INTERDEPENDENCE IN COLLABORATION WITH ROBOTS

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Introduction

In his final speech to the Australian National Press Club the outgoing Disability Discrimination Commissioner, Graeme Innes, noted that people with disabilities "would be lifters, if there were not barriers in society which cause [them] to be leaners."[1] The terms lifter (people who provide monetary, emotional or physical support) and leaner (those who need that support) were introduced into Australian politics in 1942 by Robert Menzies,[2] and revived in 2014 by Treasurer Joe Hockey in his budget speech, which positioned lifters as workers who pay taxes and leaners as those who rely upon government benefits.[3] In responding to Hockey, and others in the incumbent Australian government, Innes rejected this oversimplification of people's lives emphasising instead the importance of "providing people with disability with choice and control," thereby giving them opportunities to move from being leaners to becoming lifters.[4] This chapter considers how robots can support people with disabilities in ways that can facilitate this move, while also examining some of the ethical and practical issues that arise when robots are positioned as assistive or, in some cases, even as caregivers.

All members of society are likely to be leaners from time to time, increasingly so as they age. It is therefore unsurprising that a number of the robots described below have been designed with elderly people in mind. This also means that research into these developments is centred on considerations of older people's lives and needs. By broadening the discussion to engage with perspectives from disability studies, this chapter examines a wider variety of perspectives on communication, independence, autonomy and control over one's living circumstances at any age.

Many different forms of technological device are now described as robots. This term appears in marketing information, technology and mainstream media reports, whether the machines under discussion are autonomous, semi-autonomous, or rely upon the continuous direction of a human operator. This chapter concentrates on analysing devices designed to help people that operate, at least some of the time, autonomously or semi-autonomously alongside those people in a physical environment. It therefore sets aside discussions about physically instantiated machines wholly under the wired or wireless control of a person at all times, as well as software assistants, such as Apple's Siri, Google Now and Amazon's Alexa.

Autonomous assistive robots and robot carers

No longer confined to science fiction, robots are increasingly becoming a part of many people's everyday lives. While the robots most commonly found in people's homes may still be toys, their more functional counterparts, such as robotic floor, pool and gutter cleaners, are rising in popularity around the world. Robotic floor cleaners are still relatively expensive when compared with other vacuum cleaners or the humble floor mop, but they promise to save people from the drudgery of domestic labour or the expense of employing a person to clean the house. For non-disabled people, these robots are convenient tools that take over a hated task leaving more time for leisure. In contrast, for people with disabilities, who find cleaning difficult (or impossible) to do themselves, these robots offer a valuable opportunity to take more personal control over their living spaces. Robotic floor cleaners could in fact easily be classified as assistive technologies; however, this terminology is more often used to refer to machines designed specifically to help people with disabilities of all ages, including elderly people where the aging process has resulted in some level of physical or mental impairment.

The most complex and expensive assistance robots are large machines that navigate physical environments entirely on their own, such as the Carebot (Gecko Systems) and the Care-o-bot (Fraunhofer).[5] Both of these robots are still being trialled and used for research, and it is somewhat difficult to ascertain how commercially viable they might be in the future. The Carebot is designed to offer non-physical assistance, such as positional monitoring and fall detection. It can call for help if required and remind people to do things. In contrast, the robotic arm or arms on the Care-o-bot (versions 3 and 4) suggest the potential for these robots to help people with physical tasks around the home in the future. When combined with a smart home environment and body sensors other research, such as the Mobiserv Project (now completed), demonstrates how care robots can be used to monitor people at a more detailed level, keeping records of vital signs, as well as drinking, eating and movement patterns.[6] Robots can be programmed to use this information, combined with speech and screen interfaces, to suggest when people should take medication, fluids, food or exercise, based on guidelines set by human carers. Screens on robots also enable mobile teleconferencing, allowing people to make and answer video calls wherever they are in their homes.

The development of robots designed to communicate with humans, such as the care robots discussed above, can be analysed in many ways. From a cybernetic theory perspective, the robot can be thought of as a medium, since it is a "technology that translates perception, makes interpretations, and performs expressions."[7] An alternative perspective positions robots alongside television and computers as forms of mediated life that people easily equate with real life experiences. For example, "media equation" theory suggests that, whatever their form, robots will be interpreted by people in "fundamentally social and natural" ways.[8] Videos showing people communicating with care robots indicate that they do interpret the robots as social communicators, although they may not be as polite to the robot as they would be to another person. In most cases though, a care robot is not only interpreted by people as a communicator in its own right, but also recognised as a medium through which they can communicate with other people using a video interface.

The Care-o-bot uses voice and gestural communication channels alongside a touchscreen interface, while the Mobiserv Project robot just used voice and a touchscreen. In contrast, the CareBot has a voice interface, but its screen appears mainly directed towards enabling video calls with family members, carers and doctors. Promotional videos for the Care-o-bot and CareBot show both the robots relying on voice recognition and production to communicate with people much of the time. While the programming of spoken communication interfaces is improving rapidly (as seen in software robots such as Siri), it is still a challenging task that may slow the introduction of these robots into real-world (as opposed to trial) contexts, with considerable difficulties in recognising local accents, speech styles and multiple languages. It should also be noted that, to operate well for people with impairments that affect their ability to hear and/or speak, these autonomous robots will need to support a wider range of communication channels, as is seen in the semi-autonomous assistive robotic devices discussed in the next section. In addition to the challenges of supporting flexible human-robot communication, a focus on making these robots fully autonomous, and the problems of enabling robust real-world movement, dexterity, perception and precision identification of objects, complicates their deployment into everyday spaces, as opposed to specially constructed robot-friendly environments.

In spite of these difficulties, and the likely to be high commercial cost of these robots, the Mobiserv Project website suggests that robots capable of monitoring people and providing personal assistance are designed “to offer home care for (semi-) independent living with a focus on health, nutrition, well-being, and safety.”[9] This raises the question of what (semi-)independence might mean to both carers and those for whom they care. It also raises ethical issues in relation to positioning robots as replacements for human carers, a move that some researchers argue might well reduce people’s access to meaningful human social contact involving face-to-face conversation and physical touch.[10] While these sorts of robot have the potential to increase people’s self-reliance, in both cognitive and physical terms, the high level of monitoring and recording of information they perform, and the need to report this information to human carers, also lead to questions about how this might impact upon the privacy and rights of the person living with the robot,[11] issues which may cause particular concern for people with disabilities, disability-rights activists and researchers. People’s privacy worries are likely to become more pressing when these types of autonomous care robots are deployed in real-world situations in people's private homes as well as in hospitals and other care environments.

Semi-autonomous assistive robots

More readily available examples of assistive robots are semi-autonomous wheelchairs and robotic manipulators that can attach to wheelchairs or fixed furniture. Some of these robots are very specialised, for example My Spoon (SECOM) and the Mealtime Partner (Assistive Innovations), are both specifically designed to allow people with restricted mobility of their arms and hands to feed themselves.[12] In other cases, assistive robots are based on broadening the usefulness of existing non-autonomous electric wheelchairs and manipulator arms. These robots are designed to enable people to use such machines, even when controlling the whole movement, or a precision part of the movement, is not possible. Examples of assistive robots of this sort this are the SafePath Wheelchair (being developed by Gecko Systems), the iARM robot (Exact Dynamics) and the JACO robotic arm (Kinova).[13] As was the case for stand-alone care robots, these machines increase people's ability to do tasks for themselves with the help of technology, but they are less likely to be regarded as replacements for human carers, being more clearly positioned as semi-autonomous assistants.

These more specialised robots form part of an assistance network for people, with a focus on enabling them to fulfil their own physical needs. Factors that are important with this type of robot relate to the precise way in which the robot is designed to work with people, the level of control the person retains and the smooth integration of user direction and robot response, whatever interface (joystick, keypad, voice, screen, button, foot switch, sip-and-puff et cetera) is used to communicate the user's needs. While communication with these robots might be thought of as following a simple command-response structure, with specific interface commands triggering specific robot actions; as discussed later, the capability of this type of assistive device may only be fully realised if a more flexible and complex communicative relation is reached, which enables a robot to take partial responsibility for completing tasks in a collaborative interaction with the person.

The use of semi-autonomous robots to provide physical and cognitive assistance has the potential to make it easier for people often positioned as leaners, such as elderly people and people with disabilities, to become recognised as lifters in more situations (to use Innes' terminology). However, these robots nonetheless raise similar issues to the autonomous robots discussed above in relation to the ethics of care that involves machines instead of people, and perceptions of control within interactions involving humans and robots. In addition, although their primary aim is not to monitor people, even these robots have the potential to collect information that could be shared with others. Some of this information, resulting from the use of global positioning systems or cameras, might be essential for the successful operation of the robot; for example, it might be needed for navigation or to enable the semi-autonomous movement of a manipulator being used to locate and pick up a specific item. However, if the information is stored, the user of the robot may well want to retain control over any decision to share this information with others.

A number of scholars have considered the ethical and information access questions that might arise alongside the increased use of care and assistive robots, mainly in relation to support for elderly people.[14] Some of their ideas can be extended to consider the possible impact on people with disabilities as well, but these questions also deserve careful consideration from the perspectives offered by disability studies, which may pinpoint different focal concerns. A key question asked by disability studies scholars, is what it means to live independently, retaining a level of autonomy in light of a recognised need for assistance that might involve calling upon other people, animals and/or machines for help.

Independence, autonomy and care robots

The idea of what independence constitutes for people with disabilities, and therefore also elderly people who develop cognitive or physical impairments as they age, depends on one's personal perspective, training and experience. Solveig Reindal, for example, notes that care professionals and the disabled people for whom they care define dependence and independence differently from one another. She suggests that this may in part be due to the way in which disability itself is understood by these groups.[15] In particular, care professionals tend to measure independence against a person's ability to care for themselves without the help of others, a judgement that may be reliant on adopting the medical model of disability.

The medical model has been strongly criticised in disability studies scholarship,[16] but continues to shape policy around, and therapy for, people with disabilities in many countries. As might be expected, the model concentrates its attention on disabilities as "inherently pathological conditions that can be objectively diagnosed, treated, and in some cases ameliorated".[17] Disability within this framework is defined as the problem of an individual subject, and the goal of rehabilitation is to maximise the "functional independence and self-sufficiency" of people with disabilities.[18] From this perspective the development of assistive technologies, including robotic technologies, should focus on allowing a person with disabilities to live within the world as independently and as safely as possible. In this context, independence is most often defined in relation to avoiding the need to ask for human help.

Unlike many care professionals, people with disabilities are more likely to recognise independence as stemming from having the ability to gain assistance, whenever and however they might require it, in order to live their lives as they wish. This sense of independence is reliant on "a mind process that is not contingent on having a normal body", and is strongly related to retaining a sense of personal autonomy in one's life.[19] As Reindal argues, whether one understands independence as stemming from self-reliance or from having the autonomy to ask for and to receive assistance whenever necessary, both perspectives "individualise independence" by reinforcing a "modernist view of the subject,"[20] a view that is also central to the medical model of disability. When a robot is recognised as a *carer* or as *assistive*, people's reliance on the machine, because it is not another person, does not detract from judgements about the level of independence a care receiver attains, and may also enhance that person's sense of their own personal autonomy.

The use of autonomous care robots, such as the Carebot or Care-o-bot, can be framed as removing people's everyday reliance on other humans for assistance, but they may nonetheless undermine people's independence by sharing stored information—on issues such as falls, forgotten medication, or less than ideal eating and drinking patterns—with family members or remote human caregivers. In addition, the use of robots might reduce opportunities for care receivers to reinforce their autonomy by asking for, and receiving, human assistance when that is what they would prefer. As Bohlen and Karppi note, robots have the potential to change healthcare by redefining "not only the dependencies between machines and people but also the concept of care" itself.[21] More broadly, the use of the Internet for self-diagnosis, as well as the introduction of "medical 'expert' systems" and care robots, might mean that care receivers "miss the expertise and skills of the physician who would examine them and rely on their visual and tactile, embodied understanding, their know-how" to provide assistance.[22] The idea that expert knowledge can be formalised, and that a record of electronic monitoring can hold all relevant information about a person, overlooks the value of a human carer's "personal, practical, and tacit knowledge."[23]

A related concern, is the loss of a "deep sense" of care, through a "focus on the mechanical delivery" of medication, information or advice,[24] alongside the "utilitarian" touch of a robot that lifts or bathes a person, completing the task with skill but lacking the "affective touch" of a human caregiver and level of emotional communication that involves.[25] Parviainen and Pirhonen argue that "robots can take care" of people, "but they can't care about them."[26] In spite of these concerns, the designers of more complex autonomous care robots discuss the ways their robots can engage socially with the people for whom they care, while some research suggests that "older adults expect a robot to be more like an assistant or an appliance rather than a friend."[27] Nevertheless, it seems that in general, while the importance of communication in the form of information that can be collected, transmitted and stored digitally and without human intervention is clearly recognised, the value of embodied, experiential understandings, cultural nuance and affective contact between care givers and receivers is more easily overlooked.

It is therefore good to note that care robots can be positioned not as replacements for human caregivers, but rather as caregiving assistants. By completing "the hard physical work" such robots enable human carers to focus on "embodied social interactions" with those for whom they care.[28] When deployed in this way, robots become part of a "care triangle," supported by "human-robot-human interaction" with different roles for "caregiver, care receiver and robot."[29] This perspective introduces the idea that care and assistive robots have the potential to make care receivers "feel that they have more *relational autonomy* in care practices" as part of a triangle of interaction within which affective communication and touch remain an essential element.[30] Importantly, "relational approaches to autonomy grant that individuals' actions are inevitably linked to the affordances of the agent's environment."[31] Thus the idea of "relational autonomy" goes beyond individual autonomy to embrace the importance of "care, interdependence, and mutual support,"[32] key aspects of the social model of disability.

Interdependence, partnership and collaboration with robots as agents

In contrast with the medical model, the social model moves away from situating disability within the individual, to argue that disability is the effect of “discriminatory social practice, social reactions or ignorance.”[33] At times, the focus on social factors seems to imply that “*all* restrictions of activity experienced by people with impairment are caused by social barriers.”[34] More often though, researchers who adopt the social model, in particular those that mobilise critical and feminist perspectives, continue to recognise the impact of individual impairments, while arguing that the ways cultural and societal norms discriminate against bodies and minds that are not those of the ideal human raise important issues.[35] For example, Rosemarie Garland Thomson argues that the interaction between bodies and their environment, societal situation and specific interactional context results in “varying degrees of disability or able-bodiedness, or extra-ordinariness.”[36] This perspective acknowledges not only the difficulties that people with disabilities may experience living in a world often designed with non-disabled bodies in mind, but also the potential they have to highlight new and extra-ordinary ways to live in that world. In some cases this may well involve engaging with technology in unusual and inventive ways.

Although researchers employing social models of disability, including more critical or feminist articulations of these theories, do discuss ideas of independence, Reindal suggests that the stress they place on the embodied and embedded subject makes them particularly compatible with a concept of “interdependence”, within which “independence is partnership.”[37] The conception of partnership is reiterated by Donna Goodwin, who explains that interdependence “can be seen in relationships that lead to a mutual acceptance and respect as diverse people come together in a synergistic way to create environmental and attitudinal supports to foster full participation in preferred activities."[38] Adopting the concept of interdependence therefore highlights the underlying links between people with disabilities, the help they request and receive from others, and their sense of autonomy. It also opens up ways to consider human interactions with assistive robots as more than tool use, acknowledging the semi-autonomous or autonomous nature of these machines as people collaborate with them to complete everyday tasks.

In contrast with the larger care robots, semi-autonomous assistive robots such as robotic arms are rarely seen as undermining the position of care receivers, or reducing their access to human social contact. Instead, individualised ideas of independence and autonomy tend to drive the assumption that wherever possible the person should be in full control of the robot. Unfortunately, positioning a robot as a tool in this way makes it difficult to accept the idea that collaborating with a robot, such that it can contribute a level of control for its actions, might make the task easier to complete.

Research relating to the development of robotic electric wheelchairs and manipulator arms has found that the "users of assistive devices overwhelmingly prefer to cede only a minimum amount of control authority to the machine."[39] It is nonetheless important to recognise the need to make these assistive machines easier for people with even a "severe motor impairment" to control.[40] This can be achieved by transferring "some of the control burden … from the user to the machine," so that these machines become better classified as robots that are "able to accomplish tasks autonomously, in some capacity."[41] Alongside this, it is vital that the person using the robot can exert the level of control that they want, or are able, to retain through a variety of communication interfaces with the machine.

Brenna Argall describes a "control spectrum" for robots, from "full manual control" to "fully automated control," the latter made possible by developing autonomous robots.[42] Between these two extremes exists "a continuum of *shared control* paradigms, that blend—whether by fusion or arbitration—the inputs from manual control and automated controllers."[43] Ideally designers, and the users of these robots, want to locate the "sweet spot", "where sharing control makes the system more capable than it is at either of the continuum extremes."[44] Alongside this, it is vital to achieve a situation "that is both *effective* at accomplishing tasks and *accepted* by the human user."[45] This involves creating assistive robots "that make the human *more* able … but still ultimately *in control* through shared control paradigms that leverage machine learning to be customizable to and teachable by the user."[46] In practice, Argall has found that managing the flexible allocation of control involves creating an assistive robot that alters its level of trust in the human operator based on past experience and the level of "agreement between user and automated controller commands."[47] From this perspective, the interaction between human and assistive robot does not position the robot as a tool, but rather as an agent, albeit one whose actions are carried out under the overarching control of a human.

It seems likely that retaining a sense of control over the robot reduces the potential of feeling wholly dependent on the machine, which might well undermine the sense of independence and autonomy that such a machine is designed to give to its user. In some situations, it might be necessary for a robot to increase its autonomy; an action that would allow a robotic wheelchair to follow a person or create a convoy with other wheelchairs, follow a sidewalk or wall or renegotiate a previously followed path (or reverse that path to return home).[48] However, in general, robotic wheelchairs and manipulator arms will work more effectively when their human user is able to exert control over some aspects of the movement, thus sharing the burden of control back to the user.[49] The balance point of control between robot and user may depend on the environment as well as the task at hand, but can also be altered according to the energy level of the user, to increase robot autonomy as the person becomes fatigued. The idea of balancing control to maximise the usefulness of the machine emphasises the way in which human and robot are interdependent and must work together flexibly to get things done.

While it might seem radical to suggest that assistance robots should be regarded as a kind of agent with which people can collaborate, there is evidence that, when this perspective is taken, humans gain more from their interactions with autonomous or semi-autonomous machines by combining their abilities with those of the machine in flexible and adaptive ways. A consideration of the details of human interactions with robotic floor cleaners provides a simple example of the importance of this type of collaboration. While these robots are broadly autonomous, as already noted above, they nonetheless require regular assistance from humans. The robot may sometimes request this help directly, for example through the use of light or sound indicators showing the dust container is full. However, on other occasions the needs of these robots are interpreted by their owners from less direct signals, for example through the noise they make when stuck beneath a piece of furniture.[50]

Without the assistance of a person, these robots are unable to complete the task they are designed to undertake with any great success. In general, people who treat floor cleaning robots as tools are more likely to become disillusioned with them, relegating them to the cupboard, while people who work with the robot, tidying and preparing spaces for its presence are not only happier with its operation, but also have cleaner houses.[51] A more precise consideration of the way in which regarding robots as agents may promote better teamwork with them is provided by Guy Hoffman's research with AUR, the robotic lighting assistant.[52] Hoffman's work investigated the effect of creating a robotic lamp that could learn alongside a human. AUR could operate in two modes. In the first, the robot simply responded to the human's movement and vocal instructions. In the second, AUR learnt the task for itself, allowing it to anticipate the human's instructions as they completed a repetitive task together over a series of iterations. Hoffman found that when AUR anticipated commands, showing indecision through its movement if it was misdirected, people responded to the robot as an agent. In this mode, the human-robot team worked together flexibly, completing the set task more quickly and accurately.[53]

The results of Hoffman's work, which brings together a robot and a human to work on a task that requires both their abilities to complete, extends Argall's idea of the "sweet spot."[54] In addition, the implementation of this robot goes some way to fulfil Mark Coeckelbergh's insistence that people's perceptions of robotic technologies should involve recognising their worth as assistants (in AUR's case a lighting assistant), as opposed to replacements, for humans.[55] It is therefore important to acknowledge that, in spite of its lamp-like appearance, people who experienced AUR's ability to learn, anticipation of commands and attempts to correct misdirection thought of AUR as a teammate that would be let down by any errors they made.[56] It is possible to argue that people's anthropomorphic response to robots with which they interact is unavoidable, something that might be expected given the human propensity to name cars, computers and other non-robotic technologies.[57] However, it is also likely that "when interpreting non-humanoid robots, peoples' anthropomorphic and zoomorphic responses are *tempered* by the clarity with which they are also understood as machines."[58] This suggests that assistive non-humanoid robots have the potential to be recognised not as agents that can replace humans, but rather as a new type of nonhuman agent with which people can collaborate at least some of the time.

The interactions between humans and assistive robots described above would seem to move beyond tool use, to encompass collaborative work that involves humans and machines that are recognised as active agents, able to sense and respond to changes in their environment intelligently. The idea of positioning robotic technologies as agents can be linked with theoretical streams such as object-oriented ontology and actor-network theory;[59] however, these frameworks tend to flatten ontological distinctions between people and technologies, to regard them as equivalent in their agency and ability to experience the world. In relation to care robots and assistive technologies, it is particularly important to recognise that people generally do not understand these robots as equivalent to humans; rather, people's experience of the agency of robots and the potential to collaborate with them, emerges through processes of communication and interaction. Not only can human caregivers be involved in these processes, but also overarching control of the use of the technologies remains with people (in some cases those receiving and in some cases those providing care).

Leaning and lifting with robots in the future

There is little doubt that leaning on technology as an assistive tool is perceived by most people as being very different from leaning on another person. It is already possible to argue that many people, with disabilities or non-disabled, are increasingly reliant on technology in their day-to-day lives. This is particularly evident with devices such as smart phones and tablets. Whether people's reliance on such technology amounts to an undesirable level of dependence is a source of argument in scholarly research and the popular media.[60] From a disability studies perspective, the moral panic around screen use as detrimental to face-to-face human communication skills and social relations is particularly unhelpful, given the importance of such technologies for people with disabilities, in some cases enabling their everyday communication.[61] On a less contentious level, the mainstream acceptance of technology into people's homes, including robots such as floor cleaners, not only makes the use of such technology less remarkable (and therefore more generally accepted), but also has the potential to make this technology more functional and affordable. These positive effects have already been seen with the mainstreaming of voice to text and text to voice technology on computers and smartphones, and a similar trend has supported the rapid development of autonomous robotic floor cleaners.

Of course, in comparison with small household appliances, autonomous care robots are larger, more complicated, considerably more expensive and may operate in ways that raise fears about human safety and privacy. In general, the development of such robots is driven by concerns relating to the aging populations of many societies, including the United States, Europe and Japan, expected to increase care needs with fewer and fewer young people to work in that capacity.[62] In spite of this perception of future demand, while there are many examples of assistive robots in development, relatively few have become commercially available.[63] This may be why the Care-o-bot, and commercially available robots such as REEM (PAL robotics) and Pepper (Aldebaran), are marketed as having the potential to offer assistance more generally, not only in relation to care, but also in service roles in hotels, restaurants and shops.[64] By broadening the possible uses for these robots the manufacturers likely hope to engage a wider market, with more sales to finance the development programmes needed to tackle the difficulties associated with attaining safe autonomy, perceptual skills, dexterity and flexible human-robot communication.

For the more specialised task-specific semi-autonomous robots, such as the robotic arms discussed above, commercial development and public availability is more evident. The manufacturers have demonstrated their safety and efficacy for a range of people with disabilities who communicate using a variety of channels. Unfortunately, while cheap in comparison with autonomous care robots such as the Care-o-bot and CareBot, the price of semi-autonomous assistive robots, alongside the difficulties of accessing government funds to help mitigate this cost, makes it hard for people with disabilities to procure them. However, it is possible that 3D printing technology has the potential to reduce build costs for these assistive robots in the future, as has been the case with the robotic prostheses created by Open Bionics.[65]

To realise the potential of care and assistive robots, it is vital that people with disabilities, both young and old, are involved from the early stages of their design and development. This will help to ensure that robotic technologies are created in ways that respect people's choices not only about care provision itself, but also relating to the privacy of information collected to guide that care. Inclusive design and development practices will also be important in creating robots that people with disabilities can communicate with, and in some cases through, using a wide variety of interfaces. Alongside this, it will also be helpful to set aside independence as the ultimate goal for human-robot care interactions; to embrace instead the idea of relational autonomy and the interdependence that state recognises. This is because moving beyond individualistic conceptions of independence and autonomy has the potential to alter how assistance robots are perceived, by destabilising the assumption that people must maintain a sense of control over the robot at all times, when it might instead work better by undertaking a semi-autonomous engagement of its own with the task at hand. With a goal of interdependence in mind, it is easier for people to accept robots not just as simple tools, but rather as collaborative agents. When relations with assistance robots are framed in this way, there is potential for both the person with a disability, and the robot, to switch roles between being a lifter and being a leaner, in a relation of interdependence that aims to produce the most effective way to complete a task, given its nature, environmental factors and the ability of person and robot at any given time. Recognising the value of human-robot collaborations, within which human and robot help each other to complete a task, makes it possible to reach a higher level of joint ability through flexible and cooperative interaction than either human or robot could achieve alone. This move acknowledges the way in which all people, not just people with disabilities, live in a state of interdependence, lifting and leaning alongside one another, animals and technologies that are likely to include increasing numbers of assistive robots in the future.

Notes

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[1] Graeme Innes, "I Have Never Accepted the Concept of 'Lifters' and 'Leaners,'" *The Guardian*, February 7, 2014, http://www.theguardian.com/commentisfree/2014/jul/02/graeme-innes-i-have-never-accepted-the-concept-of-lifters-and-leaners

[2] Menzies, Robert. "The Forgotten People." Speech, May 22, 1942. http://www.liberals.net/theforgottenpeople.htm.

[3] Joe Hockey, "We are a nation of lifters, not leaners," *Australian Financial Review*, May 14, 2014, http://www.afr.com/news/policy/tax/joe-hockey-we-are-a-nation-of-lifters-not-leaners-20140513-ituma

[4] Graeme Innes, "I Have Never Accepted the Concept of 'Lifters' and 'Leaners.'"

[5] For more information about Carebot (Gecko Systems) see http://www.geckosystems.com/markets/CareBot.php; and for more about the Care-o-bot (Fraunhofer) see: http://www.care-o-bot-4.de/

[6] See the Mobiserv website for more information: http://www.mobiserv.info/

[7] Chris Chesher, "Mining Robotics and Media Change," *M/C Journal* 16, no. 2 (2013), http://journal.media-culture.org.au/index.php/mcjournal/article/view/626

[8] Byron Reeves and Clifford Ivar Nass, *The Media Equation: How People Treat Computers, Television, and New Media like Real People and Places* (Stanford, Calif. : New York: CSLI Publications; Cambridge University Press, 1996), 5.

[9] http://www.mobiserv.info/

[10] Amanda Sharkey and Noel Sharkey, "Granny and the Robots: Ethical Issues in Robot Care for the Elderly," *Ethics and Information Technology* 14, no. 1 (March 2012): 27–40; Jaana Parviainen and Jari Pirhonen, "Vulnerable Bodies in Human-Robot Interactions: Embodiment as Ethical Issue in Robot Care for the Elderly," *Transformations* 29 (2017): 104-115.

[11] Sharkey and Sharkey, "Granny and the Robots."

[12] For more information about My Spoon (SECOM) see http://www.secom.co.jp/english/myspoon/; and for the Mealtime Partner see (Assistive Innovations) http://assistive-innovations.com/en/eatingdevices/mtp.

[13] For more information about the SafePath Wheelchair (being developed by Gecko Systems) see http://www.geckosystems.com/markets/wheelchair.php; the iARM (Exact Dynamics) see http://www.exactdynamics.nl/site/?page=iarm; and JACO (Kinova) see http://www.kinovarobotics.com/service-robotics/products/robot-arms/

[14] Sharkey and Sharkey, "Granny and the Robots;" Robert Sparrow and Linda Sparrow, "In the Hands of Machines? The Future of Aged Care," *Minds and Machines* 16, no. 2 (2006): 141–161.

[15] Solveig Magnus Reindal, "Independence, Dependence, Interdependence: Some Reflections on the Subject and Personal Autonomy," *Disability & Society* 14, no. 3 (1999): 353–367.

[16] Meryl Alper, *Digital Youth with Disabilities*, The John D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning (Cambridge, Massachusetts: The MIT Press, 2014); Donna L. Goodwin, "Self-Regulated Dependency: Ethical Reflections on Interdependence and Help in Adapted Physical Activity," *Sport, Ethics and Philosophy* 2, no. 2 (2008): 172–184.

[17] S. Gabel and S. Peters, "Presage of a Paradigm Shift? Beyond the Social Model of Disability toward Resistance Theories of Disability," *Disability & Society* 19 (2004): 587, quoted in Goodwin, "Self-Regulated Dependency," 174.

[18] Goodwin, "Self-Regulated Dependency," 174.

[19] Reindal, "Independence, Dependence, Interdependence," 354.

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[21] Marc Böhlen and Tero Karppi, "The Making of Robot Care," *Transformations* 29 (2017): 2.

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[65] For more information on Open Bionics see: https://www.openbionics.com/