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The Current Status and Future Role of Senior Scientists in Universities
— Effective Use of the Senior Generation of Researchers —

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1 Introduction

Japan's population has the world's longest life expectancy. Today, for example, 65 year-olds cannot be considered elderly, and many continue to be active[1]. "Senior" has many meanings, such as "elder", "experienced person", "superior", "retiree", and so forth. In this article, we use the term to refer to those in universities and companies who are close to or just past retirement age, and we refer to such researchers as "senior scientists". "Senior scientists", for the purposes of this article, specifically means those who have accumulated intellectual reserves and skills and are capable of actively utilizing them in scientific and technical research and development, rather than all researchers of that age.

2 Comparison of World Retirement Ages and Labor Force Populations

2-1 Comparison of labor force populations

As illustrated in Table 1, the standard retirement age in each developed country, including Japan, is the age at which payment of retirement benefits begins[2]. Even in the United States, where there is no national retirement age, each employer implements a similar policy. In virtually every country, because of increased longevity, the trend has been to raise the age at which retirement benefits begin; accordingly

Table 1 : Standard retirement ages and ages at which retirement benefits begin in Japan, USA, and major European countries

Country	Standard retirement age	Age at which retirement benefits begin
Japan	Age 60. In addition, employers are required to make an effort to retain workers until age 65. (Law for the Stabilization of Employment of the Aged)	Age 60 (special payment of old-age pension, males). Under a 1994 revision, it is being raised in stages, from 2001 through 2013, to age 65.
USA	No mandatory retirement age (Age Discrimination in Employment Act)	Age 65 (age 62 possible with reduced benefits). Under a 1983 revision, it is being raised in stages, from 2000 through 2027, to age 67.
UK	Age 65 (age 60 for most women at present). Laws guarantee that workers cannot be dismissed for age alone before retirement age or the age at which employees ordinarily retire.	Men aged 65, women aged 60. Under a 1994 revision, the age designated for women in labor agreements will be raised in stages to age 65 by 2020.
Germany	Age 65. This is generally designated by labor agreements.	Age 65 (age 60 possible with reduced benefits). There are some exceptions with early payments, but they are being phased out.
France	Age 60. This is generally designated by company rules.	Age 60. The age was lowered from 65 to 60 in fiscal 1983, in order to encourage early retirement by the elderly and secure employment for the young.

Source: Charts 4-7, reference[2]

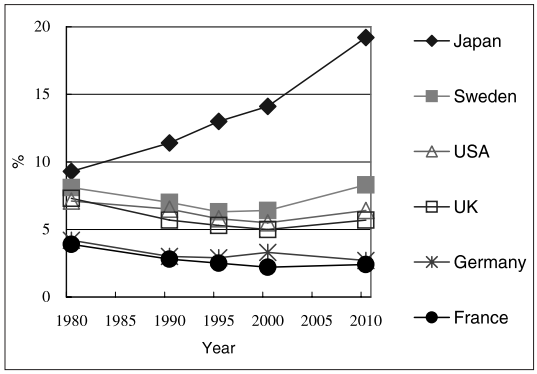
the retirement age has risen to 65 in most cases. France, alone among developed countries, has lowered its retirement age, from 65 to 60, in order to provide employment opportunities for younger workers.

In Japan as well, most companies are raising the retirement age in stages to 65 by 2013. Japan's solid employment system provided a guarantee of a stable living income. It made Japanese workplaces secure places to work and was a motivating power behind the nation's postwar recovery and development. As can be seen in Figure 1, the labor force population aged 60 and above is much larger in Japan than in other major developed countries[3, 4]. Along with demonstrating the diligence of the Japanese, this confirms the existence of a long-lived, vigorous labor force that has passed retirement age.

2-2 The year 2007 problem

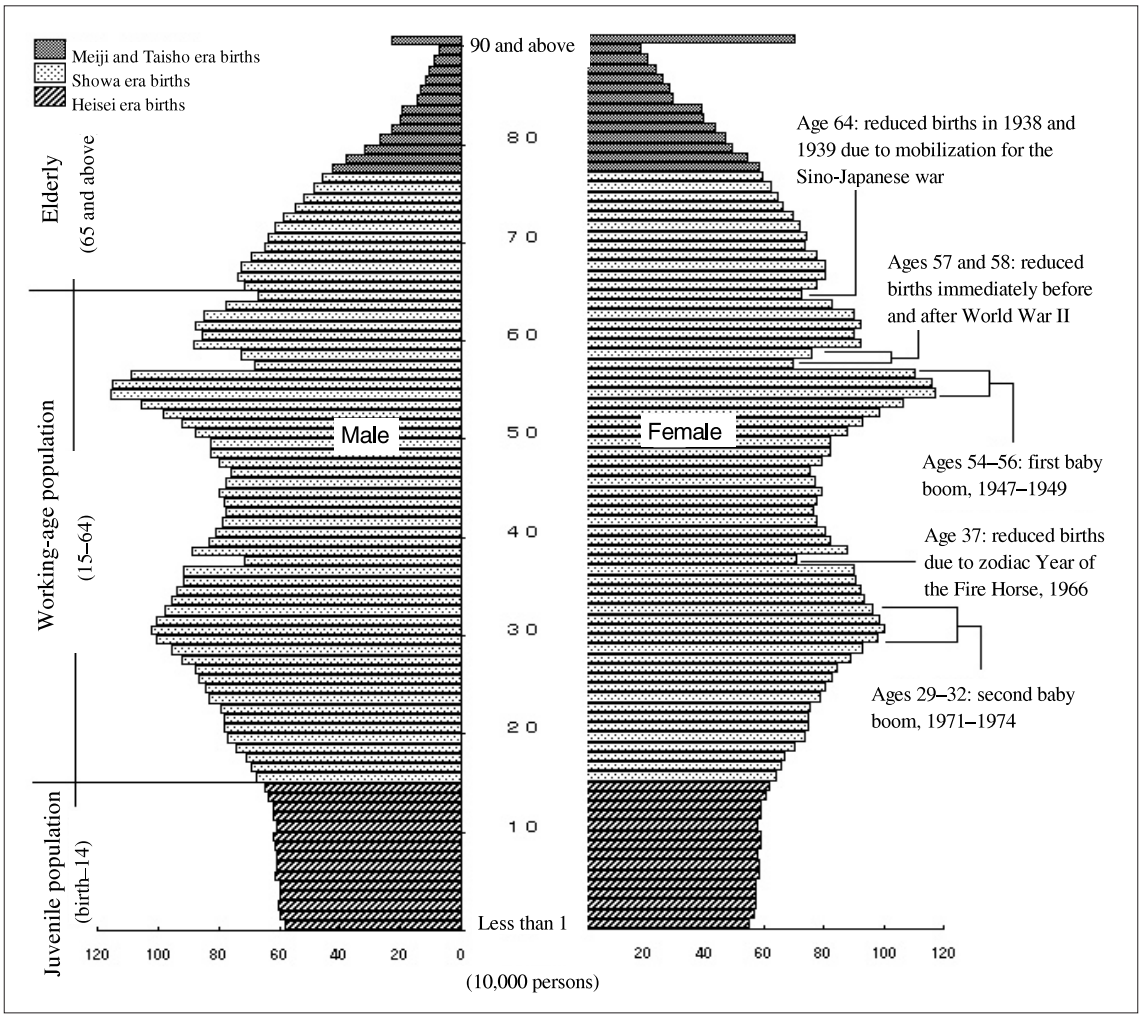
With an average lifespan of 82 years, Japanese enjoy the world's longest life expectancy. In addition, the birthrate has dropped all the way to 1.29, making Japan the country where the phenomenon of a low birthrate and a graying

Figure 1 : International comparison of labor force population (percentage age 60 and above)



Source: Prepared by STFC based on reference [3]

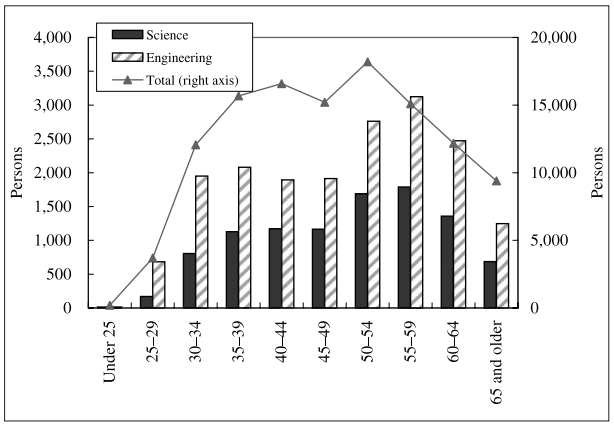
Figure 2 : Japan's population structure



Note: Population aged 90 and above cannot be calculated by year, so it is combined as "90 and above".

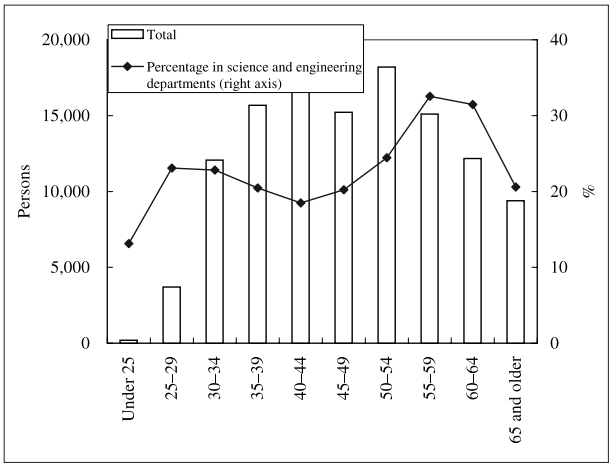
Source: Reference [5]

Figure 3 : Number and age distribution of faculty in university science and engineering departments in 2001



* Ages as of October 1, 2001

Figure 4 : Total university faculty and percentage in science and engineering departments



Source: Prepared by STFC based on reference [9]

society is advancing faster than anywhere else in the world. Japan's responses to its aging society are therefore being watched as precedents for the rest of the world. As can be seen in Figure 2, Japan's population structure forms an inverted pyramid[5]. This structure differs from those of other countries, and typifies a low birthrate and an aging population. The large population aged 54 to 56 in the chart is Japan's first baby boom, called "*dankai*" in Japanese. These baby boomers, Japan's dankai generation, are also identified as the "year 2007 problem" because this large demographic that is about to reach retirement age is rich in experience and expertise and remains vigorously active. The retirement of the dankai generation is being studied from numerous perspectives. The Policy Research Institute of the Ministry of Finance formed a study group in November 2003, and has published a report. According to that report, the retirement of a large number of people between 2007 and 2010 will have a major impact on Japan's economy, reducing the GDP by an estimated ¥16 trillion. The reasons given are increases in the pension burden and local welfare costs, a hollowing-out of technology, and unemployment due to managerial restructuring[6]. The dankai generation includes many of the people who have led Japan's economic and technical development, and many of those who are even older are still active on the front lines of their fields, even after retirement age[7, 8].

2-3 *Age distribution of university faculty in Japan*

The age distribution of university faculty in Japan, as seen in Figure 2, is quite similar to the population structure for the nation as a whole. Figure 3 and Figure 4 depict the age distribution of faculty in university science and engineering departments and the percentage of all faculty accounted for by science and engineering faculty in 2001[9]. The *dankai* generation in these charts falls into the 50-54 and 55-59 groups. Looking at the whole, this generation is large, making up a particularly high percentage in engineering departments. The mass compulsory retirement of the *dankai* generation will increase employment opportunities for young people, so the phenomenon is not without its positive aspects, but the knowledge and experience that have been amassed by the dankai generation are important intellectual resources for Japan, and they cannot be obtained by younger workers.

3 Conditions of senior scientists in universities

3-1 *Cases in Japanese universities and academic societies*

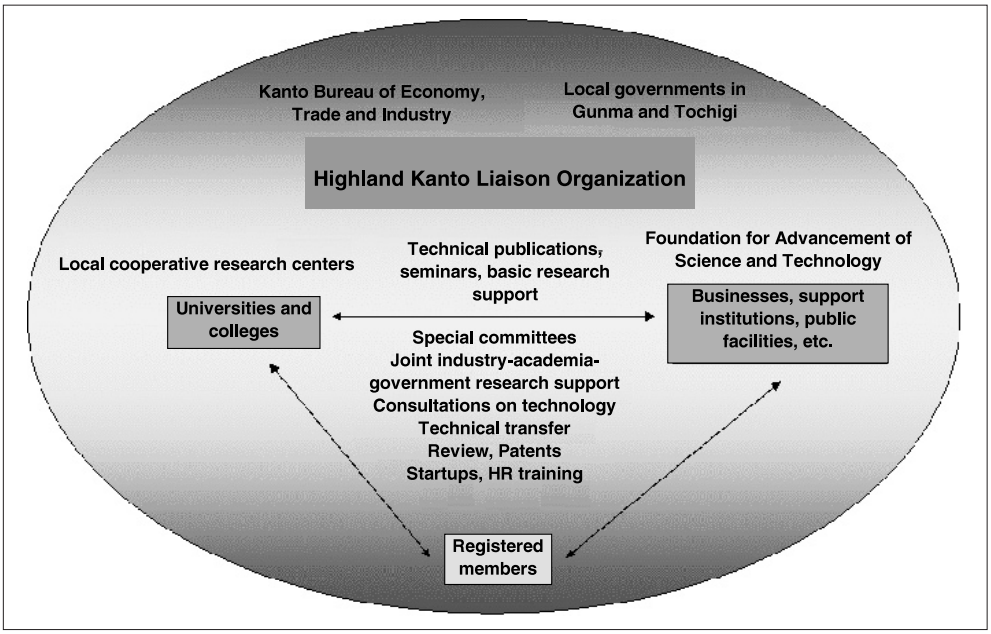
Until now, retirement age in Japanese universities has varied widely between private and national and other public universities. At the University of Tokyo and Tokyo Institute of Technology, the retirement age was 60, while

at other national and other public universities it ranges from 63 to 65. At many private universities, the retirement age was 65 to 70, while some set no maximum age, at all. However, with the age at which retirement benefits begin being raised in stages to 65, most universities are also shifting to a retirement age of 65. Some universities have systems under which faculty who have reached retirement age are released from managerial responsibilities and employed for fixed terms to provide lectures, and so forth. In such cases, they are positioned differently from ordinary adjunct faculty. The result has been that, after retirement, professors from national and other public universities would typically continue teaching and research as professors at private universities. However, the incidence of such cases is expected to decrease.

Recently, academic societies have also been taking note of the importance of the social contributions of senior scientists, and accordingly have been promoting various measures. For example, the Institute of Electrical Engineers of Japan registers the career data of longtime members with a high degree of technical ability and specialized expertise, recognizes them as "IEEJ Professionals" (provisional name) in their specialties or preferred fields, and provides "knowledge and experience distribution services" enabling those members to remain active as technical consultants, teachers, experiment leaders, and so forth. In a survey taken regarding the new service, about 70 percent of members responding were 50 or older, and members in that age group indicated that they were very interested in such intellectual service activities[10]. This shows that senior-age personnel also recognize the need to pass on their accumulated expertise and are actively interested in doing so.

The Highland Kanto Liaison Organization, an NPO established mainly by local university faculty, is a specified non-profit corporation with individual members from nearby prefectural universities, local businesses, universities, colleges, and research institutions, and supporting members such as local public entities. Including the introduction of senior engineers in their vision, they carry out activities in order to contribute to the development of industry and universities in the northern Kanto region. A complete overview of the organization is shown in Figure 5. The organization carries out such activities as registering people with many years of experience in universities and businesses as scientists or engineers, and referring them as coordinators to link university-generated technologies with markets, as researchers for small and medium enterprises needing technology, and so forth. Senior researchers are at the core of these activities[11]. It has not been

Figure 5: Diagram of the Highland Kanto Liaison Organization's program implementation



Source: Prepared by STFC based on Highland Kanto Liaison Organization website [11]

unusual for universities to welcome professors who have worked as corporate researchers or have other practical experience, and the practice has become widespread. Recently, there have been many cases of people leaving corporations for full-time university employment, but adjunct faculty members are common where education requires special techniques or experience. This shows the great need to bring practical experience into education[12].

3-2 Conditions in North America

The United States of America passed the Age Discrimination in Employment Act (ADEA) in 1969. It prohibits discrimination based on age, gender, etc., in the employment of those aged 40 and above. The NPO, American Association of Retired Persons (AARP), actively supports retirees. This organization is the world's largest NPO, with 35 million members aged 50 and older in the United States.

The perception of retirement in North America differs from that of Japan. For example, scientists who are able to obtain outside funding will not be forced out of their organizations and can continue their research. Accordingly, consciousness of outside funding is very different than it is in Japan. Professors and associate professors with good records in education and research during fixed employment terms receive the right to lifetime employment (tenure). Ordinarily, tenure is awarded through a strict evaluation process that includes the number of papers published, recommendations from full professors who work for outside of foreign countries' professors. Faculty who are unable to obtain tenure must change organizations. Moreover, those who cannot obtain funding mainly from outside sources are unable to conduct research. Because they are unable to hire graduate students and technicians to actually carry out their research, the scope of their research activities is narrowed. They also lack funds to travel in order to present their results. Furthermore, outside funding comprises part of university revenue for overheads, so universities try to lure outstanding professors with large grants away from each other. Salaries are paid in relation to classes, so many universities pay for only nine months of the year. Naturally, a portion of research grants can be allocated as the professor's own salary.

In Canada, there is one national university; all the rest are provincial institutions. All faculty members are civil servants and thus are paid for 12 months of the year. Under provincial government guidelines, retirement comes when the combination of age and years of employment reaches 80. "Retirement" means retirement from teaching, and because research may continue as long as funding can be obtained, it is not unusual for professors to take early retirement from teaching and specialize in research only. Indeed, there are many professors over 70 who maintain laboratories and work as active scientists. The percentage of overhead going to the university varies by the type of university, department, course, and funding, but in any event, outside funding stands next to tuition in importance as a revenue source. To help obtain outside funding, universities have research support departments that manage funds and support research. This is because younger scientists, in particular, may be skilled researchers but have yet to develop the ability to manage funds well, so the departments play a large supporting role as research promotion advisors. The existence of such organizations helps to vitalize research, and because they enable scientists to concentrate on research, many venture corporations have been established by veteran professors and scientists who have made discoveries that have commercial applications. In one example, a 70-year-old professor discovered and commercialized a new method of manufacturing isotopes using a nuclear reactor rather than an accelerator, as had been necessary in the past. Universities encourage such commercialization because, when a significant amount of that type of work is carried out within a university, its revenues increase through overhead payments. On the other hand, many such ventures go bankrupt, so greater management ability is needed from both research services and researchers[13, 14].

The high value placed on people in research and development and the systems for promoting energetic research activities, even by those over 60, are among the major reasons why North

America leads the world in technology.

3-3 Conditions in Europe

State universities predominate in Germany, and their faculty members are civil servants with lifetime appointments guaranteed until retirement age. As in other countries in Europe, the retirement age is generally 65. However, in 2002 the higher education system was revised and the position of professors was significantly altered. Particularly significant is the systemic shift of the linchpin of research to younger scientists. The revision established positions at universities for independent associate professors who specialize in research under fixed-term contracts, and eliminated the system of assistants who played a supporting role in research. One major point of the revision was to introduce competitive principles within universities to a greater degree than before. Under the old law, professors received only basic salaries. The revisions enabled them to receive both their basic salaries and merit pay commensurate with their outside funding. Adoption of the competitive principle of obtaining outside funding is a worldwide trend.

All universities in France are national, and all professors are national civil servants, so all employment of professors is based on open recruitment. The National Council of Universities creates a list of qualified candidates based on a strict examination of research leadership qualifications (academic degrees), work experience in the relevant fields, experience as a visiting professor, and so forth. Those registered on the list may respond to universities' public recruitment advertising and be selected by the universities for employment. Professors account for about 30 percent of faculty. There are no salary differences between universities, and employment is guaranteed until retirement at age 65. However, a system is in place to allow professors who are still rearing children to defer their retirement. There are three ranks for professors, with only those who have especially outstanding research results reaching the highest. Upon reaching retirement age, these academics attain the status of "professor emeritus". Professors emeritus may postpone their retirement. Universities recommend candidates for professor emeritus status, but receiving that honor from the national government is extremely rare. There are not many professors emeritus in France. Therefore, although some post-retirement researchers form venture companies and continue working, there are not many professors who actively continue their research. This situation is dependent on national policy in France, where the population structure is still pyramidal.

In Poland, the general retirement age is 65 for men and 60 for women in universities. There are two types of positions for professors. Professors of the upper rank can be appointed by presidential recommendation. These specially appointed professors receive special treatment in comparison with ordinary professors. As with other occupations, professors retire at age 60, but specially appointed professors have the right to retain their positions until age 65, and the national government guarantees their right to engage in education and research activities until age 70 if they so desire. Specially appointed professors who retire at 70 may also work on national committees if they are in good health.

3-4 Conditions in Taiwan

In Taiwan as well, the retirement age for civil servants and university faculty is 65. Professors may postpone retirement until age 70, but in that case they are subject to annual evaluation. The evaluations are based on research status, the securing of outside funding, and so forth. In the case of corporations, retirement age varies by 5 to 10 years. Currently, many retired engineers from Taiwan travel to developing countries such as Vietnam and Malaysia to make transnational contributions by providing technical advice. Retirees are considered appropriate for the work because they can provide technical guidance with technologies they have already mastered. Taiwan is expected to continue such exchanges, mainly in Southeast Asia, and is also aiming to train personnel for mainland China.

4 Relationships between universities and high schools

4-1 Corporate personnel and the educational world

Universities and businesses already have relationships based on education and job recruit, but with the recent conversion of national universities into independent corporations and the adoption of open recruiting, their collaboration has become stronger than in the past. Unlike university faculty, primary and secondary school teachers must hold teaching credentials. However, since 2000, principals without teaching credentials may be hired if they have the same or greater qualifications than other faculty members. The number of principals hired from the private sector has increased year-on-year, starting with 3 in Hiroshima and Tokyo in the first school year, 2000, climbing to 9 in 2001, and then rising annually to 23 (2002), 54 (2003), and 76 (2004). Because it is a new system, there are various problems on-site, but in many cases the positive effect on education has exceeded expectations. Many of the principals hired through this system were senior people in corporations, and their fresh leadership perspectives are definitely adding vitality to classrooms.

4-2 The relationship between high school coursework and university entrance exams

According to 2002 statistics, lectures and exchanges by university faculty at high schools were carried out in 1,291 institutions in 10 municipal and 45 prefectural school districts[15]. In fact, not only educational effects, but also new initiatives in education that Japanese universities have not been involved in, are needed. This is related to the government's high school curriculum guidelines and university entrance examination methods. The guidelines, which are revised about every 10 years, currently divide most subjects into two parts. For example, science courses are divided into "I" and "II" for general science, physics, chemistry, biology, and earth sciences. Because these courses are electives, many students graduate from high school without having covered them systematically. Moreover, because many high schools divide their students into science-oriented and literature-oriented curricula upon matriculation, it is difficult for students who switch partway through to cover these fields systematically.

Meanwhile, university entrance examination methods are diversifying and covering fewer subjects, so even some subjects that will be required within majors after entering university are not required in entrance exams. High school subjects such as mathematics and science are cumulative, and are the foundation for study in science and engineering fields, in particular. However, some students have not covered them sufficiently. Therefore, gaps appear in the educational levels of new university students, and basic academic ability must be developed in order for university education to proceed smoothly. This necessitates remedial education, either before or after admission, to bring new students to a level in basic subjects that will serve as a proper foundation. In fact, many universities have begun implementing such remedial courses, but when professors and other current faculty are placed in charge of such courses it can take time away from their research. However, remedial courses will be increasingly necessary for some time, in order to maintain and improve the educational level of universities.

5 Proposals

5-1 Activities in universities that suit the abilities and desires of senior scientists

Currently, almost all universities, and especially national universities, have age-based mandatory retirement systems. However, allowing those senior scientists with ability and the capacity to obtain outside funding to remain at their universities and continue their research, as is done in North America, is desirable even from the standpoint of their potential contribution to science and technology. Following his compulsory retirement, the genetic scientist Professor Yoshiaki Ito (formerly of Kyoto University) moved his entire laboratory, including

assistants and graduate students, to the National University of Singapore's Institute of Molecular and Cell Biology (IMCB), where he is actively engaged in research. As this example shows, deciding retirement by age without regard for results or abilities is a waste of the skills of researchers who could still work actively. Not only does it create a brain drain, it lowers the research ambitions of researchers on the verge of retirement age, and possibly harms the national interest[16]. An increasing number of universities are actually permitting specially appointed professors to postpone retirement, but this sort of system should also be based on a transparent evaluation process. Furthermore, although a growing number of university faculty positions are being filled through public recruitment, currently job offers invariably carry age restrictions. Employment should be offered through fair evaluations based on ability, giving senior scientists the chance to apply as well[17].

The variation in the academic levels of new university students is also seen as a problem. Unless both the government's high school curriculum guidelines and university entrance examinations are improved, the phenomenon of uneven academic foundations will continue, and could even worsen. Therefore, many universities offer remedial classes in order to maintain their educational levels, but covering such courses by assigning full-time faculty members increases the burden on them and may interfere with their research. With the introduction of assistant professorships*1 which enable younger university faculty members to continue to compete on the basis of their research results and take on a certain degree of educational responsibility, there is potential to reduce assistant professors' burdens by entrusting such supplemental course leadership to senior scientists who are rich in research and educational experience.

Furthermore, it is feared that with the retirement of those people who have been involved in postwar technology all the way from development to application, such technologies will not be passed on. In particular, classes in fields such as nuclear energy and electrical power are being eliminated due to their unpopularity with students, and the passing on of knowledge and experience in those fields remains a major concern. This problem reaches to the core of Japan's energy system. Senior researchers are key to passing on technologies in fields that have achieved a certain degree of maturity. Rather than forcing skilled researchers who have supported Japan's development, in name and fact, to retire solely on the basis of age, they should be put to effective use. As described above, systems that enable senior researchers to remain active in various ways are being created, but it cannot be denied that they are only a small part of the solution. The decrease in the number of researchers in mature fields such as nuclear energy and electric power is a problem. Now, while there are still active professors who can teach such classes, is the time to build networks for passing on such technologies. It is necessary to create venues where senior researchers from the dankai generation, who are facing retirement, can contribute to technical succession and future technical development. Incidentally, it is not only in Japan that heavy electrical fields are becoming unpopular; this is a worldwide trend. Poor in resources and having the world's longest life expectancy, Japan needs to focus urgently on equipping the nation for 20 or 30 years hence by making effective use of the accumulated intellectual resources of senior personnel[18].

5-2 Support by senior researchers for university education, and new contributions to industry

The gross domestic products (GDP) of countries are almost proportional to the rate of business startups in those countries, so improving the startup rate is an important policy for any country. Japan's startup rate ranks among the lowest in the world, but it was not always that way. After World War II, as Japan's industrial recovery surged, the startup rate was high, and so was the rate of economic growth. The likely reason for Japan having been able to maintain a high GDP, despite the low startup rate that followed the period of postwar industrial recovery, is the expansion of production systems for industrial products. However, in recent years production of goods such as automobiles and electronics products, which are the foundation

Table 2 : International comparison of ages at which engineers can work at the forefront of their fields (%)

	Under 30	30 - 34	35 - 39	40 - 44	45 - 49	50 and over	Age not relevant
Japan	2.2	17.1	29.7	30.6	4.7	0.5	14.6
USA	0.8	1.4	2.2	2.2	1.9	12.9	77.8
UK	1.7	1.7	6.2	5.4	5.4	7.4	72.3
Germany	1.0	0.8	4.4	5.2	7.0	8.8	71.8

Source: Prepared by STFC based on "US engineers and Japanese engineers: Engineer careers and skills development" by the Japan Productivity Center, and other materials.

of "monozukuri" (manufacture by skilled labor) and have supported Japanese industry, has been moving offshore, and the trend of annually increasing dependence on overseas production is expected to continue[19]. With their venues for activity in Japan being eliminated, there is concern that a technical brain drain of retired engineers moving to China to provide technical leadership will result.

Until recently, university scientists in Japan were evaluated solely on the number of research papers they published. As a result, many professors were enthusiastic about research but had little interest in joint research with corporations, obtaining patents, and so forth. However, with industry-academia collaboration flourishing in recent years, patents have also come to be part of researchers' performance evaluations. If research results can be linked to patents, that means the results will be applied. The obtaining of patents is another source of satisfaction for researchers, and also contributes to the development of science and technology. Corporations have long had patent departments, and, since the 1998 revision of the TLO Law, many universities have established departments to oversee intellectual property. The number of university-generated patents is increasing. On the other hand, some say that, even as evaluations and the need for research success are becoming stricter for faculty members, the time they have available for research is decreasing. Therefore, if post-retirement senior researchers can join technology licensing organizations (TLOs) and other organizations, to support active faculty members who are busy every day with teaching, research, and administrative duties, they can fulfill a management role for universities and outside bodies (corporations). Invigoration to prevent university systems from becoming conservative is also necessary, as is broad preparation of systems and venues to allow some type of free agent participation. And, regarding startups, the creation of publicly funded companies that carry out research in rented laboratory space, and other responsible but low-risk small enterprises, is one possibility. If senior researchers are able to utilize their experience and work as managers in such ways, bringing in younger scientists and working together should certainly bring about numerous mutual benefits. If they can apply for patents and start businesses without worrying about serious risk, senior researchers can effectively utilize their accumulated knowledge and open the way to new technical development. At present, the risks associated with startup failure in Japan are so high that it is difficult to start a new business. Supporting decreased risk in order to avoid stifling the impetus to start businesses would be a major contribution to scientific and technical research and development, and should light a fire under the progress of the next generation of Japanese science and technology.

In addition, JICA conducts a senior volunteer program for utilizing senior personnel, with most activity directed toward developing countries. In such ways, a step at a time, Japan is beginning to utilize its active senior personnel after retirement, and is beginning to recognize both their role and the results they are obtaining.

The results of a survey on the ages at which engineers can work at the forefront of their fields are shown in Table 2. Over 60 percent of those responding in Japan nominated ages between 35 and 44, but over 70 percent of those responding in the U.S. and Europe said that age is irrelevant. Furthermore, over 10 percent of those responding

in the U.S. nominated age 50 and over.

Creating systems to provide a full range of choices to all workers approaching retirement age should make an important contribution to addressing the issues arising out of a declining birthrate, a graying society, and decreasing interest in science.

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Glossary

*1 Assistant professor
This position is held by candidates who carry out education and research in pursuit of future professorships. An employment system comprising professors, associate professors, and assistant professors is expected to be adopted within a few years.

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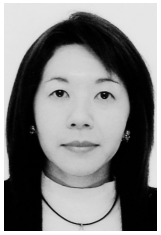

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Doctor of Engineering. She moved to her current position after pursuing research mainly on reduction of harmful substances such as pollutant gases, municipal waste, waste water etc. that impact the environment at universities in Canada and France, and industrial firms in Japan and US.

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Affiliated Fellow / Professor Emeritus at Musashi Institute of Technology
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