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Care of the elderly

Japanese technology policy for aged care

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Aged-care provision is a burning issue in Japan because of the country's unparalleled longevity and a fraying tradition of children caring for parents. Use of technology offers one approach to helping ease the increasing burden of aged care. Ways of using technology can be conveniently classified into three options. The first is to rely on well-tested technologies developed outside Japan. The second is for significant Japanese investment in high-technology aged-care supports, including robotics. The third is for significant Japanese development in barrier-free technology, a low-technology direction. Articulating these options and spelling out their likely consequences helps to highlight some of the implicit value judgements involved in Japanese technology policy for aged care.

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IN THE PAST SEVERAL decades, Japan has made a remarkably rapid demographic transition from a population that is relatively young to one of the most aged in the world. With the longest life expectancy in the world, it is expected that, by 2020, a quarter of the population will be more than 65 years old (Miura, 1998: 20). As well as the very personal impact of ageing within families, this transition has significant economic implications. As the population ages, those in paid work are in essence required to support an ever larger cohort of elderly non-workers. This means that higher productivity is required just to maintain the same *per capita* material standard of living.

The demographic transition has especially serious policy implications because, unlike much of Europe, Japan has no history of universal government provision for the aged. It has long been traditional for children to care for their parents, with government playing a relatively minor role. However, the expectation that one's children will provide for one's needs in old age is coming under pressure from a number of directions. The children of those in their 80s or 90s may be old themselves, sometimes frail or ill and unable to offer adequate care. Just as seriously, there has been a change of attitude among many in the younger generation, with fewer children feeling a strong obligation to care for their parents.

The combination of rapid demographic shift and changes in family expectations has helped trigger a heated debate about care of the aged (JARC, 1996; Ogawa, 1989; 1993). Many options have been canvassed; we summarise them in Table 1. A massive increase in government-supported aged care is one possibility, though the direct cost would be considerable if sufficient young workers are to be attracted to the aged-care sector. Another possibility is to encourage retirees to settle in lower-cost countries,

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though so far this has not been very popular given that family ties remain strong (Asai, 1997: 246; Aita, 1994). Yet another possibility is to recruit larger numbers of aged-care workers from other countries, such as Thailand, but cultural differences are a problem (Cornell, 2000).

It can be misleading to see ageing as the problem in itself. Many elderly people are quite healthy and capable of working, whereas those who are incapacitated or ill include both young and old. One solution to the problem that workers must collectively support an ever-larger proportion of non-workers is to eliminate retirement and expect people to work for as long as they are able. Indeed, the official retirement age has been gradually increasing, but without a dramatic effect on the aged-care burden. This hypothetical solution breaks down because it conflicts with strong social expectations about work life and retirement. Viable approaches to the aged-care challenge should be compatible with social values.

In this context, technology offers some hope for reducing the burden of aged care. Technology has long played a major role in health care: it includes everything from hospital beds to surgical implements to pharmaceutical drugs and, more broadly, household appliances, modes of transportation and means of shopping. For our examination here, we exclude medical treatment and focus on technology specifically designed for care of the aged, including for rehabilitation and helping carry out daily activities such as walking and eating.

In Japan, there is probably more scope for technological fixes than in many other cultures. After 1868, when Japan was opened to the West after centuries of isolation, the Government actively promoted acquisition and adaptation of foreign technology. After World War II, the Japanese Government promoted a technology-intensive path to economic growth. Japanese industry has adopted robots enthusiastically and, as a result of job security (at least until recently), Japanese workers have been less likely to see them as competitors than elsewhere.

Technology has become ingrained in people's everyday life; whether the social problem is related to health, education, housing, employment, shopping, banking, transport or whatever, technology is expected to play some role in addressing the problem. Hence, there is a sense of responsibility in taking a lead in developing technology for aged care. Interviews with academics and people working in this area in the Ministry of International Trade and Industry (MITI) and the Ministry of Health and Welfare revealed that seeking to develop technological assistance to address the needs of aged care is as natural as seeking medical assistance to cure physical ailments.

Technology is one area in which government can have a direct impact through sponsoring research, fostering investment and setting policies. In Japan, there seems to have been no consistent framework or planning process for technology policy concerning the elderly, with responsibility fragmented between different government departments, each responding to pressure from interested parties such as corporations developing particular product types. Likewise, the public debate has ranged over a multitude of issues and perspectives, making it difficult to make sense of policy directions.

Our aim here is to help clarify discussion about Japanese technology policy for aged care by spelling out three technology options. A 'technology option' here refers to a reasonably coherent direction for technological innovation and implementation. The articulation of a technology option in part depends on contrasts with alternative technology options.

Table 1. Advantages and disadvantages of some options for aged care in Japan

Option	Advantages	Disadvantages
Family-based care	Compatibility with tradition; family connection; low cost	Children unable or unwilling to care for parents
Government-supported aged care	Benefits to the aged	High cost; labour shortage
Emigration of aged people	Reduced human and economic burden in Japan	Low level of appeal; break-up of families
Importing of care-givers	Human touch maintained in aged care; comparatively lower cost	Cultural differences; lack of family; labour cost
Later retirement	Increased economic productivity	Loss of retirement opportunities
Technological aids	Less aged-care labour required	Cost; reduction in human contact

Table 2. Three technology options for aged care in Japan

Option 1: Use or adapt internationally standard technology
Option 2: Invest in, and promote use of, robotics
Option 3: Invest in, and promote use of, barrier-free technology

Out of the messy reality of Japanese debate and action about technology for aged care, we highlight three such options (see Table 2). Option 1 involves adopting only internationally standard technology. The implication is that major Japanese investment will not be made to develop new technologies for aged care, though this does not rule out refining existing technology or choosing appropriate technologies from those that have become standard in other countries. For example, as innovations in wheelchairs become standard, new models would be imported or manufactured in Japan.

Option 2 is for Japan to take a major initiative in robotics for aged care, with significant investment, testing and promotion. Option 3 is for a similarly significant initiative in developing and promoting barrier-free technology, which consists of relatively simple and inexpensive innovations, such as light switches and eating implements designed for people with poor eyesight or limited dexterity.

In the following three sections we give more details about each of these options and their implications, but first it is worth commenting on the idea of technology options in the context of technology studies.

Over the past two or three decades, a central focus of technology studies has been the social processes that lead to development and use of particular technologies. This constructivist approach includes social shaping of technology (MacKenzie and Wajcman, 1999), actor-network theory (Latour, 1987) and social construction of technology (Pinch and Bijker, 1984); these and other frameworks are related to each other in various complex ways. For our purposes, though, the complexities can be set aside: to speak of technology options is to assume that technologies can be constructed. However, rather than the usual constructivist focus on analysing why technological development occurs the way it does, attention to technology options is more future-oriented: it draws attention to possible future constructions.

In a classic constructivist analysis, Cowan (1983) looked at technologies in the home and drew attention to technology paths not taken. In our terms, this was an astute look at technology options that existed in the past. Our approach is similar but with a focus on future options.

Another important and relevant body of work is that dealing with innovation, which typically focuses on the economic, organisational, human relations, government policy and other dimensions of promoting new technology. The criteria for successful

Technology options assume that innovation choices are possible and desirable: spelling them out can clarify general directions for innovation, bringing in the constructivist insight that different futures are possible, and values and interests are involved in moving toward any particular future

innovation are usually along the lines of productivity, efficiency and economic growth, sometimes with other factors, such as environmental sustainability. The idea of technology options assumes that innovation choices are possible and desirable. Spelling them out can clarify possible general directions for innovation, bringing in the constructivist insight that different futures are possible and that values and interests are involved in moving toward any particular future.

Another theme in technology studies is the impact of technology (Winner, 1993); note that to pay attention to impacts on employment, skills, environment, health, education, political participation and other areas does not necessarily imply an assumption of technological determinism. The areas of impact themselves have a continuing influence on technology, so that it is possible to speak of the co-evolution of technology and society (Bijker, 1993); focusing on impacts, as we do in this paper, is simply to look at one side of this process. Any specific technology option will have characteristic impacts. Hence, an assessment of likely impacts can be used to help decide which technology option should be pursued.

Those involved in discussing and creating technology futures may not look beyond one or two technology options. Groups with a vested interest in particular developments, such as companies marketing their products, often promote the idea that there is only one desirable future. Militaries promote weapons-based futures, biotechnology companies promote biotechnology-based futures and computer companies promote computer-based futures. Constructivists point out that there are alternatives. For example, the particular ways that computers have been introduced can be seen as the result not only of technological and economic factors but also of organised efforts by promoters, in essence a computerisation movement (Kling and Iaconno, 1988).

By articulating technology options, analysts implicitly point to the constructed nature of technology futures and can emphasise opportunities that might otherwise be overlooked. A classic example is

Lovins' (1977) idea of a "soft energy path" based on energy efficiency and renewable energy technologies, in contrast to the "hard energy path" based on coal, oil and nuclear power. Our attention to technology options for aged care in Japan is not so dramatic but lies in the same tradition.

Option 1: Internationally standard technology

In this option, there is relatively little Japanese research and development for aged care. Rather, technologies that have become standard in other countries are selected and adapted in Japan to address and meet the needs of caring for the aged. According to figures from the Ministry of Health and Welfare, the 1998 market value of medical and dental equipment in Japan was 2.03 trillion yen (approximately US$20 billion) of which 41.2% was made up of imported medical equipment. US products dominated the imported medical and equipment market (63.5%) (JETRO, 2000: 11). Imported products include surgical instruments, diagnostic imaging apparatus and general operating supplies.

Aged-care and other products to support the activities of daily life for senior citizens and disabled people are included in the category of home-care and rehabilitation products. This market is expanding as the demand for products to improve the quality of life for the growing aged population increases. The total market size of home-care merchandise rose from 773 billion yen in 1993 to 1.018 trillion yen in 1997 (JETRO, 2000: 22).

Japan relies mainly on imports for some types of aged-care equipment, such as wheelchairs and hearing aids. Taiwan, South Korea and the USA are the main providers of wheelchairs, while Denmark, the USA and the Netherlands supply nearly half the hearing aids in Japan (JETRO, 2000: 23–24). Overall, Japan imports modern medical products and services from around the world. According to the 1998 Annual Report for Pharmaceutical Preparations (Ministry of Health and Welfare), the value of imported medical equipment increased from 289 billion yen in 1990 to 835 billion yen in 1998. However, the value of medical equipment exported has only risen from 290 billion yen in 1980 to 327 billion yen in 1998 (JETRO, 2000: 11).

According to the Japan External Trade Organisation (JETRO, 2000: 1):

> Historically, the health-care market in Japan has been import-driven, since foreign manufacturers, particularly American companies, have invested a great deal of energy in developing new health-care technologies and are expected to continue doing so. European companies have accumulated a vast amount of expertise in matters relating to care of the elderly. These companies remain the model on which Japanese enterprises base their efforts. In short, foreign products for the health-care market in Japan should continue to sell well.

Option 1 is, therefore, a feasible option for consideration. In pursuing it, it is of the utmost importance that sound decisions are made in selecting the most appropriate technologies that have become standard in other countries. Normally, the selection process follows the market mechanism of supply and demand. However, government can affect choices through regulations and taxing. The process of making the 'best' choice is important, wherever the technology is developed, and choosing from final products rather than creating new products will lead to a saving on research and development.

What Japan saves in human and financial resources by adopting overseas technology can be channelled to meet other social needs. However, there are restrictions in choice and flexibility when Japan is not in a position to decide what technology will be developed for aged care. On the other hand, Japan has a reputation for cleverly adapting and refining technologies developed in other countries to enhance utilisation.

Assessing technologies developed by other countries also allows more objectivity without domestic conflict of interests with the developers. Researchers of frontier technology are often specialists in a narrow field and need to be so focused in their area that it is difficult for them to assess how their technology will influence society. For the Japanese Government to be able to choose technology to import for aged care provides an avenue for controlling which technologies may affect the life of individuals and groups in Japanese society.

A contribution to the process of such decision-making can also be sought from a wider section of society since the potential technologies for importation can be seen and tested, whereas assessing undeveloped technologies is more difficult without expert knowledge. Additional voices in the decision-making process will hopefully bring a more sensitive and appropriate outcome for better aged-care provision.

Option 2: Robotics

We mentioned earlier that the Japanese seem to have been relatively open to seeking technological solutions to social and economic problems, including some of the most pressing problems of an ageing society. This perception is sometimes openly expressed in Japan. For example, in showcasing a non-industrial robot, Wasubot, at the Expo in 1985, the Japanese producer of the exhibit aimed to show "…that as a race the Japanese are extremely receptive to technology" (Schodt, 1988: 14).

As the proportion of aged people has continued to increase, there has been much interest shown, particularly by Japanese researchers and some Government bodies, in developing sophisticated technologies that can address aged-care problems. Here we focus on robotics as a central and visible aspect of the high-level technology option. Japan has been described as the "kingdom of robots" (an example being Schodt's (1988) book *Inside the Robot Kingdom*) and has been "home for approximately 60% of the world's total industrial robots" (*Asahi Shinbun*, 1997).

Originally robots in Japan were primarily utilised in factories. Interest and research in robots to perform non-industrial tasks developed later. In recent years, media attention to concerns about Japan's ageing society has become a major impetus to investigate how technology, including robotics, can assist care of the aged.

The development of non-industrial robots is also evolving towards a closer interaction with human beings, indicated by terms such as service robots, welfare robots, rehabilitation robots, personal robots and humanoid robots. There is a challenge for researchers to develop robots with the ability to assist directly in caring for people, including the aged. Mindful that elderly people requiring care have impairments, robots that are developed to assist them need to possess the ability for this extra dimension. There is an even greater challenge in developing and diffusing robots that will enhance the quality of life not only for the elderly population but also for those who provide care services and for society as a whole.

Three selected Japanese robotics research projects in the domain of health and welfare, in particular for the aged, are introduced here. These case studies illuminate clinical and technical functions as well as performance capabilities of robots in meeting the needs identified by the developers.

The Aid-1 project originally commenced as one way of addressing the need to improve medical treatment qualitatively in Japan because of an inordinate lack of hospital staff and a shortage of labour in non-medical and specialised medical areas (Ide *et al*, 1993: 189). "Japan has only a quarter of the number of medical personnel as America" (Ide *et al*, 1993: 191). The researchers argued that this, in turn, created an excessive burden on the nursing staff, who are known to commonly suffer from "burn-out syndrome" (Miyauchi, 2000: 228–229).

The Aid-1 research team recognised that one of the obvious problems in dealing with an unprecedented rate of ageing was meeting the increasing demand for health-care services. Aid-1 was, therefore, developed as one way of addressing and solving this problem. It is used for walking rehabilitation programmes, or gait training, and requires fewer human resources than the traditional training methods. The researchers stated that Aid-1 was designed to prevent an increase in the number of bed-ridden elderly patients by maintaining their independence.

Although the prototype machine was completed in 1985, it required further development before the Aid-1 research team described it as a walking rehabilitation robot. It now has suspended arms able to move 360 degrees horizontally and 30 degrees vertically. Using a round handrail around the patient's body, and a belt for safety purposes, the 'chin-up' bar attached to the end of the robot's arms holds up the patient by the armpits and chest wall. Support is given to the torso and the patient's body is suspended by means of compressed air to reduce body weight. This form of gait training allows patients progressively to strengthen their muscle power and their ability to walk by controlling the burden of the patient's body weight.

Functional clinical evaluation by the research team was carried out in 1993 and published in *Advanced Robotics* (Ide *et al*, 1993: 194–195). The report states that statistics were accumulated over four years with 136 patients undergoing the rehabilitation program using Aid-1. The results showed that in over 80% of the cases there was some improvement in the patients' ability to walk. Aid-1 is predominantly used in nursing homes, where 80% of these robots had been installed, the other 20% being in rehabilitation hospitals.

The price for Aid-1 as at October 1998 was approximately 5.5 million yen (tax exempted, or approximately US$47,700 using end of 1998 Bank of Japan exchange rate of 115.2yen to US$1) including the cost of delivery and setting up. Aid-1 is referred to as an ambulatory rehabilitation equipment called Rehabot in the USA. The merits of rehabilitation using Aid-1 include being pleasant and enjoyable as well as being effective, economical and safe.

A second example is an interactive face robot that is able to communicate both verbally and nonverbally with humans. According to the researchers, this is seen as an important step in creating a human care and welfare robot, particularly for care of the aged, that can communicate with end-users. Researchers use the urgency of additional aged care as one of their arguments that their project is addressing an important societal need. Among potential applications, a high priority is given to aged care in view of the expected rise in its demand in Japan.

Stone (1996: 182) describes the robot face as being "slightly larger than the average human head … part of a burgeoning effort to improve communications between humans and machines". According to

Examples of robots being developed for the care of the elderly include: one for walking rehabilitation programmes; an interactive face robot capable of communicating verbally and non-verbally with humans; and the robotics sick room

the head of the research team, Hara (Kobayashi and Hara, 1993: 276):

> in order to develop Active Human Interface (AHI) that realises heart-to-heart communication between human being and intelligent machine, the information communicated between human being and intelligent machine must include not only logical one but also psychological one. From the view point of human–human communication, facial expressions is a very important media for conveying our message and it must be very crucial even for human–machine communication media using facial expression. We think that intelligent machine will have a capability to recognise its partner's emotion from facial expressions.

Thus, the researchers of facial expressions for robots anticipate their application to include nurse robot, teacher robot, and communication recovery for disabled people.

A third example was first presented to the public in the *Nihon Keizai Shinbun* (the daily national economics newspaper), which reported on 8 December 1997 that a new concept of caring for the sick or invalid in the form of a "robotics sick room" had been developed by a team led by Sato at the Advanced Technology Research Centre at the University of Tokyo. Sato emphasised that the initiative for this research was to develop a useful robotics system to assist the care of sick patients and the elderly. The team is convinced of the need in the Japanese society because (Mori and Sato, 1999: 141):

> While two million patients were hospitalised in Japan in 1996, the number of sick people is estimated to increase up to more than five million by the year 2025. Super aged society and the increasing number of nuclear family require a lot of social service to support such sick people.

The robotics room is not a room with robots, but rather the room itself is like a robot. According to the researchers, the robotics facilities attached to this room allow monitoring of the patient's breathing and movements in the bed without intrusion. Furthermore, the robotics system is installed with an integrated function of behaviour understanding and expression. This means that merely by watching and becoming familiar with the patient's behaviour, the robot is able to ascertain when the patient wants assistance, for instance, a cup of water brought to him/her. The robot, without the patient having to rely on calling for another human's assistance, then performs certain routine tasks.

In other words, the robotics system takes the form of a room where support can be offered to a patient who is bedridden and thus provides some independence despite physical disabilities. According to the researchers, patients would appreciate not having to rely on other people to achieve some simple tasks, such as fetching drinks, tissues and so forth. By developing a robotics system that can carry out not only the mundane, simple tasks but also those that would be difficult for a human being to fulfil, the researchers believe that this system will eventually be used in normal homes as well.

These examples of robotics for aged care involve the use of cutting-edge technology to address social problems. By their nature, these projects are long-term developments and require considerable expertise and finance. These are common characteristics of high-level technology projects and differ from barrier-free technology projects described next.

Option 3: Barrier-free technology

Barrier-free technology can be described as relatively small-scale technology that is usually neither state-of-the-art nor cutting-edge. Therefore, barrier-free technology normally does not require long-term, expensive development and is less complex than high-level technology such as robotics. Nevertheless, smaller-scale technology can profoundly contribute in enhancing care for the aged. For example, handrails will provide protection for elderly people who are prone to trip and fall down stairways. This is significant in the light of a report that, in recent years, more than 200 elderly people in Japan die each year as a result of falling downstairs in their homes (Mori, 1999: 39).

Other examples of relatively simple and inexpensive technology used to assist the frail include a modification of a switch. By making gadgets with switches that flick up and down instead of flat control panels, elderly people with limited eyesight or hand movement are able to utilise the equipment more easily. Although knobs are an 'old' technology when compared with electronic touch-pad controls, for some people they are much easier to manipulate. However, for others, such as those with arthritis or similar conditions, electronic touch pads or voice-activated machines may be more helpful. Developing and utilising smaller-scale technology for additional options in aged care can benefit both the receiver and the giver of care.

Unlike high-level technologies such as robotics, barrier-free technology developments have, until recently, attracted relatively little attention from the academic, commercial or political sectors. Lack of prominence in the public arena, however, in no way implies that smaller-scale technology cannot be utilised to provide significant improvement in aged care.

The concept of barrier-free technology evolved from the notion of expanding the market share of goods and services that are universal design or *kyoyo-hin* (commonly useable goods). This is a Japanese name given for products that are designed or modified to cater for the special needs of elderly and disabled people. Additionally, these products tend to be more useful and user-friendly for all end-users. The principle of *kyoyo-hin* is rapidly being recognised and accepted by the Japanese public including the Government and business groups. The efforts of organisations, such as the Kyoyo-Hin Foundation, in promoting barrier-free goods and services and bringing them to the attention of the media in recent years are bearing fruit.

Evidence of public interest in Japan to create a barrier-free community has grown in the last two decades since the Year of the Disabled (1981) and the United Nations launch of the Decade for the Disabled in 1983 (Mori, 1999: 19). During this period, too, the concept of 'normalisation' for the disabled to participate actively in society, rather than being cared for inside the confines of an institution, filtered into Japan from Denmark and Sweden. At the same time, there was a rise in the profile of determined disabled groups in Japan who fought tirelessly to be de-institutionalised (Inoue, 1998: 25–26). There was increasing public interest in technology and care to prevent aged people becoming totally bed-ridden (Ookuma, 1990).

Likewise, Government guidelines and policies towards creating a barrier-free environment slowly became noticeable in Japan during the Decade for the Disabled. The Ministry of Transportation, for instance, began to investigate what facilities were required for the disabled in public transportation terminals (Mori, 1999: 25). Following on from these investigations, more elevators and escalators have been placed in train stations. The Ministry has continued to promote accessibility in terminals and in the trains and buses.

The Decade for the Disabled also promoted easier accessibility in public places and this process continued to develop slowly to the point that, in 1994, a law was passed for the provision of easier access (for the aged and the disabled) to public buildings. Buildings particularly targeted included department stores, hospitals, cinemas and public meeting places. The strategy involved improving accessibility in the entrance areas, hallways, elevators, toilets and other public areas of these buildings.

Products that have been developed as barrier-free goods are increasing in number and variety (Choong and Murakami, 1997; Kyoyo-hin Foundation, 1999; 2001). Examples of items that have been developed in Japan as barrier-free goods are presented in this section from the *Catalogue of Barrier-free Living* (translation of the Japanese title) (Kyoyo-hin Foundation, 1999) and the *Kyoyo-Hin White Paper 2001* (Kyoyo-hin Foundation, 2001). They illustrate that design and modifications to products tend to be made in response to identified needs of the elderly and the disabled. This development approach is often referred to as the bottom-up approach.

The technologies utilised are less complex and costly than the robotics technology described earlier and thus the development process is normally shorter and the end products are more likely to be economically viable. The crux of barrier-free goods is that they can be significantly beneficial to a large group in society, even if the fundamental technology on which they are based is not cutting-edge.

Many people are unable to distinguish a shampoo container from a conditioner container because of poor sight. The need was communicated to Kao, one of Japan's largest cosmetics companies, by a group of sight-impaired people. Makoto Aoki, then responsible for Kao's consumer liaison, was moved to respond to this seemingly insignificant request, since it represented a very real need for the visually impaired.

Visiting a school for the blind and having talks with the students clearly identified their struggles to distinguish between the shampoo and conditioner containers when washing their hair. The students revealed their attempts to solve this problem by putting a rubber band around one container or by attaching a Braille sticker to one. It was obvious that being able to differentiate the containers easily by touch would solve their problem.

After some trials, the company developed a device whereby small indentations could be made on the side of the shampoo containers. The development plan to place these tactile notches on shampoo containers took into account cost factors of implementing and producing the change. Consideration was also given in the design process to the overall texture of containers: this was for diabetic consumers who have an additional difficulty in their sense of touch.

Moreover, Kao made a deliberate decision not to patent this technology so that other companies marketing shampoos and conditioners would be encouraged to use the same differentiation system for the benefit of all consumers. This example illustrates both the bottom-up development path and how the end product can make life easier for many people, even those with good eyesight.

The shampoo and conditioner example also demonstrates that experiences of inconvenience and difficulty often act as the impetus to seek and develop a solution, often a technological solution, to solve a

The cosmetic company Kao made a deliberate decision not to patent its technology allowing the partially impaired to distinguish between shampoo and conditioner bottles so that other companies would be encouraged to use the same differentiation system

problem. Hideki Nakasone of World Pioneer Company lost his hearing as a result of scarlet fever in childhood and faced the inconvenience of not being able to hear his name called out at hospitals and banks. The pursuit of a solution to this frustration led to the development of a wireless beeper without sound.

The first beeper that Nakasone developed used flashing lights to alert the user; the second beeper used vibration, while the third beeper used both. This technology has since been utilised to produce implements to alert deaf people to incoming faxes, telephone calls and door knocks. Although the development and utilisation of this technology was initially targeted at people with hearing impairment, it is now widely used for a range of gadgets to alert users without disturbing other people around them (as in a concert or conference situation). For instance, alarm clocks that vibrate under the pillow of the user avoid annoying others. Flashing numbers or names at public places of waiting have now become more common in Japan, eliminating noise pollution. Thus, this development to benefit deaf people has, in fact, enhanced the lives of a much wider section of the community.

Tamio Endo identified certain needs of older people and, in response, began developing cooking utensils that would be easier to use for senior citizens who had diminished strength or were suffering from arthritis. He implemented similar principles to those used for children's cooking utensils, making them lightweight and easy to manipulate by those with relatively little physical strength.

In Japan, much of the cooking process is carried out with long chopsticks which, as the joints become stiff, often become too intricate to use. In solving this problem, Endo developed tongs of various types that are easy to use. He also made other barrier-free goods to ease the task of opening jars, cans, bottles and so forth. Such implements have greatly benefited not only the disabled and the elderly but also those who have lost some strength through accidents or illness, even temporarily. They are now widely used even in the kitchens of people with no disabilities.

Sony received requests from elderly customers for radio cassette players that are simpler to operate. To meet their needs, Sony developed the CFM-A50 cassette player model with large, easy-to-grip buttons and dials and big lettering and numbers that light up in the dark. Although this cassette player was developed primarily for elderly customers, the user-friendly aspects have attracted customers of all ages.

These are just some of the many everyday products on the market that can be used more easily and freely with relatively small alterations. There is increasing awareness and promotion for such products in Japan to meet the needs of the elderly and disabled. For example, the Association for Electric Home Appliances (Japan) published *Guidelines for Designing Easy-to-Use Products for the Elderly and the Disabled* in March 1999 (cited in Kyoyo-Hin Foundation, 2001: 22).

Considerations for those with some disabilities or frailties, when designing and producing goods, not only expands the corresponding markets but user-friendly designs often supply benefits appreciated by 'normal' consumers. The goal of the Kyoyo-hin Foundation is to continue developing goods so they ultimately become 'normal' or 'ordinary' on the market. As mentioned earlier, there are added advantages for producers to be in a growing industry and the market for barrier-free goods is expected to continue expanding. Particularly in Japan, where a quarter of the population is expected to be over the age of 65 in less than 20 years, the needs of this cohort and the increasing number of disabled people ensure increasing demand for barrier-free products.

Impacts of the options

The three technology options that we have outlined are ideal types; actual policy is a mixture of these directions. In other words, actual policy is a complex reality that includes contradictory and idiosyncratic decisions and policy thrusts, as different interest groups seek to promote their visions of community welfare, which in many cases are linked to their special interests and world views.

In the case of Japanese aged-care policy, there are inputs from a range of Government departments, including those dealing with technology, welfare and the economy, as well as industries and prominent individuals. To talk of technology options is an analyst's way of imposing some order on a messy reality. In particular, distinguishing these options is helpful in clarifying the implications of decisions about aged-care technology. In focusing on impacts, we do not need to elucidate all the complications of policy-making in advance. To pursue this process further, a next step is to examine the implications of each option for a range of groups in the Japanese community.

No single option is likely to be best for everyone, because what may be a beneficial aspect of one technology option for one sector of society may disadvantage another sector. Therefore, it is important not only for government and corporate technocrats but also for ordinary citizens in society to understand and respond to the development of technology. The consumers' point of view regarding different technological solutions is invaluable for the development and implementation of appropriate technology. This is particularly profound when the goal of the technology is to enhance aged care and, thus, likely to affect all individuals in Japan directly or indirectly.

Some key groups that will be affected by technology choices for aged care are recipients of that care, professional care-givers, family or volunteer care-givers, the government, business and technology researchers. For each technology option, we suggest here some plausible impacts on each of these groups.

Option 1 of relying on standard technologies for care of the elderly in Japan does not imply that aged-care technology will be stagnant. Technologies that develop in other countries will gradually be implemented in Japan, as they become standard. This option is unlikely to change the status of the elderly who receive care but, as the demand for care rises, there may be increasing burdens on family care providers. Some may be obliged to terminate paid employment to provide care. For professional care providers, there may be more opportunities for jobs and career prospects.

The Government will then be required to address the issues of a depleting labour force and increasing aged-care demands. The business sector may increase commercial opportunities in such areas as recruiting and training professional care-givers, or improving on existing technologies for aged care. Possible positive outcomes include increased economies of scale in existing technologies, more investment in improving aged-care facilities with current standard technologies, and more labour-saving devices in other sectors of the economy to compensate for the transfer of labour to care of the elderly. Researchers in technology for aged care may lose their jobs unless they are able to redirect their research to other areas or are able to focus on refining existing technology.

Option 2 of focusing on Japanese initiatives to develop high-level, sophisticated technology such as robotics provides opportunities for researchers to forge ahead in cutting-edge technology and may enhance their careers and elevate Japan's international research status. This option also provides opportunities for the business sector to develop big, profitable businesses and a new market that drives investment. Hence, the business sector will have a vested interest in this option.

The elderly themselves will experience varied consequences. On the one hand, robots may enhance independence but, on the other hand, this may lead to isolation. The cost of the apparatus will be relatively high and operating it may be complex, factors very relevant to the aged and their care-givers. Although robots may be helpful and ease the physical burden for the care-givers, their jobs may eventually be taken over by robots so that they become redundant. If they are to control the robots, new skills may be required and if they become machine minders, their status may diminish.

Moreover, if robots become the technology of choice for aged care, those who cannot afford the most sophisticated robots for their families may feel guilty. The Government may need to consider providing subsidies in such cases. It will also need to address the issues of regulations and liability for robots used in aged care.

Option 3 of endorsing the development of smaller, less costly technology such as the barrier-free technology may make daily life chores easier for both the aged and their care-givers. There is little impact of this option on the Government or the business sector, except that it provides opportunities to expand business prospects with relatively small capital and Government can provide practical assistance without a huge outlay. Researchers may find this option restricting unless one is an independent inventor or innovator. As this approach is user-driven, both the elderly and care-givers have the chance to have individual needs met.

Table 3 summarises our preliminary assessment of the main consequences of each of the three

Table 3: Summary of plausible impacts of technology options for age care in Japan on key groups

Group	Option 1: Internationally standard technology	Option 2: Robotics	Option 3: Barrier-free technology
Aged-care receivers	No change with the exception of possible improvements in human skills and empathy	Possibly enhance independence or increase isolation; complex adjustment to using robotics	Possibly enhance independence by improving daily life
Professional care-givers	More jobs and possibly greater career prospects	Possibly enhance task but may result in loss of job, may require new skills; may lose status	Possibly ease physical and mental burden
Family/ volunteer care-givers	No change but more may need to leave paid employment to care for aged family	As above, with extra possibility of guilt if unable to afford robots	As above
Government/public sector	Need to address increasing demand for care-givers	Need to address regulation, liability, subsidies issues	No major change but job opportunities benefit government
Business sector	Possible business; to train more care-givers; to invest in best existing facilities; develop economies of scale for existing technologies; create labour saving in other sectors	Possible business to expand; new market opportunities both domestically and internationally	Wide range of opportunities for relatively small capital
Researchers of technology	No new technology research; possible loss of position; require new research area or refine existing technology	Exciting cutting-edge technology research opportunities to raise research profile and status	Good opportunities for independent investors and innovators but restrict professional academic researchers

technology options for aged care discussed in this paper. This is intended merely to indicate some directions for a systematic investigation, to point to the potential value of examining impacts and to illustrate that options will have different impacts on different groups.

Conclusion

Each of the three technology options for aged care in Japan is a type of technological fix and each has ramifications for different sectors of the community. Examination of these different consequences suggests that all options are feasible, but each has characteristic merits and disadvantages and affects various sectors of the community differently. Therefore, we argue that it is important to have a practical framework by which technology for aged care can be examined in order to plan strategically towards a society for all ages, including the elderly.

By implementing technology to relieve the demand for care-givers, some of them can be redirected to other productive work. Alternatively, if technology can produce devices to increase productivity and/or assist aged people to care for other aged people, society will carry a lighter economic burden. The challenge is to incorporate technological practice that enhances quality of life ahead of efficiency *per se*. These are some issues to consider in trying to balance aged care and economic productivity that affect care-givers.

The Government recognises that it is in its interest to encourage independence in old age. However, to promote this trend, it faces the need for infrastructure and devices to assist the aged in everyday living when bodily and mental functions deteriorate. The Government is therefore interested in technology that provides some solutions to these needs and is playing a role in promoting aged-care technology. For instance, Government policy-makers hope to encourage elderly people to remain independent for as long as possible by offering various degrees of assistance in their own homes through Long Term Care Insurance (April 2000).

Industries and the business sector have a wide range of opportunities to expand their markets for aged-care goods and services as the proportion of the elderly continues to grow in Japan. Industries are likely to concentrate on promoting different types of goods and services depending on the option but there are ample business opportunities in all options.

Researchers view technology from a different angle than government and end-users. This does not imply that researchers and developers of technology do not strive for their end results to be effectively utilised. However, the long-term social consequences of new technologies are rarely foreseeable earlier in their development phase or even at their initial stages of implementation. Industrial researchers, in particular, are paid to concentrate on producing outcomes that enhance profits. For academic researchers, too, the social and economic relevance of their research may be important but such sentiments are sometimes secondary to their quest to produce cutting-edge research.

The treatment of three technology options for aged care developed in this paper offers a possible model for conceptualisation and assessment of technology options more generally. In many cases, various competing groups push for their favoured directions in technology development and use in a jumbled environment, offering no clear overall picture of alternatives and impacts. Spelling out a series of technology options, offered as ideal types, helps to clarify possible directions. The next step is to analyse each option systematically, for example, through explicating implicit values and investigating likely impacts. Such a process may result in new or modified options.

Because values are involved and different groups have differing interests, conceptualising and investigating technology options by itself cannot offer a solution to problems of technological choice. However, by clarifying possible directions and spelling out implications, discussions of technology options can make the decision-making process better informed.

Our selection of three particular technology options is specific to Japan. Elsewhere, technology options for care of the elderly might be the same or different, mainly depending on a country's technological and economic capacity. For example, countries without significant robotics research would not be able to undertake option 2. Poor countries might not be able to pursue even option 1, internationally standard technology, and instead have to rely on old or makeshift equipment — an option that is not considered in a country like Japan. On the other hand, option 3, barrier-free technology, could in principle be pursued just about anywhere, though the particular technologies introduced might depend on local social, technological and economic conditions.

Finally, it is important to recognise that some technological options may be ruled out by social values. In Japan, robotics for aged care is more viable because of a general receptivity to technological fixes. Thus, any country's technology policy can be analysed in terms of technology options, but determining actual options depends on a close examination of the specific conditions in that country.

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