MOONSHOT

RESEARCH & DEVELOPMENT PROGRAM

2022.Sep

Moonshot R&D Program
Overview

Here begins our new MIRAI

MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

9 GOALS

To tackle important social issues including our shrinking and aging societies, global climate change and extreme natural disasters, the Moonshot R&D Program is pursuing disruptive innovations in Japan and promoting challenging R&D based on revolutionary concepts. The program's research aims to achieve nine ambitious Moonshot Goals.

1 Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.

HAGITA Norihiro Chair and Professor, Art Science Department, Osaka University of Arts

2 Realization of ultra-early disease prediction and intervention by 2050.

SOBUE Gen Chairperson, Aichi Medical University

3 Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.

FUKUDA Toshio Visiting Professor, Institute of Innovation for Future Society, Nagoya University

4 Realization of sustainable resource circulation to recover the global environment by 2050.

YAMAJI Kenji President, Research Institute of Innovative Technology for the Earth (RITE)

5 Creation of industry that enables sustainable global food supply by exploiting unused biological resources by 2050.

CHIBA Kazuhiro President, Tokyo University of Agriculture and Technology

6 Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

KITAGAWA Masahiro Professor, Graduate School of Engineering Science, Osaka University

7 Realization of sustainable care systems to overcome major diseases by 2040, for enjoying one's life with relief and release from health concerns until 100 years old

HIRANO Toshio President, National Institutes for Quantum and Radiological Science and Technology

8 Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.

MIYOSHI Takemasa Team Leader, Center for Computational Science, Data Assimilation Research Team, RIKEN

9 Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050.

KUMAGAI Seiji Associate Professor, Institute for the Future of Human Society, Kyoto University

1

Japan Science and Technology Agency

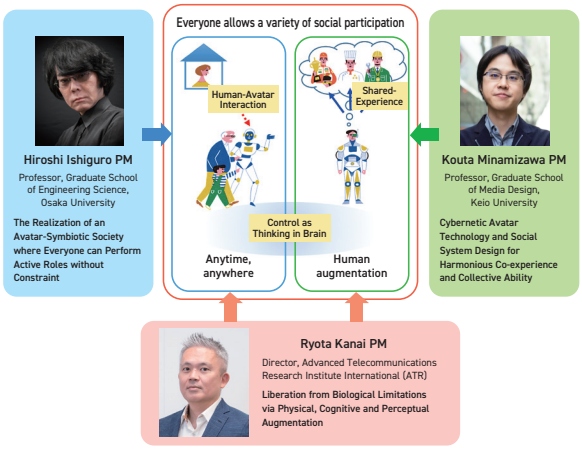
Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.

Program Director (PD) **HAGITA Norihiro** Chair and Professor, Art Science Department, Osaka University of Arts

Outline

To overcome the challenges of a declining birthrate, aging population and associated labor shortage, the key is to realize a society free from the limitations of body, brain, space, and time and allow people with various backgrounds and values – such as the elderly and those with responsibilities for nursing and childcare – to actively participate in society.

Our R&D will develop core technologies related to cyborgs and avatars, called 'Cybernetic Avatars', allowing expansion of human physical, cognitive and perceptual abilities. We will build 'Cybernetic Avatar Infrastructure' in the cloud while easing the acceptance of Cybernetic Avatars into future society.



Message from PD

Our human-centered R&D projects on Cybernetic Avatars will support the creation of cloud infrastructure and core technologies that enable a diverse range of social activities via remote operation. We also intend Cybernetic Avatars to augment the physical, cognitive and perceptual capabilities of people from various social and value backgrounds.

Cybernetic Avatars will be developed from the viewpoint of both providers and users in future society. Therefore our R&D projects should also do basic research on human stress caused by them, and methods to relieve this stress, while taking into account ethical, legal, social, and economic (ELSE) issues and information security. I hope these projects will help us adapt and adjust to a new human-centered 'Cybernetic Avatar Life'.

R&D Projects

*Cybernetic Avatar(CA)

The Realization of an Avatar-Symbiotic Society where Everyone can Perform Active Roles without Constraint

Project Manager	**ISHIGURO Hiroshi** Professor, Graduate School of Engineering Science, Osaka University
Outline	This project aims to realize an avatar-symbiotic society in which CAs allow everyone to perform active social roles without constraint. Through the teleoperation of multiple CAs that can fully transmit the user's actions, intentions, and reactions in scenarios which feature hospitality-rich dialogue, the user will be able to take part in various social activities (work, education, medical care, daily life, etc.). By 2050, our lifestyles will have dramatically changed. We will have greater freedom in our choice of location and how we spend our time, and technological advances will have enhancedour abilities. Our goal is to develop and implement avatar-symbiosis within a balanced society.

Liberation from Biological Limitations via Physical, Cognitive and Perceptual Augmentation

Project Manager	**KANAI Ryota** Director, Advanced Telecommunications Research Institute International (ATR)
Outline	This project aims to develop cybernetic avatars that can be controlled via intention. This intention will be estimated from brain activities and information observed on the surface of the human body and through interactions. We will integrate intention estimation methods using AI technologies, and enhance the functionality of cybernetic avatars controlled by brain machine interfaces (BMI) while considering ethical implications. By 2050, we will create the ultimate BMI-cybernetic avatars that can be freely operated by human intention.

Cybernetic Avatar Technology and Social System Design for Harmonious Co-experience and Collective Ability

Project Manager	**MINAMIZAWA Kouta** Professor, Graduate School of Media Design, Keio University
Outline	This project aims to develop cybernetic avatar technologies that allow people to take full advantage of their abilities and share their variety of skills and experiences with many other people. Taking into account the social and ethical issues involved in the mutual utilization of physical skills and experiences, we will design a system that fits well with humans and society. By 2050 the inter-distribution of skills and experiences will allow people to link together and produce co-creations, and help realize a society in which everyone can freely engage in physical activities and challenges through cybernetic avatars.

https://www.jst.go.jp/moonshot/en/program/goal1/

2

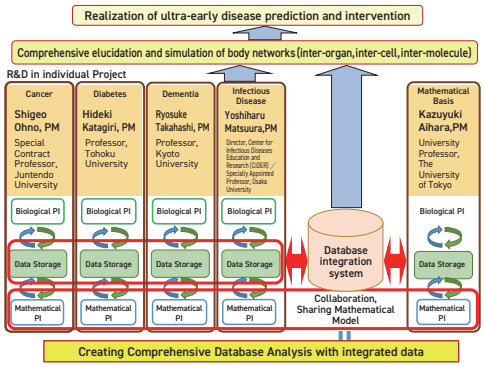
Japan Science and Technology Agency

Realization of ultra-early disease prediction and intervention by 2050.

Program Director (PD) **SOBUE Gen** Chairperson, Aichi Medical University

Outline

To ensure that our aging population has continued health and high quality of life, we need a new style of ultra-early disease prediction and intervention that supersedes today's conventional approach of treatment only after detection of symptoms.
To achieve this Moonshot Goal and realize ultra-early disease prediction and intervention we will promote R&D on technologies related to disease observation, manipulation, measurement, analysis, database creation and more. By integrating these technologies, we will advance our understanding of the comprehensive network connecting human organs.



Message from PD

The states of chronic diseases such as diabetes and dementia are linked to the breakdown of inter-organ networks. The key to our Moonshot Goal is establishing a method to foresee this breakdown and help at-risk individuals convert back from a pre-symptomatic state to a healthy one. Our R&D projects will contribute to our understanding of the comprehensive inter-organ network, building a database describing the network state, and developing a simulation system predicting unstable health utilizing mathematical models.

R&D Projects

Comprehensive Mathematical Understanding of the Complex Control System between Organs and Challenge for Ultra-Early Precision Medicine

Project Manager	**AIHARA Kazuyuki** University Professor, The University of Tokyo
Outline	This project will establish integrated research between mathematical studies with mathematical data analysis and mathematical modeling analysis, and experimental studies on interaction and control between organs. This project aims to a society equipped with ultra-early disease prevention systems by 2050 through comprehensively understanding the inter-organ network as the complex control system between organs and applying it to ultra-early precision medicine.

Challenge toward the Control of Intractable Cancer through Understanding of Molecular, Cellular, and Interorgan Networks

Project Manager	**OHNO Shigeo** Special Contract Professor, Institute for Diseases of Old Age, School of Medicine, Juntendo University
Outline	This project aims to unravel the mechanism of onset and malignant transformation of intractable cancers such as pancreatic cancer by employing cell biology, imaging technology, and mathematical and AI technology in an integrated manner. By doing so we aim to realize a society allowing us to predict and prevent the onset of intractable cancers by 2050.

Challenge for Eradication of Diabetes and Comorbidities through Understanding and Manipulating Homeostatic Systems

Project Manager	**KATAGIRI Hideki** Professor, Graduate School of Medicine, Tohoku University
Outline	This project aims to comprehensively elucidate the inter-organ communication systems underlying dynamic homeostasis of metabolism and circulation, taking advantage of original technologies, AI approaches and mathematical analyses. Furthermore, through understanding and manipulating the homeostatic systems, we will implement strategies which enable us to easily detect subjects in pre-symptomatic states of diabetes and comorbidities and to prevent the developments of these diseases by 2050.

Towards Overcoming Disorders Linked to Dementia based on a Comprehensive Understanding of Multiorgan Network

Project Manager	**TAKAHASHI Ryosuke** Professor, Graduate School of Medicine, Kyoto University
Outline	This project aims to elucidate the interdependent multiorgan network and its breakdown at the molecular, cellular, and individual levels, focusing not only on the brain but also on the relationship between the whole body and the brain. Furthermore, we will achieve a comprehensive understanding of multiorgan network through AI and a mathematical approach. Based on this, we will develop methods for predicting disorders linked to dementia at an early stage before onset and realize preemptive medicine by using an innovative method for disease prevention by controlling the multiorgan network by 2050.

Understanding and Control of Virus-Human Interaction Networks

Project Manager	**MATSUURA Yoshiharu** Director, Center for Infectious Diseases Education and Research (CiDER) /Specially Appointed Professor, Research Institute for Microbial Diseases, Osaka University
Outline	This project aims to analyze the interaction network between the virus and the human body in viral infections and classify/categorize its patterns to identify vulnerabilities in the human body's network. This will enable us to preemptively prepare effective diagnostic, preventive and therapeutic measures against even unknown viral infections, and thereby realize a society free from the threat of viral infections by 2050.

https://www.jst.go.jp/moonshot/en/program/goal2/

3

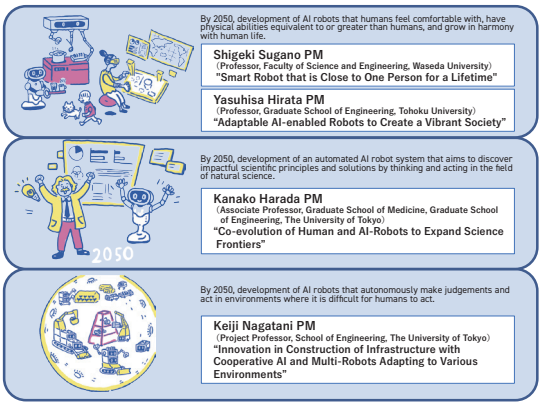
Japan Science and Technology Agency

Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.

Program Director (PD) **FUKUDA Toshio** Visiting Professor, Institutes of Innovation for Future Society, Nagoya University

Outline

Considering Japan's declining birthrate and aging population, it is important that robots can be used in all aspects of society - such as working in dangerous or understaffed sites, developing human frontiers, and supporting our everyday lives. For that purpose, robots must be able to learn and act on their own through the co-evolution of AI and robots. Our R&D aims to realize AI robots with advanced bodies and self-developed AI learning.



Message from PD

Our R&D aims to achieve the following three outcomes by 2050:

(1) AI robots that autonomously make judgements and act in environments where it is difficult for humans to act.
(2) An automated AI robot system that aims to discover impactful scientific principles and solutions, by thinking and acting in the field of natural science.
(3) AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life.

The following two concepts are core to our work:

(1) Coevolution: AI technology and robot technology cooperate to improve their own performance.
(2) Self-organization: AI technology and robot technology self-modify their own knowledge and functions to adapt to their environment.

R&D Projects

Smart Robot that is Close to One Person for a Lifetime

Project Manager	**SUGANO Shigeki** Professor, Faculty of Science and Engineering, Waseda University
Outline	This project aims to establish robot evolution technology that combines flexible machine hardware and unique AI that can understand many kinds of tasks. Our final goal is to build a human-robot symbiotic society by introducing a general-purpose AI robot that can work with people not only in housework and customer service but also in welfare and medical fields where human resources will be in short supply by 2050.

Innovation in Construction of Infrastructure with Cooperative AI and Multi-Robots Adapting to Various Environments

Project Manager	**NAGATANI Keiji** Project Professor, School of Engineering, The University of Tokyo
Outline	This project aims to develop collaborative AI robots that respond to various situations flexibly and perform given tasks in challenging environments such as disaster sites or the moon. By 2050 these collaborative AI robots will, on behalf of humans, conduct emergency response missions following natural disasters and construct lunar bases. This technology will also be useful for the construction and maintenance of ground infrastructure.

Co-evolution of Human and AI-Robots to Expand Science Frontiers

Project Manager	**HARADA Kanako** Associate Professor, Graduate School of Medicine, Graduate School of Engineering, The University of Tokyo
Outline	This project aims to develop AI-robots that conduct scientific experiments in challenging environments (e.g. in a hazardous atmosphere, or in a micro-scale setup), while interacting with scientists as their peers. AI robots and scientists will have freer interactions, and will work with unfamiliar objects and environments through trial-and-error together. By 2050 AI-robots will discover their own principles and solutions in the science fields.

Adaptable AI-enabled Robots to Create a Vibrant Society

Project Manager	**HIRATA Yasuhisa** Professor, Graduate School of Engineering, Tohoku University
Outline	This project aims to create a collective of adaptable AI-enabled robots available at a variety of places. Each robot will be usable by anyone at any time, and will adjust its form and functions according to the individual user to provide optimal assistance and services. By 2050 the co-existence and co-evolution of a wide variety of robots and people will create a vibrant society in which all people can participate.

https://www.jst.go.jp/moonshot/en/program/goal3/

4

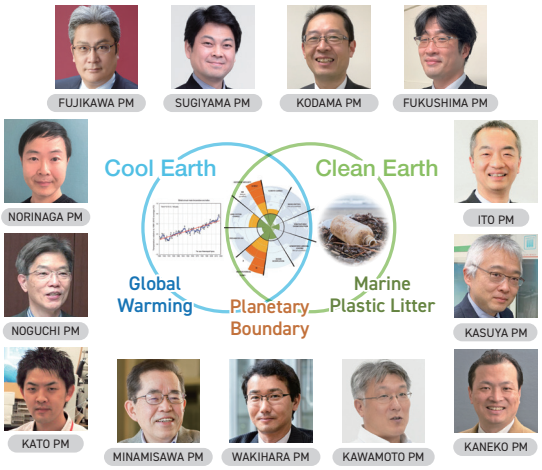
Realization of sustainable resource circulation to recover the global environment by 2050.

Program Director (PD) **YAMAJI Kenji** President, Research Institute of Innovative Technology for the Earth (RITE)

Outline

We must take measures to prevent the circulation of substances that cause global environmental problems. These include greenhouse gases (GHGs) responsible for global warming, nitrogen compounds in a high-risk state that exceed the threshold determined by the planetary boundary concept [*1], and marine plastic litter that disturbs marine ecosystems and can affect humans through the food chain.

To restore the global environment, this R&D program aims to contribute to solving the global warming problem (Cool Earth) and the environmental pollution problem (Clean Earth) while accounting for continued industrial and consumer activity. Under this program, NEDO is engaged in ambitious R&D activities to realize a new form of resource circulation that reduces environmental pollutants such as GHGs, nitrogen compounds, and marine plastic litter.



Message from PD

Moonshot R&D is characterized by its more ambitious and unconventional approach. For GHGs, the program is targeting an innovative technology known as Direct Air Capture (DAC), which directly captures CO_2 that has already been released into the atmosphere and utilizes it effectively. For nitrogen, we aim to detoxify nitrogen compounds discharged into the environment and convert them into valuable materials. As for marine plastic litter, a growing concern in recent years, we aim to design degradation initiation switches for biodegradable plastics that are functional yet safe for the environment.

*1:Under this concept, thresholds have been established in nine areas of the global environment to ensure the sustainable development of human society. Exceeding these thresholds will cause irreversible changes to the natural resources upon which humans depend.

R&D Projects

Development of a Bioprocess That Uses Electrical Energy to Fix Atmospheric CO_2

Project Manager	**KATO Souichiro** Senior Researcher, Bioproduction Research Institute, National Institute of Advanced Industrial Science and Technology (AIST)
Outline	-CO_2 is converted into useful organic matter (conversion efficiency 50 times higher than that of plants) -Artificial synthesis of super-microorganisms that utilize electricity -Development of gas-phase reaction process to maximize microbial power

Development of Highly Efficient Direct Air Capture (DAC) and Carbon Recycling Technologies

Project Manager	**KODAMA Akio** Professor, Faculty of Mechanical Engineering, Kanazawa University
Outline	-Development of innovative amine-loaded CO_2 solid sorbent -CO_2 capture and enrichment process using less energy than conventional technologies -Membrane reactor for highly efficient and energy-saving synthesis of liquid hydrocarbon fuels using inorganic membranes

Integrated Electrochemical Systems for Scalable CO_2 Conversion to Chemical Feedstocks

Project Manager	**SUGIYAMA Masakazu** Professor, Research Center for Advanced Science and Technology, The University of Tokyo
Outline	-CO_2 enrichment process at medium and low temperatures by physical absorption/desorption and electrochemistry -Creation of a system for CO_2 enrichment and reduction to chemical feed stocks by electro-chemical processes using renewable electricity -Flexible system that allows for small-scale distributed deployment

C^4S[*2] Research and Development Project

Project Manager	**NOGUCHI Takafumi** Professor, Graduate School of Engineering, The University of Tokyo
Outline	-Capturing atmospheric CO_2 with concrete waste -Permanent resource circulation by regenerating calcium carbonate concrete (CCC) from concrete waste after CO_2 capture -Contributing to sustainable circulation of calcium resources as well as CO_2 *2: Calcium Carbonate Circulation System for Construction

Research and Development Toward Saving Energy for Direct Air Capture With Available Cold Energy

Project Manager: **NORINAGA Koyo**
Professor, Graduate School of Engineering, Nagoya University

Outline:
-Direct capture of atmospheric CO_2 by employing unused cold energy from liquefied natural gas (LNG)
-Pressure swing recovery of CO_2 by the CO_2 sublimation while operating both absorber and desorber at room temperature
-Output high-purity and pressurized CO_2 ready for storage and utilization process

Development of Combined Carbon Capture and Conversion (quad-C) Systems for the Utilization of Atmospheric CO_2

Project Manager: **FUKUSHIMA Yasuhiro**
Professor, Graduate School of Engineering, Tohoku University

Outline:
-Creation of streamlined reaction system, termed "quad-C", by directly linking CO_2 fixation and conversion
-Takes energy-efficient conversion routes without carbon reduction
-Modularized process handles a wide variety of feed gases and products

Development of Global CO_2 Recycling Technology Towards "Beyond-Zero" Emissions

Project Manager: **FUJIKAWA Shigenori**
Professor, International Institute for Carbon-Neutral Energy Research, Kyushu University

Outline:
-Development of CO_2 capture unit using innovative separation nano-membranes with unparalleled CO_2 permeability
-Development of conversion unit that converts CO_2 into carbon fuel with high efficiency
-Scalable system for use in small-sized homes and medium-sized buildings

Mitigation of Greenhouse Gas Emissions From Agricultural Lands by Optimizing Nitrogen and Carbon Cycles

Project Manager: **MINAMISAWA Kiwamu**
Specially Appointed Professor, Graduate School of Life Sciences, Tohoku University

Outline:
-Focusing on agricultural lands as major sources of nitrous oxide and methane emissions
-Activation of N and C cycling in soil micro-organisms induces 80% reduction of nitrous oxide and methane emissions
-Design of soil microbial community could provide the establishment and functional expression of inoculated microorganisms

Innovative Circular Technologies for Harmful Nitrogen Compounds/ To Solve Planetary Boundary Issues

Project Manager: **KAWAMOTO Tohru**
Group Leader, Nanoparticle Functional Design Group, Nanomaterials Research Institute, National Institute of Advanced Industrial Science and Technology (AIST)

Outline:
-Development of technology to transform nitrogen oxides in exhaust gas into ammonia, a useful material
-Conversion and recovery of ammonia from toxic nitrogen compounds in wastewater

Development of Recovery and Removal Techniques of Dilute Reactive Nitrogen to Realize Nitrogen Circulating Society

Project Manager: **WAKIHARA Toru**
Professor, School of Engineering, The University of Tokyo

Outline:
-Development of selective catalytic reduction (SCR) systems with both high selectivity and activity/durability by realizing precise control of zeolite structure and composition
-Development of absorbents for selective recovery and concentration of extremely low- concentration ammonia

Development of Multi-Lock Biopolymers Degradable in Ocean From Non-Food Biomasses

Project Manager: **ITO Kohzo**
Professor, Graduate School of Frontier Sciences, The University of Tokyo

Outline:
-Breaking through trade-off between polymer degradability and dulability /toughness
-Multi-lock mechanism*3 provides high durability during use and on-demand degradation when accidentally released into ocean-Produced from non-food biomasses

*3: A mechanism that requires multiple stimuli such as light, heat, oxygen, water, enzymes, microorganisms, and catalysts at the same time for degradation

Research and Development of Marine Biodegradable Plastics With Degradation Initiation Switch Function

Project Manager: **KASUYA Ken-ichi**
Professor, Division of Molecular Science, Faculty of Science and Technology, Gunma University

Outline:
-Development of technology to control timing and speed of degradation
-Marine biodegradability (90% in 6 months in seawater at 30°C) verified in ocean
-Creation of marine biodegradable polymers based on biomass and CO_2

Development of Photo-Switching Ocean-Degradable Plastics With Edibility

Project Manager: **KANEKO Tatsuo**
Professor, Graduate School of Advanced Science and Technology, Japan Advanced Institute of Science and Technology

Outline:
-On-type optical switch function that initiates degradation in strong sunlight and water
-Off-type optical switch function that initiates degradation in dark places such as underwater and/or seabed
-Development of non-toxic ocean-biodegradable plastic products incorporating both functions

https://www.nedo.go.jp/english/news/ZZCA_100007.html

5

Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050.

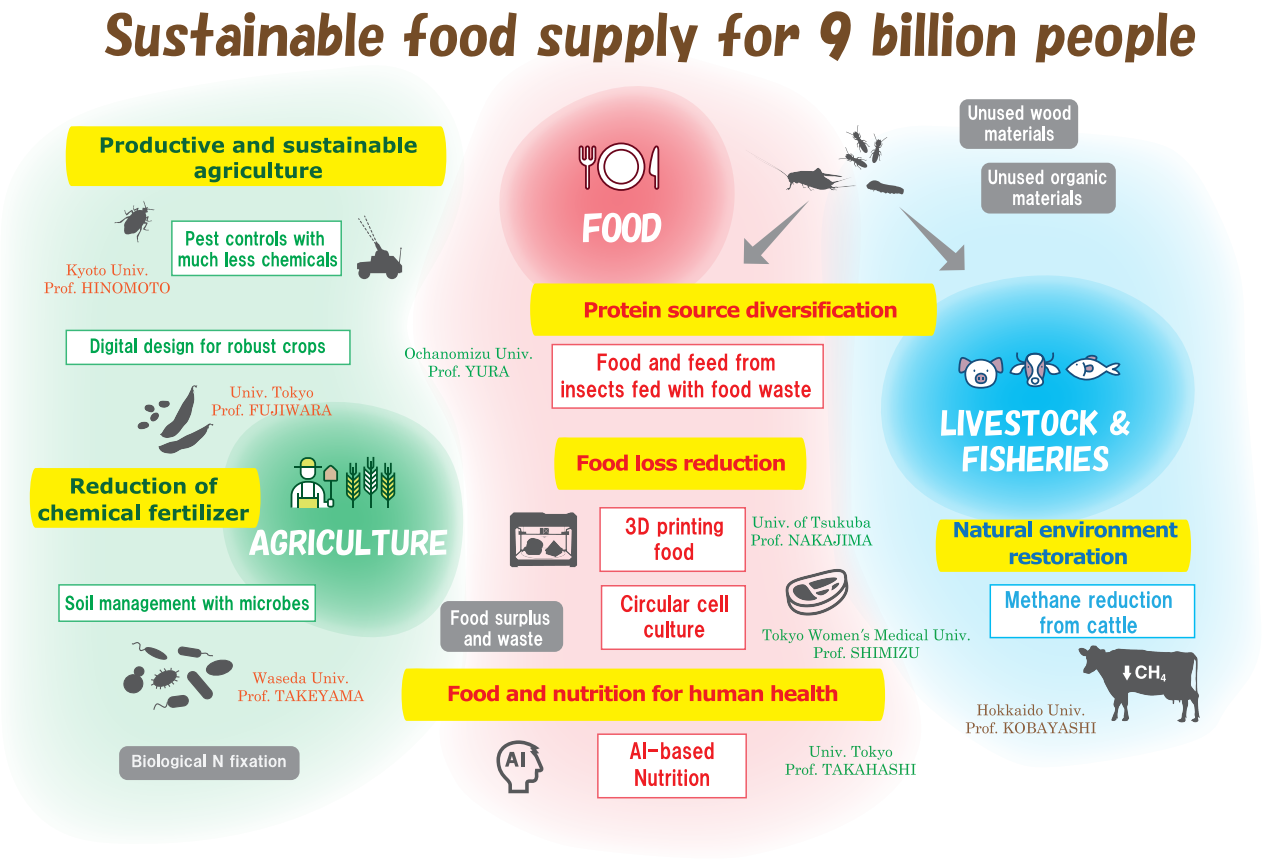
Program Director (PD) **CHIBA Kazuhiro** President, Tokyo University of Agriculture and Technology

Outline

The global demand for food is estimated to increase 70% by 2050. Since excessive focus on production efficiency would hamper the cyclical function of the earth, it is essential to establish a food production system friendly to the global environment while increasing the food supply. Moonshot Goal 5 aims to address the issue with eight R&D projects, which are promoted by the Bio-oriented Technology Research Advancement Institution.

Message from PD

With the formation of agrarian societies, humankind has acquired a stable method of sustainable food supply. However, with the dramatic expansion of human activities in recent years, the sustainable supply of food, which is an inseparable part of human existence, has fallen into a situation where there is no longer any prospect for the immediate future. Overcoming this difficulty is not only a great responsibility we have for the future, but also an intellectual challenge with unexperienced problems. With a clear vision and the ability of design, we must think outside the box and solve the global-scale problems.



R&D Projects

Food Production

Developing environmentally robust crops based on a new design approach

Project Manager	**FUJIWARA Toru** Professor, The University of Tokyo
Outline	The breeding process will be substantially faster with digital designing technology to develop crops which can be grown in extreme environments.

Enhancing soil microbial functions based on detailed understandings of soil ecology

Project Manager	**TAKEYAMA Haruko** Professor, Waseda University
Outline	The complex interaction of soil microbiology will be analyzed in detail and controlled to allow optimal crop and soil management.

Sustainable circular food production system driven by animal cells and algae

Project Manager	**SHIMIZU Tatsuya** Professor, Tokyo Women's Medical University
Outline	Sustainable food will be produced through a circular animal cell culture system using algae as nutrients and recycling waste culture fluid.

Developing non-chemical pest controls

Project Manager	**HINOMOTO Norihide** Professor, Kyoto University
Outline	Insect pests will be managed through a combination of non- chemical methods such as blue laser rays, new natural enemy strains and microbiological techniques.

Raising cows with less methane emission

Project Manager	**KOBAYASHI Yasuo** Professor, Hokkaido University
Outline	Methane emission will be substantially reduced by controlling microorganisms in cows' rumens.

Food Consumption

Producing food and feed from insects fed with food wastes

Project Manager	**YURA Kei** Professor, Ochanomizu University
Outline	Food and feed will be produced from unused resources such as food waste, with the efficient metabolism of insects such as crickets and black soldier flies.

Preparing personalized food with AI chef using food surplus

Project Manager	**NAKAJIMA Mitsutoshi** Professor, University of Tsukuba
Outline	Food will be prepared by a “3D-AI chef machine” from powdered food surplus, meeting personalized tastes and health issues as well as food loss reduction.

Developing food through an AI nutrition system

Project Manager	**TAKAHASHI Shin-Ichiro** Professor, The University of Tokyo
Outline	Food and nutrition suggestion will be made with AI technology to meet personal needs and conditions.

https://www.naro.go.jp/laboratory/brain/english/moon_shot/index.html

6

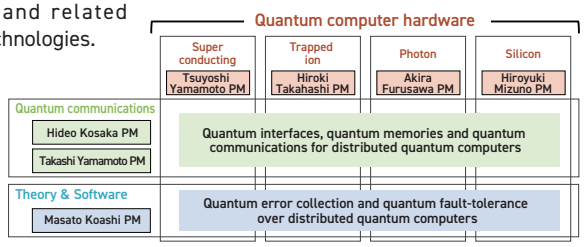
Japan Science and Technology Agency

Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

Program Director (PD) KITAGAWA Masahiro Professor, Graduate School of Engineering Science, Osaka University

Outline

While it is said that the progress of conventional computers is reaching its limits, it is important to be able to respond to the explosion of information processing demands. If we want quantum computing to rapidly solve our numerous and complex social problems, we need a fault-tolerant universal quantum computer that can perform precise computation while correcting quantum errors. In order to realize such a fault-tolerant universal quantum computer we are conducting R&D into the relevant hardware, software, networks, and related quantum technologies.



Message from PD

In order to realize a fault-tolerant universal quantum computer, it is necessary to integrate a huge number of qubits, provide redundancy using quantum error correcting codes, and reduce the physically arising quantum error to below the fault-tolerant threshold. Therefore, we aim to develop a certain scale of quantum computers and demonstrate the effectiveness of quantum error correction.
Considering the possibility of massively integrated quantum computers through quantum communication, R&D projects will be implemented in three categories: '1) hardware', '2) communication networks', and '3) theory and software'. Specifically we would like R&D projects in each category to compete for feasibility, collaborate across categories, and conduct R&D to achieve the Moonshot Goal.

R&D Projects

Research and Development of Theory and Software for Fault-tolerant Quantum Computers

Project Manager	**KOASHI Masato** Professor, Graduate School of Engineering, The University of Tokyo
Outline	This project aims to construct a co-design model encompassing qubit design, fault-tolerant architecture, and compilers and programming languages for efficient computation through collaborations of researchers in quantum information, architecture, and specific physical systems, thereby endeavoring to realize a large-scale quantum computer by the year 2050.

Development of Quantum Interfaces for Building Quantum Computer Networks

Project Manager	**KOSAKA Hideo** Professor, Faculty of Engineering /Institute of Advanced Sciences, Yokohama National University
Outline	This project aims to develop a quantum interface in which quantum memory is combined with an optomechanical crystal, in order to connect the superconducting qubit and the communication photon, towards realization of a large-scale superconducting quantum computer by 2050.

Fault-tolerant Quantum Computing with Photonically Interconnected Ion Traps

Project Manager	**TAKAHASHI Hiroki** Assistant Professor, Experimental Quantum Information Physics Unit, Okinawa Institute of Science and Technology Graduate University
Outline	This project aims to develop ion trap devices that facilitate building large-scale systems beyond the limitations posed by conventional approaches. The new approach is based on a novel idea of photonically interconnecting multiple ion traps. Thereby we aim to realize large-scale quantum computing by 2050.

Development of Large-scale Fault-tolerant Universal Optical Quantum Computers

Project Manager	**FURUSAWA Akira** Professor, School of Engineering, The University of Tokyo
Outline	This project aims at the realization of large-scale fault-tolerant universal quantum computers based on a "quantum look-up table" by 2050, which work at room temperature. Here, the "quantum look-up table" is originally developed by ourselves.

Large-scale Silicon Quantum Computer

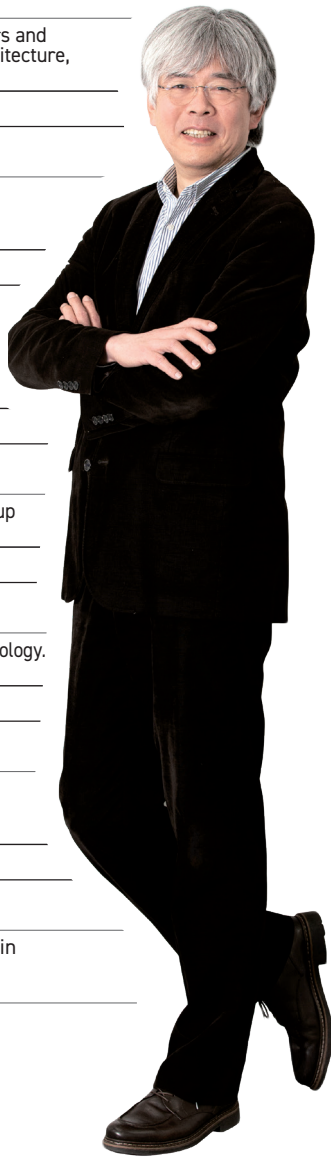
Project Manager	**MIZUNO Hiroyuki** Senior Chief Researcher, Center for Exploratory Research, R&D Group, Hitachi, Ltd.
Outline	This project aims to achieve large-scale integration of silicon qubits by utilizing silicon semiconductor integrated circuit technology. By 2050, we aim to achieve a large-scale quantum computer featuring high integration and low power consumption.

Quantum Cyberspace with Networked Quantum Computers

Project Manager	**YAMAMOTO Takashi** Professor, Graduate School of Engineering Science/Center for Quantum Information and Quantum Biology, Osaka University
Outline	This project aims to develop elemental technologies for networking quantum computers with photons, atoms, semiconductors and so on, aiming to network small and medium quantum computers. We further promote networked quantum computers on a larger scale towards the achievement of universal quantum computation by 2050.

Development of Integration Technologies for Superconducting Quantum Circuits

Project Manager	**YAMAMOTO Tsuyoshi** Research Fellow, System Platform Research Laboratories, NEC Corporation
Outline	This project aims to develop hardware technologies required for scaling up the circuit of superconducting qubits in order to accelerate R&D of superconducting quantum computers. Using these technologies we aim to realize large-scale superconducting quantum computers by 2050.



https://www.jst.go.jp/moonshot/en/program/goal6/

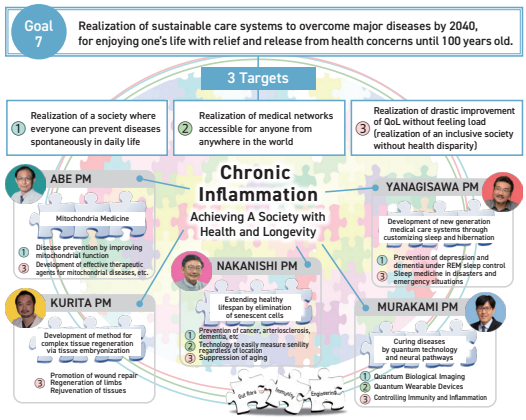
Japan Agency for Medical Research and Development

Realization of sustainable care systems to overcome major diseases by 2040, for enjoying one's life with relief and release from health concerns until 100 years old

Program Director (PD) **HIRANO Toshio** President, National Institutes for Quantum and Radiological Science and Technology

Outline

In recent years, diseases that are caused by a combination of environmental and genetic factors, such as so-called lifestyle-related diseases and diseases associated with aging, have come to have a significant impact on people in Japan, and this trend is expected to continue in the future. As the average life expectancy is increasing, the importance of prevention in addition to diagnosis and treatment will increase as we face the challenge of dealing with such diseases in order to further extend healthy life expectancy. The key is to live with as few limitations as possible even after suffering from a disease. For this reason, this R&D program will promote research and development in order to achieve the goal by 2040.



Message from PD

In order to realize a healthy society with a long life expectancy, it is important to provide medical care that maintains QoL (quality of life, that is, people feel comfortable), and does not just treat diseases in the past. Medical care includes treatment, prevention, rehabilitation, etc., and also a daily life after receiving medical care. We believe that QoL is an important perspective in the provision of medical care itself and in all the aspects of life after medical care. Cancer, brain disease, cardiovascular disease, etc., which are major diseases in a healthy and long-lived society, are considered to be lifestyle-related diseases rooted in genetic factors, lifestyle habits from infancy such as diet, exercise, and rest, and aging (life course). The most fundamental keyword for these diseases is chronic inflammation (It is a condition in which inflammatory reactions are mild but persist for a long time and become chronic. When such a inflammation persists, abnormalities in the function and structure of biological tissues occur, leading to various diseases.). We will continue our research and development projects based on this perspective of chronic inflammation.

R&D Projects

Mitochondrial Medicine

Project Manager	**ABE Takaaki** Professor, Tohoku University
Outline	To perform a comprehensive and integrated analysis of the "mitochondrial-gut flora association" to clarify which mitochondria and gut microbiota regulate the host, and develop non-invasive diagnostic methods and new therapeutic agents. We aim to achieve healthy longevity by detecting mitochondrial dysfunction at an early stage by intervening and treating it by 2040.

Development of method for complex tissue regeneration via tissue embryonization

Project Manager	**KURITA Masakazu** Lecturer, The University of Tokyo
Outline	Based on engineered gene transfer, the present research project targets the recovery of damaged compound tissues and organs that are generally considered impossible to regenerate, by means of induction of multiple adult cells into precursor cells similar to embryonal cells. We seek to develop a method for regenerating lost limbs and restoration from age-related tissue degeneration using a substantially feasible method for clinical settings.

Realization of innovative medical systems that extend healthy lifespan to 100 years old by eliminating tissue inflammation-inducing cells

Project Manager	**NAKANISHI Makoto** Professor, The University of Tokyo
Outline	This research project aims to develop innovative technologies that eliminate senescent cells (senolysis) which cause tissue microinflammation as a common pathogenesis of aging and age-associated disorders. Thereby, we will establish medical systems for the extension of healthy lifespan through which various age-associated tissue dysfunctions and disorders will be dramatically improved. In addition, we will also develop technologies that measure senility and establish medical networks that can be easily accessed by everyone and everywhere.

Quantum and neuromodulation technologies to suppress tissue-specific disease-related microinflammation

Project Manager	**MURAKAMI Masaaki** Professor, Hokkaido University
Outline	Tissue-specific disease-related microinflammation develops around blood vessels during presymptomatic disease. Currently, there is no method to detect and eliminate this microinflammation. In this proposal, we aim to establish two novel technologies to reset the presymptomatic disease state to the healthy state: quantum measurements and AI-based information integration analysis. First, we will detect a weak but minimal level of IL-6 amplifier activation that leads to the development of tissue-specific microinflammation. Then, we will establish neuromodulation technologies to eliminate the microinflammation via specific neural circuits including gateway reflexes.

Development of new-generation medical care systems through customizing sleep and hibernation

Project Manager	**YANAGISAWA Masashi** Director/Professor, International Institute for Integrative Sleep Medicine, University of Tsukuba
Outline	Through elucidating the neurophysiological roles and regulatory mechanisms for two immobile modes of animal behavior, sleep and hibernation, we will develop technologies to control sleep and induce hibernation in humans, transforming the future medicine. Induced hibernation will be a step forward to space expedition, a dream of humankind.

https://www.amed.go.jp/en/program/list/18/03/001.html

8

Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.

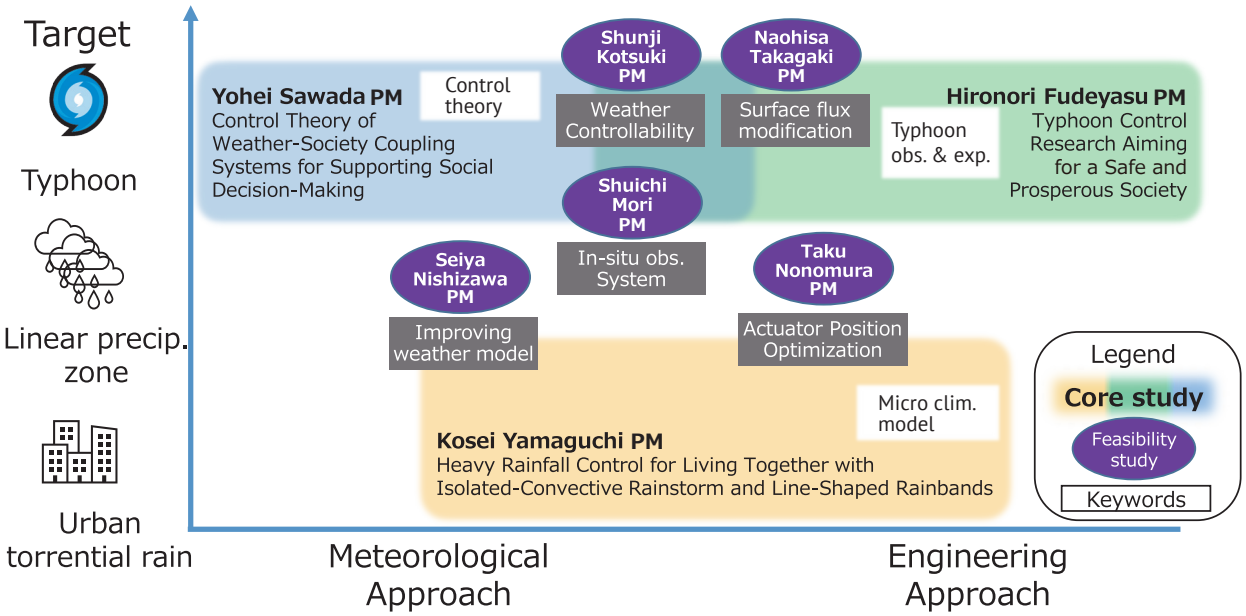
Program Director (PD) **MIYOSHI Takemasa** Team Leader, Center for Computational Science, Data Assimilation Research Team, RIKEN

Outline

Global warming means that wind and flood damage caused by extreme weather events such as typhoons and torrential rains are becoming more severe and frequent. If it is possible to change the intensity, timing, and/or location of extreme weather events that lead to disasters, it may be possible to avoid or dramatically reduce the resulting damage. In this program, we will conduct R&D aimed at: gaining a deeper understanding of extreme weather, which is essential for the development of weather control theory; improving weather forecasting technology such as weather modeling, data assimilation and ensemble methods; and realizing weather control technology that is socially, technically, and economically feasible.

Message from PD

Our goal is to significantly reduce the damage caused by extreme windstorms and floods, which are becoming more severe due to global warming and other factors, by developing weather control technology to change the intensity, timing, and location of typhoons and torrential rains. In our R&D we will combine control theory using numerical simulations, control technology that applies artificial disturbances to the atmosphere, and elements related to fundamental mathematics and ELSI. Weather control has long been a dream of humanity, and through my leadership as PD I hope to realize it as an open technology.



R&D Projects

Control Theory of Weather-Society Coupling Systems for Supporting Social Decision-Making

Project Manager	**SAWADA Yohei** Associate Professor, Graduate School of Engineering, The University of Tokyo
Outline	This project aims to develop meteorological control theory that will enable small external forces to significantly change the weather. In addition, we also pursue the ability to precisely forecast a wide variety of impacts of meteorological disasters on society, which is necessary for social decision-making regarding weather control. By 2050, we aim to be able to control weather-society coupling systems based on democratic social decision-making processes in order to free the world from the fear of meteorological disasters.

Typhoon Control Research Aiming for a Safe and Prosperous Society

Project Manager	**FUDEYASU Hironori** Director, Typhoon Science and Technology Research Center, Institute of Advanced Sciences, Yokohama National University/Professor, Faculty of Education, Yokohama National University
Outline	This project aims to develop principles and fundamental techniques to diminish typhoons, which are expected to become increasingly severe with climate change, to the level that disaster prevention infrastructure becomes effective. To this end, we will establish typhoon control theory through high-precision observations by aircraft, ships and satellites, and the development of numerical models that reproduce the inner workings of typhoons. Furthermore, we will conduct disaster forecasting and impact assessment, and tackle the issues of social acceptability and consensus-building for typhoon control. By 2050, we will realize a society of safety and that is free from the threat of typhoons.

Heavy Rainfall Control for Living Together with Isolated-Convective Rainstorms and Line-Shaped Rainbands

Project Manager: **YAMAGUCHI Kosei**
Associate Professor, Disaster Prevention Research Institute, Kyoto University

Outline: This project aims to control the intensity of “guerrilla heavy rainfall” and “line-shaped convective heavy rainfall”. Based on numerical meteorological models, field observations, and laboratory experiments, we will develop multiple control devices. We will construct a control system that considers the impact assessment and social accountability of heavy rainfall control, by using those devices at multiple points in time and in multiple phases. By 2050, we will contribute to the formation of a future society in which heavy rainfall control technologies integrate with nature and human society.

Quantifying Weather Controllability and Mitigatable Flood Damage Based on Ensemble Weather Forecast

Project Manager: **KOTSUKI Shunji**
Professor, Institute for Advanced Academic Research / Center for Environmental Remote Sensing, Chiba University

Outline: To achieve weather control, we need to enable discussions on a bottleneck for decision-making: the way to maximize the effect of control. To quantify weather controllability, this project investigates meteorological landscapes that separate disaster and non-disaster regimes which can be controlled by small operations through deep learning applied to historical disaster events. We also estimate economical damage and impacted populations throughout Japan under non-controlled/controlled scenarios, in order to quantify avoidable damage by the weather control.

Estimation and Control of Air-Sea Momentum and Heat Fluxes of Typhoons

Project Manager: **TAKAGAKI Naohisa**
Associate Professor, Graduate School of Engineering, University of Hyogo

Outline: To realize weather control, highly accurate weather forecasting is essential. In particular, for controlling typhoons, there are two bottlenecks: (1) low accuracy of typhoon intensity predictions; (2) difficulty of distinguishing natural and control effects. This project aims to solve these bottlenecks by investigating the mechanism of momentum and heat transfer across the sea surface under typhoons, and formulating the momentum and heat fluxes using parameters associated with wave-breaking and wind waves through a large laboratory experiment for simulating typhoons.

Development of an Atmospheric Simulation Model for Estimating the Probability of Local Atmospheric Phenomena

Project Manager: **NISHIZAWA Seiya**
Research Scientist, RIKEN Center for Computational Science

Outline: To realize weather control, we must solve a bottleneck to determining the optimal control method: that it is difficult to accurately estimate the probability associated with properties of local atmospheric phenomena, such as location, time, intensity. This project aims to develop an atmospheric simulation model suitable for this estimation which solves several problems inherent to current atmospheric simulation models, developing new computation schemes that are qualitatively different from conventional ones.

Actuator Position Optimization for Large-Degree-of-Freedom Fields

Project Manager: **NONOMURA Taku**
Associate Professor, Department of Aerospace Engineering, Graduate School of Engineering, Tohoku University

Outline: To realize weather control, we need to solve the bottleneck that the positions for actuators to maximize weather control effects are unknown. This project aims to organize, develop and evaluate actuator position optimization methods. We will show through weather simulation experiments that the obtained actuator positions can be used to improve control effects.

Development of Unmanned Marine Observation Vehicles Essential for Forecasting and Monitoring of Typhoon Artificial Control

Project Manager: **MORI Shuichi**
Principal Researcher, Center for Coupled Ocean-Atmosphere Research (CCOAR) of Research Institute for Global Change (RIGC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Outline: To realize weather control, nature needs to be continuously monitored. For typhoons it is important to continuously monitor the marine atmosphere and ocean surface layer near the typhoon center, which play important roles in the typhoon development process. However, it is difficult to conduct this monitoring via aircraft or satellites, which means it is a bottleneck for weather control. This project aims to develop unmanned maritime vehicles that can be virtually moored near the area of a typhoon center and continuously observe the atmosphere-ocean data along the movement path of the typhoon.

https://www.jst.go.jp/moonshot/en/program/goal8/

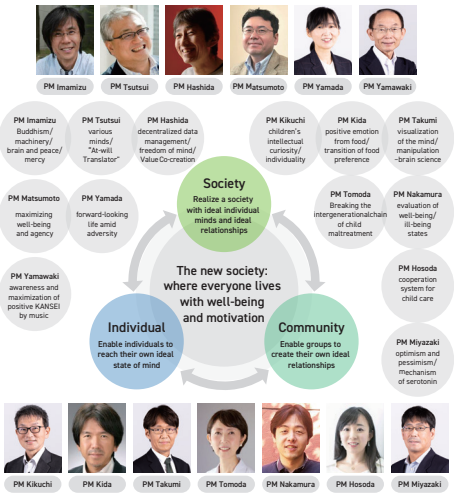
9

Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050.

Program Director (PD) **KUMAGAI Seiji** Associate Professor, Institute for the Future of Human Society, Kyoto University

Outline

In recent years, social issues related to our mental states have become increasingly severe. The key to creating a mentally healthy and dynamic society is to develop a comprehensive understanding of mental states, and kind interpersonal and intergroup communication that will lead us in a more mutually beneficial direction. Our R&D program aims to realize increased peace of mind and vitality by creating technology to realize "understanding of individual mental states and transitions" and "mental health support in terms of interpersonal and intergroup communication" so as to increase peace of mind and vitality.



Message from PD

We aim to realize a mentally healthy and dynamic society through development of technology that provides peace of mind and vitality. I believe it is necessary to discover the mechanisms behind our mental states, and use this practical knowledge for technology that will generate positive mental state transitions for users based on individual preferences. We will promote R&D using comprehensive knowledge gained by the fusion of different fields such as natural sciences, social sciences and humanities. Applying the expertise of enthusiastic researchers gathered from all over the world, together we will achieve our Moonshot Goal.

R&D Projects

Fusion of Asian humanities and brain informatics to enhance peace and mercy of the mind

Project Manager	**IMAMIZU Hiroshi** Director, Cognitive Mechanisms Laboratories, ATR Brain Information Communication Research Laboratory Group
Outline	This project aims to investigate the dynamics of the human mind based on knowledge of Asian humanities (Buddhism) and brain science, and apply our investigations to society. We will construct personality models of mental states from large-scale surveys and detailed examinations of small groups, and develop technologies that accurately estimate and visualize brain dynamics. Our models and technologies will contribute to the development of meditation methods and their social applications that enable people to understand themselves deeply, enhance the peace and vitality of minds, and achieve a society with mercy to others.

Development of "Jizai Hon-yaku-ki (At-will Translator)" connecting various minds based on brain and body functions

Project Manager	**TSUTSUI Ken-Ichiro** Professor, Graduate School of Life Sciences, Tohoku University
Outline	This project aims to develop a "Jizai Hon-yaku-ki (At-will Translator)" supporting people's communications in various situations, which may be useful in realizing an inclusive society. Neuroscienctists, molecular biologists, and VR/AR and robotics engineers will collaborate to develop technologies to quantify states of mind, and methods for perceptual, cognitive and motor interventions. The Jizai Hon-yaku-ki will be produced by combining these technologies and methods, and facilitate the communication of individuals and small groups.

Freedom of Mind and Value Co-Creation through Decentralized Data Management

Project Manager	**HASIDA Koiti** Group director, Center for Advanced Intelligence Program, RIKEN
Outline	This project aims to defend freedom of mind and promote value co-creation to strengthen both democracy and economic performance. Currently, centralized AI (CAI) and the attention economy threaten freedom of mind and democracy, and inhibit the creation of value from personal data (PD). This problem can be solved through decentralized management of PD, by which each individual's PD is fully utilized only by their personal AI (PAI). We will demonstrate that PAI creates much higher value than CAI, and will promote the replacement of CAI with PAI along with its democratic governance. We will also assist people to enhance the authenticity and diversity of information they utilize.

Maximizing well-being and agency on the basis of interpersonal comparison of brain indicators

Project Manager	**MATSUMOTO Kenji** Professor, Brain Science Institute, Tamagawa University
Outline	This project aims not only to improve "happiness" at the level of individuals, but also to achieve aggregation and equality at the level of society. To this end, we will provide innovative technology to measure interpersonally comparable indicators of "happiness" from brain/ neural activity. "Happiness" is enhanced not only by the experience of "well-being," which benefits each person's life, but also by the recognition of "agency," a way of life that each person has individually decided. We will study "well-being" and "agency" in future society using humanities and social science methods and virtual reality technology. Moreover, we will also achieve individual comparison of well-being and agency by elucidating brain indicators of subjective feelings "pleasure" and "aspiration". In doing so we will bridge neuroscience studies and real-world activities, such as evaluating mobility policies in smart cities.

Realization of a society where people can live a forward-looking life in the face of adversity

Project Manager	**YAMADA Makiko** Group Leader, Institute for Quantum Medical Science, National Institutes for Quantum Science and Technology
Outline	This project aims to realize a society in which people can live "forward-looking" lives even in the midst of adversity. To this end, we will clarify the diverse and multifaceted components of "positivity," calculate positivity indices by measuring physical posture and brain/ physiological reactions, and establish technologies to assist, train, and educate people on positivity factors tailored to their individual situations through positivity support technologies.

Innovation in “Mental Capital” through Awareness Music and creation of new liberal arts

Project Manager	**YAMAWAKI Shigeto** Specially appointed professor, Director of Center for Brain, Mind and KANSEI Sciences Research, Hiroshima University
Outline	This project aims to innovate in: 1) Awareness Music based on neuroscientific evidence to promote “awareness of one's own and others' hearts” by music and ultrasonic sounds; 2) awareness enhancing technology by Awareness Music using a wearable KANSEI visualization device; 3) technology for improving positive KANSEI such as healing, being moved and sense of unity by Neuro-Bio Feedback; 4) KANSEI communication technology that enhances empathy. We also aim to create new liberal arts through this transdisciplinary research collaboration. The “mental capital” strengthening method by integrating these technologies will be implemented in local communities, aiming to realize a peaceful society through mutual understanding and empathy - in which individuals can spend an active and happy life in the metaverse era of 2050.

Protecting children's intellectual curiosity and individuality to realize a dynamic society

Project Manager	**KIKUCHI Mitsuru** Professor, Graduate School of Medical Sciences, Kanazawa University
Outline	This project aims to realize an environment where everyone can grow up keeping their innate curiosity, thereby creating a society filled with active motivation and originality. Self-esteem damage in childhood can cause resilience to decline in later life, but by effectively preventing this type of problem we can realize a dynamic future society rich in intellectual curiosity. Specifically, we will use brain imaging technology to analyze children's brain characteristics, visualize the effects of interventions through optimized artistic activities, and implement them in society in collaboration with local governments.

Understanding the cognitively regulatory basis of food value that controls feeding behaviors

Project Manager	**KIDA Satoshi** Professor, Graduate School of Agriculture and Life Sciences, The University of Tokyo
Outline	This project aims to elucidate the mechanisms by which favorite foods induce positive emotions such as pleasure and empathy with others, and the mechanisms by which food values are changed depending on experience. Though bad eating habits can themselves be the cause of disease, stress and ill-health can also result when trying to a convert to a healthier diet. Therefore we will develop technologies to improve food preference and make it enjoyable to eat healthy food, using a rodent model from a neuroscientific viewpoint, and try to achieve the goal of “increasing mental comfort and vitality” using food as a tool.

Brain science towards visualization and manipulation of the mind

Project Manager	**TAKUMI Toru** Professor, School of Medicine, Kobe University
Outline	This project aims to visualize mice's brain functional network dynamics in action by developing a virtual reality (VR) system. We will quantify the “state of mind” of mice communicating with each other in a social environment as changes in the functional brain network. Furthermore, we will develop a technology for optical manipulation of the functional brain network using optogenetics to artificially induce changes in the “mental” state and clarify how the functional brain network responds to changes in the “mental” state and changes in behavior. Research on mice that allows direct manipulation of the brain will help develop a fundamental technology for elucidating the human mind.

Breaking the intergenerational chain of child maltreatment through revolutionary diagnostics and positive intervention.

Project Manager	**TOMODA Akemi** Director and Professor, Research Center for Child Mental Development, University of Fukui
Outline	This project aims to develop and implement breakthrough technologies to realize a society with zero childhood maltreatment and promote sound mental health for all. (1) We will develop and test the feasibility of an epigenomic panel (cross-sectional model)and brain imaging models that detect maltreatment and development in children. (2) Using longitudinal epigenetics, we will build a standard model of childhood development that reflects environmental influences for children up to age three. (3) We will conduct a clinical trial of robot-mediated remote-childcare support for families with childcare difficulties. These technologies will assist parents in nurturing their children and prevent maltreatment through early detection and positive interventions.

Construction of an AIoT-based universal emotional state space and evaluation of well-being/ill-being states

Project Manager	**NAKAMURA Toru** Specially Appointed Professor, Graduate School of Engineering Science, Osaka University
Outline	This project aims to construct an objective and universal emotional state space across species by integrating AI technology with Internet of Things (IoT)-based measurements of biological signals in daily life. Furthermore, the project will develop a method to evaluate well-being and ill-being states based on the dynamics of state transitions in the constructed emotional space.

Child care commons:Proposing social infrastructure allowing others to substitute parental roles

Project Manager	**HOSODA Chihiro** Associate professor, Graduate school of information science, Tohoku university
Outline	This project aims to propose a Child Care Commons (CCC) by clarifying the requirements for a system that allows diverse people to be involved in “child-rearing” flexibly and responsibly.We propose a system where everyone in society can voluntarily help raise children through the CCC.This system will increase people's peace of mind and vitality in three positions: parents (caregivers), children being cared for, and non-relatives participating in child-rearing. We aim to create a society where each person feels fulfilled, and a diverse range of peoplecan play an active role.

Elucidation of the mechanism of serotonin over optimism and pessimism

Project Manager	**MIYAZAKI Katsuhiko** Senior Staff Scientist, Neural Computation Unit, Okinawa Institute of Science and Technology Graduate University
Outline	This project aims to examine what kind of difference will occur in the serotonin neural network, which has been shown to play a role in regulating patience for future rewards, when mice perform the same behavior but the purpose of the behavior is different for “attainment of reward” or “avoidance of punishment”. We hypothesize that serotonin works to regulate “optimism / pessimism” toward achieving the goal and we will examine the serotonin neural network by neural recording and neural manipulation of task performing mice. By clarifying the neural mechanism of “the optimism that creates patience” or “the pessimism that leads to giving up”, we aim to realize a society in which people can improve their “ ability to overcome the difficulties of life” and “vitality of the mind”.

https://www.jst.go.jp/moonshot/en/program/goal9/

〈Three target areas〉

Society Overcoming the limits of our aging society by harnessing diversity and innovation.

Environment Supporting the recovery of the natural environment and sustainable urbanization.

Economy Exploring the frontiers of human activity with science and technology.

	Moonshot Goal	Society	Environment	Economy
1	Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.	★		
2	Realization of ultra-early disease prediction and intervention by 2050.	★		★
3	Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.	★		★
4	Realization of sustainable resource circulation to recover the global environment by 2050.		★	
5	Creation of industry that enables sustainable global food supply by exploiting unused biological resources by 2050.		★	
6	Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.			★
7	Realization of sustainable care systems to overcome major diseases by 2040, for enjoying one's life with relief and release from health concerns until 100 years old.	★		
8	Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.		★	★
9	Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050.	★		★

〈Moonshot R&D Promotion System〉

〈History〉

2018.06 The 39th Council for Science, Technology and Innovation (CSTI)
- ▶ CSTI executive members highlighted necessity for Moonshot type R&D.

2019. 03 ~07 Goal-setting Visionary Council established.
- ▶ Council members discussed potential Moonshot Goals.
- ▶ Ideas welcomed from the general public regarding most important issues to be solved, and visions for an ideal future society.

2019.12 The Moonshot International Symposium
- ▶ Various stakeholders from around the world discussed future of the program and its goals.

2020.01 The 48th Council for Science, Technology and Innovation (CSTI)
- ▶ MS Goals 1 to 6 decided.

07 The 30th Headquarters for Healthcare Policy
- ▶ MS Goal 7 decided.

2021.01 ~07 Researchers selected to create new MS Goals.
- ▶ Teams of ambitious young researchers brainstormed additional goals appropriate for the 'new normal' economy and society transformed by COVID-19.

09 The 57th Council for Science, Technology and Innovation (CSTI)
- ▶ MS Goals 8 and 9 decided.

〈About the Moonshot R&D Program〉

Cabinet Office

Moonshot Research and Development Program
https://www8.cao.go.jp/cstp/english/moonshot/top.html

〈Funding Agencies and their assigned Moonshot Goals〉

JST Japan Science and Technology Agency

■Moonshot Goals 1、2、3、6、8、9
https://www.jst.go.jp/moonshot/en/index.html

NEDO New Energy and Industrial Technology Development Organization

■Moonshot Goals 4
https://www.nedo.go.jp/english/news/ZZCA_100007.html?from=b

BRAIN Bio-oriented Technology Research Advancement Institution

■Moonshot Goals 5
https://www.naro.go.jp/laboratory/brain/english/moon_shot/index.html

AMED Japan Agency for Medical Research and Development

■Moonshot Goals 7
https://www.amed.go.jp/en/program/list/18/03/001.html

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