

Chapter 2 Creation and Use of Convergence of Knowledge to Address Social Challenges

Rapid development of science and technology in recent years has delivered many benefits to our everyday life, while at the same time causing a large effect on the state of human beings and society. Development of science and technology has been closely and inseparably related to the state of human beings and society. For this reason, in order to examine what future science, technology and innovation policies should be including solution of increasingly complex social challenges, it is necessary to comprehensively use the knowledge in the natural sciences and the knowledge in the humanities and social sciences, and explore a desirable future for human beings and society and well-being for each and every person.

Section 1 Fusion of Knowledge in the Humanities and Social Sciences and Knowledge in the Natural Sciences

① What are the Humanities and Social Sciences?

The humanities and social sciences study human beings and society. Examples are philosophy, sociology and jurisprudence. The revised Basic Act on Science, Technology and Innovation that was enforced in April this year covers matters that concern only the humanities and social sciences and that were not covered in the past. The act also presented a direction to address social challenges, which comprehensively uses the knowledge of every field. This indicates the need for fusion of knowledge in the humanities and social sciences and knowledge in the natural sciences to comprehensively understand human beings and society and address their challenges.

② Reasons for the Need for Fusion of Knowledge

There are the following three major reasons for the need for fusion of knowledge in the humanities and social sciences and knowledge in the natural sciences (“Convergence of Knowledge”).

<Response to increasingly complex social challenges>

In order to address increasingly complex social challenges including an aging society with fewer children, spread of infections and realization of an inclusive society, it is necessary to comprehensively understand diverse aspects of human beings and society. Furthermore, it requires convergence of knowledge creation and use by taking advantage of knowledge in the humanities and social sciences in addition to state-of-the-art natural science R&D.

With the development of globalization of society, digitalization, AI and life science, the state of human beings and society which is studied by the humanities and natural sciences is greatly changing. This makes the development of science, technology and innovation inseparable from the state of human beings and

society. At the same time, research methods of natural sciences including functional brain imaging and analysis of diverse data of social life are increasingly used in the humanities and social sciences. It is required to promote transdisciplinary research for creation and use of “Convergence of Knowledge.”

<Recognizing a desirable future of human beings and society and setting challenges to address>

In the midst of the rapid development of science and technology including genome editing and automated driving using AI, it is important for science, technology and innovation policies to create an image of a desirable future for human beings and society and promote measures under the vision. For example, “fusion of cyberspace and physical space” that is a premise of Society 5.0 involves a risk of violation of fundamental human rights as a result and uneven distribution of wealth caused by data accumulation. For this reason, it is necessary to establish a “human-centered society” as the central value before promoting R&D toward realization of well-being of each and every person and a sustainable society. Under this vision, it is also important to accurately recognize current and future social challenges and set the challenges to address before promoting R&D. For this creation of future visions and values, recognition of social challenges and setting of the challenges to address, it is important to have dialogues and collaboration of diverse relevant parties including humanities and social science researchers.

<Response to Ethical, Legal and Social Issues>

Problems such as where the legal responsibility of accidents caused by automated driving lies have become a reality. For the spread of new technologies in society and their evolution into innovations, it is necessary to understand challenges in terms of ethics and social acceptance, which include the need to develop legal systems and address gaps between the technologies and values of people and improve the environment for their acceptance. The response to ethical, legal and social implications/issues (ELSI) is absolutely essential for science, technology and innovation policies. Examination of the desirable state of R&D results and human beings and society requires a comprehensive view through fusion of knowledge in the humanities and social sciences and knowledge in the natural sciences.

In a survey of researchers of universities and public research institutes in 2020¹, to the question asking about changes in the need for knowledge in the humanities and social sciences in their research field (natural sciences) compared with 5 years ago, 30% of the respondents answered “increased” while only 4% answered “decreased.” To the question asking their actual experience of using knowledge in the humanities and social sciences, 22% of the respondents answered “have experience.” The result suggests increasing need for “Convergence of Knowledge” among researchers.

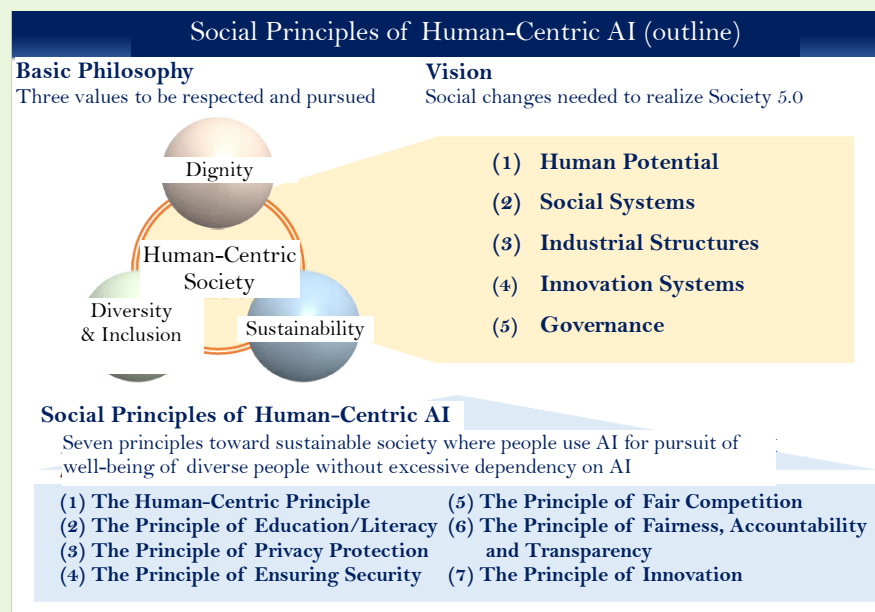
¹ Analytical Report for NISTEP Expert Survey on Japanese S&T and Innovation System (NISEP TEITEN Survey 2020) NISTEP REPORT No. 189, by MEXT National Institute of Science and Technology Policy (NISTEP) in April 2021 (<https://doi.org/10.15108/nr189>)

The ministry will strive for a safe and secure society that realizes well-being of each and every one by improving and reinforcing science, technology and innovation policies from the perspective of “Convergence of Knowledge” and deploy them in an evolved form.

Column 1-3 Social Principles of Human-Centric AI

Artificial Intelligence (AI) is a fundamental technology absolutely necessary for the realization of Society 5.0. Use of AI is expected to contribute to the solution of social challenges including aging society, labor shortage and depopulation. On the other hand, pursuit of convenience using AI could cause excessive dependence of humans on AI and use of AI for controlling human behavior. It is necessary to handle AI as a tool to create a society that helps fulfill various human potentials to realize well-being of each and every person. With the aim of promoting R&D on AI, we need to set objectives, namely “for what purpose do we use AI.”

In order to promote appropriate and active social implementation of AI, the government established “Social Principles of Human-Centric AI” as basic principles that should be noted by stakeholders. Not only natural science researchers but also various experts including legal philosophers and lawyers took part in the establishment of the principles. The principles present a vision of a change into an “AI-Ready society” that is a society that uses AI effectively and safely under the basic principles of human dignity, diversity/inclusiveness and sustainability. “Principle of Education/Literacy” that is one of the “Social Principles of Human-Centric AI” states that it is important for AI developers “to be well grounded in the humanities including social sciences and ethics, which include business models and normative consciousness.”



Social Principles of Human-Centric AI
 URL:
<https://www8.cao.go.jp/cstp/english/humancentricai.pdf>

Social Principles of Human-Centric AI (outline)
 Provided by Cabinet Office

③ International Trends

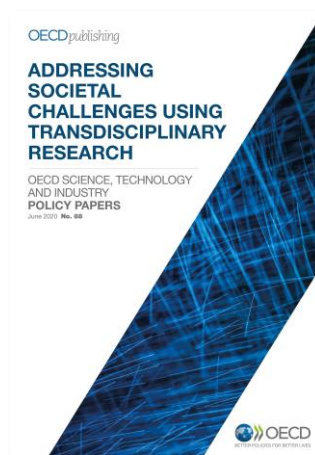
The importance of transdisciplinary cooperation between the natural sciences and the humanities and social sciences to address increasingly complex social issues is pointed out abroad as well.

For example, the Organisation for Economic Co-operation and Development (OECD) compiled a report on initiatives "Addressing Societal Challenges Using Transdisciplinary Research"¹ in June 2020.

The report suggests that for diverse stakeholders to achieve a common goal when society is rapidly changing with the

development of science and technologies, it is important that researchers of various disciplines and non-academic stakeholders including community residents, enterprises and governments make transdisciplinary efforts. It also pointed out the need for better integration of the natural sciences and the humanities and social sciences, a more direct relationship between science and society, and inclusion of non-academic stakeholders in research processes at all stages.

■ Figure 1-2-1 Addressing societal challenges using transdisciplinary research ■



Source: OECD



OECD website
URL:
<https://doi.org/10.1787/0ca0ca45-en>

④ Initiatives for Advancement of the Humanities and the Social Sciences

Diversity and excellence of knowledge in the humanities and social sciences are essential for creation and use of "Convergence of Knowledge" to address social issues.

For this reason, in addition to the promotion of research based on the intrinsic motivation of individual researchers by providing KAKENHI, it is important to establish a research support system where humanities and social science researchers lead initiatives on tackling research subjects in order to address social issues.

MEXT started the Project for Co-creating Academic Knowledge Centered on the Humanities and Social Sciences in FY2020. Under this project, humanities and social science researchers lead initiatives to build an environment for development of research subjects and form teams by gathering the knowledge of natural science researchers and diverse stakeholders including industry and civic society to address issues that will face future society (1. desirable state of society and human beings based on the future demographics; 2. overcoming divided society, and; 3. creation of values to form new human society). Under

¹ Its provisional Japanese translation can be viewed at the website of the Center for Research and Development Strategy

this project, in the light of the increasing importance of questions about what is “life” and its good state in an “age during and after the COVID-19 pandemic,” Osaka University is making efforts toward a “society that values life” while ensuring wide and open communication with diverse stakeholders in Japan and abroad.

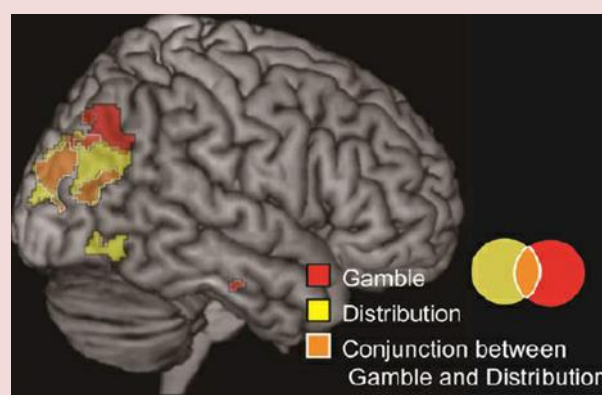
Column 1-4 Approach to the Principle of Social Justice by Brain Science

Widening disparity and poverty are often pointed out as issues facing modern society. How to distribute wealth to the disadvantaged? What tax systems do we need to create an equal society? Society is flooded with questions about just states of human beings and society, and about justice.

Under a research project led by Professor KAMEDA Tatsuya of the University of Tokyo, researchers of psychology, economics, legal philosophy and ethics studied universal subjects of the humanities and social sciences including uneven distribution of wealth and disparity by forming a transdisciplinary team with brain science researchers specialized in the neural mechanisms of decision making and information science researchers who have built a computation theory model of learning and recognition.

This research that used the brain imaging method called functional magnetic resonance imaging (fMRI) discovered “common neural circuits that spontaneously react to disparity and the most unfortunate condition” in human brain beyond individual ideology and opinion differences.

The result agrees with the idea that political philosopher John Rawls advocated in *A THEORY OF JUSTICE*: “the principle that maximizes the welfare of the worst off is unanimously adopted as the right principle of distribution.” It reveals that interest and concern about the unfortunate are commonly equipped in human minds and will serve as the basis for how to approach social issues including widening disparity.



Result of fMRI experiment showing activation of temporo-parietal junctions is visualized using a standard brain image
Provided by Professor KAMEDA Tatsuya of the University of Tokyo



Video of a lecture by Professor KAMEDA Tatsuya of the University of Tokyo
URL: https://ocw.u-tokyo.ac.jp/lecture_1708/?interface_language=en

Section 2 Examples of Initiatives to Address Social Challenges through Fusion of Knowledge

This section introduces specific examples of the initiatives to realize well-being of each and every person by using “Convergence of Knowledge” to address social challenges including support for people with dementia or developmental disorders, and preservation and presentation of valuable cultural assets.

① Initiative toward Dementia-friendly Society through Co-creative Art Activities¹

As people live longer, the number of people with dementia continues to increase across Japan. It is necessary to address challenges of everyday life facing these people in order to aid their social participation and well-being. An initiative toward a livable society in for everyone even after becoming demented is underway in Fukuoka (Fukuoka City, Fukuoka Prefecture) in cooperation among a medical institution, a university, a welfare department, a private enterprise and a non-profit organization.

It is suggested that people with dementia can have rich emotional responses despite lowered cognitive functions. Based on the achievements undertaken by the faculty of design at Kyushu University, the initiative developed a method to break the fixed relationship between “those cared-for” and “the carers” through music, drama and other creative expressive activities where “there is no correct way to do” together with various people including artists and “carers.” The initiative has led to the systematization of know-how based on knowledge in the humanities and social sciences. The team also considers verifying the effects of these art activities based on the natural sciences by using image analysis, etc. The initiative aims to create a scenario to form a livable society in for everyone even after becoming demented.

■ Figure 1-2-2 Workshop “Physical Expression and Care” of Social Art Lab at Kyushu University Faculty of Design ■



Provided by Ms. TOMINAGA Akiko



JST Research Institute of Science and
Technology for Society (RISTEX)
https://www.jst.go.jp/ristex/solve/project/scenario/scenario20_uchidapj.html

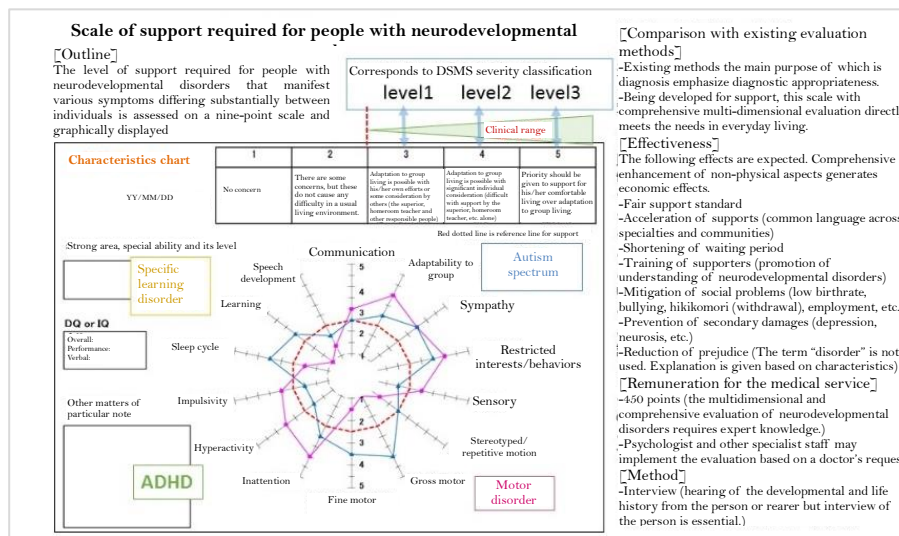
¹ RISTEX Project to “Scenario development of co-creation with multi-stakeholders towards a dementia-inclusive society” (Principal Investigator: UCHIDA Naoki, Director of Medical Corporation Suzurankai TARO Clinic.) In order to address social issues, JST Research Institute of Science and Technology for Society (RISTEX) promotes R&D using knowledge of the natural sciences, humanities and social sciences in cooperation with various stakeholders to create a new social system (social mechanism, institution, communities, etc.)

② Project across the Medical, Educational and Social Fields to Support People with Neurodevelopmental Disorders (Spread of an Evaluation Tool)¹

People with neurodevelopmental disorders including autism spectrum disorder sometimes have difficulties such as social communication problems in everyday life and social life, due to inherent characteristics in a part of their brain functions which vary greatly from person to person. Support for people with neurodevelopmental disorders can be not completed in medical settings but needs to be provided in various places including home, education, welfare and the regional community. However, it has not been easy to form common understanding including the level of necessary support among wide-ranging people involved because the manifestation of disorders is complex and different from individual to individual. In order to address this challenge and widen the circle of support, a radar chart has been developed to assess the level of support required for the person based on psychiatry knowledge, hearing and behavior observation of the person and cognitive function analysis, and to show the results in a way the person and the supporters can see at a glance.²

In order to spread the radar chart to medical, educational and social settings, researchers of medicine, psychology and other fields in cooperation with various persons involved including doctors, licensed psychologists and other psychology supporters and teachers sorted challenges of actual support and developed an evaluation support manual for each life stage of people with neurodevelopmental disorders together with a seminar program for evaluator training. As a result, the radar chart was covered by medical insurance in April 2016 and its use is steadily expanding in medical institutions and other places in Japan. The radar chart is also used in foreign countries including China, Germany and Brazil and its use is expected to expand in the world.

■ Figure 1-2-3 Multi-dimensional Scale for PDD and ADHD (MSPA) ■



SENSEI Theater, Kyoto University
"From Study of Developmental Disorders to Mental Health in General"
<https://www.youtube.com/watch?v=nPO4xCEyMec>

Provided by Graduate School of Human and Environmental Studies, Kyoto University

¹ RISTEX Project to "Practical Utilization of Multi-dimensional Scale for PDD and ADHD (MSPA) across the Medical, Education and Social field" (Principal Investigator: FUNABIKI Yasuko, Associate Professor of the Graduate School of Human and Environmental Studies, Kyoto University (at the time))

² Scale of support required for people with neurodevelopmental disorders: MSPA (Multi-dimensional Scale for PDD and ADHD)

③ Project toward Development and Social Implementation of Automated Driving System Accommodating Cultural Values of Japanese Society¹

For social implementation of emerging technologies including automated driving, it is essential to address ethical, legal and social issues (ELSI). For this reason, technology development and empirical study are conducted with the aim of proposing a social implementation model of emerging technologies through co-creation of development of automated driving technology and consideration of ELSI.

■ Figure 1-2-4 Demonstration Experiment of Automated Driving Car ■



Provided by the Institute of Industrial Science, the University of Tokyo



Citizens' Forum "Ride, talk and think
- Future Kashiwa viewed from a self-driving bus"
https://www.u-tokyo.ac.jp/focus/ja/events/z0205_00142.html

A well-known example of ELSI regarding automated driving technology is “who is responsible for an accident caused by automated driving, the developer of the vehicle or the person riding in it?” Researchers make in-depth examination of ELSI of automated driving technology by incorporating the knowledge of the humanities and the social sciences including historical sociology and ethnology to analyze the history of the acceptance of automobile as a new technology, changes in cities and society, and the morals of “mobility.” Through the examination, the team is exploring approaches of technology development and implementation of automated driving systems as an infrastructure which takes into account the cultural values of Japanese society.

④ Project toward a Spiritually Rich Society through Integration of Art and Science and technologies

The COI Site of Tokyo University of the Arts² is exploring the potentials of social implementation of arts in various fields through integration of art and science and technology, and in cooperation with education, medical care and welfare industries toward a society that is both physically and spiritually rich.

<Project to Build a Respected Nation through Promotion of Culture Diplomacy and Culture Sharing: Clone Cultural Properties>

The “Clone Cultural Properties” project is a new method to carry on culture by addressing the challenge of storing and displaying valuable cultural properties around the world and “reproducing” lost cultural

¹ RISTEX Project to “Building the Method for Social Implementation of Automated Driving Technology Complying with Actual State Based on ELSI” (Principal Investigator: NAKANO Kimihiko, Professor of the Institute of Industrial Science, the University of Tokyo).

² The Center of Innovation Program (COI program) is a project to develop a base for continuous innovation creation. For this purpose, R&D tasks to tackle are set based on the ideal society after 10 years and interested people from universities, enterprises, etc. work on the R&D from the stage of basic research together in one building.

properties. The project promotes culture diplomacy and sharing by using each cultural property as a one-and-only resource.” “Clone Cultural Properties” is an approach to physically reproduce original cultural properties by integrating state-of-the-art digital technologies including 3D printing and traditional analog techniques of artists and artisans to reproduce texture and touch.

The project was proposed at the G7 Ise-Shima Summit and has displayed “Clone Cultural Properties” in Japan and abroad, which include the destroyed ceiling mural of the Buddha in Bamiyan, the Dunhuang Mogao caves that are difficult to open to public and the statues of Shaka Triad in Horyu-ji temple that are not allowed to be taken out. Furthermore, the first start-up company originating in the Tokyo University of the Arts was established to deploy the results.

<Bring the Power of Emotion to Education, Medical Care and Welfare: “Daredemo Piano (Everyone can play piano)”>

The Tokyo University of the Arts tackles research to realize a rich society where people with and without disabilities can share music and emotion. In this project, the university together with YAMAHA Corporation have developed “Daredemo Piano”¹. When you play a melody using one finger, accompaniment and pedal operation automatically follow in accompaniment with the playing. Because everyone can play splendidly like a pianist, it is widely enjoyed not only by people with disabilities but also by children and adults who touch a piano for the first time.

■ Figure 1-2-5 Explaining the clone cultural property technology at the G7 Ise-Shima Summit ■



Provided by Tokyo University of the Arts

■ Figure 1-2-6 Experiencing “Daredemo Piano” ■



Provided by Tokyo University of the Arts



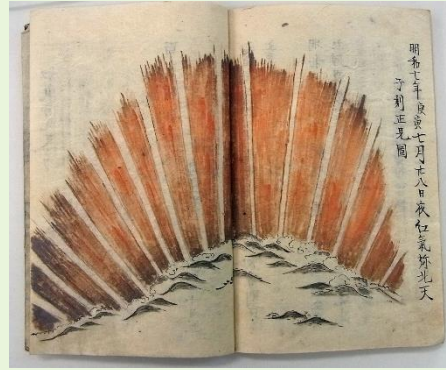
Introduction of research group activities: COI Site of Tokyo University of the Arts
<https://www.youtube.com/watch?v=siufKBkGZQU>

¹ Patent number: 6744522

Column 1-5 Space Physics Discovery through Analysis of Japanese Classics

When an explosion occurs on the Sun (Solar flare) and causes enormous amounts of matter in the plasma state to reach the Earth, the magnetic field of the Earth temporarily weakens. This phenomenon is called a “magnetic storm.” Magnetic storms can cause damages including massive blackouts and failures of artificial satellites, which gave rise to the term, “space hazard.”

When a big magnetic storm occurs, sometimes an aurora can be seen even in low-altitude areas. A history researcher discovered a description that “an aurora covered the Milky Way” in a diary housed in a shrine in Kyoto. Based on the description, a space physicist reproduced an aurora viewed from Kyoto. Its shape is much the same as the aurora drawn in *Seikai*, an already known pre-modern Japanese text. This indicates that the aurora viewed from Kyoto at the time was not the edge of an aurora in a distant sky but a huge aurora spreading to the zenith above Kyoto. This discovery generated another space physics discovery that the magnetic storm that occurred in 1770 when the diary was written and that caused the aurora was equal to or bigger than the magnetic storm of 1859 that was said to be the biggest in recorded history.



The aurora in 1770 as drawn in *Seikai*
Housed in Matsusaka City Local Archives Office
Provided by Matsusaka City (Mie)

Another research project based on pre-modern Japanese text compared the descriptions of “*sekki*” (aurora) in *Meigetsuki*, a diary written by Fujiwara no Teika from the 12th to the 13th century, which is the period when auroras were easiest to observe from Japan in the past 2,000 years, and the description of *sekki* repeatedly recorded in *Sòng Shǐ* that is a history book of the Song Dynasty of China, with measured data of carbon isotope ratios of tree rings. As a result, it was found that many prolonged and red auroras were observed during the 11-year-cycle high activity periods of the sun.

These research results by cooperation among humanities and social science researchers and natural science researchers are important for developing specific measures against possible “space hazards” in the future.



Charting the skies of history -Japanese scientists reconstruct space
history with ancient texts (Published in March 2017)
<https://www.nipr.ac.jp/english/info/notice/20170705.html>



Observations of Red Aurora over 1770 Kyoto Help Diagnose
Extreme Magnetic Storm (published in September 2017)
<https://www.nipr.ac.jp/english/info/notice/20170928.html>