

GLOBAL AGING & TECHNOLOGY POLICY:

EXTENDING THE VISION OF INNOVATION IN AGING SOCIETIES

Joseph F. Coughlin

Massachusetts Institute of Technology
Engineering Systems Division
AgeLab
Cambridge, Massachusetts USA
(coughlin@mit.edu)

Jasmin Lau

Massachusetts Institute of Technology
Engineering Systems Division
AgeLab &
Technology & Public Policy Program
Cambridge, Massachusetts USA
(jasmin@mit.edu)

Presented at the ***9th International Conference on Technology Policy and Innovation***, Santorini, Greece, June 21, 2006.

INTRODUCTION

Global aging is one of the 20th century's greatest success stories. Rapid economic development, advances in health care and triumphs in science and medicine have given us the gift of longevity. Yet as we celebrate our victories over the limitations of human life expectancy, we now come face to face with the challenges that longevity has placed before us.

Shrinking labor force participation, increasing strain on prevailing health care and social support systems and growing infrastructure demands threaten to undermine the sustainability of developed nations. Maintaining strong social networks becomes difficult, as the elderly often become financial and psychological burdens for their caregivers who need to care for their own children as well as their aging parents. For the individual, living longer can be both a blessing and a bane. Post-retirement years allow individuals to explore interests and dreams that have been put on hold, but the physical and cognitive decline that accompanies aging often dampens the optimism.

As competition in the global economy heightens, policymakers will be assuaged by a myriad of demands that compete for space on the policy agenda. Among these demands, the issue of population aging must be addressed with utmost priority, because it has profound impacts on the social, economic, and political wellbeing of a country.

Opportunity for Technology and Innovation

The aging of Europe's, Australia's and North America's post-war baby boomer generation signals the entrance of a new generation of seniors, healthier, more educated, and more financially independent than before. They also have a wide variety of interests and spend more money on communication technologies, electronics and leisure goods. According to Nikkei Marketing Journal, starting in 2007, total leisure spending by Baby Boomers or 'Dan Kai' generation in Japan is expected to increase to \$44 billion annually.

Technological innovations to accommodate the aging process have emerged since centuries ago, some of which have become ubiquitous today. One of the first technological innovations associated with aging was the eyeglasses. In 1289, Sandro di Popozo wrote in a Florentine manuscript:

I am so debilitated by age that without the glasses known as spectacles, I would no longer be able to read or write. These have recently been invented for the benefit of poor old people whose sight has become weak.¹

In 1595, King Phillip II of Spain had in his possession one of the earliest forms of a wheelchair – a rolling chair with movable arm and leg rests.² The early ancestor of today's hearing aid did not require engineering expertise or machining tools. Seashells

¹ <http://www.teagleoptometry.com/history.html>

² http://www.wheelchairnet.org/WCN_WCU/SlideLectures/Sawatzky/WC_history.html

and bulls' horns were used as simple ear trumpets, and these gradually evolved into the electrical hearing aids we see today, which were patented as early as 1892.³

Imaginative yet simple, these innovations were all developed in response to unmet needs of the aged. They extended the human capability beyond the limitations of aging and sparked off the notion that we can compensate for our physical decline by pursuing the benefits of technology. Since then, gadgets and devices have been developed with the same objectives, but with varying success.

On a national level, policy makers are beginning to look to technology as a strategy for transforming the liabilities of the demographic shift into competitive advantages. While nearly all observers agree that technology has an important role in helping individual countries meet these multiple and costly demands, few have defined a pathway to innovation. The urgency of the challenge makes it impossible for us to wait for creative inventors to chance upon groundbreaking innovations. Instead, conscious and organized efforts to address aging needs using innovative technologies and services are needed.

For some, technology is no longer being seen through the narrow lens of providing 'assistance' in activities of daily living, instead technology may improve the productivity of an aging population while providing a valuable basis for the development and export of products, services and expertise. One policy strategy to both support an aging population and achieve economic advantage is to incorporate "Technology & Aging" initiatives into national R&D policy or innovation strategies.

Successful innovations can move quickly from small national niche markets into a growing global market. Countries hoping to transform aging challenges into growth opportunities are looking at a market worth more than \$55 billion in 2004⁴, with expectations of exponential growth when developing countries reach their peak demographic shift in two decades. As innovative countries in Europe and Asia start to recognize these economic opportunities and begin to encourage domestic industries to respond to the age wave, international competition in "Technology for the Aging" will heat up and intensify in the near future.

³ <http://www.ccent.com/PHS/history.html>

⁴ The Economist: The World in 2004; pp 74-75

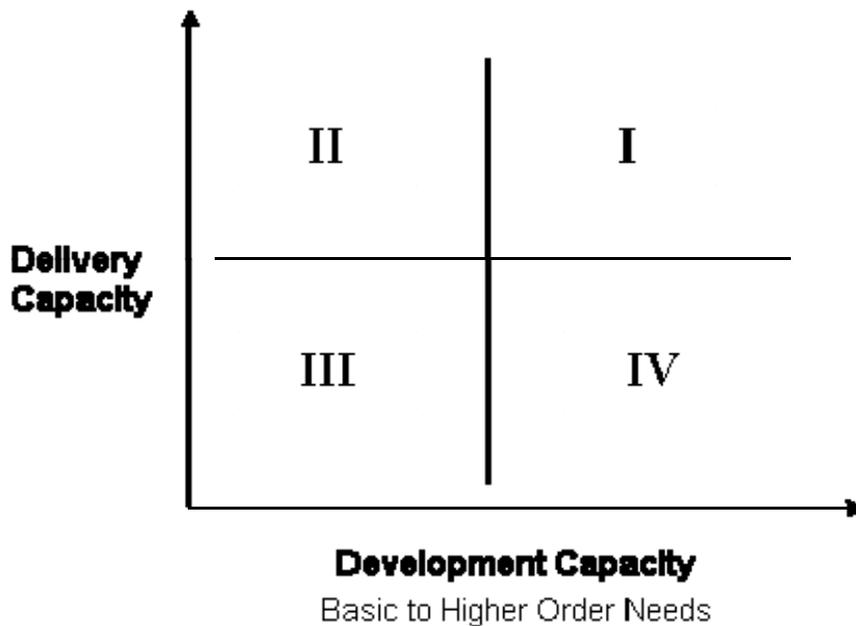
RESEARCH MOTIVATION

There is consensus that technology can help countries meet the challenges of aging, but to many policy makers the role that technology may play is unclear and there is little guidance on how best to capture the benefits of technology for the aging population. Current policy initiatives in nearly all industrialized economies are still in their nascent stages, and few countries have defined an overall strategy to leverage technology for aging. We believe that enhanced international policy awareness and comparative learning among developed nations will be valuable for meeting the challenges that are occurring on such a global scale. Moreover, the development of these innovations along with sustainable business and policy models may make their availability and affordability more likely in the developing world where aging is becoming a growing issue.

FRAMEWORK

We present a typology (Figure 1) to locate, map and compare the capacities of countries to develop and deliver technologies and innovations to their elderly population.

Figure 1. Delivery and Development capacities framework



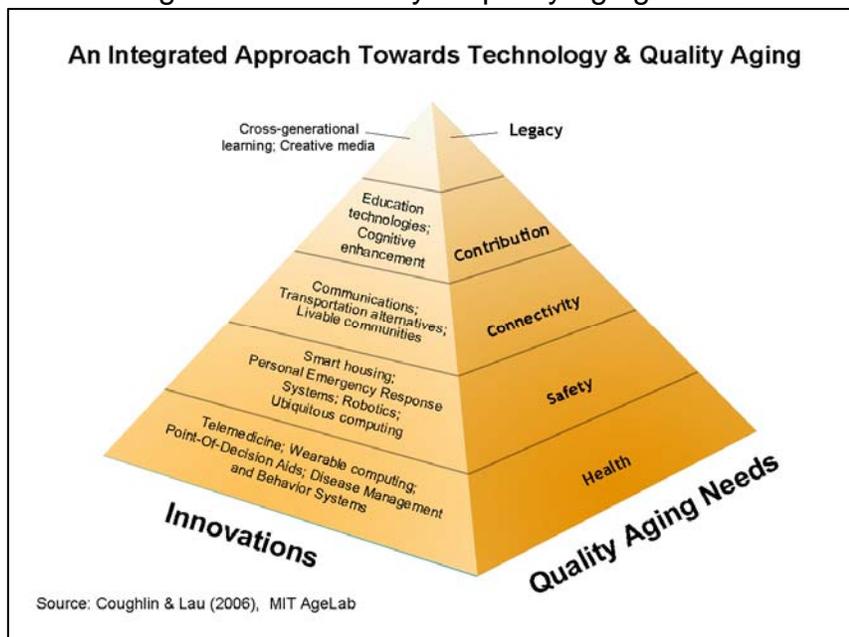
We define *delivery capacity* on the vertical axis as the *existence* of government agencies, industry stakeholders, senior citizen groups, non-profits and charitable organizations, that deliver aging services, innovations and technologies, as well as the *synergy and extent of collaborations* within the network to provide a range of business, health, social and transportation needs to the elderly and family caregivers.

We define *development capacity* on the horizontal axis as the capacity of government agencies, senior citizen groups or non-profit aging services organizations to develop or influence the development of novel technologies and applications in partnership with business and technology research communities along a hierarchy of quality aging needs. Abraham Maslow (Maslow 1943) contended that human needs can be represented in a hierarchy in terms of their potency. We adapt his hierarchical representation in Figure 2 below (Coughlin & Lau, 2006) to lay a foundation for identifying both the range of needs and the target opportunities for policy and market innovations. This approach enables us to examine and compare current national policy foci and highlight the existence of unmet quality aging needs.

Health – The base of the hierarchy represent the most basic health needs, including fundamental needs such as physical wellness, nutrition, shelter and clothing. The common association of old age with frailty and disability has resulted in innovations today being focused on health needs.

Safety – Also a fundamental need, safety is an important concern for older adults as well as their caregivers. From the Alzheimer’s disease patient at risk of wandering, to the older parent living alone, technology can be used to monitor the safety of elderly parents with Alzheimer’s or those living alone. However, the trade-off between privacy and dignity of the older adult with safety concerns must be addressed in a sensitive way.

Figure 2. A hierarchy of quality aging needs



Connectivity – Staying healthy and safe is insufficient for older adults. They also treasure connectivity to their families, friends and to society. Innovations in communications and transportation can enable them to age-in-place freely and independently while remaining socially connected.

The internet and email are beginning to become important tools for older adults to stay connected, and e-mail's success shows that technologies offering more than basic needs can be attractive to older people.

Contribution – The second highest need in the hierarchy is Contribution. Contribution needs reflect the desire of older adults to maintain or improve their self esteem and confidence. Both the *capacity* to contribute and the *means* to contribute are equally important. Technology can enhance a senior's confidence in his own mental and physical ability, and it can also improve cognitive function that is essential for an older adult to remain an active member of our family, community and society.

Legacy – Legacy is the capacity of the older person to use their personal talents developed over a lifetime. The apex of the needs hierarchy represents the older person's desire for means to construct one's legacy, to attain self fulfillment and realize one's full potential. Its elusiveness may attract the most interest from older people. Technologies that enable older adults to construct their legacies and transmit their experiences to future generations will improve the quality of life of older adults and enrich younger generations. (Coughlin & Lau, 2006)

In this framework, the five dimensions of quality aging needs do not exist in isolation. Although the fundamental needs of health and safety tend to draw more attention from policy makers and business leaders, higher needs of connectivity, contribution and legacy cannot be ignored. If inadequately addressed by public policy, baby boomers will translate these higher needs into the critical mass of a new passionate politics of unmet expectations (Coughlin, 1999). Business will find that as large as the health and safety market may be, the willingness of older adults and family members to spend disposable income on these three "higher" dimensions is immeasurable.

As shown in Figure 1, we then divide the typology into four quadrants to represent four sub categorizations of countries according to their relative development and delivery capacities. The four quadrants are characterized as:

- I High Delivery / High Development
- II High Delivery / Low Development
- III Low Delivery / Low Development
- IV Low Delivery / High Development

Locations along this four quadrant typology are not necessarily static, but they do show the potential policy strategies and directions available to decision makers. This framework is valuable to governments in assessing their current capacities to absorb and leverage new technologies. It also suggests possible policy directions that lay ahead and is instructive to businesses seeking to develop new products for aging markets.

METHODOLOGY

In this study, we examine the capacities of four industrialized economies to develop and deliver novel technologies and innovations to their aging populations. The four countries – Germany, United Kingdom, Switzerland and Japan, were chosen because they best typify the characteristics of each quadrant, and they are part of an ongoing multi nation study. Delivery capacity is characterized by the existence of government, private and voluntary sector organizations to access and deliver services to older people and caregivers. The existence of these groups is a necessary but not sufficient condition of delivery capacity. We also look for indications of collaboration in the provision of integrated services. Data collection was done through policy reports, literature reviews, industry reports & interviews. To evaluate the characteristics of each nation’s network, a template for information gathering was developed (Table 1). This allowed us to represent information on the different actors involved in the networks in a comprehensive and comparable format. We grouped participants in the networks into five main categories: Government, Senior Citizens Representation, Industry Stakeholders, Health Care and Aging Services Delivery and Human Capital Development.

Table 1. Country Information Template

	Delivery	Development
Government <ul style="list-style-type: none"> • Agencies • Plans 		
Senior Citizens Representation <ul style="list-style-type: none"> • Interest / Advocacy • Political Representation 		
Industry Stakeholders <ul style="list-style-type: none"> • Industry / Trade Associations • Technology & Aging Interest Groups • Major Private Companies 		
Health care and Aging Services Delivery System <ul style="list-style-type: none"> • Provision System • Financing System 		
Human Capital Development <ul style="list-style-type: none"> • Technology training for professional carers • Major Educational Institutions 		
** Visible Projects **		

Government – Governments in developed countries respond to the needs of the aging through existing health and welfare departments or by establishing specialized agencies, task forces and inter-agency collaborations. Strategic planning and goal setting efforts reflect national awareness and intention to address aging issues and may indicate active development of delivery capacity.

Governments influence development capacity through science and technology policies. Resource commitments, investment in education and

training, intellectual property protection, and R&D tax policies affect the overall innovative capacity of a nation. The launching of national programs or earmarking of funding streams to develop these innovative capacities provide incentives for R&D efforts and improve collaborations between public and private actors. Incorporating “Technology and Aging” initiatives into national innovation policies as a strategic focus can provide useful mental maps for research institutes, universities and private businesses. Government agencies established to implement technology policy help to foster policy awareness and provide a roadmap to guide technological development. As bridging institutions, they also help to coordinate collaborations in technological developments between private industry, academic and research institutes, and user groups.

Senior Citizens Representation – Senior Citizens Groups can facilitate the diffusion of technologies into the aging populations. Their effectiveness is enhanced by the legitimacy that they embody, which allows them to act as trusted advisors for their constituencies, providing a platform for adult children and older adults to gain access to useful technologies.

Senior Citizens Groups are united voices that represent the interests of the elderly in a country. They can articulate unmet aging needs and exert political influence to varying degrees. To the extent that unmet needs can be fulfilled by innovative technologies, senior citizen groups can enhance development capacity by pressuring national governments to promote “Technology & Aging” innovation strategies. These groups are valuable to industries and research institutes developing technologies for aging, as their direct interaction with the elderly and their caregivers can provide important consumer demand information. Financially endowed interest groups can also provide support for research initiatives to develop technologies for the aging.

Industry Stakeholders – In countries that tend to rely on free market provision of goods and services, private companies and industry associations often develop their own business models and delivery channels to advance the diffusion of their innovations. Industry interest groups or trade associations strengthen the industry’s potential to successfully penetrate the consumer market. As the scope of the “Technology for Aging” industry shifts away from disability aids and health based technologies, an industry association representing the evolving needs of industry participants may become necessary. Depending on the characteristics of the product or innovation, strategic partnerships between industry and traditional service delivery networks can facilitate the development and diffusion of new and beneficial technologies.

Best practices by individual companies can also help to guide emerging businesses. Successful businesses may establish delivery networks that can be leveraged upon by new entrants through mergers, acquisitions or alliances. This can reduce the perceived risk of a new industry sector and can also stimulate pooling and coordination of investments among participants. Needless to say, Industry interest and support in the form of funding and human capital investment is critical to the development capacity of the network.

Health Care & Aging Services Delivery System – The historical association of aging with frailty and illness is likely to lead to a natural adoption of the health care system as the main channel for delivering technologies to the elderly. Public systems may have a broader reach, but they are deeply rooted in national infrastructures and tend to undergo incremental changes. Private systems may be more responsive to environmental changes but less accessible to everyone.

The availability of delivery systems can influence industry interest and investment in the development of new technologies for the aging. The willingness of health care or social care providers to partner with technology developers can help to reduce barriers to market penetration, providing an added incentive for the private sector and research institutions to develop new technologies rapidly and thus enhancing the development capacity of the network.

Human Capital Development – How well the technology & aging network functions is dependent on the human resource capability within it. The “Technology for Aging” industry is a multi-sided platform market whose customers include service delivery professionals, caregivers and the elderly users themselves. Individuals involved in the delivery of technologies to the elderly, e.g. healthcare and social care professionals, need to be trained to use the technologies and to be able to teach the elderly how to use the technologies.

The investment in human capital development is just as important for the development capacity of the network. Engineers, scientists and technology developers need to gain a comprehensive understanding of the elderly consumer market profile, their needs and demands. Universal design and “design-for-all” concepts reflect growing efforts to understand and focus on the specific demands of the elderly.

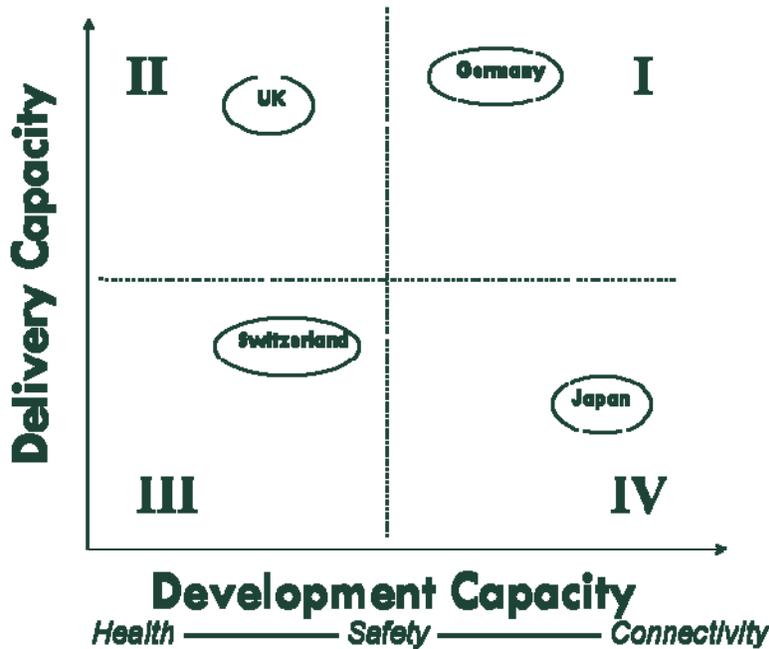
Identifying key academic institutions involved in the enrichment of human capital for both the delivery and development capacities of the network will give us an idea of the level of investment in human capital. Examining the relationships between academia and industry or government can also

provide information on the knowledge transfer from the academic setting into practical applications.

TECHNOLOGY & AGING IN 4 INDUSTRIALIZED COUNTRIES

A comprehensive survey of actors and relationships within the technology and aging ology networks in four developed economies enable us to present a static snapshot of the current development and delivery capacities of each nation’s aging and technology network. This static snapshot neither indicates how successful a country’s “aging policy” is, nor does it indicate the rate of growth of development or delivery capacity in each country. We discuss the general characteristics of the countries in each of the four quadrant of the framework.

Figure 2. Relative delivery and development capacities of four industrialized countries



Quadrant I: High Service / High Technology
Germany

Countries in the High Service / High Delivery quadrant have well aligned networks of providers, users and technology developers that engage in synergistic partnerships to develop and deliver a range of technologies that meet basic and somewhat higher-order individual needs. The needs of senior citizens are well articulated through senior citizen groups and responded to by both the public and the private sector.

BAGSO, the German National Association of Senior Citizens' Organizations, represents over 10 million senior citizens and comprise of 76 national associations. Major German political parties have special working groups for older people, such as the "60plus" of the Social Democratic Party and the Senioren-Union of the Christian Democratic Party, and Länder governments each have their own local senior councils. The Sentha interdisciplinary research project⁵ is an example of a project that focuses on older people in the development of household technology and appliances

Industry Associations focusing on technology for the aging population have also emerged. The Deutsche Gesellschaft für Gerontotechnik (German Society for Gerontology Technology and Equipment) and the Bundesfachverband Elektronische Hilfsmittel für Behinderte e.V. (a union of companies developing assistive technologies) in Germany coordinate industry and private sector efforts to further developments in the Technology & Aging Industry. Technology and Aging interest groups such as the Association for Gerontotechnik and the Center for Gerontotechnik in Iserloh generate greater awareness and also serve as platforms for the creation of collaborations between the private and public sector to develop and promote technology for the aging. The Association for Gerontotechnik also issues certificates for household products that are supposed to be suitable for elderly people.

National governments recognize the economic potential of the demographic shift. Germany's Federal Ministry of Family Affairs, Senior Citizens, Women and Youth (through its "Selbstbestimmt Wohnen im Alter" – Living self-determined even at high age program) promote actively the development of technologies for the elderly. Regional initiatives such as the North Rhine-Westphalia Senior Citizens Economy Initiative in Germany have also been developed to mobilize senior citizens' purchasing power and encourage economic and innovation activities.

Current technological developments include safety monitoring, smart houses, robotics and wearable computing. Germany's Intelligent House Duisburg Innovation Center - "inHaus" are among the current projects under development.

Quadrant II: High Service / Low Technology

United Kingdom

Countries in the High Service / Low Technology quadrant have well developed organizational capacity to access and deliver existing services to elderly. In the United Kingdom, senior citizen interests are addressed by government departments depending on the issues of concern. Departments include Health, Social Security, Labor and Housing. Significant planning and vision setting efforts, such as the "Extending Quality of Life for Older People" initiative (EQUAL) in 1993, the work undertaken by the Royal Commission on Long Term Care for the Elderly in 1998 and the Technology Foresight Exercise in 1999, have been taken by the UK government to address aging needs. The UK government

⁵ Sentha is an interdisciplinary research project funded by the German Science Foundation (Deutsche Forschungsgemeinschaft) (1997-2003). http://www.senhta.tu-berlin.de/index_e.html

provides public, universal health care systems funded by public taxation. Residential elderly care is also financed by national government, with some services provided by religious, charitable or for-profit providers. Policy strategies are focused on improving accessibility of home care and home help services. Service provision is significantly decentralized and local authorities are responsible for organizing and providing public welfare services.

Senior Citizen interests are represented by groups such as Age Concern, Help the Aged and the Association of Retired and Persons Over 50. These groups focus on helping the disadvantaged elderly and campaign mainly for issues such as pensions, mobility, health and elder abuse.

Development capacity in the UK is moderate and current technological trends are focused on assistive technologies such as mobility aids, telecare and home modifications. The Foundation for Assistive Technology (FAST) is a good platform for raising awareness about emerging technologies for disabled and older people, bringing together users, developers and manufacturers to build partnerships and coordinate collaborations within the assistive technology community. However, assistive technologies – devices typically used by the disabled to maintain and enhance their independence – tend to target only the health, safety and mobility needs of the elderly.

There is significant effort to develop the telecare industry. The government is aggressively developing telecare ubiquity, announcing in 2004 its plans to invest £80 million between 2004 and 2006 in a Preventative Technology Grant designed to develop Telecare services. Industry associations such as the Telecare Services Association (TSA), and the Social Alarm and Telecare Association (SATA) represent the interests of providers and users to government departments and statutory regulators and also support the development of open standards within the sector.

Quadrant III: Low Service / Low Technology Switzerland

Countries in the Low Service / Low Delivery quadrant have limited development and delivery networks to leverage technologies and innovations for their elderly populations. Residential elderly care is still a commonly sought after service for elderly care, although rising costs and limited capacities are creating concerns for these countries.

In Switzerland, the interests of the elderly are fairly well represented by senior citizen groups. The Pro Senectute is the biggest foundation representing and lobbying for elderly interests. It also provides services for the elderly in areas such as home care and education. The Schweizer Seniorenrat SSR (Swiss senior citizens council), the Schweizerischer Verband für Seniorenfragen (Swiss organization for senior citizens), and the Vereinigung aktiver Senioren- und Selbsthilfe-Organisationen der Schweiz (Association for active senior citizens and self-help organizations in Switzerland) are other groups that help to articulate the demands and needs of the elderly.

Development capacity in Switzerland is moderate. The Swiss Foundation for Rehabilitation Technology (Fondation Suisse pour les Téléthèses FST) is active in the development of assistive technologies, especially communications technologies and safety technologies within the home. In 2004, the Swiss announced the Commission for Technology and Innovation initiative 'Innovation for Successful Ageing' (CTI-ISA), designed to target R&D projects that lead to innovative solutions addressing the specific needs of older people. This initiative provides financial incentives for industry and academia to engage in collaborative or independent projects to develop innovations for the aging population. The Smart House project Futurelife – an inhabited intelligent house, and the Project Quo Vadis – an anti-wandering system are two examples of current technologies undergoing development in Switzerland.

Quadrant IV: Low Service / High Technology Japan

Countries in the Low Service / High Technology quadrant exhibit high levels of innovation activity in the private sector. Companies and businesses recognize the market potential of the aging population and are striving to meet the unmet aging needs through product innovations. However, delivery capacity is underdeveloped or fragmented. Elderly services are typically provided by the private sector, with some support from charitable organizations.

The introduction of the Long Term Care Insurance in 2000 reflects the Japanese government's interest in encouraging the elderly to remain independent, although a large part of the services it supports focus on home care or nursing care. Local governments bear responsibility for procuring and supplying technologies and services. The interests of senior citizens in Japan are represented by the Japan NGO Council on Aging (JANCA) as well as other organizations such as the Foundation of Social Development for Senior Citizens, the Japan Association of Retired Industrial Persons and the Japan Pensioners' Union. JANCA consists of about 50 organizations, including seniors' and retirees' associations, care provider organizations for the elderly, educational and recreational service providers, and research institutes on aging. It engages in activities ranging from planning symposia, to making recommendations on social security system reforms. However, its activities do not significantly emphasize the implementation of technology to address social participation, employment and health care issues.

National Industry development strategies also reflect efforts to reap rewards from the growing elderly market. The Tohoku Industrial Cluster Project – “Project to promote industries corresponding to Aging Society” in Japan is an example of a national effort to encourage private industry innovation in Aging Technologies and Services.

Visible projects in Japan reflect innovative vision and creativity that are beginning to address the higher order needs of the aging populations. The Robotics industry in Japan has responded actively to the demographic shift by developing innovations such as the Matsushita Electric – Robot Bear Companion and the Hybrid Assistive Limb (HAL) 5

Robotic Suit. Brain Age, a brain training video game developed by Japanese software maker Nintendo, has proved extremely popular with baby boomers who desire to have fun and remain cognitively fit through intellectual stimulation.

CONCLUSIONS AND FUTURE WORK

The use of the two-dimensional typology to represent the relative capacities of countries to develop and deliver technologies to their aging populations highlights the existence of two factors vital to the overall ability to leverage the benefits of technology for aging populations.

For national governments, understanding their current capacities relative to other countries creates an international policy awareness that can help them develop trade and sustainability policies tailored for technology and aging issues. Countries in the Low-Delivery / High-Development quadrant can consider exporting their technologies to countries in the High-Delivery / Low-Development quadrant, capitalizing on well established delivery networks that can speed up the adoption and diffusion of technologies into the market. Conversely, countries in the High-Delivery / Low-Development quadrant can still benefit from technology by importing technologies from countries in the Low-Delivery / High-Development to address and meet the needs of aged care. Such a strategy of choosing from available technologies rather than creating new technologies can lead to savings on R&D investment, which can be channeled to meeting other social needs. Chosen technologies for import can then be adapted and refined according to the unique characteristics of the elderly population in the home country.

This paper provides an exploratory examination of selected industrialized nations to assess their capacities to leverage technology in order to meet the growing and urgent demands of their aging populations. Future work will examine in greater detail the synergy between delivery and development capacities and will evaluate the relative capacities of an expanded set of industrialized countries.

REFERENCES

Maslow, Abraham, "A theory of human motivation," *Psychological Review*, 50, 1943, 370-396

Coughlin, Joseph F. and Jasmin Lau, *Cathedral Builders Wanted: Constructing a New Vision of Technology for Old Age*, Public Policy & Aging Report, Winter 2006, 4-8

Coughlin, J., (1999). Technology needs of aging boomers. *Issues in Science and Technology*, 16(1), pp.53-60.

Angelino, Henri and Collier, Nigel, Comparison of Innovation Policy and Transfer of Technology from Public Institutions in Japan, France, Germany and the United Kingdom, *NII Journal* No. 8 (2004)

Seniorwatch report, "Older People and Information Society Technology: A Comparative Analysis of the Current Situation in the European Union and of Future Trends", April 2002

Campbell, Andrea L. & Morgan, Kimberly, J., Federalism and the Politics of Old Age Care in Germany and the United States, *Comparative Political Studies*, Vol. 38 No. 8, October 2005

The Myer Foundation, 2020 A Vision for Aged Care in Australia, 2002

Department of Health, Older People and Disability Division, Building Telecare in England, Department of Health report, July 2005

The Economist: The World in 2004; pp 74-75

Webpages

http://www.wheelchairnet.org/WCN_WCU/SlideLectures/Sawatzky/WC_history.html

<http://www.ccent.com/PHS/history.html>

<http://www.teagleoptometry.com/history.html>

http://www.senhta.tu-berlin.de/index_e.html