject objects. *Feminist Theory*, *12*(2), 119–145.
Takayama, L. (2009, March). Making sense of agentic objects and teleoperation: In-the-moment and reflective perspectives. In *2009 4th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 239–240). New York: IEEE.
Taylor, A. S. (2009, April). Machine intelligence. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2109–2118). New York: ACM.
Turkle, S. (2007). *Evocative objects: Things we think with*. Cambridge, MA: MIT Press.
Vallgårda A., (2014) Giving form to computational things: Developing a practice of interaction design. *Personal Ubiquitous Computing*, *18*(3), 577–592.
Verbeek, P-P. (2005). *What things do: Philosophical reflections on technology, agency, and design*. State College: Penn State Press.
Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Cambridge, MA: Harvard University Press.
Wakkary, R., Oogjes, D., Hauser, S., Lin, H. W., Cao, C., Ma, L., *et al.* (2017, June). Morse Things: A design inquiry into the gap between things and us. In *Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17)* (pp. 503–514). New York: ACM.
Wakkary, R., Oogjes, D., Lin, H. W., & Hauser, S. (2018, April). Philosophers living with the Tilting Bowl. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, paper 94 (pp. 1–12). New York: ACM.
Weiser, M. (1991). The computer for the 21st century. *Scientific American*, *265*(3), 94–104.
Wiberg, M. (2014). Methodology for materiality: Interaction design research through a material lens. *Personal and Ubiquitous Computing*, *18*(3), 625–636.
Wooldridge, M., & Jennings, N. R. (1995). Intelligent agents: Theory and practice. *The Knowledge Engineering Review*, *10*(2), 115–152.

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