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Innovators' Legacy：The Wisdom of Trailblazers

New Ethics for an Era of Human Security and Well-being

[Part 1] Thoughts on the Post-COVID-19, Post-Ukraine Era (3 of 3)

#Innovation Creation #Sustainability

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In 1971, Koizumi graduated from the Department of Pure and Applied Sciences in the College of Arts and Sciences of the University of Tokyo, and in the same year, he joined the Department of Optical Instruments at Naka Works of Hitachi, Ltd. In 1976, Koizumi submitted his thesis to the Faculty of Science and received his doctorate in science from the University of Tokyo. He discovered and developed many new principles in fields such as the environment and medicine, and applied them in society. In 2000, Koizumi was appointed General Manager at the Advanced Research Laboratory. He became Corporate Chief Scientist in 2003, a Fellow in 2004, and has been working in his current role since 2017. Koizumi is a Fellow and a member of the RCAST Board, the Research Center for Advanced Science and Technology (RCAST) of the University of Tokyo, a Foreign Member of the Chinese Academy of Engineering (CAE), and Professor Emeritus at Southeast University. He has also worked as Director at the International Council of Academies of Engineering and Technological Sciences (CAETS), and as board member at various research institutes and foundations in the USA, Europe, Australia, and other countries. Recently, he published "Albert Einstein's Inverse Omega: Considering Education from the Perspective of Evolution of the Brain (Evolutionary Pedagogy)" (winner of Papyrus Award, Bungeishunju Ltd.).

Highlight

In today's society, which is notable for its volatility, uncertainty, complexity, and ambiguity (VUCA), what do we need to do to create a better existence for individuals, companies, organizations, and the state? In this series of articles, Hideaki Koizumi, Honorary Fellow of Hitachi, Ltd., who is active internationally in a wide range of cross-disciplinary research activities, such as brain science, education, science, and ethical issues, discusses this question from a wide variety of perspectives, including the theory of ideas, philosophy, technology, science, and art. The theme of Part 1 is the question of how we should understand the post-COVID-19, post-Ukraine era. The coronavirus pandemic swept across the world for over two years and had a profound impact on the society and economy of every country. Then, just as we were starting to overcome this crisis, the Russian government invaded Ukraine, which had knock-on effects on the global food supply and caused upheaval in global security frameworks. In a world that stands at a crossroads on many fronts, what will serve as the basis of a better existence for individuals, companies, and the state? What do we need to do to cultivate new possibilities?

"Neuroscience" is the Starting Point for Both Old and New Capitalism

Continuing from the second article of this series, and connecting the previously discussed ideas to actual application in society, this final article will explore economics from the perspective of neuroscience. And then I would like to discuss the concept of trans-disciplinarity as a means of bridging and integrating the natural sciences with the humanities and social sciences.

Now that I think of it, there were economists who took an interest in neuroscience even before I met Professors Rothschild and Sen, who I introduced in the second article. One such scholar was Professor Kenichi Imai (1931–2021) of Stanford University. Professor Imai was appointed Director of Research at the Stanford Japan Center in 1991, and he also had a home in Kyoto. I too began to wonder, after many interactions with economists and politicians at the University of Cambridge and elsewhere, whether a neuroscientific approach to economics was required*1.

I learned from many illustrious economists that the so-called "Father of Economics," Adam Smith (1723–1790), had based his ideas on a strong sense of ethics. Smith is most widely known for his magnum opus, "An Inquiry into the Nature and Causes of the Wealth of Nations" (1776) (often shortened to just "The Wealth of Nations") and his concept of the "Invisible Hand of God," but he was actually an ethicist from Scotland. Seventeen years before the "Wealth of Nations," Smith published the "Theory of Moral Sentiments" (1759). The very first section of this book, Chapter 1 of Section 1 of Part 1, is titled "Sympathy." Sympathy is an important subject of research in modern advanced neuroscience, and is regarded as a basic cognitive capability that has only been acquired by modern humans. In other words, if our actions take place on a foundation of ethics, even free competition will settle into an appropriate balance. But unfettered competition, as in the ferocious battle for survival seen in wild animals, will not lead to good results*2.

The knowledge of neuroscience shows us that if we deviate from a sound basis of ethics, as in the invasion of Ukraine, the behavior even of seemingly modern humans can degenerate into that of wild animals.

***1 Encounters with economists**

In the 1980s, partly at the suggestion of Dr. Taro Takemi, I was working hard at the Naka Works in Ibaraki Prefecture on the practical application of magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and functional MRI (fMRI). Later, I received guidance from Dr. Imai at the Stanford Center, which had been established in Kyoto. As a gift, Dr. Imai gave me a thesis, The Sensory Order: An Inquiry into the Foundations of Theoretical Psychology, (1952), a work by Friedrich August von Hayek (1899–1992). In addition to being a very famous economist, Hayek was also a cognitive neuroscientist, and he cultivated new fields of study by applying neuroscience to economics.

Around this time, I happened to meet Mahathir bin Mohamad (1925–), the Prime Minister of Malaysia, while he was visiting Japan, and I was invited to the hotel room where he was staying. Prime Minister Mahathir was originally a doctor of internal medicine. He told me that he would like to devise new policies by applying his specialist field of medicine to politics; in particular by establishing new governance systems. Some time later, I was invited to his study in Kuala Lumpur, and with a trusted advisor who had deep knowledge of religion at his side, he told me how he was focusing on integrating politics and economics with the ethics of religion. I felt that the New Economic Policy of Islam had great potential for addressing economic inequality, which I will describe later.

I saw a strong sense of trans-disciplinarity underlying the efforts of such pioneers. Professor Ikujiro Nonaka (currently Professor Emeritus at Hitotsubashi University and the University of California) asked me to give a lecture describing this concept of trans-disciplinarity. At the time, Professor Nonaka was also serving as the Dean of the Graduate School of Knowledge Science, Japan Advanced Institute of Science and Technology (JAIST), which had only just been established in 1990. After the lecture, he took me to atmospheric hot springs in the local Hokuriku region.

In the 2000s, Dr. Yasumi Matsumoto returned from the University of Oxford to Waseda University, and out of the blue, he invited me to participate in a special lecture and panel discussion at an international economics conference. I decided to take the plunge, giving a lecture to some of the world's most renowned economists and answering their questions. I explained to them how neuroscience helps reveal aspects of human evolution, and described the evolution of human desires and the neuroscientific basis for them. In 2017, NHK broadcast a special program called "The Capitalism of Desire," which summarized debates that had been ongoing since the 1990s about the origin and mechanism of human desires. [Hideaki Koizumi, "Capitalism from the Perspective of Brain-Science," pp. 162–204, Tsutomu Horiuchi and Hideaki Koizumi eds., "Where Will Capitalism Go?" Nippon Hyoron Sha Co., Ltd. (2019) in Japanese]

***2 Concept of the "Invisible Hand of God"**

When we go back and check his original work, we find that Adam Smith never actually used the word "God." Even the phrase "Invisible Hand" only appears once in both "The Wealth of Nations" and "Theory of Moral Sentiments." This shows how the concept of the "Invisible Hand of God" has taken on a life of its own and is no longer closely connected to Smith. Smith himself was deeply knowledgeable about science and technology, and may have been interested in the research about "universal ethics" that I explore in this series. In neuroscience and cognitive science, "sympathy" is seen as an emotion that is unique to humans. Feelings such as appetite, libido, and will to action that are widely present in the animal kingdom are generally understood to be "instincts."

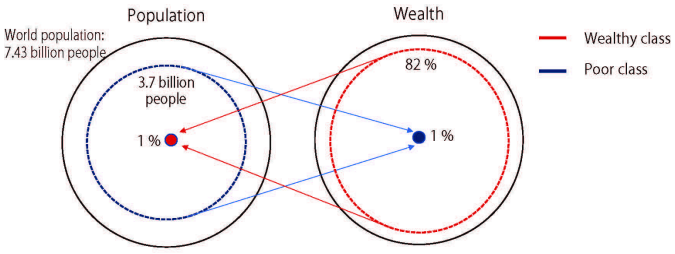
The essential elements that make humans different from animals and other living things have always been an area of great debate among us humans. Just as in the example of the “Invisible Hand of God,” I believe that “God” as an object of faith has always lurked in the background as we trace the history of understanding the natural and human worlds. In the field of evolution, even more than Charles Robert Darwin (1809–1882) himself, I believe that the arguments of Ernst Heinrich Philipp August Haeckel, (1834–1919) which include the empirical results of development and fossils, have had a profound impact on many historic ideas. I cannot describe all of the people who were influenced by these ideas because they are too numerous, however, they include Jean Piaget (1896–1980), Sigmund Freud (1856–1939), and Friedrich Engels (1820–1895). Piaget and Freud in particular wrote papers closely connected to the field of paleontology in the early stages of the discipline’s development. The religious backlash to these ideas has always been floating under the surface, an issue that continues to this day. I believe that a universal ethics is being born from these great trends.

Economic Inequality

Economic inequality between social classes is one of the most serious issues we face today. To achieve coexistence within the planetary boundaries, it is essential for us to show consideration toward each other. But if too many people depart from “mutualism” and practice “commensalism” instead, Smith’s basis for a harmonious economy will collapse. As an example, the “American dream” is the attractive notion that hard work and talent will be rewarded with a wonderful material life, but this promise is based on many preconditions. In the limited resources of the terrestrial biosphere, it is unacceptable that people who find even day-to-day living difficult due to economic inequality are forced to make sacrifices.

To show that today’s economic inequality goes far beyond normal ethical boundaries, I created the figure below based on 2018 data from Oxfam. By looking at this figure, you can see at a glance how the world’s wealth is distributed between segments of society. The poorest half of the world’s population have only 1% of the world’s wealth. In contrast, 82% of the world’s wealth is owned by just 1% of its population. This economic inequality is getting worse and worse.

Figure 1—Global Economic Inequality



Every year, immediately before the World Economic Forum (WEF) is held in Davos, Oxfam (an NGO from Oxford) publishes data highlighting inequality. Their 2018 report showed that 82% of newly created global wealth went to the top 1% of richest people in the world. In contrast, the poorest half of the world’s population, about 3.7 billion people, received less than 1% of the world’s wealth.

Modern economics idolizes wealth creation based on free competition, but this can only be desirable if the poorest people make enough money to live like human beings. One of the most serious ethical issues today is that some people are becoming far richer than they need to be, even as poor children are continuing to die in developing countries.

Professor Joseph Eugene Stiglitz (1943–, winner of the 2001 Nobel Prize in Economics) who received instruction from Dr. Hirofumi Uzawa (1928–2014) while he was at the University of Chicago for about a year, has explored issues of inequality in depth. Recently, he argued that entrepreneurs need to understand that further government deregulation and widening of inequality will have long-term negative effects, because they will prevent free competition from functioning properly in the economy (“Science and Technology in Society Forum (STS forum) 19th Annual Meeting in 2022, ” in Japanese, STS forum 2022).

However, on other occasions, when I asked some Nobel Prize winning economists who I happened to meet about inequality, I was surprised to hear several of them reply that economics is a discipline that researches the mechanisms of the economy scientifically, and that inequality was not their problem.

When thinking about free competition, it is important to always keep in mind the issues of “freedom and responsibility” and “rights and obligations.” Some time ago, I had the opportunity to hold a discussion late into the night with Ms. Mamphela Ramphele (co-president of the Club of Rome from 2018), who fought against apartheid alongside Nelson Rolihlahla Mandela (1918–2013). Ms. Ramphele also appears at the start of the classic movie, “Cry Freedom,” as the first female doctor in South Africa. She told me that when she was fighting against apartheid, it was relatively easy to awaken an “awareness of rights” in people. But when she was Vice-chancellor at the University of Cape Town, she found it much more difficult to make students understand the “responsibilities” and “obligations” that should accompany “rights.” Her confession about how difficult this was made a deep impression on me. I would like to revisit this issue when I discuss ethics later.

Figure 2—Urban Planning in Cape Town, Republic of South Africa

Photo by H.Koizumi

The highway from the airport to the city is surrounded by the housing of poor people (top left), but government efforts are improving the situation little by little (bottom left). On the other hand, the areas of Cape Town containing upscale housing and villas, with their backdrop of Table Mountain, are said to be amongst the most beautiful in the world (right).

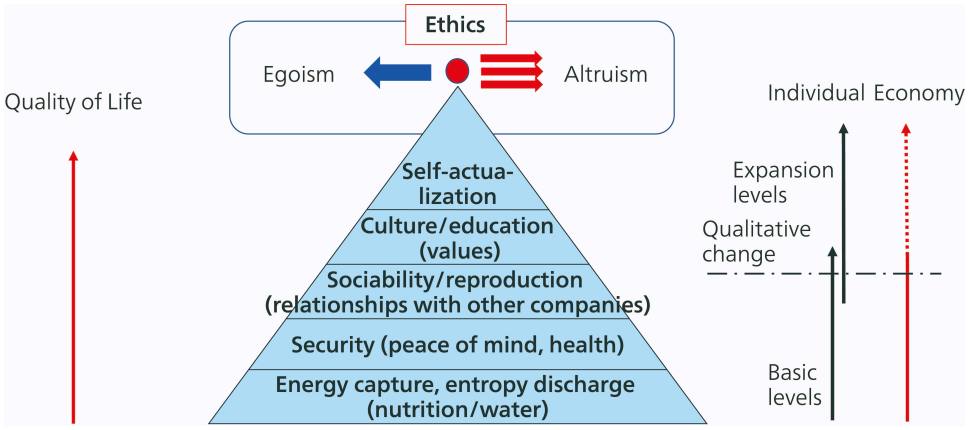
Do people who become extremely rich also become commensurately happier?

Eastern thought states clearly that this is not always the case. I strongly agree, even based on my own limited experience.

This idea is represented by Figure 3, my adaptation of Abraham Maslow's famous Hierarchy of Needs. Maslow was a psychologist who believed that human needs could be divided into a hierarchy of five levels, leading to self-actualization. I adapted the diagram to express this concept more directly from the perspective of natural sciences and the humanities/social sciences. The concept of "human security and well-being" is expressed along the vertical axis as the quality of life. Economics generally assumes that as income increases, the degree of self-actualization also increases in proportion (in conventional economics, individuals are impersonal). But in reality, this relationship is non-linear, as shown on the right in the figure. In other words, the quality of life, including income and psychological needs, is linear (proportional) up to the level where we have sufficient food and clothing. It is only once we go beyond this level that psychological needs become dominant.

We should also remember that poor people may live emotionally very rich lives even if their material conditions are poor.

Figure 3—Quality of Life Hierarchy and Well-being Viewed from Perspective of Natural Sciences and Humanities/Social Sciences



Hideaki Koizumi: Hitachi, Ltd.'s 100th Anniversary, Hitachi Technology Forum (2010) (Adaptation of Maslow's Hierarchy of Needs from Scientific Perspective)

Abraham Harold Maslow (1908–1970) was a pioneer in the field of human psychology. He divided human needs into five levels: Self-actualization, Esteem, Social needs/ Love and belonging, Safety needs, and Physiological needs.

Trans-disciplinarity

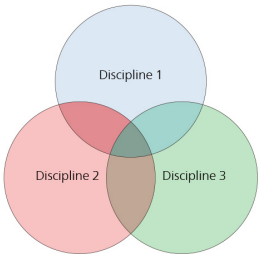
As we transition into the post-pandemic era, the world continues to face numerous problems, both new and old. One serious issue of the same magnitude as economic inequality is climate change, and the extreme weather that it causes. Although the international community has made promises to cut emissions and is implementing policies to combat climate change, a scientific approach is essential for solving these problems.

But in reality, rapid progress in science and technology has further segmented fields of specialization, making communication between disciplines very difficult. It is natural for high and thick walls to grow between specialist fields, with the tendency for researchers and engineers to become experts locked within their areas of expertise. For example, a neurosurgeon becomes ignorant of issues from the neck down, while a gastroenterologist loses expertise from the neck up. In medicine, there is a growing trend of organ specialization, instead of examining the patient as a whole.

This phenomenon is called siloing. The word “silo” originally meant a storage tank for livestock fodder. Now, it has also developed a metaphorical meaning of concentrating exclusively on one’s own work without collaborating with others, like working in a sealed space with no windows.

But if nothing bridges different disciplines or integrates knowledge, innovation will be severely obstructed. This concept of bridging and integrating different fields has progressed from inter-disciplinary, to multi-disciplinary, to trans-disciplinary. (See Figure 4 and Figure 5)

Figure 4—Inter-disciplinarity and Multi-disciplinarity

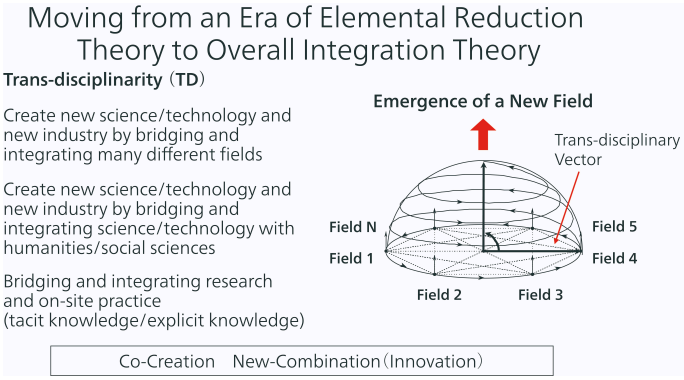


H. Koizumi, “Trans-disciplinarity,” Neuroendocrinology Letters, 22-219-221 (2001)

Inter-disciplinarity first arose from a concept called boundary areas. This is an intersection straddling two existing fields, and the first typical examples included physical chemistry and chemical physics. Both of these bridge physics and chemistry, but the first belongs to the field of chemistry while the second belongs to the field of physics, and separate academic journals are published for each. Bio-chemistry and bio-physics are other typical examples of bridging and integrating even more distant fields.

In the 1970s, I proposed the concept of inter-disciplinary analytical science instead of analytical chemistry. In the 1980s, I worked as the 55th Chairman of the Japan Society for Analytical Chemistry (JSAC) to promote this new concept, but I also met strong opposition in some quarters. Bridging different fields is very difficult to do in real life.

Figure 5—Trans-disciplinarity



Koizumi, H. (ed.), TD Symposium on Mind-Brain Science & Its Practical Applications, Hitachi, Ltd. (1995)

I believe that the concept of trans-disciplinarity (TD) is very different from other concepts such as inter-disciplinarity and multi-disciplinarity. According to Joseph Alois Schumpeter (1883-1950), the original meaning of “innovation” is “new combination” (neue Kombination), which is similar to the concept of TD. TD can have a strong metaphorical meaning based on quantum mechanics, as I will describe later. I later found out that the term “trans-disciplinary” had been used in the context of environmental policy in northern Europe in the 1990s, but when used in this way, I do not think that it has a particularly strong relationship to innovation[*3]. The Interfaculty Initiative in Information Studies (III) and the Graduate School of Interdisciplinary Information Studies (GSII) were established at the University of Tokyo in 2004 with the aim of providing informatics, which integrates the humanities and sciences.

Innovations occur as discontinuous transitions within the concept of trans-disciplinarity. One time, I was invited to the Santa Fe Institute in the USA, an institute famous for its research on complex systems. During my time there, I held wide-ranging discussions with researchers about complex systems and deepened my understanding of the trans-disciplinarity concept[*4].

The “boundary” is one key idea when thinking about complex systems. For example, living organisms evolved with the cell as their basic building block, which is surrounded by the boundary of a cell membrane. In all living things, the cell membrane acts as the boundary between the inner and outer worlds. The membrane has a thickness of about 10 nm, regardless of the size of the cell. The membrane is selectively permeable, meaning it acts like a door between the inner and outer worlds. In a similar manner, academic fields and disciplines are surrounded by boundaries, but they are not sealed off spaces like a silo. Some of what exists in the space of the inner world surrounded by the boundary can interact with the outer world.

Critics of inter-disciplinary and multi-disciplinary concepts argue that the world of academia only exists because of these boundaries between the fields of natural sciences, humanities, and social sciences, and once you take away these boundaries, it is no longer an academic system.

However, my concept of trans-disciplinarity is profoundly different from the concept of multi-disciplinarity, and should be understood as a functional membrane that acts as a boundary between fields like the biological cell membrane. Functional membranes that perform active transport require energy for entropy control. This point is very important for trans-disciplinarity. Multi-disciplinarity tends to end in just a jumble of different fields. The bottom line is that this will not result in the hoped for innovation. This point may be difficult to grasp unless you have an on-site understanding of development[*5].

A recent buzzword in science and technology policymaking is “under one roof,” a means of fostering innovation by gathering researchers from different disciplines in a single location in order to bridge and integrate their various fields. The analogy of the “crucible” is also frequently used. The idea is to seal off researchers from various fields together inside one location. However, just bundling together different fields or locking researchers inside a room is not by itself going to create innovation. In fact, thick walls may form even between these new fields. A crucible is a vessel that is heated to a high temperature to input energy and mix together its contents; but the key element is the process that brings about the high heat.

In my case, the quantum mechanics experiments that I was conducting inspired me to create a concept of trans-disciplinarity that went beyond multi-disciplinarity. The mechanism of the transitions that emerge from innovations (new combinations), where random spin is aligned within the field and the spin is inverted by energy input from the outside world, can be captured simultaneously by the two models of classical mechanics and quantum mechanics. At this time, not only is spin inherent to elementary particles, but it also expands to vectors where other quantum numbers overlap. Perturbations (small changes in the energy level due to the Zeeman effect) gain a common field, and in the same way as microscopic changes become coherent in phase and macroscopic changes become apparent, the microscopic spin phases are aligned to produce macroscopic results. A detailed explanation will be provided later, but I believe that this concept of trans-disciplinarity has actually given birth to several new fields*6.

Currently, the trans-disciplinary concept of bridging and integrating different fields is becoming widely accepted overseas. Since the early 1990s, I too have been advocating for trans-disciplinarity across the fields of measurement, environment, and neuroscience by repeatedly holding trans-disciplinary symposiums and publishing papers in international academic journals. I hope it is not too immodest to say that I am very happy at recent trends in the academic world. Some overseas academic societies discovered a paper I published in Japan in 1998 (in English), and they recompiled and published some of its contents in 2001.

[H. Koizumi, “Trans-disciplinarity,” Guest Editorial, Neuroendocrinology Letters, 22, pp. 219–221 (2001)]

***3 What is trans-disciplinary?**

The following is the foreword to the April 1999 edition of the “Seibutsu Butsuri” journal, written by Ryoji Suzuki, Emeritus Professor of Osaka University.

“The term trans-disciplinary has been borrowed from ‘The New Production of Knowledge,’ Trans. S. Kobayashi, Maruzen Publishing Co., Ltd., Tokyo, 1997, (‘The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies,’ SAGE Publications Ltd., California, July 1994), written by Michael Gibbons, Secretary General of the Association of Commonwealth Universities and an expert in science and technology policy. However, I recently learned that Hideaki Koizumi from Hitachi Ltd.’s Central Research Laboratory proposed in 1995 using ‘trans-disciplinary’ as a new term with a different meaning from ‘multi-disciplinary.’ Gibbons’ use is more focused on building a team to fulfill a certain mission, but both he and Koizumi do not simply propose collecting knowledge from two or more disciplines, but rather think the fields can be integrated to create new knowledge.”

***4 Santa Fe Institute**

The Santa Fe Institute (SFI) was founded in 1984 in Santa Fe, USA, by Murray Gell-Mann, Philip Anderson (physics), Kenneth Arrow (economics), and others, based on the ideas of Dr. George Cowan (1920–2012). The institute soon became a focal point for research on complex systems (complex adaptive systems), triggering a new dawn in such research.

***5 Awareness of trans-disciplinarity**

I became aware of this concept naturally soon after graduating, thanks to the support I received almost simultaneously from The Japan Society for Analytical Chemistry (JSAC), The Chemical Society of Japan, The Optical Society of Japan (OSJ), The Japan Society of Applied Physics (JSAP), and international academic associations in these fields.

Everything started for me as an elementary school student with an interest in chemistry and physics. I used to conduct various experiments in the garden of my house with the help of a local pharmacy. When my neighbor heard about this, he took me to meet his instructor, Associate Professor Hiroshi Kametani of the Department of Metallurgical Engineering, the Faculty of Engineering, the University of Tokyo (established in 1879 as the Department of Mining and Metallurgy, the School of Science, the Tokyo Imperial University). I spent the month of my first summer vacation as a middle school student in the basement of Building No. 4 in the Faculty of Engineering, surrounded by the odors of chemicals. From morning to evening, I repeatedly washed various glass analysis instruments (this was just like washing dishes at a restaurant, but it made me familiar with the basics of analysis), and at the same time, I was trained in wet analysis. By the end of the summer vacation, I was able to organize the results of large-scale titration analysis using the reaction between sodium thiosulfate and iodine into graphs using a hand-cranked calculator, and I could work with glass using an acetylene burner. As a reward, I was given an ultra-short wave vacuum tube called the RCA955 (an acorn tube shaped like the planet Saturn) and semiconductor devices, which had only just become available at that time. Using these, I made my own electronic circuits and Lecher line antennas, and quickly obtained an amateur radio license. I feel like the experiences I soaked up that summer formed the foundation of the rest of my life.

Without these experiences, it would have been difficult for me to conduct the analysis work at various institutions in the USA, which I described in the second article of this series. Furthermore, the three-dimensional wiring I learned about when making my own ultra-short wave circuits was directly useful for me later when I was developing a dedicated ultra-high-speed parallel computer for MRI. Three dimensional chips have now also become a focus of semiconductor development.

***6 Siloing between academic fields**

This issue also has deep roots, and I believe was first discussed during the French Revolution (1789–1795), when Marie Jean Antoine Nicolas de Caritat, marquis de Condorcet (1743–1794), proposed and tried out an idea for a network of thinkers called the “Republic of Letters.” He tried to foster collaboration between different fields by focusing on issues such as, (1) Population statistic charts, (2) A recycling society, and (3) Efficient use of energy [E. Rothschild, “Environmental Measurement” in the Trans-disciplinary Forum on Science and Technology for the Global Environment: Environmental Analysis (H. Koizumi; Ed.), pp. 11–21 (1996), Newly Translated Version “Most Advanced Environmental Measurement” Mita Press (1998) in Japanese].

In the conclusion to the results of his trial, he described the difficulty of innovation by bridging and integrating different fields as being “Cyclic Nullity.” Even more than 200 years later, the crux of this difficulty has not changed. I believe that the key is execution rather than theory.

The appearance of new inter-disciplinary academic journals will play an important role in achieving this. This is because such journals are directly linked to the formation of platforms for science and technology, and the emergence of new fields. One result of siloing is that having papers accepted by established authoritative journals frequently becomes the objective of academic research. I believe that a fundamental paradigm shift is required to halt Japan’s decline.

To that end, we need to further consider the issues of diversity and inclusion. The Japanese word for “inclusion” has two equivalents in English. One is the commonly used “inclusion,” and the other is “subsumption.” The second term appears in Karl Marx’s “Capital.” I will explain the importance of this concept later.

Launch of the International Society of Mind, Brain, and Education

In 2004, I helped launch the International Society of Mind, Brain, and Education (MBE) together with Dr. Kurt Fischer (MBE Founding President, 1943-2020) of the Harvard School of Education, Dr. Antonio Battro (member of the Pontifical Academy of Sciences), and others. This society was founded to bridge and integrate different fields in natural sciences, social sciences, and the humanities, and I continued to support the society as a founding director.

In 2007, the society started issuing the MBE Journal via Blackwell Publishing (now Wiley), and I assisted as founding Associate Editor-in-Chief. This was the first attempt to launch such an international inter-disciplinary journal that transcended the boundaries of science and the humanities, and we received the Best New Journal of the Year Award from the Association of American Publishers (AAP). In the very first article of the journal, published under the bylines of the editors and vice-editors, we argued why we thought that such an inter-disciplinary journal was necessary.

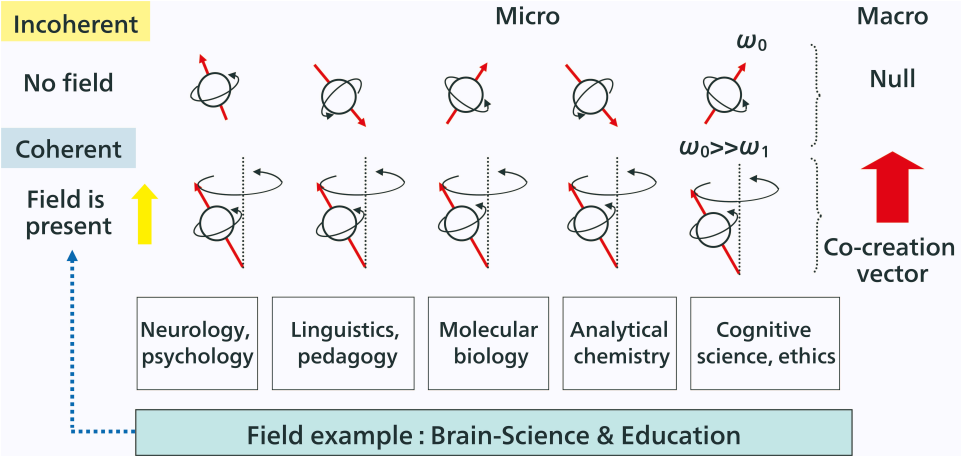
[K. Fischer et al. including H. Koizumi, “Why Mind, Brain, and Education? Why Now?” (March 2007)]

Also, while serving on the international advisory council of national programs in Australia in 2015, I helped launch “Science of Learning,” a sister publication to Nature. This was the era of Dr. Philip Campbell (Editor-in-Chief of Nature from 1995 to 2018), who was the predecessor of current Nature Editor-in-Chief, Magdalena Skipper. Science of Learning was the first academic journal from the Nature Publishing Group (NPG) to focus on the humanities and social sciences field of “pedagogy.” Before we launched the journal, I had many discussions late into the night with Editor-in-Chief Campbell of Nature, and we agreed that the key issue going forward would be the necessity of a “new ethics.” To this end, we are currently working on specific policies together with like-minded people; for example, we added new ethical considerations to the Objectives in the Bylaws of the International Council of Academies of Engineering and Technological Sciences (CAETS).

Even when such inter-disciplinary publications are successfully launched, they are sometimes criticized for being minor endeavors. To be sure, the inter-disciplinary field itself is still in its infancy and may appear small.

However, the “Engineering” journal (Elsevier) launched in 2015 is an inter-disciplinary academic journal, which at the time of writing (2022), has already reached an Impact Factor (an index measuring the quality of an academic journal) of 12.784. The most popular academic journals are Nature and Science, and the next is thought to be the Proceedings of National Academy of Sciences (PNAS). Currently, the Impact Factor of PNAS is 12.779. The Editors-in-Chief of the Engineering journal are Professor Raj Reddy and Professor Ji Zhou, and this invaluable academic journal could be launched in such a short period of time thanks to their passion. In my role as Associate Editor-in-Chief, I have continued to offer my support for this publication while promoting the importance of trans-disciplinarity.

Figure 6—Bridging and Integration of Perturbed Parts



H. Koizumi, “Trans-disciplinarity”, Guest Editorial, Neuroendocrinology Letters, 22, 219-221,（2001）

Here, the concept of trans-disciplinarity is used to show the principle behind the emergence of a new educational field based on brain science (Brain-Science Based Education). A diagram that was originally created to explain physical phenomena based on the quantum effect of magnetic resonance in terms of classical physics has been applied to describe the emergence of a new field of pedagogy within the social sciences and humanities.

Bell Laboratories and fMRI

Bell Laboratories, commonly known as Bell Labs, has its origins in the activities of Alexander Graham Bell (1847-1922), inventor of the telephone. It is a world-renowned research institute that has already won seven Nobel Prizes. At the dawn of MRI technology in the 1980s, research was led by an international conference called the Society of Magnetic Resonance in Medicine (SMRM). Every year, I met a Japanese researcher from Bell Labs who attended this conference, Dr. Seiji Ogawa. Dr. Ogawa was conducting research by putting rats into an MRI machine designed for small animals. One time, it seemed as though an anesthetized rat was on the brink of death, so he urgently pumped in oxygen gas to continue the test. This resulted in large changes in the cross-sectional images of the brain before and after he did this. Blood vessels particular to rats, which had been clearly visible up to then, disappeared from the image. I believe that this experiment by Dr. Ogawa was the first in the world to discover the principle of fMRI. Later, after he published a paper in PNAS, Dr. Ogawa used a machine made by Professor Kamil Ugurbil of the University of Minnesota with the world’s most advanced MRI for humans (magnetic field strength: 4T) to successfully observe activated regions of the human brain (1992). While it is difficult to understand unless you see the actual on-site conditions, fMRI is just one type of MRI, and no special parts need to be added to the machine. The activated regions of the brain can be shown by subtracting the image with the visible blood vessels discovered in the rat experiment and the image where the blood vessels are not visible.

Applying this method in human psychological measurements requires a high-performance MRI machine. Research centers at Hitachi also conducted research, with the Hitachi Research Laboratory and Hitachi Works developing a whole-body high magnetic field superconducting magnet with a magnetic field strength of 2.1T. Trans-disciplinarity was crucial to the success of the Central Research Laboratory and the Hitachi Medical Corporation of the time in developing an fMRI product.

Many people who previously had no connection to MRI brain function measurement came into the field. When fMRI imaging made frequent appearances on the front pages of the famous journals Nature and Science, I then started to receive more requests to hold similar symposiums.

In January 2000, we held another Trans-disciplinary Symposium on the progress of brain science over the previous five years, bringing together experts from industry, government, and academia for an even wider perspective, and focusing on brain function measurement. We invited Masao Ito (1928–2018), the first Director of RIKEN Brain Science Institute (BSI) established in 1997, to give the special lecture. Dr. George Cowan, founding director of the Santa Fe Institute (SFI) in the USA, which is famous for its research into complex systems, also came to Japan to participate. We used this opportunity to discuss the concept of "Brain Science and Education."

Although it is not widely known, Dr. Cowan told us that the ultimate purpose of the SFI is education research. [H. Koizumi, et al., Ed., "The Proceedings of the Transdisciplinary Symposium on the Frontier of Mind-Brain Science and Its Practical Applications (II)" (2000)]

At an international conference on global environmental issues based on measurement and analysis held in 1996 that I previously mentioned, there was a session called "Interactions between the environment and brain." Expanding from this session, in 2000, as part of my role as Executive Chairman of the Trans-disciplinary Forums of the Ministry of Education, Science and Technology Agency, and Japan Science and Technology Agency (JST), I organized an international conference titled "Brain Science and Learning/Education" to incorporate brain science into the fields of education and childcare as we looked forward to the 21st century. This triggered many new discussions and findings in the fields of learning and education*7.

New fields often emerge independently and spontaneously from completely different organizations at the same time. In this field as well, Brain Science and Education originally emerged from a conference on the environment held in Japan in 1996. The concept we devised at the time was as follows: "Learning is the process of building new neutral circuits through external stimuli from the environment (all stimuli other than oneself). Education is the process of controlling and complementing external stimuli from the environment." I believe that this new concept made it possible to deal with learning and education from the standpoint of the natural sciences.

In 2023, a new government body called the Children and Families Agency (Cabinet Office) will be established. Preparations are also being made to hold an international conference about childcare and child rearing this same fiscal year. I am spending some time helping out with the latter event, in the knowledge that children are our future. It is my fervent hope that we can develop systems designed earnestly and substantively for the benefit of children as much as possible*8.

***7 Brain Science and Education**

In the USA, the Harvard School of Education established their Mind, Brain, and Education department at the end of the 1990s, and an international association was launched in 2004. In 1999, a preparatory meeting for an international conference was held at the Center for Educational Research and Innovation (CERIA), which is affiliated with the Organisation for Economic Co-operation and Development (OECD) Education Directorate. A key figure in this was Bruno della Chiesa, an OECD diplomat and sociolinguist.

Non-invasive brain function imaging was first developed in the early 1990s, and this coincided with the start of preparations for interpreting the intracerebral mechanisms of learning.

In retrospect, however, I believe that the intra-disciplinary collaboration between Dr. Toshihiko Tokizane [(1909–1973), Professor at the University of Tokyo], author of the famous work, "Brain and Childcare" [(1974), published posthumously] and Dr. Jushichiro Naito [(1906–2007), the first President of the Japan Pediatric Association and Director of Aiiku Hospital], which started at the Director's Aiiku Medical Office, was the true origin of this field of Brain and Education/Childcare. This is something we can be proud of around the world.

When the OECD was first founded in 1961, it was composed of 18 countries that believed in free market economics. In 2000, 12 more countries joined to make a total of 30 members, including Japan. Today, the number of members stands at 38. In 2020, the OECD celebrated the 60th anniversary of its foundation. The theme of the OECD Forum in 2002 was to return to the fundamental principles of the OECD in terms of security, equality, education, and growth. (OECD Forum 2002 Highlights: Taking care of the fundamentals: Security, Equity, Education and Growth)

This forum saw the official launch of a major OECD program lasting almost a decade, called "Learning Sciences and Brain Research." In this series, I would like to describe the background and results of this program, which was implemented based on collaboration with the world divided into three blocks (North America, Europe, and Asia-Oceania).

***8 Children are our future**

Years ago, there was a Japanese person whose child became a bridge between West and East. Her name was Mitsuko, Countess of Coudenhove-Kalergi (née Mitsuko Aoyama, 1874–1941). The cemetery of the Aoyama family is at Shorenji Temple near my home, so I became intrigued by her story. It is said that on a cold winter morning, Mitsu (later Mitsuko), the daughter of a major landowner and antique dealer, took care of an injured foreigner after his horse slipped on the icy road (although there are many theories for how they met). This man was Count Heinrich Johann Maria von Coudenhove-Kalergi (1859–1906), a diplomat who had been posted to Tokyo by the Austro-Hungarian Empire. For Mitsuko, it was love at first sight, and they soon married. She gave birth to their first and second sons in Tokyo, and after that, she lived in an old castle on Count Coudenhove-Kalergi's lands and also in Vienna. Without any previous knowledge, she dedicated herself to studying the West's languages, customs, and academic disciplines, and she became a member of the European aristocracy. Her second son, Eijiro or Richard von Coudenhove-Kalergi (1894–1972) obtained a doctorate in philosophy and wrote a famous work called "Pan Europeanism" (one of the books burned by Hitler). This book was globally influential and is said to have been one of the inspirations for the European Union (EU). I was very interested to find out that Mitsuko's second child, Richard, who she also gave the Japanese name of Eijiro, created the basic concept of the EU, and that he proposed using Beethoven's "Ode to Joy" as the European anthem. The EU actually adopted this piece from Beethoven's Ninth Symphony and continues using it to this day. Richard lived through an extremely complicated period of history from the First World War to the Second World War, and he acted as a bridge between West and East. His actions influenced the direction of future events such as the current Russian invasion of Ukraine, the formation of the North Atlantic Treaty Organization (NATO), and the UK's withdrawal from the EU (Brexit).

Russia's largest women's organization, the "Committee of Soldiers' Mothers of Russia" (Union of the Committees of Soldiers' Mothers of Russia: Союз комитетов солдатских матерей России, a union of 300 committees) has had a huge impact within Russia. Recently, it has been said that some organizations belonging to the union have issued open letters condemning the Russian government's invasion of Ukraine (Jiji Press, Ltd., November 29, 2022). As we saw in the case of Mitsuko Aoyama, a mother who is willing to sacrifice herself for her children with a strong desire for peace is a great thing to behold.

The essential role of mothers in securing the future of children was emphasized by Dr. Noboru Kobayashi [(1927–2019), President of the International Pediatric Association (IPA), Honorary Director of the National Children's Hospital, Professor Emeritus at the University of Tokyo] in one of his final books, "Motherology" (Aprica Childcare Institute, 2015). Dr. Kobayashi founded The Japanese Society of Baby Science (JSBS) in 2001 and he devoted himself to research on early childhood development that would enable a comprehensive understanding of the essence of human beings.

I have so many great memories of Dr. Kobayashi. One that stands out was during the period when Junichiro Koizumi was Prime Minister (2001–2006). Mr. Koizumi invited Dr. Kobayashi to the Prime Minister's Official Residence for direct discussions about education policy. I accompanied Dr. Kobayashi while carrying one sheet of paper on which I had summarized the future of education. I would like to describe this document and its results later. Education is the starting point not only for academia, but also for everything else as well, including government policy, economics, and industry. I had the honor of writing words of commendation for Dr. Kobayashi's work, "Motherology," as well as for "Childcare Basics: The Japanese Method" (Aprica Childcare Institute, 2021, winner of the 2022 Good Design Award), written by Jushichiro Naito, whose research was supervised by Dr. Kobayashi. Also, when JSBS was founded more than 20 years ago, I learned a lot in my support role as Founding Vice President.

Building the Future on a Warmhearted Foundation

So far in this series, we have taken a bird's eye view of the challenges faced by modern society, including the pandemic, the Ukraine crisis, planetary boundaries, capitalism and economic inequality, the importance of trans-disciplinarity, and new educational methods, and the future of our children. As we ponder all these issues, I believe that our post-COVID-19 and post-Ukraine society will provide us with the opportunity to achieve Human Security and Well-being.

Recently, I often hear the word "backcasting" being mentioned. This is a technique where you first define the desired future, and then work back to the present by establishing an approach for achieving this future. This method was used for environmental policy in Sweden in the 1990s. Backcasting as a concept is paired with forecasting, with backcasting like casting a fishing rod in the backward direction and forecasting casting it forward. I prefer to express this pair of concepts as "looking back from the future." This was also an idea suggested by Dr. Taro Takemi about half a century ago. He told me that he was inspired by the concept of Pramana (reasoning) in the Nyāya school of ancient Indian logic. He told me that we must first understand past data to gain an accurate awareness of the present, and then derive the expected future based on this. We should deeply contemplate the future world that we expect, then further reflect the results of this in our present, and by controlling the present, lead ourselves to a better future. (Dr. Taro Takemi had already outlined these concepts during talks in the 1970s.)

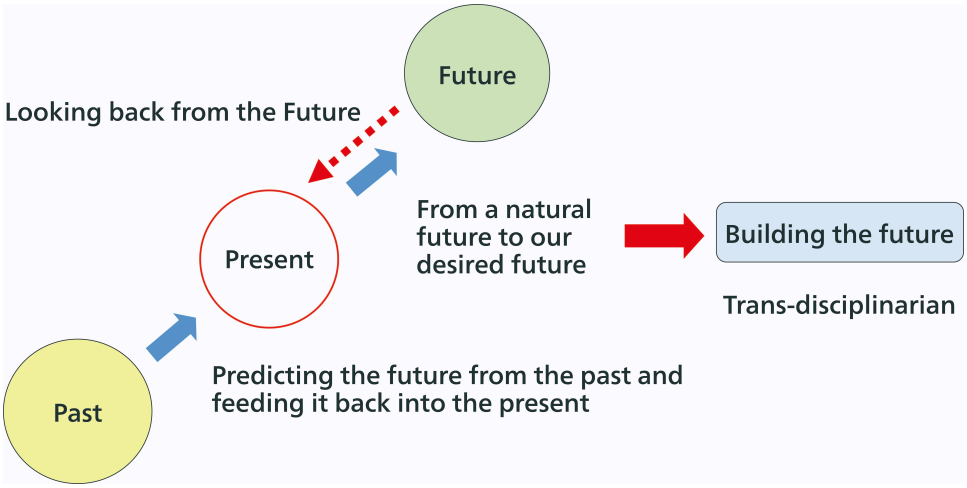
I believe that it was the acquisition of language that made it possible for the human race to form a concept of the "future" and to think deeply about the kind of future that we want. A unique characteristic of the language developed by modern humans is that it enables us to speak not only of things that are happening now, but also past and future events, as well as hypothetical theories and fictional stories. Other animals do not possess a language and cannot freely form ideas that extend from the present into the future, which would enable them to plan future actions, even though their genes contain information captured repeatedly in the past.

Dr. Tetsuro Matsuzawa (primatologist and former Director of the Primate Research Institute, Kyoto University) told us at a joint symposium that chimpanzees, the closest relatives to humans, only have a concept of “now.” Only modern humans can use the power of language, not just to describe a static future in which we have no agency, but also to imagine a future we create ourselves. I think we always need to remind ourselves of this fact.

Considering how self-centeredness has become so rampant from the past to the present, with selfish development of resources and technology, and how today’s social problems have been caused by unfettered competition with no sense of responsibility, in order to build a future that overcomes the challenges we face, we need to take an approach that is the opposite of what we have followed up to now. It is essential that we rediscover our forgotten spirit of altruism and promote policies, research, development, and innovation that have an ethical basis.

(Listening to locals is key to building Society 5.0　)

Figure 7—Concept of Looking Back from the Future



Hideaki Koizumi, “Requirements for Science and Technology,” Hitachi, Ltd. 100th Anniversary Commemorative Lecture (2010)

So, what do we mean by “ethics”? Generally, ethics are understood as being “principles that should be followed,” but for many years, I have believed that this word has a deeper meaning. I came to see ethics as being “warmheartedness” from the writings of Dr. Hajime Nakamura, a leading authority on Indian philosophy. I was instructed in these matters over the last 20 years by many scholars of Eastern philosophy, and by experts from each of the three major Western religions, including Vatican scholars. I would like to discuss this later, in addition to the new “universal ethics” based on the natural sciences.

But first, I would like to clarify one issue. In the field of pre-sectarian Buddhism, there is a field that researches the oldest type of Buddhism, called earliest Buddhism or primitive Buddhism, but the discussion of life after death or the end of universe is deliberately avoided. The real world is full of matters that require our immediate action. This way of thinking corresponds to a philosophy. It is different from a religion, which is an axiomatic system.

I believed that this learning could be approached with a similar method as research on physics. However, the earliest Buddhist texts were arranged into the English and Pali languages by The Pali Text Society in the UK more than 100 years ago. I never thought that I would be studying Buddhism in English. Many people, including the Chinese monk Xuanzang, went through great hardships to bring home a large number of sutras and translate them into Chinese, and versions of these entered Japan as well. In fact, this approach is similar to a methodology used to identify the evolution of species from DNA fragments using AI in projects that are currently underway. This is because searching for fragments of ancient texts from the earliest Buddhist texts that entered Japan via a circuitous route from northern Tibet and others in the Pali language that survived via southern Sri Lanka is a similar physical methodology.

Regarding ethics, this issue is the background drum beat to this entire series, and I would like to continue discussing it next time.

Generally, it is thought that ethics and laws often originated in customs. I think we can say that in older times, cultural beliefs such as religion and customs were strong. However, as I have previously described in this series, the terrestrial biosphere is just a thin zone of life clinging to our planet’s surface like the film of soap bubble. A long time ago, carbon dioxide was the main component of our atmosphere, but about 3 billion years ago, cyanobacteria (blue-green algae), a living organism, started converting carbon dioxide to oxygen. After a long time, oxygen became one of the main components of the atmosphere. Then, the single species of modern man started to grow exponentially, and our human artifacts filled up this narrow space in the biosphere, resulting in what some people term the Anthropocene epoch.

In response, new ethics and laws are needed that are based on the perspectives of science and technology. Looking at greenhouse gases, for example, emissions from human science and technology sources are starting to exceed those from natural sources. The climate crisis and rising sea levels have also become real problems. Meanwhile, Russia’s invasion of Ukraine, where modern humans are fighting each other, has resulted in huge expenditures of explosives and fuel used for destruction, and cities have been horribly damaged. Recovering from this destruction will require huge amounts of energy and entropy to be consumed.

In other words, it has become impossible for us to talk about ethics without mentioning science and technology. As we take a further step forward, advances in science have slowly revealed the regions of the brain that govern the thinking functions of modern humans. We are becoming able to consider the roots of ethics and laws while verifying scientific evidence. I believe there is a good chance that a more universal system of ethics and laws will appear from this. In the future, I would like to continue my observations based on “primary sources of information” and “on-site” data.

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