Final Report
Toyota Foundation Research Grant Program

Assessment of socially assistive robotics in elderly care: Toward technologically integrated aged care and well-being in Japan and Australia (TYTID D16-R-0242)

Project representative: Professor Anthony Elliott, University of South Australia.

Part 1: Introduction

Background

Population ageing – a shift in the distribution of a country's population towards older ages – represents one of the great global challenges of the 21st Century. While there is considerable variation between countries in terms of both the proportion of elderly citizens and the rate this is changing over time (see Table 1) – this reflecting a range of local factors and conditions – nearly all countries are experiencing an upward shift in the age distribution of their populations.

Country	**2015**	**2030**	**2050**
Japan	33.1	37.3	42.5
Italy	28.6	36.6	40.7
Germany	27.6	36.1	39.3
Canada	22.3	29.4	32.4
China	21.7	33.6	40.9
USA	20.7	26.1	27.9
Australia	20.4	24.6	28.3

Table 1: 2015 as well as 2030 and 2050 projected proportion of selected national populations aged 60 and over. (Source: United Nations World Population Ageing Report, 2015)

The primary drivers of this trend are changes in fertility and mortality rates, these being strongly correlated with increased levels of economic and social development (UN 2015). In short, birth rates, most notably in the technologically developed world, are declining owing to, among other things, increased gender equality, enhanced access to employment opportunities, education opportunities and family planning, along with the promotion of reproductive health. At the same time improvements in public health and living conditions, along with advances in medical technologies, mean that people are living longer, healthier lives.

Rising expectations regarding aged wellbeing, along with the escalating costs of care provision, are currently prompting the development of new models of care that incorporate "socially assistive robotics". These are assistive technologies for which a measure of social interaction is important to the provision of caregiver support, and to enabling independent living for ageing populations. They may, for example, augment and enhance people's mobility, navigation, sensory capabilities, access to information and communication, health and safety monitoring, provide domestic care and companionship, or constitute more wide ranging 'intelligent assistive environments' (Morris et al 2012; Broekens, Heerink and Rosendal 2009; Broadbent, Stafford and MacDonald 2009). Robotic technologies are also being developed to assist with medical procedures, rehabilitation and therapeutic tasks, while others still are being developed to obviate the risks and other burdens experienced by care providers (Papadopoulos, Koulouglioti and Ali 2018) – those that are readily accommodated

by Lin's (2012) well known taxonomy of "dull, dirty and dangerous" tasks.

Aims

The overarching aim of the study was to generate new sociological insights about how the development of robotic technologies have the potential to transform the lives of elderly people in Japan, and the opportunities and risks entailed. The study was specifically directed towards investigating how elderly people are culturally perceived by robot developers in Japan who are seeking to create technologies aimed at this social group. Specific aims included:

- Analyzing the technological potentials for enhancing elderly people's engagement with and participation in the world through the use of robotics and other 'smart' technologies, and to assess risks.
- Identifying the social and cultural factors that shape the ways people in specific contexts interact with these technologies, and which will, accordingly, need to be considered in design and development processes if the technology is to succeed as intended.
- Provide an evidence base for thinking about new care values around social participation for ageing populations emerging through the integration of socially assistive robotics into everyday interaction contexts involving the elderly.

Research Program

The research program consisted of 2 main strands:

1. Fieldwork - In-depth semi-structured interviews with respondents involved in the design, development and deployment of socially assistive robotics systems for use in aged care in Japan and Australia. The interviews provide scope for respondents to detail their views on topics including: aged care applications for the technologies they are helping to develop; the role of end users in the design, development and deployment of these technologies; assessments of benefits and risks; user and public perceptions; understandings of what it means to age 'successfully; and, robotics and changing understandings of aged care and its entailments.

2. Archival Research - A critical review of the literature in the field – including robotic engineering and design as well as social science and humanities discussions on the topic of the use of robotics in aged care. This is focused on the perceptions of, and social and cultural assumptions about, older users, their needs, the"normal" ageing process and relationships with technology, along with understandings of caregiver – receiver relationships, that are drawn upon and embedded in the ways developers of socially assistive robotics for aged care conceptualize human-robot interaction and operationalize it in their own research and published outputs.

The main components of the research program are reported on in greater detail below.

Research Team

Project representative:
Professor Anthony Elliott, Dean of External Engagement, Executive Director of the Hawke EU Jean Monnet Centre of Excellence and Research Professor of Sociology at the University of South Australia, and Super Global Professor of Sociology (Visiting) in the Graduate School of Human Relations, Keio University.

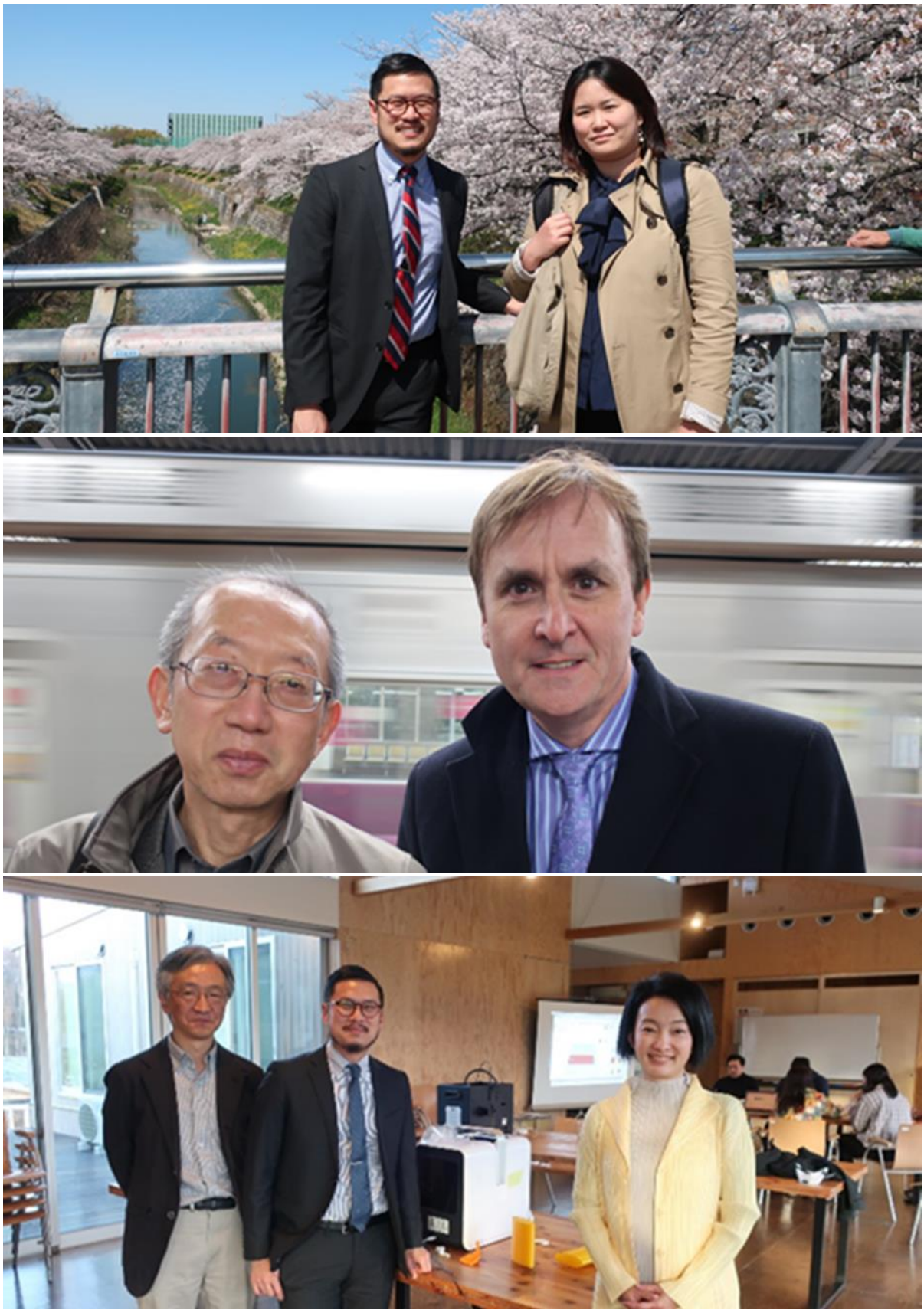
Team Members:
Professor Atsushi Sawai, Director of the Institute for Journalism, Media and Communication Studies and Professor of Sociology at Keio University, Tokyo. Adjunct Professor at the Hawke EU Jean Monnet Centre of Excellence at the University of South Australia.

Professor Masataka Katagiri, Professor in the Faculty of Literature and Institute of Cultural Science at Rissho University, Tokyo, and Emeritus Professor at Chiba University, Chiba, Japan. Adjunct Professor at the Hawke EU Jean Monnet Centre of Excellence at the University of South Australia.

Dr Eric Hsu, Lecturer in the School of Creative Industries, and Platform Leader of the Migration, Mobilties and Cultural Identities for the Hawke EU Jean Monnet Centre of Excellence at the University of South Australia. From September 2019 to January 2020 Dr Hsu will be a Visiting Faculty Member in the School of Sociology at Kwansei Gakuin University, Japan.

Dr Yukari Ishii, Assistant Professor, Department of Sociology, Toyo University, Tokyo, and Lecturer, Faculty of Humanities and Social Sciences, Tokyo Metropolitan University, Tokyo. Adjunct Fellow at the Hawke EU Jean Monnet Centre of Excellence at the University of South Australia.

Dr Ross Boyd, Senior Research Associate at the Hawke EU Jean Monnet Centre of Excellence and JM Network at the University of South Australia



Team members during fieldwork at various locations in Japan

Part 2: Report on Research Program

Preparatory activities.

The project commenced in May 2017. Key **Preparatory Activities** included:

- Obtaining ethics clearance. A Human Ethics Application (ID: 200124) along with draft "Participant Information" and "Participant Consent" documents were prepared throughout June and July, 2017. These were submitted to the University of South Australia Human Research Ethics Committee on August 1, 2017. The Ethics Committee Review Group gave qualified approval (subject to a number of amendments) to the project in mid-October, with final clearance being granted January 12, 2018.
- Establishment of Project Webpage. A project webpage was set up in January 2018. This contains a project description, information about the team and information for prospective participants. Project outputs – including drafts of scholarly publications – will be also included. http://www.robotic-futures.com/research-news/2018/1/22/assessment-of-socially-assistive-robotics-in-elderly-care-toward-technologically-integrated-aged-care-and-well-being-in-japan-and-australia
- Fieldwork Preparation. In September 2017 Dr Hsu travelled from Australia to Japan to meet with Japanese team members, Professors Sawai and Katagiri, and Dr Ishii, in order to plan the Japanese fieldwork component of the project, scheduled for early 2018. A priority was to consolidate and establish relationships with key informants who would assist with access to study participants. During this visit Dr Hsu attended the "Culturally aware robotic assistance for the elderly" workshop at the 2017 Society of Instrument and Control Engineers Conference in Kanazawa and met with key figures in the "Culture-Aware Robots and Environment Sensor Systems for Elderly Support" project, jointly funded by the Japanese Ministry of Internal Affairs and Communications and the European Commission. On this visit Dr Hsu also met with researchers at the Tadano Robotics Laboratory (Tokyo Institute of Technology), Waseda University, RIKEN, Keio University, Kwansei Gakuin University and Ishiguro Laboratories. While in Japan Dr Hsu also met with Dr Oba of the Toyota Foundation. In November 2017 Professor Elliott travelled to Japan to meet with the Japanese team members and finalize arrangements for the fieldwork. While there he, along with Professor Sawai and Professor Katagiri, also met with Dr Oba of the Toyota Foundation. In December 2017 Professor Elliott and Dr Hsu circulated draft copies of questions for the semi-structured interviews for team members to review and provide feedback. Interview schedules were finalized by the end of January 2018

Archival Research: Critical Literature Review.

Introduction:

In late July 2017 a critical review of relevant literature from design, engineering social science disciplines commenced. Critical literature reviews aim to extensively research as well as critically evaluate literature from diverse sources bearing upon a given set of concerns (Grant and Booth 2009). While often less comprehensive than other review types (e.g. mapping reviews, meta-analysis, umbrella reviews) critical reviews are best suited to

outlining and assessing competing disciplinary and other approaches to the given field, providing for conceptual innovation and serving as the starting point for further evaluative assessments. Given the project was geared towards assessing and evaluating the development and deployment of robotic technologies in elder care from the perspective of the concept and entailments of 'care' it was considered that a critical review was the most productive review type for this project. The review both provided a wider contextualization for the fieldwork and, through providing a sociological account of gaps and inconsistencies in current approaches, provide conceptual support for the analysis of interview data**.**

What follows is a summary of the review. The team is currently considering what are the best options for presenting a detailed elaboration of the materials and commentary developed through the critical literature review for publication as an open access resource.

Procedure:
A search of databases including Web of Science, Scopus, ProQuest, SpringerLink, Google Scholar and the University of South Australia Library was undertaken between July 2017 and March 2018. The search covered peer reviewed journal articles and conference papers from the relevant design and engineering disciplines (including human-computer interaction), along with the social sciences and humanities. This followed an initial scoping phase during which published systematic reviews of the socially assistive robotics for elderly care literature were consulted in order to both gain a good understanding of the field as well as identify potentially relevant publications, especially books (Shishehgar, Kerr and Blake 2017; Flandorfer 2012; Vichitvanichphong, Talaei-Khoei, Kerr and Ghapanchi 2018; Kachouie, Sedighadeli and Abkenar 2017; Broekens, Heerink and Rosendal 2009; Broadbent, Stafford and MacDonald 2009; Peek et al 2014; Yusif, Soar and Hafeez-Baig 2016; Morris et al 2012). Consulting these earlier reviews also allowed the current review to more closely focus on literature from the last 10 years.

A subsequent process of selection (based on an assessment of abstracts) eliminated all publications that did not include any substantive discussion of the ageing process, elderly people – including their needs, perceptions and capabilities - or on the entailments or concept of care. The critical appraisal then focused on documenting the extent elderly people are represented in this literature, the ways they are represented and how these representations subsequently figure in the design process for socially assistive robotics.

The vast majority of engineering and design literature was, accordingly, excluded as it dealt solely with a range of technical aspects of various hardware and software systems. So too was most of the Human-Robot Interaction literature (this growing out of the earlier tradition of Human-Computer Interaction research, Ergonomics and Human Factors research; Goodrich and Schultz 2007). While directed towards questions concerning how people (users) respond to and perceive robotic technologies these studies focus largely on the appearance and functioning of the technologies as central to their acceptance by users. Our project, in contrast, emphasises roboticists understandings of and assumptions about the users and contexts of use for their technologies (along with their values and perceptions) and the ways

these get ‘built in’ to the technologies they construct (see also Cheon and Su 2016).

In all over 900 items were initially identified, these being reduced through the selection process to 61. This compares favorably with full double-coded reviews which routinely resolve upon around 100 studies (Kachouie, Sedighadeli and Abkenar 2017, Vichitvanichphong, Talaei-Khoei, Kerr and Ghapanchi 2018).

Discussion:

1. Social Sciences and Humanities Literature

Debates over the application of robotic technologies to care – and especially elder care – practice and contexts have been characterized by a set of statements (largely but not exclusively from ethicists) that are strongly critical of this development, and a number of important counterstatements that qualify these and open research in this field out to more complex and ambivalent understandings.

While critics of the introduction of robotic technologies in elderly care do acknowledge that there may – at least hypothetically – be some advantages flowing from this in the form of alleviating some of the stresses of care work on care providers and accordingly reduce the potential for inferior care that comes from this (along with incompetence), in the main they present a dystopian outlook (Sparrow and Sparrow 2006; Sharkey and Sharkey 2012; Borenstein and Pearson 2012; Sparrow 2016). Linda and Robert Sparrow, for example:

> *“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.”* (2006; p152)

This potential for diminishing human contributions to care provision is considered problematic for a range of reasons, including:

- It entails an element of deception – both in terms of presenting robotic technologies as genuinely caring about the elderly, and in the use of virtual or augmented reality technologies in the maintenance of social relationships (including remote monitoring functions). This deception is possible, it is argued, due to the underdeveloped technology literacy skills of elderly persons (Sparrow and Sparrow 2006; Sparrow 2016). This can also lead to vulnerabilities to excessive, and especially intimate, technological attachment – especially with the use of technologies such as the robotic baby fur seal *Paro* that provides care through eliciting care (Turkle 2011).
- It presents robots as substitutes for rather than complements to human care giving (Borenstein and Pearson 2012). This can lead to situations where positive developments with respect of some aspects of care – eg eliminating the physical risks to both care providers and care receivers in lift and transfer situations – may

> paradoxically contribute to deficits in other aspects of care, eg diminished human contact (Sharkey and Sharkey 2012). Any marginalizing of human contributions to care may also lead to care being fragmented into discrete component parts in contradistinction to care being conceived holistically ('caring about' as well as 'caring for') and embedded in social and cultural relations (Ishiguro 2018; Jenkins 2017).

These claims have been subject to a number of qualifications and critiques. These include:

- They underestimate positive health outcomes for elderly people observed in settings where robotic technologies are being trialed -including lower blood pressure, improved immune system response and reductions in stress (Robinson, MacDonald and Broadbent 2015; Broekens, Heerink and Rosendal 2009).
- They romanticize the positive experiences of care work and understate the reality that in many situations "it is emotionally and physically taxing work, work frequently undertaken by disenfranchised members of society". (de Falco 2017)
- The 'robot care' or 'human care' dichotomy falsely assumes that all care is either robotic or human, this being inconsistent with a reality that entails 'human-machine-human relationships' (Ishiguro 2018).

The most important criticism from the perspective of our project is that the arguments made by those largely opposed to the applications of robotic technologies in elder care rest explicitly or implicitly upon a number of assumptions about elderly users that are empirically and conceptually unsustainable. Mark Coeckelbergh (2016), for example, has challenged the assumptions that underpin claims about deception and limited technological literacy. The main point of his conclusion is worth reproducing here:

> "*The future of elderly care is a future which may or may not have robots in it, but it will certainly have us in it: care receivers and care givers who are used to deal with ICTs or who are even digital natives: people who have never known a world without ICTs. If robots are going to swarm elderly care and health care at all (it may not happen), it is very likely that they will meet "robotic natives" who are used to having all kinds of ICTs around in their lives, including robots. In that scenario, they will not experience living with robots as deception; they will see it as part of what it is to live with technology: part of what it is to work and to entertain, part of what it is to connect and communicate with others*." (p461)

Coeckelbergh's argument finds empirical support in the work of de Graaf, Allouch and Klamer (2015) that demonstrates the ways elderly people can and do interact with robotic technologies in an active, creative and importantly reflexive manner. This study reports on one of the first long term field studies of social robots being trailed for use in aged care in the community – the EU Social Engagement with Robots project, involving elderly participants welcoming a companion robot into their homes over a two-month period. A key finding was that people were willing to engage in social hedonic interactions with the robots – those entailing enjoyment, companionship and sociability.

What is noteworthy here is that key criticisms that can and are made against those arguing or at least cautioning against any extensive deployment of robotic technologies in elder care that rest on problematic assumptions about ageing and the aged have also been levelled against dominant understandings that are guiding the work of engineers and robotics designers in this field. In a series of sole authored and collaborative studies Louis Neven (Neven 2010; 2015; Neven and Peine 2017; Peine and Neven 2019), for example, demonstrates that the Ageing-and-Technology nexus has tended to have been construed – by designers as well as in general discourse - in terms of technology intervening to mitigate or compensate for age related bodily changes (eg declines in sensory, motor or cognitive capabilities). Underlying this interventionist argument is a global view of ageing and the aged as entailing progressive illness, social isolation, frailty, and lost competences – and that the elderly will grow to appreciate the application of these technologies to alleviate these growing deficits as their faculties decline. Neven argues that the reality and experience of ageing is far more diverse than this, that elder technology users routinely reject negative stereotypes of ageing and that the dominant understanding and practice of 'gerontechnology' development needs to be shifted from an interventionist model – in which elderly people are presented as passive and in deficit – to a co-constitutive model.

2. Engineering and Robotics Design Literature

The engineering and design literature can be characterized as having several key features.

First, consistent with concerns expressed by, for instance, Ishiguro (2018) and Sharkey and Sharkey (2012), elder care tended to be broken up into constituent components amenable to task specific engineering. There are, for instance, well established literatures on the use of robotic technologies to provide physical assistance (rehabilitation, lifting and transfer, domestic aids), social assistance (companionship, virtual/augmented reality and gaming, remote or emergency monitoring, telemedicine, social connectedness) cognitive assistance (stimulation, exercise, game playing) and smart homes (see Morris et al 2012, for a comprehensive review; also UK Govt 2018). What is absent in these discussions is a consideration of how these discrete technical care elements might be integrated into a holistic concept of care incorporating robotic and human care providers. This would entail an extension of processes of integration within the engineering and design disciplines – computer science, electrical and mechanical engineering - with the social sciences and humanities (Cheon and Su 2016).

Second, most of the Engineering and Robotics Design literature reviewed reproduced negative stereotypes and generalizing assumptions about the ageing process and experience of elderly people consistent with the critiques of Neven and others. As Righi, Sayago and Blat (2017) put it, the most predominant view in this literature sees

> *"older people as individuals in need of help, due to the impact of age-related declines in functional abilities on their everyday lives, and with little or a lack of experience of using Information and Communication Technologies (ICTs)."* (15)

Examples of commonly stated views are:

> *"Elderly people need support due to their declining capabilities and also to age-related illnesses. Ageing societies would benefit from the design of "intelligent" homes that provide assistance."* (Torta et al 2012)

> *"Aging can degrade the human life by introducing considerable reductions in the individual's physical and social activities, which may lead to a reduction of the individuals' social bonds with the Family, Friends and former Co-Workers"* (Reis et al 2017)

Accordingly, a view of technological innovation as something that is done to and for elderly people, not something that they are actively engaged with, let alone initiate, has tended to prevail (eg Wu, Fassert and Rigaud 2011; Khosla, Nguyen and Chu 2017; Yumakulov, Yergens and Wolbring 2012).

Third, there are a growing number of studies emerging within the engineering/design literature that both portray a more positive view of ageing and aged people as competent with digital technologies and actively contributing to families and societies regardless of their age (Righi, Sayago and Blat 2017). These include highly innovative approaches to robotics design drawing upon, for example, sociological concepts and analyses (Quan, Niwa, Ishikawa, Kobayashi and Kuno 2011) and the humanities (Nishiguchi, Ogawa, Yoshikawa, Chikaraishi, Hirata and Ishiguro 2016). As a result, an increasing number of engineers and robotics designers are starting to incorporate the elderly and other users as collaborators in new participatory or co-constitutive design processes (Peine and Neven 2019; Lee, Sabanovic, Chang, Nagata, Piatt, Bennett and Hakken 2017)

Fieldwork.

Fieldwork for the project consisted of semi-structured interviews with persons who self-identified themselves as developers of robotic technologies that had applications for older persons. Interviews were conducted with 28 aged care technology developers in Japan and 7 interviews were completed in Australia. More interviews were carried out in the former context than in the latter because the development of robotic technologies in Australia is a much less advanced industry than it is in Japan, as many studies have indicated.

Interviews in Australia were conducted in either Melbourne or Adelaide between October 2018 and March 2019. Interviews in Japan were mainly conducted in three of Japan's most populated regions: the Kanto, Aichi, and Kansai areas, between March 2018 and October 2018. The interviews were all primarily conducted in English. Study participants, however, were given the choice to use Japanese, if that was their preferred language. In those cases, a person with native fluency was on hand to provide on-the-spot translations. Persons providing translations were familiar with the relevant research fields in the social sciences, to mitigate problems with interpretations across cross cultural contexts.

Method:
The research method used to gather data was semi-structured interviews. Semi-structured interview questions were designed to elicit comments from robot developers about they believed their technologies could do to transform and affect the aged care realm. Interview questions also sought to promote discussion of the roles of older persons in Japanese society and how older persons have been or should be involved in the technological development process. Research Instruments are included in Appendix XX below.

The thematic analysis method developed by Braun and Clarke (2006) was used to analyze the collected data.

Study Parameters:
The study's sample in Japan was purposively constructed using the criteria of maximum variability. The sample included robot developers with varying levels of experience. The sample also included developers working on a myriad of different technologies aimed at older person, such as those developing mobility, rehabilitation, companion, human-symbiotic, robotics. Additionally, the sample took into account the issue of gender. 5 women and 22 men in Japan were recruited as study participants, which reflects the gender imbalance found in Japan in the engineering sector (UNESCO Science Report 2015).

Results:
Analysis revealed that there was a tendency for some technology developers in Japan to hold simplistic or stereotyped understandings of older aged persons. There was a tendency to view ageing in Japan as a growing and serious social problem. The future of older people in Japan was not commonly portrayed in a positive light. Robot developers held a such an image of ageing because it helped to justify why there was an urgent and sustained need for robotic technologies to be developed.

'The physical condition of the elderly people gets lower and lower. And so the lengths they can walk gets shorter and shorter. In order to support that, some people want to introduce actuated types of physical assistant robot. But we want to use non-actuated ones. That means even though your lower limbs are weaker and weaker, you can still move something like this [uses arms to indicate a fluid 'walking' motion] and the device is wired.
-- Senior robot developer of physical assistant robots, Aichi region

'Human beings use tools. It is essential for lifestyles. But especially for elderly people, special caution is needed. For example, touch panel is not good for them because their skin is not smooth, and they cannot move well. So instead of remote controller, you can use a robot to make orders.'
-- Senior robot developer of rehabilitation robots, Aichi region

Robot developers in Japan also indicated that there was not much direct or sustained input from older persons in the design process. This was due to the fact that developers felt they lacked resources, time, and training to engage with older people.

> *'We sometimes ask caregivers and sometimes ask the elderly persons [for their input]. But it is very difficult to understand the situation of elderly persons. We need trials. But in companies it is very difficult to conduct trials because they need resources. But in universities and national research institutes, it is more possible to conduct trials. However, these are not very common.'*
> --Senior robot developer of tele-robotic technologies, Kanto area
>
> *There's a laboratory policy. In the Bachelor's Degree. We should not meet with actual users. Only in Masters year and above are we encouraged to think more about user needs and to directly engage with them. We sometimes talk with people like doctors.*
> --Junior robot developer of rehabilitation robotic technologies, Kanto area

Many robot developers voiced opinions about how to better develop technologies for older persons that would be more economically successful and more socially beneficial. Recommendations included:

- An increase in the amount funding being allocated to user trials and to projects that put user participation at the center of the design process;
- Greater opportunities for technology developers and researchers in the social sciences to work together on joint projects;
- More awareness in the general public about the serious limitations of robotic technologies;
- Greater recognition of the diversity of robotic developers in Japan.

Findings from the field work are detailed and discussed at greater length in Project Outputs listed below.

Part 3. Project Outputs

Elliott, A (2019) *The Culture of AI: everyday life and the digital revolution*, London and New York; Routledge. Research findings from the Toyota Foundation research grant Program supported project are reported in this analysis. The Foundation is acknowledged both in the 'Acknowledgements' section of the book as well as in the relevant citations. In this book Anthony Elliott argues that much of what passes for conventional wisdom about artificial intelligence is either ill-considered or plain wrong. Research from the '*Socially assistive robotics in elderly care'* project forms the basis of an analysis of the ways self-actualization, autonomy and other facets of emotional life could be enhanced through human-

robot interaction. **An excerpt from the book is reproduced in Appendix 3.**

Hsu, E.L., Elliott, A. Ishii, Y., Sawai, A., Katagiri (to be submitted 2019), 'The development of autonomous aged care technologies in Japan: understanding the complexity of user representations', ***Journal TBD*****.** Technological advances are increasingly thought to play an integral role in addressing the challenges of an ageing population. This has become markedly so in Japan, where public discussions of ageing tend to involve optimistic accounts of automated and robotic technologies in terms of what they can do to improve the lifestyles of the elderly. The aim of this paper is to present findings of a sociological study which investigates how elderly people are culturally perceived by robot-developers in Japan who are seeking to create technologies for this demographic group. Why it is important to understand how elderly people are represented as users in the technological-development process is because it has the potential to affect how elderly people are socially positioned, valued, and cared for. The findings presented in this paper indicate that Japanese robot-developers appear to share many assumptions about what elderly people are capable of and what constitutes the most optimal way of ageing. Many robot developers view the advent of new technologies as being vital and central to enhancing the lives of elderly people. However, it is also important to recognize the existence of competing cultural narratives, which express a more critical view of what robotics should be used for in the realm of elder care. Even though these narratives might be less prominent in the discourses of robot-developers, they are still significant because they help to construct a more nuanced account of how elderly people are represented as users of emerging robotic technologies.

Hsu, E.L. (forthcoming), 'Technogenarians: Ageing and Robotic Care', in A. Elliott (ed), ***Routledge Social Science Handbook of AI,*** **London and New York: Routledge.**

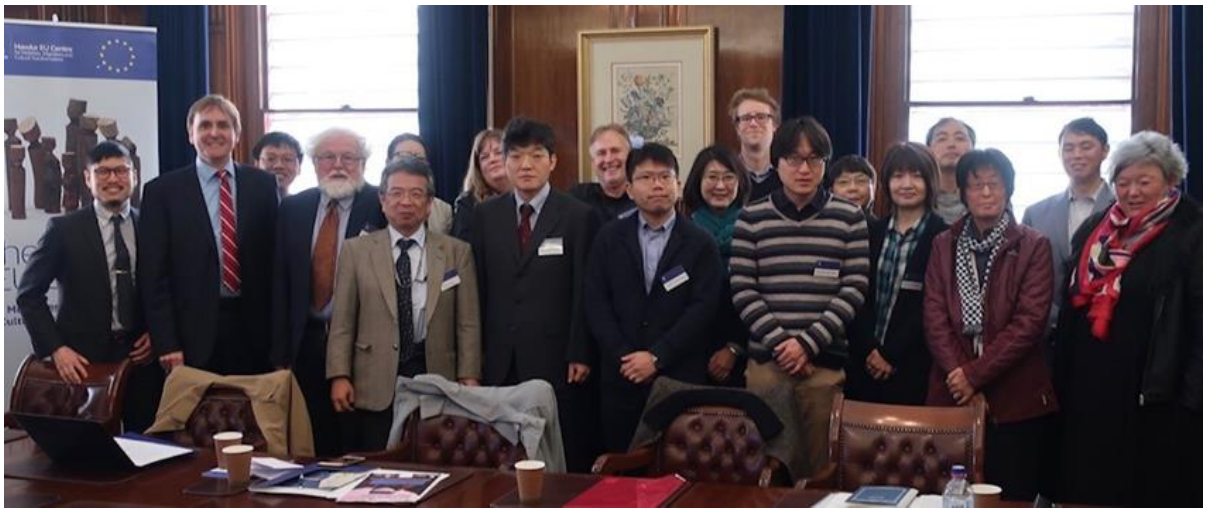
Elliott, A. "The Social Impact of Digital Technologies: Robotics and Aged Care in Japan and Australia", ***Australia - Japan Innovation and Research Symposium,*** **Kyoto, October 22 - 25, 2018.** The presentation reported on both the research collaboration between Australian and Japanese team members on the '*Socially assistive robotics in elderly care'* project, as well as on some of the findings of the project. The Innovation and Research Symposium itself was a high-level event intended to highlight outstanding work already underway and discuss how to increase institutional linkages and explore avenues for cooperation outside of universities including with research institutes, centres of excellence and industry-led research.

Hsu, E.L. & Elliott, A., ''The social implications of digital robotic technologies for elderly persons in Japan', Paper presented at the ***'New Perspectives on the Digital Revolution: Media and Cultural Transformations'*** **Workshop, August 2018, Adelaide, Australia.** This presentation, given at a joint Australia-Japan research workshop, Outlined the background of and rationale for the '*Socially assistive robotics in elderly care'* project as well as for the composition of the project team. This was followed by a discussion of the research design and method as well as reporting preliminary findings.

Boyd. R. "Sociology in AI, AI in Sociology", Dalhousie University Department of Sociology and Social Anthropology, Halifax, Nova Scotia, Canada, February 8, 2019. This presentation was given as part of a suite of activities at Dalhousie, including a prestigious MacKay public lecture delivered by Dr Boyd. The overall intention and design of the Toyota Foundation funded '*Socially assistive robotics in elderly care'* project, along with a report of project results, provided an analytic frame and evidential support for a program statement urging the social sciences to not just study AI/robotics research carried out by computer scientists, engineers and so forth, but rather position themselves as core elements within this research if outcomes are to be socially responsible and responsive to needs.

Hsu, E.L, 'Robotics and Sociology', Seminar presented at the Faculty of Nursing and Medical Care, Keio University, March 2018, Fujisawa, Japan. The seminar covered the ways in which robotics and artificial intelligence can be studied through the lens of sociology. In particular, his seminar explored how sociology can better understand the impact of robotic technologies on aged care, as evident in the activities of the project funded by the Toyota Foundation. Participants at the event not only were introduced to the theoretical and methodological underpinnings of the Toyota Foundation funded project, they were also encouraged to provide their critical reflections and feedback. Key theoretical approaches discussed included 'science and technology studies', the 'social construction of technology' approach, and 'practice theory'.

Hsu, E., 'Understanding robotics and new digital skills', Masterclass presentation at 'Robotics and New Digital Skills' Workshop, May 2018, Munich, Germany.
This presentation was part of a project on 'Digital Technologies, Transformations and Skills: Robotics and EU Perceptions (D3REU)' funded by the European Union's Jean Monnet Project program. The masterclass presented novel and unique ways of understanding the robotics revolution around the world, using powerful social scientific approaches and theories. Preliminary findings from the project funded by the Toyota Foundation were presented as a cast study.



***'New Perspectives on the Digital Revolution: Media and Cultural Transformations'* Workshop, August 2018, Adelaide,**

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Appendices.

Appendix 1: Issues Arising – reflections on the project and lessons learned.

a. In the original research design it was intended that semi-structured in-depth interviews would be conducted with managers and care providers employed in the aged care sector in situations where robotic technologies were being deployed or trialed. This would have allowed the research to address both how developers envisaged people interacting with, and how people were actually interacting with these new technologies. A review of the March 2018 fieldwork by the whole team, however, gave rise to the shared concern that, given a clearer grasp of fieldwork and analysis complexities in this area, along with budgetary constraints, it was going to be- difficult to conduct interviews with aged-care managers and care providers with sufficient academic rigor to yield meaningful and publishable findings. The team was of the view that the aims of the project could still be achieved if focus was solely placed on robotics developers. Direction on this matter was sought from the Toyota Foundation, and permission for the necessary modifications to fieldwork given.

b. In order to direct more funding to fieldwork and analysis, the team decided to take Dr Oba's

advice to not proceed with holding outreach summits in Tokyo and Adelaide. Dr Oba discussed this with Dr Hsu in late September 2017 and with Professor Elliott in November 2017. Alternative arrangements were instead made to allow the team to disseminate preliminary findings of the project at other events, which were being funded or organized by other parties. These included the "New Perspectives on the Digital Revolution: Media, Identity and the Body" workshop to be held in Adelaide in August 2018, the Australia-Japan Innovation and Research Symposium in Kyoto, in October 2018, as well as presentations at Keio University, Dalhousie University (Canada) and the Technical University Munich (Germany).

Appendix 2: Research Instrument

'Assessment of Socially Assistive Robotics in Elderly Care'

SEMI-STRUCTURED INTERVIEW SCHEDULE – ROBOT DEVELOPERS
(version #3, 1 February 2018)

1. I'd like to begin by asking a bit about the work that you do here. In non-technical terms, what robotic technologies are you helping to create?

2. What specific role do you play in the development of these technologies?

3. What applications for elderly people do these technologies have?

4. Please describe a specific scenario when someone would need or want to use the technology that you are helping to develop.

5. How did you come to be involved with the development of robotic technologies?

    a. Is this interest recently developed or a long-standing one?
    b. Who has most influenced your thinking and approach to robotics? What has been the most important thing you have learned from this person or persons?

6. Who do you envision will purchase and use the technology that you are developing?

7. Who do you think will be more reluctant to use the technologies that you are working on?

8. What input, if any, do you receive from the end users of the robotic technologies that you are developing?

    a. How does the input you receive from end users influence how you develop the technologies you are working on?

9. What do you think are the biggest challenges facing the lives of elderly people in Japan?

    a. Where does this knowledge come from? Is any of this knowledge based on social research you have come across?

10. What social benefits do you think your work on robotics is likely to produce?

11. Are there any risks or dangers for end users associated with the technologies you are developing?

    a. Are there any uses of the technology that you are creating, which should be discouraged or forbidden?

12. How do you think the general public views the work on robotics that you are carrying out?

    a. Are there any common misconceptions that people have about robotic technologies? If so, what are they?

13. How is developing robotic technologies for elderly people different from or similar to developing technologies for other age/social groups?

    a. Is there anything you specifically need to bear in mind about elderly people and how does this influence your own work?

14. In your personal opinion, what do you need to do and need to have to age 'successfully'?

    a. Conversely, what would you like to avoid in old age?
        i. To what extent does this involve the technology you have developed?

15. Do elderly people 'trust' robots? Do they sometimes 'like' robots more than humans?
16. How pervasive are robotic technologies in the provision of care to elderly persons?

17. How do robotic technologies alter how societies care for elderly persons, if you think they do at all?

Appendix 3: Excerpt from Elliott, A (2019) *The Culture of AI: everyday life and the digital revolution*, London and New York; Routledge, pp 167 – 169.

As an illustration, take the changes now occurring in elderly care, associated with a raft of AI technologies and sensor-equipped environments that automatically collect data on aged users without requiring the direct involvement of such individuals. Experts in the preventative medicine and health-promotion literatures have emphasized the gains of smart digital technologies and social robots and referred to the importance of automated health data and

indicators as a means of aged patients avoiding disease and illness. But in matters of health for the elderly, robots and automated digital technologies may offer much more than simply enhanced personal health information. The work of Maartje de Graaf on elderly people's acceptance of companion robots provides a source of evidence here.[1] As de Graaf and colleagues demonstrated, in experiencing relationship-building with social robots in elderly domestic environments, with all the challenges that human-robot interactions entail, individuals are constructing innovative forms of emotional attachment with robots. The work of de Graaf was set against the background of an EU Social Engagement with Robots project, and involved elderly participants welcoming a companion robot "Karotz" (which resembled a rabbit) into their homes over two month period. There were, needless to say, negatives as well as positives for these elderly people in their engagements with the companion robot, Karotz. Significantly, the connections established with the social robot were not simply functional or utilitarian, but often appeared to involve enjoyment, care and companionship.

The work of de Graaf concerns two key modes of human-robot interaction. Individuals, she points out, "seem to respond to robots in one of two ways: either humans love and nurture social robots and build relationships with them, or humans see social robots as artificial, as machines". The ability to build a relationship with a companion robot, as de Graaf shows, depends on imagination and empathy. Constructing new forms of companionship and emotional relation to robots depends on an individual's capacity to "anthropomorphize" technical objects. Participants in the study described human-like attributes of the robot in the following ways: Karotz "gives you a few funny looks"; the robot "went into a coma with its lights still on"; or, Karotz "would sort of start to wake up and have its ears up and down". The study by de Graaf shows how individuals actively "anthropomorphize" robots and construct new forms of sociality. Yet certainly many individuals reported a sense of feeling beleaguered or ashamed. A concern that other people might think them odd for spending time and interacting with robots was prevalent. However, at the same time, it is strikingly evident from the study that individuals did share stories and confide secrets, promoting a psychological attachment to these robots.

These findings chime strongly with research I've been conducting with a team in Japan and Australia, investigating how robot developers conceive robots as possible companions in elderly care.[2] My colleagues on the team call the application of robotic technologies to the aged care sector an " imagining out" of connections with social robots. "Imagining out" involves the mobilization of imagination, fantasy and empathy as a resource to create connections, drawing together social robots and related socially assistive digital technologies to actively restructure relations between the self and the object-world, as well as new forms of

[1] de Graaf, Maartje M.A., Ben Allouch, Somaya, Klamer, Tineke. 2015. "Sharing a life with Harvey: Exploring the acceptance of and relationship-building with a social robot" *Computers in Human Behavior* 43, pp. 1-14.

[2] This research forms part of a project I lead in Japan at Keio University, and which is funded by the Toyota Foundation: '*Assessment of socially assistive robotics in elderly care: Toward technologically integrated aged care and well-being in Japan and Australia',* 2017-2019 (D16-R-0242). The interdisciplinary research team includes Atsushi Sawai, Masataka Katagiri and Yukari Ishii in Japan, and Eric Hsu and Ross Boyd in Australia.

sociality. Like de Graaf, Mark Coeckelbergh wants to speak up for the potential positives of social robots, or at least help us to think about digital developments in this area in less constraining ways. As Coeckelbergh writes:

> Just as we are used to living with fiction and non-fiction, we are also increasingly used to living simultaneously online and offline, or at least we are used to switching between them. The future of elderly care is a future which may or may not have robots in it, but it will certainly have us in it: care receivers and care givers who are used to dealing with ICTs or who are even digital natives: people who have never known a world without ICTs. If robots are going to swarm elderly care and health care at all (it may not happen), it is very likely that they will meet "robotic natives" who are used to having all kinds of ICTs around in their lives, including robots. In that scenario, they will not experience living with robots as deception; they will see it as part of what it is to live with technology: part of what it is to work and to entertain, part of what it is to connect and communicate with others. New technologies might even influence what we mean by dignity, autonomy, reality, and social relations.[3]

Acceptance of social robots is in some ways even more generative than this characterization suggests. With the conjoining of AI and advanced robotics, faith or trust in impersonal technological systems, as well as in non-human others such as social robots, becomes paramount to social life. But this is not simply a reordering of relations between human actors and non-human technical objects, with robots recast as social actors; it is a fundamental transformation of the nature of personal identity itself. Personal life is increasingly intertwined with networked technological systems and objects. Both the external and internal characteristics of human-machine configurations, including relations with social robots, are shot through with personalized connections.

[3] Coeckelbergh, Mark. 2016. "Care robots and the future of ICT-mediated elderly care: a response to doom scenarios". *AI and Society*, 31, pp. 455-462. Quote from p.461.