“Innovation 25”

~ Creating the Future, Challenging Unlimited Possibilities ~

Interim Report

(Unofficial Translation)

February 26, 2007

Innovation 25 Strategy Council

List of Member of the Innovation 25 Strategy Council

(Chair)	Kiyoshi Kurokawa	Special Advisor to the Cabinet on Science, Technology and Innovation
	Katsuhiko Eguchi	President of PHP Research Institute
	Tadashi Okamura	Vice Chair of Nippon Keidanren (Chairman of the Board, Toshiba Corporation)
	Ichiro Kanazawa	President of the Science Council of Japan (President, National Center of Neurology and Psychiatry)
	Ken Sakamura	Professor, Graduate School of Interdisciplinary Information Studies, University of Tokyo
	Chiyono Terada	Vice Chair of Kansai Economic Federation (President of Art Corporation)
	Taizo Yakushiji	Member of Council for Science and Technology Policy (Adjunct Professor, Keio University)

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Introduction

Function of the “Interim Report”

Ms. Sanae Takaichi
Minister of State for Innovation

[Instruction given by Prime Minister Abe concerning formulation of “Innovation 25”]

I was appointed to the post of Minister of State for Innovation, a position that was created by the Abe Cabinet (inauguration: September 26, 2006).
Three days after the formation of the cabinet, Prime Minister Abe gave the following directives.

(1) To reach a conclusion by around May to July of next year about the formulation of a long-term strategy guideline for Japan for the period up to 2025, called “Innovation 25,” in areas such as medicine, engineering and information engineering, and with the aim of creating innovation that would drive growth and contribute to development in Japanese society

(2) First, to gather the wisdom of experts in academia and industry about the “image of innovation that Japan should aim for by 2025” and to compile their thoughts and ideas into a report by around February of next year

(3) Based on this interim report, to compile a strategic policy roadmap to realize the “image of innovation that Japan should aim for by 2025,” with the help of the Council for Science and Technology Policy, etc.

Prime Minister Abe specifically stated, “What I mean by ***Innovation*** is something that goes far beyond technological renovation. It means to widely spread groundbreaking and revolutionary achievements to social systems and people’s lives through completely new social systems, including new ideas, new frameworks and business plans. So, please stick to this principle.” He also mentioned that it was not desirable to have a society in which people overly indulged in technology, losing the clarity of simplicity in lifestyles and ways of thinking.

[Process of Compilation of Interim Report]

On October 3, Prime Minister Abe appointed Kiyoshi Kurokawa, the former President of the Science Council of Japan, as Special Advisor to the Cabinet, thus leading to full-fledged cooperation from Dr. Kurokawa, who has abundant scientific knowledge and information on scientific trends.
On October 5, the "Innovation 25 Special Mission" and its full-time staff were set up within the Cabinet Office, and members of an "Innovation 25 Strategy Council" were being selected for the formulation of "Innovation 25."
The Innovation 25 Strategy Council, chaired by the Special Advisor to the Cabinet Kurokawa, comprises seven intellectuals from academia and industry.
Mr. Mitarai Fujio, head of Nippon Keidanren, was asked to provide information and advice on innovation and to act as an advisor to me on an as-needed basis.
On October 26, the first meeting of the Innovation 25 Strategy Council was held at the prime minister's office, with Prime Minister Abe in attendance.
Following that, the Strategy Council members met eight times altogether and had heated discussions before the submission of the Interim Report of today.
At the Strategy Council meetings, we had presentations from intellectuals other than those from each council member. Such presenters are Toshiaki Ikoma (Director General, Center for Research and Development Strategy, Japan Science and Technology Agency), Kazuhito Hashimoto (Director, Research Center for Advanced Science and Technology, The University of Tokyo), Ikujiro Nonaka (Professor Emeritus, Hitotsubashi University), Koichi Kitazawa (Vice Chairperson, Committee for the Investigation of Innovation Promotion, Science Council of Japan), and Minoru Kuniya (Director-General, National Institute of Science and Technology Policy).
In addition, works were carried out at the Special Mission while experts from home and abroad were sharing advice.

On October 27, a section for public opinions was opened on the website of the Innovation 25 of the Cabinet Office. The section closed on December 31, and many people have presented valuable ideas
Suggestions from the people were submitted to the fifth Strategy Council Meeting, which was held in January 16, and have been reflected in various parts of the Interim Report.

Many organizations associated with science and technology have also accomplished considerable cooperation.

On October 2, I asked the Science Council of Japan, the prominent community of scientists in Japan, to support the formulation of Innovation 25.
On October 30, the Committee for the Investigation of Innovation Promotion was set up within the Science Council of Japan (SCJ), comprising 20 members, with Ichiro Kanazawa, a member of the Strategy Council, as its Chairperson and Koich Kitazawa as its Vice Chairperson, and conducted various discussions.
Furthermore, the Committee called for 2,200 members and associate members of the registered academic societies by SCJ to formulate recommendation reports on the innovations to promote.
On January 25, 2007, Chairperson Kanazawa and Vice Chairperson Kitazawa presented to me the "Future Society as Envisioned by the Science Community" with the gift of wisdom of scientists of Japan. Recommendations listed in this report have greatly contributed to formulation of the Interim Report.
Because I believe that technological forecasts compiled by the Japanese government in the past and the results of discussions on the technological revolution/system reform to be promoted should be fully utilized, I conducted hearings from various ministries at the Minister's office on an as-needed basis.
Proactive support was gained from the Central IT Unit of the Cabinet Office, Ministry of Internal Affairs and Communications, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Health, Labor and Welfare, Ministry of Agriculture, Forestry and Fishery, Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure, Transport and Tourism, and Ministry of Environment.

Section 1 of "IV. Japan in 2025 Explored by Innovation" in the Interim Report lists 20 demonstrative cases of changes in daily life so that people can get a clearer image of Japan in the future, which can be realized through technological revolutions and reforms of social systems.
Future technologies introduced in these examples use the results of the Technology Foresight Survey conducted by the National Institute of Science and Technology Policy of the Ministry of Education, Culture, Sports, Science and Technology, in addition to the above-mentioned report of the SCJ. A total of 2,500 experts participated in this survey, and the Delphi method is used to present the time of technical realization and the time of social adaption. Efforts were made to provide as much technological evidence as possible that can be foreseeable with the scientific knowledge of today.

As described above, we have come to the point where we can present the Interim Report, which is the first step of the formulation of the Innovation 25, with great support from various

organizations, scientists and, of course, from the general public.
I would like to express my sincere gratitude to everyone who kindly offered their cooperation with this task.

[Future Schedule]

This Interim Report presents the “image of the innovation society for which Japan should aim by 2025.”
In particular, the “image of society that we aim to create in 2025” is presented in IV-2; basic strategies to achieve this goal are listed in V; and demonstrative policy issues to be addressed urgently are presented in VI.

We will start working on the final report of Innovation 25 tomorrow, hopefully to finalize the report by the end of May, specifically, a “strategic policy roadmap to realize innovation.”

The instruction given by the Prime Minister is to develop a “strategic policy roadmap.”
Upon scrutinizing more specific “policies (strategies/tactics) to be realized,” we need to formulate a plan that can present “tactics (strategies) for policy management, overlooking all directions” in order to realize the Japan that we desire.

Once formulated, Innovation 25 will be submitted to the Economic Advisory Council so that it can be incorporated in the Basic Policies of 2007.
Next year will be considered the “first year toward 2025.” We will energetically set about various measures, such as budget formulation, tax reform and legal system reform to improve social systems, etc.

Innovation 25 requires periodic follow-ups and reviews before realization of all the items. Science and technology are making rapid progress and, in the future, we may need to revise the roadmap due to changes in the international environment that surrounds Japan.
It is necessary to establish a cross-ministerial PDCA (Plan→ Do→ Check→ Action) Cycle. This is an issue that we need to address after the summer.

[My thoughts～The Standpoint of Citizens/Taxpayers]

When I received the directive for "Innovation 25" from Prime Minister Abe, the first thing that came to mind was that I would like to address science and technology policies from the

standpoint of the citizens and taxpayers of Japan.

The national budgets allocated to science and technology measures in FY 2006 was 3 trillion 719.4 billion yen. The public's investment in research and development amounts to 12 trillion 745.8 billion yen (FY 2005).
Although we are not aware of it, our lives in Japan today benefit greatly from discoveries and ideas emanating at each stage, from basic research to technology and development.

It is easy to see this if we compare life today with life 20 years ago.
Back then, I had no mobile phone or personal computer at home. Today, when I send an e-mail in the evening, I receive a reply the next morning. Back then, I used expensive international phone calls or the post. I listened to music on records or cassette tapes, not CDs. Videotapes were used to record pictures instead of DVD or HDD. I used to struggle to find a location with a roadmap in my hand because my car was not equipped with a navigation system.
The service industry has progressed while utilizing the outcomes of the technological revolution. You get a parcel the next day using a home-delivery service, and a parcel-tracking service is available on the Internet. If you are not home when a parcel arrives, you can call the driver directly on his/her mobile phone to ask for a re-delivery. A taxi arrives to you faster than ever if the taxi company uses GIS (Geographic Information System) or GPS (Global Positioning System using satellite). Various services associated with moving homes are available 24 hours a day on the Internet, such as cost estimation, collection of disposed articles, and procedures required when moving.
Our lives have become drastically more convenient and richer in these 20 years.
These changes are the results of efforts of manufactures that have persevered time and costs required during the period from R&D to commercialization and efforts of the service industry, which has continued to improve services using new technologies.
In addition, these changes are also the result of the government's science and technology policies, which had been supported by "taxpayers," giving back to the people.

This is why I believe that efforts toward the technological revolution and social system reforms that the government intends to achieve in the next 20 years should be based on the "dreams and desperate hopes" of citizens and taxpayers.

Today's Japan is more filled with material goods when compared with the past. At the same time, we are faced with many uncertainties: deterioration of the global environment, threats of expansion of terrorism or infectious disease in the borderless world, the emergence of new

crimes abusing new technologies and rapidly declining birthrates, etc.
I contemplated what Japanese people of today wish for.
For example, “to stay healthy and enjoy a long life,” “to lead a safe and secure life,” “to have a fulfilling work and home life,” “to be fairly rewarded,” “to have secure welfare systems backed by a strong Japanese economy and not to worry about retirement,” “not to feel handicapped because of age, disability or gender,” “to be proud of being Japanese,” “to live surrounded by peaceful and kind people,” and so on.
Although there must be many more wishes, these are the messages I gathered from the people who posted their opinions on the website of Innovation 25 of the Cabinet Office.
If the technological revolution and social system reforms are to facilitate the realization of Japan that citizens/taxpayers envision, the government must launch the challenge immediately.

[Fight, Japan! A Future to Achieve Together]

“Innovation 25” is not a “dream vision” in a distant future, nor is it a mere “prediction of the future.” It is “Japan’s future to be created” in a cooperation between the people and the government, in nearly 20 years from this summer (the time when the roadmap is scheduled to be complete).
With this spirit in mind, I am passionate about taking the next step with members of the Strategy Council, including Chairperson Kurokawa, and staff members of the Special Mission.

Finally, I would like to mention one more point.
I have received encouraging words from many people, such as “please show us ideas that eliminate the sense of stagnation,” and I have exerted all my efforts to draw an ideal image of the future in the Interim Report.
However, I personally expect the road ahead to be rough and challenging.

Naturally, various issues that face today’s Japan will not vanish like dreams simply by the power of science and technology.
An elderly man committed suicide after killing his sick wife because of economic difficulty or the burden he faced in caring for his wife. Whenever I hear sad news like this, it reinforces my determination. Even if multifunctional caring devices are developed and family support systems are improved in the future, the unfortunate and less privileged will be left unnoticed in society, as long as there is no social framework to bring the benefit of technology and systems to individuals in need and as long as an awareness of mutual support is not created within the community.

That is why Prime Minister Abe did not interpret “technological revolution” narrowly, but insisted on establishing a system to return the benefit back to the people by combining technology with “social system reforms.” At the Strategy Council, we also conducted a series of discussions based on the principle that we should not avert our eyes from the urgent issues that need to be seriously addressed by the government.

Various difficulties are foreseeable in gaining the consensus of the people on the idea of “changing the system of the country so that strong innovations can emerge.”
On the one hand, Technology Innovation contributes to the improvement of productivity and convenience, but on the other hand, there is a dark side. For example, a wearable personal computer could reduce risks involving elderly people and children while they are away from home and could create a cashless society; however, it is important to gain a consensus as to how to deal with personal data and to overcome concerns about online crimes.
Also, human resources underpin innovations and we won’t be able to survive fierce competition unless we create, as Chairperson Kurokawa says, “a society that cultivates the nail sticking up (or unusual talents).”
However, the traditional Japanese society has been described by such expressions as a “jealous culture,” “excessive equality” or “Yokonarabi (following the herd).” In past discussions on educational reforms, the introduction of “performance-based classes” or a “grade-skipping system” was strongly opposed.
For a new challenge that might require a “grand transformation of values of the Japanese,” the government should strive to share the future vision of Japan to be achieved with the people, by raising issues to the people with courage and determination, and without being afraid of getting hurt. Plain and simply, the government cannot proceed with measures unless it has the understanding or support of the taxpayers.

Before reading the text of the Interim Report, please take a look at a day in the life of the Inobe (coined from the word “innovation”) family, and see how their lives in the year 2025 benefit from innovations.

A Day in the Life of the Inobe Family

"A Day in the Life of the Inobe Family" is a story depicting a family scene about 20 years from today, based on "IV. Japan in 2025 Explored by Innovation" (p. 37–p. 50).

(Family Members)
Grandfather: Ichiro (age 77)
Former CEO of a small/medium sized company. He transferred his position to a young employee with a PhD in engineering ten years ago. He then took a course in nanotechnology for a year at a local university. He now spends about 15 hours per week teaching classes at local primary, junior- and senior-high schools and a university (freshmen class), using his skills in manufacturing and knowledge on the changes in science and technology.

Grandmother: Masako (age 74)
She had helped with accounting work at her husband's company since they were married. After her husband retired, she has been actively involved in a volunteer group led by young people, which holds various events in the local community, while enjoying flower arrangement as a hobby.

Father: Naoyuki (age 50)
After graduated from a university, he once worked for a major company but quit the company 20 years ago to utilize his research background and established a venture company with friends whom he met on the Internet. Due to a problem associated with product development strategies, the venture business failed in three years. He was then able to set up a new venture thanks to fund providers and his efforts to utilize lessons learned from past failure. The company is rapidly growing.

Mother: Yumiko (age 51)
She married Naoyuki 25 years ago when she was working for an interior design company. She gave birth to her son, Daiki three years later and her daughter, Misaki, eight years later. She has been working throughout the entire marriage, using support systems for childbirth and childrearing and through telework.

First son: Daiki (age 22)

A senior at a university. Considering whether to go to grad school.

Daughter: Misaki (age 17)
Studying at a high school in Beijing as an exchange student since last year

Second son?: INOBEE (age 5): a Robot (2^{nd} generation)
Size of a primary school child. He is intelligent and is connected to the home network and local network. He has good conversational skills, too. Father Naoyuki named him INOBEE, deriving from the word "innovation."

(February 5, 2025)

06:30 ·

Ichiro and Masako get up.

Then, they check "Tokay's Health Condition" on the 26-inch display (it looks like a flat-screen desktop monitor from twenty years earlier) installed in their room. With this device, you can have a simple health check on physical conditions at home, including sleep conditions. Following various data, the message "You are healthy today" appears on the screen.

Since the computer contains genetic information, when a person gets sick and needs medication, it gives instructions on suitable drugs at the initial stage. Well, that gives them peace of mind. Thanks to this system, they don't need to see the doctor very often. Nonetheless, if the symptoms are severe or they need to see the doctor, the computer network connects them with a specialist who will give a diagnosis.

Since the data of doctors and those of homes are connected, the diagnosis is quite accurate and reliable.

07:00 ·

Naoyuki, Yumiko and Daiki are also up. Everyone in the family gathers in the dining room and has a pleasant morning time.

A large-size display (103 inch) is on the wall. With divided screens and headphones, each can enjoy different programs (TV, Internet, etc.). Today, they are having a pleasant chat while watching a TV program on Beijing, where Misaki is studying.

08:00 ·

Naoyuki leaves home for work.

He goes to his office using bus and train. Due to the penetration of telework and flextime arrangements (this is what it was called twenty years ago), fewer people commute to offices and it is easy to find an empty seat on busses and trains. Half of the employees at Naoyuki's company work at home. It is said that 30% of the employees of the company Naoyuki used to work for are teleworkers.

Naoyuki reads the news on a flexible display on his mobile phone like people in the old days used to read magazines, thinking "I cannot imagine the horrendous commutes back in old days."

The news is about the intensive rainfall in the Kyushu region. It appears that floods and mudslides have occurred. However, residents had ample time to evacuate and no one was killed thanks to the sensor network covering the hazardous zones and emergency information systems for residents. It is reported that structures built within the past 10 years have not collapsed.

The house of the Inobe family was built using long-life housing technology and they say that it will last for 200 years. It is resilient to natural disasters such as earthquakes. The house withstood an intensity 7 earthquake in the resistance test.

When an earthquake happens, the quake is detected automatically and a system is activated to prevent secondary disasters by connecting various infrastructures and home appliances, which gives peace of mind.

The bus is a battery-charging electric vehicle. All the public transportation busses are either this or a fuel-cell vehicle.

A vehicle using CO_2 as an energy source was recently developed by using artificial photosynthesis technology.

There is no congestion on the roads. Although not fully developed nationwide, the Intelligent Transportation System (ITS) has been developed for Naoyuki's commuting route, and no traffic accidents have been recorded three years in a row.

09:00 ·

Grandfather Ichiro goes to work by electric bicycle.

The improvement of functions of electric bicycles due to advancement of

battery technology and development of bicycle lanes has made commuting by bicycle very popular. The secret to the popularity is that bicycles are environmentally friendly and good for health.

Ichiro says to himself on the way to work, “The amount of gas emissions has greatly declined and we see more greenery along the roads compared to 20 years ago. So, I enjoy cycling so much that I almost forget that I am commuting.” A person of Ichiro’s age can easily commute within 10km from home.

Due to advancement of information and networking between automobiles and roads, automatic collision-avoidance systems and automatic driving systems have spread, and it is quite safe to ride on a bicycle.

The advancement of battery technology has realized the dissemination of electric vehicles and various types of new mobile phones. Japan has the world’s leading technologies in this area, providing many products and services to the world.

10:00･･

Ichiro is teaching “manufacturing” at a local high school.

He teaches the value of “manufacturing” in Japan using a virtual reality device as teaching material, and brings students to experience the value of it. Maybe because young people today have become used to this type of class since they were in primary school, he finds it rewarding that the students are delighted to listen to his lectures.

The level of difficulty is different, but he gives the same type of lecture to primary and junior-high schools. Numerous active researchers and engineers of various companies ranging from large companies to small- and medium-sized companies also teach at schools, and Ichiro is the oldest among them.

According to statistics, approximately 20% of the Ichiro’s generation are still actively working, in different occupations and in different forms.

12:30 ･･

Daiki is having lunch with his friends at a campus cafeteria.

Among 10 of his friends, three are Japanese and the rest are international students from Europe, the United States, Asia, Central and South America, the Middle East and Africa. Half of the faculty and students of his university

(including graduate school) are from abroad.

A popular academic field among foreign students is environmental education. In many cases, they return to their home countries and contribute to the realization of an environment-oriented economy, utilizing knowledge learned in Japan.

Today's topic is Daiki's plan to study abroad. Daiki studied in the United States while in high school and he is now undecided about where he should go to grad school. His three options are Japan, the United States and China.

14:00 ·

Grandmother Masako is at a flower arrangement class.

It takes about 30 minutes on foot to get to the class, but she always goes on foot, thinking it is a good opportunity to take a walk.

She puts a wearable computer on her wrist. Because of this, even an elderly person can safely go anywhere. In a complicated urban area, a sensor buried on the road tells a car driver the position of a pedestrian. In case someone suddenly faints, an alarm goes off automatically through an emergency medical network.

Masako was diagnosed with Alzheimer's disease 10 years ago. But unlike the old times, early detection is now possible. Medical technology has advanced to slow the progress of the disease, and drugs for Alzheimer's suitable for individuals without side effects have been developed. Thus, she can lead a healthy life.

It is reported that commercialization of a drug that cures Alzheimer's disease completely is in sight, which was jointly studied between a university-initiated venture company and a major pharmaceutical company. Masako thinks it would be great not only for her but also for all people in the world if the drug became available on the market.

Come to think of it, Fumiko, one of her friends at the flower arrangement class, was diagnosed with a cancer five years ago but now she is completely healed by taking drugs and without surgery because it was detected early.

The wearable computer is also connected to the emergency crime-prevention network. There was an incident several days ago in which a suspicious individual tried to snatch a primary school child in the neighborhood. But before the police arrived, the offender was overpowered by local residents after they had heard an alarm. Anyway, it was later found that he was not

considering a serious crime.

In any case, thanks to this system, Japan has the lowest crime rate in the world. Masako recalls the days of her childhood occasionally, “It was safe to play outside until dark back then. I was constantly worried when Naoyuki was a child. Now, I am so happy and lucky to live in Japan where safety and security are ensured.”

16:00 ·

Masako stops by a supermarket on the way home to pick up some groceries for dinner, which Yumiko asked her to do.

You can do shopping through a computer at home and have products delivered to home through a home-delivery service, but it costs slightly more. Besides, Masako enjoys time to browse the store, where various products around the world are gathered.

You can check the production history by picking up an item and bringing it close to the wearable computer. A freshness inspector is also installed to show the freshness of fresh produce. Grandson Daiki has an allergy, but production technology has been established to produce non-allergy food based on allergen-measurement technology. So you can safely purchase any food.

To make a payment, you simply put products in the shopping basket and go through the exit gate. The list of products and the total costs appear on the basket and it is easy to check if you have purchased too many or too few. By reading the electronic tag on the products, payment is settled online as a debit to Masako’s account. This eliminated the long cues at cash registers.

Masako uses a card when shopping at department stores, although she has not used it today. This card is different from the credit card of the old days. This card alone can be used for almost everything in Japan, including all transportation fees and shopping.

This made-in-Japan technology (system) is now recognized as an international standard, and the card can be used at airports, hotels, transportation and major stores abroad. When Masako traveled to Europe with Ichiro last year, all they needed was this card. Ichiro uses a mobile computer instead of the card, fearing he might lose it.

People other than the holder cannot use the card or mobile computer, owing to the advancement of cryptographic technology and personal verification

technology.

Masako has not seen cash so far this year. She feels nostalgic when she recalls 20 years ago, when her husband's wallet, not hers, was full of coins, paper money and so many cards. She thinks now it would be worrisome if she had such a wallet.

Besides the card, there is a useful item when traveling abroad: a headphone equipped with a sophisticated automatic translation system. Masako does not speak a foreign language but she was able to enjoy shopping thanks to this headphone. It was also greatly useful when interacting with the local people.

She still keeps contact with an Indian couple whom she met on a liner motor car that runs more than 500 km/hour.

17:00 ・・・

Yumiko has finished the telework in her workroom and is now talking to INOBEE. "Have you finished cleaning the house? Any messages? Is there a hot bath ready?"

INOBEE replies, "I cleaned everywhere except your workroom. Grandpa says he comes home at 6:00. I think grandma comes home soon because she says she will be back at around 5:00. I will get a hot bath ready at around 6:30. I just got a message from daddy saying he would be home at around 7:00."

Due to the advancement of artificial intelligence technology, current INOBEE has a much better learning capacity than the last one, and he can get by in daily conversation without problems.

INOBEE is connected with various home alliances (including the cleaning robot) and a car (family car) through the Robotics Network System and he is sort of the brain of the Inobe family.

INOBEE is also connected with a super-small vehicle of the Inobe family, Masako's wearable computer, and a self-propelled carrier that accompanies a person when shopping, acting as a conversation partner during the trip.

Some people in the neighborhood use a renting service for home robots, but the family bought INOBEE when he was introduced on the market.

Yumiko thinks that she was able to build up her career while raising two children, thanks to the family-support policy promotion that had started taking concrete shape around when Daiki was born.

Back then, IT investment of her company was still only half way even if she

wanted to do telework, and she was using her own personal computer. It was not allowed to use office data from home due mainly to security concerns. The former president of the company was reluctant to adopt the home-office working environment because it was not possible to count working hours. By the time Yumiko had Misaki, however, a performance-based assessment method was established and a personal verification system and secure Internet environment were also developed. Yumiko thus was able to get updates on company news during maternity leave. While Misaki was taking a nap, she was able to work and earn some petty cash, in addition to the childcare allowance.

The current house of the Inobe family is a single family home that is 200m² in size. When the children were small, they used to live in a tower-type condominium with 2,000 units.

The government would just start to promote "compact policy," and apartment and condominium complexes of a certain size had to install childcare facilities, medical institutions and schools. So parents were free from worries about their children being involved in an accident on the way to or from school.

Although high-rise buildings increased, a comfortable urban space is embellished with greenery and flowers through the use of concrete materials that allow air to pass through and plants to grow. When Misaki was in primary school, she planted rice in a common space of the tower-style condominium.

A developer is obliged to develop green areas in order to receive a new development right (credit). So there are almost more green areas now than when Yumiko was a child.

18:00 ・・

When Noriyuki was getting ready to go home, a young researcher came to work.

She had just had a baby and was working while taking turns with her husband to care for the baby. By wisely using telework and flextime arrangements, she is trying to strike a balance between work and family.

Naoyuki's company adopts the annual salary system to facilitate professionalism among employees. The company has introduced a system to assess the employee's challenges and their outcomes, instead of emphasizing

working hours and length of employment.

Time to spend with a family outside of work is important to creating flexible ideas that are essential for innovative work. Naoyuki also tries to go home early to enjoy time with his family if there is no urgent work.

19:00 ・・・

All five family members are sitting at the dinner table.

Masako, Yumiko and Naoyuki take turns preparing dinner. (Daiki also cooks, but his cooking is not very appreciated, and he is no longer placed in charge of cooking.) It is Naoyuki's turn today.

Daiki saw a news trailer saying that a robot successfully traveled to the moon, and the 103-inch display screen was quickly tuned to the news.

A clear image of a robot conducting observations appears on the screen. Our blue and beautiful Earth looks like it is glowing. Everyone wishes the Earth to be beautiful forever. Daiki thinks that he would like to go on a space trip to see the Earth with his own eyes.

20:00 ・・・

Misaki contacted the family.

Daiki operates a panel of the multi-function mobile computer, and the image of a healthy looking Misaki appears on the 103-inch display on the wall. You can see several young people, who look like Misaki's class mates, around Misaki enjoy chatting in Chinese.

Each of her Chinese friends starts talking to Misaki's family in Chinese. Japanese subtitles appear on the display and, at the same time, you can hear the voice of simultaneous interpretation. This automatic translation function is installed in the mobile computer and it was quite useful when they took a trip to Europe last year.

The family of one of Misaki's friends, Lee, is engaged in agriculture work in inland China. The area used to be a vast barren desert area, but forestation of deserts is being carried out and desert-resistant crops are being produced, owing to biotechnology from Japan (including safety assessment of genetically modified foods).

All the electricity used for living, irrigation and agriculture in the area is generated by solar energy of a joint Japan-China company. Currently, a large electric transmission project is underway to expand the scale of power

generation and to transmit the electricity to the Chinese coastal areas through superconducting cables.

Lee talks proudly about his hometown and about his dream of taking up energy-related work after graduating from a university to make China like Japan, where environmental conservation and economic development are in good harmony.

Lee became interested in Japan and now has a good knowledge about Japan through digital archives of Japanese culture, entertainment and animation.

23:00 ·

Everyone goes to bed.

Wall lightings dress up the living room and bedrooms (fluorescent lights of 20 years ago have been replaced by LED and healing lights; the ones enabling high-volume communication are now available and various materials are used), the brightness is automatically adjusted depending on the presence of people and their activities.

The world's top level energy-saving system is installed not just for lighting but for energy use in the house. (This is also adopted as an international standard and is increasingly used in many countries.) Along with the introduction of a large-scale energy-saving system in urban areas, commercial energy consumption per capita has dropped to half of 20 years ago.

On a global scale, the increase in the amount of atmospheric CO_2 has been curbed due to penetration of new energies such as solar energy, well-established nuclear power generation, progress of energy-saving and various other efforts.

I. Basic Principles

Kiyoshi Kurakawa
Chairperson: Innovation 25 Strategy Council

1. Looking Ahead, Creating a Future

About a hundred years ago, at the beginning of the 20th century, predictions about the world in the next 100 years were posted in a Japanese newspaper. It included the invention of air conditioners and fax machines. The dreams of that time have come true in the 21st century, and future progress is underway. Of course, some predictions have yet to be achieved, such as a conversation between humans and animals.

The first flight by man was in 1903, only eight years after a famous scientist said, "Objects that are heavier than air cannot fly." When computers were first invented, people did not anticipate the need for the high performance we get from today's personal computers. However, small and high-capacity memories were made available due to the rapid progress of semiconductor technologies, and small personal computers perform better than the old large computers. They are now used as a means of networking, including e-mails and search engines, rather than the initial function of computing.

What is common in the history of a variety of innovation so far is that there were "high goals that seemed impossible at first," "people with ambitious spirits who boldly faced and overcame difficulties," and "people with plenty of drive" at the starting point. A giant leap has been made, overcoming various challenges, numerous failures and then great success. Other than a simple scientific discoveries or technological revolutions, there is a certain process behind the success of innovations, in which such discoveries and revolutions are integrated over time, demanded changes in the social systems and generated a new dimension. The repetitions of this process have formed our today's world.

As described above, human society has experienced the most rapid and radical changes in history in the past 100 years. Amazing progress in transportation means has shortened the distance around the world. Rapid advancement of information networks has enabled many people around the world to share information instantly. The drastic changes sometimes throw questions about our common sense, values and norms associated with ideas, culture and civilization that have been fostered over so many years. One must realize that this is an

underlying factor in the globalized era of the 21st century. Japan has become "a major economic power" and experienced the "collapse of the bubble economy" in the past 50 years, and has just embarked on a renewed journey towards development, overcoming the economic stagnation or the so-called "lost 15 years."

Globalization also provokes serious global-scale issues. Common global issues of the 21st century include population growth, global warming/climate change, deterioration of global environment and a growing North-South gap. The very sustainability of human society is being questioned[1].

Now the question is yours: In 2025, a quarter into the 21st century, how old will you be, and what will you be doing in what kind of society? What will your family, your children and your grandchildren be doing? What will the world, Asia and Japan be like then? Or rather, what would you like the world to be? Faced with the external pressure of "internationalization = opening Japan to the world" at the time of the Meiji Restoration, many young people went abroad to study and contributed greatly to building a new country of a new age with an international perspective and a network of personal connections. We are now facing a time of the second "opening of Japan" in a globalized century. What is the key to exploring this task? As you can see from history, the key has always been an unusual talent, or "the nail sticking out," and innovations that bring about changes in society[2].

2. Globalized Era and Global Information Networking

Japan achieved remarkable economic growth in the latter half of the 20th century and is just about recovering from the collapse of the bubble economy following the end of the Cold War between the East and the West. In the past several years, the economy has finally shown some signs of recovery. However, with various issues such as the rapidly aging population, falling birthrates and decreasing population, Japan is now seeking policies for the future. At the same time, surprising and rapid advancement of science and technology in the 20th century has drastically changed the industrial structure, society and the lives of people, and furthermore,

[1] "Essence of Science and Technology Policies of Japan,", The statement of the Science Council of Japan (April 2005)
"Japan Perspective," Recommendations of the Science Council of Japan (September 2005)

[2] Innovation
Derived from a Latin word "innovare" (to renew) (=in + novare (to change)). It refers not only to technological renovation, but also to drastic social change through creation of new values, by incorporating completely new technologies and ideas into the existing products and frameworks.

brought great benefits to the society, such as solutions to various diseases and increase in life expectancy, and the world's population has quadrupled in 100 years. Rapid changes in transportation means, satellite-broadcasting televisions, computers and Internet information technologies have led to the "globalized era," in which people, goods and money can swiftly move anywhere and information can be shared everywhere. Apart from the Japan's situations mentioned above, apparent global issues in the 21st century include further increase in population, global warming, degradation of the environment and a widening gap between the North and the South. These issues are not always region–specific for developed countries such as Japan, the United States, the European Union, and rapidly developing countries, such as BRICs, Asia, Middle East and Africa), but they do affect each other dynamically, but while each of them is definitely facing its own regional issues in the globalized economy groping for a new framework for peace in the post-Cold War era. The world in the 21st century is steadily transforming into the "globalized era". The current of globalization will not backflow. Furthermore, "revolutionary advance of informatization" is drastically changing the states of the world in the areas of industries, economy, finance and education and the like, and the mentality of the people, values and society.

Being aware of these circumstances, competitions are getting even more intense in the area of science and technology, which serves as an incubator for economic development, various movements are underway in every country, which include input of public funds, R&D investments of private companies and institutional reforms to promote research assistance. Japan also took various measures in the past 10 years that include the formulation of the Science and Technology Basic Plan and conversion of national universities and national research institutions into independent corporate entities. The policies based on the recognition of the importance of science and technology are regarded as a priority area in investment for the future. In recent years, there has been a rapid increase in the world's awareness of the importance of "innovation." That is to say that its importance is widely recognized as a tool to bring the outcomes of science and technology into both domestic and foreign markets as quickly as possible and to translate them into economic and social values. Achievements of basic science and research activities, developments and discoveries alone are not "innovations." The establishment of an appropriate "environment" (so-called, "ecosystem"), where such processes can smoothly happen, is extremely significant as a core of innovation.

"Speed" at an international level is quite essential in this process, reflecting the Globalized era. "Innovation," as will be described later, is not merely a word or a magic solution. Perhaps the reason that this word has suddenly stepped out into the limelight in the past 5–10 years is that a

country might make the wrong policy decisions, universities might take up the wrong missions and companies might make the wrong management strategies if they are not aware of "innovation." In the era of global competition, "innovation" requires a panoramic point of view that looks at the entire world at every step, and the speed of the decision is a crucial element.

3. Status and Issues of Japan in a Globalize Era

Japan is an island situated in the East Asia, and has established a close relationship geographically and historically with China rapidly developing with a big population, India, the Korean peninsula, Asian countries such as those in the East-Southern Asia. On the other hand, Japan of the 21st century cannot steer in the right direction only by boasting the strong relationship with the U.S. and the Western Europe over the past 100 years and its value as a model of success in the field of economy for the latter 50 years of the 20th century.

The economic recovery of Japan in recent years owes largely to the economic growth of Asia and the United States. If companies neglect continuous efforts for a full-fledged structural reform and an improving competitiveness in the international markets, it is impossible to maintain the superiority of Japan. Incessant and speedy execution of entrepreneurship is of great importance in the globalized era. Big companies are not exceptions. Companies need to create economic and social values strategically while they recognize their own "Strength" and "weakness" and go on innovation strategy, or understanding of citizen's needs. Also, they have to fully realize that citizens are "not only Japanese".

Japan's strengths include the "power to produce," "perfectionism" and "meticulousness." On the other hand, its weaknesses include "closed mentality," "weak comprehensive and international perspective," "weak individual capacity" and "mentality relying on the government." "Organization man," which used to be regarded as somewhat of a strength of Japan, may, in a sense, be a weakness.

In the field of science in Japan, basic research and development technologies have delivered excellent performance and abundance. However, in the globalized era, with free mobility of people, goods and money, developed countries are increasingly competing to acquire diverse and excellent minds, with an awareness that the future of the nation depends on human

resources[3]. Universities around the world, in particular, have launched strategies on human-resources development by inviting various types of human resources at the undergraduate level and exploiting their talents to their fullest abilities. This is all done under a notion that, in the globalized era, the leading universities of the world are to cultivate human resources who would play a leading role in every field. The mobilization of the top minds in the world is becoming prominent in recent years due partly to policy change of the United States.

Against these international movements, Japanese universities, even the top ones, are still basically closed in nature. Almost all undergraduate classes are taught in Japanese, but they need drastic, urgent and radical reform. In the past 10 years, the discussions on university reform in Japan remained on domestic matters, such as conversion of status into corporate entities. Internationalization of universities was limited to lectures at the graduate level, and has yet to be truly achieved. It will be impossible to attract diverse and excellent human resources who would play a leading role in the future unless universities, corporations and local communities urgently establish a system to receive these human resources, actively accepting these movements in the globalized era. An increase in opportunities to interact with diverse human resources, talents and unusual abilities on a daily basis would direct the ideas and goals of Japanese youth to the world, accept diverse cultures and talents, and increase the possibility of nurturing a variety of talents that are suitable for the globalized era. Each one would form personal connections in an international arena. Further increase in such innovative individuals would surely become a valuable asset and a power source for Japan. In particular, if the traditional "vertical mentality and vertical social structure" of Japan are too strong, they might be incompatible with values in the globalized era, which brings about "horizontal human relations" beyond national borders, thus adversely affecting our nation. The traditional "seniority system" of the vertical society, and social or corporate structure with "low horizontal mobility" tend to foster a culture in which mistakes are feared and concealed and decision-making processes, responsibility in a liberal research environment and bold corporate activities are not clearly defined, all of which would serve to weaken competitiveness. In other words, a "vertical society" would lessen the potential of innovation, or creative destruction. Thus, it is necessary to further reform human resources development and management of research institutions and industries.

Corporate assessment in the globalized era, or evaluation axis for Corporate Social

[3] Newsweek (August 2006), Times Higher Education (October 2006), The Economist (October 2006), etc.

Responsibility (CSR), is also rapidly changing in the international scene[4]. Corporate values in the globalized era take various elements into the CRS evaluation axis, in addition to maximization of profits in the market. Specifically, these values rest on transparent corporate governance, investment in human capital, efforts toward improving the quality of products and services, social contribution activities and contribution and response to various global-scale issues such as global warming, climate change, degradation of the environment, energy and human security issues (e.g., poverty). This strongly suggests a change in awareness (sometimes subconscious awareness) of the people of the world about corporations. Ordinary citizens have been empowered by information networks, and the traditional authority has declined. The "wisdom of people" is actually influencing many aspects of society. Thus, corporations are rapidly transforming their values from visible values to invisible values: for instance, corporate governance, high transparency, services and social contributions.

Many industries in OECD countries are changing their forms in order to adapt to a new era. In other words, in response to an increased diversity of needs in the globalized era, an inevitable consequence of time, a winning team must have a groundbreaking, innovative and positively aggressive process that starts from exploring diversified needs of citizens to exploiting and creating the needs, rather than seeking the values of corporations (supply side). This is part of the essence of innovation.

In principle, innovation is the creative destruction of established organizations and values and is revolutionary. Therefore, a niche market is created at the beginning. Innovation rapidly and widely expands the niche to the domestic and international markets and is the process of drastically changing and creatively destroying existing corporate and social systems.

At the same time, with respect to production, small- and medium-sized enterprises in Japan have a number of excellent technologies. This is a structure known as "upstream industry" and "downstream industry." For instance, mobile phones are produced by more than ten companies in Japan, however, the total number of production of all Japanese companies is less than that of Nokia, Motorola or Samsung in the international market. However, 65% of the components of the world's mobile phones are made in Japan. This clearly shows where Japan's strengths and weaknesses lie. The strength is to do with an idea that a parts-production industry, which has traditionally served as a "group company/subcontractor of affiliated transnational companies,"

[4] Council on Competitiveness "Innovate America-Thriving in a World of Challenges and Change" (December 2004)
McKinsey & Company, Tim Koller, Jack Murrin, Thomas E. Copeland, & Tom Copeland "Valuation: Measuring and Managing the Value of Companies" (July 2000)

can become a strategic advantage in a flat and open era of globalization and innovation.

Natural resources are scarce in Japan, and the spirit of "Mottainai" (a Japanese word meaning "too precious to waste") has manifested through experience. Utilizing the experiences of mass production in the latter half of the 20th century, a mass-consumption culture, economic growth propelled by the consumer spending, experience with pollution and the oil crisis of 1973, Japan has attained the world's most advanced environmental technologies, such as clean energy and green technologies. Solar batteries, nuclear-power generation, energy-saving technologies, and water-treatment technologies of Japan lead the world. When taking an overview of the world, the contribution of Japanese technologies is quite substantial to meeting increasing energy demand as a consequence of the economic growth of Asia, and against global warming and environmental degradation, etc. By further utilizing the point as a large pillar of values, we should actively expand the strengths, strong products and strong services of Japan into the ever-increasing world market, particularly focusing on Asia. Such technological strength is a great achievement of science and technology, industries and society in Japan. These international contributions can improve Japan's credibility and presence in the international community more than Japan's economic benefits can.

4. Conditions for Innovation Creation: Society Full of Dynamism

Many new discoveries and inventions are born in universities and research institutions. This is why investment in science and technology is encouraged. However, many of university researchers do not have much interest in social application, although interest in social application is a necessary attribution of researchers. Creative and edgy knowledge often emerge from unusual ideas in unexpected places. "Uniqueness" (unusual talent/unorthodox ideas) is important. When observing the achievements of Nobel Prize winners and the backgrounds of those who have drastically changed society, you find, in many cases, social conditions and an environment where it is easy for "uniqueness" and "outstanding elements" to emerge and grow. It is necessary to build an environment where "uniqueness" is not suppressed, and one that offers opportunities for various unique talents to meet. World history tells us that positively aggressive "innovation" is unlikely to emerge in matured corporations and societies, and that it's the "different" element or "odd idea" for the time that triggers innovation. "Now the question is how quickly the results of research can be brought to society and how to explore the needs of the people. It is not necessarily up to the universities alone to understand and improve the seeds of research, discovery and ideas, to combine them with other technologies and ideas, to provide

funds and to contribute to commercialization. The environment, where different people with unique talents can mingle freely, attracts many people as a place for innovation. One example is Silicon Valley. There are numerous success stories achieved by making the most of mistakes and accumulating experience. The primary issue is the very environment that can create various teams and combinations suitable for a given situation. These conditions create unexpected new industries from universities. That is why university-initiated universities, industry-university collaboration, venture funds and tax schemes are all important.

How should we explore the needs of ordinary citizens (innovation of process, marketing, design, branding, etc.)? The idea of "uniqueness" is also effective here. Various innovations, sometimes referred to as "service innovation," are the driving force for exploring and establishing a new market (Yamato Transport, Art Corporation, FedEx, Amazon, Google, etc.).

In the era of globalization, the terms "ordinary citizens" and "society" are not limited to those in Japan. In order to achieve growth in the international market, it is important to have the ability to capture the social needs with high growth potentials and to create values. If you stick to Japanese values, the market is likely to slip away. There are regional differences in needs. In order to explore the achievements of research activities and the perspectives of ordinary citizens, the following conditions are necessary to generate innovation: whether the optimized "place" and "ecosystem," which brings research outcomes to society, satisfy the most appropriated conditions in a given situation; whether the "place" and "ecosystem" are compatible with various combinations irrespective of nationality; and whether there are diverse and various personal connections and business partners. These are not direct processes but involve various and complicated processes. The strengths are reinforced and the weaknesses are supplemented. It is then necessary for the government and each stakeholder to urgently implement necessary reforms by identifying optimal conditions and scrutinizing universities, institutions, corporations, investments and financial and human resources.

Then, how can we transform society to one with changes and various possibilities? We need policy research based on scientific rationale, formulation of several policies appropriate for the induction toward such society, presentation of options, and political decisions and implementation based on the concept of drastic selection and concentration. This creates an innovative society in the true sense. Both national and corporate policies must gain international credibility. They must further be based on scientific rationale and eliminate the precedent-based system. It is important to decide and implement highly transparent policies by appropriately utilizing various opinions and perspectives from independent policy-formulation agencies,

various think tanks and scientific communities. These are the core of reliability of the government and corporations in the era of globalization.

In the globalized era, Japan needs to strengthen the strengths and to combine the weak areas with the strongest partners (regardless of domestic or international). What are the policy options? Some important requirements of the national policies are to clarify the difference between public and private funds, project cost efficiency and its rationales and evaluations, and to identify where responsibility lies. Injecting public resources into a weak area is not necessarily a wise financial choice. In such a case, one should rather consider tax measures or decentralization measures. Public investment in the weak area should emphasize human resources development. How to optimize the strengths of a nation, corporations, universities, research institutions and individuals is the issue, selection and decision of each actor.

5. Key of Innovation Is Human Resources: To Cultivate the Nail Sticking Out

Every organization, society or government charts its course based upon how people think, plan and behave. Thus, the basis of a policy of innovation is to decide who should be developed and how to develop human resources. Roughly speaking, the major contents of early primary education (Grade 1-4) are “reading/writing and calculation,” those of late primary and middle school education (Grade5-8) are basic science, social studies, English, foreign language, etc. Those of later middle school education (Grade 9-12) are presentation of options with deeper and wider academic coverage in accordance with the ability of each student and learning capacity to solve problems and tasks by selecting independent studies and practical training, etc. During this period, plenty of opportunities should be offered so that students can learn about human resources, goods, technologies, traditions and culture, in which they take pride.

The main objective of the traditional educational system in Japan tends basically to pass an entrance examination focusing on a standard score. Unless the nature of university education is reformed, the core of the educational problems cannot be resolved. This issue is stemming from the basic structure of Japanese society.

Furthermore, the options that Japanese people have for higher education are not limited to Japan. Rather, promoting interaction with foreign cultures, different values and cultures will aid in developing a Japanese sense of identity, cultivating human resources with an understanding and

tolerance of different cultures suitable for the globalized era and cultivating innovative human resources with different values and various ideas.

If you have more experience with international exchange at a young age, in other words "opportunities to live by other rules," you are able to make Japan widely open to the outside world. This is the desirable "condition for the second opening up of Japan." For human resource development, it is imperative to have open universities that are not constrained by the existing framework and conventional ideas. They can then serve as places for highly motivated young people from various backgrounds to develop themselves through friendly competition. In any case, graduate schools and research institutions are required to have high international profiles.

Despite a sudden external force to open up the country, many highly ambitious young people departed Japan to study abroad 150 years ago, cultivated international points of view and personal networks and played decisive roles in building a nation suitable for the time. Many young people from Asian countries have started to come to study at Japanese universities since the latter half of the Meiji Era, contributing to the modernization of Asia. If you compare this with today's Japan, a university reform to be an open space is a perfect opportunity and the most important reform.

"Innovation" is a process to pick up the needs of ordinary citizens and society, and to transform the matching seeds into a new value. These seeds have the potential to emerge endlessly from universities and from companies depending ideas; and it is particularly important to increase the potential. What are the policies to that end? Furthermore, the very essence of innovation is to direct such seeds, ideas and discoveries to the social needs, to direct them to the exploration of needs and to provide them as quickly as possible. What are the social needs? Priorities are different within Japan, within Asia and within the world. Nonetheless, it is necessary for Japan to make efforts with an international perspective and open attitude to the international community with full awareness of its role in the international community as the second largest economic power in the world. From an Asian perspective in science and technology, Japan's environmental and energy technologies are expected to make a significant contribution to the growth of China and India for the time being, which will lead to an international market.

Current and future (in five years/10–20 years) major issues of the world include "global warming/climate change-resources/energy," "water/food," "population growth," and "poverty-human security." Based on these issues, it is crucial for Japan to envision the kind of country it intends to be in the context of a rapidly developing Asia and the country it aspires to

be in the world. In order to achieve this task, we must develop innovative human resources.

II. Next 20 years of Japan and the World

There are three large currents at present and in the next 20 years as listed below.

○ Rapid demographic aging and population decline in Japan
○ Advance of knowledge-based society, information-based society and globalization at an explosive rate
○ Increase in the issues posing a threat to sustainability of the earth

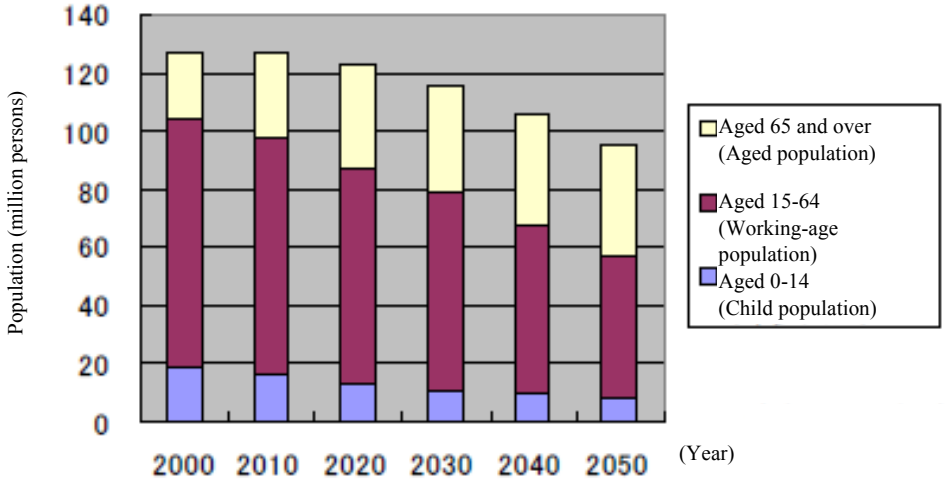
These issues are the ones we are already facing, but the speed of the trend is expected and predicted to be faster. Each of them is a new current that has never been experienced in the past.

1. Rapid demographic aging and population decline in Japan

The total population of Japan reached its maximum in the year 2005, and a population decline has become a reality.
Since baby boomers will begin making their way toward retirement, the working-age population, based on the current statistical definition, is projected to decline rapidly, possibly by as much as 12 million people by 2025.

The ratio of the working-age population to the population aged 65 and over was 4 to 1 in 2005, but is expected to fall to 2 to 1 in 2025. This estimated figure means that the working power, which supports one elderly person, will decline drastically in 20 years, provided that various social systems remain unchanged.

Demographic Change in Japan (by age)



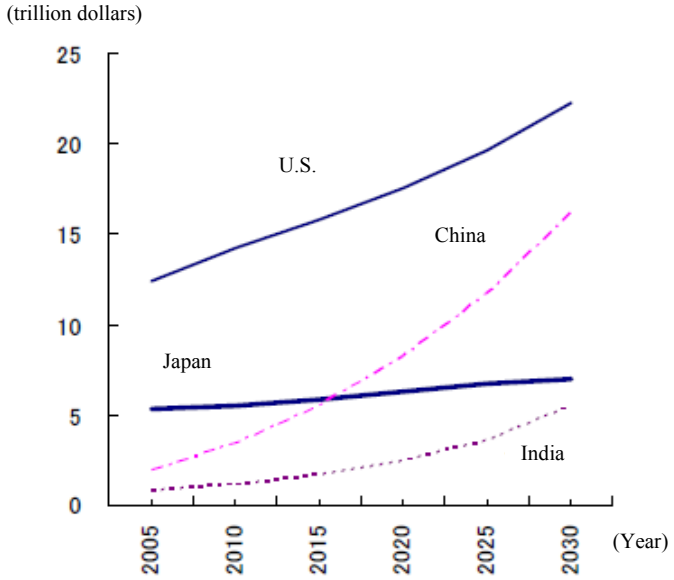
Source: "Population Projections for Japan, December 2006" National Institute of Population and Social Security Research

In the midst of the declining labor force population, the potential growth rate will decline unless productivity improves.

On the other hand, due to the remarkable economic growth of newly developing countries, such as BRICs1 (particularly China and India), the world's current economic landscape is expected to change drastically.

The future of Japan's economic status depends on the efforts to take part in the growth impetus of the global economy in cooperation and coordination with countries that have huge emerging markets, instead of considering the economic growth of China and India as a threat.

Change in GDP of Japan, the United States, China and India



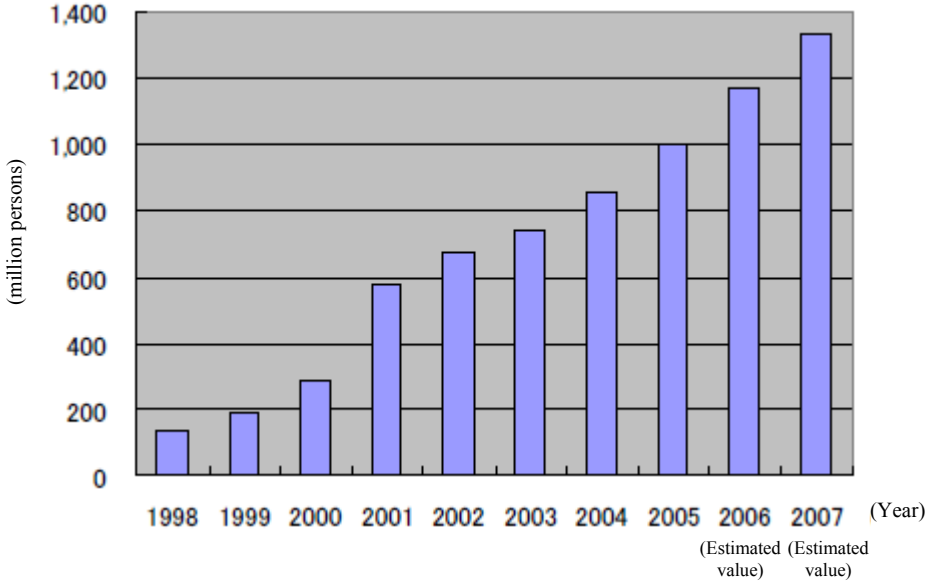
Source: "Global Economics Paper No.134," The Goldman Sachs Group, Inc.

2. Advance of knowledge-based society, network society and globalization at an explosive rate

In the latter half the 20th century, "globalization" came in the form of corporate activities represented by trade and local production.
Today's "globalization" is developing in a much larger scale and speed, and the major cause for this is the progress of the so-called "network society." Because consumers around the world have easy access to foreign goods and services (including healthcare and education), suppliers are expected to take action with constant consideration of consumers, who know the world.

Another notable characteristic of "globalization" in the future is an international competition over knowledge and the brain. It is hard to keep pace with the speed of progress in science and technology in the fields of IT, nano-technology and bio-technology by domestic human resources alone, and each country is in fierce competition to gain the brains of the world.
There is no doubt that the progress of globalization described above will accelerate even further. On the other hand, there is a possibility that the gap between North and South will widen since some developing countries miss out on the wave of international competition, losing a chance to escape from poverty.

Internet Users of the World



Source: "Internet White Paper 2006," Internet Association Japan

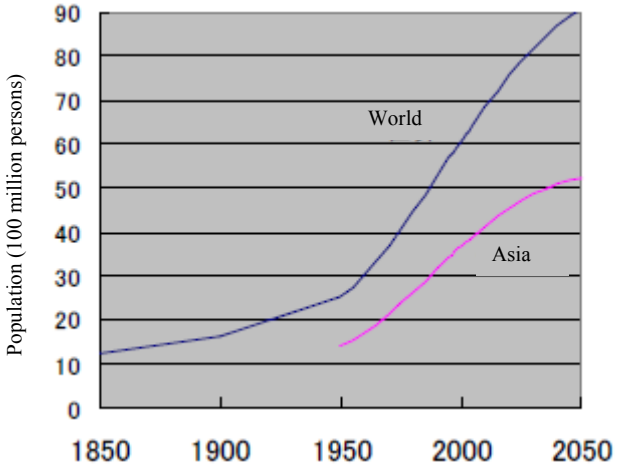
3. Increase in the issues posing a threat to sustainability of the earth

<Population>

The population explosion in many countries throughout the world is expected to continue into the future, reaching 8 billion by 2025. Out of that number, about 4.7 billion are estimated to be in Asia, including the hugely populated China and India.

Increasing concerns are being voiced about further deepening various issues that pose a threat to sustainability of the earth, and that have already come to surface.

Demographic Change in the World



Source: "World Population Prospects 2004," United Nations

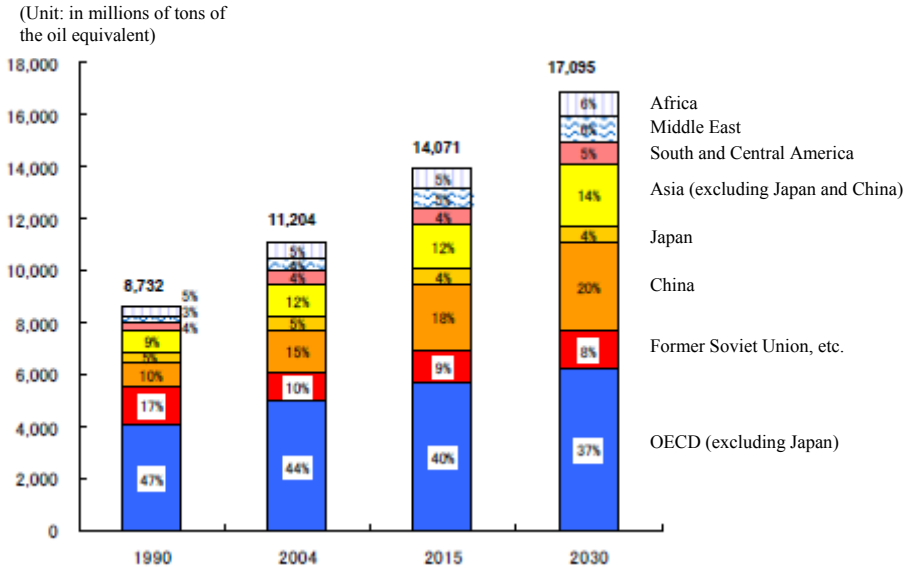
<Resource and energy>

Along with the world population growth, the demand for resources and energy is also expected to increase rapidly. This issue is particularly notable in Asia, where high economic growth is expected further.

China is currently the second largest energy consumer, surpassing Japan, and there is a prediction that China will depend on imports from foreign energy resources for 80% of its energy needs in 2030.

The increase in consumption of resources and energy influences the economy of Japan through the distortion of the supply-and-demand balance. At the same time, there is a great impact on environmental issues as described below.

Projection of Energy Demand in the World



Source: "World Energy Outlook 2006," International Energy Agency

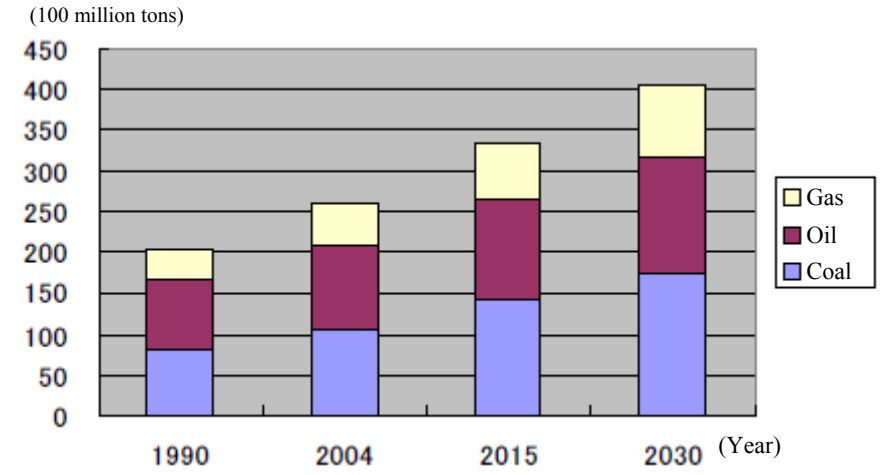
<Global warming/climate change and environmental issues>

If energy needs will continue to be largely covered by fossil fuels, its increase will be directly linked to the increase in the emissions of greenhouse-effect gases.
With regard to global warming issues, there is a report that at least 5% and possibly 20% (in the worst-case scenario) of the world's GDP will be lost unless countermeasures are taken, for instance, investing 1% of the current world's GDP for 10–20 years from now[5].

Furthermore, there is concern that the global population increase and economic growth will not only affect global issues but also cause environmental degradation at the regional level. The regional environmental degradation is also highly likely to be prominent in Asia due to outstanding economic growth, huge populations and advancing urbanization. (Currently, 11 of the 20 largest cities in the world (with populations of more than 10 million people) are in Asia.)

[5] Stern Review on the Economics of Climate Change
In response to the request by the government of the United Kingdom, Sir Nicholas Stern (Economist and Former Senior Vice-President of the World Bank) compiled a report on the impact of the global environmental issues on the world economy, which was published in October 2006. The report states that if countermeasures against global warming are taken now, the cost is limited to 1% of the world's GDP; however, economic loss caused by climate change is projected to be 5–20% of the world's GDP if countermeasures are not taken.

Change and Projection of Energy-Derived CO_2 mission in the World

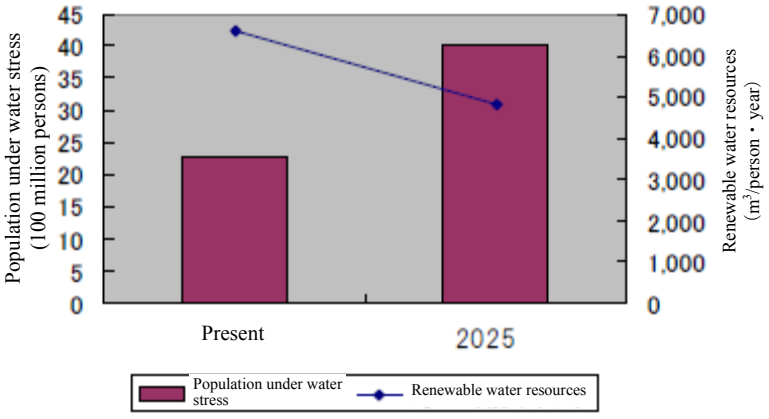


Source: "World Energy Outlook 2006," International Energy Agency

<Water and food>

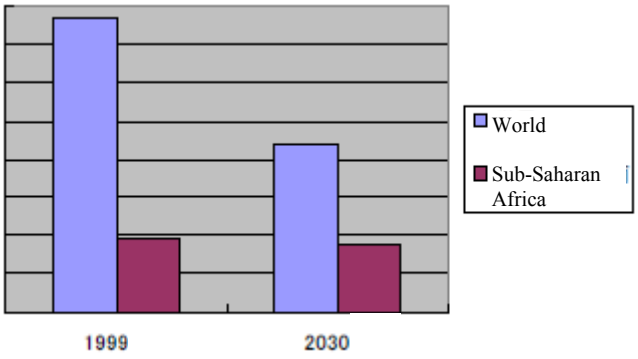
A water shortage is predicted to become critical on a global scale alongside population growth and advancement of global warming.
With regard to a food crisis, the least developed countries (regions), such as Africa, will remain in a severe condition although the number of undernourished people is expected to decline on a world scale.

Worsening Water Shortage in the World



Source: Compiled from the White Paper on the Environment 2002 edition, Ministry of the Environment and The World Water Visions, the World Water Forum

Undernourished Population of the World（less than 2,200kcal/day）



Source: “World Agriculture: Towards 2015/2030 - An FAO Perspective,” Food and Agriculture Organization of the United Nations

<Terrorism>

Since the simultaneous terrorist attacks of September 11, 2001, the “war on terror” is still a work in progress, and terrorism issues are no longer those of specific countries but those of the entire world. Unfortunately, it is still difficult to foresee the threat of terrorism diminishing in the near future.

<Infectious disease>

With the advance of globalization and the greater and faster mobility of people, animals and goods globally, Japan is always facing the risk of the transmission of a disease-causing agent and the entrance of infected patients/animals, which can take place in a very short period of time. Population increase and economic growth through development in developing countries are the factors causing the emergence of new infectious diseases. It is expected that the impact of newly emerged and re-emerged infectious diseases on the world will be increasingly pronounced.

Occurrence of Emerging Infectious Diseases

Year	Emerging Infectious Disease	Country affected by the disease	Year	Emerging Infectious Disease	Country affected by the disease
1957	Argentine hemorrhagic fever	Argentina	1994	Hendra virus disease	Australia
1959	Bolivian hemorrhagic fever	Brazil	1994	Brazilian hemorrhagic fever	Brazil
1967	Marburg disease	Germany	1997	Avian influenza	Hong Kong
1969	Lassa fever	Nigeria	1998	Nipah virus	Malaysia
1976	Ebola hemorrhagic fever	Zaire	1999	West Nile virus	U.S.
1977	Rift Valley Fever	Africa	2003	SARS	China
1981	AIDS	Venezuela	2003	monkeypox	U.S.
1991	Venezuelan hemorrhagic fever	U.S.	2004	Avian influenza (Asian type)	Each countries
1993	Hantavirus pulmonary syndrome	Brazil			

* Increasing Occurrences of Emerging Infectious Diseases in Recent Years

Source: “Viruses and Humans,” Kazuya Yamauchi, Iwanami Shoten

III. Why is innovation important now?

As described earlier, Japan and the world will enter an era that human beings have never experienced before, whether we like it nor not. Can we live through this era with conventional ideas and subsequent responses? The answer is "no."

The population of Japan declined in 2005 and the total fertility rate recorded the lowest in the postwar period. The Dankai generation (the postwar baby-boomers born 1947–1949) enters the age of mandatory retirement starting this year. If the current employment practice and framework are maintained, the labor force population will continue to decline for the next 20 years. Unless we change our ideas and frame of mind, no bright future is in sight.
Furthermore, in light of the increase in the world population and buoyant growth in the BRICs, developed countries of the world are now aware that "innovation" is a key factor to maintaining growth, while overcoming global-scale constraints, and each country has established its own innovation strategies. Amidst the competition in the globalized era, if Japan cannot utilize its merits, some predict that the ratio of Japan in the world's GDP will decline from the current 15% to a mere 4% by the year 2025[6]. The only tool for sustainable economic development in a country like Japan, a country with a declining population, is the improvement of productivity, and its basis is undoubtedly innovation with a holistic view of the world.

To that end, it is necessary to take on a new concept without being constrained by the conventional methods concerning the work style of individuals, organizational structures and various regulations.
In other words, it is fundamental to increase per capita productivity by sharing and implementing the basic principles of innovation, which are to enhance individual abilities, to integrate foreign and unique elements utilizing advantages of a network society, to exploit the maximum ability of individuals through cooperation, to create new added values by new science, technology and services, and as a result, to bring about changes in society, including in the lives of ordinary citizens.

Fortunately, Japan has high quality technology, which was derived from demanding consumers. Also as a result of constantly seeking energy-saving solutions, being the country with limited natural resources, Japan has a high level of energy-saving technologies.
As symbolized by these examples, problems do not represent risk but a chance to create a new

[6] Japan's 21st Century Vision/ Globalization Working Group Report (April 2005)

technology.
The aging society creates a new demand, which then is an engine to develop new technologies and services. In the end, our lives will be healthier and economic development will be achieved.
Global-scale environmental issues, such as global warming, present the opportunity to commit ourselves to the pursuit of the highest standards of environmental technologies, in which Japan is strong, and to calling on the world to create a new international framework. Japan's challenge to these tasks will generate innovations, which will bring about economic growth and enrich the lives of ordinary citizens.

Then, in order to take on the challenge of solving the issues that face Japan, it is necessary to further expand investment in science and technology in which Japan is strong. In Japan's weaker fields, it is necessary to enhance technologies if they are necessary to maintaining responsiveness under a changing international environment, and if not, they must be enhanced in cooperation with the world.
Since innovation is born from unexpected ideas, Japan must constantly invest in the diversified and unpredictable research and development activities. In order to strengthen Japan's competitiveness and international contribution, there is no other time than now for investment in science and technology (basis of innovation), enhancement of human resources and framework in which the outcomes of innovation can be implemented to its full extent.

Innovation has played a role in removing various social barriers. The IT innovation, specifically the dissemination of the Internet, has enabled instant communication among people around the world, and temporal, spatial and information walls, which kept people separated from one another, have virtually vanished. We are free from various diseases due to advances in medical technology, and it is a significant advantage in saving physically frail people. The advancement of means of transportation shortens geographical distance and facilitates people's activities, making the issue of where to live trivial.
Thus, innovation plays a significant role in eliminating or reducing the conventional handicaps, such as age, disability and gender difference.

Furthermore, innovation plays a great role in narrowing or eliminating various differences observed among individuals, such as regions, international scenes and information and family patterns.
The advancement of science and technology brings various benefits, and the genuine goal of innovation is to extend the benefits to as many people as possible. Further down the road of the "innovation-based country," we envision a vigorous society where individuals can exercise their

maximum abilities.

IV. Japan 2025 through innovation

1. 20 Demonstrative Cases of Innovation and Technical Assessment

What kind of Japanese society do you envision from your own standpoint?
In the year 2025, high-school students today will be in their 30s, and babies today will be university students.

When formulating "Innovation 25" last year, we solicited public opinions to draw an outline of society in 2025 created by innovations: "Our lives, jobs and education will be changed in this way if we had these inventions, these social frameworks and these people[7]".

The Science Council of Japan first created the scenario of society in 2025 and discussed how to promote innovations in the course of achieving the goals; it then published a report titled the "Future Society Envisioned by the Science Community[8]."

Using public opinions, opinions of researchers and the Technology Forecast Survey[9] as references, the outlook of Japan in the next 20 years is projected. Then, various social images that Japan should aim for in 2025 took shape, among which 20 cases that are particularly ideal are listed below.

Technological forecasts used for these cases are based on the Technology Forecast Survey and "(Year XX/ Year XX)" indicates "(Year of technological realization/Year of social adaptation)."

[7] Soliciting public opinions
Public opinions on "Society in 2025 Established by Innovation" were solicited through the Cabinet Office website and others from October 27 to December 31, 2006. A total of 385 responses were obtained. Details are available at: http://www.kantei.go.jp/jp/innovation/dai5/siryou1-2.pdf

[8] Science Council of Japan Report "The Future Society Envisioned by the Science Community" (January 2007)
In response to a request made by the State Minister (in charge of innovation), Sanae Takaichi, the Science Council of Japan set up the "Committee for the Investigation of Innovation Promotion" in October 2006, and spent three months collecting 2200 voluntary proposals from the members and affiliate members of the Science Council of Japan.

[9] Technology Forecast Survey, etc.
A holistic forecast survey on medium- and long-term development of science and technology conducted by the National Institute of Science and Technology Policy of the Ministry of Education, Culture, Sports, Science and Technology for two years from FY2003, in which a total of 2500 experts participated.
Many other experts contributed to the survey.

＜Healthcare/Health＞

Case 1. Health check while sleeping by taking a capsule

Health checks can be done at any time: for example, by taking a micro-capsule before going to bed, so that your health check can be complete by morning. Furthermore, the check-up results can be sent to a hospital immediately to receive diagnosis or remote treatment anytime and anywhere.

【Technologies/systems required for realization】

- Home health-management system and diagnosis system for abnormalities (2012/2018)
- Super small health-management device based on a micro-machine (2015/2025)
- Remote healthcare services in which a doctor makes a diagnosis through the Internet, gives standardized treatment instructions and prescribes medication, all based on personal medical data taken at home (-/2015)
- Safely protected wide-area healthcare information systems in which one can look at the personal electronic medical chart at home (2008/2013)

Case 2. Healthy body at an advanced age, drastic decline of dementia

The spread of regenerative medicine for bones, cartilage, skin and teeth, and of technologies to cultivate and transplant autologous tissues enable elderly people to maintain the health of a person 50 years of age.

The development and dissemination of highly sophisticated care–giving robots and sovereign remedy for dementia enable the elderly to lead social lives almost exactly like healthy people without placing much burden on family members or caregivers.

【Technologies/systems required for realization】

- Biomedical ceramics that have nearly the same functions as human bones (2012/2020)
- Therapy to enhance recovery from motor paralysis by transplanting neural stem cells (2020/2030)
- Technology to voluntarily control a prosthetic limb without using the spinal cord/peripheral nerves by signaling and conveying motor-related brain activity (2018/2029)
- Permanent cure for Alzheimer’s disease (2019/2029)

・ Care-giving robot that helps a person in need of care to take a bath, etc., without giving the person discomfort or anxiety (2012/2016)

Case 3. Overcoming cancer/heart attack/stroke

Innovative drugs and medical technologies will be developed to cure three major lifestyle-related diseases (cancer, heart attack and stroke): for example, the development of groundbreaking medicine to cure cancer without surgery, which has no side effects and is suitable for constitutions of individual patients. These achievements will reach patients quickly, eliminating worries about illness.

【Technologies/systems required for realization】

・ Anti-cancer therapy with few side effects that suits the patients' constitutions (2014/2023)
・ Gene therapy enabling localized treatment approaches for arteriosclerosis focus (2015/2024)
・ Gene therapy for cancer (2018/2029)
・ Gene therapy for familial hypercholesterolemia (2016/2024)

＜Environment/Water/Energy＞

Case 4. Vehicles that clean the air as they run

Automobiles will be developed to run using CO_2 as an energy source, using artificial photosynthesis technology.

【Technologies/systems required for realization】

・ Clean fuel without emitting dust or NOX (excluding hydrogen) (2014/2021)
・ Transportation means with fuel cells (automobiles, ships, etc.) (2012/2021)
・ Dissemination of hydrogen-supply stations for fuel-cell vehicles (2013/2023)
・ Artificial photosynthesis technology with a solar-energy conversion rate of 3% or more (that of plant photosynthesis is around 1%) (2030/after 2036)
・ Artificial photosynthesis technology using a dendritic polymer compound (2017/2028)

Case 5. Environmental leaders fostered in Japan

Young people from the world, including Asia, will study environmental education in Japanese universities, etc., and will be actively involved in environmental businesses of the world. They will contribute to the realization of the environmental-friendly economy in their home countries.

Case 6. Green oasis in barren deserts

Rain will be created artificially in the areas suffering from serious desertification, and freshwater will be produced using technology to desalinate seawater in the coastal areas. Furthermore, barren deserts will be turned into a green land by recovering healthy soil through the use of desalination technology, while introducing hardy plants that grow under poor conditions through the application of state-of-the-art biotechnologies, such as genetic modification.

Also, within Japan, various forms of green spaces in urban areas will be created, regardless of the presence of soil or difference in geographic features, and people will be able to feel "the co-habitation with greenery."

【Technologies/systems required for realization】

- Economic/practical technology for desalination of seawater and purification of polluted water using, for example, a reverse osmosis membrane (2006/2013)
- Highly efficient vegetation regeneration in deserts (2014/2022)
- Technology for desert-greening and food-production technology in the desert in order to avert a food crisis caused by population growth (2018/2029)
- Crop-production/greenery technology in deserts, etc., using useful plants with reinforced salt-resistance, draught-resistance and cold-resistance properties (2015/2027)

＜Lifestyle/Industry＞

Case 7. Communication with people around the world with a headphone

Using a headphone equipped with sophisticated automatic translation functions, owing to the advancement of artificial intelligence and speech-recognition technology, the wall between Japanese and foreign languages will be removed, and communication with people around the world will greatly expand.

【Technologies/systems required for realization】

- Wide use of telephones with simultaneous translation function (2017/2025)
- Systematic-saving system of knowledge that greatly facilitates access to necessary information, with an improved search function for information in various languages, owing to an advanced automatic-translation function on the Internet (2010/2015)
- Wearable automatic-translation device with speech input/output capabilities (2013/2020)

Case 8. Experiencing Japan and experiencing the world through the cyber world from home

Technology to reconstruct three-dimensional images that you can touch, hear and even smell by wearing headgear, etc., will be developed, bringing the cyber world much closer to the real world. With this, a Japanese person, for example, can experience the hustle and bustle of Manhattan without leaving Japan, or a person abroad can feel the atmosphere of the entrance gate of Senso-ji Temple in Asakusa from their own living room.

【Technologies/systems required for realization】

- System to enable one to enjoy arts or music in a remote area: for example, to be able to enjoy arts as if one is actually walking around the exhibition hall and to be able to listen to live music as if sitting in a concert hall (2013/2021)
- Learning system to enable us to experiment and experience phenomena in a virtual reality space, which is hard to do in the real world, by using simulation technology, so as to improve scientific thinking (2010/2015)

Case 9. Escaping household chores －One home robot/household ―

Robots with advanced artificial intelligence and the ability to do housework are being developed. New services/businesses will emerge, such as a robot-rental service, and home robots will be safely introduced, which will free people from household chores, give them more free time and allow ample time for childrearing/work/hobbies with ease.

【Technologies/systems required for realization】

- A house-helper robot to do the cleaning and washing in each house (2015/2023)
- Robot-rental services in accordance with various needs, such as gardening, caring for the

sick, and house chores (2013/2021)

Case 10. You can go anywhere in the world without a wallet － The Cashless World ―

Realization/dissemination of internationally standardized cyber money and ID-management technology will enable the use of highly safe and convenient services without carrying a wallet.

【Technologies/systems required for realization】

- Multi-functional electronic card with security functions (personal verification, etc.) and electronic-settlement functions so that one can conduct almost all procedures and transactions all around the world (2009/2014)
- Wide use of cyber money that enables payment and receipt of money anonymously with the same credibility as conventional money (-/2014)
- Dissemination of cyber money will reduce the cost of settlement of amounts less than 500 yen down to zero or to a negligible level. (2008/2013)

Case 11. Foldable display

The development of a foldable display that can be folded like a paper and carried in the pocket will enable us to access the latest news and images; street billboards will thus take on a new look.

【Technologies/systems required for realization】

- Mobile electronic display with flexibility (thin and soft), that can replace a newspaper (2011/2016)
- Foldable display of a similar size, thinness and resolution as a newspaper (2015/2023)
- Display device that can be directly reflected in the eyes so one can enjoy movies anytime and anywhere (2015/2024)

Case 12. Food safety information at a glance

Food safety will be ensured by obtaining safety information of foods by means of an electric tag attached to a food product, which gives distribution data from producers when shopping, or allergy information when placing an order at a restaurant.

【Technologies/systems required for realization】

- Generalization of a production and distribution information-tracing system that links electronic information rendered to electronic tags on products or foods with distribution/POS (system to calculate sales proceeds of products by singly item unit)/home delivery services (foods, recycling, etc.) (2009/2014)
- Global-scale production and distribution history information-tracing system that covers most food products (2011/2019)
- Home test kit for food freshness (2012/2018)
- Technology to produce allergy-free foods based on allergen-measurement technology (2014/2021)

Case 13. Intelligent robot: A reliable colleague at a production site

Robots will be introduced to a number of production lines due to the development of robots with artificial intelligence (AI) that can voluntarily deal with dangerous operations, which then improves safety/security standards. Factories that have moved abroad seeking low-cost labor will return to Japan, and employment will expand, including the creation of services related to management and distribution.

【Technologies/systems required for realization】

- Utilization technology of robots for dangerous and hazardous environments in production processes to ensure safety of operators (2011/2017)
- AI robot technology used at construction sites to shorten the work period and to ensure safety (2013/2020)
- Production technology using robots that can perform operations responding to changing environments by three-dimensional real-time image-rendering and force sense-control system (2015/2024)
- Production system technology using robots with self-repair capability (2021/2031)

＜Safe/Secure/Comfortable Local Community＞

Case 14. Child protection by sensor networks

An environment will be realized in which children and the elderly can live safely. This will be possible through the development/improvement of "high altitude monitoring technologies" using GPS (Global Positioning System), robot technology, and ubiquitous sensor network technology. The latter is technology that enables optimal movements based on independent information flow by automatically recognizing various situations and environments, such as conditions of men/objects and their surroundings, as well as through the efforts of local communities to protect children and the elderly.

【Technologies/systems required for realization】

- Automated security system to detect suspicious activity before something happens through networked surveillance cameras (2008/2014)
- Technology that helps to find the location of wanted criminals/primary witnesses by identifying them with surveillance cameras installed in public spaces and by analyzing their descriptions, behaviors, facial features and voices (2012/2019)
- Community security system that interconnects each home security system through the use of home life-support robots that provide various services to the users, in addition to fire/crime prevention and in-home care support functions (2014/2021)
- Technology that promotes formation of local communities, focusing on disaster reduction, crime prevention and welfare (2011/2018)

Case 15. Vehicles that will not collide

With the progress of sophisticated information network systems for both vehicles and roads, automatic collision avoidance and automated driving will be realized, resulting in a drastic decrease in car accidents.

【Technologies/systems required for realization】

- Accident-prevention system, such as "collision at intersections," using a car-to-car communication system (2009/2016)
- Automated driving system that allows safe/smooth driving on highways, etc., by setting destinations (2012/2020)
- Generalization of a system that prevents collisions by recognizing cars' surroundings, using various sensors such as image recognition (2010/2015)

- Technology that allows objects to detect the presence, characteristics and situation of each other in order to automatically avert danger and conduct collaborative work (For instance, when a car and a bicycle or a heater and a sofa come close to each other, the two objects can communicate with each other to avert danger by setting off an alarm, stopping or extinguishing a fire.) (2013/2020)

Case 16. Tokyo-Narita 15 minutes, Tokyo-Osaka 50 minutes

With linear motor car technology, travel between Tokyo and Narita will take 15 minutes and Tokyo and Osaka 50 minutes. Linear motor cars will be adopted in other countries, resulting in the shrinking distance of the world. Furthermore, the amount of energy required to move the same distance and CO_2 emissions will dramatically decrease. (There is an estimate that the energy will decline by 50% and CO_2 emission by 70% when linear motors are introduced to the travel between New York and Washington DC[10].)

【Technologies/systems required for realization】

- Commercial operation of the Superconducting Maglev Train with a maximum speed of around 500km/h (2010/2021)

Case 17. Prediction of mudslide/flood disasters, greatly reducing damage

High performance sensor devices will be extensively embedded in all roads, buildings and hazardous areas and a network connecting them will be established, thus enabling forecasting of intensive rain falls/floods, and rapid understanding of conditions and implementation of countermeasures, which would then lead to a reduction of damage caused by mudslides/floods, etc.

【Technologies/systems required for realization】

- River flow measurement and flood forecast using satellite observation to prevent sudden occurrence of disasters (2012/2020)
- Highly precise precipitation forecast technology to allow provision of reliable flood/mudslide disaster forecast information (2012/2020)

[10] An estimation when all of today's transportation means (aircrafts and automobiles) are replaced by linear motors

- Significant reduction of human damage caused by river / road flooding through technology for short-period precipitation forecast and rainwater management (transport / storage / treatment) and advancement of warning / evacuation / regulation systems (2012/2017)
- Positioning and communication technologies that identify the location of an individual and communicate with the individual anytime and anywhere (regardless of being indoors or outdoors) in order to accurately provide emergency-positioning information and messages, such as evacuation calls to hazardous areas

Case 18. Considerable reduction of earthquake victims due to emergency response within 15 seconds after an earthquake

By networking seismographs and various infrastructures/home appliances, it will be possible to automatically stop transportation or the gas supply and automatically switch off electric heaters at home, using the 15-second interval between when an earthquake occurs and the arrival of ground shaking. Furthermore, utilization of ubiquitous technology will greatly facilitate understanding of conditions and relief activities after an earthquake, which will then minimize the secondary disaster of the earthquake and significantly reduce the number of victims.

【Technologies/systems required for realization】

- Highly precise earthquake forecast technology (for both ocean-trench earthquakes and inland earthquakes) that would lead to the reduction of human damage to predict the occurrence of a potentially devastating earthquakes of magnitudes greater than 7 (time and place) (2021/2030)
- System in which people can recognize and understand the hazards associated with natural phenomena, such as earthquakes, volcanoes and floods, and manmade accidents and can establish disaster-mitigation measures in cooperation with the government (-/2014)
- Disaster-reduction system using guiding technology/ubiquitous networking technology that allow smooth evacuation through wearable personal computers (2009/2014)
- System that allows proper implementation of accident-prevention measures, such as road closure, by predicting slope failures, based on the elucidation of the mechanism of slope failure (2012/2018)

Case 19. Houses of 200m² in size that can last for 200 years

Compact cities will emerge all around Japan with concentrated functions that allow integration of the promotion of energy saving and greenery activities of the entire community, childcare or nursing care support of the whole community and development of emergency medical and crime-prevention systems. At the same time, various working styles, including telework, will be made available, alleviating the excess concentration of population and industry in the metropolitan areas. In addition, it will be possible to live in houses 200m² in size due to the review of asset evaluation and dissemination of design technology for long-lasting houses.

【Technologies/systems required for realization】

- Teleconference system connecting multiple stations in a realistic setting with functions for information sharing and natural language conversation (2013/2020)
- A highly responsive and adaptable housing and building system responding to changes in needs due to generational changes, changes in life stages, changes in working patterns and changes in urban environment, as well as responding to deterioration over the course of time due to generational changes (2011/2018)
- In Japan, the medium- and long-term growth rate of added values created by local communities, outside of metropolitan areas, will be greater than that of metropolitan areas, owing to policy guidance and corporate decisions, represented by the development of IT and transportation systems and advancement of decentralization of industries. (-/2015)

＜Frontier＞

Case 20. Moon trip by robots

Send robots to the moon to conduct observations and have them safely return to Earth.

【Technologies/systems required for realization】

- Space and planet exploration technology by robots with comprehensive judgment capabilities similar to that of humans (2026/2034)
- Satellite system allowing on-orbit maintenance, repair works and function enhancement by robots (2017/2026)

2. Image of Japan that We Aim to Achieve in 2025

When various dreams, such as those described in the previous section, come true through innovations, the flowing future scenarios of Japan in 2025 come into sight, presenting model cases to the world.

(Note: See Reference 1 for related technologies)

○ Society where everyone can stay healthy throughout life

Provision of medical care (partially) will expand to scenes of daily life from the time when the majority of it was provided by medical institutions.

Constant checkups during sleep and preventive medical care through diet are carried out at the individual level. At the same time, information pertaining to health and hospitals can be shared as needed through a medical information network.

Preventive medical care tailored to individual needs is available anywhere. It helps those living on a remote island maintain their health in the same way as those living in urban areas.

Once the top three lifestyle-related diseases (cancer, cardiac infarction, and cerebral stroke) are overcome, there will be few life-threatening diseases left.

The developments of regenerative medical technology, an advanced human-care robot and a specific agent for dementia will drastically reduce the number of so-called “bed-ridden” people and the burden of the family members and caregivers will notably decrease.

People with accidental injuries or illnesses will be swiftly brought to the 24-hour emergency medical care institutions under the developed emergency medical information network to save their lives.

○ Safe and secure society

Automatic ID and automatic surveillance systems are in place everywhere in living environments, and crime-prevention network systems and emergency medical network systems

assist children, elderly people and handicapped people to live safely (in a community full of caring and watching eyes).

Many buildings last longer owing to sturdy material technologies with self-repair functions and the like, contributing to the development of disaster-resilient communities. Progress in advanced prediction technologies and a disaster information network will drastically reduce damages caused by natural disasters such as earthquakes, landslides, floods and typhoons.

An Intelligent Transport System (ITS) that integrates vehicles, roads and townships is being developed, contributing to smooth traffic, including the elimination of congestion, to the drastic reduction of auto accidents and to virtually no deaths caused by car accidents. Smooth traffic also contributes to a reduction in CO_2 and distribution costs.

Cards with an electronic chip enable users to make various payments and conduct public procedures under a safe and secure environment, with the protection of personal data.

○ Society that embraces diversity in life

Changing jobs has become easier owing to the diversified working patterns and improved pension portability, contributing to creating a society where everyone, including those who are raising children, elderly people, handicapped people and foreign nationals, can work with enthusiasm. Career formation has been realized due to the enhancement of a life-long education system, which enables individuals to select jobs according to their life stages.

The realization of barrier-free facilities (a living environment where handicapped people can engage freely in social activities), universal design (design that caters conveniently to people of all ages and abilities), close office-to-home proximity and an automatic transportation system enable handicapped people, elderly people and those who are raising families to continue working and makes cooperation easier, including with foreign personnel.

The solid establishment of telework (home office) arrangements has made it possible to work at home while taking care of children. The installation of a home LAN (Local Area Network) and artificial intelligence-programmed robots connected to the home LAN have reduced the time spent on house work and child care, generating more time for one's own activities. Each individual is able to afford the time to be engaged in various activities as they wish, such as

local activities and self-development programs, thus helping them live more fulfilling and abundant lives.

Retired elderly people are able to have many options of living and working, such as engagement in different career paths and participation in social contributions and hobbies. Necessary learning systems have been developed to create such options. Also, an environment where you can work without geographic and physical constraints are realized and ease of daily shopping and convenient use of banking services are securely available.

Also, for the sake of cooperation among all generations and the passing on of knowledge from one generation to the next, a community life has been established in which the experiences and communication abilities of the elderly are effectively utilized.

○ Society contributing to solving global issues

Japan has the world's top environmental technologies, and leads the world in contributing to the improvement of global-scale environmental issues, involving not only the government and businesses, but also ordinary citizens, to solve such issues as a drastic reduction of greenhouse gases, resources and energy issues, waste management issues, and water issues.

Many opportunities to learn about environment and energy are offered at the primary school stage. People have more opportunities to have contact with nature, are more interested in environmental protection, and take more active actions toward energy conservation and the 3Rs (reduce, reuse, recycle) in their daily lives. Many people, from children to the elderly, participate in environmental volunteer activities. It is a general principle that businesses take support measures on a nation-wide scale to grant leaves of absence to their employees who take part in such activities.

Japan's sustainable recycling-oriented society is the envy of the world, and many researchers from all over the world visit Japan to gain knowledge and experience on the matter. We have observed that many young people from Asian countries have studied environment at universities and companies in Japan and returned to their home countries to promote economies that are in harmony with nature.

Owing to revolutionary environmental technologies, environmental business has expanded and

the international competitiveness of Japanese corporations has improved. Our society now leads the environmental market in Asia and the world.

○ Society open to the world

The spread of automatic translation systems enables us to communicate with anyone around the world, deepening mutual understanding.

Japanese people have a broad and deep knowledge about human resources, goods, technologies, traditions and cultures in which Japan takes pride, and Japan sends its message to the world. Also, many people around the world have more direct contacts with Japanese people through travel, work and studying abroad, particularly by overcoming the barrier of the language. Living with people with different nationalities has become an ordinary part of our daily lives.

Furthermore, virtual reality technologies have been advanced, and people are now able explore the real world while at home. Japanese people can get a sense of the cultures and historical heritages of the world and the people of the world can do the same for Japan. Based on such experiences, the number of Japanese people who excel in an international arena is increasing. At the same time, the number of foreign nationals coming to Japan and doing well in Japan is dramatically on the rise.

V. Basic Strategies for Innovation Promotion

We must overcome challenging hurdles in terms of technology, institutions and society in order to realize "Japan in 2050," as described in part IV.
People (ordinary citizens) have their own "dreams" and "expectations" that vary from the 20 cases provided, and we can expect high hurdles on the path to realizing them.

There needs to be some sort of breakthrough in every field of basic research/technology development, institutional design, development of concerned human resources and awareness-raising. It is certainly fair to say that the conventional efforts would not enable us to overcome these hurdles in a mere 20 years.
Constructive social transformation can be achieved only when these hurdles are cleared. The hurdles (tasks) to be cleared are, more or less, attributed to common factors, rather than individual issues. With this in mind, we must develop basic strategies to promote innovation.

In doing so, the following four basic principles (major premises) must be considered.

① Integrated approach in promoting "science and technology innovation," "social innovation" and "human resources innovation"

For innovation to occur in tandem, we must promote "science and technology innovation," "social innovation" and "human resources innovation" in an integrated manner. "Science and technology innovation" produces technological seeds and develops them into the finished products/systems by removing various barriers, "social innovation" creates an environment in which innovation can emerge easily, and "human resources innovation" develops human resources who are to create innovation.

② Awareness raising of each individual citizen

In the past, Japan was long embedded in such social values as "Kanson Minpi"—"respecting the authorities and denigrating ordinary citizens," "worshipping large companies," "emphasizing school records," "the nail sticking out gets hammered down: those who stand out in the crowd

are likely to arouse opposition," and "exclusion of the different." It has been pointed out that these values are the very opposite of innovation.

In the future, the values must be transformed as follows:

- From "focus on organization" to "focus on eliciting individual abilities";
- From "inward-looking competition" to "competition and harmonization with the world";
- From "focus on preemptive actions" to "focus on openness/cooperation";
- From a "society that does not tolerate failure" to a "society that learns from failure";
- From "a culture of 'better safe than sorry'" to "a culture emphasizing speed"; and
- From "a group of people with the same values" to "an increase in opportunities to meet and integrate the different."

③ Establishment of "open" and "universal" systems

In the upcoming era of fierce competition in innovation, effective research, development and marketing are necessary. Hence, both private and public sectors should compete with the world while enhancing their strengths, and at the same time should make "open" efforts to cooperate with others both in domestic and international settings and develop business in international markets to supplement weaknesses.
In terms of the effectiveness of innovation, we should establish a universal infrastructure for every entity to create new innovation, and make it available to numerous companies, organizations and individuals aspiring for innovation.

④ Developing strategies based on "citizen's perspectives of Japan and the world"

In the future, when compiling government policies and formulating corporate project plans, one should base strategies on the "citizen's perspective" instead of the "researchers' perspective" or "suppliers' perspective." Furthermore, as represented by the global environmental issues, many of the individual's tasks do not remain confined to Japan alone, and accordingly, strategies should be developed with the world in mind.

1. Science and Technology Innovation

We are facing increasingly fierce competition in the area of science and technology, which would provide the seeds of boundless innovation; and its products, in turn, would provide the thrust for economic growth.
Under such circumstance, in order to create knowledge that can generate innovation and deliver outcomes towards solving the issues of Japan and the world, the following efforts should be strengthened after analyzing the strengths and weaknesses of international competition.

○ Ensuring diversity of basic research and strengthening research with high risks and impacts

Basic research that can inspire innovation contains the most uncertain factors among all research activities; but it is the alien and different discoveries/inventions that are more likely to lead to innovations.
Thus, basic research should be promoted widely and particularly, high risk research with originality should be strengthened.

○ Establishing research centers where the minds of the world gather

In order to effectively perform research and development activities based on the basic research and its achievements, which provide the seeds of innovation, it is necessary to recruit competent human resources from both abroad and home. To that end, Japan should develop an innovative research center with a research environment that is attractive to researchers.

○ Enhancement of research capacity through management reform in universities, etc.

In order to nurture innovations effectively, it is not appropriate for every research institution to conduct similar research activities, but each should perform its own unique research. Thus, research institutions, including universities, are expected to implement management reforms and to enhance research capacities, making full use of merits from the conversion into the independent corporate entities.

Furthermore, universities should improve international competitiveness in both research and educational components.
It is necessary to conduct support and assessment for practical research activities (without pursuing immediate gains or benefits), and to learn from the empirical evidence that it takes a long time, usually 20–30 years, before the outcomes of research papers and patents can substantially contribute to people's lives in a practical setting as tangible achievements.

○ Promotion of new projects integrating various sectors

The role of integrated knowledge in different areas is significant in innovation. Research in each individual area is expected to progress: such as life science, IT, engineering, environment/energy and service science. At the same time, cross-sectoral cooperation is also necessary to solve numerous complicated problems that we will face in the next 20 years.
In order to create innovations that would bring about changes toward a better society, we should promote new projects that are based on the standpoint of ordinary citizens and that integrate various sectors.

○ Strengthening the framework for cooperation among different businesses and exchange of different areas

Innovations emerge from integration of "different" elements. Thus, in addition to conducting simple basic research activities, Japan should activate academic societies and associations, enhance cooperation among different businesses, and promote an exchange of different areas between basic research institutions and markets, as well as strengthen the framework of inter-ministerial cooperation and human-resource exchange. This is all necessary in order to promote research activities with broad perspectives and without being confined to one area.

○ Promotion of International Collaboration Project for Science and Technology

Japan depends on other countries for most of its energy, water and food. Therefore, the world expects Japan to play an active role in solving global-scale issues in the era of globalization.
In particular, Japan boasts about having the world's leading technologies of solar cells, nuclear-power generation, energy conservation and water-treatment technologies. Utilizing

these excellent technologies and research results, Japan should take initiatives to promote the international collaboration project for science and technology with aims to solve global issues, such as environmental and energy issues, and to lead science and technology development in the world. At the same time, Japan should play a leading role in implementing the outcomes of such efforts both domestically and internationally.
On the other hand, in the weak areas, Japan needs to collaborate with people of the world through, for example, the application of overseas technologies and interpersonal exchange.

○ New international development of intellectual property/standardization activities

Japan needs to address imminent issues such as the environment and falling birthrates, and is committed to solving theses issues ahead of other countries. In this sense, too, the world needs the technologies that Japan possesses or will acquire in the future.
Thus, when trying to explore a market, we should conduct activities with a broad view of the world, including intellectual property and standardization, instead of setting an eye on the domestic market alone.
At the same time, the government, society and communities need to understand their own strengths and weaknesses and to address competition or cooperation beyond national borders.

2. Social Innovation

Science and technology alone do not generate innovation. Innovation emerges only when the results of science and technology activities reach large-scale communities and markets both abroad and at home, generating economic and social effects.
Based on this notion, various measures have previously been implemented to connect the outcomes of science and technology research with communities and markets. However, under fierce international competition in the era of globalization, bolder and speedier measures must be taken.
Furthermore, in view of emphasizing self-worth and improving productivity, all women with the motivation to work need to exercise their abilities to their full potential, particularly in a society with an aging and declining population. At the same time, elderly citizens are expected to participate even more in the social activities, and an environment must be developed to facilitate their participation.

Under these circumstances, the following efforts should be strengthened to expand the germ of innovation over society and to improve productivity in Japan.

○ Strengthening efforts for creating "service innovation"

The service industry accounts for nearly 70% of Japan's economy (GDP base/employment base), but its productivity remains low compared to other countries like the United States. The gap of the increase in productivity with the manufacturing sector is also narrow compared with other developed countries. In order to ensure sustainable economic growth, it is essential to greatly improve productivity. This is not always a drawback. When looking at it from a different perspective, it means there is much room for improvement in this area: to increase the overall productivity of Japan.

Japan should promote the creation of new businesses and promote the introduction of businesses into existing areas through active use of IT and deregulation, and promote research on service science.

While values are changing from material wealth to spiritual wealth (new value), the creation of service innovation is necessary to provide a variety of new services.

○ Speedy social reform

With respect to risks associated with new businesses, it is necessary to establish a framework to promote speedy and powerful innovations (for example, the Safe Harbor Rule[11]) to identify exclusions and promote trial and error.

In particular, the government should actively introduce a framework necessary to bringing the outcomes of research and development to society and to immediately review the regulations that would hinder the development of new businesses.

[11] Safe Harbor Rule
By pre-determining some regulations and the scope of tolerance, Safe Harbor Rules renders an entity exempt from liability otherwise incurred, unless maliciously intended, thus promoting free activities by assuring the entity that it shall not be subject to liability as long as it is in compliance with certain rules. This is also known as the Safe Heaven Rule. For instance, in order to protect a provider from being sued for invasion of privacy or for defamation by an individual or organization due to information written on the website, the liability of the provider is limited as long as it complies with certain rules (so-called Law to Limit Liability of Providers). This law is said to have removed impeding factors to the penetration of the Internet and promoted an information society.

○Establishment of new systems to induce innovation

There is a view that the procurement of the US Department of Defense has greatly contributed to prompting innovation.
Also, the public sector's efforts to present benefits of technically demanding new technologies or of those that have yet to be marketed and to create initial demand are significant in not only contributing to the policy goals of each sector but also to stimulating private innovations.
Thus, Japan should establish new systems (including promotion measures) that can induce innovation[12] through industry-academia-government cooperation, for example through utilization of special district systems, creation of initial demand by the government, and research and development based on the needs of the procurement entity.

○ Framework for supplying funds to support challenges

A challenging framework is necessary in order to generate innovation. This encourages a bold and radical attitude to depart from the existing ideas, without sticking to them.
Such challenging tasks require funds at each phase of research and development and commercialization. Needless to say, a framework should be developed so that necessary funds, including those from individuals and corporations, can be properly allocated.

○ Development of a framework for a new work style

In order for Japan to maintain its innovative society amidst globalization and declining birthrates with the aging population, it is crucial to draw out the maximum potential of individuals, regardless of age or gender. Thus, it is necessary to develop a social environment that provides flexible work styles with opportunities to start over in order to maximize motivation and work opportunities for everyone.
At the same time, it is necessary to promote a work-life balance, involving concerted efforts of

[12] Systems that would induce innovations
For instance in the United States, the "Americans with Disabilities Act" was enacted. It guarantees the rights of all persons with disabilities and stipulates that products and services procured by public-sector entities shall be usable by people with disabilities, thereby promoting companies and business entities to apply the concept of universal design.
In Singapore, specifications of IC cards were standardized in 1997, allowing people to shop and use transportation means with one card. It is said that this has contributed to the realization of a cashless society.

the public and private sectors to expand the ways of spending time other than for "business," such as local activities, intergeneration exchange, social contributions through volunteer activities, family pastime, and hobbies.

Furthermore, there are times when innovations emerge from a local community, and a group of people give rise to and nurture new work styles, market formation and businesses. This includes social entrepreneurs[13], and there have been many in the world; some are emerging in Japan.

To promote this system, it is necessary to develop a practical education and training system as well as an employment system as quickly as possible, so that motivated individuals can solidly acquire competitive skills and knowledge and can serve as the engines of a society in which forms of employment are becoming diversified.

Also in order to exercise the capabilities and experiences of individuals to their fullest, a framework should be developed in such a way as to utilize personal resources to the maximum extent: for example, the promotion of personal exchanges between industry, academia and government, and diversification of career paths by eliminating the disadvantages of changing jobs.

Moreover, it is necessary to introduce and disseminate recruitment systems in every sector based on diversified work styles, such as telework, and employment agreements responding to career development in which individuals are able to develop themselves and select jobs from a range of employment opportunities.

At the same time, ensuing a secure safety net to help an individual make a comeback after failure would continue to be an important role of the government.

○ Development of environment that promotes business activities open to the world

Universities and companies in the globalized era need self-help efforts to create innovation, and they need to compete and be evaluated in an international market.

To that end, the government should promote the development of an environment where these organizations can carry out corporate activities as well as distributional, educational and cultural activities that are open to the world.

[13] Social Entrepreneur
An individual who tries to solve social issues through a project. The Grameen Bank, which helped the poor through micro-credit systems and won the Nobel Peace Prize in 2006, is an example.

○ Promotion of efforts that “activate local communities,” e.g., regional system

Needless to say, efforts responding to local characteristics are essential to promoting innovation from the viewpoints of ordinary citizens.
Thus, the government should promote efforts toward activation of local communities through utilization of local characteristics, which promote decentralization in a true sense, for example, the introduction of the regional system.

○ Promotion of research concerning design of social systems that induce innovations

The following research activities are necessary: 1) reform of mind-set and values; 2) promotion of system design consistent with society, 3) promotion of understanding about science and technology, and 4) establishment of social technologies for appropriate risk-management capacity. They are all required to create an environment that facilitates innovation.

3. Innovation in Human Resources

"Human resources" make up the main player in innovation. In order to establish a society that generates a chain of innovative ideas, instead of a single or accidental act of innovation, the following efforts should be strengthened upon clearly specifying what kind of human resources should be developed and how they should be developed, as described in section I.

○ Development of human resources who can accept diversity and be a "nail sticking up"

The starting point of innovation is, needless to say, an idea of an individual and efforts to realize the idea; but the driving force of an idea is an individual who can accept diversity and become a "nail sticking out."
In order to develop such an individual, the following efforts should be made to help young people acquire the capacity to think and act for themselves through encounters with "different elements" and "opportunities for integration."

- Expanding exchange opportunities with people from abroad as early as elementary education
- Transforming education from memory-based learning to education that stimulates thinking, and strengthening mathematics and science education at elementary, junior- and senior-high schools
- Enhancement of experiential learning to know the authenticity of humans, goods, technologies, tradition and culture
- Improvement of teaching staff and strengthening life-long learning
- Increase in exchange and home-stay opportunities of junior- and senior-high school students

○ Human resources development with broad knowledge and deep expertise

Some argue that the inflexible division between humanity courses and science courses narrows the choices of classes at senior-high schools and universities as well as subsequent career paths (employment choices, etc.).
Since human resources with deep expertise after acquisition of broad and basic knowledge are needed in the future, the following measures should be implemented.

- Take most advanced science and technology courses by the end of senior high school and implementation of internship experience
- Review of division between humanity courses and science courses
- More active use of AO Entrance Examination of universities[14]
- Strengthening of university education (encouragement of wide range of liberal arts education and multiple majors, etc.)

○ Development of environment to accept outstanding human resources from abroad

In the age of competition over knowledge, the world competition to gain human resources (professors/students) is becoming increasingly fierce. In order to improve international competitiveness of Japanese universities under these circumstances, the government should promote bold measures to globalize universities by, for example, developing an environment to accept outstanding human resources (offering classes in English, etc.).

○ Development of sense of independence and nurturing entrepreneurship through provision of internship at an early stage

The government should take measures toward educational systems in which people can realize the value of challenges and successes rather than leading stable, organized lives and can have pride and motivation in their work. The government should also create an environment for experiential learning, such as though internships, and should develop human resources with wide ranges of knowledge and entrepreneurship, who would be the driving force in creating innovation.

○ Establishment of life-long learning systems using local universities

When life expectancy extends and an individual acts according to his/her own aptitude, with a

[14] Admission Office (AO) Entrance Examination
In general, it is viewed as one of the selection methods in which capacity/aptitude, learning motivation and sense of purposes of applicants are comprehensively evaluated by combining the detailed screening of application documents and intensive and time-consuming interviews, without putting too much emphasis on academic achievements tests. ("Improvement of University Entrance Examination," Report of the University Deliberation Council, November 22, 2000)

sense of mission, the supply of new knowledge would make it is possible to further widen the potential for challenge.

The government, therefore, should establish a life-long learning system that responds to the needs of the time, while utilizing the resources of education of local universities.

VI. Policy Issues to be Addresses Urgently

Based on “V. Basic Strategies for Innovation Promotion,” the issues urgently required in order to realize a country based on innovation are as outlined below.

1. Making the Environment an Impetus for Economic Growth and International Contribution

Environmental and energy issues, such as global warming and climate change, are among the most crucial contemporary issues, and responses to these environmental issues will gain even more importance in the process of achieving sustainable economic growth of the world.
In Asia in particular, which is projected to grow considerably in the future, demand for energy will increase drastically. Along with this, demand associated with environmental and energy-related measures is anticipated to increase.

In the meantime, Japan has some of the world’s highest levels of technology in areas such as clean energy, green technology, nanotechnology and biotechnology, and there are good opportunities for Japan to make inroads into the environmental business.
With its world’s leading environmental and energy technology, Japan should contribute to the solution of global issues and should make the environment an impetus for economic growth, both in Japan and worldwide.

＜Major Agenda＞

① Promotion of technical cooperation, international joint research, joint verification, etc. (utilization of ODA, etc.)
② Development of international leaders in the area of the environment
③ Acceleration of the speed of the international application of environmental technology (international standardization, etc.)
④ Framework for the promotion of environmental business
⑤ Strengthening of environmental diplomacy

2. Doubling Investment in Next-Generation Sectors (investment in young people, efforts for expanding IT use)

The basis for rolling out new innovations one after another is the "individual," and the key to maintaining economic growth in the future in spite of the population having entered a deceleration phase is the power of "individuals" who are fostered in Japan and actively playing leading roles.
From a policy viewpoint of Japan as a whole, emphasis should be shifted from the prioritization of "materials" such as infrastructure hardware to the prioritization of investment in science/technology and education, with focus on "individuals", who are the sources of competitiveness. In particular, investment in young people who are to play a leading role in the next generation should be doubled.

At the same time, now that the Internet revolution is taking place, the basic infrastructure that would continue to increase productivity in the future is IT, and therefore Japan should promote use of IT in areas where IT is not being sufficiently used, and should strengthen the building of frameworks so that various private- initiated new ideas for IT use can be commercialized.
In doing so, it is necessary to shift the orientation from traditional hardware to software with an emphasis on systems.

＜Major Agenda＞

① Full-fledged expansion of international youth exchanges
- Expansion of junior- and senior-high school exchanges with Asian countries
- Dramatic expansion of university exchange programs, etc.

② Increase in opportunities for youth to take initiatives, such as the expansion of scholarships, etc.
③ Improvement of mathematics and science education
④ Promotion of IT use which would lead to productivity increase (development of open and universal IT infrastructure, etc.)

3. University Reform

Universities in the world are in the process of dynamic transformation into centers of international university consortia through industry-academia collaboration with international

companies and competition and collaboration between international students, business people and domestic students. Under these circumstances, Japanese universities will inevitably face competition.
Japanese universities should be open to the world and be rebuilt as places for the creation of new dynamism by accepting many foreign students to interact and positively compete with fellow students, thus developing energetic and diverse human resources.

＜Major Agenda＞

① Promotion of internationalization at the graduate and undergraduate levels
② Strengthening international competitiveness in terms of both education and research programs at universities
③ Review of divisions between humanities and science/engineering
④ Further use of AO Entrance Examination for university admission
⑤ Strengthening of research functions involving review of competitive allocation of funds
⑥ Strengthening of educational functions involving enhancement of adult education

4. Drastic expansion of investment in science and technology so as to ensure successful innovation 20 years from now

It is empirically evident that in the case of the sort of science/technology-initiated innovation that radically changes society, it takes considerable time for the outcomes of basic research reach society.
Japan should undertake full-fledged expansion of investment in basic research activities that are the seeds of innovation in the future and in cutting-edge science and technologies and formulate an effective framework so that the outcomes thereof can reach society in a precipitous fashion.

Since innovations always entail the risk of failure, appropriate investments and implementing systems are necessary.

＜Major Agenda＞

① Assurance of diversity of basic research so as to produce incipient innovation that will bloom 20 years down the road particularly by way of active support for young researchers who would be the primary players in 20 years

② Review of evaluation systems for new technologies, government support for creating initial demand, development of a framework to promptly convey the achievements of basic research to society
③ Strengthening of efforts in the areas of advanced science and technology
④ Framework aimed at promoting private investment in research and development programs in accordance with specific business types
⑤ Facilitation of cross-sectoral and cross-organizational exchange

5. Review of various regulations, systems and rules for the creation and promotion of innovation

Some regulations, while they functioned appropriately and effectively at the time of enactment, must be reviewed in consideration of the fostering of innovation in response to the dramatic changes in circumstances represented by globalization and Japan's declining and aging population.

The basic goal of the review process is to encourage and support innovative activities and to improve international competitiveness in this globalized world.

＜Major Agenda＞

① Review of regulations aimed at promoting "service innovation"
② Review of regulations to facilitate distribution systems
③ Social systems aimed at promoting expedient and robust innovation (utilization of special districts, etc.)
④ Review of systems related to work patterns aimed at generating innovation

6. Development of promotional systems to build an "innovation-oriented country"

In order to promote "science and technology innovation," "social innovation," and "human resource innovation" in an integrated manner and to continue promoting "an innovation orientation" over the next 20 years, it is necessary to develop a system to comprehensively

promote cross-ministerial measures and to realize a PDCA cycle.

The Innovation 25 Strategy Council plans to deepen further discussions in consultation with concerned government organizations and to formulate a final report by the end of May.
Based on this final report, we expect the government to formulate strategy guidelines and implement measures aimed at building an “innovation-oriented country” at the earliest time possible.

Reference Materials

Reference 1

Examples of the technology necessary to realize the "Japan in 2025: A Nation Based on the Exploitation of Innovation" vision

1. Society wherein all can stay healthy throughout life

【Constant health checks and remote medical services】

- Micro-machine technology for health management devices
- Technology which enables home health management and diagnosis at a time of emergence of abnormalities
- Advanced security technology capable of making a card available for use which records individual medical data such as health check results, clinical history and prescriptions.
- Technology that supplements vital functions such health condition monitoring or pacemakers through the use of bioenergetics such as body temperature or bloodstream
- Highly reliable network technology that enables doctors to make diagnoses via the Internet based on medical data measured at home
- Advanced security technology for wide-range information systems which provides individuals with access to their own electronic charts at home
- Various sensor and manipulator technology for performing surgery via remote-controlled micro machines

【Overcoming three major lifestyle-related diseases】

- Technology for tailored cancer therapy
- Gene therapy technology enabling localized treatment approaches for arteriosclerosis focus
- Technology for gene therapy for cancer
- Technology to produce bioceramics, which have nearly the same functions as human bones
- Gene therapy technology for familial hypercholesterolemia

【Drastic decline in bedridden patients】

- Regenerative medical technology for transplantation of neural stem cells in order to enhance recovery from motor paralysis
- Technology for voluntarily control prosthetic limbs without use of spinal cord/peripheral nerves by way signalizing and conveying motor-related brain activity
- Technology for nursing robots that help a person in need of care to take a bath, etc., without giving the person discomfort or anxiety.
- Permanent cure for Alzheimer's disease
- Technology for quantification of psychological stress applicable to mental illness/dementia

2. Safe and secure society

【Safety of living environment】

- Automated security systems designed to detect suspicious activity before anything happens through networked surveillance cameras
- Technology that helps locate wanted criminals/material witnesses by analyzing the descriptions, behavior, facial features and voices of people captured by surveillance cameras installed in public spaces
- Community security systems that interconnect home security systems through the use of home life support robots that provide various services to users, in addition to fire/crime prevention and in-home care support functions
- Technology that allows objects to detect the presence, characteristics and status of other objects so as to automatically avert dangerous situations and conduct collaborative work (for instance, when a car and a bicycle or a heater and a sofa come into close proximity of each other, the two objects can communicate with each other in order to avert danger by setting off alarms, stopping, or extinguishing fire.)

【Food safety】

- Technology for home food freshness testing kits
- Technology to produce allergy free food based on allergen measurement technology
- Tracing technology that links electronic information rendered to electronic tags placed on products or foods with distribution/POS/home delivery services (ingredients and recycling, etc.)

【Longer life of structures/safety of products】

- Housing and building technology that is responsive to changes in needs and deterioration over the course of time due to generational change, changes in life stage, changes in working patterns and changes in urban environment, etc.
- Monitoring, evaluation, conservation technologies for structural/environmental performance
- Seismic isolation/control technologies that bring about dramatic improvement in building safety and property protection
- Maintenance and control technology that extends the life of infrastructure assets
- Sensor network technology designed to monitor fatigue and deterioration by embedding IC tags into all building materials for houses and buildings, which also enables recycling or separation of recyclable materials

【Countermeasures against mudslide/flood】

- River flow measurement and flood forecasting technology using satellite observation to prevent the sudden occurrence of disasters
- Long-range disaster monitoring network technology using satellite images/radar with an emergency evacuation guide system
- High performance precipitation forecast technology/short-period precipitation forecast technology and rainwater management technology (transport/storage/treatment) and advanced technology for warning /evacuation/regulation systems
- Positioning and communication technologies that can identify the location of individuals and communicate with them anytime and anywhere (regardless of whether they are indoors or outdoors), in order to provide accurate emergency positioning information and messages, including evacuation calls to hazardous areas.

【Anti-earthquake measures】

- Highly precise earthquake forecasting technology (for both ocean trench type earthquakes and inland earthquakes) to predict the occurrence of potentially devastating earthquakes of magnitudes greater than 7 (time and place) (2021/2030)

- Seismo-geodetic sensor technology designed to predict earthquake several minutes before they occur
- Technology to predict the occurrence of medium-term (within 5-10 years), large-scale (greater than M8) earthquakes
- Comprehensive control technology for buildings equipped with earthquake detection systems
- Technology for disaster prevention message networks achieved by way of detecting seismic shockwaves prior to their reaching the surface
- Personal mobile computer-based information transmission/navigation technology with the potential to assist with evacuation activities
- Technology to detect risks prior to rockslides, base on elucidation of the mechanisms of rockslides

【Road traffic safety】

- Systems designed to prevent accidents such as intersection collisions through the use of car-to-car communication technology
- Technology to prevent collisions by way of car surroundings recognition through the use of various sensors such as image recognition devices
- Automated driving technology that allows for safe/smooth driving on highways, etc. by way of setting destinations

【All-purpose card】

- Highly reliable network technology and advanced security (personal verification, etc.) technology for multifunctional smart cards with electronic settlement functions that are usable in almost all transactions and trade setting worldwide
- Advanced security (personal verification) technology for electronic money that allows for anonymous financial transactions with the same level of reliability as conventional money

3. Society with diverse lifestyles

【Collaboration with overseas human resources】

- Speech-recognition technology/artificial intelligence technology that allows for speech input/output
- High precision image recognition/image processing technology that can ascertain the intentions of a person based on biological information as well as non-verbal traits such as facial expressions and eye movement
- Technology for international communications designed to promote mutual understanding by way of outlining the cultural traits, customs and social norms that underpin speeches on a screen as opposed to basic linguistic translation
- Search engine technology designed to facilitate multilingual Internet searches in specific languages and Data Base (DB) technology aimed at establishing a knowledge repository system allowing for instantaneous extrapolation of the necessary information from around the world

【Childbirth/childrearing support, work-life balance (harmony of work and personal life)】

- Highly reliable network technology which allows doctors to make diagnoses based on medical data measured at home, allowing for safe and secure childbirth and pediatric care anytime and anywhere
- Advanced security technology for wide-area information system allowing individuals to have access to their own electronic charts at home
- Home helper robots to assist with cleaning, washing, gardening, and caring for sick persons in the home
- Home security systems that includes home helper robots designed to ensure safety of children at home
- High-speed network technology, three-dimensional/super high-vision technology that offers multi-station teleconference connection in realistic settings together with information sharing and natural language conversation functions

【The elderly/handicapped persons】

- Ubiquitous computing technology that provides information so that elderly and handicapped persons (with visual impairments) can safely and freely move about in urban public spaces
- Human interface technology, such as information-oriented computers and software, that

- High performance mobility/walking-aid device control technology capable of drastically expanding the social lives of elderly and handicapped persons
- Mechatronic, regenerative and bio-interface technology designed to supplement the five senses, including vision and hearing, aimed at overcoming the handicaps of the elderly and handicapped persons
- Regenerative medical technology for neural stem cell transplantation aimed at enhancing recovery from motor paralysis
- Technology for voluntarily control of prosthetic limbs without use of spinal cord/peripheral nerves by way of signalizing and conveying motor-related brain activity
- ITS (Intelligent Transportation Systems) technology that supplements the driving ability of those who have difficulty in driving regular cars due to aging, etc.
- Tracing technology that links electronic information rendered to electronic tags on products or food with distribution/POS/home delivery services (ingredients, recycling, etc)

【Advancement of life-long education system】

- Search technology that enables the use of networked and various globalized information sources (websites, etc.) in the form of an encyclopedia
- Technology designed to automatically extract meta-data (structured data pertaining to data) from visual and sound content
- Simulation technology that allows one to experiment with and experience events which would be hard to accomplish in a real life in virtual reality space, in order to improve scientific thinking
- Search technology that satisfies advanced access needs, such as search technology allowing a person watching a video and wants to search information relevant to the video to receive tailored search results by way of an amassing of information on the searcher, such as the person's interests, skills and search contexts, by way of sensors

4. Society contributing to the solution of global issues

【CO_2 Reduction】

- Small cogeneration system technology for home use

- Artificial photosynthesis technology with a solar-energy conversion rate of 3% or more (that of plant photosynthesis is around 1%)
- Technology for large area film solar cells with high conversion efficiency (more than 20%/year)
- Fuel cell mounting technology for modes of transportation such as automobiles and ships
- Power generation and synfuel production technology through gasification of colas, biomass, and waste materials
- Technology for burying CO2 at the ocean floor
- Relatively small nuclear system technology usable in the production of hydrogen
- Technology related to nuclear fusion reactors

【Waste treatment】

- Recycling technology for the effective collection and reuse of resources/energy from waste materials
- Eco-material technology with low environmental loads such as easily recyclable plastics and photocatalytic materials
- Plant/microorganism utilization technology designed to purify polluted soil/underground water/air
- Technology designed to produce polylactide plastic from ordinary wastes
- Technology designed to produce recyclable composite materials from wood

【Water/food】

- Compact waste water treatment technology designed to eliminate wastes generated from water treatment by effectively treating persistent substances and hazardous substances and by completely and effectively utilizing generated sludge
- Economic and practical technology for desalination of sea water and purification of polluted water by way of reverse osmosis membranes
- Genome technology designed to develop groundbreaking plants with high yields even under poor conditions and disease–resistant plants that do not require pesticides

【Promotion of contact with- and interest in the natural environment】

- Technology for comprehensive management of river basins that ensures the quality and quantity of water necessary to allow persons to swim in local rivers
- Visualization technology for environmental information, such as comprehensive monitoring/report systems for air pollution substances through sensors installed in houses and on the streets

5. Society open to the world

【Automatic translation】

- Speech-recognition/artificial intelligence technology designed to allow for automatic translation with speech input/output capabilities
- Technology for international communication aimed at promoting mutual understanding by way of outlining the cultural traits, customs and social norms that underpin speeches on screens as opposed to simple linguistic translation
- Search engine technology designed to facilitate multilingual Internet searches in specific languages and Data Base (DB) technology aimed at establishing a knowledge repository system allowing for instantaneous extrapolation of the necessary information from around the world

【Virtual reality】

- Technology that allow us to enjoy art or music in remote areas, allowing one, for example, to enjoy art as if actually walking around an exhibition hall and to listen to live music as if sitting in a concert hall
- Simulation technology allowing one to experiment with and experience events which would be difficult to accomplish in a real life in virtual reality space, in order to improve scientific thinking
- Three-dimensional/super high-vision technology for the home that does not require glasses
- Technology designed to automatically extract meta-data (structured data pertaining to data) from visual and sound contents
- High-speed network technology, three-dimensional/super high-vision technology that offers multi-station teleconference connection in realistic settings together with information

sharing and natural language conversation functions

Reference 2

Examples of improvements in productivity / economic effects of innovations

1. Labor force

Life expectancy will be extended as a result of people becoming free from diseases like cancer/cardiac infarctions/cerebral strokes as well as slower aging of bones thanks to regenerative medicine. Work patterns will be diversified due to the promotion of telework. There will be fewer household chores along with the full-fledged introduction of robots into people's homes. Thus, the non-working population (females and elderly persons) will join the labor force, all of which will contribute to an increase in the labor force population despite the population decline, thus increasing the GDP as a result.

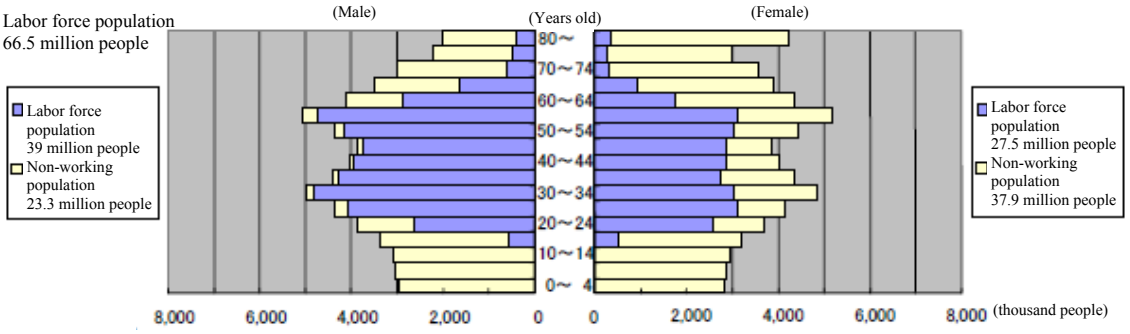
If half of the non-working population (female and elderly persons aged between 60 and 75) joins the labor force in 2025:
2005: approximately 66 million people ⇒ 2025: approximately 70.5 million people
(In the case wherein participation in labor market is slow, this total would be around 5.9 million people, resulting in an increase of 11.5 million people (male:2.8 million people/female:8.7 million people))

(Reference) Average life expectancy
1947: Male 50.06 years, Female: 53.96 years
2005: Male 78.53 years, Female: 85.49 years
Due to these changes, it would be more realistic to change the definition of population of productive age from the current 15-65 to, for example, 20-75.

Source: Population is based on the "Estimated Population Data Base," the National Institute of Population and Social Security Research
Labor force population for the year 2005 is based on "Annual Report on the Labour Force Survey 2006," Statistics Bureau, Ministry of Internal Affairs and Communications

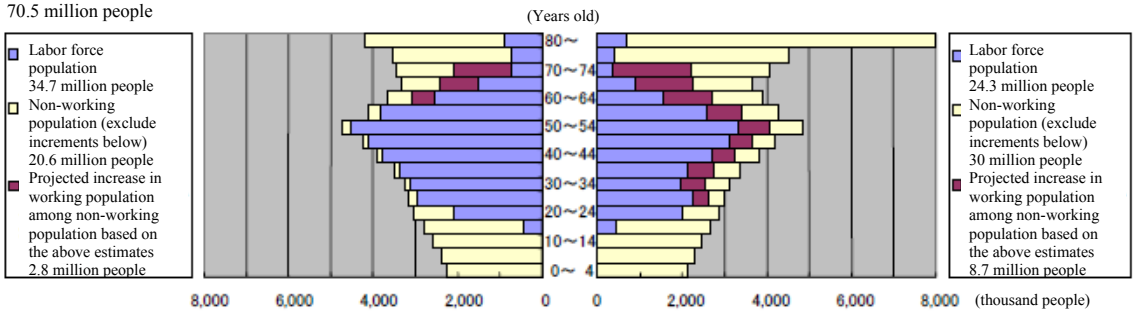
○ Year 2005

Labor force population
66.5 million people



○ Year 2025

Labor force population
70.5 million people



2. Traffic

It is possible to dramatically reduce economic losses from traffic accidents (human and physical damages) and traffic congestion due to progress and introduction of advanced information network technologies for both vehicles and roads.

- Economic loss from traffic accidents: approximately 4.3 trillion/year
- Economic loss from traffic congestion: approximately 12 trillion yen/year

Source: Traffic accident statistics, "Research Paper on Economic Loss from Traffic Accidents 2001", Cabinet Office
Traffic congestion statistics, "Outline of Congestion Data 2002", Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism

3. Tourism

The amount of spending on tourism in Japan is expected to increase to approximately 2.7 trillion yen (estimation of FY 2005) if the number of foreign tourists visiting Japan increases at the same level as the number of Japanese tourists visiting foreign countries due to a reduction of language barriers facilitated by automatic translation devices and the enhancement of the branding and message framework necessary in order to propagate information on Japanese culture (animation/food).
New service businesses, etc. aimed at attracting increasing numbers of foreigners are also expected to emerge.

- Amount spent on tourism by foreign tourists visiting Japan: Approximately 1.6 trillion yen
- Number of foreign tourists visiting Japan: 6.73 million people
（Per-capita spending: approximately 244,000 yen）

Number of Japanese tourists visiting foreign countries: 17.4 million people

Source: "Research Paper on Economic Effects of Tourism Industry (December 2006)", Ministry of Land, Infrastructure, Transport and Tourism
"White Paper on Tourism FY 2006" Ministry of Land, Infrastructure, Transport and Tourism

4. Employment and Commuting

Economic predictions include an increase in teleworkers due to the introduction of IT, the reduction of commuting costs, the reduction of the global environmental load, the promotion of the employment of women and the elderly, the alleviation of difficulties in returning home at times of disaster and local revitalization due to an increase in employment in non-urban areas. Reclaimed commuting time will be converted into free time, learning opportunities will increase and lifestyle diversity will be promoted, leading to an activation of life as a whole.

When the proportion of teleworkers increases from 6.1% to 20%,

- Volume of commuting traffic: 45 million trips/day ⇒ 42.88～41.33 million trips/day
- CO_2 reduction: 3.21～4.42 million/year (equivalent to 2.0～2.7% of the emission of the travel sector)
- Female teleworkers: 1.04 million people⇒4.57 million people
- Elderly teleworkers: 220,000 people⇒1.11 million people
- Number of people faced with difficulties in returning home at times of disaster: 4.18 million people⇒ 3.85～3.52 million people

Source: "The Telework Guide Book (2005)," Japan Telework Association

The proportion of teleworkers in 2005: 10.4% (Ministry of Land, Infrastructure, Transport and Tourism)

(Reference) Average commuting time of four prefectures in Tokyo metropolitan areas (Tokyo, Saitama, Chiba, Kanagawa): 1 hour 18 minutes
(Male: 1 hour 30 minutes, Female: 1 hour 1 minute)

Source: "2001 Survey on Time Use and Leisure Activities," Statistics Bureau, Ministry of Internal Affairs and Communications

5. Disaster reduction

Using the 15-odd seconds that it takes for the large seismic waves of an ocean trench-type large-scale earthquake to reach the surface, bullet trains will be stopped and large-scale construction work will be immediately suspended, which will drastically reduce damage. Also by using this time to prepare for prompt post-earthquake response operations, the magnitude of

the ensuing disaster will be reduced substantially.

Disaster reduction goals for the next ten years concerning estimated economic damage from Tokyo metropolitan earthquake (North Tokyo Bay Earthquake: M7.3/wind velocity 15m/s), based on the current level of technologies.

112 trillion yen ⇒ 70 trillion yen (reduction of 42 trillion yen)

Source: "Earthquake Disaster Reduction Strategies for the Tokyo Metropolitan Earthquake (April 2006)

6. Environment

According to the Stern Review[15], it will be necessary for the world to spend 1% of its GDP on a yearly basis by the year 2050 in order to stabilize greenhouse gases. If this is not done, long-term economic losses would amount to 5-20% of the global GDP. However, when looking at this from a different perspective, this can serve as a good opportunity for Japanese industries that possess strength in environmentally friendly technology.

7. Medical Care

(1) Dissemination of medical IT systems

Use of electronic data in medical institutions, such as electronic medical charts, will spread and the handling of health data will be made easier, contributing to increased availability of remote healthcare.

・Market size of medical IT technologies in Japan : Approximately 1.2 trillion/pear (2010)

Source: Compiled from "Healthcare Information Systems", BCC Research (US research company): the figure is based on the size of medical IT technology market in the US (US$34.7 billion) and the size of the medical device market in Japan (about 1/3 of the US).

[15] See footnote 4 in the main text of the Interim Report (page 32)

(2) Market expansion through regenerative medicine and nursing-care robots, etc.

The spread of regenerative medicine for bones, cartilage, skin and teeth, and of technology designed to cultivate and transplant autologous tissue will enable the elderly to maintain the healthy body of a 50 years old.

- Size of regenerative medicine market in Japan: approximately 620～855 billion yen/year (2020)
- Size of nursing-care robot market in Japan: 93.2 billion yen (2025)

Source: According to a market survey (questionnaire) conducted jointly by Nikkei Inc. and Mitsubishi Research Institute, Inc., it is estimated that the size of the markets for artificial organs and regenerative tissues in Japan will be 855 billion yen in 2020, and that of the world will be 3.26 trillion yen. An estimation by another marketing company arrived at a total of 620 billion yen. (Improvements in labor productivity from the application of regenerative technology were not taken into consideration in these surveys.)

The size of nursing-care robot market was based on the "Report of Next Generation Robot Vision Group (2004)", Ministry of Economy, Trade and Industry

(3) Countermeasures against lifestyle-related diseases

Worries about diseases such as cancer, heart attacks and strokes will be eliminated; for example, the development of groundbreaking medicine with few side effects suitable for individual constitutions will allow for surgery-free cancer treatment.

- Effects from reduction of medical expenses due to countermeasures against lifestyle-related diseases : approximately 2 trillion/year (2025)

Source: Documents used for deliberations on medical systems by the Ministry of Health, Labor and Welfare (2006)

(4) Decline in the number of bed-ridden elderly

It is estimated that the number of bed-ridden people or those heavily in need of nursing-care will reach 2.7 million by 2025. However, with the advancement of regenerative medicine and

the development of specific drugs for dementia, many of them will be able to live without becoming bedridden or needing care.

Given that the number of people requiring nursing care will be reduced by one million and assuming that the benefits for a person heavily in need of nursing-care is about 300,000 yen/month, the social cost reduction due to the reduction of the number of bedridden elderly people would be approximately 4 trillion yen/year (2025)

Source: The projected number of people in need of nursing care, such as those with dementia, in 2025 is based on documents from the Ministry of Health, Labor and Welfare

Reference 3

Process of Deliberations of the "Innovation 25 Strategy Council"

- Fist meeting : October 26, 2006 (Thursday)
- Second meeting: November 9, 2006 (Thursday)
  - ➢ Presentation
    - ✧ Mr. Toshiaki Ikoma: Director-General, Center for Research and Development Strategy, Japan Science and Technology Agency
    - ✧ Mr. Ken Sakamura: Member, Innovation 25 Strategy Council

- Third meeting: November 30, 2006 (Thursday)
  - ➢ Presentation
    - ✧ Mr. Kazuhito Hashimoto: Professor, Research Center for Advanced Science and Technology, The University of Tokyo
    - ✧ Mr. Ikujiro Nonaka: Professor Emeritus, Hitotsubashi University

- Forth meeting: December 21, 2006 (Thursday)
  - ➢ Presentation
    - ✧ Mr. Tadashi Okamura: Member, Innovation 25 Strategy Council
    - ✧ Mr. Ichiro Kanazawa Member, Innovation 25 Strategy Council

- Fifth meeting: January 16, 2007 (Tuesday)
- Sixth meeting: January 31, 2007 (Wednesday)
  - ➢ Presentation
    - ✧ Ms. Chiyono Terada: Member, Innovation 25 Strategy Council
    - ✧ Mr. Koichi Kitazawa: Vice Chairperson, Committee for the Investigation of Innovation Promotion, Science Council of Japan
    - ✧ Mr. Minoru Kuniya: Director General, National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology
- Seventh meeting: February 19, 2007 (Monday)
- Eighth meeting: February 26, 2007 (Monday)