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Abstract

"Future Design," a new movement among Japanese researchers and stakeholders, asks the following question: what types of social systems are necessary if we are to leave future generations sustainable environments and societies? After reviewing the human activity impact on the global environment and society, I ask why we live in a society producing a series of future failures that will cost future generations so much. I then argue that liberalism could be the source of such a society and that market and democracy derived from it will not be able to avoid these future failures. Therefore, one must design social systems to activate a human nature called *futurability* when he/she experiences an increase in happiness as a result of deciding and acting toward foregoing current benefits to enrich future generations. One method to study those is using "imaginary future generations." Here, I present an overview of the theoretical background of this method, the results of relevant laboratory and field experiments, and the nature of some relevant practical applications implemented in cooperation with several local governments.

Keywords: Future design, imaginary future generation, futurability, intergenerational sustainability dilemma, time inconsistency problem

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1. What is it that we have done?

Detected on December 31, 2019, the Covid-19 outbreak began in Wuhan, China, quickly spreading around the world. The World Health Organization declared it a global pandemic on March 11, 2020 [1]. The peak dates of the first-wave outbreaks were: February 12 (China); March 3 (South Korea), 21 (Italy), 26 (Spain), 27 (Germany), 30 (Iran), and 31 (France); and April 10 (England), 11 (Japan), and 24 (USA) [2]. Covid-19 was rapidly spread by air transport, which, since 1950, expanded annually by approximately 5% and 6% for passenger and cargo air traffic, respectively [3, 4]. That is, the number of air passengers would double every 14 years, and the cargo capacity, every 12 years. The air passenger growth rate approached 6 percent per year for the 2010-19 decade, the 2019 passenger numbers being over 32 times larger than the 1950 ones. Since the global GDP growth rate has been less than 4% since 2000 [5], airline passenger numbers are growing at a greater rate than GDP. Moreover, such globalization has been supported by fossil fuels. Carbon dioxide emissions from international air transport of passengers and cargo have doubled between 1990 and 2016 [6]. Although growing at a slower rate than air passenger numbers and cargo volume due to improvements in aircraft fuel efficiency and other factors, these emissions increased at approximately a 3% annual rate from 1990 to 2016, with 5.2% during 2015-6 [6].

Steffen et al. [7] demonstrated that indicators of the human activity impact on the global environment (i.e., concentration of carbon dioxide, nitroxide and methane in the atmosphere, the volume of nitrogen influx into the oceans, and reduction of tropical forests) show changes at an accelerating pace since the Industrial Revolution, especially during the second half of the 20th century. Further, an accelerating change in indicators such as population, real GDP, use of fossil fuels and fertilizers, and the number of automobiles has also been reported. The acceleration of air traffic described above is one such trend. These trends are known as the *Great Acceleration*.

Planetary boundary research by Rockström et al. [8] identifies nine domains essential to the maintenance of the comparatively stable Holocene environment that has been in place for more than 10,000 years and proposes acceptable levels for those planetary boundaries. However, the authors demonstrate that such acceptable levels have already been breached for climate change, biodiversity, land system change (the proportion of forest lost), and the cycles of biochemical substances such as nitrogen and phosphorus. For example, the concentration of atmospheric carbon dioxide and the radiative forcing should not be higher than 350 ppmv and 1 Wm^{-2} , respectively, compared to their levels before the Industrial Revolution. Both these indicators are already above these levels, increasing the risk of irreversible climate changes such as the depletion of the polar ice caps, acceleration of

ocean level rise, and sudden changes in the forestry and agricultural system [8, 9]. Regarding this, Steffen et al. [9] mentioned the necessity of taking into account the time needed by society to react to early warning signs. Furthermore, Steffen et al. [10] found that there is a risk that the Earth system could be irreversibly pushed down a "Hothouse Earth" pathway despite the Paris Accord target being met.

Crutzen and Stoermer [11] and Crutzen [12] propose that the Holocene age has ended already, and human beings pushed the Earth System into a new geological age, the *Anthropocene*. However, to the extent that human activity has indeed changed the Earth, this planetary boundary research can be seen as an evaluation of natural sciences since the Industrial Revolution.

Next, let us look at the relationship between the Human Development Index (HDI) and the per-capita Ecological Footprint (EF) of a country [13]. HDI measures well-being achievements such as average life expectancy, level of education, and per-capita income. EF, a "sustainability" indicator, reveals whether that country is living within its share of global means. HDI and EF values are low for developing countries and high for developed countries. Almost all countries progress from low to high HDI and EF, although they should instead aim for high HDI and low EF. The relationship between these two indexes represents a link between scientific and social evaluations. When viewed in conjunction with the evaluation related to planetary boundaries, it can be inferred that we are threatening our own continued existence.

Moreover, developed countries have high levels of outstanding debt. According to the IMF's World Economic Outlook Database [14], the outstanding debt of Japan is 2.37 times its GDP, and that of Italy, USA and France, 1.35, 1.09, and 0.99 times their GDPs, respectively. Increasing the existing debt, governments are spending massive amounts of money to cope with the current pandemic. The current generation is maintaining wealth by using up the resources of future generations. Regarding Japan's public debt, for example, a consumption tax raise from 10 to 40% for the next 100 years would still account for only approximately 60% of the outstanding debt balance [15, 16]. Would any generation implement such a drastic measure?

2. Why are we in this situation, and what will happen next?

Why do we live in a society producing a series of *future failures* that will cost future generations so much? One major factor could be the social contract supported by Hobbes [17], Locke [18], Rousseau [19], and others, as the source of liberalism [20]. By breaking the yoke of social classes and norms, ending the "struggle of all against all," and creating a social contract, people gain freedom, independence, and equity. Another factor might be

the idea of mankind's conquest of nature conceived by Bacon [21].

Sapolsky [22] identified three human traits underpinning the social system based upon liberalism. The first is "contrast." For example, our five senses react to a change in volume, rather than the absolute volume. A sudden noise or shadow constitutes a change that may represent a risk, and we naturally react (by default) to it, to increase our chance of survival. For example, we react more to a change in volume - that is, to its differential value - than to absolute volume. In other words, human beings react when external factors change. If, owing to the change in the parameters (external factors) within the objective function, the variable maximizing the objective function ought to also shift, we can conclude that "contrast" expresses the optimality principle of humans. Of course, "contrast" does not stop with a person's five senses. The human brain is said to react strongly to the body's position relative to other people. For example, in a group of people chased by a lion, a person would not need to be fast in absolute terms, but merely faster than the slowest.

The second human trait is "impulse." It is not easy to resist eating something tasty laying in front of you. "The dopamine reward pathways in the human brain light up on brain-imaging tests when we go for the impulsive immediate reward" [22]. In short, to increase the likelihood of survival, the best thing to do when food was available was to eat it. Interpreted more broadly, the impulse can be considered "myopia."

The third trait is "sociality." Human beings do not possess the physical abilities of other creatures. Humans run slower than dogs, let alone horses, our sense of smell is rather dull, and our eyesight not very keen. For human beings to adapt better than other mammals, and indeed, to thrive, it required a deep understanding of our relationship with other people. For example, humans could hunt big animals only in groups, not alone. By cooperating with multiple agents, humans reached the top of the food chain, eventually. However, in sociality, education and experience are necessary; it is not possible to obtain these immediately.

I would like to add a fourth human trait, namely "optimism" when we consider our future. The difference between the expected result and the actual outcome has an optimism bias. According to Sharot [23], approximately 80% of people display this bias. In other words, people think that good rather than bad things will happen to them in the future.

There is hardly any research that delves into these human traits and examines their relationship with social systems. However, it is natural to consider that human traits are the basis for the construction of markets and democracy, which form the basic framework of our society. First, let us consider the markets. Although the market is an "extremely good device for realizing the short-term desires of people," it does not "allocate resources in a way that takes account of future generations." Future generations cannot participate in

today's markets. Moreover, democracy is a "device that profits people who are currently living," and it does not "incorporate future generations." If a candidate in an election proposes a policy that leads to enriching people a hundred years later, the current generation would not vote for him/her [24, 25].

Dunbar's Number, the maximum number of people with whom a human being is cognitively able to maintain stable social relationships, is approximately 150 [26]. It would not be wrong to suggest that markets and democracy are devices that preserve some sort of sociality when that number is exceeded. Within these devices, a person who displays the optimality principle, i.e., contrast, can demonstrate both myopia and optimism.

There is no definitive judgment yet on the Industrial Revolution; however, some researchers opine that it allowed the transition from reliance on organic energy to that on fossil fuel energy. According to Allen [27] and Pomeranz [28], the mid-14th century Black Death reduced England's population, giving rise to high wages in the country. In the early modern era, Europe, and in particular the UK, experienced a rise in the price of wood due to urbanization; energy source substitution occurred in favor of coal, which abounded locally and happened to be cheap. To fulfill the coal demand required by pumping out the subterranean water accumulating in coal mines, steam engines would work the water pumps instead of the expensive manual labor. It was exactly this kind of energy shift that led to the "industrial revolution" and the various innovations that we have experienced.

Innovations continued throughout the Industrial Revolution, and large volumes of cheap and seemingly limitless fossil fuels were used. These factors are likely to have strengthened the human traits of contrast, myopia, and optimism while weakening the sociality. The change in human traits transformed, in turn, the market, democracy, and innovation. This is likely to have created a society blindly focused on growth, despite its leading to the various "future failures" mentioned above. On the other hand, rather than with social institutions as in the Covid-19 crisis, the way we think and behave changes significantly with radical changes in the environment, which includes social institutions. In other words, our way of thinking and behaving itself is shaped by our environment, including our society, and then we change the social institutions.

If this is the case, then the transformation of social institutions themselves should be a major challenge for the first half of the 21st century. However, the various fields of social science—which are supposed to be the engines of institutional reform—have become fixated on individual paradigms, and an answer to the question of how to transform institutions for a sustainable future has not yet been found. Nevertheless, the current mainstream approach is to coordinate and synthesize knowledge from humanities, information science, neuroscience, and other fields, in addition to that from the social

sciences, to understand human behavior, devise social systems based on this knowledge, and solve various problems.

Future Design (FD) takes the *opposite* position. Traditional social science has assumed that people's behaviors, thinking, and nature do not easily change. However, they are transformed by social institutions and their feedback. In other words, the market and democracy themselves shape the way we think and behave. To this end, we design various social mechanisms that transform our thinking itself, and test their performance using knowledge from various fields. This is the basic framework of FD.

3. Is transformation in favor of a sustainable society possible?

Future Earth (<http://www.futureearth.org/>) was established in 2012 as an international research platform that provides knowledge and action intended to accelerate radical innovation conducive to a sustainable society; it became active by 2015 [29, 30]. One of its basic concepts is transdisciplinary research. Stakeholders and scientists co-design research projects, co-produce knowledge, and co-deliver results. However, both stakeholders and scientists are part of the current generation, and, despite a win-win outcome in following their own incentives, future generations may still stand to lose. To improve their odds, the future generation should be included as stakeholders, and the change target should be the thinking way and the behavior of the current generation.

"FD" emerged in 2012 with the aim of creating human "futurability," independently of Future Earth [25]. A person exhibits *futurability* when he/she experiences an increase in happiness as a result of deciding and acting toward foregoing current benefits to enrich future generations. FD is the praxis of creating futurability through designing social systems. It is fundamentally a question of whether the willingness of a parent to eat less and feed more their children can extend to a future generation not related by blood. In epigenetic terms, it is the designing of mechanisms that allow the expression of futurability that could not be conveyed due to markets and democracy, and thus, control markets and democracy. This is set-up against the background of stubborn concern regarding the concept of sustainable development (fulfilling the needs of the current generation without disregarding the needs of the future generation) in *Our Common Future*, written by the Brundtland Commission in 1987 [31]. For example, in resolving the aforementioned outstanding debt, it is impossible to reduce the burden of the future generation without sacrifices made by the current generation.

There are two basic concepts in the FD research framework: "how humans think" and "social mechanisms." In social sciences, in the past, both "how humans think" and "social mechanisms" were immutable conditions, and the research approach was to investigate

what would happen with various issues. Taking consequential impartiality and efficiency as social aims while assuming that the human thought processes or tastes do not change, the mechanism design of the late 20th century has taken into account the design of social mechanisms needed to achieve those aims. However, this approach ignores the viewpoint of changing the way that people think. The nudge method is a behavioral economics approach in which there is no transformation of the social mechanisms, and the alteration of behavior, rather than the change in ways of thinking, is encouraged. However, this method is likely to be successful in, for example, reducing greenhouse gases by a few percent, but unlikely to lower them further. Although Future Earth and Sustainable Development Goals are calling for transformation in social systems, it seems that markets and democracy are not part of the picture. FD research aims to realize sustainable societies by designing "social mechanisms" that change the very "way that humans think."

The idea for the FD research comes from the Iroquois, a confederation of five-six tribes of Native Americans. They considered seven generations in the future when making important decisions [32]. As one might imagine, they shifted their perspective to the distant future and considered the present from there to maintain the peace of the confederacy. The American founding fathers George Washington and Benjamin Franklin united 13 colonies using federalism learned from the Iroquois. During the Bicentennial of the U.S. Constitution, the Senate and the House of Representatives even issued a joint resolution thanking the Iroquois for their contribution [33]. However, while federalism is ingrained in the U.S. Constitution, the concept of the "seven generations" appears to have been forgotten.

Of course, even if we assume that humans possess "futurability," it is not easy to activate this trait. Is it possible that new social mechanisms will be constructed, sociality weakened in the name of the market and democracy strengthened, and that contrast, myopia, and optimism will be weakened? I summarize here the FD research of the past few years.

4. FD experiments

Let us summarize the experimental research of Kamijo et al. [34], which constituted the starting point of the FD research. Three-person groups representing different generations were asked to choose between Options A and B. Both options involved an amount of money that each group would decide how to distribute among themselves. The discussion time was limited to 10 minutes. The first generation (G1) chose between A (\$36) and B (\$27). If they chose Option A, Options A and B for the next generation would be reduced by \$9. If they chose Option B, Options A and B for the next generation would remain

unchanged. Table 1a shows the payoffs up to the third generation. For example, if G1 chooses Option A, G1 gets \$36, and G2 has to choose between an Option A of \$27 and an Option B of \$18. If G2 chooses Option B, they get \$18, and G3 faces the choice of the same Options A and B (\$27 and \$18, respectively). Unlike in the static prisoner's dilemma game, if the current generation chooses selfishly, it puts a burden on the subsequent generations. Kamijo et al. [34] dubbed the game the "Intergenerational Sustainability Dilemma Game" (ISDG).

Table 1. Kamijo et al. [34] – Payoff and results

a. Payoff				b. Results without imaginary future persons				
G1	G2	G3	...	G1	G2	G3	G4	G5
		A 18		A	A	A	A	A
	A 27			A	A	A	A	B
		B 9		A	A	A	A	B
A 36				A	A	B	B	A
	B 18			B	B	A	A	B
		A 27						
	B 18							
		A 27						
	A 36							
		B 18						
B 27								
	B 27							
		A 36						
	B 27	B 27						

c. Results with imaginary future persons

G1	G2	G3	G4	G5
B	B	B	B	B
B	B	B	B	A
B	B	A	A	B
B	A	B	B	A
B	A	A	B	A
A	B	B	A	A
A	B	A	B	A

In the experiment, a table of the gains of up to the sixth generation was distributed. Each generation understood that the following generations exist. The participants were paid according to the decisions that had been made. 210 undergraduate and graduate students of the Kochi University of Technology participated, and almost all groups chose to distribute the money equitably.

If a human activates his or her contrast trait (the principle of optimality), Option A would be chosen automatically. One person per group was asked to negotiate with the other two not for their own sake, but as a representative of the groups from future generations. The compensation received by this participant agreed with the decision made by all three. These participants were designated, imaginary future persons.

Table 1b shows the results of the ISDG when there was no imaginary future person. In

the first row, all generations chose Option A. Note that the actual experiment continued until the sixth or seventh generation because the final generation would be aware that there was no further generation and consistently choose Option A. Seven groups out of 25 chose Option B (28% selection ratio). Table 1c shows the results when there was an imaginary future person. In this case, 21 groups out of 35 chose Option B (60%). Nakagawa et al. [35], using a new qualitative-deliberative approach, discovered that a human icebreaker having a neutral attitude toward Options A and B contributed to the selection of sustainable Option B.

After the experiment, a questionnaire on Social Value Orientation was administered. Participants were classified as "pro-socialist," "individualist," "competitor," and "other." A participant had three sets of payoff levels for himself/herself and a virtual person to choose from. Those who chose the option that gave them the same payoff were pro-socialists, those who maximized their payoff were individualists, and those who maximized the difference between their and the other person's payoff were competitors [36]. Note that social psychology defines the terms "individualist" and "competitor" differently from economics. Among the participants, 78% were "pro-socialist." When there was no imaginary future person, Option B was selected only when all group members were "pro-socialist." In this case, "pro-socialists" comprised 76% of the participants who chose Option A. However, when in the presence of an imaginary future person, pro-socialists comprised 79% of the members in the groups that chose Option A and 73% of the participants in the groups that chose Option B. Thus, the difference between the proportions of pro-socialists in the two situations was small. In other words, whether or not individual participants were pro-socialist had no impact on selecting Option B. However, following the discussions in which one of the three group members took on the role of the imaginary future person, that person's behavior changed and impacted those around them.

Saito [37] used the data from this experiment to conduct the following thought experiment. Macro-economically speaking, based on a discount rate r , the G1 gain W_A is taken to be the present value of the most selfish payoff stream (i.e., G1 selected Option A and all other generations selected Option B) and the G1 gain W_B , the present value when all generations choose the sustainable Option B. Hence, the following are taken to be true:

$$W_A = 36 + \sum_{t=1}^{\infty} \frac{18}{(1+r)^t}, \quad W_B = \sum_{t=0}^{\infty} \frac{27}{(1+r)^t}$$

If $r = 1$, then $W_A = W_B = 54$. If $r > 1$, then $W_A < W_B$. If the first generation lasts 30 years, $(1 + 0.023)^{30} \approx 2$. Thus, if the discount rate is converted to an annual rate, Option A

will be chosen if the discount rate is 2.3% or above, and Option B if it is lower than that. The result of the experiment by Kamijo et al. [34] is interpreted as "a change toward a lower generational discount rate" due to the introduction of the "social mechanism" of an imaginary future generation. Although the interpretation is clear, I would note the lingering doubt surrounding the suitability of a macroeconomic framework that considers the current generation payoff as the present value of an unlimited payoff stream for all generations.

Table 2. Results of the ISDG experiment in Bangladesh

Selection of Option B	Dhaka	Bogra
With imaginary future person	29%	86%
Without imaginary future person	31%	74%
Proportion of pro-socialists	20%	45%

From only one experiment, it is impossible to decide the effectiveness of introducing a new mechanism based on imaginary future generations. Results for various areas with different economic development and historical and cultural backgrounds are needed. Hence, Shahrier et al. [38] decided to carry out an ISDG experiment in Dhaka, Bangladesh, a megacity with a rapidly growing population, and Bogra, a contrasting rural area. In contrast to the Japanese experiment, where the participants were students, the Bangladeshi participants were recruited from within the community (252 participants, each, from Dhaka and Bogra). As shown in Table 2, regardless of whether or not the imaginary future person existed, the selection rate of Option B differed significantly between Dhaka and Bogra (approximately 30% vs. 80%, respectively). The scenario involving an imaginary future person contributed to a higher selection rate of Option B in Bogra, but not in Dhaka. The Social Value Orientation questionnaire revealed a sharp gap between the proportion of pro-socialists in Dhaka and Bogra (21% and 45%, respectively). In contrast to the Japanese study participants, the Bangladeshi participants received a monetary incentive corresponding to the option chosen in the Social Value Orientation questionnaire. Therefore, the proportion of pro-socialists is rather low in Bangladesh.

In light of the results of Shahrier et al. [38], the issue lies with the design of a mechanism that would allow for a sustainable selection in the ISDG in Dhaka as well. In the study of Kamijo et al. [34], one person represented the imaginary future generation, increasing the possibility of sustainable selections. For example, it would be possible for all decision-making participants to be part of the imaginary future generation. However, will members of the current generation accept decisions made by members of an imaginary

future generation? To answer this, Shahrier et al. [39] proposed the Future Ahead and Back mechanism (FAB) mechanism, as follows.

Stage 1: All three participants, as imaginary next future generation members, select either Option A or B, and then submit a request to the current generation (i.e., themselves).

Stage 2: All three participants, as the current generation, select either Option A or B and, if the selection is the same as in Stage 1, the process ends.

Stage 3 : For a different selection than in Stage 1, the outcome is decided on a majority rule basis.

Based on the FAB mechanism, the Option B selection rate was 85%, similar to the case when one person represented the imaginary future generation in Bogra. However, there were 28% of pro-socialists in this experiment, compared to the 20% in the Shahrier et al. [39] study. Sustainable decision-making was made possible by adding beforehand two stages to the majority decision mechanism, a technique often used in democracy.

However, what if, in ISDG, there is one decision-maker, instead of three? Shahan et al. [40] experimented within this scenario by giving previous generations' decision sequences such as ABAAB if this person belonged to the sixth generation. Each participant made 36 different decisions. Consider the case where the participant is not an imaginary future person; here, participants are likely to choose the unsustainable Option A when the proportion of previous generations that chose A is high, or when the number of future generations who can receive positive benefits is low. This is quite intuitive, in the sense that the people of the current generation tend to give up on sustainable decisions when previous generations chose unsustainable options, or only a few future generations will have the same resources due to being too late, or too grave of a current situation, for sustainability to be improved. On the other hand, when participants are asked to take the perspective of the future generations, their behavior drastically changes; they become more sustainable even when the percentage of unsustainable previous generations is high, or the future generations who can receive positive benefits are few. These results suggest that left to their own devices, individuals will act selfishly, with no consideration for future generations, when intergenerational sustainability is highly threatened. Thus, new institutions that could influence the individual in taking the perspective of future generations might be the only way to mitigate intergenerational unsustainability.

Then, what about democratic voting? Katsuki and Hizen [41] conducted a voting experiment with 156 participants, using the ISDG described by Kamiyo et al. [34]. Each generation had three participants, and each participant was assigned to one of six

generations, to cast hypothetical votes. If a participant belonged to the second generation, he/she had to decide based on two possible cases: the first generation choices of either A or B. If a participant belonged to the sixth generation, the number of cases increased to 64. The methods of voting were: (a) one vote per person, (b) two votes per person, and (c) one vote per two of the participants and two votes per the third. In scenario b, the participants were instructed to cast one vote for themselves and the other for the future generations. Randomly choosing three participants from each generation results in a choice sequence such as ABAABA, for example. 50 million simulations performed for each voting method resulted in Option B being selected at the rate of 9.25%, 17.11%, and 14.66% for scenarios a, b and c, respectively. Voting methods b and c are types of Demeny voting, which will be discussed later. Given that the selecting rate of Option B in the absence of an imaginary future person was 28% in the Kamijo et al. [34] experiment, voting may not constitute an effective method for sustainability.

Hauser et al. [42] conducted an experiment using the Intergenerational Goods Game, where five participants vote for the amount of fish they will catch. The total number of fish is limited, say 100. If the number of catches is at most 50, the next generation's resource is 100; otherwise, it is zero. The study found that median voting works well. For example, assume the numbers on the ballots are 4, 5, 9, 14, and 20 (median is 9). Hence, everybody must catch 9 fish. If this is the case, the total number of fish caught is 45; hence the next generation's fish resource is 100. Consider the case (a) for Katsuki and Hizen [41]. Once I establish that the median of AAB is A, and the median of BBA is B, this matches exactly the majority voting and, apparently, median voting may not work well either.

Deliberation could constitute a method of resolving problems within and between generations. To show the effect of deliberation alone within the ISDG framework, Timilsina et al. [43] carried out a field study in urban and rural settings in Nepal. When three people were involved, they were asked to choose an option both before and after deliberating. The results showed that deliberation had hardly any impact on the selection outcome. That is, this experiment shows that democracy does not always serve the desired function in solving intergenerational problems. Furthermore, the selection rate of Option B in the urban area was 64%, while in the rural area, 84%. The selection rate of B is almost double in Kathmandu compared to Dhaka, which has a five times denser population. Although due to Covid-19, migration from urban to rural areas is expected, it is undeniable that the number of people acting with future generations in mind will further decline as urbanization continues.

So far, participants in the experiment have assumed the role of imaginary future people traveling back in time to consider their choices in the present, through the viewpoint

of the future. Nakagawa et al. [44] are developing a method named *Past Design*, in which participants evaluate past events that have already occurred from the present. 155 participants from Kochi Prefecture—where 84% of the land area is forested—were recruited. Using the case method, they were presented with the history, current situation, and issues for debate surrounding Kochi's forests, and also with five relevant policy options/scenarios (maintenance of status quo; intentional neglect of inefficient forests; minimum care for inefficient forests; providing forest roads for the continuation of forestry business; turning forested land into recreation forests). When no conditions were imposed, the current generation groups' most favored option before debate was turning the forested land into a recreational forest. When asked to debate the future of the Kochi's forests from the viewpoint of the present, the most favored scenario changed to minimum care for inefficient forests. Simultaneously, the other groups were asked to follow the same twin procedures. The scenario selected by most individuals, after advising people from 30 years ago, was to provide forest roads to continue the forestry business; the same scenario was most frequently selected after the subsequent debate as an imaginary future generation. In other words, even without debate, the "social mechanism" of looking back at the past - or *Past Design* - had a significant effect on the scenario selection.

As mentioned above, the sustainability of public debt is an important issue in Japan and many other countries. Hiromitsu [45] and Nakagawa et al. [46] carried out subject experiments using an imaginary future generation. Hiromitsu [45] conducted experiments in different parts of Japan, considering two scenarios: whereby the burden is postponed for 30 years or more (Option A) or shared between the current and future generations (Option B). Ordinary people ranging in age from their late teens to their seventies were grouped in teams of three, and asked to choose between the two options through debate. Similar to Kamijo et al. [34], teams were assembled from current generation members, or contained imaginary future generation members (one teammate played an imaginary person of the future). 60 of the 83 current generation teams (72.3%) and 57 of the 65 imaginary future generation teams (87.7%) chose Option B. In addition, the "silver democracy hypothesis" (stating that older people tend to postpone a burden) was investigated; although Option B was selected less often as the age of the participants increased, the decrease was small compared to the profit-and-loss arithmetic implied by their own life expectancy. Further, the pros and cons of the "deliberative democracy hypothesis" (when debating is involved, Option B is more likely to be chosen than Option A) were investigated; this hypothesis seemed to be supported by the increase of the selection rate of Option B from 71.6% before discussion, to 87.7% after discussion. Hiromitsu [45] surmises that this could perhaps be attributed to group pressure to conform.

Nakagawa et al. [46] recruited 379 ordinary people from Kochi Prefecture, Japan, and conducted a deliberation experiment for teams of four; all members of a team belonged either to the current generation or the imaginary future generation. Employing the Harvard case method used in business schools, materials were developed to teach national and prefectural financial administration in a short time. Among these, maintaining the status quo or reducing the budget of local prefectures (two policies) were proposed as national policies, and maintaining the status quo or the support for specific regional agglomeration aimed at regional self-reliance (two policies), as prefectural policies. The participants assigned to the current generation group debated the most favorable policies - out of the proposed four - for the year 2047 society, chose one, and then individually reported their preference. The imaginary future generation group was asked to follow two procedures. First, before debating, they were asked to complete a Past Design session consisting of reading 30 years old newspapers, and then send advice to the people of that time. Then, they "time-shifted" 30 years into the future and debated from the perspective of the year 2047, which one of the four policies they would want people to choose in 2018. They reported their selection from the perspective of an individual living in 2017. After the experiment, they filled in questionnaires designed to measure the "generativity" (engaging actively in behavior that creates value for the next generation) and "critical thinking" (the quality of being able to think logically without bias and creativity), developed by McAdams & de St Aubin [47] and Hirayama & Kusumi [48], respectively. A higher score than the median value in at least one of these two indicators suggested that an imaginary future person was more likely to choose to support specific regional agglomeration aimed at regional self-sustainability than a current generation person. In other words, people with a high score in at least one of these indicators chose a scenario that took into account the future generations, owing to the experience of the "social mechanism" of becoming a future generation person in the twin procedures. Although not an experiment, it should be noted that Saito [49] created a fictitious deliberation narrative with an imaginary future generation on the issue of the consumption tax.

The experimental results listed above suggest that one can assume the role of an imaginary future person, think from the standpoint of future generations, and consider the well-being of future people even after one "returns" to the present. In this case, the question to be answered is: what type of people possess these characteristics? Within the same framework as the fiscal experiment in Nakagawa et al. [46], Nakagawa et al. [50] have tried to answer this using critical thinking and generativity for testing purposes. Critical thinking measures "whether you tend to always think *logically*," and "whether you tend to be *curious* about everything all the time" (see also [51]). They found that a person with

higher levels of both traits is more likely to successfully become an imaginary future person. In addition, a person with high levels of *curiosity* can think about the well-being of future generations even after they "return" to the present. Moreover, a person who is more likely always to be aware of future generations (i.e., a person with a high generativity trait) is also more likely to act with the well-being of future generations in mind, even after he/she returns to the present. If we were to create an organization such as some ministry of the future, we would be looking for people with these characteristics.

As the falling of birth rates and the aging of society continues, what type of electoral system would be suitable to promote a sustainable society? Kamijo et al. [52], as a mechanism to reflect the children's voice, conducted an experiment based on the voting system suggested by Demeny [53]. This system gives voting rights to children, exercised by their parents by proxy. Three types of votes were used by parents—one vote; two votes: one for him/her and one for a child; no vote (since this person belongs to a future generation). Participants voted for either Option A (the current generation receives a large reward) or B (the reward is split evenly between the current and future generations), options slightly different than the ones of the ISDG experiments. When both participants have one vote, half of them previously voting for B supported A when the Demeny voting system was used. In other words, under normal voting conditions, many participants (equivalent to the older generation at the life stage of having no children or adult children) took into account the future generations and chose B. However, under Demeny voting, the half of one vote participants switched support to Option A, which benefited themselves. This suggests that the Demeny voting system does not serve the purpose for which it was intended.

Kamijo et al. [54] invited 1,000 parents with children below the legal voting age and another 1,000 with children above the voting age, to participate in a survey experiment where participants donated to a non-profit organization benefiting a future society. The donation amount was determined by the participants through voting. Two voting systems were observed: regular and Demeny (parents gave one vote on behalf of their child if they had any). Mothers of children below the voting age displayed more altruism for posterity in the voting process, in general. However, when the Demeny voting system was used, any difference vanished, and the average donation amount was smaller. In other words, Demeny voting does not necessarily lead to decision-making benefiting future generations. Kamijo et al. [52] compared the case where Demeny voting specified that one more vote than usual was cast for future generations with the case where it did not. Again, they observed no effect of Demeny voting when that was not explicitly stated [41]. To mitigate this issue, Hizen [55] suggested the necessity of introducing other systems than voting.

Examples of such systems include the "Mission: The Future," established in Sweden as an executive government branch to investigate long-term problems, and the ombudsman system set in Hungary to oversee the executive government branches from the viewpoint of the future.

Hiromitsu [56] showed results that are different from the "silver democracy hypothesis" and concluded that the judgment of individuals becomes unbiased as they age and approach Nirvana. Saito and Kameda [57] answered that question. To verify the strength with which older people desire to represent the welfare of future generations, they conducted a postal survey of 2,000 randomly sampled residents of the Bunkyo ward of Tokyo, aged 18 or older (772 valid responses). The survey revealed that it is possible to anticipate the level of a person's desire to represent future generations from their stage in life alone (respondents were grouped by the following stages: no children, children but no grandchildren, and grandchildren). The question used to assess the desire to represent future generations was: For the sake of the generations as yet unborn, would you like to take on the role of advising on existing social policies from the position of future generations? The most important point of the question is that it does not ask to advise (future) generations already born (i.e., grandchildren), but "generations as yet unborn." In other words, as people progress through life stages, they focus on the welfare of future generations that will comprise the society after their own death. This fact suggests the possibility that the sustainability of future generations is understood in relation to "third parties with no connection to oneself" who will come after one's own grandchildren. Saito and Kameda [57] emphasize the possibility that, when people face the problem of sustainability, they are buoyed by "expanded egoism," seeing it not as a problem related to unselfish altruistic behavior, but as their own problem. Although "expanded egoism" has been obscured by the market and democracy, another possible explanation is that "expanded egoism," or "futurability," fostered as human beings have progressed through life stages, is a social system similar to an imaginary future generation.

Japan has faced various Natural Hazard Triggering Technological Disaster (Natech) events. Kurashiki [58] assumed population changes in a city in the Osaka and Nankai areas as a consequence of the megathrust earthquake, asked participants to propose various policies from the perspective of risk communication, and verified the effect of an imaginary future generation. In the future, this is likely to become an important FD research problem.

5. What is the premise of the imaginary future generation?

Kobayashi [59, 60] developed an argument regarding the rationalization of the introduction of an actor (imaginary future generation) representing the good of future

generations, as follows. The image of a human being in Rawls' [61] theory of justice is that of a self-interested rational individual. Behind a "veil of ignorance" ("original position," where a person does not know the generation to which they belong nor their own age, wealth, or health), a person should apply the difference principle (the maximin rule, a social system in which the utility of the least-fortunate generation is maximized within its various systems). However, even if a social contract can be agreed upon in the original position when the veil of ignorance is lifted, and history begins, a self-interested rational generation has no incentive to follow such a social contract. In other words, the current generation has no incentive to sacrifice its own gain to secure gains for future generations. This is because we face the time inconsistency problem, whereby future generations can impose no penalty if the social contract is broken (Calvo [62]).

Here is an experiment on the veil of ignorance by Klaser et al. [63]. Each generation consists of three participants supposed to divide 21 Euros. If the total is more than 16 Euros, the game ends. If not, the game continues. Each participant knows which generation he/she belongs to but does not know the total number of generations involved. Under these conditions, six cases ended in one generation, and the two cases ended in two generations. On the other hand, without knowing which generation they belong to, the three would vote until they are unanimous on what allocation should be made under the veil of ignorance. After that, they know which generation they belong to. Four ended in one generation, and two ended in two generations. The veil of ignorance faces a time consistency problem in this experiment, finding also supported by Wolf and Dron [64].

If an imaginary future generation is introduced into society ahead of its time, it is possible for the happiness of the least-fortunate generation of that society to improve. People in the original position who stand behind the veil of ignorance, in anticipation of happiness, agree to the introduction of an imaginary future generation as a social contract [60]. To establish such a new social contract, the imaginary future generation must possess strong altruism toward future generations. Kobayashi [60] weakened the assumption of self-interested rational individuals and claimed that people possess a "weak altruism" with regard to future generations. When people from a future generation fulfill their assigned roles, they can gain the empathy of others (Smith, [65]). The empathy received from others produces positive feelings, strengthening the altruism of these imaginary future persons, and helping establish a new social contract theory.

In constructing his principle, Rawls [61] excluded the environment that could foster feelings of altruism and empathy, imagining instead self-interested, rational actors. However, as shown by the behavioral ecology research of Saito and Kameda [57], humans display "expanded egoism." If we can activate futurability by introducing the social

mechanism of the adoption of an imaginary future generation, this type of social contract can be aligned with the new social contract theory of Kobayashi [59, 60].

However, if the starting point of our discussion is *not* the assumption of a self-interested rational actor, Hiromitsu [66, 67] considers that agreement between people of the same generation supports the intergenerational principle; this agreement is, in turn, supported by "the reasonable" described by Rawls [68]. "The reasonable" is a concept that Rawls contrasts with "the rational" and describes people who understand that, if other people respect the fair conditions of cooperation, the principle in question has to be respected, even at the expense of self gain. In addition, Hiromitsu [66], while focusing on the fact that Rawls himself intended "the reasonable" to be only a political concept, claims that this image of the human beings is analogous to that proposed by Hume [69], who argues for altruism as their true character. If we view the expansion of reasonableness as including the fate of future generations as "futurability" within FD, this provides a logical foundation of the framework for designing or agreeing to social systems that activate this futurability.

6. Practical application of FD

Parallel to the experimental research mentioned above, practical applications of the FD are underway. The main framework for laboratory and field experiments relay on researchers presenting scenarios likely to happen in the future. This enables us to understand if the selected scenarios change when the future is examined from the viewpoint of the present and vice versa, as by an imaginary future generation. However, in FD practical applications, the participating citizens themselves design the scenarios, and the issue becomes their choice of scenarios and present-day policies. The proposed scenarios differ qualitatively when considering the future from the standpoint of the present and when examining the present from the viewpoint of the future. The following paragraphs describe practical cases applied in Yahaba, Iwate Prefecture, and Matsumoto, Nagano Prefecture.

In Yahaba, an imaginary future generation was created in the present to represent future generations' interests and approach vision design and decision-making from their perspective [70]. It examined the possibility of decisions taken through negotiation between this future generation representatives and the current generation, considering the conflict of interests of the different generations. Because the Cabinet Office required all municipalities to produce a "long-term vision" for the year 2060, monthly workshops were held between November 2015 and March 2016. Four teams of five-six residents of Yahaba were assembled. Two of these teams were asked to think about the Yahaba of 2060 as

members of the current generation, and propose policies at the present time, for the future. Meanwhile, the remaining two teams were asked to "travel to 2060 in a time machine" and draw up the policies from there.

At this point, I would like to outline the nature of the debate, based upon Hara et al. [70]. Let us start from the position of the imaginary future generation. First, their overriding aim was securing and building a prosperous life for the future inhabitants of Yahaba; debates arose around their livelihood, lifestyle, and values. For example, while the current generation proposed policies such as free medical care for children to increase the population directly, the imaginary future generation did not have such a specific aim, discussing instead the possibility of population increase as a result of vision and policies. Second, they did not propose individual strategies and long-term ideas to achieve their aims; they constructed a narrative instead, connecting strategies and ideas. Third, if that helped achieve the aim, existing systems, etc., were regarded as flexible and open to change. Fourth, they displayed a willingness to actively incorporate any radical technical innovations that may occur in the future. Fifth, they demonstrated the highest possible sensibility and awareness by considering new strategies to respond to urbanization and the aging of society. Sixth, having become aware of the current issues, they devised a new vision to eliminate those.

Now let us examine the approach of the current generation. First, a better life at present became the primary focus. For example, they proposed things such as "eliminating waiting lists for nursery schools" or "improving care for the elderly." Second, they tended to consider improvements to existing facilities and frameworks. Third, they leaned toward proposing policies that did not burden them. Fourth, they favored policies producing results in the short term. Fifth, they tended to consider policies by comparing the corresponding policies of other regions. Sixth, they also tended to regard existing frameworks and systems as immutable.

The current generation regarded the future as an extension of the present time, constructed visions that resolved immediate problems, and proposed ideas based on current conditions and restrictions. Meanwhile, the imaginary future generation creatively gave the highest priority to solving the most complicated and time-consuming problems and depicting the future thoroughly regardless of current circumstances. They noted the physical and aesthetic merits and resources of the region and examined ways to utilize these on a continuous basis.

Six months after the field application described above ended, Nakagawa et al. [71] conducted interviews with several of the participants and reported the following. The locals who had undertaken the role of imaginary future persons experienced no conflict

between the current generation and imaginary future person parts of themselves, having a comprehensive overview of both sides. In addition, the very act of thinking as an imaginary future person was a joy; in their everyday life, they found themselves thinking like an imaginary future person automatically. The impact of this experience persisting six months later shows that the effect of introducing imaginary future persons is robust. This validates the possibility to activate the futurability of humans by prompting them to think like imaginary future persons. However, when the current generation examines the future, future generations are seen as outsiders.

In Yahaba, the first 26 of the 1,000 randomly sampled residents were recruited to participate in discussions in the period January–March 2017. To summarize, the theme of this practical FD application by Hara et al. [72] was to develop a plan for public facilities and municipal housing in the year 2060. Given the effectiveness of Shahrier et al. 's [39] FAB mechanism, deliberations were carried out based on the following arrangement. The first session of deliberations was conducted from the perspective of the current generation. In the second session, one month later, proposals for policies and long-term ideas were discussed from the standpoint of an imaginary future generation living in the year 2060. In the third session, vision proposals and decision-making were welcomed from the perspective of either current or future generation. Participants filled out various questionnaires after each session. As shown by Nakagawa et al. [71], it was ascertained that the viewpoints of from both the current generation and imaginary future could coexist within one individual. In addition, when examining the "degree of shared viewpoint"—a yardstick measuring the extent to which persons in the current and future generation shared views—it was found that the higher that degree, the stronger a person's awareness of the current generation's responsibility. Moreover, in policy proposals, a focus on both "the possibility of realization" and "leaving scope for future generations to be in a position to decide for themselves" was observed. In addition, the language analysis of the first set of discussions revealed that there were many opinions and proposals relating to facilities as physical items. However, elements missing in the first session emerged as the second and third sessions of discussions progressed, such as concern about the current residents of municipal housing.

Yoshioka [73] had been conducting waterworks workshops for residents at Yahaba since 2008 (no FD methods) and observed that the thinking of the participants could be changed from taking an inexpensive and reliable water supply for granted to believing it unreasonable to expect such facilities without any cost to oneself. FD sessions started in 2015, and Yahaba held resident FD workshops on the increasingly difficult-to-maintain water utilities in 2017. Consequently, the residents proposed on their own a water rate

increase. The town collected an extra 6% the next year. There was little opposition from the residents' side. After observing these workshops, Mayor Shozo Takahashi declared Yahaba an FD Town in his 2018 policy speech and established the Future Strategy Office in April 2019. The first task of the office was to develop, together with the residents, a future plan using the FD approach. The development of this plan scheduled to be completed presently. Thus, Yahaba Town is set to change the town structure, while the very mindset of its residents is also beginning to undergo change.

A three-day workshop for local government workers was held in November 2017 in Matsumoto, Nagano Prefecture (Nishimura et al. [74]), to discuss how to work out a basic concept for the new city hall due to be rebuilt. That was followed by a two-day workshop for the general public (January and February 2018). The current generation group attached information to a blank map and conducted the "spatial journey task" of writing down the problems encountered for each region. The imaginary future generation group, in addition to the blank map task, conducted the "spatial and temporal journey task." Based on a timeline for Matsumoto City from 1960 to 2060, they looked back at past events and imagined the shape of the region and the society of the future. They also added predictions for various future statistics and technological innovations on the timeline. On the first day of the local government employee workshop, all groups undertook the spatial journey task. On the second day, only the future generation group experienced the temporal journey task. The future generation group performed a lively exchange of views at the meta-level regarding the future and the functions left for the local government after persistent low birthrate and increased artificial intelligence use. The starting point in the current generation group related to current problems, and methods to resolve these were examined. The general public workshops yielded the same results.

Nishimura et al. [74] administered questionnaires on discount rates before and after the events. There was no change for the current generation group. However, for the future generation group, the discount rate was lower after experiencing the temporal journey task and, thus, acquiring a long-term viewpoint. Furthermore, women's discount rate was lower than that of men. This experiment was designed to compare the "spatial task" and the "spatial and temporal journey task" + "imaginary future generation." It may have been possible to verify the effect of the imaginary future generation if "spatial and temporal journey task" groups without any imaginary future generation element were considered.

Future designers of a city may ask participants at various practice sites to time travel to the year 2050, for example. However, it is hard to believe that an ordinary citizen can be an imaginary future person without effort. Therefore, among those who participated in the first practice in Yahaba, Nakagawa interviewed people who became imaginary future

people. Based on these interviews, Nakagawa et al. [75] created two 10-minute narrated picture-story shows. Rather than directly using them in practice, their effectiveness was tested by experimenting with regular people as participants. One hundred eighty-six participants immersed in the same environment of financial sustainability problems of [44] and one picture-story show were used to measure individuals' attitudes both before and after exposure to this intervention. It was found that exposure to this visual narrative significantly altered participants' preferences as proxies for future generations. Specifically, after this intervention, participants were able to avoid regret for not doing certain things in the past. They tended to wish that the current generation had chosen a more distant option from the status quo. Based on the results of this study, four picture-story shows were created and subsequently used in many practice sites.

In many practical FD applications, the designers form groups of approximately four participants. The group members discuss the issue in depth from the viewpoint of future generations. In most cases, a facilitator controls the deliberations. At the end, participants and facilitators summarize the results. It is of crucial importance to note that the act of summarizing deliberations can never be arbitration-free. In fact, there are infinite ways of selecting and meaningfully connecting statements mentioned during deliberations, the way these are done depends on the person doing it. With this understanding, Nakagawa [76] proposed a method to visualize contexts of deliberations using a *dialog map* and extract viewpoints of the participants based on the transcripts. This method is applied to secure the transparency of the act of summarizing the deliberation, even if, in principle, objectiveness cannot be achieved. During the most creative deliberations, the participants' statements intertwine as if they were running up a flight of stairs. Thus, a collective new vision is created, which could not have been created by individual members alone. By visualizing such lines of deliberation (or context), this method provides clear reasons for why some parts of the deliberation are prioritized rather than the rest to extract visions ex-post (see also [77]).

FD projects in progress are related to renewable energy and environment (Suita City, Osaka metropolitan area [78]), infrastructure (Uji City, Kyoto metropolitan area), global warming (Kyoto City), water and sewer (Kyoto prefecture), water (Nagaokakyo City, Kyoto metropolitan area), infrastructure (Saijo City, Ehime prefecture), future planning with Kochi Association of Corporate Executives (Kochi Prefecture), urban redevelopment (Ohnuma Town, Hokkaido [79]), and more.

In addition, Matsunaga and Managi [80] question the nature of social sustainability and propose replacing the GDP with a new, inclusive wealth measure (wealth available to the society to enhance well-being, benefiting both those alive today and future

generations), calculating it in practice. This has the potential to become an indispensable indicator for evaluating FD research.

So far, in practicing FD, researchers and local government officials collaborated to provide an appropriate "mechanism" for each municipality and then held workshops in which local residents could participate. Note that the researchers merely provide mechanisms for residents to make decisions, and do not address problems themselves. When, where, and how to bring in problem experts is an important part of the design of "mechanism," of course. However, an FD researcher should not interfere with the problem itself, the same way a football referee should not play in a game, and neither should a spectator get in the field and play. Furthermore, it follows Hayek's position that "the knowledge of the particular circumstances of time and place" in an area is not easily transferred to outsiders [81,82]. Although each researcher seems to adopt a variety of implicit rules in practice, I would like to present here principles adopted by the Research Institute for FD of the Kochi University of Technology (RIFD) [83].

Principle 1: Designers should not be players

In the practical designing of a workshop, any researcher should assume the role of a supporter; the person in charge should make the decisions. The practice should be conducted by the people in charge, and the researcher should not have any role in the practice. Furthermore, the researcher must not force or guide the participants or those in charge of any aspect of the FD practice.

Principle 2: Critical Publicity

Kant [84] defines this concept by "all actions having relations to the rights of other men, whose maxims do not allow publicity, are unjust." Whether it is FD or not, any practices involving citizens must satisfy Kant's criterion. Based on this principle, RIFD proposes the following two principles.

Principle 2-a: Informational Publicity

All parties involved must share information in both directions with all other parties. For example, regarding emails, this means that all parties are always on the mailing list. Any other way of exchanging information does not satisfy this principle. The concentration of information refers to a form of network in which one person acts as a hub, and information is transmitted to others only through that person.

Principle 2-b: Equality

This requires researchers and citizens to participate on an equal footing. In practice, as Hayek [81] and Scott [82] show, the researchers who design the mechanism lack field knowledge, where RIFD shifts the weight to the citizens. In other words, this principle implies refusing to be led by the researcher. Leading here means one person chairs or presides over a deliberation, leads the decision-making process, and so on. For example, consider the case in which one person assumes the role of the hub and leads the exchange of emails and meetings for researchers only, omitting the person in charge. Such a method of recognizing the person who becomes the hub does not satisfy the condition of equality.

Principle 3: Evidence-based selection of method

A new method must be validated beforehand through theoretical verification or laboratory testing, rather than directly used in practice. When using an untested method, the people involved should be aware of the fact, the advantages and disadvantages of the method must be made clear, and the choice to use it or not must be left to them.

Principle 4: the "fading away" principle

When researchers and outsiders support citizens, including a variety of stakeholders, the latter can conduct practical applications without further support from the former. In other words, supporters are assumed to withdraw in the future completely.

Principle 5: the "external eye" principle

If a researcher serves as a supporter for an FD session, he/she must submit to critical evaluation by a party external to the design of the mechanism, the practice, and the output of the practice. In this context, the external parties exclude the supporter in question and outside stakeholders.

7. Outstanding issues with FD – in lieu of conclusions

FD research began in earnest in late 2015, now encompassing a variety of issues. With reference to Kobayashi [16], let us examine three such issues.

The first relates to whether the imaginary future generation will function as intended. In the experiments reviewed here, people have been found to self-activate their futurability. In addition, in FD practical applications, they have also been found to exercise an "originality" not found when the future is viewed from the position of the current generation. That said, the mechanism of the "mind" at work is still unclear. As a result, Aoki et al. [85] conceived a research area dubbed "neuro future design," in which collaborations between psychology, biology, neuroscience, and related fields are essential.

Even if many people are willing to become imaginary future persons, how will they function within existing organizations? This problem also relates to the second issue: will it be possible to compensate for the impulsiveness and optimism of the democracy merely by constructing within existing frameworks new organizations such as a Ministry of the Future, future departments within various bodies, and a future discussion chamber? We certainly do not know yet how will policies be drawn up or be chosen from among various proposals and how will they be pursued. In other words, with the issue of designing "social mechanisms" offering places where the general public can demonstrate futurability and originality, we also face the issue of designing new "social mechanisms" able to implement such ideas. We must learn to construct social mechanisms in which general public members who understand the perspective of the future generations can draw up and implement various policies. Moreover, they should do that not as a task for the sake of others, but as one that relates directly to them. This frame has the potential to change the existing representative democracy significantly.

The second FD research issue is the validity of the creation of an imaginary future generation (with new systems such as a Ministry of the Future) within a democracy. For example, with Demeny voting, parents with proxy votes for their children ultimately obtain the right to vote more than once, which contradicts the democratic principle of "one person, one vote" and lacks validity. With the rationalization of the imaginary future generation examined in Section 5, the necessity to consider the validity of a Ministry of the Future and of various social mechanisms that may be proposed will arise at some point.

The third FD issue refers to what needs to be done so that ordinary people automatically become imaginary future persons. According to Kobayashi [16], "the next generation to whom we are bound to contribute must be regarded as something that has permanence," and we must understand that there is value in contributing to the progress of human intelligence, i.e., to progress in "expanded reason." If "expanded reason" rings alarm bells regarding the sustainability of the natural environment and societies of the next generation, we should begin taking countermeasures now. Kobayashi argues that, if "progress in expanded reason" can be considered an asset, implementing countermeasures today is only logical if the value of that asset is expected to be undermined in the future. Self-sacrificing behavior on behalf of the next generation is transformed, for the current generation into logical behavior, to maintain the value of its own asset. Such an attempt can be found in [86].

In addition to the three issues described above, another important aspect requires attention is reforming the impulsive market from the viewpoint of FD. One strategy considers using the market by setting limits (within the carbon budget) on the amount of

fossil fuel that can be burned each year and trading the relevant emission rights (volume). How this relates to futurability is still unknown.

Finally, let us investigate the possibility of radical innovations in science from the viewpoint of FD. Although futurability is not a human quality that ought to survive from the perspective of evolutionary biology, it does find a way to stay relevant. It is important to reexamine existing frameworks to investigate why this should be so. Moreover, discounting future economic gains at the expense of future generations for the sake of the current one is the norm. Every aspect of life and decision making lacks the perspective of future generations. Thus, to ensure sustainable environment for generations to come, perhaps the revolutionizing of science itself is required.

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