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Controlling Smart Devices in the Home

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Domestic appliances have replaced much human labor in the home. But how human do we want these devices to be, and how much autonomy do we want to give them? To throw some light on these questions, first the use and limitations of conversational agents (natural language interfaces) are discussed. Then some aspects of the experience of families living in a smart house are described, and compared with that of employers of servants in 19th-century Britain. On the basis of this research it appears that people do not want household devices to be very human, and do not want to give them much autonomy. Designers are recommended to observe two rules: Smart domestic devices should put people firmly in control and should as far as possible be unseen and unheard.

Keywords chatterbots, conversational agents, domestic appliances, natural language interfaces, smart house, servants, Turing test

A smart home or house can be defined as "a residence equipped with information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security, and entertainment through the management of technology within the home and connections to the world beyond" (Aldrich, 2003, p. 17). In other words, it is a home containing *smart devices* or what might be called *smart domestic technology*. But how smart do people want smart homes to be? How human do we want these devices to be? And how much autonomy do we want to give these devices? These questions are addressed via an historical analogy and empirical research, including work undertaken at the Digital World Research Centre (DWRC) of the University of Surrey.

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First the development and the current state of the art of conversational agents are reviewed together with some evidence of how people react to them, drawing largely on evidence from the 2003 Loebner Prize Contest, a Turing test. This shows that not only are there technical problems with natural language interfaces but also what might be termed social interaction problems. Yet as shown by DWRC's smart homes research, and reported here, the use of natural language to control devices is seen as a desirable alternative to the current clumsy methods of interaction. However, the use of natural language suggests that there is more to the human–machine relationship than "command and control." But is that what people want? To address that question, the relationship between servants and their employers in Britain in the 19th century is then examined to see if that has any implications for people's preferred relationship with mechanical servants in the 21st century. This suggests that control and unobtrusiveness are important issues. Finally these three strands are brought together and on the basis of all this evidence, I suggest two new rules for designers of smart domestic devices.

TALKING COMPUTERS

In 1950, Turing devised what he called the "imitation game," now known as the Turing test. It involves three parties: an interrogator in one room, and a computer and a person in another. The interrogator asks questions via terminals to determine whether he or she is talking to a computer or a person. Turing wrote, "I believe that in about fifty years' time it will be possible to programme computers... to make them play the imitation game so well that an average interrogator will not have more than 70% chance of making the right identification after five minutes of questioning" (p. 442).

Just 16 years after Turing's paper was published, ELIZA appeared. Developed at the Massachusetts Institute of Technology (MIT), ELIZA is recognized as the first computer program to converse with people using natural language. ELIZA was written to mimic a certain kind of psychotherapist: "This mode of conversation was chosen

TABLE 1
Analysis of scores in the 2003 Loebner Prize Contest

	Interpretation					
Score	Definitely machine Up to 1.5	Probably machine 1.6–2.5	Undecided 2.6–3.5	Probably human 3.6–4.5	Definitely human Over 4.6	Total
Number of scores for programs	48	16	7	1	0	72
Number of scores for humans	4	1	1	2	10	18

Note. From Loebner Prize Contest (2003).

because the psychiatric interview is one of the few examples of categorized dyadic natural language communication in which one of the pair is free to assume the pose of knowing almost nothing about the real world" (Weizenbaum, 1966, p. 42). Thus, "From the purely technical programming point of view then, the psychiatric interview form of an ELIZA script has the advantage that it eliminates the need for strong explicit information about the real world" (Weizenbaum, 1966, p. 42). Essentially, ELIZA worked by keyword recognition and transforming sentences, for example:

> Person: Well, my boyfriend made me come here
> ELIZA: Your boyfriend made you come here.
> Person: He says I'm depressed much of the time
> ELIZA: I am sorry to hear you are depressed. (Weizenbaum, 1966, p. 36)

Turing expected that by about the year 2000, computers would be well on the way to imitating people, at least for short periods of time. So in 2003, DWRC hosted a Turing test: the Loebner Prize Contest. From more than 20 entries from all around the world, eight conversational agents—often called "chatterbots" or "chat bots"—were selected for the final. Ten identical terminals were set up: eight linked to programs and two to people in another room. Each of the nine judges conversed at each of the ten terminals, and scored their conversational partners on the following 5-point scale:

1. Definitely a machine.
2. Probably a machine.
3. Could be a machine or a human; undecided.
4. Probably a human.
5. Definitely a human.

The judges had little difficulty distinguishing computers from people. No machine was mistaken for a human. Table 1 shows that of 72 scores given by the judges—nine judges each looking at eight computer programs—all but eight were identified as "definitely" or "probably" machines. In just seven cases, the judges were not sure. In only one case was a program given a score of 4, "probably a human." This program won the contest even when it scored on average only 1.9, placing it as "probably a machine" overall. In contrast, 12 of the 18 scores given to the humans were in the range of "probably a human" or "definitely a human" and on average the humans scored 3.7, "probably a human." Note that the humans were instructed to "at all times converse in such a manner as to convince the judges that you are human. In general, you should be honest and truthful in your responses. But you are allowed to make humorous asides and untruths about identity where appropriate."

Some of the judges' comments are quite revealing. The word "hopeless" was commonly used. More explicit comments included:

> "Like talking to an obstinate, mentally ill person who doesn't speak much English."
> "Either lacking in social skills or a robot."

Examination of the transcripts[1] reveals that there were five main reasons for the judges' poor rating of the programs' performance:

1. The bots could not manage standard conversation openers, including names, for example:

   > JUDGE: Hello.
   > BOT: How are you doing today?
   > JUDGE: I'm well thanks. How are you?
   > BOT: Fine, thanks. And you?
   > JUDGE: Good thanks. What have you been doing this morning?
   > BOT: By the way, How are you?
   > JUDGE: I'm well.
   > BOT: By the way, How are you?

   and:

   > JUDGE: My name is irrelevant
   > BOT: Nice to meet you, Irrelevant!

2. The bots did not remember things they had already been told, for example:

BOT: By the way, I still don't know your specialty—or, possibly, I've missed it?
JUDGE: You missed it!

and:

BOT: And I forgot to ask you where you are from...
JUDGE: No you did not and I did tell you!

3. The bots replied inappropriately, for example:

JUDGE: Have you ever been to Australia?
BOT: Thank you.

and:

JUDGE: How many kids do you have?
BOT: Yes, that's true.

and:

JUDGE: What would you usually be doing on a Saturday afternoon?
BOT: Really?

4. The bots ignored the judge and changed the subject, for example:

JUDGE: What do think about pop music then?
BOT: It is not true that Columbus was the first person to think the earth was round.

5. The bots simply fed the judge's words back, ELIZA style, and not always making sense, for example:

JUDGE: You are very repetitive
PROGRAM: You think I am repetitive.

and:

JUDGE: That is the third time you have included a large amount of my previous comment in your response.

and:

JUDGE: I'd rather talk about opera than trance
BOT: Sure, opera than trance sounds like a good topic.

and:

JUDGE: howdy
BOT: When I was a kid they had a TV show Howdy Doody.
JUDGE: Would that be in the States?
BOT: Although in some States it is legal to smoke marijuana for medicinal purposes.

As a result of these conversational blunders, the judges often became annoyed. Nass (2004) suggests that the better a computer's use of language, the more polite people will be to it. There were many examples where the Loebner Prize Contest judges said the bots were "mad" or "geeks," and the judges often spoke to the bots in a way they would not have spoken to another adult, for example:

JUDGE: Do you have a new governor?
BOT: Doesn't everyone have a governor. I have a lot of friends on the Internet.
JUDGE: I don't care about your friends. Tell me who the governor of California is

and:

JUDGE: I am getting frustrated
BOT: What are you frustrated about?
JUDGE: You—can't we have a decent conversation

A study of a well-known chatterbot program showed that people trying to converse with it felt free to insult the bot but found it unacceptable if the bot responded or criticized the person: "Users wanted an asymmetric relationship in which they were in the dominant position" (De Angeli et al., 2001, p. 5). This is confirmed in the Loebner Prize Contest transcripts. While the judge could call the bot a "dum robot" [sic], the bot could not do likewise:

BOT: I think you may be the bot here.
JUDGE: How insulting!

It seems that little progress has been made in the 40 years since ELIZA first appeared. The basic problems remain unsolved, and computers cannot communicate well in natural language. In part, this is due to lack of vocabulary and failure to understand the nuances of English. But it also reflects the fact that computers do not understand the real world. Turing (1950) identified what he called computers' "disabilities," by which he meant things that they could not do. One of his examples was the fact that they are not able to appreciate strawberries and cream. He was not suggesting that machines should be built to eat strawberries and cream but that their inability to do so "contributes to some of the other disabilities, e.g., to the difficulty of the same kind of friendliness occurring between man and machine" (p. 448) as between people.

That computers cannot communicate well with people is not surprising, given the complexity of human communications. As Goffman (1981) said:

> Everyone knows that when individuals in the presence of others respond to events, their glances, looks, and postural shifts carry all kinds of implication and meaning. When in these settings words are spoken, then tone of voice, manner of uptake, restarts and the variously positioned pauses similarly qualify. As does the manner of listening. Every adult is wonderfully accomplished in producing all of these effects and wonderfully perceptive in catching their significance when performed by accessible others. (p. 1).

The computers' inability to follow the thread of conversations demonstrates the underlying deficiencies in these programs. Yet this inability to "maintain topicality" in Goffman's terms is not surprising when one looks at his example of possible responses to the simple query, "Do

TABLE 2
Examples of potentially smart equipment in UK homes: 2003–2004

Equipment	Percent of households with equipment
Central heating	94
Video recorder	90
Microwave	89
CD player	86
Washing machine	80
Tumble dryer	57
Dishwasher	31

Note. From ONS (2005, Table 50).

you have the time?" He identifies six broad types of possible responses, each with several different sets of words, all plausible in different contexts (Goffman, 1981).

In theory, these problems could be overcome with appropriate programming: clever sentence parsing and massive databases to provide knowledge. However, we appear to be a very long way away from Turing's vision of computers that can pass as people: The android computers of science fiction such as C3PO from *Star Wars* or Marvin in *Hitchhiker's Guide to the Galaxy* are well into the future.

"SMART" DOMESTIC TECHNOLOGY

Although Turing proposed a conversational test of artificial intelligence, he did not ask why we should want to talk to computers in the first place. Underlying the development of natural language interfaces is the assumption that people want to converse with computers as if they were humans. To examine whether or not that is a valid assumption, the use of smart technology in the home is reviewed.

Our homes are full of domestic appliances that are, or could potentially become, smart, as shown in Table 2. (Table 2 does not list refrigerators, as these are now universal in the United Kingdom.) There is growing interest in studying how these and other domestic appliances might be usefully linked to each other and to external agents, machine or human (e.g, Aldrich, 2003). In 2001, DWRC undertook a study of families living for a short period of time in a smart home (Randall et al., 2001; Randall, 2003).

The visiting families were offered a variety of mechanisms to control the equipment, ranging from PDA (personal digital assistant) devices to wall panels. However, these were often found to be frustrating, and participants thought that voice control would be better. For example:

> "Have to go to the dishwasher to load it, so don't need remote if you're in the house.... Want one or other—remote or local control. Don't want remote control when you're local but do want remote when you're not local... Verbally would work"

> "Things must be simpler to do than in a normal house ... I don't want to work through a menu just to turn off the lights. Again, I hope this will be improved with voice control."

> "Voice activation would definitely work."

Since they did not actually have voice activation, the families were not able to test whether it was in fact better or worse. But we know from the discussion in the previous section that computers are not good at natural language. Furthermore, the Turing test described was based on typed exchanges. To achieve voice activation, speech recognition would have to be added, bringing with it yet another set of technical problems.

Another aspect of control that came up repeatedly was the need for manual override, not just in unusual circumstances, such as a power failure, but also in everyday use. One participant complained:

> "There's not an ordinary tap in the house and it drives you mad. You can't control the water volume and it's inconsistent. I really missed the lack of control."

And:

> "You can't control any of the hi-fi stuff the way you want to. You can't choose your CDs, it picks them at random. On the wall panel you can choose 'next' or 'previous' but that's all. It was so much easier to unlock the door, choose the CD you wanted, come out and lock it again."

Talking about the security system, one of the participants again complained of lack of control:

> "You could lock yourself out if you're not careful. We could be out on the [patio] and the door slams shut and you could be locked out if you don't have the bleeper. Another thing where you need to have complete control when you're in the house."

More generally, one of the families said:

> "If computers start to take over, then I think people will resent it. It's like with these lights... you get fed up with it. It becomes intrusive.... You get irritated with it. We'd lost control because we couldn't override it."

There had been much talk of intelligent refrigerators, and even intelligent waste bins, which would order replacements when items had been used (e.g., BBC, 1999; VNUnet, 1999). The concept of an intelligent refrigerator was discussed with one of the families in the study, who pointed out that a refrigerator-based shopping list would not be complete because it would not cover non-food items like washing powder. Their feeling was that while the list might be useful as an aide-memoire, the list would have

to be reviewed by a person before being sent to the store. This was underlined by the families' experience of online shopping. In one case the family ordered its groceries online for the first time. Putting aside the issues arising from the use of new, unfamiliar technology (such as confidence in credit card security and the learning process involved), one of the main concerns was lack of control. This was expressed in terms of needing to ensure that good quality and good value were obtained (Randall et al., 2001):

> "I'd much rather see what I'm buying."
>
> "I think I want to be able to look at what I'm buying. I have a few worries about E numbers and hyperactivity, so I like to be able to see what additives there are. I don't like food to be too processed. The other thing is, I like to look at the sell-by dates—the newest stuff is always stacked at the back and I like to make sure that's what I get."
>
> "I look for good deals, the buy 2 get 1 free sort of thing."*

This illustrates another, rather different, aspect of control.

Randall (2003) noted the paradox that "elaborate control mechanisms could generate a sense of lack of control" (p. 233) and suggested that this arose because "designers had simply presumed they could predict what people wished to do" (p. 233).

People wanted to talk to their household machines in order to tell them what to do And they wanted to stay in control, to override different machines in different circumstances. But which, and when?

LESSONS FROM THE PAST

Domestic technology has developed very quickly over the past 100 years. Today, many of the duties of servants have been taken over by domestic appliances, which have reduced the need for human labor in the home (e.g., Hamill, 2003). Flanders (2003) argues that "servants were, as consumer durables are today, a symbol of status" (p. 93), an idea that can be traced back to Veblen's treatise, *The Theory of the Leisure Class* (Veblen, 1970 [1899]). The development of these appliances was in part driven by the shortage of servants that occurred as other employment opportunities arose for young women at the beginning of the 20th century (Horn, 2004 [1975]). For example, "suction cleaning machines and dust extractors" were available from a major London store by 1907 (Horn, 2004 [1975], p. 171). Although a writer to *The Times* in 1914 foresaw the introduction of electricity as the solution to the shortage of servants, the widespread use of such appliances was hampered by the limited availability of electricity to households (Horn, 2003; Aldrich, 2003). However, by 1949, a revised edition of *Mrs. Beeton* was pointing out that although appearing expensive, labor saving devices were economical because they saved servants' wages (as cited in Horn, 2003). As machines have now largely replaced servants, I suggest that we can obtain some insights of value to designers of smart devices from examining the relationship in the past between servants and their employers.

In 1999, a UK TV channel set up a late Victorian London house and installed a family in it for 3 months (McCrum & Sturgis, 1999); this could be seen as a kind of reverse of DWRC's smart house project. But in the Victorian house, the servant issue emerged as one of the key themes. A family in that position in 1900 would have employed a maid-of-all-work, but the 20th-century wife was uncomfortable with her role as mistress and eventually fired her maid and undertook all the housework herself. She wanted to be able to come home and find all the work done, "which is exactly what my little electric slaves do for me in 1999. I load up the washing machine, I go to work, I come back, it's done. But I feel more comfortable about having an electronic device to do it for me than a human being" (McCrum & Sturgis, 1999, p. 146).

In Victorian times, the proportion of households with live-in servants varied across Britain. For example, in York in 1901, Rowntree found that about a quarter of households kept servants (Horn, 2003, p. 3). In 1911, there were estimated to be 170 servants per 1000 families in Britain, but this varied from 97 per 1000 in Lancashire to 353 in Surrey (Horn, 2003, p. 19). Managing servants was a major theme of advice books, of which *Mrs Beeton's Book of Household Management*, first published in 1859, is the best known (Beeton, 1986 [1859]). Two aspects of the employment of domestic servants in the 19th century seem to be relevant to our relationship with smart domestic appliances. The first is the issue of trust and its related issue of control. The second is what can be termed "non-presence," the desire that the servants be as invisible and quiet as possible at all times.

Trust and Control

Flanders (2003) reports that "supervision extended to every aspect of the relationship between mistress and servant" (p. 82). Beeton (1986 [1859]) was very firm about this:

> We would point out here an error—and a grave one it is—into which some mistresses fall. They do not, when engaging a servant, expressly tell her all the duties which she will be expected to perform. This is an act of omission severely to be reprehended. Every portion of the work which the maid will have to do, should be plainly stated by the mistress, and understood by the servant. If this plan is not carefully adhered to, domestic contention is almost certainly to ensue, and this will not be easily settled; so that a change of servants, which is so much to be deprecated, is continually occurring. (p. 7).

*This feature was not available for online shoppers at that time.

Another recommendation, by a later Victorian writer, was that the mistress should give every servant a book in which was written the daily work as well as other details of the household's routine (Flanders, 2003). In other words, servants should be given clear and very detailed job descriptions.

Servants were, in general, not to be trusted to do the shopping. Beeton (1986 [1859] p. 6) stated, "It is desirable, unless an experienced and confidential housekeeper be kept, that the mistress should herself purchase all the provisions and stores needed for the house." Lack of trust and eagerness to get good value for money resulted in many householders undertaking the ordering themselves, even of household basics. Horn (2004 [1975]) gives an example of a housekeeper to Sir John Ramsden writing to ask him to order more "oil, soap and candles."

Nor were servants to be trusted with supplies once the goods had been purchased and delivered to the house. As well as various deceptions, such as reselling of goods, there are many examples quoted in historic documents of theft by servants from employers, backed up by court records (Horn, 2004 [1975]). It was assumed that "all servants were prone to dishonesty" and that "the good housewife" should "keep everything locked and under her supervision" (Flanders, 2003, p. 116). In larger establishments many housekeepers were given the control of household stores, but in effect they simply took the role of the mistress and exerted similar control over the lower servants. As a result, "the large bunch of household keys [the housekeeper] carried were a symbol of her authority" (Horn, 2004 [1975], p. 59). A strict control was maintained even in small households. Ideally, according to the household management guides of the day, the mistress would give out what was needed in terms of food and household necessaries from the locked storeroom daily. "Soap, candles, matches should all be handed out only as needed, otherwise servants would run riot with them" (Flanders, 2003). This behavior was confirmed by ex-maids. They reported having to ask for "every pot of jam or box of matches" and "never being allowed to use the key even after many years of service" (Flanders, 2003, p. 83). Another tells how her mistress "went into the storeroom every morning and gave out the stuff that had to be cooked and she would count out the prunes" (Horn, 2003, p. 15).

To summarize, the message is that servants were in general not trusted and were subject to very close management. Their employers told them exactly what to do.

Non-Presence

Servants were kept in the house because they were deemed essential to the functioning of the household. Many of the jobs that are done today by appliances and involve very little effort were in the past time-consuming and demanded hard physical labor. Heating is one example: The lighting of fires, carrying of coals, and cleaning up of resulting soot from the fires all required time and effort. Laundry too was very hard work: At least two people were needed and in houses with only one servant it was recommended, that she—and it invariably was a woman in such circumstances—should get up 2 hours earlier than usual on wash day (Flanders, 2003).

But keeping servants meant having people in the home who were not members of the family and who were not of the same social class, an important distinction in 19th-century Britain. In his survey of poverty in York in 1901, Rowntree used the keeping of servants to distinguish between working-class households and higher "orders" (Horn, 2003). This gave rise to tensions. Horn (2003) quotes former servant keepers saying that they welcomed not having to "keep up appearances" and preferred the privacy and freedom of a life without servants.

Consequently, houses were designed to keep the servants out of sight and out of earshot. Moreover, there were rules about where servants could go, and when. In 1864, in his book *The Gentleman's House*, architect Robert Kerr put privacy above "comfort, convenience and cheerfulness," and his greatest concern was that that "the Servants' Department shall be separated from the Main House, so that what passes on either side of the boundary shall be both invisible and inaudible from the other" (quoted in Flanders, 2003, p. xlvii). In an article in the *Fortnightly Review* of 1888, it is stated that "Life above stairs is as entirely severed from life below stairs as is the life of one house from another" (Horn, 2004 [1975], p. 123). In some cases, there were backstairs that linked the basements in which the servants often spent their days and the attics in which they slept (Horn, 2004 [1975]). "Within the house, [the maids] were restricted to certain rooms—except when they were cleaning the others—and they had to use different entrances and staircases from the family when going to and from the house, or moving around within it" (Horn, 2003, p. 14).

"It had always been the custom in great houses that servants, more especially women servants, should keep out of sight as far as possible" (Turner, 1962, p. 263). In some of the larger houses, this could be taken to extremes. For example:

- In the 17th-century West Sussex house of Uppark (at which H.G. Wells's mother was a housekeeper in the 1880s) there are tunnels running from the main house to various outbuildings so that the servants could move back and forth without being seen.
- Any servant that crossed the path of the tenth Duke of Bedford (d. 1893) "after noon when household

> duties were supposed to be over, were liable to instant dismissal. It was the rule in many great houses that housemaids must be virtually invisible above stairs" (Dawes, 1973, p. 14).

If they could not be invisible, servants should be deferential and preferably silent. According to the *Servants Behaviour Book* (quoted by Horn, 2004 [1975]), a servant should never reply without saying "Sir, Ma'am or Miss" and "every girl who wishes to live in a gentleman's family must learn to keep guard over her tongue" (p. 121). A manual issued by the Ladies Sanitary Association entitled *A Few Rules for the Manners of Servants in Good Families*, published in 1895, "contained over twenty pages of 'Do's and Don'ts,'" including "Never begin to talk to ladies or gentlemen, unless it be to deliver a message or to ask a necessary question and then do so in as few words as possible" (as quoted in Horn, 2004 [1975], p. 121). Servants were not to speak until spoken to and were advised not even to say "good morning" or "good night" other than in response to a similar greeting (Flanders, 2003; Horn, 2004 [1975]). Even as late as 1923, a revised edition of *Mrs Beeton* was advising that "a too-easy rule and undue familiarity are bad alike for mistress and maid" (as quoted in Horn, 2003, p. 168).

The social world of the Victorians was very different from the one we live in today. While the Victorians often treated their servants like children (e.g., Flanders, 2003), they did not apply to them the edict that children should be seen but not heard. They applied a stricter rule: Servants, in their view, should be neither seen nor heard.

NEW RULES FOR DESIGNING SMART DOMESTIC DEVICES?

Today we want machines to save us from drudgery and menial, repetitive tasks. We want computers to get on with boring jobs without having to give them constant instructions. We want what Dix (2002) calls "incidental interaction." By this he means "interactions where actors perform actions for some purpose (say opening a door to enter a room) and the system senses this and uses it for some purpose of which the actors are unaware (perhaps adjusting the air conditioning), but which affects their future interactions with the environment or system" (Dix, 2002, p. 1). But, as Dix points out, this is quite a different model of user interaction from what might be called the traditional person–computer interaction, where the actions are "purposeful and direct" and the outcomes are "explicitly attended to and evaluated" (Dix, 2002, p. 1). In this traditional model, "the design emphasis is on making the affordances of interaction unambiguous and available and ensuring that system feedback and state are clearly visible" (Dix, 2002, p. 1). For incidental interaction, the opposite is wanted: The machine should get on with its job with little or no communication with the human.

Yet we also want to remain in control. Leppanen and Jokinen (2003) summed it up nicely. "On the one hand it would be magnificent if the house managed to take care of the home automation, safety and expenses, but on the other hand people are too scared to give control to the technology alone" (p. 222). If the machine is left to do everything with complete autonomy, people have lost control.

Just as the mistress of the Victorian household wanted to control her servants, people today want to control their domestic machines. For example, people no more want computers to do the shopping—by the automatic ordering of goods—than our ancestors wanted to let their servants do it. Servants were in general not trusted and were given little autonomy. So it is with technology today, although the distrust arises in part for different reasons: Machines are not thought to be dishonest but are regarded as incompetent.

One reason for appearing incompetent is that machines, in common with human servants, cannot know our intentions; they cannot read our minds. For example, even if an intelligent refrigerator knows all the beer has been drunk, how can it know whether or not you want to replace it? You may have decided that you really don't like that brand; or that you drink too much and want the house to be "dry" for a while; or even that all your friends are coming round to watch the match at the weekend and you want to treble the usual order! Thus, the intelligent refrigerator should not be allowed to order without first checking with the householder. More generally, smart domestic appliances may know what has happened and what the current status is, but they cannot know what people want to happen next. As Schmidt (in Baxter et al., 2005) points out, "Our work on incidental or implicit interaction suggests great potential in such technologies, but it is hard to see how they work and how users respond without experimenting in the wild" (p. 74). It seems likely that there is a spectrum of needs for control of smart domestic devices: from those that require human intervention only very rarely and in exceptional circumstances to those that require almost constant monitoring. Shopping perhaps falls somewhere in the middle: Smart devices might produce the first draft of the groceries list but a person will have to check and authorize it.

The people in the DWRC smart house study wanted to communicate with digital devices by voice, that is via a natural language interface. But why did they want to talk to them? While much conversation between people is about sociability, as illustrated in DWRC's research on mobile phones (e.g., Lasen, 2005), people wanted to talk to machines not because they wanted to chat but because speech was perceived as being the simplest way of relaying instructions. They literally wanted to tell the machines

what to do. One of the exchanges in the Loebner Prize Contest sums it up:

> BOT: ... If you could have any kind of robot what would it be?
> JUDGE: One that kept its opinions to itself and did all the housework!

In the past, people wanted to minimize their contact with servants and they certainly did not want servants to talk to them unbidden. So why should people today want mechanical, computerized servants to talk to them?

General conversation requires a wide range of knowledge, of both language and topics. In contrast, control only requires a small subset of conversation. Indeed, it may require a machine to have only an ability to understand and not to reply. As Goffman (1981) notes, when people are giving orders, they do not expect a verbal response but an action. However, there is a case to be made for at least an acknowledgment of the order to give feedback, to confirm that the command has been received, understood, and will be acted upon.

In today's society, many people are uncomfortable with asking other people to do chores for them. The fact that *The Times* newspaper discusses how au pairs should be managed (*The Times*, 2005) suggests that there is a problem. Despite all the changes in society since Victorian times, professional advice on managing au pairs today remains remarkably similar to that given by Mrs Beeton: "Lay down the boundaries" and "don't try to make her your friend" (*The Times*, 2005). Recall, too, the late-20th-century woman who was "taken back" to the 1900 house and could not cope with managing the servant (McCrum & Sturgis, 1999). It appears that on the one hand we want to treat servants as equals, but on the other we need to tell them what to do. Having a person in the house who is not a member of the family and who is expected to do unpleasant or intimate jobs creates a social problem. Although society has changed, and some of the reasons for the social tensions have changed, nevertheless the relationship between householder and domestic servant remains a difficult one.

This suggests that we may not want our smart domestic appliances to be too human. Yet Nass and Brave (2005) argue that designers of voice interfaces should understand all the subtleties of voice communication that humans have evolved and should exploit them in machine–human communication. The implicit assumption seems to be that replicating humans as closely as possible is a desirable goal. Yet the danger is that the closer the designers move toward achieving that goal, the closer they come to entering Mori's "uncanny valley" (e.g., Dautenhahn, 2002). Essentially Mori's argument is that while people respond well to non-human entities that show human-like traits, they respond negatively to an entity that appears to be almost but not quite human. People sense that there is "something wrong," and this generates a strong antipathy toward the entity.

However, the social relationship between smart devices and people in the home has been little explored. Fong et al. (2003) report that "Thus far few studies have investigated people's willingness to closely interact with social robots" (p. 159). Severinson-Eklundh et al. (2003) argue that "the social character of human–robot interaction does not imply, however, that the robot and the human are assigned equal or comparable roles" (p. 224). This is in line with our findings of people's interactions with conversational systems reported earlier. Furthermore, in their study of a robot that could fetch and carry, Severinson-Eklundh et al. (2003) report that "the majority of participants preferred to view the service robot as a smart domestic appliance" and that it should do "only what it has been instructed to do, and not act independently" (p. 224).

Thus, because of the problems of the servant role and the danger of the "uncanny valley," smart domestic appliances should not strive to emulate humans too closely. So in designing smart devices for use in the home, I suggest that designers should observe two rules:

1. The control rule: Smart domestic devices should put people firmly in control.
2. The nonpresence rule: Smart domestic devices should as far as possible be unseen and unheard.

CONCLUSION

This article has addressed the issue of how people want to control smart technology in their homes. Because of the difficulties encountered with devices such as remote controls and keyboards, people believe that voice control would be better. Yet current natural language interfaces not only need to be improved technically but also raise social interaction issues that must be addressed before they can be successfully deployed in the home.

These social issues do not appear to have been investigated adequately, and indeed there appears to be an assumption that people want smart devices to be as human as possible. Yet the evidence presented here suggests that such an assumption is not warranted and could in fact be counterproductive.

While people want smart domestic appliances to free them from menial tasks, they also want to remain in control. This suggests that a key issue to be addressed in designing for "incidental technologies" is to create the right balance between the independence of machines in the home and their control by people.

Domestic machines have in effect replaced servants, and I suggest that we can learn lessons from the way domestic servants were treated in 19th-century Britain. Servants were then seen as social inferiors and were

expected to do as they were told, and do it as unobtrusively as possible. The little evidence that is available suggests that we regard smart devices as our social inferiors. And although the 19th-century social world was very different from today's, in some ways the changes that have come about make it even more difficult to cope with having and managing strangers in our 21st-century homes.

I therefore recommend that designers of smart domestic devices should observe two rules: the control rule, putting people firmly in control; and the non-presence rule, keeping the devices as unobtrusive as possible.

Smart domestic appliances reduce physical labor and drudgery, but they do not currently replicate humans. At the start I raised two questions: How human do we want these devices to be, and how much autonomy do we want to give these devices? I suggest that on the basis of the evidence presented here, the answer to both is "not very much."

NOTE

1. The transcripts of the 2003 Loebner Prize Contest are copyright of the Cambridge Center for Behavioral Studies, Cambridge, MA, and are available at http://loebner03.hamill.co.uk.

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