



Responsible Domestic Robotics: Exploring Ethical Implications of Robots in the Home

Journal:	<i>Journal of Information, Communication & Ethics in Society</i>
Manuscript ID	JICES-12-2018-0096.R1
Manuscript Type:	Journal Paper
Keywords:	Robotics, Trust, Privacy, Social responsibility, Human-comp interaction

SCHOLARONE™
Manuscripts

Responsible Domestic Robotics

Exploring Ethical Implications of Robots in the Home

Dr Lachlan D. Urquhart

Lecturer in Technology Law, School of Law, University of Edinburgh; Visiting Research Fellow, Horizon Digital Economy Research Institute, Department of Computer Science, University of Nottingham.

Dominic Reedman-Flint

PhD Student, Horizon Centre for Doctoral Training, University of Nottingham, Department of Computer Science.

Natalie Leesakul

PhD Student, Horizon Centre for Doctoral Training, University of Nottingham, Department of Computer Science.

Abstract:

Purpose: The vision of robotics in the home promises increased convenience, comfort, companionship, and greater security for users. The robot industry risks causing harm to users, being rejected by society at large, or being regulated in overly prescriptive ways if robots are not developed in a socially responsible manner. The purpose of this paper is to explore some of the challenges and requirements for designing responsible domestic robots.

Design/methodology/approach: The paper examines definitions of robotics and the current commercial state of the art. In particular it considers the emerging technological trends, such as smart homes, that are already embedding computational agents in the fabric of everyday life. The paper then explores the role of values in design, aligning with human computer interaction and considers the importance of the home as a deployment setting for robots. The paper examines what responsibility in robotics means and draws lessons from past home information technologies.

An exploratory pilot survey was conducted to understand user concerns about different aspects of domestic robots such as form, privacy and trust. The paper provides these findings, married with literature analysis from across technology law, computer ethics and computer science.

1
2
3 **Findings:** By drawing together both empirical observations and conceptual analysis, this
4 paper concludes that user centric design is needed to create responsible domestic robotics
5 in the future.
6
7
8
9

10 **Originality/value:** This multidisciplinary paper provides conceptual and empirical
11 research from different domains to unpack the challenges of designing responsible
12 domestic robotics.
13

14
15 **Keywords:** Domestic Robotics, Cyber-Physical Systems, Internet of Things,
16 Responsibility, Regulation/Governance, Law, Trust.
17

18 **Paper Type:** Research Paper (Conceptual; Literature Review and Empirical Findings)
19

20 21 **1. Introduction: The Robots are Coming**

22
23 The vision of robotics in the home promise increased convenience, comfort,
24 companionship, and greater security for users. However, the reality, and impact on users,
25 may not always meet this vision. Fears of robot uprisings are peppered throughout decades
26 of science fiction literature and film (Higbie, 2013). However, visions of technological
27 futures often say more about the period they were written in, than actually forecasting what
28 futures might emerge (Reeves, 2012), as we have seen with computer science research into
29 ‘ubicomputing’ (Bell and Dourish, 2006). Whilst popular science and cultural visions of robots
30 may not have fully emerged, computational agents have most definitely left the lab and
31 entered daily life in a variety of forms. The Internet of Things (IoT) is incrementally
32 making homes smarter by embedding networked, ambient technologies with varying
33 degrees of autonomy into the physical and social fabric of domestic life. These devices can
34 be for security (smart CCTV and locks), comfort (smart bulbs and thermostats) and
35 entertainment (conversational agents in smart speakers). These artefacts may not all be
36 ‘robots’ in the popular sense of the word, but they are restructuring interactions, social
37 order and relationships in the home. As domestic service robot technologies advance and
38 become more commercially accessible, the smart home will have already changed the
39 domestic setting and laid the groundwork for robots to assimilate. Accordingly, they need
40 to learn from mistakes being made with smart homes, including being designed in more
41 user centric ways. It is important to understand user concerns and respond to these
42 accordingly, to create a more sustainable domestic robot future.
43
44
45
46
47
48
49

50
51 Our paper structure firstly explores changing definitions of domestic robots before
52 considering human computer interaction perspectives on value sensitive, user centric and
53 contextually aware design in the home. Secondly, we unpack the nature of responsibility,
54 arguing roboticists need to understand and respond to user concerns. This often does not
55 occur currently, creating technologies unfit for purpose and disruptive to the social order
56
57
58
59
60

of the home. We conclude by presenting user concerns from our small-scale exploratory survey, focusing particularly on trust, privacy and form of robots as key hurdles for creating *responsible domestic robotics*.

2. Definitions

Standards are a good place to start navigating a definition of domestic robots, as they can show what multiple stakeholder consensus is around a topic. The International Federation of Robotics/ United Nations Economic Commission for Europe were influential in classifying robots, culminating in the ISO standard 8373:2012 on Robots and Robotic devices. This standard differentiates between, among others, industrial, mobile, service, personal service and professional service robots. According to them, a robot is “*an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention*” (ISO 8373, s2.08). We focus on ‘service robots,’ which are ‘*robot[s] that perform useful tasks for humans or equipment excluding industrial automation applications*’ (ISO 8373, s2.10) and particularly the sub category of ‘personal service robots’; “*service robots for personal use...used for a non-commercial task, usually by lay persons... (i.e.) domestic servant robot, automated wheelchair, personal mobility assist robot, and pet exercising robot*” (ISO 8373, s2.11). As we can see, these definitions foreground the materiality of the artefact (i.e. being able to actuate physically), the varying degrees of autonomy they possess to shape the environment, the relationship of utility to humans, and the split between industrial and personal.

If we look more widely, by turning to academic sources we see robots framed slightly differently. For Mataric, (2007, p. 2) “*a robot is an autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals*”. Bryson and Winfield state *robots* are “artefacts that sense and act in the physical world in real time” and they state a smartphone counts as a robot as it can sense when its falling or orientation changes (Bryson and Winfield, 2017, p117). Both definitions encapsulate the ability to act in the physical world, but don’t necessarily prescribe the robots as being physical themselves. In providing a more design orientated definition for domestic robots, Bartneck and Forlizzi (2004, p. 2) highlight the interactional aspects, stating “*a domestic robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact*”. This definition foregrounds the interactional aspect, and particularly to what extent robots fit into pre-existing norms and contexts. All of the above perspectives feature in EU legal discussions around civil liability for robots, which recommend defining ‘smart robots’ by focusing on the attributes of:

1
2
3 " – the capacity to acquire autonomy through sensors and/or by exchanging data with its
4 environment (inter-connectivity) and the analysis of those data;

5
6
7 – the capacity to learn through experience and interaction;

8
9 – the form of the robot's physical support;

10
11 – the capacity to adapt its behaviour and actions to the environment."
12 (European Parliament, 2017, p. 18)

13
14 However, in defining robots, neatly separating them from interactive AI becomes a
15 challenge e.g. human-agent collectives, IBM Watson, Google Duplex, DeepMind AlphaGo
16 etc. Whilst some definitions above focus on the physicality of robots, they do not exclude
17 non-physical, more ethereal robots that actuate in the real world. Given the current trend
18 towards smart homes with integration of more ethereal devices not providing physical
19 interactions, but cognitive support, there is a case for considering interactive AI too. This
20 includes search functionality (conversational agents in different devices, like Amazon
21 Alexa), heating management (smart thermostats like Nest) or observational security of
22 space (Nest Cam).

23
24 It is worth briefly reflecting on definitions of AI as digital artefacts that have intelligence,
25 i.e. "capacity to perceive contexts for action...to act...to associate contexts to actions"
26 using techniques like speech or pattern recognition (Bryson and Winfield, 2017, p. 117).
27 This wider framing encapsulates many of the domestic IoT technologies. Accordingly, this
28 paper considers interactive artificial intelligence in addition to more material framings of
29 robots.

30 31 32 33 34 35 36 **3. Commercial State of the Art**

37
38 Irrespective of definitions, there are various degrees of agency and artificial intelligence
39 emerging in the domestic setting. The number of service robots in the home is growing at
40 an impressive rate globally. The *International Federation of Robotics 2017 Report on*
41 *World Robotics* states there was an annual increase in sales of personal and domestic
42 service robotics from 2015-2016 of 24% to roughly 6.7m robots, with the market valued at
43 US\$2.6bn (International Federation of Robotics (IFR), 2017, p. 14). Interestingly, US
44 companies dominate as manufacturers of domestic service robots, whereas 94% of
45 elderly/handicap assistance bots come from Asian/Australian companies (IFR, 2017, p.
46 18).

47
48 The current domestic service robot market includes both start-ups and major
49 manufacturers' offerings. Companies creating new robot products include Honda's 3E
50 family of modular robot platforms for assisting with mobility and even sports training
51 (Honda, 2018); Panasonic's desktop companion robot complete with child-like voice to
52

1
2
3 'add realism' (Panasonic, 2017); and Bosch's Mykie which helps with cooking and
4 projecting recipes onto the wall (Clark Thompson, 2017). Humanoid robots are hitting the
5 market too, performing tasks as diverse as conducting funerals (Gibbs, 2017), teaching
6 yoga (Ubtech Robotics Lynx (Gebhard, 2018)) and personal videography (Kuri, 2018).
7
8

9 For macro level insights, IFR (2017, p. 14) states more than 4.6 million domestic robots
10 sold in 2016, are for "vacuum and floor cleaning, lawn-mowing robots, and entertainment
11 and leisure robots, including toy robots, hobby systems, education and research". In
12 Appendix 1 we provide our non-exhaustive analysis of the domestic robot market, as of
13 May 2018. We now turn to HCI to understand why the home is a complex deployment
14 setting for domestic robots.
15
16
17

18 **4. The Importance of the Home**

19

20 One of our key arguments is the growth in domestic internet of things technologies, the so-
21 called smart home, is paving the way for domestic robots. However, the process of
22 integrating IoT into the home has impacts for residents living with these devices. There is
23 a growing interface between domestic IoT and robots. Robots that manage and speak to
24 IoT devices act as mediators for users and intermediaries for services, providing more
25 intuitive interactions between user and devices e.g. LGs Cloi (Kelion, 2018). Companies
26 such as Amazon, already established in homes through Alexa/Echo, have robotics
27 aspirations too (Gurman and Stone, 2018). We need to learn from the mistakes that are
28 currently being made in terms of responsibility for privacy, security and trust with IoT, to
29 ensure these are not being replicated for robots.
30
31
32
33

34 Like robots, IoT has moved from the lab to the home and the consumer market has grown
35 hugely in recent years (Cisco, 2013; Panetta, 2017). Ownership of domestic IoT devices
36 is anticipated to rise significantly, with the OECD predicting by 2022, a family of four will
37 own 2 connected cars, 7 smart light bulbs, 5 internet connected power sockets, 1 intelligent
38 thermostat and so on (OECD, 2013). Whilst these predictions may be optimistic, they are
39 no longer constrained to visions like Weiser's ubiquitous computing (Weiser and Mark,
40 1993) or Philips Ambient Intelligence (Aarts and Marzano, 2003). An IoT future is here,
41 just perhaps not the one originally envisioned of invisible computers and seamless
42 networking (Bell and Dourish, 2006). However, many market offerings are for goods or
43 services individuals do not know they even want or need (Lee, Choi and Kim, 2017).
44
45
46
47

48 Domestic technologies being developed without regard for what users actually want and
49 neglecting domestic routines and social practices has been an established challenge in HCI.
50 (Rodden and Benford, 2003; Tolmie *et al.*, 2002; Crabtree and Rodden, 2004). Smart
51 homes deployments, for example, implement an instrumentalist visions whilst neglecting
52 interests of users (Leppänen and Jokinen, 2003). Wilson (2015) found that whilst benefits
53 like increased efficiency, comfort, convenience, energy management, care, security are
54
55
56
57
58
59
60

1
2
3 promised, designers need to look at “how the use and meaning of technologies will be
4 socially constructed and iteratively negotiated, rather than being the inevitable outcome of
5 assumed functional benefits” (p. 466) because homes are ‘internally differentiated,
6 emotionally loaded, shared and contested places’ (p. 470) .
7
8

9
10 Numerous studies examine how individuals live with smart domestic technologies. A US
11 study found user’s frustration caused by unreliability, devices requiring iterative tweaking
12 over time, and security concerns about unauthorised remote access (particularly for locks
13 and home cameras) (Brush *et al.*, 2011). Users still desired such technologies, and in a
14 recent study, on user perceptions of privacy risks in IoT, they find users still purchase these
15 devices, despite privacy concerns, showing the privacy paradox continues with IoT
16 (Williams, Nurse and Creese, 2017). Mäkinen (2016) found internal tensions for 13
17 residents around trade-offs with home surveillance systems in Finland, for example
18 balancing a sense of safety and protection of the home against fear of being watched
19 without knowledge or implications of monitoring other home occupants, such as perceived
20 spying. More recently, Coskun, Kaner and Bostan (2018) explored reasons why smart
21 home technologies don’t have greater uptake. They found elements like users want smart
22 home technology to take over chores, but not for automation to interfere with pleasurable
23 activities, such as cooking, or going beyond comfort to improving skills such as cooking.
24 This shows the contested nature of domestic life, and the need to respond to context and
25 users through user centric design approaches. These lessons from smart homes could
26 inform domestic roboticists to and support design of systems users actually want.
27
28
29
30
31

32 33 **5. Responsible Robot(icists)? The Challenges of Domestic Robots.**

34
35 Robots pose numerous ethical challenges for privacy rights, security management, trust
36 relationships, identity formation and limitations on user autonomy (Coeckelbergh, 2012;
37 Leenes and Lucivero, 2014). As IoT paves the way for domestic robots, security and
38 privacy vulnerabilities are arising (Brown, 2015). This can be unintended, such as publicly
39 accessible unsecured IoT devices with video feeds enabling data to move outside of
40 contextually appropriate boundaries of the home (Nissenbaum, 2009; Osborne, 2016;
41 Wetmore, 2018). Similarly, it can be intended, driven by business models of data
42 repurposing, such as Roomba selling floor plans of user homes (Jones, 2017). Private
43 practices are often made visible in the process of human robot interaction, and data about
44 these practices is used as a resource in the provision of new value-added services with
45 robots, hence perceptions of robots and interactive AI monitoring for surveillance are
46 established (Calo, 2010; Sharkey and Sharkey, 2012; Schafer and Edwards, 2017).
47 Inferences about behaviour based on social sorting (Lyon, 2003) of data doubles (Haggerty
48 and Ericson, 2000) can be used for social control and manipulation, with the home setting
49 making intimate behaviours observable and auditable. Opacity around the ecosystem of
50 stakeholders interested in knowing how users live makes it hard to know if and why they
51
52
53
54
55
56
57
58
59
60

are being watched: is it to monetise, police or manage their actions? Examples of products being pulled because of privacy concerns, particularly with child users e.g. Mattel Aristotle (Hern, 2017), highlight the public perception of such risks.

Accordingly, a 2015 Eurobarometer study on Autonomous systems (EU, 2015) found “*Eight in ten Europeans (82%) who use robots think well of them, while nine in ten (90%) among them would purchase one*”. A more recent 2017 Eurobarometer study (EU, 2017) of c28,000 EU citizens, states that 35% would be comfortable with robot support at work or delivering goods, but only 26% when it is for companionship or services when elderly/infirm or for performing an operation. They find, “*overall, 88% of respondents agree robots and artificial intelligence are technologies that require careful management.*” (EU, 2017). Therefore, we now consider questions of responsibility for one stakeholder group in particular: roboticists.

6. The Nature of Responsibility and the Role of Roboticists.

Responsibility is a loaded concept, having different meanings for different communities, morally, legally, and societally. This paper is interested in the responsibilities of roboticists, as opposed to robots themselves. The influential EPSRC Principles of Robotics recognises this divide, targeting their principles towards designers, builders and users of robots. They argue “*Robots are simply tools of various kinds, albeit very special tools, and the responsibility of making sure they behave well must always lie with human beings.*” (Boden *et al.*, 2017, p. 125)

Accordingly, by considering responsibilities of roboticists we turn to existing work on the how innovators address their wider responsibilities to society. The case for engineers and developers duty to look beyond function is that “*engineering design is an inherently moral activity*” (Verbeek, 2006, p. 368) and “*in effect, engineers ought to be considered de facto policymakers, a role that carries implicit ethical duties*” (Millar, 2008, p. 4). In foregrounding the needs of users in this, Shneiderman called on ‘researchers, system designers, managers, implementers, testers and trainers of user interfaces and information systems’ to exert influence, moral leadership and responsibility to find “ways to enable users to accomplish their personal and organisational goals whilst pursuing higher societal goals and serving human needs” (Shneiderman, 1990, p. 2).

One popular tool to support exercise of responsibility is codes of ethics. Professional bodies such as the Association of Computing Machinery (ACM), Institute of Electrical and Electronic Engineers (IEEE) and British Computing Society (BCS) have provide general guidance for members for many years (IEEE, 1963, ACM, 1992). The IEEE Code of Ethics, for example, asks members to consider how their work impacts quality of life of others, and introduces broader notions of responsibility to public welfare, safety and health. However, there are specific codes emerging for robots and interactive AI too. These range

1
2
3 from Asilomar AI Principles and ACM US Public Policy Council on Algorithmic
4 Transparency & Accountability to Japanese Society for AI and Montreal Declaration for
5 Responsible AI. Within these, the concepts of accountability, respect for human values,
6 privacy and safety, among others, recur (Winfield, 2017). More recently, the high-profile
7 *IEEE Ethically Aligned Design Version 2* proposed ethical commitments to human rights,
8 well-being, accountability, transparency and awareness of misuse. A key element the report
9 raises is around legal liabilities. Similarly, principle 2 of the EPSRC Principles states
10 “Humans, not robots, are responsible agents. Robots should be designed; operated as far
11 as is practicable to comply with existing laws, fundamental rights & freedoms, including
12 privacy” (Boden *et al.*, 2017).
13
14
15
16

17 This charge is being taken up by the EU, where efforts to establish civil law liabilities
18 around robotics are underway (European Parliament, 2017). This includes a proposed *Code*
19 *of Ethical Conduct for Robotics Engineers* (European Parliament, 2017). Again, it provides
20 utmost importance to the principles of dignity, privacy and safety of humans. But it also
21 includes principles on designing robots to respect fundamental rights, the precautionary
22 principle, inclusiveness, accountability, safety, reversibility, privacy, and maximising
23 benefit/minimising harm. Whilst all can be important for the home, the notes on privacy
24 are particularly interesting as they highlight the need for designers, particularly around
25 obtaining valid consent prior to man-machine interactions. This is a clear challenge for
26 human robot interactions, of communicating sufficient information to users in a
27 transparent, temporally sensitive manner.
28
29
30
31

32 There is need for operationalisation and strategies to embed such values in design. A
33 Responsible Research and Innovation approach is important here, as it focuses on practical
34 reflection and interaction with a range of stakeholders, to ensure stewardship for the future,
35 going beyond high level aspirations (Von Schomberg, 2011, p. 9). Reflexivity of designers
36 on their position, knowledge and impact is key but a sense of responsibility can depend on
37 if designers are doing more applied or fundamental research (Grimpe *et al.*, 2014). Thus,
38 responsibilities within roboticist communities can be fragmented due to their role.
39
40
41
42

43 Drawing on its role in human computer interaction, the role for human values in design is
44 growing, as the ‘third wave’ of HCI widens the field to consider cultural, societal aspects
45 of computing, as opposed to purely functional aspects (Bødker, 2015). Authors such as
46 Nissenbaum, (2005), Flanagan, Howe and Nissenbaum (2008), Sellen *et al.* (2009) highlight
47 the need for bringing values into design. Sellen *et al.*, (2009, p. 66) argue for user centrality
48 in the design process, stating, “*HCI must also take into account the truly human element,*
49 *conceptualising ‘users’ as embodied individuals who have desires and concerns and who*
50 *function within a social, economic and political ecology*”. In bringing values into design,
51 ‘value sensitive design’ (VSD) (Friedman, Kahn and Borning, 2008; Friedman, Hendry
52 and Borning, 2017) has been a key framework, trying to make “*moral values part of*
53 *technological design, research and development.*” (Van den Hoven, 2006, p. 67).
54
55
56
57
58
59
60

1
2
3 Within the VSD framework, values with ethical import should be brought into the design
4 process, i.e. values that “a person or group of people consider important in life” (Friedman,
5 Kahn and Borning, 2008, p. 70), such as those that “centre on human well-being, human
6 dignity, justice, welfare and human rights” (Friedman, Kahn and Borning, 2008, p. 1180).
7 Criticisms of VSD have focused on “what values”, and bringing more situated, local values
8 into design, not just high level values, such as those in the codes of ethics above (Le Dantec,
9 Poole, E. and Wyche, 2009). Accordingly, for responsible domestic robotics, user centric
10 design strategies such as design ethnographies (Crabtree, Tolmie and Rouncefield, 2012)
11 and co-design (Steen, 2011) are critical to understanding the real needs and values users
12 want in domestic robotics. There is growing recognition of the importance of these
13 concepts in robotics too, as one prominent definition of human robot interactions states,
14 there is need to “meet the social and emotional needs of their individual users as well as
15 respecting human values” (Dautenhahn, 2018). Furthermore, there are already examples of
16 use of VSD for robotics, particularly care robots (van Wynsberghe, 2013b, 2013a).
17 Recognising the need to understand user concerns, we conducted a short survey which we
18 now present.

25 **7. Presenting the Survey**

27 The small-scale pilot survey was constructed to establish views and concerns of the
28 general public around the emergence of domestic robots. It was informed by existing
29 literature, from a breadth of disciplines considering legal and ethical matters around
30 robots e.g. law, philosophy, computer science, engineering science fiction. The survey
31 adopted a broad view of ‘domestic robots’ to include interactive artificial intelligence, to
32 capture existing new technology such as Alexa and other personal assistants that
33 respondents may have experience of using. The survey was approved by University of
34 Nottingham Computer Ethics process, ran from 6th – 28th March 2018, and was shared
35 primarily through social media channels (namely Twitter, Facebook and Reddit). Of the
36 43 respondents to this survey, 18 were identifiably male and 18 female, 1 non-binary and
37 6 remained anonymous. There was an age spread from teenage to over 70 years old with
38 a concentration from 20-45 years old. The survey was broken into 3 broad themes,
39 namely, general feelings & experience with robots; trust and interaction; future thinking.
40 This enabled us to establish current understanding and exposure to robots before
41 exploring views on future usage, ethical guidance and trust in more depth. The findings
42 can be summarised under the following themes.¹

51
52
53 ¹ As is the nature of surveys, participants sometimes omit to answer questions. We have accounted for this
54 in any descriptive statistics presented. Any results based on less than the full 43 participants are labelled as
55 such, and the result is recalculated to reflect this. Again, this is a small scale, explorative pilot study, but
56 provides useful insights we present here on their own, limited terms.

1
2
3 *General Feelings and Experiences:* Existing technology such as Alexa, Google Home and
4 other domestic robots such as Roomba (robotic Hoover) had only been experienced by just
5 over 30% of all respondents with the remainder citing cost (36.7%) dislike (23.3%) and
6 others (50%). For those who cited others, the main recurring theme was lack of
7 trust/privacy issues as the reasons for lack of engagement,² as one participant stated, “I
8 don't see a tremendous amount that these devices could do to improve our family life at the
9 moment; certainly not enough to justify the cost and personal data implications.”³
10
11
12

13 Privacy and informational harms are major concerns⁴, and when asked to state two fears
14 from the introduction of domestic robots almost 75% of all participants cite concerns
15 around covert listening/privacy/hacking. The challenge for the domestic robot industry will
16 become managing the privacy trade-off for consumers. The responses made clear that
17 people were aware of their privacy being traded for the benefits conveyed by AI/domestic
18 robots but striking that balance where the robot's duties outweigh the loss of privacy has
19 yet to be achieved in the majority of respondent's opinions.
20
21
22

23 On the positive side, 50% of 42 respondents were at least slightly positive about the
24 increase in Artificial Intelligence in the home.⁵ Additionally, the most cited two benefits
25 from the introduction of domestic robots among the 43 respondents are time
26 saving/convenience and companionship/care.⁶ When all 43 respondents were asked about
27 a range of tasks for future domestic robots to perform, among others, the top roles were
28 cleaning (95.3%); washing/ironing (79.1%) and medical/care (69.8%). Somewhat
29 contradictorily, in a later question asking what robots should not do, 54.8% of the 31
30 question respondents felt that robots should not be allowed to have childcare/parenting/care
31 roles, which appears contradictory.⁷
32
33
34
35

36 *Future Thinking:* Respondents were wary of providing domestic robots with legal rights.⁸
37 Only 16.3% of all respondents felt that domestic robots should have any rights protected
38
39

40
41
42
43 ² Finding 1

44 ³ In addition to the statistics, we also present qualitative quotes or other feedback from our respondents. This
45 provides further context and is sourced from free form boxes in the survey where they could further explain
46 their answers.
47

48 ⁴ Finding 3

49 ⁵ Finding 2

50 ⁶ Finding 2

51 ⁷ Finding 4

52 ⁸ Finding 5
53
54
55
56
57
58
59
60

1
2
3 by law although the sentience of the robot was recognised largely as the deciding factor.
4 This implies that respondents are not yet comfortable with robots having legal rights,
5 although by pointing to sentience as a variable for legal protection, where robots sit in
6 relation to other species, such as animals, will be a legal challenge for the future.
7
8

9 Independence in ethical control for robots was key⁹, with 78.6% of 42 respondents wanting
10 an independent body to be responsible for controlling the any ethical rules driving domestic
11 robots. Interestingly, government was the second most approved controller (57.1%),
12 perhaps demonstrating an inherent trust in governmental control (or perhaps showing a
13 lack of trust in other options). An interesting comment that backed this up is:
14
15

16
17 *I don't trust companies to regulate themselves at all, not under capitalism where*
18 *they aim to make profits, see Uber evading police controls, Volkswagen messing*
19 *about with the Diesel fumes, Facebook not caring about people abusing data mined*
20 *from their service - it's a mess.'*
21
22

23 The physical form of the domestic robot matter¹⁰, and in this survey almost 60% of 42
24 respondents felt that the physical form a domestic robot takes makes a difference. Some
25 stated, *"it's still a machine regardless"* and *"they perform a function so looks are*
26 *irrelevant"* whilst another stated *"the more human like it is the more users are likely to*
27 *regard it as human. This can have advantages and disadvantages."* This recognises the
28 impacts of the form domestic robots take remains an unsettled domain. However, robot
29 form (humanoid or not) links back to discussion of robot rights, and more broadly, robot
30 personhood, which is an ongoing debate in the EU (European Parliament, 2017) and wider
31 academic circles (Darling, 2016; Schafer, 2016). As such personhood would also enable
32 responsibility to be passed from roboticist to robot this remains a contested point (Delcker,
33 2018).
34
35
36
37

38 *Trust and Interaction:* Over 95% of all respondents either do not implicitly trust (51.2%)
39 or don't know (44.2%) about trusting domestic robots.¹¹ Some felt machines can fail, errors
40 can be made in programming and they are susceptible to hacking accurately replicates the
41 lack of trust highlighted earlier. Surprisingly, despite the lack of trust and recognition that
42 domestic robots are only machines, 74.4 % of all respondents felt that robots could help
43 with feelings of social isolation.¹²
44
45
46
47
48

49
50 ⁹ Finding 6

51
52 ¹⁰ Finding 7

53
54 ¹¹ Finding 8

55
56 ¹² Finding 9

This exploratory survey whilst not large scale, provides indicative topics for further reflection, particularly around the issue of trust, which we unpack further below.

7.4 Unpacking the Themes

Trust is key because, as Holder et al argue, “*user acceptance will be critical to uptake [of robots] and acceptance will be based on trust*” (Holder et al., 2016, p. 384). Various aspects of trust are considered below, before considering safety, privacy, transparency and control.

Human Robot Interaction and Trust: To address the shift from industrial robots to domestic robots that can “communicate with environment, follow human social norms, and mimic human abilities.” (Haidegger et al., 2013, p. 1216), better understanding of how users live and is needed. The field of *Human—Robot Interaction (HRI)* has emerged, “dedicated to understanding, designing, and evaluating robotic systems for use by or with humans” (Goodrich and Schultz, 2007, p. 204). Mataric (2007). set out a comprehensive list of human robot interaction orientated challenges, similar to those outlined above, around safety, privacy, attachment, and trust. Attachment is interesting for the domestic environment, as users become attached to their robots. “*Roomba users already refuse to have their Roombas replaced when they need repair, insisting on getting the same one back. What happens when the robot is much more interesting, intelligent, and engaging than the Roomba?*” (Mataric, 2007, p. 285-286)

Not all users are so attached, and from an interactional perspective, the line between trustworthiness and distrust can be tenuous (Mataric, 2007). Whilst Wagner (2009), shows that studies indicate humans tend to trust and confide in robots, in contrast, Pagallo argues “personal and/or domestic robots will raise a number of psychological issues concerning feelings of subordination, attachment, trustworthiness, etc.” (Pagallo, 2013, p. 502). Similarly, Holder et al. (2016) found that people have become more sceptical of robots as the technology advanced and capabilities increased. Hence, trust in human robot interactions has to deal with the legacy that it is normally formed between humans, but as humans & robots co-exist, metrics for trust need to adapt as “*the change in a user’s perception of a robot from simply being a technology to being a social actor.*” (Moran, Bachour and Nishida, 2015 p. 2)

Trust and Robot Form: One basis for trust is the *form of the robot*, ranging from non-humanoid (e.g. Roomba) to humanoid (e.g. Aeolus) or ethereal interactive AI (e.g. Alexa). This is highlighted above. Some robots may utilise more human attributes in their relationships with users “*which can help increase the perceptions of anthropomorphism, including facial features, physical expressiveness, emotions and personality.*” (Moran, Bachour and Nishida, 2015, p. 1). Similarly, affective robots have abilities to “[*recognize*] and [*synthesize*] emotional cues and response but are still largely incapable of emotional

1
2
3 *reasoning*” (Sullins, 2012, p. 399). However, given the possible emotional connection
4 between human and robot, human psychology can be exploited and user behaviour
5 manipulated (Darling, 2016). Hence, there legal and design-based protections for
6 vulnerable users who could be adversely influenced are necessary.
7
8

9 *Law and Trust*: The law can support trust in robots by ensuring they are safe and respect
10 privacy. With the legal approach, it could help set an equal playing field in the market
11 while regulating and protecting consumers by supporting “*trust in brands, trust in*
12 *functions, trust in privacy, trust in a fair market.*” (Holder *et al.*, 2016, p. 384) We explore
13 the legal frameworks around safety and data privacy below.
14
15

16
17 *Safety* – Currently, there is a lack of coherent legislation governing service robot safety.
18 For example, Directive 93/42/EEC concerning medical devices (as amended by Directive
19 2007/47/EC) (“Medical Device Directive”) and Directive 90/385/EEC on active
20 implantable medical devices (“AIMDD”) only apply to care robots in dealing with
21 medicine but not care robots with other functions. Standards, such as ISO 13482, plug this
22 gap. As care robots inherently deal with vulnerable populations, appropriate regulation
23 (Holder *et al.*, 2016), is necessary, especially given the multitude of contexts domestic
24 service robots may live in. Accordingly, whilst design can address some challenges,
25 ensuring legal frameworks that do exist are applicable is vital to protecting user interests.
26
27
28

29
30 *Privacy and Data Protection* – As Finding 3 states, privacy is a big concern. With domestic
31 robots, privacy risks are amplified as they are within the intimate setting of the home,
32 collecting sensitive data from users longitudinally, and profiling their behaviour over time
33 to provide contextually appropriate services. New European Data Protection frameworks,
34 such as the General Data Protection Regulation 2016 (GDPR) and proposed ePrivacy
35 Regulation, provide compliance requirements. This includes problematic requirements
36 such as around data portability (Article 5(2) GDPR; (Urquhart, Sailaja and McAuley,
37 2017)), accountability (Article 20 GDPR; (Urquhart, Lodge and Crabtree, 2018)) and the
38 right to be forgotten (Article 22 GDPR). As in many areas of IT regulation, the fast pace
39 of technological change and slow legal landscape means there is an increasing turn to
40 design as a regulatory tool (Lessig, 2006; Urquhart, 2017). Law and policy concepts like
41 privacy by design and default (PbD – Article 25 GDPR) and security by design (Article 32
42 GDPR) provide the mandate for ensuring personal data driven technologies embed
43 safeguards from the beginning, not just after a harm occurs. Supporting how best roboticists
44 can do PbD in practice requires extra thought, as it does for other developers (Luger *et al.*,
45 2015; Hadar *et al.*, 2018). As Mataric recognises “*Privacy has to be taken seriously when*
46 *the robot is designed, not after the fact, as a result of users’ complaints*” (Mataric, 2007,
47 p. 285-286). Navigating, the interface between HRI practitioners and researchers and law
48 will be critical, as it is already for HCI and law (Urquhart and Rodden, 2017).
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 *Transparency & Control*: Linked to data protection, is questions of transparency and
4 control. The degree of agency a robot has is a big concern as this impacts the degree of
5 uncertainty and ability to control its actions. Oversight of autonomous decisions, and how
6 these are made accountable to users is as much a design issue as it is a legal one (Edwards
7 and Veale, 2017). It is predicted that eventually robots will achieve the level of autonomy
8 where “they themselves become the data controller and responsible for compliance with
9 data privacy legislation” (Holder *et al.*, 2016, p. 395), a prediction also supported by
10 Pagallo, (2013). However, for now, focus should be on establishing and operationalising
11 the responsibility of roboticists to their users, and in particular, protecting their legal rights.
12 Translation between legal frameworks and design guidelines is important for this
13 (Urquhart, 2014).
14
15
16
17

18 **8. Conclusions**

19
20
21 The growth of smart homes is paving the way for domestic robots. There are a multitude
22 of existing challenges around robotics that need to be dealt with. Findings from the pilot
23 survey were numerous but highlight the relationships between robots and users with form,
24 privacy and trust. Given the current pitfalls being experienced with emergent smart homes,
25 there is a responsibility on roboticists to learn from these mistakes and design such robots
26 in legally, socially and ethically responsible ways. A key dimension of this is the need to
27 design technologies after engaging with, understanding and respecting needs of users.
28 Whilst there are commitments to many high-level ethical principles emerging in new codes
29 of conduct for roboticists, these need to be situated and operationalised. The current focus
30 in HCI on values in design is one approach to doing this. Similarly, the turn in law to design
31 for regulation means there is similar drive to consider end user interests and rights within
32 the design process. If the roboticists creating domestic robots ensure they engage with end
33 user interests, there is a chance they can emerge in a more responsible manner.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Funding: The research benefitted from the activities undertaken in: the “Moral-IT: Enabling Design of Ethical & Legal IT Systems” project as part of the Horizon Digital Economy Research Institute (EPSRC Grant EP/M02315X/1); RCUK Horizon Centre for Doctoral Training (EPSRC Grant EP/G037574/1).

Acknowledgements: The authors would like to acknowledge the contribution of all project participants and all project activities to the ideas that underpin this paper. The paper was presented at ETHICOMP 2018, and the authors thank participants for their comments.

Copyright: Copyright remains with the authors. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

References

Aarts, E. and Marzano, S. (2003) *The New Everyday: Views on Ambient Intelligence*. Rotterdam, Netherlands: 010 Publishers.

Bartlett, J. (2018) *Will 2018 be the year of the neo-luddite?*, *The Guardian*. Available at: <https://www.theguardian.com/technology/2018/mar/04/will-2018-be-the-year-of-the-neo-luddite> (Accessed: 25 May 2018).

Bartneck, C. and Forlizzi, J. (2004) ‘A design-centered framework for social human-robot interaction’, in *International Workshop on Robot and Human Interactive Communication*, pp. 591–594.

Bell, G. and Dourish, P. (2006) ‘Yesterday’s Tomorrow’s: Notes on Ubiquitous Computing’s Dominant Vision’, *Personal and Ubiquitous Computing*, 11(2), pp. 133–143.

Boden, M., Bryson, J., Caldwell, D., Dautenhahn, K., Edwards, L., Kember, S., Newman, P., Parry, V., Pegman, G., Rodden, T., Sorrell, T., Wallis, M., Whitby, B. and Winfield, A. (2017) ‘Principles of robotics: regulating robots in the real world’, *Connection Science*. Taylor & Francis, 29(2), pp. 124–129. doi: 10.1080/09540091.2016.1271400.

Bødker, S. (2015) ‘Third-wave HCI, 10 years later---participation and sharing’, *interactions*, 22(5), pp. 24–31. doi: 10.1145/2804405.

Brown, I. (2015) *GSR Discussion Paper - Regulation of the internet of things*, Geneva: International Telecommunications Union.

Brush, A. J. B. *et al.* (2011) ‘Home automation in the wild’, in *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*. New York, New

1
2
3 York, USA: ACM Press, p. 2115. doi: 10.1145/1978942.1979249.
4

5 Bryson, J. and Winfield, A. (2017) 'Standardizing Ethical Design for Artificial Intelligence
6 and Autonomous Systems', *Computer*, 50(5), pp. 116–119. doi: 10.1109/MC.2017.154.
7

8
9 Calo, R. (2010) 'Robots and Privacy', in *ROBOT ETHICS: THE ETHICAL AND SOCIAL
10 IMPLICATIONS OF ROBOTICS*, Patrick Lin, George Bekey, and Keith Abney, eds.,
11 Cambridge: MIT Press, Forthcoming.
12

13
14 CES 2018: LG robot Cloi repeatedly fails on stage at its unveil - BBC News . Available at:
15 <https://www.bbc.co.uk/news/technology-42614281> (Accessed: 23 May 2018).
16

17 Cisco (2013) *The Internet of Everything*. San Jose. Available at:
18 https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoE_Economy_FAQ.pdf
19 (Accessed 24 May 2018)
20

21
22 Clark Thompson, A. (2017) *Bosch made a countertop robot with recipe smarts*, CNET.
23 Available at: <https://www.cnet.com/products/mykie/preview/> (Accessed: 24 May 2018).
24

25
26 Coeckelbergh, M. (2012) 'Can we trust robots?', *Ethics and Information Technology*.
27 Springer Netherlands, 14(1), pp. 53–60. doi: 10.1007/s10676-011-9279-1.
28

29
30 Coskun, A., Kaner, G., & Bostan, I. 2018, 'Is Smart Home a Necessity or a Fantasy for the
31 Mainstream User? A Study on Users' Expectations of Smart Household
32 Appliances.', *International Journal of Design*, vol 12, no. 1.
33

34
35 Crabtree, A. and Rodden, T. (2004) 'Domestic routines and design for the home',
36 *Computer Supported Cooperative Work: CSCW: An International Journal*, 13(2), pp.
37 191–220. doi: 10.1023/B:COSU.0000045712.26840.a4.
38

39
40 Crabtree, A., Tolmie, P. and Rouncefield, M. (2012) *Doing Design Ethnography*. London:
41 Springer Verlag.

42
43 Le Dantec, C., Poole, E., A. and Wyche, S. (2009) 'Values as Lived Experience:
44 Proceedings, Evolving Value Sensitive Design in Support of Value Discovery', in *CHI'09*.
45 New York: ACM, pp. 1141–1150.
46

47
48 Darling, K. (2016) 'Extending Legal Protection to Social Robots: The Effects of
49 Anthropomorphism, Empathy, and Violent Behaviour Towards Robotic Objects', *We
50 Robot Conference 2012*, 3, pp. 60–74. doi: 10.2139/ssrn.2044797.
51

52
53 Dautenhahn, K. (2018) 'Human Robot Interaction', in *The Encyclopedia of Human-
54 Computer Interaction*, 2nd Ed. Interaction Design Foundation.
55

56
57 Delcker, J. (2018) *Europe divided over robot 'personhood' – POLITICO*. Available at:
58
59
60

1
2
3 [https://www.politico.eu/article/europe-divided-over-robot-ai-artificial-intelligence-](https://www.politico.eu/article/europe-divided-over-robot-ai-artificial-intelligence-personhood/)
4 [personhood/](https://www.politico.eu/article/europe-divided-over-robot-ai-artificial-intelligence-personhood/) (Accessed: 24 May 2018).
5

6
7 Edwards, L. and Veale, M. (2017) 'Slave to the Algorithm? Why a Right to Explanation
8 is Probably Not the Remedy You are Looking for', *SSRN Electronic Journal*. doi:
9 10.2139/ssrn.2972855.
10

11 EU (2015) *Eurobarometer 427 on Automomous Systems*. Brussels.
12

13
14 EU (2017) *Special Eurobarometer 460: Attitudes towards the impact of digitisation and*
15 *automation on daily life - Datasets*. Available at:
16 https://data.europa.eu/euodp/data/dataset/S2160_87_1_460_ENG (Accessed: 22
17 November 2018). Brussels.
18

19
20 European Parliament (2017) *Civil Law Rules on Robotics*. Brussels.
21

22 Flanagan, M., Howe, D. and Nissenbaum, H. (2008) 'Embodying Values in Technology:
23 Theory and Practice', in Van Den Hoven, J. and Weckert, J. (eds) *Information Technology*
24 *and Moral Philosophy*. Cambridge: Cambridge University Press.
25

26
27 Friedman, B., Hendry, D. G. and Borning, A. (2017) 'A Survey of Value Sensitive Design
28 Methods', *Foundations and Trends® in Human-Computer Interaction*. Now Publishers,
29 Inc., 11(2), pp. 63–125. doi: 10.1561/11000000015.
30

31
32 Friedman, B., Kahn, P. H. and Borning, A. (2008) 'Value Sensitive Design and
33 Information Systems', in Himma, K. and Tavani, H. (eds) *The Handbook of Information*
34 *and Computer Ethics*. New York: Wiley and Sons.
35

36
37 Gebhard, A. (2018) *Ubtech Lynx review: Alexa in a yogi bot is surprisingly boring*, *CNET*.
38 Available at: <https://www.cnet.com/products/ubtech-robotics-lynx/review/> (Accessed: 24
39 May 2018).
40

41
42 Gibbs, S. (2017) *The future of funerals? Robot priest launched to undercut human-led rites*,
43 *The Guardian*. Available at: [https://www.theguardian.com/technology/2017/aug/23/robot-](https://www.theguardian.com/technology/2017/aug/23/robot-funerals-priest-launched-softbank-humanoid-robot-pepper-live-streaming)
44 [funerals-priest-launched-softbank-humanoid-robot-pepper-live-streaming](https://www.theguardian.com/technology/2017/aug/23/robot-funerals-priest-launched-softbank-humanoid-robot-pepper-live-streaming) (Accessed: 24
45 May 2018).
46

47
48 Goodrich, M. A. and Schultz, A. C. (2007) 'Human-Robot Interaction: A Survey',
49 *Foundations and Trends® in Human-Computer Interaction*, 1(3), pp. 203–275. doi:
50 10.1561/11000000005.
51

52
53 Gurman, M. and Stone, B. (2018) *Amazon Has a Top-Secret Plan to Build Home Robots*,
54 *Bloomberg*. Available at: [https://www.bloomberg.com/news/articles/2018-04-23/amazon-](https://www.bloomberg.com/news/articles/2018-04-23/amazon-is-said-to-be-working-on-another-big-bet-home-robots)
55 [is-said-to-be-working-on-another-big-bet-home-robots](https://www.bloomberg.com/news/articles/2018-04-23/amazon-is-said-to-be-working-on-another-big-bet-home-robots) (Accessed: 24 May 2018).
56
57
58
59
60

1
2
3 Hadar, I. *et al.* (2018) 'Privacy by designers: software developers' privacy mindset',
4 *Empirical Software Engineering*. Springer US, 23(1), pp. 259–289. doi: 10.1007/s10664-
5 017-9517-1.
6

7
8 Haggerty, K and Ericson, R. (2000) 'The surveillant assemblage', *British Journal of*
9 *Sociology*, 51(4), pp. 605–622. doi: 10.1080/00071310020015280.
10

11 Haidegger, T. *et al.* (2013) 'Applied ontologies and standards for service robots', in
12 *Robotics and Autonomous Systems*, pp. 1215–1223. doi: 10.1016/j.robot.2013.05.008.
13

14
15 Hern, A. (2017) 'Kids should not be guinea pigs': *Mattel pulls AI babysitter*, *The*
16 *Guardian*. Available at: [https://www.theguardian.com/technology/2017/oct/06/mattel-](https://www.theguardian.com/technology/2017/oct/06/mattel-aristotle-ai-babysitter-children-campaign)
17 [aristotle-ai-babysitter-children-campaign](https://www.theguardian.com/technology/2017/oct/06/mattel-aristotle-ai-babysitter-children-campaign) (Accessed: 24 May 2018).
18

19
20 Higbie, T. (2013) 'Why Do Robots Rebel? The Labor History of a Cultural Icon', *Labor*
21 *Studies in Working-Class History of the Americas*. Duke University Press, 10(1), pp. 99–
22 121. doi: 10.1215/15476715-1899057.
23

24
25 Holder, C. *et al.* (2016) 'Robotics and law: Key legal and regulatory implications of the
26 robotics age (Part I of II)', *Computer Law & Security Review*. Elsevier Advanced
27 Technology, 32(3), pp. 383–402. doi: 10.1016/J.CLSR.2016.03.001.
28

29
30 Honda (2018) *Honda 3E Robot Series Press Release CES 2018*. Available at:
31 <http://world.honda.com/CES/2018/> (Accessed: 24 May 2018).
32

33
34 Van den Hoven, J. (2006) 'ICT and Value Sensitive Design', in Goujon, P. *et al* (ed.) *The*
35 *Information Society: Innovations, Legitimacy, Ethics and Democracy*, *IFIP International*
36 *Federation for Information Processing*. Springer Netherlands.
37

38
39 International Federation of Robotics (2017) 'Executive Summary - World Robotics
(Service Robots) 2017', *World Robotic Report - Executive Summary*.
40

41
42 Jones, R. (2017) *Roomba's Next Big Step Is Selling Maps of Your Home to the Highest*
43 *Bidder*. Available at: [https://gizmodo.com/roombas-next-big-step-is-selling-maps-of-](https://gizmodo.com/roombas-next-big-step-is-selling-maps-of-your-home-to-t-1797187829)
44 [your-home-to-t-1797187829](https://gizmodo.com/roombas-next-big-step-is-selling-maps-of-your-home-to-t-1797187829) (Accessed: 27 July 2018).
45

46
47 Kuri (2018) *Kuri: Your Companion, Assistant, Photographer And So Much More*.
48 Available at: <https://www.heykuri.com/living-with-a-personal-robot> (Accessed: 24 May
49 2018).
50

51
52 Lee, S.-E., Choi, M. and Kim, S. (2017) 'How and what to study about IoT: Research
53 trends and future directions from the perspective of social science', *Telecommunications*
54 *Policy*. Pergamon, 41(10), pp. 1056–1067. doi: 10.1016/J.TELPOL.2017.09.007.
55

56
57 Leenes, R. and Lucivero, F. (2014) 'Laws on Robots, Laws by Robots, Laws in Robots:
58
59
60

1
2
3 Regulating Robot Behaviour by Design', *Law, Innovation and Technology*. Routledge,
4 6(2), pp. 193–220. doi: 10.5235/17579961.6.2.193.

5
6
7 Leppänen, S. and Jokinen, M. (2003) 'Daily Routines and Means of Communication in a
8 Smart Home', in *Inside the Smart Home*. London: Springer-Verlag, pp. 207–225. doi:
9 10.1007/1-85233-854-7_11.

10
11
12 Lessig, L. (2006) *Code: Version 2.0*. New York: Basic Books.

13
14 Luger, E., Urquhart, L., Rodden, T. and Golembewski, M. (2015) 'Playing the Legal Card:
15 Using Ideation Cards to Raise Data Protection Issues within the Design Process', in
16 *Proceedings of the ACM CHI'15 Conference on Human Factors in Computing Systems*,
17 pp. 457–466. doi: 10.1145/2702123.2702142.

18
19
20 Lyon, D. (2003) *Surveillance as social sorting : privacy, risk, and digital discrimination*.
21 New York: Routledge.

22
23 Mäkinen, L. A. (2016) 'Surveillance ON/OFF. Examining home surveillance systems from
24 the user's perspective', *Surveillance and Society*, 14(1), pp. 59–77.

25
26
27 Mataric, M. J. (2007) *The Robotics Primer*. MIT Press.

28
29 Millar, J. (2008) 'Blind visionaries: A case for broadening engineers' ethical duties', in
30 *2008 IEEE International Symposium on Technology and Society*. IEEE, pp. 1–4. doi:
31 10.1109/ISTAS.2008.4559780.

32
33
34 Moran, S., Bachour, K. and Nishida, T. (2015) 'User perceptions of anthropomorphic
35 robots as monitoring devices', *AI & SOCIETY*. Springer London, 30(1), pp. 1–21. doi:
36 10.1007/s00146-013-0515-6.

37
38
39 Nissenbaum, H. (2005) 'Values in Technical Design', in Mitcham, C. (ed.) *Encyclopaedia*
40 *of Science, Technology and Ethics*. New York: MacMillan.

41
42
43 Nissenbaum, H. (2009) *Privacy In Context: Technology Policy And The Integrity Of Social*
44 *Life*. Stanford Law Books. doi: 10.1207/S15327051HCI16234_03.

45
46
47 OECD (2013), "Building Blocks for Smart Networks", OECD Digital Economy Papers,
48 No. 215, OECD Publishing, Paris, <https://doi.org/10.1787/5k4dkhvnzv35-en>.

49
50
51 Osborne, C. (2016) *Shodan: The IoT search engine for watching sleeping kids and*
52 *bedroom antics* | *ZDNet* . Available at: [https://www.zdnet.com/article/shodan-the-iot-](https://www.zdnet.com/article/shodan-the-iot-search-engine-which-shows-us-sleeping-kids-and-how-we-throw-away-our-privacy/)
53 [search-engine-which-shows-us-sleeping-kids-and-how-we-throw-away-our-privacy/](https://www.zdnet.com/article/shodan-the-iot-search-engine-which-shows-us-sleeping-kids-and-how-we-throw-away-our-privacy/)
54 (Accessed: 24 May 2018).

55
56
57 Panetta, K. (2017) *Top Trends in the Gartner Hype Cycle for Emerging Technologies, 2017*

1
2
3 - *Smarter With Gartner*. Available at: <https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/> (Accessed: 3 October 2018).

7
8 Pagallo, U. (2013) 'Robots in the cloud with privacy: A new threat to data protection?', *Computer Law & Security Review*, 29, pp. 501–508. doi: 10.1016/j.clsr.2013.07.012.

10
11 Panasonic (2017) *Panasonic Demonstrates Desktop "Companion" Robot at CES 2017*,
12 *Panasonic Newsroom*. Available at:
13 <https://news.panasonic.com/global/stories/2017/45856.html> (Accessed: 24 May 2018).

15
16 Reeves, S. (2012) *Envisioning Ubiquitous Computing*. in *Proceedings of the 2012 ACM*
17 *annual conference on Human Factors in Computing Systems - CHI '12*. New York, New
18 York, USA: ACM Press, p. 1573. doi: 10.1145/2207676.2208278.

19
20
21 Rodden, T. and Benford, S. (2003) 'The evolution of buildings and implications for the
22 design of ubiquitous domestic environments.' *Proceedings of the SIGCHI Conference on*
23 *Human Factors in Computing Systems. USA*, p. 9-16

24
25
26 Schafer, B. (2016) 'Closing Pandora's box? The EU proposal on the regulation of robots'
27 *Pandora's Box -*, *The Journal of the Justice and the Law Society of the University of*
28 *Queensland*, 19, pp. 55–68.

29
30
31 Schafer, B. and Edwards, L. (2017) "'I spy, with my little sensor": fair data handling
32 practices for robots between privacy, copyright and security', *Connection Science*, 29(3),
33 pp. 200–209. doi: 10.1080/09540091.2017.1318356.

34
35 Sellen, A., Rogers, Y., Harper, R. and Rodden, T. *et al.* (2009) 'Reflecting Human Values
36 in the Digital Age', *Communications of the ACM*, 52(3), pp. 58–66.

37
38
39 Sharkey, A. and Sharkey, N. (2012) 'Granny and the robots: ethical issues in robot care for
40 the elderly', *Ethics and Information Technology*. Springer Netherlands, 14(1), pp. 27–40.
41 doi: 10.1007/s10676-010-9234-6.

42
43 Shneiderman, B. (1990) 'Human Values and the Future of Technology: A Declaration of
44 Empowerment', in *Computers and the Quality of Life*, pp. 1–6.

45
46
47 Steen, M. (2011) 'Tensions in human-centred design', *CoDesign*. Taylor & Francis, 7(1),
48 pp. 45–60. doi: 10.1080/15710882.2011.563314.

49
50
51 Sullins, J. P. (2012) 'Robots, love, and sex: The ethics of building a love machine', *IEEE*
52 *Transactions on Affective Computing*, 3(4), pp. 398–409. doi: 10.1109/T-AFFC.2012.31.

53
54 Tolmie, P. *et al.* (2002) 'Unremarkable computing', in *Proceedings of the SIGCHI*
55 *conference on Human factors in computing systems Changing our world, changing*
56

1
2
3 ourselves - CHI '02. New York, New York, USA: ACM Press, p. 399. doi:
4 10.1145/503376.503448.

5
6
7 Urquhart, L. (2014) 'Bridging the gap between law and HCI: Designing effective
8 regulation of human autonomy in everyday ubicomp systems', in *UbiComp 2014 - Adjunct*
9 *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous*
10 *Computing*. doi: 10.1145/2638728.2638844.

11
12
13 Urquhart, L. (2017) 'Ethical Dimensions of User Centric Regulation', *ORBIT Journal*,
14 1(1), p. 17. doi: 10.29297/orbit.v1i1.14.

15
16 Urquhart, L., Lodge, T. and Crabtree, A. (2018) 'DEMONSTRABLY DOING
17 ACCOUNTABILITY IN THE INTERNET OF THINGS', *ArXiv*.

18
19
20 Urquhart, L. and Rodden, T. (2017) 'New directions in information technology law:
21 learning from human-computer interaction', *International Review of Law, Computers &*
22 *Technology*. Routledge, 31(2), pp. 150–169. doi: 10.1080/13600869.2017.1298501.

23
24 Urquhart, L., Sailaja, N. and McAuley, D. (2017) 'Realising the right to data portability
25 for the domestic Internet of things', *Personal and Ubiquitous Computing*, August, pp. 1–
26 16. doi: 10.1007/s00779-017-1069-2.

27
28
29 Verbeek, P. -P. (2006) 'Materializing Morality: Design Ethics and Technological
30 Mediation', *Science, Technology & Human Values*, 31(3), pp. 361–380. doi:
31 10.1177/0162243905285847.

32
33
34 Wagner, A. R. (2009) 'The role of trust and relationships in human-robot social
35 interaction', *Georgia Institute of Technology*, p. 283.

36
37 Weiser, M. and Mark (1993) 'Some computer science issues in ubiquitous computing',
38 *Communications of the ACM*. ACM, 36(7), pp. 75–84. doi: 10.1145/159544.159617.

39
40
41 Wetmore, J. (2018) 'What Can We Learn About Vacuum Cleaners from Vampires', *IEEE*
42 *Consumer Electronics Magazine*, vol. 7, no. 2, pp. 103-105, March 2018.

43
44 Williams, M., Nurse, J. R. C. and Creese, S. (2017) '"Privacy is the Boring Bit": User
45 Perceptions and Behaviour in the Internet-of-Things'. 15th Annual Conference on Privacy,
46 Security and Trust (PST), Calgary, Alberta, Canada, 2017, pp. 181-18109.

47
48
49 Wilson, C. (2015) 'Smart Homes and Their Users: Analysis and Key Challenges', *Personal*
50 *and Ubiquitous Computing*, 19, pp. 463–476.

51
52
53 Winfield, A. (2017) *A Round up of Robotics and AI Ethics*, *Alan Winfield's Web Log*.
54 Available at [http://alanwinfield.blogspot.com/2017/12/a-round-up-of-robotics-and-ai-](http://alanwinfield.blogspot.com/2017/12/a-round-up-of-robotics-and-ai-ethics.html)
55 [ethics.html](http://alanwinfield.blogspot.com/2017/12/a-round-up-of-robotics-and-ai-ethics.html). (Accessed 24 May 2018)

van Wynsberghe, A. (2013a) 'A method for integrating ethics into the design of robots', *Industrial Robot: An International Journal*. Emerald Group Publishing Limited, 40(5), pp.

Sector	Example and explanation	URL
Domestic Chores	- A. Vacuum Cleaner - iRobot Roomba – robot vacuum that uses intelligent sensors to move through home, adapting to surroundings and cleaning floors.	www.irobot.co.uk
	- B. Mopping - iRobot Braava – Similar to above but offering wet mopping, damp sweeping, or dry sweeping.	www.irobot.co.uk
	- C. Window Cleaning - Ecovacs Winbot - Cordless vertical window cleaning for the majority of window types.	www.ecovacs.com
	- D. Home Butler –Aeolus – Humanoid home assistant that can learn and develop in situ and perform basic cleaning and tidying tasks, integrate with personal assistance technology and smart devices	www.aeolusbot.com
Gardening	- A. Lawnmower – Robomow - Automatic sensor lawn mower.	www.robomow.com
Pets & Care	- A. Litter Tray – Litterbot - Automatic self-cleaning litter box.	www.litter-robot.com
	- B. Pets – Sony Aibo dog resurrected in 2018 after original launch in 1999; more threatening Boston Dynamics dog SpotMini also emerging too	www.sony-aibo.co.uk https://www.boston-dynamics.com/spot-mini
Food & Drink	- A. Moley Robotics – robot kitchens (humanoid arms behind glass) that can cook different selected recipes.	www.moley.com
	- B. Miso Robotics Kitchen Assistants – burger flipping robots that detect when reach desired temperature.	www.misorobotics.com
	- C. Starship – food delivery robots that were tested in San Francisco, but pedestrians don't like them hugely.	www.starship.xyz

433–440. doi: 10.1108/IR-12-2012-451.

van Wynsberghe, A. (2013b) 'Designing Robots for Care: Care Centered Value-Sensitive Design', *Science and Engineering Ethics*. Springer Netherlands, 19(2), pp. 407–433. doi: 10.1007/s11948-011-9343-6.

Corresponding Author: lachlan.urquhart@ed.ac.uk

Appendix 1: Example Domestic Robots.

	<p>- D. Robot Barista - Automated processing of drinks orders in a known environment trialled in Japan.</p>	<p>www.cnet.com</p>
<p>Care & Companionship</p>	<p>- A. Care robots – ‘Stevie the Robot’ is a research project bot that can perform autonomously or be remotely operated by human operators e.g. for tasks such as reminding elderly to eat (and taking photos as evidence) or reminding to clean up after themselves (detecting when plates are dirty).</p> <p>- B. Elli-Q - Keeping older adults active & engaged, the robot suggests activities and can make phone calls for the elderly users.</p> <p>- C. Paro Robot seal - Animal therapy has proven benefits for the elderly and this robot allows such therapy to be administered in places where a live animal may be inappropriate.</p> <p>- D. Pepper Robot – able to assess and react to perceived emotional state of individual it interacts with.</p>	<p>www.junoassistive.com</p> <p>www.elliq.com</p> <p>www.parorobots.com</p> <p>www.softbankrobotics.com</p>
<p>Home Management e.g. Security, Energy</p>	<p>- A. UB Tech Walker – can perform basic roaming security duties and other tasks such as calendar and email management.</p> <p>- B. Robotex Avatar III Security Robot – fully functioning all terrain stair climbing security robot linked via wi-fi for continual monitoring.</p> <p>- C. Appbot Riley – Similar to above, Riley uses Wi-Fi connectivity to stream live video and audio.</p>	<p>www.theverge.com</p> <p>www.robotex.com</p> <p>www.ipatrol.net</p>
<p>Existing Interactive AI e.g. Home Personal Assistant Devices</p>	<p>- A. Amazon Echo - Smart speakers developed by Amazon. Uses voice-controlled intelligent personal assistant, Alexa and is capable of playing audiobooks, music playback, setting alarms, making to-do lists, streaming podcasts, and providing real-time information such as weather and rail times. It can also control several other smart home devices such as heating and lighting.</p> <p>- B. Google Home – Similar to Alexa, Google Home speakers enable users to speak voice commands to interact with services through Google's intelligent personal assistant called Google Assistant. Offering the same breadth of services as above.</p> <p>- C. HomePod – Again, this smart speaker developed by Apple Inc. uses Apple's own smart assistant, Siri, to control the speaker and other HomeKit devices. This can connect to all Apple based product such as iPhones and through to services such as iTunes.</p> <p>- D. Invoke – A further iteration of the smart speaker, this time utilizing Microsoft's intelligent personal assistant, Cortana. Effectively providing all of the same services but to a Microsoft user.</p>	<p>www.amazon.co.uk</p> <p>store.google.com</p> <p>www.apple.com</p> <p>www.harmanardon.co.uk</p>

Toy Robots	<p>A. Luka the Owl - reads bedtime stories to children.</p> <p>B - Pleo Robot Dinosaur - Pleo uses a basic AI to grow and develop from a baby to an adult dinosaur taking cues from the user to develop a unique personality (within a set of predefined algorithms).</p> <p>C.- CHiP the smart dog - Artificial intelligence robot dog with adaptive personality. Will respond to App and wearables.</p>	<p>https://intl.ling.ai/pages/luka</p> <p>www.pleoworld.com</p> <p>www.wowwee.com</p>
------------	---	--

Appendix 2: Key Survey Results

General Feelings & Experience with Robots

Finding 1: Q.16

16. Have you used domestic robots EG Alexa/Google Home/Roomba?

- Yes
- No

- 13 out of 43 respondents answered 'Yes' which equates to 30.2%
- 30 out of 43 respondents answered 'No' which equates to 69.8%

a. If 'No', what has prevented you to date?

- Cost
- Don't like devices
- Other

**Note that respondents may tick all that apply*

- 11 out of 30 respondents who answered 'No' in Q.16 answered 'Cost' which equates to 36.7%
- 7 out of 30 respondents who answered 'No' in Q.16 answered 'Don't like devices' which equates to 23.3%
- 15 out of 30 respondents who answered 'No' in Q.16 answered 'Others' which equates to 50%

i. If you selected Other, please specify:

- 7 out of 15 respondents who answered 'others' in Q.16a cited the answer under the theme of trust/privacy which equates to 46.7%

Unique Response number	Responses	Theme
1	Don't want someone else's microphone in my home	Trust/privacy
2	Lack of interest, not that bothered, unsure of where my data's going and how being used.	
3	Have not found any that would improve lifestyle or help in a meaningful way	
4	Not researched them enough to know whether I want one	
5	I haven't really got a clear sense of what I would use them for at this point	
6	I don't see a tremendous amount that these devices could do to improve our family life at the moment; certainly not enough to justify the cost and personal data implications. Also my husband thinks that IoT tech is ridiculous and doesn't want it in the house.	Trust/privacy
7	I'm wary of networked appliances and am uncertain of 'always on' technologies.	Trust/privacy
8	I don't trust em	Trust/privacy
9	Don't see the point	
10	No interest/incentive	
11	Privacy concerns	Trust/privacy
12	Not yet comfortable with the idea of more data being collected through voice interfaces (always listening)	Trust/privacy
13	I not sure what benefits they would offer over and above being able to 'goggle' information other than being voice activated. I'm also concerned about becoming reliant upon a device and also my capacity to remember information deteriorating.	
14	Not sure how useful they actually are	
15	Privacy Concerns	Trust/privacy

Finding 2: Q.17 & Q.18

17. How does the increase in artificial intelligence in the home (eg Alexa) make you feel?

- Very Positive
 Slightly Positive
 Neutral
 Slightly Negative
 Very Negative

- 8 out of 42 respondents answered 'Very Positive' which equates to 19%
- 13 out of 42 respondents answered 'Slightly Positive' which equates to 31%
- 9 out of 42 respondents answered 'Neutral' which equates to 21.4%
- 12 out of 42 respondents answered 'Slightly Negatively' which equates to 28.6%

18. Identify 2 benefits you can see from the introduction of domestic robots?

- 25 out of 43 respondents cited the benefits under 'Time saving/Convenience' theme which equates to 58.1%
- 14 out of 43 respondents cited the benefits under 'Companionship/Care' theme which equates to 32.6%
- 10 out of 43 respondents cited the benefits under 'Domestic work' theme which equates to 23.3%

Unique Response Number	Responses	Theme(s)
1	Spare time Better cleaning	Time saving/Convenience Domestic work
2	Easy use of sophisticated technology Tasks done for you which means less wasted time on your part	Time saving/Convenience
3	- Less human error / forgetfulness - Additional (physical) security	
4	Useful for people with disabilities. Potentially timesaving	Companionship/Care Time saving/Convenience
5	To save time. To make tasks easier.	Time saving/Convenience
6	Energy efficiency Ability to do new things	
7	They are fun and helpful e.g for security or heating to be controlled remotely.	
8	Easier music playing Keeping people company	Companionship/Care
9	Quick support and decisions making	Time saving/Convenience
10	Comfort Convenience	Companionship/Care Time saving/Convenience
11	Less Housework Easier to control more things at once	Domestic work Time saving/Convenience
12	Being able to create a smart home is great. The ease of using voice activation is a brilliant achievement.	
13	More time for humans to do other things. Makes chores more interesting ie can watch domestic robots at work.	Time saving/Convenience Domestic work
14	Feeding up time, can do more enjoyable stuff	Time saving/Convenience
15	Easy access to information Increased time to spend on other things	Time saving/Convenience
16	TIME SAVING HELPFUL FOR DISABLED/ELDERLY	Time saving/Convenience Companionship/Care
17	More convenient - dont have to get up to turn lights off/on Richer experience - ie, bulbs wth different colours for when watching films relaxing, having these integrated with a smart speaker eg homepod	Time saving/Convenience
18	Could improve safety for ageing population by monitoring there actions and health and contacting emergency services. Aiding disabled people to live a fuller life and improve interaction and assist in doing tasks perhaps by voice control	Companionship/Care

19	Labour savings New ways of living ones life by being presented with new ideas / approaches by AI	Time saving/Convenience
20	quicker and easier decisions	Time saving/Convenience
21	Sorry I actually don't see any benefits.	
22	1. Do the chores that I don't enjoy doing 2. Help me to remember things	Domestic work Companionship/Care
23	Entertainment (seeing what I can get it to do that it wasn't designed to do) pure laziness .	
24	Making life easier for people with a disability; being able to remotely control equipment etc. in the home when away	Companionship/Care Time saving/Convenience
25	1. Easing the burden of domestic chores. 2. Means to meet increasing care needs of aging population.	Domestic work
26	Easier to complete tasks Quicker to complete tasks	Time saving/Convenience
27	Natural integration, talking/interaction with people, pets or animate objects mostly comes easy to people Access of ease, quick and easy interaction (no need to unlock laptop, open browser, search etc.), you could just ask your "robot buddy"	Companionship/Care Time saving/Convenience
28	1. Integration of household tasks 2. making homes more accessible for those with disabilities	Domestic work Companionship/Care
29	Background performance of tedious tasks, labour saving	Time saving/Convenience Domestic work
30	Maybe beneficial to those who feel isolated. Monitoring/Assisting who need it	Companionship/Care
31	1. Reduction of domestic labour 2. Increased safety for older people	Domestic work companionship/Care
32	They can help with the automation of certain tasks and, in the case of digital assistants like Alexa/Google home, to access answers to some questions quicker than if we had to search for them on our phones or computers.	Time saving/Convenience
33	Less cleaning work Integrated systems, less to worry about	Domestic work
34	simplify the interface to the house appliances; earn people more time	Time saving/Convenience
35	1) Domestic robots have entertainment value 2) Domestic robots might have value in helping people with disabilities to live more comfortably and self-sufficiently	companionship/Care
36	Care	Companionship/Care
37	provides entertainment - it's quite funny to keep asking Alexa to play obscure tracks or be finding out answers to various questions, I used it once or twice when socialising and we all had a good laugh. Other, less advanced functions like the alarm clock are also useful.	
38	Do mundane tasks that humans are happy to miss out Free up time for other human pursuits	Time saving/Convenience
39	1. Allow mundane tasks to be performed more conveniently	Time saving/Convenience
40	Automating domestic tasks. Being able to perform domestic tasks while away.	Domestic work
41	1) Being able to access information in an immediate, seamless (voice activated way). 2) Easier access to such information for multiple users	Time saving/Convenience
42	1. increased convenience 2. increased efficiency	Time saving/Convenience
43	1. Convenience 2. Helping people with disabilities	Time saving/Convenience

Finding 3: Q.19

19. Identify 2 fears you can see from the introduction of domestic robots

32 out of 43 responses involve covert listening, privacy and hacking which equates to 74.4%

Unique Response Number	Responses	Theme
1	Safety of pets and children Damage to possessions	
2	Disclosing your personal details Errors occurring	Covert listening/privacy/hacking
3	- Use of data by unknown 3rd parties - Loss of control	Covert listening/privacy/hacking
4	They could go wrong and, for example, start playing music when you're asleep. Potential to result in families spending less time together.	
5	They will make jobs redundant. The fear that we are being monitored e.g. whereabouts etc.	Covert listening/privacy/hacking
6	Hacking Unreliable programming	Covert listening/privacy/hacking
7	Cutting jobs. Could be dangerous e.g driverless cars.	
8	More targeted adverts played from devices People listening in on you	Covert listening/privacy/hacking
9	People becoming over dependent on them and them lacking in 'soft' skills	
10	Lose of privacy Disruption of home environment	Covert listening/privacy/hacking
11	Cost of repairs More things to go wrong	
12	There is a fear that people or the government can hack into these devices. The expense of kitting out your home with domestic robots	Covert listening/privacy/hacking
13	Data they gather can be hacked. Makes humans lazy.	Covert listening/privacy/hacking
14	Data they collect, at what point do we say gone too far	Covert listening/privacy/hacking

15	Invasion of privacy, being continuously supervised by a robot that is relaying your personal information to an outside entity. You do not know what data is being sent, what is being stored and when it is being sent. Using the gathered data for malicious purposes	Covert listening/privacy/hacking
16	MALFUNCTION COULD CAUSE DANGER LACK OF PHYSICAL MOVEMENT	
17	Always listening - bit weird but I can get over it, don't really think about it. Hacking - criminal activity/terrorism	Covert listening/privacy/hacking
18	hacking into home and personal data and possible reprogramming to do harm or ignore some actions. Increase in obesity as people do less and rely on robots for manual tasks without moving.	Covert listening/privacy/hacking
19	Cyberdyne Systems / Skynet Sloth developing in users	
20	unconsented data capture, misfunction (eg. the creepy laughter episode from Alexa)	Covert listening/privacy/hacking
21	Domestic robots can slow down our daily routine if broken It's another task to deal with (setting them up etc) They take away spontaneity They're just creepy	
22	1. Things going wrong 2. Being listen to or watched without my knowledge	Covert listening/privacy/hacking
23	Malfunction , being an annoyance	
24	Too much dependence on machines (lack of control); expense and hassle of keeping them working and up to date	
25	1. Unwanted/unknown surveillance and data harvesting by private companies for their own commercial gain. 2. Unemployment of human carers, cleaners, delivery couriers etc.	Covert listening/privacy/hacking
26	Personal data issues Can be hacked	Covert listening/privacy/hacking
27	Surveillance: Companies listening in on, government actors tapping into collected data, e.g. alexa is constantly listening to catch its wake word, so private conversations will also get processed by Amazon, feels like a breach of privacy if your "robot buddy" is just a glorified moving microphone Safety: What if your "robot buddy" gets hacked and harms/endangers you in some shape? E.g. administering wrong information, opening doors to strangers etc.	Covert listening/privacy/hacking
28	1. data breaches caused by IoT having intimate knowledge of people's daily lives. 2. Possible issues surrounding trust and accountability within the home.	Covert listening/privacy/hacking
29	Will be expensive for limited functionality; will be hooked into a larger data ecosystem that i dont want to be connected to	Covert listening/privacy/hacking
30	Intrusive Harvesting data	Covert listening/privacy/hacking
31	1. Can be vectors for stealing information about me/my household. 2. Connection to other online services (as much as possible I would like to keep internet separate from real life).	Covert listening/privacy/hacking
32	That the networking protocols used may not be secure enough and the devices could be accessed and controlled by strangers. This, of course, may also depend on which "robot" you are acquiring and using, and how your network is configured.	Covert listening/privacy/hacking
33	I go on holiday and they decide to do something crazy for two weeks. Data concerns	Covert listening/privacy/hacking

34	data leaks; the device being hacked	Covert listening/privacy/hacking
35	1) Privacy invasion - especially from devices that are "always listening" 2) Service disruption might impair system efficacy - for example, if a device relies on having a reliable internet connection, how does a user adapt when internet service is disrupted?	Covert listening/privacy/hacking
36	privacy, misinformation	Covert listening/privacy/hacking
37	I am worried about the data that the robot is collecting, even things like my daily routines etc. could be used against me (by the robbers) if they would leak out. I have a little awareness of what could happen with this data, but the device like Alexa doesn't seem to have much internal storage, so it may be sending it somewhere else to store it, and we can never be sure of the safety of the information that is put on the internet. I also have this unexplained fear of relying on the technology and being unable/ forget how to carry out some tasks when I need it and the tech. is not available	Covert listening/privacy/hacking
38	The robots knowing 'too much' about me/us The security risk of remotely accessible technology being the target of malicious attack	Covert listening/privacy/hacking
39	1. Increased invasion of privacy by companies	Covert listening/privacy/hacking
40	Data collected might be breached or sold on to third parties. Risk of being unable to do domestic tasks if tech fails (e.g. being locked out)	Covert listening/privacy/hacking
41	Personal information being potentially disseminated The information being accessed / delivered to me may be biased based upon my on evolving choices and not being aware or in control of this	Covert listening/privacy/hacking
42	1. lack of control 2. less independence	
43	1. Privacy 2. No internet connection/electricity	Covert listening/privacy/hacking

Finding 4: Q.20 & Q.21

20. What domestic roles should robots perform (Tick all that apply)?

- Medical/Care
 Cleaning
 Washing/Ironing
 Cooking
 Entertainment/playing games
 Tutoring
 Other

**Note that respondents may tick all that apply*

- 30 out of 43 respondents answered 'Medical/Care' which equates to 69.8%
- 41 out of 43 respondents answered 'Cleaning' which equates to 95.3%
- 34 out of 43 respondents answered 'Washing/Ironing' which equates to 79.1%
- 24 out of 43 respondents answered 'Cooking' which equates to 55.8%

- 32 out of 43 respondents answered 'Entertainment/playing game' which equates to 74.4%
- 26 out of 43 respondents answered 'Tutoring' which equates to 60.5%
- 6 out of 43 respondents answered 'Other' which equates to 14%

21. Any tasks robots should not be allowed to perform?

17 out of 31 respondents mentioned that robots should not perform tasks related to parenting, medical or caring roles which equates to 54.8%.

Unique Response Number	Responses	Theme
1	Parenting	Parent/medical/care
2	Anything that could cause danger/hazards if there is a malfunction	
3	Babysitting! When considering tasks like tutoring and medical care I think there needs to be a certainty that they can't get it wrong. It doesn't matter if they get the ironing a bit wrong but it does matter if they get a medical matter wrong.	Parent/medical/care
4	Mental health therapy or to replace personal care	Parent/medical/care
5	Robots shouldn't be allowed to take over job roles at the cost of self worth.	
6	No	
7	Domestic robots should not perform medical care in these early stages.	Parent/medical/care
8	Dressing and bathing	Parent/medical/care
9	Anything which involves human interaction eg medical care.	Parent/medical/care
10	Anything that makes life easier/ more efficient	
11	CHILDCARE	Parent/medical/care
12	no.	
13	Some actions concerning health and finances etc should require a human input to confirm action proposed by robot. Robots should be programmed so cannot do harm even if someone tries to change this basic rule.	Parent/medical/care
14	Childcare?	Parent/medical/care
15	Medical care/ I wouldn't trust the robot to perform anything more serious than cleaning	Parent/medical/care
16	This depends on who lives in the home, a robot should not be able to spy on another human, or do anything that affects a person without their consent. This might be difficult though, where one person controls the robot in the home. Robots oughtn't be able to do anything that might go wrong without someone present, I guess, like cooking if they might set the house on fire because they didn't notice a tea towel on the stove.	
17	Not in principle but it would very much depend on how they were programmed and controlled to ensure safety, ethics etc.	

18	I suppose any role is acceptable if it supports the user's wellbeing. However, there might be psychological risks involved in robots taking on certain roles in people's lives, e.g. reinforcing risky behaviours or replacing social contact with other humans. But all this would be context dependent and difficult to regulate. Would the sexual use of robots be preferable to the exploitation and criminality associated with prostitution?	
19	None	
20	Violence, no military robots, no justice/judge robots, no police robots, any form of policing/power-exercising robot is super scary to me because machine learning/AI tends to be biased (wonky data sets, engineers not thinking about social stigma etc). These robots would and will discriminate against marginalised people.	
21	Anything that may put the public at risk. Cooking/medical / ironing/ cleaning.	Parent/medical/care
22	Standing in for parents	Parent/medical/care
23	Anything that involves a "blank cheque" (I don't want a robot spending money on my behalf)	
24	Depending on the type of robot, they should not be left alone with vulnerable people that can't notify anybody else of a potential malfunctioning/dangerous situation, or that do not understand the consequences of using such robot.	Parent/medical/care
25	Dangerous tasks	
26	babysit	Parent/medical/care
27	Education	
28	Childcare, Banking transactions, Legally binding agreements	Parent/medical/care
29	Unsure	
30	- (considered as no response, so not counted in analysis)	
31	They shouldn't replace human interaction, such as putting children to bed, giving them a bath etc	Parent/medical/care
32	Important Decision (e.g. which medication to take)	Parent/medical/care

Future

Thinking

Finding 5: Q.22

22. Should robots have 'rights' protected by law?

- Yes
 No
 Don't Know

- 7 out of 43 respondents answered 'Yes' which equates to 16.3%
- 18 out of 43 respondents answered 'No' which equates to 41.9%
- 18 out of 43 respondents answered 'Don't Know' which equates to 41.9%

a. Why do you believe this?

- 21 out of 35 respondents cited answer under the theme of the sentience of the robot which equates to 60%

Unique Response Number	Responses	Theme
1	Depends on level of sentience	Sentience
2	They are not 'human'	
3	If 'consciousness' is demonstrated then yes, else no.	Sentience
4	They are not sentient.	Sentience
5	It depends how autonomous they are	
6	They should have the right to be used ethically.	
7	If artificially intelligent to a human level, why not? If they are able to not want to work then yes.	Sentience
8	Because they are not programmed with emotions/ understanding of this area	Sentience
9	If they have any kind of feelings they must be protected	Sentience
10	Assuming they aren't sentient, that would be like giving a kettle rights.	Sentience
11	Because they are automonus machines and they do not half feelings.	Sentience
12	This would give the programmers an excuse to hide behind legislation is something went wrong.	
13	Currently no as not sophisticated enough, unsure for future. Should the limit if robot AI development be that we don't create robots that should have rights?	
14	Quite honestly it depends on the level of intelligence displayed by the robot. Simple forms of intelligence are never protected by laws - an example being insects. The higher the levels of intelligence, the more laws are set to protect the creatures. In biological experiments it is much harder to experiment on a monkey than it is to experiment on a cockroach. I believe that we should not discriminate based on the type of lifeform though. If silicon based intelligence eventually develops to the levels of animal/human based intelligence then it too should be protected by laws. Technically speaking we are far away from this, and most AI applications require insect level intelligence to operate.	Sentience
15	ONLY IF THEY WERE TO BECOME SELF AWARE	Sentience
16	Its Technology, my phone doesnt have 'rights' nore my connected speaker	
17	We are at the start of artificial intelligence in the future robots could become "Human" in their outlook and should have rights not to be abused or forced to cause harm.	Sentience
18	AI improving all the time ... fully sentient robots only matter of time ...	Sentience
19	Because they are a human-made device	
20	I think it highly unlikely that robots will reach a level of consciousness that makes them more than a machine anytime soon.	Sentience
21	Because they aren't a living thing	Sentience
22	As they are not human it does not seem appropriate to give them human rights - it seems that the most relevant/appropriate laws would be related to property, safety etc.	Sentience
23	There should undoubtedly be regulation of how robots are designed and used, but whether this equates to the AI having 'rights' I'm not sure.	

24	I answered yes, but these things should be carefully negotiated... maybe not through laws? More through best practises/social treaty/community enforced rules. I don't know how that could really look like, because it could go south really quickly (e.g. companies being treated like people is a super scary thing in the states!), but I think robots should be protected from harm... I don't want people to murder or rape their robots, but I tend to anthropomorphise objects (I apologise to objects when I bump into them and have said thank you to doors), so I recognise that I am not very objective on this.	
25	This is a problematic question in that neither 'robots' or 'rights' are adequately defined.	
26	At this time there is no sense they are sentient - assuming you buy it (not hire it) it is just a tool. My washing machine does not need rights.	Sentence
27	If you mean 'rights' as in stuff I can't complain about, no (like it has a 'right' to spy on me for Amazon). There is another kind of 'rights' that are really less about the robot and more about the regulation of human behaviour. If it were possible to be cruel to a robot in a way that could be learned/normalised and transferred to people or animals, there is an argument for preventing it but I'm not sure about this owing to liberal impulses and the fact I'm not sure being mean to The Sims actually led to bad behaviour in real life (I think this is called "the media hypothesis" and is generally used in bad arguments for censoring things). Then again, maybe robots are different. It may depend on the degree to which the robot approximates a living thing, I'm not sure.	Sentence
28	This would depend on what are those 'rights'	
29	I believe right now they are not much different from any other house hold appliances. In the distant future, if such robots become conscious (if anyone can define/prove that), my answer will be yes.	Sentence
30	I don't know enough about this topic to form an opinion.	
31	I heard about these AI programmes that managed to create their own language and were using it to communicate between themselves. As people couldn't follow what they are talking about they killed the processes by disconnecting the machines from power. One of my fiends told me about it and I remember that we had this conversation on whether it is ethical to finish the existence of another intelligence, and even though I think we shouldn't overreact (as computers and robots are not living beings), I would feel better if this type of issues was assessed by the professionals and regulated. Also there should be laws that strictly regulate the access to the data & protection of data gathered by robots.	Sentence
32	Depends on level of intelligence	Sentence
33	They're not yet sentient, just lines of code	Sentence
34	Robots tend to belong, be designed or be maintained by large corporations. Giving domestic robots legal protection would give these corporations leverage against the consumers that use the robots, e.g. you wouldn't be allowed to unplug a machine you've bought.	
35	Robots should have regulations and a legal framework within which they operate. Robots cannot be given natural or legal 'rights' (if we choose this distinction) since they are artifacts and that will contradict the definitions of the term 'rights'.	

Finding 6: Q.23

23. Who should control the ethical rules driving domestic robots (Tick all that apply)?

- Manufacturer
 User
 Seller
 Government
 Independent Body
 Other

**Note that respondents may tick all that apply*

- 15 out of 42 respondents answered 'Manufacturer' which equates to 35.7%
- 16 out of 42 respondents answered 'User' which equates to 38.1%
- 5 out of 42 respondents answered 'Seller' which equates to 11.9%
- 24 out of 42 respondents answered 'Government' which equates to 57.1%
- 33 out of 42 respondents answered 'Independent Body' which equates to 78.6%
- 4 out of 42 respondents answered 'Other' which equates to 9.5%

Finding 7: Q.24

24. Does the form a robot takes (eg humanoid style/Alexa style 'home assistants) make a difference to your interaction with it

- Yes
 No

- 25 out of 42 respondents answered 'Yes' which equates to 59.5%
- 17 out of 42 respondents answered 'No' which equates to 40.5%

Trust & Interaction

Finding 8: Q.25

25. Would you implicitly trust a robot?

- Yes
 No
 Don't Know

- 2 out of 43 respondents answered 'Yes' which equates to 4.7%

- 22 out of 43 respondents answered 'No' which equates to 51.2%
- 19 out of 43 respondents answered 'Don't Know' which equates to 44.2%

Finding 9: Q.27

27. Do you think robots could help with feelings of social isolation?

- Yes
- No
- Don't Know

- 32 out of 43 respondents answered 'Yes' which equates to 74.4%
- 2 out of 43 respondents answered 'No' which equates to 4.7%
- 9 out of 43 respondents answered 'Don't Know' which equates to 20.9%