Special Contribution

R&D That Contributes to Human Beings and Society

Creating New Ethics

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OVERVIEW: From the perspectives of physics and brain-science, the key to realizing future innovation is exploration with a comprehensive view of the world of nature, which consists of matter (energy) and information (entropy). With a special focus on human beings residing in the world of nature—homo sapiens, which acquired languages and symbols, the author (hereinafter, "I") would like to consider the further evolution of homo sapiens. Science and technology with a high possibility of realization in the near future such as the formation of new intelligence based on brain-science, the production of life using artificial stem cell technology and human beings designed by gene editing have unprecedented significance. In other words, human beings are at an extraordinary point in the evolution of lifeforms. From this perspective, we need to consider the meaning of ethics, which is necessary in science and technology as well as business entities. At the same time, I would like to examine the R&D activities conducted by business corporations. Lastly, revisiting the significance of the vision of the Hitachi Group at its dawn, I would like to emphasize the current importance of establishing new ethical guidelines.

INTRODUCTION

WE (homo sapiens) are now at an extraordinary point, or a singularity point, in the evolution of lifeforms because brain-science-based new information processing and applications of induced pluripotent stem cells (iPS cells) and gene editing of human beings are becoming real. The former is exemplified by deep learning using an artificial neural network and the latter by the surfacing possibility of creating a human using partial skin from a person and re-forming a human into a desired person for someone simply by inserting or deleting a certain gene. Related animal-based R&D is already ongoing. There is an urgent need to establish "New Ethics" or new ethical guidelines.

Human body parts and organs comprise matter, whereas the human information system such as the peripheral nervous system that spreads throughout the human body forms a vast and intricate nervous network, combined with the brain, which is the center of the central nervous system, through the spinal cord, which is the hub. It also has been uncovered that the intra-brain insula, located behind both temporal lobes, collects information regarding the condition of the body and is in charge of one's physical condition. Sensory organs capture external information (the so-called five senses), then the information is processed in the brain (information system), and the result is output using muscles—a comprehensive system consisting of the sensory system (input), the central information processing system and the action system (output). Furthermore, overlaying the circulatory system, which is related to metabolism and energy, and the information system exists self-consciousness. From the perspective of "the matter system and the information system," the current world is nearing a human-like system, the whole society being symbolized by "Brain and Mind."

The Internet of Things (IoT), which recently has drawn much attention, is an example of the combination of the matter system and the information system via a network. This concept exists ubiquitously as part of the world of nature[1, 2]. In this paper, I attempt to extrapolate the histories of science and industry from ancient times to the modern era to the future. Furthermore, innovations in R&D will be discussed from the perspective of "looking back from the future." As is addressed later, only homo sapiens can think about the future[3]. Being at an extraordinary point in the history of evolution, "human ethics" is increasingly important. I would like to discuss human ethics from the perspectives of bioethics and corporate social responsibility (CSR).

THE WORLD OF NATURE WHERE MATTER AND INFORMATION INTERACT

New Brain Function Distinct to Homo Sapiens

René Descartes (1596–1650) stated *Cogito ergo sum* (I think, therefore I am) (*Discours de la méthode*) and Blaise Pascal (1623–1662) stated that "man is a thinking reed" (*Pensées*). Thinking/considering is a brain function, therefore to know the brain leads to knowing the essence of human beings. In this sense, brain-science research is deeply related to the humanities and the natural sciences, which differs significantly from conventional natural science research. Moreover, the research results directly affect the core of our lives and thoughts. Observing the recent cutting-edge neuroscience, I think such research has started to cast a new light on an unprecedented discussion in the humanities, including philosophy and ethics, and in the social sciences and education, including economics and sociology.

Furthermore, the recent success of the genetic analysis, fully utilizing informatics, of the fossil remains of the bone marrow of Neanderthals, which existed 40,000 years ago, reported a language gene that mutated for the first time at the stage of homo sapiens[(4)]. In the 1990s, when the movie *Jurassic Park* was released, research on a wrong gene extracted from an infected fossil remain was reported worldwide, but recent gene analysis results announced by the Max-Planck Institute for Informatics (Germany) are considered to be highly reliable[(5)].

Homo sapiens acquired a hierarchical grammar for the first time in the long history of evolution. It is highly possible that the acquisition of a hierarchical grammar enabled homo sapiens to acquire the ability to plan the future[(6)]. We have developed functional magnetic resonance imaging (fMRI) and optical topography (OT)/functional near-infrared spectroscopy (fNIRS) and researched the true nature of language. Through such research, I found that it is impossible to think of a future without language or symbols[(3)].

Peter F. Drucker (1909–2005), a scholar on business management, frequently used the expression, "create a future." From the aspect of the brain, only homo sapiens possesses the ability to create a future. It has been uncovered that behind the language function exists the phonetic loop of the language area of the brain including the working memory of the prefrontal area. It is highly possible that homo sapiens conducts sophisticated thinking even at the subconscious level, utilizing a linguistic phonetic loop[(3)]. Furthermore, human language possesses a function of displacement, which allows one to transcend space and time easily, and arbitrariness, which allows one to express a situation that does not exist in the world of nature.

Although the ability of homo sapiens to predict the future is considered to have helped achieve significant developments, this ability also created karma to deeply worry about the future. Thoughts about one's own future eventually end with a scenario of death. With a hypothesis that this point might be partially responsible for mental illness, research is under way on the development of differential diagnoses of major emotional disorders (depression, bipolar and schizophrenia) using optical topography.

Thanks to the efforts of doctors in the mental illness departments of many universities and national research institutes, optical topography was approved as a method to assist with differential diagnoses of symptoms of depression by the Ministry of Health, Labour and Welfare under its Advanced Medical Treatment Evaluation System in 2009. In the mental disease treatment field, which used to have only limited methods such as questions/answers and observations, optical topography is the first officially approved method to assist in differential diagnoses. Moreover, health insurance started to cover this method in 2014.

Looking Back from the Future

Whether for R&D or business development, it is important to project the future accurately. A future is created by ubiquity and historicity. Although it is difficult to predict historicity-based occurrences that are highly coincidental (e.g., genetic drift), it is possible to predict a future that should happen based on the ubiquity. As mentioned earlier, the ability to predict the future was first acquired by homo sapiens in the long history of evolution. If the future can be read accurately, R&D and businesses will not go wrong.

Dr. Taro Takemi (1904–1983; former president of the Japan Medical Association and the World Medical Association) presented the concept of "looking back from the future" in 1976[(7, 8)]. In other words, viewing the present from the past, that view is extrapolated to the future. Furthermore, by projecting from the estimated future to the present, a controlled future can be achieved. According to Dr. Takemi, this concept originated in *Inmyo (hetu-vidyaa)* theory, which is the

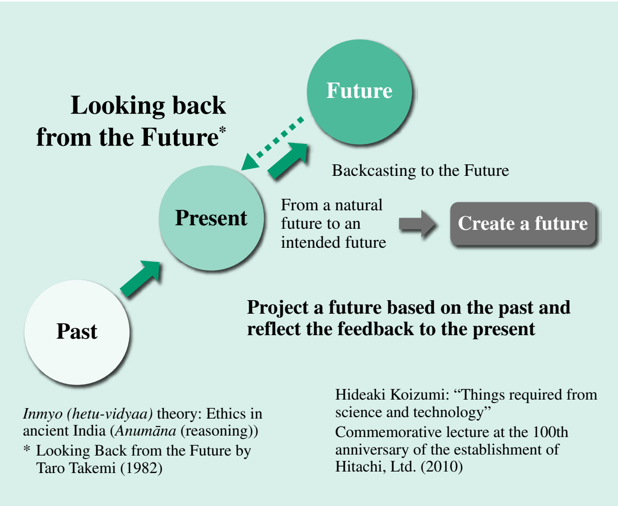

Fig. 1—Concept of Looking Back from the Future.

logic of ancient India[9, 10]. As per my understanding, this concept is described in Fig. 1[11, 12].

In the 1990s, in environmental activities mainly in Sweden, a similar method called backcasting was proposed and researched[13, 14]. Backcasting, which is also a concept included in "looking back from the future," lately has been utilized often in Japanese national projects.

Background of the Era of Innovation and IoT

The whole world regards the term *innovation* as a key to economic development. Drucker stated that marketing, which creates customers, and innovation, which creates markets via customers' new desire/needs and satisfaction, are the two wheels of a vehicle and the steering wheel is the business management necessary to realize the purposes of the company[15]. A "new combination (*neue Kombination*)," which is the original meaning of innovation indicated by Joseph A. Schumpeter (1883–1950) in his *Theorie der wirtschaftlichen Entwicklung* (Theory of Economic Development) in 1912, also has deep significance. If innovation, which creates new meaning and functions, is understood as a "new combination," this meaning becomes significantly different from "technological revolution," a translation in a narrow sense indicated in an early white paper on science and technology and Drucker's innovation. Without the emergence of something completely new, such is not innovation in its original meaning. In other words, the purpose of innovation is not gradual progress toward a visible goal but to create a non-continuous leap or emergence. Non-continuous emergence is not visible at the beginning. R&D that gradually progresses is for direct problems, whereas inverse problems are solved by a non-continuous leap and emergence because such a process is to find out new value that has never been seen before from many combinations of solutions.

Schumpeter was afraid that capitalism might decline due to the cessation of innovation. He was afraid of a structural impediment: As economic development continues through innovation and society becomes more affluent, people would lose their hungry spirit or passion, resulting in a shortage or the disappearance of the entrepreneurs and technologists to lead the innovation. As the functions of the reward system of the brain are clarified, this tendency becomes more visible. Naturally, innovation is also caused by a brain function.

As mentioned above, the birth of IoT is considered to be a natural consequence, reflecting the background of the times. As described in Fig. 2, it is because the world of nature itself comprises matter and information. The first law of thermodynamics explains that energy (mass) does not change and the second law of thermodynamics explains that entropy, meaning order and information, always increases. The world of nature and the world of human beings both consist of matter, structure and information. The relation between "the brain and the mind" becomes the relationship between "matter and information," also corresponding to the relationship between physics (body, matter) and metaphysics (mind, information). Where the structure is in order, information exists and entropy is low. The duration of a quantum system in a certain quantum state staying in the same state is determined by the size of the combined energy as expressed by Schrödinger. This equation predicts, for

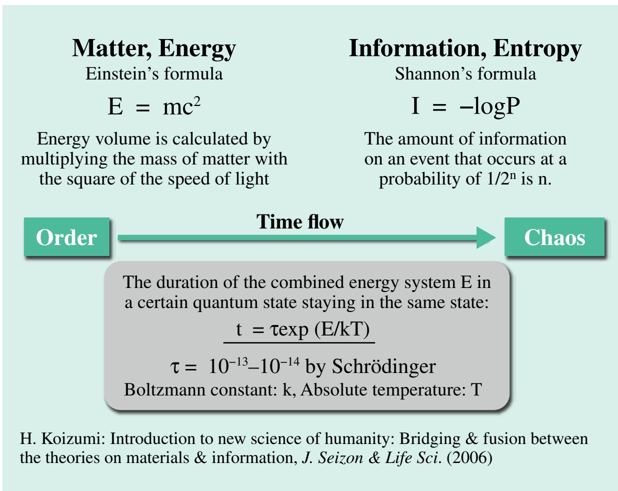

Fig. 2—World of Nature Consisting of Matter and Information.

example, DNA stability or the probability of mutation. In other words, this equation predicts that even the Pyramid and the Sphinx will deteriorate over time and eventually return to sand and dust.

In the same way that human beings acquired body as a "matter" system and the brain as an "information" system, various types of equipment, which are also "matter" systems, evolved to be equipped with an "information" system, which corresponds to the brain. Having undergone a 3.5-billion-year evolution of life with the clear existence of fossil remains, the entire human brain has been optimized. The modern era is when massive volumes of fully evolved information systems have entered equipment (matter systems).

Turning Point of the Era

The root of information technology is so-called digital technology, which originated in Chinese Yì, which started several thousand years ago. The digital "1" and "0" correspond to the two elements of "yīnyáng." Divinatory symbols (trigrams) were defined in the binary system (see Fig. 3). Later, approximately 2,500 years ago, the basics were compiled in "Zhou Yi" (Yì Jīng)" as one of the Four Books and Five Classics.

Gottfried W. Leibniz (1646–1716), a German philosopher and mathematician, who was also deeply familiar with ancient Chinese culture, completed a binary system in 1698, receiving ideas from Zhou Yi, in which he had a strong interest. In addition, Leibniz devised a formal language in logic (which later became Boolean algebra) and further produced a mechanical calculator. However, it took nearly 300 years until the practical application of the initial electronic calculator in the 1940s–1950s. The more significant the innovation, the more time that is required to achieve it. As an example of innovation, I would like to reflect on the history of such information equipment.

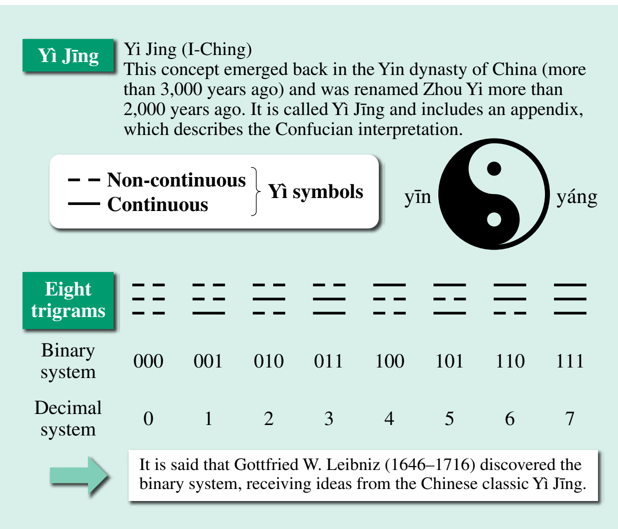

Fig. 3—Origin of a Digital System.

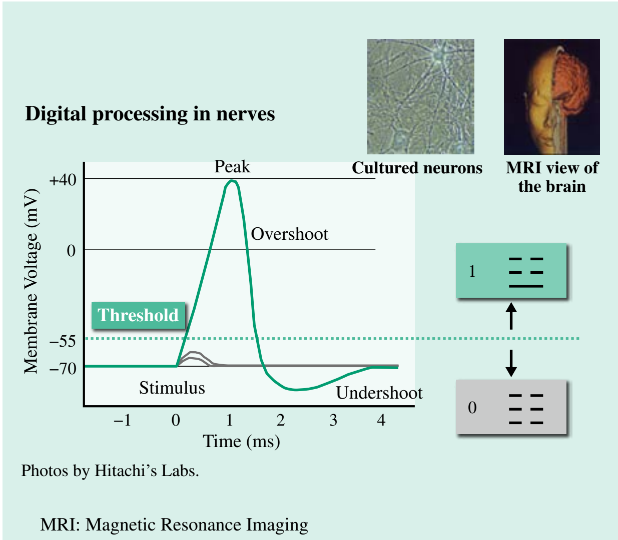

Fig. 4—The World of Nature Is Digital-based.

Although the processing of bio-information tends to be considered to be analog processing, animals' information processing is, in principle, digital. Signals sent to nerves exceeding a threshold are regarded as 1 and those not exceeding the threshold as 0. This mechanism is important in understanding the inherent nature of life (see Fig. 4). Moreover, energy in the world of nature is quantified, therefore it is digital.

In the process up to the realization of an electronic calculator, a leap occurred in printing technology, that is, photolithography to produce a semiconductor device. This concept of printing was born in China more than a thousand years ago. Precision printed products with a clear year of production include "HYAKUMANTO DARANI" of the Horyu-ji temple (printed in 770) and "KONGOKYO" (The Diamond Sutra) discovered in Dūnhuáng (printed in 868).

Johannes G. Gutenberg (1398?–1468), a German, advanced woodblock printing to a metal letterpress printing system and achieved large-volume printing of an exquisite Bible in 1455. This technique led to recent 3-D printing.

Later, a vacuum tube was invented by John Ambrose Fleming (1849–1945) in 1904—the birth of electronics. Although the basic principle (Edison Effect, 1883) was discovered by Thomas Alva Edison (1847–1931) when he produced the electric light bulb, he did not appreciate its importance and did not apply for the basic patent. Although the performance

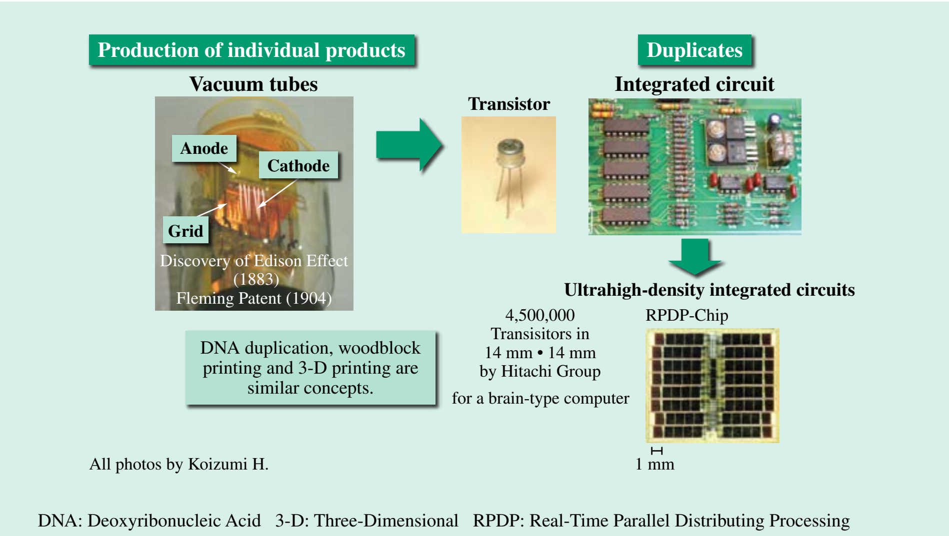

Fig. 5—Innovation for Production [ICT Infrastructure][16].

of vacuum tubes is defined by model numbers, the internal structure varies significantly according to the manufacturer. In the process of shifting from individually produced vacuum tubes to semiconductors produced using a duplicating technology (printing), a qualitative change occurred in manufacturing (see Fig. 5). Photolithography, which became possible due to the characteristics of semiconductors, helped realize highly reliable high-density integrated circuits (ICs). (Regarding the use of vacuum tubes, two vacuum tubes with three electrodes are required per bit, therefore 1 kB requires approximately 16,000 vacuum tubes, which made it difficult to achieve a full-scale practical application of electronic calculators using vacuum tubes.)

It took approximately 300 years for a practical electronic calculator to be achieved after undergoing all the above processes. Ultrahigh-speed and large-scale arithmetic circuits, which are impossible with vacuum tubes, have supported information processing technology. It is therefore becoming possible to mount information processing equipment with functions of the brain or central nervous systems onto many kinds of equipment. As a result, the IoT era emerged as a natural consequence. This trend had been predicted long ago by "looking back from the future" (see Fig. 6).

Ultimate Evolution of Human Beings

Another extraordinary point of this era is a new challenge regarding the handling of life by the life sciences and bioengineering. It is now undeniable that with sufficient funds it is becoming possible to create a human artificially and design a human who meets certain purposes and intentions. The aforementioned iPS cell and other stem cell engineering is rapidly developing in the name of regenerative medicine.

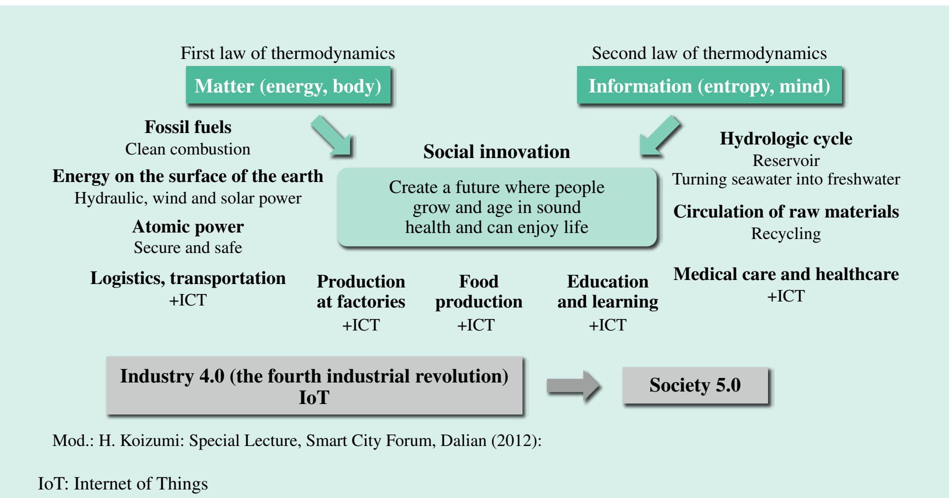

Fig. 6—Future Society in Which Matter and Information Collaborate.

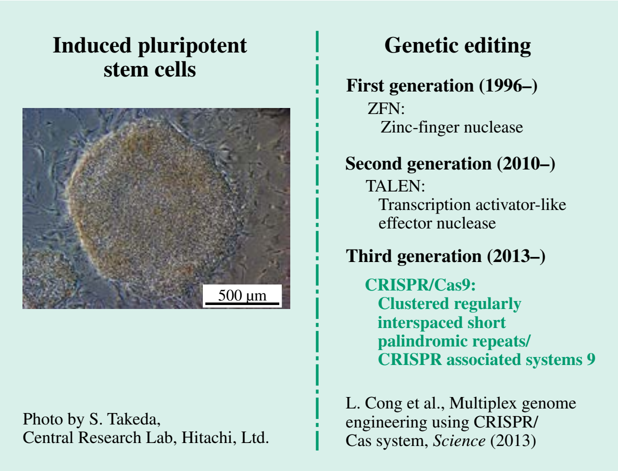

Fig. 7—Induced Pluripotent Stem Cells [Ips Cells] and Genetic Editing.

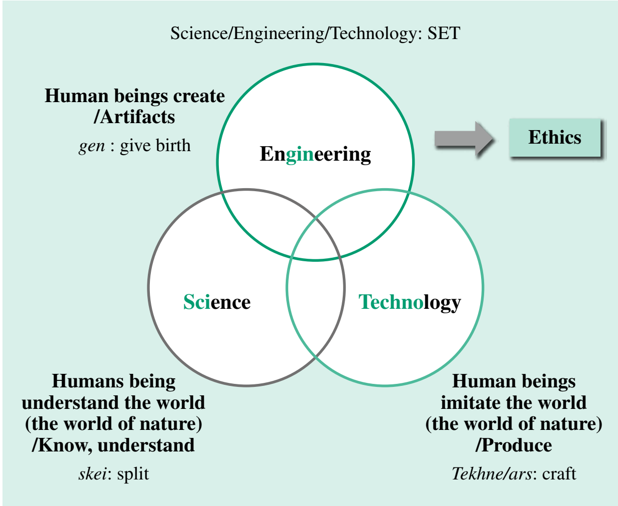

Fig. 8—Mutual Relationship among Science, Engineering and Technology.

Moreover, genetic engineering reached its third generation a few years ago. Today is an era during which we can edit the genes of an experimental animal using a kit sold over the counter (Fig. 7).

Brain-science is so complex that it is still far from a stage of genetic manipulation. However, deep learning, a neuro-computing technology, has started to raise awareness in society about ethical problems that could be caused by artificial intelligence(16).

The illustrations inserted in *Faust* by Johann W. von Goethe (1749–1832) include an illustration of an alchemist producing an android ("homunculus" at that time). The ultimate purpose of the alchemy was not only to produce precious metal but also to create a human. It might not be an overstatement to say that today's world has come close to that stage. Although somewhat deterred by production costs, "artificial elements"—another goal of alchemy—already were achieved when technetium was produced in 1937. The realization of the ultimate goal of producing an artificial human is just around the corner.

Last year, in preparation for the issuance of a new science publication, I had the opportunity to discuss such issues with the editor of *Nature*. We agreed that ethics is an urgent issue in science and technology(17).

As shown in Fig. 8, the word stems of *science, engineering* and *technology* are "*sci-*," "*gin-*" and "*techno-*," respectively. As shown in Fig. 8, the meaning of the word stems in ancient Greek are "divide/split," "to give birth/create" and "imitate the nature," respectively.

Science is to know the world of nature deeply and accurately, but it does not directly create anything substantial. To "divide/split" means to understand a system by dividing the system into components, or to "analyze," which leads to the reductionism addressed by René Descartes in his *Discours de la méthode*. (Although Descartes explained that a final understanding is obtained by comprehensive summarization after the analysis, this point is often overlooked.)

On the other hand, engineering is to create human artifacts in the world of nature. Therefore, everything that is created by human beings is in the domain of engineering. Even if a wonderful scientific discovery occurs, the discovered attribute was inherent in nature and was not created by human beings.

The word stem of *technology*, "*techno-*," has the same root as the ancient Latin "*ars*" and refers to human activities to produce artifacts by imitating nature.

In R&D, it is crucial to distinguish these three orthogonally intersecting (completely different) concepts and manage and plan them. Furthermore, it is important here that ethics is required especially from engineering and technology (art), rather than from science. What impact would the created artifacts have on human beings?

The Fifth Science and Technology Basic Plan, which was formulated by a resolution of the Cabinet meeting of Japan in January 2016, includes a description regarding Society 5.0. This vision also contains new concepts that should be noted. Overseas, the Academies of Engineering are deeply involved in the industrial policies of governments. The drafts of such plans as Germany's "Industry 4.0" (acatech) or China's "Made in China 2025" (Chinese Academy of Engineering (CAE)) were formulated by each country's Academy of Engineering and later entrusted to the respective governments to reflect the plan in actual policy. Although most industrial policies in Europe, the United States and Asia are based on customer markets and innovation, the ultimate purpose of Japan's Society 5.0 is a "satisfied society." Both the purpose and its method (scientific technologies) address the perspective of "Human Security & Well-Being." Business corporations must also further nurture this vision and future generations with rich mind[18, 19]. I explained similar concepts in Dalian, China, in 2012. I think it is important to nurture the right concepts going forward (see Fig. 6).

FROM COMPLIANCE TO ETHICS

Journey to Ethics: Measurement and Analysis of Organomercury, Cause of Minamata Disease

Regarding myself, the first new principle I formulated after joining Hitachi, Ltd., was polarized Zeeman atomic absorption spectrometry (PZAA), a highly sensitive and high-precision method to analyze trace elements (see Fig. 9). At that time, Minamata disease caused by organomercury poisoning was a serious social problem, followed by Itai-itai disease due to cadmium poisoning and hexavalent chromium contamination; mercury poisoning that occurred at the Agano River in Japan, in Canada, in Indonesia and at the Amazon (caused by discharged organomercury and the mercury amalgam used to dig for gold); and arsenic poisoning in China and Southeast Asia. Bombarded by such problems, the newly developed equipment was in full operation every day, 24 hours

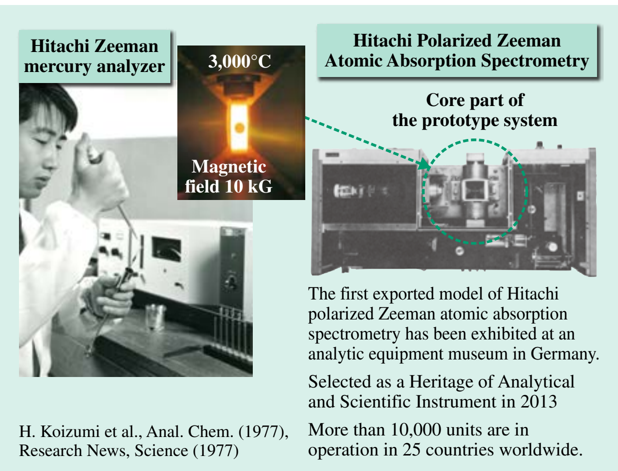

Fig. 9—Working on Environmental Issues Using Accurate Analysis Method for Minor Elements.

a day. The first imported model of Hitachi's 170–70 PZAA was exhibited at a museum of analytical science in Germany and designated as a Heritage of Analytical and Scientific Instrument (2013) in Japan. Also, the basic patent for this system was selected as one of "Japan's 50 Top Patents" by the Ministry of International Trade and Industry in 1985 at the 100th anniversary of the establishment of the patent system of Japan. Furthermore, during the 40 years since the initial model, more than 10,000 units have been sent worldwide. During this period, the company handling this system changed from the Department of Optical Instruments at Naka Works of Hitachi, Ltd., to Hitachi High-Technologies Co. and later to Hitachi High-Tech Science Corporation.

This principle (PZAA) utilizes the distinct characteristics of photons—moving constantly nonstop at a high speed, zero mass, zero electrical charge, integer-1 spin and mutually interacting with elementary particles such as electrons and protons. Although photons exist everywhere ordinarily, they are the most distinct elementary particles. Based on the only two states of photons with spin ±1 as a principle, orthogonally intersecting polarized elements are used like a balance scale to detect the difference. On the other hand, by dissolving the degeneracy of energy levels of intra-sample electrons that mutually interact with photons, a difference in the state of ±1 spins of the photons is created. Midnight experiments using waste products led me to this principle. In the field of element analysis, next to the large-scale isotope-dilution mass spectrometry, the PZAA became the second most accurate and sensitive analysis method. Moreover, the PZAA uses the Zeeman effect during mutual interactions between photons and electrons, whereas the medical-use magnetic resonance imaging (MRI) uses the Zeeman effect during mutual interactions between photons and protons.

I studied pollution problems first, then issues on the global environment, and noticed the importance of brain-science and education because of the mutual interaction between the environment and the brain. For me, the origin of research was always on environmental issues. As the root of the environmental issues was in the Ashio Mine and Minamata disease, the pollution was caused by human artifacts brought by or discharged by human beings into nature. Along the Amazon River, greedy gold diggers spread a massive volume of mercury to capture gold easily by turning gold into mercury amalgam. Local habitants' living places were polluted by mercury and their suffering continued generation after generation.

Dual Use of Scientific Technologies

Ethics/morals is a recurring issue that began with the Nicomachean Ethics of Aristotle (BC384–BC322) and religious norms. Frequently discussed in the early modern era was the invention of dynamite by Alfred B. Nobel (1833–1896). Dynamite was used not only at mines but also for flood control, saving many people's lives. On the other hand, dynamite was used for military purposes in many places around the world, generating enormous wealth. Smokeless gunpowder that is often used for guns or cannons was also invented by Nobel (Ballistite, patented in 1887). Although the production of new high-performance bombs and sales of such weapons to both sides in warfare at the request of markets and clients have been criticized, the wealth generated in this way is still alive today as a resource for the Nobel prizes.

German genius chemist Fritz Haber (1868–1934) developed a process to fix nitrogen from the air (Haber-Bosch process) and provided synthetic nitrogen fertilizers for practical use, contributing to the lives of people worldwide (receiving the Nobel Prize in Chemistry in 1918). Currently, half the world population is supported by food produced using synthetic nitrogen fertilizers. However, nitrogen compounds by fixing nitrogen from the air are also raw materials for explosives. Haber became absorbed in research on toxic gas as a military technology. At the second battle at Ieper (1915) in World War I, Haber led a toxic gas battle. Immediately after the poison gas battle, Haber's wife, Clara Immerwahr (1870–1915), committed suicide to protest his beliefs and actions. She was a rare female chemist with a Ph.D. at that time.

To justify the use of dynamite, toxic gases or atomic bombs as a result of scientific technologies, the logic used repeatedly by Nobel, Haber and Julius R. Oppenheimer (1904–1967) was that the use of high-performance weapons helps to end war quickly, or works as a deterrent, thereby saving many people's lives. However, in reality, the use of such weapons led to increases in military weapons and caused diffusion.

Marie S. Curie (1867–1934) and Pierre Curie (1859–1906), who discovered radium, an element that emits strong radiation, concluded a lecture at the award ceremony in receipt of the Nobel Prize in Physics in 1903 with remarks to the following effect:

"Science is neutral in values. Whether to use the results of scientific research for good or bad purposes is entirely up to the humans who use them. We would like to believe that humans are mature enough to use scientific technologies only for good purposes."

The dual use of scientific technologies is also an old and new issue. Discussion is brisk at the Science Council of Japan, Cabinet Office of Japan.

Origin of Hitachi's Ethics

After investigating the dawn of the Hitachi Group, I felt that Hitachi has had a strong ethical vision from its inception. This investigation was triggered by a comment from Professor Kenichi Miyamoto (former President of Shiga University), who published "*Sengo Nihon Kougaishi-ron* (On the post-war pollution history in Japan)[20, 21]."

The Hitachi Mine and Hitachi, Ltd., started during the time when industries emerged after the Russo-Japanese War (1904–1905). Namihei Odaira (1874–1951), founding President of Hitachi, Ltd., joined the Fujita-Gumi Kosaka Mine and engaged in the construction of a power plant (1900) after graduating from the electrical engineering department of Tokyo Imperial University. After the Portsmouth Peace Treaty was signed in October 1905, Fusanosuke Kuhara (1869–1965), who was Odaira's superior at that time, bought out the Akasawa Mine on December 12 of the same year and started operation as the Hitachi Mine on December 21, 1905. Kuhara first joined the Fujita-Gumi Kosaka Mine in 1891, as ordered by his uncle, who was then President of Fujita-Gumi, and achieved a big success by quickly adopting the black copper flash smelting method. However, due to a conflict, he left the Kosaka Mine and moved to a new place, Hitachi.

Odaira also left the Kosaka Mine and joined Hitachi, Ltd., following Kuhara. Odaira's occupational transition (from Hiroshima Dento Corporation to Tokyo Dento Corporation, and a meeting with Motoji Shibusawa at Saruhashi Daikokuya, and other episodes) has been explained in many publications, therefore the related explanation is omitted in this paper. Tokyo Dento is currently Tokyo Electric Power Company (TEPCO). Odaira followed Kuhara by quitting such a big company. I imagine that Kuhara might have had something great in his personality. In fact, Odaira wrote at the beginning (preface) of his "*Hitachi Seisakusho Shi* (History of Hitachi, Ltd.)": "I owe so much to Fusanosuke Kuhara and Yoshisuke Ayukawa. I cannot be more grateful to them. Especially Mr. Kuhara provided valuable guidance and helped me since I was at the Kosaka Mine, even at a personal level. The establishment of Hitachi, Ltd., was achieved by Mr. Kuhara. Today's Hitachi owes both Mr. Kuhara and Mr. Ayukawa so much[22, 23]."

Reviewing Kuhara's activities in the history of pollution, as pointed out by Professor Miyamoto, I recognized Mr. Kuhara's tremendous efforts on corporate ethics to tackle environmental issues head on.

Environmental Pollution from Smelting and Its Countermeasure

Although Minamata disease, in which the cerebral neural system is destroyed by mercury poisoning, has been regarded as ground zero of issues of the global environment, there was a prior case in Japan: mining pollution at the Ashio Mine. As is well known, Shozo Tanaka, a member of the House of Representatives, directly appealed to Emperor Meiji in 1901 regarding the sulfur dioxide (SO_2) emitted from smelting, which weighs twice as much as the atmosphere and falls to the ground causing enormous damage to the surrounding environment, killing not only rice paddies and crop fields but also forests and causing landslides and the outflowing of rocks from the mountains. At the Watarase River, which became a raised-bed river, large-scale flooding occurred repeatedly. As an environmental measure, the Watarase Reservoir was created. However, flooding still occurred again in the fall of 2015.

Given such a history of pollution, I learned from the aforementioned remark by Professor Miyamoto that the Hitachi Mine was an exception. For more than 40 years, I was absorbed in quick and accurate measurements of organomercury, the cause of Minamata disease. Later, I often walked around Mt. Kamine in Hitachi with my family. I found a crystal like a gem at the Hitachi Mine's *zuri* (the dump for low-grade ores), but particular phenomena caused by pollution was not seen much in the surrounding area, which was unexpected. Such an experience became the first reason I got interested in the Hitachi Mine.

Hitachi Mine as a Role Model of Hitachi, Ltd.

Utilizing his experience at the Kosaka Mine, Kuhara acquired a few power plants near Hitachi to generate electricity and used compressed air produced by large-scale motors as the power source inside the mine. The actual entities existed there as miniatures of the current Hitachi Group, such as power generation, transformer and power transmission facilities, motors as a power source, a transportation track, a small electric engine, a lift (elevator) to descend deep down to the underground passage in the mine, lighting for a dark underground passage, a pneumatic rock grinder, the element analysis method, optical measurement equipment, meteorological observation instruments and communications equipment. Such technologies were further used to support the mine workers' lives and to help develop such welfare facilities as company housing, restaurants, kiosks, hospitals and schools.

Corporate Social Responsibility (1905–)

Moreover, considering the lives of the residents in the surrounding area, pollution compensation was paid to them every year from the inception of the company at an amount combining the damage compensation and condolence money. However, as production surged, the compensation payments were augmented, which pushed the company into a managerial predicament. The Hitachi Mine Great Chimney was built as a result of enormous turmoil although the company could have just made an excuse to justify the production of copper in an era of warfare. The Chimney is a legacy in Japan's history of pollution. There was a fact, though, that the diffusion of smoke to remote areas did occur, as the toxic chemical emerged on tobacco leaves because it took time to complete a technology to capture all the SO_2 gas[24].

The Kamine Smoke Trail (dubbed *Mukade Endo*, a long and twisted smoky trail like a scolapendrid) of exhaust smoke from the refinery at Daioin along the line of the mountaintops, "*Aho Entotsu* (stupid chimney)," for which the Japanese government's design did not work at all, and one-third of the base of the Hitachi Mine Great Chimney, which was completed as a result of serious turmoil and towered as high as 480.7 meters above sea level, remain today (see Fig. 10). The Nippon Mining Museum, at the site where the Hitachi Mine existed, stores Kuhara's

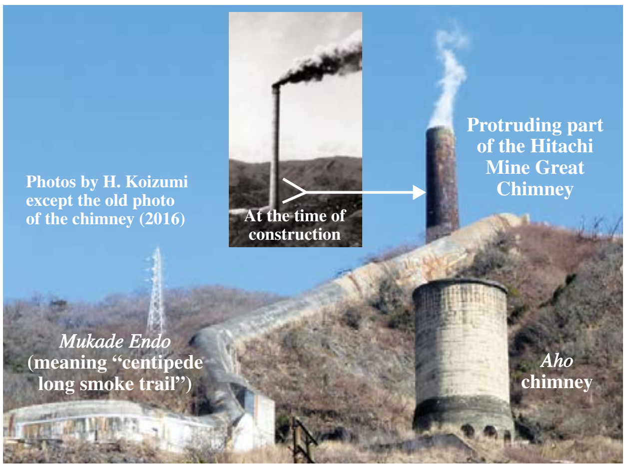

Fig. 10—Current Situation of the Hitachi Mine.

calligraphy, "*Kushin-Santan* (Mindboggling efforts to address tremendous difficulty)," and the foundation stone with the same calligraphy "*Kushin-Santan*" on it. Although there are many corporate managers who make lofty statements, Kuhara's "*Kushin-Santan*" expresses how he was and sounds more real.

The Hitachi Mine Great Chimney was completed in 1915. The chimney was 155.75 meters high, the world's highest at that time, exceeding the 152-meter brick chimney in Montana in the United States. For more than 40 years, every time I visited the Hitachi Mine Great Chimney, I was impressed by such a thing having really been made. The chimney, standing on the summit of the mountain, was made from reinforced concrete for the first time in the world so that it could be sustained on the top of a mountain even in the event of being hit by a typhoon. The grand chimney atop the mountain could be viewed clearly even from the remote coastal line.

Because SO_2 gas weighs 2.26 times air, unless it is put on an upward airflow and diffused, the chemical falls down on the surrounding area. Therefore, by observing the local high-altitude climate, this height was determined. In the event of occasional sudden downward airflows, based on the information collected at the central office from the meteorological observatories located on the mountains surrounding the chimney, smelting was temporarily suspended as a measure to address the situation. Over time, most damage to the area surrounding the observatories was removed and the trust relationship with nearby residents continued, according to the record[(25)].

In 1972, the total volume of SO_2 gas was collected as sulfuric acid (H_2SO_4), achieving zero pollution. Right after that, I visited the Hitachi Mine Great Chimney. The chimney, which accomplished its mission, suddenly collapsed in 1993, leaving one-third of its base (57 m) as a remnant.

Conclusion

I attended a board meeting of the United Nations Foundation (the "Foundation" below) that was held in Tokyo, invited by Professor Emma Rothschild, Professor at the University of Cambridge and wife of Professor Amartya Sen, who received the Nobel Prize in Economics (the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel) in 1998. I was introduced first to the founder of the Foundation, Ted Turner (the founder of the U.S. Cable News Network (CNN)). The United States left the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1984 because the contribution made by the United States did not benefit the United States but rejoined in 2003. Turner, in contrast, contributed $1 billion (approx. ¥100.0 billion) as an investment for the future of humanity, creating the Foundation in 1998.

During the meeting, a sudden request was made for opinions from Japanese corporations. Yotaro Kobayashi (1933–2015), then Chairman of Fuji Xerox Co., Ltd., explained the current situation of Japanese corporations in fluent English. Immediately after that, Professor Rothschild said that she wanted to hear Koizumi's opinion. With no preparation for such a sudden request, I decided to introduce the vision of Namihei Odaira, founder of Hitachi, Ltd., and explained the relationship between the companies' purpose and methods (or means) in not-so-fluent English: "Corporations exist to contribute to society, and reliable management is essential to achieve the purpose of a company." Immediately after the close of the meeting, one gentleman showed up in front of me. He requested a handshake right away and said he was impressed by what I said. On his business card was "Muhammad Yunus," founder of the famous Grameen Bank of Bangladesh, which makes small loans for poor people. The bank achieved a stunning 98% loan recovery rate. He received the Nobel Peace Prize in 2006.

Based on general Western management theories, it is a common concept that the purpose of business corporations is the creation of customers and the values desired by customers[(26)]. However, the vision of Namihei Odaira, founding President of Hitachi, Ltd., was at a higher dimension. As reflected in the aforementioned Nobel's and other cases, even in an era when certain justification might have been accepted, he prioritized human ethics, which seemed to be a fresh approach to Western corporate managers.

Recently, many incidents have occurred related to not only compliance but also ethics at companies throughout the world. We need to refocus on the corporate vision at the dawn of Hitachi Mine and Hitachi, Ltd. The last publication by Professor Hajime Nakamura (1912–1999), an authority on Eastern philosophy, was *Atatakana Kokoro: Toyo-no Riso* (Compassion (think about others): Ideal of the Eastern World) (1999). Also, in "*Die Metaphysik der Sitten* (Metaphysics of human ethics)" (1797) by a Western philosopher, Immanuel Kant (1724–1804), one of his last publications, it is indicated that compassion for others is ethics (“promote other people’s happiness as one’s own purpose”). I also regard warmheartedness as the essence of ethics. With regard to the concepts and discussion of ethical education, I would like to use our next opportunity to discuss that topic(27)–(30).

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