Mind Mach (2006) 16:141–161
DOI 10.1007/s11023-006-9030-6

In the hands of machines? The future of aged care

Robert Sparrow · Linda Sparrow

Received: 23 December 2005 / Accepted: 3 July 2006 / Published online: 8 August 2006

Abstract It is remarkable how much robotics research is promoted by appealing to the idea that the only way to deal with a looming demographic crisis is to develop robots to look after older persons. This paper surveys and assesses the claims made on behalf of robots in relation to their capacity to meet the needs of older persons. We consider each of the roles that has been suggested for robots in aged care and attempt to evaluate how successful robots might be in these roles. We do so from the perspective of writers concerned primarily with the quality of aged care, paying particular attention to the social and ethical implications of the introduction of robots, rather than from the perspective of robotics, engineering, or computer science. We emphasis the importance of the social and emotional needs of older persons—which, we argue, robots are incapable of meeting—in almost any task involved in their care. Even if robots were to become capable of filling some service roles in the aged-care sector, economic pressures on the sector would most likely ensure that the result was a decrease in the amount of human contact experienced by older persons being cared for, which itself would be detrimental to their well-being. This means that the prospects for the ethical use of robots in the aged-care sector are far fewer than first appears. More controversially, we believe that it is not only misguided, but actually unethical, to attempt to substitute robot simulacra for genuine social interaction. A subsidiary goal of this paper is to draw attention to the

We dedicate this paper to the memory of Jean Woodroffe, whose strength and courage at the end of her life journey inspired the authors' interest in aged-care issues.

R. Sparrow (✉)
Faculty of Arts, School of Philosophy and Bioethics,
Monash University, Clayton, Vic. 3800, Australia
e-mail: Robert.Sparrow@arts.monash.edu.au

R. Sparrow
Centre for Applied Philosophy and Public Ethics, University of Melbourne, Melbourne, Australia

L. Sparrow
Independent Aged Care Consultant, Melbourne, Vic., Australia

discourse about aged care and robotics and locate it in the context of broader social attitudes towards older persons. We conclude by proposing a deliberative process involving older persons as a test for the ethics of the use of robots in aged care.

Keywords Robots · Social robotics · Aged care · Ethics · Human–robot interaction · Electronic monitoring · Assistive technology

Introduction

The history of robotics is replete with grandiose claims about a future in which intelligent robots take their place alongside human beings. One such claim, which has received a significant amount of media coverage in the last few years, is that, in the near future, robots will play a substantial role in caring for the increasing percentage of dependent or frail older persons within the population of advanced industrial nations. Articles with titles such as ''Robot to keep elderly from going senile'', ''Nurse Gadget patrols the wards'' and ''Japan looks to robots for elderly care'' advertise the supposed benefits that robots offer older persons (Allen, 2005; Cox, 2003; Kageyama, 2002; Kitano, 2005; Kunii, 2000; Metcalf, 2005; Scanlon, 2000; Sullivan, 1999; Sydney Morning Herald Online, 2004). It is in fact remarkable just how much robotics research, if it is not being sponsored by the military, is promoted by appealing to the idea that the only way to deal with a looming demographic crisis is to develop robots to look after older persons! (Arthur, 2004; Birmingham Post, 2005; Brooks, 2002; Kitano, 2005; Morrison, 2004; Severin, 2004).[1] U.S.-based robotics corporation, Acrotek, already advertises a robot for sale in an aged-care role, claiming on its website that

> The Actron MentorBot™ can also act as a companion and attendant for elderly family members. It will keep track of the elderly person, remind them to take pills or a meal and alert you when something is not right. It has the ability to call the authorities and report a problem or call you when your loved one has gone astray (Acrotek Robotic Products, 2005).[2]

Sometimes the claim that robots might play a useful role in aged care is clearly hyperbole and an attempt to provide a public justification for research into the researchers' own intellectual interests. Yet, there are also researchers genuinely dedicated to developing robots for roles in aged care, as well as research evaluating the effectiveness of robots in such roles (Kitano, 2005; Lytle, 2003; Pineau, Montemerlo, Pollack, Roy, & Thrun, 2003). Australia has recently established a research centre on autonomous systems which aims to test robots in a nursing home by 2007 (Australian Research Council Centre of Excellence in Autonomous Systems, 2004). Social robotics is a flourishing field, pursued by a large number of researchers devoted to the goal of developing robots capable of interacting with humans in a sophisticated fashion (Brezeal, 2002; Dautenhahn, Bond, Canamero, & Edmonds, 2002; Fong & Nourbakhsh, 2003).

This paper surveys and assesses the claims made on behalf of robots in relation to their capacity to meet the needs of older persons. We consider each of the roles that

[1] For a survey of robotics research which discusses interest, especially in Japan, in robots as carers and companions for older persons, see Menzel and D'Aluisio (2000).

[2] The Actron Mentorbot also features heavily in Severin (2004).

has been suggested for robots in aged care and attempt to evaluate how successful robots might be in these roles. We do so from the perspective of writers concerned primarily with the quality of aged care, paying particular attention to the social and ethical implications of the introduction of robots, rather than from the perspective of robotics, engineering or computer science. Because the claims made by roboticists can seem so outlandish to ordinary persons we have been careful to reference each claim to the existing literature.

Adopting an aged-care-centred perspective productively and strikingly illuminates a literature which is currently dominated by the claims of roboticists. It allows us to inject a much-needed dose of reality into a literature characterised by exaggerated and utopian claims, by emphasising the importance of the social and emotional needs of older persons—which, we argue, robots are incapable of meeting—in almost any task involved in their care. Even if robots were to become capable of filling some service roles in the aged-care sector, economic pressures on the sector would most likely ensure that the result was a decrease in the amount of human contact experienced by older persons being cared for, which itself would be detrimental to their well-being. This means that the prospects for the ethical use of robots in the aged-care sector are far fewer than first appears. More controversially, we believe that it is not only misguided, but actually unethical, to attempt to substitute robot simulacra for genuine social interaction.

A subsidiary goal of this paper is to draw attention to the discourse about aged care and robotics and locate it in the context of broader social attitudes towards older persons. We see the idea that we can solve the ''problem'' of caring for an ageing population, by employing robots to do it, as essentially continuous with a number of other attitudes and social practices which evidence a profound disrespect for older persons. This, in itself, is reason to be cautious in our enthusiasm for research that might bring us closer to a future in which the care of frail older people is in the hands of machines. An awareness of the continuities between the current enthusiasm for robotics and a history of institutionalising care for older people suggests that an important test both for the ethics of the use of robots in aged care and for the merit of dedicating resources to research to this end is whether those people who such robots are supposed to serve would want them. We therefore conclude by proposing a deliberative process involving older persons as a test for the ethics of the use of robots in aged care.

The future challenge of aged care

One of the consequences of the post-World War II prosperity boom, is a shift in the demographics of industrialised—and industrialising—nations. The post-war baby boom, along with the increase in life expectancy made possible by modern medicine, as well as recent declines in the birth rate, means that an increasing percentage of the population consists of older persons. This demographic change, combined with changes in family structure and social expectations, has led to a greatly increased demand for services relating to the care of older persons. We will discuss this phenomenon in the Australian context with which we are most familiar; however, a similar story could be told about most of the industrialised nations.

At the most recent census in 2001, there were nearly 2.4 million people in Australia over 65, or 13% of the population. Current estimates are that this will increase to 18% in 2021 and to 24.5% in 2042, when the total population is expected to be more than 25 million people (Australian Bureau of Statistics, 2000). Longer life expectancy (82.5 years for men and 87.5 for women in 2042) means that the number of people 85 years and over will double during the next two decades and will triple by 2051 to comprise over 9% of the population, or 2.3 million people, in 2051. In 2001, there were 2,503 people aged 100 years and over. This is projected to grow to 38,000 people by 2051.

Often these impending demographic changes are presented in terms of a doomsday scenario. Media reporting on them encourages fear of an old, static population and of tax and health systems unable to cope. There are warnings of the threat of increasing numbers of old people demanding more prescription medicines, taking up expensive hospital beds for prolonged periods of time, and requiring more from the already stretched health and aged-care sectors (Alzheimer's Australia, 2005; Kissane, 2002; Wood, 2005). The economic consequences of this anticipated ageing of the Australian population have been heavily publicised in recent times—most recently in the form of the research report from the Productivity Commission, ''The Economic Implications of an Ageing Australia''. In this report, it is estimated that ageing-related pressures on government finances will open up a fiscal gap nationally of $55 billion a year in today's money by 2044 (6.5% of GDP by 2044–2045) (Productivity Commission, 2005).

Historically, social policy in Australia has tended towards the position that caring for frail older people is predominantly a family responsibility. Family care (provided by spouses and children) accounts for a significant proportion of the aged-care support hours available to those who live alone (Wenger, 1992). The majority of care-givers to the old are women—mainly wives and daughters, but also daughters-in-law and other female relatives (Australian Bureau of Statistics, 1999). Some have young children, while others are old themselves. Many are in the paid workforce. Often they are troubled from the stress of caring for their frail aged relatives (Murphy & Schofield, 1997). The changing demographics, the increased participation of women in the workforce and new patterns of partnering and child-bearing have come together to place much pressure on women. It is also expected that in the future there will be fewer children to share the caring load. The total fertility rate of Australian women has been in decline since its peak of 3.5 births per woman in 1961. It is now 1.76 births per woman and expected to decline further, to 1.6, by 2042 (Commonwealth of Australia Treasury, 2002).

These demographic changes, in combination with the family pressures described above, suggest that aged care will become a more pressing public policy issue in the future. It is already the case that there is a rapidly growing industry providing services relating to the care of older persons. Australia has approximately 1,600 approved providers of aged-care services, which operate almost 3,000 facilities. One third of these are private-for-profit businesses. The remainder are run by local and state governments, community groups, charitable and religious organisations, and other not-for-profit entities (Australian Government Department of Health and Ageing, 2004).

Enter the robots

Robotics researchers have suggested that robots—programmable machines capable of interacting with and manipulating their environment—might have a useful part to play in the burgeoning aged-care sector in a number of roles (Kageyama, 2002; Kitano, 2005; Lytle, 2003; Metcalf, 2005; Sydney Morning Herald Online, 2004). How might such machines help us to meet the challenge of aged care in the future?

This section of the paper surveys the robotics literature and assesses the claims made therein. Given that robotics technology is advancing steadily, it would be perilous to found any judgement about what might be possible in the future solely on the basis of a detailed analysis of existing technological systems. Instead, we will evaluate the prospects for robots based on a common sense or pragmatic assessment of the nature of the tasks that robots might be required to carry out. We will argue that a proper understanding of what would be required for robots to play a useful role in aged care suggests that these prospects are far fewer than is generally held by those who are more impressed with the technological progress that has been made in robotics over the last decades.

An important fact we need to consider while conducting this survey is that alternative technologies exist to assist in the areas where it is suggested that robots might have a role to play. There is little point in either developing a robot to play some role, or worrying about the ethics of doing so, if its job could be performed better by some other technological means. Thus throughout this brief survey of the literature we shall note competing technologies and attempt to draw out what might be the distinctive contributions that robots could make.

The first way in which, it has been suggested, programmable machines might contribute to aged care is in their traditional science-fiction role of robot butlers or robot servants (Brezeal, 2002, pp. 1–4; Dautenhahn et al., 2005; Severin, 2004, pp. 8–10, 15–17). Aged care, both residential and home-based, has always required high labour intensity. A high proportion of frail older people need daily and time-consuming assistance with toileting, showering and dressing, as well as help with a myriad of other tasks. Many residents of aged-care facilities must be lifted from bed to chair and chair to bed. Many are unable to feed themselves. Bed-bound people must be turned often and regularly. Older people who remain at home as they age also require assistance with a multitude of tasks.

In the future, voice-activated robots might relieve these pressures by playing a general service role in aged care, fetching food and drink and other items on command, opening doors, controlling home appliances and moving objects around (Morrison, 2004; Severin, 2004, pp. 8–10, 15–17; Toshiba Corporation, 2005). Such robots could allow frail older persons to remain independent longer. Robots might also provide more intimate physical assistance to older persons and their carers. They might function as aids to mobility, providing support or a helping hand to those who are frail or living with a disability (Pineau et al., 2003; Severin, 2004, pp. 10–13). They might also help with bathing and showering residents in aged-care facilities. Finally, robots might help staff in hospitals and aged-care residencies lift and turn people who are bedridden (Kitano, 2005).

Very large advances in robotics would have to occur before any of this would be possible. Robots would have to be highly sophisticated, mobile and dextrous (as well as waterproof). Existing robots are unable reliably to navigate their way around

household environments, let alone manipulate objects therein (Brooks, 2002, pp. 114–117). Robots large enough and strong enough to lift people, or large objects, would have to be heavy and powerful. Yet such robots are also inevitably dangerous and risk crushing people if they fall over or strike them in the course of their movements. Industrial robots are kept away from people for this very reason (Menzel & D'Aluisio, 2000, p. 39, 44). These safety issues will need to be addressed before robots and humans can cohabit safely. Robots would also have to be much more robust than is currently the case. A robot which broke down in the course of providing these services would be worse than no help at all. Note also that devices to increase personal mobility are already available in the form of walking frames, scooters and powered wheelchairs. Similarly, many hospitals and aged-care facilities already use other mechanical and variously assisted systems to help lift, turn and bathe patients. Given the substantial practical barriers to robots operating in households and natural environments and the existence of these alternative technologies, which can also be expected to improve over the coming years, we believe that it is exceedingly unlikely that robots will play any significant role in aged care in these capacities in the near-to-medium future at least.[3]

A second, perhaps more plausible, way in which robots might contribute to meeting the needs of older persons and their carers is by replacing people who perform various routine menial tasks associated with aged care. For instance, robot vacuum cleaners and other house-hold service robots might help clean and maintain the homes of older persons and aged-care residences. Robot vacuum cleaners and lawnmowers are already available for purchase. Other cleaning devices have been proposed (Brooks, 2002, pp. 115–126). These tasks are easier for robots to perform than the general service role described above because they involve a more limited range of motions and manipulations in a more regular environment. It is possible that over the next two decades robots may become sufficiently sophisticated, robust and adaptable to take on these roles. Whether this is likely turns in part on technical questions about the technology on which we are not especially qualified to rule. It seems clear, though, that if robots develop to the point where they can clean any building efficiently then there may be moves to employ them in hospitals, hospices, and other aged-care contexts, perhaps including private homes.

However, it is worth noting two reservations in this context. First, the homes of older persons are likely to be a more challenging environment for robot cleaners than other environments because they are often cluttered with treasured possessions accumulated over many years. This fact may restrict the use of robot cleaners to institutional contexts; even here the frailty of older persons may mean that there is an increased danger that older people may trip on the robots and injure themselves. Keeping robots out from underfoot of people with whom they share their environment is a significant technological challenge. It will be especially important in an aged-care context. Second, as we will discuss further below, replacing human beings who are working in cleaning roles with robots is not unequivocally beneficial in the context of aged care, as social interaction with cleaning staff may be something that individuals who are socially isolated look forward to.

Another role that has been proposed for robots is assisting in monitoring persons who are frail, or suffering from dementia, in order to alert the relevant people when

[3] According to at least one report this is also the judgement of investors when it comes to providing capital for product development in the area (see Morrison, 2004).

assistance is required (Acrotek Robotic Products, 2005; Arthur, 2004; Metcalf, 2005; Severin, 2004, pp. 10–12). In this way, robots could allow people to live in their own homes for longer than is currently the case. They might also allow hospices, hospitals, and other aged-care facilities to provide a higher standard of patient care with the same number of staff (Cox, 2003; Kageyama, 2002; Lytle, 2003; Metcalf, 2005; Pineau et al., 2003).

Note, however, that electronic monitoring is not a new concept in aged care. This monitoring role is one which is already, to some extent, performed by CCTV cameras, alert buttons, personal alarms, and other medical monitoring devices. In particular, many frail older people have benefited from wearing ''alert pendants'' and similar devices which enable them to call for help in the event of an emergency.

If robots are to make a useful contribution, they must be able to offer an improvement beyond these systems. This might be possible if robots can provide mobile surveillance of patients in aged-care facilities or even in their homes. For instance, they might allow carers to check on their charges remotely via some form of telepresence. There are several robots already manufactured which allow the person controlling them to move the robot around an environment while seeing what the robot ''sees'' through a video camera mounted on the robot (Brooks, 2002, pp. 131–143). One could imagine people perhaps being more comfortable with having a robot enter their home occasionally to check that everything is in order rather than having CCTV cameras installed in their living areas.[4] Alternatively, robots might offer improvements in monitoring if they possessed sufficient artificial intelligence to be able to make their own judgements about when residents were in distress; that is, if as well as visiting, or accompanying, those whose health is fragile, they were capable of making reliable judgements about their health and well-being and about when they required assistance. Robots could then monitor people who would otherwise be without a carer and call for assistance on their behalf. This would require major improvements in robot mobility, sensory systems and artificial intelligence. Moreover, it seems likely that such 24-h care could be achieved more efficiently through the use of an expert system monitoring the output of medical equipment that could be worn or implanted.

The most ambitious and controversial role proposed for robots, however, is as companions for lonely older people. We noted above that an increasing percentage of people are living into their eighth and ninth decade. More older Australians than ever before are currently living alone; in 2002–2003, some 44% of older person households were lone person households (Australian Bureau of Statistics, 2005). This phenomenon is expected to increase (Weston, Qu, & Soriano, 2001). Changes in family structure and increased mobility within the workforce mean that many of these people are separated from their families and other support networks. Loneliness and social isolation are consequently serious factors impacting on their happiness and well-being. A number of writers have suggested that such peoples' need for social interaction could at least partially be met by robots (see, for e.g. Allen, 2005; Dautenhahn, 2004; Gooch, 2005; Knight, 2005; Lytle, 2003; Osedo, 2004; Severin, 2004, p. 12, 37; Sydney Morning Herald Online, 2004). Perhaps, in the future, robots will be able to talk to us, entertain us, and respond sympathetically to our emotions, such that we will never need to be lonely—as long as we have our ''robot companion''.

[4] Rodney Brooks suggests that telepresence robots would allow children to ''visit'' and monitor the well-being of their ageing parents from a distance (see Brooks, 2002, p. 141; see also Cox, 2003).

This idea has been encouraged by the recent commercial success of various ''robot pets''. Sophisticated electronic toys such as ''Furby'', ''Aibo'' and ''NeCoRo'' offer a simulation of personality and social interaction and consequently offer their owners greatly expanded opportunities for play and entertainment. They are equipped with silicon chips and sophisticated programming which allow them to present the appearance of both personality and learning. Their sensors are designed to allow them to recognise various limited ways in which people can relate to them in order that they may respond appropriately. Several of these robot pets are advertised as potential ''friends'' or companions for those who are unable, for one reason or another, to look after an animal pet (Kageyama, 2004; Severin, 2004, p. 12, 37; Sparrow, 2002). Media reporting on these devices frequently mentions their possible future role as companions for socially isolated (and especially older) persons (Allen, 2005; Kageyama, 2002; Lytle, 2003; Osedo, 2004).[5]

These toys are in fact the first commercial versions of ''social robots''—robots which are designed to interact with and entertain people. Research into social robotics is a growing field and research robots in this area have much more sophisticated capabilities than those demonstrated by their commercial cousins (Brezeal, 2002; Dautenhahn et al., 2002). An explicit aim of many researchers in this field is to develop robots which can play a role in aged care, including a role as companions and/or carers (Dautenhahn, 2004; Severin, 2004).

Later in this paper we will argue that this use of robots is actually unethical, as it is akin to deception. The supposed benefits provided by robots are premised on people believing that robots are something that they are not. For the moment, however, we will simply note the substantial pragmatic, and perhaps conceptual, barriers standing in the way of robots becoming the objects of meaningful relationships.

The practical barriers standing in the way of the development of robots with whom we might develop meaningful social relationships are substantial. There is a sizeable gap between an entertaining and amusing novelty and an entity with which one might form a friendship or any other meaningful social relationship. While robot pets have proved popular, we are cynical about just how long existing devices remain entertaining and how involving the relationships people form with them are in practice.[6] One suspects that a large number of Aibos now lie abandoned and neglected at the back of storage cupboards, their owners having exhausted their possibilities and grown bored with them.[7]

In order for robots to be emotionally engaging for more than a few weeks, improvements in both their form and behaviour will be required. They would need to be able to demonstrate a wider range of behaviours, in a more natural context, than existing robot pets. If robots are successfully to compete for the affections of people with real (animal) pets they will also need to develop soft skins which are warm to the touch, and limber, pliable bodies (Sparrow, 2004). Although some steps have been taken in this direction with toys such as Furby, Paro and NeCoRo, significant challenges remain.

[5] It was noticing just how often this idea came up in the media that prompted one of the authors to begin his research in this area.

[6] For a description of a recent attempt at developing a robot which can sustain long-term human interest see, Gockley et al. (2005).

[7] The interesting comparison here, of course, is with the fate and role of (real) animal pets.

These difficulties could in all probability be overcome by robots which were sufficiently sophisticated. However, it is less clear that it would be possible for any robot to overcome another, deeper, conceptual barrier which stands in the way of meaningful human–robot relationships. An important source of the capacity of our relationships with people or animals to involve us is that such relationships make demands upon us that originate in the needs or desires of the other party. Other people are ''ends in themselves''. Animals too have needs and desires independent of our own. The demands that our friends—or even pets—make on us are therefore unpredictable, sometimes unexpected and often inconvenient. This is an essential part of what makes relationships with other people, or animals, interesting, involving and rewarding (Sparrow, 2002, pp. 312–313). Entities that are entirely at our disposal and under our control are *things* rather than potential friends.

The role played by the autonomous demands of the other in establishing meaningful relationships presents the designers of social robots with an interesting dilemma. On one hand, designers need to realise this capacity in their creations in order that they can provide the desired level of personal engagement. Thus, a number of the existing robot pets already get ''bored'' or ''distressed'', or ''sulk'' when neglected by their owners (see Brezeal, 2002, Ch. 8; Fujita & Kitano, 1998). On the other hand, one of the main advertised advantages of robot pets or companions over real pets or companions is that they are *not* so demanding—or that the level of demand that they make can be controlled to suit the circumstances of the owner. As a last resort, robot pets can be turned off when the owners get bored with them or are too busy to look after them.

There is an obvious tension between these two sorts of imperatives. It is unclear whether, or how, this tension can be reconciled in such a way as to make it possible for robots to be the objects of meaningful relationships for older persons. Robots which can be neglected, ''paused'', or turned off, are unlikely to be able to establish the independent presence that is a necessary condition of meaningful relationships. Robots which cannot be controlled in this fashion will have far fewer of the advantages over real animal (or human) companions than is advertised for them. The possibility of building engaging robot companions is contingent upon some workable compromise between these alternatives being found. In the meantime, we must note that no existing robot is capable of simulating emotion to a sufficient degree and over a sufficient period of time to sustain the interest of a normal adult for more than a few hours.

Thus, to summarise, if we are to believe the claims of the researchers we have been surveying, robots may offer a plethora of benefits in the area of aged care. They could offer 24-h care, perhaps even on an individual basis. They could assist those involved in aged care in a number of capacities. This in turn means that they might offer substantial savings in labour—and perhaps other—costs. They could also offer companionship, and perhaps even friendship, to lonely older persons.

The cost of robot carers

We must note at this point that we are extremely cynical about the cost savings made possible by robots. Workers in the aged-care sector are already by-and-large paid very low wages (Australian Nurses Federation, 2005). For those wages, people feed themselves, transport themselves to work, maintain themselves, repair themselves,

and produce the next generation of workers. Robots would have to become much *much* cheaper to compete effectively in this area. While changing demographics in the industrialised world can be expected to increase the demand for, and decrease the local supply of, aged-care workers, it is possible that various sources of cheap labour, perhaps including immigrant labour (legal or illegal), will be used to fill this gap instead of robots. Robotics researchers have much more to do to demonstrate that their proposals offer genuine cost-effective solutions to problems in aged care.

It is also important to understand that the labour savings made possible by robots can be described in two different ways. It can be argued that robots will allow a given number of staff to offer a better standard of care to the patients or residents for whom they are responsible.[8] This seems hard to object to—after all, the residents are not getting any less attention from human beings than they were previously, while they are enjoying the increased services made available by the robots. Alternatively, it might be argued that robots will allow a given number of staff to care for a greater number of residents, or that they may allow a given number of residents to be cared for with fewer staff. This is much more problematic, as it is clear that human contact is being reduced as caring roles involving human beings are replaced by services provided by robots.

A crucial question then, in assessing the impact of robotics on the quality of aged care, is whether robots will be working to supplement the activities of staff or working to replace them. Our strong suspicion is that, regardless of the intentions of the designers and manufacturers, in reality robots will inevitably be used to replace human staff. The work pressure on aged-care staff, within both the community and residential sectors, and within both private-for-profit and not-for-profit aged-care homes, is already great. Staffing costs are by far the most expensive item within the aged-care budget. In high-care facilities, these generally amount to 75–80% of operating costs (Australian Government Department of Health and Ageing, 2004). The opportunities for providers—from both sectors—to increase the revenue obtained from subsidies, fees and bonds are limited. Thus, the containment of expenditure becomes an imperative. As a consequence, the wages of workers in the aged-care sector are often low, with aged-care nurses in Australia generally earning up to 25% less than their counterparts in the acute sector. The high demands placed on workers in the sector already impact negatively on their ability to spend sufficient time providing quality care to individual residents (Australian Nursing Federation, 2004; Richardson & Martin, 2004). Frequent scandals within care facilities attest to the significant pressures within the current system and the phenomenon of elder abuse is becoming an increasing concern (for e.g. Alexander, 2005; Kerin, 2000; McIlveen, 2005).

In the Australian context, funded home-care programs to support older people, such as those provided through Home and Community Care (HACC) and Community Aged Care Packages (CACPS), are also under considerable stress, with demand outstripping supply. Both HACC and CACPS providers are now finding that they must rationalise their funding and, as a result, are setting strict limits on the number of hours of help received by frail older people.[9]

[8] See claims made by Joseph Engelberger reported in, The Wharton School, University of Pennsylvania. 2002. The new age of service robots: from fighting fires to serving beer. Intouch Health. November 20. Available online at http://www.intouch-health.com/ar-wharton-11-20-02.html [3.09.05]

[9] See, for example, submission by Aged Care Assessment Services Victoria to the Senate Community References Committee Inquiry into Aged Care June 2005. Available online at http://www.aph.gov.au/senate/committee/clac_ctte /aged_care04/submissions/sub100.pdf

In the context of such pressures, it is not surprising that much of the promotional and speculative literature concerning the role of robots in aged care focuses on their possible benefits in terms of staff replacement and cost-efficiency (Birmingham Post, 2005; Morrison, 2004). The combined impact of the demographics, staffing shortages, and the need for cost efficiency suggest that, should it occur, the introduction of robots will lead to the reduction of the number of hours of human contact experienced by those in need of care.

Care and the human touch

As can be seen from our previous discussion, the roles that robots might play in aged care usually involve two different types of service: first, physical services which augment the activities of residents or staff, such as lifting and turning bedridden persons, monitoring those who are frail, or fetching and carrying heavy objects; and second, caring and emotional labour, such as conversation, social interaction, sympathy and emotional support. In current models of care, the two roles of providing physical services, and offering care, companionship, and conversation, often go hand-in-hand. Sadly, in many instances, the only regular human contact experienced by frail older people is with those people who provide the physical care for them—who lift, shower, dress and feed them—and with those who clean their rooms or homes. In institutional settings, it is often the cleaning staff who provide much of the ''human contact'' for patients and residents. When older people live at home and receive cleaning and household maintenance assistance, the companionship afforded at these times is equally, or even more, important than the actual duties performed.[10]

There is a large body of research which shows that frequent interpersonal communication is critical for good aged care. Many studies, over several decades, have examined interactions between residents and staff in residential aged-care facilities. These studies consistently show that good communication is essential to high quality care (Keily, Simon, Jones, & Morris, 2000; Marquis, 2002). Other studies relating to those older people who remain at home also confirm that having meaningful social relationships is critical to a good quality of life (Gabriel & Bowling, 2004). Even when there is impairment of cognitive capacity, the need for involvement with other people remains, and there is much evidence indicating the value of social interaction and appropriate communication, both verbal and non-verbal, when caring for people with dementia (Kelly, 1997). Similarly, while depression is one of the most common psychiatric disorders affecting older people and is often considered to be an inevitable part of the ageing process—and therefore remains largely untreated—recent research questions its inevitability and points to the pivotal role of social engagement in the prevention and treatment of depressive illnesses in older people (Rickwood & Rylands, 2000). Less research has been undertaken on how the lack of social engagement affects the life expectancy of older people. However, several recent studies have identified this as a significant mortality risk factor (see for e.g. Keily et al. 2000; see also Pulska, Pahkala, Pekka, & Kivelä, 1999; Rosack, 2003).

The crucial role played by emotional labour and meaningful communication in generating good outcomes in aged care has important implications for the ability of

[10] On average, older people who live alone spend over 79% of their waking time in isolation (Australian Bureau of Statistics, 1999).

robots to play a productive role in the provision of quality aged care. Given the economic pressures noted above, it is likely that success in introducing robots into the aged-care sector will be at the expense of the amount of human engagement available to frail aged persons. We have highlighted the importance of social contact and both verbal and non-verbal communication to the welfare of older people. Any reduction of what is often already minimal human contact would, in our view, be indefensible. It is our view that handing over cleaning and other household tasks to Robocare, Rosie, Yumel, Wakamaru, or Mentorbot—or their equivalent—would therefore most likely be detrimental to the well-being of frail older people.

The number and strength of our intuitions about this possibility can be gauged if we imagine a future aged-care facility where robots reign supreme. In this facility people are washed by robots, fed by robots, monitored by robots, cared for and entertained by robots. Except for their family or community service workers, those within this facility never need to deal or talk with a human being who is not also a resident. It is clear that this scenario represents a dystopia rather than a Utopia as far as the future of aged care is concerned.

We acknowledge that this is not the future that robotics researchers are striving for. Many researchers clearly see their work as dedicated to developing robots which can free people from the mundane aspects of aged care in order that they can devote their energies to the more important task of providing companionship and emotional support for each other. However, we believe that it is naive to think that the development of robots to take over tasks currently performed by humans in caring roles would not lead to a reduction of human contact for those people being cared for. Certainly, the evidence of the current organisation of—and trends in—the aged-care sector is that a significant percentage of managers in this increasingly for-profit sector will reduce staffing levels to the minimum required to maintain their market share.

Furthermore, we consider that the introduction of such robotic technology would actually diminish the extent to which frail-aged persons felt that they were in control of their lives, by reducing the opportunities for meaningful interpersonal communications available to them, rather than increase their independence, as is sometimes asserted (Severin, 2004, p. 10; Metcalf, 2005). Interaction with cleaners and maintenance workers provides not only human contact for home-bound or institutionalised persons but also an opportunity to express opinions about such matters as the arrangement of furniture and articles within the room or house, or other issues important to their well-being. These decisions allow them to exercise an, albeit small, element of control over their life as well as to assert their interests and autonomy in a social and/or institutional environment where their desires and opinions are often neglected. Importantly, part of what allows the making of such decisions to be experienced as an expression of autonomy by the person making them is that their wishes are being granted moral weight by another human being. The respect and recognition of other people is essential to our self-respect. Having one's wishes carried out by robots may satisfy one's desires but is unlikely to provide the social recognition necessary to experience this as the exercise of autonomy.

A concern for the autonomy and self-respect of older persons also has significant implications for the use of robots in monitoring roles in aged care. These technologies also risk replacing human contact, for instance, regular visits to check on the well-being of an individual, with contact with robots. While our remarks about the potential negative impact of reducing human contact apply, the use of robots and

other devices may be laudable where such visits from many human beings would be intrusive and unwelcome, as may sometimes be the case when monitoring is at issue. However, use of robots in these roles may impact negatively on the relationship between the person being monitored and those ultimately responsible for their care, by making it possible for relationships of trust and concern to be neglected or abandoned in favour of the technical efficacy of remote monitoring. These technologies are also likely to raise significant privacy issues.[11]

Our concerns about the negative impacts that replacing human carers with robots might have on the quality of care leave open the possibility that robots may have a useful part to play in roles where they operate to assist human workers without any danger that they may replace them. In particular, the use of robotics to assist human carers accomplish such tasks as the lifting and turning of bed-bound residents, and the carrying of meal and medication trays, *might* improve the quality of care available to frail older persons *as long as it did not lead to a reduction of the number of staff or hours dedicated to their care*. Unfortunately, we suspect this caveat to be a significant barrier to the ethical use of robots in aged care.

Respect and robots

In the previous section, we argued that it will be extremely difficult for robots to achieve what is required of them if they are to play a useful role in aged care. We now argue that not only is it misguided to believe that robots could offer care or companionship to older persons but that the desire to place them in these roles may actually be unethical.[12]

The problem with offering robots as carers, or companions, stems from an ambiguity which infects descriptions of what these machines are (or will be) capable of. Discussions of human-robot interactions, or the higher order properties of robots, are plagued by equivocations about how genuine the properties attributed to robots are. In almost all cases, these discussions take place with crucial terms in inverted commas (Brooks, 2002, pp. 148–159). Thus, for instance, we talk of robot ''friends'', with ''emotions'' and ''intelligence'' (for e.g. Kageyama, 2004).

The use of inverted commas in this context seems appropriate because it foregrounds our reservations about the extent to which the appearance of such phenomena in robots really deserves these names. These reservations stem, we believe, from a number of sources. First, they reflect a justified cynicism about claims made on behalf of robots, in the light of the historical record of hype and exaggeration of such claims. Second, they stem from deep-seated, although perhaps ultimately not philosophically defensible, intuitions that these properties are genuinely present only in evolved biological entities, and cannot be realised in any artefact (Dreyfus, 1992). Third, it is a consequence of the fact that the proper application of the contested terms requires their object to be appropriately situated in a complex network of social and affective relations which includes types of behaviour that have their sense only in the context of facts about people that relate to their biological limitations.

[11] While these are an important consideration, for reasons of space they must be beyond the scope of this paper.

[12] The argument of the following section draws upon Sparrow (2002).

This third claim requires explanation. The intuition here is that what it is to be a real friend, or to really love someone, or to possess genuine rather than ersatz intelligence, is not something which can be exhaustively specified or captured by any algorithm or set of algorithms. Instead, what is required is that the candidate for these descriptions behaves in an (only loosely specified) appropriate fashion in a wide range of circumstances. Crucially, the forms of behaviour that are appropriate for someone, or something, who possesses the qualities necessary to be able to take on a caring role include some that only have their sense because humans (and to some extent, other creatures) are biological corporeal entities with particular limitations and frailties. Thus, for instance, if we care for someone, we reach out to take their hand, stroke their brow, wipe away their tears, or shed tears ourselves for them, when appropriate (Gaita, 1999). For robots to be capable even of imitating these responses successfully they would need to possess physical bodies capable of the same level of expressiveness and individuality as human bodies. Moreover, entities which do not understand the facts about human experience and mortality that make tears appropriate will be unable to fulfil this caring role. Sometimes the only appropriate response to another's suffering is the acknowledgement that we too share these frailties, as for instance, when our friend's suffering moves us to tears. Entities which do not share these frailties are therefore incapable of responding appropriately to them. Robots would therefore have to have a similar set of capacities and frailties as human beings in order to be capable of genuine emotional responses (Sparrow, 2004).

Some robotics researchers—and many authors writing about robots—believe that these limitations will be overcome in the not-too-distant future (Dyson, 1997; Kurzweil, 1999; Moravec, 1998). That is, they believe that robots will be capable of genuine love, friendship, affection, etc., and not just imitations of such. We think that this is highly unlikely for the reasons given directly above. However, if robots do become capable of experiencing and expressing these emotions and participating in these social relations then there would presumably be nothing wrong with substituting relationships with robots for human relationships.[13]

In the meantime, robots are clearly *not*capable of real friendship, love, or concern—only (perhaps) of their simulations. This has a number of important implications for their involvement in caring roles. First, as we argued above, robots will by-and-large not be capable in succeeding in aged-care roles where emotional work is an important part of the role. But, second, it suggests that to the extent that people do feel cared for, and gain the benefits of being cared for, as a result of services provided by robots this can only be because they are deluded about what the robots offer.[14] Third—and most importantly—it suggests that the desire to place them in such roles is itself morally reprehensible.

The ethical problem with future robots working in roles where emotional labour is an important component is *not* that people will necessarily be unhappy with robot

[13] However, our intuition that robot friends are always likely to be a poor substitute for real friends lends weight to the intuitions described above, that robots will not ever be capable of fully realising the required emotional states. For an extended discussion of what would be required in order for robots to become ''persons'' with whom we might be friends, see Sparrow (2002).

[14] Riekert, Mary. (2005). Professsor takes his robots at face value. The Age, Creative and Media, August 8, 1–2. In this report, Professor Noel Sharkey, a leading roboticist, is quoted as commenting ''I do think though that we will be able to build machines that will look as if they are feeling emotion and thinking but it will be all trickery and illusion. Humans are pretty easy to fool''.

carers. Some people may respond well to robots, relate to them, form emotional attachments to them, even feel loved by them, and be happy as a result. Given people's oft-observed willingness to anthropomorphise their cars, computers and toys, and the efforts to which manufacturers go in order to encourage it, it would be surprising if this did *not* occur (Brezeal, 2002, Ch. 2). To a certain extent, where this occurs, it is a good thing; it is, all other things being equal, clearly better that people be happy rather than sad.

However, in the vast majority of cases, other things will *not* be equal if people are happy as a result of the care and affection they receive from robots in the future. In most cases, when people feel happy, it will be because they (mistakenly) believe that the robot has properties which it does not.[15] These beliefs may be conscious beliefs, as in cases where people insist that robots really are kind and do care about them, or are pleased to see them, etc. They might also involve unconscious, or preconscious, responses and reactions to the ''behaviour'' of the robot (Brezeal, 2002, Ch. 2). It is these delusions that cause people to feel loved or cared for by robots and thus to experience the benefits of being cared for.

This delusion is problematic for two reasons. First, failure to apprehend the world accurately is itself a (minor) moral failure. We have a duty to see the world as it is. It is a sad thing to be deceived about the world; it is a bad thing to perpetuate and prolong such deception ourselves. Thinking that an expensive and sophisticated electronic toy is really our friend is sentimentality of a sort we should avoid (Sparrow, 2002). Second, and more importantly, such deception is a bad thing because our preferences are unlikely to be met, our interests advanced, or our well-being served, by illusions. What most of us want out of life is to be loved and cared for, and to have friends and companions, not merely to *believe* that we are loved and cared for, and to *believe* that we have friends and companions, when in fact these beliefs are false. That is, we desire the real world to be a certain way and not just our beliefs about, or experience of, the world to be a certain way. This is why most of us would not be happy to exchange our real-world life for life in an ''existence simulator''—a sophisticated virtual reality machine which would offer us a convincing illusionary set of experiences in which our life is much better (Nozick, 1974). While we might be happier confined to such a machine, we would not be any better off. Indeed, we are likely to be substantially worse off because without knowledge of the way the world really is we are unable to realise our desires—which refer to states of the world.

Insofar as robots can make people happier only when they are deceived about the robots' real nature, robots do not offer real improvements to people's well-being; in fact the use of robots can be properly said to harm them. The desire to place robots in caring roles is therefore foolish; worse than that, it is actually unethical. To intend to deceive others, even for their own subjective benefit, is unethical, especially when the result of the deception will actually constitute a harm to the person being deceived. It is to treat them as objects to be manipulated to serve our ends—even if

[15] There is, of course, the possibility that people might be amused and amazed by robots and be happier as a result. Such a reaction is possible—indeed, perhaps even likely, for a little while at least—in cases where people are not deluded at all about the capacities of robots. However, such a response is unlikely to result in a significant or lasting improvement in the well-being of people being cared for by robots. Instead, it is akin to delight at having an interesting view out of the window. While one may prefer to have an interesting view rather than none at all, it is a poor substitute for human contact.

our ends include their happiness; it thus violates a fundamental Kantian duty to respect others as ''ends in themselves''.

The argument of the preceding section has offered a slightly complex route to a conclusion that might be expressed more forcefully in ordinary language. Robots cannot provide the care, companionship, and affection that older persons need. To place them in roles where these are essential is to express a gross lack of respect for older persons.

Conclusion

The results of our survey of the possible benefits to be gained by the use of robots in aged care are pessimistic. The tasks that robots would need to carry out in order to play a useful role are more difficult than first appears. We also believe that there is likely to be a big difference between laboratory tests and commercial use of robots in this context, with the conditions that would need to be met for the real-world application of robots, in terms of the robustness, reliability and cost of robot carers, being much more demanding than laboratory tests reveal. An important barrier to the ethical use of robots in aged care is the possibility that their introduction will result in a significant reduction of the number and quality of the social relationships experienced by the recipient of the service. We have identified and outlined economic pressures on the aged-care sector that, we believe, make this a real danger. We have also expressed concern about possible negative impacts on the autonomy of older persons related to this reduction of social contact. Consequently, we believe that the prospects for robots improving the quality of aged care are much slimmer than the robotics literature acknowledges. However, we have acknowledged that robots *may* have a part to play in roles when they might assist rather than replace human carers. Finally, we have argued that the desire to place robots in roles wherein they could only succeed if the people they were caring for were deluded about their capacities is immoral because of the deceit involved. For the foreseeable future then, using robots to provide emotional care and companionship to people will be unethical.

The extent of popular enthusiasm for the design and manufacture of aged-care robots, which could only succeed in their proposed roles if those they were caring for were deceived and manipulated, is doubly disturbing because the attitudes towards older persons that it expresses are arguably essentially continuous with a broader set of social narratives which deny the human dignity of older persons. Too often, in our society, older persons are considered only as problems, or as objects of study, rather than as full citizens with a valuable contribution to make to the community. The desires and opinions of older people themselves are neglected in favour of the expertise of gerontologists, sociologists and economists; the deeper philosophical questions concerning the meaning of the end of life experience are passed over in favour of concentrating on achieving technical solutions to problems defined in terms amenable to such solutions. Enthusiasm for the development of robots for aged care both participates in, and contributes to, this phenomenon.

This last criticism points towards what we believe is the appropriate way to move forward in this area. The primary means whereby we should evaluate proposed applications of robotics in aged care is by asking whether the people being cared for

would prefer robots over human carers, when fully informed of the nature of the robots and what they offer.[16] Before we introduce robots into aged-care roles we must be sure that the people being cared for actually want them.[17] Before we spend more money researching robots on the basis that they will allow us to deal with the coming ''crisis'' in aged care, we should ask the people who both constitute this ''crisis'' and who are its ''victims'' whether the development of advanced robots would meet their needs.

It is important that these questions be asked in such a way as to offer genuine options to the people whose opinions are being sought. We should not ask whether those being consulted would prefer robot carers to *no* carers, as this would be a misrepresentation of the choices at hand. Instead, we should ask whether they would prefer robot carers or any of range of plausible alternatives. This may mean more expensive care provided by human beings, or perhaps even care provided by human beings for shorter amounts of time. It may also mean campaigns to reprioritise social spending in relation to aged care to ensure that the needs of older persons for high-quality care are met. When consulting older persons about the value of *research* into robotic solutions for issues in aged care, we should also ask them whether they might prefer that the same level of research and funding should be available for the investigation of human-centred solutions.

It is also important that these questions are asked in a fashion and in a context which elicits informed—rather than merely initial—opinions about the benefits and costs which might be associated with the use of robots in aged care. This is necessary both in order that older persons have genuine and not merely token input into policy in this area and also in order that robotics researchers can be convinced of the moral weight of these opinions. Thus older persons making decisions about the value of robots in aged care should have access to robotics researchers who can advertise their wares as well as to other researchers in the field of aged care, including critics of the use of robots in this area.

There is, of course, a model for consultation with stakeholder groups of the sort we are proposing here. It is called ''deliberative polling'' and has been extensively refined and developed over the past decade (Ackerman & Fishkin, 2002; Fishkin, 1997; McCombs & Reynolds, 1999). Deliberative polling involves gathering a statistically representative sample of a community together in a forum where they are able to consider a specific issue for an extended period of time while having access to experts to allow them to gather information and test hypotheses. At the end of this

[16] Such a consultation process would also be likely to contribute to better outcomes when technologies are introduced. There is evidence that those assistive technologies currently in use are most effective when the designated older person has been a party to the decision to use it (see McCreadie & Tinker, 2005).

[17] We should acknowledge that there is some evidence that people would prefer robots over human carers in some roles. For instance, Pineau et al. (2003) in ''Towards robot assistants in nursing homes'' report a good deal of enthusiasm for the robot they were evaluating amongst the older persons participating in their experiments (we would note, however, that there are alternative explanations for this phenomenon in this case and that people might have much less enthusiasm for robots if their opinions were not being sought about them for the purposes of research and instead they were simply introduced to them as part of the institution in which they were being cared for). The possibility that people might prefer robots to human carers is also canvassed in Kitano (2005). Japan looks to robots for elderly care. On the other hand, in a preliminary survey of what people desire of the robots of the future, Dautenhahn et al. report little enthusiasm for the development of robots for caring roles (see Dautenhahn et al., 2005).

period the group votes on policy options or otherwise formulates its findings. There is now a considerable body of evidence which suggests that this process allows groups containing a diversity of initial views to come to a decision which all consider substantially more worthy of respect than a straight majority vote (Dryzek, 2000; Elster, 1998; Gutmann & Thompson, 1996; McCombs & Reynolds, 1999).

Our proposal, then, is that the test of the ethical use of robots in aged-care roles, and also for the ethics of devoting scarce resources to research towards such a goal, is whether these practices would be endorsed by a deliberative poll of those who they are intended to serve. Instead of treating older persons as a problem to be addressed, we should address them about the problems that they face. We believe that it is highly unlikely that such a poll would endorse the use of robots in most of the aged-care roles that have been proposed for them. Presumably, robotics researchers will beg to differ. However, until they are willing to put their convictions to the test by conducting such a poll, it will be difficult to avoid the suspicion that research into robotics in aged care is driven more by researchers' enthusiasm for robots than by any genuine concern for the needs or desires of older persons.

Acknowledgements We wish to thank Jim Sparrow, Debra Dudek, Justin Oakley, and John Weckert for comments, discussion, and assistance which have improved this paper.

References

Acrotek Robotic Products (2005). Available online at http://www.acrotek.com/Products/Robotics.htm [5.1.05].

Ackerman, B., & Fishkin, J. S. (2002). Deliberation day. *The Journal of Political Philosophy, 10*, 129–152.

Alexander, M. (2005). More problems for sick system. *Sunday Mail*, May 29, Queensland, Australia.

Allen, M. (2005). Hardly cuddly, but Nuvo the robot can be your buddy. *International Herald Tribune*, July 16, Paris, France.

Alzheimer's Australia (2005). 1000 people a week will be diagnosed with dementia in 2005. *Media Release*, March 14. Available online at http://www.alzheimers.org.au/content.cfm?infopageid=1926 [28.10.05].

Arthur, C. (2004). Rise of the robot. *The Age*, September 9, Melbourne, Australia.

Australian Bureau of Statistics (1999). *Disability, ageing and carers: Summary of findings*. Canberra: Australian Bureau of Statistics, p. 52.

Australian Bureau of Statistics (2000). ABS says grey power on the rise. *Media Release*, August 17. Available online at http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/39B403AE5-D5EE4B7CA25693E00078924 [10.11.04].

Australian Bureau of Statistics (2005). *Australian social trends*. Canberra: Australian Bureau of Statistics, p. 169.

Australian Government Department of Health and Ageing (2004). Review of pricing arrangements in residential aged care. In W. P. Hogan (Reviewer). Canberra: Australian Government Department of Health and Ageing. Available online at http://www.health.gov.au/internet/wcms/publishing.nsf/Content/health-investinginagedcare-summary-index.htm/$file/summary.pdf [2.11.05].

Australian Nurses Federation (2005). Wage gap for nurses in aged care $200 a week and rising. *Media Release*, February 17. Available online at http://www.anf.org.au/news_media/Media_2005/news_press_050217.html [13.04.05].

Australian Nursing Federation (2004). Aged care workforce census and survey welcome. *Media release*, April 2. Available online at http://www.anf.org.au/news_media/Media_2004/news_press_040402.html [28.04.05].

Australian Research Council Centre of Excellence in Autonomous Systems (2004). Available online at http://www.services.eng.uts.edu.au/cas/research.html [31.10.04].

Birmingham Post (2005). Switched-on Japan looks to robots for elderly care. *Birmingham Post*, August 30, Birmingham, England.
Brezeal, C. L. (2002). *Designing sociable robots*. Cambridge, MA and London: The MIT Press.
Brooks, R. (2002). *Robot: The future of flesh and machines*. London: Penguin, pp. 136–137.
Commonwealth of Australia Treasury (2002). 2002–2003 Budget paper no 5: Intergenerational report 2002–2003, May 2002, Australian Government Publishing Service, Canberra. Available online at http://www.budget.gov.au/2002-03/bp5/html/01_BP5Prelim.html#TopOfPage [2.11.05].
Cox, D. (2003). Retirement complex greets Rosie robot. *Dayton Daily News*, July 23, Dayton, OH, USA.
Dautenhahn, K. (2004). Robots we like to live with?!—A developmental perspective on a personalized life-long robot companion. In *Proceedings, IEEE Ro-man 2004, 13th IEEE international workshop on robot and human interactive communication, September 20–22, Kurashiki, Okayama, Japan* (pp. 17–22). IEEE Press. Available online at http://www.homepages.feis.herts.ac.uk/~comqkd/papers.html [2.11.05].
Dautenhahn, K., Bond, A. H., Canamero, L., & Edmonds, B. (2002). *Socially intelligent agents: Creating relationships with computers and robots*. Norwell, MA, USA: Kluwer Academic Publishers.
Dautenhahn, K., Woods, S., Kaouri, C., Walters, M. L., Koay, K. L., & Werry, I. (2005). What is a robot companion—Friend, assistant or butler? In *Proceedings of the IROS2005 IEEE/RSJ conference on intelligent robots and systems, August 2–6, Edmonton, Alberta, Canada* (pp. 1488–1493). Available online at http://www.homepages.feis.herts.ac.uk/~comqkd/papers.html [2.11.05].
Dreyfus, H. L. (1992). *What computers still can't do: A critique of artificial reason*. Cambridge, MA: The MIT Press.
Dryzek, J. S. (Ed.). (2000). *Deliberative democracy and beyond: Liberals, critics, contestations*. Oxford: Oxford University Press.
Dyson, G. (1997). *Darwin amongst the machines: The evolution of global intelligence*. Reading, MA: Addison-Wesley Pub. Co.
Elster, J. (Ed.). (1998). *Deliberative democracy*. Cambridge, UK and New York: Cambridge University Press.
Fishkin, J. (1997). *The voice of the people*. New Haven: Yale University Press.
Fong, T., & Nourbakhsh, I. (Eds.). (2003). *Robotics and Autonomous Systems, 42* (special issue on socially interactive robots).
Fujita, M., & Kitano, H. (1998). Development of an autonomous quadruped robot for robot entertainment. *Autonomous Robots, 5*, 7–18.
Gabriel, G., & Bowling, A. (2004). Quality of life from the perspectives of older people. *Ageing and Society, 24*, 675–691 (at 675).
Gaita, R. (1999). *A common humanity: Thinking about love & truth & justice*. Melbourne: Text Publishing, pp. 263–268.
Gockley, R., Bruce, A., Forlizzi, J., Michalowski, M., Mundell, A., Rosenthal, S., Sellner, B., Simmons, R., Snipes, K., Schultz, A. C., & Wang, J. (2005). Designing robots for long-term social interaction. In *Proceedings of the 2005 IEEE/RSJ international conference on intelligent robotics and systems, August 2–6, Edmonton, Alberta, Canada*. IEEE. Available online at http://www.cs.cmu.edu/~reids/papers/Valerie-IROS2005-final.pdf [3.11.05].
Gooch, L. (2005). Look to the land of the rising sun to deal with our ageing population. *The Age*, June 20, Melbourne, Australia.
Gutmann, A., & Thompson, D. (1996). *Democracy and disagreement*. Cambridge, MA: Harvard University Press.
Kageyama, Y. (2002). Nurse gadget patrols the wards. *The Age*, April 6, 44, Melbourne, Australia.
Kageyama, Y. (2004). Robot companions seen as aids for elderly. *Arizona Daily Star*, April 11, Tucson, Arizona. Available online at http://www.azstarnet.com/dailystar/relatedarticles/17597.php [30.8.05].
Keily, D. K., Simon, S. E., Jones, R. N., & Morris, J. N. (2000). The protective effect of social engagement on mortality in long-term care. *Journal of the American Geriatrics Society, 48*(11), 1367–1372 (at 1370).
Kelly, M. (1997). Social interaction among people with dementia. *Journal of Gerontological Nursing, 23*, 16–20 (at 20).
Kerin, J. (2000). Care for aged: A kerosene dip. *The Australian*, February 25, 5.
Kissane, K. (2002). The age-old quandary: Is Australia's overloaded aged-care system going to burst at the seams? *The Age*, April 20, Melbourne, Australia.

Kitano, M. (2005). Japan looks to robots for elderly care. *Sydney Morning Herald*, July 20, Sydney, Australia. Available online at http://www.smh.com.au/articles/2005/07/20/1121539008922.html [28.7.05].
Knight, W. (2005). The 2020 vision of robotic assistants unveiled. *NewScientist.com*, May 24. Available online at http://www.newscientist.com/article.ns?id+dn7421 [31/8/05].
Kunii, I. M. (2000). How much is that robot in the window? *Business Week: Asian Edition*, November 27, 22.
Kurzweil, R. (1999). *The age of spiritual machines: When computers exceed human intelligence*. St Leonards, NSW: Allen & Unwin.
Lytle, J. M. (2003). A yen for a hi-tech life. *The Guardian*, September 11. Available online at http://www.guardian.co.uk/online/story/0,3605,1039233,00.html [11.9.03].
Marquis, R. (2002). Quality in aged care: A question of relational ethics? *Australasian Journal on Ageing, 21*(1) 25.
McCombs, M., & Reynolds, A. (Eds.). (1999). *The poll with a human face: The national issues convention experiment in political communication*. Mahwah, NJ: Lawrence Erlbaum Associates.
McCreadie, C., & Tinker, A. (2005). The acceptability of assistive technology to older people. *Ageing and Society, 25*, 91–110.
McIlveen, L. (2005). Old people tied up and neglected. *The Courier Mail*, April 27, Brisbane, Australia.
Menzel, P., & D'Aluisio, F. (2000). *Robo sapiens: Evolution of a new species*. Cambridge, MA: The MIT Press.
Metcalf, F. (2005). Robo nurse fits bill on future aged care. *The Courier-Mail*, July 9, Brisbane, Australia.
Moravec, H. (1998). *Robot: Mere machine to transcendent mind*. Oxford: Oxford University Press.
Morrison, S. (2004). 'Care machine' wobbles on its way to market. *Financial Times*, July 30, London, England.
Murphy, B., & Schofield, H. (1997). Women with multiple roles: The emotional impact of caring for ageing parents. *Ageing and Society, 17*, 277.
Nozick, R. (1974). *Anarchy, state and utopia*. New York: Basic Books, pp. 42–45.
Osedo, H. (2004). Cuddly companion a caring know-it-all. *The Courier-Mail*, December 3, Brisbane, Australia.
Pineau, J., Montemerlo, M., Pollack, M., Roy, N., & Thrun, S. (2003). Towards robot assistants in nursing homes: Challenges and results. *Robotics and Autonomous Systems, 42*, 271–281.
Productivity Commission (2005). Economic implications of an ageing Australia, Research report, Canberra. Available online at http://www.pc.gov.au/study/ageing/finalreport/ageing1.pdf [3.10.05].
Pulska, T., Pahkala, K., Pekka, L., & Kivelä, S. (1999). Follow up study of longstanding depression as predictor of mortality in elderly people living in the community. *British Medical Journal, 318*, 432–433.
Richardson, S., & Martin, B. (2004). The care of older Australians: A picture of the residential aged care workforce, National Institute of Labour Studies, Flinders University, Adelaide. Available online at http://www.health.gov.au/internet/wcms/publishing.nsf/Content/ageing-workforce-workforcerep.htm [13.04.05].
Rickwood, D., & Rylands, K. (2000). Predicting depression in a sample of women living in a retirement village. *Australasian Journal on Ageing, 19*(1), 40–43.
Rosack, J. (2003). Age, gender may determine impact of depression, mortality link. *Psychiatric News, 38*(1), 22.
Scanlon, C. (2000). Glimpses of a robotic future. *BBC News Online*, December 30. Available online at http://www.news.bbc.co.uk/1/hi/world/asia-pacific/1048602.stm [11.01.05].
Severin, E. O. (2004). *Robot companions: Mentorbots and beyond*. McGraw-Hill, New York (xi, p. 13).
Sparrow, R. (2002). The march of the robot dogs. *Ethics and Information Technology, 4*, 305–318.
Sparrow, R. (2004). The turing triage test. *Ethics and Information Technology, 6*, 203–213.
Sullivan, K. (1999). Robot dog a Japanese techno-sensation. *The Augusta Chronicle Online*, May 16. Available online at http://www.augustachronicle.com/stories/051699/tec_robot.shtml [11.01.05].
Sydney Morning Herald Online (2004). Robot to keep elderly from going senile. *Sydney Morning Herald*, December 2, Sydney, Australia. Available online at http://www.smh.com.au/articles/2004/12/02/1101923240261.html [12.9.05].
Toshiba Corporation (2005). Toshiba to showcase advances in sophisticated home life support robot. Available online at http://www.toshiba.co.jp/about/press/2005_05/pr2001.htm [3/9/05].

Wenger, G. (1992). The major English-speaking countries. In H. Kendig, A. Hasimoto, & L. C. Coppard (Eds.). *Family support for the elderly: The international experience* (pp. 117–133). Oxford: Oxford University Press (at 124).

Weston, R., Qu, L., & Soriano, G. (2001). The changing shape of Australia's population. *Australian Institute of Family Studies, 10*, 1–6.

Wood, L. (2005). Of pills and bills and the ageing boomers. *The Age*, September 24, Melbourne, Australia.