Feature2 Science and Technology Development toward the Tokyo Olympic and Paralympic Games in 2020

The Tokyo Olympics (1964)
Courtesy of Kishimoto Corporation

Japan made significant advances in preparing for the 1964 Tokyo Olympic Games. The Shinkansen, automobile expressways and other infrastructure were developed, and Tokyo, which then had the vestiges of a historic townscape, was transformed into a modern city. In addition to demonstrating the remarkable reconstruction and development of post-war Japan, the Tokyo Olympics marked a major turning point for Japanese society, which had been devastated by war and was in the process of recovering its confidence and achieving economic development.

In addition to being major world sporting events, the Olympic and Paralympic Games have served as magnificent opportunities to send messages to the international community. Also, science and technology, which have the potential to revolutionize societies, have made great contributions to the success of the Olympic and Paralympic Games.

The 2012 London Olympics, which aimed to be "the most environmentally friendly Olympics in history," drew global attention by obtaining the ISO 20121 Event Sustainability Management Systems international standard. In formulating ISO20121, which was issued in June 2012, the London Organizing Committee of the Olympic and Paralympic Games (LOCOG[1]) played a leading role. As the organizer of the Games, the LOCOG made full use of cogeneration systems and cutting-edge environmental energy, such as renewable energy. Thus, the LOCOG successfully demonstrated to the world that the London Olympics were "green games."

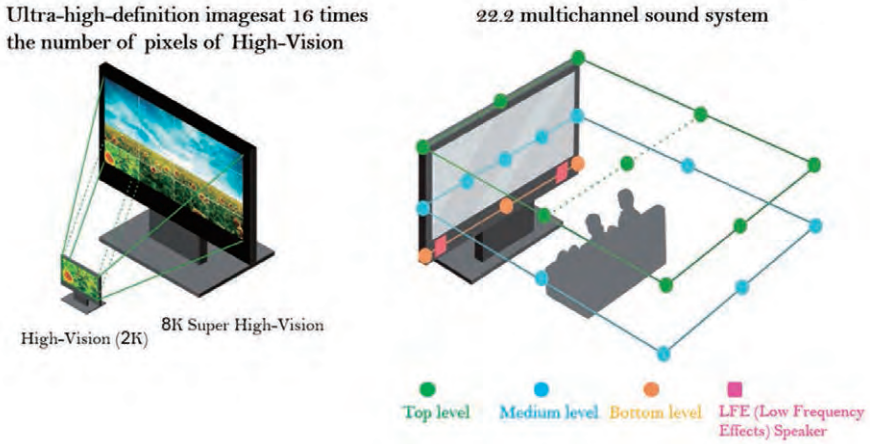
In addition, the London Olympics were the first truly "social Olympics" and "digital Olympics." Olympic broadcasts could be enjoyed on smartphones, so people could watch the games wherever they happened to be. Also, people could interview players via Twitter, which opened the possibility of new ways of watching the games. In addition, NHK (Japan Broadcasting Corporation), the BBC (British Broadcasting Corporation) and the OBS (Olympic Broadcasting Services) jointly organized public viewings in 8K Super High-Vision[2], a technology that employs ultra-high-definition imaging technology and a three-dimensional sound system, in the United Kingdom, Japan and United States. Visitors at the viewing sites were able to experience great thrills, as if they were at the Olympic site. This imaging technology, which was developed in Japan, demonstrated to the world the high technological level of Japan.

Science and technology were used in infrastructure development for the 1964 Tokyo Olympics. At the London Olympics, environmental technology, information and communications technology and imaging technology were fully utilized. Thus, science and technology have played a major role in the success of the Olympics. Science and technology are also closely connected with society, sometimes serving as a catalyst that can transform society, as in the case of the Tokyo Olympics.

1 The London Organizing Committee of the Olympic and Paralympic Games
2 8K Super Hi-Vision is a next-generation broadcast media that gives viewers a "you-are-there" experience by combining ultra-high-definition images, 16 times the number of pixels as current High-Vision, with a 22.2 multichannel three-dimensional sound system.

In 2020, the Olympic and Paralympic Games will be held in Tokyo. The following text outlines the society that Japan can realize by applying science and technology, as well as the ways in which Japan can spread science and technology achievements to the world from 2020 onward.

In addition, projects will be introduced that apply cutting-edge science and technology in Japan. They will reach fruition in 2020, with world-leading sports medicine and science being introduced. In 2020, when the eyes of the world are on the various activities of Japan, this nation will be strongly expected to showcase the results of those efforts.



A broadcasting medium of the near future: 8K Super High-Vision
Courtesy of NHK

Column Feature-2

Dream Superexpress: A driving force behind worldwide "railway rehabilitation"

2014 marks the 50th anniversary of the start of the Dream Superexpress, the Tokaido Shinkansen, which demonstrated the reconstruction and development of our country to the world at the time of the 1964 Tokyo Olympics. This column introduces the world-class railway technology of the Tokaido Shinkansen, which contributed greatly to the rapid economic growth of Japan and demonstrated the new potential of the rail industry, which was said to be in decline due to the emergence of airplanes and automobiles.

The Dream Superexpress: Tokaido Shinkansen
Courtesy of Central Japan Railway Company

The Tokaido Shinkansen debuted in October 1964, between Tokyo and Osaka. As the world's first high-speed railway, its speeds exceeded 200 km/h. Before the Shinkansen started operation, it took 6 and a half hours to travel between Tokyo and Osaka. The Tokaido Shinkansen shortened the trip time to about 4 hours, dramatically speeding up the service.

The big challenge was how to safely operate such a high-speed train. It is extremely difficult for an operator on a train moving faster than 200 km/h to visually recognize traffic lights. Therefore, automatic train control (ATC) was introduced to the Shinkansen system. ATC has the cab signal system that transmits the prevailing civil speed commands and displays directly within the train cab, and reduces the speed when a train is exceeding the indicated civil speed command.

Centralized traffic control (CTC), which utilizes electronic technology, was also introduced. CTC displays the locations of all trains on a display console in the operation command room such that those locations can be recognized at a glance. This enables points at train stations to be controlled from the operation room in a centralized manner. CTC contributes to the streamlining of train operation management. This was the first introduction of CTC on a high-speed, long-distance, double-track railway anywhere in the world.

Moreover, the Shinkansen also involved the development of the following: technology to reduce air resistance, which is a problem associated with high speed; a drive system for a train in which small motors are dispersed to each railroad car; and longer rails than conventional rails to provide a comfortable ride and mitigate damage to the track rail joints. Thus, all the fruits of science and technology of Japan were brought together from various fields of industry, such as civil engineering, machine engineering, electrical industry, material-related industries and the like, which led to the success of the "Dream Superexpress Project." Japan was also able to demonstrate its high technological skills to the world at the time of the Tokyo Olympics. In addition, the Tokaido Shinkansen acted as a catalyst for the development of high-speed trains in Germany and France, thus serving as a driving force behind worldwide railway rehabilitation.

1 The Society Japan Aims to Realize by 2020: Roles Played by Science and Technology

Japan is facing various problems, such as the instability of the energy supply, as revealed at the time of the Great East Japan Earthquake, and demographic aging so severe as to be unprecedented anywhere in the world. So far, Japan has overcome numerous problems by harnessing the power of science and technology. For example, Japan faced two energy crises in the 1970's, but all industries made serious efforts to use energy efficiently. As a result, Japan was able to survive these energy crises.

The problems Japan now faces are those that other countries will face in time. As a developed country that faces new issues, we will have a great opportunity in 2020 to demonstrate the society that can be realized when problems are solved through the use of science and technology capabilities, and to show the future vision of Japan to the world. At the same time, the Olympic Games can be an opportunity to demonstrate how Japan has solved problems by means of the latest science and technology to the world, which can give a boost to the world-wide development of Japanese industries and also encourage overseas companies to make investments in Japan. Thus, the success of the Games can give enormous momentum to the growth of the Japanese economy.

In addition, as the host country of the Olympic and Paralympic Games, Japan bears the responsibility of ensuring safety against natural disasters and terrorism, as well as conducting event management appropriately so that everyone, including overseas visitors, elderly people and physically disabled people can enjoy themselves. Japan is expected to show the hospitality, or "*omotenashi*" that has been passed down from generation to generation and is deeply rooted in modern Japanese culture by utilizing cutting-edge science and technology.

What vision of a future society can Japan present to the world in 2020 by utilizing science and technology? Five areas will be discussed in the following section: "a sustainable society," "a safe, secure society," "a society that accommodates elderly and physically disabled people," "Japan, a country of *omotenashi*" and "Olympic and Paralympic Games that are exciting for everyone."

(1) A sustainable society

Japanese society of mass production, mass consumption and mass disposal has brought us prosperity and made our lives convenient. However, the socioeconomic activities of human beings are beyond the self-restorative capacity of the environment, and they raise environmental problems such as pollution and other environmental detriments. As people living today, we have the responsibility to hand down a rich, bountiful global environment to the next generation. Therefore, we have to transform our society of mass production, mass consumption and mass disposal, which is burdening the environment, into a sustainable society. In addition to being the year when targets for greenhouse emissions reductions have to be achieved, 2020 is the year in which a new legal framework will be initiated; therefore, it is expected that Japan will utilize cutting-edge environmental technology and raise the profile of Japan as an environmentally advanced country through the Games.

1) Hydrogen technology

It is expected that R&D on technologies for producing, transporting, storing and utilizing hydrogen will be accelerated and hydrogen energy will be widely used in industry and everyday life, including in power generation, heat utilization and automobiles.

Hydrogen can be produced from water and various other primary energy sources in many ways. Also, hydrogen can be stored and transported in any form: as a gas, a liquid or a solid (in hydrogen-absorbing alloys). Depending on how it is used, hydrogen can have high energy efficiency with a low environmental load. From this, the *Basic Energy Plan* (Cabinet Decision on April 11, 2014) states: "As for future secondary energy, hydrogen is expected to play the central role," and "To realize a 'hydrogen society' that will make full-fledged use of hydrogen, it is important to promote cost reduction as well as technology development activities with sufficient depth and diversity...under the strategy that overviews the entire supply chain of hydrogen from production to storage and transport to use." *The Basic Energy Plan* also states that "If fuel cell vehicles play an active role as a means of transportation necessary for operating the 2020 Tokyo Olympic and Paralympic Games, that will provide a chance to convince the world of the possibilities of hydrogen as a new energy source." This plan declares the policy of aiming to realize a "hydrogen society" that makes full use of hydrogen.

To realize a "hydrogen society," it is expected that further efforts will be made to promote the spread of technologies that have developed to the point of practical use, such as household fuel cells, fuel cell vehicles and hydrogen-supply infrastructure, in addition to developing technology that enables hydrogen to be converted into an energy carrier that is easier to handle and excels in safety for future use.

With regard to fuel cell vehicles (FCVs)[1], the Japan Revitalization Strategy (decided by the Cabinet on June 14, 2013) sets the goal of installing 100 hydrogen refueling stations in four major metropolitan areas toward commercial introduction in 2015 and the world's fastest dissemination of FCVs.

Since hydrogen can be produced from various energy sources and does not emit carbon dioxide when used as an energy source, the realization of a hydrogen society can lead to improvements in the energy security of Japan and can contribute to reductions in environmental loads. In addition, with regard to techniques for the production of carbon fiber used in manufacturing fuel cells and hydrogen tanks, Japanese companies lead the world and are expected to grow this market in the future. The realization of a hydrogen society is of great significance in terms of industrial policy.

2) Environmental technology to be used in the 2020 Tokyo Olympics

The Tokyo metropolitan government has formulated the *Environmental Guidelines for the 2020 Tokyo Olympic and Paralympic Games*. This guideline emphasizes the importance of giving careful consideration to the environment throughout processes; from the preparation period for the Games, during the Olympic Games, to the time when the results become a legacy to the next generation after the Games. To realize a carbon-neutral Games, various efforts are being made to apply environmental technologies that are tried and trusted in Japan, such as those related to energy conservation, solar power generation, eco-friendly electric and hybrid vehicles, water purification and specialized greening of buildings, to the competition venues and the Olympic Village. These efforts are being made in order to show the world what measures can be taken to protect the environment and create a sustainable society, in addition to encouraging further development of environmental technologies by using the Games as a springboard.

1 A fuel cell vehicle (FCV) powers the motor with electric energy generated by a chemical reaction between the hydrogen and oxygen in a fuel cell. Gasoline-powered cars are supplied with gasoline at gas stations. Similarly, fuel cell vehicles are supplied with hydrogen at hydrogen stations. FCVs have performance standards similar to those of existing gasoline vehicles and have been developed to a level almost suitable for practical application. FCVs, which use hydrogen, emit only water and have a greater range per refueling (500 km/h or more) than electric cars. Additionally, FCVs can be fully fueled in the relatively short time of 3 minutes.

(2) A safe, secure society

As the host country during the Olympic and Paralympic Games, Japan must take measures at the various stages of monitoring, prediction, detection and prevention against a wide range of risks, such as man-made disasters, natural disasters and others. In addition, to prepare for natural disasters, appropriate maintenance on aging infrastructure is required. Also, since a great number of people will visit Tokyo during the games, it is recommended that comfortable and safe transportation be developed.

1) Science and technology as measures against natural disasters

It is predicted that in order to prevent human suffering from large-scale natural disasters resulting from weather phenomena, techniques will be developed by around 2020 for observing the atmosphere, the hydrosphere and the geosphere on a nationwide scale with a high degree of accuracy.

Also, it is assumed that robots with the senses of vision, smell and hearing that exceed human perceptual abilities will play an important role in promptly discovering disaster victims and in assisting rescue work if a disaster should occur. To create disaster response robots, science and technology from various fields, such as mobility technology, sensing technology, information technology among others, are required. Therefore, the improvement of robotic technology for disaster relief is considered to contribute to raising the level of the technological platform for the entire machinery industry in Japan.

2) Infrastructure-related technology

In Japan, amidst the progressive aging of infrastructure constructed during the period of high economic growth, serious risk of accidents, such as the Chuo Expressway Sasago Tunnel Ceiling Panel Collapse of 2012, are becoming apparent. There is growing concern about the rapid increase in the costs of maintenance and renewal. Under these circumstances, in order to prevent accidents and to minimize the life-cycle costs of infrastructure, it is imperative to manage infrastructure by utilizing new technologies.

It is predicted that semipermanent implantable sensor technology, to indicate a structure's degree of deterioration, age and recommended reconstruction time will be realized by around 2020 as a technology that contributes to infrastructure management. In addition, it is assumed that a technology will be developed for creating robots that perform inspection and repair work on deteriorated infrastructure, or at dangerous locations in areas devastated by natural disasters.

With regard to the traffic situation in Japan, there were approximately 630,000 traffic accidents in 2013, which is considered a large number. By 2020, various types of sensors will be deployed in cars to prevent rear-end and head-on collisions on highways. A driving system that can predict failures of the engine and tires will be developed. Thus, it is expected that a society where people can travel more safely will be realized in the near future.

3) Anti-terrorism technology

With regard to anti-terrorism technology, in 2012, Hitachi, Ltd., in collaboration with Nippon Signal Co., Ltd. and the University of Yamanashi, succeeded in the trial production of a boarding pass reader (boarding gate) with a built-in apparatus for detecting explosives. The prototype boarding gate can detect the presence or absence of explosive components in a second or two by efficiently collecting particulates clinging to an IC card or a mobile terminal used as a boarding pass and analyzing the harvested

particulates with an apparatus built into the boarding gate. Conventionally, components have been detected by wiping particles off the luggage and hands of suspicious individuals at airport gates, which requires many hands and much time. The introduction of this apparatus will make it possible to detect explosive components automatically in a short time (Figure-1).

Figure 1 / Boarding Gate with a Built-in Explosives-Detection Apparatus

Airflow from a vent at the reading section collects minute particles, so explosive components can be detected immediately.

Courtesy of Hitachi, Ltd.

(3) A society that accommodates elderly and physically disabled people

The median age of the world's population is gradually increasing. In 2013, people over the age of 60 accounted for only 11.7% of the world's population. That figure is expected to reach 21.2% in 2050[1]. Japan is a country with advanced aging, in which those over age 65 already exceed 25% of the population. Building an elderly-friendly-society ahead of the rest of the international community is a requirement in this country.

1) Mobility technology

One future vision of society that is expected to be realized involves the creation of a "high-mobility society in which elderly people can enjoy an active life." So that elderly people may be able to drive without anxiety, it is necessary to promote R&D on "ultra compact means of mobility"[2] that can serve as a convenient way to get around in the community. Further R&D is also necessary on driving support technology that can compensate for delayed cognition and judgment, as well as aging-related driving impairments.

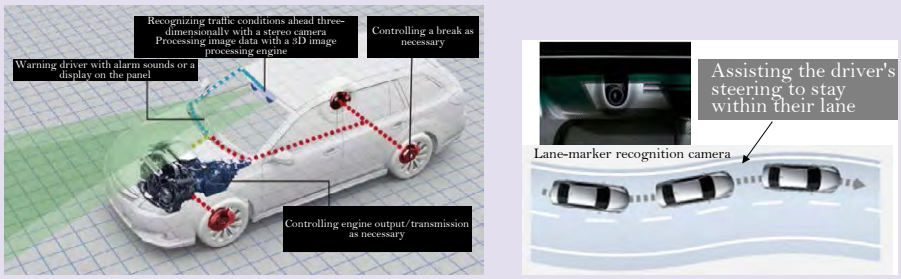
Nagoya University is playing a central role in the development of driving support technology that can analyze the positional information of cars, bicycles and pedestrians around a driver in real time. It can predict their movements and inform the driver of those movements with the aim of preventing traffic accidents involving pedestrians and other vehicles. In addition, efforts have been made to develop techniques to measure a driver's biological information: heart rate while driving, image information such as facial expressions and behavior while driving, in addition to checking whether the driver is driving in a healthy state.

Japan leads the world in driving support technology and has succeeded in developing the world's first control technology to recognize the risk of hitting running vehicles and obstacles ahead in order to stop a

1 *Profiles of Aging 2013* (United Nations)
2 A one- or two-seat vehicle that is more compact than an automobile and that excels in environmental performance, which can serve as a handy way to get around in the community

vehicle by means of an automatic braking system when danger is imminent. Also, an apparatus that can detect white pavement markings by using high-precision cameras to maintain lane-keeping is already commercially available (Figure-2).

Figure 2 / Driving Support Technology



Courtesy of Fuji Heavy Industries Ltd. (left) and Toyota Motor Corp. (right)

With regard to "ultra compact means of mobility," or ultra compact vehicles, a three-wheeled model that achieves a new ride satisfying both comfort and convenience that are comparable to those of a bike has been developed. Field tests on ultra compact vehicles have started in Europe as well as in Japan (Figure-3).

Figure 3 / "Ultra Compact Means of Mobility" or Ultra Compact Car

Courtesy of Toyota Motor Corp.

It is expected that the wide spread of ultra compact vehicles equipped with driving support technology will enable people of all generations, including elderly people, to have a safe, convenient means of transportation. It is expected to overcome aging-related mobility limitations and the decrease in opportunities to go out.

2) Information and communications technology

There is a growing demand among elderly people for monitoring systems that utilize information and communications technology (ICT). Behind this is the sharp increase in the number of elderly one-person households in Japan. The *Household Projections for Japan by Prefectures*, published by the National Institute of Population and Social Security Research in April 2014, estimates that the number of elderly one-person households in 2020 will increase by 34% over that in 2010. In Tokyo, which has more one-person households than any other prefecture in Japan, one-person households, which numbered 650,000 in 2010, will increase to 850,000 in 2020 and will exceed 1 million in 2035.

Many elderly people who are living alone are worried about dying alone. According to the *Survey on the Health of the Elderly*, published by the Cabinet Office in March 2013, more than 40% of people over age 60 (total of respondents answering "very immediate" or "fairly immediate") who are living alone regard solitary death, such as being found after dying alone, as an immediate problem. In addition, according to the *Official Announcement of Report from ICT Super-aging Society Design Council* published by the Ministry of Internal Affairs and Communications (MIC) in May 2013, 60.8% of elderly people named "a safety

confirmation service in which a sensor installed in the building summons a security guard in the event of an emergency, such as a fall or the inability to move" as one of the ICT services they want to use in the future.

There is an urgent need to realize a society where elderly people can lead secure everyday lives without worrying about dying alone. Presently, efforts are being made to develop techniques to collect information, in an unobtrusive manner, on the everyday physical and mental status of elderly people based on their behaviors by using an ultra-compact high-performance sensor. That technology will enable the continuous monitoring and understanding of the lifestyle and health conditions of elderly people.

3) Science and technology to support people with disabilities

The *Candidature File* formulated in the process of bidding for the 2020 Tokyo Olympic and Paralympic Games involves the following concept: "Through the Paralympic Games, we will send the message that involving all people in society, without discrimination, and thinking about the needs and interests of people with disabilities will lead to the creation of a better world and will bring a bright future to the whole world." The Paralympic Games provide a good opportunity to show that the development of technology that encourages people with physical disabilities to participate in activities in society will broadly improve the quality of life for ordinary citizens.

Figure 4 / HAL

Courtesy of Sankai Laboratory, University of Tsukuba, Cyberdyne Inc.

Examples of technologies developed for supporting people with disabilities involve the world's first wearable self-motion-assisting robot, the Hybrid Assistive Limb (HAL), designed for physically improving, supporting and enhancing the wearer. This robot was created by Cyberdyne Inc., a company that originates from the University of Tsukuba. This company aims to cultivate new fields for the future (Figure-4). HAL is designed to improve and assist the physical functions of people who are experiencing motor deterioration. HAL reads bio-electric signals of a wearer's intentions that are secreted on the skin surface when he or she tries to move their body, and assists the user with the Cybernetic Voluntary Control (CVC) system that controls power units based on the obtained signal and with the Cybernic Autonomous Control (CAC) system that autonomously builds up a motion program based on the basic motion data stored in advance.

In addition, the outcome of the safety study on life-support robots, including HAL, by the Life-support Robot Practical Application Project of METI and the New Energy and Industrial Technology Development Organization (NEDO) were adopted by the International Organization for Standardization (ISO) in February 2014, and Global Safety Standard ISO13482 was issued. Also, HAL for Medical USE became the first robotic device in the world to receive ISO/DIS 13482 from the Japan Quality Assurance Organization in February 2013.

In addition to being used for welfare-related purposes, HAL is also used in the medical field. In June 2013,

HAL became the first robotic therapy equipment in the world to obtain a CE mark[1], so HAL can be freely sold in the EU. Additionally, in August of that year, physical function improvement treatments using HAL became eligible for coverage under Germany's public industrial injury insurance. It is expected that the robot technology of Japan will be greatly utilized in medical settings in the future.

In addition, the development of a prosthetic foot with "functional beauty" that satisfies both functionality and beauty is also promoted (Figure-5). The technology development currently advanced is geared to athletes; however, innovations in the manufacturing process being advanced in this study are expected to lead to the widespread use of prosthetic legs with "functional beauty" in daily life. Adding the value of beauty to prosthetics that compensate for lost functions will encourage people with disabilities to actively participate in social activities. This is an example of how science and technology can support people who experience a loss in creating a renewed sense of worth and build a bright future.

Figure 5 / A beautiful Prosthetic Leg that Goes Beyond Compensating for a Lost Body Part

Courtesy of Yamanaka Lab of the Institute of Industrial Science, University of Tokyo

(4) Japan, a country of "*Omotenashi*"

During the Olympics and Paralympics, people in Japan and from around the world will visit Tokyo for the Games. During that time, it will be important to show hospitality so that those visitors can enjoy the Olympics and Paralympics and sightseeing regardless of their nationalities. The development of service sciences that contribute to hospitality needs to be promoted.

1) "*Omotenashi*" technology

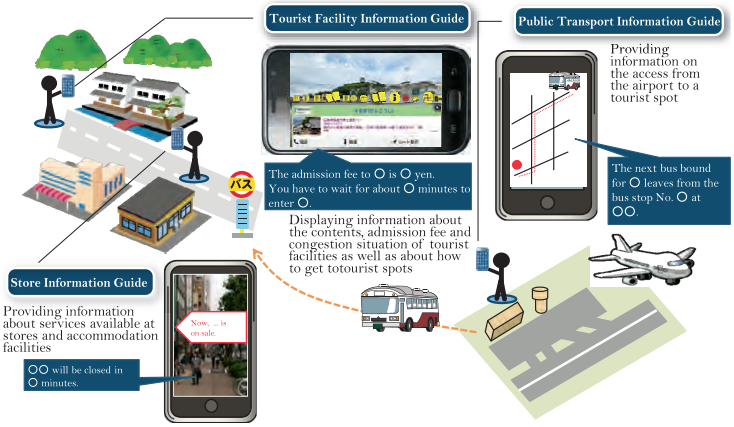
A society that can provide information to overseas visitors in their own languages without any barriers, and a hospitable society that offers meticulous service in a natural manner, needs to be realized. A translation system that can automatically learn the cultural background of people, as well as place and personal names names, and that can translate Japanese to other languages and vice versa is expected to be available by 2020.

It is also planned that a sensor will be deployed at every corner of the non-virtual world which will make it possible to search for information within the entire non-virtual space from any part of Japan through the information network. For example, people will be able to know the weather of their selected location by using a retrieval key, and they will be able to make plans and enjoy the scenery there.

1 CE Marking is mandatory for certain products that are commercially available principally within the European Union (EU).

Furthermore, a recognition technology that makes it possible to provide needed information, on demand, by analyzing the services that the user wants based on his or her "life-log"[1], is expected to be realized.

Already, several local governments have been experimentally providing information to overseas visitors in an easy-to-understand manner by using augmented reality (AR) displays. AR is an ICT technology in which digital information (characters, graphics, sound) is superimposed on a view of the real world.



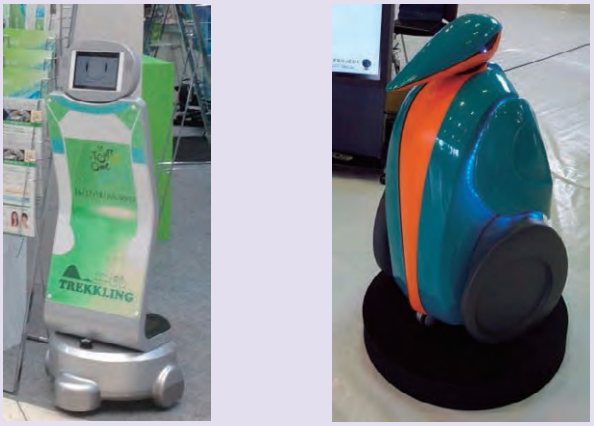
Schematic of the future development of guidance information-provision tools that use AR technology
Courtesy of MLIT

AR technology can be used not only to provide guidance information to overseas visitors, but also to provide a variety of other information. Efforts are being made to create a unique outdoor AR system, by which at any public space in a city, one can see the old-time scene of the same place displayed on one's personal tablet terminal in an all-sky projection, so that it is possible to enjoy and relive the feelings that people might have had in the past. This system can be used to acquaint overseas visitors with bygone Tokyo (Figure-6).

Figure 6 / Outdoor AR system

Courtesy of Hirose Lab. of the Graduate School of Information Science and Technology, The University of Tokyo

Figure 7 / "*Omotenashi*" Robots



Concierge Robot[2] (left:); **Hino *Omotenashi* Robot**[3] (right)

Courtesy of the Ome Camber of Commerce and Industry, Vector Inc. (left), Hino City (right)

1 A "life-log" is a record of activities (action history) acquired and accumulated by a personal computer or a portable terminal.

2 The Institute for Robot Industry Development (managed by the Ome Camber of Commerce and Industry) was established for industrial development in the Tama area with assistance from the Tokyo Metropolitan Government. As part of such efforts, Vector Inc. produced the Concierge Robot in 2013. Minami Design Co., Ltd. (Ome, Tokyo) is cooperating with Vector Inc. in the production of the robot, and Creansmaerd Co., Ltd (Ome, Tokyo), Technom (OME, Tokyo) and the Faculty of System Design of Tokyo Metropolitan University engaged in the development of the application software of the robot. This robot, which is stationed at a bicycle rental shop in Okutama, Tokyo, presents information about cycling courses in response to user requests. (Reference: http: http://www.omecci.jp/somu/news/2013/201308/201308.htm#6)

3 Hino City produced this robot in collaboration with six small and mid-sized enterprises in Hino City, Tokyo Metropolitan University, Tokyo Metropolitan Industrial Technology Research Institute (TIRI) and other organizations in 2013 with a view to its utilization at the National Sports Festival. The robot, designed to resemble a kingfisher, the official bird of the city, is friendly-looking and appears to be breathing, due to a lighting effect. It is designed such that visitors will come to feel like touching it. If you pat the robot on the head, local tourist information and other various information is displayed on the monitor installed nearby. (Reference: http://www.city.hino.lg.jp/index.cfm/198,116642,322,1911,html)

In addition, at many local governments and other relevant public organizations, robots are playing a partial role in showing *"omotenashi"*, for which they are enjoying a good reputation (Figure-7). Robots are expected to play active roles in showing *"omotenashi"* to overseas visitors in their own languages at the Olympic and Paralympic venues in 2020.

(5) Olympic and Paralympic Games that are exciting for everyone

The Olympic and Paralympic Games are world-wide events held every four years; therefore, we want as many spectators as possible to feel the excitement of the Olympics through the great performances of top athletes. To that end, technology is expected to be developed that enables anyone, at any time and in any place, to feel as if he or she is actually watching the games in the stadium.

(Imaging technology)

Imaging technology enables the viewer, wherever he or she is, to get the sensation of being at the Olympic and Paralympic venues or of being right up close to the athletes.

For example, utilizing an imaging technique called holography (used for taking and displaying three-dimensional pictures) and showing the images of competing athletes in real time in the city of Tokyo will lead to the realization of a new "Olympic and Paralympic Games that are experienced," instead of the conventional "Olympic and Paralympic Games that are only watched." If you could see a pole-vaulter jumping while you were surrounded by a group of city buildings and if you could see how high the pole-vaulters were jumping compared to those buildings, you would feel even more keenly the height of the technology (Figure-8). Also, since holographic images can be reproduced repeatedly, the images can be used in various ways: for example, a viewer could run on a lane side by side with the image of an athlete who won the gold medal in the 100-meter race and experience world-class speed.

Figure 8 / Holograms in the City, Watching Sports in the City

Courtesy of TeamLab Inc.

Column Feature-3

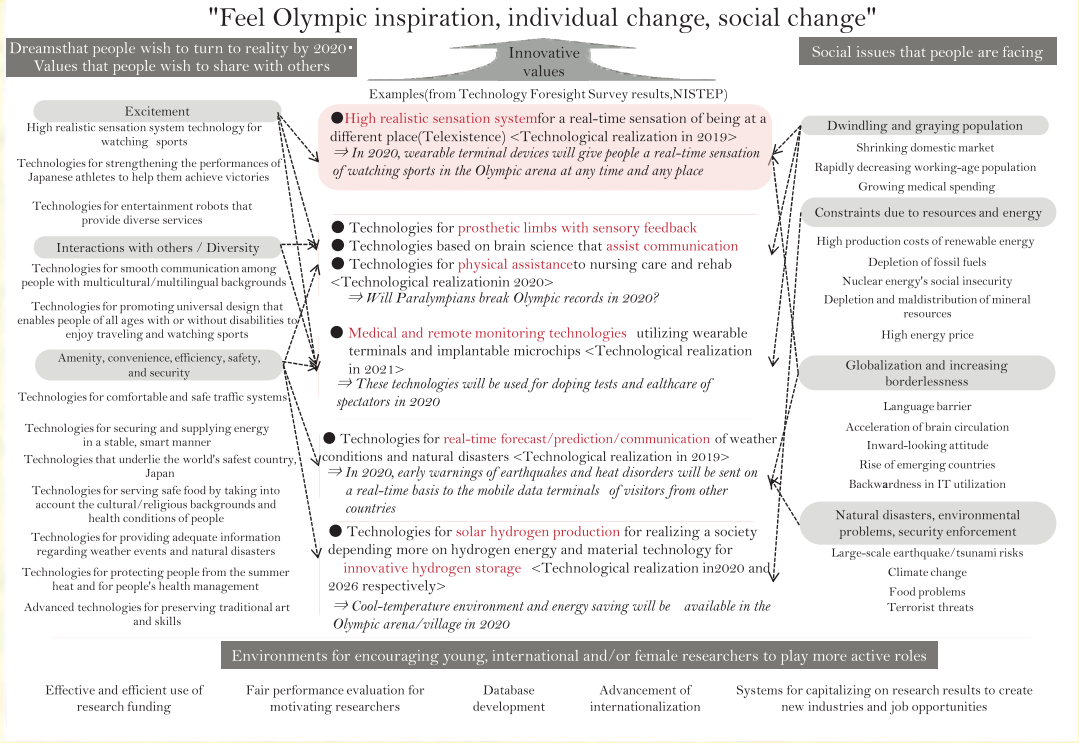
Japan Vision 2020

It is important to regard the year 2020 not only as the year of the Olympic and Paralympic Games, but also as the year when a "large movement" to change the future of Japan will be created. How should we regard the 2020 Tokyo Olympic and Paralympic Games, and what must we do to realize this vision? Also, as a country that faces new issues before the rest of the world, what message can we send to the world?

At MEXT, at the initiative of Hakubun Shimomura, Minister of Education, Culture, Sports, Science and Technology and Minister in Charge of the Tokyo Olympic and Paralympic Games, mid-level and young staff at the ministry took the lead in discussing what can be done to vitalize all of Japan, not just Tokyo, and what can be done to achieve new growth leading up to the target year of 2020. After intensive discussion, future efforts were summarized in *Japan Vision 2020* in January 2014.

Japan Vision 2020 summarizes as many as 350 proposals from MEXT staff, as well as ideas obtained through intensive discussions and open exchanges of views on the "dream" toward the year 2020 in citizen workshops and among young athletes, artists and people in business. *Japan Vision 2020* declares that the concept of "feel Olympic[1] inspiration, individual change, social change" will lead to the success of the Olympics. In addition, with regard to how Japanese people and Japanese society can "upgrade" themselves as we approach 2020, *Japan Vision 2020* emphasizes the following: 1. realizing an innovative "value creation society" by having global vision and creativity, combined with being hardworking, 2. strengthening and disseminating the Japanese power of culture that is innovative while still valuing tradition and 3. creating systems of "dynamic total optimization" that are adaptable to changes and that are expected to make Japan a forerunner of mature societies. To transform Japan in this way, what can science and technology contribute? The following are the detailed plans proposed in *Japan Vision 2020*.

Proposal 1: Realizing and Sharing Our "Dreams" through the Olympics
(Promoting dream-inspiring research development aimed at reforming society)



Japan Vision
Source: MEXT

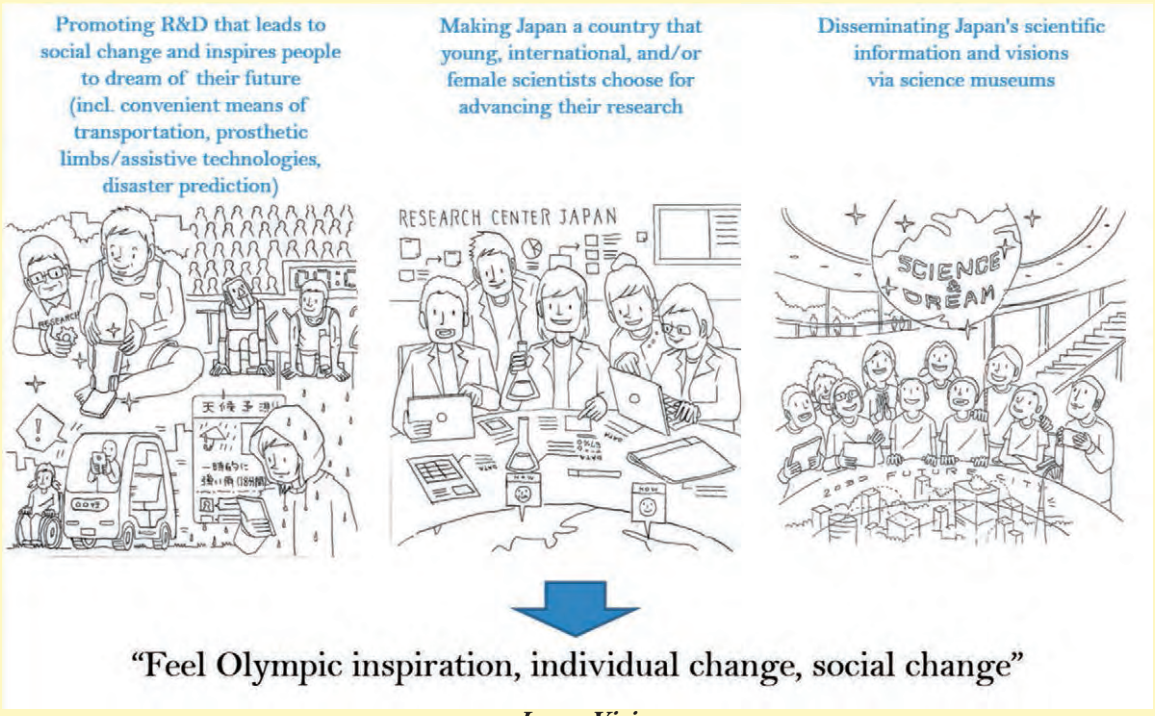
- Accelerating R&D that realizes our "dreams to be realized in 2020, and values to be shared in 2020". We also identify social problems we are facing, and we accelerate R&D to address such issues and to transform society.

1 In Column Feature-3, "Olympic Games" refers to both the Olympics and the Paralympics.

(Making Japan "the Most Innovation-friendly Country in the World," with a target year of 2020)
- With the aim of realizing a country where "young researchers, foreign researchers and female researchers want to engage in research," we will review the restrictions that act as impediments to collaboration with related ministries and agencies. Such restrictions are, for example, the regulations that limit conducting demonstration tests of developed technology on public roads, and the regulations that cause inconvenience for researchers and their families from other countries who come to Japan.

Proposal 2: Introducing Japan's cutting-edge science and technology and innovators to the world
("The Research in Japan" campaign)
- Disseminating Japan's cutting-edge science and technology as attractions of Japan. Immediately after officially announcing *Japan Vision 2020*, MEXT created the *Research in Japan* page on the MEXT website (English). Since then, MEXT has been introducing successful experiences of researchers from other countries who are playing active roles in Japan, in addition to drafting the *Japan Vision 2020* leaflet and distributing it at international conferences in other countries.

(Curiosity, excitement and dreams of children and adults citizens of the world)
- Formulating a network of science museums, universities, companies and related organizations in Japan, and collaborating with them for the effective and strategic dissemination of Japan's cutting-edge science and technology. To this end, we will work with designers to develop unprecedented new exhibition methods and we will produce content for science and technology information provision, organize traveling exhibitions at museums in Japan and abroad, and present special exhibitions in 2020.
- Providing opportunities for children who like science, as well as children who like sports, to improve themselves through friendly competition. Specifically, the 2016 International Earth Science Olympiad and the 2022 International Physics Olympiad will be held in Japan. Additionally, ongoing discussions are under way toward holding the International Science Olympiads in Japan around 2020.



Japan Vision
Source: MEXT

Column Feature-4

Vision of Cutting-Edge Medical Care and Healthcare in the Future

Recently, wearable computers have been in the spotlight as next-generation devices that will follow smartphones and tablets. A wearable computer is a computer that you can wear and carry around. Quite a few people must have seen Google Glass, an eyeglass-type information device developed by Google Inc., in the newspaper. However, Japanese companies are not to be outdone in this field. In January 2014, a leading domestic electronics manufacturer released a wristband-type product that can record "life log" information, including the sleep time and the number of steps the wearer takes by integrating the product with a dedicated application.

SmartWear
Courtesy of Sony Mobile Communications Inc.

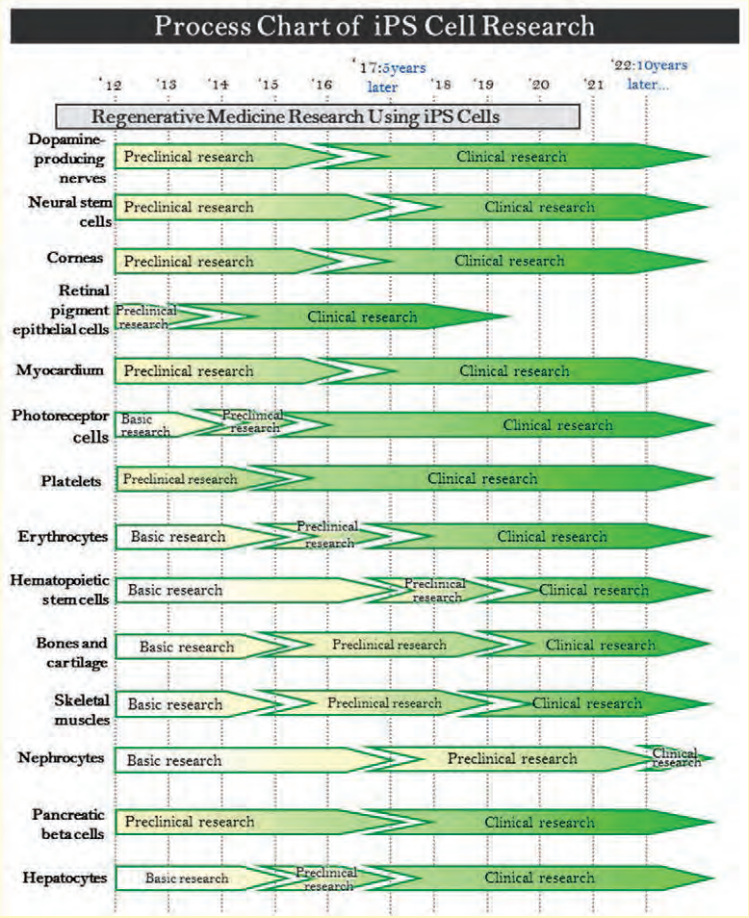
In the future, people will probably be able to collect biological information such as heart rate, blood pressure, blood-sugar level and calorie consumption simply by wearing such a device and without paying particular attention to the data being measured. Also, people will be able to regularly enjoy the health support services that are based on those measurements. In addition, by integrating vital data collected from many people into a database and by conducting analyses, it will become possible to provide tailored health support service for disease prevention. The ultimate wearable device might be a kind of terminal that the wearers cannot even feel they are wearing, or it might even be a terminal implanted in the body. The R&D includes a sensor sheet technology that obtains biological information. With a density of 3 g/m² and a thickness of 2 μm, the sensor sheet is lighter and softer than a feather. This technology is expected to be widely used in the future.

A sensor system that is lighter and softer than feathers
Courtesy of Someya Lab, Department of Electric and Electronic Engineering, School of Engineering, The University of Tokyo

Even if you try to maintain your health in daily life, you may suffer impairment of bodily functions due to unexpected diseases and injuries. Regenerative medicine involves therapeutic methods of using stem cells to restore impairments. The Road Map for iPS Cell Research, *Future of Research on Stem Cells and Regenerative Medicine*, was published by MEXT in February 2013. According to the road map, following the commencement of clinical research on retinal pigment epithelial cells in August 2013, clinical research on regenerative medicine using iPS cells will be developed into clinical research for humans.

Dr. Shinya Yamanaka, the father of iPS cell research and the Director of the Center for iPS Cell Research and Application (CiRA) at Kyoto University, set the following four goals to be fulfilled by 2020.

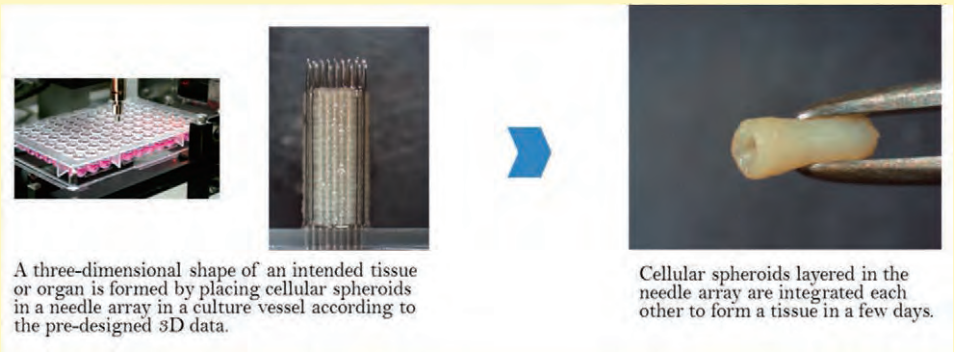
1) Establish basic iPS cell technology and secure the associated intellectual property rights.
   Secure the associated intellectual property in order to disseminate the technology, in addition to elucidating the "initialization" system to return mature cells to undifferentiated pluripotent stem cells that can change into various cells.
2) Build a stock of iPS cells for use in regenerative medicine.
   Create iPS Cells with a low potential for rejection in advance and preserve them in a freezer, in preparation for the treatment of patients who urgently need transplant surgery, such as patients with spinal cord injuries resulting from accidents.
3) Carry out preclinical studies and make progress toward clinical studies.
   Conduct clinical experiments on diseases that can be treated by using iPS cells, such as Parkinson's disease.
4) Contribute to the development of therapeutic drugs using patient-derived iPS cells.
   Make special efforts to use iPS cells in the development of therapies for rare intractable diseases.



Process Chart of Regenerative Medicine Research Using iPS Cells

Source: MEXT

In addition, R&D on application of "3D printers" is in progress within the field of regenerative medicine, because 3D printers can easily reproduce complex three-dimensional objects on the basis of available three-dimensional data. Using a bio 3D printer, tissues and organs of the intended three-dimensional shapes are created according to the pre-designed 3D data by placing cellular spheroids in needle arrays in a culture vessel. In January 2014, Saga University and a bio-venture company in Tokyo jointly disclosed a technology that uses a 3D printer to create blood vessels from cells taken from the skin of a patient. Regenerative medicine can open the way to the new treatment of diseases that have been very difficult to treat. Therefore, accelerating the R&D is important to enable as many people as possible to benefit from cutting-edge regenerative medicine as early as possible.



Bio 3D printing

Courtesy of Cyfuse Biomedical K.K.