Shaping the Future beyond Modernity

International Institute for Advanced Studies

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International Institute for Advanced Studies (IIAS)

International Institute for Advanced Studies (IIAS) was founded in Keihanna Science City in 1984 as an institute for "conduct research for the future and happiness of mankind". Thirty years later, in 2014, we returned to this original spirit, and discussed intensively "What are the big issues in the world of the 21st century, and what are the issues to be addressed immediately at International Institute for Advanced Studies?". Now, to contribute to solving the serious problems facing the drastically changing global society in the near future, we have set up a core program to tackle the following issues in 2015.

A: Transforming Science and Technology in the 21st Century
- value, system and practice -
(Principal Investigator: Tateo Arimoto, Vice Director, International Institute for Advanced Studies)

B: Sustainability of Human Survival
- Rebuilding of Value Axis towards 2100 -
(Principal Investigator: Takamitsu Sawa, Research Advisor, International Institute for Advanced Studies)

C: Towards Peaceful Co-living in a World of Diversity
(Principal Investigator: Ryuichi Ida, Vice Director, International Institute for Advanced Studies)

D: 30 Year Concept for the Keihanna Science City
(Principal Investigator: Hiroshi Matsumoto, Vice Director, International Institute for Advanced Studies)

To solve various issues in the global society, how should academic studies, science and technology, society, economy, humanity, and near-future cities be? Can we, human beings, continue to survive on the Earth with the ways of life and values as we are? We hereby publish a report on the results of our attempts to transcend countries, organizations, and fields, and have discussions by people of various positions, to find a new direction towards the future of human beings and the Earth.

Abstract of Key Research Programs

A: Transforming Science and Technology in the 21st Century - value, system and practice -

How should we deal with the difficulties faced by human beings, society and the earth of the 21st century, and therefore what is the science and technology of the 21st century? There is a serious awareness that the development of science and technology through extension and fine adjustment of the current situation will cause a serious crisis in the lives of mankind, the earth and people.

This study group presents the recognition and the world view of the era of science and technology in the 21st century, from the viewpoint of people and institution. We describe the thesis from a perspective and summarize some concrete recommendations and practical examples for change.

B: Sustainability of Human Survival - Rebuilding of Value Axis towards 2100 -

In consideration of limited earth, a pressing issue facing humanity, it is obvious that the relentless pursuit of wealth through modern capitalism will lead, if unchanged, to the depletion of global resources, an increased wealth gap, and the swift extinction of the human race. As such, it is necessary for us to go beyond our concept of progress and development, build a stable, recycling economy and a sustainable society, reduce the wealth gap as far as possible, and create a society that guarantees a cultural lifestyle.

This study group will paint the picture of such society and discuss what needs to be done to make a smooth transition into it.

C: Towards Peaceful Co-living in a World of Diversity

This study group was established with the goal of returning to the dignity of human beings while respecting tolerance, cooperation, and the spirit of reciprocity, and building values for peaceful co-living. We examined ideas and elements that would form the basis for presenting the factors for achieving peaceful co-living, arising in Japan, as an index.

We will further refine the index elements shown here and the confirmation method of their effectiveness, and then will construct a concept of a world of peaceful co-living, based on the existence of diverse values, to disseminate from the International Institute for Advanced Studies.

D: 30 Year Concept for the Keihanna Science City

*available in Japanese edition only

How cities and/or regions should be in the 21st century. How the International Institute for Advanced Studies (IIAS) should commit to develop recommendations towards molding Keihanna into a model science city in the future. 30 years has passed since Keihanna’s opening. Taking this opportunity, "Advisory Panel on the Future of Keihanna" have discussed the future of Keihanna with a long term view to draw 30 Year Concept for the Keihanna Science City.

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A: Transforming Science and Technology in the 21st Century
- value, system and practice -

Principal Investigator Tateo Arimoto

Introduction

How should we deal with the difficulties facing humanity, society, and the Earth in the 21st century, and for that purpose, how should the academic studies of science and technology be in the 21st century?

There is a serious awareness that the development of academic studies or science and technology through extension and fine adjustment of the current state will cause a serious crisis in the lives of the humankind, the Earth, and the people. Also, there is a great concern as to whether current science and technology and its direction will give hope to students, and young scientists and engineers. On the other hand, as seen in SDGs, the “2030 Agenda for Sustainable Development," which the world agreed upon at the United Nations two years ago, the expectation is getting bigger for science and technology to solve global or local socioeconomic difficulties.

This study group first presents the recognition of the era and the worldview concerning issues and prospects of science and technology in the 21st century, then describes the discussions and analyses from a perspective of people and institution - a system that promotes innovative changes to scientists as human beings and science - from various perspectives of the members, and finally concludes with some concrete recommendations and practical examples for change.

Given the historically accumulated, enormous number of modern science and technology methods and the ways in which human resources should be, what we can do as a small group is limited, but we think that it is important to step into practice now without fear of risk, even if it is small, to network with many other such movements inside and outside, and to expand cooperation. We hope that this report will be a medium for such activities.

This report was written with the following structure by the respective members.

Chapter 1　Relationship between Science and Society

- A Discussion on the Future Development of Science in Japan -

Mitsunobu Kano

1. Definition of "science" in this paper

First, I will clarify the definition of "science" in this paper.

“Science” may have various definitions, but this paper defines it as follows. "Science" as used in this paper refers to the acts of 1) “recognizing the question,” followed by 2) devising a "new (not yet accepted) hypothesis,” then 3) gathering “logically related” 4) “evidence that is reproducible by others” with respect to the devised hypothesis to prove that 2) is true, and 5) asking others about this hypothesis and the contents of the proof.[1] So, what are the roles of such acts, and what are the roles of those who perform such acts (i.e., scientists) and the significance of their presence in society?

2. What can "science" do?

Science has been searching for truth so far by investigating whether there are any relationships between observed phenomena (correlations), and whether there is a relationship of cause and result (causal relationship). In this way, science has given a certain explanation in the form of a proved hypothesis to questions concerning various phenomena, such as why the color of the sky is blue, why the blood is red, when and why an object is easily flammable, how the growth of a plant changes with what kind of substance, and when and why we feel pain. Also, by utilizing, applying, and combining accepted explanations, “ways to always reproduce something when a given method is followed” have been developed, and because of this, the industries have developed as well. Mass-produced industrial products around us are likely to be products of these trains of thought.

For these reasons, due to the achievements of giving accurate answers to various questions and applying them to produce various products that people desire, there is a possibility that people have somewhat had an "expectation that science is universal."

However, is science versatile? In fact, it’s possible that it is not so.

Concerning the expectation of versatility, there is a limit in the sense that scientific outcomes almost always have the two sides of the good and the bad as one of the limits of science. Issues related to medical care and nuclear energy are probably suitable examples for talking about the dual nature of science. Both definitely give humans a method of "giving a big influence" on humans, but if the influence is too strong, it will cause health problems or death, and if used properly, it will be beneficial. It “is neither poison nor medicine," or “can be either poison or medicine." In medicine, a desirable effect among others is called the main effect, and an undesirable one is called a side effect. The outcomes of science should also have main effects, and of course, side effects, in this sense. Therefore, we cannot say that it will always be versatile towards the desired direction.

Another limitation is the limit of phenomena that a method that is science can handle. If science is in fact defined as mentioned at the beginning, it is very difficult to deal with a phenomenon unless “reproducible evidence" can be gathered. That is, unless it is a "reproducible phenomenon," it cannot be a subject of scientific study. However, not all phenomena in the world are reproducible. Indeed, we can say that the life of a human being itself is not completely reproducible, and is a once-in-a-lifetime phenomenon. A phenomenon that a person experiences and recognizes at a certain time is basically “limited to that time," and is a one-time occurrence caused by the combination of the following main explanatory factors of the combination of certain genes that a person was born with, the kind of experiences that the person has gone through up to that point in time, and the environment in which the person is placed at that time. Is stating a little bit of probability theory for each of these factors what a method of science can do to explain such one-time phenomena? For example, it should be something of the following extents: if a certain gene exists, the probability of occurrence of something increases (since there are multiple individuals having a certain gene); if a person has a certain experience, the probability of occurrence of something increases (since there are multiple individuals having the same experience, for example those who have received the same educational content);

[1] *Ronriteki kangaekata tsutaekata: konkyo ni motozuku tadashii giron no tameni*. (*Logical Ways of Thinking and Communicating: For Correct Discussions Based on Grounds*.) Mitsunobu Kano. 2016. Keio University Press.

or if they share a certain period of time, the probability of occurrence of something increases. Even in the stage of estimating the probability, if there are multiple pieces of data that can be analyzed, difficulty awaits in the process of trying to extract samples that can be used to estimate the true population from them.

It is suggested that it is very difficult to expect versatility from science at least from these two aspects, and after the earthquakes in 2011, many Japanese citizens no longer expect “versatility,” at least.[2]

3. What is the societal expectation for "science"?

- Science for "problem solving” -

So, what kind of content do people not engaged in science want from science?

It should be mainly “useful" activities for those people. To guess at what moment they feel it is “useful," it is probably when 1) “it gives me what I do not have now but am longing for (dreams, hopes),” or when 2) “it helps me with what I am in trouble with (solves a problem).”

An interest in a science that "gives me what I do not have now but am longing for,” such as interests in research on the universe or the ocean, [3] would correspond to this. Or, some science comics and sci-fi, so to speak, are loved may be loved for the same reason. In a way, I think that expressions that “chase a dream” and “there is a romance” are appropriate, and scientific activities at present realize this to quite an extent.

On the other hand, society's support for science “that will help me when I am in trouble,” for example, would include support for medical research.[4] When people get sick and are at a loss, science which elucidates the reason and gives them a coping method that anyone can reproduce must seem like a wonderful existence. In addition to medical care, there are voices in Japan expecting promotion of science against disasters such as earthquake and volcanoes. It should be natural in an environment troubled by disasters. In recent years, sustainable developmental goals (SDGs) by the United Nations exist as a summary of “troubles," or in other words, "problems to be solved,” on a worldwide scale. Alternatively, at the “Meeting of Young Asian Scientists" held by the National Young Academy of Japan, Science Council of Japan, with the support of the International Institute for Advanced Studies, which invited Asia’s regional members of GYA in March 2016, "realizing an inclusive society" and “countermeasures with clear effects to realize a sustainable ecosystem" were raised as future issues.

How important, as a scientific objective, should scientists consider such a science with a “problem-solving” focus? Voices may be heard saying that even with “truth-searching" only, science has produced a lot of results. Let us consider a little more on why the “problem-solving" type tends to be considered important in recent years.

Human beings engaged in scientific activities are just one of the sectors that constitute human society. Therefore, on the one hand, science and scientists can be regarded as an answer to the question as to what role they play as they exist while allowing others to live and being allowed to live in human society.

There are many reasons why humans dominated other animals, but there is the idea that the ability to "exchange" can be cited as one reason.[5] It is the idea

[2]For example, *Heisei 24 nen ban kagaku gijutsu hakusho*. Dai 2 setsu, kagaku gijutsu seisaku ni towareteiru mono (Section 2, S&T policy at stake. *White paper on science and technology 2012*). http://www.mext.go.jp/b_menu/hakusho/html/hpaa201201/detail/1322773.htm

[3] Kagaku gijutsu ni kansuru kokumin ishiki chousa - 2014 nen 2 gatsu - 2015 nen 10 gatsu kagaku gijutsu no kanshin to shinrai -(Public attitude survey of science and technology - interest and trust for S&T in 2/2014 - 10/2015). Moritaka Hosotsubo. National Institute of Science and Technology Policy. Research material; 244. P.9 in particular. http://data.nistep.go.jp/dspace/handle/11035/3120

[4] The same as above. Below are several quotes. [Measures with many requests are: “promotion of R&D on infectious disease prevention measures" (57%); “providing information to the general public on natural disaster prediction measures" (55%); “providing information to the general public on infectious disease prevention measures" (52%); “promotion of R&D on earthquake and volcanic eruption prediction measures" (52%), etc. Many were related to infectious diseases and natural disasters.] ["Science and technology are occasionally abused or misused" (74%); “danger that cannot be anticipated is lurking in the use of science and technology" (65%); “government should support scientific research for advancing cutting-edge academic studies” (65%), etc.] ["Living becomes more convenient and comfortable as science and technology progress" (59%); “knowing science in everyday life is important for me" (45%); “it is good for experts who are familiar with the contents of science and technology to decide the direction of R&D” (39%).] ["Can trust institutions and organizations that conduct R&D of science and technology" (45%); “can trust the scientific basis of the science and technology" (41%); “can technologically control that science and technology (39%); "the magnitude of a possible accident" (39%), are some of the higher ones.]

[5] *Han-ei -- ashita o kirihiraku tameno jinrui 10 mannenshi* (*The Rational Optimist: How Prosperity Evolves*). Matt Ridley. Translated by Naoko Ota., Taeko Kajihara., & Hiroyuki Shibata. 2013. Hayakawa Nonfiction.

that the human race won prosperity through the activities of exchanging what they had with others who did not have it, and having others offer what they did not have if they had it. From this point of view, “what” can science offer to “whom”?

In other words, it seems useful for people who makes living out of science to think about what they have, and about what they do not have that others have, in thinking about the role of science in society. I will show what scientific activities “have” from this point of view. Does that mean that we will provide "accurate" answers to “troubles" through thought and data collection? However, if it is just about “providing answers to troubles,” not only science but also “solutions" that business activities provide to society through already commercialized services would be a very good example of it. Therefore, if there is no differentiation from “answers to troubles" through existing products and services, we cannot talk about the reason why "science" is necessary sufficiently. Taking this perspective into consideration, can scientific strengths be summarized as "the possibility to provide more accurate answers to phenomena for which there is no understanding or countermeasure"? On a side note, in the history of science being accepted in Japanese society, at least at the beginning of the transition from the Edo period to the Meiji era, it is highly probable that science was an activity that gave the aforementioned "solution" than created new things on its own. There was a clan, the Tsuyama clan, which actively incorporated Dutch studies in northern Okayama. At the museum exhibiting this accomplishment, I asked, “While I recognize the importance of the fact that there were those who pursued Dutch studies, did any of them utilize it to create new things?” The answer was no. Of course, there have been many who created new things as scientists after that. However, there is room for verification as to whether the acceptance surrounding scientists by society and the institutions have been optimized for creating new things.

On the other hand, the "weak points" of science are probably that it is hard to make their result easily redeemable into money, and that it takes time and effort to provide an accurate answer. In addition, there are cases where the targeted phenomenon is only visible to the scientist, and while it could be one that will be shared to society in the future, at times it may not be recognized that way when the scientific activity is carried out. These weak points create great challenges in the following relationship to money.

Money can be thought of as a kind of substitute index of the "exchange" mentioned above. For example, if Umisachihiko the Fisherman has two mackerels that he just caught, and Yamasachihiko the Mountain Hunter had a heap of mountain vegetables, and if they are what each of them wants, the exchange should be successful even without money. However, in this case, if they cannot agree on what they consider to be of equivalent value, it will be a source of trouble. How many brackens are an equivalent of two mackerels in value? Money is very useful for making an adjustment here. Scientific activities cannot be unrelated to money. Those engaged in science for living must first nurture themselves and their families daily, and also obtain labor and materials necessary for conducting data collection activities for their own businesses. Then, we return to the question of “what” science can offer to “whom” in order to obtain the money or funding. Furthermore, in modern environments, this fund is mostly covered by government budgets in the case of science. In comparison with the time when science was conducted with self-expenses or funds from patrons among aristocrats or others,[6] when we think about “what” science can offer to “whom" when using funds forcibly collected from the members of society, i.e., taxes, “whom” will be the citizens who are the tax payers, and “what” will be the value that only science is supposed to be able to provide as previously discussed. Even in corporate activities in which they try to raise profits by themselves and create jobs, companies are required to have an awareness as public institutions of society in recent years.[7] Furthermore, in times when the financial situations of many governments and citizens are not good, it should be understandable that

[6]According to Peter Dear. *Chishiki to keiken no kakumei - kagaku kakumei no genba de nani ga okottaka* - (*Revolutionizing the Science - European Knowledge and its Ambitions, 1500-1700, second edition*). Misuzu Shobo. 2012., the patrons of the time supported those who created their own new insights and presented them because it would eventually raise their own status as an authority.

[7]For example: *Kigyo navigator* (*Entrepreneur navigator*). Kenichi Sugano., & Yoshihiko Fuchibe. 2016. Toyo Keizai Inc.

scientific activities in the direction of “giving answers troubles" and “problem-solving" are strongly emphasized as requests to activities using public funds.

However, along with the importance of “problem-solving type" science, we must not forget about the value of “truth-searching type" science. This is already well practiced in the current scientific activities, so emphasis tends to be forgotten in the current situation, but unless not only the surface understanding of a problem and proposing a countermeasure but also acts of thinking about the reason why the phenomenon occurred, what the mechanism is, and what the essence is, pursuing them, and systematizing the results parallel to the “problem-solving type” science exist, the known matter which will be the material used for thinking will be shallow, and the solutions devised by accumulating the known matters will be shallow. It is also meaningful to use a science of such “truth-searching type" as a venue for education. We need to make efforts to cultivate human resources who try to think about the essence rather than those who only see surface phenomena. However, if we quest for this direction too much, the targets of activities will be too small. Balancing is important.

These elements of “problem-solving" and "truth-searching" in science do not correspond perfectly to this, but they may have some commonalities with the comparison between "induction" and “deduction." “Induction" is a way of thinking about what kind of generalization can be made when many observed facts are scattered in front of you, and when there is no known law, there is no choice but to start with this. This should be an appropriate method to solve a "problem" about which “you have no idea what to do." “Deduction,” on the other hand, is a way of thinking in which you confirm whether a new phenomenon applies to existing rules, theorems, and the like, as the premise.

The latter, deduction, makes it easy to see the correct and the wrong, so judgment according to this thinking is likely to be preferred in evaluating others. In my impression from spending time in Japan, the balance between 'induction' and 'deduction' is poor, and 'deduction' is dominant from the educational contents, maybe because there is an “admiration” for “absolute correctness.” I think that it is impossible to have a balance unless we emphasize the necessity of "induction" a little more. From this point on, I believe that the importance of the “problem-solving" type should be emphasized to balance things, and that tone is strengthened also in this paper.

4. In advancing science of the “problem-solving" type

I will discuss the current state of medicine facing the field of clinics, one which is probably the oldest science of the problem-solving type. Of the tasks demanded by society, I think that there is a significance in deriving the question of how much of the material aspect is left, that is, how much is left that can be answered by the "natural scientific approach."

I think that one of the reasons why research on diseases, or Western medicine since the 19th century, was able to develop to this extent is that they treated the material and mental aspects of human beings separately, and kept exploring the material aspect and reproducible parts. In other words, it was a natural scientific approach. The reason why anatomy is at the beginning of a medical department’s education is, while it did not come to my mind when I went through it but looking back, probably because it was meant to make them first pay attention to the material aspects of the existence of humans and the material structural commonalities between individual humans. In addition to the significance of decomposing a target problem into material and mental elements and further decomposing the material element into details to make analysis easier, as long as we treat the material elements, reproducibility is higher than for mental elements, and there will be a significance of making it easier to reach an agreement by finding some absolute truth by a scientific method. If some kind of material obtained from a patient shows a change in contrast to a counterpart material obtained from a healthy person, it is possible to devise a hypothesis that it is some material linked to the cause of the disease, and prove it. It is much easier than establishing a hypothesis by comparing behaviors, etc., which seem to be due to mental abnormality, to that of a healthy person, and to prove it.

Among the various phenomena surrounding human beings, classification is made roughly between natural science, and humanities and social sciences, depending on which element is to be focused in practicing science. Basically, natural science deals with the material. In this case, it is easy to obtain data as a numerical value, and proof of causality can be easily obtained by an intervention experiment. However, when trying to deal with activities brought by higher-order functions of humans (social activities), it is difficult to turn them into numerical values. It will be necessary to deal with so-called qualitative data, and because intervention experiments are difficult, only correlations can be shown, and in many cases, there is no choice but to rely on inference for causality. The so-called big data can only show correlation basically, also. Also, to begin with, a human being analyzing another human being means that there is no way of having an absolute point of view, and it is inevitable to become relative.[8]

For this reason, to advance science dealing with issues of society, it is often not easy to obtain results that satisfy scientific standards set by those skilled in natural science. It is not easy to attempt to systematize the results of scientific activities in a simple and clear way, either. As a result, science of the problem-solving type gives the impression that it is not well accepted in the community of scientists who prefer the rigor of discussion, especially with regard to the contents targeting society or higher-order human functions. However, if we do not go beyond this gap, it will not be easy for scientific activities to get out of “being in the silo[9]" of each specialty.

In addition, a difficulty is foreseeable when science for responding to social problems prospers. Here again, it will be helpful to look at the trend of clinical medicine. This is because clinical medicine is exactly the “science to respond to the humans’ problem of disease." What tends to happen there are; 1) While there is always a problem ahead, and in the pressure of having to respond to it, the method of coping is not established easily. Moreover, to search for countermeasures based on problems, academic rigor is difficult to pursue, for example, compared to the world of physics. Sometimes it is too much work to simply describe a problem with data, not just an impression of it; 2) Since there are many problems to which we do not know how to approach, there tends to be a rise and fall of research methods according to trends; 3) The classification of fields will tend to be organized by problem or by coping method (for example, by approach such as internal medicine and surgery, or by organ), and even if a mechanism common to phenomena included in other classifications is found, it tends to be difficult to make a move. From the above, it should be concluded that science that responds to problems is not enough, and that science of the truth-searching type is also necessary.

5. Acceptance of science in Japanese society

Next, I will consider how acceptance of science should be in Japanese society in the future. I will discuss this from 1) the aspect of the balance between emotion and rationality, and 2) the aspect of family composition.

Let's begin with analyzing the current situation.

I will divide the aspects of higher-order functions of humans into the emotion and rationality, for the time being. Japanese society has emphasized empathy or emotional aspects in communication. For example, I think *kuuki o yomu* ("reading the air”) means not causing negative emotions to others sharing the situation, and for that purpose maximizing empathy. In such a trend, how can "rationality" and its result be utilized?

They say that human perception generally has the "fast system" and the "slow system."[10] The fast system is intuitive. It is based on experience and memory, forms an impression, and relies on heuristics. It is affected by emotion. It answers quickly to complicated problems, but it is inaccurate. It has a priming effect, and brings illusion. It is also impulsive and gives an illusion of causality. On the other hand, the slow system is logical. Working this system requires attention and

[8] Ways of Knowing, Competing Methodologies in Social and Political Research, 2nd ed. By Jonathon Moses, Torbjørn Knutsen. 2012, Palgrave.

[9] *Silo effect: Kodo senmonka shakai no wana* (*The Silo Effect: The Peril of Expertise and the Promise of Breaking Down Barriers*). 2016. Gillian Tett. Translated by Nami Hijikata. Bungeishunju.

[10] *Thinking, Fast and Slow*. Daniel Kahneman. 2012. Penguin.

effort, and it becomes dull if you are cognitively busy or tired. Even fatigue and hunger make it dull. However, intuition can be modified by logic or statistical data, and it has the function of self-control.

Then, this can mean that what Japanese society has emphasized more is utilizing the “fast system," while what science aims for is to make efforts to make this "slow system" work.

According to Kahneman, the content of the slow system can be incorporated into the fast system by training. Then, scientific thinking can possibly be incorporated into the “fast system" by training. If that is possible, this will be important for “more precise” thinking.

Regarding the techniques of "logical" thinking, composition education can be considered to contribute to it.[11] The fact-based type of composition education in Japan is mainly of the type that only arranges events that occurred in the chronological order. "About today's events. I washed my face first, then I ate my meal...Today was a good day." This is the type. Even when I want a scientific paper written, at times I see that this style is brought in. "About the object. First, I got the finding 1, then I got the finding 2...I did a good research." However, in Western cultures, at least since the ancient Roman times, there have already been several other types included, and training is given for thinking about which type to select and write.[12] Especially noteworthy are the persuasion type and the discussion type. Both are the same in the way that the contents of an assertion are supported by adding the facts related to the contents of the assertion as the reason. "I think that aaa. The reasons are 1) bbb, 2) ccc, and 3) ddd. So, this idea is correct." The difference is that the persuasion type enumerates only the reasons that are consistent with the asserted content, whereas the discussion type lists content that does not support the content of the assertion in addition to content that supports it, and argues that the content of the assertion is still correct. "I think that aaa. Evidence that support it are 1) bbb, 2) ccc, and 3) ddd. On the other hand, also, evidence that does support it are 1) eee, 2) fff, and 3) ggg. However, I thought that this idea was better from the viewpoint of hhh." As you can see, this is the prototype of scientific thinking or argumentation. On a side note, in the United States, in the 19th century, education was not provided with respect to the discussion type which required more complicated thought, and because of its immigration culture, they started teaching only up to the simpler persuasion type. The five-paragraph essay is exactly this persuasion type.

Next, I will discuss the current state of family composition. Further considering the factors that determine a person’s relationship with others, I think that the influence of the early childhood before a child “remembers anything” is probably great. For example, there is a survey result which says that experiences or liking of a particular subject during early schooling have a large positive influence on the direct effect on their trust on scientists.[13]

There is a way of thinking that discusses the potential influence of such human thought from the aspect of family composition.[14] According to this, Japan, Germany, Sweden, Korea, and Taiwan are in the “stem family" type (at least traditionally). That is, one of the children (generally the eldest son) stays with their parents. Parents are authoritative to children, and brothers are treated unequally. The basic values are those of authority and inequality. They are eager to educate children. The status of women is relatively high. They are oriented toward order and stability. There are few changes of the government’s administration. They are ethnocentric. Organizations are vertically segmented. On the other hand, the United States, the United Kingdom, and France are of the "nuclear family" type. In this type, children leave their parents’ house when they become an adult. Parents and their

[11] *Ronriteki kangaekata tsutaekata: konkyo ni motozuku tadashii giron no tameni*. (*Logical Ways of Thinking and Communicating: For Correct Discussions Based on Grounds*.) Mitsunobu Kano. 2016. Keio University Press.

[12] http://www.suepalmer.co.uk/education_publications_skeletons_non_fiction.php

[13] Kagaku gijutsu ni kansuru kokumin ishiki chousa - 2014 nen 2 gatsu - 2015 nen 10 gatsu kagaku gijutsu no kanshin to shinrai -(Public attitude survey of science and technology - interest and trust for S&T in 2/2014 - 10/2015). Moritaka Hosotsubo. National Institute of Science and Technology Policy. Research material; 244. http://data.nistep.go.jp/dspace/handle/11035/3120

[14] *Sekai no tayosei kazoku kozo to kindaisei* (*La Diversité du monde: Famille et modernité*). 2008. Emmanuel Todd. Translated by Fumitaka Ogino. Fujiwara-shoten.

children are independent of each other. Their basic value is freedom. The status of women is high (because the husband and the wife are equal). They are not keen on their children's education. They prefer individualism and free economy. Mobility is high. By the way, in comparison, it says that the former communist regions, such as China and Russia, are categorized as the “exogamous community family” type. All sons remain with their parents to make a large family. Parents are authoritative to children, and brothers are equal. The basic values are those of authority and equality. They are not keen on their children's education. The status of women is generally low. They have a high affinity with communism which is currently being practiced. Of course, Todd himself admits that it is impossible to explain all social phenomena from this point of view alone. For example, Japan and Germany are traditionally both of “stem family" type, but Japan emphasizes consideration toward others, while Germany emphasizes frankness, and these influence the ways in which these societies are. However, I have the impression that this view captures the structure of society quite well.

In Japan, which currently seems to be rapidly transitioning from the “stem family" type to the "nuclear family" type in many ways, it seems possible to predict to some extent how the social structure will change. However, in current Japan, not all the patterns mentioned above apply. The current situation in Japan is that parents are not authoritarian to their children, but parents and children are not independent, brothers have become more equal, parents are enthusiastic for their children's education, and so on. It is heading toward the "nuclear family" type while keeping half of the “stem family" element. As Todd also points this out, because "society has inertia," we should expect it to change over decades. It is consistent with this.

Then, based on these, I would like to consider the future in Japanese society. In particular, what should be done to bring motivation in the direction of the bottom-up scientific thinking rather than the top-down thinking?

First, about how coexistence of rationality, and emotion and empathy should be. How to make "rationality" and its result utilizable from now on in Japan?

To begin with, it is necessary to train people how to set goals (agenda) for them to have their own content of assertion. Where can we find a problem to cope with from phenomena around us, and find a question? Can we extract and organize it? To be able to do this training based on intrinsic motives, it is necessary to think about how we can set up the “exhilaration (excitement)." The opportunity to start a “troublesome," rational activity should be when emotions and empathy “move you.” When do we feel that we have a dream? Do we feel motivated for things that are unreachable, such as settings related to the universe, or what is likely to make us better, like achievement of what we hope for?

Next, I suggest that training is necessary for thinking about verifiable reasoning (i.e., it can be agreed upon by others; the aforementioned persuasion type), and in addition, for thinking about both pros and cons as comprehensively as possible (i.e., the aforementioned discussion type). Training for such reasoning is an issue of types of composition, and the training does not have to be done in English but can still be done in the native language of Japanese.

Also, I think that the training of this way of thinking seems to be the content which higher education, especially graduate school education should support, given the current state of Japan where elementary, junior high, or high schools rarely provide it. This is because small group education at graduate schools with research labs and seminars can provide the most suitable opportunity for these thinking methods as on-the-job training. Of course, the teachers’ mindset that graduate school education is conducted for that purpose is extremely important. If this becomes generally accepted, the hypothesis should be established that a graduate school education should be received for the purpose of acquiring the know-how of the thinking methods necessary for internationalized corporate activities in recent years.

Next, I will consider how values that flow in Japanese society can change in the future. The family structure in Japan is changing from the stem family

type to the nuclear family type[15] in Todd's words? Among the characteristics raised for a "stem family," the points that one of the children (generally the eldest son) remains with the parents, parents are authoritative to their children, and brothers are treated unequally, are rapidly being lost with the younger generations. As inference, the value of society changes accordingly, and if it does, the value of community building will need to be reorganized. For example, the relationship between teachers and students at the place for school education was probably one of the form in which teachers, likened as parents, had authority, and students, likened as children, had respect for them, but in recent years, this way of thinking is being lost rapidly. However, in the sense of the speed of change, as described above, because "there is inertia in society," a change will occur for the first time after over decades, or even after generations when the number of people who "have thought it natural since they were born" increases.[16]

Amid this change, I will present a "re-recognition of the value of altruism" as a feasible proposal. In other words, it is a suggestion to recognize what public means.

The "nuclear family" type is said to head toward individualism, but if this involves strengthening of "selfishness," the power to support society as a community will naturally weaken. Amid this, however, we must redefine the way society should be in which a large number of people live together. Here, the redistribution of the concentrated resources (e.g., wealth) makes it difficult for the resources to gather, but the importance of supporting what is necessary as a human group (society) will be re-recognized.[17] The emphasis on "public interest" that shares a commonality with this way of thinking is beginning to be talked about by other experts.[18] However, if Japanese society becomes one of the "absolute nuclear family" type as defined by Todd, and "selfishness" is strengthened and the emphasis on "altruism" becomes difficult as a whole, it may be one idea to formulate a system that facilitates volunteers among independent individuals to perform altruistic activities with their individual intentions "separately." Also, in the American culture that prioritizes rationality in addition to being a "nuclear family" type, the fact that a book arguing for the importance of "virtue" and "personality"[19] was sold in a large number gives an important suggestion on human society.

Here, I will dig deep into my analysis of "altruism" as in motivation to conduct science. Especially I will discuss the way science supported by public funds should be. I have the impression that the current scientific evaluation index in Japan tends to lean toward what is easy to be commercialized, that is, what will yield an economic benefit quickly, or what everyone wants to use right now even if they have to pay money. A purchaser (a company or an individual) comes out to the science with a short-term "altruistic" purpose and the result thereof. Therefore, it agrees with the current index. However, there is much tendency to contribute funds to such subjects which are easy to understand and explain. Then, what should we do about targets which everyone understands the necessity to grapple with but that does not pay their own money immediately? For example, in the past there were examples such as the Newtonian dynamics, Linnaeus' plant classification, Darwin's theory of evolution, Wegener's continental drift theory, and Schliemann's Trojan excavation. Even if some value was recognized on the spot, did anyone think that they could invest their money on the spot?

[15] According to Todd, the "nuclear family" type can be divided into two. They are the "absolute nuclear family" indifferent to the brothers' equality, and the "equality-oriented nuclear family" type where the brothers are equal. This difference is said to emerge as a difference in acceptance of immigrants. The equality-oriented nuclear family arrive at universalism, and immigrants are not regarded as essentially different people. Absolute nuclear families and stem families arrive at differentialism, and regard immigrants as different ethnic groups. I think that Japan is shifting toward an absolute nuclear family type that has no concern about the difference between the eldest son and the rest? That is, it seems to be pursuing the American type.

[16] After all, it will proceed like a "paradigm shift." Paradigm shift: Thomas Kuhn, *The Structure of Scientific Revolutions, Second Edition, Enlarged*, 1970, Chicago University Press

[17] I will list the following report as an example regarding dementia, one of the social issues. Ninchisho ni okeru kokusaitekina sankangaku no renkei taisei (PPP) no kochiku to katsuyo no tameni: mendan hokoku oyobi teian (For building and utilizing international collaborative system of industry, government, and academia (PPP) regarding dementia: Interview report and proposal). Mitsunobu Kano., Shunpei Komura., & Ken Aoo. 2017. http://www3.grips.ac.jp/~GHIPP/wp-content/uploads/2017/02/PDF 統合 1.pdf

[18] *"Koeki" shihonshugi: eibeigata shihonshugi no shuen* (*"Public Interest" Capitalism: The End of the British-American Capitalism*). George Hara. 2017. Bunshun Shinsho.

[19] *The 7 Habits of Highly Effective People*. Stephen Covey. 2004. Simon & Schuster. "15 million copies sold."

From this point of view, I think science of medium to long-term "altruistic" purposes may not be sufficiently supported by the current measures or systems. On the other hand, however, there may be an aspect that requires caution as to whether it is sufficiently distinguished from the science of "selfish" purposes.

The activity of science is one in which, once again, a (new) method that no one could think of but can be pursued by anyone once it is shown (reproducible), and leads to solution of a certain problem or elucidating a mystery. Therefore, it can solve or elucidate a problem or mystery of others (society) in a generally acceptable way. So, I think that we can say that medium to long-term science will eventually arrive at being "altruistic" and meet "public interests."

This discussion is also directed toward a discussion of how to evaluate science. That is, when there are multiple research projects which are subjects of evaluation, a question arises as to how to decide the winner and the loser. When evaluated based on the research method, it will be necessary for them to satisfy all the quality requirements of the existing related fields. This is very harsh on new fields. When this method is taken, only existing science will win. Then, how about measuring them based on motivation? If only motivation is measured, it will be relatively easy, but if it is not accompanied by evaluation of the content, then the party that “just tried saying as much as they could” will end up winning this time. It’s difficult. One thing for sure is the need for humility in evaluation. Or, it is the need for a critical spirit against themselves, meaning the recognition of "limits" in their activities in that they are not perfect. Moreover, it is necessary to recognize clearly what is the “limit." It is because without this, we would not be willing to evaluate what is different in a positive way, and cooperation would not be successful.

6. Part of science that “needs to be fixed," and its means in future society

According to Thomas Kuhn's extremely famous book on “paradigm shift,” *The Structure of Scientific Revolutions* (Second Edition, Enlarged, 1970, Chicago University Press), “...the manner in which anomalies, or violations of expectation, attract the increasing attention of a scientific community needs detailed study, as does the emergence of the crises that may be induced by repeated failure to make an anomaly conform.”

Now, what is becoming an “anomaly (contradiction)" whose internalization cannot be avoided for “methods" of science? How will the consistency as a system collapse if it remains in the current state?

First of all, as stated so far, the background is that regarding the fact that scientific outcomes are widely used in general and the consequent expectations for and public investment in the outcomes (however, we cannot say with certainty that this expectation and investment are intended for the long road of verifying a hypothesis, which is a steady process that science goes through, and the tendency to expect output is as already stated), a point can be made that a conflict has arisen in the academics seen from the society’s side as well as in society seen from the academic’s side.

From the viewpoint of seeing academics from society’s side, there are the following issues. Society expects contribution of science (outcomes) to social issues that cannot be solved without transcending conventional disciplines. However, it is difficult to afford investment that are necessary from a long-term perspective rather than a short-term one. On the other hand, from the viewpoint of seeing society from the academics’ side, as previously mentioned Kuhn stated, while there is a propensity for general human beings including academics to strengthen existing systems rather than seeking new ones, it is difficult to receive acceptance when trying to create a new system to deal with an issue. When you do try to create one, a "paradigm shift" is just what is required. Furthermore, society’s expectations for "outcomes" of science are strong, but understanding of and entry into the process of science, that is, the moves to pursue scientific thinking are far from sufficient. In addition, it is difficult for society to make a necessary investment from a long-term perspective rather than a short-term one. For this reason, when a scientist is heading towards solving a social issue in an effort to fulfill their "duty" accompanying the "freedom" that they get, even if the issue is visible from the scientist’s perspective, it may not be visible to society, and a “difficulty" of not

being able to finance their activity can arise.

Then, concerning such anomalies, in what direction will it be desirable for a change occur in the future?

In thinking about this, we will divide the principles of human behavior roughly as follows:

System 0: Layer for survival and maintenance of the species

System 1: Layer for emotion, motivation, action, and waiting

System 2: Layer for logic, sociality, and long-term prospects

We will first place this insight in the background that human behavior is divided into these stratified layers.[20] The problem is that the actions that each system aims for do not match in many cases. How to balance them is an issue in every culture. Regarding their balance, it is said that the standards of measuring the "good or bad" is 4S (1. Survival; 2. Sex, including gender balance etc.; 3. Security, i.e., “defense” which is more proactive than Safety; and 4. Success), and whether they can be “improved” means a "better environment = an environment which you want to move to."[21]

For reference, in Success, for example, some of the items listed are: "tolerance for change," “quality of work and ability over nepotism and inheritance," "importance of the current moment, not the afterlife," “efforts over stability," “curiosity over lethargy,” “that having a dream is evaluated positively and it is put into action,” “dynamic and creative educational environment,” and “freedom over fate.” In Survival, some of the listed items are: “solid investment in art culture," "knowledge and research over superstition," “dialogue over one truth," "science over faith," "respect for diversity," “questioning the maintenance of the status quo," and “prizing how to learn over what to learn." In Security, “legislation of freedom rather than prohibition," “culture of trust and respect," “power of unity towards a common crisis," “having opportunities for economic independence," “that taxation is effective and its use is efficient," and so on, are listed. The item of Sex includes: "that parents have equal determination rights within their family," “that both sexes can receive education at school and can choose what to learn," and “that choice of work is not affected by gender,” among others. Of course, among these directions, there are things that depend on family structure, educational content, and social norm at the time of growing up, among others, but as a result of human evolution, almost all human beings seem to be commonly aware of many of these items.

Here, I will set a question of what kind of other person human beings in general would want to support. Isn’t this exactly the other who contributes to the improvement of the aforementioned "4S" of themselves, or of the group that includes them? In particular, it is said that a country that has achieved and become "a society that creates new things and can accept those new things without being able to maintain its established interests" will continue to prosper.[22] If that is done using science, it would be appropriate to support that science as well. Concerning the possibility that the method must be science, or for example, that it could be art or others, in general, if a good way to better ensure the accuracy of new information for an unknown phenomenon is required, I think we can answer that science is appropriate. For example, I think the rise of science was in parallel with reflection on the time when religion was dominating society.

Then, in that case, can the science that is supported be of any quality? That is, what is the essential element that should not be conceded by science (an element without which science would not be science) when seen from the science’s side? First, what is important is the freedom of content of a "question" based on the intuition of the scientist, which is the root of a “hypothesis." Without a question, essentially scientific activities would not start. After that comes the importance of the method. As stated as the definition at the beginning, it means to make efforts to maximize the accuracy and reproducibility of the information (evidence) used to support the hypothesis (or more

[20] On a side note, if I dare to name them in association with their anatomically corresponding parts of the brain, it would be 0. brain stem and basal ganglia; 1. limbic system; and 2. cerebral cortex, but their forms and functions do not always match.

[21] *Move up: Why some cultures advance while others don't*. C Rapaille and A Roemer, Penguin Books, 2016

[22] *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. Daron Acemoglu, James A. Robinson. 2013. Profile Books Ltd. (Japanese version: *Kokka wa naze suitai surunoka (Vol. 1) & (Vol. 2): Kenryoku, han-ei, hinkon no kigen.* Hayakawa Nonfiction. 2016.)

broadly, materials for thought). Also, the accuracy of the logical relationship between the information and hypothesis is of course also necessary. Next, when we tell this to others, I think we can answer the question of whether the form of academic paper is necessary in science by saying yes, if there is another good way of securing the accuracy of the contents to be communicated. However, even in the current formal framework of the academic paper, I think that the background explanation may contain more passion or emotion toward the theme. On the other hand, I hear that a method of attempting to communicate a result in the form of literature has also begun.[23]

And what is most important is, because science is a human activity, human beings themselves, that is, human resources to advance science. In other words, from the viewpoint of raising science to prosperity to respond to social issues in parallel with the truth-searching type of science, it is necessary to make this field “attractive,” that is, to design a system that makes competent human resources to want to enter the field. Particularly relevant is what scientists can feel it is Success with what. What can define Success in science? Currently, is it achievement by papers, or a commendation of that? Or, is it sufficient funding necessary for an activity? It should not be the amount of money per se. Does it include the degrees of social contribution, justice, and goodness? However, we need to continue to think about how we can measure and promote these.

7. Summary

This paper discussed the background behind and the reasons why science in modern society has come to strongly require the transdisciplinary, or problem-solving type, not only the former discipline-based, or truth-searching type. It also discussed its method and targets, and the way the society’s side should change.

Science is originally one of the activities in human society, and in particular the modern science sector is in the position of a public entity receiving support of public benefits. Therefore, science should have a role, as a member of society, to head together toward grappling with the challenges facing human society. Also, while recognizing the limits of scientific methods, I believe it is desirable to share its strengths and methods "to create new things more accurately" with the changing society.

[23] Uwe Flick. *Shitsuteki kenkyu no “shitsu” kanri -- SAGE Shitsuteki kenkyu kit 8* (*Managing Quality in Qualitative Research - SAGE Qualitative Research Kit 8*.) shin-yo-sha. 2017.

Chapter 2　Expectation for Science in Responding to the State of the Modern World

Satoru Ohtake

1. Changes of the times and science

1-1. Change of the times

Today's world is changing rapidly. With the development of information communication and transportation means, people and information travel around the world, people and countries are connected with and influenced by each other, and as a result, they are changing increasingly rapidly. Although it is still necessary to improve the state of poverty and bad living environments, nevertheless the average living standard of the world as a whole has dramatically improved compared to the level of the previous century, which will further bring about change.

For citizens constituting modern society, especially in developed and emerging countries, the knowledge and intellectual levels have improved with the spread of democracy and education, and consciousness toward society and the world is getting higher, not just their requests for the minimum standard of living.

In addition, with the rapid progress of ICT, various kinds of information have become available, bringing about a great innovative change to the state of society. The progress of science and technology made possible things that could not have come to our mind in the previous century, and the changes brought about by it can at times overturn a previously held common sense or value. For example, the progress of information and communication technology has brought about the convenience of being able to obtain a large amount of information instantly wherever we are, but its downsides are the question of how to obtain the necessary information from a large amount of information, and in some cases, that only the information that we like or are interested in is transmitted to us due to the development of artificial intelligence, and the convenience of information collection may conversely prevent us from acquiring a wide range of information. Modern people who become uneasy without a smartphone are examples where ways of society are changing due to the development of ICT.

On the other hand, while there are many challenges facing modern society, their characteristics are that they are diverse and complicated. Many of these are difficult to solve with past methods of coping, for example, with one piece of technology alone, and even if one aspect is solved, for some, matters are made worse in other aspects. Furthermore, there are many things that are common not only in one region or country but on the global scale. Human beings have developed rapidly since the previous century, and have deprived the resources called Earth along the way. As a result, sustainability is argued for so that human beings can reconcile complicated problems on Earth to survive in the future. The times have become aware of the limits of the planet called Earth, and the search has begun for the future of human beings who can only live on this one planet. In response to such common global issues, the United Nations adopted the "2030 Agenda for Sustainable Development (SDGs)" unanimously in 2015, and the SDGs are an example of a condensation of the change of the times and its accompanying issues.

Today, when complex issues surrounding the world, and the latest science and technology have come to influence even human society and people's ways of living, expectations for science, in the broad sense including social sciences and humanities, are great towards solving the problems. It is a natural request from the people’s standpoint that science make full use of the accumulation of knowledge and experience so far, mobilizing all necessary fields, to contribute to solving the issues facing human beings today.

1-2. Changes in the science in the world

Science has long been dominated by experts exclusively engaged in research, publishing the results in the form of papers, etc., to give back to society.

However, in the Budapest Declaration of 1999, scientists themselves greatly changed the perception of the science’s position. The conventional mainstream thinking is placed first as "science for knowledge," but in addition to this, "science for peace," "science for development," and “science in society, science for society” were written as three important roles of science along with “science for knowledge.” The roles of science included in the Budapest Declaration made a major change in the future direction of science. When considering scientific contributions to the 17 goals listed in the SDGs, the source of many of them is found in the Budapest Declaration. The Budapest Declaration captures the roles of science from a high perspective in

relation to society while foreseeing the social problems of the 21st century.

Furthermore, in the 2010s, the trend of open science became prominent. Scientific papers compiling research results were mainly distributed among experts and used in the form of subscriptions to journals. However, research published as papers is often done using public funds, and open access has been advocated that allows anyone to read them freely. In the background there seem to be the rising prices of journals, an increase of people among the public with a strong interest in science mainly in developed countries, and their enhanced consciousness on their rights. These movements further have led to the open data as well, requesting disclosure of data obtained in the research processes. In addition to the consciousness that the product of research using public funds belongs to society, open data, like open access, reflects the fact that research per se also needs enormous funds and facilities, the awareness of scientists who wish to conduct research efficiently and effectively by effective utilization data, and the idea that it will be a countermeasure against research fraud such as fabrication of data.

The trends of open access and open data largely leads to open science, which includes participation of the public in scientific research. This drastically changes the ideas which have lasted for 350 years that science belongs to the scientists who specialize in research, and that while the results are presented in the form of a paper, the data obtained in the process are those of the scientists. Now that the public is participating in the world of science, scientists will also have to pay more attention to society and its requests.

2. The present and the past of science in Japan

2-1. Request for switchover to transdisciplinarity

Journal *Nature* posted a feature in March 2017 expressing a concern for the decline in quality of science in Japan, but at present it is still high compared to the world's standard. However, it has been pointed out that, while the standards of individually established disciplines such as electronic engineering and mechanical engineering are high, it is weak in cooperation between fields and creation of new fields.

On the other hand, looking at the challenges facing contemporary society, what one field of science can respond to is limited, and even if a scientific field can suggest a coping method, there is a possibility that it can bring about a new issue. So, we cannot reach an optimal solution unless, while having a holistic view of the issue, we bring in wisdom of multiple scientific fields together, and moreover, consider the social conditions other than science. For example, the relationship among water, food, and energy are mutually related (Nexus). For example, when an attempt is made to secure clean drinking water, it will lead to a large consumption and scrambling with food production over energy. In anticipation of future, if 70 to 75% of the world's population lives in urban areas in 2050, it will also have a strong relationship with urban problems as well. Also, when considering popularization of a new medicine to the society, it will not remotely be popularized only by considering its simple scientific efficacy, but it must start with consideration of the effects and adverse effects, and the impact of the pricing on the social insurance system, among others.

Until now, the importance of collaboration between fields, i.e., an interdisciplinary approach has been advocated, but in addition to that, it is now required to have a transdisciplinary approach with viewpoints other than those of science.

2-2. The past of science in Japan
- establishment of engineering departments -

Turning to Japan's past, when modern science was introduced into the country along with the country's opening at the time of the Meiji Restoration, not only basic scientific theories (mathematics, physics, chemistry, biology, etc.) but also engineering was constructed as an academic discipline that dealt with real social issues far more systematically than Western engineering schools did, whose exclusive purpose was skill acquisition, by first launching the Imperial College of Engineering and then engineering departments at universities ahead of the world.

Originally, in the Edo-period Japan, various techniques such as surveying, construction of castles and bridges, and the like, were remarkable, but in basic

science, only physics as “natural philosophy" which tried to understand the existence of nature, astronomy which tried to understand the movements of the celestial bodies, and Japan’s traditional mathematics were noticeable. Among them, it is said that in physics they studied more of a natural philosophy, and tried to introduce knowledge of Western science while linking it to Eastern philosophy. Because of this, it did not lead to establishment of a system like that of Western basic science, which was written with mathematical expressions. Astronomy also developed discussions on the basis of intermittently introduced Western knowledge, but it was rather utilized for creating maps, etc. Also, it is said that the traditional mathematics were highly oriented toward practical use, focusing on numerical calculation. Such a historical background can be considered as a foundation that made it possible to establish a “Department of Engineering." It was a Japanese spirit with a Western wisdom, or blending of Japan and the West in a good sense.

Then, the education, it is said, was composed of the three stages of preliminary basic education in the first two years, specialized education and some practical field application in the following two years, and on-site training in the final two years, maintaining a balance among theories, academic exercises, and applied training on-site, according to the curriculum created by the Briton Henry Dyer, the first principal of the Imperial College of Engineering (Yoichiro Murakami. *Kogaku no rekishi* (*History of Engineering*). Human resources who had graduated from a department of engineering spread to government-owned industries which were the key players in promoting industrialization to catch up with the West, governmental and public offices in charge of national policies, government-owned laboratories, or universities, among others. There, it is thought that a network of human resources that were centered on a certain engineering field was formed naturally, and education, research, policy, and industry formed an ecosystem as it would be called today. In other words, when a person who had acquired the latest engineering and practiced it at an industrial site, and if an issue arose, a university devised a new theory to overcome the issue, a laboratory tested up to the point of practical use, the government formulated a policy to adapt the new technology born this way, and a step was taken forward. This flow ran smoothly through the network of human resources consisting of graduates of engineering departments. I think that it was university engineering departments that were the center of this.

In terms of science, while the basic academics were analytical, the practical studies of engineering were integration-oriented, aiming at solving real world problems, hence supporting Meiji’s policy of industrialization promotion, and the postwar rapid growth. I think we can say that the fact that they did not simply introduce the state-of-the-art technology resulted in a creative science different from the basic science up to that time.

When American sociologist Ezra Vogel released "Japan as Number One" in 1979, the shock must have been great in the United States, which boasted being the world's number one in everything. This was the same in the field of science, and the National Science Foundation launched the Engineering Research Center (ERC) program in 1984. This was done in response to the unprecedented challenge towards the industrial competitiveness of the United States, promoting interdisciplinary research at universities to develop human resources to attempt at improvement by leaps and bounds, and at the same time to establish a center leading to the development of new industries. This was precisely a movement consistent with the idea in establishing a department of engineering in Japan. It can be said that engineering departments have taken the spotlight in the United States after 100 years or so since the foundation of engineering departments in Japan.

Another thing to consider is that the presence of the colleges of National Institute of Technology has been part of the system that supports the engineering and industries in Japan. At these colleges, after graduation from junior high school, mainly specialized education is conducted for 5 years. Since education is provided by professors, associate professors, assistant professors, etc., unlike vocational schools that merely aims at acquiring skills, education of higher quality is provided, and graduates play active part as high-level technicians. It seems that they have supported Japan's industry as people that support Japan’s first "engineering" system

in complementary relationship with human resources who have graduated from an engineering department.

I think that the idea that established the system called "engineering" with Japan as its origin has not lost its light even today.

3. Changes in the relationship between science and society

Now, while the system called "engineering" can be called an invention of Japan, has science as a whole taken root in Japan?

Today, science has penetrated every corner of society, and the present society can no longer be complete without utilizing the principles and results of science. On the other hand, in developed countries like Japan, the standard of living has improved due to economic development, the citizens' intellectual levels have improved conspicuously as a result of education, and more people now understand various things and have opinions.

However, unlike in the West where science has a long history and is deeply rooted in society, in Japan, it is doubtful whether the very existence of science or scientific thinking is respected and awed by Japanese people. Considering the history of the introduction of science since the Meiji Restoration, it seems that many Japanese understand it to have brought benefits that led to practical use.

Except, if we see Japanese people's reactions to successful outcomes of basic science such as Nobel Prize being awarded as represented by the case of Dr. Hideki Yukawa after the World War II, and the Subaru Telescope, admiration for science is not nonexistent.

While science provides a process of thought to elucidate various things, scientific achievements necessarily have risks and benefits. For example, X-ray examination may influence health due to radiation exposure, but it has a possible benefit of finding a more serious disease compared with this probability. We use it because the benefit outweighs the risk. In this way, since it is not possible to say "100% so and so," we can say that it is a scientific viewpoint to calmly compare the degree of risk and the magnitude of benefit.

There is a cause and effect for things, and the causal relationship can be elucidated to a lot of extent. For that, logical thinking is necessary, and science provides its foundation.

In Japan, I don't think that these ideas are fully rooted.

There seems to be two things in the background.

One is, as discussed with the basic science in the Edo period, Japan has a natural philosophy-type historical and cultural climate, just as with the "eight million gods," there is a temperament to consider it good to accept nature as it is. In addition to that, I think that because it was an agricultural society that maximized the group interests through the harmony of its members, it did not adapt to the culture of going back to the principle to clearly explain everything, and for that purpose having a discussion. This is different from the Western society that tries to elucidate the providence of nature that God created to approach the Almighty God in the monotheistic world, and the ways of thinking of modern science which were nurtured there.

Secondly, there is a point that scientists have been regarded as a special existence that is detached from the floating world. Even 15 years after the World War II ended, in 1960, the university entrance rate was 10.3% with the rate for the junior colleges combined, and for the natural sciences, the rate was even lower at about 30% of that. It seems that people had the idea of science as being for some geniuses, which created the long distance between the everyday life and science. However, as stated earlier, this is changing rapidly.

Today, Japan has achieved rapid growth and material affluence, but in society there is a feeling of entrapment and anxiety about the future. Amid this, I think that as long as the Japanese people's current understanding of science remains intact, and if science cannot give sufficient answers to social issues, people's trust toward science as a whole, including basic science, cannot be maintained. At the same time, deepening the awareness of people about the depth of science and of the intrinsic relationship between the basic science and human beings as intellectual species, thereby deepening the relationship between science and society, is a task for scientists and the scientific community in Japan.

4. Current state of science in Japan and issues for the government administration in science and

technology

Science in Japan has held a high standard in the world so far, and this is still the case now. However, looking at various indexes, with the growth in emerging countries such as China, Japan's growth rate has been relatively slow. Regarding this, research sites point out the sluggish increase of expenditure on science mainly by the government, increase of research funds seeking early results, and reduction of recurring expenses, but is this true? What about the quality of scientists themselves? Even scientists are members of society, and cannot exist independently of society. Have they stopped focusing on changes in the world and society, and are they not confined to their own narrow scientific fields? As science is an activity in human society, and its largest supporters are the society and the people, unless we can have a conversation with the society about the significance of science and explain it to the people, I do not think that we can get support for science. In the past, scientists were a small number of elites, and many people believed in their talents and entrusted science in them, so the idea that "you should only trust it, and do not have to know the details" stood up, but in today's Japanese society, it rather seems like, "If you are to trust it, you should know the details."

On the other hand, in order to ask people to understand science, and for scientific ways of thinking to take root in society, people must also have some scientific knowledge. Education up to junior high school in Japan in fact provides very fulfilling contents, and if they are sufficiently acquired, it is said that they can understand and deal with a variety of issues and scientific problems that they face in society to a moderate degree. However, Japanese education tends to be focused on university entrance examinations, with a high school entrance examination before them, both of which test how well the materials covered in the previous curriculum have been learned. However, because they are selection examinations, they tend to test the amount of knowledge rather than ask about and evaluate their ways of thinking about issues. Then, the situation can be one where processes of examining various ways of coping with practical problems based on scientific thinking are put off until they go to a university or the real world. Now, it is not necessarily self-evident whether such education is being conducted at Japanese universities today. If university entrance examinations change, high school entrance examinations will change, and I think that education in junior high school can emphasize how human beings have utilized knowledge, as well as acquiring knowledge.

Moreover, university education has issues in specialized education above general education and science and engineering related universities. General education should take time touching upon the fundamental problems such as the relationship between science and human society including the history of science, and scientific ways of thinking. Also, as the issues to be handled in today's society are diverse, and their relationships with society are becoming complicated and deepening, it is also necessary to cultivate tolerance for diversity, and I want to value the so-called liberal arts. I think that specialized education should teach the basics of scientific methodology, setting a theme, constructing a hypothesis, verifying it, evaluating the results, and creating a new knowledge system, along with the integrity of the procedure. This should be taught not only in the classroom but also be learned as an experience consistent precisely with the academic theories that were learned previously. It is exactly the idea of when engineering started.

Regarding engineering, I mentioned the possibility that a network and ecosystem centered on people was formed in Japan. I think that the formulation of industrial policy was also an important factor in that.

Today, when thinking about a new science for the future of Japan, we must also consider how the corresponding administration should be.

It was just during the wartime before the World War II when the Japanese scientific administration extended from policies for scientists to policies for society. Until then, the Ministry of Education, Science and Culture and its institutions such as the Imperial Academy, the predecessor of the Japan Academy, the Academic Research Council, the predecessor of the Science Council of Japan, and the Japan Society for the Promotion of Science, which allocated research funds, were promoting academics, that is, science. Then, the Cabinet Planning Board participated in the scientific

policy for the total mobilization to the Sino-Japanese War. After that came the Cabinet Technical Institute, etc., a system became one of total mobilization of science during the wartime. Then, with the launch of the Science Council of Japan after the war, this became the background behind the ban on military research.

Details of science and technology policy after World War II are omitted here, but the Allied Forces General Headquarters launched the Science and Technology Administration Council (STAC), and positioned science and technology within the postwar administration. After that, in 1956, the Science and Technology Agency was established, and in 1959, the Science and Technology Council, an advisory body for the Prime Minister, was launched, and a system of science and technology administration was created. The report by the Science and Technology Council on the consultation of the Prime Minister serves as the basis of Japan's science and technology policy, and 1960's No. 1 report, "About the comprehensive basic policy of science and technology promotion aiming at 10 years later," set the goals of science and technology as driving force of economic society and catching up with Europe and the United States, such as the goal for science and technology to reach in each scientific field in 10 years, to promote science and technology necessary for economic development and improvement of the citizens' lives from a long-term perspective. On the other hand, a system centered on the departments of engineering succeeded and contributed greatly to the subsequent rapid economic growth. From the latter half of the 1970s when the economic society achieved a dramatic development, it was required to achieve the catch-up and create new seeds themselves, and enrichment of basic research became a major policy issue. In 1981, the Science and Technology Promotion Coordination Fund and the Creative Science Technology Promotion System were newly established amid this trend. Report of the Science and Technology Council No. 11 of 1984, "The comprehensive basic policy of promotion of science and technology based on the long-term prospect in response to a new situation change," aiming at comprehensive development of science and technology which would be the foundation of a new culture and civilization towards the 21st century, with these three basic points of "promotion of science and technology rich in creativity," "harmonious development of science and technology, and human beings and society," and "development with an emphasis on international characteristic," as the pillars, Japan stepped up to create a new science and technology on its own. In the following year, to steadily implement Report No. 11, "Science and Technology Policy Outline," which would be the basis of science and technology promotion policy for the administrative level to strive to realize for the time being, as Report No. 12.

After that, the government's science and technology budget expanded by 2 to 3 times by 2000. With these budget increases, various measures were widely devised and deployed, and the environment of science and technology in Japan dramatically improved. In 1995, the Basic Act on Science and Technology was enacted. It was decided that the government would establish a five-year science and technology basic plan with a view on the following ten years, and a five-year investment target with a view to make the government's R&D investment to 1% of the GDP was also incorporated. The First Science and Technology Basic Plan decided in 1996 set an investment target of 17 trillion yen within five years, while advocating to solve various problems pertaining to the implementation of science and technology towards the 21st century. Solving of the issues got underway with active introduction of competitive research funding and introduction of researchers with fixed terms, and the investment target was also achieved.

However, in the 21st century, the government's finance became tight, and the budget for science and technology remained largely flat under fiscal reconstruction. Despite accumulation by occasional supplementary budget, the investment targets exceeding 24 trillion yen since the 2nd basic plan have not yet been reached.

Amid this, science and technology administration repeatedly formulated basic plans seeking various types of creativity, but the method of attempting at new fields and various system reforms with the budget expansion became difficult, and there was no choice left but to respond through scrap and build. On the other hand, the

mindset that the budget increases brought to the scientific community did not change, and researchers and administrators with the vested interests of the budget they have had up to that point made it difficult to boldly introduce new measures based on the demands of the times.

The science and technology policy staff members, who had tailored the new research field introduced by some researchers to new policies during the time of the upward trend, so to speak, seem to be perplexed to not be able to respond fully with the way of work they have continued so far, after the budget leveled off, and in parallel, the environment surrounding science and technology in the 21st century changed rapidly entering the 21st century.

Currently, what is required of the science and technology administration are to set a big goal required for science and technology in line with the big change of society, design an institution corresponding to it, and recognize the issues of the site management in realizing those. To that end, it is essential to highly develop and share ideals and ambitions within their organization, and to communicate with the worksites of science. By that means, it will be possible to always secure talented human resources with a high ideal. Specifically, it is necessary to advance the science and technology policy by correctly recognizing policies to promote science required by scientists (policy for science), coexistence with a strong correlation between science and policy such as cutting-edge research being closely related to the creation of new industries (science with policy), and a case in which a scientific finding, though not necessarily cutting-edge, leads to a solution of an issue required by the policy (science for policy). This is because, for example, the method of procurement, amount, and period of funding are different.

For this reason, it is always necessary to also have a comprehensive perspective, set a clear purpose of what to realize, and discuss policies properly.

Such qualitative changes should be sought from the administration of science and technology.

5. The future of science in Japan

In heading towards the future, for Japan, science is one of the strong keys for future development. Japan has been recognized as a country that has held a high level of science and thus realized the world's leading innovations. It largely comes from the fact that it recognizes the importance of both science and education represented by the spirit of "engineering" established in the Meiji Restoration, has established academic theories through human resource development and scientific research, and has established a human network in that process.

However, while the academic principles of "engineering" that Japan has constructed has steadily been constructed, hasn’t it deviated from the demands of the times? For example, from immediately after the Meiji era to the period of rapid growth, metallurgy was established as academic theories that brought a scientific basis for metallic materials. Today, however, the value of metallurgical engineering per se has not changed, but in terms of materials demanded by the world, not only metal materials but also their combinations with composite materials, inorganic materials, and even biomaterials are demanded. It is necessary to think about the optimum material for purpose, leaving the situation limited to metals, and stride academic theories that are broadly related to substances.

Earlier I noted that the idea that established the system called "engineering" with Japan as its origin has not lost its light even today. With the principles built up in engineering up to now as the foundation, it is an urgent issue to redesign a new integrated science to respond to the current social issues. This is possible as it is Japan’s signature skill. However, unlike when the systematization of engineering started in the Meiji era bloomed 100 years after, today the issues have become more diverse, complicated, and fast-changing, so extremely flexible responses are required. In other words, even if we aim for the same thing, we cannot respond in the same way as in the past.

First, it is necessary to master the essence of science. It is to cultivate not only knowledge but also the ability of individuals and communities to determine the essence of natural phenomena. It is to embody the way of thinking called critical thinking, and see not part of a phenomenon but the whole, while create an environment that recognizes diversity including

academic freedom.

The second is to identify the issue. It is often said that if you can set a task properly, the issue is as good as half solved. This is the same with the mystery of nature and the request by society, and it boils down to the same thing, i.e., the ability. Furthermore, it is to be prepared to cope with issues by involving anything necessary, because the issue is to solve the issue. It is to not draw the boundaries of academics or organizations at an early stage, but to cross them if necessary, and have a flexible mind to be able to do so.

The third is to always have the society and the people in perspective while putting energy into specialized sciences. For example, when adaptation to society becomes an issue for new technologies, it is necessary to discuss them while involving the people and society from the time such technologies appear. This is because people are well educated, and are important stakeholders of science. We must keep in mind that both scientific activities and scientists are elements of human society. Scientists should not only get absorbed in research activities but also value opportunities to exchange directly with people. Such activities will deepen the relationship between science and society, and society will better recognize the meaning behind science. We should build a trusting relationship between society and science in that context. Otherwise, society will not only not support science but may forget about science as being unrelated to society, or regard it to be causing more harm than benefits. Today, when science and society cannot be separated, we could say that it is irrational for science, people, and society, and an unfortunate relationship. Therefore, a dialogue with society should proceed while both the benefits and risks that science brings to society are clarified. This is a serious dialogue, should be done by scientists who are trying to figure out the essence of science, and should not be science communication that only one aspect of science is talked about by communication methods alone. Also, keeping the integrity of science by eliminating research fraud is an indispensable attitude in carefully conducting science, whose outcome (whether it is an outcome of public research or private research) will be that of society, as a contract with society. It is also obvious that scientists are obliged to pay attention to ethical, legal, and social issues related to science and its outcomes.

Finally, as science and technology have spread to every corner of society, the relationship between science and politics, whose was as distant as it could be, is also important as one ultimate form of how science and society should be. When politics makes policy decisions, scientific advice that shows a scientific basis or provides options based on science towards better decisions is important. This is clearly different from promoting science required by scientists (policy for science), or coexistence with a strong correlation between science and policy such as cutting-edge research being closely related to the creation of new industries (science with policy), but it is a case in which a scientific finding leads to a solution of an issue required by the policy (science for policy). In other words, the former two contain scientific interests on subjects and motivation for the scientist to conduct research, while the latter directly contributes to society with the knowledge of science, so at least the research activities will not be the kind whose primary focus is on the interest of the scientist. Scientific advice is not for scientists to market their own research and scientific fields to politics, but rather to communicate what the current science can do and show without exaggeration, and contribute to policy-making. In that sense, scientific advisers are called honest brokers. Scientists, when giving scientific advice, are not representatives of their own field but of the whole of science, and they do not make claims for the sake of science. For scientific advice to work, scientists must work with considerable self-awareness and recognition. And science merely provides options, and science alone is not the basis for final policy decisions but is just one of various other factors, and the decision-makers are responsible for the decisions. Unfortunately, in Japan, such principles were not shared at all in response to the Great East Japan Earthquake and the ensuing nuclear power plant accidents, and scientific advice did not work. As a reflection of that, the Science Council of Japan has revised the code of conduct for the scientists.

Future science needs to face society directly, and to create future science together with the people and society.

6. Several suggestions

When thinking about Japan's science in the future, what kind of measures will be necessary? Here are a couple of possible ideas.

1) Essence of science

I think that science is the basis of what one thinks. Therefore, logical thinking and critical thinking must be taught firmly regardless of whether students proceed to study scientific fields in the future. In other words, it is the "common sense," or the minimum level of education in the era when the relationship between science and society has evolved.

Furthermore, in specialized education of science, education that teaches scientific ways of thinking and methodology more thoroughly is important, but this should be done first with the established academic theories. This is because, while interdisciplinarity is important and it is necessary to learn a broader perspective and tolerance and not stick to their own area of expertise only, to receive education of a science that is at an early stage in areas where the methodology has not been established poses a risk of not being able to acquire ways of thinking or methodology properly. I think that interdisciplinary issues should be grappled with by those who have received training as a scientist.

2) Platform that deals with academic theories that respond to social issues

It is necessary to establish a platform to solve issues like the former engineering departments. What comes to my mind is to refer to the Engineering Research Center (ERC) program of the National Science Foundation in the United States, which turned the structure of the engineering department of Japan into a contemporary system, and to reproduce the originally Japanese idea once again in Japan. Its targets are what will create a new field that will respond to social issues with a great impact, and it will not be limited to only one field that has already been established, but it will be an interdisciplinary one where multiple fields collaborate.

3) Sharing the recognition of three categories of the relationship between science and society

To clearly organize the relationship between science and society and to share their perceptions are important for mutual a trust relationship, in particular for scientific advice to function, where mutual trust is essential.

- A relationship in which scientists appeal to society about the importance of science for the sake of science, based on their discipline, and seek understanding and support: The classical relationship between science and society.
- A relationship in which necessary sciences are proposed in consideration of future society including social expectations: - A relationship between science and society in line with the science and technology policy for conducting cutting-edge scientific research to solve issues.
- A relationship in which knowledge of science is mobilized to provide options for solution in response to policy-makers' requests: A (transdisciplinary) relationship that considers social conditions other than those of science. Knowledge of science is necessary, but it is neither everything nor the only thing.

4) People-centered science

We propose that science should be advanced as a people-centered one in every sense.

First, I share the fact that science is positioned within society, and scientists are also members constituting the society. No matter how advanced and intellectual activities they perform, scientists are the same as a lot of people making up the society, and are not in a privileged class. I believe that many scientists are aware of this fact, but I think that they should recognize this matter once again.

Although scientists make living by advancing science, science per se is a common property of human society. While there are various settings of conditions, an outcome of science is basically something to be shared. And regarding those whose publishing is restricted, the legitimacy of such treatment should be disclosed by presenting clear rules.

Next, as for scientists, they are equal as human beings, and are to make it a principle to have logical discussions based on facts and data. Therefore, between

generations, it is natural for seniors to pass down scientific methods adequately, and treat their juniors as equal scientists. It is unfortunate that we see acts of treating young scientists like unskilled laborers to advance their own research without adequately teaching them the scientific methods. Such acts are not scientific, nor social, and should be refrained from.

In addition, science is an intellectual activity of human beings. Even after the singularity when the artificial intelligence (AI) is said to exceed the human abilities, it will be necessary for human beings to be at the center of the scientific activities, and advance science proactively.

Finally, science per se is neutral, but its results also benefit the society and people, while there are also risks. It involves the nature of science itself, but with human intervention, it is possible to lower the risks and make the benefits outweigh them. In other words, scientists should take the stance of advancing science while always keeping in mind the happiness of the people.

7. Looking back so far

The above is the summary of my discussions and analyses at the moment. However, even at this point, I am still stimulated by various events, and my consideration is changing. I will continue to think about the relationship between science and society for my lifetime, and my task is to continue to see the prospects of future science. So please excuse me in that this is just my interim consideration.

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Chapter 3　Roles of Humanities and Social Sciences at the Transition Period

Sayaka Oki

2. Transition example of "storytelling" leading the science and society
- “progress" and “innovation" -
2-1. From faith to disillusionment of "progress"

The era from the end of the 18th century to the middle of the 20th century can be said to be an era in which the concept of "science" and "progress" was emphasized as an issue in the West and areas in contact with the West. Regardless of the scientists at the scene, "progress" was often mentioned when politics, economics and science were talked in relation to each other. On the other hand, after 1970s and the collapse of the cold war system in the 1990s, the situation changed completely.

Instead of “progress," it is "innovation" that is mentioned more often when talking about today's science. Regarding innovation, as it is considered to be important too naturally as one of the scientific outputs, some people might feel a sense of incongruity as it is cited as well as a vague concept of “progress." But what you should not forget is that “innovation" itself is also basically a concept and has a date on which it is to be mentioned as important. As will be described later, such a transition occurred in Europe from the 1980s and in East Asia from the 1990s to the 2000s. The main epicenter of the change is an interdisciplinary field centered on economics called "Innovation Research" developed after the mid-20th century.

It is Siva Vaidyanathan, a cultural history researcher who raised the issue of how far "progress" has been deeply embedded in the past political and social agenda and that it showed a role similar to the concept of “innovation." Let us refer to section 8 of clause 8 of the Constitution of the United States established in the 18th century along his remarks.

> The Congress shall have power …To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries[1]

This is a passage which is regarded as the basis of patent law in modern times, and it is worth noting that scientific and technological activities are encouraged under the name of "progress" and are the basis for protection of intellectual property rights. It would not be amazing if the word “innovation" could be included in here if it were today.[2]

"Progress" was meant for the people of those days, the advancement of knowledge in science, the improvement of material well-being through it, and the “moral perfection”, that is to say, realization of a society composed of rational and well-mannered citizens, liberated from prejudice and loving peace. However, the concept was exposed to the first strong criticism after the two warfare periods. In the background, there was a reflection on the fact that the West which was regarded as the center of “civilization," especially Europe, caused a barbaric war.

Nonetheless, after the Second World War, high economic growth of some non-European countries including Japan, which was financially supported by the U.S., temporarily suspended doubts about "progress". As we know, the Soviet Union developed, advocating a "progressive" revolution. The U.S. succeeding in mediating capitalistic and social democratic policies to realize a welfare state policy. In the 20th century, these countries were also areas where "progress" was realized in the form of improving material well-being through the development of science and technology, and industrialization.[3]

The serious disillusionment of "progress" at the historical scale came along from the 1970s to the 1990s when the Cold War regime was upset. The seriousness of environmental problems that resulted from the development of science and technology brought about doubts about scientific “progress." In addition, the decline of Marxism crushed the illusion of “progress” of society controlled by rationality and science. At the same time, the tide of criticism against colonialism and the feminism campaign, the concept of “progress," reclaiming “universal" was condemned as Western-centric and male-centric one.[4]

[1] U.S. Constitution, Article I, Section 8, Clause 8, 1787.

[2] https://aeon.co/conversations/why-has-innovation-supplanted-the-idea-of-progress [Consulted April 17, 2017] This is a discussion in the forum.

[3] Arnold Burgen, Peter McLaughlin and Jürgen Mittelstraß ed., *The Idea of Progress,* Berlin, New York: Walter de Gruyter, 1997, 65-76.

[4] Sayaka Oki, “‘Innovation’ as an adaptation of ‘Progress’: Revisiting

In the "Budapest Declaration," adopted at the World Science Conference in 1999, the importance of "progress" in the sense of the development of natural scientific knowledge (“Science for knowledge: knowledge for progress ") is mentioned. Meanwhile, it also stated that “the applications of scientific advances and the development and expansion of human activity have also led to environmental degradation and technological disasters, and have contributed to social imbalance or exclusion." There is also the wording that “there is a need for a vigorous and informed democratic debate on the production and use of scientific knowledge." The declaration is famous for mentioning the importance of "science in society and science for society", but from this, it is understood that, by this time, the international communities had shared the values that do not encourage "progress" of science in an international agenda formation.[5]

2-2. Policy focus of “innovation" (after the 1970s)

From the 1970s to 1990s when the Cold War system was upset and collapsing, the word “innovation" came to be interpreted as an important policy-oriented concept. Behind this background, there is an interdisciplinary approach of Innovation Studies, which was centered on European Neo-Schumpeterian economists including Richard Nelson and others of the United States research institute RAND and Christopher Freeman and others of England (later to be the founder of SPRU - Science Policy Research Unit, University of Sussex).[6] They essentially overwrote the definition of the word “innovation” and changed it to the core concept of science and technology policy and economic policy.

So, what was the “innovation” before Freeman? It was virtually synonymous with “technological innovation.” "Technological innovation" in the Cold War period meant "historical development by technology." It is based on a linear model idea that “Science-based technologies lead change in society.”

In place of innovation as a conventional “technological innovation,” Freeman and his colleagues reinterpreted the concept of “innovation” as one concerning all the processes from product inventions to penetration to the market. They focused their attention to the design of R & D structure that had basically been taken as a black box, left to the scientists, but was then perceived as the beginning of innovation. In addition, they also reconsidered the role of private enterprises not as mere recipients of the invention, but entities involved in the invention, and proposed to design a R&D structure based on the existence of private companies. The background of such proposals was the question against the efficiency of research investment in “Big Science” basic research and military-industrial complex in the Cold War period.

The proposal of Freeman and others, which aimed at interactivity between science and technology and market economy, had a great influence on economic policy and science & technology policy of developed countries, mainly on policy reports at the OECD since the 1970s. Even in the Budapest Declaration mentioned earlier, there are expressions based on Nelson’s claim about the importance of constructing the "National Innovation System."[7] Then, in the 2000s, as is evident in the *Oslo Manual* (2005), the range of meaning for the word “innovation” gradually expanded, and it came to be used also for objects other than science and technology.

This semantic transition in the concept of "innovation" has also spread to the Japanese speaking world with a time difference. From the 1990s, the interest in "innovation policy" gradually increased, and the *Kagaku gijutsu hakusho (White Paper on Science and Technology)*, Heisei 14 version (2002), stated that innovation can no longer refer solely to technological

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[5] Declaration on Science and the Use of Scientific Knowledge, Text adopted by the World Conference on Science 1 July 1999. Definitive version http://www.unesco.org/science/wcs/eng/declaration_e.htm Refer to the following for Japanese translation. http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu4/siryo/attach/1298594.htm　For the contents of the Budapest Declaration, Mr. Arimoto and Mr. Ohtake gave me advice.

[6] Neo-Schumpeterian developed from around the middle of the 20th century and was originally known as "Science Research Policy." Jan Fagerberg, Ben R. Martin and Esben Sloth Andersen ed., *Innovation Studies: Evolution & Future Challenges*, Oxford: Oxford Univ. Press, 2013, ch.1, 13.

[7] See section 37 of Declaration on Science... The Japanese version official translation has the national innovation systems as "system of national innovation" and seems to be not being able to capture the claims of Freeman, Nelson, and others.

innovation, and began to use *inobeshon*, transliterated form of the word for this new meaning, in place of *gijutsu kakushin*, old translation implying both innovation and technological innovation. In 2006, innovation was also positioned in the 3rd Term Science and Technology Plan, and in the *Kagaku gijutsu hakusho (White Paper on Science and Technology)*, Heisei 20 version (2008), re-describes innovation (*inobeshon*) as “creating new values for social systems and systems, and bringing about a big change."[8]

As of the 2010s, "innovation" has also become a concept emphasized when thinking social issues, and it is beyond the framework of concrete industrial technology policy. And, as the approach to social issues is emphasized, there is a situation where expectation increases for those fields such as humanities and social sciences as a means for extracting social issues, especially in fields that can have something to do with modern society such as economics, sociology, and anthropology.[9]

3. Exhaustion caused by “innovation" and SDGs

3-1. Criticism of innovation policy and proposal for orbit correction

While innovation enhances expectations as a means of solving social issues, the experts in the humanities and social sciences got started criticizing the current situation where "innovation" is used like a versatile magic word, and proposing the orbit correction of the current trend.

What is regarded as a problem is the situation where various innovations are accelerated by policy guidance and as a result, social consensus and democratic debate are left behind, while discontinuous changes are accumulated.[10] As we will see later, it can be said that it is inevitable in times because the innovation policy since the 1990s is closely related to the "globalized" economy that has been also criticized recently.

For example, Luc Soete, a renowned researcher in the field of innovation studies, argues as follows. There are not only "creative destruction" conventionally mentioned in innovation theory, but also "destructive creation" bringing about destruction of societally shared value and a non-sustainable consumption pattern. In particular, the following two trends are problematic. First, the encouragement of innovation systematically creates "outdated products" and excessive consumption trends, which puts strain on the global environment. This applies to the ICT technology sector, most manufacturing industries that sell goods by image strategy, fashion industry, and so on. Secondly, the various financial innovations brought about by the development of financial engineering and the spread of electronic transactions are not subject to appropriate regulation, which constitutes the risk of causing confusion and disturbance in the economic system. For instance, the credit default swap that was created in 1994 is an example.[11]

Mariana Mazzucato points out the danger that existing innovation policies, particularly that of the U.S., will expand the inequality, profiting only some of the developed countries. And she asks how to innovate not only in a "smart" way but also in an “inclusive" way. Since the 1990s, the innovation policy has focused on ICT, nanotechnology and biotechnology in the United States, and economic disparity has increased, as is well known. In the background, she says there is a structural problem with the current innovation policy.

Like most developed countries, even in the United States, it is the huge amount of public money funded by the state that supports the truly advanced science and technology innovation. However, unlike conventional investment in public policy, the funds put into research and development in the privileged high-tech fields such as ICT, biotechnology, and nanotechnology have little

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[8] Shinichi Kobayashi. Kagaku gijutsu innovation seisaku no tanjou to sono haikei (The birth of science and technology innovation policy and its background). *Kagaku gijutsu shakai ron kenkyu (Journal of Science and Technology Studies)*. No. 13. March 2017. pp. 66-82. See also the following about the situation in Japan. Kunio Goto. “Kagaku gijutsu innovation” no shisou to seisaku (Thought and policy of “science and technology innovation”). Id. pp. 66-81. Nobumichi Ariga & Osamu Kamei (Ariga & Kamei). Kagaku gijutsu hakusho ni miru “gijutsu kakushin” no imiai no hensen (Transition of the meaning of "technological innovation” seen in the white paper of science and technology). *Bulletin of the National Museum of Nature and Science*. Series E (Physical Sciences & Engineering). 2014. Vol. 37. p. 38.

[9] Sayaka Oki. “Yuuyouna kagaku” to innovation no gainenshi ("Conceptual history of “useful science” and innovation). *Iwanami kouza gendai, dai 2 kan, post reisen jidai no kagaku/gijutsu (Iwanami Course Contemporary, Volume 2, Science/Technology in the Post-Cold War Age)*. Hideto Nakajima ed. Iwanami Shoten. February 2017. pp. 67-90.

[10] The paper mentioned above.

[11] *Innovation Studies*. ch. 6. Unfortunately, I am not familiar with this field, so it is difficult to fully explain it.

tendency to give much return to the rest of society, as they never create sufficient local employments. Moreover, the high-tech multinational corporations that received those outcomes and developed through it not only benefit from the tax reduction policy, which became remarkable after the 1990s, but tend to even avoid tax and did not contribute much to the national tax revenue increase (Apple is one of the typical examples of these companies).

Before the Bayh-Dole Act was enacted, it was a problem that the results of research by public funds remained asleep in public sectors such as universities and were not marketed. However, the problem of the present age is that public funds are leaked to the market through investment in research, and then only the commercial sector of some industrialized countries gets benefit from it, never bringing sufficiently return to society as a whole. Therefore, Mazzucato and others try to propose a method for the public sector to retrieve its investment in a way that does not reduce too much the vitality of the private sector.[12]

3-2. Positioning of SDGs and the humanities and social sciences

Changes in the tone in the innovation studies referred to in the previous section are not irrelevant to the adopting process of the "Sustainable Development Goals (SDGs)" consisting of 17 goals adopted by the United Nations in September 2015. Indeed, in the discussions of development economists, which are areas that are deeply committed to SDGs, we can find the point of reviewing innovation policies in developed countries.[13]

SDGs claim economic growth, environmental protection and social inclusion. They come from the philosophy that Colombia, Guatemala, the Peruvian government and others proposed at the 2012 Sustainable Development Conference (Rio + 20) conference.[14] As a major difference from the preceding "Millennium Development Goals" (MDGs), social approach to the cause of poverty is emphasized in SDGs, and furthermore, not only developing countries but all countries including developed countries were targeted.

As mentioned earlier, the situation created by innovation, based on current advanced science and technology, is far from achieving sustainability. Considering from the balance with SDGs, it is required to pursue R & D and innovation across sectors in a more sustainable manner. Moreover, it is not completed in urban areas of industrialized countries, it must also involve the industries and non-profit sector grassroots activities in developing countries.

Researchers who are interested in SDGs, mostly development economists, think it necessary for their ideals to encourage and promote diverse efforts in developing countries in sharing and dissemination of the local knowledge.[15] Movement of open science and open data which has advanced in recent years is also linked with that idea.[16]

Compared to MDGs, SDGs are goals that involve more extensive academic communities, including the humanities and social sciences. However, because the fields of environmental science and development economics were the main actors in their formulation, even in Western countries, it takes time for the communities of humanities and social sciences to fully recognize the whole SDG as a global agenda. In particular, it is not so evident for some academic communities and local party agencies that have already engaged themselves in the concrete issues related to social inclusion to see much difference between those new goals and what they have done. From the spirit of SDGs, it will be meaningful to connect the researchers and people "already active in the grassroots" to the new global agenda.[17] Various actors need to deepen their

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[12] *Innovation Studies*. ch. 10. It introduces an approach to invest in research in the form of a loan in which repayment obligations arise when research outcomes lead to profits, such as SITRA in Finland and KfW, an investment bank in Germany.

[13] For example, University of Sussex, the center of innovation research, also has a pivotal center of development economics, and cross-citations of articles and personnel exchanges are seen as in the discussion cited in footnote 19.

[14] https://pub.iges.or.jp/system/files/publication_documents/pub/issue/2545/rio_issue_brief_vol1_sdgs_mar2012.pdf
Leach, M., J. Rockström, P. Raskin, I. Scoones, AC Stirling, A. Smith, J. Thompson, E. Millstone, A. Ely, E. Arond, C. Folke, and P. Olsson. Transforming innovation for sustainability. Ecology and Society ", 2012, 17 (2):[15] 11. http://dx.doi.org/10.5751/ES-04933-170211

[16] For example, the next event and the like are typical as indicating its direction.
http://www.codata.org/news/166/62/Open-Data-and-Open-Science-for-the-SDGs-UN-STI-FORUM-Side-Event-15-May ;
http://www.jst.go.jp/csc/join/overseas/south-america/cilac/index.html

[17] For example, the following explanation according to the Canadian situation.

dialogue in each country.

1. "Transition Period" and roles of humanities and social sciences

Because the fields of humanities and social sciences are very diverse, they should not be considered together in theory. Also, there are aspects of limitation for my special abilities. Therefore, in the discussions of this report, we take into consideration mainly Science & Technology Studies, economics, and history, fields closely related to the author, among those included in the humanities and social sciences.

1-1. Essential role of humanities and social sciences

One of the important roles for humanities and social sciences is to prepare a framework that systematically and theoretically interprets politics, economics, and society, and provides guidelines for concrete actions as necessary.[18] Especially in the West, along with the process of modernization, various fields of humanities and social sciences have developed spontaneously as knowledge necessary to talk rationally on the “self” as subject and "society" as a community.

However, because of their nature, the fields of humanities and social sciences are often experiencing a great crisis at the transition period of the times. When a new society or economic phenomenon is born and events that cannot be assumed by the framework to date have arisen, they also have a mission to prepare a proper interpretation and "talk" to the society. Therefore, if we are in a transition period today, it will also be necessary to have a rough outlook on what is going on in the humanities and social sciences in a progressive way and what is going to be talked about in various fields.

1-2. Various aspects of the transition period in the past

Before discussing the present age, I would like to overview the past. Representative examples of the "transition period" in which the humanities and social sciences experienced a certain crisis since the 20th century are (A) the two warfare periods of the 20th century and (B) the turbulent period of the Cold War system, that is, the 1970s or so-called "postmodern" period. There is also a discussion that further regards the 2010s onwards to be the further new stage as (C), but we do not affirm this because it is currently in progress.

During the two warfare periods of (A) was an era when the European world, which proclaimed freedom and rationality, was confronted with war damage, disorder, and economic crisis, and made it lose its confidence. Criticism of the imperialistic capitalist regime became increasingly strong, and Marx-Leninism gained momentum. Totalism, on the other hand, brought serious reflections on political thought and philosophy, and the economics at the time that could not prevent the depression was criticized. Then, a welfare state model associated with Keynesianism emerged, and it was put into action.[19]

(B) is the era when our living "global economy" was full-blown. Developed countries converted policies to neo-liberalism due to deadlocks of welfare states, and due to the decline and collapse of the Soviet Union, thoughts and various fields related to socialism have declined. As a change in law and political thought, reinterpretation of the concept of "human rights" and the concept of "citizenship" became conspicuous, following the creation of policy issues of environmental problems and the creation of communities across the nation-state like the EU.[20] In economics the neoclassical economics became mainstream. Postmodern thought developed in humanities and social sciences, and there was a big impact beyond the field in methodology and ideological framework. A representative example of the latter trend is the consciousness of issues such as criticism of Eurocentrism and reflection of colonial problems, awakening consciousness to feminism and

http://www.ideas-idees.ca/blog/global-sustainable-development-goals-have-potential-drive-change-canada

[18] In addition to this, the succession of the next generation of cultural resources including books, art works, and historical materials, and the qualitative and quantitative description/recording of social phenomena are also important roles.

[19] Tatsuya Sakamoto. *Shakai shisou no rekishi (The History of Social Thought)*. The University of Nagoya Press. 2014. Chapter 11-12. The theory itself adopted by Keynes was not entirely new as an economic theory but rather said to have been eclectic. However, it can be said that it was a "turning point" in adopting a policy of government intervention and in affirming criticism of laissez-faireism.

[20] For example, Karel Vasak, "Human Rights: A Thirty-Year Struggle: the Sustained Efforts to give Force of law to the Universal Declaration of Human Rights," *UNESCO Courier* 30:11, Paris: United Nations Educational, Scientific, and Cultural Organization, November 1977. Kunihiko Uemura. *Shimin shakai towa nanika, kihon gainen no keitou (What is Civil Society? Genealogy of Basic Concepts)*. Heibonsha Shinsho. 2010. Chapter 8.

environmental problems, and human rights issues of sexual minorities.[21]

And (C) is the world after the Lehman shock, and also the world after the Fukushima nuclear power plant accident. As symbolized by SDGs to be discussed later, the mediation of environmental problems and economy becomes increasingly a matter of concern, but in parallel with the progress of globalization, the problems of economic disparity and social inequality are confronting humanities and social science with new challenges. In economics, as Thomas Piketty's book shows, research on the themes of inequality and disparity has begun to attract attention again. In politics, the extreme right powers and extreme left powers also expanded in the shadow of globalization, and they are heightening attacks to the beliefs, which were mainstream in the times of (B), each from their standpoints.

In these "transition periods," the fields related to politics and economics among the humanities and social sciences have often become the place of controversies. A criticism discourse against the mainstream discourse has always been born, and it has pushed concrete social changes and policy formation. Therefore, we find the language of humanities and social sciences has already been embedded in society to a certain degree without making us notice it.

Below, as examples showing how words of humanities and social sciences have influenced policies, I will describe the two concepts of "progress" and "innovation" that have given impact directly or indirectly to science and technology policies over the long term. Then, I would like to consider what kind of roles the humanities and social sciences can play in the above transition period of (C).

4. Issues of humanities and social sciences in Japan

Finally, I will describe the humanities and social sciences of Japan in the “transition period" as far as I understand. SDGs are formed with what comes after the era led by the brutal calls of the Western-centered "progress" and the "innovation" issued from the developed countries (especially the United States and the UK). There may be more role than ever for a society like Japan that has already experienced the exhaustion of sudden rapid change through its history. The humanities and social sciences of Japan have conducted a series of studies on these changes. At the same time, it will be necessary to consider the difference, as Japan's exhaustion is not necessarily the result of neo-liberal economic policy, but it is a product of "modernization" in general, problems accumulated through the 20th century.[22]

Given the future, the fields such as economics (especially development economics and innovation studies), environmental science, gender research, Science and Technology Studies, science of policy, philosophy, history and sociology (also those studying both the regions of East Asia and the West) should increase opportunities to exchange opinions. However, in doing so, what I care about personally is the existence of discommunication inside the humanities and social sciences. People to meet do not seem to have met. For the moment, I have only some hypothetical ideas on the cause of this situation as the followings. Firstly, there is a general tendency for Japanese academic organizations to have a strong vertical structure that never facilitates transdisciplinary communications among researchers. Secondly, there still exists the negative side effect of the students movements in 1968, having divided the Japanese academic community in a different way from North America and Europe. Thirdly, some political problem as the legacy of the Cold War period still divide easily Japanese academics in parties, as the serious conflicts over Japan's security policy and nuclear policy did.[23]

It is really important to re-enhance now the intellectual feeds back circuit between humanities and social sciences to the Japanese administration. As far as I know, for the moment, there seems to exist unfortunate

[21] "Post-modern" itself is a term used also in architecture and art since the 1960s, but here it assumes structuralism and post-structuralism thought, also called "modern thought," since the 1970s.

[22] For example, the social science of Japan has always been concerned with problems such as depopulation and exhaustion of local cities, but until the early 2010s, they were rarely emphasized in the international agenda setup. It was recently revealed by Brexit and the birth of the Trump regime that those countries also have "rural areas" that are exhausted and face problems.
(http://thinktank.php.co.jp/kaeruchikara/1407/?Print=1)
The fact that how to accept university conflicts in 1968 greatly differs from field to field was seen in Europe itself.[23] For example, see a series of research by Charles Soulié, sociologist.

dissonances between the majority of administrative sector and the academia, especially researchers deeply involved in SDGs related issues, such as environment, regional studies, and gender studies. The former criticizes the quality of research in Humanities and Social Sciences, while the latter raises dissatisfaction that Japanese administrative organizations are not able to properly select experts when dealing with social issues. I am not going to declare that either is unilaterally correct, and I do not have that ability to judge, but one thing is sure that their opinions crossed each other in a tragic way. In order for collective intelligence to be displayed to aim the goals such as SDGs, it is necessary for each of them to take into consideration of the diversity of historical and cultural background of people in different fields with different roles, and to try to think about measures to make different people to cooperate more.

Chapter 4　The Meaning in Questioning Postmodern Science and Technology

- Now is the Time to Talk about “Academics Studies” -

Naoki Miyano

Certainly, we can say that an innovative change is now being called for regarding how "science and technology" should be. However, isn't it always the case that a change and a reform are called for? The "reform fever" that Tosaka began to talk about in the 1930s is still continuing even now.[1] In the generally accepted idea of regarding constant changes such as innovative changes and reforms as good things, the figure of a vehicle going furtively forward and forward with a "sense of crisis" (which is often borne out of comparison of circumstances with those of other countries) as a fuel, with "practice" and "evaluation" arranged as the wheels on the both sides, and with "strategy and proposal" as the landmark, is considered ideal. According to the purpose of this study group, the starting point of this thesis is that, if we are to face and think about the fact that "Science and technology must change!" then this figure of the vehicle moving "forward!" "forward!" should probably be subjected to doubt first.

I say this because I wholeheartedly agree with the words that it is crazy to repeat the same thing and expect a different result.[2] It goes without saying that while we seem to be thinking freely in various ways, we are captured in an invisible rut. I feel that because the "problems of science and technology"[3] that we face today closely related to our actions and lifestyles when they are solved, people are inadvertently captivated by that influence and real effect, not paying attention to their ways or habits of thinking, namely the forms in which they think. Even worse, these very forms are methods born out of "science," which makes them hard to deal with. I mean that, especially with respect to this "science and technology," it is not possible to separate content and form, that is, because the form of thinking is what "science" is, to reconsider and revise science and technology in a true sense, it is essential to properly reconsider its form as well.

By format here, I would like to mean the logical framework held by the classical "science." As a precondition, I want to make a complete separation between subjectivity and objectivity, emphasize objects substitutable with a number i.e., what we can see (and in some cases, even believe that the number is the thing itself), believe that it can be operated, and furthermore, believe that things can move (or be moved) with a linear causal relationship of "if you do this, this happens." The tendency to place emphasis on evaluations and indicators such as rankings and the like is a typical example of these. Furthermore, this is also true with an emphasis on discovering issues and the opinion that "Now is the time that we need a strategy and vision!" The issues and the direction to aim for are captured with an image of them being somewhere other than the "people" including themselves, and the self and the object are confronted with each other, splendidly placing a distance between them. Oddly enough, while holding out that "science and technology is entering a period of transformation, and it is necessary to escape the so-called modernism such as paper supremacism, technology supremacism, rationalism, operationism, etc.," the actual forms and methods to escape are deeply immersed in modernism. When that is the case, is it really possible to escape them?

This opinion does not in any way deny the purpose of this study group. Rather, I believe that it is essential to reach the aim of this study group which is in its purpose. To begin with, are "science and technology" something which we can talk about as having become better or worse? After all, what are we supposed to target, to be unsatisfied with, and discuss? Among the "problems of science and technology" that are brought to light by noble advocates and policy-makers, how many of those problems are really worth dealing with? Is that problem really a problem? Are they not too high to reach just as the likes of desire for happiness or pursuit of the good, not much meaningful even if a comparison is made, or not something that would have no influence whatsoever on the ordinary world even if they are solved? Who should lament the problems (or where), and who can

[1] *Gendai nihon no shiso tairitsu* (*Confrontation of Thoughts in Contemporary Japan*). Aozora Bunko. 1936. Jun Tosaka.
[2] They are considered to be the words of Einstein or Benjamin Franklin, but the truth is said to be unknown.
[3] Various incidents and problems in the relationship between society and science in the sense of a discourse of science, technology, and society. I am acutely aware of the outrageousness in grouping evaluation of science and technology, how policies should be, comparison with overseas countries, rankings, fear of the tendency to value the number of papers written or overemphasis on competitive funds, how science should be, how technology should be, etc., as simply "problems of science and technology." However, I did this because I wanted to make the theme "attitudes of the intelligent class involved in science and technology" as the subject of this thesis, rather than pursue accuracy by dealing with individual problems.

solve them (or where)? Problem! Problem! Do you feel assured that you are on the right side, if you make that noise? After all, now the problem is exactly what the problem is, and the question to rethink is the commonly held idea of regarding the current problems as problems, and the forms that produce it. Unless we become more conscious about this, “science and technology" will not change in a true sense. For example, when they say that Japan's science and technology are losing, or that Japan is lagging, what does that mean? On the contrary, is the state of winning, or the state of being "good”? If so, then what is good about what? As you can see, the way of thinking that what remains after the competition is better is the so-called "science" itself.

Below, I would like to summarize it in three points as a foothold for escaping the forms of today's thinking.

1. Cause and result

As an example of the current science and technology not performing well, I will show the following excerpts from the 5th Science and Technology Basic Plan, which is perfect as an authoritative representative of the writing on science and technology, and the Expert Survey on Japanese S&T and Innovation System by National Institute of Science and Technology Policy (NISTEP) of the Ministry of Education, Culture, Sports, Science and Technology.

- From the Overview of the 5th Science and Technology Basic Plan, Chapter 1, Basic Ideas (2) The achievements and issues of the 20 years of Science and Technology Basic Plan

.....However, in recent years, the "fundamental power" has weakened, such as the fall in the international status in both the quality and quantity of academic papers, the delay in establishing an international research network, and the inability of young researchers to demonstrate their abilities. The industry-academia collaboration has not become full-scale, either. Delays in the reform of management and human resource systems of universities, etc., and the presence of "walls" between organizations turned out to be factors.

- From 2015 nen kagaku gijutsu no jokyo ni kakaru sogoteki ishiki chosa (NISTEP teiten chosa) (Analytical Report for 2015 NISTEP Expert Survey on Japanese S&T and Innovation System (NISTEP TEITEN survey))

.....In addition to the recognition of the increase of “researchers who strongly aim for short-term outcomes," “researchers who conduct research with a high reliability of achieving a result," “researchers who release their results in small pieces (to deal with evaluations) being shown, the recognition of the decrease of "researchers who carefully work on their research topics with emphasis on long-term research strategies" is shown.

I think that those working in this community of “problems of science and technology" are familiar with these words already, but please read it again with unbiased eyes. What a worst wording ever! In particular, the excerpt from the 5th Science and Technology Basic Plan is terrible beyond the extent of, “how dare they say that!” No matter how positive the information shown in the previous stages of this paragraph was, the words scattered here are so bad that they would overturn it. Then, I would want to ask this simple question. What have the academia and the world of science and technology policy protected so far doing what?

When you try to rethink this extremely simple causal relationship between the cause and result, it should be normal to doubt the cause first. Because of this, that. I cannot help but wonder that a result completely opposite to this extent came about because the main premise in the discussion of "because of this" was wrong.[4] The major premise is the concepts shared by us like our views on academics, science, and universities, such as various definitions such as “research is...,” “academic studies are...,” “universities are...,” “science is...,” and “science and technology are...,” that is, our commonly held ideas. You might say, “No, this common idea is not wrong. It’s just that we did it the wrong way.” However, just because we did it

[4] Or, maybe in the beginning there was something to protect, but they were so desperate to protect it that they forgot what they were supposed to protect in the first place. However, as will be stated later, we can say that the case is also a result of neglecting the “in-the-first-place discussion."

the wrong way, could the situation be so opposite to the ideal (or the original state of academics)? As you know, discussing various definitions and talking about commonly held ideas is an extreme pain, so very often we make light of it or do not even work on defining them, and then move on to practice.[5] The idea that it is important to move “Forward!” and “Forward!” must be making us do so. This current situation is the payback of having very easily skipped over the inevitable path we had to take if we truly wanted to change things, and truly wanted to improve them. The fact that we are in this situation, even though we continued to say that change was necessary, is the testament to our avoidance of discussing our commonly held ideas. A giant patient, who continues to eat high-calorie meals every day for three meals, shouts that "the medicine is not working," and continues to seek and consume expensive medicine developed with even more money. But, of course, his body does not get better at all. Is it his attitude or the medicine that’s bad?

2. Inside and outside

It is perfectly fine to lament the current state of "science and technology" and try to change them, but we should not forget that the current state is the result of changing things little by little thinking that it was a good thing. Denying the present situation is a simple act that even children can do. However, what on earth is the denial supposed to be denying? For example, there is a result of a questionnaire survey, famous evidence data concerning the current state of science and technology, which says that researchers' research themes are increasingly becoming short-term and short-sighted.[6] Taking this up, it is easy to say, "This is an inconvenient fact. Research should be long-term by nature." However, as it is in more practical research that there is significance, or because the words of “science for society” have been appreciated, clearly it is we, not other people, who have pushed forward this number of legal revisions in the policy area alone, including the 1996 Science and Technology Basic Plan about 20 years ago, the 1998 Act on the Promotion of Technology Transfer from Universities to Private Business Operators, the 1998 establishment of TLO, the 1999 Act on Special Measures concerning Industrial Revitalization, the 2001 establishment of the Council for Science and Technology, and the 2006 revision of the Basic Act on Education, in which “contribution to society" was explicitly stipulated as a mission of the universities. Researchers especially cannot blame this on policymakers or enterprises influencing it. That’s because, researchers are listed as members of any of these conferences or committees.

As another example, why is it that people in the community of science and technology feel that the "science and technology" of our country are not improving, and that they are in a crisis? Is it the "evidence data" saying that the so-called top 10% papers are decreasing? Except, of course, there are not a few data showing that Japan's "science and technology" are excellent.[7] They do not compare all the data to say their opinions, they cannot gather all the data in the first place, or the results of individual data vary considerably depending on how they are acquired. What and in what way on earth do we pick from the many “data” available to feel that things are not getting better?

Of course, I have an intention in using the sensory expression of "feel" here. That is because, if we continue to think of the above questions, the source of the dissatisfaction with the current state, after all, boils down to the fact that there is "something they can’t stomach" about the events occurring within the category of individual experiences around themselves. Each of them should simply start listing those things they can’t stomach, but intellectuals are quick and eager to preach from a broader perspective as if it were their mission. Besides, when they express their opinions on science and technology “in my country,” “whose” country is “our country”? Is there someone who can

[5] “No, the definition is appropriate. You see it at the beginning of the words of the policy," some may have thought. Indeed, in some cases there are such words of definition. However, the problem is that the definition is not a result of thorough discussion. That is, despite the work being even more necessary if we are in a period of confusion.

[6] Kagaku gijutsu no jokyo ni kakaru sogoteki ishiki chosa (Analytical Report for 2015 NISTEP Expert Survey on Japanese S&T and Innovation System (NISTEP TEITEN survey 2015)).

[7] The number of Nobel Prizes won during this century, the rankings by Nation Brands Index, etc. Also at the worksite level, strengths have been pointed out including improvement in the ease of using scientific research grants, and strengthening the development of the research support system (development of URA) (from NISTEP TEITEN survey 2015)

represent the science and technology of this country with responsibility? In the end, the constituent elements of “our country" are the individuals, and improving xx in “our country” is none other than improving xx of the individuals. And the most important thing is whether they are thinking while including themselves among the individuals who are the constituent elements of “our country.” The same goes for “science and technology." To put it roughly, the “problems of science and technology" boil down to being merely thinking and actions of the individuals, including themselves. It is probably the intellectuals, held captive by today's forms of thought, who do not doubt that they can have discussions standing at the position to say, “Our country!” or “Science and technology!” while putting aside this most important thing. Cry out "I am!" because you are also “our country” and science and technology. Don’t say this or that, and shut up and sweat so you can accept it yourself (so you can truly be happy). If the "science and technology of our country" does not change as the whole of this, I would like someone to tell me what will.

After all, what to question now is the habits and forms of our ways of thinking. Because they see the inconvenient reality like an object that has been disconnected from the past, all those countermeasures are temporary, and none of them demonstrates its true effect. Moreover, because they do not doubt that they see this inconvenient reality objectively, they create a measure like it is somebody else’s business with a feeling of getting nowhere and with no sense of reality. This very way of viewing things as individual objects is typical of scientificism, and if we do not have any doubt about that, we will not be able to get close to the root cause. It is evil now, but in the old days, it was good. It was a very innovative policy. However, now it produces undesirable results. If we think in a continuum like this, will it not lead us to reflect on ourselves first? The very introspection on what held us captive when we were working so hard must end up producing the next “science and technology.” Otherwise, we can see the reforms being merely those of the branches and the leaves, but not the trunk. Sure, in the policy world, work is being done in the name of a follow-up or review to look back on policies. However, if we do not have a doubt and think that the axis of evaluation at the time of looking back is the most important subject to look back on, we will merely be making evidence to fulfill this thing called accountability.

3. Thoughts and actions

If a reader replaced what I have stated so far with a claim, “So, you mean that an ‘in-the-first-place’ discussion is important” (which is also fine),[8] they would say, "But we can’t just think about it, right?" This is a way of thinking of pragmatism often heard here and there, that is, the way of thinking that actions and practices are important, and that without them, strategies, plans, or thoughts are pointless. That is true. But why do we need to separate thought from action? We do not need to make a decision as a precondition when we perform some act in the first place. Especially, as we have the phrase “impulse buying,” an active action truly happens when thought and action are intertwined. In the policy area, the administrative side often formulates a recommendation, strategy, or roadmap, and then says, “the rest is just the actual practice.” But what exactly is the practice if it cannot be done without creating incentives or penalties after making the plan for the practice to be implemented? If they are going to spend money, time, and effort on such follow-ups, it will be much better for them to use their energy so that the moment that people touch the thought behind the strategy or plan, it immediately influences their actions. When people make others eat bad-tasting food one way or another, saying “it’s nutritious,” the one eating it does not understand and accept that it is in fact nutritious. They wouldn’t have to spend so much money or effort if they were convinced. On the other hand, people to eat it were not convinced, but it filled their stomach, so in the beginning they were eating it with patience. However, before they knew it, it became commonplace, and now they have forgotten what they really want to eat. How have we come to this?

To summarize this paper, I would like to say that the

[8] “In-the-first-place discussions" are not so easy. It is not because it requires philosophical thinking or knowledge, but because it is a task of doubting common sense while having common sense. How do you turn over the cushion on which you are sitting yourself?

meaning in questioning postmodern science and technology lies in questioning how the intellectuals in the community of "science and technology" should be. If there is dissatisfaction that changes are not happening while being called out, the cause is not "it does not change because we are not thinking." "A well-tailored strategy is important," "a well-thought-out goal setting is important," and "why isn't everyone thinking and taking actions!" are not the truth. Because we have been thinking about it all along and we have come to this now. If you ask me, the cause is not "it will not change unless you think," but "it will not change unless we think properly." Then, what does it mean to think properly? What should we do?

Regarding that, in fact academic studies have already taught us to (1) think about "thinking," (2) think in terms of "my world" where there is nothing that can be blamed on other people in this world, or (3) think in a way that touches on or is consistent with reason of the world such as universality and existence.[9] The posture of introspection, embodied in our own ways of living, such as trying to be aware of the confinement of our own thought by doubting what was believed about the ways we thought or did things, and seeking new ideas and ways of doing things, is exactly what academic studies are about. The system of knowledge is only a product of that. Whether it is science or literature, what kind of field, what point of view, why we do it, why we who do it exist, where we exist if we do exist. Loss for words at the point where subjectivity and objectivity, and the inside and the outside, intersect and dissolve, for example like things which do not touch upon such reason of this world, is not academic studies. If they are to stay with an act of finding a vacant lot that has not been touched yet to seemingly observe it, survey it, analyze it, and write a paper, that is, "doing research," they can do it at an enterprise or a research institute established under a national strategy, according to the purpose of each time such as convenience, comfort, safety, or problem-solving, for example. Because it is a very important thing that concerns a lot of people. Meanwhile, universities should just focus on academic studies. And, if the reason why it is impossible to think about the "problems of science and technology" based on introspection is that the place called university, which should originally be for academic studies, is not properly aligned with the way it should be, we must reflect on it fiercely because we are not producing human resources who introspect.

It is still not too late. We only need to have a dialogue with the person sitting in front of us, by us. And it is good enough to continually devote ourselves so that the dialogue is an academic study, putting aside the intellectuals nowadays crying out this or that. There is no way we are not better than anyone in the world when our inner tradition has the thoughts of freedom and independence [10] in Fukuzawa's words, and self-orientedness[11] in Natsume's words. Now, everyone is doing their best. We only need to realize with a little preparedness that the "way" we do our best is just different.

Keywords

Introspection, form of thought, causal relationship, criticism of intellectuals, philosophy

[9] Here, do I need a citation like "As Socrates said in the *Phaedrus* by Plato..."? It would be necessary if this was an academic paper, but it is not. In the first place, it is not possible to give such a single and clear source for this opinion of mine about "thinking properly." I merely wrote publicly the words I believe in as a result of having encountered people and words, and thought in my life, following the etymology of the word professor. Also, this is also a sarcasm toward the people who think that writing papers make them a professor.

[10] Freedom as referred to by Yukichi Fukuzawa almost means "independence." He stressed that having your own thought regardless of the predetermined notions was freedom (= independence).

[11] Self-orientedness as referred to by Soseki Natsume does not mean being selfish, but roughly means that you should do things within the scope that you understand and accept, with responsibility.

Chapter 5　Science Practiced by Human Beings

- Emotions that Connect Thoughts -

Shoji Komai

1. Preface

I do not mean to claim something like “We should increase drinking parties,” or “We should process things emotionally." Neither, do I want to say that we should immerse ourselves in researches or academic studies without any inhibition. None of the wonderful researches have started from zero. They exist on some accumulations, sometimes not directly, but they are built on many bases. As in the words of Francis Bacon, "The clever one creates opportunities, more than finding them." Opening eyes to a wider world to find opportunities, and spinning it to real actions opens the future. By reconfirming that thoughts are spun by humans, and by making good use of this to prepare for the future beyond our imaginations, I think we’ll be able to open the future.

2. Cannot focus on the problem

2-1. Problems hidden in daily life and society

2-1-1. A society in which the gap is flourishing

Now that globalization has progressed and diversification of value has progressed to an excessive degree, the situation of rich people being richer and poor people being poorer is accelerating in this world. According to the international NGO Oxfam’s survey, the total household assets in 2013 reached 241 trillion dollars, but the top 1% is monopolizing 110 trillion dollars, which is nearly half of the total, and it is reported that the total assets of the top 85 people is equivalent to the total assets of the people in the lower 50%. In response to this, in the report at the annual general meeting "Davos Conference" in January 2014, the World Economic Forum (WEF) pointed out that the biggest threat of the world economy is the expansion of income disparity. Furthermore, in the report of January this year 2017, it was pointed out that the assets of the world's wealthiest only eight people was about the same as the total amount of about 3.6 billion people in the lower 50% of the world population, and the gap between rich and poor was expanding unprecedentedly.[1]

These disparities are not only affecting economy, but are creating disparities in various forms such as education and health, and occupies a large part of the issues facing the humankind.

The Sustainable Development Goals (SDGs) were adopted by the United Nations under the participation of over 150 member states' leaders with the aim of promoting solution of the issues that this world is facing. SDGs are the successor to the Millennium Development Goals (MDGs) and consist of 17 goals and 169 targets, and based on this, all member states of the United Nations are required to do their best to achieve the various goals for sustainable development from 2015 to 2030.[2]

2-1-2. What can science and technology do to eliminate disparity?

Also in Japan, each ministry and agency, including the Council for Science, Technology and Innovation, is embarking on activities to achieve the targets listed here. In particular, Japan Science and Technology Agency has begun concrete efforts, and has been advancing more progressive and actionable discussions. With substantive opinions being exchanged on institutional design of funding, the relationship between science and technology and policies, and diplomatic strategies, it advances formulation of a framework in which Japan can lead the world and respond to these problems. So, what can we do as Japan’s academic community, and what should we do?

We often hear voices of researchers such as "I do not know what to target," or “It is not in my field, so I cannot be involved," when bringing in solution of social problems like SDGs in the science and technology fields. That may actually be true. I think, for example, that it is easy for them to imagine how to deal with items such as safety of food and water. However, I imagine that it is very difficult to bring problems into their own fields such as gender balance, poverty, and balance among nations.

Isn’t this point the most important problem to be solved? Modern civilization underpinned by the development of science and technology that human beings have built has made various phenomena more

[1]Report on economic disparity by Oxfam in January 2017.
https://www.oxfam.org/en/pressroom/pressreleases/2017-01-16/just-8-men-own-same-wealth-half-world

[2]Commentary on the "Sustainable Development Goals (SDGs)" by the United Nations
http://www.un.org/sustainabledevelopment/sustainable-development-goals/

convenient, and have strived to maintain the homeostasis of the environment inhabited by the humankind. As a result, the population has exploded, and it has built a more convenient environment. It is conceivable that this resulted in imbalance in various forms, causing widening of inequality. If it is, it is possible for scholars to confront this problem themselves, and it rather seems necessary to tackle it seriously.

2-2. Development of science and technology

2-2-1. Natural sciences

Defining natural science as what tries to understand the general idea of all things, I think that the so-called sciences including physics, chemistry, and biology, correspond to this. The answers are just around us, and it aims to understand our own existence, the regularity regarding the formation of the world and the universe, to clarify the general principles. Human beings have so far tried to maintain homeostasis inside and outside of themselves by accumulating and understanding knowledge of various things, and making predictions by promoting this natural science. The facts and knowledge of them related to nature that humankind has revealed so far have changed the view of the world of humankind, and it has come to replace the existence of God. Also, in addition to these facts and knowledge, "logic" as a methodology of natural science became extremely important for human beings due to the high foreseeability on various things, and it began to be used in various scenes.

2-2-2. Supernatural science

The so-called natural science has had its answers in the long history of 4.6 billion years, and it was possible to predict the future by looking back on this history. However, in the field of supernatural science mentioned here, there is a possibility of causing what humankind or nature has never experienced before. Either thing may be contained in nature after all, but the combination is extremely artificial. I think that engineering (and engineering science) and information science, etc., that produce completely new things that have never been produced by nature, ranging from new materials and space to living things, correspond to this. I think that such a way of science and technology will make us human beings' lives even more affluent but more complicated.

2-2-3. Social sciences

The ways of capturing things in natural sciences began to be applied to our society as well. This is thought to be the result of the diffusion of methods and ways of thinking in cognitive science as the technology of measurement improved. Measurement of various kinds of biometric information such as brain waves, finger plethysmograms, size of the pupil, direction of the line of sight, etc., can now be performed precisely, and in recent years, it has become more popular to visualize brain activities noninvasively. Its targets are not only limited to indicating the state of a single individual but to measuring changes in the brain activities and physiological indicators seen when multiple individuals interact with each other, so it has become possible to understand actions which humans can take or group characteristics i society in numerical terms. Because of the influence by numerical understanding of phenomena, more rigorous logic and grounds have come to be required for observational research, which has made it possible to garner more understanding. In addition, I think that the idea of predicting the future of society more accurately has also spread further, due to the introduction of logic in natural sciences.

However, as society diversifies due to the advance of supernatural science into society, and values becoming more complicated, how should the humans behave to understand various phenomena found in modern society and reach a solution? How should humans respond to unknown problems? To understand the science and technology, and the human beings themselves, that produced these problems, I would like to review what kind of living things are in the first place.

3. Humans are living things that can do anything, but cannot do anything

3-1. From the viewpoint of brain science

In the process of their evolution, humans have developed their brains, and have developed society and culture. The world seen from the brain's point of view is all unknown, and we can see that the brain is given variables that must be handled each time. So, what kind

of brain power does this brain have? By reviewing briefly on "brain power" of our brain, I want to consider how we as human beings can maximize our brain power in the future.

3-1-1. Our "brain power"

It is not an exaggeration to say that our brain, which is a network of 100 billion nerve cells gathered, controls almost all our activities (Herculano-Houzel, 2009). It can be said that it is a wonderful device that guides us individuals and society in an adaptive direction, considering various environments and information.

However, it is self-evident that the brain does not possess infinite capacity.

Illusion and cognitive bias, etc., can be regarded as a strategy to cover the low memory capacity and processing speed. For example, if you have a doubt that the horizon over the other side of the building may possibly not be connected, even if you have a devise with high capability, you will run out of resources.

3-1-2. Comparing computer and brain

Personal computers in offices and homes perform various tasks indiscriminately for us. Their abilities are very high, and their memory and calculation speed are far beyond our abilities. A gigantic computer like the K computer is calculated to perform an equivalent of all 7 billion people on the planet gathering with a calculator to keep calculating once every second for 24 hours a day without sleeping, and finally finishing after about 17 days. "K" can do this in only 1 second.[3] They are becoming stronger in chess and shogi than humans, and high school girls in CG come closer with such a sense of reality that you can hardly tell them apart from a real one.

On the other hand, how “great” are our brains? In terms of memory capacity and processing speed, human brain is already no match for the current computer. A result obtained by actually calculating the brain’s processing capacity has been shown. A study led by Dr. Terry Sejnowski of the Salk Institute in the United States announced that the human brain could store 10 times more information than what the conventional theory had said (Bartol et al, 2015). According to the team’s research, the average synapse has a memory capacity of 4.7 bits (0.5875 bytes), and the entire brain can store information of about 1 petabyte (1,024 terabytes). Since 3 terabytes of hard disk at the current price is approximately 10,000 yen, it would be about 3.4 million yen. However, the brain of the general adult at the time of rising from bed is extremely energy-conserving, consuming only 20 watts of energy, an equivalent of one LED fluorescent lamp of the latest type.

It is hard to make a judgment based on this numerical value on whether we should view such brain’s processing capability as amazing, or think that it is only that much good. However, due to the development of IT in recent years, it is a fact that these numerical values are not necessarily so high as to exceed our imagination. It is used for performing all processes such as exercise, sensation, memory, and thinking in parallel, including autonomic innervation, so maybe it can be said that we do not have that many resources that we can consciously use.

3-1-3. "Brain power" is to adapt

The brain is plastic. Plasticity refers to a phenomenon in which the brain is left as a form once pushed like clay and the shape remains that way for a while, but I am not talking about pushing down the brain physically. It is a description of its ability to learn and memorize various kinds of information, and it is no exaggeration to say that the greatest feature of brain power is having this this ability.

Due to the plasticity of the brain, humans can start to see things at the developmental stage and learn to understand various phenomena in the world. Even if the environment in which they were born and raised are different, we recognize the world as a human and constitute a society. On the other hand, values change by changing biological responses, clothes, language, etc., according to the climate, environment, and culture. Because of this kind of brain power, humans could spread to every place on Earth.

Computers can perform extremely complicated calculations accurately and at a high speed. It is also extremely accurate regarding followability of logic. Our

[3] Commentary on the performance of the K computer by FUJITSU LIMITED, the developer http://www.fujitsu.com/jp/about/businesspolicy/tech/k/whatis/system/index.html

brain can be thought of as being superior and better in different aspects from those of the computer's brain power. The brain power of plasticity has brought many benefits to us the humanity, but the processing speed is no way faster than that of a personal computer. I imagine that the weak followability of logic and the plasticity create a seemingly illogical brain power called creativity.

3-2. From the viewpoint of psychology (cognitive science and behavioral science)

3-2-1. This is how distorted it is

3-2-1-1. Illusion

Since the word illusion is a word that is too commonly used, many people should be able to imagine its meaning. It may even be used synonymously with "misunderstanding." It is considered as a phenomenon induced in the sense of various modalities, and the most advanced research is the illusion in visual sense, "optical illusion." There are various examples such as Müller-Lyer's illusion, Ebbinghaus illusion, Cannizzero's triangle, etc. It seems that they are categorized into several groups by moving optical illusion, ambiguous figures, or subjective contours, as well as characteristics of the phenomenon. Almost nothing has been made clear as to its neuroscientific corroboration of "why optical illusion occurs," but many optical illusions as phenomena have been found, some of which have been given a behavioral explanation of depth perception, size homeostasis, or the relationship between figure and ground.

3-2-1-2. Heuristics (bias)

Although this word may not sound familiar enough, heuristics refers to a simple and easy solution that humans use unconsciously when making some complex decision on a complex problem. This deviation of recognition born by this heuristic is called "cognitive bias." A judgment using this heuristic is very quick, and it does not devote much brain resource. However, the judgment is not necessarily correct, and the result of judgment often has a certain bias. Several examples can be cited, one of which is "representative heuristics," and it refers to the process of decision-making that makes it easy to overestimate the probability of an item which is considered typical. For example, the probability that six dice appear randomly and the probability that everything turns out to be one are equal, but such a thing happens because the random appearance is more similar to the disorder which is generally conceivable. In some cases, characteristics of these heuristics are used for anti-virus software algorithms in the field of computer science to reduce resources.

3-2-1-3. Information overload

Information overload is a term by Bertram Gross (Gross, 1965), but as a psychological term, it refers to an excessive state of information that can come into sight when you are walking in a crowded city street. Such perceptual overload was thought to be the cause of confusion and loss of responsiveness. Alvin Toffler hypothesized that such influences were more on higher order cognitive functions than sensory devices, in his book *Future Shock* .

In fact, due to the spread of the Internet and the development of the transportation system, internationally the society is becoming one in which various events and values can be obtained instantaneously. It may be more accurate to say that we are forcibly exposed rather than obtain them. Such a situation should be regarded as more serious than in the 1970s when the phrase "information overload" began to be used extensively, and perceptual overload has a bad influence on productivity and decision-making to some extent, and there is a concern about the possibility of useful information being masked with incorrect or erroneous information.

3-2-1-4. Prison experiment

Stanley Milgram (1933-1984) tried to uncover experimentally whether or not the organized Jewish persecution by the Nazi that occurred in the 1930s and 1940s was a case caused by special people (Milgram, 1963). It aimed to experimentally clarify the "mediocrity of evil" pointed out by Hannah Arendt in the record of Nazi's Eichmann trial "Eichmann in Jerusalem" (Arendt, 1963). Please refer to other sources for details, but the result showed that even ordinary citizens, under certain conditions, could perform extremely ruthless and inhumane acts. The problem is this "under certain conditions," a point where various factors are complicatedly involved, but it includes

thoughtlessness and responsibilities, diffusion of responsibility and anonymity in a group setting, and it is thought to show the vulnerability of human thought in a straightforward way.

3-2-1-5. Filter bubble (post-truth)

Last year was a year when internationally big decisions were made, such as the U.K.'s withdrawal from the EU and the presidential election in the United States. This year is a very important one for the decisions to be put into practice, but as the unrestful movements in the Middle East, the relationship with Russia over these, and the various moves in Asian countries including China are seen, and with each of them interrelated, there is no doubt that we should keep our eyes on all these situations.

Since the Arab Spring, politics of public opinion via the Internet and their influence on the international community have been raised as topics in various ways. It was the "filter bubble" that was specifically picked up as a topic in last year's U.S. presidential election. This means a case in which the search algorithm on the Internet provides a search result based on selective estimation on what information the user would likely want to see based on their search history and click history, and the user is quarantined from information that does not match their viewpoint, virtually trapped in their own ideological "bubble" (Pariser, 2016). Various ghost news sites (websites with an appearance that can mislead you to believe it is a real news site) have been launched, and information that is not possibly true have become rampant. In the increasingly diverse and complicated contemporary informationized society, various kinds of information including those from these ghost news sites are readily available, and they jump off to us regardless of our intentions. Under such circumstances, how do humans judge what is right and select appropriate information to internalize it as their own thought?

3-2-2. Searching for homeostasis of individuals and aggregates

What are living beings, including humans, interested in, and what are they living their daily lives for? What were living things originally made for? There is now a field of synthetic biology, and research has been done in various forms on ways of life, but there is no way of knowing the answer yet. Although there is the idea that it is due to the "selfishness" of nucleic acids, amino acids, and proteins, it can be said that they were born in pursuit of maintenance of homeostasis as an aggregate, or in today's term, sustainability.

Going back to the origin, what is the extremely basic desire of humans, the living things? While there are many criticisms on Maslow's hierarchy of needs, we must admit that he is correct in placing the fact that there is a basic need for life activities at the bottom. It is possible to first consider food intake for maintaining individuals, and escape from stimulation from the outside world. Division and reproduction to leave descendants should come next. The strategy which primates could use to maintain these activities was the formation of an aggregate, having also no particular strength. Isn't this nothing but the strategy that life used unexpectedly when life was born? Maybe the social structure was meant to maintain this aggregate well, and the development of the brain and nerves was meant to operate this structure well.

Individuals as constituent members of an aggregate of society may have been searching for how their aggregate should be by exchanging information with each other. This state appears similar to how cells exchange information with each other through chemical substances. It is probably because the more diverse antennas, the more diverse kinds of information can be captured at one time, and it will be possible to make that aggregate more sustainable. What human individuals created as a tool for information exchange through such activities must be language. By using language little by little, their abilities for abstraction of things and extraction of their elements were cultivated. It seems that, thanks to this, it became possible to understand the laws and rules of various matters, and logic and mathematical sciences were needed to organize, accumulate, and understand more sophisticated concepts. In addition, it seems that humans gained the ability to predict the future through such acts, and ensured maintenance of homeostasis at various levels.

However, this plastic and flexible structure that foster diversity ended up having more freedom than the aggregates at the time of life's birth, which were merely

governed by the law of energy. We can say that, because of this, complicated conflicts have become connoted in society and human aggregates, and they have become difficult to understand.

3-2-3. Deepening thought through language

How have we humans as primates evolved? Primate means "an animal chief," but is it really a good idea to position humans as that? Humans do not have sharp tusks, feathers to fly in the sky, or muscles and bones built strong enough to overwhelm the opponent. Some aspects of sociality and tool usage are also found in chimpanzees and bonobos. Information communication in society is also famously seen in bee dance, and imitation learning can be done even by an octopus, they say.

Then, what makes a human a human? One turning point may have been language. Monkeys have their epiglottis close to the soft palate, and the pharyngeal cavity is very short in comparison to the oral cavity, so the tongue is long and thin in the anterior and posterior directions. For example, macaques such as Japanese monkeys, have almost no oropharynx, so the structure only allows the shape of the tongue to change mainly in the anterior and posterior directions. Therefore, there are anatomical constraints such as difficulty in changing the shape of the vocal tract, and it is considered that monkeys are considerably inferior to humans in their ability to generate and manipulate vocalic speech sounds. In other words, it seems that the fluent manipulation of language like that of humans has been achieved thanks to the anatomical characteristics of humans, which makes it possible for various kinds of communication to be made, forming conceptions and fostering sociality (Nishimura, 2010).

As an event that probably caused humans to be the animal chief with this occurrence of language, development of the brain is of course conceivable. As the brain developed, memory of various things became possible, and the obvious past was born. The memory has been handed down as the memory of the organization, and information has come to be passed over for generations due to the invention of the written language. This has made it possible for humans to have food and enough information to counter diseases. It is possible that know-how of social activities and the affairs of the cities (politics) were further accumulated, which enabled them to manage their present behavior with the future in mind. Perhaps these abilities amounted to the ability to compensate for the fact that humans were very weak creatures.

3-2-4. Necessity of sociality - I and we -

As stated earlier, humans were very weak and did not possess noteworthy weapons or abilities in the natural world. Perhaps to compensate for this, they used the strategy of constructing an organization with multiple individuals. However, the social nature of humans differed from those of ants or bees, and they soon developed as extremely complex beings. As also seen in the mural paintings of Lascaux, humans have been exposed to various problems such as food, sex, and diseases from the ancient times. Perhaps because life was finite, and they were very weak creatures, survival as an individual (I) and as a species (we) became a strong motivation for the creatures, and sociality was utilized as a means to comprehensively solve these problems, coupled with the development of language. To obtain food stably, humans who had acquired language and memory planned to carry out hunting collectively, and carry out agriculture. To get a better partner, they developed the conceptual exchange in the form of negotiation. They also developed religion and medical care to counter disease and death. At any point, they developed perhaps because they had the "cradle" of society, and because they were able to create this society.

3-2-5. Creatures teach the importance of diversity

It is still a mystery why nature has become so diverse. However, this diversity is very important for surviving extremely complex and unpredictable spacetime, and creatures are considered to embody this importance. Even the same species has diversity, and each combination has produced something a bit more different. This gave them a means to mitigate the risk of the entire species being lost. This way of being gives us a very important point of view for our ways of being both for now and in the future.

Through science and technology, we the humanity have fallen into the illusion as if we acquired the "perspective of God." It became possible to think through various things from an overhead perspective or

in detail, and even about abstract space and concepts. However, this is only a part of God's point of view, and we can never see the whole body at once or the future. In other words, human beings can be considered as small parties in a vast jungle. How should this small community respond to unpredictable things in the future? We the humanity need to be aware of the effectiveness of the diversity given unconditionally by nature, once again review the "excessive simplification" by academic studies including science and technology, and implement fostering of diversity of knowledge and the momentum to nurture it, in society.

4. Pass it on to the future

- Societal implementation of endogenous motivation -

4-1. Imagine/create the future

4-1-1. Rationale for prediction

How can we human beings predict supernatural phenomena spreading to society, based on the logic of natural science as the rationale? If we must give some response to the state in which all is unknown and we are given a variable to be handled each time, perhaps we will need to take on various ideas and values, and imagine/create the future. I think that by thinking about how we should be and making plans to head over there by trial and error, we will be able to overcome and create.

What can we human beings do to take on diverse ideas and values?

4-1-2. Emotional connection and science

Since the Industrial Revolution, various new things have been invented and developed in the age of rapid economic development, and a lot of things have been consumed at an unthinkable speed. However, now we have taken over the negative heritage of mass consumption, and we are entering an era in which we must seriously discuss the ideal form of a "sustainable society" for the next generation, and promptly execute this. Perhaps it is necessary to modify the future of humans and the future of Earth by bringing out viewpoints and ways of thinking that used to be unthinkable, and by creating values that are different from ones we have had so far. As science and academic studies are also matters performed by humans, it is obviously necessary to bear this risk. Then, how can we draw out different viewpoints and ways of thinking, and create new values?

I have overviewed the possibilities and limitations of the brain, how people should be and how society has been made, and discussed how academic studies should be. The humanity has come as far as expanding its ability not only regarding what is present and what has been done so far but also by inventing and developing a new framework not found in nature. The future of the humanity will become more difficult to predict. In preparation for this, it will be required to share the viewpoints and values of various things, and proceed as a team (we). Therefore, it will be required to implement and reimplement the "emotional connection" which has been neglected from the viewpoint of academic progress, as a mechanism to encourage team building.

4-1-3. Emotion that shows "acceptability"

What is *jocho* (emotion)? According to the online dictionary Weblio, it is “how something is that evokes a person a certain strong feeling, peculiar to that thing." Also, it is "various strong feelings caused by touching or experiencing things," and as a psychological term, "the same as *jodo* (emotion)." *Jodo* refers to a sensory response occurring in a relatively short period of time, and a feeling is induced by this. It can be understood that it signifies a state in which this lasts for a relatively long time. It is considered to be a word that is close to mood.

When the mood is stable and shared, perhaps it will shorten the distance to deepen the understanding of individuals, to revitalize the discussion, to overcome negative events such as failure, to provide a cognitive venue that leads the team or the community to success.

4-2. What do to imagine/create the future

4-2-1. Emotional connections as the key to success

Google, a major IT company, launched an in-house survey called Project Aristotle in 2012, and the findings were released last February.[4] According to this, no common pattern could be found, such as that there were teams that had succeeded even if their methods had

[4] Report on in-house research by Google https://www.nytimes.com/2016/02/28/magazine/what-google-learned-from-its-quest-to-build-the-perfect-team.html?_r=0

been completely different. Adding to that, it said that a key to success would be to eliminate the anxiety that they might be scolded or mocked by the leader or teammates, and to use a psychological term, to nurture an atmosphere called psychological safety, within the team. Moreover, it is considered important that such an atmosphere be spontaneously fostered. In other words, spontaneous "emotional connections" are necessary for revitalizing the organization, and perhaps maintaining this is an important task. In fact, according to Mr. Mitsuru Hisata, Chair of the Japanese Society of Community Psychology, a community is a network of people and people, which is said to include (1) a long-term continuation to some extent, (2) common ideals shared among the members, (3) emotional bonds, and (4) contribution to its continuation and maintenance. “A large group relies on its large number, but a small group work united," Shogun Ieyasu Tokugawa said. It seems that he knew from practice about the way a community should be in the process of surviving the chaos of the warring era.

4-2-2. Surviving an unpredictable society

Claude Lévi-Strauss, a French social anthropologist, wrote in *The Savage Mind* (*Le Pensée Saugage*) that science and bricolage were more parallel rather than conflicting (Levi-Strauss, 1976). Bricolage is translated as a do-it-yourself carpentry, and compared with actions such as making full use of things and diverting them from its original purpose or use, it refers to the method of thinking to create new things by using small differences at various levels. Scientific thinking predicts things with its rigor and reproducibility, giving us an index of how and what to do to reach the goal.

As living things, we must eat food. We do not bear weapons such as fangs or horns, nor do we have a rugged body. For this reason, we chose the measure of confronting nature as a group while developing the system of society. Our brain has also developed to allow these activities to proceed well. Since knowledge was coherently systematized by the development of language, it has dramatically been enriched. Thanks to that, in modern times, at least in developed countries, food supply has become stable, and measures against climate change are now also supplied stably.

Along with the development of language and knowledge, we human beings have come to have a sense of versatility and even a worship-like sense for science. Long before our language was born, and long before we humans were born, nature's activities had been continuing. Our brain has developed to understand its activities, maintain homeostasis by constructing society, and supply and maintain food and environment in a stable manner. However, not only we have not fully understood everything but also have further developed a world largely different from nature. The brain that originally developed to understand reason of nature and predict it is now able to secure surplus ability as the society and the environment became stable, and to imagine/create new things. This is exactly the bricolage as told by Lévi-Strauss, which can be thought to gather materials currently available in various forms, further extending the knowledge system and by this means aiming to maintain homeostasis.

4-2-3. Communicative rationality

German philosopher Habermas said that rationality which tries to persuade another is "instrumental reason," which can make people a group for achieving a purpose. On the other hand, distinction was made for the rationality that respected the other and aimed to reach an agreement together by calling this communicative rationality. The three principles that are necessary for this are listed as follows: (1) the participants speak the same natural language, (2) the participants describe and defend only what they believe is true as facts, and (3) all the parties participate on equal terms. He regards them as transforming these judgments and views in these processes, and there is a possibility that they may change each other’s thoughts. He said that the significance of a dialogue lied in this regard. (Habermas, 1985)

If we are to have communication as a means of sharing our diverse values and ideas to imagine/create the future in a manner of bricolage, perhaps we should not impose things but rather each of us needs to address various issues with the intention of respecting the other party and aiming for consensus together.

4-3. “Finding it interesting"

There is a phrase called playful learning. This is the educational practice advocated by Professor Nobuyuki

Ueda, and borrowing the words of Professor Jun Nakahara who also has been promoting this practice, it refers to “learning in which different people and things meet each other while having fun, which triggers changes and noticing to be born.” (Ueda, 2012)

“Playful” does not by any means mean fooling around, but it means to play seriously. One notices on their own from playing seriously, and learns through change. It also has a commonality to the sense of being the person performing the activity, also mentioned as one of the components of the so-called "flow" proposed by American psychologist Mihaly Csikszentmihalyi. Flow refers to a mental state in which a human being concentrates extremely highly on what they are doing and succeeds in the sense of activating themselves (Csikszentmihalyi, 2008). In other words, it expresses how human motivation surfaces, and it shows the means to make maximum use of it by considering the human brain and mind movements and the brain power discussed above. To put it briefly, the driving force is “finding it interesting."

Are we not in a situation where our academic studies are forced upon us by somebody else? Are we conducting it actively with a sense of leadership? According to an *Economist* magazine issue in October 2013, the survey conducted by Amgen in the previous year found that only 6 of the 53 "landmark" studies done in the field of oncology could be reproduced.[5] In addition, in the field of psychology, about one-third of follow-up research could not confirm their reproducibility, but also some authors of the original theses felt that they were treated unfairly, being subject to the reproducibility experiments, it was reported.[6] It is unclear to what extent this number can be generalized about, but it may be certain that the reproducibility of many papers cannot be confirmed.

In the Stone Age, people created stone axes themselves for their own use, but today there are very few people who create and use a mouse that is about the same size by procuring raw materials. Humankind has acquired affluence by division of labor and can now have time to be free (Ridley, 2010). Although it has become possible to utilize a complex but useful tool and knowledge related to it, the part that involves us has become extremely limited, and we may be in a time when only those who can see the whole picture take steps forward. Precisely because this is an increasingly complex contemporary society, perhaps it is necessary to live it as a community playing an active part.

I do not necessarily agree with him, but I would like to quote the new U.S. President’s words at his inauguration ceremony.

"That all changes - starting right here, and right now, because this moment is your moment: it belongs to you,” by Donald Trump.[7]

Human thought belongs to individual humans, not governed by anyone else. Let each of us have “a sense of finding it interesting” toward the future with responsibility, think little by little, and form it with teamwork. That way, the future will surely be wonderful.

Keywords

Brain power, logic, unpredictable, social evolution, communicative rationality, personal affairs, sociocentricity, emotional connection, endogenous motivation, interesting

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Chapter 6　Issues for Universities as Institutes for Basic Research

Hidetoshi Kotera

1. State of research work of university

To think about the model of the 21st-century scientist and the mechanism of research work, it is necessary to discuss about education and research work as the role of the university. There have been discussed and analyzed about the university's organization and the positioning of education and research work based on the Imperial University Order of 1886, the University Order of 1918, Basic Act on Education of 1947, the implementation of the general principles and the prioritization of the graduate education in 1991, and the total revision to the Basic Act on Education in 2006. Numerous books and papers were written considering comparisons of domestic and overseas situations, but I would like to add a little consideration from views of education for science and technology.

The current university education is composed undergraduate, graduate master's, and graduate doctoral courses. With the enactment of the Basic Act on Education of 1947, the contents taught for three years in high school under the former system would be taught in the liberal arts program during the first two years at the university under the new system, and the specialized subjects learned in the three years at the university under the former system (four years for the departments of medicine) would be learned in the shortened period of two years. Also, due to the implementation of the general principles in 1991, the liberal arts subjects and specialized subjects are said to have been arranged as a so-called wedge-shaped curriculum. Because of this, subjects are allocated based on a curriculum in which liberal arts subjects are studied in the first and second years, and the number of credits required for graduation in the specialized subjects are taken in the second, third, and fourth years. Today, both liberal arts and specialized subjects are increasingly lectured in English, with internationalization in mind. Due to this change, I think that education of basic knowledge as liberal arts to have been acquired by a full-fledged member of the society may have diminished. Also, with the decrease in the number of specialized subjects, it is inevitable that the levels of expertise are declining due to the formation of larger departments.

In graduate school education, educational purposes by means of curriculum are clarified by categorizing subjects into the so-called core, major, and minor subjects, in addition to the research departments and majors guaranteeing the purposes and quality of training for producing highly skilled human resources.

In the education at these undergraduate departments and graduate schools, with regard to the positions and definitions of the curricula of lectures, graduation research, and special research in master's and doctoral programs, as well as master's and doctoral theses, and with regard to the so-called three policies of "awarding degrees (diploma policy), "organizing and implementing educational curricula (curriculum policy)," and "accepting the incoming students (admission policy)," do both the faculty members and students have a clear understanding? I think that faculty members who have experienced the university evaluation currently undertaken by National Institution for Academic Degrees and Quality Enhancement of Higher Education, and independent external evaluations, understand that many faculty members only submit data for evaluation, and have next to no opportunity to know and understand them at the present situation, perhaps. There are many universities that have opportunities of faculty development, and many other universities are making efforts to clarify the position of their curricula, and the positions and significance of special research at their educational system committees, reflecting them in their education. However, do they regularly allow assistant and associate professors, who are closest to the students, to join this system design, curriculum examination, or reform process? I think that, as a result, there are many young faculty members engaged in the actual education without many opportunities to know the contents of these three policies or how they are reflected in the curricula and daily instructions. Also, this is also true for professors.

By the way, according to the website of Kyoto University,[1] the diploma policy of its Faculty of Engineering stipulates that "To be awarded a Bachelor's degree by the Faculty of Engineering at Kyoto University, a student must have been enrolled for the period specified, earned the required number of course

[1] http://www.kyoto-u.ac.jp/ja/education-campus/policy/de_policy/gakubu_de/kougaku.html

credits, and cultivated a foundation capable of demonstrating knowledge and ability of a high-level researcher or engineer as described below through special research (graduation research).

- Abilities to understand scientific knowledge on humanity, society, and nature, and on public based on this, and to see things with an enriched human quality and a global perspective.
- Foundational knowledge in a specialized field and ability to think logically based on this
- Ability to comprehend knowledge and think rationally about solutions regarding various problems concerning science and technology, and
- Communication skills to understand opinions of others and to express their own opinions precisely."

We can regard the first item to be representing the position of the old liberal arts curriculum (present-day humanities and social science subjects), the first part of the second item representing the position of the specialized subjects, and the other parts representing the position of graduation research. In particular, from now on, it is necessary to acquire an ability of having an overall understanding from a global perspective to grasp and solve problems.

Teachers at universities have rarely received adequate training in terms of education, and in many cases, they are hired for their achievements as a researcher. With respect to the above three policies and curriculum structure which are indispensable for education even after their employment, the meaning and position of the liberal arts subjects and specialized subjects, knowledge on graduation research and special research as well as screening of dissertations and awarding of degrees, and knowledge and experiences regarding educational skills and educational psychology, perhaps the current situation is one in which they are provided as part of on-the-job training. I think that, as a result, many faculty members consider their research and achievements in it to be their top priority. However, as in the report by the Cabinet Office Commission on Human Capability Strategy in 2003, the university education should primarily consider it important to have the following 12 points[2] of human capabilities as the first point of view.

1. Basic academic skills (basic intellectual ability acquired through school education)
2. Specialization: Professional knowledge and know-hows
3. Durability: Ability to continuously enhance it on their own
4. Ability to think logically
5. Creativity
6. Communicative abilities: Communicative skills and listening skills
7. Public morals
8. Normative awareness
9. Ability to improve each other while respecting others and working hard together
10. Motivation
11. Perseverance
12. Ability to pursue one's way of life and success

Primarily the university education and the research at the university are divided into the two, and it seems that many university faculty members recognize them as two sides of the same coin. In addition, I believe that educational objectives are defined as the development of highly skilled human resources, as well as conducting cutting-edge R&D of advanced science and technology.

According to the result of the Basic Survey on School in fiscal 2008[3], the number of the university students was 2,567,000, and that of the graduate students was 249,000, among which the number of the master's students was 159,000, and the that of the doctoral students 73,000. The rate of advancement to graduate school after the undergraduate program continued falling every year with the peak at 15.9% in 2010, and it was 12.1% in March of 2016. Furthermore, the rate of advancement to the doctoral program decreased from 12.1% as of March 2007 to 9.8% in March 2016, and the employment rate upon completion of a doctoral course was 58.8% in March 2007, but saw a change to 67.4% in March 2016. The lowering of the rate of advancement to the graduate school and to the doctoral program are also felt at the educational sites.

[2] Report by Study Group on Human Capability Strategy
http://www5.cao.go.jp/keizai1/2004/ningenryoku/0410houkoku.pdf

[3] Result of Basic Survey on School, FY2016
http://www.mext.go.jp/component/b_menu/other/__icsFiles/afieldfile/2016/12/22/1375035_1.pdf

The mission of university education is to cultivate highly skilled human resources. While undergraduate departments of engineering and the graduate schools of engineering contribute to the development of researchers and engineers who will support manufacturing based on science and technology in Japan, the decline in the advancement rate to graduate school leads to a decrease in the number of graduates as highly skilled human resources. There are a lot of voices from faculty members pointing out fears on training of future human resources and successors who will be responsible for science and technology in Japan, and problems with the current situation. In the United States, it is clearly recognized that the development of science and technology in the basic fields and applied fields is an important element in the development of industries and economy, as well as in the formation of the country as the core of the global industries and economy. In Japan as well, the Science and Technology Basic Plan notes the need to strengthen the fundamental abilities and build a virtuous circulation system of human resources, knowledge, and funds. However, there is no doubt from the above figures that this development of highly skilled human resources that will support the future Japanese science and technology is at stake.

Now, although the rate of advancement to the doctoral program in graduate schools is decreasing, and at the same time their sufficiency rate is also in a declining trend, the current situation is that those from overseas who desire to go on to a doctoral program are increasing, which means that, in the future, internationalization will inevitably progress at educational and research sites in Japan.

Although the actual situation of the advancement rate as described above seems to be occurring not only in natural sciences but also at the sites of humanities and social sciences, isn't it the case with educators' recognition in that they only view the education and research at universities and the decline of the advancement rate solely from the standpoint of faculty members to make claims on their issues?

I have a doubt that when faculty members discuss the students' advancement rate, they may regard the students as human resources to lead their own research and as their successors. Many students have their primary objective of acquiring knowledge of liberal arts as broad knowledge at the university, adding high-level knowledge in specialized courses to that, and training their own human capability, so that they can proceed to be employed as a full-fledged member of society, it can be said. In this case, perhaps it would be better to view the students as not having a perspective of a university faculty member or researcher who conduct R&D in the future science and technology in Japan. I imagine that some students naively want to become a researcher or scientist in the future when they are children in elementary, junior high or high schools, or immediately after graduation from high school when entering a university However, when they go on to the next step from university to making a choice between advancing their studies and finding employment, the current situation is that many students choose employment to be a full-fledged member of society, and it is necessary to discuss what causes this.

There seems to be two major reasons for the drop in the rate of advancement to the doctoral program. One is that they feel uneasy about employment and incentives regarding post-employment are not clear, and the other is the problem of educational expenses. This was also analyzed in "*Jisedai o kirihiraku yushuna hakase jinzai no jizokutekina katsuyaku no tameni* (For the sustainable success of outstanding human resources with a doctorate who will frontier the next generation)" released by Research University 11 (RU11) on July 8, 2016, and this can be seen in the three recommendations, which are: (1) review of scholarships and scholarship systems for promoting advancement to doctoral programs, as well as collaboration between differing systems and retirement income systems, (2) organizational collaborative projects with the industry in the process of employment so that human resources with a doctoral degree can play an active role widely, and (3) increasing the degree of freedom in accounting for personnel expenses and operation by public external funds for improving employment environment in the academia).

Regarding employment, according to statistical data, those who have earned a doctoral degree find employment as a university instructor, or at a public

research institute or a company within a few years (those who have experienced postdoctoral fellowship) in reality, but it is an issue that the employment rate is as low as 64%. Those who find employment as a university instructor or at a public research institute need to have a doctoral degree, so they will not be discussed here. Then, is there any incentive to be employed at a company? Those who have earned a doctorate often take an R&D job. However, there is currently no incentive to have a doctorate, and they never get to assume an upper post or receive a high salary from the beginning as they do in the West. However, there is no doubt that globalization will progress in many companies in the future, and when that happens, I think that there will be incentives for holding a doctoral degree. Companies tend to think of doctorate holders as highly specialized and narrowly focused, but a doctoral degree means the ability to find new issues and solve on their own. Indeed, they have acquired knowledge and skills in their specialized fields to earn their degree. However, those knowledge and skills are only the smallest part of their subdivided research fields. Companies should value their ability to solve issues by acquiring knowledge and skills on their own rather than the content of the acquired knowledge and skills. Therefore, perhaps it should be recognized that it is wrong for companies to express that their areas of expertise are narrow, and consequently, they are difficult to use. Also, I think that it is important for economic and industrial groups to consider the structure of human resources that will support the future Japanese industrial and economic circles, and to advocate the necessity of highly skilled human resources, in promoting the development of highly skilled human resources who will be responsible for the future.

2. How young researcher training works

Is it enough to only enrich the scholarship systems and posts to develop highly skilled human resources who will be responsible for science and technology, as suggested by many? According to the PUBMED statistics, the number of coauthors of papers was 2.5 back in 1980, but increased to 5.5 in 2015. This is in many cases due to the necessity for researchers in multiple fields to collaborate to solve the issues in their research. At the same time, internationally coauthored papers are increasing. This can be regarded as an expectation for the contribution to the development of the economy and industry by aiming at creating innovative science and technology through international collaborative projects even in the competitive funding system such as that of EU Horizon 2020.

In this kind of environment, it is important to nurture young researchers in Japan so that they can play an active part in the international stage. The Ministry of Education, Culture, Sports, Science and Technology's Tobitate! (Leap for Tomorrow) Study Abroad Initiative is a program promoting from undergraduate freshmen to graduate students to study abroad in various ways. I think that it is important to promote study abroad for research for graduate students more strongly, as well as promote the life of research at overseas laboratories as a career path for young researchers who have earned a doctorate or who have earned a research position. It is necessary to devise a comprehensive system design so that especially a few years of study abroad will form a career path and a salary, retirement income, and pension system for young researchers and instructors, like the sabbatical year leave in the United States. Also in the 40s and 50s, a sabbatical year leave system is indispensable to develop a new field and promote international collaborative research. There are currently universities and graduate schools that have such a system. However, in reality it is not currently used effectively due to the issues of teaching workload. From this viewpoint of teaching workload, several universities have shifted to a four-semester system to make it possible to use their study abroad and sabbatical year leave systems, and their successful results are much anticipated.

3. Basic research and technology transfer as roles of university

Besides education, basic research and technology transfer can be listed as university's roles. Many competitive funds have been issued to promote industry-academia collaboration, due to expectations and demands for industry-academia collaboration and technology transfer.

Now, what is the issue here? I would like to think about that.

In the 1970s and 1980s, many companies had research institutes such as a central research institute or developmental research institute. However, with the collapse of the Bubble economy in the 1990s, names and missions of research institutes changed. At the same time, it is perhaps also apparent in the forms of the decline in the number of corporate researchers participating in academic societies, and introduction of competitive funds to industry-academia and technology transfer projects.

Research is divided into phases such as "basic research," “basic applied research," “developmental research,” and "product development." Among them, the central research institute was responsible for basic research to early developmental research, and the developmental research institute was responsible for part of basic applied research up to product development. At universities, engineering departments also conducted basic research by setting research themes from among basic research based on free thinking and exchanges with corporate researchers. In conducting that research, they fostered graduate students. As a result, highly skilled human resources with a master’s or doctor’s degree were employed as a researcher at a central research institute or a developmental research institute of a company. There were few people who remained a researcher from the time when they had first been employed until they retired, and in many cases, most of them assumed a management position in charge of R&D, it can be said. They were positioned more as an expert in the technical field characteristic of the company, and many of them were active as human resources who could compete with the world in the content and direction of the technology in that field. For university researchers, because of the high skills possessed at the destination of technology transfer and their research institutes which were responsible for basic applied research, it can be said that division of their roles were clearer than it is today, and the transfer was easier.

However, when there were no longer central research institutes responsible for basic research and basic applied research in companies with many shifting to developmental research, they began to request universities to take on the R&D phase which used to be the responsibility of central research institutes. As a result, it can be said that the demand for industry-academia collaborative research increased. Also, regarding the contents of research, in the technical fields of materials, processing, structure, and system, an ecosystem was implemented for research ranging from basic to applied research conducted in academia, and basic, applied and even developmental research conducted at companies. At companies, researchers and engineers in each field worked together to develop products. However, at present, there may not be enough talented human resources capable of integrating each technical field. After the collapse of the Bubble economy, the central research institutes disappeared, fewer highly skilled human resources were employed. I think that, as a result, the number of human resources, who have experiences ranging from basic research and applied research to developmental research and are able to supervise them, is decreasing.

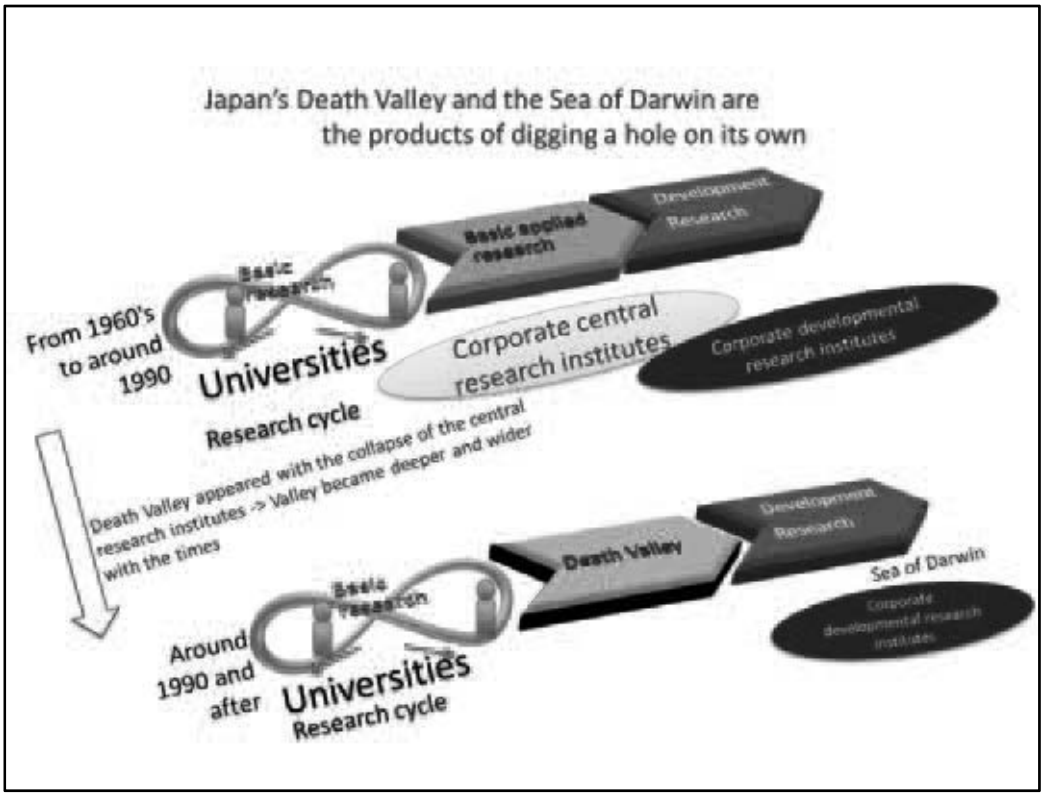
To fill this gap, the expectation and demand for industry-academia collaboration towards universities are increasing in order to compensate for the function of the central research institutes of so-called lost companies. However, for university researchers, they have no knowledge or experience from development to commercialization at corporations, and development and commercialization, if conducted, are rarely evaluated as their achievements. In addition, it is very difficult to devote their time to engage in industry-academia collaborative R&D in addition, when many efforts and time are required only for teaching and their own research. From these, we can say that most young instructors and researchers are now displeased to engage themselves in research in the development and commercialization phases.

That is, in the current Japan, it should be fair to say that, the fact that industry-academia collaboration has not progressed and there are expectations for technology transfer and innovations through industry-academia collaboration, owes part of its cause to the formation of the so-called “Death Valley” due to the widened distance between the universities’ research phase and companies’ developmental phase as a result

of losing central research institutes. This also causes a decrease in places where researchers, who have completed master's and doctoral programs and earned their degree, can play an active part, which in turn leads to a decrease in the rate of advancement to doctoral programs. That is, it seems to be in a negative spiral.

Now, where did Japanese companies seek for this function of a central research institute? Since the 1990s up to today, companies have invested a large amount of joint research funds in universities in the United States, but they say that the amount of joint research funds for Japanese universities is less than one tenth of those of U.S. universities. Perhaps this is due to “the development of science and technology in basic and applied fields will develop the industry and the economy as well as the global core of the industry and economy” being formed, promoted in the United States since the 1990s. In other words, by linking clarification of university missions of basic and applied research and development of highly skilled human resources, as well as promotion of introducing private grants to university's research funds and enriching responses to companies’ expectations, to incentive systems (research, environmental, salary, scholarship, and pension aspects) for university faculty members and doctoral students who will be responsible for them, the functions of "basic research" and “basic applied research” were realized, which are the roles of the central research institute which was lost in Japan, and amid this, development of venture companies have come to collaborate. Since university faculty members collaborate with multiple companies, it seems that international brain circulation and open innovation are more likely to be born as well. In other words, I think it is reasonable to think that an ecosystem of a positive spiral has been formed.

Then, has that brain circulation been formed in Japan? I think that everyone recognizes that the salary system in Japan cannot be compatible in the international community. I think that the system design of incentives for highly skilled human resources, such as evaluation, salary, and pension system, is what we must realize first to regain R&D by highly skilled human resources who will support the Japanese economy and industries.



In addition, the number of foreign students employed is very small, and the internationalization of academic posts is not progressing. It is currently difficult to invite excellent foreign instructors or researchers to Japan because there are problems of where their family members will work or go to school. We may not regard the Tokyo area the same way as other areas. For example, there are some French language schools in Tokyo but very few in rural areas. If a French-speaking family member wishes to live and have their children go to school, the only option is to live in Tokyo. As seen in this case, internationalization of cities and of companies are an important element of brain circulation.

The following four pillars are clearly stated in the 5th term Science and Technology Basic Plan.

i) Efforts to create new values for future industrial creation and social change
ii) Responding to economic and social issues
iii) Strengthening the foundational power of science and technology innovation
iv) Building a virtuous circulation system of human resources, knowledge, and funds for creating innovation

This iv) is in agreement with the aforementioned issues, but as I already stated, who should play the role of the lost central research institute of companies? It is extremely difficult to demand this from university faculty members or many young researchers. Recognizing the importance of fulfilling this role while organizing a group of researchers who will fulfill that function, and training researchers who will fulfill that function and building a system for their compensation are urgent tasks. I think that this is our responsibility necessary in order to hand over Japan's economy and industries to our grandchildren’s generation.

Chapter 7 Roles and Responsibilities of Science and Technology in the 21st-Cetury

- A New Contract with Society -

Tateo Arimoto

1. Historical Transformation of Modern Society and Japan's Position

1-1. Shaking of norms of modern society

It can be said that democracy, capitalism and science and technology are some of the basic norms of modern society. These have developed modern society while interacting with each other, but in recent years it seems that they are being shaken greatly (1). Some of the factors behind this are as follows.

- Globalization of economic structure and the rapid rise of developing countries.
- Sharp changes in society, economy, lifestyle, and employment due to the development of information and communication technologies.

"The Fourth Industrial Revolution." Increasing in socio-economic problems such as expansion of the gap between the rich and poor.

- Shaking of trust as the foundation of society.

Changes in the mechanisms of formation of public opinions and policy-making. Diffusion of biased information.

- The rapid penetration of new technology into society and its impact.

Concern about the social impact of new technologies such as artificial intelligence (AI) and genome editing. A sense of crisis toward employment and human survival.

1-2. Various discourses and Japan's position

Now, here are some of the discourses that discussed such situations from the perspective of world history. Mr. Drucker, a father of modern business management says, "The modernization process until the 20th century, which originated in the West and then came to Japan, and the process of modernization of China, India, etc., which is about to occur in the 21st century, will be greatly different" (2). Former President of Harvard University and former Secretary of Treasury Mr. Summers said at the Davos Conference, "The impact of the Internet will be equivalent to that of the Renaissance or Industrial Revolution." At a study group for introduction of the Internet to Japan a quarter of a century ago, chairman and Professor Hiroshi Inose once said in what sounded like a prediction that "the Internet has the potential to destroy the authenticity of modern society and modern science."

As Drucker pointed out, Japan succeeded in modernization after the Meiji Restoration, for the first time to do so outside the West. We can say that Japan has built a modern society by introducing democracy, capitalism, and science and technology, which are the foundation of modern society, while harmonizing them with traditional Japanese culture, social system, skills, etc. This experience and knowledge will give useful lessons to many challenges towards the modernization which will be faced by developing countries in the future. In addition, I think that Japan can play a role in contributing internationally to overcome the shaking of the norms in society and instability of the world.

1-3. Two big flows: domestic-first principle and international harmony principle (United Nations SDGs)

There seems to be two major flows in the world at the moment.

One is that domestic first principle, populism and protectionism are rapidly spreading, as seen in the decision in 2016 by the United Kingdom to withdraw from EU and election of President Trump in the United States. While one needs to watch the movement for a while as to whether this phenomenon is a long-term structural one, the basic norms of modern society that the West has led the way over several hundred years (democracy, capitalism, and science and technology) are beginning to be shaken greatly. Also, with the disastrous experiences of the two world wars in the 20th century in mind, it seems that the mechanism of international harmony and international order that the West has led and built are destroying themselves. The instability of the world, as seen in *deja vu* of the 1930s, return to an emphasis on hard power, superiority of authoritarian nations, etc. are now showing in reality. Even though it is being shaken, we cannot return to the state of tyranny, control, or non-scientific thinking that has been overcome by these norms in modern history. New ideas are now necessary. I think that UN-SDGs are what is expected as a powerful vision of the 21st century.

At the United Nations General Assembly in

September 2015, every country unanimously made a resolution for the Sustainable Development Goals (SDGs) by 2030 (3). SDGs are a magnificent attempt to solve 17 goals such as poverty eradication, health and infectious diseases, food, employment and humane labor, balance of production and consumption, climate change, energy, water, city, ocean and forest, disaster, global partnership and legal system through collaboration between developed and developing countries. While the principle of international harmony is being shaken, SDGs aim to secure the sustainability of human beings and the planet, going beyond the boundaries of nations, sectors, and fields, from which a great effect can also be expected from the standpoint of remedying the shaking of norms in modern society. Dr. Colglazier (former Science and Technology Adviser to the U.S. Secretary of State), U.N. Chair of the SDGs-STI Forum's 10-member advisory group, stressed that "SDGs will be a great gift to humankind in the 21st century."

2. Historical Transformation of Modern Science and Technology

2-1. Whitehead's insight

"The greatest invention of the 19th century was the invention of the method of invention." The philosopher, A. Whitehead continued; "Rather than focusing on individual inventions such as railway, telegraph, radio, spinning machine, and synthetic dyes, we must focus more on the method itself. It is this very method and way of thinking that are truly new and has destroyed the foundation of the old civilizations" (4). Indeed, much of the norms and methods of modern science and technology were established from the 19th century to the beginning of the 20th century. Some examples are: establishment of professionals called "scientists" and "engineers", modern university system and seminars, experimental research laboratory system, "Publish or Perish" as researcher's code of conduct, "Peer Review" system which ensures the quality of research, system for research evaluation, exchange, and results distribution through academic societies and journals, research support systems including grants, contracts, fellowships, intellectual properties, reward systems, etc.

However, 200 years after institutionalization began, today, modern science and technology is being pressed for major transformation in its norms and methods due to rapid globalization and the rise of developing countries, the revolution of information and communication technologies, and responses to the increasingly complex global problems. For example, the EU, under the concept of "Science 2.0," advocates the necessity of transformation in entire stage of activities in science and technology, from setting research themes to making use of research results.

There is also a wave of transformation in the industrial structure. As emphasized by the Davos Conference (2016), we can say that it is now an era of the "Fourth Industrial Revolution." With the fusion of "Cyber" and "Physical," a new industrial structure and new methods of production and creation of knowledge are emerging. Historically, the Industrial Revolutions are as follows: The First Industrial Revolution (1784; steam, water, machine production), the Second Industrial Revolution (1870; division of labor, electricity, mass production), the Third Industrial Revolution (1969; electronics, IT, automated production), and now the Fourth Industrial Revolution (cyber and physical system) (5).

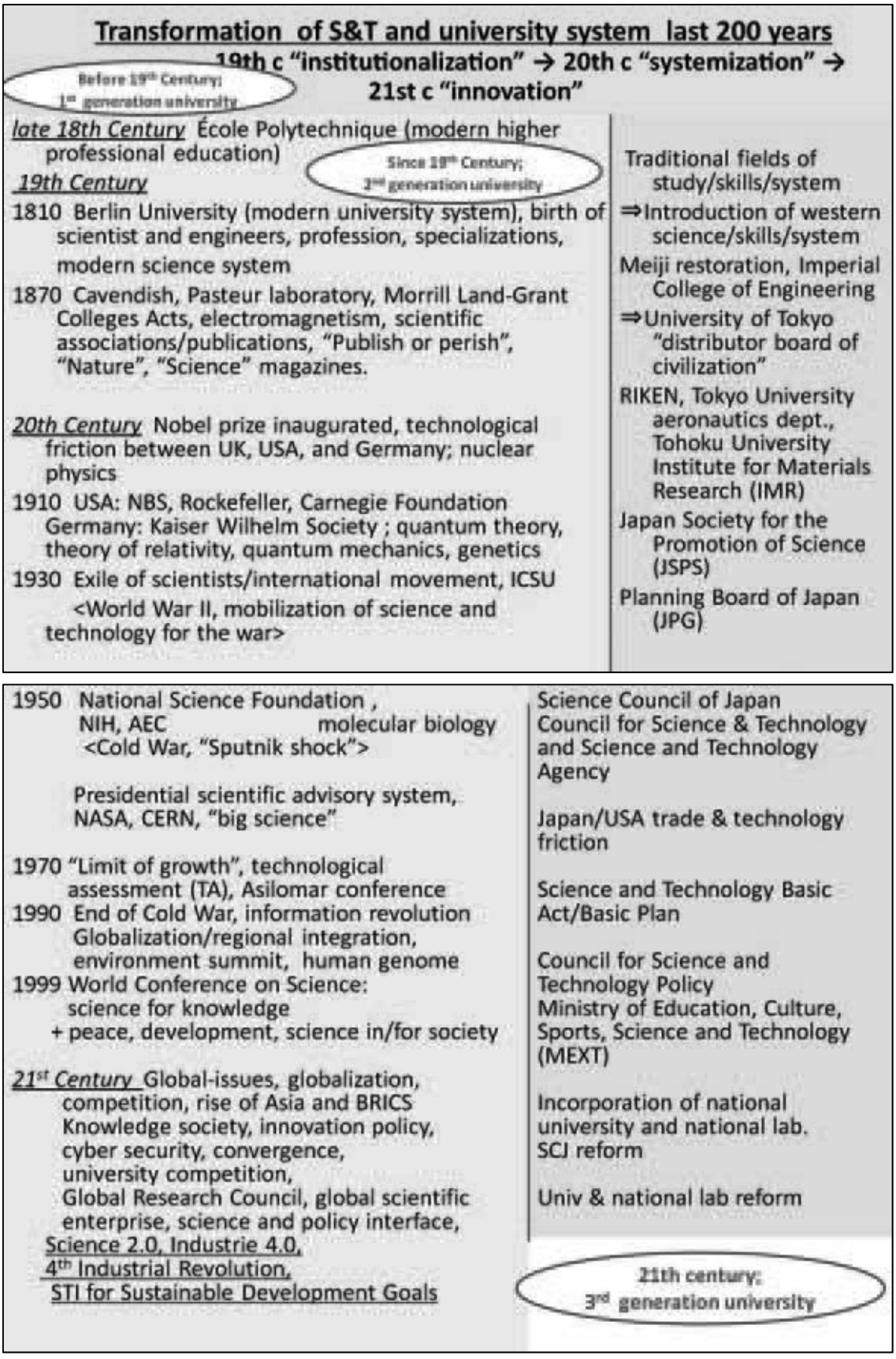


Figure A-1 Transition of the Institutions and Systems of Science and Technology

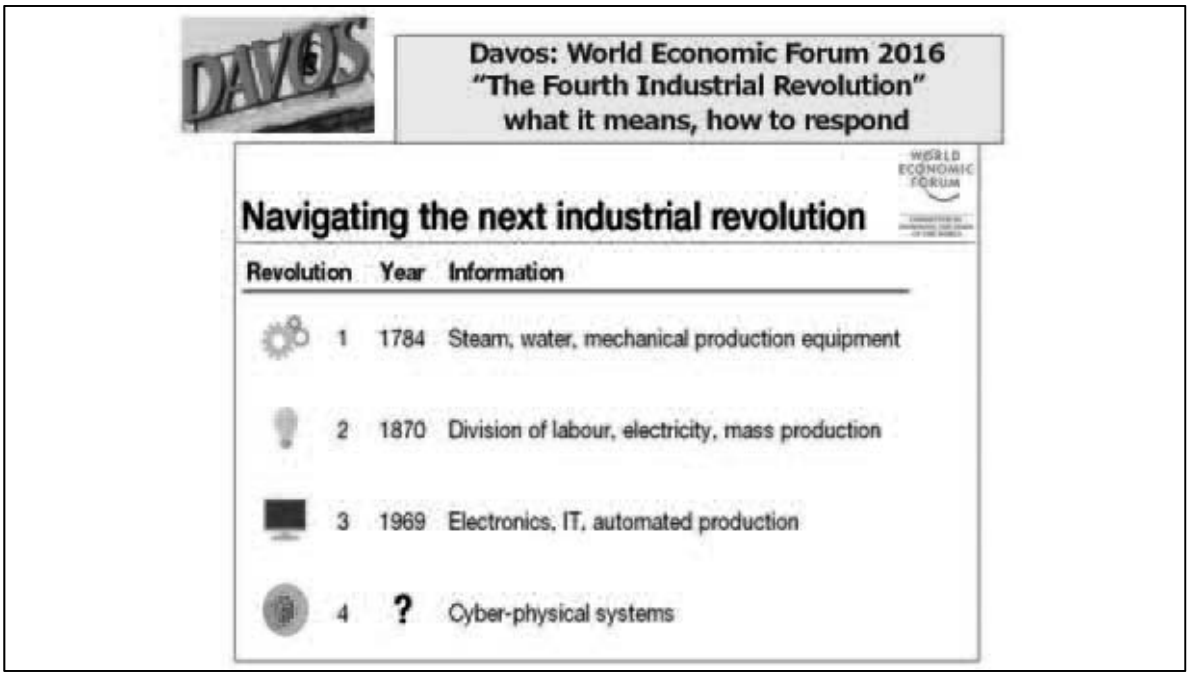


Figure A- 2 The future of the Fourth Industrial Revolution

2-2. Path to Budapest Declaration "Science in society and for society"

The previous Tokyo Olympic Games were held in 1964, half a century ago from now. It was around the time when Japan's rapid economic growth began. In that year, Japan joined the OECD, a group of developed countries, and the bullet train Tokaido Shinkansen line was opened. Meanwhile, the Vietnam War became muddy and a yellow light was given to the golden era of the United States. Many new technologies were mobilized in Vietnam, and the serious relationship between war and science and technology revealed again. Rachel Carson published *Silent Spring* (1962), and it received a wide-spread attention in many countries, including Japan, that suffered from environmental pollution.

In the 1970s, the Club of Rome announced *The Limits to Growth* (1972), and the American physicist Weinberg advocated the arrival of the "trans-science" era. In each country the environmental impact assessment system became popular, the Office of Technology Assessment (OTA) was set up in the US Congress, and the Asiloma Conference on genetic modification was held (1975). From the "golden age" of science and technology that had only focused on progress, it came the time to think deeply about the relationship between science and technology and society. Since the establishment of modern science and technology as a system of society in the 19th century, the simple value that advancement in scientific research and production of knowledge would lead to development of society was forced to make a big change. In 1979, the nuclear power plant accident on the Three Mile Island in the United States dropped a big shadow on the social acceptance of nuclear technology, which was a symbol of advanced science and technology after the Second World War.

In the 1980s, the risk regarding health and environment such as carcinogenic substances became a social problem, and the U.S. National Research Council (NRC) established the relationship between risk assessment and risk management (1983). A major nuclear accident again occurred at this time, the Chernobyl nuclear accident in USSR (1986). The world recognized the difficulty of control of huge technologies. It was in 1988 that the Intergovernmental Panel on Climate Change (IPCC) was established.

In the 1990s, the United Nations Global Environment Summit was held (1992) and the Framework Convention on Climate Change was adopted. The

external evaluation committee (Schmidt Committee) of the ICSU (International Council for Science) proposed the importance of scientific advice (bridge between science and politics) for the first time as a world academic society (1996).

Then, in 1999, ICSU, UNESCO and the Hungarian Academy jointly hosted the World Science Conference, hosting 2,000 people coming together from all over the world, including scientists, engineers, politicians, administrators, and journalists. In the background, there was deep reflection on the value of science and technology in the 20th century, which was "science for knowledge, knowledge for progress." Science and technology realized the economic prosperity of industrialized nations, but it created wars, environmental destruction, and the gap of poverty. It was a serious problem-raising as to whether science and technology in the 21st century could go on with small adjustments as it did. After a week's discussion, the Budapest Declaration was issued as the commitment of science in the 21st century. In addition to "science for knowledge," a new value was declared, which was "science for peace, science for sustainable development, and science in society and for society (6).”

This is a historical event for the world's scientific community, which has observed value neutrality and distanced itself from making value judgment publicly. But now, for the first time, it declared that it should clearly express responsibility on the relationship between the scientific community and society, and act on it.

2-3. Beyond the Budapest Declaration “From idea to reality" - Bridging science, society, and politics -

Twenty years is about to pass since the Budapest Declaration, which is now the basis of policies in science and technology of respective countries. During this past two decades, the terrorist attacks in the United States (2001), Lehman Shock (2008) that caused the global economic crisis, Palmisano Report (2004) that coined the new concept of innovation, start of Twitter (2006), the start of the G20 Summit (2008), the BSE problem in Europe, Italy’s Laqua earthquake (2009), and the Great East Japan Earthquake and the Fukushima nuclear power plant accident (2011) occurred.

The relationship between science and technology, society, and politics has become deeply connected with the survival of humans and the earth, not only domestically but also beyond national boundaries, becoming complex, uncertain, and fast. Distrust of science and technology has increased, while evidence-based policy formation has come to be demanded in all policy areas. In the 2010s, the concept of scientific advice began to draw attention globally at once (7).

In 2013 the United Nations Secretary-General's Science Advisory Committee was established. In the same year, the OECD launched an international collaborative project on the relationship between science and politics of each country and its mechanism and published a comprehensive report on scientific advice in 2015 (8). Furthermore, in 2014, "International Network on Scientific Advice to the Government (INGSA)" was organized and the first meeting was held in Auckland with the support of ICSU (International Scientific Council). In 2016, 600 people from 70 countries participated in the second meeting, held in Brussels (9), and the third meeting is planned to be held in Japan in 2018.

Also in Japan, the interest of scientific advice has been growing after the Great East Japan Earthquake and Fukushima Nuclear Power Plant accident happened, and in 2013 the Science Council of Japan published “Scientists' Code of Conduct, Revised Edition." In 2015, Japan's first Science and Technology adviser to the Foreign Minister was appointed and played a major role in realizing the science and technology international program of Japan-hosted G-7 Summit, Japan-Africa Cooperation (TICAD). Strengthening scientific advice was emphasized in the 5th Basic Plan for Science and Technology, which was decided by the Cabinet in 2016. Japan’s new ST policy stressed building “super smart society”, called “society 5.0” though integration of cyber-physical systems. They can make human centric socio-economic structure.

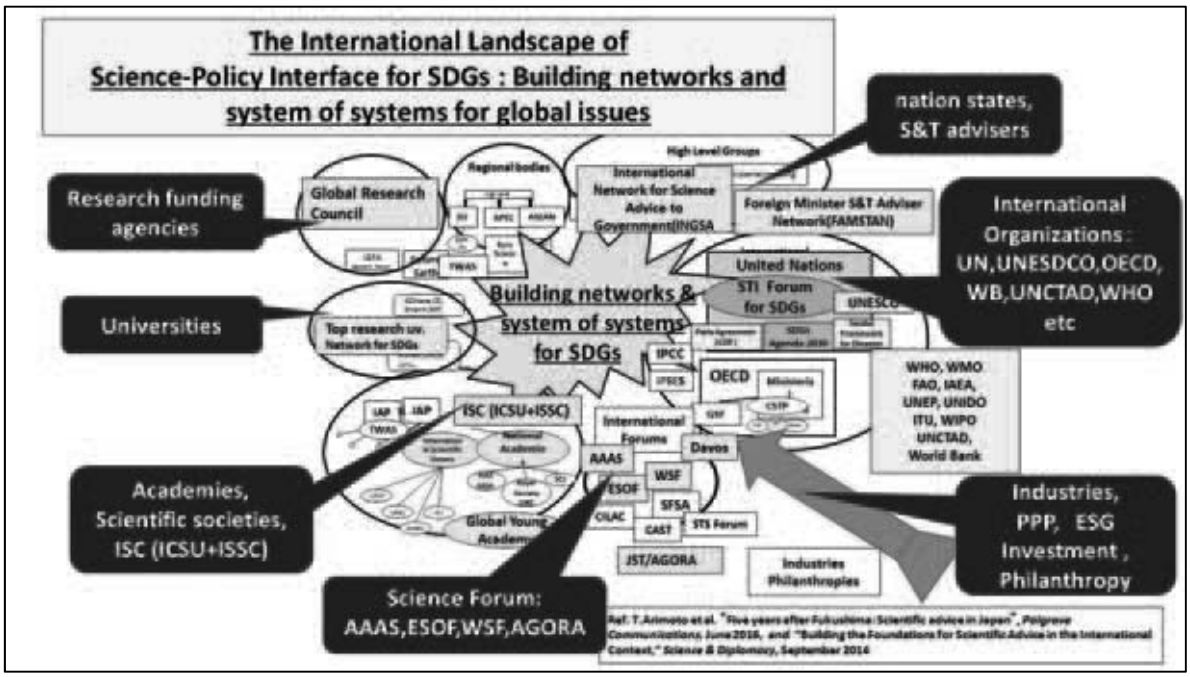


Figure A-3 International Landscape of Science-Policy Interface for Global Issues

In October 2018, ICSU (International Scientific Council) and ISSC (International Social Science Association) plan to merge (10). The goal is to build a system that allows the global science community to address social problems as a whole beyond the boundary of humanities and social and natural science. Looking back to the history of ICSU, United Kingdom and the United States led to form the international scientific community that later became ICSU after the First World War in 1919. As it changed being influenced by international politics, after the Second World War it distanced itself from politics and has served as a coordinator of international cooperation in scientific research. In recent years, through new programs such as "Future Earth", it actively cooperates with the United Nations and other countries to solve global social issues. Currently the Secretary-General of the ICSU is signed as a Co-Chair of the UN SDGs-STI Forum, which is a forum for discussing how the world of science and technology will contribute to SDGs in consultation with global policy sectors.

3. Direction of Science and Technology in the 21st Century

3-1. Concerns and points made by scientists in the crisis

In February 2017, the annual meeting of the American Association for the Advancement of Science (AAAS) was held in Boston. The main theme was "Serving Society through Science Policy." As part of this, a special session was held with the theme of "Defending Science and Scientific Integrity in an age of Trump." This session was held in the over-packed venue with heated discussion amid the demonstration march on the streets of Boston, which opposed Trump administration's policy of disregarding science (11).

When the prominent American scientists and powerful counselors of science and technology policy, Branscomb, Lepchenko, Holdren (Assistant to the President for Science and Technology in the Obama administration), made remarks, they were not those of criticism of the government, at the moment, but a more serious concern for and suggestion to the scientists and science in the crisis. Some of the remarks were: "Many citizens think that scientists as a group of people that uses public funds doing whatever they want"; "citizens do not understand what science is, who a scientist is, or why science is important"; "scientists need to understand more about the structure and reward system that support their activities"; "the scientists themselves should introspect as to why science is important to society and promote dialogue with society." It was a

rigorous and insightful indication that sought self-awareness and resolution from scientists and the scientific community in the changing world.

When we consider the uncertain and complex 21st-century global society, where the norms of modern society are being shaken, this 75-minute discussion gives very important suggestions on science and technology, scientists and engineers, values of the community of science and technology, behavioral norms, and ethos. As it is clear, the world of science and technology in the West has a mechanism and a spirit of sensitively responding to the time and calmly accumulating essential arguments about the relationships between society, politics, religion, etc. Promising young people grow up from that process. I expect the Japanese community of science and technology to establish such a mechanism and spirit.

3-2. International discussion at the policy and strategy levels

In 2004, the America's Council on Competitiveness (COC) emphasized that science and technology in the 21st century aims to create human and socioeconomic values and for that purpose it would be important to form an ecosystem of innovation. The so-called "Palmisano Report" (Co-chair by IBM's Chairman Palmisano and President Crow of Georgia Institute of Technology) (12). This proposal elicited 'innovation fever' all over the world. Since then, the policy of science and technology of each country has spread its wing widely from the policy of research and development to that of science and technology innovation, and it is necessary to change the funding systems, universities' mission governance, evaluation system, etc.

Also, in recent years, at influential international organizations, discussions and trials have been made on how science and technology in the 21st century should be, some of which are shown below.

The main theme of the 2016 Davos Conference, where global political and economic leaders gathered, was the "Fourth Industrial Revolution" (5). The fundamental change in the socioeconomic structure that is currently undergoing at a furious speed, scale and driving force was named the "Fourth Industrial Revolution," and new ideas and efforts were discussed while facing issues of employment and poverty. Regarding the impact of new technologies such as rapidly developing AI and genome editing, deep concerns about the collapse of employment and labor structure and crisis of human survival were expressed. Consideration to the poor was also directly sought from the Pope.

The OECD released the "Innovation Imperative" of the new era two years ago (13), emphasizing digitization of science and technology, rapid expansion of science and technology in developing countries, building of Global Science Commons in the age of globalization, and new mechanisms that urged multi-stake holder engagement at the initial stage of strategic preparation and program design. The EU is advancing the comprehensive strategy of science and technology, "Horizon 2020," and it emphasizes Open Science which makes use of digital technology. Among them, the change in the method of science and technology is irreversible, and it is necessary to change the values of the traditional scientist's "Publish or Perish," and they are developing a new educational research system. Also, emphasizing cooperation between humanities and sciences that quality innovation will not be born unless humanities and social sciences are embedded in the science and technology system centered on natural science (Vilnius Declaration) (14). This direction of the EU is an attempt to fundamentally change the methods of modern science and technology.

3-3. Diplomacy of science and technology/SDGs/Japan's contribution

Discussions are continuously being held on various international scenes, such as the International Network for Government Science Advice (INGSA), the World network of Science and Technology Advisers to Foreign Ministers, World Science Forum (WSF, Fall 2017, in Jordan with the main theme "Science for Peace"), on the relationship between science/technology and international politics, such as SDGs, cross-border disaster countermeasures, social impacts of new technologies such as AI, and big data and policy formation (15). A new concept of "diplomacy of

science and technology" has also been established (16), and the world networks of young researchers such as Global Young Academy are expanding.

In order to achieve SDGs, many developing countries emphasized at the 1st UN SDGs-STI Forum that transferring high-tech and knowledge from developed countries directly to developing countries with different contexts will have limited effect. Customization of ideas and direction with context is needed. In addition to traditional public policy tools, new financial mechanisms and investment, industry-academia collaboration (PPP), and development of diverse human resources are emphasized, and in addition to the conventional science and technology community, humanities and social sciences, young researchers, the World Bank, multinational corporations, large-scale charitable foundations, pension funds, etc. are actively participating in such activities.

In order to respond to such movements that go beyond scientific disciplines, organizations, and national borders, a bottom-up approach alone is insufficient, and a strong leadership at policy and strategy level is indispensable as well as linkage with the domestic policy. It has become necessary to have a grand worldview and historical view that Japan's new STI policy "Society 5.0" can lead to SDGs if they go beyond national borders, and some Japanese companies and universities are already beginning to move with this orientation to SDGs (17).

In this current big transformation of the world system, it is required of Japan's science and technology communities of government, industry, academia, and administration to collaborate to set the new values of science and technology in the 21st-century global society and transform the system and spirits, by sharing the recognition of the era and a sense of crisis from the strategic and policy levels to on-site levels of education and research.

If Japanese universities in the 21st century only educate and study traditional fields with a traditional way, they will be left out of the transformation of universities around the world. It is essential for young people to learn knowledge, practical skills and ways of thinking that can respond to rapid structural change and diverse values of social economy. Among them, SDGs can be regarded as giving a great vision for reforming university education, research, and social collaboration strategy. In order to realize this, it will be necessary to be prepared and able to switch from academic-papers-centricism and subdivision of fields, and actively participate in problem-solving, systematic thinking, collaboration between natural science and humanities and social sciences, and networks of politics, businesses, academia, and administration which are expanding globally and dynamically. I expect that it will be also possible to develop a frontier of a new academic field from that effort.

4. Several Proposals for Japan's Science and Technology in 21st Century

SDGs can be said to be one of the visions of the 21st-century global society that are agreed upon by all human beings. SDGs give the great opportunity to transform the modern STI eco-system to the science and technology community. To achieve that, what can Japan communicate to the world and what kind of contribution can it make? As Mr. Drucker, introduced in Section 1, suggests, it can be said that Japan is the last runner of Western-style modernization and also the first runner of the new type of modernization that is emerging in Asia and Africa in the 21st century. It can also be said that it is an equivocal country that experienced and fused the friction between globalism and local diversity that are now occurring on a global scale for the first time as a non-western country. In recent years, Japan has also been seen from overseas as a unique country that has maintained social stability and resilience by overcoming the global economic crisis, the Great East Japan Earthquake and Fukushima Nuclear accident.

In the course of modernization, how did a country without resources, Japan, get over the such issues as pollution to become an economic superpower? How has she fused with the universal Western-style value while maintaining the culture unique to Japan? How is she trying to overcome the fact that it is the first country in the world to see the aging society?

If we can talk about the development of Japan's unique hardships and experiences, culture, and science and technology to the world in a universal language and

communicate the story to the world (18), it can give great suggestions and hope to other countries. As the short-circuiting protectionism and domestic-first principles are spreading to the world today, Japan could play a role in organizing a global collaborative system as shown in Figure 3, aiming to solve international issues such as SDGs and cooperate with industry, academia, administration, and citizens around the world (19). I think that they also contribute to modifying and stabilizing the shaking of modern society such as that of democracy, enhance soft power of empathy and trust in people, and give young people hope for the future.

Finally, I will make several proposals for Japanese scientists and engineers, and their communities in the 21st-century.

(1) "Sharing Historical Recognition." The values and methods of modern science and technology are now at a major turning point. Think deeply about the development of academics and the interaction between science and technology and society and politics, about the past, present and future beyond the boundaries of humanities and science and be aware of our own roles and responsibilities and foster dialogue and trust between society and politics.

(2) “Comprehensive Recognition of Our Own Positions and Roles.”

Cooperate with others while recognizing our own positions and roles, from the setting stage of policies, programs, and research themes, to the formation and practice of research system, funding system and evaluation method, and implementation of results to the society. Process, ability to design, ability to create options and stories will be important.

(3) "From experts to intellectuals." Understand the flow of the world and the times, actively lead international conferences and joint projects for public interest, beyond areas of specialization, and participate in scientific advice activities. Aim beyond "experts” and become “intellectuals." Leaders of university management and policy formation, scientific advisers to governments leaders of international conferences, etc. will be produced from among these.

(4) "Flexibility and sensitivity to new knowledge that go beyond the boundaries and organizations." Strive to cultivate new academic frontiers and to create social values multi-disciplinary, and for that purpose plan and operate a place for diverse participants to have discussions. Give an opportunity to tackle on new fields and activities independently to outstanding students and young researchers struggling as "data producers" and "research workers" within a given narrow sides. Establish a place of free exchange and discussion to support this and attempt to establish a new funding system. Expand the structure and increase the capital to support development of research methods, cross-field exchanges, technology assessment, impact analysis, etc., instead of just spending big money on hard science. Allocate about 5% of the funds to these activities; way of thinking and formulation of the problem.

(5) "Strengthening think-tank functions at agencies of implementation such as those at the policy level and universities." Universities, national research Institute and funding organizations should not leave the design and reform of the institutional structure to politics and administration but formulate a vision by themselves and propose and practice new science and technology value, system, and programs. Politics and administration will improve their knowledge and ability to the extent that they can cooperate with implementation community with trust.

(6) "Ethos of scientists and engineers in the 21st Century"

About the philosophical types, Merton and Ziman have proposed the ethos of scientists of the 20th century[1] (20). Based on these, it is necessary to discuss and develop the type of new ethos tailored to the 21st century. During the course of doing so, new concepts such as diversity, inclusiveness, generational responsibility, and the fact that scientists and engineers are people in the global

[1] Merton: “Nature of public property" "universality" "selflessness" "organizational skepticism"
Ziman: "Ownership" “locality" "authoritarianism" "contractability" “specialism"

society will be the starting point (18). These share a commonality with the reconsideration of “Budapest Declaration” and will be the foundation for deeply thinking about knowledge and wisdom development, the support system and methods of science and technology for that purpose, and the relationship between science and technology and politics/administration to address the global-issues such as SDGs.

Keywords

① Historical transformation of modern society and Japan’s position
② Shaking of norms of modern society
③ Issues and values of the 21st-century as a global society
④ Transformation of values and methods of modern science and technology, and maintenance of scientific integrity and quality
⑤ Social contract of science and technology in the 21st century
⑥ Relationship between science and technology and politics
⑦ Emerging technologies (artificial intelligence, genome editing, etc.) and impact
⑧ Training and securing diverse human resources
⑨ Securing public space for diverse discussion, particularly for young generations

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Chapter 8　The 21st-Century Global Society

- From the Perspectives of the Past, Present, and the Future -

[Overview of Lectures]

1. Science and technology in the 21st century from the perspective of sustainability science

Monte Cassim

2. Science and technology, human beings and society in the post-growth era

Yoshinori Hiroi

1. Science and technology in the 21st century from the perspective of sustainability science

Study Group session held on: August 1, 2016
Speaker: Dr. Monte Cassim[1]

Overview of lecture

1. The way of thinking in sustainability science

1) To find a solution to a big global-scale issue, it is necessary to have a system that is not based on the traditional discipline-focused approach. For scientists to be involved confidently, they first need a field of expertise as a foundation.
2) I feel that there is a problem in a situation where scientists or their discussions are nonexistent at international conferences even though global-scale issues are discussed.
3) While there is no barrier to the natural phenomena, it seems that myth that you cannot get close to science unless you are a scientist has penetrated society. What can we do to not keep citizens away from science, but to allow them to participate in it actively and routinely?
4) Recognition of the spatial inclination that the wealth of the world is created in metropolitan areas, and that the cutting-edge science and technology is most rationalized in metropolitan areas.
5) While the human race has developed since the end of the Ice Age at the beginning of Holocene, the humanity has entered Anthropocene in the 21st century (Crutzen P.J. (2002) Geology of mankind. *Nature,* 415. pp. 23), and I see that the era has changed into one in which human beings change the global environment.
6) Rockstorm's concept of planetary boundaries is the idea that catastrophic changes for humanity can be avoided by grasping the limits of the extent to which human beings can survive.
7) The nine planetary boundaries: Climate change, ocean acidification, ozone depletion, cycles of nitrogen and phosphorus, air pollution due to increased dust, use of freshwater, change in land use, loss of biodiversity, and pollution by chemicals
8) The order of the value sizes of economy, human society, and global-scale nature should be "economy < human society < global-scale nature, but it is currently reversed.
9) The phenomenon called life creates large individuals by re-fusing molecules that disperse and diffuse with time. It is a wonderful phenomenon that creates individuals with very low entropy to make them self-viable. How should the global environment be to support this phenomenon of life? It is our issue.
10) Three conditions of sustainable development of humanity toward the future: Guard of the life forms on Earth, growth within the planetary boundaries, an impartial and just society
11) Responsibilities of the scientists for future creation: Transition to an economic system based on public interest, pursuit of order in the global society beyond the nation-states, promotion of exchange between science and society

2. Three concrete efforts

2-1. Climate change: Application in agriculture

1) The amount of rainfall in Sri Lanka is decreasing. While light rain decreased, the number of cases where a lot of rain fell at once increased. Tea fields were usually in a dry state and no longer suitable for growing tea, and the quality of taste was also dropping.
2) If this continued, they would lose the 200-year-old wisdom of the tea industry. It could take away 400,000 jobs in Sri Lanka with a population of just 20 million, which could lead to deterioration of public security and decline of its national power. For this reason, I was contracted by the administration to start a project in 2009 to reconsider the importance of the primary industry and allow continuation of the tea industry. As the rainfall was also declining in Uji, this area was also targeted for research.
3) I first recorded their wisdom and made

[1] Director, Kyoto Museum of World Peace, Ritsumeikan University, and Professor, Ritsumeikan Research Center for Sustainability Science. (At the time of the lecture)
He previously served as a Senior Research Fellow at United Nations Centre for Regional Development, President of Ritsumeikan Asia Pacific University, Professor at Ritsumeikan Asia Pacific University, and Vice-Chancellor of Ritsumeikan Trust. His areas of expertise are industrial policy, environmental science, national land planning, urban engineering, and architecture.

measurements. Measurements were made on indices for obtaining optimum growth environments for a given endemic species, such as sunlight index, dryness index, night cold index, excessive rainfall and humidity indices, and the average temperature during growing seasons. I also made sure that measurement instruments were available at a low price to popularize them. I also created a mechanism that allows integrated handling of big data through cloud services.

4) I provided information on scientific bases about climatic conditions, optimal species, seasons for planting, and conditions to improve taste. I applied this not only to tea but also to fruits.

2-2. Humanity's happiness: Contribution by science and technology to serious illness

1) I saw the situation of Dr. Hawking around 1996, and I took the opportunity to set a goal as to whether the wheelchairs could be made more comfortable and inexpensive.
2) I developed a nursing robot and a remote correspondence system for people with a disability and elderly people.

2-3. Biodiversity: Promotion of understanding across the boundary of science and society

1) Development of Terra-Green Network.
2) I asked people to take pictures of leaves with a smartphone and created a system that could automatically identify an approximate object from its shape and size, allowing people to participate in a biodiversity survey as citizen scientists.

3. Summary

1) I will think about what I can do as a scientist to bring sustainability to humankind and Earth as well as practice it, in the present age of Anthropocene.
2) The grand challenge underlying the three concrete efforts introduced is to enable technology to be implemented in society, to prevent academic studies from being compartmentalized, and to have an increased number of stakeholders with a global-scale spatial axis and a time axis of 10,000 years of humanity, thereby contributing to solution of global-scale problems.
3) Based on the network cultivated thus far, I will expand these efforts to India, Malaysia, and Vietnam, and continue the efforts to solve global-scale issues together with society, industrial communities, and local communities.
4) Regarding the Sustainable Development Goals, I believe that if we develop a core project, we can achieve multiple goals at the same time. In developing countries, they try to implement them on a 1-goal, 1-project basis, but that is not reasonable. Moves to set a big grand challenge and multiple goals and to try to accomplish them at the same time will become a driving force behind the people, and bring about change. That is what I feel from my previous studies.

(The Administration Office takes full responsibility for the wording and content of this article.)

2. Science and technology, human beings and society in the post-growth era

Study Group session held on: September 5, 2016
Speaker: Mr. Yoshinori Hiroi[1]

Overview of lecture

1. How to make sense of the present era
- Three historical contexts -

1-1. Context in Japanese society

1) In *The Economist* just before the earthquakes in 2011, the world had its attention drawn as to whether the declining birthrate and aging population in Japan was a crisis or an opportunity.
The article said that Japan's experience would serve as a helpful reference to the world.
2) The population of Japan stabilized in the Edo period at 30 million, and then increased to the peak of 120 million in 2005. A rapid decline followed, and it is projected to be below 100 million in 2050 and 50 million in 2100.
3) I think that there are definitely more than the negative aspects to the population decline.
4) The three indicators of happiness: World map of happiness (2006), World Values Survey (2008), and World Happiness Report 2016 (UN). Japan was ranked 90th, 43rd, and 53rd respectively. Different cultures have different senses in viewing their level of satisfaction. Still, why does Japan not have a high level of happiness, where the economic level is not low?
5) Discussion became active on the levels of happiness which would take over GDP as an indicator after 2010, inside and outside the country. The Cabinet Office's Commission on Measuring Well-being released "Proposed Well-being Indicators" (December 2011). Three pillars of its contents are (1) economic and social conditions, (2) physical and mental health, and (3) relationships.
6) Economic affluence and life satisfaction are not proportional after they go beyond a certain level. What is satisfaction: Community, disparity, relationship with the natural environment, and spiritual bases can be considered as factors.

1-2. Context in human history

1) Three waves of world population expansion: 200,000 years ago -> stationary due to hunting, 10,000 years ago -> stationary due to agriculture, 400 years ago -> stationary due to modern industrialization.
2) Cultural maturation has occurred especially in the stationary phases. For example, the generation of universal thoughts around the 5th century B.C.: Buddhism, Confucianism, the philosophy of Laozi and Zhuangzi, Greek philosophy, Middle Eastern Old Testament philosophy (Axial Age: proposed by Jaspers in 1949)
3) From a quantitative expansion of material production to a stationary phase in which cultural and mental development occurred.
4) Will there be a fourth expansion/growth?

1-3. Context of capitalism/post-capitalism

1) Capitalism aiming at unlimited expansion and growth. The background is perhaps the exploitation of natural resources and use of them as energy, affirmation of pursuit of private interests, and circulation to other people's expansion of interests. Perhaps the current situation is at its limit/turning point.
2) Bernard Mandeville (the Netherlands): Until now it has been considered good to have less desire, but it might be a better thing if pursuit of private interests leads to an expansion of the wealth of the whole. (from *The Fable of the Bees*, 1723)
3) The present situation is perhaps going in the opposite direction to the Mandeville's thought. Shifting concerns to a model transcending the individuals, relationship of human beings, altruism, cooperative behaviors.
4) The 2045 problem: Will highly developed artificial intelligence exceed human intelligence? The movies

[1] Professor, Kokoro Research Center, Kyoto University. He previously worked for the Ministry of Health and Welfare, and served as Professor at Faculty of Law and Economics at Chiba University, and as Visiting Researcher at Massachusetts Institute of Technology (MIT). His areas of expertise are public policy and the philosophy of science. His published books include *Post shihon shugi: kagaku, ningen, shakai no mirai* (*Post-capitalism: The Future of Science, Human Beings, and Society*) and *Jinko gensho shakai toiu kibo: community keizai no seisei to chikyu rinri* (*Hope That is the Population-Declining Society: Generation of a Community Economy and Global Ethics*).

"Transcendence" "Lucy" and "HER" are a transcendental trilogy.

5) Three possibilities: Energy revolution, escape from Earth, advancement into space posthuman (alteration of the existence of human beings). These will not be fundamental solutions. -> Affluence of the stationary phase, the concept of a sustainable welfare society
6) Ultra-capitalism vs post-capitalism (economy connected to the community and nature)
7) United States: Budget allocated to healthcare and military. The ratio of investment in medical research to the GDP is high, but the average life expectancy is not.
8) Factors of the high average expectancy in Nagano Prefecture: Purpose of life, vegetables, preventive healthcare.

2. What kind of society to aim for? - Possibility of "sustainable welfare society/stationary society" -

1) International comparison of the Gini coefficient which shows disparity, the larger the coefficient, the larger the disparity. Japan is 5th. It belongs to the group with larger disparities among the developed countries. Households on welfare also increased from around 1995. Its breakdown shows not only elderly people but also an increasing number of young people.
2) Unemployment rates of young people in developed countries are in an increasing trend. Paradox of Paradise (the Club of Rome, 1997), unemployment increases as productivity rises to the highest level. Redefining productivity and efficiency is necessary.
3) Societal model to aim for

   Sustainable welfare society:

   A society in which individual livelihood is secured and distributive justice is realized while these can survive for a long time in harmony with environmental and resource constraints.

   Stationary society:

   A society in which sufficient affluence is realized without making economic growth an absolute target
4) A high EPI (environmental performance index) and a low Gini coefficient are probably ideal.
5) An era in which machines do what used to be thought only possible for human beings to do. In 1930, Keynes warned that technological innovation would lead to fewer jobs, and predicted lives of people who would be enjoying leisure time in 2030. After 2000, the reality that labor productivity and employment are not proportional.
6) On-demand economy: Services to deliver necessary goods and services when necessary and where necessary, according to demand. Increased productivity with less labor force. Uber: Protests concerned that it would cause bankruptcy of taxi companies.
7) Sweden: The unemployment rate of those aged 25 years or older exceeded 20%. Even with the decrease in working hours from 8 to 6, no reduction of income. Managing to improve productivity through 12 hours of operation with 2 shifts. What would take 8 hours to do only takes 6. Two hours for leisure, for enriching the quality of life.
8) Basic income: Whether or not people work, they would receive a minimum necessary living allowance. A new way of income which can change the premise of working for income, and change the previous ways of viewing capitalism. National referendum conducted in Switzerland, rejected.
9) History of capitalism: Welfare around 1600, social insurance around 1900 after the Industrial Revolution, employment creation around 1930 during the Great Depression. Until now, there was an underlying idea that people would be equal by being paid wages, but along with the development of capitalism, there is a deeper awareness of the value in what cannot be converted into money.

3. What are science and technology in the post-growth era?

1) What are science and technology for? Keywords include happiness, sustainability, safety, community, and equality.
2) Reason for existence of science and technology in the post-growth era: Pure intellectual curiosity, responding to social issues
3) A possibility of "science as care": Re-fusion of sciences -> science of relationship, science of individuality and diversity, science of endogeneity
4) For example, local knowledge inherited from ancient

times, sciences overlapping folklore and historical studies

4. Final words: Possibilities of global stationary society and global ethics

1) Society aging at the global level. Especially rapid in Asia. The global population will be stable at 11 billion in 2100. The 21st century is the end of the increase in the global population and the century of aging society.
2) Five of the most populated countries in the world in 2100 are projected to be African countries (United Nations World Population Prospects).
3) Possibility of global stationary society: Realization of an environmentally friendly type and a stationary aging society. Japan as a front runner. A position to link the modern Western civilization with Asia, and developed countries with developing countries. It is perhaps in a position to lead the rich stationary economic model, and the new way of science and technology.
4) Characteristics of global ethics as the value principle in the third stationary era: (1) Finity, (2) diversity, and (3) cyclical fusion of the local and the universal

(The Administration Office takes full responsibility for the wording and content of this article.)

Appendix Concrete Actions

We are attempting dialogues about science and technology, and the surrounding issues and future measures, regarding institutions, environments, and new academic fields transcending the boundaries, based on the field experiences of the next generation responsible for academic studies, science and technology, and universities.

1. Dialogue between young bureaucrats and researchers

Young bureaucrats of the Ministry of Education, Culture, Sports, Science and Technology, and the Study Group members have discussions on science and technology administration, institutional and environmental issues surrounding it, and future measures. They have continued to discuss the necessity of understandings of history and the world and lack of environmental conditions for that purpose, budget supremacism, populist trend, lack of visits to R&D worksites and dialogues, short-term personnel transfer of bureaucrats, circumstances peculiar to relevant ministries, bureaus and divisions such as high walls among them and their countermeasures, interaction between the institutional structure and activities in science and technology, differences between methods of pure basic research and methods of social-problem-solving type research, positions of various funding systems and their relationships with how 21st-century science and technology should be.

At the beginning of a meeting, they conduct Biblio-battle (introduction of the books that participants have recently read and their thoughts), expressing their recognitions of problems as individuals, and discussions start. The contents of the discussions are summarized in a newsletter format.

The sessions were held on the following dates:
The first session on December 21, 2015
The second session on March 25, 2016

Place:
Kasumigaseki Knowledge Square Expert Club

2. Dialogues by young researchers - Exploring new academic fields transcending boundaries -

Young researchers gather and aim to reconstruct the scientific community by refining their areas of expertise, and discussing exploration and pioneering of new academic fields that are not confined to the previous systems.

Each speaker is asked to present the appeals of their research, with the aim of potential collaboration in their following research. Video are available on the Internet for regarding the discussions.

The session is held about once a month.
Place: International Institute for Advanced Studies

3. Regional Meeting of Asian Young Scientists Association

In March 2016, the Science Council of Japan and the International Institute for Advanced Studies collaboratively held the Asia subcommittee meeting of The Global Young Academy (GYA), an international organization of young scientists aiming for social contribution of science. Discussions were held on measures to solve issues by transcending the differences of academic fields, cultures, and nations, by extracting issues that are of global scale as well as cross-sectional themes, including mutual understanding for scientific education, scientific diplomacy, and sustainability. The future issues raised were: “realizing an inclusive society" and “countermeasures with clear effects to realize a sustainable ecosystem."

Meeting held on: March 16 - 18, 2016
Place: Science Council of Japan

4. All-field-collective Symposium: “The Academic World”

Meeting held on: February 22, 2018
Place: 5F, Symposium Hall, International Science Innovation Building, Kyoto University
Organized by: Center for the Promotion of Interdisciplinary Education and Research, Kyoto University
Co-organized by: International Institute for Advanced Studies, Suntory Foundation

This symposium was held with the proposal of Associate Professor Naoki Miyano of Center for the Promotion of Interdisciplinary Education and Research, Kyoto University (member of this Study Group), organized by Center for the Promotion of Interdisciplinary Education and Research, Kyoto University and co-organized by Suntory Foundation and International Institute for Advanced Studies.

Young researchers in all 79 fields of Grants-in-Aid for Scientific Research gathered from all over the place to share visions and issues in their respective fields, to get an overall picture of the directions of the academics and science and technology, and frameworks for promoting and evaluating them. With this, they tried to make it an opportunity to form a network of exchanges for the future’s young researchers to link different fields and discuss pioneering of new academic fields.

A total of 93 people participated in the symposium from 75 fields out of 79, with 1 to 2 persons from each. The age groups of 30s and 40s occupied three quarters of all. In addition, about one-third attended from outside the westside of Japan. Each participant gave their opinions to the 33 questions posed by Dr. Miyano of the Center for the Promotion of Interdisciplinary Education and Research at Kyoto University.

In Session 1, questions regarding basic information were asked, which could be answered based on facts as you can see below. The answers varied between arts and literature, and the scientific fields.

[Question examples]

- The number of pages per paper, the average number of authors?
- The frequency of publication of academic journals in your field, the average number of papers written per year by a researcher?

- The rule in the order of the names of the authors to be listed when a paper is written by multiple authors?
- The name of the academic society of your main affiliation and its number of members?
- When you are evaluated for your achievement of presenting at an international conference, which are valued more, books or papers?
- The Annual research expenses of researchers in your field?

In Session 2, questions were asked about visions and issues in each field. For example, to the question, "what is the interesting thing about doing research," there were answers such as "When something unexpected or unknown happens and when I feel I have come to see part of the truth, I feel intrigued," and they were rather common answers. On the other hand, regarding the "implicit premises," answers were given which were characteristic of the respective fields, including "educational institutions / family is important / differences between individuals and groups / the brain is amazing / science will move forward / what happens to a mouse will happen to a human.

[Question examples]

- When asked from a junior high school student, "What is the field of ○○, and what kind of thing do you research on," how would you explain it?
- In your field, what is the moment when you think "doing research is interesting"?
- What kind of paper is would you think "This is amazing! Good article!" in your field?
- The image of an outstanding researcher in your field?
- "This is the weird thing about my field"
- The forbidden words and phrases in your field?
- The implicit premises of your field with which the field will collapse if you doubt

In the final session, questions were cast about common items in the preceding discussions. Many opinions were given on future continuation and development of the program, including holding such an event in the eastside of Japan and doing it in a specific field such as engineering. Others expressed their opinions such as that this attempt became an opportunity for them to be conscious of other fields or to reflect on themselves as researchers, as they had a chance to get an overview of the world of academics, as well as that they were intellectually stimulated which were different from what they get in daily life of research.

[Question examples]

- Better society, better life; how would you talk about them in your field?
- What has to happen in what way for something to be "good"?
- Do you think the world can be described by symbols (languages, mathematical expressions, etc.)?
- Comments on the day

This was an attempt to reconsider the current academic fields by encompassing the fields, visualizing and sharing specific, actual voices of the research sites. By the observation of the researchers who work on the actual research sites who come to a voluntarily come to a place like this, I was able to see that there were not a few researchers who

were conscious of issues regarding the directions of the academic fields and science and technology, and frameworks for evaluation. With this as the first step, we will continue our activities to transform the voices of young to mid-level researchers into a larger movement.

B : Sustainability of Human Survival
- Rebuilding of Value Axis towards 2100 -

Principal Investigator Takamitsu Sawa

Introduction　Science and Technology towards Sustainable Society

The term sustainability has come to be frequently used since the incorporation of this term in *Our Common Future* (1987), which is the final report of the UN Brundtland Commission.

At the G7 Summit in 1988 and 1989, the global environmental issue was taken up as one of the most important issues, and the Framework Convention on Climate Change was adopted at the "World Conference on Environment and Development" held in Rio de Janeiro in 1992. The Convention came into force in about two years, and the first Conference of the Parties was held in Bonn in 1995 and the third in Kyoto in 1997, where the Kyoto Protocol was adopted.

The Kyoto Protocol, which imposes the 41 advanced countries the obligation to reduce greenhouse gas emissions, not only struck a warning that the 20th century industrial civilization purported to mass production, mass consumption, mass disposal is unsustainable but also pushed for a major shift in the coordinate axes of advances in science and technology. Almost all technological innovations leading the economic growth in the 20th century led to the development of products that increased carbon dioxide emissions, i.e., used electricity or petroleum products as their power source. Henceforth, transformation of coordinate axes of innovation was inevitable.

Generally speaking, overcoming "constraints" and "shortage" is an incentive for technological innovation. What drive technological innovation in the 21st century have been and will be resource and environmental constraints. Thus, at least one of the coordinate axes of technological progress is replaced with "more fuel efficient." All technologies have a trade-off relationship, that is to say, the side effect becomes more serious as the effect is made sharper.

Engineers who are engaged in technological innovation should not look away from the trade-off relationship that is held inevitably by technological products. At the same time, when scientific knowledge is not decisive such as that of climate change, we should not neglect taking "early actions" based on the precautionary principle. Finally, following Steve Jobs, engineers in the 21st century must aim at owning technologies that are blended with humanities and social sciences.

Introduction　Science and Technology towards Sustainable Society

Takamitsu Sawa

1. What is sustainable development?

The term sustainability has come to be frequently used commonly since *Our Common Future* (1987), the report by the United Nations Brundtland Commission, which is the alias of the "World Commission on Environment and Development" chaired by former Prime Minister Brundtland of Norway, used the term “sustainable development.” It is not an exaggeration to say that this term has become a keyword in discussing global environmental issues since then. The above report defines it as follows: "Sustainable development is development that fulfills the desires of today's generation without compromising the ability of future generations to satisfy their desires."

It should be noted that this definition receives criticism that it is “too human-centered; for example, in "New World Environment Protection Strategy" (1990), there exists another definition that emphasizes more the ecosystem: sustainable development means achieving the qualitative improvement of people's lives while living within the limits of the capacity of each ecosystem that is the supporting base for those lives."

Anyway, towards the end of the 20th century, it became widely recognized that the “20th-century industrial civilization" based on mass production, mass consumption, and mass disposal will be "unsustainable" in the coming 21st century, especially in the context of depletion of natural resources, pollution of the global environment, and expansion of economic disparity between Southern and Northern countries.

2. From the Toronto Summit in 1988 to the Kyoto Conference in 1997

The warning sign rung by the Brundtland Commission stated, “if we keep the 20th-century type industrial civilization as it is, we will have to compromise future generation’s welfare.” This caused a reaction that went beyond expectation, and at the Toronto Summit in June 1988, global environmental issues were taken up in the agenda for the first time. Immediately after that, the "International Conference on Global Environmental Issues" sponsored by the Canadian government was also held in Toronto. There, a shocking simulation result was reported: if we continue to increase carbon dioxide emissions at the current pace, at the end of the 21st century the average temperature on Earth will have risen by 3 degrees centigrade and the sea level will have gone up by 60 centimeters."

Turning to Japan in the late 1980s, the era was at the climax of the bubble economy. People accepted mass production, mass consumption and mass disposal as a symbol of richness, almost no interest was focused on global environmental issues. The Toronto Summit became the takeoff, though delayed, for mass media in Japan also became far more enthusiastic about reporting on global environmental issues. Corresponding to this, people’s attention towards environmental problems has enhanced form local to global.

At the Arch Summit in Paris in 1989, the interest in the global environmental problems showed a rising trend by the day to the extent that global environmental problems accounted for one-third of the “Economic Declaration." In 1992, the United Nations Conference on the Environment and Development (Earth Summit) was held in Rio de Janeiro, and the United Nations Framework Convention on Climate Change (UNFCC) was adopted. After the Convention came into effect, the first meeting of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP1) was held in Berlin from the end of March to the end of April in 1995. Then COP3 was held in Kyoto in December 1997, and the "Kyoto Protocol" was adopted which imposed a reduction obligation, as compared with the 1990 level of greenhouse gas emissions (GHG: CO_2, CH_4, N_2O, HFC, HCFC, SF_6), by 8% on the European Union (EU), by 7% on the U.S. and by 6% on Japan for the five years from 2008 to 2012. At the same time, the introduction of a scheme “utilizing market

mechanisms," including emissions trading, joint implementation, clean development mechanism, was incorporated in the Protocol.

After that, COP was held at the end of every year, but due to the circumstances in which the United States withdrew from the Kyoto Protocol in February 2001 and China, which became the world's largest CO_2 emitter (as of 2014, the ratio of China's emission to the global total is 28.2%), was not obliged to reduce emissions, the total emissions of the countries that were obliged to reduce GHG emissions by the Kyoto Protocol accounted only for 20% of the world's emissions, and CO_2 emissions in 2014 increased to 1.6 times from the 1997 level with the efforts of Annex 1 countries in vain, whose reduction obligation was imposed by the Protocol.

3. From the Kyoto Protocol to the Paris Agreement

At COP21 held in Paris at the end of 2015, the Paris Agreement as summarized below was adopted, and the climate change mitigation measures came into effect at the end of 2016, in which not only developed countries but also emerging countries and developing countries would participate. 1) All UNFCCC Parties participate in GHG reduction efforts. 2) Keep the temperature rise from before the industrial revolution to less than 2 degrees. Make efforts to keep it less than 1.5 degrees. 3) Have the peak of the world's greenhouse gas emissions as soon as possible, and make it virtually zero in the second half of this century. 4) Verify the state of reduction on the global scale every five years from 2023. 5) Oblige all countries to create and submit a reduction target and review it every 5 years. 6) Set a global target for mitigation of damages by the global warming. 7) Oblige developed countries to contribute to the fund for assistance of developing countries' reduction, but also encourage emerging countries to voluntarily contribute to the fund. 8) Developed countries will contribute more than the current commitment ($100 billion) to developing countries (target amounts not included).

The joint announcement by the United States and China that the two countries ratified the Paris Agreement after President Obama (at that time) and President Xi Jinping of China held talks on September 3, 2016, just before G20 was held in Hangzhou, China, was largely effective for the Paris Agreement's coming into force earlier than expected. This is because the two countries accounted for 38% of the world's GHG emissions, and hence, it had become quite likely that the requirement would be fulfilled that "the total of GHG emissions by the Parties should be 55% or more of the world's total," which is one of the necessary conditions for the Agreement to come into effect.

4. The 20th century was a century of increase in carbon dioxide emissions

One of the most probable answers to the question, "what kind of century was the 20th century?" is that it was "the century of economic development and growth." So why was it possible to achieve such rapid economic development and growth in the 100 years of the 20th century?

One of the answers is "because technological innovation came one after another." In that sense, the 20th century may be paraphrased as "the century of innovation." So why did technological innovation occur one after another in the 20th century? One of the answers is that towards the end of the 19th century we obtained two sources of energy: petroleum, and electricity. Thanks to technological innovation, new products that improve the convenience of our lives and realize a more comfortable life have appeared one after another, but all of them use electricity or petroleum products as its power source. In that sense, the 20th century may be paraphrased as "the century of electricity and petroleum."

However, the other side of the coin is that the 20th century was "the century of carbon dioxide emissions." In other words, by continuing to increase carbon dioxide emissions, we have been able to acquire "wealth." Quite ironically, it just means that people have come to share the recognition that "the 20th century industrial civilization is unsustainable" when the Kyoto Protocol was adopted at the Kyoto Conference (COP 3) in which about 160 countries participated in December 1997. To put it differently when the 20th century was about to be over, 40 advanced countries were obliged to "reduce at least 5%" of the annual average emissions of greenhouse

gases compared to the 1990 level (after conversion to CO2), including carbon dioxide, which is a symbol of the 20th century, in the five years from 2008 to 2012.

Science and technology in the 20th century set its purpose to contribute to economic development and growth. However, it is certain that science and technology in the 21st century must set its goal to contributing to "sustainable development."

5. Changes in coordinate axes of “progress" of science and technology

Until the Oil Shock that occurred in October 1973, the coordinate axis of technological progress was one that aimed at being "bigger," "faster," "stronger" as symbolized by jumbo jets and Concorde. However, since the last quarter of the 20th century, meaningful changes have occurred in the coordinate axes of technological progress. In other words, the progress of technology has come to mean the development of new equipment with "more fuel efficient” and "superior in terms of cost effectiveness." The emergence of global environmental problems since the 1990s accelerated these trends.

In general, technological innovation is driven by some constraints or shortages. The 21st century is often said to be "the century of the environment." It has two meanings. One is that global environmental problems will probably become increasingly serious. Another is that the environmental constraints will be the driving force for technological innovation.

Often it is said that “thanks to technological innovation, this world is full of things." It is certainly not exaggeration to say that devices related to the fast and safe transportation system of humans and goods including cars, aircrafts, and so on, household appliances, communication equipments, computers, etc. have almost approached the realm of completion.

When we are asked what kind of constraints and shortages as the spring of technological innovation in the future, the following two will be cited. One is the inexhaustible desire for eternal youth and longevity, and freedom from illness. In order to fulfill these common wishes, a large amount of public research expenditure is being introduced into life science. There was a truly remarkable progress in medical care in the past quarter century. The other is the environmental constraints. At least from the viewpoint of "precautionary principle," we will have to spend money on climate change mitigation, i.e., measures to reduce GHG emissions. Also, adaptation measures to climate change have to be taken into account. By taxing fossil fuels according to the amount of carbon content, it is possible to suppress the consumption of fossil fuels, induce the development of energy conservation technologies, encourage popularization of fuel-efficient cars, encourage the use of renewable energy, secure profit from energy conservation investment. In addition, tax revenues can be utilized as a capital fund for investment in R&D of public and private sectors, and as a financial support for adaptation measures inside and outside of the nation.

What I would like to point out next is the irreversibility of technology. There are definitely not very many cases where a technology that once appeared was banned legally because it had damaged the life or the environment; a product based on a technology disappeared from market, since people repudiated or refused it. To the best of my knowledge, this is limited to a small number of harmful chemical substances such as DDT (insecticide), thalidomide as a sleeping pill, CFC which destroys the ozone layer, and asbestos.

Why is technology irreversible? One of the reasons is that technological innovation forms a professional group of engineers specializing in that technology. For the members of the professional group, it is literally a matter of life and death to defend that technology. The second reason is that companies that produce new products based on technological innovation function as pressure groups against policies that would hurt their profits. The third reason is that new products provide unprecedented comfort and convenience to consumers, or benefit of cost reduction to producers. Therefore, in order to accept the irreversibility of technology, it is necessary to reform technology to minimize its potential risk, and to reform the social system so that it functions to precautionarily refuse the acceptance of risky technology.

6. Science and technology, and globalization

With the beginning of the last quarter of the 20th century, science (information, life) and technology (medical, information, environment) came into the spotlight, instead of science (physics, chemistry) and technology (electricity, machinery, chemistry, construction, civil engineering). This shift of the leading role of science and technology is also a reflection of the transition of the context of the era, especially the change of value norms from growth and development to sustainability.

In particular, the development of information science and information engineering, that is, the progress of “informationization," caused an unpredictable social phenomenon that brought about the "collapse of socialism" terminated by the demolition of the Soviet Union in December 1991. Concisely, communication satellites have come to fly, and we can now see the CNN news in real time no matter where we are in the world. "Iron curtain" which bisected the so-called East and West of Europe, could block the flow of people and things, but could not block the flow of information.

The 1990s was an era of globalization. In fact, in the English dictionaries that were compiled up to the end of the 1980s, the word *globalization* does not appear. This means that the phenomenon that is signified by the word globalization has made rapid progress since the entering the 1990s. Why did the phenomenon, signified by globalization, progress all at once in the last decade of the 20th century?

One of the answers is "collapse of socialism" and the other is "progress of informationization." According to the data released by the Bank for International Settlements (BIS), exchange transactions exceeding 2 trillion dollars per day have come to be traded recently, and this is because it became possible to instantly make transactions of huge amounts of money simply by clicking on the computer mouse.

For better or worse, the parent of the "age of speculation" from the late 1980s to the 1990s was no one else but information communication technology (ICT). Financial engineering created various financial derivatives, and these came to be put into the international financial market. As a result, declining housing prices in the United States triggered the 2008 international financial crisis.

7. Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident

When something happens that would normally be impossible in the light of common sense, it is called a *black swan*. Its etymology is as follows. In 1770, Captain Cook found the continent of Australia. The British who landed was surprised to see that in Australia there inhabited a waterfowl, whose figure was nothing but a swan itself, but whose color of the wing was not white but black. Since then, when something happens that is supposed to be impossible has come to be called a black swan.

The Great Eastern Japan Earthquake on March 11, 2011 was black swan itself in the sense that “the Great East Japan Earthquake was unpredictable." That is, "things that should have been impossible happened." On the other hand, the accident at Fukushima Daiichi Nuclear Power Plant was not a black swan. This is because, until the accident broke out, both electric power companies and the Ministry of Economy, Trade and Industry have been saying that nuclear power plant is "absolutely safe" (an accident can never happen!), and ordinary citizens also continued to believe the myth that “nuclear accident cannot happen.” In short, there was a definite lack of awareness in this country that “there is nothing that is really impossible."

It is only in Japan that the absolute safety myth passes. For example, the nuclear plant maker Areva in France, where nuclear power plants account for more than 70% of its electricity supply, constantly keeps robots and wastewater treatment equipment ready in case of an accident. If Japan's nuclear plant maker, Toshiba, Hitachi, and Mitsubishi Heavy Industries do the same thing, the trust in the myth of absolute safety will be shaken, and consequently add fuel to the anti-nuclear fire. After March 11, 2011, both the Ministry of Economy, Trade and Industry and the electric power companies had no choice but to drop down the sign of "absolute safety."

Prime Minister Abe officially announced at the G7 Summit in June 2015 about reducing GHG emissions by 26% from the 2013 level by 2030. In order to achieve the goal, he said that 20~22% of electricity

would be supplied by the nuclear power plants, and 22~24% would be covered by renewable energy including large-scaled hydraulic power. In order to achieve the above nuclear power plant ratio, it is necessary to apply the exceptional provision of the revised Reactor Regulation Act (with extension of up to 20 years) which sets the life expectancy as "40 years in principle" for almost all nuclear power plants. According to experts' calculation, as long as it complies with the “40-years principle," even if the two plants currently under construction are added, the nuclear power plant ratio will still be 15% at most. After the severe accident at Fukushima Daiichi Nuclear Power Plant, with the construction costs nearly doubled as regulations were strengthened, and also with the growth rate of electricity demand having declined, it can be inferred that electric power companies will never have intention to newly construct nuclear power plants.

There is much debate about whether nuclear power generation cost is higher or lower than thermal power generation and renewable energy generation. If I may state my opinion on this point, it is as follows: As far as the average cost including the amortization of the equipment (power plant) initially invested is concerned, nuclear power plants are more expensive than other sources such as thermal power plants and renewable energy sources. However, as far as the marginal cost of running existing facilities is concerned, nuclear power plants are overwhelmingly inexpensive compared to thermal power plants. It is said that the marginal cost of the nuclear power plant is nearly one yen per one kWh. That is why power companies are keen on restarting nuclear power plants. In addition, just to be sure, the marginal cost of renewable energy generation is zero.

It seemed that the “fixed price purchase scheme of renewable energy” (Japanese version of FIT: Feed in Tariff) implemented in July 2012 would spur the spread of renewable energy, but due to the lowering of the fixed purchase price, the penetration rate is in a state of cease. Trends in the ratio of detached and owned houses where solar panels are installed on the roof are as follows: It was 0.9% in 2003, which markedly increased to 1.6% in 2008 and 4.6% in 2013. FIT, which originally started in Germany, deserves praise as a representative example of effective social technology. However, it has to be pointed out that, the only difficulty is that we cannot avoid the problem of impartiality as to whether or not it is acceptable that the difference between the purchase fee and the electricity charge be covered by raising the electricity price.

I will summarize the trends in crude oil prices in the past decade. Although it fell in response to the international financial crisis after reaching the unprecedented high price of 134 dollars per barrel in June 2008, it stayed between 80 to 110 dollars from July 2009 to December 2014. However, it fell sharply to 41 dollars in August 2015, and after that it has been in the upper half of $40s to lower half of $50s.

The cause of the sharp fall in the middle of 2015 was that the OPEC General Assembly in November 2014 decided to stop their reduction in crude oil production in order to block the development of the shale oil fields which was progressing in North America. The marginal cost of shale oil is around 50 dollars per barrel. Including amortization expenses for the facility, it is not profitable unless the price of crude oil is around 100 dollars. If the price of crude oil remains around 50 dollars in the coming years, development investment in shale oil fields will have to be postponed. For Japan's economy, which relies on import from overseas for 99% of its crude oil, the transition at the low price of crude oil should be welcome, but it cannot be content with the fact freely. This is because the comparative advantage of the development of fuel-efficient cars that Japanese car makers are good at will be compromised.

In April 2012, Haruhiko Kuroda, Governor of Bank of Japan pledged to "cause inflation of 2% per annum in the next two years.” Although he aimed at achieving the goal by nearly unlimited purchase of government bonds and Exchange Traded Funds (ETF), declines in crude oil prices are said to have blocked consumers’ price hike. Although there is an inclination to say that the depreciation of crude oil in recent years is called "reverse oil shock," it is a fact that is hard to deny that the Japanese economy is also suffering a considerable positive influence of the reverse oil shock.

8. Conclusion

It should not be an overstatement to say that every piece of technology always has a trade-off relationship in itself. Examples include effects and adverse effects of medical products, clinical application of iPS cells and possibility of its canceration, insurance application of high-priced drugs and its financial burden, risk of an accident of nuclear power plants, destruction of natural environment due to large-scale public works, social impacts for better or worse due to the spread of digital devices.

In considering how science and technology should be in the future, the "precautionary principle" should be adopted more actively. The question is being asked on whether judgements on the pros and cons of genetically modified crops, and the pros and cons of measures against global warming (reduction of carbon dioxide emissions) should be made based on the “precautionary principle” or “sufficient scientific knowledge” is needed. In the former case, unnecessary costs have to be paid, whereas in the latter case there is the possibility of falling into a situation in which it is "too late!" (it is irrevocable).

So far, I mentioned the trade-off relationship that is held by all kinds of science and technology and the precautionary principle, but it is indispensable to incorporate the knowledge of scholars in humanities and social scientists in deriving the optimum solution on how to reach a compromise for these problems. Now, developed countries in the West, are under the trend of moving from STEM (the initials of science, technology, engineering, and mathematics) to STEAM (with ‘arts’ added to STEM). In other words, recognition of the fact that humanities (arts) are indispensable for thinking about how today's science and technology should be is becoming universal.

Steve Jobs skillfully expressed the idea that we could not hope for innovation in science and technology without knowledge of humanities and social sciences, when he made the following well-said remark at the announcement of iPad 2 in March 2011: "To develop a product that makes our hearts sing like the iPad 2, technology alone is not enough. We need technology married with liberal arts or humanities."

In order to refine the "thinking ability, judgment ability, and expressiveness" that the Ministry of Education, Culture, Sports, Science and Technology talks about, not only learning mathematics and physics but also learning literature, philosophy, history and social sciences, and cultivating a critical spirit are indispensable. I would like engineers involved in technological innovation to be the owner of such a critical spirit that criticizes existing technologies. I do not want them to forget that criticism is the source of creation.

In the former Soviet Union and China, the majority of the members of the parliament, high-level bureaucrats, and corporate managers were originally engineers, and many intellectuals in humanities and social sciences were excluded. Countries like those were supposed to have disappeared in line with the collapse of the former Soviet Union in December 1991, but over the past two years, the signs of totalitarian rebuild that can threaten liberalism and democracy showing everywhere. In order to block the way to the totalitarian management state (to protect democracy) depicted by George Orwell in the novel *1984* (1949), which held three slogans "war is peace," "freedom is subjugation," and "ignorance is power,” we should not reject knowledges in the fields of humanities and social sciences. At the same time, it is indispensable for scientists and engineers to wake up to knowledges of humanities in order to block the way to the totalitarian state

Chapter 1 Resource Energy

1. Options for the technology: What is possible now?

Not only human beings, but all of the lifeforms on the Earth constitute the supply chain of the material and energy required for their survival, using a finite amount of substances and a nearly constant energy flow that are coming from the sun and being released to the outer space. While this process is driven by energy and promotes a steady energy flow and material circulation together with other organisms, it discharges entropy to outside and performs entropy reduction and value creation are by organizing and sophistication of its self-system. In the stable phase, the throughput and stock of materials and energy constituting the system do not increase, and only the value is accumulated. Humans build this living system by technology. Some sustainable models do exist, and there are options for the technology to realize them.

2. Renewable energy and future economic development

Regarding Japan's global warming target of 26% reduction in fiscal 2030, Japan has set an excessive economic growth rate, and the amount of renewable energy introduced is small. Although the introduction of renewable energy is making a progress around mainly solar power generation due to the feed-in tariff scheme, but the supply of renewable energy is decreasing, and the policy of renewable energy is not widespread in municipalities with a smaller population. The introduction of renewable energy has the potential of contributing to future economic development both in the "growth department" which brings in income from outside the region and the "sustainability department" in which the capital base in the region is cared for.

3. Sustainable low-carbon society

Human beings have used technology in composing their living zone's supply chain, but the technology itself is neutral and forms a purposeful system in accordance with the specific direction set by human society. Up to the modern era, technology aimed to expand throughput of material and energy supply and increased its growth rate, started using underground resources and fossil energy, and freed the constraints on material and energy supply rate and growth rate limited by the photosynthesis. On the other hand, the low-carbon energy system targeted by current technology is sustainable, not toward quantitative expansion, but towards highly structured and highly efficient energy infrastructure. This system has little dependence on material consumption, and the marginal cost approaches zero in a sustainable state. Even in this process, energy is the driving force of the supply chain, and energy has the function of maintaining to make a structure and creating value. This function indicates that sustainable growth is possible.

1. Options for the technology: What is possible now?

Satoshi Konishi

1. Basic sustainable model

Living organisms do not exist independently as bare individuals alone in the natural world but are always living and at the same time incorporate necessary materials and energy, etc. from the surrounding environment and emit what is unnecessary. In other words, they build a "living sphere" that is supply chains of materials and energy for their own survival. However, these materials and energy are not always around them conveniently. To begin with, living organisms live in the places where materials and energy necessary for themselves are relatively abundant. Also, according to the relatively classic evolutionary theory of the observation of the nature that survival competition is fought for over such a good condition, and those that are well adapted to the environment would survive the "natural selection" and consequently would be seen as "adapted." Certainly, the materials themselves exist equally on the Earth in terms of opportunities. In fact, however, if one would look closely, competition for acquisition of these materials and energy is not necessarily carried out as commonly given resources to any organisms under a common condition. Different species obtain different materials and energy at unique times, places, and routes. Sometimes there is a supply chain that seems to be roundabout, and organisms bother to use material resources and energy even from places that seems to be difficult to obtain, in a form that is suitable for them and through complex routes and procedures. However, this is the result of the optimizing the acquisition route of necessary resources by organisms, by harmonizing with the surrounding environment for a long time.

They do not always obtain the energy of sunlight and heat in the atmosphere from the sun and the temperate climate, and there are cases where the energy is used with best efficiency in shade or cool areas, such as when and where there are no competitors or there are few other constraints, even if physical conditions are bad. Some organisms prefer dry environment rather than underwater or wet environments for water as resources. Even though it seems physically difficult to obtain it, if an organism can develop its own route or if there is little competition with other organisms it may rather be easier to obtain it. And they are not necessarily obtained directly from the external environment, and many are obtained in relation to other organisms.

Such a model of how organisms acquire energy and resources can probably be seen in common with human activities in many aspects. Human beings have created a supply chains that includes many routes other than direct predation, which are not seen in other organisms, especially by using their intelligence and artifacts. However, its supply chains have the continuous flows of energy and the circulation function of materials, just as the system by other organisms. Since energy has a conservation law and materials neither disappear nor are generated, the balance of the whole materials and energy is zero, and it becomes possible for the system of the concerning organism to be driven stably. Looking at the living sphere of each organism, in most cases it is formed in the context of circulation with other organisms. Among them, each species interacts as part of a sustainable system.

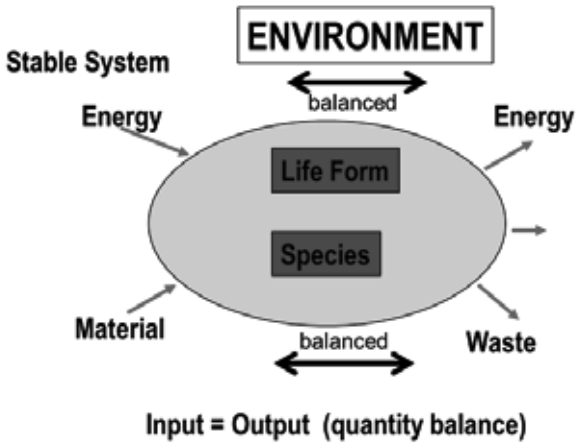


Figure B-1 Sustainable material circulation system

A typical example of this system is shown in Figure B-2. This is an example of a sustainable system - biosphere - in a closed system of a certain organisms, which has been demonstrated experimentally. Algae,

Daphnia, killifish, (and although its existence is not felt so much) bacteria constitute the material circulation system, nothing is supplied from the outside nor is discharged to the outside. While energy is supplied as light from the outside, the same amount is constantly released as heat to the outside so even as the total amount (J) or per unit time (W), it does not accumulate. Although in the course of this cycle, all organisms metabolically circulate the material, and they neither accumulate nor consume them. Energy is in fact ingested as chemical energy of the materials predated as food (they discharge exactly the same amount), and is released as heat. In other words, the material ingested as each food is regarded as an energy medium.

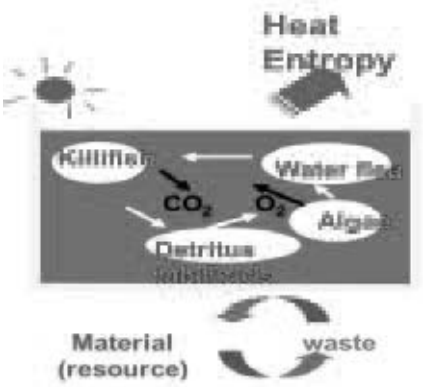


Figure B-2 Biosphere model

Such a material and energy supply chain, if it is not itself stable, can naturally not be sustainable. However, this is only a necessary condition. Even if the material balance and energy balance seem stable in the short-term, if consumable resources are consumed somewhere, or if waste accumulates and environmental characteristics change in the longer period, the supply chain cannot be sustainable beyond the range of the time constant and can lead to collapse. The throughput of the material and energy circulation can fluctuate to some extent according to the capacity of the buffer function in the supply chain, and can expand or contract. The long-term stable solution may include oscillating functions, but it is evident that there is no stable solution other than the steady circulation throughput, including oscillating functions, when it is sustainable.

2. Sustainable structure and properties

When the energy supply chain functions, the flow of energy serults entropy emissions, and in the living sphere, structure construction – accumulation of negative entropy. Constituting the living sphere, structurization itself is the system that has established a supply chain, and it is an entity that maintains and operates a material and energy circulation loop including multiple species of orgasms and has the characteristic of continuing and advancing structuralization and complications. When plants grow and mature as trees, for example, by photosynthesis they form complex compounds from constituent elements and form the structure that they shape, and then they form forests. Animals also make circulation system with other organisms as chemical synthesis by metabolism, composing individual bodies, furthermore, self-organizing gregaloids and groups, and taking in the necessary materials and energy such as food from the surrounding environment, while discharging unnecessary materials. Many systems that consume energy, whether they are biological systems or artificial objects, have the basic function of generating, updating, and accumulating compounds, structures, and information coded within the structure in the process of energy conversion.

Evolutionary selection also occurs between these living spheres as the unit in the course of their interactions. When multiple groups of species construct material and energy circulation systems for each of the groups, complicated energy/material exchanges exist between the supply chain systems, and these tend to become more efficient and more complicated as a whole. Resources and energy are immortal, and they are not really “depleted.” Between each supply chains, however, they may compete with other systems, in comparison to the time constant of the throughput of supply.

As a result, the throughput of energy and materials on the Earth, which is originally finite, has been competitively contested and distributed in an environment suitable for the survival of many creatures. They have already been shared, and in almost all systems we see, they are without surplus, and we do not see much of them in an unused and neglected state. In

some cases such as the desert and alpine, high latitude, deep sea, where more critical circulation of resources necessary for survival, such as water, light and heat, may regulating, but in the environments where the majority of organisms are suited for survival, resources have already been allocated.

This yields the result that almost all of each material energy circulation system can be observed in the nature in a way that the effective utilization of resources is carried out in a sustainable manner. This is because the living sphere's supply chain has continued to be refined and improved its own efficiency, and as they have competed in the course of evolution and reached a state of equilibrium, they are all in a state of balance. Of course, not all systems succeed like that, and observation can be made because only the model that happened to have succeeded has been sustained for a long time on the sacrifice of many extinctions that occurred in the many processes of evolution. From the viewpoint of biology (evolutionary theory), it is said that the majority of the generated species will be extinct, and about 0.1% will remain. In such a state of equilibrium, the equilibrium point shifts when a new material-energy supply path is developed because the throughput changes between related systems. The occurrence of new species corresponds to that phenomenon, and due to the movement of such equilibrium, the occurrence of the species is always observed intermittently in a state of equilibrium and suppress other species and lead to their decrease or extinction. The phenomenon that we call here the occurrence of a new species does not necessarily mean a change in biological or evolutionary genetic traits. Changes in the living sphere, such as migration or expansion of the residential environment, changes from diurnality to nocturnality, changes in temporal behavior such as seasonal dormancy of plants, changes in food, among others, cause changes in the material-energy supply chain. They also affect other living things and the environment they are associated with. In this way living creatures appear and some prosper and others die out.

The emergence of humanity, especially its agricultural activities and industrialization through the industrial revolution, is a history of mere prosperity and expansion for humanity, but has drastically changed the flow of resources on the Earth and the relationships with other creatures sharing the flow cycle. Resource and materials do not disappear as stated above but are converted on the Earth by a different route from the previous ones, and human beings discard them after use and leave that flow up to the environment again. Even though the humanity, appeared, the amount of solar energy that the Earth receives or the total amount of materials on the Earth have never increased or decreased. It is just that the flow path and throughput have changed. As a result, the circulation capacity in the environment is consumed to a large extent. Furthermore, the change in the amount and path of the material-energy circulation gives fatal results to systems involving various species and causes the extinction of many species. In many cases, this is caused by the exploitation of resource utilization opportunities of other species by human beings, but the flow throughput of circulation by living organisms - the amount observed as biomass actually - has increased greatly due to human activity, and the route and content are changing. The best example is agriculture, in which a small number of breeds with very few genotypes alter the material circulation on the Earth in large amount by agriculture, livestock, and the like.

Almost all observed species have been established over an extremely large number of generations and they have used their supply chains to carry out the energy circulation necessary for their survival. The system in which living spheres have continuously supplied and circulated materials and energy in its constituent organisms and environments is sustainable, while those whose supply has not reached the steady state are all merely at transient states until collapse.

Human activities can also be described in this framework from the viewpoint of supply of materials and energy and system construction. Up to the present time, viewing this historically or in terms of mechanism, humanity has succeeded in constructing a system that supplies necessary resources and energy to necessary places in various forms. Moreover, its throughput has greatly increased, and the system is more and more large and complicated. However, given that the throughput of this system continues to increase,

it is clear that sustainability for that supply chain is not guaranteed, or rather indicating it is not in a sustainable state.

When thinking about the behavior of such a general model, the sustainability of this supply chain itself seems to determine the feasibility of humanity as a species. In other words, human beings have an option to extinct by inherent reasons, and that possibility is quite high. It can be integrated into the problem of relatively simple system dynamics of stability of humanity's living sphere model as material-energy circulation system. As stated above, this stable solution of material-energy throughput is merely a necessary condition for sustainability, and even if this requirement is met, it does not mean that permanence of humanity is guaranteed. However, at least the requirements to be satisfied by a system that allows the humanity to survive can be described by a fairly simple model. This study will consider the system that the humanity has created to maintain and expand their own survival, and in particular, it will consider the stability of the process that has expanded characteristically by the methodology of "technology" and "economy" in the past several hundred years.

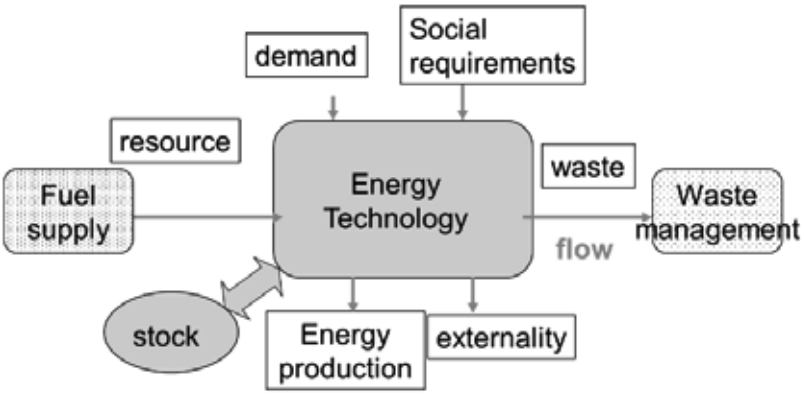


Figure B-3 General structure of material energy supply chain

3. Dynamic characteristics of growth and supply chain

The material-energy supply system by this organism can be evaluated the of its feasibility at each level of 0th order (stock and structure), 1st differentiation (flow and supply chain), and 2nd differentiation (growth and deceleration) and as a result it has been culled out from the viewpoint of phenomenology. Many or the stable phases have 0th-order stationarity while vibrating solutions are included. There is some correlation between the throughput, the total biomass of organisms consisting the system, and the amount of system structure information (which is measured by negative entropy). In other words, the system throughput expressed by the first differential amount determines the amount of resources used on the Earth by each species. In speaking of use of resources, "depletion" is not actually the disappearance of these stocks (0th-order quantity), but occurs when the flow which is the time differential quantity does not satisfy the demand amount. System throughput of material and energy also determines the number of living organisms that is fed there.

For example, at least for the majority of the history of the Earth, the carbon cycle on the Earth and in the atmosphere has been dominated by loops centered on plants. Plants fix carbon dioxide by photosynthesis, form their own structure, and the waste compounds (such as fallen leaves) associated with maintaining its structure are turned back to carbon dioxide again by other organisms such as insects and rot fungi. This throughput is driven by solar energy, and the energy of 6,000K irradiated from the sun to the Earth is discharged to outer space by night time radiation, during which negative entropy accumulation in the plant and entropy emissions to the universe occur. Synthesis of organic compounds and construction of complicated structures by these polymers are endothermic for the most part and plants accumulate organic matter on the Earth at longer time constants,

although they are in an nearly equilibrium state annually. This is also the case with the accumulation of coral and calcareous in the sea, and the result of these low entropy accumulation can be seen in the form of fossil resources, limestone and the like. Because the material-energy throughput is regulated by solar energy, its amount is small at high latitudes and large at low latitudes.

An increase or decrease in throughput as a second differentiation is observed as growth rate, but this is also regulated by the growth rate of the supply chain itself in each circulation system. This growth phenomenon has been progressing with the-zero sum of the total amount among individual species because the throughput is still determined by solar energy by far. This describes the occurrence, development, and stable phase of the species as a logistic curve. (Otherwise it will be destracted. This is called as a J curve.) When system dynamics analysis is performed, even if the logistic curves are observed in general, many vibration solutions are obtained. It is strongly nonlinear and cannot be analytically solved, but it is solved comparatively easily numerically because the survival of the constituent organisms of the circulation system depends on the material-energy throughput.

Human activity has greatly increased this throughput by first improving energy utilization efficiency and expanding space for energy use. That is the occurrence of farming. Cultivation, irrigation, fertilization, selective nurturing of single varieties greatly expanded the incorporation of solar energy into human survival through photosynthesis of plants. On the other hand, it is needless to say that the throughput through other plants not edible for human beings were largely reduced, and that necessarily the circulating loops of insects and animals passing through them have been destroyed or shrunk. The energy requirement for the survival of humankind should not have changed so much biologically, and in short, it means that almost all of energy of so-called 2000 kilo-calories a day is obtained from the sun. Energy consumption slightly less than 10 MJ a day is extremely small compared to the sunlight of 1 KW/m^2, and when viewed on a global scale, human nursing by sunlight has only negligible influence. The expansion of this part of human activity basically is linked to the expansion of the population. Food supply does not grow beyond the growth rate of agricultural production, and it has historically been at a rate that almost always outperformed human population growth.

If human activities are measured from the viewpoint of material-energy throughput, the growth rate in agriculture is slower than that of technology development as a whole. This is because the energy supply density is regulated by sunlight, and the growth rate itself has been constrained by it. However, technology development has made it possible to increase the energy throughput of humankind more rapidly. This far exceeds the expansion of the population, and in today's developed countries it is accompanied by about 50 times the energy consumption of aforementioned 2,000 kcal per day per person. This expansion of energy usage, that is, the growth rate greatly exceeded the upper limit of energy use using solar light, and has progressed this way in the past several hundred years. This is the result of the rapid expansion of energy throughput, which was basically within the range of solar energy such as food production by agriculture and use of wood and charcoal by forest, through unearthing of fossil energy resources. It came to be the case that the rate of expansion and growth of energy throughput as second differentiation had a major impact on the material-energy circulation system on the Earth in a form that far exceeded the others. However, it is still only about 1/10000 of the solar energy that is falling on the Earth. Rather, we should keep in mind that it is not the size of energy but the power supply chain using it which has the ability to change the appearance of the Earth even though it is quantitatively small.

In human beings, as in other plants and animals, establishing the living spheres by this technology development, however, is supposed to turn a certain fraction of flow to the construction of the structure in an intentional and planned way (which is occasionally incidental, intrinsically-oriented), in construction of the system of supply chain itself. The fact that the material - energy circulation system itself is larger by several tens of times in throughput for human beings than those for other living creatures was realized by the reason

that, the each function of the system that captures, transforms, and transports the individual distribution processes themselves at an advanced level, by means of the structure (mechanism) enabling its performance. Such enabling systems are, farmlands, cities, and production systems observed as trail of human activities, and they themselves are the results of performing negative entropy accumulation of human kind from among expanded energy throughput.

In a sustainable system, growth is not accompanied by expansion of physical scale and does not interfere with other living systems. (It happens during the selection process. The place where it ends is the stable phase.) However, the expansion of the living sphere of humankind has been accompanied by a large throughput growth, and it has resulted in the deprivation, deformation, and destruction of the living sphere of so many other living creatures on the planet. Although the stability of the system of humanity itself has not been determined yet, at least the influence on the living spheres of other creatures on the Earth as a whole is irreversible as a result of the expansion of the physical scale.

On the other hand, for the sustainability of the humanity's system itself, at least throughput stability is a necessary condition, as mentioned previously. If the throughput growth curve is a logistic curve, the growth as seen in the current human activity will come to an end sooner or later. The stable phase of the logistic curve has zero growth rate and does not involve expansion of scale any more.

However, human activities are also carried out in the construction and structuring of the supply chain itself of material-energy circulation. Material utilization itself such as mining and collection (consumption) as the resources available on the Earth will not expand infinitely, after the quantitative expansion of the living sphere of humankind ends. On the other hand, almost the same amount of energy is always used to drive this supply chain and is discharged. This discharge is accompanied not only by the total amount of energy but also by entropy emissions, and this is because human activity includes accumulation of negative entropy.

The accumulation of economic value (or capital?) can be evaluated with this negative entropy accumulation when abstracted. In other words, even under conditions of constant material-energy throughput in a sustainable system, value creation as seen economically can continue for a certain amount. Here, (economic) growth is defined as the speed of value creation through structural construction within the living sphere. It has a dimension of energy that is equivalent to the discharged surplus entropy, and this is regarded as result of the growth.

4. Options for the technology

When human activity is seen from the viewpoint of building and driving the material-energy supply chain, it can be said that human beings have developed a methodology of technology development in the process of building the living sphere, and made it their own. This building of living spheres itself is common to all living creatures and is not an activity or function specifically unique to humankind. As mentioned earlier, plants have created a situation where it can be regarded that they built and dominated their living spheres long before the occurrence of humanity. In addition, all living creatures, from the evolutionary point of view, have constructed their living spheres and their own traits more efficiently and in a more complex and highly functional way, for extremely long time constants.

However, there are quite distinctive differences in time constants between human beings' strategy of "technology development" in constructing their living spheres, which is remarkably faster than that of other creatures in terms of the time constant of growth (about 1 million times). Technology development is essentially trial and error process, and the result differs depending on the objective function and evaluation function, so in that respect it is not much different from the mechanism of evolution itself. However, intentional trials and structure building are the essence of technology, and it is conceivable that human technology development can provide an effective option for the survival of the humanity itself, and construction of a sustainable model. At least in the sense that the possibility of taking measures against unsuccessful system worked effectively. It is a fact that the current advanced industrialization and high-growth societal model are

inevitably adopted as the most advantageous methodology in the process of human beings' past construction of living sphere and its expansion. Especially it worked most advantageously for the groups of human beings (such as states, enterprises, social cohorts) that adopted and implemented it.

However, if this is a model that human beings cannot prepare an outcome for other than a failure, different choices will be needed. When sustainability and the possibility of survival of humanity are defined as objective functions and evaluation functions, the methodology of "human development" given for humankind can show some different options. Until now, economic growth has been discussed without separating the increase in material-energy throughput and construction, maintenance and improvement of the living sphere structure, and economic growth itself is regarded as the purpose of economic operation. Although it cannot be determined whether zero growth would be possibly established economically, at least it is indicated by this model consideration that the structure formation is possible at a certain rate even without an increase in throughput, and that it is sustainable.

2. Renewable energy and future economic development

Hidefumi Kurasaka

1. National policy on renewable energy

In the Paris Agreement, a framework was adopted to have each country release a target for prevention of global warming, confirm its achievement status in a prescribed manner and report it, and revise the target every five years. In revising targets, they are required to aim for more stringent goals.

Japan has set the goal of reducing greenhouse gas emissions by 26% in fiscal 2030 compared to fiscal 2013. In determining this target, an estimate was made to supply about 13 to 14% of the primary energy input and about 22 to 24% of the generated electricity in fiscal 2030 with renewable energy. The breakdown is also shown on the basis of the generated electric energy, which is said to be about 8.8 to 9.2% for hydropower, about 7.0% for solar power, about 3.7 to 4.6% for biomass, about 1.7% for wind power, and about 1.0 to 1.1% for geothermal power.

Although Japan's global warming reduction target of 26% by 2030 seems to be high at first glance, in fact it is not.

The first problem is that as a result of setting the baseline energy consumption to an excessive extent, the contribution from energy conservation is not considered fully. The baseline set for target setting is based on the premise that economic growth of 1.7% will continue until fiscal 2030. If this is realized, it means that the economic scale in 2030 will have increased by about 29% compared to that of 2015. On the other hand, according to the median estimate by the National Institute of Social Security and Population Research, the population will be 116.62 million in 2030, which is about a 9% decrease from 2015. In other words, by simple calculation, it is required to raise the added value production per capita by 40% or more. This will be extremely difficult. The government’s calculation estimates the base energy consumption with an assumption of excessive economic scale, so the government expects thorough energy saving, but in fiscal 2030 the electricity consumption is projected to increase by 1.5% compared to fiscal 2013. If we review the base, a reduction target to a further extent should be possible.

Secondly, the target for introducing renewable energy is low. In 2012, it is said that the proportion of renewable energy is 21.2% in the entire world’s power generation and approximately 21% for the OECD countries. This means that at the stage of 2012, the world as a whole and OECD countries as a whole has achieved the level close to Japan's target for introduction of renewable energy in fiscal 2030. On a side note, EU’s target for 2030 says that it will supply 27% of all primary energy supply and 45% of all generated electric energy with renewable energy. Compared with Japan's target, they are almost doubled.

The reason why the target level of introduction of renewable energy in Japan is low is because the target level of fluctuating renewable energy (wind and solar power) is particularly low. In setting this target, the Advisory Committee for Energy forecasts that the amount of electricity generated by wind power in fiscal 2030 will be 18.11 billion kWh, but by the wind power generation plan included in the environmental impact assessment procedure in fiscal 2015 alone it reached 10.2 million kW, and this is equivalent to the annual power generation amount of 17.9 billion kWh. In addition, although the committee expects annual power generation amount of 74.55 billion kWh by solar power generation, the solar power generation facilities certified as the feed-in-tariff scheme facilities as of the end of January 2015 amount to 71.62 million kW’s worth. Even if the operation rate is 14%, this number will achieve the annual power generation amount of 87.8 billion kWh.

Although not fully considered in the study of Japan's global warming targets, the report of the Ministry of the Environment's subcontractor's study in fiscal 2014 estimated the amount of renewable energy that can be introduced in 2030 and 2050 (Mitsubishi Research Institute (entrusted research by the Ministry of the Environment) “Committee Report on Verification and Investigation of the Possibility of Popularization of

Dispersed Energy such as Renewable Energy in year 2050," March 31, 2015). In this trial calculation, calculation was performed for three cases: higher-level case, mid-level case, and lower-level case. The high-level case is one that is calculated based on the policy that, in general, the potential for the introduction of renewable energy taking into consideration technical and institutional constraints takes full account in 2050, and the lower-level case was calculated based on the policy to extend the trend so far. In the mid-level case, which is the middle point of these, the amount of electricity generation is projected to be 33.2% of 2012 in 2030 and 63.7% of the same in 2050. Although this is an estimate based only on the electric power, if energy saving of 30 to 40% is carried out by 2050, this is a scale in which most of the generated electric energy can be covered by renewable energy. In addition to continuing capital investment, I think that efforts should be made to achieve this level by introducing technologies to control the fluctuation of renewable energy amount including stored energy technologies.

On a side note, although there is a way of thinking that has an expectation toward nuclear power generation as an energy source for breaking away from the greenhouse effect gas, in the situation where the development of the fast breeder reactors including Monju nuclear reactor is not progressing, nuclear power is energy that depends on uranium which is an exhaustible resource.

In Japan, with the introduction of feed-in-tariff scheme for renewable energy generation in July 2012, the introduction of renewable energy such as solar energy made a progress, and in fiscal 2015, renewable energy including large-scale hydroelectric power generation has come to account for 14.4% of all primary energy supply. Among them, the ratio of solar power generation was 3.3%, an increase of 1.1% from the previous fiscal year's 2.2%. By the way, the nuclear power generation ratio is 0% in fiscal 2014 and 0.9% in fiscal 2015 when Kawauchi Nuclear Power Plant and others were restarted. It is a situation in which solar power generation is growing at a faster pace than nuclear power generation that are being restarted.

The energy reaching Earth from the sun reaches 10,000 times the amount of energy consumed by humankind. In the future, in order to secure the sustainability of energy supply, it is necessary to switch from a fossil fuel-based economic society to a renewable energy-based economic society.

2. Introduction of renewable energy as seen in “sustainable zone" research

The Kurasaka Laboratory and the accredited NPO corporation Institute for Sustainable Energy Policies have been conducting a “sustainable zone" study since 2005 to estimate the supply of renewable energy of all municipalities and calculate the regional energy self-sufficiency rates. I would like to see the state of introduction of renewable energy in Japan from that data.

"Sustainable zone" is defined as the area that can cover energy demand and food demand in that area by renewable energy and food available in the area. This is a computational concept and it has been decided that it is not necessary for an area to actually be self-sufficient.

The sub-concept is the concept of "energy sustainable zone," and it is as an area that can cover the regional energy demand of its own only by renewable energy in that area. Here, as the regional energy demand, energy demand for consumer use (business and household) and for agriculture, forestry and fisheries industries are raised. These can be supplied by renewable energy and also can be controlled by local governments. On the other hand, due to restrictions such as that of individual data, energy demand for factory production and power generation and energy demand for transportation are excluded.

The renewable energy that is targeted for aggregation is solar power generation (for general household, commercial, and business uses), business-purpose wind power generation, geothermal power generation, small hydropower generation (limited to waterways of 10,000 kW or less and RPS-targeted facilities, but including retention basins), biomass power generation (those with a fixed biomass ratio of 50% or more, and as a general rule, waste electricity generation is excluded, but cogeneration is included), biomass heat (limited to woody biomass but cogeneration is included), solar heat utilization (for general household and business uses),

and geothermal utilization (hot spring heat and underground heat). This research grasps the facility capacity existing at the end of each fiscal year and calculate the supply amount in a case in which the concerned facilities supply energy throughout the year.

According to the latest report, the state of introduction of renewable energy in Japan over the past three years is that, from March 2012 to March 2016, domestic renewable energy supply doubled, and in particular the amount of solar power generation increased by 7.3 times. This is the effect of the feed-in-tariff scheme introduced in July 2012. However, the effect of the feed-in-tariff scheme has not appeared sufficiently for renewable energy generation other than solar power. Biomass power generation has increased 2.6 times from fiscal 2012 to March 2016, but wind power, small hydropower, and geothermal power all made no progress. Also, the supply of renewable energy heat that is not covered by the feed-in-tariff scheme has begun to decline. Although solar power generation got on the growth path, it can be said that the other energy types have not grown sufficiently yet.

In this research, municipalities whose calculated amount of renewable energy supply within the given area exceeds the energy demand for uses by consumers and by agriculture, forestry and fisheries industries within the area are called 100% energy sustainable zone municipalities, and they have increased from 50 municipalities in fiscal 2011 to 61 municipalities in 2014 and 71 municipalities in 2015.

It is likely that municipalities with a smaller population can be a 100% energy sustainable zone municipality, but in the present situation it is also known that municipalities with a smaller population have not implemented policies that utilize renewable energy. Kurasaka Laboratory conducted policy surveys on renewable energy for all municipalities in 2011, 2013, and 2015 (excluding municipalities that were disaster-struck in 2011). According to the results, the state of formulation of the administrative plan concerning renewable energy by population size showed that 60% of the municipalities with the population of 300,000 or more have formulated administrative plan concerning renewable energy, but among the municipalities with a population of less than 30,000, less than 15% of them have formulated the said plan.

3. Contribution to the growth department by renewable energy

As detailed in Chapter 6, Section 1, the future economic development requires that development will be made in a way that strikes a balance between "growing department" which brings in income from outside and "sustainability department" which maintains the capital base in the region.

Here, migration to renewable energy has the possibility of contributing to domestic "growth department" and "sustainability department" respectively.

First, with regard to “growth department," there is a possibility that the technology to stably use renewable energy such as sunlight and wind power, whose amount fluctuates according to natural conditions, and products utilizing it may create a new growth sector.

Among renewable energy sources, geothermal and small hydropower have high availability rates and are energy sources responsible for the baseline supply, and biomass can be regarded as an energy source that whose output can be adjusted. On the other hand, solar and wind power cause various fluctuations, and especially there is a fear that the supply becomes excessive when the demand is small.

Technologies required at this time are ones such as energy storage technology, and energy flexibility and control technology.

Regarding energy storage technology, in addition to storage batteries and heat storage systems, there are methods of pooling them with materials such as hydrogen, and methods of accumulating them by exercises such as flywheels. As for storage batteries, it is said that autonomous energy utilization is possible if the storage battery of approximately 10 kWh and solar power generation of approximately 3 to 4 kW are installed in a house of about two stories. For example, Gifu Prefecture’s New Energy Park GREENY Gifu demonstrated that if we have 6.3 kW of solar power and 9.7 kWh of storage batteries, it is possible to live at night in a two-story residence in a city area in Gifu, with the power charging done during the day. GREENY

Gifu purchased 9.7 kWh lithium storage battery made by a domestic manufacturer for 5 million yen in 2009, but the price of the storage battery has decreased drastically since then. For example, in the latest unit of the Power Wall series sold by Tesla, an electric car manufacturer, a storage battery of 14 kWh with an inverter is sold at the level of 617 thousand yen.

Techniques for storing heat include both latent heat storage utilizing dissolution and solidification of materials such as water to accumulate energy and chemical storage utilizing chemical reaction that accompanies heat storage. Latent heat storage is a simple method, but large capacity facility is required. For example, some cases include use of snow ice heat utilized for cooling in the summer by accumulating snow (e.g., 3,160m^3 snow storage at Moerenuma Park in Hokkaido), and regional heating and cooling systems which uses ice thermal storage tank (e.g., 1,100m^3 of ice thermal storage tank at Minato Mirai 21). The chemical heat storage system, also called a chemical heat pump, is a technology that can store heat over a long period of time with a small capacity unit as compared with latent heat storage. For example, in a demonstrative experiment conducted in Mie Prefecture, the waste heat of a waste incineration plant was stored in a transheat container with a capacity of 500 kWh over 5 hours, and hot water of 70 °C. was supplied to a hotel 10 km away. The amount of energy required for the transportation, and storage and release of heat is about 50 kWh, and it is known that the balance of heat can be achieved if it is about 30 km.

As for a method of accumulating it as a chemical substance, the use of hydrogen has attracted attention as Toyota Motor started selling fuel cell vehicle “MIRAI." The government made the expenditure in order to subsidize the installation of 100 hydrogen stations in fiscal 2015. Of the installation cost of about 400 million yen per station, up to the limit of 180 to 290 million yen was subsidized depending on the facility size, but the number of hydrogen stations that have opened as of June 2016 stagnated at only 76 (and 14 stations in the planning stage). The hydrogen that is currently used is by-product hydrogen from existing industrial processes and hydrogen generated by reformulating natural gas and others, and carbon dioxide cannot be stopped from being discharged at the manufacturing stage. In the future, it can be expected that hydrogen (R hydrogen) produced by renewable energy will be supplied by the infrastructure that is currently being developed, for example by generating hydrogen by decomposing water on a large-scale offshore wind farm.

The technology that is highly anticipated along with energy storage technology is energy control technology. As stages of control, various stages can be expected, such as at the level of building, block in a city, and power interchange among areas.

At the building level, with the installation of smart meters in all households by 2024 being planned, it will be possible to start introducing demand side control in the 2020s, which introduces dynamic pricing, which aims at lowering the electricity rates at peak hours and promoting use at the time of over supply by reflecting the stringent state of electricity supply and demand). As a result, electric power demand according to the change in the amount of renewable energy can be boosted, and the effect of energy saving can also be expected. For example, in the demonstrative experiment of dynamic pricing conducted in Kitakyushu City Smart Community Creation Project, the result showed a power saving effect of about 20%.

In order to make effective use of energy including thermal demand, it is necessary to interchange energy between buildings with different demand patterns. An instance of grappling with this at the block level is FUJISAWA Sustainable Smart Town (Panasonic, Fujisawa City), where the town-making is progressing with goals including 70% reduction of CO_2 emissions, 30% reduction of daily water, and 30% use of renewable energy, compared to the level of 1990. Also, the SMA×ECO Project (Daiwa House) is a project to set up solar power generation, storage batteries, HEMS in each household, and interchange power among buildings.

Furthermore, as long as power can be interchanged among electric power companies, it is possible to absorb power supply fluctuations of large-scale wind farms. However, for Hokkaido, where the wind resources are abundant, the interconnection capacity of Hokkaido and Honshu (mainland) is as small as 600,000 kW, which needs to be reinforced.

The shift from fossil fuels to renewable energy is a common issue throughout the world. Among renewable energies, fluctuating renewable energy such as solar and wind power are universally available energy unlike geothermal and hydraulic power whose available areas are limited, and the required technology for stable use of them will be a technology that can be expected to be in demand throughout the world from now on. It will be necessary to strengthen policies so that industries that utilize this technology will have international competitiveness.

4. Renewable energy sector as "sustainability department"

Now, introducing renewable energy is something that contributes to the maintenance and management of the capital base in each region through bringing income to areas where population decrease is progressing in Japan and through letting people remain in the area. In other words, renewable energy can be considered to lead to the development of the "sustainability department."

In particular, it can be expected that introducing renewable energy at the initiative of the community will have the following dual effects.

The first effect is that by utilizing the renewable energy that can be obtained locally, the wealth of the area that had been leaked out of the region in the past to purchase energy can be kept within the region. For example, when a trial calculation was performed for regional energy expenditure (for consumer and for agriculture, forestry and fisheries industries) by multiplying the standard energy rate in each region by the energy demand for consumer use and for agriculture, forestry and fisheries industries use grasped by sustainable zone research, the total was calculated to be about 42 trillion yen. This scale is 2.2 times larger than the total local tax revenue (about 19 trillion yen). Also, for all municipalities, when the ratio of regional energy expenditure to tax revenue was taken, the average was 2.7. If we can use these energy expenditures by introducing renewable energy to create employments within the region, the effect of employment creation will be a stable one because the energy demand is stable.

The second effect is that the feed-in-tariff scheme can bring in wealth from outside to the region by using renewable energy that can be obtained locally, without having to develop customers themselves. Based on the power supply estimation of renewable energy grasped in the sustainable zone research, a comparison was made between the power revenue earnings (the price obtained by deducting the avoidable raw price from the anticipated revenue from the feed-in-tariff scheme) and the local tax revenue, with the assumption that all renewable energy facilities were run by public enterprises of local public entities. As a result, electric power sales revenues in the whole country was calculated to the total of 1,145.6 billion yen annually, which was equivalent to 6.0% of the local tax revenues. As a result of trial calculation for each municipality, it was found that there were 107 municipalities where electricity sales income would exceed their local tax revenue.

In revitalizing regional communities, there is an argument with a tone that emphasizes promotion of cultivating industries that correspond to the “growth sector" of the region. For example, Mr. Ryohei Nakamura calls selling things and offering services outside the community to acquire out-of-region money as the “infrastructure industry," and calls industries that earn money by selling things and services within the region "non-infrastructure industry," and insists on the importance of nurturing the infrastructure industries because the number of workers in the former prescribes the population size. Although this “infrastructure industry" can be thought of as the same concept as "growth industry" in this paper, “infrastructure industries" will invite competition to acquire customers by each region. Therefore, because Japan as a whole is declining in its population, the nurturing will not be successful in all regions. On the other hand, supplying regional energy demand with regionally dispersed renewable energy can be surely tackled with in all regions. From this, I think that the introduction of renewable energy is the key to regional revitalization.

In the future, as the population is decreasing, it is necessary to maintain and manage the land of 370,000 km^2. Even in areas where people's hands have retreated, some maintenance and management are necessary from the viewpoint of national land conservation. For this

reason, from the viewpoint of working out the long-term cost for national land conservation, it will be justified to maintain currently existing local communities as much as possible and leave vitality to maintain various capital infrastructures in the region.

* This paper has some overlap with Hidefumi Kurasaka. Renewable energy and the future direction of economic development. *Environmental Economics and Policy Studies, Vol. 10, No. 1* (2017.3).

3. Sustainable low-carbon society

Satoshi Konishi

1. Technical options and the living sphere supply chain of humanity

As I stated in Section 1, all living things form and live in a system that transports and distributes materials and energy for their own survival in some way In the case of human beings, its living sphere supply chain is composed of artificial materials in highly sophisticated manner by technology. But regardless of methods, its system construction itself is the important purpose of activities by the human civilization, and is the result of its activities, which is not much different from the other creatures. There are various aspects to the human civilization, but at least in terms of constructing, maintaining, and updating and improving the material-energy circulation system, human society has not only technical aspects and visible constructs such as civil engineering, architecture and engineering. It also contains a software-like function to influence the behavioral choices as an individual or as a group through politics, economy, laws and regulations, social system, etc.. and further give directions to their motivation and target-setting as a whole.

Through such society and activities of human beings as a whole, "technology" itself has inherent norms and methodologies in terms of objective validity, and demonstrability of verification and counterarguments, in every aspect of the large scope of scientific research and device development. As a result, the system of the methodology called science and technology is neutral to the current survival and future rise and fall of human beings, the global environment, and other species. In other words, science and technology does not guarantee the survival and prosperity of humankind even if it is implemented precisely according to the target. When trying to create a device, material, method or system that has a certain utility, science and technology always select the best fit for the evaluation function as a result of trial and error according to the set target. The set goal is greatly influenced by the orientation of the "civilization" at the time. The living sphere, which is a material energy circulation system, does not necessarily have the sustainability of making the encompassed living creatures alive for multiple generations, but science and technology at least makes it possible to intentionally form a system that is coherent to its purpose. It can be said that the directionality in the formation of the living sphere of humankind has brought about the directionality toward throughput increase (growth) and structural formation (capital accumulation) almost consistently, amid the occurrence of the species called the human beings and the rise and fall of civilizations. Although this is what happened in the evolutionary process in any creatures overall, the competitions between species and within species take the form of contest for this resource throughput. The choice of technology that has a purpose or rather directionality has always required even more material energy throughput whether in agriculture, other industries, or competition among social institutions and groups, and technological development has responded to it. However, while energy acquisition of humankind represented by food is basically dependent on the conversion and fixation effect of solar energy through photosynthesis by plants, it can be said that it was mainly performed in the implementation and progress of agricultural technology (reclamation, cultivation, irrigation, fertilization, etc.) and in the competition for the farmland itself, and the growth was regulated by agriculture and the amount of photosynthesis in the forests.

With the industrial revolution making possible the energy use that did not depend on the amount of photosynthesis by the surface plant in the form of fossil resources, the throughput of the material-energy circulation system dramatically increased. It is not a coincidence that this happened in the U.K., where the energy supply from forest resources was exhausted but coal was mined. On one hand it embodied the imperialistic demand for rapid expansion of the living sphere. Because the throughput increase by the Industrial Revolution, that is, the growth rate, was overwhelmingly large compared to the previous system based mainly on agriculture, it came to occupy an overwhelming share in the human activities as well as

expand its total amount.

Taking Japan as an example, currently the energy consumption per capita is about 50 times the required calorie (which is supposed to be 2,000 kcal/day).

As shown in Figure B-4, we can see a correlation between GDP per capita and the energy intensity unit. The range is quite wide, but each country recognizes the need to expand energy consumption on their own in pursuing wealth. In the 19th-century imperialism and the subsequent advanced industrial society, economic growth and expansion of energy supply were also directionality given to technological development, and as a result of success in these, there were those that became developed countries in the 20th century.

On the other hand, however, as can be seen in Figure B-4, its dependency is not necessarily unambiguously determined, and the dependence of energy consumption and economic wealth is not so strong.

Figure B-5 shows the relationship between the Human Development Index according to the United Nations and electricity consumption per capita. Although HDI itself is an arbitrary indicator, it can be seen that a certain amount of energy consumption is required for at least a certain level of healthy and cultural life. The majority of human beings are resigned to still be in a state of low HDI, indicating that it is necessary to supply energy (especially to have access to electricity) in order to improve this.

On the other hand, however, at a certain level of living standard or above, even if energy consumption increases, HDI does not improve greatly. When we consider this in conjunction with Figure B-4, it is also understandable that developing countries will pursue any increase in energy throughput, while at the same time in developed countries it is not necessarily the case, and that they are not directed toward an increase in energy throughput.

As mentioned above, the technology itself is neutral, and it is also possible to construct material energy systems of different characteristics based on societal demands and directionality. Its ideal image and evaluation function are not necessarily shared or necessarily one, but in the group of developed countries which have reached a certain level of economic development already, conservation of the global environment and the sustainability of humankind are considered a shared goal to a certain extent. There, the expansion of the throughput aimed at by the 20th century and its growth rate are not necessarily emphasized, and it seems that things are directed toward a more comfortable life and economic activities of high added value with relatively low throughput. In other words, human society in the 21st century is in the process of changing its living sphere to a sustainable type.

It should be noted with caution, however, that such purpose setting is currently largely different between developed and developing countries. Economic development and growth are still major issues in developing countries, where inclinations can also be seen toward traditional energy throughput increase and a rapid growth economy. While they show an understanding of global environmental issues and sustainability, the general strategy of developing countries can be regarded as one that moves in such a direction after achieving sufficient economic growth.

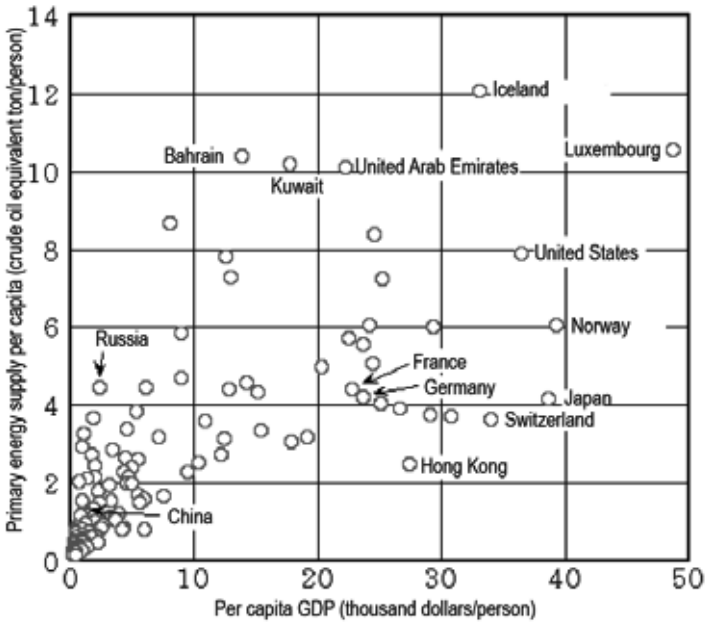


Figure B-4 GDP and energy intensity unit
(Source) *Energy hakusho 2007 nen ban* (*Energy White Paper, 2007 edition*). Ministry of Economy, Trade and Industry.

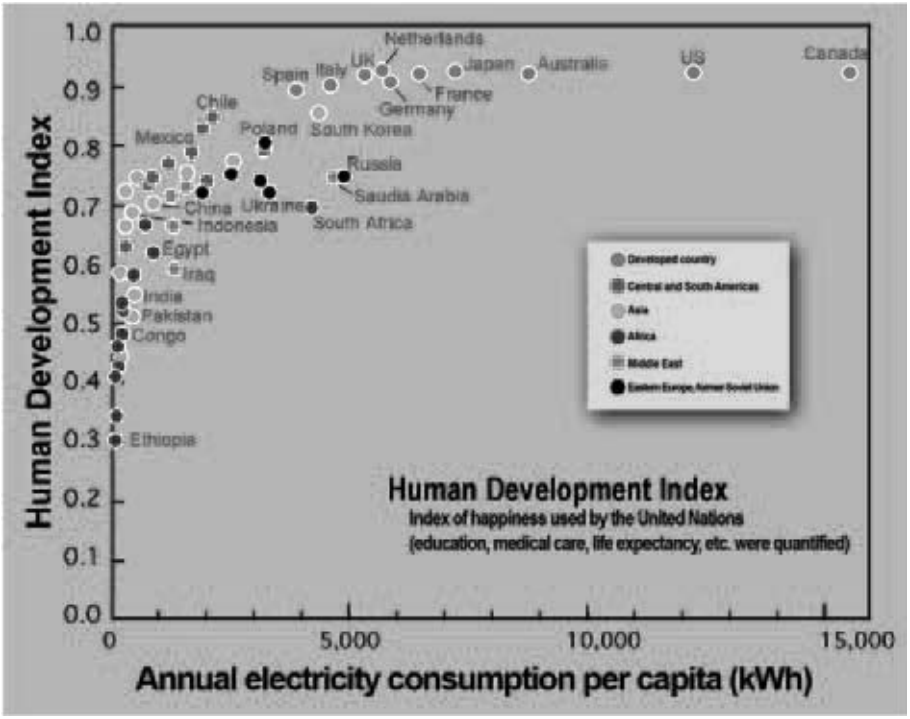


Figure B-5 Power consumption and standards of living

2. Sustainability of infrastructure systems

Technological development is still being carried out in all fields that constitute the living sphere of humankind, and as a result of its directionality toward the sustainable model of the 21st century, the system and technology developed as a resultant product is constructed with the purposes of increasing the efficiency of use of resources and energy, raising the circulation ratio, and achieving a great effect by decreasing throughput or increasing it slightly. The general structure of this system is shown in Figure B-3, but it is necessary to note that for the energy and materials, it shows the entire system from requests made from various factors up to the final point of use, which is not only the supplied part that is requested by consumers but also from the raw materials to the waste. As a result of sophistication in technologies related to these, resource dependency of material-energy supply will decrease and system (infrastructure) dependency will increase. This is because the structure of the supply chain will be more refined, complex and highly functionalized. In other words, it reduces raw materials and waste generated that are necessary to deliver materials and energy as products to consumers, and improves the function and efficiency of the entire supply chain.

As a result, the resource basic unit gradually decreases, and the structure, function and efficiency gradually increase. On the other hand, the value of the supply chain (as capital) will increase due to structural accumulation. The infrastructure system as a social structure will accumulate value in itself while reducing resource consumption, by constructing it so that it will be a sustainable model. Resource energy supply is a necessary service for human activities, and a certain amount of throughput is absolutely necessary, but it does not have to increase greatly as long as it responds precisely to the demand. On the other hand, supply anxiety, or so-called depletion and diminution, occurs when a response cannot be given to this, and it can be understood from the character of this infrastructure system that this is due to malfunction of the supply chain, and not the quantity of material.

Even after construction of infrastructure, resources are necessary for maintaining the structures, and operating and running them as software, and for this reason, it is necessary to introduce energy and resources. Some of the circulated energy is spared on this, and a structure cannot be maintained without this. Even if it is maintained, the structural function of the system, that is,

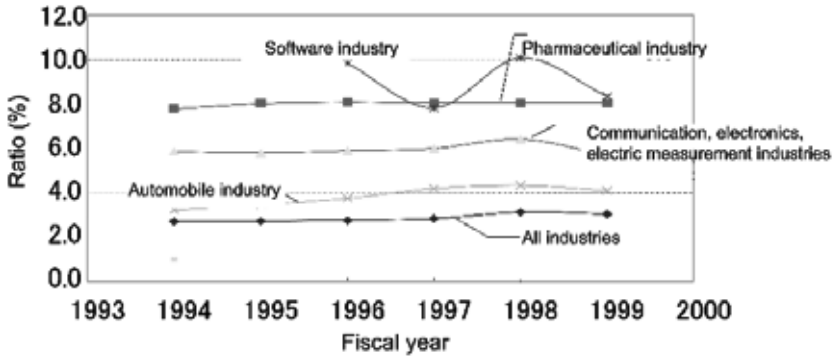
accumulated negative entropy, does not increase, but entropy emission occurs.

In addition, the sophistication function of the structure as an essential property of the supply chain itself always requires progress by research and development. This also has some cost necessarily, and sophistication of the system has decisive importance in the competition among living spheres. This resource requirement is necessary even without an increase in throughput in the form of increased production, but even if resource throughput is increased or decreased on the function of the infrastructure system as a supply chain, its required amount does not change greatly, and it has a low variety based on usage. This is a possible explanation in terms of system dynamics, as the cause of the marginal cost approaching zero in many living spheres' supply chains.

Figure B-6 shows the ratio of R&D investment to sales in the manufacturing and service industries and its changes. In any type of industry, they do not neglect investment for technological progress, and unless they constantly make progress, they cannot even continue production. In types of industry with larger consumption of raw materials and energy, R&D investment is relatively low. While at times individual developments may succeed or fail, the technology always progresses when seen in its entirety, and while productivity, efficiency, yield, and product performance improve, the amount of resources used decreases. In all of the individual products, resource dependency will decrease, and technological dependency and added value will increase.

Industry category	Ratio of sales to R&D expenditure	Industry category	Ratio of sales to R&D expenditure
Chemical industry	5.4%	Electrical machinery and equipment industry	5.9%
Ceramic industry	2.4%	Communication, electronics, electric measurement industries	5.7%
Iron and steel industry	1.9%	Precision machinery industry	6.8%
Metal products industry	1.4%	Software industry	8.4%
Machine industry	4.0%		

(Source) Kagaku tokei yoran heisei 13 nendo ban (Scientific Statistics Workbook FY2001 Edition)



(Source) Statistics Center, Statistics Bureau, Ministry of Internal Affairs and Communications. Kagaku gijutsu kenkyu chosa (Survey of Research and Develop
Sangyo betsu uriagedaka ni taisuru shanai shiyo kenkyuhi no hiritsu no sui (Trends of ratios of internal use of research fund to sales by industry (for companies).ment).

Figure B-6 R&D investment on sales in each industry

Humans' living spheres are a supply chain of energy and resources, but since many systems currently seen in developed countries are ones that were built from the 19th century to the 20th century, in many cases they are well-suited for mass consumption of resources and energy, and high growth. Even if the group of today's developed countries are directed toward a sustainable model of infrastructure systems as a social structure, that is, a supply system of resources and energy, the group of developed countries that have formed infrastructure as one of accumulation from the past is basing its lives on a structure constructed by imperialism and rapid economic growth society. In other words, the "living sphere supply chain" is not necessarily in a state suitable for the future direction, and society's structural transformation sometimes

requires a large-scale scrap and build. Or, it may become extremely gradual in accordance with the system update due to the useful life and take a long period of time.

As seen in Figure B-4, the difference in energy consumption necessary to obtain wealth for each country suggests that the structure of social infrastructure behind it is largely different. When we take for example, in achieving rapid economic growth, countries which developed industries that consumed relatively large amount of resources, and ones that became an industrial nation of a high added-value model, the difference is evident. Or even when we take transportation systems for example, it is evident between automobile-based countries and ones that have built infrastructure including railroads.

3. Low-carbon energy system

When we consider that almost all of social infrastructure is a resource energy supply chain in some form, an energy system can be easily analyzed and evaluated as one typical example. Especially energy such as renewable energy and nuclear power energy, which are said to be low-carbon energy systems, can be viewed as energy with less resource dependency, or conversely, system-dependent energy. For all of these, resource dependency is measurable together with the low-carbon property, but in its supply chain, the demand for consumptive resources is small, and the system corresponding to infrastructure has a large weight. Despite the fact that the raw energy before conversion, such as sunlight and wind themselves, is inexhaustible and free, it should be noted that there are supply constraints corresponding to supply curves anywhere in the supply chain. Thus, an upper limit and supply inconsistency is a possibility, and in fact it has already occurred in some situations.

For example, with respect to solar power and wind power, sunny roof-like places and locations where the wind condition is good with easy connection to an electric grid are limited, and furthermore, because locations with a good condition are used preferentially, the installation cost increases as the penetration rate rises, and the tendency of decrease in overall efficiency is difficult to avoid. Moreover, with natural energy having a sparse original energy density, the efficiency does not increase even if the facility is upsized, and it is difficult to obtain the merit of scale. This is a major disadvantage when compared to the fact that fossil fuel resources and nuclear power can increase the rate of further installation, that is, they can easily increase the growth rate or upsize the output per unit area or per unit plant, and also the fact that because of this, they have come to be a dominant technology in the rapid economic growth society.

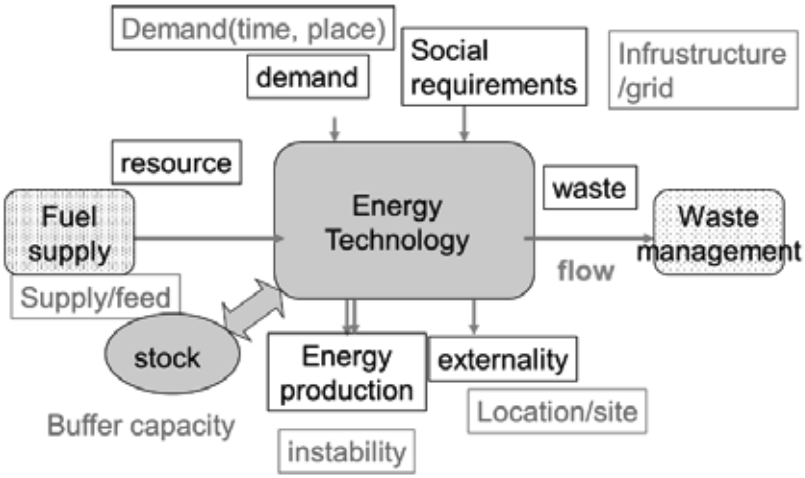


Figure B-7 Supply chain of renewable power generation

Another big limitation is the problems that solar power and wind power are inherently fluctuating and do not have the ability to respond to demand, and that it is difficult for the connected electric power system to absorb and stabilize the fluctuation. This has already occurred as the issue of connection refusal of renewable energy in many places in Japan. Although these problems ultimately return to the stability of a grid, power grids of large size, high stability, and mature control technology exist only in very limited areas of developed countries such as Europe, the United States and Japan. When we consider that an extremely large number of electricity grids in developing countries are small-scale as well as under severe supply and demand, introduction of renewable energy is actually in a tough situation in developing countries, which will be responsible for most of the future electricity demand. This problem does not occur in the conventional type of renewable energy that is hydropower generation, and rather it can be said that hydropower is an excellent power source capable of dealing with changes in demand with extremely short time constants and large fluctuating capacity, but its power generation depends on precipitation. With biomass also, resources are renewed, but its regeneration rate is determined by photosynthesis of plants, which constrains the rate. In particular, when we consider the relationship between the rapid economic growth and the fossil fuel energy system in the developed countries in the past, it has to be said that there is a big constraint on its introduction in developing countries in terms of the rate of growth of supply.

It is fair to say that future energy infrastructure in developing countries is still growth-oriented, and that there will be high interest in growth rate and energy density. However, the energy equipment and systems to be manufactured mainly in the near future will be those that are currently being developed in developed countries now. At times they are introduced to developing countries from the beginning due to the leap frog effect, but there is the issue that they are not suitable for emerging economies seeking rapid growth. In order to make the low-carbon energy system the mainstay of the world in anticipation of the latter half of the 21st century, a mechanism to give incentives to developing countries will be necessary.

As mentioned above, renewable energy and nuclear power, which are classified as low-carbon energy, have little dependency between available energy amount, resource consumption, and operation cost, and because of the extremely high weight on technology and facility, they are energy sources with low marginal cost. When a society uses energy composed only of low-carbon energy as its energy infrastructure, there is a high possibility that it will be a flat-rate energy service of zero marginal cost. Even when energy originally uses fossil resources, the weight of investment and system maintenance in building supply chains is not small. If this does not depend on resources and further demand the infrastructure a meticulous response to demands such as through implementing IT, the capital value of the system itself is large, while the energy throughput itself is in a direction of stagnation or decline due to high efficiency. It can be said that the energy infrastructure of developed countries is shifting to a sustainable model, slightly preceding the progress of low-carbonization.

Needless to say, the greatest purpose of the low-carbonized energy system is to reduce carbon dioxide emissions. Needless to say, renewable energy and nuclear power have a great effect on carbon dioxide reduction, but introduction of Carbon dioxide Capture and Storage (CCS) for the use of fossil fuels, and introduction of solar power, storage batteries, and fuel cells on the consumer side, will further the bi-directionality of energy infrastructure and its transformation into a network, in addition to carbon dioxide reduction, and will end up increasing dependency on energy supply technology and systems. As for these energy technologies, however, on the life cycle we cannot neglect the carbon dioxide produced at the time of its manufacture, and furthermore, carbon dioxide emitted at the time of manufacture can exert a greenhouse effect for a long period of time thereafter. Also, for example, it should be noted that silicon used as a raw material for solar panels is made using cheap, highly carbon-dependent power sources such as ones from China, and its emission is not a responsibility of the purchasing country.

4. Value creation

The relationship between a sustainable energy system and a society with low growth/zero marginal cost can be associated with the fact that construction of societal system using energy, namely energy throughput, is of an equivalent value to negative entropy generation (and further entropy discharge outside the system). Energy renewability and low-carbon property are accompanied by structural formation at the stage of accumulating original energy. Fossil energy resources are also low-entropy resources, since they are the result of converting high-quality energy of light, and releasing entropy over a long time, at the stage where the plant reduces carbon dioxide and accumulates as a highly structured compound. In the sense that carbon dioxide, which was dispersed in the atmosphere, is concentrated and condensed in a very limited volume, in addition to merely accumulating chemical energy, it can also be regarded as the result of paying the price of entropy emission of an extremely large amount over a long period of time, and the result of accumulating the value as its substitute price (negative entropy). Fossil energy resources are also renewable on the geological time scale, but the parts of value creation and accumulation that correspond to recovery of its carbon dioxide concentration cannot be easily recovered necessarily, even if carbon dioxide emission is reduced to zero.

Nuclear energy, along with renewable energy, also has a typical low resource-dependent energy system, and at the same time has a large negative-entropy accumulated constituent. It has a cosmic time constant, which is not what has been accumulated after the Earth's occurrence. Energy use, in the case of humankind who uses it to build a sophisticated living sphere, involves a large amount of negative entropy accumulation, which becomes a value creation. Value creation requires entropy emissions suited to it, and in a sustainable energy system, this flow cannot be ignored.

The accumulation of negative entropy in the living sphere due to this energy circulation is observed in the structural construction of the living sphere’s supply chain. The structure has a thermodynamic dimension (unit) as the information quantity = the logarithm of the reciprocal of the probability.

In this structural construction, material is used as its medium, but it does not mean that it is consumed. Further, it should be apparent that material amount and structure amount are irrelevant, and that ideally extremely few materials can be used to record a large amount of information, if we look at various devices currently used and genetic information in creatures. Infrastructure construction has accumulated structural quantities by moving considerably a large quantity of materials on Earth through construction of buildings and civil engineering work, etc. However, even if a large amount of steel material or concrete is used, it does not consume it (i.e., increase entropy by dispersing it in the environment as it depletes it), but actually extracts a specific material from the natural world, concentrates it, and converts it synthetically, thereby forming a structure. Maintenance is an action to prevent structural collapse (increase of entropy). System operation conducts entropy discharge movement (information accumulation effect), and R&D also accumulates information. All of these can be regarded as actions to create value in the form of advanced structural formation, material concentration, and uneven distribution, while discharging entropy using energy. The entropy balance can be evaluated in principle.

Also in the past, value has been measured in the form of negative entropy accumulation. The most easily understandable example would be mining and smelting of the metal element that is gold. This material exists at a reasonably low concentration on the Earth, and the part where it is concentrated in the form of a vein is rare. Furthermore, the process of physically and chemically concentrating it requires a large amount of energy, but basically the energy is simply used only to partly lower entropy. The gold that has been concentrated and collected by humankind as a result of this is said to be roughly the amount of 2 swimming pools in the whole world. That itself is not strikingly useful or highly valuable, and it does not have a large amount of material. The property of gold is measured as a symbol of throwing in a large amount of energy and accumulating the state with lowered entropy. We can say that the process of isotope separation is also a typical example of value creation from energy. To extract heavy water from water, or to extract uranium 235 as concentrated uranium from natural uranium,

enormous energy, technology, and facility are used. However, what is obtained as a result is the same uranium as the raw material, and the same uranium as the raw material. Each isolated isotope is useful and valuable, and is extremely expensive in reality, but they are chemically almost the same as the original uranium or water, and only the isotope composition is different. As a material, there is almost no increase (although there is a little loss). That is, it is not that the material itself that has value, but this value is something that was created by separative work and it is a result of energy conversion. If you leave this as it is, it will be mixed, and entropy will increase, losing its value.

Introduction of IT, informationization greatly improved the efficiency of value creation, and the efficiency of accumulating information structure that does not involve consumption of resources. Currently, virtual currencies have come into being, bitcoin being their notable example, and they are used as a valuation standard in place of gold and meteorological materials. This principle is also the same in this case. A large amount of energy is put into a computer, and a sequence with low probability is accumulated by accumulating the calculated amount. This value is negative entropy itself, not dependent on the material medium. Value purely exists as information that contains a dimension of energy. Of course, the value of such information is the value creation of humankind, which is similarly found in artistic activities such as literary works, music, etc., and scientific research activities, and it is easy to see that these are almost irrelevant to the consumption of material resources. Human beings, through technology, can isolate value from material, and extract it as having pure energy dimension.

The recognition of the facts that value is not attributable to materials or energy but is separable, that value occurs due not to materials but to their manners of existence, especially condensation, separation, and structural formation, and that its structure and distribution are created by entropy emissions using energy, inevitably results in the understanding that there is actually no value in things themselves. It can be concluded that the sustainable energy system, which is the main themes of this chapter, can be organized by the composition and transition of the supply chain through this series of discussions. Here, the energy itself or the energy medium itself does not actually have value. From sunlight, wind, streams flowing through rivers, coals sleeping in the ground and petroleum to uranium, the cost is incurred, and value is created not for the thing itself but for obtaining it, converting it into an available form, and delivering it to those who demand it. That is, only the operation with the composition of supply chain has value. And the relationship between energy throughput and value generated by the system is not strong, and rather the system structure and function are the essence of value.

Such features are common not only to energy, but to all necessities of daily life, such as food and water. That is, because an extremely large number of people, or all people need these things, and lack of them will interfere with the individuals' survival, it is important to compose a system for universally delivering a required amount to the places that require them at a required timing, which is the only thing that has value, and in fact energy, food, and water are quite cheap in price. If the living sphere is established, these are of course all obtained through natural survival behaviors for all living creatures, and human beings are no exception to this. However, with the efforts in technology and by previous generations, humanity has built up these supply chains in the realm of value creation by investing resources and efforts.

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Chapter 2 Population and Food

1. Population problem of the world

The population of the world reached 7.3 billion by 2015 and is expected to be about 10 billion by around 2050. Especially rapid population growth is expected to occur in least developed countries, and it is expected to make it more difficult for these countries to deal with challenges such as eradicating poverty and economic inequality, expanding their systems of education and sanitation, and expanding basic services such as food services. On the other hand, about a quarter of the world, including Japan, will face a declining population by 2050. With the extended average life expectancy and the decline of the birthrate, the aging of the population is seen globally, and we face challenges such as the decrease in the working population and its impact on the social security system. On the other hand, there are countries and regions where the young population still occupies a considerable proportion, and it will be necessary to deal with issues such as providing young people with education and employment opportunities. Internationally, the recognition that population problems are interrelated with development and environmental problems has been established, and viewpoints to solve these problems as one unit are required.

2. Population problem of Japan

The population of Japan has been increasing over the long term while experiencing several fluctuations since the Jomon period, but it has been declining since 2008. Population decline can have negative effects on the Japanese economy both on the flow side which is economic growth and on the stock side which is maintenance and control of capital base. However, even if growth in the flow of the economy as a whole cannot be realized, securing stock abundance per capita can be realized depending on the policy. In this direction, in order to secure abundance under the state of declining population, transition to economic operation on a stock basis and materialization of decentralization will be necessary.

3. Sustainability of food production

The food supply chain is described as a single material energy supply system driven not only by photosynthesis by sunlight but also with external energy invested in it. This expansion of food throughput can be described by the growth rate, and the growth rate of energy supply after the Industrial Revolution has achieved a rapid expansion of food production. Expansion of the population is represented by growth rate and is of a geometric scale as typified by Malthus, and the result of driving larger growth rate of food supply is the rapid population expansion. Human energy throughput has further expanded, and population growth has already deviated from that. On the other hand, the material energy supply chain via food has a low marginal cost which is similar to other living sphere systems, and there are many systems which are not based on the market economy. Many agricultural communities have completed a system that does not depend on the monetary economy. On the other hand, internationally, supply chains with less sensitivity to distance and quantity have been formed, and the food supply system has become a service industry of large cities. Population concentration in urban areas also corresponds to global changes in food supply systems.

4. Sustainable water supply

We also use the water supply chain bypassing the circulation route on Earth, instead of consuming it. Resources are being invested in building, operating, and maintaining facilities as infrastructure, and its marginal cost is low. There, energy is introduced to reduce entropy and it is delivered and distributed to those who demand it. Many of the water is used as a material energy transfer medium such as for washing and cooling, and the water after use returns to natural circulation. There are inherent regeneration time constants in groundwater and river water, and their throughput is constrained. It is possible to increase throughput by supplying energy by desalination of seawater and circulation treatment. Wastewater also requires treatment with introduction of energy in case when the wastewater exceeds the regeneration time constant of the natural world. Agricultural production also needs a lot of water, but in this case transfer of agricultural crops streamlines transfer of water as virtual water. The water supply system can also be constructed as a sustainable system by energy and technology.

1. Population problem of the world

Yukari Takamura

1. Current situation of the world's population

According to "The 2015 Revision of World Population Prospects" released by the United Nations in 2015, the population of the world reached 7.3 billion by the middle of 2015. This means that it has increased by 1 billion people in the past 12 years.

The regional distribution of the 7.3 billion people is as follows: about 60% (4.4 billion people) in Asia, 16% (1.2 billion people) in Africa, 10% (740 million) in Europe, 9% (630 million) in Latin America and the Caribbean region, the remaining 5% in North America and Oceania. China (1.4 billion people; 19% of the world's population) has the world's largest population, followed by India (1.3 billion; 18% of the world's population).

Looking at the age composition, 26% of the world's population is under 15 years old, 62% is between aged 15 and 59 years old, and those aged over 60 years old accounts for 12%.

During this, the population of the world continues to increase. However, the rate of increase is gradually becoming slower. Ten years ago, it increased by 1.24% annually, but currently it is increasing by 83 million people every year at the rate of 1.18%.

2. Prediction of the world's population

The population of the world will continue to increase, and it is predicted that it will increase by more than 1 billion over the next 15 years, and the population is expected to be 8.5 billion in 2030, 9.7 billion in 2050, and 11.2 billion in 2100.

Especially in Africa, the birthrate is expected to decrease considerably in the near future, but still a rapid population increase is expected. As a result, the proportion of Africa's population to the world population will increase from the current 16% to 25% in 2050, and 39% in 2100. (On the other hand, the proportion of Asia's population decrease from the current 60% to 54% in 2050, and 44% in 2100). Therefore, how population growth in Africa will progress will have a major impact on the future population size and population distribution of the world.

One characteristic of the future population increase is that the rate of increase is high in the so-called 48 "least developed countries (LDCs)," 27 of which are African nations. The least developed countries are certified by a resolution of the General Assembly of the United Nations after deliberations by the United Nations Economic and Social Council, based on the criteria certified by the United Nations Development Programme Committee (CDP). Certification is made on the 3 criteria, which are: (1) GNI (Gross National Income) per capita; (2) HAI (Human Assets Index) (an indicator of the degree of human resources development, which indicates the proportion of nutrition deficient population, infant mortality rate under 5 years of age, and secondary education enrollment rate); and (3) EVI (Economic Vulnerability Index) (an indicator of economic vulnerability). The population of LDC countries is expected to reach 1.9 billion in 2050 from 950 million in 2015, and 3.2 billion in 2100, and population growth is expected to concentrate in the poorest countries. Therefore, this is expected to make it more difficult for these countries to deal with the challenges of eradicating poverty and economic inequality, deal with starvation and malnutrition, expand systems of education and sanitation, and expand basic services such as food.

Also, by 2020, the population of India is expected to exceed that of China. The population of India has continued to increase over the last few decades and is projected to reach 1.5 billion in 2030, and 1.7 billion in 2050. In contrast, China will maintain its population at the level of 1.4 billion until about 2030, and it is expected that it will gradually decrease.

In contrast to LDC countries, India, etc., it is predicted that the population will decline in the world's 48 countries in the years up to 2050. In particular, several countries including Japan are predicted to have a population decline by 15% or more from the present situation by 2050.

Although it is the birthrate that largely prescribes the projection of the population in the future, but on the other hand, there are not a few issues in controlling the population. The population problem is under the sovereignty of each country, and international intervention or compulsion that ignores the intention of the state is not admissible. Also, measures must be considered and implemented to effectively address population problems while guaranteeing all couples and individuals the basic right to decide the number of their children freely and responsibly, the interval between births, and the timing, and the basic right to obtain information and means pertaining to making such decisions, as well as the right to obtain the highest standard of health concerning sex and reproduction, which is “reproductive rights.”

3. Extended life expectancy and aging of society

The world's average life expectancy has been extended in recent years, extending from 67 years of between 2000 and 2005 to 70 years between 2010 and 2015. Extension of the average life expectancy is seen in all parts of the world, and the extension of the average life expectancy in Africa, in particular, is prominent.

It is estimated that the average life expectancy will extend to 77 years between 2045 and 2050, and 83 years between 2095 and 2100. Especially in Africa, it is estimated that the average life expectancy will extend by 19 years by the end of the 21st century. Whether such an extension of the average life expectancy becomes a reality depends on how the measures against HIV and other diseases will progress.

Changes in the age composition of the population, particularly the increase in the aging population over 60 years of age, meaning the aging of the population, are one of the future tasks, due to the factor such as extended average life expectancy and the declining birthrate.

As of 2015, the population over the age of 60 was about 900 million, accounting for about 12% of the world population. By 2050, in other regions excluding Africa, the population over the age of 60 is expected to be 25% or more of the entire population. It is expected to increase to 1.4 billion in 2030, 2.1 billion in 2050, and 3.2 billion in 2100.

Such aging of the population, as indicated by the decline of the Potential Support Ratio (PSR) (which is population aged 20 to 64 years divided by population over 65 years old), causes the problem of decrease in the number of workers who support one retired person. The latent PSR of Japan is the lowest in the world at 2.1. Such population trends can have very serious consequences such as the on the fiscal situation due to the decrease in the workforce population, on politics, and on social security.

The aging of the population is a prominent characteristic, but on the other hand, the proportion of the young population still remains high, especially in developing countries such as those in Africa. For example, in Africa, the population under 15 years of age accounted for 41% in 2015, and the population aged 15 to 24 years accounted for 19%. Education, employment opportunities, and health support for such young population will secure a productive and competent workforce and contribute to eradication of poverty and improvement of living standards, and this is vitally important in realizing sustainable development in developing countries.

4. Interrelationship between the population problem and the developmental/environmental problem

It was when the World Population Plan of Action (WPPA) was adopted at the Bucharest Conference in 1974 that for the first time, the recognition was stated in clear words that solving the problems of population and development would require mutual solving of each other’s problem. The principle (c) of WPPA states this point as follows.

"Population and development are interrelated. Population variables influence development variables, and are also influenced by development variables. In this way, the creation of the World Population Plan of Action reflects the recognition of the international community that population trends are important for social and economic development, and the social and economic nature of the recommendations in the Plan of Action reflects the recognition of the international community concerning the importance of the roles played by development in influencing population

trends.”

At the Mexico City Conference 10 years after, recommendations were given on the importance of adopting an integrated approach on population and development at national policy and international level, and the necessity of not only the actions of developing countries but also policies on the side of developing countries and the international community in supporting such efforts to achieve the goals, while WPPA's action plan was reaffirmed. Then, the Cairo Conference in 1994 reconfirmed the basic principle of approving the mutual relationship between population and development as prescribed by WPPA, and confirmed the need for providing new funds to developing countries, within the framework of "Sustainable Development (SD)."

On the other hand, concerning the interrelationship between the population and environmental problems, some pioneering advocates like Ehrlich had pointed out the influence of population growth on environmental problems as early as in the 1960s, but it was on the Declaration of the Human Environment in 1972 that it first appeared on an international document. Although part 5 of Preamble is indeed optimistic, it states that while "the natural increase in the population continually raises issues concerning conservation of the environment," "human beings are the most precious things among all things," and that problems could be solved “if adequately appropriate policies and measures are taken." Then, Principle 16 stated that "Population policies that do not harm basic human rights that are considered appropriate by each government must be implemented in areas where the population growth rate or excessive population concentration adversely affects the environment or development, or in areas where depopulation hinders improvement and development of the human environment."

What confirmed the interrelatedness of the problems of population, development, and the environment in the framework of “SD," and explicitly stipulated that none of these problems could not be solved without solving the other two problems was the Brundtland Report. The report, in view of the finite nature of the resources, expressed the view that if the world population continued to increase, it would not be possible to manage the population, improve quality of life, and eradicate poverty, and as one of the critical goals in environmental policies and developmental policies derived from the concept of “SD," “maintaining the population at a sustainable level" was laid out. It is also this report which advocated that the population problem should be captured from the viewpoint of each person's progress and equality, and not just of the figure of the total population. This direction was handed down to the Rio Declaration of 1992, and Principle 8 of the Declaration stated that "the state should promote appropriate population policies to achieve sustainable development and higher quality of lives of all people."

The Cairo Programme of Action, adopted two years after, used the framework of “SD," but this time it positioned three issues of population, development, and environment from the viewpoint of population problem. The action plan states, “there is an agreement in the international community as a whole that “continuous, pervasive poverty and grave sexual inequity of the society have a serious influence on demographic parameters such as population growth, composition, and distribution, and conversely, they are influenced by such parameters," “unsustainable consumption and production patterns are contributing to an unsustainable use of natural resources, deterioration of the environment, expansion of the social inequity that involves influence on the above demographic parameters” and “if the population increase becomes slower, it will be possible to nurture the ability to fight against poverty, protect and restore the environment, and build a foundation for future sustainable development,” and that “it is possible to suppress population increase and achieve stability of the population at an early stage by eradicating poverty.”

In this way, the recognition was established in the international community that the problem of population was interrelated with the two issues of development and the environment, which were pressed for its solution by the international community, and that solution to each of the problems depended on the other problems. In particular, if the population rapidly increases in developing countries and the concerned developing countries are not equipped with sufficient economic capability to nurture the rapidly increasing population,

it can cause shortages of food, and health and medical services. Furthermore, labor opportunities will not be able to catch up with the rapidly increasing population, which can lead to a rise in the unemployment rate and low-wage labor. As a result, developing countries will end up with economic and political instability factors domestically, and at the same time economic disparities between the North and the South can expand further. This not only brings the factor of instability to the side of developing countries but also makes it difficult for developed countries to secure stable export markets and supply bases for import goods, and it can greatly influence developed countries through international migration of population, including an outflow of economic and environmental refugees abroad.

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2. Population problem of Japan

Hidefumi Kurasaka

1. The Long-term trend of Japan's population

Hiroshi Kito, *Jinko kara yomu nihon no rekishi* (*The History of Japan Read from the Population*) (Kodansha Gakujutsu Bunko) pointed out that there have been four waves in the population of Japan in the past 10,000 years (Figure B-8).[71]

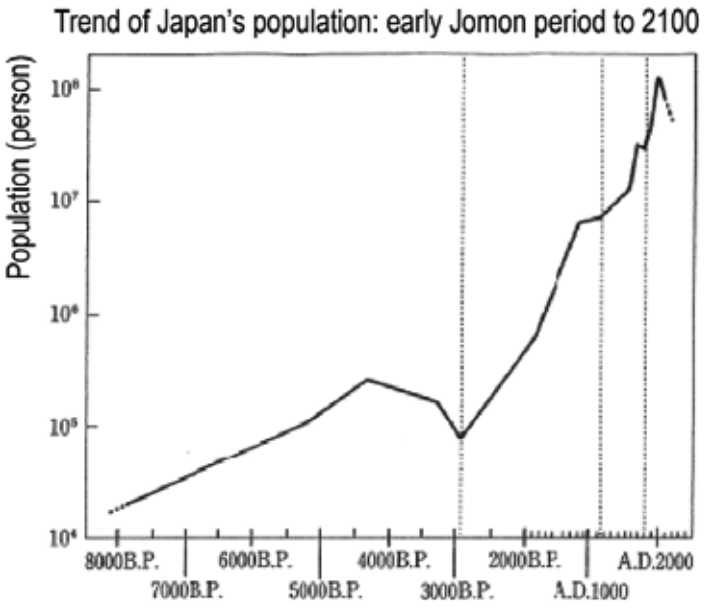

Figure B-8 Trend of Japan's population
(Source) Hiroshi Kito. *Jinko kara yomu nihon no rekishi* (*The History of Japan Read from the Population*). (Kodansha Gakujutsu Bunko). p.19.

The first is the population circulation in the Jomon period. In the Jomon period, the population increased from 20,000 in the early period to 261,000 in the middle period, but declined to 160,000 in the latter period and to 76,000 in the late period, according to him. This is believed to be due to the sharp decline in the population in eastern Japan with the cooling of the climate. The second wave is the population increase from the Yayoi period to the 10th century and after. The population which declined in the late Jomon period was recovered by rice farming agriculture and its popularization, and rose to about 6.5 million around the 10th century (which is early Heian period). According to Kito, although the population increase slowed down after that, the third wave of population growth began in the 14th and 15th centuries, and it continued until the 18th century. Although the estimation of the population in 1600 has some range, it was estimated to be around 10 million to 15 million. The population of the early Edo period grew, and according to the shogunate's demographic survey, it reached 26.05 million in 1721. However, the population in the late Edo period stagnated, which is said to be 26.84 million in the demographic survey in 1846. Kito points out that behind the third increase in the population, there was a permeation of behavior based on economic rationality. And the fourth wave is the population growth accompanied by industrialization in the 19th century and after. According to Kito, Japan's population in 1872 according to family registry was 34.81 million, then it reached 43.85 million in 1900, and finally exceeded 100 million in 1967.

2. Outlook for the future population decline

The fourth wave pointed out by Kito has already finished, and Japan's population is headed for a declining period. The population of Japan turned to a decreasing trend at the peak of 2008. Figure B-9 shows the long-term trend of Japan's population based on the population projection by the National Institute of Population and Social Security Research. According to the estimated future population of Japan up to 2065, published in April 2017, the total special fertility rate is forecasted to recover to 1.44 in 2065 (previous estimate being 1.35 in 2060), and this will somewhat put the brakes on the population decline. However, we can see that the overall trend will not change greatly.

The decline in 1945 is the impact of World War II. At this time, 2.3 million people were lost in one year, but the population recovered the following years. It is predicted that the population will be below 60 million in 2100, falling back to the level of the Taisho era, and the population decline expected in the future will be at

[71]Hiroshi Kito. (2000). *Jinko kara yomu nihon no rekishi* (*The History of Japan Read from the Population*). (Kodansha Gakujutsu Bunko)

the average rate of 800,000 annually until 2060. With this population decline, the population aging will progress. Because of this, the working age population will decrease faster than the population will decrease. From the viewpoint of sustainability of the economic society, it can be said that Japan has come to a major turning point.

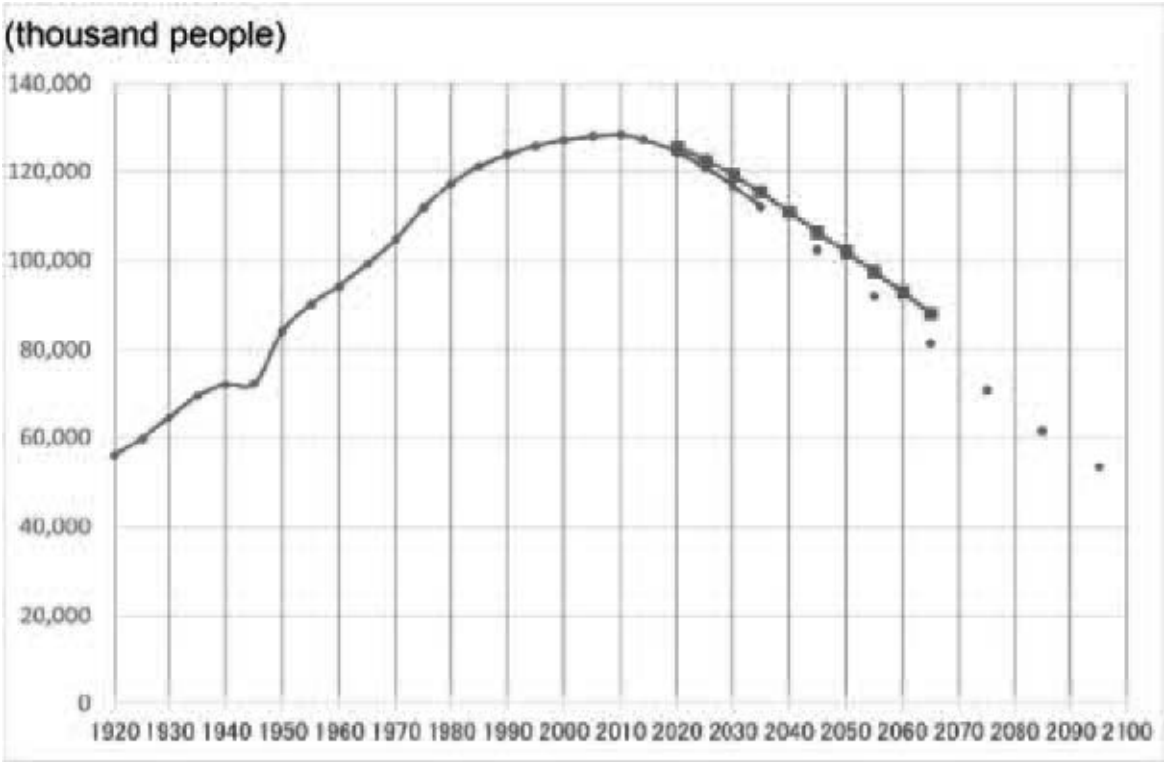

Figure B-9 Long-term trend of Japan's population

(Source) Created by the author, based on *Statistical Handbook of Japan 2016.* The Ministry of Internal Affairs and Communications.For the period between 1920 and 2005, and for 2010, population according to Population Census is used (except 1945 for which Demographic Survey is used); (includes people with an unknown age). For the periods between 2006 and 2009 and between 2011 and 2014, the estimated population as of October 1 based on the population according to Population Census is used. For the period between 1945 and 1970, Okinawa Prefecture is excluded. (For the period of 1950 and onward, the aggregate number of the entire population, male/female, and the population according to the division into three age ranges include the statistics of Okinawa Prefecture. However, for 1950, the population according to the division into three age ranges excludes the statistics of Okinawa Prefecture.) The future population is based on the middle estimate value on October 1 of each year according to National Institute of Population and Social Security Research, based on the fact that the numbers were determined for the 2010 Population Census Basic Aggregation Result and Vital Statistics of the same year. And the line from 2020 to 2065 indicates an estimation by median age at birth (median age at death) of the future population of Japan (estimation as of 2017).

3. What will happen with the population decline

Population decline may give various negative impacts on the Japanese economy.

Firstly, there is a negative impact on the flow side. In this respect, negative impacts can be expected on both production and consumption aspects. Due to the decline in the working-age population, production capacity will decrease. In addition, due to the population decline, domestic demand may decline and the economy may recede.

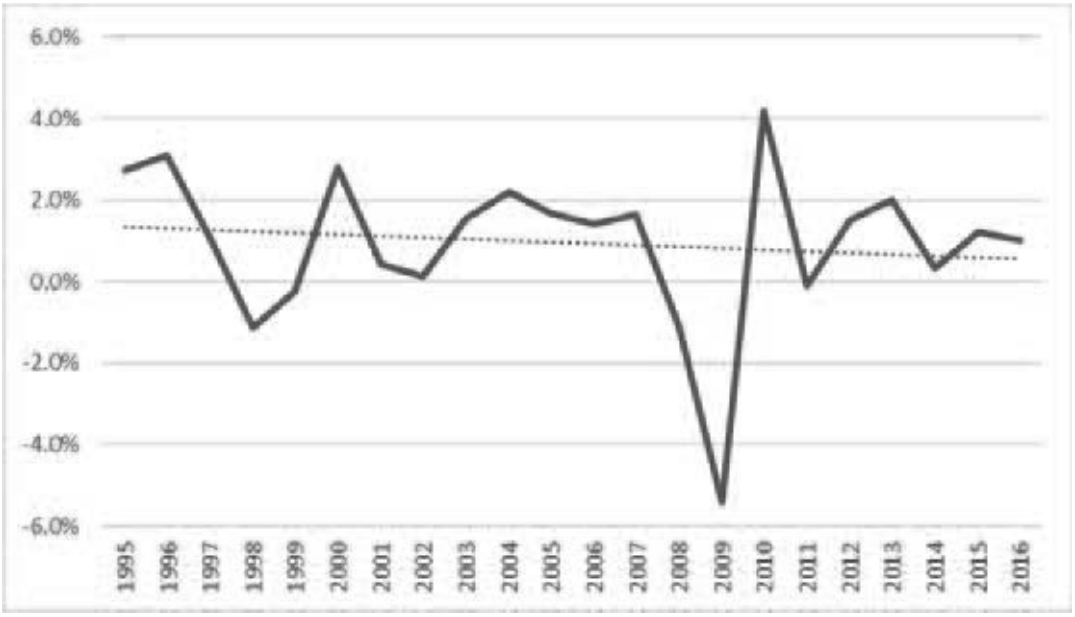

Figure B-10 Trend of GDP growth rate of Japan (in real terms)

(Source) From "National Accounts." 'Gross Domestic Product (Expenditure side, Real terms: Linkage method: 2011 calendar year linkage price)'

However, there is also a claim that economic growth can be made even under a declining population. For example, a group of the Ministry of Economy, Trade and Industry stated, "(the constraining factor that is the population decline) can be overcome by enhancing abilities of individuals, increasing productivity, and shifting the industrial structures toward a more productive field in Asia," and claimed that it was possible to achieve a 2.2% growth in real growth rate on the annual average by 2015.[72] This goal has been adopted as it is in "Economic Growth Strategy Outline" formulated by the Fiscal and Economic Integrated Reform Council in 2006.

However, since the Economic Growth Strategy Outline, the real growth rate of Japan's GDP is in a situation where the long-term declining trend has not stopped, as shown in Figure B-10. Even in the face of such a reality, there is something persistent about the growing faith that prevails among economists. Hiroshi Yoshikawa states as follows. "Even in a mature developed nation, economic growth that fits each economy, as if it is more comfortable for each person to walk at the pace that suits him rather than staying still for a single point for a long time, it is much more natural than zero growth. Under zero growth, employment of the currently working generation, especially young people, has no choice but deteriorate. From that viewpoint also, economic growth is necessary. That is my opinion." Then, he insists that product innovation is "source of economic growth in developed countries.[73]"

If the productivity per capita multiplied by the working age population is GDP, and if the productive age population decreases, unless productivity per capita is raised at a rate that exceeds that of decrease, we cannot expect a GDP growth as compared to the previous fiscal year. This is the same with the demand aspect, and economic growth cannot be expected without acquiring foreign demand to the extent that it can supplement the decrease in domestic demand due to the declining population. Even if he states that economic growth is possible without verifying its feasibility, it is probably not convincing. The group of

[72]Takao Kitabata, Masashi Oshita, & Keisuke Saito. (2006). *Jinkogenshoka deno "aratashii seicho" o mezasu "shinkeizai seicho senryaku" o kataru* (*Talks about "New Economic Growth Strategy" aiming at "New Growth" under a Declining Population*). Research Institute of Economy, Trade and Industry.

[73]Hiroshi Yoshikawa. (2016). *Jinko to nihon keizai* (*Population and Japanese Economy*). Chuko Shinsho.

the Ministry of Economy, Trade and Industry, mentioned above, named its own strategy the "new strategy," and in those words are written, “We'd like to show that growth is possible even in the society where the population is going to decrease from now. This is the new growth." Their extremely emotional obsession with growth is humorous and at the same time harmful.

The adverse impact of the declining population is not limited to the flow side. Adverse effects on the stock aspect are also important. This means that there is a concern that the burden of maintaining and managing various capital base stocks will be uncoverable and stock quality will deteriorate. Our economy is supported by various capital bases. The capital base is defined as an existence with a mechanism that provides usability, and as one whose mechanism will not be lost by providing usability. There are four types of main capital bases: human capital base, artificial capital base, natural capital base, and social relationship capital base. If these capital bases are not properly cared for and maintained, the duration of the capital-based mechanism will be shortened, and the usability of the capital base will be diminished.

Declining population and aging of the society mean that care of human capital base (especially nursing and medical care) is required more than ever. It also means that the maintenance and management burden per capita of artificial capital base called social infrastructure such as water and sewer pipes and roads will increase. Furthermore, the natural capital base (artificial forest, agricultural land etc.) maintained by human hands will enter a state where sufficient manpower is no longer required, and its quality will deteriorate. This is recognized by the national biodiversity strategy, which can be regarded as the deterioration of the quality of nature due to the lack of maintenance by humans. Finally, in order to maintain mutual support among people, it is necessary to maintain a moderate population density, and in this respect the population decline has an adverse impact.

4. What is the richness in the era of population decline?

Then, does the declining population equal to a decline of the Japanese economy? From the viewpoint of urban planning, Toru Nakayama said, "If we say that the population and industries are declining, it may give an image that seems to suggest promotion of the decline of the local area. But that is not true.[74]" The point is in the shrinking of the planned urban area. Nakayama insists, "If we can proceed with the contraction of the planned urban area, we can send the same life as before, at the same burden. Furthermore, if the natural environment can be regenerated on a large scale using the newly vacant land, the urban environment will improve."

This is the argument that, speaking in line with the organization from the previous section, the richness of stock can be realized depending on ingenuity even under the declining population. Even if growth in the flow of the economy as a whole cannot be realized, securing the per capita stock abundance can be realized depending on the policy.

In addition, the latter part of Nakayama's argument would correspond to the benefit that is accompanied by the population decline. Yoshinori Hiroi insists, "It makes more sense to think that the population that is somewhat more diminished than it is now is positive in various aspects such as correcting overcrowding, being free from spatial, temporal, and spiritual constraints, environmental and resource problems, among others.[75] The items that can be expected as merits of population decline are listed below. Firstly, it is possible to operate the economy with less resource energy consumption. Secondly, it is possible to operate the economy with less environmental impact. Thirdly, the space for human occupancy can be made less, and fourthly, the adverse impact due to competition with others for limited opportunities can be corrected.

Hiroi says, “It may be possible to think that a transformation into a society with a declining population is a perfect opportunity or an entrance to making a society that is truly rich and where people can feel happy.” "In the coming 50 years, the reverse phenomenon of what happened in the rapid growth

Toru Nakayama. (2010). *Jinko gensho jidai no machi zukuri: 21 seiki = shukushogata toshi keikaku no susume* (*Town development in the era of population decline: 21st century = an encouragement of reduced city planning*). Jichitai Kenkusha.

[75]Yoshinori Hiroi. (2013). *Jinko gensho shakai toiu kibou* (*Hope that is the population declining society*). Asahi Sensho.

period will begin to occur. For example, the rice paddies in the suburbs that changed to residential areas in the 1970s will return to empty lots, green spaces, farmlands, etc., again in the future," states Hiroi, with an optimistic outlook[76].

However, as described before with withholding remarks such as depending on ingenuity" and "depending on the policy," in order to be able to enjoy the merit of the society with a declining population, it is necessary to revamp the framework of the citizens' thoughts which exert an influence on policy-makers and their policies. This point is in line with Hiroi when he says, "As long as we consider things in the framework of ideas and values of the rapid growth period or by its extension, we will not be able to think of the society with a declining population as one that has been defeated or progressing towards "decline[77]."

Measuring the economic prosperity in terms of economically added value has become unsuitable for the actual situation of Japanese local governments and municipalities which already face population declines. On the other hand, if the population size is moderate, there is a possibility that it can sustainably support the living with resources obtained in the region. This is the background of the idea of "*satoyama* capitalism" which is being gaining empathy in various regions.

According to Kosuke Motani, "'*Satoyama* capitalism' is a secretly constructed subsystem independent of money, alongside the economic system of 'monetary capitalism' built on the premise that the circulation of money will decide everything." Then he states, "*Satoyama* capitalism is the ultimate backup system for keeping water, food, and fuel even when money loses its function[78]."

Motani views the population decline positively and says, "It is in the very depopulated areas, which have been regarded to be in a disadvantageous condition under the monetary capitalism, that is, where the amount of natural energy per population is large and assets from the pre-modern era remain unoperated, that there is a greater possibility[79]." This is an indication that resonates with the "sustainable zones" research.

"Sustainable zone" is a concept proposed by the author[80], and refers to an area that can by calculation meet all of the energy demand and food demand in the area by renewable energy and food available there. Since 2005, in a joint research with the Institute for Sustainable Energy Policy Research, the local energy self-sufficiency rate and the food self-sufficiency rate have been estimated and published for all municipalities annually. (For details, refer to Chapter 1, Section 2, "Renewable energy and future economic development.") The three roles of this index are listed, which are; 1) to make visible districts where long-term sustainability has been secured; 2) to have the possibility to change the perception of "progressivity," and; 3) to clarify the path to an era of post fossil fuel era.

Figure B-11 shows the relationship between the population size of municipalities and the regional energy self-sufficiency rate ascertained by the sustainable zone study. The regional energy self-sufficiency rate is the ratio of renewable energy supply within a region to the energy demand for civilian use and uses for agriculture, forestry and fisheries industries within the region, and for the municipalities plotted above the line with the arrow in the figure, this proportion exceeds 100%. 71 such municipalities exist as of March 2016[81], and the data shows that there is a higher possibility that municipalities with a smaller population size are more likely to fit this case.

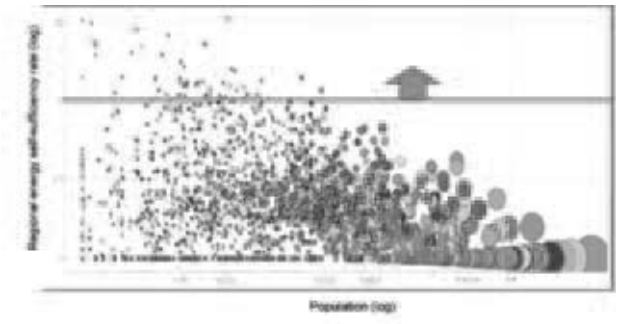

Figure B-11 Relationship between population size of municipalities and regional energy self-sufficiency rate
(Source) Kurasaka Laboratory & the Institute for Sustainable Energy

[76]Same as the previous note.
[77]Same as Note 5.
[78]Kosuke Motani & NHK Hiroshima Interview Team. (2013). *Satoyama shihonshugi* (*Satoyama capitalism*). Kadokawa Shoten.
[79]Same as the previous note.
[80]Hidefumi Kurasaka. (2002). *Kankyo o mamoru hodo keizai wa hattensuru* (*The more environmental protection, the more economic development*). Asahi Sensho.
[81]Kurasaka Laboratory & the Institute for Sustainable Energy Policy Research. (2017). Sustainable Zone: FY2016 Report. http://sustainable-zone.org/

Policy Institute. Persistent Zone Report.

5. To enjoy the richness of the era of population decline

In the policy to secure richness under the population decline, it will be necessary to reform the framework for policy operation from two perspectives.

The first is to transfer the indicators of economic operation from one based on flow to one based on stock. Increasing the amount of added value of the economy as a whole is a means, not an end. The purpose is a happy life of each citizen, and continued prosperity in the future. Even if the amount of the added value of the economy as a whole does not increase, if we can secure the sustainability of a sound capital base stock according to the population of the citizens, we can ensure a happy life and prosperity in the future. Specifically, we will need a capital base stock management that secures profit from the flow, to the extent that it can cover the labor and demand that are required for maintenance of the capital base, while agreeing on how much capital base should be secured for the future on the societal level. (See Chapter 6, Section 1, "Sustainability of capital base" for details.)

The second is the materialization of decentralization. The state of capital base stock varies from region to region. Also, the state of renewable energy and food production that can support this varies from region to region. Therefore, in accordance with the principle of complementarity, the policy of capital base stock management must first be done with the local initiatives. And the tax and financial mechanisms will need to be transformed, so that the benefits of the expansion of the flow of the economy as a while, promoted by the national government, can be used for capital base management promoted by rural areas.

3. Sustainability of food production

Satoshi Konishi

1. Malthus' error

As mentioned in Chapter 1, food is a means to bring energy into the body for all living things, and each creature obtains this through the help of other creatures (or through preying on them) in the “living sphere,” a path that is composed by multiple creatures with the solar energy being the origin, in the supply chain created by the creatures on Earth to enable this. Even today, all human beings eat continued to be bio-based (except for some inorganic salts such as salt for consumption). The fundamentals of the system for that purpose of human beings is a technically constructed system, that is, agriculture, but its fundamentals remain unchanged. Through photosynthesis by sunlight, energy restores carbon dioxide and water respectively, and is converted into chemical energy of carbohydrates such as glucose. For not only animals but also plants, among the materials that constitute their living bodies, ones that are hard to be photosynthesized are nitrogen compounds typified by amino acids, and in addition others are phosphate compounds which are the medium for recording genetic information of the living bodies. Introducing these compounds into the photosynthesis process dramatically increases its conversion efficiency, but its supply is regulated by the action of cyanobacteria and the amount circulated in the natural world, and it has never expanded greatly up until the modern agriculture. However, as stated in Chapter 1, the increase in throughput due to the industrial revolution, that is, the rise in the growth rate, is overwhelmingly larger than that of previous agricultural-based systems, and it dramatically increased food production.

As one of the results, the population of the humankind also began to expand greatly. Here, we will consider the relationship between food production and the population, but the population theory of Malthus, which is often referred to, can actually be interpreted in a reversed way. In other words, "If the population has increased (at a geometric rate), it proves that the corresponding food supply has increased geometrically." It is true that we can say that the human population has increased geometrically because it can be expressed in a form like birth rate or population growth rate, but the usable energy throughput of humankind can also be described by growth rate, and a much larger numeric value became possible with the advent of energy that “can be increased by mining” after the Industrial Revolution. As far as agriculture is concerned, synthesis of fertilizer by fossil energy, cultivation, etc., greatly improved agricultural productivity. In other words, it simply happened that as the growth rate of food production increased, the increase in population followed it. Humanity has always increased energy consumption per capita through technological progress, and the time when it succeeded was the increasing phase of the population, which became pronounced after the Industrial Revolution which dramatically expanded energy throughput. Indeed, the economic growth rate, food production increase rate, and population increase were linked for the period a little after the Industrial Revolution. When the increase in food production stagnated, the population of human beings stagnated or decreased. In fact, as far as the available food statistics are concerned, consistently after the war, even in developing countries, the growth rate of food production has exceeded the growth rate of population, and thus the calorie intake per capita has also increased.

However, since human beings passed the stage in which they relied on plants’ photosynthesis for energy supply in a way that was almost done left naturally, and energy consumption per capita exceeded the calorie per capita by several times even in countries and regions which were at a quite low stage of economic development, it should be considered that the food production and the population problem have deviated considerably for a very long time. Even now, the fact remains that there exist quite a few people, several hundreds of million people in the world, for whom food supply is directly linked to the population, and they are the people that live while maintaining an extreme

balance under nutritional stress or can easily starve to death. However, in many cases it is not that there is a shortage of food production throughout the world, but in most cases, it is just that the food cannot be obtained or does not reach the people who need it, meaning in fact that the food production is not putting a constraint on the population. There are many cases in which the poverty is the cause, but this is also a problem of the social system and the politics, and by no means there are many cases where food is truly rare and too expensive to buy. In those areas, agricultural production is close to one of self-sufficiency, and it is a societal problem that they cannot make investments (such as irrigation and fertilization) enough to improve its productivity. Rather, food prices are falling on a global level in the long run. However, this is working as a pressure to cut production against agriculture in developed countries which are suffering from constant overproduction and price stagnation, not a phenomenon favoring food supply in developing countries, especially in the hunger areas. As mentioned in the energy section, food has little value as a thing, and most of the cost is paid to a series of supply chains to convert solar energy into a medium in a form that is usable for human beings, such as food. Moreover, in countries where food supply is a problem in particular, food is often delivered to users not as a commodity but through means other than commercial means.

2. Food production and energy system

As we saw in the previous section, agriculture itself, on which human beings depend for their food supply, is a complex energy conversion system itself, and even in pre-modern agriculture, various forms of energy were introduced other than solar power, including cultivation and reclamation, irrigation utilizing potential energy of rainfall and wind power, and fertilization using biomass other than agricultural crops. In modern agriculture, this has a strong characteristics of energy conversion using fossil energy resources, and in fact in modern agriculture, far more direct energy and indirect energy are supplied from energy sources other than the sun. Cultivation, operation of agricultural machinery, and warming of greenhouses and greenhouse cultivation consume a large amount of energy, but indirectly consumed plant metabolic substances such as nitrogen, phosphorus, and potassium are also industrially manufactured. The situation is that as such material throughput came to be introduced in great excess of the constraints of plants and the environment surrounding them (e.g., supply by river water), food production has increased greatly, and this means that throughput of material that pass through humans are driven by external energy supply. And the fact that the rate of increase was one of high growth peculiar to fossil energy and rapid economic growth model achieved a quantitative expansion of energy system of food production and at the same time was a factor in triggering a sharp increase in population. The greatest increase in production was brought about by the progress of a series of agricultural technologies called "Green Revolution", which realized a much higher growth rate in agriculture than the population growth rate. The greatest element of those is the input of high-yielding varieties, and the yield per unit area has more than doubled for most crops. In other words, increase in the conversion rate of solar energy to food means that the energy throughput that goes through humankind in the supply chain has increased.

In the general supply chain as shown in Figure B-3 of Chapter 1 (p. 16), the supply amount of any of them limits the overall throughput, and in extreme cases if one of the paths fails the whole stops. If there is an alternative route, it can be continued, and if there is buffer capacity, the stop can be avoided within that range. Also, if the throughput of the path that was the constraining condition is expanded, the overall throughput increases until it is limited by the next constraint.

Much of the energy material circulation of the whole living world is driven by solar energy, but at the beginning of its driving mechanism is photosynthesis, which simultaneously receives constraints of supply including temperature, water, carbon dioxide and several kinds of mineral components besides the sunlight. Even though water and carbon dioxide are supplied from the atmosphere and precipitation, agriculture extracts minerals in the soil through the plant body, so for sustainable production all the elements that plants absorb from the soil must continue

to be supplied from the outside in some form.

Especially while plants cannot ingest nitrogen directly from the air, because it is a major element constituting chlorophyll, amino acids, and all proteins, it is administered (fertilized) in the form of a compound (nitrate ion or ammonium ion). This can markedly enhance the growth of plants, which in turn has greatly increased the material throughput of all organisms originating from plants. Also, phosphoric acid is a constituent element of DNA and RNA, and also puts a constraint on the growth of creatures dependent on the food chain starting from there, unless the plant absorbs it from the soil. Material circulation in agriculture has been carried out since the ancient times by composting excreta by humans, livestock, and other plant bodies, but as in the case with fossil fuels, it wasn't until the modern times that it became possible to input them into the ecosystem by mining. Chilean nitrate (ammonium nitrate) have been used since the beginning of the 19th century, and fertilizer made from phosphate ore began to be also used from around the mid-19th century. It was in the 20th century when chemical synthesis of the necessary elements (fertilizer) to these plants began, and also ammonia synthesis by Harber Bosch was conducted in 1913, and material technology to withstand high pressure was necessary. Besides this, there are many elements required by plants such as potassium, magnesium, calcium, but supply from soil and river water is small. It is these fertilizers that are important for industrial supply, and its synthesis is currently an important element in the supply chain for the survival of humankind.

Because animal husbandry currently also relies on forage for the majority of its production and the forage crops rely on agricultural production, similarly it can be said that animal husbandry converts fossil energy resources into meat, dairy products, etc. In reality, as for livestock products, the calorie intake is worse by some fraction to even one tenth in efficiency when grain is compared with food as it is, so this means that the increase in meat consumption happening in developed countries is markedly lowering the energy efficiency associated with food production. Because the calorie intake per capita according to the aforementioned food statistics is often converted on the basis of grains, in fact, it means that surplus grains actually increase in value due to animal husbandry, and that they are being consumed in a large amount per capita in wealthier countries.

The fisheries do not occupy a very large proportion in the energy intake especially in terms of calorie base or protein conversion for the entire humankind, and it is said to be at most several per cents, and its catch has not shown a larger increase than agricultural products. On the other hand, even in fishery, energy dependence is extremely high, and an extremely large proportion of catch cost is due to fishing boat fuel. Unlike agriculture, fertilization and cultivation are not carried out in fisheries, and even if technological progress is made, as long as the regeneration rate of marine products by the ocean is constant, rapid increase in production cannot be expected. Rather, it is well known that as a result of improvement in catch technology, many fishery resources have decreased, and catch restrictions have become necessary.

This situation was greatly improved in some aquaculture fisheries, and the growth rate of marine products produced by aquaculture became extremely high due to external resource input. However, as with most livestock feeds, the dependence of aquaculture fisheries on energy supply has also become high, as most of the feeds used in the aquaculture industry are made of fish meal, that is, fishery products.

As for the ocean, human beings are not actively intervening in the material circulation system itself in the fisheries as much as in agriculture, the material throughput has not been as greatly affected. However, the elemental circulation in the ocean is known to be relatively limited, especially where it is far away from the land in the center of the ocean and in the deep sea. There is an attempt to supply iron ions artificially, in order to promote the photosynthetic absorption of carbon dioxide in the ocean. It is also known that coasts, which have mineral supply from the land, still have a large amount of resources for the fisheries industry. On the other hand, the influx of domestic wastewater by human activities, especially disturbance to the ecological system in the water due to excessive eutrophication of coastal areas because of the influx of detergents and fertilizers has also become a problem.

Forests, while they do not contribute much to food supply of human beings directly, make a greater contribution to photosynthesis on Earth than agriculture at the current situation, greatly influencing the absorption of atmospheric carbon dioxide and the trend of organic matters that eventually reach human beings. Management of forests is carried out artificially in the form of forestry, which also greatly changes the vegetation on Earth, like agriculture. Currently no fertilization has been performed. It is also known that tree species have changed greatly through logging and the associated afforestation of forests since the beginning of history forests as well as in forests that are renewed naturally. Regardless of whether this is artificial or not, it has changed depending on underground minerals and mutually dependent, competing relationships among plants, and of course the disappearance of forests due to the felling by humans and desertification have also become a problem. Human beings currently use a massive amount of energy for material circulation on a global scale to make a large-scale intervention, such as discovery and breeding of plants related to food, breed improvement and formation of new species, cultivation by clones, and biotechnology. In the future, it is expected that many attempts to change global environmental problems, especially changing the balance of carbon dioxide to the side of atmospheric concentration decrease, will have a new influence even if food production is not necessarily the main end.

As described above, various systems supporting human food production can be sufficiently analyzed for their characteristics, as typical examples of energy material supply chains. As a result, considerable introduction of external energy, mainly fossil energy and the high growth rate peculiar to it, have been the major driving force factor behind the population growth and the prosperity of today's humanity. At least regarding food supply up to about 10 billion people, which is supposed to be where the humanity’s population will be constant, and the energy supply conversion system necessary for that, we can say that pessimistic views are baseless for the most part if we consider the progress of food production technology that is still going on. In other words, the sustainability of food supply is not a problem that threatens the survival of humankind, which is a concern in a simple mechanism like the one by Malthus.

The relationship among population, energy, and the food supply chain, however, also contains more complicated causal relationships which cannot be analyzed from the statistics of the whole world or of specific countries. First, direct energy input in agriculture and fisheries is mainly fuel, which is not easily converted by renewable energy or nuclear power. In addition, food consumption as seen on a calorie basis is not so elastic in price, but in reality, food has become highly value-added products in developed countries, and food production itself is placed in an extremely unstable market environment. As mentioned previously, the energy dependence of meat consumption and aquaculture fisheries is high, and commodity food production is greatly influenced by the price of energy. In industrialized countries, agriculture as an industrial structure declines, and the little remaining part is forced to head towards producing a small quantity with high added value. The same applies to fisheries. On the other hand, even now, the income of developing countries still has not reached food prices which are international products. It is not a simple quantitative relationship but the future food production of the world should be viewed as being governed by the technological progress in the supply structure, due to the producer income and food prices. There is no guarantee that the input of high-yielding varieties which have supported the major part of food production up to now will continue in the future. On the other hand, there is still a problem of hunger in low-income areas. As with energy, food is also international products, and transactions must be made at the same price between countries with a per capita GDP difference of a hundredfold or larger. Inevitably, the world will have a dual structure in which low-income countries will use energy that is not products to produce food that are not products, and live with it. And there is no guarantee that agricultural production and forest management are sustainable if they are not dependent on the monetary economy or international markets with insufficient quantifiable statistics. Furthermore, the trend of BECCS (Bio-Energy with Carbon Capture and Storage) as a

non-food photosynthetic economy and emissions credit markets will increase in importance in the future.

3. Food production supply chain

As seen at the end of Chapter 1 about value creation, food is basically not valuable as things, just like energy. In most cases the supply chain of agricultural products that have been produced, and by further extending the range of analysis, agriculture itself, is a system for delivering food, by converting solar energy into energy medium that can be metabolized by humans, and the cost for this operation accounts for almost all of the price. It is not that humans are paying for the sun, the ground, or the plants. As a matter of fact, even in developed countries, in many areas where "food other than commodity" is eaten in many cases, and in many such areas where food supply really involves life and death and population trends, food is not supplied through commercial transaction. Food is also similar to other energy services in that the marginal cost is low, and can be viewed as a product of the supply chain so that it can function to provide supply to its constituent members.

The essence of the food system is the energy supply chain, with its center of gravity in the infrastructure that distributes large quantities to all consumers without breaks. Because of this, inherently the usage system is low, the price elasticity is small, and the marginal cost is low. The agricultural communities of developing countries (and even in developed countries, in some cases) basically has a closed supply chain, and its constituent members are not necessarily exchanging food at the same price as in external markets. For this reason, even if grain prices are far more expensive in the international market, they can get by, and self-employed farmers in fact can get enough food in many developing countries that have not failed politically. Many of the problems of hunger are due to dysfunction of the food supply chain on the part of politics and systems. Although poverty is a problem, citizens such as those in sub-Saharan countries cannot buy food of at an international price even if their income is slightly improved, and it is necessary to build a sound system that can produce food and provide supply in solving food problems in developing countries, and remove social constraints (war, institutional deprivation, lack of social capital, etc.) for that purpose.

On the other hand, in the local system, the food supply chain in the international market does not always make local production and local consumption more advantageous. This is due to the fact that progress in modern transport and storage technologies is reducing the usage-dependence on transportation costs to an extreme extent (even in terms of distance and quantity). In Japan, for example, even for vegetables that are supposed to be fresh foods, imported products from Australia or South America may be cheaper than domestic products. Regarding basic foods (such as grains), the marginal cost of food has already become considerably low, and rather the cost of constructing and operating the supply chain accounts for a large proportion. As a result, in most parts of the world where trading is done at international prices, food can be transported from the most productive area to the demand area (to the extent that destructive price decline does not occur), food production has already been adjusted for the majority of world demand in accordance with the demand. On the other hand, in this way, because it has become possible to transport a large quantity while maintaining quality at a relatively low cost even to a distant location, or because food can be preserved time-wise regardless of the harvesting period, there have been cases where competitiveness is lost in terms of scale, production cost, and especially personnel expenses and climate, even in the close proximity of place of consumption. This is similar to the phenomenon that occurred in developed countries, especially in the coal industry. Since agriculture has the character of managing while influencing a wide range of ecosystems as well as producing food, land conservation and rural communities as a result have a great impact on traditional societal formation itself.

It has become technically possible for human civilization itself to efficiently construct a supply chain of material energy necessary for daily living across quite a wide area. For this reason, the marginal cost is extremely low in the supply system for almost all of the supplies necessary for human life. In both developing and developed countries, it is for food (and water) that

the supply system is formed first, otherwise society cannot be established. In that living sphere system, food, energy, and water are physically available in the amount necessary for daily living, and within that range, a system has been constructed in which the majority of the constituent members can acquire them price-wise. Because such mechanisms also occur in humanity by movement and migration of individuals, a conspicuous increase in the population of humankind is occurring in cities in developing countries. As a community, in rural areas, only the population within the scope of self-sufficiency on its economic scale can be supported, while cities are more productive and food as commodities can be obtained in that area. On the other hand, also the social structure itself is changing greatly with changes in the food supply system, because the supply chain is in close contact with the lives of the humankind itself. The food supply in the major cities on which today's human beings depend is the logistics and service industries, and much of their costs are on the system and operation, not on the raw materials.

4. Sustainable water supply

Satoshi Konishi

1. Typical material supply chain

The water resource problem is a representative example of the fact that it is actually a transit type circulation like the energy, while it appears to be a consumable resource material supply chain. Water resources are of course finite, but they are incompressible and circulate throughout the environment. "Depletion" of water resources is not a shortage as a quantity, but it is a problem of the supply chain in which the supply speed cannot keep up with consumption rate. Originally, water bypasses the process of precipitation flowing through the river into the sea, and then this is used by human beings. There are some instances where precipitation that becomes groundwater is pumped up similarly. Basically, it is typical of renewable resources, and if a system has simply been constructed which supplies the required amount properly in the human beings' living sphere when needed and where needed, in many cases it is supplied to consumers in a way that is close to one of zero marginal cost. Once the system is constructed, water passes through it, so the cost does not depend on additional usage, whether the water is used or not.

On most of the surface of Earth is extremely rich in water as a material, but most of it is salt water in the ocean, and there are few water resources of water quality suitable for human use, and that is the freshwater on a limited part of the surface. In addition, for the purpose of supply this is accompanied by added value (value creation) through input of energy and technology (purification, separation, transportation, distribution etc.), and that should be all that a supply chain is. Raw water itself is free and inexhaustible just as sunlight, wind power, etc., are, but the supply amount has a time constant and limit due to the natural environment. Ground water supply time constants vary widely from several days to tens of thousands of years, and in the sense that it can be depleted due to use exceeding the supply rate, it has a similar limit as biomass (especially woody biomass). In Japan, the quality of tap water is at the level of drinking water level in the world, which is an exceptional case globally, but the necessary amount of drinking water is 2 liters per day per person, and for domestic water this ranges from 100 to 1,000 liters. The demand for water is larger for agricultural and industrial uses, which account for a large part of water resource use, but the water quality required for that is different from that of drinking water. Agricultural water is used for irrigation, but if the water is at the level of river water or groundwater, special treatment is unnecessary, and the only cost is for transportation. For the above reasons the price is extremely cheap, and globally there are many cases where it is provided at a fixed price. Consequently, incentives for conservation do not function well, but this is also an example of a zero-marginal cost system that is characteristic of infrastructure-dependent supply chains. Significant saving is possible through drip irrigation, and indeed some Middle Eastern and developed countries use this.

Water is required in large amounts, and transportation is difficult except by a waterway, so human beings have from the beginning lived within the range of their supply capability, where water is available, and have constituted their living sphere there. The fact that agricultural water accounts for a large part of the water demand by human beings is the reason why, when water is necessary for food production and only food could be imported, it has still been made possible for human beings to live where water (for agriculture) cannot be supplied and living spheres have been constructed. As a result, the supply chain of water can be considered including the concept of "virtual water" when considering food. As a result, food supply from extremely remote water resource-rich areas to urban population-dense areas is made possible. Virtual water makes it possible for the entire human beings to consume a larger amount of water without transporting it for a long distance and using it, and the amount of water used has increased beyond the physical constraints of the supply chain.

Industrial water, which accounts for tens of percent of the use of water resources, is mainly used for cleaning

and cooling, which are only devalued and are renewable. As for domestic water, almost the same amount flows into the river, etc., from the sewage after use, and it may be used in the downstream as well. In this point, it is different from agricultural water that is ultimately lost in soil absorption or evaporation. In a sense, unlike ceramic water for which we do not have to think about “post-treatment," these water supply chains occupy a large proportion of wastewater treatment, but this issue will be discussed in the next section. Including purification by the natural environment, it is possible in terms of cost and labor, and river water including sewage can be recycled in this way, if necessary.

Water for agriculture also eventually returns to precipitation via evaporation or underground water, and the use of water by human beings is not different in that it bypasses the circulation amount in the vicinity of Earth's surface. Ultimately, it is similar to the biosphere stated in Chapter 1, and water resources are sustainable as long as the necessary water resources in the closed water circulation system are able to add value to the required water quality by some energy input. Conversely, water supply will be depleted unless the supply chain is normally operated and maintained, and energy supply is provided to the extent that it enables entropy reduction which is a separation of work of water quality.

The supply shortage caused by the deviation of the physical constraints of the supply chain from the water consumption may trigger the "depletion" problem that typically occurs in "renewable" resources, in the sense that the required water does not reach people or places that need it. Every water resource is a finite resource that is dependent on the amount of supply from the upstream even if it is renewable. It is exhaustible from the viewpoint of supply rate, and it seems to be inexhaustible within that limit, if it exceeds the limit, it will not be renewed. When we talk about the upstream, if it can be obtained through evaporation, condensation and precipitation in the clouds, or underground filtration process, it means that there is a constraint on the circulation rate by solar energy and gravitational energy, respectively.

For this reason, groundwater is inexhaustible within its supply, but it is exhausted if it is pumped up too much. While some of the shorter generation time constants are several days, some of the longer ones, for example, like Mt. Fuji’s floodwater, takes several hundred years, and large groundwater found in continents have a time constant of hundreds of thousands of years, and the rate of regeneration cannot catch up with the pace when it gets pumped up too much. If the water is made to flow out to the river more quickly because the earth surface gets covered with asphalt due to urbanization, or trees in mountainous areas are cut, the amount of effective available water resources decrease.

Where there is a limit to circulation with natural energy, in the sense that artificial energy input can construct a supply chain, water and agricultural products are the same. Even now, Middle Eastern oil producing countries (Kuwait, Libya, Saudi Arabia, UAE) make water by desalination of seawater. Water distillation and reverse osmosis membrane method are the main technologies, and it can be easily manufactured technically, but energy consumption is much larger than that of processing river water, etc. However, this is also evidence that what restricts the real supply chain in water resources is the energy supply, not the water supply. Since this raw cost is 100 yen per kiloliter or less at the current energy price, it can be said that this decides the upper limit of the water resource price at global level by the backstop effect. The amount of energy required for seawater desalination is huge in response to the demand for water, but the quality of energy does not have to be high. Therefore, it can be used with low-quality direct solar or windmill power that does not have to be strictly controlled for the stability and voltage frequency by putting it into low-temperature heat of the exhaust heat level accompanied by the nuclear power generation or into the grid. In other words, we can say that it is possible to introduce it by cogeneration, etc., along with low-carbonization of the energy system in the future, especially along with the rapid energy development of developing countries, and access to water is an issue that is comparatively easy to solve through energy and technology.

2. Water supply as a service medium

In agriculture (irrigation), mainly water is used on the ground surface in the open system, and after changing the route of the river and groundwater flow, etc., eventually the majority is evaporated, lost, and circulated to the precipitation. In this regard, it has a supply chain very similar to natural energy. Dams and inflow-type hydropower generation are systems in which water use and power generation coexist in the first place. Although it seems that this does not intervene much in the water circulation in the natural world, environmental impacts are not negligible because of the nature of water as a medium, which may not always be sustainable. Domestic and industrial water are mainly distributed in a closed system, and it is used exclusively as a material and heat transport medium. Even in these processes, it seems that water is used in large quantities, but it does not mean that the water itself is consumed but that only the route is changed for the water to pass through. Most of it is streamed to the river or sea, as sewage or industrial waste water, and the sustainability of the environment again becomes a problem here.

Because the plundering of water from the river by dams and agriculture naturally means the plundering of the water at the river basin in large quantities, it affects vegetation, and because it hinders the arrival of sediment on the coast, a great decrease in sandy beaches has already been observed in Japan. Dams themselves also need dredging due to sediment deposition, and they are not necessarily sustainable. On the other hand, irrigation has the effect of sucking up salt from the ground, causing the destruction of the well-known Mesopotamian civilization.

As mentioned earlier, water for domestic and industrial uses is used as a medium to carry materials and heat. Sorting and cleansing in the mining industry also separate useful substances from unnecessary substances, or transports pollutants, and do not reduce the amount of water itself but dissolve and suspend pollutants and carry them to sewers and rivers. Substances that must be removed from the product line due to the mining process are carried away after being cleansed with water, and then discharged. If this is emitted in the environment, as long as it is sufficiently low in concentration and promptly discharged to the ocean, etc., it will be rendered harmless by diffusion, decomposition by other creatures and chemical processes in the natural world. If this exceeds the processing throughput of the environmental purification process, the entire water supply chain will fail unless it is processed with a waste liquid technology. Since the problem of water is not only a supply problem but also a problem of securing throughput in a closed circulation system, processing of sewage drainage and environmental pollution are often more important, and if we want to use water exceeding the limits of the above-mentioned natural energy circulation system, we must build and operate a system for increasing throughput and entropy emissions through artificial energy input. This applies not only to the supply side but also to the waste liquid treatment side, and actually wastewater treatment may result in large expenses and large costs of social efforts, system construction, and operation. Especially when contaminants are spread widely when water is drained, it will take a lot of labor and cost to recover it. On the other hand, if harmful substances are also diluted and diffused in the ocean, it is also possible to isolate them from the living sphere for a sufficiently long period of time, even when viewed from the time constants of human survival.

In thermal and nuclear power plants, the discharge of heat itself is the main function comprising the heat engine, and exhaust heat to the environment can affect it. For example, wastewater with a temperature higher than 7 degrees above the raw water is not permitted in Japan, but wastewater with an extra high temperature dilutes and releases this extra entropy by evaporation and heat dissipation to the surrounding environment.

In other words, the main function of water use is to discharge a large amount of entropy in the process. Conversely, filtration of water and production of drinking water are purification of water and extraction of entropy from it, which consume energy. Water can be regarded as not consumable by itself but as one form of entropy discharge by energy use. In the series of processes such as flow by gravitational energy, filtration in the ground, diffusion in the ocean, and evaporation and condensation in high altitude, water circulation in the environment has a sustainable system structure

similar to the ones in Figures B-1 through B-3 in Chapter 1, that is, circulation by and entropy discharge by natural energy and entropy decrease of water itself

Chapter 3 Mitigation of and Adaptation to Climate Change

1. Whether the Paris Agreement will work: Its evaluation and issues

In the Paris Agreement, the agreement was reached on a long-term goal aimed at "zero emissions" in the latter half of the century, and on a mechanism that would raise targets to achieve long-term goals by having each country review its own target every five years. In order for the Paris Agreement to function effectively, it is necessary to establish international rules by which the international scheme under the Paris Agreement, including this target raising mechanism, will effectively operate. The progress of countermeasures for decarbonization in each country is the key. Economically rational choices have come to be seen for developing countries towards decarbonization while responding to the expansion of energy demand that accompanies economic development, due to the reduced cost of renewable energy. As a result, the position of developing countries is starting to change, which has previously shown a negative attitude toward strengthening international countermeasures against global warming. The Paris Agreement affects not only the nations but also the behavior of business, finance, and investors in particular, and that has enhanced the support for the Paris Agreement and its effectiveness.

2. Rethinking the meaning of sustainability

Environmental problems arise when the waste generated by human activity exceeds the limit that is acceptable by the natural environment, and when we use renewable resources beyond that limit when it was supposed to be used within the range in which originally they could have been reproduced. Also, in the way of thinking about “strong sustainability”, there is a recognition that natural capital cannot be substituted by other artificial capitals, etc. While human beings have produced much artificial capital so far, they have caused degradation of the natural capital that has supported life on Earth. Taking that humbly, we should dare to think about future sustainability based on "strong sustainability."

3. Sustainable cities and transport

In urban areas where the majority of human activities are performed, its spatial structure prescribes the manner of activities. Especially transport activities consumes much energy and generates much environmental load. The sustainability of the city depends on the planning and management of the transport network and modes because the interrelationship with the urban spatial structure is also strong. Logistics gains its relative importance by diffusion of IT. More efficient logistics caused by the compactification of urban areas, enhancement of added value of people’s movement, and low-carbonization are in demand.

1. Whether the Paris Agreement will work: Its evaluation and issues

Yukari Takamura

1. Adoption of the Paris Agreement

On December 12, 2015, the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) adopted the Paris Agreement and the COP decision on its implementation. The Paris Agreement is an international treaty for the first time in 18 years since the adoption of the Kyoto Protocol, agreed to deal with global warming (climate change) issues.

The international community has so far established a framework for international coping with climate change problems based on the 1992 Climate Change Framework Convention and the Kyoto Protocol adopted based on it at the 1997 Kyoto Conference (COP3). However, the effectiveness of the Kyoto Protocol, which imposed duty on emission reduction only for developed countries, was questioned on account of the economic development of emerging economies and the accompanying increase in emissions, and the non-participation of the United States. Although it was aimed to establish an international framework in which all countries promise to conduct reduction internationally, and while an agreement could not be reached at the Copenhagen Convention (COP15), developed countries and major emerging countries among others submitted and have implemented their 2020 targets based on the political agreement at the 2010 Cancun Conference (COP16) (the Cancun Agreements). However, even if the 2020 target submitted by each country is accumulated, emissions cannot be reduced enough to achieve the 2°C target of keeping the temperature rise below 2°C compared to before the industrialization, which was agreed upon by the international community as a long-term goal. The Intergovernmental Panel on Climate Change (IPCC) said in the latest 5th Assessment Report (2014) that, in a scenario with a high possibility of keeping the temperature rise below 2°C compared to before the Industrial Revolution ("2°C Scenario"), greenhouse gas emissions would be nearly zero or negative in 2100 compared to 2010. With such a background, the Paris Agreement was agreed upon at COP21 as a result of negotiations that began in 2012, aiming at the creation of an international treaty by which all countries would agree on reduction.

Now, will the Paris Agreement effectively function to achieve its long-term goals of 2°C target and zero emission in 2100?

2. What was decided in the Paris Agreement

As with the Kyoto Protocol, the Paris Agreement is a legally binding international treaty consisting of 29 articles. In addition to the emission reduction measures, the Paris Agreement also specifies transparency of adaptation measures, funds, technology development and transfer, capacity building, action, and support to the adverse effects of climate change. Due to the constraints of the space of this paper, I will focus on the following three points considered characteristic of the Paris Agreement as compared with the previous international framework.

2-1. Long-term goal aimed at "decarbonization" and "zero emission" in the second half of this century

Particularly important among the agreements of the Paris Agreement is the fact that long-term goals and vision that the international community would aim at were more clearly defined. Under the growing concern worldwide over the negative impacts of climate change, the Agreement aimed to strengthen global response to the threat of climate change, and for that purpose stipulated that the world's average temperature rise kept to the level “well below” 2°C compared to before the industrialization, and that efforts be made to keep it within 1.5°C (Article 2). In addition, in order to achieve this goal, the Paris Agreement stipulated that the world's emissions set off as soon as possible, and then, in accordance with the best of scientific knowledge, it aimed at a rapid reduction in a way that would maintain the balance between anthropogenic emissions of greenhouse gases and its anthropogenic absorption in the second half of the century (Article 4.1), showing a

vision of a decarbonated society and economy that would make emission substantially zero (zero emission) in the second half of this century.

As the British "The Guardian" newspaper called the adoption of the Agreement "the end of the fossil fuel era," the Paris Agreement showed the common value and vision aimed at by the international community, which was to be free of fossil fuel dependence. The IPCC Fifth Assessment Report, while identifying the eight major climate change risks with high confidence such as flood damage in metropolitan areas, outages of infrastructure due to extreme weather phenomena, etc., many other major risks were an important issue for the least developed countries with limited capabilities and communities which would be easily-affected. Not to mention the 1.5°C target, the 2°C target is not an easy goal by any means, but in consideration of the risk of climate change faced by the most sensitive countries and people despite having made little contribution to emissions, the international community agreed to choose to reduce emission and aim to achieve it.

These long-term targets provide guidelines for each country, including Japan, to create and implement targets, as well as show directions of the future society and businesses to businesses and citizens who will be key players of reform for decarbonization. The report by thinktank 'Carbon Tracker' and the University of London (LSE) Grantham Institute, "Unburnable Carbon 2013" pointed out that merely burning all fossil fuel assets that private companies have already invested in developing, excluding government-owned assets, would result in emission going well above level of the carbon emissions that could keep the temperature rise to 3°C, not to mention to 2°C, and the investment in the fossil fuel business would take the risk of not being able to recover its investment. The report called the unrecoverable assets "stranded assets." In this way, the long-term goal such as the 2°C goal uncovers the risk of investing in future fossil fuel projects.

2-2. A sustainable framework for raising targets every five years, aiming for the long-term goal

The Kyoto Protocol obliged developed countries to "achieve" numerical targets, but the Paris Agreement mandates all countries to create, submit, and retain the reduction target (nationally determined contribution; NDC) to be achieved, and to implement domestic measures for achieving the target (Article 4.2). Using the results of the overall progress evaluation (global stocktake) towards the long-term goals (Article 14) as the guideline, each country has an obligation to submit its target every five years (Article 4.9) Just because they create their own target, it does not mean that the goal may be anything. It has to exceed the given country's current target, and it must be a maximum possible target (Article 4.03). The Paris Agreement, which stipulates that a target be submitted every five years continuously, is supposed to be a sustainable framework that will continue until the long-term goals are realized, not until the immediate targets are achieved.

In the case of the Kyoto Protocol, the target levels were determined through negotiation among countries and prescribed in the Protocol, and then the Protocol was concluded and implemented (also called the "top-down approach"). On the other hand, in the Paris Agreement, the level of the target to be achieved is determined by the government on its own, and the target is to be the international target under the Paris Agreement (also called the "bottom-up approach"). Because according to the Paris Agreement, each country creates its own goal, while certain conditions are attached to the target to be submitted (in some cases additional conditions may be added in the negotiation of future implementation rules), so it may be more appropriate to call it the "Hybrid Approach."

The Paris Agreement does not oblige the "achievement" of the targets because, in addition to countries like China and India being reluctant, the United States was also reluctant, which wanted to conclude the Agreement as an international agreement which would not require advice and approval of the Senate. However, regarding this way that the rule of the Paris Agreement was made, the explanation that "there is no legal obligation for each country regarding reduction" is incorrect. A country that does not create and submit their targets every five years will be considered violating the obligation prescribed in the Paris Agreement. Also, if a country does not implement domestic measures in good faith to achieve its targets, it can be deemed to be in violation of their obligations

prescribed in the Paris Agreement. Each country report will the progress of measures for achieving reduction targets once every two years and receive international examination (Article 13), and the Paris Agreement will establish a mechanism to promote implementation and compliance concerning cases in which compliance with the obligations of the Agreement will become an issue (Article 15). These detailed rules are planned to be adopted at COP24 in 2018.

For COP 21, most countries of the international community, including major emitter countries, have submitted targets following 2020. However, the International Energy Agency (IEA) estimates that, although when these goals are fully implemented, it will suppress the rise in temperature below the current state, the temperature will rise well above 2°C by 2100. For this reason, the Paris Agreement set up a mechanism for approaching the 2°C target by having every country review the target every five years and raise the target based on the assessment of the overall progress (Figure B-12). Furthermore, the decisions at COP21 also requested that a "promotional dialogue" be conducted in 2018 before the full-scale start of the Paris Agreement, and that each country review its target which they have submitted, and submit new targets by 2020. The 2030 target submitted by Japan (26% reduction from 2013 = 25.4% reduction from 2005) will also be reviewed as to whether the target can be raised by 2020. The Paris Agreement has also prescribed a responsibility to strive to create medium- to long-term strategies for emission reductions by around 2050 (Article 4.19). Submission of these strategies has been requested to be made by 2020 by the decision at COP21.

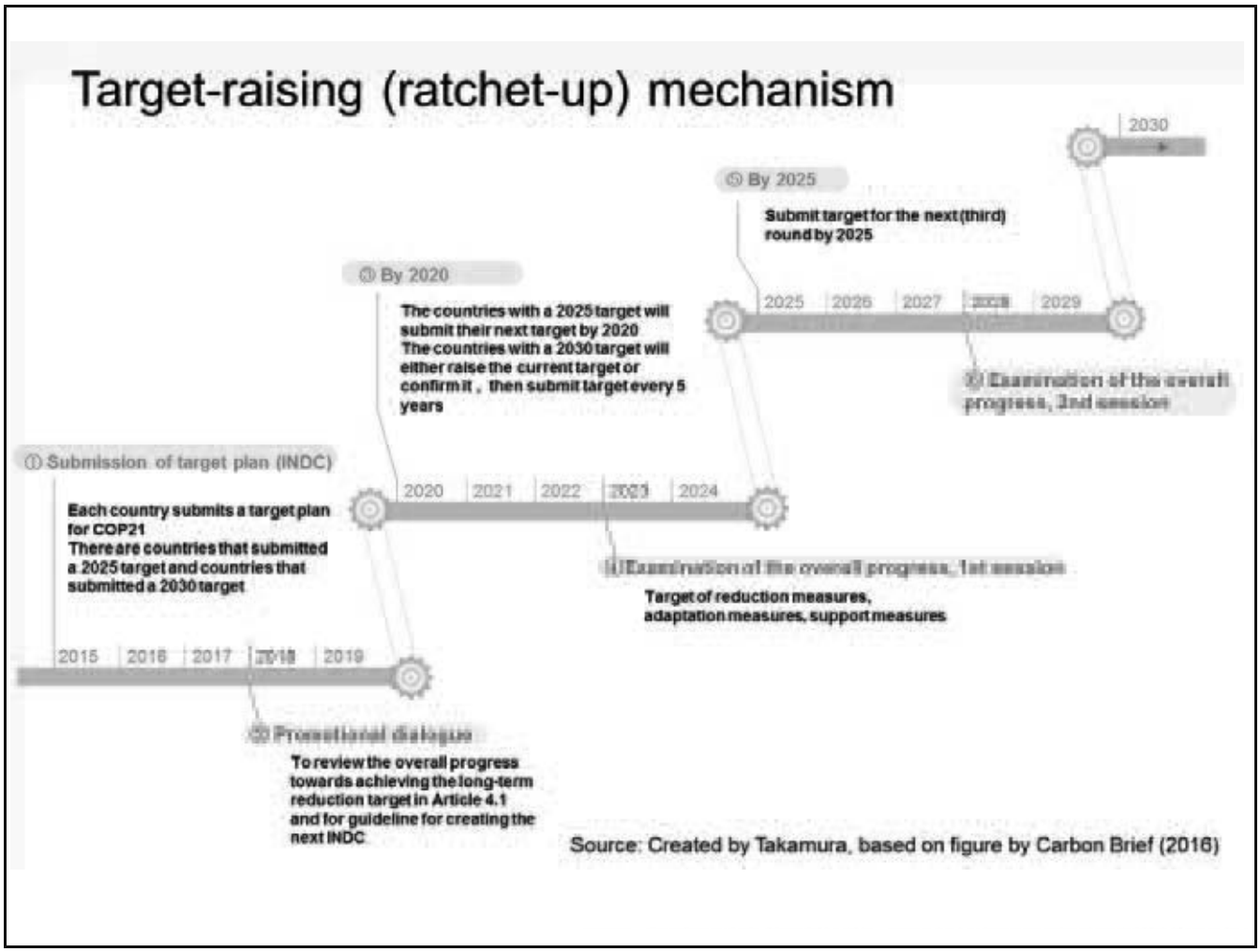

Figure B-12 Target raising (ratchet-up) mechanism

2-3. Fine-grained differentiation of duties considering the reality, while directing toward one framework

The Framework Convention on Climate Change and the Kyoto Protocol, describe the names of developed countries in the Annex (listing) in accordance with the Common But Differentiated Responsibilities (CBDR) Principle (Article 3.1). By doing so, it divides them into the group of developed countries (Annex I countries) and the group of other countries (non-Annex I countries), and basically imposes the legal obligation of the former. Such a scheme which bisected the countries into developed and developing countries came to be questioned with regard to its validity, due to the economic development of the emerging countries such as China and India and the increase of the emissions accompanying it, especially since the 2000s. While developed countries insisted on building a single framework resolving the differentiation based on the bisection, among developing countries, those that questioned the responsibility of developed countries for making emissions historically insisted on adhering to conventional differentiation that bisected developed countries and developing countries.

The Paris Agreement will make a very exquisite and detailed differentiation of the obligations, based on the reality according to the nature of the problems such as emission reduction measures and adaptation measures, while directing toward a single framework in the future.

For example, regarding emission reduction, as described above, it has been made a common legal obligation of all countries to create and submit reduction targets, and to implement domestic measures towards its achievement. On top of this, the Paris Agreement prescribes the political obligations of the developed countries that will take a lead by committing to the absolute emissions target for each country according to the Kyoto Protocol, and the political obligations of developing countries that will continue to make reduction efforts, and introduces the concept of “concentric differentiation,” which will encourage developing countries to head towards country-wide emissions reduction and control targets such as those of developed countries' goals over time, while making a differentiation between the responsibilities of developed and developing countries (Article 4.4). Regarding adaptation measures, it has been made a common obligation for all countries to work on implementing of the adaptation planning processes and adaptive actions (Article 7.9). However, it provides the stipulation of "as appropriate," and gives the country great discretion with respect to fulfilling its obligation.

The framework of transparency, that is, the framework of report on the progresses of countermeasures and assessment, has established a common framework regardless of developed or developing countries, while it gives developing countries flexibility in implementing them according to their capacity. Regarding the obligation to submit information, it will make a differentiation according to the differentiation of the substantive obligations for each of the aforementioned emission reduction measures, adaptation measures, and financial support measures. The obligation to submit the information on the amount of emissions and absorption and information necessary for follow-up of the progress of the reduction targets is an obligation common to all countries. As for information on adaptation, since the substantive obligations give the country large discretion, it is limited to the duty to make a submission when it is appropriate (Article 13.8). As for Information on support, the developed countries are obliged to submit information as support is their legal obligation, but for other countries for whom support is not a legal obligation, submission of information is only a duty. On the other hand, concerning the submitted information, it is an obligation of all countries to conduct examination by experts and participate in multilateral examination on progress.

3. How to view the Paris Agreement: Its evaluation and issues

3-1. Is the Paris Agreement effective?

How effective really is the Paris Agreement in dealing with climate change?

The Paris Agreement established a framework in which all countries would submit reduction targets regardless of the distinction between developed and developing countries, making an international promise to implement measures to achieve the targets, thereby

realizing a shift from the conventional regime. By adopting a method whereby each country creates a target and submit it, as almost all countries in the international community submitted their targets ahead of COP21, the Paris Agreement is expected to increase the effectiveness of the scheme by expanding the scope of the countries that have international reduction targets and raising the universality of participation.

Meanwhile, the mechanism in which each country sets its own target does not automatically guarantee a solution to problems. Even if the targets submitted by each country are accumulated, it will not reach the reduction level necessary to achieve the long-term goal set by the Paris Agreement. In addition, the way that each country creates a target (i.e., decides the reduction level), if the country does not set a target in good faith and does it arbitrarily, will impair the fairness of the scheme of the Paris Agreement, possibly allowing each country to lower the reduction level due to concerns about free riders, or impairing participation of each country in the scheme, which may result in impairment of its effectiveness.

Whether the Paris Agreement will be truly effective depends on whether each country can steadily progress towards decarbonization by implementing the goals that it submitted, no matter what. To that end, the establishment of an international rules is the key, by which it is made possible to secure implementation of targets by each country, and to raise the target in the 5-year cycle. At the same time, international rules to support decarbonization progress in each country are important, and among them are, 1) rules on the process of the 5-year cycle of "evaluation of overall progress -> creation of the targets and submission by each country -> evaluation of overall progress," 2) rules on the framework transparency which would make transparent and promote the progress the implementation of domestic measures of each country, and 3) the rules on mechanisms for promoting implementation and compliance. These rules are scheduled to be adopted at COP24 to be held in 2018, and negotiations for making rules will become full-fledged in the future.

3-2. Evaluation of the Kyoto Protocol

How to evaluate the Kyoto Protocol is one of the issues in evaluating the Paris Agreement. From Table B-1, which compares the Kyoto Protocol, the Cancun Agreements which set rules up to 2020, and the Paris Agreement, we can see changes in the scheme among these.

Table B-1 Comparison between the Kyoto Protocol and the Paris Agreement

Kyoto Protocol ・the Cancun Agreements ・Paris Agreement

	Kyoto Protocol First Commitment Period (2008 - 2012)	International framework based on the Cancun Agreements (until 2020)	Paris Agreement (after 2020)
Legal nature of purpose	・Obligations for industrialized countries to achieve targets (obligation of results). No obligation for developing countries	・Developed countries promise politically to fulfill their targets. Developing countries voluntarily set an reduction	・Obligations for all countries to prepare and submit targets every five years. Obligation to implement domestic measures towards achievement
Target-setting method	・The level of the numerical targets of each country is determined by negotiations among the countries	・The level and content of each country's target are set by each country (voluntary differentiation). Information is submitted internationally and explained	・The level and content of target of each country are set by each country (voluntary differentiation + concentric differentiation). Obligation to submit and explain information internationally
Rules for means of achieving the target (accounting)	・Kyoto Mechanism, absorption sources such as forests, etc., are clearly stipulated internationally	・The rules of the target achievement means remains vague	・Establish rules on means to achieve targets internationally. Details will be negotiated in the future
Approaches to reporting/reviewing and compliance assessment	・Developed countries report emissions annually and go through review. After the commitment period, evaluate the achievement of the target compared to the amount of the emission allowance held by the country	・Report emissions annually and go through review. In addition, once every two years, report measures to achieve the target and their effects, etc., and receive international review. Procedures distinguished between developed and developing countries	・All countries have one transparency framework. Flexibility for implementation to developing countries according to their abilities. Based on the framework of the Cancun agreements, details will be negotiated in the future
Measures against non-compliance	・Measures such as achievement of the unachieved amount in the following commitment period, as stipulated under the compliance proceeding	・Measures against non-compliance are not planned at the time.	・Details of the mechanisms of implementation and promotion of compliance will be negotiated in the future

Through negotiations and implementation of the Kyoto Protocol, a social norm of consciousness to suppress and reduce greenhouse gas emissions was fostered, and measures against global warming in developed countries advanced much further than before the adoption of the Kyoto Protocol. The Kyoto Mechanism which would use markets, the Adaptation Fund that would not be dependent on contributions from developed countries, and other innovative schemes that did not exist previously were born. Remember that many of the components of these schemes in the Kyoto Protocol were handed over to the Paris Agreement as well. The concept of concentric differentiation was introduced, where developed countries would continue to have their Kyoto-style reduction targets, and developing countries would shift to such targets over time. It was decided that the market mechanism would also be set up under the Paris Agreement.

As a problem of the Kyoto Protocol, it is pointed out that reduction targets were imposed only on developed countries. At the time of the adoption of the Framework Convention on Climate Change in 1992, developed countries, which accounted for around 20% of the population, emitted 70% of the world's greenhouse gases or more, and the mechanism by which developed countries would fulfill their reduction obligations ahead of others was reasonable. However, as a result, the method adopted by the Kyoto Protocol of writing down the country name in the Annex (i.e., listing) fixed the classification of the countries based on their national circumstances at that certain point in time, and the protocol was unable to respond to the drastic change in the circumstances, which was increased emissions in emerging countries, including China and India.

The Paris Agreement did not adopt the listing in the form of writing down the names of the countries in the Annex, and despite the provision which adopted the distinction of developed and developing countries, it does not explicitly specify to which category a country

belongs. It can be said that it is a scheme with the inherent flexibility to respond to changes in circumstances. On the other hand, it may be said that it is a method for each country to decide on its own which category it belongs to, but if a country arbitrarily carries it out, there is a risk of impairing the fairness of the Paris Agreement's scheme.

3-3. Early entry into force of the Paris Agreement

The Paris Agreement came into force on November 4, 2016. The entry into force in less than a year from its adoption is a very unusual rate as a multilateral treaty, including the environment treaties. As of April 7, 2017, 142 countries and the European Union ratified it, which was an equivalent of more than 80% of the world's greenhouse gas emissions, including that of Japan.

The entry into force was also aimed to be made in 2016, because even if as a result of the U.S. presidential election the administration tried to withdraw from the Paris Agreement, it would not be able to withdraw immediately (see below). The ratification by each country at this exceptional speed is also an expression of the strong will of the countries to ensure that the Paris Agreement will be the key to future climate change measures, without being influenced by the domestic politics of the United States, and an expression of the expectation for the Agreement. Indeed, the conclusion of the Paris Agreement has been progressing even after the change of the administration in the United States.

The Kyoto Protocol set reduction targets for each developed country, but did not begin domestic implementation process immediately after adoption. Indeed, domestic processes for conclusion and implementation began after COP7 in 2001 when the implementation rules of the Kyoto Protocol were agreed upon. Because each country recognized that some implementation rules included things that could change the level of targets for each country, depending on the rule. For example, the amount of absorption from absorption sources such as domestic forests is set by Articles 3.3 and 3.4 of the Kyoto Protocol, but the level of targets agreed upon at COP3 may vary depending on how much of this is accepted. Indeed, the negotiations on the rules of absorption sources such as forests bore the aspect of "renegotiation of goals." The Kyoto Protocol made it possible to agree on COP3 by making it a protocol that could be called a "framework protocol" that would entrust detailed implementation rules to the negotiations of the COP after adoption, while it left negotiations on implementation rules that would substantively influence the level of targets, thereby postponing the domestic implementation of the Kyoto Protocol to the point of the agreement of the implementation rules. As a result, it ended up taking over 7 years from the adoption to conclusion and entry into force.

On the other hand, in the case of the Paris Agreement, because each country took the method of considering and submitting its own target before adopting the Agreement, the process of domestic implementation began early. Probably because Japan takes a full security principle when concluding a treaty, it created and submitted a 2030 target with some prospects of achievement by gathering the policies and measures planned by each ministry and agency. As a result, before the Paris Agreement was agreed upon, the ground for the plan of implementation of the target had already been created. Because of this, the discussion of the global warming countermeasure plan after the adoption of the Paris Agreement was based on that premise, considering the long-term goals stipulated by the Paris Agreement, and was limited to discussion of issues such as how to set long-term goals for Japan.

In this way, the domestic implementation process substantially began before the decision of the targets in the international negotiations and the decision of the implementation rules, and it became possible to conclude more quickly than the Kyoto Protocol and to start early domestic implementation. In addition, the implementation rules concerning emission reduction measures to be decided through negotiations from now are set to apply to the second and subsequent targets, and by deciding that its application to the targets submitted by each country for COP21 this time is up to each of them, it has become possible to conclude the Paris Agreement prior to the agreement on the implementation rules and to accelerate the start of domestic implementation.

4. Why was the Paris Agreement agreed upon - a worldwide “great energy shift" that changed the rules of the game -

Due to the economic development and political emergence of emerging economies, the interests of developing countries have diversified, resulting in an increase in the number of players in negotiations, complicating the negotiations. These changes also create pressures to change existing rules. In such a period of change for the international community, it is not easy to obtain consensus among many countries, not just in global warming negotiations. Six years after the breakdown at the Copenhagen Conference in 2009, why was it possible to reach the Paris Agreement at COP21?

First of all, 2016 was the year of U.S. presidential election, and with the future of the new administration after 2017 being uncertain, there was a shared sense of crisis that the consensus would be further delayed if COP21 was missed, achievement of 2°C goal would become more difficult, and the risk of the adverse effects of the climate change would increase. The second reason is the elaborate ”planning" by the Obama administration of the U.S. to make it possible to reach the agreement in Paris. The administration positioned the agreement as its “legacy” a few years prior to COP21, urging all countries to submit their targets by using all diplomatic channels and making it a top priority, and established a summit-level consensus by the major emitter countries in advance on the central elements of the Paris Agreement. The third is the command taken by the chair country France. The Paris Agreement contributed to restoring confidence in multilateralism, demonstrating "the power of diplomacy" by which the international community could act in union on global issues that needed cooperation by multiple countries.

Another important background that established the Paris Agreement is a global movement that could be called the ”Great Energy Transition.” Both Europe and the U.S. will greatly reduce coal-fired power by 2030 to 2040, and turn the rudder of policy into transitioning to gas and expanding use of renewable energy. On the premise of the 2030 target of at least 40% reduction compared to the 1990 level, the EU aims to make the reduction by at least 27% of the final energy consumption, and make at least 45% of the total power generation renewable energy. Although the U.S. energy policy is led by each state, about 30 states will set a target for renewable energy. For example, in 2030, California will make 50% of its total retail electricity renewable energy, New York State 50% of the total power generation, and Hawaii 50% of the total retail electricity.

China will also set the 2030 target of making the non-fossil fuel ratio of primary energy consumption to about 20% from the current 10%, and India will also set the 2030 target of making 40% of total capacity of electric power facilities of non-fossil fuel origin. It will promote the decarbonization of the energy department at a considerable speed and scale, and it will be the renewable energy that will be the pillar. For example, India aims to introduce solar power of 100GW which is 100 times the current amount by 2020, and introduce 60GW of wind power which is 20 times the current level. In the energy mix of 2030, which is the basis of Japan's global warming target (26% reduction compared to the 2013 level and 25.4% reduction compared to the 2005 level), the 2030 renewable energy targets are 22-24% of total power generation and 13-14% of the final energy consumption.

On the other hand, the regulation of carbon dioxide emission on the thermal power plants is expanding. France launched the direction of abolishing domestic coal-fired power by 2023, the U.K. by 2025, and Canada by 2030. On April 5, 2017, the federation of European electric power companies announced a statement that, excluding Poland and Greece, no coal-fired power plant will be newly established after 2020. Coal-fired power supplied about 70% of electricity in China in 2015, but measures were taken and it declined by about 10% compared with the 2011 level. In 2014, the production and consumption of coal declined for the first time since 2000, and further declined in 2015. In the world as a whole, the consumption of coal in 2015 decreased by 2.3%, which is an unprecedented decline in the past 45 years.

Each country’s circumstances vary, such as shale gas and air pollution problems, but lowering of the cost of renewable energy through technological development

and mass introduction is a common factor that drives it. For example, according to the International Renewable Energy Agency (IRENA), the cost of solar power of the world halved in the five years from 2010 to 2014, becoming a competitive level cost-wise with thermal power generation. The cost of onshore wind power generation has already become competitive with the cost of thermal power generation at the stage of 2010. This is in contrast to the nuclear power whose generation cost has risen due to safety measures taken after the Fukushima Daiichi Nuclear Power Plant accident. The power generation cost of the British Hinckly Point C Nuclear Power Station is assumed to be 85-125 pounds per MWh, and the government plans to guarantee the price for 35 years at 92.50 pounds, which is considerably higher than the wholesale electricity market price. The British Audit and Research Office report in July 2016 introduced the British Department of Energy's forecast that in 2025 the cost of onshore wind and large-scale solar power generation would be 50-75 pounds or even well below it.

The impact of such a major turnaround in energy has already appeared in the emissions trend from the energy sector. Since 2013, the world's energy-origin carbon dioxide emissions in 2014, 2015, and 2016 transitioned flat, despite the global economy growing by about 3% (i.e., the decoupling of economic growth and carbon dioxide emissions). According to the IEA, when the emissions did not increase in the last 40 years, it was limited to economic stagnation periods such as during the oil shock, collapse of the Soviet Union, and Lehman Shock. My analysis is that the reasons are improvement in energy efficiency and expansion of renewable energy. For example, in 2015, for the first time in history, the capacity of renewable energy facilities exceeded that of coal power generation facilities, and the capacity of newly-built renewable energy facilities exceeded that of newly-built fossil fuel and nuclear power generation facilities. The introduction is expanding at a rate faster than predicted, and the investment amount in renewable energy in 2015 recorded the highest ever and the investment amount in renewable energy excluding large-scale hydroelectric power is twice or more than the amount of investment in coal and gas.

Economically rational choices have come to be seen for developing countries towards decarbonization while responding to domestic requests of the expansion of energy demand that accompanies economic development, due to the reduced cost of renewable energy, especially the solar power which does not require construction of a large-scale electrical grids. As a result, from the idea that global warming countermeasures will restrict the use of "cheap" energy and become a “hindrance" of economic development, developing countries that have demonstrated a negative attitude toward strengthening global warming countermeasures have started to change their position.

With the adoption of the Paris Agreement as an occasion, support for developing countries is increasingly focusing on decarbonization and renewable energy. One example is the Solar Alliance in which 120 countries or more participated by the initiatives of Prime Minister Modi of India and President Hollande of France, and with India also contributing, it aims to mobilize an investment of 1 trillion USD necessary to introduce solar power facilities by 2030. Games among nations concerning global warming are turning into a game of how to promote energy switchover in cooperation towards a decarbonized society, from how to distribute "burden" of emission reduction among nations.

Reduction in the cost of renewable energy pushes down demand for fossil fuels, becoming a contributing factor to oversupply and price reduction and increasing consumption of fossil fuels in Southeast Asia and the Middle East, which is increasing carbon dioxide emissions. Cost reduction of renewable energy does not mean that it will automatically realize energy switchover. What is important is a "policy" that shows clear direction and vision towards decarbonization and promotes energy switchover.

5. Business and financial changes accelerated by the Paris Agreement

With COP 21 as an occasion, the world’s major companies have begun to focus on decarbonization in the second half of the century. Also in Japan, Toyota Motor announced "Toyota Environmental Challenge 2050" in October 2015. This will reduce CO_2 emissions while travelling (on the average) of new cars sold

worldwide by Toyota by 90% compared to the level of 2010, and cut the CO_2 emissions from the factories to zero. Furthermore, it aims for zero CO_2 in the life cycle from material production to disposal. Efforts aimed at zero emissions in the entire supply chain have a great ripple effect on its suppliers. Similarly, Nissan Motor will set long-term targets such as zero emission mobility and a roadmap, and execute them. Sekisui House aims to make 80% of the new houses built in 2020 ZEH (Net Zero Energy House).

Efforts in “Renewable Energy 100%" (RE100) also proceeds. The BMW Group aims to cover 100% of its energy in the whole business with self-generated power and locally procured renewable energy. GM is aiming for 100% renewable energy in 2050. Google will triple procurement of renewable energy by 2025, aiming for a 100% renewable energy use. Microsoft has already realized 100% renewable energy since 2014. Philips, Nike, Nestle, Wal-Mart, and Starbucks also follow these initiatives. An increasing number of local governments and municipalities are aiming for 100% renewable energy, such as Fukushima Prefecture, Vancouver, Canada, Malmö of Sweden, etc.

Requests for information disclosure on fossil fuel-related risks symbolized by "stranded assets" are globally increasing. The Financial Stability Board (FSB) established a special working group on the disclosure of corporate risks related to the climate change, chaired by Mr. Michael Bloomberg, and in December 2016 it released the Principles and Recommendations on Voluntary Information Disclosure. The process of disclosing information on fossil fuel-related risks by companies is also linked to the movement in which investors make investment which integrates environmental, social, and governance considerations (ESG investment), and promote socially responsible investment, as typified by the United Nations Principles for Responsible Investment (UNPRI) proposed in 2006. France enacted an energy switchover law in 2015, which obligated institutional investors registered in France to disclose how they evaluated and considered climate change risks. Here, climate change risks were the climate change risks and the fossil fuel-related risk which included the investment risk which would become a “stranded asset."

With the COP21 as an occasion, the movement to seek “divestment (investment withdrawal)" from fossil fuel businesses, especially coal businesses, has also become strengthened. The Norwegian Government Pension Fund, one of the world's leading pension funds with the asset size of over 100 trillion yen, decided to sell all of its stocks of the 122 companies which engaged 30% or more of their business in coal mining and coal-fired power (which was about 8 billion US dollars), and it started implementing this on January 1, 2016. Divestment is often seen as a social movement protesting against investors who disregard global warming issues, but institutional investors are beginning to make investment decisions taking into consideration the investment recovery risk of businesses. Among such global changes, energy and global warming policies towards decarbonization are becoming increasingly necessary for Japanese companies in enhancing their corporate values over the long term.

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2. Rethinking the meaning of sustainability

Seiji Ikkatai

1. Relationship between environment and human society

Figure B-13 was prepared, with a slight addition by me, based on the general schematic diagram of the relationship between environment and human society, which is frequently used in textbooks of environmental economics and others. One of the points of this table can be seen where non-renewable resources and renewable resources come in at "human society's operation = economy" in the center. Renewable resources such as animals and plants have been acquired and used by humans from the natural world since the birth of human beings, and there formed a cycle of circulation in which they were used and disposed of before they became, namely, raw materials to make its renewable resources again. On the other hand, in modern times many materials that are extremely useful in terms of energy and resources, such as oil and coal, are widely used, but these are non-renewable resources, and they did not exist within the circle of conventional ecosystems.

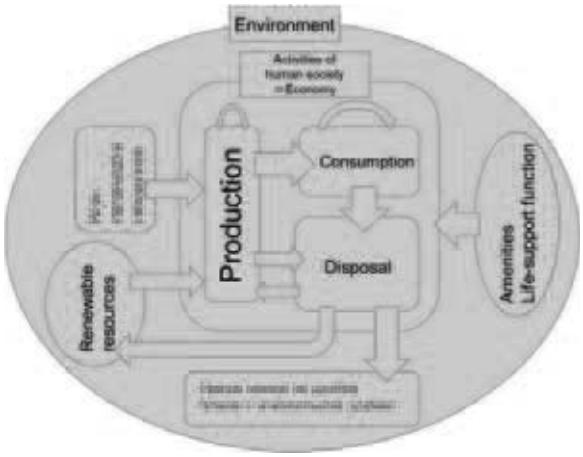

Figure B-13 Relationship between environment and human society concerning environmental problems

Because of this, from the use of these resources to their disposal, the waste that nature cannot circulate and purify has come to stay in the environment. This is the environmental problem. A typical example of this is the problem of global warming, which is caused when mass consumption of fossil fuels results in carbon dioxide being abandoned in the atmosphere, so to speak, to the extent that it cannot be fully absorbed in the atmosphere or the ocean, and it stays. However, it does not mean that environmental problems will not happen if we only use renewable resources. Even with renewable resources, if they are consumed excessively to the extent that they cannot be renewed, and if the stock itself becomes unmaintainable, it will still be a big environmental problem. Problems such as species extinction and decrease in biodiversity caused by overhunting of wild animals and plants are environmental problems of this sort.

Frequently, voices can be heard saying that modern environmental problems are complicated phenomena that occur while intertwined with many matters including the economy, and that it is not easy to make an investigation into its cause and solution. Of course, in a sense the point is correct, but on the other hand, as long as we understand environmental problems according to a schematic diagram such as the one above, environmental problems arise when the waste generated by human activity exceeds the limit that is acceptable by the natural environment, and when we use renewable resources beyond that limit when they were supposed to be used within the range in which originally they could have been reproduced. It is a very simple and clear phenomenon, and we need to remember that again.

2. International efforts on sustainable development

With regard to this environmental problem, the concept of "sustainable development" was established since the United Nations Conference on Environment and Development in 1992, also known as the Rio Summit. This is a concept proposed by the Brundtland Commission in 1987, which says, "Sustainable development refers to such development that meets the desires of the current generation in a way that will not reduce the ability of future generations to meet their desires.

It became a concept that filled in the large gap between developed countries which emphasized

environmental conservation and developing countries which wanted economic growth at the time, and it played a major role in avoiding forcing a choice between the two alternative arguments of development or environmental conservation and in promoting more constructive discussions. However, on the other hand, this concept is somewhat abstract, and there is the aspect that it did not become a direct solution to the problem of "how much environmental care should be taken," confronted by the reality. By the way, there are many other definitions and discussions about "sustainable development," and the definition by the Brundtland Commission is not necessarily the only one.

At the Rio Summit, Agenda 21 was agreed upon, a document that should be regarded as guidelines for the whole humanity concerning sustainable development towards the 21st century. And it was required for each country to formulate a sustainable development strategy for its own and to create a national organization to carry it out. In response to this, each country has defined its own development strategy.

Incidentally, initially in Japan, a government document with exactly the same structure as Agenda 21, titled "Japan version Agenda 21" was created and submitted to the United Nations in December 1993. This was the earliest response at that time. After that, in Japan, the "Basic Environmental Plan" based on the Basic Environment Law has come to be prepared as a Cabinet decision document, and now this plan is reported to the United Nations as Japan's sustainable development strategy. However, although this plan is a document that represents the entire government, it is created mainly by the Ministry of the Environment on the basis of the opinion of the Central Environment Council, and except mainly regarding preservation of the environment, it has not become a high-level plan which is positioned as the policy of each ministry, which is a big problem.

Meanwhile, in 2002, Germany formulated a national-level sustainable development strategy, "Germany's Prospects - Our Strategy on Sustainable Development."

3. Concept of sustainability

Today, when we look at national and governmental documents, or environment-related documents of private enterprises, there are many wordings such as "sustainable development" or "sustainable society."

However, although the definition of the Brundtland Commission above was famous for this concept of "sustainability," there was a side to it in that it was not necessarily clear what it specifically signified.

Under such circumstances, in 2015 the United Nations agreed upon the goals for sustainable development (Figure B-14).

This is aimed at improving not only the environment but also various problems of the modern society such as poverty over economy and society as a whole, health, human rights, inequality and peace, and the idea is that sustainable development is realized only when these are realized.

This is one consistent way of thinking in its own right, and we can say that it is currently accepted by many people including those in developed and developing countries. However, speaking from the environmental point of view, the problem of global warming is one of the 17 goals, which does not necessarily occupy the central position in sustainability.

Figure B-14 Goals for sustainable development
(Source) United Nations Information Center

In environmental economics, there are roughly two ways of thinking about the sustainability. They are “strong sustainability" and "weak sustainability." The idea of strong sustainability is that human economic growth has "the optimal scale,” and since natural capital is the ultimate source of human welfare, it is impossible to grow beyond the constraints of natural capital such as the forests and the ocean. On the other hand, weak sustainability is a way of thinking that natural capital is one of the determinants of human welfare and it can be replaced with other artificial capital, etc. It can be said that, in a sense, the difference in these ways of thinking poses a very big problem to humankind. Originally, the humankind relied on the natural capital on Earth, utilized it, and developed civilizations while supported by the foundation for maintaining life. In the process, resources such as petroleum and coal that until then had not been used in the circulation of the Earth's ecology came to be used, and due to the development of science and technology, many energies such as new materials and nuclear energy came to be used. As a result, this has created a situation in which the daily lives can be managed without relying solely on natural capital.

This created a social situation in which many people could enjoy the massive amount of materials and energy that previously could only be enjoyed by some powerful and wealthy people. In that sense, as a result of removal from the constraints of natural capital, the human civilization has made a great leap, and this has also become a driving force for new economic growth in the history of humanity for the past several hundreds of years.

However, on the other hand, the forest area on Earth has drastically decreased, and biodiversity has been greatly impaired, as seen in the extinction of wild animals and plants. A further problem is that the quality of the atmosphere, which can be regarded as the essence of the global environment, is changing due to the increase in carbon dioxide, and similar changes are occurring in the oceans also.

In modern times, the proportion of people living in cities is increasing even further, and there is a situation where comfortable city life can be enjoyed despite the absence of abundant natural capital in the immediate vicinity. There is a situation there, in which it has become more difficult to be experientially conscious of the importance of the natural capital as a basis for supporting life, the role which the natural capital has

played since the ancient times. This is illustrated by an episode that became a hot topic in recent years, when a consumer requested that only flower be used on the front cover of children's study book because the pictures of insects were gross, and it was complied with by the manufacturer of the study book.

Although I stated that the discovery of fossil fuels and the Industrial Revolution liberated human beings from the constraints of the natural capital, but while we can say that it appeared on the outside to be the start of the leap of humankind, it is by no means a coincidence that it led to the problem of modern climate change.

In other words, we can say that, at a time when humanity relied on natural capital, natural capital was the foundation of sustainability of the human survival, and although human beings had no means to take a leap from there, sustainability was guaranteed instead within that great constraint. On the contrary, human beings, who gained the means to take steps from there owing to the Industrial Revolution, the scientific revolution, and the development of the market system since the 18th century, lost the guarantee of sustainability by the natural capital, and humanity has ended up in the situation in which they themselves have to guarantee their own sustainability, which can be considered as the current situation.

That the difference between the concepts of strong sustainability and weak sustainability poses a very big problem humankind more so than the sounds of the words “strong” and “weak” do is as mentioned above.

4. Herman Daly’s three principles

Viewed from the context of the above analysis, the idea by Herman Daly is in the position of "strong sustainability."

Herman Daly is an American economist and is known for the "Three Principles of Sustainable Development by Herman Daly," proposed in the 1970s. As shown in Figure B-15, Daly's idea never claims that only the environment is important for humans. Instead, it is the idea that happiness that is the ultimate goal of people exists above the social capital and human resources supported by the artificial capital and human capital. However, the position is based on the premise that natural capital exists as the most important foundation that supports that happiness, and that this is secured. From this standpoint, Daly advocated the following three principles.

(1) Resources should be used within the range in which they can be renewed, (2) unrenewable energy should be used within the range in which it can be substituted with by renewable resources, and (3) waste and noxious substances should be discharged in the range in which they can be accepted and purified by nature.

These are principles which consider the importance of natural capital focusing on the point of renewable resources. On the other hand, the concept of weak sustainability mentioned earlier is the idea that natural capital is one of the determinants of human welfare and that it can be replaced by other artificial capital, etc. However, humankind, who thought that a new nonrenewable resource called coal could substitute renewable resources like firewood, currently faces climate change problems, and humankind, who thought that it exceeded the constraint natural capital with power generation at nuclear power plants, faces the difficulty of controlling their danger, including their accidents and waste disposal cost.

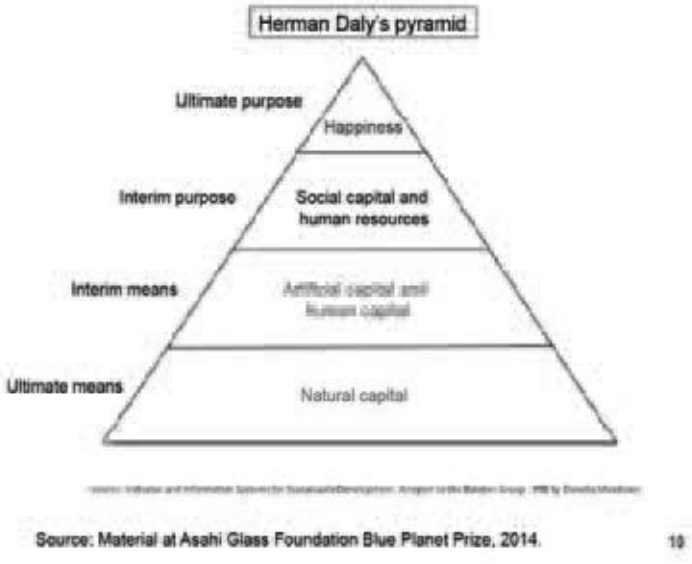

Figure B-15 Herman Daly’s Pyramid

In that sense, we can say that the idea of strong sustainability is in a position to ring a strong alarm bell to the idea that humankind can easily substitute natural capital with other artificial capital.

Even in today's scientific and technological development, we are not in a situation where it can be said that human beings have elucidated all the mechanisms of nature that have supported the life on Earth so far. Taking that humbly, we should dare to think about future sustainability based on "strong sustainability."

Of course, this does not mean that we should go back to the way of living like in the Edo period without using any new technologies that we had never had before. Solar power generation, large wind power generation, etc. could not have been realized without modern technology development. The point is, given the constraints of natural capital, technologies must continue to move forward in the direction of maintaining natural capital as a stock, and thinking about how to effectively utilize the grace of renewable resources and others without destroying natural capital.

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3. Sustainable cities and transport

Hirokazu Kato

1. Transport system prescribe the spatial structure of cities and national land

For people, transport is often referred as the important element of living next to clothing, food, and house. Since human activities are carried out in the spatial spread, the change in transport activities depending on the spatial position of each activity and the mutual positional relationship. That also changes resource and energy consumption, and environmental load. Therefore, in considering the sustainability of human society, it is important to examine the spatial structures of cities, areas, and national land. Also, careful attention must be paid to the fact that the infrastructure and buildings constituting them have a long life, and it takes a long time to change or update them. This is because, if we forget the consideration for sustainability when we promote spatial structure formation, human activities in the future will be greatly constrained, and it will take time to get out of there.

In Japan, as a result of the long-term spatial formation, its spatial structure and transport system have largely been divided into two types. One is a high-density urban area where public transport has developed, and the other is a low-density area dependent on automobiles. From the early Meiji era to the rapid growth period after the World War II, the leading role in land transport in Japan was played by railways and tramways. This is due to the fact that, in the Edo period, the shogunate forbade the use of cars (i.e. carriages and large hand-drawn carts) and adopted the policy of not paving roads and streets, and the government preferentially advanced railway development after the Meiji Restoration. For this reason, business models that acquired undeveloped areas to conduct urban district development, constructed the tracks and sold the land lots, and further developed stores and leisure activity facilities along the railroad tracks became active mainly in metropolitan areas, and urban areas dependent on railways and tramways, namely Transit Oriented Development (TOD), spread with the power of the private sector rather than the national and local governments. In this way, the urban structure was formed by development of railways and tramways. However, the presence of the roads remained weak because people could not possess a car by low income, and the road condition was not enough good for driving.

However, since the 1960's, development progressed rapidly because a financial system for road development was established. Also, car ownership increased due to rising income. Many of the automobile-related taxes were positioned as taxes for road-related purposes, and more ownership and use of cars led to more tax revenue, furthering the road development which also in return encouraged the diffusion of automobiles. Metropolitan areas such as Tokyo and Osaka had a very convenient for public transport and dense urban structure. The convenience of automobiles in these areas did not increase. Meanwhile, in other areas, automobiles are very convenient. The urban structure also changed from point- and line-based expansion centered on public transport, to area-based expansion accompanied by automobile use, with the automobile-dependent lifestyle of residents penetrating further. Once this happens, even if public transport is improved, there are few switchovers from automobiles to public transport, and it is also difficult to change the urban structure. In other words, motorization is an irreversible phenomenon. The time before its progress, or to put it differently, whether or not to create an urban area with high density and high convenience of public transport before an economic growth period happens, will change the subsequent urban structure greatly. East Asia and Southeast Asia chasing Japan. They are already advancing their motorization considerably. South Asia and Africa will also advance motorization probably.

Motorization has become a driving force for economic growth by increasing the available land and revitalizing exchange and trade. On the other hand, it consumes a large amount of fossil fuel and discharges a large amount of carbon dioxide. It causes damage to

people in the forms of traffic accidents and pollution, and destroys the ecosystem by road construction and land development. People can now go anywhere and live, which means that the load on the global environment has increased. Appropriate control of motorization is important to form a sustainable society.

2. ICT and dematerialization will reduce transport activities

However, now the change comparable to the motorization is sweeping the world. It is "meaninglessness of spatial separation" due to the diffusion of ICT.

There is a theory which says that the time that people spend a day on transport activities have not changed much for a long time. In other words, it has become possible to go farther and farther thanks to the development of transport systems, and although the distance traveled has increased, it has not reached a point where the time traveled has increased. Similarly, it has often been said that the trip generation intensity is relatively stable, which is about 3 times per person per day and about 1000 times per person per year. However, it is also known that there is a difference depending on a person's attribute, and in Japan the generation intensity and the time for transport activity are smaller for the elderly than the working age population, and for females than men.

There are signs that characteristics of such transport activities are likely to change dramatically. In the results of the National Urban Transport Characteristic Survey (preliminary report version) released by the Ministry of Land, Infrastructure, transport and Tourism as of the end of 2016, it was found that the number of days and times that a person goes out was the lowest since the survey began in 1987. However, this is contributed not only by the progress of the aging society, but also by the fact that young people go out less often. According to this time's result, people in their 20s go out about 10% less often than those in their 70s. Young people are no longer going out except for indispensable movements like commuting to work and school. This trend is noticeable in metropolitan areas. Likewise, in the metropolitan areas, the young generations' driver's license holding rate is also declining.

Unlike the elderly in the present, the elderly in the future is expected to have a high percentage of driver's license holders. It is because they benefited from motorization from the young age, and lifestyles that depend on the automobiles do not change easily even when they get older. Driver's license holders have large trip generation intensity. Therefore, from the viewpoint of society as a whole, it seems that even if the trip purpose changes, trip generation intensity or the trip distance do not decrease so much. On the other hand, today's young people have been in an environment where they can use the Internet from their birth, and they can receive various services without going out, on top of the economic difficulty of car ownership and its bad cost-effectiveness, so that is why it can be considered that they move less often and travel less distance.

In this way, as the content of the transport activities change, it is conceivable that the use of ICT instead of transport activities will increase mainly among young people. In particular, the impact is great in terms of procurement of goods. Prior to motorization, commercial districts accumulated mainly at stations and bus terminals because people traveled on foot or on public transport. However, as consumers directly accessed large stores in the suburbs due to motorization, it was as if traditional wholesale changed to retail. The transport of individual shoppers replaced the purchase by retailers. On the contrary, convenience stores developed by increasing the efficiency of conveying various types in small quantities through increasing the number of stores. This flow has declined shopping districts in the central urban areas.

However, from now on, ICT will advance service innovation that makes traveling unnecessary. Many of the distribution industry will shift their weight to virtual stores on the Internet, and actual stores in the suburbs will become warehouses and showrooms. In addition, such systems will be more common in which the use of ICT will increase the sense of reality and make travelling unnecessary in areas like work, conferences and meetings, and education. In the past, many opinions were "ICT will increase opportunities for exchange, so it will also revitalize more actual movement." However,

rather it is probable that the number of times and the duration of travel by people which were said to be stable may decrease due to the diffusion of ICT. Also, this may be particularly conspicuous in rural areas where convenience of transport is low.

However, though the passenger transport may decrease, the freight transport may rather increase, so the transport network does not become totally meaningless. At the same time, logistics and supply chains will be considered more important as factors determining the urban structure. On the other hand, the amount of freight transport will be reduced if socioeconomic "dematerialization" progresses. If the necessity of transport activities decreases as a whole, the perspective of living environment and safety in a disaster will likely be dominant.

3. Urban structure must change from "diffusion" to "agglomeration"

After the World War II, the population of Japan sharply increased, and in 2005, it became twice as large as that of 1930. However, with this as the peak, the population started to decline, and it is projected to be halved in 2080. Meaning it doubled in 75 years, and returns to the former state in 75 years. However, since the area used by one person for living, labor, etc., is increasing, this does not mean that the required urban area will be halved. Then, while the proportion of the elderly was 5% in 1930, it was 20% in 2005 and will be 42% in 2080. Infrastructure and buildings which supported urban areas that spread faster than population growth are deteriorating, but on the other hand, the economic power to renew them is declining, and large urban areas will not be necessary in the first place. In the hilly and mountainous areas of Japan, the population is drastically decreasing, and the number of marginal settlements is also increasing, where the residents are mostly the elderly. Desolation of the *satoyama* (village forest) and the fields are progressing, and it is possible that the urban areas may be desolated with a landscape of nothing but ruins, if people fold their arms. In Asian developing countries which follow Japan, it is expected that the speed of their urban expansion is going to be faster than in Japan, and the rate of progress in the declining birthrate and aging population will also exceed that of Japan. Japan's future response will be of great help to those countries.

The Japanese government set "compact + network" as a major policy in the "Grand Design of the national land 2050" announced in 2014. In order to cope with the population decline, super-aging society, and matured economy, it is indispensable to thin out infrastructure and buildings, and to turn "urban areas" that have "spread" into a state of “agglomeration.” This is, of course, impossible without being free from excessive motorization. Promoting realization of that are the two pillars of strict regulation of land use and formation of a transport network centered on public transport. However, this is like going backwards the way Japan has advanced over the past 60 years, and it does not seem to go so easy. If you designate an area to withdraw from, the land will lose its value. It will be resisted by the landowners. Then, even if the government tries to buy the land for its previous price, it will have no reserved capacity to pay for it. Also, since it is not practical to forcibly withdraw all households at a certain time, it will have to happen gradually. However, because households which are difficult to relocate, such as those of the elderly, are thought to be mainly left out, until the withdrawal is complete, administrative services that must be continued will be inefficient, and infrastructure must also continue to be maintained.

For this reason, it will be extremely important for promotion of withdrawal that the compact cities, which are to be the destination of agglomeration, will be updated as districts that are attractive as well as cost- and resource-effective, and thereby improving the relative land prices (i.e., added value) of the district. There, it will be necessary to be in genuine so that the maintenance cost of urban areas and consumption of resources and energy will be little in the life cycle, and so that the QOL of residents will be higher in every life stage and generation. As previously stated, the situation of transport activities had a large influence on these factors in the past, but while the weight of passenger transport will decrease, the weight of the surrounding environment and safety against disasters will increase in the future. In the future it will also be necessary to expect to adapt to climate change, and it will also be

important to modify urban areas so that they will be resilient in dealing with disasters. Also, since transport activities are currently highly dependent on fossil fuels, their decrease is directly related to reduction of fossil fuel consumption and carbon dioxide emissions. In addition, in order to promote conservation and storage of energy within the region, it is also effective and contributes to securing resilience at the time of disaster to form a micro-grid, which can stably produce and consume energy locally without having to rely on system power or fossil fuel supply, through utilizing unused energy such as heat, increasing electricity storage capacity including electric cars, and demand-leveling by introducing demand response. In highly dense cities, with many common spaces, private cars will be driven out, slow mobility such as by walking will become main stream, and the life will be easy for the young and old, men and women, which will contribute to community formation. As a result, urban structures with high sustainability will be realized from all of the economic, social, and environmental aspects.

4. How the passenger transport will survive?

Up to this point, I have discussed transport activities as the “necessary evil" for logistics and communication. In order to mitigate this necessary evil, human beings have developed transport facilities that enable them to move freely with as little effort and as few resources as possible and have continued their efforts to develop transport networks. The diffusion of ICT will be recognized as one that will replace these efforts, i.e., people will be able to perform various activities without travelling physically. However, do people really regard transport as a necessary evil?

At the beginning of a transport planning and engineering textbook is written that "the demand for transport is mostly due to the necessity for other activities, so it is a derived demand, and there is little intrinsic demand for use of transport only because people want to use it itself." In reality, however, there are clearly those who think that actual movement is pleasant in itself. This is the case not only with the intrinsic demand but also with the derived demand. Needless to say, if the virtual reality technology advances in the future, it will be possible to obtain a more realistic feeling, but I do not know if it will lead to an immersive feeling that will satisfy all five senses. Either way, the demand of passenger transport is expected to decrease steadily unless it becomes possible to obtain charms that can only be experienced in real life (added value) on the way or at the destination on a low-carbon and low-cost basis. Then, the bustle of people in central urban areas and sightseeing spots will disappear, and the emphasis on "place" also will disappear, which will diminish the point of discussing the urban structure from the perspective of securing QOL. In this way, competition between transport and ICT, and real and virtual lives will become intense in the future. Movements toward diffusing self-driving cars and ridesharing that are expected to arrive in the future will be discussed in Chapter 5, Section 2. For the time being, it is necessary for those who are engaged in passenger transport and urban and regional development will continuously create and promote methodologies to turn them into something attractive and environmentally sustainable. When a person wants to do something, either they will choose an autonomous driving service that comes out of the Internet search, or they will choose a service that does not require travelling. Preferences in this respect will determine the future transport system and urban structure.

Chapter 4 Anti-Globalism and Populism

1. The rise of populism that will threaten the sustainability of human survival

With the dismantling of the Soviet Union in 1991, the Cold War ended, and globalization was rapidly promoted along with rapid advances in information and communication technologies. Globalism which considered globalization favorable became universal, and it was convinced that free trade would promote the well-being of all countries. However, the decision by the U.K. to withdraw from the European Union in the referendum in June 2016, and Trump's victory in the U.S. presidential election in November of the same year signaled the emergence of anti-globalism (anti-immigration and anti-free trade). The world is now at the turning point of its tidal current.

2. U.S. administration change and the Paris Agreement

Although the possibility of a U.S. withdrawal from the Paris Agreement is pointed out with the change of the administration of the United States, opinions are still divided within the U.S. administration. The possibility of suspending and withdrawing from contributing to funds for the Framework Convention on Climate Change and the Green Climate Fund is high. However, the switchover from coal to gas and renewable energy will progress further due to the structure of the its domestic energy costs, and the emission reduction in the United States will continue. States, cities, and businesses support the Paris Agreement, promoting measures and initiatives for decarbonization, and this also supports the emission reduction.

1. The rise of populism that will threaten the sustainability of human survival

Takamitsu Sawa

1. Globalization promoted by innovation of information and communication technologies and collapse of socialism

This is a story from quite a long time ago, but it was about a quarter of a century ago at the end of 1991 when the Soviet Union was dissolved and the collapse of socialism became decisive. The Cold War period that lasted nearly half a century was finally ended. In the meantime, I have always advocated that advancement in information and communication technology (ICT) was remarkable, and that it was ICT that triggered the collapse of socialism. The reason is as follows.

Between the Eastern and the Western Europe was an "invisible wall" called the "iron curtain." Although the iron curtain was effective in hindering the traffic of people and goods, it could not hinder the traffic of information using the medium of communication satellites. The image information transmitted from Western countries burned the lives of people living in the Western countries enjoying their freedom, and their economic affluence to the eyes of people living in the Eastern countries painfully. The innovation of ICT which visualized the difference and the disparity between the East and the West to such an extent is the true cause of the collapse of socialism.

It was in November 1989 when the Berlin Wall collapsed. The curtain of globalization was cut off at the time of the collapse of the Soviet Union two years later, when the iron curtain collapsed unexpectedly. "Globalization," which has now become an everyday word, began to be frequently used since the beginning of the 1990s, and it quickly became an essential key word in telling stories of the social conditions towards the end of the 20th century.

Each of the Eastern European countries broke up with socialism on one level or another, promoting liberalization and democratization of politics and economy, and completely removed the "wall" that hindered not only the movement of people and goods but also the exchange of information. China and Vietnam, which adhere to the socialism of one-party dictatorship, also push forward the transition into the market economy with respect to the economy. At least as far as economic outcomes are concerned, they have gone beyond most expectations, successfully balancing socialism and market economy. In promoting the market economy, democracy does not necessarily seem to be a necessary condition. This is exemplified by the past cases in which the progress of socialist market economy, and the "development dictatorship" of Singapore and other East Asian countries were effective for economic development of each of those countries.

2. Good and bad of free trade

Globalization progressed in every aspect of human activities, but the impact of the globalization of the market economy was greater than anything, including its positive and negative aspects. You can buy and sell stocks and currencies in the global stock market and foreign exchange market by simply clicking the mouse on a computer. The total amount of foreign currency trading (spot) per day released every three years by the Bank for International Settlements (BIS) was less than 400 billion dollars in 2001, but it expanded to over 1 trillion dollars in 2007, and over 2 trillion dollars in 2013. The financial market has gone globalized to such an extent that the decline in housing prices in the United States shook the global financial markets and it led to the outbreak of the international financial crisis in 2008.

Manufacturers in developed countries moved their production bases to developing countries with low wages, and devoted themselves to strengthening their price competitiveness. East Asian countries with low wages and diligent labor force attracted Western and Japanese manufacturing companies. Rising wages of workers in developing countries naturally increased their purchasing power, and contributed to the market expansion of the products of manufacturing companies in developed countries.

In 1993, the "Maastricht Treaty" came into effect, and the European Union (EU) was established with

most of the Western European countries joining. Eastern European countries, which turned into liberalized and democratized countries, joined the EU one after another, and as of 2017 the number of its member-states is 28. In economic terms, the divisions between the countries within the region disappeared, tariffs within the region were eliminated, and people's migration became free.

From the perspective of economic efficiency, it is certainly desirable to integrate the markets of 28 countries. The North American Free Trade Agreement (NAFTA) by the United States, Canada, and Mexico also came into force in 1994, and most of the tariffs between the three countries were eliminated. The Trans-Pacific Partnership (TPP), in which Japan participated, was also on the verge of entry into force.

The theory of comparative advantage that David Ricardo advocated in his book *On the Principles of Political Economy and Taxation* (1817) has been regarded as the logical basis of common sense that "international free trade enhances welfare in all countries." If we compare the productivity of the two countries of the U.K. and Portugal, Portugal surpasses the U.K. for both two goods, wine and woolen fabric, but if we compare the productivity of the two goods in each country, production of woolen fabrics in the U.K. surpasses that of wine, and in Portugal production of wine surpasses that of woolen fabric. In this case, we say that Portugal is absolutely superior in both wines and woolen fabrics, but the U.K. has a comparative advantage in woolen fabrics, and Portugal has a comparative advantage in wine. If each country specializes in what they have a comparative advantage in and trade them, the welfare of both countries will increase together.

The theory that Ricardo advocated 200 years ago is still alive now, and at least in principle, free trade has been endorsed. However, with Ricardo's two-countries, two-goods model, the following doubts cannot be wiped out. What would happen to workers working in British wine factories and workers in Portuguese woolen factories? Both kinds of labor should require skills. It is doubtful whether workers who used to work at a wine factory until yesterday could work at a woolen factory from today. In addition, consideration with respect to people's migration (or immigration), which Ricardo did not expect, and security of food and resources (i.e., the possibility that trade will be disrupted by an outbreak of some conflict) can be pointed out as a disadvantage of free trade.

3. Liberalism and democracy threatened

To summarize the above, the period between 1991 and 2016 was when globalization bloomed and bore its fruit. It was the British referendum, which approved the withdrawal from the EU in June 2016, that first stopped the tidal current that lasted for a quarter of a century. A large number of immigrants from the Eastern European countries flocked into Britain in accordance with the EU law, which set the freedom of immigration in the region. It caused a decline in wages, unemployment, and deterioration of public safety, according to the argument by the advocates of the withdrawal. In short, the U.K.'s withdrawal from the EU pulled the trigger of the rise of anti-globalism and populism.

In the U.S. presidential election in November 2016, Donald Trump won. The position where Trump stands is called populism, but indeed the aim of Trump's economic policy is solely focused on creating jobs for Americans. The inflow of illegal immigrants from Mexico and other Central and South American countries deprives employment. U.S. and Japanese automakers export cars made in Mexico with low wages to the United States to deprive Americans of employment. As a countermeasure to regain employment, Trump says that he will impose a high rate of border tariff on imports from Mexico. Also to regain employment, he declared a withdrawal from TPP and review of NAFTA immediately after inauguration as President. This is in stark contrast with former President Bill Clinton's statement, which said that NAFTA would create jobs in the U.S., and even better, it would create jobs with good salaries, when he signed the NAFTA bill.

An era of globalism in which globalization was positively viewed lasted for the past quarter century. Everyone had anticipated that the tidal current of globalization would continue in the future.

Whether the year 2017 will be the historic turning point or not will be decided soon. If a far-right party

embracing anti-globalism and populism just as Trump does emerges in the Netherlands' general election in March, France's presidential election in April, or Germany's general election in September, the values and norms nurtured by modern Western Europe, namely individualism, liberalism, and democracy, will be trampled. Economics that presupposes a free and competitive market economy can also be a candle flickering in the wind. It is truly a horrifying story.

4. Age of new uncertainty

Every year, as early as on the New Year's Day, the result of the annual questionnaire to prominent managers and economists on the New Year's economic prospect is posted on *The Nikkei* morning edition. For the four years since 2013, forecasts such as on the economic growth rate, stock price, exchange rate, etc. varied widely from person to person depending on how they evaluated the effectiveness of Abenomics. However, with regard to the forecast for 2017, as of the end of 2016, international circumstances were completely unclear as to the political and economic policies of the President-elect Trump, results of the elections in European countries planned for 2017, and whether or not a far-right party advocating anti-globalism and populism would emerge, so their predictions were mostly the same. There were few remarkable differences among respondents.

As soon as it was reported that Trump's victory was definite in the U.S. presidential election in November 2016, Tokyo Stock Exchange recorded a major drop by more than 1,000 yen, but in the New York market which opened half a day later, the stock price recorded an unexpectedly large hike, and in response to this, the stock price in Tokyo quickly returned to its original level. After that, stock prices continued to be on an upward trend in both Japan and the United States, and yen's depreciation and dollar's appreciation continued. Why did the American financial market view Mr. Trump's victory favorably immediately after the election? The following reasons are possible.

The first reason is an expectation for extravagant public investment to the aging domestic infrastructure such as airports, roads, bridges, and harbors. The second reason is an expectation for corporate tax cuts and income tax cuts for the rich. The third reason is an expectation for financial deregulation. The fourth reason is an expectation for relaxation of environmental regulations. The fifth reason is an expectation to trade protectionism. These five "expectations" will raise expectations for an economic growth of the U.S. and improvement of employment environments. Active finance brings about a rise in long-term interest rates and inflation. Given this, the policy interest rate will be raised earlier by the FRB, and the gap of interest rates between Japan and the United States will be expected to widen, triggering dollar buying and yen selling (i.e., yen depreciation and dollar appreciation). The fading light of goals aimed at by Bank of Japan's monetary easing of a new dimension will receive support shooting by Trumponomics, the economic policy of Trump.

It is difficult to deny that Mr. Trump's anti-globalism is exclusively aimed at protecting the domestic manufacturing industries. As already stated, globalization means that the inevitable "phenomenon" that was meant to occur, which was the disappearance of boundaries on Earth, including national borders, accompanied by the collapse of the Soviet Union in December 1991 (the collapse of socialism and the end of the Cold War), and the rapid progress of information technology. In other words, the phenomenon of relative "liberalization" of movement of people, goods, and money beyond national borders is called globalization. The idea that this is desirable is globalism, and the idea that it is not is anti-globalism. In the referendum on June 23, 2016, the votes supporting the British withdrawal from the EU exceeded the opposition votes by about 3%, but this was nothing but a manifestation of anti-globalism of British workers against wage sluggishness, a reflection of the supply and demand of the labor market with jobs deprived of by immigrants from Eastern European countries.

5. "Employment:" the treasure of the populist tradition

At the first press conference on January 11, 2017, the President-elect Trump said, "I am going to be President who will produce the largest number of employment in the history of the United States," and to stop the

American companies' production bases from moving abroad, he restrained them by saying that he would impose a border tax of 35% on products manufactured at plants relocated outside the country. He had warned on Twitter on January 5 saying, "I will apply a 35% border tax on Toyota, which is building a factory to make Corolla in Mexico, if they are going to sell Corolla produced in Mexico in the US." He also said that he would impose a border tax on cars made in Mexico, even for American car manufacturers (GM, Ford, and Chrysler).

The North American Free Trade Agreement (NAFTA), which came into force on January 1, 1994, is an agreement to liberalize the investment and trade among Canada, the United States, and Mexico (and to remove barriers such as tariffs). It is a rational choice as a private company that Japanese automobile manufacturers as well as American automobile manufacturers relocate their production bases to Mexico where labor wages are only one-sixth of that of the United States. At the same time, it benefits consumers who can buy inexpensive cars. Ford, which was made a victim by Mr. Trump's Tweet, quickly withdrew the plan to relocate its factory to Mexico. Mr. Trump said at a press conference, "I want to thank Ford. I expect that the major automobile manufacturers such as GM will follow the move of Ford as well."

An excuse of saying, "We are not cutting employment in the United States just because we built a factory in Mexico" does not apply. This is because, if Toyota exports passenger cars made in Mexico to the United States, sales of passenger cars domestically produced in the United States will surely decrease, and employment in the United States will surely decrease. Toyota announced its intention to "invest a capital expenditure of $10 billion in the United States over the next five years," and is striving to extinguish the fire. Rather, I think that the following indication may be an appropriate counterargument. Mr. Trump says he will create a wall on the border with Mexico to block the influx of illegal immigrants. Employment opportunities will be produced in Mexico if Japanese and American automakers build plants in Mexico to benefit from NAFTA. To that extent, the number of illegal immigrants from Mexico should decrease.

Because the cause of illegal immigration is due to the lack of employment opportunities in Mexico, for automobile manufacturers to transfer part of their production bases to Mexico will be an equivalent of creating an "invisible wall" at the Mexican border. There is no doubt that illegal immigration from Mexico will increase further if the Trump administration takes measures to virtually prohibit creating a car factory in Mexico by imposing a border tax.

Mr. Trump said at a news conference: "The U.S. trade negotiations have failed;" "There are a trade deficit of hundreds of billions of dollars annually with China, and trade imbalances with Japan and Mexico as well." The pretense is reminiscent of the Japan-U.S. trade friction in the 1980s. Mr. Trump says that bilateral negotiations are preferable to multilateral negotiations like TPP. The Japan-U.S. trade friction at the end of the 1980s seems likely to be reproduced, such as self-regulation of exports, local production, and elimination of import barriers.

To sum up, the economic policies, Trumponomics, that President-elect Trump talked about at a press conference boil down to the following two points. For one thing, increasing employment opportunities is the top priority of Trumponomics, so for that purpose he will not hesitate to withdraw from NAFTA, not to mention TPP. The fact that Amazon.com made its intention as early as on the day after Mr. Trump's press conference, saying that it would hire 100,000 people or more in the next year and a half," clearly shows that there are not a few companies in the United States that are afraid of Trump. Jeff Bezos, the CEO of Amazon, being also the owner of the Washington Post, which was the forefront of opposition against Trump during the presidential election, he probably feared that Trump could take retaliatory measures against his core business of Amazon.

The other is the recognition that for the American economy, there is an urgent need to reduce the trade deficit of 4.5% against the Gross Domestic Product. In particular, he sees China, which accounts for 49% of the total trade deficit, Japan 9%, and Mexico 8%, as problematic. Whether he was conscious or not, he did not dare to mention Germany, which accounts for 10% of the deficit. Reducing the trade deficit will also leads

to an increase in employment opportunities in the United States, which is the top priority of Trumponomics.

6. President Trump, who says No! to former President Obama

Regarding large income tax reduction of corporations and individuals, public infrastructure investment, the removal of medical insurance system reform (Obamacare), easing of financial regulations, review of climate change countermeasures, which President-elect Trump had promised during his presidential election campaign, he made no mention at all at the first press conference after election (January 12, 2017). An increase of domestic employment opportunities is originally intended to meet the "expectation" of the white workers (originally supporters of the Democratic Party) who turned to support Mr. Trump. At the same time, it is an extremely easy-to-understand target without any room for doubt. In other words, the guarantee of employment and increase of employment opportunities is a policy goal which symbolizes populism.

The following reason seems plausible for Mr. Trump's press conference being narrowed down to guaranteeing employment and increasing employment opportunities. Considering the current state of the United States with the fiscal deficit of nearly 800 billion dollars annually, it is inevitable that large tax cuts and large-scale public works are incompatible. He must have dared to avoid mentioning financial issues to avoid questioning by reporters about this contradiction. Although Mr. Trump graduated from comes from the Real Estate Department at the Wharton School of the University of Pennsylvania, surprisingly he may be unfamiliar with macroeconomics. If he started to talk about financial easing, reform of medical insurance system, climate change countermeasures, etc., he could have met with a barrage of questions by the reporters. Having effused his own prejudiced theories on Twitter, he must have avoided going too deep into economic issues as he did not want to shame himself at his first TV-broadcast press conference.

You cannot be too cautious, but if Mr. Trump is ignorant of the ABC of macroeconomics, will Trumponomics, like Reaganomics (former President Reagan's economic policy), bring about a "twin deficit" (fiscal and trade deficits)? There is much tendency to point out the commonalities between Trumponomics and Reaganomics, and certainly both attempts at balancing large tax cuts and fiscal expenditure (military expenses for Reaganomics and infrastructure development for Trumponomics).

However, the crucial difference between Trumponomics and Reaganomics is that the former emphasizes trade protectionism. This means that, while Reaganomics emphasized the suppression of inflation due to the appreciation of dollar, there is no hesitation in Trumponomics in violating the fundamentals of the liberal economic policy in order to protect domestic manufacturing industries with a border tax. Reaganomics was underpinned by the "theory" of supply-side economics, which had earned a certain reputation among American economists, even though it was ridiculed as "Voodoo Economics."

On the other hand, Trumponomics does not belong to any of the existing schools of economics, nay, it is an economics (?) probably not supported by any economist, unable to wear any theoretical armor. There should be no mistake in thinking that the trends of the global economy and the Japanese economy during 2017 to 2020 will be disturbed by Trumponomics.

2. U.S. administration change and the Paris Agreement

Yukari Takamura

1. U.S. administration change and the Paris Agreement

What will happen to the Paris Agreement with the change from the Obama administration, which led the climate change negotiations leading up to the adoption of the Paris Agreement, to the Trump administration?

The general principles (platform) indicated by the Republican Party during the presidential election said, "Neither the Kyoto Protocol nor the Paris Agreement are not subject to discussion," and "The Agreement is not binding for the United States until it is submitted to the Senate and ratified." In addition, the platform urged the immediate suspension of the U.S. contribution to the Framework Convention on Climate Change fund, and referring to the Foreign Relations Authorization Act of 1994, it stated that contributions to the fund for the Framework Convention on Climate Change and the Green Climate Fund (GCF) were illegal.

Regarding the Paris Agreement, no clear policy has been indicated by the Trump administration yet, and there are concerns that it may withdraw from the Paris Agreement. One of the possible scenarios is that while the Obama administration concluded the Paris Agreement with an Executive Order without seeking advice or approval from the Senate, the Trump administration will issue a new Executive Order to cancel this Executive Order. It is possible to issue such an Executive Order, but it does not mean that the action by the United States regarding its conclusion of the Paris Agreement will be invalid internationally. Now that the Paris Agreement is in effect, in order to withdraw, the United States will have to follow the aforementioned procedure of the Paris Agreement, and a withdrawal is not possible for at least 4 years from its entry into effect.

Another possibility is to withdraw from the Paris Agreement by withdrawing from the Framework Convention on Climate Change, which is the parent treaty, under Paragraph 3 of Article 28. It is legally possible, but considering that the Framework Convention on Climate Change is a treaty concluded with the advice and approval of the Senate during the George H.W. Bush administration, nearly all countries in the international community have concluded it, and it may have a diplomatic consequence to withdraw from the treaty that has become the legal foundation for dealing with the climate change problem over the course of a quarter of a century including the times of the Republican administrations, it does not seem to be an easy option politically.

In an interview with the New York Times in November 2016, Mr. Trump said, "I have an open mind (not excluding any option)" about the Paris Agreement, suggesting a possibility of taking a more flexible measure than a withdrawal from the Agreement as previously suggested. Exxon CEO and a candidate for the next Secretary of State, Mr. Tillerson, also made a remark at a nomination hearing on January 11, 2017, that it was better to participate in a place to discuss climate change issues than to leave it. Recent news has reported that there are concerns within the administration over the diplomatic consequence of clearly showing the position that denies the Paris Agreement, which is withdrawal, and also that opinions are split over whether or not to withdraw. In addition, there have been reports that the U.S. coal industry, which is supposed to be a supporting body of the Trump administration, hopes that the United States will not withdraw from the Paris Agreement, concerned about a formation of international rules without the United States, which could affect overseas markets.

It is more realistic to stop and withdraw payments to contributions to the Framework Convention on Climate Change and to the Green Climate Fund. This is because the reason for that is also concerned with the political issue of dealing with the U.N. agencies that recognize Palestine as a nation (Palestine ratified the Framework Convention on Climate Change on December 18, 2015).

The contribution by the United States accounts for over 21% of the core activity budget of the Framework Convention on Climate Change for 2016 (9.4% for

Japan). Of the USD 10 billion pledged to be contributed to the Green Climate Fund, the amount pledged by the United States is USD 3 billion (about 30%) (about USD 1.5 billion for Japan). There is a concern about the impacts of the budgetary and funding constraints, while negotiations on the implementation regulations of the Paris Agreement is becoming full scale aiming for the COP24 in 2018 and developing countries are also trying to proceed with their efforts to achieve their targets. In the climate change negotiations, developing countries have requested expansion of financial support for many years, and if the suspension or withdrawal of funds by the U.S. is conducted, the demands from developing countries for support measures including the funding will become stronger, and the issue will be bigger than ever in the negotiations. In fact, at the BASIC group meeting held in April 2017 by the four countries of Brazil, South Africa, China, and India, the problem of lack of funds to support developing countries was one of the items on the agenda.

2. Impact on U.S. domestic measures and emissions reduction

The Trump administration showed the policy of relaxing regulations on coal very early, and we cannot expect a federal government's positive measure like the clean power plan aimed at regulating carbon dioxide emissions from coal-fired power plants proposed under the Obama administration.

On the other hand, the greenhouse gas emissions in the United States (the amount absorbed by forest and other sinks are not included in the account) had increased since 1990, but turned to a declining trend with the peak of around 2005. Greenhouse gas emissions in 2015 decreased by 1.1% compared to the level of 2014, and by 9.4% compared to the level of 2005. Greenhouse gas emissions of energy origin also showed a similar trend, decreasing at the pace of about 1.1% every year, and in 2015 the emissions decreased by 10.4% compared to the level of 2005. Emissions in 2016 decreased by 3% compared to the level of 2015 (the economic growth rate was 1.6%). A reason for the decrease is that the shift from coal to shale gas progressed, and it is also due to the progress of introduction of renewable energy. Renewable energy (excluding large-scale hydroelectric power) only accounted for 2.2% of the total power generation in the United States in 2005, but it expanded to 7.4% (about 13% if large hydroelectric power is included) in 2015.

If aggressive measures do not come out of the Trump administration, the emissions reduction in the United States may be delayed, but the tendency of such emissions reduction seems unlikely to stop easily. The first reason is the structure of the domestic energy cost in the United States. In the United States, while the average power generation cost using gas is 52 dollars per MWh, the average power generation cost using coal is 65 dollars per MWh. The Trump administration has also launched a policy to deregulate not only coal but also gas, so the cost advantage of gas will likely not change. The cost of onshore wind power is about 60 dollars per MWh, which is cheaper than coal. Solar power is also cheaper than coal in most states in the United States, and cheaper than gas in half of all states, due to federal investment tax cuts and state subsidies.

Federal investment tax cuts are aimed at promoting investment, revitalizing the economy, and increasing employment opportunities, and the Republican-dominant Congress decided it was to be extended for another five years at the end of 2015. U.S. employment opportunities in the field of renewable energy increased by 6% compared to the level of the previous year to reach 760,000 in 2015. According to the economic model analysis conducted before the extension of the investment tax reduction, it was estimated that 100,000 jobs would be lost in 2017 in the case of no extension, and with an extension, the employment opportunities in the solar power field from 2016 to 2022 would increase by 32% compared to the case without extension. Because of this, it is considered that the possibility that the administration advocating an increase of employment opportunities will abolish this is small.

The second reason is that a considerable number of states are proceeding with aggressive measures to reduce emission and introduce renewable energy independently. Although the U.S. energy policy is led by each state, about 30 states will set a target for renewable energy. In 2030, California will make 50% of its total retail electricity renewable energy, New York

State 50% of the total power generation, and Hawaii 50% of the total retail electricity.

Even more interesting is the movement of businesses in the United States. Over 1,000 businesses and investors signed a letter requesting Trump to continue and expand climate change and clean energy adoption measures, saying that unless a low-carbon economy was built, the prosperity of the United States would be threatened (Business Backs Low-Carbon USA http://www.lowcarbonusa.org). Businesses lead the introduction of renewable energy from the demand side's point of view. Google, Microsoft, and Wal-Mart, among others, concluded purchase agreements of renewable energy, aiming to use renewable energy for 100% of the energy consumed by themselves, which amounted to 2.3GW per year in 2015 alone. In the next nine years the amount is estimated to increase further by 17.4GW.

Federal measures may retreat, but the energy switchover driven by the market and state/municipalities will advance emission reductions in the United States. However, we cannot expect acceleration of that speed, due to lack of policy.

3. The Paris Agreement from now on

Ratification of the Paris Agreement proceeds even after the change of the U.S. administration became clear. As of April 13, 2017, 142 countries, including Japan, and the EU have ratified the Agreement, an equivalent of more than 80% of the world's greenhouse gas emissions. At COP22, each country also clearly indicated their intentions to continue climate change measures under the Paris Agreement.

The major difference from the time of the U.S. withdrawal from the Kyoto Protocol is the difference in economic and social conditions surrounding the Paris Agreement. Due to technological development and mass introduction, the switchover to renewable energy proceeds globally as the cost of renewable energy drops sharply. Expanding the introduction of renewable energy, which has become an economically rational alternative to other power sources, is a highly anticipated measure that not only serves as a countermeasure for climate change but also responds to increasing energy demands of developing countries, providing stable energy supply to people in developing countries, and the Paris Agreement has strong support from developing countries as an institutional basis promoting such energy switchover. Improvement of air pollution, job creation, industrial promotion, energy self-sufficiency and security, etc. also back the support of the Agreement. As stated earlier, it is also a big difference that the initiatives of municipalities, cities, and businesses besides the national are growing.

The greatest influence of the change of administration will appear in the international negotiations where the federal government plays the leading role. It may be difficult to expect a leadership that the Obama administration demonstrated in negotiation and agreement on the Paris Agreement and its early entry into force. At COP22, it was agreed that implementation rules of the Paris Agreement would be agreed upon at the latest by COP24, to be held in 2018. Creating rules is quite diverse, ranging from what international rules should be used to manage the target submission and hike mechanism every five years, how to report on progress of countermeasures in each country, what to examine, to what measures should be taken against countries that do not comply with the Agreement, etc. Unlike the Kyoto Protocol, developing countries will submit targets and implement them internationally, so creation of implementation rules for the Paris Agreement is a more difficult negotiation task than that of the Kyoto Protocol.

At COP22, movements were seen in which major countries launched cooperative and collaborative platforms with other countries in the fields that they were good at and took the initiatives. Some of them are "10-100-1000," China's South-South cooperation platform that will launch 10 low-carbon model areas, 100 emissions reduction and adaptation projects, and 1,000 climate-change-related training businesses locations in developing countries, and "BioFuture Platform" launched with the initiative of Brazil. Also for "International Solar Alliance," aiming to mobilize USD 1 trillion investment for large-scale introduction of solar energy by the year 2030, launched at COP21 with the initiatives of India and France, the framework document was agreed upon at COP22.

It is vital that Japan not lose sight of its national

interests without being influenced by the change of administration of the United States. The decarbonization of the world aimed at by the Paris Agreement will greatly expand the global market for energy conservation and renewable energy. It is also a big business opportunity for Japanese companies which have strengths in energy saving and renewable energy technologies. According to the World Intellectual Property Organization (WIPO), among the top 20 companies in the world according to the number of patents owned by regarding renewable-energy-related technologies such as solar and wind powers, 12 Japanese companies such as Panasonic are in fact ranked in. According to the International Renewable Energy Agency (IRENA), Japan holds the largest number of patents related to renewable energy in the world, surpassing the United States. It is necessary to think that it is exactly of Japan's national interests to agree on the implementation rules of the Paris Agreement at an early stage, and to lead the world in anticipation of the full start of the Paris Agreement.

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Chapter 5　Sharing Economy; Minimalism; Zero Marginal Cost Society

1. Economics of zero marginal cost society

Jeremy Rifkin, at the beginning of his book titled *Zero Marginal Cost Society*, says, "Capitalism is now creating a successor. It is a sharing economy that is deployed in the Collaborative Commons. (Omitted) There, the majority of goods and services are free, profits disappear, ownership loses its meaning, and the market is useless." In particular, he states that renewable energy is expected to see an exponential development like the spread of the Internet, and that it will become a lush energy with little environmental impact. Although Rifkin's viewpoints and ideas may not always be right, they offer us perspectives worth considering.

2. Car sharing and autonomous driving

The IT transformation will bring about a major change in the field of transport systems. The keywords are autonomous driving and sharing. Providing mobility not based on driving license and car ownership will bring benefits such as eliminating the weak point in transport system, improving vehicle efficiency, and reducing traffic accidents to the society. On the other hand, ensuring security is an important issue, and mass transit systems are still necessary. The redesign of transport networks and urban structure will become an urgent matter.

3. What is minimalism for?

Minimalism is not just a lifestyle of having few things. It is an act of asking once again what "happiness" is that has been believed up to now by taking distance from escalating consumption once. Aren't we targeting the wrong goal? Minimalism restarts "happiness" at the principle of action of people.

1. Economics of zero marginal cost society

Seiji Ikkatai

For the description below, I would like to say in advance that I owe much to Jeremy Rifkin's *Zero Marginal Cost Society*. Aside from the cited parts in the text, I am responsible for the entire passage as they are my opinions.

1. From capitalist economy to sharing economy

Rifkin states at the beginning of his book: "Capitalism is now creating a successor. It is a sharing economy that is deployed in the Collaborative Commons. (Omitted) The Collaborative commons provide the possibility to sharply reduce the income disparity, democratize the global economy, create a more sustainable society in a more ecologically friendly way, already changing the way of our economic lives," and then," There, the majority of goods and services are free, profits disappear, ownership loses its meaning, and the market is useless."

In a sense, this is a surprising claim. He says that many of the major problems of human society that have no prospect of being solved today, such as poverty within richness is regarded as a problem, the elimination of inequality has been loudly pointed out, the problems of global companies becoming powerful transcending national borders, climate change problems, etc. have the possibility to improve in the future.

Regarding that ground, Rifkin states as follows. In other words, this is not a point that has been made now for the first time, but it was something that has been claimed by prominent economists and others from before.

For example, he says that Keynes, an economist in the 20th century, stated in a 1930 essay "Economic Possibilities for Our Grandchildren" as follows; "We will hear the words 'technological unemployment' many times in the coming years. This refers to the unemployment that arises because the discovery of means to conserve labor force surpasses the speed at which new uses of labor force can be discovered. (Omitted) Technological unemployment is a major benefit in the long term, because it means 'human beings are solving their own economic problems' although people suffer in the short term." Then, "When these needs are fulfilled, the time when we will want to devote more energies to non-economic purposes will arrive sooner, or possibly much sooner, than we all think."

He says that the contradiction at the heart of the capitalist system that Keynes and his contemporary Lange foresaw are in the following two phases of capitalism: First, it is in "the entrepreneurial dynamism peculiar to competitive market that pushes up productivity and pushes down marginal cost" and "that economy is most efficient when consumers only pay marginal cost of products."

Then, when it reaches such a situation, since it will be difficult for a company to gain sufficient profits, "the market will try to prevent the aim at the most efficient economy with marginal cost almost zero, heading toward realization of nearly free goods and services." He says that, in other words, the more capitalism succeeds, the more it will be forced to leave the world's front stage.

He says that, shared type commons that come up instead of this is not appearing suddenly, but it is in fact a place of institutionalized voluntary management activities, which is the oldest in the world with a longer history than either the capitalist market or the representative government. Those commons have been handed down to the present day, including official and unofficial organizations such as charity groups, religious organizations, arts and cultural groups, consumer cooperatives, and consumer organizations, for example.

Originally, the commons were developed as an economic model in which farmers united to form a shared economy, maximizing utilization of its resources and sharing them, in their farming in the feudal age. Today, this has come to be understood as social commons, with the words social relationship capital. However, primarily it is not a financial value but social value that such shared type commons create, so in that

sense it is quite different from the capitalist market. Rifkin used the expression that, "While capitalism is based on the pursuit of private interests and uses material benefits as its driving force, social commons is motivated by the benefits of a collaborative type, and uses its strong desires to be connected to other people to share things as its driving force."

The reason why the argument above cannot be called absurd is because we can see many instances that support it, in fact due to the communication and information revolution such as the Internet. Today, consumers do not simply exist to buy products that are made from the market. For example, they are also producers that publish videos that they made on the Internet (called prosumers). "Prosumers are not merely newly producing and sharing their own information and entertainment, green energy, mass media, 3D printer products, and large open online courses at the Collaborative Commons with almost zero marginal cost. They share automobiles, housing, and even clothing through social media sites, rental shops, redistribution clubs, cooperatives, etc., at a low marginal cost or nearly zero marginal cost."

2. From large-scale centralized energy system to small-scale distributed energy system

Among the forecasts of major changes in the economic system above, those related to energy will have great implications for human sustainability.

Rifkin states in Chapter 5 of the same book, "Extreme Productivity, the Internet of Things, and Free Energy" as follows. "There are two surprising similarities between the fields of renewable energy and IT and the Internet;" "Firstly, the energy harvesting capability of renewable energy technology is exponentially increasing with solar power generation and wind power generation, and geothermal power generation, biomass power generation, and hydroelectric power generation are also expected to follow that." "Secondly, although the initial cost of establishing communication and Internet infrastructure reached a considerable amount, marginal costs of creating and circulating information are minimal. Likewise, energy and the Internet also require a huge initial cost for establishment, but the marginal cost per unit for generating electricity from sunlight and wind is almost zero."

In addition, Rifkin continues to state as follows. "If this trend continues at the current pace, the electricity price from solar power will fall to the same level as the current electricity retail price by 2020, and by 2030, it will be half the price of the current coal-fired power generation."

In fact, in Germany, with the EU's liberalization of electricity, there are cases where the short-term market price of renewable energy is lower than the market price of other power sources.

Now, these major changes in energy supply and demand have been caused by the creation of new technologies and systems. That is, it is a shift from a so-called large-scale centralized power supply system to a small-scale distributed energy supply system. Until now, whether it is a power station that uses fossil fuels such as coal or natural gas, or a nuclear power plant that uses nuclear fuel, they have been as large as possible to increase efficiency, and electricity generated there was sent to individual consumers through power transmission lines. Solar power generation, wind power generation, etc., existed technologically for a relatively long time, but it was not popularized because it was not economically feasible mainly due to its cost.

Then, social costs such as climate change due to fossil fuels were recognized globally, and with the introduction of feed-in-tariff system for renewable energy became full-scale since around the beginning of 2000 and with the technological improvement and decline cost, the spread of renewable energy also reached the general public.

This has led to the change from the recognition that the energy problems were those of the national government and major electric power companies and that the ordinary citizens could not be involved in them, to the recognition that each area can create its own energy system according to their choice. For example, it also leads to the idea of and campaign for energy self-sufficient cities based on renewable energy, which can already be seen in German cities, as well as to the movement to build a sustainable society in the region mainly based on the community and its residents.

However, will this kind of movement over renewable

energy really be realized, and is it completely problem-free from the viewpoint of sustainability?

One thing to keep in mind is that although there is a high possibility that the shift from large-scale centralized power generation centered on fossil fuels and nuclear power to small-scale distributed power generation is likely to progress, many technical and system-wise backups are indispensable, including the so-called smart grids. Especially, when a national consensus on such a big direction is not established, unlike in Japan, there is a fear that a serious political friction may occur between the existing industries involved in fossil fuels and nuclear power, and the new industries involved in renewable energy. In that sense as well, it is important to formulate a neat sustainable development strategy at the national level, and to implement it according to the plan over a certain amount of time necessary.

Either way, if we can make the energy base renewable, it is expected that the negative impact on human sustainability from the viewpoint of environmental and resource problems will be reduced to a considerable extent.

3. Rise of the Collaborative Commons

Now, what kind of world is the worlds of shared economy and Collaborative Commons, according to Rifkin? Rifkin introduces the claim by American law professor Carol Rose in Chapter 10 titled Commons Comedy.

"Besides the purely private property and the "public property" managed by the government, there is a unique category of "essentially public property," which is not completely managed either by the government or any individual. It is a property that the whole society collectively "owns" and "manages," the ownership of which is independent of any administrator called government authorities, and in fact the ownership is superior to that of such administrators."

In other words, it is a so-called customary right to navigate freely in the waterway, walk along the country road, or use public plazas, and so on. This used to be the most fundamental thing in the past. For example, it was an indispensable element for us to communicate with other people, enjoy the time spent with others, and nurture the local community through the place called public plaza.

In other words, the right to participate "jointly" is the basic ownership, whereas the private property, which is in short, the right to enclose, to own, to lock out, is merely a limited deviation from the fundamentals. In modern times, Rifkin says that it is the limited deviation has practically become the norm.

In addition, Rifkin introduces the book *Governing the Commons: The Evolution of Institutions for Collective Actions*, written by Elinor Ostrom, who received the Nobel Prize for Economics for the first time as a woman in 2009, as follows. "History shows that Commons is a very excellent governance organization and deserves reconsideration from the viewpoints of environmental, economic and social problems that humankind faces in a global world that gradually deepens the connection, and she made the fact clear to a point where there was no room left for discussion."

In addition, he says that Ostrom's research also touched on the fact that mountainous pastures and forests exceeding 12 million hectares were governed under the commons-type arrangement of the jurisdictions of thousands, and tens of thousands of villages during the Tokugawa period in Japan.

One of Ostrom's claims was that the idea that human nature, according to many economists' basic premise so far, is selfish, and that each person tries to maximize self-determination rights, is by no means the universal truth of humankind, but that the human nature depends a far greater deal on collective sociability.

According to Rifkin, from a historical point of view, in modern countries, the basic infrastructure and services in society have been managed by the government. Movement since the Meiji Restoration in Japan is no exception. However, dissatisfaction that its management is not necessarily efficiently performed, deregulation and privatization began in various countries, following the opinion that it would be better to leave those items to the free market. However, the result was not necessarily satisfactory.

In other words, people became disillusioned by the polarization of the centralized, and sometimes inhumane, bureaucratic government administration on

one hand, and the enormous, manipulative, and controlling private sectors that tried to take in every aspect of life into their source of income and profit, and people began to look for a model of governance that could potentially allow more democratic and collaborative methods to construct their economic life. And they rediscovered the Commons, Rifkin says.

Certainly, the Internet now seems to connect the world, creating a new area of human activity. And it seems that instead of merely being a place for information exchange, the area is expanding the possibility of Collaborative Commons as a new social system based on new values substituting the traditional market economy.

4. From ownership to access

Now, according to Rifkin, in the present age where things and the Internet are rapidly being linked, there is a change occurring from ownership to access. Certainly, the phenomenon is occurring where people stop owning a car and use only the service at a lower cost by car sharing, etc. Also, it is becoming a reality to share everything, changing from the form of owning everything, including cars, buildings, and clothes, and uses them jointly. Of course, this is not to say that everything will be shared eventually, but the traditional capitalist market based on ownership will continue to shrink to a further limited niche market, Rifkin expects.

However, will such a change not cause a “rebound” that is often mentioned in economics? As we have often seen so far, will the cost-reduced part not evoke new demand, including other things? Regarding this point, Rifkin states as follows, denying that concern. “In a society where anyone can obtain much of what they want, nearly for free, (omitted) it is highly probable that a considerable part of the human temperament will be liberated from their impulse to relentlessly try to get more things while they are being uneasy about what might happen tomorrow.”

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2. Car sharing and autonomous driving

Hirokazu Kato

1. Limits of transport system depending on humans

In the transport sector, innovation as never before may occur due to ICT's popularization and progress of sharing economy. Its impact may be comparable to, or even greater than, innovation resulting from the fact that we have acquired power from fossil fuels, and private car popularization, or motorization, in the past.

Transport behavior is the accumulation of choices that each person makes based on its experiences and obtained information. However, as transport conditions change from moment to moment, it is very difficult to make optimal choices. It does not satisfy the condition of "complete information" which are necessary for working the market principle. For example, if the parking lots become insufficient overall in the center of a city, unless the availability information of the parking lots can be obtained, many people will be at a loss due to many car parking lots which are full, and useless transport will occur and congestion will be encouraged. On the other hand, if information is issued, cars will rush into vacant parking lots, congesting the surrounding roads and on top of that making the parking lot full and as a result there will probably be cars which have to go to another parking lot after all. Therefore, if information is to be issued regarding transport conditions to support personal choice for the optimum transport behavior, it will be necessary to think how the person will change the choice, and thereby how the transport conditions will change. The challenges of "Transport Demand Management (TDM)" which attracted attention in the field of transport engineering is based on this recognition, and combined with prediction technology of transport conditions, etc., it is intended to optimize the transport conditions by changing not only the route selection but also the modes, the destination, and the selection of the departure time.

After that, the methods and contents of information transmitted to persons were enriched by utilizing the information technology which was advancing rapidly. The "Vehicle Information and Communication System (VICS)" in which real-time congestion status is displayed on the car navigation system is typical. Various ITS (Intelligent Transport Systems) technologies including this have been put to practical use. The introduction of information technology in public transport as well as road and expressway are also on the way. Besides the operation management system that supports high-frequency operation in the metropolitan areas and high-speed operation of the Shinkansen trains, with provision of information on delay and cancellation for users and improvement of the transfer search websites on the Internet, the convenience has been improving compared to the past. These progresses of information technology surrounding transport can also be utilized to support TDM.

Various technologies have also been introduced to reduce accidents as a major transport problem. Improvement of safety performance of automobiles is remarkable, and deadly traffic accidents have been on the declining trend recently.

However, there are limits to trying to optimize transport behaviors and reduce accidents with these technologies. It depends largely on the decision of persons. Even if you support by providing information and improving safety performance, person takes the steering wheel and push the pedal. As long as he/she relies on their own selfish, sometimes misjudged choices, traffic jams and accidents will not go away.

Meanwhile, shortage of occupational drivers has become rapidly evident in Japan over the past several years. The main reason is the deterioration in treatment due to deregulation of transport business in the early 2000s. Now, the lower occupancy rate of taxis due to insufficient drivers, and reduction and abolition of bus lines are becoming more apparent. As the aging society progresses, more stringent procedures have been introduced for retaining a driver's license. However, despite the increasing importance of passenger transport by taxis and buses, the country is in a situation where sufficient supply cannot be made.

2. Autonomous driving

"Autonomous driving of cars" has become a technology of topic in recent years. We can say that it is a dream technology that can relieve people from the troublesomeness of driving, increase safety, and ease the restrictions on public transport supply by occupational drivers. It has been taken up by the press many times, and watching it makes it seem that the day when it will become common is not far away. It seems to take a considerable time to become available in general, although practical application is within sight under limited circumstances. However, the world of IT evolves rapidly, and the day may come earlier than expected when the digital data on roads around the world are prepared at what feels like that speed, its automatic update is systemized, the road conditions and the movement of the pedestrians and bicycles are also grasped in real time, and based on these data Artificial Intelligence (AI) will drive a car safely.

Prior to autonomous driving, the introduction of IoT (Internet of Things) technology in automobiles, that is, "moving Internet device" will progress. Together, if we further make power electric-based, automobiles will merely be a kind of home appliances. The question is being asked whether it is possible to quickly design, form and occupy the picture of the automobile market which seems to change largely.

If we are confined to the system built on the premise of the existing technology, in the meantime, the basic software of autonomous driving, the communication protocol, and the operation rule will be decided, and when it becomes possible to do so, there will be no choice but to obey the market formed by the first-mover, and we will have to accept not being able to demonstrate any initiative. This is the same road taken by various products and services created by ICT (Information and Communication Technology) in recent years. As Japan has led the automobile industry, we would like to aim to be the first-mover. To that end, it will be necessary to review various existing institutional frameworks.

3. Ride-sharing

On the other hand, while this is less often talked about than autonomous driving, "ridesharing" has received much attention. This is a private-car version of "sharing economy," and it is making cars available not only for personal use but also for other persons' use. If individual travels can be combined into one, cost can be reduced, and the transport volume, energy consumption and environmental load can be reduced.

Sharing of private cars (carpooling) was conceived as a measure for alleviating congestion, and concrete promotion measures were taken in the United States and elsewhere, but since the methods for matching people moving in the same direction at the same time were limited, it did not become popular. This was solved by launching a website that recruited and matched supply and demand on the Internet, and on top of this smartphones became popular, making applications and browsing possible while moving. However, it is probabilistically not easy to match people who have a purpose of moving with each other. However, in response to the demand that has emerged, it is possible to also step forward for that transport, even if there is no specific purpose for moving. In anticipation of it, smartphone applications enabled online settlement and opened records of user evaluation to the public in order to guarantee the quality of drivers was developed and popularized around the world.

"Uber", the largest company in the field, expanded into more than 70 countries and nearly 550 cities in the world in less than eight years since its establishment. In Japan, Uber also provides a taxi dispatch service in Tokyo, and further began putting their hands on transport by white number vehicles (paid private transport under Article 79 of the Road Transport Act) by paid volunteers in depopulated areas. Uber's application can be used as a reservation and allocation system to car for general taxis (green number vehicles), but its effectiveness will be increased by utilizing it for ridesharing on private cars. This is because taxis are fixed both in supply quantity and fare due to regulation, but for private cars these can be variable, matching of supply and demand can be instantaneously enabled by the application, and a more flexible market can be formed. In the first place, due to the interval use of private cars, expenses are cheaper, and the fares for users are often cheaper than for taxis, and both private

car owners and application providers (platformer) can gain benefit. However, in this mechanism, there is no guarantee whether supply that can meet the demand will appear even if the fare is variable (up to the market principle).

On a side note, ridesharing originally refers to riding of one vehicle by people who share a similar place of departure and destination (uberPOOL, notteco etc., apply. In a broader sense, it also includes shared public transport). However, as mentioned above, ridesharing, which is frequently talked about currently, is not the purpose of the driver's own movement but is aimed at providing transport for people exclusively for obtaining fare income, and in English it is generally called ride-hailing (calling a ride).

According to the current law of Japan, the onerous transport business by white-numbered cars can only be operated where the service cannot be supplied by green-numbered taxis or buses, or in cases they cannot provide service to the target (such as elderly people or the handicapped) and when it is permitted by the council held by the municipality in which the relevant parties participate. All other cases are illegal. For this reason, attempts have been made in areas where public transport is absent, but in such areas, it is not easy to secure drivers because there is little transport volume in the first place. The majority of elderly people who cannot use private cars, who will be the main users, are not used to smartphones, either. Therefore, if it becomes fully legalized, it is expected to be rather popularized in urban areas, and the groups of customers will overlap with those of taxis. The existing corporate taxi business frameworks and wireless dispatch systems will be incapacitated, and standby business at stations and business while driving through the road, etc., in which the range of selection is small, may become comparatively inferior. If they take reservation and allocation to car from Uber, etc., they will need to bear the burden of fee, and the initiative to acquire customers will also be deprived. The taxi and bus industries in Japan are strongly opposed, arguing that transport environment will be greatly impaired if the private car ridesharing is legalized, the existence of businesses will be compromised just as it did in cities in other countries, the transport safety will not be guaranteed, and the fare will also fluctuate greatly.

On a side note, there is "carsharing," similar to the ridesharing, and it is also spreading in Japan. This is a mechanism that allows sharing a car and using it when necessary, and a cost reduction effect can be expected. In Japan, especially in rural areas, private car ownership has progressed from one car per household to one car per person, but the occupancy rate of private cars is low, and there are data that it is less than 10% on the average on a time basis. Having said that, because the operation is concentrated on commuting hours, etc., there is a limit to promoting the sharing, but it has become more common in metropolitan areas in particular, where there are few uses of private cars.

4. Form of Next Generation Mobility

The above-mentioned autonomous driving, ridesharing, and car sharing are very strong in affinity with each other and can draw a form of next generation mobility by combining them. In private car ridesharing, supply can be flexibly changed but securing a driver remains to be a constraint. However, if autonomous driving becomes common, we will not have to think about it. When that happens, the green-numbered cars and the second-class driver's licenses will be meaningless. The taxis and the private car ridesharing will also mean the same thing. If autonomous driving happens, as a private car owner, some people will want to supply their cars to ridesharing while they are not using them. Many people will stop owning a car and begin switching to ridesharing in the first place. As a result, the use of ridesharing by shared cars will become the majority. Given this possibility, it is natural that auto manufacturers are willing to collaborate with ridesharing application management companies from now. This is because, even here, it will be important to secure the first-movers, that is, a large number of suppliers and consumers, as quickly as possible.

For ridesharing, reservation (departure time and destination, vehicle type, etc.) is mandatory, and the application management company obtains reservation and traveling data. It should be noted that this is personal information, but it can be used for various analyses. It is exactly the same as the use of search logs by search websites. Peak pricing, which makes the

charge more expensive on routes and times where congestion is expected, can also be anticipated. Private cars will drive it just by registering the destination on the car navigation system, and when you do not use it, you can have it used for ridesharing.

Now, sometimes we see the claim that public transport will be unnecessary when the automobiles become autonomous driving. Certainly, the taxi will be united with the ridesharing, but the medium and large public transport systems with a capacity over a bus will continue to remain. Even if the ridesharing spreads, the transport capacity of the private car size is too small to substitute medium and large public transport systems. It may transfer to a medium or large transport system as a recommendation at the time of vehicle reservation. We can imagine that it will be possible to make a reservation of a taxi, i.e., ridesharing, on a transfer search website. When this happens, routes and operation schedules may become variable by tailoring buses and on-demand shared transport according to the state of reservation. Hence, a land use and facility location planning will be very important. They can form a spatial structure of cities and areas around the network of a transport system as railways, tramways and BRT (Bus Rapid Transit).

5. Summary

I imagined a little about the future of "autonomous driving and ridesharing society." A switchover is expected from the situation where each person makes a judgment based on limited information and acts as transport as it does in the present situation, causing problems such as congestion, accidents, increase of environmental load etc., to a form in which the cost is made more efficient while the demand of each person is met by utilizing limited infrastructure and vehicles as much as possible. In addition to improving transport efficiency, we can also think of considerably reducing the environmental impact by electrification (on the premise of using renewable energy). Transport which is easy to use for those with mobility constraints, so to speak, can easily be provided, and there will be fewer accidents.

At the same time, the business models involved in public transport will also undergo major changes. As stated in Section 3.3, although the progress of IT is expected to reduce passenger transport, it is thought that cargo transport will increase instead. By linking it with the logistics system of a logistics company, we can expect that the efficiency of cargo transport will improve, and the benefit of labor saving will also be great.

On the other hand, systems for realizing autonomous driving and matching systems for sharing will be monopolized. In that case, there will be concerns about handling of personal information and security aspects. Although this can be said about all IoT technologies, we should pay attention to the possibility that social dislocation caused by perpetration of a security hole will be immeasurable.

While the automotive industry and the IT industry are making a tremendous progress towards this innovation, the passenger transport industry, which is likely to collapse or change the business model because of this, has hardly been able to take measures at the present situation, and it is behind other industries with regard to IT utilization. It is an urgent matter to actively incorporate new technologies centering on IT into operation management and customer service, and to trigger a breakthrough in passenger transport services. If this is neglected, more and more of other businesses will enter the industry, and they will likely be driven out of business. Also, creating a transport network that has an appealing power where people will "still want to use transport" in society where various activities can be performed "without transport" is also still a big issue.

3. What is minimalism for?

Fumio Sasaki

1. Background of the birth of minimalism

The gist of minimalism is not to have fewer things. I think that it is about reconsidering the meaning of things that have become too big, and thinking about the merit of "small" while only scale merits have been loudly promoted.

The term minimalism was already born in the 1960s in the worlds of music, architecture, and art. In the sense that it is a lifestyle in which you only have things and others necessary for yourself, a lifestyle in which you live simply, it was born in the United States around the time of Lehman Shock in the late 2000s, and in Japan, it gradually came to be known after the Great East Japan Earthquake in 2011. At the same time, things became consolidated, as represented by smartphones, and services for digitalizing made a progress. iPhone was first launched in 2007 (the launch of iPhone 4, which popularized smartphones in full swing, was in 2010). Facebook and twitter started their services in Japan in 2008. Cloud storage Dropbox will be launched its service in Japanese in 2011. The Japanese-language kindle store opened in 2012.

We cannot hope for economic growth like we did before any longer, and it has become difficult to enjoy consumption. Speaking for Japan, huge earthquakes occurred in various places in a short cycle, and it came to be known that not only were things lost in vain but also could become a weapon in the event of a disaster. On the other hand, with a smartphone, it became sufficient for most purposes. A thick dictionary, a big camera, and a calculator have been replaced by a single smartphone. Books, pictures, and music have also been converted into data, so if you save it in a cloud storage, you do not have to have anything at hand. We can no longer keep things like we used to, and we now have no need to do so. It may be natural to think that minimalism was born at such a time. Because everything was ready.

2. Minimalism for rethinking "happiness"

When minimalism as an art was born, "art" must have become bloated. They did not understand well what the essence of art was. I think that the essence to be reconsidered in terms of minimalism regarding the aspect of life is "happiness." "Happiness," which everyone never ceases to seek. However, few things are known about what happiness is, and most resources have been devoted to money and goods which are only part of happiness. We work hard to buy something. And it takes a huge amount of time to manage things we bought. It costs money to heal the exhaustion from the labor and housework. It costs money, so we have to work again. Everyone worked hard, believing that "happiness" should be right there. Then we made a wealthy country. Compared to the level of 1960, real GDP per capita in 2010 was quadrupled. However, "life satisfaction," which is one of the indicators of happiness, has remained unchanged for 50 years. Why did money and things not make people happy?

3. Why "money" and "things" did not bring happiness

One of the answers is simple. It is because people get accustomed to money and things they have gained. I would like to tell one story as an example. Suppose there is a tomato with a sugar content of 10. People who feel this is sweet are usually those who eat tomatoes with a sugar content of 5 or 8. For those who always eat tomatoes with a sugar content of 10, they are regular tomatoes. For those who eat tomatoes with a sugar content of 12, they are rather sour tomatoes. The fact that the sugar content is 10 is just an indicator, and how it feels depends on people. If everyone aims to eat tomatoes with a sugar content of 10, and if everyone can now eat one, it will become a boring, commonplace thing. It is good to replace the number 10 of the sugar content with anything, such as GDP or an annual income of 10 million yen. Those that can turned into a number tend are reasonable and easy to understand, and are easily made a goal. People act seeking it, but what they feel after they have actually acquired it is a sense of extreme unreasonableness. In psychology, a

phenomenon such as this is called “hedonic treadmill.” A treadmill shows how many kilometers you have run in number. However, the person actually running remains at the same place.

Then what do we have to do to feel happier? There is one suggestive study. Harvard Medical School conducted the Harvard adult developmental study, which is called the longest research in history on “happiness.” They tracked 724 men over 75 years by various means such as obtaining medical record, blood tests, and family interviews. There were also various subjects such as Harvard students, and poor people in Boston, and occupations also varied, such as brick craftsmen and doctors. What they learned from this study was that the biggest factor in making people happy and healthy was “human relationships.” People who had the happiest relationships with people at the age of 50 were most likely to say that their health condition was good when they were 80 years old. The rich human relationships protected people from memory disturbance, according to the study. Sometimes money is necessary for human relationships. However, the most important thing is the time to listen to people’s stories, cooperate with each other, and share joy. Uruguay’s former President, Mr. Jose Mujica, said, “People think that they buy things with money, but they buy them with the precious time they spend on work.” It can be when a person feels happy, eat, listen to music, take a bath, watch their child’s sleeping face, or take a nap, but there must be a time available for it.

4. From individual ownership to sharing

I think that it is like humankind’s “measles” to enjoy individual ownership and consumption of things. Just as it was the case in the Bubble-era Japan, in countries where economic growth is remarkable, similar phenomena are expected to continue to happen in the future. Everyone admire it once, and they to try it. Like “measles,” it is a disease that people suffer from at least once. Of course, Japan was also infected. Around 1960, TV was precious. If there was only one TV in the area, people would plead and go there to watch it. It was a hassle. If each household had one, they would not have to bother going to watch it any longer, and it was convenient. The desire to own things individually will not stop. Gradually people began to have one TV in one room, and brothers no longer needed to fight for the channel. Now we can do anything with a smartphone per person. It was communication that was lost instead. Because enjoying the same entertainment together was communication, and “lending and borrowing” itself was communication.

In the Edo period, neither the toilet nor the well was in each household, and they were shared. Of course, they took the bath at a public bathhouse, and they flocked to the bathhouse like potatoes in a tub. There must have been troublesome things. However, they must have learned to be polite there, and communication to learn about the society must have blossomed. Communication, lost because individual ownership progressed and people demanded convenience excessively. Lending and borrowing of soy sauce with neighbors was communication. Now we do not know who lives next door. There are also attempts to regain lost communication. For example, 500 guest houses in the whole country, which are still increasing, is a case in point. While a guest house has a private room for each individual, basically it is dormitory-style. And the kitchen, the shower room, and the living room are shared. There, travelers interact with each other beyond national boundaries, cook together, drink alcohol together, etc., and it functions like a third place. With the facilities set up in each room, such communication will not be born.

Attempts to create new communities are also thriving. Partly self-sufficient lifestyle and permaculture are being practiced based on relationships connected loosely by SNS, where people can freely enter or leave, instead of previous, dubious communities which were closed both in space and in human relationships. “Saihate” of Kumamoto, “Shalom Hutte” of Azumino City, Nagano Prefecture, “Itoshima Share House” in Itoshima City, Fukuoka Prefecture, “Permaculture Dojo” in Isumi City, Chiba Prefecture, Hakone’s “Hakone Eco Village,” etc. Opening funds are procured through cloud funding. The success rate is high, and such places are still growing.

Now, new communication is being born through the Internet for exchanging things. For example, there is a service called “Jimoty.” Simply put, it is a matching

service for people living in the neighborhood. It is a service in which if there is something they do not need, they can give it away for free or an extremely low price, provided the receiver comes to take it. There is a cultural practice called "hand-me-down" in which brothers and relatives hand down clothes of older ones one after another, and this can now be done in Japan by people who do not know each other. It is becoming possible to circulate goods without newly producing them. To my surprise, there are cases in which farmers use this "Jimoty" to give leftover vegetables to their neighbors. The giver of vegetables will be free from guilt for letting them go bad, and the receiver gets free vegetables. I think money was born because it took too much time and effort to match people who had fish and people who had vegetables, but now with the Internet, even if you do not have fish, you can get surplus vegetables. I disposed of unused items to move out last month, and I also asked people on twitter, and delivered them to those who needed them for free. If goods are optimized by being handed over from those who do not need them to those who do without wasting them, sales of goods will appear to decrease. This is because what has been exchanged there is not money but the feelings of thankfulness. Happiness has surely increased.

5. What I really gained from minimalism

I gained a lot of things from practicing minimalism.

1) Because I reduced the long working hours to buy unnecessary goods and the time to manage them, I can now take my time.
2) Because I reduced goods and became fine living in a small place, I now only have to pay a small rent, which used to be a large fixed cost.
3) Because there are fewer expenses to be worried about, I now have the freedom to do whatever work I like, even if I have a low income.
4) I always feel comfortable in my room, and I can go out any time. Through the small thing that is being able to clean up my room, the sense of self-affirmation improved. When I go out, more often I now seek nature such as the sea and the mountain.
5) The money I used to spend on goods in the past, I now spend on traveling and spending time with my friends. Then the relationship with others became much more enriched than before.

Now I have more time, I can choose home freely, and I can do the work that I like. Speaking of what the most valuable thing that I gained practicing minimalism is, I now think that it is relationships with friends in the "minimalist" community. The concept of what "happiness" is is complicated and cannot be summarized easily, but rather than being economically rich and exchanging things for money or goods, its essence should be closer to the points I raised here.

When people are "considerate of the environment," or "think about the future generations," they do so because they themselves feel that they are happier than if they behaved selfishly and gained short-term benefits. It is because it would feel painful if they did not do so. "Happiness" is the motive power to make people act, and it is a purpose. Apparently, the destination we have believed in seems to have to be modified slightly.

On the other hand, I think that minimalism can exist, although it is stagnant, thanks to the still affluent condition. Thanks to the past economic growth, we already have enough infrastructure in place. Thanks to the economic growth of emerging economies, it has become possible to get anything at cheap prices. The reason we do not have to have goods is because we now have services that can convert music and books into digital data, and also because the invention of smartphones now allows us to get most things done. However, the behavior of people who made the economy the top priority all too lacked moderation. Minimalism is not about having little. It is an opportunity to rethink that balance once again. In that sense, I think minimalism is like a "small gate." It is not something that you have to continue for the rest of your life, but once you go through that gate, the weight on you will be lifted, and it will allow you to rethink the values that you have believed in. My book, *Goodbye, Things: On Minimalist Living,* which introduces minimalism, is to be released in 20 countries, and minimalism is spreading in various countries. A lot of people are starting to pass through that "small gate."

Chapter 6 Is Economic Growth Everything?

1. Sustainability of capital base

In the population declining society, the sustainability of society is threatened by the deterioration of the four capital bases of human capital, artificial capital, natural capital, and social capital. The capital base is an existence with a mechanism that brings usability, and it will not be lost by providing usability. In the future, there is a need to switch to stock-based economic indicators, such as indicators to measure how much the needs of care for the capital base stock is satisfied and indicators concerning the capital base stock quantity properly maintained and managed per capita population.

2. Economic growth and democracy

On June 8, 2015, a notification from the Minister of Education, Culture, Sports, Science and Technology that says, "We request undergraduate and graduate schools of humanities and social sciences to abolish the organization or shift to a field with more social demands" was sent to 86 national university presidents. It is nothing but the tradition of Japanese educational administration to acquaint universities that it is their mission to train science and engineering personnel who are the key players of economic growth and to regard the humanities and social sciences as useless. The mission of the humanities and social sciences departments is to train sound doers of democracy. "Country without economic growth" and "country without democracy." I would like to ask, which country would you rather not live in?

3. Limit of market economy

Looking back on the history so far, there is an aspect that the development of market economy has certainly improved our welfare, but in recent years there are other aspects of problems starting to occur associated with the development of the market economy, such as the growing concern for environmental problems, economic disparity issues, and problems of divergence between those and happiness or motivation of people working there. To fundamentally solve this, it is necessary to reexamine social rules that are the premise of the market economy. Also, for what individuals can do, "distance from the market," "self-sufficiency," "returning to true materialism," and "reinvesting in the community" advocated by Juliet Schor are helpful.

4. Artificial intelligence and employment

It is said to be that the evolution of artificial intelligence (AI) will make 49% of Japan's labor force population to lose their job. Factories will become unmanned, majority of administrative labor will be replaced by AI, and professionals including doctors and lawyers will feel less significant. Gross domestic product (GDP) is allocated to capital and labor. At present, the labor share of around 70% falls to about 10% and around 90% is distributed to capital. The average tax rate of employee income is around 4%. The interest dividend income tax rate is 20%, and the corporate income tax rate is 30%. If the government's tax revenue, which is increased rapidly due to the decline in labor share, is used to increase the employment of public services, it can prevent the loss of employment.

1. Sustainability of capital base

Hidefumi Kurasaka

1. Decline of sustainability due to declining and aging population

From the viewpoint of sustainability of the economic society, Japan is approaching a major turning point. The population has turned to a downward trend with a peak in 2008.

This can be regarded as a decrease in human capital, but a decrease in human capital means it is a decrease in labor force to care for physical capital such as artificial capital and natural capital.

With respect to artificial capital, various buildings and construction made during the rapid growth period will have their renewal timings concurrently. For example, at the Ministry of Land, Infrastructure, Transport and Tourism, renewal, maintenance, and management expenses in the infrastructure improvement will increase sharply, reaching 15 trillion yen around 2030 which is almost twice as much from now, and it is expected to maintain the same level thereafter.

Regarding natural capital, it means that the once man-made nature such as artificial forests and agricultural land will be abandoned. For example, the number of forestry workers has declined rapidly from 146,000 in 1980 to 51,000 in 2010. In addition, the number of key agricultural workers engaged in agriculture as a work decreased from 5,428,000 in 1985 to 1,754,000 in 2015. The average age of key agricultural workers is 67 years old in 2015, and it is expected that the number of agricultural workers will further decrease in the future.

The abandonment of nature leads to deterioration of the quality of nature. In the national biodiversity strategy, since the third national strategy in 2007, the impact of reducing and withdrawing human action against nature is regarded as a crisis of biodiversity. Managing the breeding of wildlife, such as wild boar and deer, mainly on abandoned artificial forests is an issue.

Furthermore, as the population declines, the network of cooperation among people is compromised as symbolized by words such as lonely death, shopping refugees, and disconnected society. It is a deterioration of social capital. For example, the single household ratio was 18.2% in 1986, but it is predicted that in 2030 it will double to 37.4%.

In this way, in the population declining society, the sustainability of society is threatened by the deterioration of the four capital bases of human capital, artificial capital, natural capital, and social capital.

2. What is sustainability of capital base stock?

Then, I would like to define what capital base is once again.

The capital base is defined as an existence with a mechanism that brings usability in which it will not be lost by providing usability.

There is a similar concept of the concept of fund-service resources in ecological economics. In 1971's *The Entropy Law and the Economic Process*, it was pointed out by Nicholas Georgescu-Roegen that fund and stock are different. He uses a hotel room or a light bulb as an example of fund and a piece of candy as an example of stock. Based on this arrangement, in the textbooks of ecological economics of Herman Daly and Joshua Farley, a distinction is made between fund-service resources and stock-flow resources. The former is a resource which cannot be deformed physically even when the resource is used and can be used repeatedly, and the latter is a resource which deforms physically when the resource is used and does not remain. The capital base in this paper is equivalent to fund-service resources.

On the other hand, I also want to define the concept of transit resources as a concept equivalent to stock-flow resources. Transit resources are defined as a resource that deforms physically when providing usability and do not remain. The use of transit resources leads to an increase in environmental burden. Environmental burden refers to the impact added to the physical environment by human activities and needs to be assimilated using ecosystem services. If

environmental burden occurs, the amount of ecosystem services will decrease.

An exhaustible resource is one in which the mechanism of the natural capital base that produces the resource is lost, among the transit resources. Mineral resources and fossil fuels are typical. Uranium, a fuel for nuclear power generation, is also an exhaustible resource.

On the other hand, updatable (renewable) resources are those that are transit resources and have a mechanism of natural capital base that produces it. For example, sunlight, wind, waves, geothermal, tides, and biological resources (biomass) are typical. It runs out if it exceeds the update speed.

Water is an updatable resource if it can be updated by water circulation system (natural capital base) like rainwater, surface water, and seawater. On the other hand, if it is separated from the water circulation system like the desert groundwater or glacier, it is an exhaustible resource. Agricultural crops are updatable transit resources, and agricultural land is a capital base that produces agricultural crops which combine natural capital base and artificial capital base. A captured fish is an updatable transit resource, and the system that reproduces fish is the capital base for fish. Even when fully cultivated, the species of fish itself is a natural capital base.

And now, there are thresholds in the capital base where the mechanism that brings usability cannot be sustained. For example, human capital base has various conditions for sustaining human life and health. The artificial capital base has various conditions concerning maintenance, repair, and renewal of artifacts. The natural capital base has various conditions for securing the usability of agricultural land, forest land, and the like. Regarding social relationship capital base, although it is not as clear as the other three capital bases, a threshold of human occupancy conditions (number and density) for sustaining people's cooperative relationship is assumed.

At this time, the management principles of the capital base consist of estimating the threshold at which the system cannot be sustained, providing a feedback system to check whether the system is approaching the threshold or not, preparing backup and parcellation as it might be partially damaged by external disturbance, and the like.

For example, in *Fragile Dominion*, Simon Levin presents eight commandments of environmental management: (1) reduce uncertainty, (2) prepare for unexpected circumstances, (3) maintain inhomogeneity, (4) keep modular structure, (5) secure redundancy, (6) strengthen feedback, (7) build relationship of trust, and (8) provide things you want to other people as well.

It should be noted that there are principles that will not come out from the idea of pursuing efficiency in the market. For example, pursuing only profit maximization invites the planting of similar crops and leads to the creation of vulnerable ecosystems.

Moreover, if you "groom" (maintenance, care) the capital base, it becomes possible to use for a longer period of time, and the service provision amount per unit time can be increased.

In judging the level of the threshold or the amount of care for sustaining the capital base, it is necessary to refer to the knowledge of natural science in each field. For example, it is necessary to refer to medicine and nursing knowledge in human capital base, engineering and architectural knowledge in artificial capital base, and ecology, agriculture and forestry knowledge in natural capital base, respectively.

3. From the richness of flow to the richness of stock

In a society with a declining population, it is necessary to review the indicators of economic development from flow indicator to stock indicator.

Kenneth Boulding pointed out 50 years ago about the necessity of converting from flow indicator to stock indicator. In the article "The Economics of the Coming Spaceship Earth," Boulding said the economy where environmental constraints are manifested (the astronaut economy) is different from the economy without environmental constraints (the cowboy economy) and stated as the following. "The basic indicator of the success of the astronaut economy is not production volume or consumption but status, quantity, quality, and diversity of the total capital stock, including human body conditions. In the astronaut economy, the most important emphasis is on maintaining stock, and the technological development that will allow you to

maintain the total stock provided by fewer transit items (i.e. less production and consumption) is an evident progress."

The discussion of Boulding indicates that it is not appropriate to set the expanding of flow of physical production and consumption as an indicator for good economy if you focus on the environmental burden accompanying the use of resource energy, and it is necessary to switch to an indicator of keeping the state of the capital stock, which human life is based on, healthy. However, despite the global environmental constraint of global warming becoming apparent, we are still not fully aware of the environmental constraints associated with the use of resource energy, so flow-based economic indicators as symbolized by the growth rate of GDP compared to the previous year are emphasized in the economic management of countries around the world.

However, due to the declining population and the aging of society that Japan faces, the expansion of flow has become difficult due to the shrinking of population base supporting the economy. At the same time, it has become impossible to cover the maintenance and management burden of the capital base stock in the region. Through these two factors, inevitably, we had no choice but to switch the economic indicators from flow-based to stocked-base and think about the sustainability of capital base stock.

At this time, as economic indicators focusing on the capital base stock, for example, indicators for measuring how much the needs of care for the capital base stock is satisfied, such as the proportion of care recipients/patients who are appropriately receiving nursing care/medical service, proportion of buildings/infrastructure that are appropriately maintained and renewed, and proportion of cultivated land/artificial forests that are appropriately maintained and managed, and also indicators concerning the capital base stock quantity properly maintained and managed per capita population are assumed.

With regard to these indicators, we can set targets in a positive direction even in a society in which the population is decreasing. It will aim for a richness towards increasing the amount of healthy stock per capita. In addition, it is necessary to think about breaking down systematically or switching to natural renewal with regard to natural capital maintained by human hands and artificial capital that cannot be maintained. Including this direction, it is necessary to develop the future economic society in the direction of securing the richness of stock.

4. Economy consisting of "growth department" and "sustainability department"

For the future economic departments, it will be necessary to realize an economy that is balanced between the two economic departments "growth department" and "sustainability department."

"Growth department" is an economic department that has customers outside the region and brings income into the region from outside the region. On the other hand, the "sustainability department" is an economic department that maintains, manages, and updates various capital bases within the region. These two economic departments are not independent of each other. For example, if special products can be developed in the agricultural sector, income can be brought from outside the region, and at the same time, agricultural land within the region can be managed. Although there are overlapping parts like this, it will be meaningful to assume these two economic departments as an economic department that contributes to the expansion of flow and an economic department that contributes to the maintenance of stock.

Regarding the "sustainability department," job categories such as childcare, education, medical care, and nursing care apply to the human capital base. For artificial capital base, job categories such as architecture/construction, repair, and recycling are applicable. The sharing service that has been drawing attention recently can be put into the sustainability department from the point of utilizing the existing artificial capital base. A typical sustainability department for natural capital base is agriculture, forestry and fisheries. The renewable energy industry, which is the subject of this paper, can also be said a sustainability department for natural capital base. As a sustainability department related to social capital base, NPO and the like concerning town development including civil servants and shopping districts may be

applicable.

It can be said that the “sustainability department” is community-based and labor-intensive. It is a business according to the culture of the area and needs of the local community, different from a business model based on large-scale mass production. For this reason, it is a business with a generally low margin. On the other hand, as we maintain a capital base stock in the local community, the needs for the sustainability department according to that amount can be expected on a continuous basis.

Today, there are situations in which personnel for maintaining and managing capital base stock, such as nursery teachers, care workers, workers engaged in maintenance and renewal of social capital, and agriculture, forestry and fishery workers, are not sufficiently secured.

To maintain and manage the capital base stock, it is necessary to appropriately maintain its scale and at the same time, introduce a tax finance mechanism for appropriately spending the income from “growth department” for maintenance and management of the capital base stock.

2. Economic growth and democracy

Takamitsu Sawa

1. Ripple of the notification from the Minister of Education, Culture, Sports, Science and Technology

A notification from the Minister of Education, Culture, Sports, Science and Technology (MEXT) that says, "With regard to teacher-training departments/graduate schools and humanities and social science departments/graduate schools, we request the universities to formulate an organization review plan based on the decline in the population of 18 years old, demands for human resources, securement of educational research level, role as a national university, etc. and actively tackle the abolishment of organizations and shift toward areas with high social demands" was sent to 86 national university directors as of June 8, 2015.

Prior to that, in November 2013, the MEXT released the *National University Reform Plan* and encouraged each national university to accelerate the reform and reorganization toward the 3rd term mid-term starting in fiscal 2016. What is the reform for? One of the objectives was to create innovation, second was to promote internationalization of education and research, and third was to raise world rankings of Japanese universities.

The Industrial Competitiveness Council was set up shortly after the Abe administration went into effect in December 2012. When I took a look at the minutes of the "industrial metabolism and innovation" working group (WG) of the Industrial Competitiveness Council which presently consists of the Prime Minister, 10 other ministers, 8 economists, and 2 university professors. Since one of the professors Kazuhito Hashimoto, Professor of Engineering School, the University of Tokyo (at that time), was serving as the chairperson of the WG, the discussion had focused mainly on national university reforms.

All of the various national university reform plans proposed by the MEXT's Corporate Support Division of Higher Education Bureau seem to have been based on the discussion in the above WG. The summary of the discussion at the WG can be seen in the report *Basic Idea of University Reform from the Viewpoint of Innovation* (December 17, 2014). It says, "For national universities, in the 3rd term mid-term target period from fiscal 2016, all national universities will have to be classified into the three categories whose missions are classified as follows: 1) regional revitalization as well as specific field prioritized support bases; 2) specific field prioritized support bases, 3) education and research at the highest level in the world prioritized support bases. We will set up a new framework based on these categories, make detailed budget measurements and evaluations from the viewpoint of maximizing their unique functions as well as missions, and strengthen their function as a university." 55 out of 86 national universities selected category 1), 15 selected category 2), and 16 selected category 3). In addition, the proposal in the relevant WG is regarded as the basis for introducing the annual salary system of national university faculty members and the cross-appointment system (a system in which two national universities/national research and development corporations apportion the salary payment amount).

In short, in order to accelerate "industrial metabolism and innovation" that is indispensable for enhancing the international competitiveness (contributing to economic growth) of Japan's industry, which is in an apparent downward trend in recent years, the reform of universities that cultivate innovators, especially national universities, must first be given priority. I am not going to deny the necessity of national university reform. What is to be a problem is the contents of reform. At least, I do not think that dividing universities into three categories and gradually allocating the budget will immediately bring about improvement of the research capabilities of 16 universities belonging to type 3).

To put it briefly, I believe that all institutional reforms of Japanese universities that began in the 1990s, such as introduction of a common primary exam (the predecessor of the center exam), prioritization of graduate schools, deregulation of general liberal arts education, and establishment of professional graduate

schools including Law School, being a failure that made the international competitiveness of Japanese industry slump as a result contrary to the intention.

2. Emphasis on science and less on humanities is a tradition of Japan

In Japan, the bad practice of measuring the value of academics and sciences by a narrow scale of "usefulness" is not yet cut off. In this country, the idea that the study of science is "useful" while the study of humanities is "useless" is widely shared both now and in the past. Let's pick up some examples for evidence from the past history.

According to the provisions of the military service law (promulgated on April 1, 1927), recruitment was suspended for students aged less than 26 who were enrolled in higher education institutions (former high school, university, vocational school, higher teacher's school). In September 1943 during the Second World War, shortage of troops became prominent due to the increase in the number of deaths accompanying the expansion of war and deterioration of the war situation since the previous year right after the opening of U.S.-Japan war, and it was decided to cancel the deferment limited only to students of humanities. On October 21 of the same year, the first group of students went to war. College students of humanities and former high school students of humanities are "useless" students, even if they are conscripted and sent to the battlefield or even die, national interests are not damaged. On the other hand, College students in the science and science students of the former high school are knowledgeable students who can contribute, such as developing weapons, and are recognized to be "useful" in continuing the war, so instead of sending them to the battlefield, it corresponds to national interests to mobilize for work in places like research institutes of the army and navy.

3. The era of the versatile science and engineering: 1960's

In March 1960, Minister of Education under the Nobusuke Kishi's Cabinet, Masuda Takechiyo, unleashed his opinion that "national universities should abolish the undergraduate departments of law and humanities, and primarily focus on science and engineering, leaving education of law and humanities to private institutions," which caused a controversy. Behind this remark by the Education Minister two facts existed. One was that at the time the student movement opposing the revision of the Japan-U.S. Security Treaty had reached its climax, and most of the university students who led the demonstration opposing the security treaty were students of law or humanities departments at national universities. Another was that the rapid economic growth period had begun in July 1958, and the promotion of the science and engineering departments at national universities was strongly requested by the industrial sector as well as the government.

In the "income doubling plan" decided by the Cabinet in December 1960 shortly after the Ikeda Cabinet was inaugurated, "promotion of science and technology is indispensable for economic growth, and the student capacity of science and engineering departments at universities shall increase by 170,000."

It should not be an exaggeration to say that it was the historic *Economic White Pape*r in 1956, known for its famous quote, "no longer in the postwar era," and the masterpiece writing by Yonosuke Gotoh (1916-1960) who was Survey Manager at the Economic Planning Agency, that pioneered the science- and engineering-oriented educational policy. In the wording of "no longer in the postwar era," Gotoh connoted the following deep implications. In 1955, the Japanese economy recovered to the prewar (1937) level. For the decade following the war, the Japanese economy attained its goal with the spring-load aiming at "postwar recovery." In order to promote more economic development, it is indispensable to set up new spring-loads. As new spring-loads, Gotoh proposed innovation and transformation.

The word *innovation* whose Japanese translation is *gijutsu-kakuhin* that was coined by Gotoh, was a timely four-character Japanese idiom suitable for symbolizing the era in which "catch up and overtake" was the motto. The key players in technological innovation would be graduates from undergraduate departments and graduate schools in science and engineering. After that, for several years, a rush of new establishment of science

and engineering undergraduate departments and schools continued. Kyoto University, where I worked for 37 years, tends to be thought of as the "hall of useless studies" where literature and science departments were influential. However, from the late 1950's to the 1960's, the rush to establish new departments and expand the student capacity of the engineering faculty at Kyoto University was impressive, with the irregular structure of having one out of three new students as an engineering student continuing up to this day. On a side note, Yonosuke Goto was also a bureaucratic economist who graduated from Tokyo Imperial University's Department of Electrical Engineering.

4. Totalitarian state where graduates from science and engineering fields exert their influence

Mr. Masaru Ibuka (1908-1997), founder of Sony and a graduate from Faculty of Science and Engineering at Waseda University, was stubborn about his loud opinion that not only business managers but also senior officials of the government, ministries, and agencies, as well as the majority of the Diet members would eventually be comprised by graduates of science and engineering departments. Fortunately or unfortunately in Japan, his forecast did not turn out to be correct. Today, most of the senior officials of the government, ministries, and agencies, about half of the managers of manufacturing companies, and the majority of the Diet members are graduates from the humanities and social science departments.

Why is it so? The reason is simple. Because after all, Japan is a democratic country. Many of the graduates of humanities and social science departments tend to have a more vigorous critical spirit utilizing their academic knowledge than their peers who graduated from a science department. At the same time, they excel in their expressive abilities relatively. It is nothing but a vigorous critical spirit and skillful expressive ability that enable them to state their views logically enough in places like conferences which are built upon democracy.

Ironically, Mr. Ibuka's forecast turned out to be exactly true in totalitarian states such as the former Soviet Union and China. Former Soviet Union's supreme leaders after Vladimir Lenin (1870-1924) and Joseph Stalin (1878-1953), were either graduates from an engineering school or a former factory worker, generation after generation. Mikhail Gorbachev (1931 -), the last supreme leader of the former Soviet Union, had an unconventional background having graduated from Law School at Moscow State University. It is conceivable that Gorbachev was able to play the leading role in the dissolution of the former Soviet Union because he was "unconventional" as the supreme leader of the Soviet Union.

In China as well, for three consecutive generations, Jiang Zemin (served: 1993-2003; hereinafter the same), Hu Jintao (2003-13), and Xi Jinping (2013-) have taken office as a graduate from prestigious science and engineering universities. For Premier also, Li Peng (1987-1998), Zhu Rongji (1998-2003), and Wen Jiabao (2003-2013) were graduates of prestigious science and engineering universities for three consecutive generations, followed by Li Keqiang (2013-), a graduate of Law School at Peking University and a holder of Ph.D. degree in Economics. Because the speech criticizing the system is not permitted in a totalitarian state, graduates of humanities and social sciences departments cannot climb the career ladder of the Communist Party to the top, and along the way, they are frowned upon by the authority of the time to be purged miserably.

As I looked at such sequence of events, I came up with the following thesis. "The totalitarian state inevitably excludes knowledges of humanities and social sciences. A state which neglects humanities and social science-related knowledges will end up as a totalitarian state as a matter of course." I am afraid to digress somewhat, but there is something I want to say taking this opportunity. During the deliberation of the security-related bill at the National Diet in 2014, most constitutional scholars, regardless of whether they were constitutional revisionists or protectionists, insisted that "the security bill was unconstitutional under the existing constitution." Instead, the administration steamrollered the bill both through the House of Representatives and the House of Councilors, refusing to listen.

To this extreme extent, politics that unapologetically ignore the opinions of constitutional scholars can be

practiced openly in this country, without receiving citizens' accusations. This is a typical example of "neglect of humanities and social science-related knowledge," and according to my thesis, Japan is steadily progressing towards a totalitarian state. In fact, the Liberal Democratic Party's draft revision to the Constitution (February 2012) states that while it shall respect the freedom of speech and fundamental human rights, it came with the proviso which said, "provided, however, that this shall not apply, if it is against the public interest or public order." In addition, the phrase "citizens are respected as an individual" is rejected for "respected as a person" as it is not good as it may lead to an unwanted spread of individualism.

For me who considers modern Western ideology of liberalism, democracy, and individualism as universal and inviolable values, if the Abe administration steamrolls a constitutional revision that takes the gist of the draft, it seems that his frequently used proposition "the seven advanced nations share a sense of value" might lose its legitimacy.

5. From STEM to STEAM

In the *Japan Times* dated August 23, 2015, I contributed a commentary entitled "Humanities under attack" criticizing the MEXT Minister's notice dated June 8. I criticized the usefulness-oriented academic and scientific evaluation method peculiar to Japan. Then I received an email from Vice President Thomas Katsouleas of the University of Virginia in the United States, with the following contents. Just in case, I add that Vice President Katsouleas is the authority of electronic engineering, who has also gained a high reputation regarding university administration.

> I heard that the Minister of Education, Culture, Sports, Science and Technology of the Abe Cabinet notified the presidents of the national universities in Japan that "they should either abolish undergraduate departments and graduate schools related to humanities and social sciences, or attempt a shift to a field with a higher societal demand." I hear the aim of the notice is to increase the international competitiveness of Japanese industries, but it is quite likely that such a measure can have adverse effects. Recently, among the leaders in the fields of STEM (an English acronym of science, technology, engineering, mathematics), there is a rapidly spreading recognition that humanities and social sciences are of crucial importance in yielding results in the STEM fields. As an example, recently, the deans of engineering schools at 122 universities across the United States jointly submitted the following request letter to President Obama.
>
> "I would like you to have the next generation of engineers acquire technical and thinking skills that will be enough to overcome social issues that need to be dealt with urgently. For example, engineering alone cannot secure profitability of solar power generation, put artificial intelligence into practical use, defend against cyberattacks, etc. We strongly hope for cooperation based on mutual understanding with scholars and practitioners of humanities and social science fields such as human behavior science, policy science, and economics."
>
> At the international conference of deans of engineering departments held in Adelaide, Australia this September (sic; 2015), all the participants signed a statement of a similar intention. One of the proposals is as follows. "We should incorporate learning and acquisition of interdisciplinary and global insights into engineering education to educate students to have a wide range of abilities to understand human behavior, policies, and culture, i.e., knowledges of humanities and social sciences."
>
> Recently, countries outside Japan are switching from STEM to STEAM (which adds arts, meaning humanities to STEM). Amidst this, I feel obliged to say that it is a wrong policy for only Japanese universities to turn off the rudder of higher education and go against the global trend.
>
> I would like Japan to learn from the following bad precedent. In the remarks in the opening ceremony of the Shanghai Summit "Education for Economic Innovation" held in 2011, then Minister of Science and Technology of China stated as follows. "Chinese universities train 75,000 engineers immediately ready to join the workforce each year, but many of them struggle to find employment. The reason is that in the eyes of those in human resources at

multinational companies, the way China's engineering education is done is considered inappropriate. "

6. Transition of coordinate axes of technological progress

I gratefully received the email from Vice President Katsouleas, and I took the following two points from it.

Firstly, academic and scientific views that consider science almighty and neglect humanities are apparently unique in Japan compared to other developed countries. Since ancient times, in Europe, emphasis has been placed on history, philosophy, literature, etc., and there are not a few bureaucrats and politicians who majored in humanities (especially history) at a university. With a strong tradition of pragmatism rooted deep in the United States, lawyers who are graduates from law schools seem to have a dominant control of politics, and the social standings of MBA holders who are expected to be business managers and economists with PhD degree in economics are also high. Despite the relatively small number of undergraduate and graduate students majoring in humanities, not a few researchers boast excellent achievements in fields such as literature, philosophy, linguistics, sociology, and political science.

Massachusetts Institute of Technology (MIT) tends to be misunderstood as a college of engineering, but encompasses a lot of departments in humanities and social sciences. As Vice President Katsouleas says, we can consider MIT to traditionally have prepared a system to train engineers knowledgeable in humanities and social sciences.

Secondly, at the end of the 20th century, as pointed out in the introductory chapter earlier, the coordinate axes of technological progress changed drastically. The technological progress up to the 1960s in the 20th century was aimed at "faster," "larger," "stronger," and "higher." However, since the oil shock in 1973 and since the adoption of the "Kyoto Protocol" at the 3rd UN Conference of Parties to the United Nations Framework Convention on Climate Change in 1997, there has been a significant change in the vectors of technological progress. "More resource-saving," "less greenhouse gas emissions," "lighter, smaller, and thinner," "more multi-functional," "smarter," "safer," "more harmonious with society," etc. As a result, the possibility that engineers who only possess knowledges of engineering (lacking aesthetic sense, knowledge of humanities and social sciences) become leaders in groundbreaking innovation became slim. In short, it is a transformation from modernism to postmodernism in the world of technology.

7. Japanese engineers who lack knowledges of humanities and social sciences

At the launch of iPad 2 in March 2011, Steve Jobs concluded his speech with the following message. "Technology alone is not enough. It's technology married with liberal arts, married with humanities, that yields the results that make our hearts sing." A reporter of *The Economist* commented as follows: "It was unusual statement for the head of a technology firm, but it was vintage Steve Jobs." (*The Economist*, June 5, 2012 issue).

It is likely one of the reasons why many Japanese electronics manufacturers are on the decline, that many Japanese engineers are technological supremacists, lacking in knowledges of humanities and social sciences. Since the introduction of the common primary examination in 1979, Japanese language and social studies including history became excluded from the required subjects in individual entrance examinations of engineering departments of Japanese national universities (except the University of Tokyo and Kyoto University). Since the detailed rules of university establishment standards were abolished in 1991, "general principles" has been implemented, and general education curricula were abolished, and the curriculum for liberal arts education has been left up to the autonomy of each university. Because of this, after entering a university, most engineering students became able to avoid learning liberal arts subjects related to humanities and social sciences.

The *Industrial Competitiveness Conference* was organized by the Japanese Economic Revitalization Headquarters in January 2013. According to Meeting minutes of the Japanese Economic Revitalization Headquarters, "they will hold an industrial competitiveness conference to investigate and deliberate embodiment and promotion of the

strengthening of the competitiveness of the Japanese industries, and the growth strategy for international expansion." As of May 9, 2016, the members of the conference are 10 ministers including Prime Minister Abe, 8 business owners, and 2 university professors. Eight business managers have joined as conference members from the private business sector, but aside from Mr. Akio Mimura, Honorary Chairman of Nippon Steel & Sumitomo Metal and Chairman of the Japan Chamber of Commerce and Industry, and Mr. Yoshimitsu Kobayashi, Chairman of Mitsubishi Chemical Holdings and Chairman of Japan Association of Corporate Executives, the other 6 members from the business sector have a background of founding an IT or consulting-related company, distancing themselves from the mainstream businesses. One of the two scholars is Professor Kazuhito Hashimoto of Engineering School at the University of Tokyo, and the other is Professor Heizo Takenaka of Toyo University who used to be a cabinet member of Koizumi Administration.

If the Industrial Competitiveness Conference composed of these faces think that the undergraduate departments and graduate schools of humanities and social sciences contribute next to none to the economic growth and strengthening of industrial competitiveness, and therefore that it is urgent to attempt to abolish or change them, I can agree with it wholeheartedly.

I myself do not find it bothersome to admit that undergraduate departments and graduate schools of humanities and social sciences do not contribute to the economic growth, at least not directly. However, if we take in my opinion that "a country that rejects the knowledge of humanities and social sciences is certain to be a totalitarian state," the following question should be raised. "Would you rather not live in 'a society without economic growth' or 'a society without democracy'"? My answer to this question is as follows. "Even if it would mean no economic growth, I would not want to live in a society without democracy." I assume that the majority of the readers have the same opinion as mine, but it should be nothing but unexpected if many of the members of the Industrial Competitiveness Conference will even end up asking such a question.

3. Limit of market economy

Seiji Ikkatai

1. Deviation between market economy and wealth

We are currently in the midst of the market economy, so we tend to think that this is a matter of course. However, when we look back on history, it is not that long ago that the market economy was established in human society and developed to this degree.

In the Edo period, agriculture was the basis of society, and the proportion of people engaged in agriculture was overwhelmingly large. This is partly because, under the isolation policy in the Edo period, people had to be self-sufficient regarding food with a limited area of farmland, and at the same time because they had to depend on human power, cattle, and horses for cultivating agricultural crops which were troublesome, as there was no fossil fuel or steam engine, etc.

Of course, even in the Edo period, there were special products in each *han* domain, with a thriving handcrafting industry, and various products produced there circulated to various places by means of currency. However, in agricultural areas, the food was mostly self-procured, and even among the common people living in urban areas, they made most of what they could make themselves and repaired them.

The time when the social system gradually advanced from that of self-sufficiency to that of division of labor, and it was further advanced, must have been after the period of rapid economic growth after the World War II, and furthermore, after sophisticated industrial products and the like began to overflow in general households.

The background of it was, on one hand, that individual income had increased rapidly, and the purchasing power in the market had improved. Also, it should be noted that as each product or service sold in the market became more sophisticated and could no longer be made by amateurs easily, and also that what was relatively expensive in the past became easier to purchase due to mass production, progress of technology, etc., having made them cheaper. From family-owned cars that spread through each household in the decade following 1955, to the three sacred treasures of TV, refrigerator, and washing machine, they are typical examples of this.

We can say, for generations that actually experienced such a period, that purchasing such items from the market definitely made the affluence feel real, and the development of the market economy was also linked with the sense of affluence and happiness of individuals. In other words, common social recognition that the development of the market economy was to promote the wealth and happiness of individuals was established.

However, since the beginning of the 1990s when such rapid development of market economy after the war ended, around the time of the collapse of the so-called Bubble economy, a situation arose in which buying goods from the market as in the past did not necessarily directly link to improving the sense of affluence or happiness.

One of the reasons is that the relationships with others in society have an important influence on the sense of richness and satisfaction after the basic desire for human survival has been satisfied. I say the modern situation is that because of this, no matter how many things or services you buy from the market, you cannot feel affluent or happy if you are conscious of others who are purchasing more expensive things, and because of this, you have the consciousness in which you must earn more and consume more. For this reason, sometimes, it also produces a tragedy that should not exist from the standpoint of richness and happiness, such as death from overwork. In addition, unlimited production and expansion of consumption have brought about waste of resources and deterioration of the environment.

On the other hand, it is not only when people buy things from the market that people feel rich. Speaking from how I feel, for example, there is certainly something that can be obtained from what is not sold in the market, such as the green of the surrounding trees, wild animals including birds and insects that come into sight, and the beautiful starry sky. There are also

richness and happiness that you feel by making something yourself, not by purchasing goods, or by interacting with others. Furthermore, things like hope and anxiety about the future such as that of the global environment and the future of humanity also lead to a sense of affluence and happiness that cannot be bought directly from the market.

In that sense, it seems that the double problem seems to be occurring in the modern time, in which in addition to being in a situation where affluence and happiness gained by purchasing something from the market is increasingly difficult to obtain, the sense of happiness that cannot be directly obtained from the market originally is decreasing, due to the deterioration of the global and regional environments, etc. Therefore, it feels today that the common perception of the society, which once existed, that human beings can be affluent and happy as long as the market economy is developed, is greatly being shaken.

2. The form of society determined by market capitalism and economic growth

Sapiens - A Brief History of Humankind, published by Israeli historian Yuval Noah Harari in 2016, states that the credit system based on the modern monetary economy and development of new technologies that create new values have led to the global economic growth. And it says that the supremacism of free market capitalism, which argues that it is best for the government to refrain from making interference in order to ensure such economic growth, is the most common and influential of the present capitalist beliefs.

However, Harari states, looking back on history, European capitalism in the early modern era led to the tragic fact that the Atlantic slave trade flourished as a result of the market principle, which was not subject to any control, dominating the society. Such behaviors lacking capitalist ethics did not improve even in the 19th century, he says, but in the 20th century, especially after the World War II ended in 1945, due to fear of communism, it seems that the capitalist's greed was stopped somewhat. However,

"The pie of the economy is much larger than that of 1500, but its distribution is so unfair that even if farmers in Africa and laborers in Indonesia work their fingers to the bone all day, the food they get is less than the amount that their ancestors had 500 years ago," he says. Therefore, "Although humanity and the global economy will continue to develop, more people may live while suffering in hunger and poverty," Harari says.

On the other hand, Harari points out, when measured by purely material and physical aspects such as average life expectancy, child mortality rate, caloric intake, etc., the average person's standard of living in 2014 dramatically improved compared with the level of 1914, despite the drastic increase in population. However, as stated earlier, there is now a situation in which people cannot feel the affluence or happiness in countries that are supposed to be enjoying the fruits of affluence and happiness. What on earth should we do?

3. Formation of a society based on the idea of social common capital

When we look back on the history so far, there is certainly an aspect of the development of the market economy which has improved our welfare. The fact that general living standards have improved, nutritional conditions have improved, life expectancy has increased, among others, should be testimony to this. However, can we leave much of the formation of society to the market economy in the future as it is now?

In the present age, many activities are entrusted to private enterprises from the viewpoint of increasing the efficiency of the economy. In Japan also, from such a viewpoint, the railway business, which was once directly managed and operated by the government and was in huge deficit, was privatized and divided into financially independent businesses in principle. The effect was remarkable, with the service improving in profitable business companies and convenience improving as well. However, on one hand, in rural railway companies such as JR Hokkaido which have not been able to gain profit, a vicious circle of reductions in users and deterioration in convenience has arisen, and it is in an inevitable situation to abolish unprofitable routes. On the other hand, some companies have emerged, such as JR Tokai, with an annual profit of 500 billion yen, trying to invest it in a maglev railway that is less energy efficient, and much

problematic from the viewpoint of improving sustainability in the future. Under such circumstances, there is a debate as to whether the railroads, as public transportation responsible for Japan's core transportation, can really be left up to the management of private enterprises.

That can be said, for example, about forests, one of the important natural capital of Japan. With respect to the forest management in Japan, many forests have been abandoned and cannot be taken care of from the viewpoint of timber production, because Japan has imported cheap foreign timber since the rapid economic growth period and the accompanying stagnation of prices of domestically produced timber. This can also be said to be the result of entrusting socially important natural capital to the market economy. There is also a debate as to whether it is advisable to leave the future of rice paddies, which have played a role in maintaining the environment in the Japanese land also, to the market economy called free trade.

Needless to say, it is a fact that there are excellent aspects to the market economy, such as the function to continuously pursue efficiency, but there are many issues, as seen earlier, that cannot be solved by the market economy, such as the disparity and equality issues, and the environmental problems. For that reason, concerning management of basic social capital commonly needed by people in any age, it may be necessary to examine the possibility of such management not by the government or a private enterprise, but in the form of Collaborative Commons so to speak, collaboratively managed by the people within the scope that is agreed upon, rather than leaving everything up to the private enterprises.

Incidentally, in Germany, many cooperatives on regional renewable energy have been established, and Collaborative Commons-style management, so to speak, is actually being carried out.

4. Construction of true abundance individuals can start

We have seen many problems surrounding the market economy so far, but it does not seem not easy to solve them. Especially, what can be done by individuals may be limited.

On that point, Professor Juliet Schor of Columbia University, in her book *Plenitude*, states as follows. I will quote some points although it will be a little long.

"The modern time is an era of environmental crisis including climate change issues, and at the same time, it is also an era of economic crisis as seen in economic instability as made evident by the Lehman Shock, and inequality problems. (Omitted) Many of the conceptions of sustainability presented in recent years are based on environmental preservation technology, but that alone is insufficient. Unless we transform the structure of many socioeconomic systems in totality, including the energy system, and unless we incorporate unconventional rhythms into labor, consumption, and everyday life, we will not be able to stop the deterioration of the environment or regain economic soundness. (Omitted) However, collective consensus is always necessary to make a large-scale transformation successful. We need a mechanism to reduce carbon dioxide, and we need a new labor market policy. (Omitted) However, while working on these changes, there are things we can do during that transition period. They are actions based on the four basic principles of <plenitude> below. The first principle is new allocation of time. It means that, while we work long hours in the market to earn income, and acquire consumer goods from the market, we should lower this level of market dependence. The second principle is to get out of the market, and make, grow, or do something for ourselves, i.e., "self-sufficiency." The third principle is "true materialism." It is not about being trendy or status-oriented, but living a life while being aware of the functions inherent to the materials, and their environmental impact, in life. The fourth principle is to restore investment in each other and our community, so-called social capital."

Some may think that there is something unusual about the idea of reducing the level of market dependence of the first principle, but from the perspective of the long history of humankind, as seen before, it is only recently that the so-called market economy was established, division of labor developed so much, and the lifestyle became one of purchasing almost all goods and services necessary for daily living with the income earned from working. Moreover, in

modern times when many energy and materials can be produced and consumed, while income and consumption should have originally been “means” to acquire <plenitude>, gaining more of those things became the “end” in itself, and people are damaging their minds and bodies as a result of extraordinarily long hours of work and black part-time jobs. On the other hand, if we simply reduce the level of market dependence, there may be concerns that income will be reduced and people will be even poorer. Schor’s answer to that is the idea of the second principle below.

That is, in modern “self-sufficiency,” there is a movement that is changing the conventional common sense that “If I want to do that, it will take time and cost. It is easier and cheaper to buy that from the market,” she says.

That is the progress of technology and the spread of the Internet. For example, due to the emergence of 3D printers and the transformation of information into an open source one, what could not be made previously by laypeople at all unless expensive machines, and design and production information were available, it is now possible to make one much more cheaply thanks to 3D printers and free information.

Of course, if we assume they should be exactly the same things as what are overflowing in town, it may be difficult to make them. However, on the premise of the third principle “true materialism,” it seems to be possible to make goods which are satisfactory functionally.

I myself had the experience of building a small garden hut in the garden of my house last spring. However, rather than procuring the materials to make it from scratch, I purchased a kit of storage shed of a panel assembly type developed by using domestically produced cedar from a small company in Tohoku, assembled it myself, and created my own interior. I was able to complete the assembling and roofing themselves with my daughter’s help in two full days using holidays, and after that it required a little more than two months to finish the interior and the furniture. During that time, the work every weekend was a fulfilling and challenging experience for me, and the time made me very happy. Now, my greatest pleasure is to read there. The price was reasonable, and although I was not completely self-sufficient, I felt the potential of “self-sufficiency” advocated by Schor spreading in the future.

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4. Artificial intelligence and employment

Takamitsu Sawa

1. The merits and demerits of the Industrial Revolution

Now, a major change is deeply and quietly progressing, a change that only occurs about once every half a century. We refer to that change as Industry 4.0, or the 4th Industrial Revolution.

It was the highly efficient steam engine invented by James Watt in 1769 that drove the 1st Industrial Revolution in the early 19th century. In coal mines, where coal to be used as fuel for steam engines was mined, horses were used as power sources. Ironically, the introduction of steam engines to coal mines as power sources to replace horses became the beginning of its widespread use. Later, around 1800, steam engines began to be used for transportation systems such as steamboats and steam locomotives (railroads), spinning machines and the like. Various transportation systems and spinning machines replaced human and horse labor, resulting in significant improvement in productivity.

The driving force of the 2nd Industrial Revolution in the early 20th century was the spread of two power sources: oil and electric power. It is said that the 20th century was "the century of innovation," but every new product that appeared one after another used petroleum products or electric power as its power sources.

It was the computer that drove the 3rd Industrial Revolution. Initially, the Japanese translation of the word computer was *denshi keisanki* (electronic calculator). However, the proportion of calculations comprising the usage of personal computers became equal to none, and the word *denshi keisanki* has become almost like a dead word. The Chinese translation of computer, *dennou* (electronic brain), was a translation that far more appropriately captured how computers would be today. It was after the beginning of the last decade of the 20th century that the so-called digital revolution i.e., the 3rd Industrial Revolution occurred. Thanks to the digital revolution, the convenience and comfort of our lives has dramatically improved. If you have a smartphone, you can send and receive email for free, you can browse the Internet to shop freely, and you can browse the news for free. Most of encyclopedias and dictionaries have become useless. Medical advances in the past quarter century have been remarkable, and it is not an exaggeration to say that most of their birth parents were digital technologies.

Now, artificial intelligence (AI) is driving the 4th Industrial Revolution that is currently progressing. The power of AI was put on a show in March 2016 when the AI *go* player named "Alpha *Go*," developed by a subsidiary of Google, defeated the world's best professional go player by overwhelming 4 wins and 1 loss. The professional player who lost three consecutive games in the beginning fought back and won the fourth round, but lost in the following fifth round. It was the ability known as "deep learning" that decided the victory of Alpha *Go*. By repeating rounds, Alpha *Go* becomes a better player through deep learning.

Making the factory unmanned by making full use of AI and robots is the aim of the 4th Industrial Revolution. The 1st to 3rd Industrial revolutions caused the following bad effects: global warming, air pollution, marine pollution, river pollution, biodiversity reduction, personal information leakage, hacking and so on.

Although the aspect of these negative effects cannot be overlooked, the merits of human's liberation from physically hard labor, and the remarkable improvement in convenience and comfort of their lives, were enormous enough to compensate for the negative effects. However, the 4th Industrial Revolution confronts us with the following unprecedented challenges that shake the foundation of the economy.

2. Decrease in labor distribution rate due to unmanned factories

In manufacturing industries, raw materials are processed to produce goods, with production factors: capital and labor. When processing, energy including fossil fuels and electric power is indispensable. The value added (the product sales minus cost of raw materials and energy) is distributed among labor and

capital. The value added distributed to labor is again distributed to each employee as wages according to his/her contribution, while the value added distributed to capital is allocated as dividends to shareholders, remuneration to executives, repayment of loans from banks, and payment of interest. The value added becomes either individual's income or corporate income. The government applies progressive taxation to employee income, and fixed rate taxation on corporate income, interest income and dividend income, to secure financial resources for public services.

What will happen if a factory become unmanned? There will be no one at all in the factory. It will be just several people in the control room, tens of administrative staff members, tens of engineers who are responsible for research and development, and some ten-odd executives. Mass production will be possible only with capital (factory and facility) and 100 to 200 employees. Currently, the labor share of value added has been around 70%. With the progress of the 4th Industrial Revolution, the number of people working at factories and offices will decrease, and artificial intelligence and robots will replace human labor. As a result, of course, it is fair to expect the labor share of added value to certainly decline and fall to around 10%. In other words, capital share will rise to around 90%.

3. Half of the labor force population will be unemployed

Service industries that sell hospitality such as luxury hotels, fine restaurants, and bars, are quite unlikely to be able to replace humans with AI or robots. Although the professions in school education, academics, nursing care, medical care, legal affairs, public affairs, finance, etc., will not be completely eliminated, it will be inevitable to receive assistance from AI and robots as is exemplified with respect to medical care later.

Communication through language is also one of the areas in which AI is weak. Stylized communication, such as ordering meals at a restaurant, can be left to AI. However, AI is not likely to substitute a skilled chef. It seems that only humans can adjust steak doneness according to customers' taste, not to mention creating menu and serving plates in Japanese cuisine.

An organizational management skill is also one of the abilities in which AI falls short of human knowledge.

With the 4th Industrial Revolution, human beings will finally be released from the hardship of labor. Labor referred to here includes not only sweat-dripping physical labor but also clerical labor and brain labor performed while sitting at a desk. Liberation from labor for a lot of people means that they do not get to have a place to work even if they want to work.

In fact, according to a joint research by Nomura Research Institute and Associate Professor Michael Osbourne of the Oxford University, "49% of Japan's labor force population to be replaceable by artificial intelligence and robots". Trial calculation were performed on their probability of replacement with computer technology. Most of clerical works are categorized as replaceable. Nearly half of the labor force population have no place to work even if they want to work. What should we do? A proposal frequently made is the introduction of measures in which the government guarantees what is called the basic income for citizens' living. In other words, it says that about half of households should go on welfare. Today, not a few people feel that working is not necessarily a toil, and find joy and meaning of life in working. So, I would like to make the following proposal.

4. The 4th Industrial Revolution and employment

Let's assume that 90% of the value added was distributed as interest and dividend incomes, corporate income, and executive remuneration. In other words, only 10% of value added would be distributed to employee income. If the value added was the same, a decline in labor share would greatly boost the total tax revenue. The average tax rate of employee income is around 4%. The interest and dividend income tax rate is 20%, and the corporate income tax rate is over 23%. Due to the change in the share of the value added, the government's tax revenue would increase by about 2.7 times. The funding source for distributing basic income would be secured for the time being. However, nobody would want to live in a society where about half of the households are on welfare, i.e., recipients of the basic income.

Therefore, I would like to propose the following measures. Until now, under the name of administrative reform, the number of people engaged in public service has been reduced as much as possible. Concerning the people who have lost their workplace due to replacement by AI and robots, it is probably the most reasonable solution that the government provides them with public service work and pay wages.

The number of teachers at elementary schools, junior high schools, and high schools are 890,000 combined. The number of teachers at national, public, and private universities is 180,000. If they are doubled, more than 1 million employment opportunities will be created. The number of caregivers, nursery school teachers, and nurses should also be doubled. Graduate students engaged in research can receive a generous scholarship. The only option is to increase employment opportunities for other public services and provide a place to work for those who want to work but have lost the place to. In addition, access to education, medical care, nursing care, and other public services should be made free.

In the administrative reform, the top priority was placed on reducing the number of civil servants. The number of teachers at elementary, junior high and high schools, and the number of teachers at national, prefectural, and private universities are now gradually decreasing. Why was it necessary to reduce the number of civil servants? Needless to say, it is due to the government's fiscal rebuilding (reduction of the fiscal deficit). However, thanks to the 4th Industrial Revolution, a substantial increase in tax revenues will be achievable, and the government will have room for increasing public servants with abundant financial resources. To employ people who have lost their jobs because of unmanning of factories as civil servants and to have them contribute to the enhancement of public services will not only be an unemployment countermeasure but also make this country happier place to live in through improvement of the quality of educational services, promotion of research, and safety and security of the socially vulnerable.

It will be no longer necessary to relocate factories overseas for cheap labor. Capital investment required for unmanning a factory will be enormous, but as production quantity increases, the fixed cost per product will decrease gradually. We can anticipate with certainty that, in the not so distant future, unmanned factories will have a price competitiveness that will rival that of a manned factory in developing countries.

As the production capacity of the factory is increased by capital investment and employment increase because products sell well, the demand gradually decreases with the popularization of the products, and it will be inevitable to curb the production until the accumulated stock of products is sold. It is one of the merits of unmanning factories to be able to solve this "stock circulation," that is, the classical economic cycle. For the smart AI, looking ahead for demand should be quite easy, and it can avoid troubles such as shortening working hours and dismissal of temporary workers, which are why stock circulation can be avoided.

The average production cost (the sum of the fixed cost and the raw materials and fuel cost per a product) will undoubtedly decrease since the labor cost is nearly zero. In other words, the marginal cost of production is zero. What about the costs required outside the production site, such as for advertisement, sales, finance, planning, general affairs, and clerical work such as human resources and labor management? First, since the Internet will be the mainstream of advertising media, advertising costs will certainly go down. Much of the office work will be taken over by AI. Human resources and labor management will be unnecessary, and finance is AI's strongest point among everything. Work such as general affairs and planning will be solved in real-time by AI, based on its memorization of all the past documents of the company and its complete familiarity with the current state of politics and economy. As a result, most of the clerical work will be unnecessary.

5. Medical care, legal affairs, and artificial intelligence

According to the joint research by Nomura Research Institute and the University of Oxford, doctors are categorized as an "irreplaceable" occupation, but an event occurred that would overturn this. According to NHK News on August 4, 2016, the University of Tokyo's Institute of Medical Science made IBM's

artificial intelligence “Watson” learn more than 20 million medical papers and more than 17 million drug-related information, and gave it genetic information of a cancer patient, to have it infer the type of cancer and candidate therapeutic drugs.

When they inputted relevant diagnostic information including the genetic information of a leukemia patient who did not respond to anticancer drug treatment in Watson, it diagnosed the patient with a specific type of leukemia that the doctor in charge had not remotely thought in just 10 minutes, and moreover, it showed a prescription to be combined with the cancer drugs. The patient who changed the medicine recovered comfortably and was discharged in a few months.

While AI increases the accuracy of a doctor’s diagnosis and prescription, it does not make doctors unnecessary. Once various examination data, genetic information and others are inputted, ultra-medical Doctor Watson who can diagnose and prescribe better than a human doctor will find it a piece of cake to ask a patient medical questions. Nonetheless, it must be uncomfortable for a human patient to listen to and answer Dr. Watson’s questions. It should not be an exaggeration to say that it is impossible for anyone other than human doctors to ask a patient some questions about his/her medical history. During oral questions by a doctor, a patient is in an extremely nervous mental state. It is not Dr. Watson but a human doctor who can relieve the nerve and receive honest answers from the patient, after all.

The surgical assistance robot “Da Vinci” has also been frequently used in urinary-related surgery. Da Vinci’s duty is to assist a surgeon with surgery only, and it is a surgeon who performs surgery. Thanks to Da Vinci, the accuracy of surgery has increased dramatically.

Lawyers’ work will also be replaced by AI. There will soon be a time when Lawyer Watson memorizes the Compendium of Basic Laws and judicial precedents, searches the relevant past cases and laws related to the case concerned, and writes an argument justifying the client’s claim. However, it is still necessarily human lawyers that who expand and exchange arguments in court.

It is inevitable that AI and robots will dramatically alter factories and medical, legal, and other worksites. The question is being asked on how humans will coexist with AI and robots well.

C: Towards Peaceful Co-living in a World of Diversity

Principal Investigator Ryuichi Ida

In this research, we examined the third issue of the three issues presented by the IIAS Strategic Committee (ISC) "Measures for a Peaceful Coexistence of World with Differing Values," to propose a new index which will replace current various indices.

Preface

The Strategy Committee, in its report, due to the present situation in which there are people, society and states with various ideas, and diverse values and ethics in modern times, and they are not in peaceful coexistence, we sought to examine measures to remove their causes, and how to pave a way to peaceful coexistence from there. Then, we set a goal to consider an index to replace GDP based on human-centered values, which is an indicator of economic activities which is still widely used, and to build a network to discuss this globally.

This study group was established under such a request with the goal of returning to the dignity of human beings while respecting tolerance, cooperation, and the spirit of reciprocity, and building values for peaceful co-living. We examined ideas and elements that would form the basis for presenting the factors for achieving peaceful co-living, arising in Japan, as an index. This is a report for that. We will further refine the index elements shown here and the confirmation method of their effectiveness, and then will construct a concept of a world of peaceful co-living, based on the existence of diverse values, to disseminate from the International Institute for Advanced Studies.

1. Research method

Human beings have made the efforts to overcome confrontations, disputes, and wars, through ethics, morality, or religion. Similar issues have been taken up and discussed at various places in the world, so it is not the purpose of this study group to reconstitute them in an overview. Rather, based on the results of the research accumulated by the members of this study group, we focused on what kind of new index should be created, based on Japanese values with the spirits of tolerance, cooperation, and reciprocity.

We have three research themes.

1) The first is how to view the provided issue of "measures for a peaceful coexistence based on human-centered values" as a concept? We must consider what the human-centered values are, and what elements are needed to recognize those values.

Here, as a premise, the two concepts of "human-centered values" and "peaceful coexistence" are included. Between them, we reconstructed the basis of discussion about the latter. This Strategy Committee Report uses the term "peaceful coexistence," but this concept of "peaceful coexistence" has the historical background of an ideology claimed by the former Soviet Union during the Cold War era. The former Soviet Union often used this term in the United Nations, but it was not accepted by many member-states of the United Nations, so instead the term "friendly relations" was used. The result was the 1970 UN General Assembly Resolution 2625 (XXV) "Declaration on Principles of International Law concerning Friendly Relations and Co-operation among States in accordance with the Charter of the United Nations" ("Friendly Relations Declaration"). This study group, while understanding the intention of the Strategy Committee, avoided using such an ideological term, and decided to use the term "peaceful co-living" as a concept expressing a content that is one-step further advanced in the more modern situation.

At the same time, we understand "peaceful coexistence" to have relationships at the inter-state level in mind, whereas "peaceful co-living" is a broader concept that focuses on people living in nations and society as well. The idea of "peaceful coexistence," held by the Strategy Committee, not only has relationships between states in mind, and in that sense the traditional international relations, but also clearly has peace and happiness of the people who live there in mind, when the Committee talks about "human-centered values."

2) Second, what is the "index" based on human-centered values to take place of GDP? Particularly, GDP is an index of a strong economic character. When we refer to the index of GDP, it is often associated with the concept of so-called "development." However, as seen in the MDGs (Millennium

Development Goals), for example, it became clear that the development itself could not be measured by GDP alone. If that is the case, we will need to extract what need to be considered as elements for the new index. What is sought there is the basic idea of ”human-centricity,” but in reality, we live in a society with a variety of values towards “human.” The very issue in the modern world is to have a common recognition and common values amid diversity, so it is necessary to have communication and mutual understanding among various cultures and civilizations. That means mutual respect for the basic values of each culture.

Because of this, in considering an “index,” it is particularly required to explore factors that integrate various values such as Japanese, Asian, Islamic, and African values in addition to the values centered on the West, before formulating an index based on those elements.

However, an index here does not mean one to assess the current situation like the previous indices, but one whose criteria should be met by the time the world reaches the point of peaceful co-living. Therefore, it is essentially a goal-oriented, qualitative index, not a quantitative or numerical index.

3) Even if an index can be formulated, that is not enough. It will be necessary to verify that the formulated index truly brings about peaceful co-living. The new index is to be applied at various levels on a trial basis, and the effectiveness of it will be confirmed. As already mentioned, peaceful co-living will not be truly effective unless it is recognized not only at the inter-state level but also at the community level and resident level. So, by surveying residents by a questionnaire, we will investigate what they feel as peaceful co-living on the one hand, and at the same time whether they are in fact in a situation where they co-live peacefully.

This survey will be carried out mainly by members who have abundant experiences in surveying and researching at the sites of peacebuilding. The target residents will be from regions where peace have actually been destroyed or they have experienced warfare, and where either peace has been reconstructed or is in the process of reconstruction in the given country or region. The purpose of the survey, detailed methods, and contents will be described in Chapter 2 of this report.

4) We will disseminate from Japan to the world the new index formulated based on the working on the above three issues and their underlying ideas, and propose a discussion. At this stage, after summarizing the research, our aim is to promote discussion on realization of peaceful co-living by conducting a presentation the result in Japanese and English.

The interim report has been published with the aim of leading domestic discussions at the symposium in Osaka and Tokyo held in 2017. This research will be presented as a final report to be prepared after various reactions on the interim report and discussions at the symposium. We believe we can bring this kind of discussion to the world.

2. Attempt at an index

To formulate an index of peaceful co-living, which is the final goal of the research, we need to keep in mind comprehensively the various indices that have previously been used, and construct a concept that is to be the basis when disseminating the index from Japan. Therefore, in Chapter 1, we will clarify the concept that will be the basis. In particular, unless the concept and the framework are theoretically clarified about the issue of the “world of diversity” and the fundamental goal of “peaceful co-living,” this research per se is equivalent to a sandcastle.

In addition, we extracted the keywords that could be some bases of the index, including some basic values and concepts suggested so far by the issue. It is provisional in accordance with the purpose of this report, but I will present it here. These keywords will be examined further in consideration of the basic concepts in the next chapter. An index through these will be formulated in future research.

(1) Human (human dignity, human-centricity)

The first important keyword in formulating an index of peaceful co-living is “human.” This is used in words such as “human dignity” and “human-centricity.”

Through the keyword "human," it is possible to grasp both human beings as individuals and human beings as groups (such as communities, regions, and nations).

However, it is not easy to explain, for example, what "human dignity" is. The principles of autonomy, beneficence, non-maleficence, justice, solidarity, and equity, used in the field of bioethics, may be helpful here.

(2) Development

Needless to say, the keyword "development" is not just one from an economic point of view. "Development," which has been used in the United Nations, is now a term used not only for economic development but also for social development and human development, as shown in recent years' MDGs (Millennium Development Goals) and SDGs (Sustainable Development Goals). Here, it is an important issue how the existence and actuality of economic, health, and educational disparities among others influence development. In addition to the economic disparities, it is necessary to consider disparities in areas such as resource access and governance.

(3) Identity

Each human being has an individual identity. The individuality and uniqueness are important not only for individuals but also for groups, and they are the source of diversity. Identity is also determined by the relative relationship with others, from which mutual relationships surface, and at the same time, the importance of mutual respect is guided.

Now, the identity held by the group of "nation" has been large so far, but in the present situation where the activities and actions of not only the states but also the non-state groups are expanding rapidly, the conventional schema of inter-state peace may not necessarily apply. So, we must consider what a nation's identity is in itself.

(4) Subjectivity and objectivity

In considering diversity, the existence of self and others are a prerequisite. Therefore, each subject (including individuals and groups) will search for its objective evaluation and judgment as well as its subjective evaluation and judgment. There, the issue arises as to how to measure the subjective elements and create an index out of them, from which we will think about what constituent elements are necessary for the index, including the keywords mentioned here. In addition, ordering is necessary between the index and its constituent elements.

(5) Inclusiveness and exclusiveness

When discussing peaceful co-living among members of various levels in the world of diversity, we must also pay attention to its structural factors. Especially, when thinking about a world based on diversity, participation of those who have been alienated is indispensable. However, we may not ignore the fact that this is the other side of the exclusiveness that real society has.

(6) Where do we live: place, environment, and time

In considering the index in the world of diversity, we need to set up a framework to set up indicators about those of us who are living now and future generations to live from now, such as the times, regions (domestic, foreign, and of Earth), and relationships (international and intergroup relationships such as those between ethnic groups). In doing so, we must keep in mind the time axis in particular. I do not think that they can be examined uniformly according to simple general premises such as society of diversity or the international community.

I have shown keywords considered important above, but at the present stage, these elements are not ready to be set to form an index yet. In the future research, we would like to clarify these elements along with implementation of the questionnaire survey of residents in communities that have finished going through a conflict.

Chapter 1 Basic Concepts

In this study, we discussed the basic concepts of the world of diversity, peaceful co-living, and measures, to consider the measures for peaceful co-living in the world of diversity.

1. World of diversity

1-1. What is diversity?

Currently, people in the world have diverse values, ethics, religions, and ideas. Such a diverse world is not necessarily peaceful. Rather, human beings have an inclination to refuse something different from themselves, and conflicts and confrontations have occurred repeatedly between different groups.

Such diversity is by no means classified only by state. Other units include religions, ethnic groups, and habitats. In fact, in the Middle Ages when conflict arose over religion, and when the modern sovereign state was established, wars were repeated among the states. Furthermore, when nationalism spread among people, hatred between ethnic groups was fueled, and genocide also began to occur. Even after the end of the Cold War, in which democracy, capitalism, and socialism competed over which one of them was superior, frequently there occurred conflicts over differences in religion or ethnicity, such as the conflict in former Yugoslavia and another in Rwanda. Historically, humankind has been intolerant of diversity.

Such diversity has developed in the history of the people in each region, but it has been greatly affected by the difference in the natural environments around the world. That is because people have fostered politics, economy, and culture by responding to each of their natural environment. It is suggested that factors must be taken into consideration, such as differences in the natural environments, as well as political and economic mechanisms of the country and people's cultures and thought, in thinking about measures for peaceful co-living in the world of diversity.

1-2. A new way of thinking about diversity

Conflicts and confrontations have been repeated between groups with different values, thought, religions, and ideologies, but in the contemporary times, ways of thinking about diversity are changing little by little.

First, in economic activities, diversity is now emphasized as well as integration. Certainly, the globalization of the economy promotes integration of economic systems, but among people, products that meet their individual tastes are becoming increasingly popular. From the era of mass production of the same varieties, it has shifted to the era in which it is preferred that many varieties are produced in small quantities.[82]

Moreover, maintenance of diversity in the living not only has the passive meaning of protecting the natural environment that we have had so far but also the positive meaning that diversity in fact enriches it. It can also be said that maintaining diversity in various respects in human society and the global society is indispensable for strengthening our society.

While we should set a question on how to achieve peaceful co-living in the world of diversity, at the same time it even seems that we should set up the issue of how to maintain the diverse world and seek solutions in the first place.

2. Peaceful co-living

How can we create a world in which there are fewer wars and conflicts, and diverse groups can peacefully co-live? In this day and age when nuclear weapon technology has proliferated and terrorism crosses national borders, this is an urgent issue.

First, after defining co-living and distinguishing it from its synonym, I will organize concepts linked to an index of peaceful co-living.

2-1. Definition and distinction from synonym

I would like to define peaceful co-living while contrasting it with its synonym, peaceful coexistence.

The term peaceful coexistence is often used to describe the U.S.-Soviet relationship during the Cold War era. There, there are differences in values and philosophies. Over these differences, both sides insist on their superiority and confront each other, and fight so that they can expand their sphere of influence. While policies (e.g., military expansion) to dominate the opponent with force and violence are pursued, it is to refrain from the exercise of force or violence, and instead acknowledge the mutual existence.

[82] In the EU which promotes regional integration, the way of integration is expressed as "united in diversity."

On the other hand, peaceful co-living can be defined as follows. First, even if there are differences in values and philosophies among states and groups, it does not consider that confrontation exist because of the differences. It does not try to impose their own values or philosophies on the other. Rather, it accepts the existence of various values and philosophies (pluralism).

Second, while it believes in its own values and philosophies, it also respects the values and philosophies of the other. This is what co-living means. Regarding the entire global society as well, it not only recognizes diversity and accepts the existence of diverse values and philosophies, but also even considers them ideal for the entire global society. These ideas are included in the term co-living.

Thirdly, because it does not try to impose its own values and philosophies on the other, the method of co-living cannot be violent, but is peaceful.

There is also a possibility of a passive co-living whereby involvement with others is reduced as much as possible (e.g., isolationism), but it is difficult to reduce involvement in modern times when globalization is progressing, so I will proceed with my discussion by assuming that co-living is an active one.

2-2. Towards peaceful co-living

In this study, to think about measures for peaceful co-living in the world of diversity, we first considered what was the state in which peaceful co-living was lacking, and then at what level (state, religion, habitat, etc.) peaceful co-living was lacking, or in other words, at what level an examination of measures for peaceful co-living was requested as needs of the global society. After that, we discussed what conditions should be satisfied to implement the measures for peaceful co-living.

a. What is the lack of peaceful co-living?

- Minimum requirements for peaceful co-living -

What is the state like in which peaceful co-living is lacking? In this study, we considered the minimum requirements for peaceful co-living (minimum peaceful co-living) by thinking about this.

The lack of peaceful co-living means a situation in which human security and human dignity are not secured. Of course, it does not mean that peaceful co-living is secured if human security and human dignity are secured. Securing of human security and human dignity are the minimum requirement for peaceful co-living.

Human security consists of freedom from poverty and freedom from fear. The former is about whether basic needs to live as a human being are secured. The latter is about whether they are free from fear regarding everyday safety, or whether they are able to escape fear of domestic extremist violence and attacks from other countries.

It can be understood that human dignity is to have one's individual personality treated as something precious. It is difficult to judge in practice how much of treatment of individual personalities must be shown to say that human dignity is secured. Rather, in this case as well, if we make it a question of what a lack of human dignity is, "treatment like insects" would correspond to it, which is easier to understand.

b. In which groups and between which groups peaceful co-living is lacking - subject of the measures -

Co-living is one of self and other. What distinguishes self from other? Is it the state, ethnicity, religion, class, gender, company that one works for, university one is from, or baseball team that one supports?

It is not necessarily just one single group that he or she has a sense of belonging to. If they identify with more than one group, which one of them does one identify with strongest?

Now, to what extent do people feel that they are participating in a group that they feel a sense of belonging to? In other words, do they not have the feeling that they are left out or excluded? In this case, it is important to make a consideration by distinguishing the issue of the objective fact on whether they are actually left out, and the subjective issue of feeling that way.

Then, is the group to which one belongs not discriminated against compared with other groups? In this regard also, it is necessary to distinguish between subjectivity and objectivity to examine it.

c. What are the necessary conditions for realizing peaceful co-living? - elements to be incorporated into the measures -

What conditions are necessary to realize peaceful co-living? This study requires the three elements of norm sharing, common awareness to problems, and preparation to bear the burden of cost. We believe that these three elements should be incorporated in the measures.

I would like to add some explanations. The first condition is whether the minimum value and norm that peaceful co-living is necessary are shared with each other. That is because there are also groups and people with a recognition that it is not necessary to co-live with others, especially with certain other groups. It is the degree of tolerance with respect to the existence of others. We can say that it is a major premise for taking the measures.

The second condition is whether they recognize that there is a disparity or discrimination between their own group of belonging and that of others. In other words, it is about whether they recognize that some improvement measures are necessary for peaceful co-living. It is the sharing of recognition about the existence of a problem. There are quite diverse groups of people in the world, and whether or not they have a common understanding as to which units (state, ethnic, religious, or class) have unfairness or inequality in them influences the effects of the measures greatly.

Third, how much cost can we be ready to pay for improvement? This is because, even if they realize that peaceful co-living is necessary as a general theory and are aware of intergroup disparities and discrimination as real problems, when they have to pay for the actual costs, their attitudes may change.

Payment costs include cases in which (1) one's own group of belonging (state or organization) pays for the cost and he or she does not directly bear the burden, and (2) one accepts others in their own group of belonging. A case with the largest cost is when (3) one and his or her family enter a group of others, or are asked for consent to do so. In this case, they may lose their identity, and it involves a big mental burden.

3. Towarsa peaceful co-living

- Key concepts and specific indices -

(1) The minimum requirements for peaceful co-living, (2) the targets of the measures, and (3) the necessary conditions for co-living, which we considered in order to think about measures for peaceful co-living, constitute the three dimensions of measures for peaceful co-living. The correspondence between key concepts (this chapter) and specific indices (Chapter 2, major questionnaire items and middle items) in each dimension can be summarized as Table C-1 (pp: 234- 235).

Chapter 2 New Index for Peaceful Co-living and Survey Plan

1. Objectives of opinion survey

As described in Chapter 1 of this report, it is an extremely serious issue for the modern international community whether different countries can co-exist and whether different political forces, ethnic groups, and tribes within a state can realize co-live in a peaceful manner.. "Not being able to co-live" eventually encompasses the risk of falling into a military conflict, and if it actually becomes a conflict, the safety, life, and dignity of the people living there will be threatened from the ground.

Then, in what way can we recognize whether people are respecting each other's life and dignity, and are being able to co-live? Is it possible to create an index that recognizes the degree of co-living? Will making such an index help to analyze what is hindering co-living and what promotes it? The "Measures for Peaceful Co-living in the World of Diversity" study group has been discussing this problem several times.

As a result, it was argued that we could measure the degree of co-living and risk of a military conflict by conducting a common consciousness survey in the target area just like the risk of vascular disease (heart disease, cerebral infarction, myocardial infarction, etc.) can be measured by questionnaire survey.

Specifically, it was agreed that "consciousness survey (questionnaire survey) items" will have components such as , A) the degree of safety of themselves, B) the degree of their participation in decision-making in the group they belong to and their identity (the degree of how much their dignity is respected), C) the degree of tolerance and co-living with different countries and people with different identities (others), etc. It would aim to grasp how people perceive their situation subjectively.

On the other hand, it was confirmed that it is important to have not only quantitative grasp with such questionnaire survey but to dispatch experts who will go the country to conduct qualitavie field research. She/he will conduct an analysis politically, economically, and historically, and analyze why the country has succeeded in a long-term peaceful co-living and why other countries failed. For this reason, we concluded that it is desirable to conduct the simultaneous parallel processing of the quantitative method and the qualitative method.

Based on these conclusions, proposed by Dr. Daisaku Higashi, who had an experience of conducting a questionnaire survey in post-conflict countries, the study group created consciousness survey questionaires for conflict-affected region residents. The consciousness survey consist of three elements. The first is about consciousness concerning safety and security of individual residents. This component will grasp people's perception of safety and peace, including sense of fulfillment of basic needs, fear of daily safety, fear against domestic extremists, and fear and caution against attacks from other countries. The second component is identity survey. This part will investigate to what extent the participant feels that he/she is participating in the decision-making or alienated from his or her affiliations, such as family, community, region, local government, state, and company. The third is a survey to grasp people's attitude to others. This part will covers tolerance in cases where your family members might get marriage with somebody from other political, ethinic, and religious groups.

2. Features of this survey

The main feature of this survey is, first, to investigate the residents' consciousness in the conflict-experienced countries/regions and prepare the consciousness survey data on ethnic groups and tribes.

Conventionally, there was a problem that domestic conflicts lacked these data. Of course, for quantitative data on military conflict, data such as Uppsala Armed Conflict Data by Uppsala University in Sweden is widely used. However, this data only measures the objective intensity of conflict (represented by the number of dead and others), and data that focuses on the subjective perception of people living there and enable different regions of the world to be compared has not been developed worldwide. Regarding subjective perceptions, at most, there are only results of consciousness surveys carried out as a consignment of UN organizations or on extension lines of individual field surveys by each case such as different countries

and regions.[83]

The proposed survey is original in respect of systematically investigating subjective perceptions in the conflict-experienced countries/regions and making it into a database, and it contributes greatly to conflict research in the world.

Secondly, conducting consciousness surveys around the conflicted regions is accompanied by a great danger, and residents may not answer easily to consciousness surveys due to conflict areas. However, in this survey, many of the study group members have abundant experiences of working on field work;therefore it is possible to conduct a consciousness survey on site. The fact that numerous researchers in this studyg group have experiences of conducting there field researches in conflicted states is a big feature of this research.

Thirdly, we will widely release the results obtained by the consciousness survey in conflicted regions as a database for researchers worldwide. Traditionally, even in Japanese research institutes, database creation has been promoted for economic data, mainly in Japanese economy, and they have been used a lot by abroad researchers, making a certain contribution. However, frankly speaking, such contributions are limited to the fields of economics and business administration, and in conflict study, Japanese researchers were rather often database consumers. In this survey, by preparing the consciousness survey data of the residents in the conflicted regions, we will create a database of consciousness surveys and contribute to the world.

3. Impact on society this survey can possess and dissemination of data

This research is to conduct a survey on residents' consciousness around conflict areas and can be regarded as basic research for promoting research in many related fields.

First of all, peacebuilding is an important theme in international relations research and Japanese foreign policy, and this survey will prepare essential data to improce policy discussions on peacebuilding, backed by data from the fields.

Next, the study will contribute to promotion of dialogue with regional studies. The researchers participating in this research are diverse, and specialists in each region; thus it will enhance regional studies as well. In some countries and regions, the level of conflict is relatively low and coexistence (or peaceful co-living) between diverse groups has been established. On the other hand, there are regions where coexistence is collapsing. By comparing the situation between these different regions, it will promote comparison and dialogue among the respective regional studies.

Lastly, Mr. Ida, the representative of this research who had been instructing us as a chairperson of the study group since 2015, took office as president of Shiga University, one of the prominent national universies in Japan from April 2016, and prepared the establishment of "Faculty of Data Science" (established in April 2017). It is expected that the results of this survey will be publicized internally and externally from the data bank based in the Faculty of Data Science at Shiga University. Therefore, the results of this survey will be published in both Japanese and English, with visually appealing 2D and 3D graphs, created by the Faculty of Data Science, and will be distributed to the world.

4. Survey plan

In the future, we will submit an application form for competitive funds, and if it gets adopted, we can obtain a financial basis for this research. Below is a temporary plan if the application passes.

4-1. Countries and regions to be specifically surveyed

This research is planning to survey the following nine countries, and from the comparative study, we will analyze factors that make co-living possible and factors that make co-living difficult.

1) Cases where peaceful co-living is relatively successful (Tanzania, East Timor, Lebanon)

[83] For example, regarding the questionnaire survey of conflict areas, there is a survey in Afghan and East Timor that Dr. Daisaku Higashi conducted in 2008 (refer to Challenges of Constructging Legitimacy in Peacebuilding (Routledge 2015) . By a consciousness survey on about 300 people in each country, quantitative data on political settlement, coexistence with enemies, recognition to foreign troops, etc. was grasped, and by combining that quantitative survey and qualitative survey, possibilities and methods of a new settlement process in Afghanistan were discussed.

2) Cases that lie between co-living existence and conflict (Democratic Republic of the Congo (DRC), Mindanao, Tunisia)
3) Cases where co-living does not go well and military conflict persists (South Sudan, Afghanistan, Syria (survey planned in Turkey with Syrian refugees))

4-2. Plan for 2018

A) Interviews and negotiation for field survey at the United Nations Headquarters in New York

In order to make such field survey possible, first of all, Principal Investigator Ida and I, who have network with the United Nations Headquarters, will conduct interviews with UN political officers and executives of the department in charge of each country at the UN Headquarters in New York. In parallel with the interview, we will also ask for cooperation in the field survey to be carried out in the future.

Dr. Daisaku Higashi has so far built a cooperative relationship with UN Department of Peacekeeping Operations, Department of Political Affairs, Department of Field Support, Peacebuilding Support Office at the UN Headquarters, obtained the recommendation letters by the Under-Secretary General and Assistant Secretary-General, and has conducted numerous survey in the field. In the summer of 2016, a survey on the peace process of South Sudan was conducted in Kenya and Ethiopia. After announcing its contents in various places in Japan and at the Academic Council on UN System and Japan Broadcasting Corporation (NHK), in November 2016, Dr. Higashi made a presentationat the UN Headquarters in New York, jointly hosted by the Department of Peacekeeping Operations, Department of Political Affairs, Department of Field Support, and Peacebuilding Support Office.

By utilizing these network, the proposed survey will be conducted with cooperation of important departments dealing with peace and war issues at UN headquarters.

B) Field survey: Tanzania (case where peaceful co-living is successful in Africa): Four weeks of 2018

Tanzania is a country that was formed by the merger of “Tanganyika (Mainland)” and Zanzibar “(Islands)” in 1964, and despite Christianity and Muslim believers each occupy half of them, it has maintained peace since its independence and is known as the country that is most peaceful and continuously stable in Africa. What is the reason that co-living is going well? Centering around Mr. Yoichi Mine specializing in Africa, while conducting historical, political, and economic analyses based on field survey, our study group will also conduct our own consciousness survey in collaboration with universities in Tanzania and clarify as to why co-living is maintained.

C) Field survey: East Timor (case where peaceful co-living is successful in Asia): Four weeks of 2018

East Timor who fulfilled separation and independence from Indonesia in 1999 has been promoting nationwide development with the support of UN PKO missions. Despite the political crisis in 2006, after that, while the government and the opposition forces (the opposition party) compete in the election, they maintained a democratic way and continued an inclusive political process, such as the government actively adopting opinions of the opposition party. As a result, at the end of 2012, UN Mission withdrew. Even then, political stability has been maintained, and it is said to be one of the most successful cases in peacebuilding by the United Nations in recent years. Dr. Higashi will be responsible for conducting research in East Timor as he conducted questionnaire surveys to a total of 300 people at three locations in East Timor in 2008. He will conduct a consciousness survey with the cooperation of students of the University of Dili in the capital city of East Timor. At the same time, he will also conduct qualitative survey on the cooperation and coexistence relationship between the government and opposition parties.

D) Field survey: Lebanon (case where peaceful co-living is progressing successfully in the Middle East): Four weeks of 2018

After suffering from the civil war of 15 years, Lebanon did a thorough allocation system (quarter system) on ministers and senior officials of each ministry by 18 denominations after the end of the civil war in 1990, and they have been maintaining peace by having the government share power. We will conduct

both qualitative surveys and consciousness surveys in Lebanon, which is said to have achieved peace through the most thorough power sharing in the Middle East, and explore the actual situation on co-living. Middle East expert Ms. Hisae Nakanishi will lead the survey.

E) Data analysis to be conducted centering around the Faculty of Data Science, Shiga University: As needed in 2018

As soon as the data is gathered in the above three countries, we will analyze at the Faculty of Data Science, Shiga University and summarize the results into 2D and 3D graphics, and we will announce it to the press and others as needed.

4-3. Plan for 2019

A) Field survey: Democratic Republic of the Congo (DRC: the in-between case in Africa): Four weeks of 2019

Democratic Republic of the Congo experienced a long civil war and the UN PKO missions were dispatched from 1999. The battle continued with the anti-government armed forces M23 who took charge of the eastern part, and it had been difficult to build peace and stability throughout Congo. As a result of the UN Force Intervention Brigade being dispatched from 2013 and fighting against M23 along with government forces, they are currently in a state of lull, and the capital Kinshasa has developed that you would hardly recognize from five years ago. We will conduct the survey with the cooperation of UN PKO missions (MONUSC) and JICA who has a large-sized office. The survey will be conducted mainly by Mr. Mine who has experiences of surveys on DRC and is fluent in French.

B) Field survey: Mindanao (the in-between case in Asia): Four weeks of 2019

The Mindanao region of the Philippines, which suffered from decades of conflict. In March 2014, the Government of the Philippines and Mindanao's largest anti-government armed forces Moro-Islamic Liberation Front (MILF) signed the Comprehensive Agreement on the Bangsamoro and took a big step forward to resolve the Mindanao conflict. In line with Malaysia, Japan has been actively participating in peace mediation of Mindanao since 2006, and in particular, JICA has been engaged in activities to promote dialogue of peace-related participators through social-economic development support. While Mr. Duterte takes office as President of the Philippines and the influence on peace process is drawing attention, we will conduct qualitative and quantitative surveys with full cooperation of JICA. (We will conduct surveys while looking for guidance, advice, and introduction from JICA experts who have experience working in Mindanao for JICA as an advisor to the peace process.)

C) Field survey: Tunisia (the in-between case in the Middle East): Four weeks of 2019

A social change called "Arab Spring" occurred in the Middle East, but as Syria shifted to a civil war and Egypt became a military dictatorship, Tunisia continued its transition to a democratic government, and while there were threats such as terrorism, different sects and political groups coexisted, and minimum security and peace is maintained. Utilizing the fact that our Principal Investigator Mr. Ida has a network with the universities in Tunisia, we will conduct consciousness surveys and qualitative surveys in Tunisia under cooperation and collaborating with such universities.

4-4. Plan for 2020

A) Field survey: South Sudan (case where battle continues in Africa): Four weeks of 2020

South Sudan fulfilled independence in 2011, but in the summer of 2013 President Kiir dismissed Vice President Machar, and a massive battle broke out between the Machar, who responded strongly about it, and the Kiir in December 2013. South Sudan entered into a civil war state, and more than 2 million people became refugees and more than 50,000 people died. In August 2015, President Kiir and Vice President Machar reached a peace agreement, which seemed to regain peace once, but again in July 2016 the two sides collided militarily. Vice President Machar was dismissed again, and the peace process is in chaos. Regarding the peace process in South Sudan, since Dr. Daisaku Higahsi surveyed the neighboring Ethiopia and Kenya in the summer of 2016 with the full cooperation of the AU special representative of UN and UN special

envoys for Sudan and South Sudan, and have a track record of reporting the results in the NHK Close-up Gendai and the magazine *Gaikou (Diplomacy)*, etc., he will plan and implement surveys with the cooperation of the UN PKO missions.

B) Field survey: Afghanistan (case where battle continues in Asia): Four weeks of 2020

In Afghanistan, the Taliban regime collapsed due to the attack of the United States in 2001 and peacebuilding of the country was started. However, the offense by anti-government armed forces has been restored since around 2005, and now it is considered to be that 70% of the country's territory is dominated by the anti-government armed forces. For Afghanistan, Doshisha University, where our Principal Investigator Mr. Ida serves as a visiting professor, has accepted dozens of graduate students from Afghanistan, and they have returned to Afghanistan after completing the master's degree. Ms. Hisae Nakanishi and Mr. Ida, who belong to the Research Center for Peace and Development for Afghanistan in Doshia University, will conduct the surveys on consciousness, etc. by asking the Doshisha University Afghanistan alumni.

C) Field survey: Syria (case where battle continues in the Middle East): Four weeks of 2020 (scheduled to be conducted with refugees in Turkey)

Regarding Syria, where the civil war continues, it is a situation where it is unpredictable whether peace is regained even in 2020. If peace has been recovered, consciousness surveys will be conducted at the site, and if that is difficult, we will conduct them with Syrian refugees who have escaped to the neighboring country Turkey. In addition, Dr. Higashi conduted five weeks researches on Syrian peace process, obtaining special support from Staffan de Mistura, UN special envoy for Syria, who was supervisor for Dr. Higashi when they worked together in UN Assistance Mission in Afghanistan in 2010.

D) Data analysis to be conducted centering around the Faculty of Data Science, Shiga University: aggregated data summarized in 2020

The Faculty of Data Science, Mr. Oshiba, and Dr. Higashi will mainly analyze the data. We will summarize the meaning of the data in reports and books, announce them through the press and the Internet, and at the same time, make a theoretical presentation about peaceful co-living. In making a theoretical presentation, we will summarize the final contents while receiving advice and recommendations from scholars of international politics Ms. Akiko Fukushima and Mr. Hiroshi Nakanishi, economist Mr. Akira Kousaka, and others who are also key members of the study group.

5. Consciousness survey (questionnaire survey) items

These are what we have at the moment. We will continue to improve further. In practice, first, we will make a unified version in English, and then translate it into local languages and use it.

5-1. Aim

Regarding each question, basically it is designed on a four-point scale that the higher the score, the higher the degree of peaceful coexistence including human dignity, and the lower the score, the lower the degree of coexistence. At the end, we have also put in several free response questions. You can see the overall score of the total, and you can also learn about the trends in that country or region from scores on individual questions.

Also, the relevant question draft is assumed to be a model version created both in Japanese and English and available (used) around the world. However, according to the circumstances of each country, it is possible to omit certain question items in cases where they are too sensitive and it is difficult to investigate by asking those questions. (Especially questions about ethnic groups and communities may be difficult in some countries.)

5-2. Question sheet

It is noted at the end of this chapter.

6. Summary

Whether or not peaceful co-living with other people is possible is decisively important in terms of the management of the state, in terms of the management of the organization, and in terms of maintaining the family, and it should be the most fundamental problem of

human society. In that sense, the members of this study group are fully aware that peaceful co-living can never be easily realized. On the other hand, it is a fact that humanity has succeeded in significantly lowering the possibility of military conflicts in the country, at least in some countries, by introducing a system "from bullet to vote" by establishing a system called democracy. With regard to inter-state wars between states, we might be able to reduce wars by utilizing international organizations and international rules. In this sense, the study group believes that "we simply cannot give up peaceful co-living," Even if complete co-living is impossible, how is it possible for humankind to make some progress in that direction even for a small step? We believe that there is a possibility that this survey will be an important survey for both the world and Japan, which has been a peaceful country since the end of World War II.

Question sheet
(Draft)

This questionnaire is conducted to aim for "people to have dignity and coexist peacefully (peaceful co-living)" by collecting data that contributes to peaceful coexistence. Your privacy concerning answers is kept completely. By answering honestly, we believe that it will be possible to grasp the current situation and it will lead to effective measures and policies. We appreciate your cooperation.

Regarding your own participation/involvement in central government, family, company (employer), etc. (political, social, and economic participation)

1) Participation or involvement in the central government

1-A Question: Do you feel that you are participating in the policy and decision-making of the central government of where you live in?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

1-B Question: Do you feel that the central government of where you are living now listens to your requests and opinions and respects them accordingly?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

2) Participation and involvement in family decisions

2-A Question: Do you feel that you are participating in the decision-making of the family to which you belong?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

2-B Question: Do you feel that the family you belong to listens to and respects your requests and opinions?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

3) Participation and involvement in activities of the company (employer)

3-A Question: Do you feel that you are participating in the decision-making at your place of employment (including when you work at your own company)?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

3-B Question: Do you feel that your place of employment listens to your opinions and requests and respects them accordingly?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

3-C Question: Do you feel that you are contributing to the economic activity of your place of employment?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

3-D Question: Do you feel that your place of employment appreciates and respects your ability and experience?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

About your own life and happiness

4) Minimum living and safety guarantee

4-A Question: Do you feel that you have the minimum amount of clothing you need?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-B Question: Do you feel that you are being able to consume the minimum meal you need?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-C Question: Do you feel that you have acquired the minimum necessary housing environment?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-D Question: Do you feel that you are in an environment where you can receive the necessary education?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-E Question: Do you feel that you are in an environment where you can receive the necessary medical care?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-F Question: Do you currently feel that you are getting the necessary work to live?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

4-G Question: Have you ever lost someone in your family during the past year due to crime, incidents, attacks, etc.?
(4. No one 3. One person 2. Two people 1. Three or more people)

4-H Question: Have you ever had a burglary or stealing in the past year?
(4. None 3. Once 2. Two times 1. Three times or more)

4-I Question: Do you currently feel that you are being discriminated against by someone?
(4. Not at all 3. Occasionally 2. Often 1. Always)

5) Value to live

5-A Question: Have you ever felt that you were glad to be alive in your recent life?
(4. Very often 3. Occasionally 2. Very little 1. Not at all)

5-B Question: Have you ever felt happy in your recent life?
(4. Very often 3. Occasionally 2. Very little 1. Not at all)

5-C Question: Do you feel that there is hope to keep on living?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

5-D Question: Do you feel happy to keep on living?
(4. Very much 3. Fairly 2. Not much 1. Not at all)

6) On peaceful coexistence

6-A Question: Do you feel that you can adjust the disagreement with neighbors, people with other opinions, people with other religions, and people who support other political groups without using violence?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

6-B Question: Do you feel that you can live peacefully with each other, even though there are differences in opinion and way of thinking, with neighbors, people with other opinions, people with other religions, and people who support other political groups?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

6-C Question: Do you feel that people in your country are being able to overcome differences of opinion and live together peacefully?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

(Note: Up to this point is mainly concerned with individual "dignity" and "peaceful coexistence." From below, we will enter into issues such as community problems and peaceful coexistence among communities.)

About the community to which you belong

7) About belonging to the community

Other than the country (government) you live in, which of the following organizations or groups feel most familiar to you? (Which community do you think you belong to the most?)

A) "Local community including town and village to which you belong"
B) "The smallest of the local governments to which you belong"
C) "Ethnic group to which you belong"
D) "Tribe to which you belong"
E) "Religion to which you belong"

8) About participation in the community

We will ask about the community you belong to the most that you chose above.

8-A Question: Do you feel that you are participating in the policies and decision-making of that community?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

8-B Question: Do you feel that the community listens to your requests and opinions and respects them accordingly?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

9) About coexistence and disparity among communities

9-A Question: Do you feel that the community is being able to coexist with other communities without fighting?

(4. Very much　3. Fairly　2. Not much　1. Not at all)

9-B Question: Do you feel that the community is discriminated from other communities?

(4. Not at all　3. Occasionally　2. Often　1. Always)

9-C Question: Do you feel that the community is placed in an extremely economically poor situation compared to other communities?

(4. Not at all　3. Occasionally　2. Often　1. Always)

9-D Question: Do you feel that the community is placed in an extremely disadvantageous situation about education compared to other communities?

(4. Not at all　3. Occasionally　2. Often　1. Always)

9-E Question: Do you feel that the community is placed in an extremely disadvantageous situation with respect to medical care compared to other communities?

(4. Not at all　3. Occasionally　2. Often　1. Always)

10) About immigration from abroad

10-A Question: Do you agree to accept more foreign immigrants?

(4. Strongly agree　3. Moderately agree　2. Moderately disagree　1. Disagree)

10-B Question: Do you agree with increasing language education to immigrants using government money?

(4. Strongly agree　3. Moderately agree　2. Moderately disagree　1. Disagree)

10-C Question: Do you feel that increasing the number of immigrants increases the crime rate?

(4. Very much　3. Fairly　2. Not much　1. Not at all)

10-D Question: Will you agree if your child is going to marry an immigrant child?

(4. Strongly agree　3. Moderately agree　2. Moderately disagree　1. Disagree)

11) Coexistence with other countries

11-A Question: Do you feel that your living country has a friendly relationship with neighboring countries?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

11-B Question: Is your living country in a war with foreign countries?

(4. Not at all 3. Once in the past 50 years 2. Twice in the past 50 years
1. Three times or more in the past 50 years)

11-C Question: Do you feel that your living country has the possibility of being in a war with foreign countries in the future?

(4. Not at all 3. Not much 2. A little 1. Very much)

11-D Question: Do you feel that your living country is having history problems with foreign countries?

(4. Not at all 3. Not much 2. A little 1. Very much)

11-E Question: Do you feel that your living country can reconcile history problems with foreign countries?

(4. Very much 3. Fairly 2. Not much 1. Not at all)

Concluding Chapter　A Tentative Index for Measuring the Degrees of Realization of Peaceful Co-living

In the previous three chapters, we clarified the ideas, concepts and perspectives that will be the core of peaceful co-living. In particular, the discussions have centered so far on the peaceful parallel relationship between sovereign states. On the other hand, the abstract entity that is the state consists of not only the residents who spend their daily lives there, those with a citizenship - meaning the citizens - but also people who live there including those of a foreign nationality and those with no nationality. Because of this, even when an apparently peaceful state exists between states, it is not possible to build a peaceful relationship between societies and states that have various value perspectives as they are today, unless the peaceful co-living is secure for those who are there. True peaceful co-living must be from the viewpoint of the human beings.

Therefore, we need to build the indices which are set as the final goal of our research from the viewpoints of the people who live in the world, the states, and the communities. In this chapter, I propose concrete indices based on the examinations so far.

This index proposal is presented as a necessary element to achieve peaceful co-living within the world of diversity. These indices themselves are the goals. This proposal consists of the three stages of I. Basic philosophies / principles, II. Indices and III. Interpretation of the Indices (examples). “Basic philosophy / principles” shows the philosophies and principles that will be the foundation for measuring whether peaceful co-living has been achieved in the world of diversity. In other words, it shows the value basis for making evaluation and judgments by applying the indices on site. An *index* is a criterion for judging whether each philosophy and principle are sufficiently being applied and satisfied. Put differently, it is a criterion for judging whether peaceful co-living has been achieved for each resident, that is the human beings. We can say that it is to be used to measure how each person actually feel about whether they are co-living peacefully (not as a single person but as a group). That is, it is intended to measure the level of achievement of peaceful co-living of the residents by using the indices as concrete elements as axes for evaluation, under each philosophy and principle. The basic philosophies, principles and indices are abstract and general in content; “Interpretation of index (example)” is meant to explain by showing examples what each index measures specifically.

Below I would like to describe what kind of indices are under each basic philosophy and principle, and what kind of content each index has, by showing concrete examples. Here, to make the whole picture easier to grasp, I have shown these three stages in a table format.

Basic philosophy / principle

When thinking about peaceful co-living, we need to think of the philosophies and principles on several levels. In this proposal, I present them in four distinct concepts: I. Human dignity, II. Belonging to a group and alienation, III. Inter-group relation and IV. Norms for peaceful co-living. It means the essential elements at the individual level, the relationship between self and other within the group (community), the (tense) inter-group relations, the norms for peaceful co-living to be established and perpetuated.

I. Human dignity

For peaceful co-living to be established, the dignity of individuals living there must first be respected and maintained. As already mentioned, what is essential in thinking about the peace in the world of diversity is not simply a non-war relationship between sovereign nations but a peaceful and satisfying life for each resident living there. Therefore, in a world where individual dignity is not respected, even if there is no war or tension, you cannot say that peaceful co-living is realized.

When in a state of peaceful co-living, human dignity consists of the three principles of “1. Freedom from want,” “2. Freedom from fear” and “3. “Recognition as human being.” The concept of “human dignity” is very deep in content, but to put it briefly, it means to be treated as a human being, that is, a human being must not be treated the same way non-humans are treated, such as dogs, cats, horses or cows. It also means that a self and another are human beings in the same way, meaning that they are equal and must respect each

other. These also mean that each individual can decide for themselves and act on their own will in their daily lives.

1. Freedom from want

This basic principle is one of the four kinds of freedom raised as a principle of democracy by President Franklin Roosevelt of the United States in 1941. Roosevelt meant it as an economic consensus by which every nation would guarantee a sound and peaceful life for its citizens, assuming a post-war international society against the backdrop of the Second World War. In the context of peaceful co-living, however, it must mean something wider; it must mean freedom from want at an individual level, not just limited to the national level.

Therefore, these indices measure the degree of freedom with respect to whether the four fundamental needs are met; that is, whether a stable life is secured in the four points of securing (1) clothes, food and house, (2) maintained health, (3) the right to education, and (4) employment opportunities. The indices can be used for concrete measurement by asking whether: 1) the minimum clothes and food are secured, 2) minimum living environment is secured, 3) necessary medical care is available, 4) basic education is available, and 5) jobs that earn minimum living expenses are available. These are all included in the UN Millennium Development Goals and Sustainable Development Goals as well. In particular, the former aims at eradicating the world's poverty, and it shares a commonality with the foundation of Japan's Constitution in its "minimum standards of wholesome and cultured living."

Looking back on the current conflict areas and post-conflict areas, it is clear that these basic needs are not met. In domestic conflicts between ethnic groups, because of inequality and discrimination among the ethnic groups, they have not been able to secure the basic needs listed here. Of course, not only during the conflict but also in peace building after the conflict, satisfaction of these needs at the level of each resident lead to stability of the area along with prevention of reuse of armed forces, as well as resolution of conflicts between different ethnic and tribal groups within the country.

2. Freedom from fear

This is also one of the four kinds of freedom given by President Roosevelt. He associated this with his proposal to reduce arms, but it shows more general content in the context of peaceful co-living. Fear arises within and outside the group. Therefore, the state of security in the group (community) to which one belongs must first be one of safety. It is a necessary condition to feel safe to live daily in order to feel at peace. No matter how materially rich it is, you cannot say that it is truly peaceful in an unfavorable security.

At the same time, you need to ask whether there is ⑦ any fear of violence from other groups. This can be considered in a multilayered manner. First, security within a group is often broken by confrontation, conflicts, and battles among multiple smaller groups. Simply put, confrontation and conflict between different groups (communities) within one country are antonyms of peace. These so-called tribal conflicts occurred frequently after the Cold War, and the present situation is one in which they have not been solved easily. There are too many examples of cases where despite a state being integrated or unified once, it does not continue, and the state goes back to conflicts. Conflicts between ethnic and tribal groups within a country are hard to resolve for historical and emotional reasons, which often make them harder to resolve than international conflicts.

In addition, there are inter-state wars when talking about fear of violence from other groups. This kind of war ends at the conclusion of a peace treaty for the time being, and there is a possibility that the peaceful state may be recovered. However, this index does not simply mean war. As with the Charter of the United Nations, threats of war, such as missile and nuclear tests, should also be included.

Thus, freedom from fear needs to be secured in a multilayered manner.

3. Recognition as human being

This principle consists of the indices of: ⑦ being recognized from others (raison d'être), ⑧ whether there is discrimination or inequality from others (no

discrimination), ⑨ freedom to live with dignity (respect for personality), and ⑩ freedom to live with dignity (right to self-determination). As stated above, to recognize each person as a human being is also to respect the human dignity. The fact that ethnic and tribal confrontations in recent years leave no choice for the people but refuge to another country or escape their area of residence as a domestic evacuee falls under this category.

Index "⑦raison d'être" asks, for example, 8) whether your existence is ever ignored by another, 9) whether you feel happy to be alive, and 10) whether you have hope to keep on living. "Living" is the minimum condition, but it must have a proactive meaning. It means that a society that does not allow you to have hopes for the future along with an affirmation of your own present existence is not one that is peaceful. Index "⑧ no discrimination" asks 11) whether you face discrimination or unequal treatment from others? This is an index of peaceful co-living, as well as the basic principle of human rights protection. It has already been made clear during the Second World War that a state in which human rights are not protected is not peaceful. Index "⑨ respect for personality" is on the extension of dignity, and the issue is 12) whether you feel that your personality is respected. That means people living like people. Index " ⑩ right to self-determination" is an important core concept of dignity, in which 13) whether you can decide for yourself and 14) whether the conditions are met in order for you to decide on your own are the criteria for judgment. For this, you need to be able to freely decide, judge and act with your own will, such as on whether you have options and information to live a life and whether freedom of speech, thought and creed is secure. Merely living alone - in other words, "being made alive" alone - cannot truly make people live. That is personality and dignity.

II. Belonging to a group and alienation

The second principle constitutes the indices based on which group the self belongs to and whether the self is obstructed within the group. The issue of belonging to a group and alienation lie in the identities of both the self and the relevant group, and the inclusiveness and exclusiveness of the group to which one belongs or wishes to belong.

4. Identity

Identity has four indices. The bases of judgment are: ⑪ The group of belonging to which a self sees themselves to belong (self-perception); when a self belongs to multiple groups due to the multiple criteria, for example, of ethnicity, religion, or nationality, whether they perceive any of the group to be ⑫ the most important group of belonging (self-perception); moreover, ⑬ which group do others see the self to belong to; and ⑭ which is the most important group of belonging among the multiple groups to which the self belongs or can belong?

For example, 15) What kind of group do you recognize yourself as belonging to? can possibly have various criteria and can be multilayered. In other words, we can have various ideas including local community / area / municipality, ethnic, tribal and religious groups, job type / class/ hierarchical groups, age / generational groups, gender groups, ideological groups, and income groups. Usually one belongs to not only a single one of them but also to multiple groups. Therefore, not only this but also the index "⑫ self-perception towards the most important group of belonging" is the key as an index. Since it is closely tied to your life and behavior, it may change from the past, present and the future. Therefore, first of all, 16) after answering about the most important group out of the multiple groups of belonging, the questions of 17) whether the most important group today is the same as it was 10 years ago and 18) whether the important group of belonging is the same as that of their parents.

A criterion of identity is not limited to self-perception. It is also extremely important that others perceive an individual or a group to belong to which group. Again, one may have single or multiple groups of belonging. In the meantime, from the viewpoint of others, the first stage is 19) which group one belongs to, and based on this, whether the person belongs to multiple groups and 20) which group others see the person to consider the most important group may affect how responses will be given. For example, among people with the same nationality, when each

other person judges another to belong to a group based on reasons such as the person having a different religion or coming from a different ethnic group may give rise to a sense of friendship or hostility.

5. Group inclusiveness and exclusiveness

Each group, cohort and community have its idiosyncratic inclusiveness and exclusiveness. Here, four indices come to our mind: ⑮ satisfaction with the making of policies and decisions in the group of belonging, ⑯ degree of participation in decision-making within the group of belonging (perception of alienation), ⑰ degree of respect in decision-making within the group of belonging, ⑱ level of contribution to decision-making and its implementation in the group of belonging (as self-perceived), and ⑲ level of contribution to decision-making and its implementation in the group of belonging (as perceived by others). We can think of this as the degrees to which a self participates in the group's decision-making and activities. The higher the degree to which participation is permitted, the higher the degree of inclusion is. Conversely, it means that the lower the degree of participation, the more excluded that person is. Naturally, the stronger the perception that they are participating, the more suppressed the hostility and tension. The more a person feels that they are excluded, the lower the sense of belonging, which will make them have a passive attitude in maintaining the said group's shared values. From there, seeds of tension and conflicts sprout. Therefore, questions for measuring the respective indices would be, for example, 21) Are you satisfied with the policy and decision-making of the (most important) group of belonging, 22) Are you participating in decision -making in your (most important) group of belonging, 23) is your voice heard in your (most important) group of belonging, 24) Are your opinions and actions helpful in the decision making and implementation in your (most important) group of belonging, and 25) Are your opinions and actions highly evaluated in the decision-making and implementation in your (most important) group of belonging by others.

What we have to keep in mind is that measurements with these indices can change when they are considered on the time axis. That is, even if the sense of participation and perception of contribution is involved in the given group's important decision-making, the self may be excluded from the important decision-making process due to a change in the leader or the administration, change in the systems of economy and society, and change in the international community's situation. On the contrary, those who were excluded until then may begin to play a central role. Nevertheless, such temporal change does not always produce tension. If a process of democratic changeover or changes are secured, it does not lead to exclusivity.

III. Inter-group relation

When thinking about peace, the most important thing is the inter-group relations. In particular, relationships between large groups, that is, the groups at the national level can grow into a friendly relation or lead to war. What determine this relationship are 6. Perception of differences between groups and 7. relationships between differing groups.

6. Perception of differences between groups

What constitutes an index in the establishment of a relationship of peaceful co-living is the ⑳ Perception of differences between groups of belonging and ㉑ Perception of inequality between groups. The stronger this perception, the harder peaceful co-living. The weaker, the larger the degree of co-living as the sense of identity increases. Therefore, with respect to the index ⑳ "Perception of differences between groups," for example, with the question 26) In which respects does you perceive the differences between the self's group of belonging and other's group of belonging, question such as the following can be conceived: "When interests conflict, would you perceive the differences?"; "When you have different ideas and ways of thinking, would you perceive the differences?; "When you have biological characteristics, would you perceive the differences?"; "When you have different nationalities, would you perceive the differences?" you recognize the difference when you have different biological characteristics?" These differences do not invite tension or a war immediately just because the differences exist or are large. If diversity is positively

and actively seen, the differences will not lead directly to conflict, but on the contrary, diversity will also create new creativity. However, the lower the tolerance for diversity, the more in the negative direction perception of these differences will work, and the tension will occur and expand.

What can be a cause of this tension and can give rise to a synergistic effect on its expansion is the index "perception of inequality between groups." The question to this is, 27) in what ways do you strongly feel a sense of inequality or discrimination between the groups of belonging of yourself and others? Specifically, they are; "Do you feel a sense of inequality or discrimination when economic disparity is noticeable?"; "Do you feel a sense of inequality or discrimination when there is a difference in political forces?"; "Do you feel a sense of inequality or discrimination when there is a strong societal discrimination?;" and "Do you feel a sense of inequality or discrimination when there is a difference in medical and educational opportunities?"

7. Relationships between differing groups

As for domestic tensions and ideas, the differences are recognized as seen in the index ⑳, and as stated in ㉑, it will be possible that they will occur and expand by a rise of discrimination and inequaltiy. However, if there is no contact or negotiation between the two groups, it will not necessarily lead to new tensions or escalation of the issue. Interrelationships and mutual activities between groups lead to conflict and war. Because of this, the indices here are: ㉒ Intergroup confrontation / conflict in past, present and future; and ㉓ View on differing groups.

The former index takes into account the time axis as already suggested above. For this reason, the following questions should be asked; 28) Have you ever experienced a war or a violence incident in the past; 29) Are there any important conflicts currently; and 30) Are there rumors of a potential war or violent incident in the future? Of course, just because there was or is a war in the past or present, it does not necessarily mean that there is not or will not be any war or the like in the future. However, this index measures the possibility of conflict. Therefore, the more likely the answer to these questions is no, the greater the possibility of peaceful co-living towards the present and the future. Conversely, the more likely the answer is yes, the lower the stability.

Whether indices ㉓ "View on differing groups" is one of among 31) division of roles (mutual complementarity), 32) a relationship of strong and weak, 33) judgment of good and bad, and 34) whether you like it or not, rising of tension can be different and this at the same time is a measure of friendship.

IV. Norms for peaceful co-living

To build and maintain peaceful co-living, it is conceivable that it is necessary to formulate an objective norm of peaceful co-living and comply with it. This does not necessarily need to be a strictly legal norm (international law or domestic law) but may be a moral code of ethics. Nonetheless in the international community, the legal norms have no compulsory function in the true sense. So, what is important in the norm is that it is recognized as an objective social norm and that it is observed. It means that there must be consciousness on social norm and compliance. Among them, when thinking of peaceful co-living, the core norms that are indices are: ㉔ non-violence, ㉕ tolerance and ㉖ responsibility. We can say that sharing of these norms is the foundation of peaceful co-living.

Regarding the index "㉔ non-violence," it is important to ask 35) the question of whether violence should not be exercised even if there is a conflict. That is, the existence of a situation where conflict can be resolved by peaceful means is important. Chapter VI of the Charter of the United Nations
"Peaceful settlement of disputes" shows this exactly. For this, unless the war / military exercise as a last resort is ultimately denied, the index "㉕ tolerance" is also about the norm of 36) whether to not exclude people entering from outside but accept them. It means the more tolerant a state, group, or community, the closer it is to peaceful co-living.

The last index "㉖ responsibility" is the idea that compliance is accompanied by a certain degree of responsibility. Specifically, a sense of cost for peace is indispensable. 37) For that reason, to comply with the

norm of peaceful co-living, the question will be asked whether cost can be borne and how much can be borne. This viewpoint of cost for peaceful co-living is extremely important, where there are questions as to; "Can you bear the cost to comply with the norms of peaceful co-living at the national level?; Can you bear the cost to comply with the norms of peaceful co-living at the group and local community level?; and Can you bear the cost to comply with the norms of peaceful co-living at the individual level?

Peace cannot be obtained without such efforts. We must recognize this again. In particular, in the world of diversity, to start with a psychological burden on "difference," it is not easy to "co-live" by overcoming actually different values, intention / judgment, behavior patterns, lifestyle, etc. However, if we cannot co-live in diversity, it will lead to the destruction of humankind. With this in mind, we must recognize, apply and implement indices of peaceful co-living.

It is important remember that peaceful co-living in the world of diversity is not something that imposes a burden of effort, cost, etc., that is, diversity encompasses various creative possibilities which were did not exist so far. Our efforts will continue, as we imagine large flowers of diversity blooming proudly in the future earth society. This proposal is indices and a goal to advance to such a future society.

Table C-1 Indices of Peaceful Co-living in a World of Diversity

- Necessary elements for peaceful co-living (philosophy / principle / index / interpretation of index) -

Philosophy / Principle	Index	Interpretation of index (example)
Ⅰ. Human dignity		
1. Freedom from want	① Fulfilment of basic needs (securing clothes, food and houses)	1) Is there a minimum amount of food and clothes?
	② Fulfilment of basic needs (securing that health is maintained)	2) Is the minimum living environment secured?
		3) Is necessary medical care available?
	③ Fulfilment of basic needs (securing the right to education)	4) Is basic education available?
	④ Fulfilment of basic needs (securing employment opportunities)	4) Are there jobs that earn minimum living expenses?
2. Freedom from fear	⑤ Securing daily safety and peace of mind (security on the inside)	6) Is public order in the community in a good condition?
	⑥ Securing daily safety and peace of mind (security from the outside)	7) Are there any fear of violence from other groups?
3. Recognition as human being	⑦ Having existence recognized by others (raison d'être)	8) Are you ever ignored by others?
		9) Do you feel glad to be alive?
		10) Do you feel that there is hope to keep on living?
	⑧ Discrimination from others / presence or lack of injustice (no discrimination)	11) Do you face discrimination or unequal treatment from others?
	⑨ Freedom to live with dignity (respect for personality)	12) Do you feel that your personality is respected?
	⑩ Freedom to live with dignity (right to self-determination)	13) Can you decide for yourself? 14) Are the conditions available so that you can decide for yourself? (Availability of options / information, securing freedom of speech / thought / creed)
Ⅱ. Belonging to a group and alienation		
4. Identity	⑪ Group of belonging (as self-perceived)	15) What kind of group do you recognize yourself as belonging to (there may be more than one answer*)? Community of origin / local community / local municipality Group by ethnicity, tribe, religion Group by job role, class, hierarchy Group by age / generation Group by gender Group by ideology Group by income
	⑫ The most important group of belonging (as self-perceived)	16) Which group is the most important among the multiple groups to which you belong?
		17) Is the current most important group the same as it was 10 years ago?
		18) Is the most important group of belonging the same as it is to your parents?
	⑬ Group of belonging (as perceived by others)	19) To which group do other people see you as belonging?
	⑭ The most important group of belonging (as perceived by others)	20) Which group do other people see you to be considering most important?
5. Group inclusiveness and exclusiveness	⑮ Satisfaction with the making of policies and decisions in the group of belonging	21) Are you satisfied with the making of policies and decisions in your (most important) group of belonging
	⑯ Degree of participation in decision-making within the group of belonging (perception of alienation)	22) Do you participate in the decisions-making in your (most important) group of belonging?

	⑰ Degree of respect in decision-making within the group of belonging	23) Are your opinions heard in your (most important) group of belonging?
	⑱ Level of contribution to decision-making and its implementation in the group of belonging (as self-perceived)	24) Are your opinions and actions helpful in the decision making and implementation in your (most important) group of belonging?
	⑲ Level of contribution to decision-making and its implementation in the group of belonging (as perceived by others)	25) Are your opinions and actions highly evaluated in the decision-making and implementation in your (most important) group of belonging?
Ⅲ. Inter-group relation		
6. Perception of differences between groups	⑳ Perception of differences between group of belonging (as perceived by others)	26) In what ways do you perceive the difference between the groups of belonging of yourself and others? Do you see a difference when they have differing interests? Do you see a difference when they have differing philosophies and ideas? Do you see a difference when they have differing biological characteristics? Do you see a difference when they have differing nationalities?
	㉑ Perception of inequality between groups	27) In what ways do you strongly feel a sense of inequality or discrimination between the groups of belonging of yourself and others? Do you feel a sense of inequality or discrimination when economic disparity is noticeable? Do you feel a sense of inequality or discrimination when economic disparity is noticeable? Do you feel a sense of inequality or discrimination when there is a difference in political forces? Do you feel a sense of inequality or discrimination when there is a strong societal discrimination? Do you feel a sense of inequality or discrimination when there is a difference in medical and educational opportunities?
7. Relationships between differing groups	㉒ Intergroup confrontation / conflict in past, present and future	28) Have you ever experienced a war or a violence incident in the past?
		29) Are there any important conflicts currently?
		30) Are there rumors of a potential war or violent incident in the future?
	㉓ View on differing groups	31) Do you think that the differences from differing groups create division of roles (mutual complementarity)
		32) Do you first think about which is stronger (strong / weak) for a differing group?
		33) Do you first think about which is better (good / bad) for a differing group?
		34) Do you first think about which is more likeable (like / dislike) for a differing group?
Ⅳ. Norms for peaceful co-living		
8. Norms for peaceful co-living	㉔ Non-violence	35) Is it unacceptable to exercise violence even if there is conflict?
	㉕ Tolerance	36) Should you accept incoming people and exclude them?
	㉖ Responsibility	37) Can you bear the cost to comply with the norms of peaceful co-living? Can you bear the cost to comply with the norms of peaceful co-living at the national level? Can you bear the cost to comply with the norms of peaceful co-living at the group and local community level? Can you bear the cost to comply with the norms of peaceful co-living at the individual level?

Concluding Chapter A Tentative Index for Measuring the Degrees of Realization of Peaceful Co-living

Study Group Members

As of March, 2018

A: Transforming Science and Technology in the 21st Century - value, system and practice-

Principal Investigator	
Tateo Arimoto	Vice Director, International Institute for Advanced Studies Professor, National Graduate Institute for Policy Studies
Mitsunobu Kano	Deputy Director, Vice Dean and Professor,Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University
Shoji Komai	Associate Professor, Graduate School of Biological Sciences, Nara Institute of Science and Technology
Hidetoshi Kotera	Professor, Graduate School of Engineering, Kyoto University
Naoki Miyano	Associate Professor, Center for the Promotion of Interdisciplinary Education and Research, Kyoto University
Satoru Ohtake	Principal Fellow, Japan Science and Technology Agency, Visiting Professor, Policy Alternatives Research Institute, the University of Tokyo
Sayaka Oki	Professor, Graduate School of Economics, Nagoya University

B: Sustainability of Human Survival - Rebuilding of Value Axis towards 2100-

Principal Investigator	
Takamitsu Sawa	Research Advisor, International Institute for Advanced Studies Distinguished Professor, Shiga University
Seiji Ikkatai	Dean and Professor, Graduate School of Environmental Sciences, Musashino University
Hirokazu Kato	Professor, Graduate School of Environmental Studies, Nagoya University
Satoshi Konishi	Professor, Institute of Advanced Energy, Kyoto University
Hidefumi Kurasaka	Professor, Graduate School of and Social Sciences, Chiba University
Fumio Sasaki	Minimalist, Writer, and Editor
Yukari Takamura	Professor, Graduate School of Environmental Studies, Nagoya University

C: Towards Peaceful Co-living in a World of Diversity

Principal Investigator	
Ryuichi Ida	Vice Director, International Institute for Advanced Studies President, Shiga University
Shin-ichi Ago	Professor, College of Law, Ritsumeikan University
Monte Cassim	Director, Kyoto Museum for World Peace, Ritsumeikan University
Akiko Fukushima	Professor, School of Global Studies and Collaboration, Aoyama Gakuin University
Daisaku Higashi	Associate Professor, Center for Global Education, Sophia University
Toshiya Hoshino	Professor, Osaka School of International Public Policy, Osaka University
Akira Kohsaka	Professor Emeritus, Osaka University (Graduate School of International Public Policy)
Naoko Maeda	Associate Professor, Faculty of Law, Kyoto Women's University
Yoichi Mine	Professor, Graduate School of Global Studies, Doshisha University
Toshiki Mogami	Professor, School of Political Science and Economics, Waseda University
Masanori Naito	Professor, Graduate School of Global Studies, Doshisha University
Hiroshi Nakanishi	Professor, Graduate Program for Public Policy Studies, School of Government, Kyoto University
Hisae Nakanishi	Professor, Graduate School of Global Studies, Doshisha University
Ryo Oshiba	Professor, School of International Politics, Economics and Communication, Aoyama Gakuin University
Modjtaba Sadria	Director, Think Tank for Knowledge Excellence

International Institute for Advance Studies (IIAS)

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Humanity is currently facing a number of challenges to its continued existence caused by a range of factors. Can we or future generations continue to live on this planet in the same way and with the same values we've held up to now? How can we resolve such problems that have historical and social origins? And in the 21st century, what form should our culture, science, and technology take? There are no set methods for developing ideas when it comes to such challenges.

The founding philosophy of the International Institute for Advanced Studies (IIAS) is to "conduct research for the future and happiness of mankind," and we address these issues through fundamental research based on cooperation among government, industry and academia. By consolidating wisdom from around the world and taking research forward, we aim to produce new directionality in academic research or orient ourselves towards creating new concepts, and contribute to the development of academic research culture.

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Our society has reached a turning point where we veer off the path of "single-minded pursuit for development and efficiency" and follow the one of "peaceful and sustainable coexistence of all mankind." Along this new road lie fundamental questions that need to be answered in order to secure the future and well-being of mankind. IIAS takes it on as its mission to explore those questions, uncover new problems and present our "findings" to the world. We are committed to leading in-depth discussions and shedding light on the discovered paths towards solution.

History

IIAS was established in August 1984 as an incorporated foundation strongly supported by entities from industry, academia and government that agree with its founding philosophy outlined above, and has since been running on donations from major companies and philanthropists across Japan. In October 1993, IIAS opened a research facility in the Keihanna Science City (officially known as Kansai Science City) on a land granted by the Kyoto Prefectural Government. The Institute serves as the central research organization or the "brain" of the Keihanna Science City.

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	Senior Fellow, Japan Science and Technology Agency
Ryuichi IDA	President, Shiga University,
	Professor emeritus, Kyoto University
Hiroshi MATSUMOTO	President, RIKEN
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Research Advisor

Takamitsu SAWA	Distinguished Professor, Shiga University
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Toshio KUROKI	Senior advisor, Research Center for Science Systems, Japan Society for the Promotion of Science
Kenichiro OHARA	Honorary Director, Ohara Museum of Art
Ryosuke OHASHI	Director, Japan Germany Cultural Research Center

Shaping the Future beyond Modernity

Original Japanese Edition, June, 2016
English Edition, March, 2018. (Translated by machine translation)
International Institute for Advanced Studies
9-3,Kizugawadai,Kizugawa city,Kyoto 619-0225 JAPAN
TEL:+81-774-73-4000 FAX:+81-774-73-4005 E-mail：ra@iias.or.jp
http://www.iias.or.jp/en

International Institute for Advanced Studies

9-3,Kizugawadai,Kizugawa city,Kyoto 619-0225 JAPAN TEL: +81-774-73-4000 FAX: +81-774-73-4005
http://www.iias.or.jp/en/

2018. 03-R008E