Care Robots for an Over-Aging Society: A Technical Solution for Japan's Demographic Problem?

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Abstract

Japan has the world's longest life expectancy and highest proportion of older people in its population. As a result, the delivery of old-age care is becoming an urgent and high priority issue for the Japanese government. There is a high demand for care within a society whose population is constantly aging, and within this discrepancy, we have to somehow find a balance. Since the fertility and immigration rates are too low to compensate for the labor shortage, other solutions have to be found for providing care and for sustaining economic power.

Japan is known for being a technology-loving country. Since the Meiji restoration (1868-1912), change has been connected with technology. During the period of rapid economic growth, the labor shortage was mainly compensated for by the implementation of industrial robots. There seems to be a positive relationship to technology that goes so far back that the Ministry of Economy, Trade and Industry (METI) is considering robotics as a possible technical solution for Japan's social and economic problems that emerged from its demographic transition.

After having a closer look at the origins of robots and their cultural embedment in Japan, there will be an examination of robot development for home usage, health and old-age care. Taking a closer look on Japan's robotic landscape will uncover a variety of developments, e.g. robots have taken on iconic popular status like the dog "AIBO" or humanoid robots that look like the professors that created them.

The recent robot development in the field of care covers the following areas: care assistance, interaction and therapy. Technologies for care assistance aim to reduce the burden for the nursing staff and improve the quality in care through e.g. lifting systems like the polar bear robot RIBA. Robots for interaction are developed to entertain or communicate with humans e.g. are NAO, Papero or KOBIAN-R. Technologies for medical purposes like rehabilitation and therapy are one very promising field in robotics. Through the utilization of robots for therapy or rehabilitation by using e.g. the robot seal Paro or the robo-skeleton HAL, psychical and physical conditions can be improved.

Robot usage is not only limited to Japan, and robots are also used in western countries but there are different approaches and attempts to utilize robots for elderly care, rehabilitation and therapy. The labor shortage, the high psychical and physical burden for the nursing staff accompanied with the need to respond to a wide range of scenarios may be enough motivation to rethink the use of machines in the health care sector – not only in Japan.

The Problems of the Over-Aging Society

The Japanese population is going through a rapid demographic transition. Currently the population of Japan is at its highest at around 125 million, but according to the population projection it will decrease to 90-100 million by 2050 (Atoh 2008: 20, Coulmas 2010: 24). The reasons for this development are cultural and economic changes in the early seventies that leads to a low fertility rate and also a longer life expectancy. In recent years, the fertility rate remained still very low.

The fertility rate reached its peak with 4.5 in 1947 after the Second World War baby boom. In the following high economic growth period until the mid-seventies the fertility rate settled down around the replacement level of 2.1, but in 1975 started to fall below 2.1 and in 1990 under 1.5. The lowest statistical record had been in 2005 with a fertility rate of 1.26. However, the fertility rate started to slightly increase to 1.42 in 2014 (MHLW 2015: 3).

At the beginning of the twentieth century, Japan's life expectancy had been 44.8 years for females and 44.0 for males but has doubled since then. In 2005 the average life expectancy had been 82.3 years with 85.6 for female and 78.5 for male (Coulmas 2010: 19-20). The population is not only declining, its structure is also constantly getting older. The percentage of the population over 65 years will shift from 20% to 40% (Atoh 2008: 18-19). This development can be made clearer by looking at the development of the centenarians; there were 300 centenarians in 1963 but now there are 50,000 – the population of an average Japanese town (Coulmas 2015).

The implication from this rapid demographic transition will be an extensive shrinking labor force which will not only be an issue for Japan to sustain its global economic power, but also for providing care for its constantly aging society. There is already a labor shortage in the care sector and it will be even greater in the future. The Japanese government has to work out remedial measures to counteract these burdens on the welfare system. The continuously decreasing population and the shrinking labor force could be alleviated by different approaches, which will be addressed in the following.

Problems Associated with the Increase of the Female and Senior Working Population

The low birth and fertility rate is related to socio-economic factors which had led to an increase of the unmarried and childless population. The average age of marriage for women and men had increased between 1994 to 2014 from 28.5 to 31.1 years for men and 26.2 to 29.4 for women and correlated to it the average age of first child birth shifted from 25.7 in 1975 to 30.6 in 2014 (MHLW 2015: 3-5, 13-14).
Since the eighties the Japanese government has enacted laws for more gender equality (Gender Employment Opportunity Act 1984 and Basic Law for a Gender-equal Society 1999) and for reducing the burden of women from child rearing (several Angel Plans in different versions 1995, 2000, 2005) (Schad-Seifert 2006a: 30). What they all have in common is that they have attempted to improve the employment environment, child-care services and support as well as to reduce economic insecurities (Ishii 2008: 18-19)

However, most of these laws do not include men (Schad-Seifert 2006a: 29-30). Even if the Japanese government made several efforts to establish gender equality, only the plus one plan (2002) for the declining birth rate address the issues of the Japanese work environment including the corporate culture with male work patterns (Schad-Seifert 2006b: 25-26). Only about 0.56% of men in 2004 used their childcare leave (Ishii 2008: 18-19), which shows a persistence of traditional gender roles where men are expected to do overwork and women are responsible for child rearing (Saraceno 2004).

Since the corporate structure still does not support women with young children, most women have adopted a quit-and-return employment pattern which means that they quit their jobs after birth and return as a part-time worker under worse employment conditions (Mori & Scearce 2010: 6-8). In the end, this indirectly forces women to choose between career and family.

In addition, the Japanese government has recognized that not only women, but also older workers have to be acquired. 13 trillion yen had been provided for issues in connection to the aging society and to implement new policies and programs. Among a variety of approaches like promoting the re-employment of senior workers and a more flexible work environment, raising the retirement age from 60 to 65 years has initiated a major change to utilize the longer life expectancy to at least partly counteract the shrinking labor force. However, due to the high employment costs, many Japanese companies urge their employees to early retire early and offer re-employment under less attractive conditions (Ishii 2008: 19-20). Policies can only be successful if the employer side acknowledges older workers as a benefit for their company with their high level of experiences, instead of emphasizing their age as a burden.

Problems with Increasing Immigration to Japan

Historically Japan has had a complicated relationship with immigration. During the reign of the Tokugawa Shogunate (1603-1868), the Japanese were not allowed to leave the country. Under the Sakoku Edict from 1635 trade with other countries was strictly controlled with a few limited exceptions of designated trade districts (Lam 2009: 4). The first large immigration flow was observed between 1910 and 1945 under Japan's imperial colonization politics with resettlement of citizens from the occupied territories to Japan and reached around two million by 1945. After the Second World War, only a small number, approximately half a million, of Koreans stayed in Japan (Kashiwazaki & Akaha 2006).

In 1952, based on the U.S. immigration system the Immigration Control Law was put into effect and has provided the framework for immigration policy for postwar Japan. This policy was not originally intended for those migrating to settle down in Japan or to get the Japanese citizenship. After a reform of the immigration law in 1989, the Japanese concept of immigration still remained on temporary residence instead of long-term integration. There had been two structured effort in recruiting foreign labor. The first had been the change of residential status of Nikkeijin (descendants of Japanese emigrants) to no restrictions on employment, which has caused a strong increase of the Brazilian population from 56,000 in 1990 to 286,000 in 2004. Second, the Technical Internship Trainee Program launched in 1993 brought in 75,000 foreigners to Japan (Kashiwazaki & Akaha 2006). However, in 2006 foreigners accounted for 1.6% of the total population, which is almost three times higher than the figure from 1982, which was at 0.68%. In comparison with other developed countries like the U.S. (12.9%) or Germany (8.8%) this increase is still one of the lowest among the developed nations (Lam 2009: 15-17). The increase of foreign residents is connected with concerns of the possibilities of cultural integration, the fear of more violent crimes as well as a decrease of average wages through an influx of foreign workers willing to accept lower wages (Mori & Scearce 2010: 9).

A fear towards wide scale immigration is also a present concern in the care sector, despite the fact that there is a nursing shortage that will become even more evident in the near future. In 2008, the government made attempts to recruit foreign care workers from the Philippines and Indonesia. There has been a strong resistance of the Japanese Nursing Association towards foreign care workers who feared a decrease of the average wages and care quality. The high language and professional requirements on the nursing workers from abroad caused de facto only for a temporary period of stay in Japan (Lam 2009: 10-11).

In 1986 the Ministry for Trade and Industry (MITI) – now Ministry for Economy, Trade and Industry (METI) had already estimated a high demand for care in the future and built up a scheme

called Silver Columbia Plan 92 to outsource the care issue. The initial idea was that Japanese retirees should move to Australia, Spain and Brazil, where nursing and medical care is comparatively cheaper than in Japan. In reality, thousands of Japanese retirees have decided to emigrate to the old occupied or colonized countries, Thailand and the Philippines (Lam 2009: 6). This trend proposes several risks. A rapidly increasing number of emigrates leads to capital flow out of Japan and an additional population decline. Additionally, the need for the Japanese government to deal with its war history and the stressed diplomatic relations to former colonial countries may arise, by trying to outsource their care problem to other countries.

According to a projection on international migration of the United Nations for 2050, 30-87% of the total population would have to be restocked with foreign labor to balance the population, depending on the labor population if Japan wants to maintain its population from the year 2000 (UN 2000). A shift of the immigration paradigm to a more open policy in the near future cannot be expected due to the historical background and the current immigration laws that lead to only limited experience with immigration flows.

Nevertheless, like South Korea and Taiwan, Japan is not the only country facing an over-aging society with labor shortage and a high demand on qualified care workers. Therefore, it has to rethink its immigration policies and set incentives with service and support programs for foreign workers to be able to compete for high qualified human resources on the international migrant labor market (Ishii 2008: 20-21).

The Origins of Robots: Two different Views on Robots

Originally, robots were something we would mainly associate with science fiction literature, but since the seventies they have become a part of reality. The origins of the term robot, as we use it today, came from the play R.U.R. (1920) by Karel Capek a Czech author, who derived the word from the Czech word for forced labor “robota”. In his play, humans create machines for work, but at some point start to revolt against their creators (Capek 2009).

Capek’s robot term has been influenced by religion and also by the historical developments at that time. According to creationist’s perspective such as Christianity, Judaism or Islam, the creation of artificial life like robots is seen as competition with God and the divine order, which attracts punishment as a consequence (Ichbiah 2005: 34). Furthermore, his play was written and influenced by the historical development at the beginning of the nineteenth century, a time when fascism and communism was gaining strength in Europe.

Capek's understanding of technology has greatly affected science fiction (SF) literature and is still having an impact on the present associations towards robots in the West. In classic SF literature, robots are usually hostile towards humans or act destructively. In contrast to Capek's negative view, the American author Isaac Asimov made the first step towards a positive and more sophisticated understanding of robots with his three laws of robotics introduced in his novel I, Robot (1942) (Ichbiah 2005: 50-51).

A few negative examples worth mentioning are the well-known works Frankenstein (1931) and The Terminator (1984) and positive ones like the Asimov's book I, Robot by Asimov (1950) which was also been adopted into a film of the same title in 2005 (Ichbiah 2005: 80).

Industrial Robots in Japan and the West

As there is such a strong link between technology and economical change in Japan, Japan is not only seen as a technology-loving country, but it is even referred to as the country of robots. Since the Meiji Restoration (1868-1912) where Western technology had been adapted to catch-up from a feudal state to an industrial nation, change has been linked with technology. A similar development had been seen after the Second World War, when new technologies helped to not only repair the damages sustained during the war, but also to achieve extensive prosperity. The tendency of using technology continued in the seventies with the large scale implementation of industrial robots. Process optimization with new automation approaches lead to the implementation of automatically controlled machines in fabrics – the first industrial robots.

The American engineers Joseph Engelberg and George Devol are said to be the inventors of the first industrial robot, Unimate. Devol recognized early that a large amount of tasks in fabric production consisted of simple mechanical actions and that these tasks could easily be automated (Schodt 1988: 30-35). However, after getting their patent they had problems with finding consumers in the U.S., because the companies had not seen the additional value for this new expensive invention and so their first costumers had been from Japan (Nakayama 2006: 6).

The reason for this was, that the economic growth period after the war (1955-1972) came along with a labor shortage due to a high demand in the production sector. Here industrial robotics had not only enabled extensive mass production but also secured considerable economic growth. The Japanese government and large companies had been able to avoid an opening to foreign labor through a process automation with industrial robots (Mori & Sceare 2010: 8).

Despite the development in Japan, in Europe and the U.S., there is a fear that robots will replace humans and cause lay-offs (Sone 2009). Two reasons are the negative images of robots spread through media and a working environment in which lifetime employment has become an exception in western countries.

Because of such a background, since the seventies, the majority of the world's industrial robots have been used in Japan (Schodt 1988: 15-16) and to this day it is still a pioneer in the field of robotics. Thus, metaphorically speaking America are the biological parents of industrial robots, even though the social parents who raised them had been Japan (Nakayama 2006: 9).

Japanese Robot Traditions: Shintoism and Mechanical Antecessors

Japan's unique cultural environment and understanding of technology often bear the consequence that it is also called the "robot kingdom" (Schodt 1988). History, religion and modern pop culture are discussed to give a positive environment for the acceptance and thus development of robots. In contrast to Europe and the U.S., the development of robots in Japan is more geared towards a human-like appearance.

One of Japan's religions, the Shintoism, assumes that even inanimate objects have a soul with specific attributes. According to this belief, machines and robots are also living objects and a part of the natural world (Kitano 2007, Geraci 2006, Robertson 2008). Therefore, there is a discrepancy to the Christian understanding of an object`s existence, because only living creatures are seen as autonomous.

In this context, the karakuri ningyo of the Edo period are often mentioned as the antecessor of Japanese robots (Schodt 1988: 55-57, Hornyak 2006: 21, Nakayama 2006: 16-18, Sone 2008: 353-354). Karakuri ningyo are mechanical dolls or automats that can independently perform specific movements (Wißnet 2007: 19-34). During the Edo Period (1603-1868), they had been invented using the basics of foreign watch technology. The Edo Period is remembered as a time of isolationism, during which nearly all trade and technology transfer was suspended for 200 years. Here karakuri ningyo had been an exception since research for entertainment had been allowed. These mechanical dolls enjoyed great popularity at festivals and are partly still in use today.

Three critical notes about karakuri ningyo and robots need to be made. First, Edo's precision mechanics were rather forced by an edict of the shogunate to focus on karakuri ningyo, then had the free choice. Second, Japan was not the only country with mechanical dolls in Europe at that time (Wagner 2009b).Third, the often made statement that there is a long tradition to modern robots

through karakuri ningyo, therefrom has to be questioned, because it is suppressing the 100 years between the Meiji restoration and the postwar period, where karakuri ningyo had been completely forgotten (Schodt 1988: 60-62, Wagner 2013: 127). The anchorage of robots in Japanese history and religion has to be questioned as "invented traditions" especially from the Japanese government and companies to legitimize their policies and practices.

In recent decades advanced technologies, such as automation and robotics, have made a substantial contribution to the successful development of Japan assuring international competitiveness. A high-tech nation with a leading position in the field of robotics is additionally an important part of Japan's self-created image.

Already, in the seventies, Mori Masahiro started to pay attention to the effect of the appearance of machines and also robots and its effect on their acceptance by humans. His "uncanny valley" theory (Mori 1970) is still used today as an important criterion in robot development. His theory states that the more closely a robot resembles a human in movement and form, the more likely it will be accepted; however, the acceptance does not infinitely increase. At a certain point, even if the similarity is continually increasing, the sense of familiarity will suddenly decrease and the design will be rejected by humans.

Ishiguro Hiroshi pursues Mori's theory with his research on androids. The aim is aim to develop robots that look confusedly similar to humans and to overcome the uncanny valley (Bartneck et al. 2007). The main advantage of humanoid robots can be seen in the ease of usability in human-orientated environments. Since ancient times, humans have long been doing research on their own existence (Ishiguro 2009). Ishiguro's most famous robot is his Geminoid, which has been designed according to Ishiguro's own physical model. The Geminoid is a human-like/sized communication device and is actually difficult to distinguish from a human being (Bartneck et al. 2009).

One of the most famous humanoid robots is ASIMO made by Honda. ASIMO is said to be one of the world's most advanced robots ever and is the research result of over two decades. The latest ASIMO is 130 cm tall and weighs 54 kg. Furthermore, he can walk, ride a bike and transport things and has 36 degrees of freedom (Honda 2011). Through extensive travels by ASIMO to different countries, it has become a perfect PR ambassador for Japan and its advanced technologies.

Japanese Modern Culture and Robot Popularity: Manga and Anime

In contrast to the negative view of robots in literature and movies in Europe and the U.S., their appearance in Japanese Manga and Anime is almost always positive. They are portrayed as human

friends or helpers. Among others a few well-known creations are Doraemon, Mobile Suit Gundam and Astro Boy. In particular, the latter has to be discussed in more detailed, because of its relevance for the perception of robots in and outside of Japan.

It is important to note that Astro Boy was released after the lost war, when the belief in reconstruction through technology was very strong (Itō 2010: 371). The postwar period is also particular for having many popular robot characters with different stories, but familiar views on technology, e.g. Iron Man No. 28 and Mazinger Z. Astro Boy is a manga written by Tezuka Osamu which depicts a story about a robot that wants to be as human as possible. The story often incorporates the positives and negatives of technology and their relation to humans, where Astro Boy stands up for the humans and gets into trouble or other difficult situations (Hornyak 2006: 48-53).

Astro Boy can be seen as an analogy of Japan catching up with the West through technology during the Meiji Restoration. However, Tezuka never intended to link up his figure Astro Boy with a positive view on technology. He originally intended to create a more cynical and parodic figure, but then he was forced by the demand of his publisher and reader, who had been traumatize by the lost war, draw the vision of a bright future through the help of technology (Schodt 1988: 76).

It was not the concept of the author that had found their way into the mind of the current robot developers. Tezuka never intended to communicate a positive view of technology with Astro Boy, it was the reader who projected their wishes of a recovering from the lost war through technology into his stories (Wagner 2013: 79). For this reason, it is important to be keep the historical context in mind, when highlighting Astro Boy as the symbol for the ideal Japanese robot.

The contemporary robot developers are trying to re-invoke the optimistic view of technology from the postwar years for their interests by making use of positively seen pop culture figures, in particular Astro Boy (Itō 2007: 15). In that sense Astro boy can be seen as a medium of cultural engineering, because he has been passively influenced through the spirit of the postwar time and actively instrumented by interest groups.

On one hand, pop cultural references tend to lead to unrealizable expectations of robot users and thus can generate frustration instead of excitement (Wagner 2013: 343). There has been a lot of robot prototypes developed by universities and companies in Japan, but robots that reached the product maturity with a clear value for their user are still missing. On the other hand, the importance of

visions in pop culture for the robot development and acceptance in Japan can be illustrated with Astro Boy (Wagner 2013: 85).

Astro Boy was the figure that had influenced the postwar generation of engineers, but the next generation of engineers has been influenced more by figures such as Gundam and in particular Doraemon (Itō 2007: 9-13). The latter has been in production as anime and manga for over 40 years. Doraemon is a robocat from the 22th century that assists its owner in various situations. Doreamon uses various futuristic tools that he pulls from his pocket, which sometimes makes the situation even more difficult for his clumsy master. In Japan and most of Asia, Doraemon enjoys a large popularity, which is similar to the popularity of Mickey Mouse in Europe and the U.S.

Doraemon's design and functions are close to the entertainment robots you see around today and since he is living in present-day Japan with an average Japanese family, he has also become a model for living together with robots (Wagner 2013: 94). His connection to reality does not make him an ideal robot, but rather acts as a pioneer for upcoming robots.

Economic Incentives: the Market Forecast for Japanese Care Robots

As aforementioned industrial robots played a major role in the economic revival of Japan during the sixties. The very first industrial robot was put into operation during this time (Schodt 1988: 113-114). Thanks to an employment structure focusing on long-term success, there was no fear of labor replacement by robots. Instead of replacing them, workers were simply transferred to other working fields if their current field was replaced by robots. The improvement of technology in the eighties helped the robots to become faster, more precise and more applicable, which lead to their quick and broad extension. At this point 60% of the world's existing industrial robots were in operation in Japan (Schodt 1988: 15).

Most of the future growth for industrial robots will be outside of Japan. The Japanese market for industrial robots is saturated and will slightly shrink from 310,000 to 290,000 units. Aside the market saturation one explanation for this development is the average life cycle for an industrial robots of 12 years. Japan's old industrial robots will be discarded and replaced by new models. Since the end of the sixties when industrial robots were introduced the total accumulated number of industrial robot units was 2.6 million units by 2013. The current worldwide stock of installed industrial robots in 2013 was around 1.3. Nevertheless the total market is at of 9.5 billion USD (11.4 Yen) with a growth projection of an annual increase of 12% up to 1.9 million units by 2017 (IFR 2014).

This development becomes even clearer by comparing the number of new installed industrial robot units by markets between 2004 and 2013. In 2004, Japan made 39% (350,000 units), North America 14% (120,000 units), Germany 14% (120.000 units), Italy 6% (53,000 units), South Korea 6% (51,000 units), China 1% (7000 units) and others 20% of the 850,000 total installed units (IFR 2005). In 2013, Japan made 23% (300,000 units), North America 16% (215,000 units), Germany 12% (167,000 unit), South Korea 11% (156,000 units), China 10% (132,000 units) and Italy 4% (60,000 units) of the 1.3 million total installed units (IFR 2014). However in 2017, the market share will be shifted into the order of China (430,000 units/ 22%), then a balance of Japan (290,000 units/ 15%), North America (290,000 units/ 15%), South Korea (230,000 units/ 12%), Germany (200,000 units/ 10%) and Italy (58,000 units/ 3%) of the 1.9 million estimated total installed units (IFR 2014). There are two consequences arising from this development. First, in the future, most industrial robot units will be developed for the growing overseas market, in particular the automotive industry in China and Asia. Secondly, there is a necessity to find new domestic markets.

The METI has proclaimed robotics as one of the key industries that will get economic promotion in the future with the projection of a strong growth from 1.8 trillion Yen 2010 to 6.2 trillion Yen 2025 (METI 2004, JETRO 2006). The Japanese government is providing substantial financial support for the development and research of robots. This, however, was probably primarily motivated by the issues associated with an over ageing society and a decreasing economic strength. Since the demand for new robots in the Japanese industry is saturated, the government is trying to support the establishment of a demand for service robots. Here it is interesting to have a look at the development of robots for professional, domestic and entertainment use. Robots for professional use includes defense and security applications, underwater systems as well as field (milking systems), cleaning, and medical robots. The other two big fields are robots for domestic and personnel use such as vacuum cleaning and lawn-mowing robots and entertainment robots such as toys and education robots. The former is characterized by a comprehensively low number of total robot units but a high economic value of each unit and the latter stand out due to high output and the fact that they are already produced for a mass market.

The number of units sold for professional use quintupled from 31,000 units in 2004 to 150,000 units in 2014 with the majority of the sales being for defense and security applications. Within the same period the number of domestic robots units sold almost doubled from 1.7 million to 2.7 million as well as entertainment robots also increased from 1 million to 1.2 million (IFR 2004, 2014). Vacuum cleaning robots account for a big part of the units sold for domestic robots. Nevertheless, recently the importance for health care became relevant, because of a rapid increasing demand for handicap assistance systems of over 300% in one year. The number of assistance robots increased from 160 to

860 within 2012 and 2013 and projections for the period 2014 to 2017 are estimating a multiplication to 12,000 units (IFR 2014). Through this, it can be clearly seen that the future of robotics will be not in industrial robots, but in service robots.

Even if Japan claims to be the "robot kingdom", its expertise in developing service robots cannot be evaluated as highly as their expertise in the field of humanoid robots. Starting in 1973 with the first bipedal robot WABOT at Waseda University and gaining popularity with Honda's ASIMO, there is a long research history for humanoid robots, even if they are still far away from neither making profit nor covering their research costs in the near future (Gudorf 2007: 194). Additionally, on a global level Japan does not see itself as being competitive within the field of service robots for professional use. In contrast, American and European companies have taken the initiative for finding special solutions for extreme environments such as the space or ocean, and have gained more expertise within this field. Here a high expertise in software is required and Japan's hardware expertise in basic robot functions like mobility and senor systems are not able to unfold (Gudorf 2007: 195, JETRO 2006).

The Political Framework for Robot Research

There seems to be a positive association between technology and development, and it is not surprising that the government tries to exploit robotics for their interests for solving their economic and also demographic issues. Therefore, a broad discussion about the application potential of service and entertainment robots has been taking place. This leads to a trend of new developments being considered quickly and without reserve. Robots are even being developed to interact directly with people, i.e. in nursing homes already considered for the near future.

In 2004, according to the Nakagawa Report towards a new industrial structure the robot industry had been declared to one of Japan's future key industries (METI 2004). This had been not only been an upgrade of the robot industry in the public perception but also the first step on implementing a support framework for economic promotion. Subsequently in 2005 and 2006, also against the background of the aging society and decreasing workforce, the Robot Policy Research Group analyzed future areas of applications by giving certain suggestions to realize a "neo mechatronics society" (METI 2005). One of the outcomes had been the robot business network project "Roboness" with four robot business promotion hubs in Kawasaki, Gifu, Kansai and Fukuoka (Robotto bijinesu suishin kyōgi kai n.d).

As mentioned before, anime and manga have shaped a lasting positive image towards robots in Japan. Thus, the Japanese government is also trying to utilize the positive image from manga for

communicating their policy strategies and visions. Aside the official publication of the Nakagawa Report, a manga called “Innovation 2025” was published (Eguchi & Fujii 2007). The manga attempts to illustrate the visions of the government through the fictional story of the Inobe family with explanations after every manga section. The Inobe family is introduced as the typical family of the future. They are a married couple with two children and grandparents who all live under one roof. The traditional view of family and the gender roles propagate in the story, led to criticism that it is not “innovation” but in fact “re-innovation”, because values had only been renewed, such as household and childcare is still female work in the pictured future of 2025 (Robertson 2008).

In 2014 the Committee for the Implementation of the Robot Revolution had been established. The committee meets four times a year and reports directly to the prime minster and brings together government and renowned businesses such as AIST and Mitsubishi Electrics. The difference with this committee in regards to previous committees is the range of attendees from renowned companies and also policymakers with the 2020 Tokyo Olympics being the concrete time frame for fulfilling several aims (DeWitt 2015).

The Use of Robots in the Field of Care and Therapy

Worldwide, the matter of elderly care and care in general is becoming increasingly important. Notably, Japan quickly and comprehensively needs to respond to its rapidly aging society. No noteworthy attempts have been tried to solve the demographic issues until now. Against this background, it is not surprising that robots are discussed as a technical solution for a social problem and a strong incentive for the further development of robotics. Nevertheless, since a lot of other industrialized countries are facing the same problems, the outcome of this approach will be highly relevant.

The labor shortage, the high psychical and physical burden in the field of care accompanied with the need to respond to a wide range of situations as well as problems may be a few reasons for a newly rethinking the use of robots in the health care sector. Taking a closer look on the care market in Japan shows different concepts for home usage, health care provision and elderly care.

The recent robot development in the field of care covers the following areas: care assistance, interaction and therapy. Technologies for care assistance aim to reduce the burden for the nursing staff and improve the quality of care through e.g. lifting systems like the polar bear robot RIBA or a RoboBed. Aside from this, in the field of entertainment, robots can be used for playing (e.g. AIBO, RoboCup), for communication (e.g. NAO, Papero, KOBIAN-R) or for fostering creativity (e.g. Lego Mindstorms). Here the transition between care and entertainment is smooth. Technologies for

medical purposes like rehabilitation and therapy are one very promising field in robotics. Through the utilization of robots for therapy or rehabilitation by using e.g. the robot seal Paro or the robo-skeleton HAL, psychical and physical conditions can be improved.

Also other technologies, such as the Nintendo's Wii (Watanabe 2012, Nishiwaki et al. 2012), that are not directly associated with robotics seem to be very promising for care. However, the main problems for a wide expansion of robots are their high costs and the battery limitations.

In the study and development of assistive robotic technology, Japan has already been doing research for many years. An example is the research of Hamada Toshimitsu and Naganuma Mitsuru, who analyze the effects and benefits of robot assisted therapy. In their experiments they use AIBO and Paro in nursing homes to examine their effect on the elderly (Hamada et al. 2006, Hamada 2013). AIBO is a dog-like robot that is able to interact with his owner and can be programmed through a remote control. Paro is a seal-like robot that can communicate through sound and is used for therapy. On a similar basis as animal assisted therapy, it seems that by using Paro, it can help relieve stress and discomfort in the elderly (Shibata 2006). One advantage of robots in the field of health care is that there is no problem with hygiene regulations and the running costs and so in comparison to a living therapy dog, costs are much lower.

Another Japanese robot that enjoys great media attention is the humanoid robot RIBA-II. Already his predecessors RI-MAN and RIBA were equipped with visual, olfactory, audItōry and tactile sensors (Mukai et al. 2009) and able to lift and carry people. RIBA-II is expected to be used in hospitals and nursing homes in the near future. The robot should relieve the physical burden of the nursing staff by moving people out of bed and into wheelchairs, and vice versa (Sato et al. 2012). The project is a collaboration between RIKEN and Tokai Rubber Industries, who together established the RIKEN-TRI Collaboration Center for Human-Interactive Robot Research. The most noticeable difference to its predecessor is that its design was not inspired by a human but by a polar bear.

In Japanese society, the idea of using robots within the field of elderly care seems to be highly fixed. From an economic perspective, the government and many companies have invested huge amounts of money into robotics research. From an everyday perspective, families are looking for ways to facilitate the care of their aging relatives. Noriko Dethelfs and Brian Martin (2006) have examined Japanese politics on technology in the context of elderly care. They looked closely at the prospects of international standard technology, robot technology and barrier-free technologies, such as wheelchair ramps or stair lifts. The result of their research revealed that after considering the

advantages and disadvantages a combination of the diverse options is the best strategy in terms of aging.

It is often said that Japanese society is very robot friendly. Intercultural studies, however, indicate that the attitude towards robots in Japan might be more complex than assumed. A study by Bartneck et. al. (2005), shows that in many areas the acceptance of technology in comparison to other robot technology countries, such as China, the Netherlands and Germany, is not very different. In all measured categories Japan had an equivalent acceptance towards robots as Germany. In another study (MacDorman et al. 2009) conducted in universities in the U.S. and Japan, considerable differences regarding the attitude towards robots were found. The most outstanding was that Japanese students seemed to be much more familiar with robots than students in the U.S.

Conclusion

The rapidly increasing demographic change in most industrialized countries is creating a great demand within the care sector. For a successful technology transfer, in particular in the field of care robots, it is necessary to be aware of the different mindsets and of the cultural values where these technologies will be implemented. These are connected to the acceptance of new technology within a particular society.

In the context of Japan, there seems to be a difference in their way of thinking towards technology. The reasons for this mind-set can be found in a positive environment closely connected to cultural associations. The positive mindset is creating a fruitful environment for robot R&D which must not be mistaken for “Japanese-ness.”

It is no surprise that robotics are put forth as an approach to solve problems that are associated with the demographic change (Nakayama 2006, NEDO 2009). Nevertheless, the optimistic statements by the government and business representatives make people believe that demographic issues such as a labor shortage in particular in health care can be solved through robots; however, in reality, it is not only untenable due to the fact that it simply will not be feasible in the near future. As well, it may also ultimately lead to further isolation of Japan as a "technologically gated country" (Robertson 2007) similar to the “locked country” period under the Tokugawa Shogunate. Since much of the technologies are still in research and far from large-scale production, care robots will only fulfill the role of a support medium.

Nevertheless, it can be summarized, that through less constraints towards the use of technology in particular robots the diffusion within various parts of society had been faster than in the most

western countries. Thus, metaphorically speaking America are the biological parents of industrial robots, even though the social parents who raised them had been Japan (Nakayama 2006: 9).

These pragmatism towards technology makes technical approaches thinkable that might elsewhere be not considered. In this sense the precondition for a growing future market for service robots are given, because Japanese appears to be very open-minded towards new technologies (Gudorf 2007:197).

The relationship of Japan and robots can be pointed out with the quote "So why are robots so loved in Japan? Simply because they are simultaneously science and fiction." (Hornyak 2006: 157)

References

Atoh, Makoto. 2008. "Japan's Population Growth during the Past 100 Years." In *The demographic challenge: A handbook about Japan*, edited by Florian Coulmas, 5–24. Leiden, Boston: Brill.

Bartneck, Christoph, Takayuki Kanda, Hiroshi Ishiguro, and Norihiro Hagita. 2007. "Is The Uncanny Valley An Uncanny Cliff?" In *RO-MAN: The 16th IEEE International Symposium on Robot and Human Interactive Communication*, 368–73. http://www.bartneck.de/publications/2007/uncannyCliff/bartneckKandaROMAN2007.pdf. Accessed July 13, 2015.

———. 2009. "My robotic doppelgänger - a critical look at the Uncanny Valley." In *RO-MAN: The 18th IEEE International Symposium on Robot and Human Interactive Communication*, 269–76. http://www.bartneck.de/publications/2009/roboticDoppelgangerUncannyValley/bartneckKandaRoMan2009.pdf. Accessed July 13, 2013.

Bartneck, Christoph, Takayuki Kanda, Tomohiro Suzuki, and Kennsuke Kato. 2005. "Cultural Differences in Attitudes Towards Robots." In *AISB Convention Symposium on Robot Companions: Hard Problems And Open Challenges In Human-Robot Interaction*, 1–4. http://www.bartneck.de/publications/2005/cultureNars/bartneckAISB2005.pdf. Accessed July 13, 2013.

Čapek, Karel, and David Wyllie. 2009. *R.U.R. (Rossum's universal robots).* Fairford, Gloucestershire, UK: Echo Library.

Coulmas, Florian, ed. 2008. *The demographic challenge: A handbook about Japan.* Leiden, Boston: Brill. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10355230.

———. 2010. "The Bitter Fruits of Success." In *Demographic change in Japan and the EU: Comparative perspectives ; selected papers from the VSJF annual conference 2008*, edited by Annette Schad-Seifert. 1. ed., 17–36. Düsseldorf: Düsseldorf Univ. Press.

———. 2015. "Japan's Alterung: katastrophaler Erfolg? [Japan's Aging. Catastrophic Success?]." Studium Generale Anders Altern, Heidelberg, June 29. Accessed July 13, 2015. http://www.uni-heidelberg.de/md/zentral/universitaet/studiumgenerale/studiumgenerale_altern_flyer.pdf.

Dethlefs, Noriko, and Brian Martin. 2006. "Japanese technology policy for aged care." *Science and Public Policy* 33 (1): 47–57. doi:10.3152/147154306781779163.

DeWit, Andrew. 2015. “Komatsu, Smart Construction, Creative Destruction, and Japan’s Robot Revolution.” *The Asia-Pacific Journal* 5 (2). http://japanfocus.org/-Andrew-DeWit/4266/article.html. Accessed July 13, 2015.

Eguchi, Katsuhiko, and Ryuji Fujii. 2007. *2025-nen Inobe-ke no ichinichi [A Day in the Life of the Inobe-Family in the Year 2025]*. Dai 1-han. Tōkyō: PHP Kenkyūjo.

Geraci, Robert M. 2006. “Spiritual robots: Religion and our scientific view of the natural world.” *Theology and Science* 4 (3): 229–46. doi:10.1080/14746700600952993.

Godzik, Maren, ed. 2009. *Altern in Japan*. Japanstudien 21.2009. Munich: Iudicium.

Gudorf, Pascal. 2007. “Der Wachstumsmarkt für Robotertechnologien in Japan [The Growth Market for Robot Technologies in Japan].” In *Japans Zukunftsindustrien*, edited by Andreas Moerke and Anja Walke, 183–99. Berlin, Heidelberg: Springer Berlin Heidelberg.

Hamada, Toshimitsu. 2013. “tsukuba gakuin robotto serapī 2008-2011 [Robot Therapy in Tsukuba Gakuin University 2008-2011].” *Bulletin of Tsukuba Gakuin University* 8: 71–83. http://www.tsukuba-g.ac.jp/library/kiyou/2013/08-hamada.pdf. Accessed July 13, 2015.

Hamada, Toshimitsu, Hiroki Okubo, and Hisashi Onari. 2006. “kōrei sha o taishō to suru robotto serapī - jisshi hōhō ni kansuru kentō - [Robot Therapy for Aged Peple -Study on Effective Therapy Method -].” *Bulletin of Tsukuba Gakuin University* 1: 111–23. http://www.tsukuba-g.ac.jp/library/kiyou/2006/10.HAMADA.pdf. Accessed July 13, 2015.

Honda. “Inside ASIMO Robotics: The Technology Behind ASIMO.” Accessed July 13, 2013. http://asimo.honda.com/inside-asimo/.

Hornyak, Timothy N. 2006. *Loving the machine: The art and science of Japanese robots*. 1. ed. Tōkyō: Kodansha International.

Ichbiah, Daniel. 2005. *Roboter: Geschichte, Technik, Entwicklung [Robots. History, Technology, Development]*. 1. ed. Munich: Knesebeck. http://www.gbv.de/dms/faz-rez/FD120050725294929.pdf.

International Federation of Robotics (IFR) Statistical Department. 2005. “World Industrial Robotics 2004: Executive Summary.” Accessed July 13, 2015. http://www.euron.org/miscdocs/stats06.pdf.

———. 2014. “World Industrial Robotics 2014: Executive Summary.” Accessed July 13, 2015. http://www.ifr.org/uploads/media/Executive_Summary_WR_2014_02.pdf.

Ishiguro, Hiroshi. 2009. *Robotto to wa nani ka: Hito no kokoro o utsusu kagami [What are robots? – A mirror of the human being?]*. Kōdansha gendai shinsho 2023. Tōkyō: Kōdansha.

Ishii, Chihiro. 2008. “Japan’s Demographic Future and Policy Directions.” *Pacific News* (29): 18–21. Accessed July 13, 2013.

Itō, Kenji. 2007. “Astroboy's Birthday: Robotics and Culture in Contemporary Japanese Society.” Accessed July 13, 2015. http://stspo.ym.edu.tw/easts/2007/Ito.pdf.

———. 2010. “Vor Astro Boy: Roboterbilder im Nachkriegsjapan 1945–1952 [Before Astro Boy. Robot Images in Postwar Japan 1945-1952].” *Technikgeschichte* 77 (4): 353–72.

Japan External Trade Organization. 2006. “New Possibilities for Japan's Robot Industry.” Accessed July 13, 2013. https://www.jetro.go.jp/en/reports/market/pdf/2006_10_c.pdf.

Kashiwazaki, Chikako, and Tsuneo Akaha. 2006. “Japanese Immigration Policy: Responding to Conflicting Pressures.” *Migration Information Source*. http://www.migrationpolicy.org/article/japanese-immigration-policy-responding-conflicting-pressures. Accessed July 13, 2015.

Kitano, Naho. 2007. “Animism, Rinri, Modernization; the Base of Japanese Robotics: the Base of Japanese Robotics.” In *ICRA 2007 IEEE International Conference on Robotics: Workshop on Roboethics*. http://www.roboethics.org/icra2007/contributions/KITANO%20Animism%20Rinri%20Modernization%20the%20Base%20of%20Japanese%20Robo.pdf. Accessed July 13, 2015.

Lam, Peng E. “Internationalization and Immigration: Coping with the Ageing Population Problem.” *EAI Background Brief* (442). http://www.eai.nus.edu.sg/BB442.pdf. Accessed July 13, 2013.

MacDorman, Karl F., Sandosh K. Vasudevan, and Chin-Chang Ho. 2009. “Does Japan really have robot mania? Comparing attitudes by implicit and explicit measures.” *AI & Society* 23 (4): 485–510. doi:10.1007/s00146-008-0181-2.

Ministry of Economy, Trade and Industry. 2004. “Shinsangyō sōzō senryaku [Strategy for a new Industrial Structure].” Accessed July 13, 2015. http://www.meti.go.jp/committee/downloadfiles/g40517a40j.pdf.

———. 2005. “Robotto seisaku kenkyūkai chūkan hōkokusho: ～ robotto de hiraku bijinesu furontia ～ [Interim report of the Robot Policy Research Group.To open new Business Opportunities with Robots].” Accessed July 13, 2015. http://www.meti.go.jp/policy/robotto/chukanhoukoku.pdf.

Ministry of Health, Labour and Welfare. 2015. “heisei 26 nen jinkō dōtai tōkei geppō nen kei (gaisū) no gaikō kekka no gaiyō [Result Outline of the Monthly Vital Statistics Report (preliminary data) for 2014].” Accessed July 13, 2013. http://www.mhlw.go.jp/toukei/saikin/hw/jinkou/geppo/nengai14/dl/kekka.pdf.

Moerke, Andreas, and Anja Walke, eds. 2007. *Japans Zukunftsindustrien.* Berlin, Heidelberg: Springer Berlin Heidelberg. http://dx.doi.org/10.1007/978-3-540-29808-3.

Mori, Kathryn, and Carolyn Scearce. 2010. “Robot Nation: Robots and the declining Japanese population.” *Discovery Guides*, 1–17. http://www.researchgate.net/publication/242739186_Robot_Nation_Robots_and_the_Declining_Japanese_Population. Accessed July 13, 2015.

Mori, Masahiro. 1970. “Bukimi no tani [The Uncanny Valley].” *Energy* 7 (4): 33–35.

Mukai, Toshiharu, Shinya Hirano, and Shigeyuki Hosoe. 2009. “kaigo robotto rīman [Care Robot RI-MAN].” *Robotto (tokushū: iryō･fukushi robotto)* (188): 46–52.

Nakayama, Shin. 2006. *Robotto ga Nihon o sukuu [Robots will save Japan]*. Tōkyō: Tōyō Keizai Shinpōsha.

Nishiwaki, Masato, Akinori Kuriyama, Yumi Ikegami, Nana Nakashima, and Naoyuki Matsumoto. 2012. “gēmu kinō tsuki katsudō ryō kei o mochī ta seikatsu kainyū ga shintai katsudō ryō ni ataeru eikyō: musakui waritsuke kurosuōbā shiken [Effects of a lifestyle intervention using an activity monitor with game functions on physical activity -A randomized crossover study].”

Japanese Journal of Physical Fitness and Sports Medicine 61 (3): 335–41. doi:10.7600/jspfsm.61.335.

Robertson, Jennifer. 2007. “Robo Sapiens Japanicus: Humanoid Robots and the Posthuman Family.” *Critical Asian Studies* 39 (3): 369–98. http://www.mtholyoke.edu/~kasma20n/aginginjapan/robosapiens.pdf. Accessed July 13, 2015.

———. 2008. “Science Fiction as Domestic Policy in Japan: Humanoid Robots, Posthumans, and Innovation 25.” *Asia Program Special Report* (141): 29–34. http://www.wilsoncenter.org/sites/default/files/Asia_141.pdf. Accessed July 13, 2013.

Robotto bijinesu suishin kyōgi kai. n.d. “Roboness.” Accessed July 13, 2015. http://www.roboness.jp/.

Saraceno, Chiara. 2004. “Keynote Speech: shinpojiumu chōshōshika to mukiau - towareru ikikata・shisaku [Symposiun on 'Confronting Very Low Fertility Rate -Policies and Life'].” Accessed July 13, 2015. http://www.asahi.com/sympo/syousika/05.html.

Sato, Susumu, Shijie Guo, Seisho Inada, and Toshiharu Mukai. 2012. “Design of Transfer Motion and Verification Experiment of Care Assistant Robot RIBA-II.” *Transactions of the Japan Society of Mechanical Engineers C-Series* 78 (789): 1899–1912. doi:10.1299/kikaic.78.1899.

Schad-Seifert, Annette. 2006a. “Coping with Low Fertility? Japan’s Government Measures for a Gender Equal Society.” *DIJ Working Paper* 06 (4). http://www.dijtokyo.org/publications/WP0604-%20Schad.pdf. Accessed July 13, 2015.

———. 2006b. “Japans kinderarme Gesellschaft: Die niedrige Geburtenrate und das Gender-Problem.” *DIJ Working Paper* 06 (1). http://www.dijtokyo.org/publications/WP0601SchadSeifert.pdf. Accessed July 13, 2015.

———, ed. 2010. *Demographic change in Japan and the EU: Comparative perspectives ; selected papers from the VSJF annual conference 2008.* 1. ed. Düsseldorf: Düsseldorf Univ. Press.

Schodt, Frederik L. 1988. *Inside the robot kingdom: Japan, mechatronics, and the coming robotopia.* 1. ed. Tōkyō: Kodansha Internat.

Shibata, Takanori. 2007. “hito no kokoro o yutaka ni suru mentaru komitto robotto ・paro [Paro – the Mental Commitment Robot to enrich the Human Heart].” *yobō jihō* (231): 44–49. https://www.sonpo.or.jp/archive/publish/bousai/jiho/pdf/no_231/yj23144.pdf. Accessed July 13, 2015.

Sone, Yuji. 2008. “Realism of the unreal: The Japanese robot and the performance of representation.” *Visual Communication* 7 (3): 345–62. doi:10.1177/1470357208092324.

United Nations. 2000. “Replacement Migration: Is It a Solution to Declining and Ageing Populations?” Accessed July 13, 2015. http://www.un.org/esa/population/publications/migration/japan.pdf.

Wagner, Cosima. 2009a. “"Tele-Altenpflege" und "Robotertherapie": Leben mit Robotern als Vision und Realität für die überalterte Gesellschaft Japans ['Tele-Eldery Care' and 'Robot Therapy'. Living with Robots as Vision and Reality for the Overaged Society].” In *Altern in Japan*, edited by Maren Godzik, 271–98. Japanstudien 21.2009. Munich: Iudicium. http://www.japanologie.uni-frankfurt.de/japlehre/Wagner-TelealtenpflegeDIJ.pdf. Accessed July 13, 2015.

———. 2009b. “The Japanese Way of Robotics: Interacting "Naturally" with Robots as a National Character?” In *RO-MAN: The 18th IEEE International Symposium on Robot and Human Interactive Communication*, 510–15. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5326221&tag=1. Accessed July 13, 2015.

———. 2013. *Robotopia Nipponica: Recherchen zur Akzeptanz von Robotern in Japan [Robotopia Nipponica: Research on the Acceptance of Robots in Japan]*. 1. ed. Marburg: Tectum. Univ., Diss.--Frankfurt (Main), 2008.

Watanabe, Mitsunobu. 2012. “Wī Fit o mochī ta undō kinō kunren ga kōrei sha no ninchi kinō ni oyobosu eikyō nitsuite [The effect of physical exercise using Wii Fit on cognitive function in the elderly].” *The Journal of physical medicine* 23 (1): 53–57.

Wißnet, Alexander. 2007. *Roboter in Japan: Ursachen und Hintergründe eines Phänomens [Robots in Japan: Causes and Background of a Phenomenon]*. Munich: Iudicium. http://deposit.d-nb.de/cgi-bin/dokserv?id=3015711&prov=M&dok_var=1&dok_ext=htm.