[Provisional translation]

Moonshot Research and Development

Fiscal Year 2020

Project Manager

Call for Application

Application Period

Thursday, February 20, 2020 – Noon, Tuesday, May 12, 2020

国立研究開発法人
科学技術振興機構
Japan Science and Technology Agency

Department of Moonshot Research and Development Program

February 2020

[1.1-200302]

Overview of the Call for Application

(1) Schedule of the Call for Application and Selection

Call for Application Starts from	Thursday, February 20, 2020
Explanatory Meeting	See the website for Moonshot Research and Development (https://www.jst.go.jp/moonshot/en/application/)
Applications Accepted until (Final time and date of acceptance from e-Rad.)	Noon, Tuesday, May 12, 2020 <No delay accepted>
Period of document-based review	Mid-May – Mid-June
Invitation to interview-based review (for applicants who pass the document-based review)	Mid-June – Late-June
Period of interview-based review	Late-June – Early-July
Notification and Announcement of Selection Results (Notification sent to all proponents)	Early or Mid-July

※ Use e-Rad to apply for this call (see Chapter 6, "How to Use the Cross-ministerial R&D Management System (e-Rad) for Your Application".

※ Applications will be accepted on e-Rad from Early-March. The start of the reception will be announced on the website of this call: https://www.jst.go.jp/moonshot/en/application/

※ The underscore indicates that the schedules are fixed. All other schedules remain unfixed and are subject to change.

※ JST will notify applicants of the specific time and date of the interviews.
The schedules for the interview-based review and the period in which applicants eligible for interviews are notified will be announced on the website as follows: https://www.jst.go.jp/moonshot/en/application/

※ Notifications will be sent via e-mail to all applicants who are invited to the interviews. (No postal mail will be sent. Notifications will be sent to the e-mail addresses registered

on e-Rad. Please ensure that you have set your e-mail address to receive our notifications.)

(2) The Subjects for Which Project Managers (PM) Are Called for

Below are the Moonshot Goals for the PMs.

Moonshot Goal 1	Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.
Moonshot Goal 2	Realization of ultra-early disease prediction and intervention by 2050.
Moonshot Goal 3	Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.
Moonshot Goal 6	Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

※ Moonshot Goal 4 "Realization of sustainable resource circulation to recover the global environment by 2050", will be managed by New Energy and Industrial Technology Development Organization (referred to as "NEDO" from here) and Moonshot Goal 5 "Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050," by another Funding agency, respectively.

(3) How You Apply for the Call

Download from the website the materials you need for making application including the forms for proposals: https://www.jst.go.jp/moonshot/en/application/

Use e-Rad (https://www.e-rad.go.jp/en/) to apply for this call (see Chapter 6). Applications will be accepted on e-Rad from Early-March. The start of the reception will be announced on the website of this call.

When the deadline is close, a large number of accesses may be made to e-Rad, which may overload the system, make you need a long time to view pages, make you unable to upload files, cause errors to make you go back to the top page etc., cause some other troubles, and make you unable to finish your application by the deadline. Allow yourself

sufficient extra time to finish your application. **If you have not finished your application steps from e-Rad before the deadline, your application, regardless of the reason, will not be accepted as a subject of our examination. We will not accept any replacement or substitute of your written proposals after the deadline has come.** If a large-scale system trouble should occur to e-Rad during the period of application and thus it should be difficult to make application from e-Rad, then we may post our corrective actions on the website of this call. Your understanding is appreciated.

Write the same organizations, posts, and other information on e-Rad and in the description on your written proposals (if any contradiction is found, the description on your written proposals are taken as an official one). Note that we cannot accept your proposal if your written proposal uploaded from e-Rad contains some difficulty that makes our examination difficult. "Some difficulty that makes our examination difficult" here includes any omission on the form of your written proposals, any erroneous conversion of characters that makes it difficult to read and examine the document, any important omission in any item provided on your written proposal, and the like.

For the precautions and the details of the application method, see the website of this call and Chapter 5, "Instructions for Applicants," and Chapter 6, "How to Use the Cross-ministerial R&D Management System (e-Rad) for Your Application."

The website of this call: https://www.jst.go.jp/moonshot/en/application/

[If the English version of the information of call for application does not conform to the Japanese version, the Japanese version shall prevail.]

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Chapter 0 To those who are applying for and/or participating in the project

0.1 Contribution to the achievement of Sustainable Development Goals (SDGs)

JST to contribute to the achievement of Sustainable Development Goals (SDGs)!

At the "United Nations Sustainable Development Summit" held in September 2015, "Transforming our world: the 2030 Agenda for Sustainable Development" was unanimously adopted; the document was an achievement that positioned "sustainable development goals (SDGs)" at its core, as a further comprehensive and new action target common to the world for human beings, the Earth, and its overall welfare. The seventeen goals included in the SDGs not only indicate various problems in relation to sustainability that are confronting humankind but also demand that these problems be solved comprehensively and in an integrated manner. It is expected that scientific and technological innovations will resolve such social problems and that scientific grounds are provided to contribute to the formulation of appropriate policies. We can say that these roles conform to the concept "the science in the society and the science for the society," a new objective of science that was declared in the "World Declaration on Science and the Use of Scientific Knowledge" (Budapest Declaration*) which was adopted at the International Council for Science in 1999. As a core organization aimed at promoting the science and technology policies in our country, JST promotes advanced fundamental researches and manages researches and developments that resolve problems corresponding to societal needs. SDGs are a worldwide objective that can itemize all JST's missions. Through JST programs, we want to collaborate with various industries, academia, governmental bodies, and private enterprises, as well as cooperate with researchers to realize a sustainable society.

Japan Science and Technology Agency

HAMAGUCHI Michinari, President

*The Budapest Declaration has declared that "science for knowledge," "science for peace," " science for development," and "science in society and science for society" are the responsibilities, challenges, and obligations of science in the 21st century.

・For sustainable development goals (SDGs), JST endeavors, and the like, please access the following website.

(In Japanese)https://www.jst.go.jp/sdgs/actionplan/index.html

(In English)https://www.jst.go.jp/sdgs/en/actionplan/index.html

0.2 Promoting Diversity

JST to Promote Diversity!

"Diversity" is desired as a foundation that results in scientific and technological innovation. Regardless of age, gender, or nationality, human resources with various areas of expertise, values, and the like can exchange ideas and cooperate to creatively work together to develop a new world. In all fields of science and technology, JST promotes diversity to address the problems that our future society will face and to contribute to the enhancement of our country's competitiveness and mental resources. In the Sustainable Development Goals (SDGs) advocated by the United Nations, gender equality and other targets deeply linked with diversity are also stated; we will contribute to the resolution of problems in our own country that are also common to other parts of the world.

Recently, the acts of women have been seen as comprising the core of the growth strategy and as "the greatest potential force of Japan." Also, in researches and other developments,

women's participation is important; among various human resources intended to support innovation in the field of science and technology, female researchers are essential. JST expects proactive applications from female researchers. JST has been listening to the researchers who use our "Maternity, Child Care, and Nursing Support System," which has been ongoing; and we have also been continuously endeavoring to improve the system by, for example, providing an environment in which researchers can return to their fields.

In our call for new research problems and our reviews, we will also consider applications from the perspective of diversity.

We will be grateful if researchers demonstrate their positive attitudes by applying to our program.

Japan Science and Technology Agency
HAMAGUCHI Michinari, President

We Are Waiting for Your Application

JST understands that diversification entails an understanding of people with ideas different from our own and combining them to create new values; based on this idea, JST has been promoting diversity. This will lead to not only solutions for the problems of our own country but also to those common throughout the world; in cooperation with organizations overseas, we promote diversity and in so doing, will cope with social problems on a global scale, including SDGs.

JST's diversity covers women, as well as young researchers and researchers from other countries. To ensure that all individuals can sufficiently exercise and play important roles, we have been continuously giving support to researchers during their maternity periods and those with children or in circumstances in which they are caring for the elderly. Further, we have also been making an effort to ensure that our committees will have well-balanced personnel assignments. Aiming for an environment in which a wide range of people cooperate and compete with one another, we welcome applications from female researchers, which we have not often received; thus, we are endeavoring to create new value.

We are eagerly anticipating proactive applications from you all.

Japan Science and Technology Agency
WATANABE Miyoko, Executive Director and Manager, Office for Diversity and Inclusiveness, Department of Developing Human Resources for R&D Programs

0.3 Aiming for Fair Research Activities

Aiming for Fair Research Activities

Unethical acts in researches or other dishonest research activities, which have been recurring in recent years, have destabilized the relationship of trust between science and society and have caused situations that should be cause for concern, such as those that obstruct the wholesome development of science and technology. To prevent injustices in researches, the autonomous self-cleansing function in the scientific community is needed. All researchers must strictly control themselves and based on a supreme sense of ethics, must cope with the creation of new knowledge and inventions useful for society such that they meet societal expectations.

As an organization that distributes research funds, JST takes injustice in researches seriously; we cooperate with the relevant organizations and make a thorough effort to take measures that prevent injustices from occurring, which will ultimately enable us to recover the trust of society at large.

1. JST thinks that ethics and fairness in research activities are extremely important for our country, which aims to be a nation based on science and technology.
2. JST supports research activities that are honest and accountable.
3. JST has no tolerance for injustice in researches.
4. In cooperation with the relevant organizations, JST copes with the promotion of education related to research ethics to prevent injustices and reorganize the system by which research funds are distributed.

We must grow a wholesome scientific community and culture based on societal trust to embody a bright future for society that is populated by dreams and hopes. We would like to ask for further understanding and cooperation from research communities and the relevant organizations.

Japan Science and Technology Agency
HAMAGUCHI Michinari, President

0.4 Open Access and Data Management Plan

In April 2017, JST announced this basic principle in relation to research results to promote Open Science. In this principle, we have defined the basic concepts regarding the embodiment of open access to papers related to research results and the retainment, management, and disclosure of research data.

Researchers who have participated in Moonshot Research and Development will be, in principle, obliged to disclose papers on their research results through the organizational repository or in a publication that is presumably open access.

In addition, the institutions that the project managers (PM) adopted for the project are obliged to create and submit a data management plan to document their principles and plans regarding the retainment, management, disclosure, and nondisclosure of the research data that will be produced; thus, the organizations will follow their plans to retain, manage, and disclose their data pertaining to researches and developments.

For further details, please see the following statement.

・JST's basic policies for handling research achievements toward an open science promotion
https://www.jst.go.jp/all/about/houshin.html#houshin04

・The guideline for using JST's basic principle in relation to research results to promote Open Science
https://www.jst.go.jp/pr/intro/openscience/guideline_openscience.pdf

To grasp the contents of the description, to support researchers, and to reflect the basic principles (revision), JST analyzes the numbers of data modules, the types of data, the types of publication, the storage locations, and other statistical data. The statistical data we analyze are assumed to be disclosed; however, any information that could reveal individual data or other personally identifying information will not be disclosed.

*For the items described in a data management plan, see also section 4.7, "The Items the PMs and Performers Should Note regarding Their Contacts," paragraph (5), item c.

Chapter 1 An Overview of Moonshot Research and Development

1.1 Management Principle and Organization

1.1.1 Principle of Management

Japan Science and Technology Agency (JST) began this “Moonshot Research and Development (Moonshot R&D)” based on challenging R&D concepts in which the Ministry of Education, Culture, Sports, Science and Technology(hereinafter referred to as “MEXT”) defines has defined the fields and areas where challenging research and development should be promoted to achieve Goals that attract the public (Moonshot Goals (hereinafter referred to as “MS Goals”)) regarding societal problems that are expected to have a great impact if they are realized, regardless of the difficulty in doing so, from the perspective of our future society. To begin the Moonshot Research and Development, we call for the project managers (referred to as “PMs” from here) who will propose and manage the research and development projects for the achievement of the MS Goals and the realization of R&D concepts.

1.1.2 Overall Management Organization

The general management of Moonshot R&D will be supervised by the Governing Committee organized by JST. Further, the Program Directors (PDs) appointed by JST for the achievement of the MS Goals and realization of the R&D concepts will take charge of the management. Under each PD, the PMs selected for Moonshot R&D are required to promote each R&D project. (See Fig. 1.)

1.1.3 The Roles of the PMs

(1) PM

The PMs collate the relevant knowledge from different researchers—top runner, young, and senior—in and outside Japan and formulate the scenario to achieve the MS Goals through backcasting—achieving the Goals, designing challenging R&D projects based on a bold idea that is not an extension of some conventional technology, planning and ensuring management of the organization for R&D, building an

organization to provide support to the PMs, and ensuring management of the various assignments to fulfill the above-mentioned aims (hereafter "PM activities"); thus, they take responsibility for R&D projects in general. The PMs, in principle, need to devote themselves to the PM activities.

(2) Performer

The performers must manage the assignments for the researches and developments entailed in the R&D projects, as instructed by the PMs, to achieve the MS Goals and embody the R&D concepts.

(3) PM's Institution (Representative Institution)

These are the institutions that employ the PMs, and mainly manage the operations to support the PMs' activities so they can be performed effectively and efficiently.

1.1.4 The Roles of the Committees Organized within JST

(1) Governing Committee

The Governing Committee comprises experts from outside JST, and decides the major principles and methods and discusses other important issues for the operation of the projects, selects PMs, plans the execution, continuation, acceleration, and/or deceleration of R&D projects, and makes decisions on alteration and/or termination. JST makes decisions on what are discussed by the Governing Committee.

(2) PD

The PDs are appointed by JST for the achievement of the MS Goals and for the realization of the R&D concept and select PMs, strategically construct the portfolios (the management plans to sum up the composition (combination) of the R&D projects, the distribution of the resources, and other principles), decide the execution of the R&D projects, make evaluation, and give instruction for the promotion of the R&D projects to the PMs on the basis of the daily progress management of the R&D projects; thus, they take management of various assignments for the achievement of the MS Goals and the realization of the R&D concept. In corporation with the advisors etc., who are external experts, the PD handles these kinds of work.

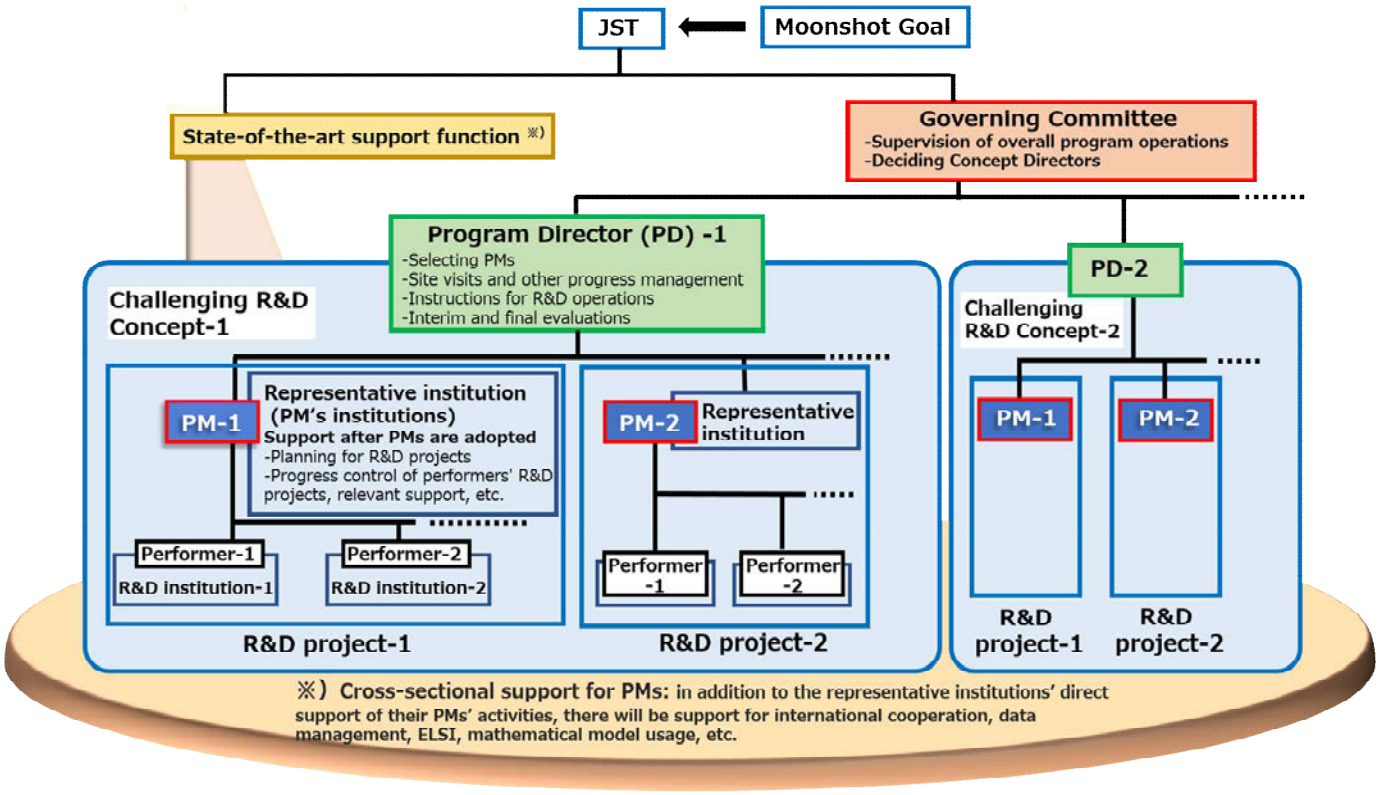


Fig.1. The Organization for the Overall Operation of the Moonshot Research and Development

1.2 The Workflow of Project Operations

1.2.1 Call for and Selection of PMs

JST, based on the MS Goals defined by the Council for Science, Technology and Innovation (referred to as "CSTI" from here) and on the R&D concept defined by the MEXT, calls for, and selects, in principle, two or more PMs, who promote the R&D projects.

*As for the details of our invitation, see Chapter 2, "MS Goals and R&D Concept etc." and, for the details of the call and selection, see Chapter 3, "The Call and Selection of Project Managers (PMs) "

1.2.2 PMs to Refine and Execute R&D projects

(1) Refining R&D projects

The PMs adopted for Moonshot R&D, with the direction by PDs in cooperation with the advisors as external experts, refine the R&D projects. During the period of refining,

they further develop (review and embody) the R&D projects they proposed at the time of application. The refining includes reviewing the scenario to attain the MS Goals, the detailed plans for the R&D project, the organization to give support to the PM activities by the representative of the organization, and the like.

The PMs, whose refining is recognized as appropriate by the PDs (hereinafter referred to as “R&D project implementation plan”), are allowed to execute the R&D project based on a determination of the refining appropriateness.

*For further details, please see section 4.2,”PMs to Refine R&D projects.”

(2) Starting R&D projects

To start an R&D project, top-level engineers, and young, senior, and other researchers are brought together for their vast knowledge to construct organizations for the same. The PMs use appropriate methods, such as designation and public invitations to select performers and construct organizations focused on research and development. The composition of the R&D institutions is determined during the refining period; however, depending on the progress status, changes in external environments, performers may be added and/or switched even during the period in which the R&D projects are executed. Further, considering this aims of Moonshot R&D, they should proactively promote invitations to accomplished overseas researchers and international joint researches.

To initiate the R&D projects, the institutions to which the representatives and performers belong (hereinafter referred to as “R&D institution”) must take a pledge regarding the regulations governing the implementation of the R&D projects in which they are participating and must also draw up a contract with JST for the entrustment of the R&D projects.

*For further details, see section 4.3, “PMs to Implement R&D projects.”

1.2.3 Evaluation etc. of the PMs by the PDs

The PDs, in cooperation with the advisors who are external experts, evaluate the PMs during the execution of the R&D projects, in principle, in the third or fifth year after the PMs’ selection; in addition, evaluation is also carried out whenever the PDs deem it necessary. The evaluation of the PMs is performed based on the progress status and

regarding the milestones that were formulated in the implementation plans for the R&D project, the status of the PMs' project management, and so forth. Based on the results of an evaluation, an R&D project may be continued, accelerated, decelerated, altered, terminated, or handled in some other way.

*For further details about the external evaluations and self-evaluations for R&D projects based on "Guidelines for Operation and Evaluation of the Moonshot R&D Program", please see section 4.4, "PDs' Progress Management and Evaluation of the PMs."

1.2.4 Other

The operation of Moonshot R&D also conforms to "Guidelines for Operation and Evaluation of the Moonshot R&D Program" (Cabinet Office; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Economy, Trade and Industry; February 4, 2020)(Appendix) defined based on "Basic Principles of Moonshot R&D Program" defined by the Headquarters for Healthcare Policy, and CSTI.

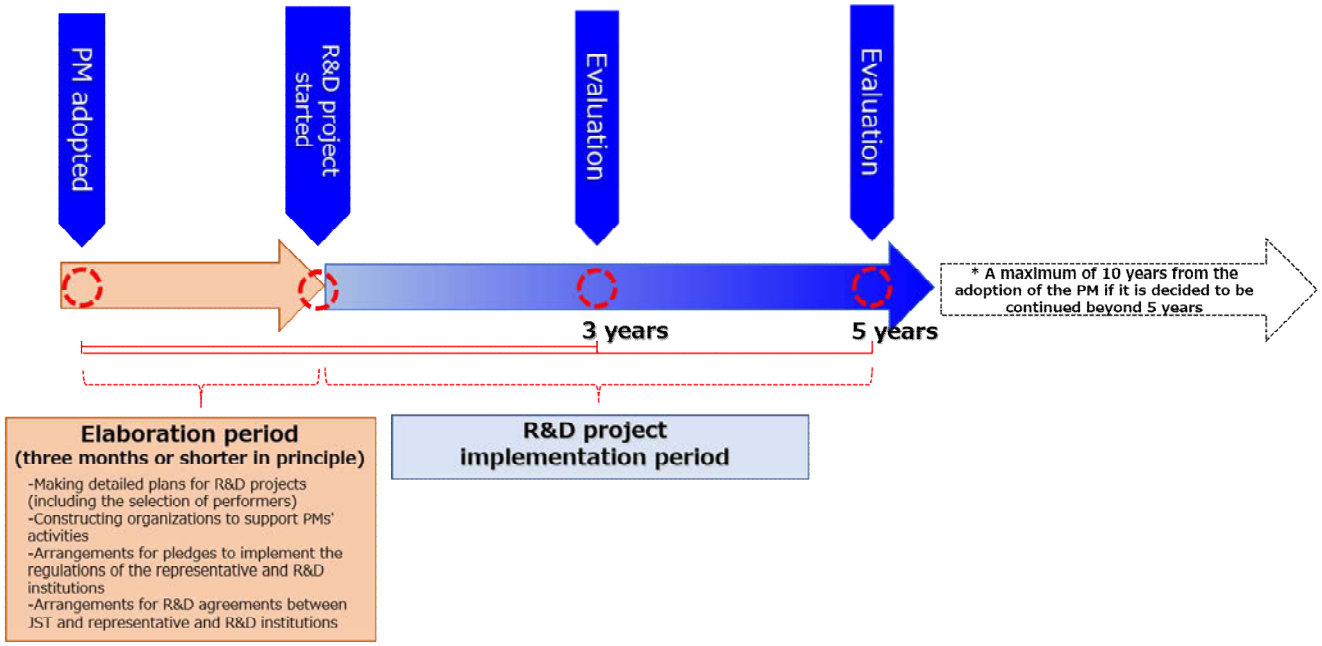


Fig.2. The Workflow of Moonshot Research and Development

[Informative] The Moonshot Research and Development Program led by the Cabinet Office (From “Basic Principles of Moonshot R&D Program” (Council for Science, Technology and Innovation(48th meeting, January 23, 2020)))

[Provisional translation]

1 Purposes of the Program

While Japan faces many difficult issues such as declining birthrate and aging population, large-scale natural disasters, and global warming, science and technology need to solve those issues and create the bright future society.

Under these circumstances, ImPACT program was established in fiscal 2013 as a new research and development program to tackle difficult issues without fear of failure and to create future growth. ImPACT was a five-year trial program.

The research and development targeted by ImPACT was high-risk and high-impact and was expected to create a large impact on industry and society, but such a high-risk R&D does not always success. ImPACT was unique because it nominated talented applicants with challenging concepts, ideas and challenging spirits as program managers, and gave them authorities to manage the research and development.

Targeting high-risk, high-impact research and development that could not be dealt with in conventional national programs, PM integrated various knowledge and ideas, crossing the boundaries of existing organizations and research areas. While some great research results were obtained in a very short time, on the other hand there were also cases that lack of novelty to anticipate the creation of future disruptive innovations has been seen. It has been pointed out that its international collaboration was not sufficient. Therefore, there is a need for further systematic improvement.

US, Europe and China aim to create disruptive innovation to realize ambitious ideas and solve difficult social issues. They are aggressively promoting high-risk, highimpact and challenging R&D with vast investment.

Furthermore, in the R & D management method, they are aiming to create an open innovation platform that emphasizes on internationality and speed, while bringing together the wisdom of leading researchers from all over the world, and adopting various business ideas.

The Moonshot R&D Program aims to create destructive innovation from Japan and the

innovation will be based on ideas that will not be just an extension of conventional technology.

① Setting ambitious Goals (Moonshot Goals) that attract people, to solve future social issues etc., under the direction of researchers who lead international leadingedge researches

② Moreover, in view of the situation where various knowledge and ideas in the basic research stage are applied to industry and society speedy, and destructive innovation is being generated in various fields today, actively promote challenging research and development to maximize the Japanese basic research potential, and lead to discovering and fostering innovative research results while allowing failures

③ While constantly adopting the R & D trends in the world, we will renovate the system in a flexible way reviewing the entire related R & D, and build the best research support system. Also, in anticipation of future commercialization, thoroughly implement the open and close strategy. Furthermore, from the viewpoint of smoothly implementing research results in society, the system that enables researchers in various fields to participate in ethical, legal, and social issues will be structured.

Under the Council for Science, Technology and Innovation (CSTI) and the Headquarters for Healthcare Policy, all relevant government agencies will promote R & D together.

Japan Science and Technology Agency (JST) , New Energy and Industrial Technology Development Organization (NEDO), Bio-oriented Technology Research Advancement Institution of National Agriculture and Food Research Organization (NARO) and Japan Agency for Medical Research and Development (AMED) carry out operations related to such challenging research and development. They will set up funds for the Moonshot R&D Program.

2 Basic Framework of the Program

The Cabinet Secretariat, the Cabinet Office, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Ministry of Health, Labour and Welfare (MHLW), the Ministry of Agriculture, Forestry and Fisheries (MAFF), and the Ministry of Economy, Trade and Industry (METI) will promote research and development in collaboration in the framework below.

（1）The CSTI and the Headquarters for Healthcare Policy will determine the Moonshot Goals that the program should aim for, based on the opinions of outside experts. The members of the relevant conferences will advise from a broad perspective on the promotion of the whole system towards the achievement of the Moonshot Goals.

（2）The Cabinet Secretariat and the Cabinet Office, in consultation with the related ministries, will conduct the following, while listening to the opinions of CSTI members.

・Propose the Moonshot Goals[*1]

・Establish a system to promote related research and development as a whole with related ministries (establish the Ministries council (tentative name))

・Determine guidelines for appointment of Program Director(PD), selection of Project Manager(PM), mid-term evaluation, end-of-term evaluation etc.

・Promote related research and development strategically to achieve the Moonshot Goals based on the discussions at the Ministries council

(*1:Moonshot Goals of CSTI are proposed by Cabinet Office, and those of the Headquarters for Healthcare Policy are proposed by Cabinet Secretariat.)

（3）The Cabinet Office, MEXT, MHLW, MAFF and METI to supervise Research promotion agencies, do the following.

・In cooperation with other relevant ministries and agencies, in order to achieve the Moonshot Goals, formulate an R & D concept that defines areas in which challenging R & D will be promoted.

・In cooperation with the Cabinet Secretariat and the Cabinet Office, strategically and integrally promote related research and development, with the aim of achieving the Moonshot Goals, based on the discussions at the Ministries council.

・Instruct Research promotion agencies

（4）Research promotion agencies are responsible for carrying out research and development in order to achieve the Moonshot Goals.

・Appoint PDs to manage research and development, and select PMs

・Establish a R & D promotion system that includes R & D implementation and the

accompanying survey and analysis functions, etc.

・In cooperation with the Cabinet Secretariat, the Cabinet Office, and related ministries, based on the discussions at the Ministries council, strategically and integrally promote related research and development

・Progress management of R & D including mid-term evaluation and end Evaluation

（5）The Cabinet Secretariat and the Cabinet Office will coordinate with related ministries to separately determine the details of the operation of this program.

Chapter 2 MS Goals and R&D Concepts etc.

2.1 MS Goals

The MS Goals that JST promotes R&D are as follows.

Moonshot Goal 1	Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.
Moonshot Goal 2	Realization of ultra-early disease prediction and intervention by 2050.
Moonshot Goal 3	Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.
Moonshot Goal 6	Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

* Moonshot Goal 4 “Realization of sustainable resource circulation to recover the global environment by 2050." will be managed by NEDO and Moonshot Goal 5 "Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050," by another Funding agency, respectively.

2.2 R&D Concepts and the PD's Supplements

(1) R&D Concepts

Toward the achieving MS Goals, MEXT set the R&D concepts that challenging R&D should be promoted. See “R&D concepts” in the appendix of the application guidance.

(2) PD's Supplements

Toward the achieving MS Goals and R&D concepts, PDs make the policy for selection of projects, and promotion of R&D. See “PD's Supplements ” in the appendix.

Chapter 3 The Call and Selection of Project Managers (PMs)

3.1 Applicant Requirements

3.1.1 Requirements Proponents as PM Candidates Are Expected to Have

Regarding the requirements for the applicants, understand the following two items in advance.

*The proposals are not accepted or adopted, in principle, if it is revealed that the applicant requirements were not satisfied.

* The requirements need to be maintained during the period of the execution of the R&D projects. The PM is dismissed if the application requirements come to be not satisfied during the period of the implementation of the R&D project. Before filing an application, ensure that you understand the content stated in Chapter 5, "Instructions for Applicants," as well as the below items, which should be considered when you apply for the project.

Applicants need to satisfy all of the application requirements (1) to (5) below.

（1） Applications must be filed by one person, not by a group.

（2） As much effort as possible must be made to monitor and manage PMs' activities.

※ However, if the PD decides that it is extremely effective for the PM to perform part of the research and development of an R&D project on his or her own to achieve a particular objective, he or she may participate in research and development as a performer.

（3） All responsibilities of the R&D project must be undertaken for all periods of the R&D project's implementation.

*For further details, please see section 4.1, "The Roles and Responsibilities of the PMs, PM's Institutions, and performers".

（4） A program regarding research and ethics education has been completed at the institution to which he or she belongs. Alternatively, an education program provided by JST must be completed by the application deadline.

*For further details, please see section 5.21, "The Obligation to Complete Research and Ethics Education and Compliance Courses."

（5） A pledge must be made regarding the following four items. The applicant must:

・Understand and be willing to conform to the "Guidelines for Responding to Misconduct in Research Activites" (decision, Minister of Education, Culture, Sports, Science and Technology, August 26, 2014)

・Understand and be willing to conform to "Guidelines for the Management and Audit of Public Research Funds In Research Institutions (practice standards)" (revised on February 18, 2014)

・Not have committed any misconduct in research and development activities (forgery, falsification, and theft) or any unjustifiable use of trusted research funds

・Not have committed any misconduct in research and development activities with respect to the past achievements of the researches and developments described in the applicable written proposal

*The pledges are available from the screen to fill in the information of applicants on the Cross-ministerial R&D Management System (e-Rad).

A PM must determine the PM’s institution as the base of his or her own activities in the country.

※ The PM’s institution must be the PM’s employer (a university, college, public organization, private enterprise, or the like) that is a Japanese corporation and has its base of activities in Japan. For the requirements a PM’s institution must meet, please see section 3.1.3, "Requirements for PM’s Institutions.)

※ You can apply for this call even if your PM’s institution is not determined at the time of application, if you belong to an organization outside of Japan, or for any other reason.

※ If, however, you are not able to determine your PM’s institution within three months(*), in principle, after the adoption, then the adoption could be canceled. (*: If PM does not choose the present institution as the PM’s institution, the deadline will be until end of fiscal year that PM is adopted.)

3.1.2 Requirements for the Proposed R&D projects

Before making an application, the proponents must understand that items (1) to (3) below must be satisfied for the R&D project they propose. Please also see section 3.7, "Viewpoints in Selection."

(1) Compatibility with the Project Aims

- To contribute to the resolution of social problems and have a significant impact on industry and/or society, as well as to introduce a challenge based on a bold concept towards achieving the MS Goals

(2) Scenarios Leading to the Achievement of MS Goals

- As a scenario that is addressed in a R&D project, that is grasped not only from technological viewpoints but also from a broad perspective, including social viewpoints, while the problems that should be overcome are analyzed and identified
- To resolve problems that should be overcome, the methods and/or means are presented based on scientific proof.

(3) Plans for Constructing a Research and Development Organization

- The measures and plans for constructing an organization that further develops the ability to conduct R&D projects at the highest level, regardless of its location within or outside of Japan, not limited to a specific research community, and leveraging knowledge from a wide range of fields to solve problems

3.1.3 Requirements for PM's Institutions

As the base of PM activities, a PM's institution must endeavor to support the PM in devising effective and efficient activities and managing the business to support the PM's activities. A proponent, even if it is unclear whether the organization to which the proponent belongs will be his or her PM's institution, is allowed to make an application; however, he or she must determine a PM's institution by the close of the refining stage. The adoption will be canceled if a PM's institution is not determined within, in principle, three months(*) following the adoption of the project.(*: If PM does not choose the present institution as the PM's institution, the deadline will be until end of fiscal year that

PM is adopted.)

Before making an application, the proponents must fully understand that items (1) and (2) below must be satisfied by the PM's institution.

（1） To be an employer of the PM, which is a university, college, public organization, private enterprise, or the like, that is a Japanese corporation and has a base of activities in Japan, and to employ the PM by the end of the refining period

（2） To accept the items described in section 4.1.2, "The Roles and Responsibilities of PM's institutions" and to finalize a contract with JST

3.2 Application Period and Schedules for Selection

Thursday, February 20, 2020 to Noon, Thursday, May 12, 2020 <No delay accepted>

Applications will be accepted on e-Rad from Early-March. The start of the reception will be announced on the website of this call:

https://www.jst.go.jp/moonshot/en/application/

For the details of the schedules of guidance sessions, selections, and others, see the opening section (1), "The Schedule of the Call for Application and the Selection."

If you have not finished your application steps from e-Rad before the deadline, your application, regardless of the reason, will not be accepted for review.

The schedule for the selection process is below.

Period of document-based review	Mid-May – Mid-June
Invitation for interview-based review (for applicants having passed the document-based review)	Mid-June – Late-June
Period of interview-based review	Late-June – Early-July
Notification and Announcement of Selection Results (Notification sent to all proponents)	Early or Mid-July

*The schedule following the document-based review reflects the current plan and is subject to change.

*JST will notify applicants of the specific time and date of their interviews.

*The schedules of the interview-based review and the period in which eligible applicants will be notified via e-mail of their selection for an interview will be announced from the website of this call as follows: https://www.jst.go.jp/moonshot/en/application/

*Notifications are to be sent via e-mail to the applicants who are invited to the interviews. (No postal mail is to be sent. Notifications are sent to the e-mail addresses registered to e-Rad. Make sure that you set your e-mail address to receive our notifications.)

3.3 The Periods to Implement R&D projects

The period to implement R&D projects is five years since the adoption of the PM. As a result of an evaluation in the third year, a R&D project may be altered (accelerated, decelerated) or terminated.

Furthermore, A period of the execution of the evaluation is supposed to be, besides the third year, in the fifth year after the timing of the adoption of the PMs and, in addition, the evaluation is performed whenever the PDs recognize it necessary to do so.

In either case, the R&D project may be altered (accelerated, decelerated) or terminated. The maximum period is ten years if it is decided to continue beyond the five-year period.

*For further details, please see section 4.4, "PDs' Progress Management and Evaluation of the PMs"

3.4 The Monetary Amount for R&D projects

Based on the content of proposal, the proponent can make the budget of R&D project the most appropriate amount that he or she estimates at the time of the proposal.

The R&D budget for a R&D project at the initial stage will be judged and determined by the PD in cooperation with the advisors etc. as external experts at the time of the refining after the adoption.

3.5 The Number of Proposals to Be Adopted

Roughly, four PMs will be adopted for each MS Goals. However, this will not apply depending on the decision by the PD or the like.

3.6 Methods of Selection

3.6.1 The Steps to Select PMs

In cooperation with advisors, who are external experts, the PD will make a selection via document- and interview-based review. The result of the selection by the PD will be examined by the Governing Committee and the PM will be selected. After that, JST makes decisions on what are discussed by the Governing Committee and determines the PM. The applicants who are adopted as the PM will immediately begin refining the R&D projects; they will further develop (review and embody) the R&D projects they proposed at the time of their application. The PMs whose refining is recognized as appropriate by the PD will be allowed to execute their R&D projects.

3.6.2 Management of Participant Conflicts of Interest in Selection Processes

To ensure a fair and transparent evaluation, parties with interest that are listed below will not participate in the selection processes regarding the applicable proponents.

a. A person or persons who is or are related to the proponent

b. A person or persons who belongs or belong to the same department, major, etc. within a university, college, or research and development organization at a national research and development corporation or to the same enterprise as the proponent

c. A person or persons who engages or engage in a close joint R&D project with the proponent or a person or persons who has or have participated in a close joint R&D project within the past five years (this refers to, for instance, conducting a joint project, authoring a research paper as coauthors, the members of an R&D project for the same purpose, or the joint researchers or the like of any other R&D project of the proponent, who practically belong to the same research and development group as the proponent).

d. A person or persons who has or have been closely related to the proponent as a teacher or a student or who has or have been in a direct employer-employee relationship for a total of ten years previously

e. A person or persons who is or are in an academically competitive relationship with the proponent’s R&D project or who belongs or belong to an enterprise that is in a competitive relationship in the market

f. Any other person or persons who is or are judged by JST to be a party with interest

3.7 Viewpoints in Selection

Our selection will be based on the following viewpoints and made in a comprehensive manner.

① Nature as a PM

○ To have a wide human network of relevant researchers within and outside of Japan and to possess specialized knowledge

○ To have the ability for management to construct an optimum R&D institution and review the organization proactively, depending on the status of the progress (including those in relation to the management and usage of research data) and to have leadership ability

② R&D projects Proposed by PMs

○ The target and/or the contents of the project proposed by the PM (referred to as "proposal contents" from here) must be based on a bolder idea than conventional ones and be a challenging one and must be a innovative one with which a strong impact is expected in the future industry and/or society.

○ The proposal contents must be able to clearly explain the adequate scenario (the hypothesis of the success) from the viewpoint of social implementation including the viewpoint of technology and the assignments of the roles to governmental bodies and private sectors for the achievement of the goal in 2050.

○ The proposal contents must entail collecting the knowledge of researches and developments and ideas at a high level, regardless of their geographical location within or outside of the country. Or the like.

And ensuring of transparency and fairness of research, appropriate treatment of research results, management of technical information and other items are to be considered because of importance in fair research activities.

3.8 How to Apply

3.8.1 Application Type

Follow the instructions on filling in the form at the end of this document to create a written proposal. Download the proposal form from the following website.

https://www.jst.go.jp/moonshot/en/application/

The list of documents that must be submitted is provided in section 3.8.2, "Documents to Be Submitted"

Before filing an application, understand the contents of Chapters 0, " To those who are applying for and/or participating in the project " and 5, "Instructions for Applicants."

For the details of how to apply, see Chapter 6, "How to Use the Cross-ministerial R&D Management System (e-Rad) for Your Application."

3.8.2 Documents to Be Submitted

The list of the documents that must be submitted is as follows. In addition, the secretariat may ask a proponent to provide additional information in the course of selection. A PM's institution may be asked to submit a statement of accounting if the organization that is supposed to be a PM's institution is an enterprise or the like.

from here

[Form 1] The Moonshot Goal You Aim to Achieve

[Form 2] An Overview of the R&D Project

[Form 3] The Scenario to Achieve the Moonshot Goal

[Form 4] Proposal for R&D project

[Form 5] Plans for Promoting R&D projects and Budget Plans

[Form 6] Proponent Management Ability

[Form 7]　Items Implemented by PM for Refining

[Form 8]　Information Related to Conflicts of Interest

[Form 9]　Status and Efforts of Application for Research Funds and Acceptance

[Form 10] Human rights protection and managing the observance of laws

[Form 11] "Letter of Recommendation"

[Appendix to Form] Performer Candidate Information Sheet

Chapter 4 Promoting R&D projects after PMs Are Adopted

4.1 The Roles and Responsibilities of the PMs, PM's Institutions, and Performers

4.1.1 The Roles and Responsibilities of the PMs

The PMs gather the wisdom of a variety of researchers such as top-runner researchers, younger researchers, and senior researchers in and outside Japan, plan, propose, and implement challenging R&D projects based on a bold idea that is not an extension of some conventional technology, construct and take management on their own, and carry the responsibility for the R&D projects in general for the achievement of the MS Goals and the realization of the R&D concepts.

Specifically, they promote the following management responsibilities for R&D projects with the support of their PM's institution or the like.

[The Management of the R&D projects Performed by PMs]

① Designing R&D projects

○ Planning and Proposing R&D projects

・To formulate scenarios backcast from the achievement of the MS Goals, to prepare R&D Plans, including the targets of R&D projects, specify milestones, etc.

○ Building Research and Development Organizations

・To formulate plans to construct optimal research and development organizational infrastructure to promote R&D projects

・To select performers based on the above-mentioned plans

② Implementing and Undertaking the Management of R&D projects

○ Undertaking the Management of R&D projects

・ To summarize the R&D Plans for each performer, as well as the budget plans, to grasp the progress status, and to summarize reports, etc.

・ To promote cooperation among each performer as necessary

・ To undertake the management of research and development implementation, in addition to that mentioned above

○ Evaluating R&D projects

・ To flexibly conduct reviews to alter the orientation, including the acceleration or deceleration of R&D projects conducted by each performer and the spin-off of

part of research results

○ Applying Research and Development Results

・ To formulate the principles of handling intellectual properties, to appropriately acquire intellectual properties, and to apply the results from the researches and developments, such as the activities required to transfer technology

③ Organizing a System to Support PM Activities

○ To hire and undertake the management of the work done by personnel supporting the PM activities from the PM's institution

○ To organize the system in relation to business management, including the cooperation of performers in addition to the above-mentioned entity

④ Cooperation with JST

○ Reports to the PD and the advisers as the external experts

・ To report on the status of the progress of the R&D projects to the PD and the advisers as the external experts

・ To respond to the advice and/or guidance from the PD and the advisers as the external experts

・ To respond to evaluation

○ Making Business Arrangements

・ The regulations governing implementation overseen by R&D institute, JST, contracting businesses, and each entity involved to manage the implementation

・ To cooperate with JST in symposiums, training sessions, etc. and participation therein

○ The management business for the R&D projects instructed by the PD or the like besides the above-mentioned

⑤ Publication and outreach activities based on the results of R&D projects

○ To undertake the management of the homepage, publish pamphlets, hold symposiums, make press releases, etc.

○ Two-way communication activities in which researchers explain their research activities to society in a way that is easy to understand (science and technology

dialogue with the public)

- ○ To report publication and outreach activities to JST
- ○ To undertake the management and operation of public relations and outreach activities regarding R&D projects in addition to those mentioned above

4.1.2 The Roles and Responsibilities of PM's Institutions

These organizations are the employers of the PMs, which mainly undertake the management of the operation to support PM activities to ensure that the PM activities can be performed effectively and efficiently.

A PM's institution, based on its contract with JST, organizes an environment in which the PM activities can be performed effectively and efficiently, hires personnel to support the PM, and constructs organizational infrastructure, thereby providing various types of support to the PMs' activities, including managing the progress of the R&D projects undertaken by the performer, who works for the PM's institution or any other organization, and supporting the PM activities.

Specifically, it supports the activities in section 4.1.1,"The Roles and Responsibilities of the PMs."

In addition, a PM's institution should manage the cross-organizational support provided to PM activities with the front-runner support function of Moonshot R&D, in addition to direct support for PM activities.

4.1.3 The Roles and Responsibilities of Performers

The performers take management of the assignments for the researches and developments in the R&D projects as instructed by the PMs for the achievement of the MS Goals and the realization of the R&D concepts. The performers make plans for the R&D project based on the targets that should be achieved within the purpose and scope to implement the applicable tasks as instructed by the PM. They then implement the R&D projects based on the R&D Plans that have been approved by the PM. Before a performer initiates a R&D project, the R&D institution to which the performer belongs must finalize a consignment research and development contract with JST, as well as take a pledge regarding the regulations under which it will abide when implementing the R&D projects

in which it participates.

Furthermore, depending on the status of the progress of the research and development, and with the approval of PD, each PM may increase, decrease, or cancel the budget of the part of R&D project.

*PMs and performers need to observe section 4.7, "Contract Items the PMs and Performers Should Pay Attention to," as well as the roles and responsibilities described in section 4.1.1, "The Roles and Responsibilities of PMs," and section 4.1.3, "The Roles and Responsibilities of Performers." See these sections for further detail. PMs must observe these roles and responsibilities as if they were a performer, if they are allowed to implement R&D projects on their own and are conducting the tasks entailed therein.

*PM's institutions and R&D institutions (referred to as "R&D institutions etc." from here) need to observe section 4.8, " Items the R&D institutions etc. Should Pay Attention to in Particular," as well as the roles and responsibilities described in section 4.1.2, "The Roles and Responsibilities of PM's institutions," and section 4.1.3, "The Roles and Responsibilities of Performers." See these sections for further detail. The PM's institution must observe them as if it were a R&D institution, if its PM is allowed to implement the research and development on his or her own and is conducting the tasks entailed therein.

4.2 PMs to Refine R&D projects

The PMs, with the direction by PDs in cooperation with the advisors as external experts, refine the R&D projects. Specific items included in the refining are as follows: propose detailed plans for R&D projects (to formulate the scenarios backcast from the achievement of the MS Goals considering ELSI to prepare the R&D Plans, including the targets of the R&D projects and specified milestones, and to construct a research and development organizational infrastructure, etc.) and to construct an organizational infrastructure to support PM activities performed by the PM's institution. Through such refining, each type of investigation, such as trends in technology, workshops, and symposiums, is conducted or held to absorb opinions from various fields to achieve the MS Goals, the contents of the R&D projects proposed at the time of the application are further developed (reviewed and

embodied), and more effective and efficient R&D plans are proposed for the achievement of the MS Goals. The period of such refining is, in principle, within three months after the adoption. (If the PM's institution is not decied, R&D project cannot be started.)

[Important Items, such as the Contents Comprising the Refining of R&D projects]

（1） Further developing (Reviewing and Embodying) the Contents of R&D projects

○ To formulate scenarios and specify the targets and milestones of the R&D project

・ To backcast the future society at the time of the achievement of the MS Goals in 2050 and to extrapolate the point of the time when the MS Goals are achieved in the third year, fifth year, and tenth year after the adoption of the PM, and, thus, to formulate the scenario that should be coped with as an R&D project

・ To specify the targets of the R&D project and the milestones that can be quantitatively evaluated regarding the progress of the R&D project upon evaluation for the embodiment of the scenario

*The evaluation is performed based on milestones previously defined at the time of the refining.

○ To make specific plans for research and development and for a research and development organization

○To make proposals for the plans for constructing specific R&D plans (the R&D items, contents, approach, plans for distributing budgets, etc.) and an R&D organization based on the scenario that should be coped with in the R&D project until the third year, fifth year, and tenth year after the time of the adoption of the PM for the achievement of the MS Goals

○ Constructing Research and Development Organizations

・ The plans for selecting necessary performers to implement the plans created in the previous item (positioning within the research and development organization, selection timing, the methods, etc.)

・ The selection of performers who participate at the beginning of the R&D project

・ The plans for the research and development of the applicable performers (the problems in the R&D items, the contents and approach, the plans for distributing budgets, etc.)

○ Gathering wisdom and expertise from various fields

・ Conducting each type of investigation, such as technology trends

・ Hosting workshops, symposiums, etc.

（2） Constructing a System to Support PM Activities

○ Determining a PM's institution

○ Proposing plans to structure the organization to support PM activities

○ Constructing an organizational infrastructure to ensure the support necessary at the beginning of the R&D project and organizing an appropriate environment

（3） Other

○ Making arrangements for and organizing implementation regulations to define items that should be observed by participants in the R&D project

○ Moving the base of activities quickly into this country (if the base of activities is outside the country at the time of the adoption)

4.3 PMs to Implement R&D projects

In cooperation with the advisors etc., who are external experts, the PD judges the adequacy of the contents of refining. The PMs whose contents are recognized as appropriate are allowed to execute the R&D projects. PMs make arrangements for the implementation of the R&D Plans with each performer, who is selected in advance to carry out the R&D project. Performers must undertake the management of the scope of the research and development designated by the PM, among the tasks entailed in the R&D project. Specifically, PMs clarify the objectives required to implement the scope of the applicable R&D project and the targets that should be achieved within the scope, and performers propose plans for the R&D project based on the targets identified. Performers implement the R&D project under the management of the PM and based on the plans approved by him or her. PMs endeavor to understand the progress status of the research and development implemented by each performer in a timely manner and give them instructions and/or advice accordingly. In cooperation with the advisors etc., who are

external experts, the PM judges the fact that the PM takes management of the R&D on his or her own. PMs are allowed to participate in the R&D on their own if they have an approval.

PMs try to understand the situation of the economy and social environment in relation to the applicable R&D project during the period of the implementation of the R&D project and need to implement the R&D project by confirming the adequacy of the scenario to reach the MS Goals having been created by themselves. In consideration to the aim of the Moonshot R&D that supports the R&D with high-risk and high-impact for leading destructive innovation(P19-22), it is expected that PM manages the R&D project by the approach with a small start and stage gates. (e.g. In the case of a project that requires technical examination, although research results can be anticipated if successful, the project starts as its feasibility study with a small start.) Under the direction of PD, and depending on the process in R&D project and the changes in at the external environment, PM needs to manages R&D project agilely and flexibly with his or her power and responsibility, by changing the direction of R&D project that contains such as increases, decreases, and spinouts of parts of R&D project. (In accordance with Guidelines for Operation and Evaluation of the Moonshot R&D Program, and considering the results of external evaluation and self-evaluation, PM should decide continuation, increase, decrease, change, and finish of R&D project.)

In addition, when considering the aims of Moonshot R&D, they must proactively promote the invitation of top-tier, overseas researchers and international joint researches.

For the start of the R&D projects, the R&D institutions etc. need to make a contract for the entrustment of the researches and developments with JST as well as to take a pledge with respect to the regulation for implementing the R&D projects.

4.4 PDs' Progress Management and Evaluation of the PMs

As for the progress management of PMs, evaluation, etc., in corporation with the advisors etc., who are external experts, the PD handles these kinds of work.

(1) Progress Management of PMs

PMs need to provide status reports of their R&D projects to the PDs as requested. Their reports should be submitted, in principle, biannually; however, the timeline

may vary. Furthermore, PDs may visit the sites of R&D institutions etc. for the purpose of grasping the progress status, giving advice and/or instruction, etc. in cooperation with the advisors etc., who are external experts, as necessary.

(2) Evaluation of PMs

The PDs evaluate the PMs during the realization of the R&D projects. The evaluation will occur three to five years after the adoption of the PMs. The maximum period is eight to ten years if it is decided that the project can continue beyond five years. In addition, Funding agency will have the self-evaluation for PMs every year. The evaluation of the PMs are performed based on the status of the progress with respect to the milestones (standards and conditions) that can quantitatively evaluate the progress of a R&D project target and/or of a R&D project that is/are defined in the R&D plans as well as the status of the project management of the PMs. The evaluations are performed in consideration, as necessary, to the state including external factors such as the changes in the economic and/or social environments in the period up to the time of the evaluation from the time for refining.

Resulting from the evaluation, the R&D project plans may change, the R&D cost may increase or decrease, or the R&D project may be terminated altogether (a PM may be dismissed).

[Viewpoints of Evaluation]

- ○ The appropriateness of project targets and contents aimed at achieving the MS Goals
- ○ The status of progress toward project targets (particularly comparisons of both domestic and overseas)
- ○ The future prospects of project targets
- ○ The status of establishing an R&D system
- ○ PM’s project management status (including flexibility and nimbleness)
- ○ Status of research data storage, sharing, and disclosure
- ○ Cooperation with industry and the status of bridging the gap between the R&D and practical use in society (including the status of acquiring private funding [matching] and spin-out)

○ Effective and efficient R&D promotion through international cooperation
○ Challenging and innovative efforts based on bold ideas
○ Effective and efficient use of research funding (including role sharing between the public and private sectors, and stage-gates)
○ Bi-directional communication activities (public dialogue on science and technology)

(3) Others

To manage the PDs' portfolios, there may be opportunities for further review of the PMs, depending on their management methods after the evaluation period defined here.

4.5 Commissioned R&D Contracts

（1）For the start of an R&D project, JST makes, in principle, a contract for the entrustment of the R&D with the R&D institution. Moreover, before the R&D entrustment contract, the R&D institutions and JST prepare regulations for intellectual property, the handling of secrecy, and other operational rules for the R&D project. The R&D institutions should make a pledge.

（2） If the R&D institutions cannot reach an R&D agreement, an organization for the management or audit of the public Research cost is not completed, or the status of financial affairs is extremely unstable, then the applicable R&D institution may not be allowed to perform the R&D.

*For the details, see section 4.8, "Items the R&D Institutions Should Pay Attention to in Particular."

(3) The intellectual properties such as patents that come from the R&Ds are, on the basis of the R&D agreement, in principle belong to the R&D institutions etc. on condition that the items described in Article 17, Industrial Technology Enhancement Act (Japanese version the Bath-Dole Act), is observed by the R&D institutions. However, this arrangement does not apply to R&D institutions overseas.

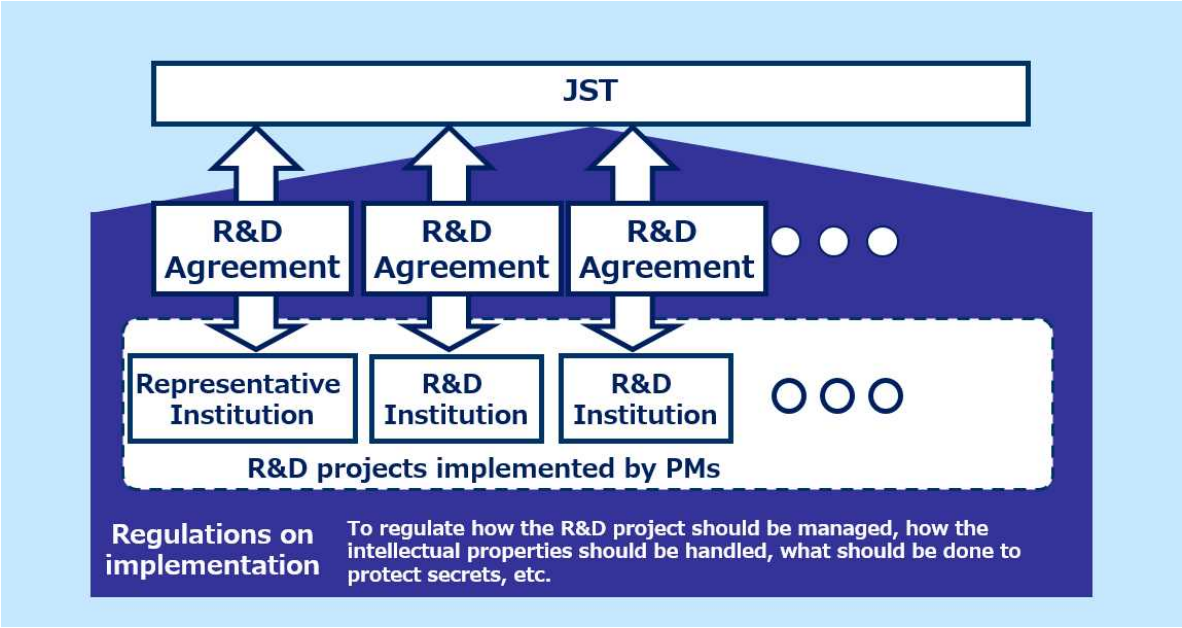


Fig.3 Organizations and Contracts

4.6 R&D Funds

JST, on the basis of the R&D agreement, pays R&D funds as direct cost and indirect cost to the R&D institutions.

4.6.1 Direct Cost

The direct cost is for the expenditures listed below payed by an R&D institution etc.

a: Cost for goods: the expense to purchase a new facility, equipment, or consumables.

*For the purchase of a new research facility and/or equipment, assume the use of "a system to share the research facility/equipment by the unit of a research organization" ("equipment sharing system" from here). It is discussed in the "Introduction of a New Research Facility/Equipment Sharing System Integrated with the Management of Research institutions" (Advanced Research Platform Group, Council for Science and Technology, November 2015). *For more details, see section 5.13, "Promotion of Sharing Research Facilities and Equipment."

*In the R&D project proposal form (Form 5), the description on the major facility to be purchased (20 million yen or higher per one, the name of the equipment, a rough estimation of the expenditure) is needed; after the adoption is determined, in the course of the refining of the R&D project by the PM, the plans for the

purchase, operation, sharing of the applicable facility should be brushed up. In addition, from the viewpoint of the effective and efficient implementation of each R&D project implemented in this program, some arrangements may be made for the facility to be purchased with the direction of the PD in cooperation with external experts as advisors etc.

b. Cost for travel: the expense for R&D project participants' travel, as described in the R&D plan for PMs and performers.

c. Cost for labor: The labor cost and rewards for the R&D project participants

The duplicated labor cost of a person that is managed by the national government with a management expense grant, government subsidies to private educational institutions, for national university corporations, incorporated administrative agencies, or incorporated educational institutions will be excluded. Furthermore, the labor cost for the PMs and the persons who support the activities of the PMs conform to the regulations of the PM's institution. It should be within the appropriate scope, according to socially accepted ideas (to be discussed in deliberation with JST in advance).

*At present, according to "Integrated Innovation Strategy" and "Comprehensive policies package of research promotion and support for young researchers", system improvement of the competitive funds has been discussed in Japanese government, for enabling more effective and efficient usage of research fund. If the policy about the competitive funds is decided during the period of call for proposal, and if it is applied to this program, JST will express the additional information at that time.

d. Others: the cost for the publication of research results (submitting a paper), leasing equipment, transport, and patents.

*In Moonshot R&D, appropriating the direct cost to other costs is allowed when the research results are expected to lead to a patent during the R&D project implementation period (the cost for a patent application, patent lawyers, travel, procedures, and translation).

*Examples of costs that will not be refunded as part of the direct cost

・Costs that do not conform to the purposes of the activities contributing to the

implementation and/or operation of an R&D project

・Costs that should be paid from the indirect cost

・Costs that the JST judges inappropriate after the settlement of the budget for the costs of consigned research (**)

** JST has rules and guidelines that are specific to this program and concern account titles based on the development contract of consigned research, the clerical procedure manual, and the table of cost processing classification common for governmental bodies. Such processes may differ between universities, colleges, public research institutions, and public corporations, as recognized by JST, and companies, such as research institutions outside of universities or colleges, and private enterprises. For more details, access the following website and see the description of the clerical procedures.

＜Moonshot Research and Development - Instruction of procedures to execute contracted Research and Development＞

https://www.jst.go.jp/moonshot/en/application/

＜Cross-ministerial R&D cost categories (Moonshot Research and Development)＞

https://www.jst.go.jp/moonshot/en/application/

*For the employment of researchers etc., note section 4.7, " Contract Items the PMs and Performers Should Pay Attention to," section 5.14, " Improvement in the Treatment of Second-Half Doctral-Course Students," and section 5.15, "Support for a Variety of Career Paths of Young Doctoral Researchers."

4.6.2 Indirect Cost

Indirect cost is the cost that is necessary for the management etc. of the R&D institutions etc. for the implementation of the R&D project, which can be paid based on a fixed ratio with respect to the direct cost.

Indirect cost is regarded, in principle, as 30 percent in comparison with the direct cost for universities and 10 percent for others (20 percent for medium- or small-sized companies only).

※ The definition of medium- or small-sized companies is based on the situation at the

time of the decision of their prospective participation in the R&D project. They must conform to the Small- and Medium-sized Enterprise Basic Act, Article 2, Paragraph 1 (the scope of small- and medium-sized enterprises and the definition of terms).

4.6.3 Multi-Year Contracts and the Carry-Over System

JST has R&D agreements as multiple-year contracts, which make it possible to carry over R&D funds and make contracts for procurements that continue beyond fiscal years. The aim is to further effective and efficient uses of R&D funds and prevent misconduct for the maximization of R&D funds. (as for the carry-over system, there may be cases in which multiple-year contracts are not allowed or carry-over is not applicable depending on the clerical management systems etc. of R&D institutions etc. besides the handling that is different among universities and companies).

4.7 Contract Items the PMs and Performers Should Pay Attention to

(1) Participants must fully recognize that the taxes of national residents cover the R&D funds of JST, and they must spend them justly and efficiently.

(2) After PMs are employed, they and the performers must observe the following items through guidance sessions, which are held by JST. They must submit to JST a document stating that the following items are confirmed. Furthermore, note that if the research ethics learning materials in Item c below are not finished, the R&D funds may be suspended until there is confirmation that the training course has been completed.

a. To observe the requirements of the public invitation and the regulations of the organization to which they belong;

b. To understand that the taxes of national residents cover the R&D funds of JST and that they should not commit improper acts in their R&D activities (falsification, alteration, and/or theft of papers) or improperly use R&D funds;

c. To notify and educate others about their participation in the course on research ethics learning materials, as designated by JST (eAPRIN, formerly CITI); to prevent in advance improper R&D activities or improper use of R&D funds among

the R&D project participants

*For more details, see section 5.1, "Completing the Course on Research and Ethics Education."

(3) To prevent improper R&D activities in advance (falsification, alteration, and theft), the R&D PMs and participants need to finish the research ethics learning materials (eAPRIN, formerly CITI).

*For more details, see section 5.1, "Completing the Cource on Research and Ethics Education.

(4) The R&D PMs and participants should proactively support and ensure a variety of career paths inside and out of the country for the young doctoral researchers who are paid with R&D funds.

*For more details, see section 5.14, "I Improvement in the Treatment of Second-Half Doctoral-Course Students" and section 5.15, "Support for a Variety of Career Paths for Young Doctoral Researchers."

(5) Handling R&D Results

a. Acquire intellectual property rights properly. You follow the R&D agreement and have your R&D institution apply for (or file) a patent.

b. If you publish a paper about the R&D results acquired from the implementation of an R&D project, explain that it is fruit of a Moonshot R&D project.

c. The PM will be asked to submit, together with the R&D project plan to JST, the "Data Management Plan" that compiles, by following the items listed below, the retainment and management and the publication or non-publication of the R&D data accrued as a fruit and the principles of the usage of the R&D data you can publish and, based on this plan, to appropriately implement the storage, management, publication, partial publication or non-publication of the data on the basis of the " Guidelines for Operation and Evaluation of the Moonshot R&D Program "(see the appendix) and "JST's basic policies for handling research achievements toward an open science promotion."

・JST's basic policies for handling research achievements toward an open science promotion

https://www.jst.go.jp/all/about/houshin.html#houshin04

For the details of the items you fill in, see "The Guideline for the Use of the Basic Principle of JST in Relation to the Research Results for the Promotion of Open Science."

https://www.jst.go.jp/pr/intro/openscience/guideline_openscience.pdf

<The Items You Complete in the Data Management Plans>

- The principles for the retainment/management of the R&D data as a target of management
- The principles in relation to the publication/non-publication of R&D data
- The methods of and organizations for publishable R&D data
- The assumed uses and purposes of publishable R&D data
- The endeavors for the promotion of the usage of publishable R&D data
- Other special remarks

d. For the advanced data management, clarify the categories of storage-sharing-publication of research data based on the open-close strategy. And promote research information exchange and storage-sharing- publication of research data, by utilizing the research data infrastructure system (NII Research Data Cloud) and other tools.

e. We will ask the MS to collaborate with R&D project participants on cross-sectional and outreach activities to promote cooperation and the multiplier effect in R&D at workshops and symposiums held by JST in or outside the country and for MS Goals and R&D concepts. In addition, we expect that global activities and publications will be proactively made in the course of the promotion of R&D activities.

(6) Understanding in advance that JST will provide the required information, such as the R&D project name, participants, and consignment cost, to the Cross-ministerial R&D Management System (e-Rad) and the Cabinet Office (section 5.22, "Handling Information, Such As Items Described in Research Proposals"). In addition, we may ask that each type of information be provided.

(7) There are cases in which a tracing evaluation will be conducted after a certain period has passed after the end of an evaluation or the like in relation to the this program and/or after the R&D project. On such occasions, you are asked to provide each type of information or participate in interviews.

4.8 Items the R&D institutions Should Pay Attention to in Particular

The R&D institutions etc. must sufficiently recognized that the original funds of the funds for the consigned R&D are public funds while the R&D project is implemented and, thus, try to implement the R&D projects efficiently. The R&D institutions etc. that cannot fulfill their responsibilities listed below are not allowed to implement PM activities or to implement the R&D.

(1) In the case in which the R&D organizations are domestic organizations

a. The R&D organizations etc. must, in principle, enter an R&D agreement with the contents presented by JST. In addition, they are obligated to implement R&D appropriately. They must follow the implementation regulations, the R&D agreement, the instructions for the clerical processes, and the R&D plan. If it is not possible to enter an R&D agreement, or if it is judged that the/or the R&D institutions etc. cannot let or lets the PM activities and/or the R&D be implemented appropriately, the implementation of PM activities and R&Ds at the applicable/or the R&D institutions etc. are not allowed.

*For the R&D agreement template, access the following website:

https://www.jst.go.jp/contract/index.html

b. The R&D institutions etc. need to make efforts for the appropriate execution of the Research funds after organizing a management and audit organization for the public R&D cost on the responsibility of the R&D institution etc. on the basis of the Guidelines for the Management and Audit of Public Research Funds In Research Institutions (practice standards) (decision, Minister of Education, Culture, Sports, Science and Technology, February 15, 2007; revised on February 18, 2014). Furthermore, R&D institutions etc. are obliged to make report periodically to MEXT on the status of the implementation of organizing the organizations etc. in relation to the management and the audit of public Research funds and to correspond to each type of surveys in relation to organizing organizations etc. (section 5.19, "Guidelines for the Management and Audit of Public Research Funds In Research Institutions (practice standards)."

https://www.mext.go.jp/a_menu/kansa/houkoku/1343904.htm

c. R&D institutions need to make efforts for the prevention of misconducts after organizing necessary regulations and organizations on the responsibility of the R&D institutions etc. on the basis of the Guidelines for Responding to Misconduct in Research (decision, Minister of Education, Culture, Sports, Science and Technology, August 26, 2014).The R&D institutions must prevent misconduct after they have organized the necessary regulations and organizations. The responsibility of the representative and R&D institutions is based on the Guidelines for Responding to Misconduct in Research (decision, Minister of Education, Culture, Sports, Science and Technology, August 26, 2014). The R&D institutions must respond to each type of organizational survey in the guideline (section 5.20, "Guidelines for Responding to Misconduct in Research").
https://www.mext.go.jp/b_menu/houdou/26/08/1351568.htm

d. The R&D institutions etc. are obliged to have the participants in the R&D projects fully recognize the contents of the guidelines described in items "b" and "c" above and to have them learn from the educational materials in relation to the research ethics defined by JST.

e. The R&D institutions etc. need to appropriately make payment and take management by following the regulations of the institutions and the R&D institutions with consideration also to flexibility and to follow the applicable rules with respect to the items for which the rules specific to Moonshot R&D are provided in the (JST) official administration manual defined by JST while executing the R&D funds. The PM's and R&D institutions that receive a subsidy for scientific research funds can conform to the handling of the scientific research funds at their PM's institutions and R&D institutions with respect to the items on the usage of R&D funds not described in the JST official administration manual.

f. The R&D institutions etc. need to make a contract to the effect that the intellectual property rights that may accrue accompanied by the implementation of the R&D belong to the research and development institutions with the participants in the R&D project belonging to the applicable R&D institutions or to organize the work regulations to define provisions to that effect. In particular in the cases in which a student or students that is or are not in the relationship of employment with the

R&D institutions etc. becomes or become a participant or participants in the R&D project, it is necessary to make necessary arrangements such as making a contract etc. with the applicable student or students in advance so that the intellectual property rights in relation to the invention (including devices and the like) made by the applicable student or students in the course of the implementation of this R&D project belong to the research and development institutions except for the cases in which the student or students clearly cannot be an inventor or inventors. Further, with respect to the conditions for transferring the rewards of intellectual property rights, the R&D institution must take measures to prevent disadvantaging student-inventors.

If the right to transfer or implement exclusively is established for the applicable intellectual property right, it is necessary to acquire approval from JST in advance. If filing an application or a patent, registering such establishment, or making a waiver is applicable, the R&D institution must submit a report to JST.

g. The R&D institutions etc. are obliged to correspond to the accounting audit by JST, the audit by a national government, or the like.

h. The R&D institutions etc. in the cases in which JST makes designation depending on an investigation on the organization for the clerical management, the status of accounting, or the like, need to follow the procedures of changing the method of payment of the R&D funds, the reduction of the consigned R&D cost, or the like. When the liquidation or downsizing of JST is necessary due to a business assessment at the end of JST's mid- and long-term targets, or when revisions arise in the budgetary policies of the national government, we may cancel a contract before its expiration or reduce the R&D funds based on the special provisions in the R&D agreement. Based on the results of an evaluation of an R&D project, we may increase or reduce the R&D funds, change the period of a contract, terminate the research, or take other measures. If JST judges that continuing the R&D project is inappropriate, we may cancel the contract or take other measures even during the contract period. The R&D institutes etc. need to follow those instructions.

i. If the applicable R&D institutions etc. are the national government or a local

government, when making an R&D agreement, they need to make sure to implement the procedure for necessary budgetary measures by the start of the R&D development agreement on the responsibility of the R&D institutions etc. (If a fault in a necessary procedure is revealed after making the contract, the R&D agreement will be canceled, the R&D funds will be returned, and other measures may be taken.)

j. As a course of the endeavors to prevent misconducts in PM activities and R&D activities, JST has determined to oblige the researchers etc. participating in a newly adopted R&D project and belonging to the R&D institutions etc. to take and finish the study course of the learning materials in relation to research ethics. (JST takes management of the procedures etc. necessary to take the study course). R&D institutions etc. are asked to take management so that applicable persons will surely take and finish the study course.

For this purpose, if the applicable researcher or the like does not fulfill the obligation to finish the study course in spite of the reminder from JST, JST will instruct the R&D institutions etc. to suspend the whole or part of the R&D funds. In these cases, the execution of the R&D funds should be suspended as instructed, and do not resume the payment of the R&D funds until another instruction is made.

k. You should provide measures, such as making a joint R&D agreement with the R&D institution to which the performer belongs. It should not violate the R&D agreement with JST or the implementation regulations for handling intellectual property rights and maintaining secrecy. Ensure that there are no issues with the implementation of the R&D project, the use of the R&D results, or the like.

(2) If the R&D institutions are overseas organizations

a. The R&D institutions should enter into an R&D agreement with the content presented by JST. In addition, they are obligated to implement the R&D appropriately by following the R&D agreement and the R&D plan. If it is not possible to enter into an R&D agreement, or if it is judged that the research at the applicable R&D institution cannot be conducted appropriately, the implementation of the R&D at the applicable R&D institution will not be permitted.

*The R&D agreement template for overseas institutions is currently in preparation. If necessary, contact us using the email address at the end of this booklet.

b. The R&D institutions etc., on the basis of the applicable principles or the like if the R&D agreement and JST defines principles separately, are obliged to make payments and manage the R&D cost appropriately. It is the responsibility of the R&D institutions to prepare in English a breakdown of the costs and describe the contents of the payments from the R&D funds (equivalent to the balance sheet of domestic institutions). In addition, the R&D institutions etc. need to correspond to each type of surveys in relation to the status of the payment in response to the request from JST even during the period of an agreement.

c. The R&D institutions should transfer intellectual property rights that accrue during the implementation of the R&D to JST for no compensation (Article 17 of the Industrial Technology Enhancement Act; the Japanese version of the Bayh-Dole Act, which does not apply to institutions outside Japan). Therefore, it is required that they submit a quick report to JST (within ten business days) if they develop an invention that may acquire intellectual property rights.

* JST may judge that an R&D agreement should not be made to control security in trade for the institutions listed in the "Foreign User List.[1]"

(3) In the case in which the R&D institutions etc. receive the payment for indirect cost

In the case in which the R&D institutions etc. receive the payment for indirect cost, it is asked to take appropriate management of indirect cost and to retain the documents that prove the appropriate payment for indirect cost such as receipts and the like for five years from the fiscal year next to the completion of the project. In addition, the R&D institution etc. that have received the payment for the indirect cost need to make a report to JST by June 30 in the next fiscal year on the results of the usage of the indirect cost.

*The documents for such proof can show the total amount of the indirect cost and other competitive costs altogether; you do not need to divide the accounting for each contract and agreement.

4.9 Other Information

4.9.1 Management of Conflicts of Interest in Relation to the Construction of an Organization

We manage conflicts of interest based on the provisions of JST from the viewpoint of the fair and transparent distribution of R&D funds for the construction of an R&D organization after the PM is adopted.

(1) Management of Conflicts of Interest with Performers

To avoid any doubts of any third party, we manage conflicts of interest between PMs and performers by appropriately considering the necessity, rationality, and adequacy of the situation.

a. The case in which the PMs are performers
b. Persons who are relatives of the PM
c. Persons who belong to the same department, major, or the like as the PM at a university, college, or R&D organization of a national research and development corporation or the like or to the same enterprise as the proponent
d. Persons who engage closely in a joint R&D project with the PM or who have participated closely in a joint R&D project within the past five years. This refers to, for instance, conducting a joint project, coauthoring a research paper, the members of a R&D project for the same purpose, or the joint researchers tasked with a problem from the PM, or who belong to the same research and development group as the PM.
e. Persons who have been closely related to the PM as a teacher or student or who have been in a direct employer-employee relationship for ten years in total in the past
f. Persons are judged, by JST, to have shared interests with the PM

If persons who have any of the interests described above are performers, there will be deliberations over the necessity, rationality, and adequacy of the applicable parties.

In consideration to the aim of this program, which is to gather the wisdom of a variety of researchers such as the top researchers, young and senior researchers in and outside the country, the conflict of interests with PMs are not judged from a uniform standard to expel them from the projects without exception. Even when there is a conflict of interest between a PM and a performer, the party's participation in the project is not necessarily blocked if the individual's necessity, rationality, and adequacy are recognized for the project.

If a proposal is made with a performer who has a conflict of interest, use the performer information sheet to declare that the applicable performer has a conflict of interest.

Extra documents may be required to implement the management of conflicts of interest with a performer candidate.

(2) Based on the provisions of JST beyond Item (1) above, necessary management will be undertaken.

4.9.2 Managing Life Events

JST has measures for compatibility between R&D projects and life events so that a researcher can continue with an R&D project without interrupting his or her career at a life event (giving birth, rearing a child, nursing) or can temporarily suspend an R&D project if necessary. There is financial support for the joint participation of men and women to promote the R&D project and reduce the workload of the applicable researcher so that the researcher can return to the R&D project and continue his or her career when possible.

In addition, we have disclosed role models for women in the field of science. For more details, access the following website.

Endeavors by JST for diversity https://www.jst.go.jp/diversity/index.html

Chapter 5 Instructions for Applicants

5.1 Completing the Course on Research and Ethics Education

To apply to this program, proponents need to have completed a course on research and ethics education. Note that if we cannot confirm their finishing the course, we will regard their applications as not having satisfied the requirements.

Take the course on research and ethics education and apply for the procedure to declare your completion by following either one of Items (1) and (2) below. See Chapter 6, "How to Use the Cross-ministerial R&D Management System (e-Rad) for Your Application," for how to input information.

(1) If the applicants have completed the program at the organization to which they belong

If an e-learning or training session, such as a course on each type of research ethics education (including eAPRIN, formerly CITI), has been finished at the time of applying, then use the e-Rad application information input screen to declare that the applicant has finished the program.

(2) If a program has not been completed at the organization to which the applicant belongs (including when no such program is provided by the organization to which the applicant belongs)

a. If eAPRIN (formerly CITI) has been finished in a JST project in the past

If an eAPRIN (formerly CITI) has been finished in a JST project at the time of the application, then use the e-Rad application information input screen to declare the applicant has finished the program.

b. Other than "a" above

If it is difficult to take a course on research ethics education at the organization to which the applicant belongs because, for example, such a program is not provided at the organization, the applicant can take a digest version of eAPRIN (formerly CITI) via JST. For how to take the course, access the website of the call for research proposals.

Website of the call for research proposals

https://www.jst.go.jp/moonshot/en/application/

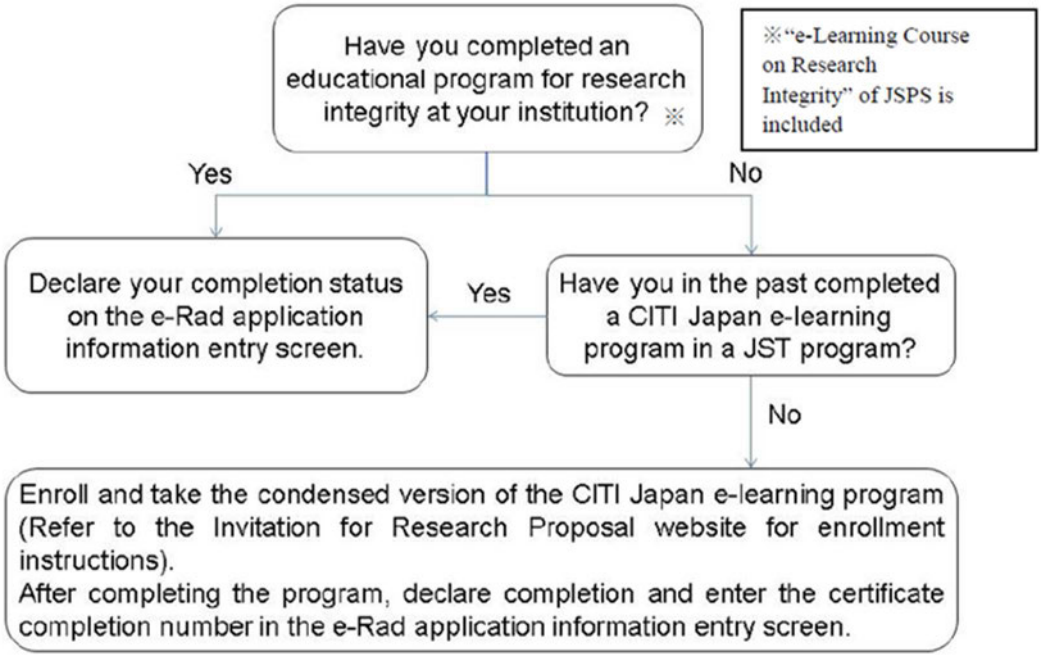
Access the following URL to take a course.
https://edu2.aprin.or.jp/ard/

It takes roughly one to two hours to take a course, and you do not need to pay for it. Complete the course promptly; on an e-Rad screen that allows you to register the information on your application, declare that you have finished the course and provide the number assigned to you when you finished the course, which is shown on your course certification (seven digits and ARD).

■ The inquiry office for the contents of the programs on research and ethics education
Research Integrity Section, Audit and Legal Affairs Department, Japan Science and Technology Agency
E-mail: rcr-kousyu@jst.go.jp

■ The inquiry office for the call for research proposals
Department of Moonshot Research and Development Program, Japan Science and Technology Agency
E-mail: moonshot-koubo@jst.go.jp
* Write, in the body of the email, the title of the call program, the problem ID on e-Rad, the proponent of the, and the title of the R&D project.

The flowchart for completing a course on research ethics and declaring the completion of a course



JST obliges the researchers participating in Moonshot R&D to complete the specific units of eAPRIN (formerly CITI). In the next fiscal year, we will provide the same opportunities; if adopted, in principle, all the R&D participants will be asked to complete the units of eAPRIN (formerly CITI). This excludes cases in which the units of eAPRIN (formerly CITI Japan) specified by JST have been finished.

5.2 Restrictions on Multiple Applications

In relation to the call of Moonshot R&D, the following restrictions were applied to multiple applications.

As for the other programs in and outside JST, certain measures may be taken if it is judged that an irrational duplication or an extreme convergence is made. For the details, see section 5.3, "Measures for Irrational Duplications and Extreme Convergences."

(1) No one proponent is allowed to make applications of two or more R&D projects for the same MS Goal .

(2) No one proponent is allowed to make applications of an R&D project for two or more MS Goals.

(3) In the case in which you plan to participate, as a PM or a performer, in the proposal for two R&D projects or more and two or more of the R&D projects are adopted,
we may make adjustment, depending on the judgment of a PD, after considering the contents, the scale, etc. of the R&D, for the reduction of the R&D cost and for not allowing the participations in some problems among the R&D project in which the applicable researcher participate.

5.3 Measures for Irrational Duplications and Extreme Convergences

○ The Measures for Irrational Duplications

If a researcher falls into any of the following cases with two or more national governmental bodies or incorporated administrative agencies (including national R&D incorporated agencies), and competitive funds duplicated and distributed unnecessarily to the same research problem (referring to the title and contents of the research for which the competitive funds and in response to a call for proposals (referred to as "competitive funds" from here) are distributed) by the same researcher, he or she may be excluded from the subjects of the selection in this program, the decision of the adoption may be canceled, or the funds may be reduced (referred to as "cancellation of the decision of adoption).

- Applications are made at the same time for two or more competitive funds for practically the same research problem (including the cases in which considerable duplication is made; the same applies to the following) and are adopted
- Applications are redundantly made for practically the same research problem that has been already adopted, and competitive funds have been already distributed
- There is duplication in the purpose of the research funds among two or more research problems
- Other cases similar to the above

Applications for other competitive funds are not restricted in the application phase for this program; however, if an application is adopted for any other competitive funds, quickly report to the office personnel of this program. If this report is omitted, the decision of the adoption in this program may be canceled.

・The Measures for Extreme Convergences

The decision of the adoption in this program may be canceled, even if the contents of an R&D proposal for this program and an R&D project implemented using another competitive funds differ, if the total of the R&D funds distributed in the applicable fiscal year to the applicable researcher or R&D group (referred to as "researcher group" from here) exceeds the limit that can be used effectively and efficiently, the amount is not used entirely within the R&D period, or any of the following applies.

- ・If excessive R&D funds have been distributed to the researcher group and the R&D method
- ・If the R&D funds distributed to the applicable R&D exceeds the researcher's effort (the ratio (%) of the time necessary to implement the applicable R&D with respect to the total time (*) of the work of the researcher)
- ・If an unnecessarily expensive R&D facility is purchased
- ・Other cases similar to the above

If the contents described in the proposal to this program should be altered after it is submitted because, for example, another application is made for another competitive funds and is adopted, quickly report to the office personnel of this program. If this report is omitted, the decision of the adoption in this program may be canceled.

*The time for research activities and teaching, management assignments, and other activities substantially equivalent to work is included in the total work time of a researcher.

How "effort" should be understood

Definition of "effort"

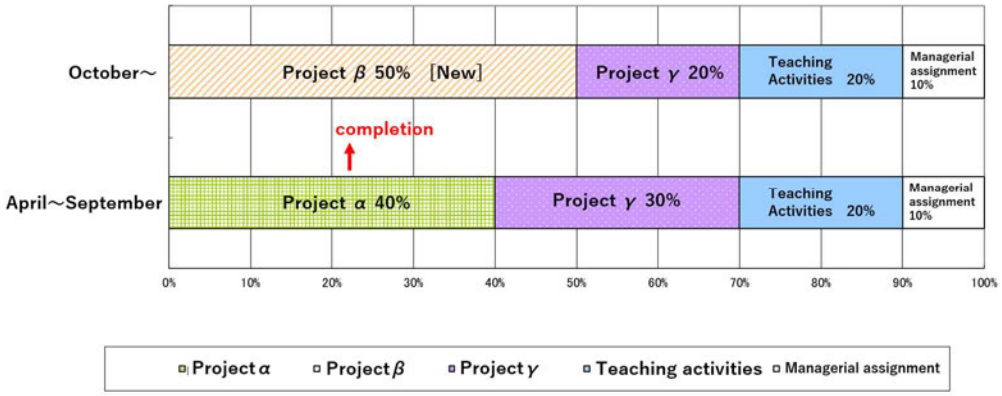
・ According to the third-term science and technology basic plans, "effort" is defined as "the distribution of time during which an individual engaging in research manages research, education, management, and/or the like."

・ When a researcher proposes a research project, he or she needs to describe the distribution of his or her time required to implement the research as opposed to the time that is taken for his or her total work."*

・The total work time includes the time for research activities and the time for teaching and management activities.

・The amount of "effort" may vary depending on the review, assessments, or the like of a research project.

Ex. Project α is canceled halfway in the fiscal year and Project β is adopted. The state of the distribution of the total work time is as shown here. (Project γ continues for one year.)



・In this example, Project α is canceled at the end of September (40% distributed). Project β start as a new one in October (50% distributed). The "effort" in Project γ varies from 30% to 20%.

*"Guideline for Proper Implementation of Competitive Funds" (an agreement at the liaison committee of relevant governmental bodies concerning competitive funds, revised on June 22, 2017)

・ Providing information on the contents of an application to prevent irrational duplications and extreme convergences

In order to prevent irrational duplications and extreme convergences, we may provide information, within the scope necessary, on part of the contents of an application (or the adopted problem or the program) to the personnel in charge of other competitive funds including other governmental bodies by way of the Cross-ministerial R&D Management System (e-Rad). In addition, we may provide information in the same manner when we are asked to confirm the above-mentioned for other competitive funds.

5.4 Acceptance Status of Applications for Other Competitive Funds, Including from Other Governmental Bodies

The PMs who describe the content, in order to prevent irrational duplications and extreme convergences, differently from the facts may not be adopted, may have their adoption canceled, or may have their funds reduced.

5.5 Managing Unjustifiable Use and Reception

As for the unjustifiable use and reception funds for implemented problems (referred to as "unjustifiable use" from here), the following applies strictly.

・Measures when an unjustifiable use of research funds is recognized

(i) Canceling contracts and other measures

The R&D agreement will be canceled or altered with respect to the problem in relation to which an unjustifiable use or the like has been recognized. We will demand the entire or partial refund of the R&D funds. In addition, we may not renew the contract in the next fiscal year or after.

(ii) Measures to restrict the qualification for application or participation *1

The measures for restricting the qualification for applying to this program or participating in it, or the measures for strict warning, are issued, as shown in the table below, depending on the degree of the unjustifiable act of the researchers *2 who

violated the due care of a prudent manager without being recognized or directly involved with the researchers who engaged in the unjustifiable use of R&D funds from this program (referred to as "the researchers who engaged in unjustifiable use").

In addition, applications and participation may be restricted in other competitive funds, including other governmental bodies by providing a synopsis of the applicable unjustifiable use to the personnel of the other competitive funds, including other governmental bodies and incorporated administrative agencies under the jurisdiction of other governmental bodies. The synopsis would include the name of the researcher who made an unjustifiable use, the title of the project, the organization to which he or she belongs, the problem to be solved by the research, the amount of the budget, the fiscal year of the research, the details of the misconduct, and details of the measures provided.

*1. "Applications and participation" refer to proposing a new task, applying for calls, and making applications to participate in a new research project as a joint researcher group or to participate in ongoing research to solve a problem (continuing problem) as one of the R&D personnel, as a joint researcher or otherwise.

*2. "The researchers who violated the due care of a prudent manager" refers to the researchers who violated the obligation to advance the program with the due care of a prudent manager even if they are not recognized so much as involved in the unjustifiable use.

<table>
<tr><th>The people within the restriction on an application due to unjustifiable use or reception</th><th colspan="2">The degree of unjustifiable use</th><th>The period to restrict applications *3</th></tr>
<tr><td rowspan="2">The researchers who engaged in unjustifiable use or the researchers conspired to make such</td><td colspan="2">Private misappropriation for acquiring personal profits</td><td>10 years</td></tr>
<tr><td>2. Other</td><td>① A case whose social influence is large and the</td><td>5 years</td></tr>
</table>

use *1	than 1	viciousness of the act is judged to be high	
		② Other than ① and ③	2 – 4 years
		③ case whose social influence is small and the viciousness of the act is judged to be low	1 year
The researchers who used other unjustifiable means to receive the competitive funds and the researchers who conspired to do so			5 years
The researchers who were not directly involved in the unjustifiable use but violated the duty of the due care of a prudent manager *2			Two years at the maximum to one year at the minimum depending on the degree of the violation of the researcher who was obligated to show the due care of a prudent manager

A strict warning is issued under any of the following conditions without restricting application or eligibility for participation.

*1. In the case of Item 1, the influence over society is minor, the malignancy of the act is minor, and the amount of unjustifiable use is small;

*2. In the case of Item 3, the influence over society is minor, and the malignancy of the act is minor;

*3. The qualification for participation is restricted in the year when the unjustifiable use was recognized.

(iii) Disclosing unjustifiable cases

In this program, among the researchers who engaged in the unjustifiable use of R&D funds, the researchers who have violated the due care of a prudent manager, and the researchers whose qualification for application and participation in this program is restricted will be, in principle, disclosed by JST in the synopsis of the applicable unjustifiable cases or the like. The synopsis includes the researcher, the title of the project, the organization to which he or she belongs, the fiscal year of the research, the contents of the unjustifiable act, and the contents of the measures provided). The researchers will be disclosed by the MEXT with respect to the synopsis of the applicable unjustifiable cases or the like (including the title of the project, the organization to which the researcher belongs, the fiscal year of the contents of the unjustifiable act, and the contents of the measures provided).

In addition, according to the "Guidelines for the Management and Audit of Public Research Funds In Research Institutions (practice standards)," if an unjustifiable act is recognized as a result of an investigation, the research institution is supposed to disclose the results of the investigation promptly; each institution is asked to take proper action based on the guidelines.

*For an overview of the unjustifiable cases disclosed on the website of MEXT as of present, access the following URL.

https://www.mext.go.jp/a_menu/kansa/houkoku/1364929.htm

5.6 Measures for Researchers Whose Applications and Qualifications for Participation Are Restricted in Other Competitive Funds

The researchers who are restricted due to an unjustifiable use of research funds, in other competitive funds* under management of a national governmental body or an incorporated administrative agency, are restricted from making an application or qualifying to participate in this program during the period in which they are restricted from qualification and application in other competitive funds.

"Other competitive funds" include those that start new calls in the fiscal year 2020 or later. The systems that were terminated in the fiscal year 2019 or earlier are also included.

*For the specific systems currently within the scope, access the following website.

https://www8.cao.go.jp/cstp/compefund/ (Competitive funds)

The research funds that use calls for proposals will be published in the coming days.

5.7 Measures for Violations of Relevant Laws

If relevant laws and/or ordinances, guidelines, and/or the like are violated to implement an R&D project, there will be consequences and/or punishment based on the applicable laws, ordinances and/or the like, the R&D funds may be suspended, and/or the decision on the distribution of the R&D funds may be canceled.

5.8 Retaining Receipts for Indirect Costs and Reporting on Use Results

If R&D institutions receive payments for indirect costs, they must undertake appropriate management of the indirect costs and retain the documents that prove the appropriate payments for indirect costs, such as receipts and the like, for five years from the fiscal year following the completion of the project.

In addition, the R&D institutions etc. that have received the payment for the indirect cost need to make a report to JST by June 30 in the next fiscal year on the results of the usage of the indirect cost (if a R&D institution have acquired two or more competitive funds, report all indirect costs from such competitive funds).

5.9 Carrying over

Carry-overs may be allowed up to the end of the next fiscal year at the latest if it proves difficult to complete the expenditures within the fiscal year because it is unavoidable. It may be due to the difficulty of the investigation before a research test or in the decision on the R&D method, various conditions for plans or designing, the weather, difficulty in procuring materials, or other reasons.

5.10 Cross-ministerial Expenses Handling Partitioned Table

The composition of the items has been specified based on the cross-ministerial expenses handling partitioned table, which is to be used commonly for competitive funds in

Moonshot R&D. Therefore, for the handling of the costs, see the cross-ministerial expenses handling partitioned table.

URL: https://www.jst.go.jp/moonshot/en/application/

5.11 Diversion of Expenses

The amount of funds that can be used for purposes outside the scope of an account title without approval from JST is 50 percent or less of the total direct cost.

5.12 Securing the R&D Period until the Fiscal Year End

JST requires that researchers who have received competitive funds of any kind must complete the tasks listed below in order to continue their JST-funded research until the end of a fiscal year.

(1) The R&D institutions and researchers must submit a notification of the completion of the project as a product creation promptly when a project is finished. JST inspects the completion of the project and the achievements of the research.

(2) Submit a report on the results of the accounting by May 31.

(3) Submit a report on the achievements of the research by May 31.

Each R&D institution should organize the necessary systems at the institution for those practices in order to secure the R&D period that continues at the end of a fiscal year.

5.13 Promotion of Sharing Research Facilities and Equipment

According to the "Renovation on the Competitive Research Funds for the Continuous Creation of Research Achievements (Midterm Summary) (Examination Meeting on the Renovation of Competitive Funds, June 24, 2015), it is appropriate that relatively large-scale facilities and equipment that have high general-purpose performance should be, in principle, shared so that original research objectives can be sufficiently accomplished.

In addition, according to the "Introduction of a New Research Facility/Equipment Sharing System Integrated with the Management of Research institutions" (Advanced Research Platform Group, Council for Science and Technology, November 2015), it is desirable that universities, colleges, national research and development agencies, and the like use "a system to share research facility/equipment by the unit of a research organization"

(referred to as "equipment sharing system" from here).

R&D institutions must endeavor to share the particularly large and general-purpose-performance research facility/equipment purchased for this program as long as it is within the scope of research and does not present obstacles to applicable research projects. This applies to research facility/equipment purchased with other research funds and for purchasing/sharing them; a total of two or more research funds based on what is stated above within the scope of the management conditions of other research funds. Note the necessity to maintain a balance between the management of shared equipment/facility and the use of the equipment for the achievement of the research objectives of an applicable research project.

Moreover, besides the equipment-sharing system stated above, endeavor to cooperate with the "University Collaboration and Research Facility Networking Project," implemented for the nationwide mutual usage of the facilities by National Institutions of Natural Sciences, and with the nationwide academic sharing system constructed in "Facility Support Center Development Project" by each national university. Promote the sharing of research facilities/equipment beyond the framework of one R&D institution.

- "Introduction of a New Research Facility/ Integrated with the Management of Research Institution" (Advanced Research Platform Group, Council for Science and Technology; November 25, 2015).
  https://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2016/01/21/1366216_01_1.pdf
- "Renovation on the Competitive Research Funds for the Continuous Creation of Research Achievements (Midterm Summary)" (Examination Meeting on the Renovation of Competitive Funds, June 24, 2015)
  https://www.mext.go.jp/b_menu/shingi/chousa/shinkou/039/gaiyou/1359306.htm
- "Guidelines for the Proper Implementation of Competitive Funds" (an agreement at the liaison committee of relevant governmental bodies concerning competitive funds, revised on April 20, 2017)
  https://www8.cao.go.jp/cstp/compefund/shishin3_siyouruuru.pdf
- "University and College Cooperation Research Facility Network Project"

https://chem-eqnet.ims.ac.jp/

5.14 Improvement in the Treatment of Second-Half Doctoral-Course Students

In order to attract excellent students and members of society in and outside the country and enrich the economic support of graduate students, especially those in the second-half of a doctoral course, the third, fourth, and fifth Science and Technology Basic Plans "aim to have about 20 percent of the students in second-half doctoral courses receive the amount equivalent to their daily-life expenses," which is stated with a quantitative target.

In addition, also in the "Reform of Doctoral Course Education to Lead the Future (conclusion of deliberation)" (September 15, 2015; University Sub-Committee, Central Education Council), it was decided that the enrichment of the research assistant (RA) and teaching assistant (TA) forms of employment should be offered to the students in the second-half of their doctoral courses with a variety of sources of revenue. As for the RA and the TA employment of the students in second-half doctoral courses, it should be foundational that the provision of the salaries should be equivalent to the daily-life expenses.

Based on the above-mentioned, the work settings must be equivalent to the work hours so that salary levels can reflect the daily-life expenses of the students in second-half doctoral courses who are employed as RAs and/or TAs in this program.

5.15 Support for a Variety of Career Paths for Young Doctoral Researchers

"The Basic Principles of the Support for a Variety of Career Paths for the Young Doctoral Researchers Employed with the Public Research Funds of the Ministry of Education, Culture, Sports, Science, and Technology" [Human Resource Committee, Council for Science and Technology, December 20, 2011]

(https://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu10/toushin/1317945.htm) expects "the public research institutions that employ young doctoral researchers with public funds and the representatives of research endeavor to support the securing of a variety of career paths in and outside the country for young doctoral researchers." Based on the above-mentioned, you are asked to support positively the securing of a variety of career paths for your applicable researchers when your proposal is adopted and your young

doctoral researchers are employed with public research funds (competitive funds, other project research funds, or educational research funds for public applicants from universities or colleges).

In addition, consider using the budget for the indirect cost to cover such endeavors.

5.16 Secure Trade Control (Managing Technology Leaks Overseas)

At R&D institutions, many kinds of state-of-the-art technology are studied. Especially in universities and colleges, internationalization has increased the number of international students and researchers from foreign countries, which has increased the risk of leaking advanced technology, research materials, and research equipment. These entities may increasingly be used viciously for the development or production of weapons of mass destruction. Therefore, for R&D institutions to advance each type of research activity, including applicable R&D, R&D institutions must organize their management so that R&D results that may be used for military purposes cannot be transferred to parties, such as developers of weapons of mass destruction and terrorist groups, that may engage in suspicious activities.

In Japan, trade is controlled (*) based on the Foreign Exchange and Foreign Trade Act (law No. 228, 1949, referred to as the "Foreign Exchange Act" from here). Therefore, in principle, it is necessary to acquire permission from the Minister of Economy, Trade, and Industry in order to export (provide) freight or technology under the restriction of the Foreign Exchange Act. Observe the Foreign Exchange Act and other national laws and ordinances, guidelines, and notifications. If research is conducted in violation of relevant laws, ordinances, guidelines, and/or the like, it will be subject to consequences and/or punishment based on the applicable laws and/or ordinances and/or the like; the R&D funds may be suspended and/or the decision on the distribution of the R&D funds may be canceled.

※ Currently, Japan’s security export control system is based on international agreements and the like and consists mainly of: ① the system (list system) that requires permission from the Minister of Economy, Trade, and Industry, in principle, in order to export (provide) freight (technology) that has a certain level of specifications and/or functions, such as carbon fiber and numerically controlled

machine tools; and ② the system (catch-all control) that requires permission from the Minister of Economy, Trade, and Industry if certain requirements (for purposes, consumers, or information) are satisfied for the export (provision) of freight (technology) not included in the list.

Not only the export of goods but also the provision of technology is a subject of control by the Foreign Exchange Act. If technology under the list control is to be provided to a non-resident or in a foreign country, permission is necessary in advance. Providing technology here includes providing work knowledge by way of technical guidance, skill training, and technical support at seminars; it includes using paper, email, CDs, DVDs, and USB memories as storage media to provide designs, specifications, manuals, specimens, test products, or other technical information. Accepting international students from foreign countries and activities for joint research may include many technical exchanges that may be subject to the Foreign Exchange Act.

The details of controlling security in trade are published on the website of the Ministry of Economy, Trade, and Industry. For more information, see the following.

- Ministry of Economy, Trade, and Industry: Security Trade Control (in general)
  https://www.meti.go.jp/policy/anpo/
- Ministry of Economy, Trade, and Industry: Security Trade Control Handbook
  https://www.meti.go.jp/policy/anpo/seminer/shiryo/handbook.pdf
- Center for Information on Security Trade Control
  http://www.cistec.or.jp/index.html
- Ministry of Economy, Trade, and Industry: Sensitive Technology Control Guide for Security Trade Control (for universities, colleges, and R&D institutions)
  https://www.meti.go.jp/policy/anpo/law_document/tutatu/t07sonota/t07sonota_jishukanri03.pdf

5.17 Promoting Dialog with Society and Collaboration

According to "About the Promotion of 'Science/Technology Dialog with Citizens'" (Guideline for Basic Endeavors; decision by the minister of science and technology policies and the members of Diet with expertise, June 19, 2010), if your proposal is adopted in this call and you accept 30 million yen or more of public funds a year per project

(competitive or project research funds), the attitude in which the excellent achievements of science and technology are constantly produced and the achievements of science and technology should be returned to our citizens to further develop science and technology in our country. Science and technology are advanced because of the understanding and support of citizens; therefore, "Science/Technology Dialog with the Citizens" is essential. In addition, the Fifth Term Science and Technology Basic Plan (Cabinet decision, January 22, 2016), seeks that the conventional type of relationship between science and technology and society, as positioned against each other, should become one of promoting "collaborative creation." This includes dialog and collaboration among researchers, citizens, media, industry, policy makers, and other various stakeholders. We want you to endeavor to explain the content of research activities and achievements to society and citizens in an easy-to-understand way and to promote dialog/collaboration among various stakeholders. You are asked to take a positive attitude toward the activities of this program, including the lecture sessions for citizens on research achievements, the continuous distribution of information on research achievements at the symposiums and over the internet, and at the roundtable conferences involving a variety of stakeholders.

(Informative) Promoting "Science/Technology Dialog with Citizens" (principles for basic measures)
https://www8.cao.go.jp/cstp/output/20100619taiwa.pdf
(Informative) Fifth Science and Technology Basic Plans
https://www8.cao.go.jp/cstp/kihonkeikaku/5honbun.pdf

5.18 Cooperation with the Bioscience Database Center

The National Bioscience Data Center (NBDC) (https://biosciencedbc.jp/) was established in April 2011 under the jurisdiction of the Japan Science and Technology Agency to promote the integrated use of the Life Science Database, which was created by a variety of research institutions. According to "The Progress of the Project to Promote the Integration of the Life Science Database and Its Orientation in the Future" (January 17, 2013), the center, as a leader, is supposed to expand the applicable projects to use the data and database.

You are asked to cooperate with us in the disclosure, from the center, of the following

types of data and databases that may be collected from this program.

No.	Type of the data	Disclosed to	ULR for Disclosure
1	Overview of the Database Constructed for Disclosure	Integbio Database Catalog	https://integbio.jp/dbcatalog/
2	Copies of the databases of the results disclosed in papers or copies of the databases constructed for disclosure	Bio Science Database Archive	https://dbarchive.biosciencedbc.jp/
3	The ones related to human beings from Item 2	NBDC Human Database	https://humandbs.biosciencedbc.jp/

<Inquiry Office>

Bio Science Database Center, Japan Science and Technology Agency

Phone: 03-5214-8491

e-mail: nbdc-kikaku@jst.go.jp

5.19 Guidelines for the Management and Audit of Public Research Funds in Research Institutions (Practice Standards)

(1) Organize the institution according to the "Guidelines for the Management and Audit of Public Research Funds In Research Institutions (practice standards)"

R&D institutions that are applying to this program and researchers need to observe the contents of the "Guidelines for the Management and Audit of Public Research Funds at Institutions (standard for implementation)" (revised on February 18, 2014)

R&D institutions must try to properly execute the research funds by organizing a system for managing and auditing the research funds under their responsibility based on the guidelines mentioned above. As a result of the investigation of the status of the organization based on the guidelines, if MEXT recognizes a fault in the relevant status of an institution, then the measures for reducing its indirect cost from all the competitive funds distributed by MEXT or an incorporated administrative agency under the jurisdiction of the MEXT may be taken with respect to the applicable institution.

*1 For "Guidelines for the Management and Audit of Public Research Funds in Research Institutions (practice standards)," access the following website.
https://www.mext.go.jp/a_menu/kansa/houkoku/1343904.htm

(2) "Self-evaluation Checklist for Structuring Organizations" based on "Guidelines for the Management and Audit of Public Research Funds in Research Institutions (practice standards)"

To enter into a contract in this program, each R&D institution must structure their organization so that it manages and audits the research funds based on the above-mentioned guidelines and must submit the "Self-evaluation Checklist for Structuring Organizations," which is a report on its status (referred to as "checklist" from here). Research cannot be implemented until a checklist has been submitted.

Therefore, until the contract begins, it is necessary to submit a check list by using the Cross-ministerial R&D Management System (e-Rad) from the R&D institutions etc. to the Competitive Funds Control Office, Promotion and Planning Section, Research Promotion Bureau, MEXT since April the 1st, 2020. However, if a checklist was submitted in April the 1st, 2020 or after, it is not necessary to submit another one. Further, you do not need to apply if your organization is not engaged in research activities or, if it is engaged in such activities but does not accept funds from MEXT or an incorporated administrative agency under the jurisdiction of MEXT.

For details on how to submit the checklist, access the following website of the MEXT.
https://www.mext.go.jp/a_menu/kansa/houkoku/1301688.htm

*Note: You are required to make e-Rad available. Note that it normally takes about two weeks to register. For details on the procedure for using e-Rad, access the following website.
https://www.e-rad.go.jp/en/researcher/index.html

The standard guideline promotes the "communication of information and the commonization." Therefore, it is asked for the R&D institutions etc. to post the check list on a website or the like for proactive communication of information.

5.20 Guidelines for Responding to Misconduct in Research

(1) Structure Organizations based on the "Guidelines for Responding to Misconduct in Research"

The R&D institutions etc., in applying for this program and implementing research activities must observe the "Guidelines for Responding to Misconduct in Research" (decision, Minister of Education, Culture, Sports, Science, and Technology, August 26, 2014)*1.

As a result of an investigation into the status of an organization based on the guidelines mentioned above, if MEXT recognizes an error in the status of the applicable institution, then measures for reducing the indirect cost of the competitive funds distributed by the MEXT or an incorporated administrative agency under the jurisdiction of MEXT may be taken against the applicable institution.

*1. For the "Guidelines for Responding to Misconduct in Research," access the following website.

https://www.mext.go.jp/a_menu/jinzai/fusei/index.htm

(2) Submitting a checklist on the status of the endeavors based on the "Guidelines for Responding to Misconduct in Research"

To enter into a contract in this program, the R&D institutions must submit a checklist on the status of their endeavors based on the "Guidelines for Responding to Misconduct in Research" (referred to "research misconduct checklist" from here). They will not be allowed to implement research until the research misconduct checklist has been submitted.

Therefore, until the contract begins, it is necessary to submit a research misconduct check list by using the Cross-ministerial R&D Management System (e-Rad) from the R&D institutions that conduct R&D to the Research Fairness Promotion Office, Human Resource Policy Section, Research Promotion Bureau, MEXT since April the 1st, 2020. However, if a research misconduct checklist was submitted in April the 1st, 2020 or after, it is not necessary to submit another one. Further, you do not need to apply if your organization is not engaged in research activities or if it is engaged in such activities but does not accept funds from the MEXT or an incorporated administrative agency under

the jurisdiction of MEXT.

For details on how to submit a research misconduct checklist, access the following website of MEXT.

https://www.mext.go.jp/a_menu/jinzai/fusei/1374697.htm

*Note: Your institution must make e-Rad available. Note that it normally takes about two weeks to register. For details on the procedure for using e-Rad, access the following website.

https://www.e-rad.go.jp/en/researcher/index.html

(3) Measures for research activity misconduct based on the "Guidelines for Responding to Misconduct in Research."

Strict measures will be taken, as stated below, if any misconduct is performed during research activities in this program.

(i) Canceling contracts and other measures

If a specific type of misconduct (forgery, falsification, or theft) is recognized in an R&D project in this program, the R&D agreement will be canceled or altered depending on the case. We will demand a whole or partial refund of the R&D funds. In addition, we may not enter into a contract in the next fiscal year or after.

(ii) Measures to restrict the qualification for application or participation

We will take measures to restrict the qualification for application and participation in this program, as stated in the table below, depending on the viciousness of specific types of misconduct and the degree of the responsibility of the parties involved in the misconduct and the parties recognized as having a certain degree of responsibility because of their obligation to use caution with the applicable papers, reports, and the like even if they were not directly involved in research papers, reports, etc. in this program.

In addition, if measures for restricting the qualification for application or participation are taken, the qualification for application and participation may be restricted in the same manner in the competitive funds of MEXT and the competitive funds of the other

governmental bodies; the information will be provided to the personnel of the competitive funds distributed by MEXT and the incorporated administrative agencies under the jurisdiction of the MEXT (referred to as "the competitive funds in relation to the MEXT" from here). It will also be reported to the personnel of the competitive funds distributed by other governmental bodies and the incorporated administrative agencies under their control (referred to as "the competitive funds of other governmental bodies" from here).

<table>
<tr><th colspan="3">Persons restricted from application due to a specific type of misconduct</th><th>The degree of the specific type of misconduct</th><th>The period of restricted applications *</th></tr>
<tr><td rowspan="3">The person involved in a specific type of misconduct</td><td colspan="2">1. The person’s misconduct is especially vicious; for example, if he or she intended to perform misconduct from the beginning of the research project</td><td></td><td>10 years</td></tr>
<tr><td rowspan="2">2. The author of the paper or the like in relation to the research in which a specific type of misconduct occurs</td><td rowspan="2">The author who takes responsibility for the applicable paper or the like (the supervisor, representative for the authors, or the person with</td><td>The influence over the development of the research in the applicable field and/or the social influence are significant, and the viciousness of the act is judged to be high</td><td>5 – 7 years</td></tr>
<tr><td>The influence over the development of the research in</td><td>3 – 5 years</td></tr>
</table>

		responsibility equivalent to the above-mentioned person)	the applicable field and/or the social influence are insignificant, and the viciousness of the act is judged to be low	
		The authors other than the above		2 – 3 years
	3. The persons involved in a specific type of misconduct excluding 1 and 2 above			2 – 3 years
The author who takes responsibility for the paper related to the research in which a specific type of misconduct is performed even though he or she is not involved in the misconduct (the person responsible for supervision, the representative of the authors, or the person who is recognized as having responsibility equivalent to the above-mentioned persons)			The influence over the development of the research in the applicable field and/or the social influence are significant, and the viciousness of the act is judged to be high	2 – 3 years
			The influence over the development of the research in the applicable field and/or the social influence are insignificant, and	1 – 2 years

	the viciousness of the act is judged to be low	

* The qualification for participation is also restricted in the year when the misconduct is recognized.

(iii) Measures for researchers whose applications and qualifications for participation are restricted from competitive funds and in fundamental costs.

For the researchers whose applications and qualifications for participation are restricted due to misconduct in research activities, the application and qualification for participation in this program are restricted for the same duration as that of the competitive funds of the MEXT, a grant for the operation cost of national university corporations, inter-university research institution corporations, and the independent administrative agencies under the control of MEXT, the fundamental cost from the subsidies to private educational institutions, or the competitive funds of other governmental bodies.

(iv) Disclosing misconduct cases

If any misconduct is performed during research activities in this program, JST, in principle, will disclose a summary of the applicable misconduct case. This will include the name of the researcher, the title of the project, the organization to which he or she belongs, the fiscal year of the research, the contents of the unjustifiable act, and the contents of the measures taken. In addition, MEXT will disclose the contents of the applicable cases (the title of the project, the type of misconduct, the field of research in which the misconduct took place, the title of the funds with which the misconduct was performed, the outline of the misconduct case, the measures taken by the R&D institution, and the measures taken by the organization that distribute the funds).

In addition, according to the above-mentioned guideline, if some misconduct is recognized, the R&D institutions etc. that manage the R&D are supposed to disclose the result of the investigation promptly; each institution is asked to take proper action based on the guideline.

https://www.mext.go.jp/a_menu/jinzai/fusei/1360483.htm

5.21 Obligation to Complete Research and Ethics Education and Compliance Courses

The researchers who participate in an R&D project of this program are supposed to take the research ethics education to prevent misconduct in their research activities, as required in the "Guidelines for Responding to Misconduct in Research." They must also complete compliance education courses, as required in the "Guidelines for the Management and Audit of Public Research Funds in Research Institutions."

During the procedure for reaching an R&D agreement, which comes after a proposed research challenge is adopted, the PM and the R&D personnel need to submit a document to the effect that the researchers and all other participants of the research challenge in Moonshot R&D have taken research ethics and compliance education courses and understood the content.

5.22 Handling Information, such as Items Described in Research Proposals

・ The information included in the documents submitted at the time of the proposal will be used for the examination to determine the adoption of an R&D project. In addition, "Form 2" in the proposal will be used for the statistical analysis of research trends to contribute to the business operations of JST; individuals will not be identified. The secrets in the content of applications will be strictly kept to maintain the benefits of the proponents and the viewpoints of "the Act on the Protection of Personal Information Held by Independent Administrative Institutions" and others. For details, access the following website.
https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=415AC0000000059
In addition, the written proposals of adopted projects may be used by JST to promote R&D after they have been adopted.

・ The handling of information, such as problems, on e-Rad

The information on e-Rad about specific adopted problems (the title of the project, the

title of the research challenge, the name of the R&D organization, the name of the person in charge of the R&D, the amount of the budget, the period of the implementation, and the overview of the problem) is handled as "the information that is supposed to be published" as defined in Article 5, Item 1-a in the "Act on Access to Information Held by Independent Administrative Agencies" (law No. 140, 2001). The above-mentioned information will be disclosed on the website of Moonshot R&D promptly after the adoption.

・Providing information from e-Rad to the Cabinet Office

In the fifth Science and Technology Basic Plan (cabinet decision, January 2016), in order to promote the science and technology innovation policy based on objective grounds, evaluations and analyses are supposed to be conducted thorough registration to the Cross-ministerial R&D Management System (e-Rad) with respect to public-invitation funds. The information registered to e-Rad will be used for the appropriate evaluation of R&D with national funds, effective, efficient, and comprehensive strategies, proposals for planning, and the principles for distributing resources. To correspond to that, CSTI and relevant governmental bodies should thoroughly encourage the e-Rad registration of information on achievements, such as papers, patents, and accounting results, in order to link the information on outputs and outcomes to the input of the call type of research funds.

Therefore, it is asked that information on research and accounting results in each fiscal year of the adopted problems be registered to e-Rad.

The information necessary for macro-analysis is provided to the Cabinet Office; it should include information on research and accounting results.

5.23 Registering Researcher Information to researchmap

One of the largest researcher information databases in the country, researchmap (https://researchmap.jp/) provides a comprehensive view of researchers in Japan, which enables you to disclose information on achievements over the Internet. In addition, researchmap is lined to e-Rad and educator databases at universities. It enables registered information to be used in other systems; therefore, researchers do not need to register the same achievements repeatedly in written declarations and databases.

The information registered to researchmap is effectively used to instigate and check the statistics of proposals for the academic and science and technology policies of the national

government. The parties that implement this program are asked to cooperate and register information to researchmap.

5.24 Patent Applications by JST

If an invention or the like is not turned into a right by the R&D institution, JST may do so. Therefore, if the R&D institution does not expect to turn an invention or the like into a right, we want the researcher to submit a quick report of the information on the applicable invention or the like to JST in any form. ("The information on the applicable invention" stated above refers to the information necessary for JST to judge whether the application is suitable to become a right; it could include a copy of the invention notification used by the R&D institution.)

Based on the received report, JST will deliberate on whether the invention should be turned into a right. If it is judged that JST can apply the invention or the like, the R&D institution and JST will make another contract, "Agreement to Transfer the Right to Acquire a Patent."

5.25 Human Rights Protection and the Management of the Observance of Laws

If a research project that needs to follow the procedure of specific laws and ordinances, such as needing an agreement about cooperation with an opponent, then it will need to consider the handling of personal information. If a research project needs to include life ethics and/or safety measures, then it must acquire approval from the ethics committees in and outside the R&D institution and/or follow necessary procedures. In addition, the laws and ordinances in the relevant countries must be observed when a research activity overseas and/or a joint R&D project with an overseas R&D institution is performed.

In particular, laws and ordinances formulated by each governmental body may be revised with respect to the research in relation to life science. Always confirm the newest version. Note that laws and ordinances may be formulated with respect to the content of a research project. If a research project is conducted in violation of relevant laws, ordinances, guidelines, and/or the like, the distribution of the research funds may be suspended and/or the decision to distribute the R&D funds may be canceled.

For details on life ethics and ensuring safety, as provided by MEXT, access the following

website.

・A forum on life science, "Endeavors for Life Ethics and Safety"

https://www.lifescience.mext.go.jp/bioethics/index.html

If a research project or investigation, which requires an agreement and/or the cooperation of an opponent and/or social consensus, is included in the R&D plan, make sure to provide appropriate measures for handling human rights and the protection of benefits before applying.

5.26 Using the JREC-IN Portal

The researcher human resource database (JREC-IN Portal https://jrecin.jst.go.jp/) is a service that allows you to post and view the recruitment information of human resources in relation to researchers, research supporters, and technicians. It is one of the largest research human resource career support portal sites.

At present, 130 thousand users have registered to the site. Moreover, more than 19 thousand job offers are posted yearly by universities and colleges, public R&D institutions, and private companies. If you are looking for human resources for researchers (postdoctoral students, researchers, etc.) who have high-level knowledge of promoting research projects, you must use JREC-IN Portal.

In addition, JREC-IN Portal is linked to researchmap, so you can use the ID and password of researchmap to log in to it. JREC-IN Portal also has a function for preparing resumes and offers a list of business results. You can use the information registered to researchmap to prepare the forms.

5.27 Results of the JST Advanced Measurement and Analysis Technology and Machine Development Program

○ JST has provided a variety of R&D systems, ranging from basic research to industry-academia cooperation systems; the results from the R&D have been applied to practical issues.

○ Among them, in the Advanced Measurement and Analysis Technology and Machine Development Program, which aimed at the construction and progress of R&D foundations (an R&D platform), many R&D tools have been applied to practical use.

○ Please visit the site if you have an R&D tool you are examining for the first time in your R&D process.

For details, see the website. https://www.jst.go.jp/sentan/

Chapter 6 How to Use the Cross-ministerial R&D Management System (e-Rad) for Your Application

6.1 The Cross-ministerial R&D Management System (e-Rad)

The Cross-ministerial R&D Management System (e-Rad) brings a series of processes in relation to the management of call-for type research systems (accepting applications > selection > adoption > management of the adopted problems > accepting the registration of research results and accounting results, etc.) online, which is managed by each governmental body.

*"e-Rad" has been abbreviated from "electronic Research and Development"; the first letter of each of these words has been used to create the short form that the Cross-ministerial R&D Management System is referred to as.

6.2 How to Use e-Rad for Your Application

You are supposed to use e-Rad for your application.

For the process flow of your application, see the following instructions.

(1) Registration prior to the use of e-Rad

You need to register the proponent and his or her organization before using e-Rad.

① Registering the proponent's organization

The organization to which the proponent belongs must be registered on e-Rad by the time of the application. Appoint one person from the organization to which the proponent belongs as the representative to manage all clerical work on e-Rad. The representative should use the e-Rad portal site (referred to as "portal site" from here) to download the registration form for the R&D institution and apply for registration (the proponent must undertake the abovementioned process by himself or herself if he or she belongs to an organization outside Japan or does not belong to any institution). This registration step should be completed at least two weeks prior to the intended start date for using e-Rad because it may take several days to process your registration. Once registration is completed, you do not need to register again when applying for some other system or program provided by a governmental body, even if you have already finished the registration for the same.

② Registering information on the researcher

The organization to which the proponent belongs must register information regarding the proponent as a piece of researcher information and, then, provide a login ID and password.

For how to register researcher information, see the manual for the representatives of the clerical work and for the clerical work personnel at R&D institutions.

(2) Registering application information to e-Rad

For how the proponent uses e-Rad for his or her application, see the instruction manual (https://www.e-rad.go.jp/en/manual/for_researcher.html) for researchers available on the portal site. Agree to the terms of the service and register your application.

(3) Preparing R&D project proposals

In order to prepare an R&D project proposal, carefully read the instructions in this application form.

<PRECAUTIONS>

① Make sure the recommended system requirements are met before you log in to e-Rad. Recommended system environments for using e-Rad include IE, Firefox, Chrome, and Safari.

② You need to register the application information over the Internet. When registering your application, attach the R&D project proposal. Access the website of this call (https://www.jst.go.jp/moonshot/en/application/) and download the application form and the R&D project proposal form. You can upload a file that is roughly 3 MB or smaller as the electronic media for your application form; the maximum file size is 10 MB. Pay attention to the file size when using image data.

③ You can upload PDF files only as application forms. Note the following instructions when preparing PDF files.

- Before you convert a file into PDF format, delete revision histories.
- Do not use a password to protect the PDF file of your R&D project proposal.
- Make sure that the PDF file contains page numbers after its conversion.
- Make sure that you check the PDF file after its conversion. The characters in the page or the whole file may be incorrectly converted if you use external

characters, special characters, or the like.

④ Your application is invalid if the status of your application is not “Processing to distribute to an organization” or “Accepted.” For the status of your application, see the “Problem List” page.

(4) Others

Your application is not examined if the documents in your application are not complete or are faulty. Carefully read the instructions about preparing the files described in this application form and the template of the R&D project proposals. (Do not change the formats of the application files.) You will not be allowed to replace your application files. Your application files will also not be returned.

6.3 Others

(1) Inquiries about how to use e-Rad

Contact our personnel in charge of JST programs if your inquiry is about the program per se. Contact e-Rad Help Desk if your inquiry is about how to use e-Rad. Double-check the website of this call or the e-Rad portal site before you make inquiries. You are not allowed to make any inquiries about the status of our examination or the adoption or rejection of the program.

Inquiries about this program; inquiries about the processes of preparing, submitting, or any other step concerning your application files	Department of Moonshot Research and Development Program, JST	<Make sure to use email for your inquiries (unless urgent)> E-mail:moonshot-koubo@jst.go.jp Phone Number: 03-5214-8419 Office hours: 10 AM – 5 PM *Except for Saturdays, Sundays, national holidays, and year-end new-year holidays [We may ask you to email if you call to make an inquiry.]
Inquiries about how to use e-Rad	e-Rad Help Desk	Phone Number: 0570-066-877 (Navigation Dial) Office hours: 9 AM – 6 PM *Except for Saturdays, Sundays, national holidays, and year-end new-year holidays

・The website for this call (https://www.jst.go.jp/moonshot/en/application/)

・ e-Rad portal site (https://www.e-rad.go.jp/en/)

(2) When e-Rad can be used

e-Rad is, in principle, in operation 24×7. However, the service may be interrupted for system maintenance.

Before we interrupt the service, we post notifications on the portal site.

(3) What you should do specifically and some precautions

Specific steps to use e-Rad will be posted on the website of this call during Early-March.

Your applications will be accepted on e-Rad from Early-March.

The start of acceptance of applications will be announced on the website of this call.

・The website of this call (https://www.jst.go.jp/moonshot/en/application/)

Proposal for R&D project (How to Complete the Form)

[Form 1] The Moonshot Goal You Aim to Achieve
[Form 2] An Overview of the R&D Project
[Form 3] The Scenario to Achieve the Moonshot Goal
[Form 4] Proposal for R&D project
[Form 5] Plans for Promoting R&D projects and Budget Plans
[Form 6] Proponent Management Ability
[Form 7] Items Implemented by PM for Refining
[Form 8] Information Related to Conflicts of Interest
[Form 9] Status and Efforts of Application for Research Funds and Acceptance
[Form 10] Human rights protection and managing the observance of laws
[Form 11] "Letter of Recommendation"
[Appendix to Form] Performer Candidate Information Sheet

[Instructions for Filling In the Proposal for Projects]

- Do not change the format or style settings of the forms.
- Do not exceed the specified page count for each form.
- Always use 10-point font or larger for the body text.
- You can use drawings and tables as necessary in [Form 2] to [Form 6].
- Erase the instructions for filling in the forms which are shown in blue before you submit the forms.
- Remove this sheet (the cover page of the instruction about how you fill in the form) before you submit the form.
- The file size should be roughly 3MB or smaller.
- You are not allowed to change documents after the deadline.

Proponents who do not observe the instructions above will not be adopted and their proposals will not be accepted.

[Form 1] The moonshot Goal you aim to achieve

Moonshot Research and Development – Proposals for R&D projects

The MS Goal this proposal aims to realize
Select one MS Goal you aim to realize in this proposal. ☐ MS Goal 1: "Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050." ☐ MS Goal 2: "Realization of ultra-early disease prediction and intervention by 2050." ☐ MS Goal 3: "Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050." ☐ MS Goal 6: " Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050."

Checklist on each Goal *Describe about the goals you select above.*	
MS Goal 1	*Select what is applicable to the contents of your proposal from the following goals. (You can select two or more.)* ☐ Cybernetic avatar base ☐ Cybernetic avatar life
MS Goal 2	*Confirm that it is necessary to include both approaches in your proposal at MS Goal 2. (You should contain both content for the proposal)* ☐ Molecular cytological, biochemical, physiological approaches ☐ Approach from AI or other mathematical data analysis technology and mathematical modeling
MS Goal 3	*Select what is mainly applicable to the contents of your proposal from the R&D groups below. (You can select two or more.)* ☐ The AI robot that does not cause discomfort to men, does have the physical ability equivalent to men or higher, and does grow together close to human lives ☐ The AI robot system that thinks and acts on its own and aim to proactively find the scientific principles and solutions ☐ The AI robot that makes judgment on its own in the environments where it is difficult for men to act and autonomously acts and grows.

MS Goal 6	*Select what is applicable to the contents of your proposal from the categories below. (Select one.)* ☐ Hardware ☐ Communication network ☐ Theory, software

[Form 2] An overview of the R&D project

Title of the R&D project
Describe the title of the R&D project you propose
An overview of the R&D project you propose (within 225 words)
Describe an overview of the R&D project you propose *(within 225 words including marks and signs)*
Keywords
Write the keywords that express the feature of the R&D project you propose (five or less).
The research and development funds etc. you want (total budget for the five years (2020-2024) after a PM is adopted)
●●●million yen *The same amount as Form 5.
Information on the proponent (PM)
Your Full Name:
Nationality/Gender: / Date of Birth (Gregorian calender):
Institution/Post:
Address/Boarding:
Educational Background and Work Experience of the Proponent
・Educational Background (the university you graduated from and the other academic institutions after) *Examples of description)* *Year: Graduated from xx University, Department of xx*

Year: Graduated from xx School of xx, Department of xx, majored xx
Year: Graduated from xx School of xx, Department of xx, majored xx
Year: Ph.D. of xx (xx University)

・Work experience

Examples of description)

Year – year: xx Company, xx Department (developed xx)

Year - year: Project Associate Professor, xx University (involved in the study of xx)

Year – year: xx Company, xx Department (in charge of xx project)

Effort for the management of the R&D project
The ratio of the time for the management activities to the others in the R&D project you propose●●% *If the PM participates also as a performer, describe the ratio of the time for the research and development activities in another form.

PM's institutions and the status of their arrangements
As stated in the application guidance, section 4.1.2, if a proponent is adopted as a PM, he or she is supposed to support the PM activities as the "PM's institution." *Describe the name of the candidate for the PM's institution and the status of the agreement on accepting the post of the PM's institution.* *If this is not yet determined, you are asked to acquire an agreement from the PM's institution until the refining is finished after the adoption.* *Candidate for the PM's institution: xx University, School of xx (or, xx Corporation, xx Business Head Office, xx Business Department)* *The status of the agreement with the candidate for PM's institution: ☐ Done, ☐ Being arranged, ☐ Not arranged (Select one.)*

Information on the candidate for the major performer
Describe the person, his or her organization and post, and the assignments (in 80 characters or less including marks and signs) with respect to the person who is essential for implementing the R&D project you propose among the candidate for performers (the

persons who implement the contents of the assignments for the research and development in the R&D project as instructed by the PM) *(Describe the details in "Appendix to Proposal, Performer Candidate Information Sheet." If this is yet to be determined, describe "TBD."* **As to MS Goal 2, the project should include 2 approaches, one is "1) molecular cell/ biochemical/physiological approaches" and the other is "2) approaches using mathematical data analysis techniques such as AI and mathematical modeling". Describe at least 1 performer for each approach, and which approach he/she is in charge of for "assignments".* *(Examples of description)* *Performer Candidate 1: Name, organization and post, assignments (describe within 80 characters including marks and signs)* *Performer Candidate 2: Name, organization and post, assignments (describe within 80 characters including marks and signs)* *Performer Candidate 3: Name, organization and post, assignments (describe within 80 characters including marks and signs)*	
Researcher Number of the Proponent	*Fill in the 8-digit researcher number assigned from the Cross-ministerial R&D Management System (e-Rad).*
Information on the proponent in researchmap etc.	*URL:* *Author ID:* **Describe the URL if there is a website containing the information on the proponent (the homepage of an office at his or her organization, a page on researchmap, etc.) or describe the ID if the researcher ID of ORCID ID or Web of Science or the author ID on SCOPUS is known.*

[Form 3] The Scenario to Achieve the Moonshot Goals

** Describe within four pages in Form 3.*

1. The scenario to reach the accomplishment of the MS goals in year 2050 from the current starting point in this proposal

Describe the scenario to reach the accomplishment of the MS goals in year 2050 from the current starting point in this proposal with appropriate goals in specific years.

(1) The scenario for reaching the achievement of the MS goal (from the year 2030 to 2050)

(2) The scenario for reaching the achievement of the MS Goals (from present to the year 2030)

**Describe the present to 2030 and 2030 to 2050 separately.*

** For the present to 2030, summarize item 5, "The Contents of the R&D project You Propose" in [Form 4]*

**Explain how this proposal corresponds to the R&D concept and MS goal you chose.*

**Discuss the impact on industries and society of the achievement of the MS goal and the estimated time you will achieve the goal.*

2. The major problems that should be overcome to reach the achievement of the MS goal in 2050

Describe the major problem that should be overcome and why you should solve it to achieve the MS goal.

Describe major problems that should be overcome in the field of science and technology, in terms of social acceptance, regulations, social economy, and so forth, which may present barriers to the realization and/or spreading of the achievement.

(Examples of description)

(2-1) Problems in science and technology

Problem 1) Technology xx: the development of the xx technology that enables xx by xx

<Plans for Measures> To anticipate significant improvement in its accuracy by applying xx in the xx field to the xx technology

Problem 2) xx system: To construct the xx system to provide the xx service in the

field of xx

<Plans for Measures> To advance xx by accelerating the link between corporations in the xx field and the xx service for verification

Problem 3) Efficient application of xx: the efficiency of xx is currently xx percent, which needs to be improved to xx percent or higher

<Plans for Measures> To significantly improve the efficiency by concentrating on xx, accumulating data, using AI, and applying it to xx

(2-2) Problems in society

Problem 1) The approval and permission system of xx: the international regulation of the approval and permission system for xx has not yet been determined; forming a framework for an international agreement is necessary.

Problem 2) Developing an understanding among the residents of xx region: To implement xx, providing an explanation to and acquiring an understanding from the residents of zz are necessary to use the xx region.

3. Conventional endeavors for achieving MS goals and overcoming problems

Describe the reason why you think previous endeavors have struggled to solve the "problem to be overcome." Explain why the achievement of the MS goal in 2050 is difficult by discussing two or more endeavors that have been performed in and outside the country to solve the "major problem to be overcome" (Item 2 above).

**Describe the measures for the problems in the field of science and technology and the measures for the social problems.*

**Explain why the field of specialty and the occupational experiences of the proponent are not limited.*

**Mention references or the like that can offer the grounds for verification, if necessary.*

**Make sure to mention the endeavors made by parties other than the proponent.*

**See the examples below and itemize your description so that the evaluators will understand your explanation.*

(Examples of description)

1) Example of endeavor 1: the research and development of xx and its implementation in society

Overview: To improve xx and yy, the major technology of zz, to spread xx to the xx percent of the world

Major problems to be overcome	Problems facing conventional endeavors (The reasons why you think the achievement in or before 2050 will be difficult)
●Scientific and technological problems ・To enhance the efficiency of xx from yy to zz ・To enhance the performance of xx from yy to zz	・As opposed to the enhancement of the performance of xx, the development of yy is necessary, and zz trillion yen is necessary for zz years. ・The enhancement of the performance of xx is difficult theoretically (Abcd,20xx).
●Social problems ・Situating xx so that it can be accepted by general consumers ・Conformity to the yy system	・xx acceptance in the world is about yy according to a test calculation; according to a reference (Efgh,20XX), these endeavors will produce about zz of xx around the year 2050, which is unacceptable at in the market. ・For the conformity to xx system, the solution to the yy problem above is necessary. In addition, zz, the international association, opposes revising the system; therefore, it is difficult to persuade them.

Reference)

Abcd,E., XXXXXXXXX,Journal of XX, pp.x-x, 20XX

Efgh,A., XXXXXXXXX,Journal of XX, pp.x-x, 20XX

2) Example of endeavor 2: Spreading xx technology

(Examples of description)

Major problems to be overcome	Problems facing conventional endeavors (The reasons why you think the achievement in or before 2050 will be difficult)
●Scientific and technological problems ...	... ...
●Social problems	... ...

4. Measures for solving the "problem to be overcome" in this proposal (concept)

Describe the measures (concept) for solving the "problem to be overcome" (Item 2 in this form) in this proposal

**Provide a hypothesis for the solution based on scientific grounds or the like.*
**Include references or the like that can give grounds for verification, if necessary.*

Major problems to be overcome	*Measures for the solution (concept)*
●*Scientific and technological problems* *...* *...*	*...* *...*
●*Social problems* *...* *...*	*...* *...*

Reference)
Abcd, E., XXXXXXXXX, Journal of XX, pp. x-x, 20XX
Efgh, A., XXXXXXXXX, Journal of XX, pp. x-x, 20XX

5. The adequacy of the scenario of the proponent

Describe why the scenario of the proponent, compared with the conventional endeavors mentioned in Item 3, is better suited to achieve the MS goal in 2050.

**Explain the adequacy of this scenario and why it should be used for the implementation despite the difficulty of achieving the MS goal by 2050 with conventional endeavors; compare the conventional scenario with the proponent's scenario.*
**Give reasons from the field of science and technology and society.*

[Form 4] Proposal for R&D project

Describe within five pages in Form 4.

If the proponent is adopted as a PM, he or she will manage the R&D project for achieving the MS goal in 2050. The proponent should specify the milestones in the third, fifth, and tenth years starting from the time of the adoption as a PM. The milestones are quantitative targets that can be verified based on the "scenario."

In the following sections, describe the R&D project that the proponent expects to reach.

1. The milestone for the tenth year from your adoption as a PM and the reason for the specification

(1) The milestone for the tenth year from your adoption as a PM

Backcasting the accomplishment of the MS goal in 2050 and, based on the scenario, describe the milestones (can be plural) as the quantitative targets that can be verified, the accomplishment of which you aim at in the tenth year from the adoption as a PM.

(2) The reason for the specification of the applicable milestones

Explain your specification of the milestones so that the positioning of the scenario and the necessity of them are understandable.

2. The milestone you aim to reach in the fifth year from your adoption as a PM and the reason for the specification

(1) The milestone you aim to reach in the fifth year from your adoption as a PM

Backcasting the accomplishment of the MS goal in 2050 and, based on the scenario, describe the milestones (can be plural) as the quantitative targets that can be verified, the accomplishment of which you aim at in the fifth year from the adoption as a PM.

(2) The reason for the specification of the applicable milestones

Explain your specification of the milestones so that the positioning of the scenario

and the necessity of them are understandable.

3. The milestone you aim to reach in the third year from your adoption as a PM and the reason for the specification

(1) The milestone you aim to reach in the third year from your adoption as a PM

Backcasting the accomplishment of the MS Goal in 2050 and, based on the scenario, describe the milestones (can be plural) as the quantitative targets that can be verified, the accomplishment of which you aim at in the third year from the adoption as a PM.

(2) The reason for the specification of the applicable milestones

Explain your specification of the milestones so that the positioning of the scenario and the necessity of them are understandable.

4. The problems to be overcome in the R&D project

Name the five problems (or more) that should be overcome in this R&D project for the accomplishment of the "milestones in the third year from the adoption as a PM," the "milestones in the fifth year from the adoption as a PM," and the "milestones in the tenth year from the adoption as a PM" and give a specific explanation of the contents also based on the quantitative expressions.

Mention the positioning of the "scenario" and the significance of your management of the problem in this R&D project.

5. The Content of the R&D project You Propose

Refine the scenario to the achievement of the "milestones in the third year from the adoption as a PM," the "milestones in the fifth year from the adoption as a PM," and the "milestones in the tenth year from the adoption as a PM."

Show measures for the solutions based on the scientific background for the problem mentioned in Item 4 above and give a specific, concise explanation about how you will try to achieve the milestones.

Explain how the R&D project you propose is a unique, bold concept and whether you have sufficiently considered how to hedge the risk presented by the difficulty of solving the problem to be overcome.

6. The Ripple Effect of the R&D project

Describe what accomplishments are produced for each step at the time when the R&D project you propose accomplishes the "milestones in the fifth year from the adoption as a PM," the "milestones in the fifth year from the adoption as a PM," and the milestones in the tenth year from the adoption as a PM" and, in addition, describe what ripple effects (impact) will be brought to the academe, industries, or society.

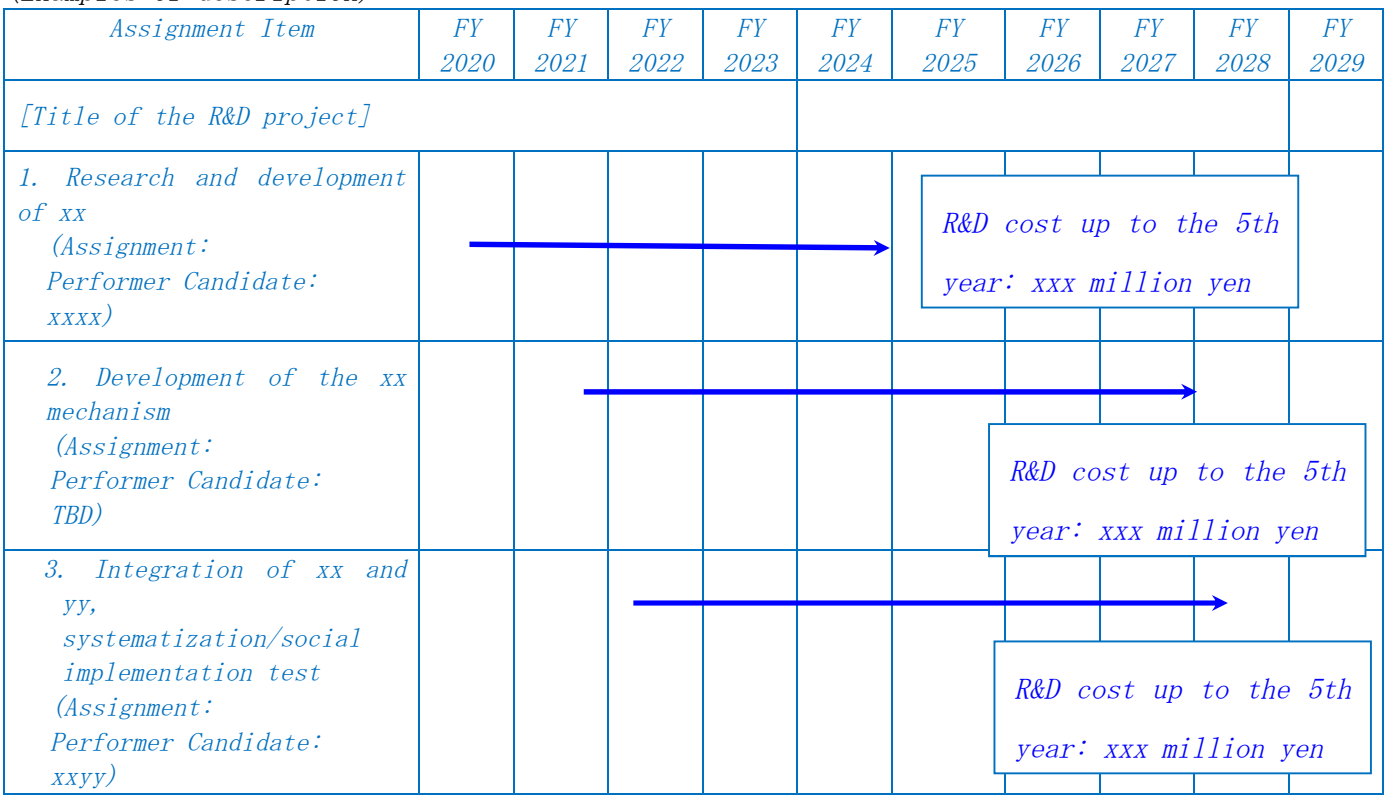
[Form 5] Plans for Promoting the Research and Development Projects and Budget Plans

1. Plans for the Promotion of the R&D project

Describe specific plans for promoting the "R&D project" described in [Form 4]. Filling in this proposal form does not mean that you are promised to receive the funds for the planning and/or the R&D or that the applicable performer will be allowed to participate. The above-mentioned will be determined in the course of refining on the R&D project. (See sections 4.2 and 4.3 of the application guidance.)

Describe the overview of the assignments, the candidates for performers, the period of implementation, and the R&D cost of the assignment items (from the adoption of the PM up to the fifth year; including indirect cost) for each of the major assignment items.

(Examples of description)



2. Yearly Plans for Research and Development Cost

Describe the rough amount of your R&D cost. (Unit: 100 million yen)

Fiscal Year	2020	2021	2022	2023	2024	2025 - 2029 (total *)
R&D cost (including indirect cost)	X.X	X.X	X.X	X.X	X.X	X.X

* The period of R&D project is 5 years, in principle. The project will be evaluated in 3rd year, and may be changed(increased/decreased) or finished according to its result. And in addition to the evaluation in 3rd year, the project will be evaluated in 5th year and

when PD need to do. In all cases, the project may be changed(increased/decreased) or finished according to its result. If the expansion of project over 5 years, the duration will be 10 years at maximum.

*For the ratio of the indirect cost, see section 4.6.2, "Indirect Cost."

3. Major Equipment to Be Purchased (20 million yen or more per piece, the name of the equipment, a rough estimation of the expenditure)

If you are planning to purchase equipment that costs 20 million yen or more per item by the fiscal year end of 2023, itemize the name of the equipment, a rough estimation of the expenditure, and the year when you want to purchase it.

(Examples of description)

Name of the equipment: xxxxxx Rough estimation of the expenditure: xxx thousand yen (Desired year of purchase:zzzz)

Name of the equipment: yyyyy Rough estimation of the expenditure: xxx thousand yen (Desired year of purchase:zzzz)

**After the adoption is determined, in the course of the refining of the R&D project by the PM, the plans for the purchase, operation, sharing of the applicable facility should be brushed up. In addition, from the viewpoint of the effective and efficient implementation of each R&D project implemented in this program, some arrangements may be made for the facility to be purchased with the direction of the PD in cooperation with external experts as advisors etc.*

[Form 6] Management Ability of the Proponent

*Describe within two pages in Form 6.

To complete this form, see the application guidance, section 3.7, "Viewpoints in Selection, ① The nature of being a PM."

1. Experience and achievement as they pertain to the Management Ability of the Proponent

Itemize your experiences and achievements in the management of R&D projects, business applications, etc. in an easy-to-understand way. If you have no experience or achievements to describe, write "None."

○ If you have been a representative for any other research fund systems, list the title of the R&D problem, the research cost, and the evaluation of it afterwards for major examples. See the example in the following table.

(Examples of description) Copy the following table if you need to describe two or more examples.

Title of the fund system	Research base formation system by Ministry of xx
Period(fiscal year)	Fiscal year - fiscal year
Subject of research	The new xx science on the observation of yy developed by using zz
Research cost (direct cost)	xxx thousand yen
Results of the evaluation of the completed research	S) An excellent result was achieved; a significant contribution was made to the promotion of the use of xx.

○Describe the details of the roles and contributions of the proponent in any business application achievements. Include an overview of the business (the details of the business, results of order-taking and sales, etc.) in the description.

2. The reason why you well-suited to be a project manager (PM) in this program

Include the core skills of your management ability to describe why you think you are suitable for the management of a long-term, challenging theme *such as an MS goal to be achieved in 2050.*

(For instance, core skills can include leadership, intuition, problem-solving, decision-making, and influence over people via communication.)

3. The proponent's plans for the implementation of the R&D project management

Describe the ideas about what point should be strengthened to take management (data management, industry-academia cooperation, liaison, international cooperation, science and technology dialog with citizens, etc.) of the R&D project you propose in consideration to the experiences of the management in the past of the proponent him- or herself, including the details and the ideas of the implementation for the enhancement.

See the examples below and itemize your description so that it will be easy to understand.

Example of description

Content that should be strengthened	*Ideas on the implementation*
Ability to imagine a strategy for the business application of the research results	*To xx yy for zz.*
The expertise in the field of *xx* research	*To xx yy for zz.*
Activities for the management of research data	*To xx yy for zz.*
Activities for industry-academia cooperation and liaison	*To xx yy for zz.*
Activities in relation to international cooperation	*To xx yy for zz.*
Activities for science and technology dialogs with citizens	*To xx yy for zz.*
If none of the above apply, please explain them.	*To xx yy for zz.*

Write "None" if you do not think there is nothing that should be strengthened for implementing the R&D project.

4. Achievements in information exchange and collaboration with people from a wide range of fields

Include specific examples in your description so that we can see your ability to communicate with researchers and relevant parties in and outside the country. Show that that you have networks with experts across the fields of academia and industry and the ability to collect information.

Describe the proponent's achievements in information exchange and collaboration with people from a wide range of fields.

[Form 7] What Are Implemented by the PM for Refining

**Describe within two pages in Form 7.*

The PMs, when adopted for Moonshot R&D, with the direction by PDs in cooperation with the advisors as external experts, refine the R&D projects.

(For the refining, see the application form, section 4.2, "PMs to Refine R&D projects" and section 4.3, "PMs to Implement R&D projects.")
Describe what you think the PM should do presently in terms of the items below.

1. Realizing the Plans for the Promotion of R&D projects in the Refining Phase

Describe how the proponent will determine and prepare the content that cannot be determined as of present to promote the R&D project ([Form 4] and [Form 5] and explain the proponent's ideas for the implementation.

Example of description (Add or delete the rows in the table if necessary.)

Content that needs to be determined and prepared	*Ideas for the implementation*
To select performer candidates who can advance the research of xx	*To hold workshops to find prospective young researchers*
To look for an optimal method for approaching the problem of xx	*To conduct a survey on trends in the technology in and outside the country on the research on xx to solve the problem yy and narrow possible methods for approaching it*
The place of the verification test using a public road has not been determined in the development of the technology for driving cars.	*To assume the using of the xx special zone system in yy prefecture and zz prefecture and to collaborate with the sector of the local government in charge to form plans for a verification test.*

2. The proponent's ideas for the construction of the organization to support PM activities by the PM's institution in the refining phase

Describe the necessary content and the implementation by the proponent about what support organization will be constructed at the PM's institution to ensure the execution of the ideas of the implementation described in Item 3 of [Form 6], which refers to the ideas of the proponent for the implementation of the R&D project management.

Describe how you will determine and prepare the contents that cannot be determined

presently or that are insufficient at the time of refining as well as the proponent's ideas for the implementation.

Example of description (Add or delete rows in the table if necessary.)

Content that needs to be determined and prepared	*Ideas for the implementation*
Optimal management organization for the budget execution to each R&D institution	*To xx yy for zz.*
To hire personnel to oversee technical support for the PM	*To xx yy for zz.*
To assign a professional to conduct outreach and who has sufficient knowledge in the field of xx	*To xx yy for zz.*
An organization to support turning intellectual property into rights and engaging in standard development	*To xx yy for zz.*

If you think that an optimal organization has already been established to support PM activities, show the organization for supporting the PM and describe why you think it is sufficient.

[Form 8] Information on Conflicts of Interest

1. Information on a PD's Conflicts of Interest

Select whether the proponent has any shared interests with the PD that correspond to the MS goal you have selected.

If there are shared interests, describe the content of them specifically. For a fair and transparent evaluation, the PD who has a shared interest with the proponent will not participate in the selection processes with respect to the applicable proponents.

Select whether the proponent has a shared interest with the PD who oversees the MS goal you selected. ☐ Yes ☐ No *Select one.

Provide a specific description if you answered, "Yes."

The definition of the applicable person who has a shared interest is as follows.

1) A person who is related to the PD

2) A proponent who belongs to the same department or major at a university, college, or a research and development organization or national corporation, or enterprise as the PD

3) A person who engages in a close joint R&D project with the PD or a person who has participated in a close joint R&D project within the past five years. This may refer to conducting a joint project, coauthoring a research paper, being members of a R&D project for the same purpose, or the joint researchers of any other research and development problem of the PD, who belongs to the same research and development group as the PM

4) A person who has been closely related to the PD as a teacher or student or who has been in a direct employer-employee relationship for ten years in total in the past

5) A person who is in an academically competitive relationship with the research and development activities of the PD or who belongs to an enterprise that is in the same competitive market

If it is confirmed that the requirements of a relation of interest are met between the proponent and the PD and no declaration is made from the proponent to JST, we may take measures, including not adopting the project or canceling the project, unless JST recognizes appropriate reasons for the omission.

2. Information on conflicts of interest with the performer candidate

If there is a relation of interest between the proponent and the candidate of a performer described in "Performer Candidate Information Sheet" (Appendix to Form), specifically describe the contents and write the applicable item number in the "Conflicts of Interest with the Proponent" column in "Performer Candidate Information Sheet" (Appendix to Form).

The definition of an applicable person who has a relation of interest is as follows.

1) If the PM is a performer candidate

2) A person who is a relative of the performer candidate

3) A person who belongs to the same department, major, or the like as the proponent at a university, college, or research and development organization of a national research and development corporation or to an enterprise that is the same source of a second form of employment or originally hired the performer candidate

4) A person who engages in a close joint R&D project with the performer candidate. This may refer to conducting a joint project, coauthoring a research paper, being members of a R&D project for the same purpose or the joint researchers of any research and development problem of the PM, who belongs to the same research and development group as the PM

5) A person who has been closely related to the performer candidate as a teacher or a student or who has been in a direct employer-employee relationship

If it is confirmed that the requirements for a relation of interest are met with no declaration made to JST, we may take measures, including not adopting the project or canceling the project, unless JST recognizes appropriate reasons for the omission.

In consideration to the aim of Moonshot R&D, which is to gather the wisdom of a variety of researchers such as the top researchers, young and senior researchers in and outside the country, the conflict of interests with the proponent are not judged from a uniform standard to expel them from the projects without exception. Even when a proponent and a performer candidate share a conflict of interest, their participation in the project is not necessarily blocked if the necessity and rationality of their presence are recognized for the project.

[Form 9] Application Status, Effort, and Acceptance of Other Research Funds

The proponent should describe the competitive funds of the national government or any other research aid (including private funds and overseas organizations) the proponent is currently participating in, has applied for, or is applying for. Include the title of the problem, the period of implementation, the role, and the amount of the research funds you receive, your efforts, and the like. In addition, provide an overview of the business other than research and efforts.

As for "Effort," describe the ratio (percent) of the time necessary for the implementation of the applicable business to the time for all tasks in one year (not only the time for research and management activities but also the time for profitable business and non-profitable activities, education, medical activities, etc.); it should total 100 percent.

**See section 5.3, "Measures for Irrational Duplications and Extreme Convergences."*
**If a description is different from the fact, the adoption may be canceled later.*
** Correct this form and contact our inquiry office shown at the end of this application form via email if any change arises in the content described in this form. For example, an application you filed and/or an application you plan to file for a research subsidy or the like is adopted or rejected while your proposal in this R&D project is still in the selection process.*
**If you are selected as an applicant and invited to our interview-based review, we may ask you to submit the application form, the plans, and the like for other systems.*

(Example of description) Add or delete rows in the table if necessary.

Full Name: xxxx xxxx

(1) The research fund you have applied for

Title of the fund system/research fund (research period/name of the organization providing the fund)	Title of the problem (Name of the representative)	Role (Classification of representative, assignment, etc.)	Cost in the fiscal year 2020 *1 (Amount for the whole period)	Effort (%)	The reason why you applied for this program other than the research funds *2

[This proposal] Moonshot research and development		Representative			
Science research budget: Subsidy Fundamental research (S) (April 2020 - March 2024)	*The creation of xx by yy (xxxx)*	*Assignment*	*100 thousand yen (x.xx billion yen in total)*	*5*	*For xxxx*

(2) The research funds to be received

Title of the fund system/research fund (research period/name of the organization providing the fund)	Title of the problem (Name of the representative)	Role (Classification of representative, assignment, etc.)	Cost in the fiscal year 2020 *1 (Amount for the whole period)	Effort (%)	The reason why you applied for this program other than research funds *2
JST Strategic Basic Research Program – CREST October 2019 - March 2024)	*The highly functional application of xx by yy (xxxx)*	*Assignment*	*140,000 thousand yen (x.xx billion yen in total)*	*5*	*For xxxx*

(3) Other activities

Organization	Post	Activity	Effort (%)
XX Corporation	*Director (Part-time)*	*Deliberation on business plans, business operation plans*	3
yy Corporation	*Advisor*	*Guidance on R&D projects*	2

*1. The direct cost

*2. You do not need to fill in this table if you have not applied to any programs other than ours.

[Form 10] Human rights protection and the management of the observance of laws etc.

Review Chapter 5, "Instructions for Applicants" of the application form, and ensure that you understand the laws, ordinances, and guidelines that you should observe with respect to the project you propose and confirm that what you have formulated aligns with such regulations; when you do, check the check box (□).

(Examples of the laws, ordinances, and guidelines you should observe)

☐ "Guidelines for Responding to Misconduct in Research" (decision, Minister of Education, Culture, Sports, Science, and Technology, August 26, 2014; including the revisions after)

☐ "Guidelines for the Management and Audits of Public Research Funds at Institutions" (standard for implementation), enforced on February 15, 2007; decision, Minister of Education, Culture, Sports, Science, and Technology, February 18, 2014; including the revisions after)"

☐ The laws and ordinances, ministerial ordinances, and notifications as well as the Foreign Exchange and Foreign Trade Act (Foreign Exchange Act) so that the achievements of state-of-the-art research are not transferred to any party that may perform any activity for possible military purposes, such as develop weapons of mass-destruction, or to terrorist groups with respect to security trade control (the measures for leaking technology overseas.

☐ The laws of relevant countries if you are to be engaged in on-site activities overseas (including collecting biological resources) and/or in joint activities with overseas research institutions.

☐ The laws and ordinances, ministerial ordinances, and ethics guidelines concerning life ethics and security with respect to the research and/or activities related to life science

Check the following box when you have reviewed the laws, ordinances, and guidelines that you should observe when making a proposal.

☐ I have reviewed the laws, ordinances, and guidelines that I should observe.

[Form 11] "Letter(s) of Recommendation"

Submit the following two types of letters of recommendation. They should describe the reasons why the proponent is well-suited to be a project manager (PM) of a long-term, challenging theme, such as the achievement of an MS goal in 2050.

It is not obligatory to submit letters of recommendation; if you are going to, submit one letter of Item 1 and one or more letters Item 2. If you need two sheets for this table, copy this page.

Each letter of recommendation must be one page or less on A4 size paper.

No.	*Letter of recommendation written by*	*Requirements in relation to the description*	*Language*
1	*The "head" of the institution that is expected to be the PM's institution (the institution the proponent belongs to)*	*The reason why he or she is recommended as a PM for the Moonshot Program*	*In Japanese or English*
2	*An appropriate person who belongs to the institution overseas*	*Including a description in relation to the evaluation of "the leadership and communication skills" necessary to promote the project of the applicant*	*English*

Submit the letters of recommendation from persons who can cooperate with us in an investigation. We may interview the persons who have written the letters of recommendation and/or contact them by telephone, via email, or other means.

Letter of Recommendation (No.1)

Name of Recommended Person	
Institution/Post	
Reason for Recommendation	
(1) Describe the reason why he or she is recommended as a PM in the Moonshot Program (2) Other special remarks	
The "head" of the institution that is expected to be the PM's institution (the institution to which the proponent belongs)	

Name of Recommended Person	
Institution/Post	
Contact of the Recommender	(Tel) (Fax) (e-mail) (Personnel) *Specify if the contact is not the recommender but another person*

Recommendation（No.2）

Recommendation for Mr./Ms.	
Title:	

(1) Reasons to be recommended as Project Manager for the Moonshot Project

* Please include a rating for his or her "leadership and communication skills"

(2) Other remarks, if necessary.

Your Name	
Title	
Contact Information	(Tel) (Fax) (e-mail) (Person in charge) *If the contact person is not the recommender, fill in.*

Appendix to Form

*Copy this page for each performer candidate. Fill it in for candidates whom the proponent thinks are essential for the implementation of the R&D project proposed here (*This sheet needs to be submitted even when the proponent will also act as a performer.)*
Filling in this proposal form does not mean that you are promised to receive the funds for the planning and/or the R&D project or that the applicable performer will be allowed to participate.

"Performer Candidate Information Sheet" (One page or less per person)

Description of Assignment	*Research and development of xx*
Full Name	
Institution and Post	
Evaluation of the performer candidate and his/her achievements in R&D	
1) Describe concisely the reason why you think the applicable performer is the most preferable to oversee the applicable item to be performed. *2) Describe five especially important achievements in the field to which the performer candidate is to be assigned in order to give grounds for the above-mentioned.* *Itemize important achievements, if any, in any relevant review paper, book, award, patent, invitation lecture, or presentation at an international institution. Underline the name of the performer if there are two or more authors or presenters.*	
Role and Period of Participation	
Describe these points so that the positioning of Item 5, "The Contents of the R&D project You Propose" of [Form 4], will be clear.	
The status of the agreement from the candidate to participate in the project	☐ Done, ☐ Being arranged, ☐ Not arranged *(Select one.)*

Effort for the project	(The ratio of the time for the activities in the R&D project in whole work hours) %
Conflict of interest with the proponent (*)	☐ No ☐ Yes (The item(s) of the conflict of interest applicable: *1), 2), 3)* *(Select either one. If you select "Yes," write the number(s) of the applicable item(s) in section 2 of [Form 7].)*

Note *: For "conflict of Interest," see [Form 8], "Information on Conflicts of Interest."

Appendix

R&D Concepts and the PD's Supplements

○ **MS Goals**

The MS Goals that JST promotes R&D are as follows.

Moonshot Goal 1	Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.
Moonshot Goal 2	Realization of ultra-early disease prediction and intervention by 2050.
Moonshot Goal 3	Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.
Moonshot Goal 6	Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

* Moonshot Goal 4 “Realization of sustainable resource circulation to recover the global environment by 2050." will be managed by NEDO and Moonshot Goal 5 "Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050," by another Funding agency, respectively.

○ **R&D Concepts**

Toward the achieving MS Goals, MEXT set the R&D concepts that challenging R&D should be promoted. See “R&D concepts” in this appendix.

○ **PD's Supplements**

Toward the achieving MS Goals and R&D concepts, PDs make the policy for selection of projects, and promotion of R&D. See “PD's Supplements” in this appendix.

○**Guidelines for Operation and Evaluation of the Moonshot R&D Program (Cabinet Office, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Economy, Trade and Industry)**

【Moonshot Goal 1】

R&D Concept of “Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.”

February 2020
Ministry of Education, Culture, Sports, Science and Technology

1. Moonshot Goals

Within the Moonshot Goals (decided on January 23rd, 2020, by Plenary session of Council for Science, Technology and Innovation), the Ministry of Education, Culture, Sports, Science and Technology (“MEXT”), with Japan Science and Technology Agency (“JST”) as a research and development promotion agency, will undertake research and development activities for achieving of the following Goal.

＜Moonshot Goal＞

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

○Cybernetic avatar[1] infrastructure for diversity and inclusion

- Development of technologies and infrastructure to carry out large-scale complex tasks combining large numbers of robots and avatars teleoperated by multiple persons by 2050.
- Development of technologies and infrastructure that allow one person to operate more than 10 avatars for one task at the same speed and accuracy as one avatar by 2030.

○Cybernetic avatar life

- Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities to the top level, and spread

[1]Cybernetic Avatar is a concept that includes not only remote avatars using robots and 3D images as proxies but also augmentations of physical/cognitive abilities of humans using ICT and robotics. We aim to make Cybernetic Avatar active in the cyber-physical world of Society 5.0.

of a new lifestyle that will be welcomed by society, by 2050.

- Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities for specific tasks, and proposal of a new lifestyle that will be welcomed by society, by 2030.

2. Direction of research and development

Based on the discussion and proposal made in the Moonshot International Symposium (held in December 17, 18, 2019), direction of research and development at present is shown as follows.

(1) Area and field to promote challenging R&D

To overcome the challenges of a declining birthrate and aging population, we must realize a society free from the constraints 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.

To realize such a society, as shown in Fig. 1, we will research and develop cyborg and avatar technology that will expand human physical, cognitive and perceptual ability, and aim to promote Cybernetic Avatar infrastructure and lifestyles. These are the fields in which challenging R&D will be promoted in the Moonshot Research & Development Program.

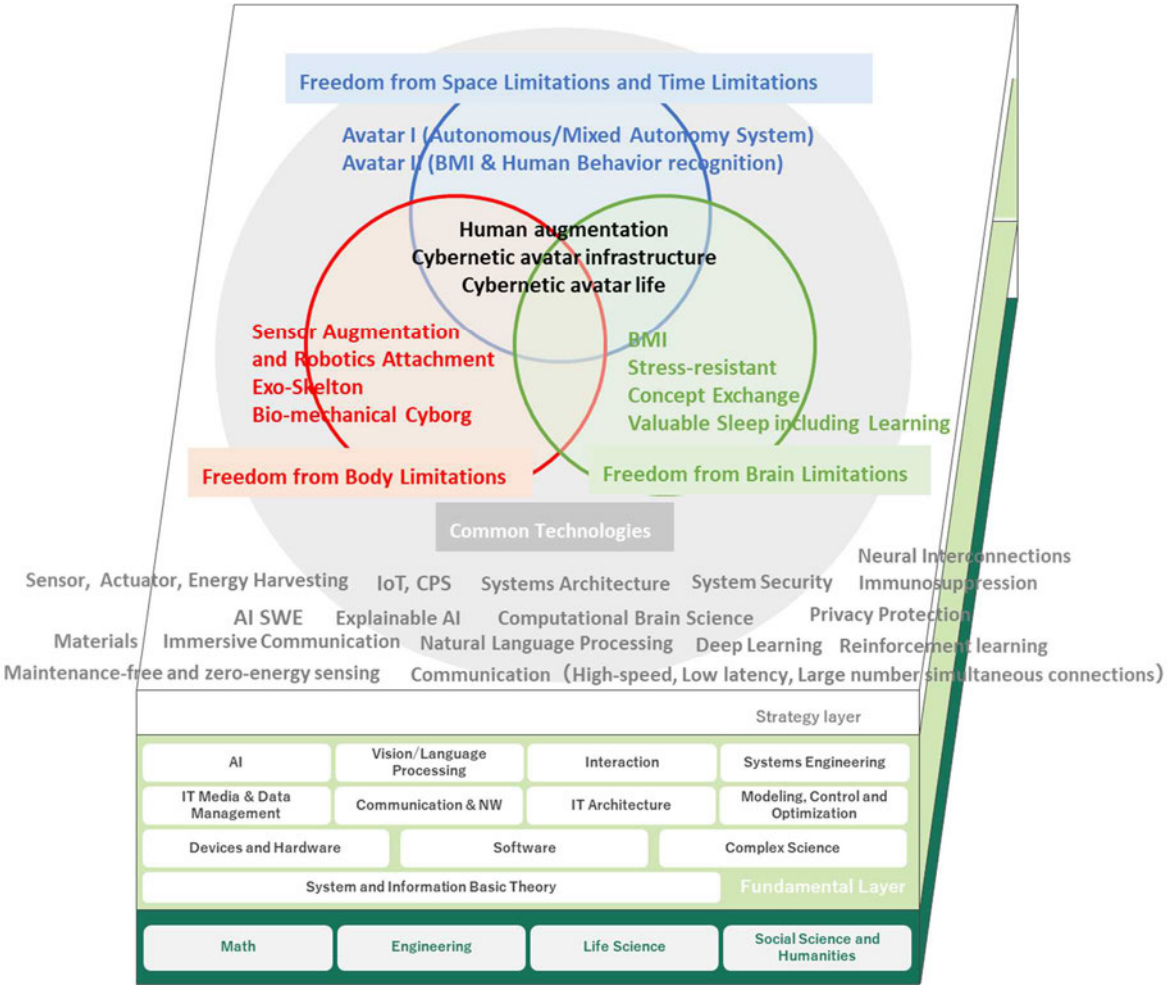


Fig.1 Main R&D fields required for Realization of a society in which human beings can be free from limitations of body, brain, space, and time

(2) Research subject for realization of MS Goal

The image in Fig.1 is the area and field for challenging R&D to be promoted under the Moonshot Research & Development Program. R&D that contribute to the achievement of this MS goal ”realization of a society in which human beings can be free from limitations of body, brain, space, and time” should proceed. In order to have the most effective and efficient countermeasure, the most cutting-edge scientific trends shall be researched and used for R&D.

In concrete, such as the following research and development will be promoted.

<Cybernetic avatar infrastructure for diversity and inclusion>

R&D to realize an avatar that is deployed throughout society and enables

various tasks to be performed by remote control, and the infrastructure necessary for its operation.

<Cybernetic avatar life>

R&D to realize technologies that can augment human physical, cognitive, and perceptual capabilities to the top level.

The creation of Cybernetic avatar infrastructure and Cybernetic avatar life require similar R&D, so there will be ample cooperation in their joint development.

In conducting R&D, various sources and types of knowledge and ideas will be adopted, stage gates will be established. And evaluation will be conducted to promote R&D to achieve Goal.

In addition, from the viewpoint of smoothly implementing research results in society, a system that enables researchers in various fields to participate in ethical, legal, and social issues will be considered.

(3) Direction of research and development for realization of the Goals

○ By 2030

<Cybernetic avatar infrastructure for diversity and inclusion>

Development of technologies and infrastructure that allow one person to operate more than 10 avatars for one task at the same speed and accuracy as one avatar.

<Cybernetic avatar life>

Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities for specific tasks, and proposal of a new lifestyle that will be welcomed by society.

○ By 2050

<Cybernetic avatar infrastructure for diversity and inclusion>

Development of technologies and infrastructure to carry out large-scale complex tasks combining large numbers of robots and avatars teleoperated by multiple persons.

<Cybernetic avatar life>

Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities to the top level, and

spread of a new lifestyle that will be welcomed by society.

To realize a society free from the limitations of body, brain, space and time, it is necessary to realize Cybernetic avatar infrastructure and Cybernetic avatar life. For the Cybernetic avatar infrastructure, we must first develop technology that allows one person to operate multiple avatars for a single task, then multiple people operating multiple avatars at the same time on a single task. Eventually this will expand to multiple people operating a large number of avatars for multiple tasks. As a starting step, the goal in 2030 is to develop technologies and infrastructure that allow one person to operate more than 10 avatars for one task at the same speed and accuracy as one avatar.

For Cybernetic avatar life, we must first develop technologies that can augment physical, cognitive, and perceptual abilities for specific tasks, and then later technologies that can augment physical, cognitive, and perceptual abilities to the top level. As a starting step, the goal in 2030 is to develop technologies that can augment physical, cognitive, and perceptual abilities for specific tasks.

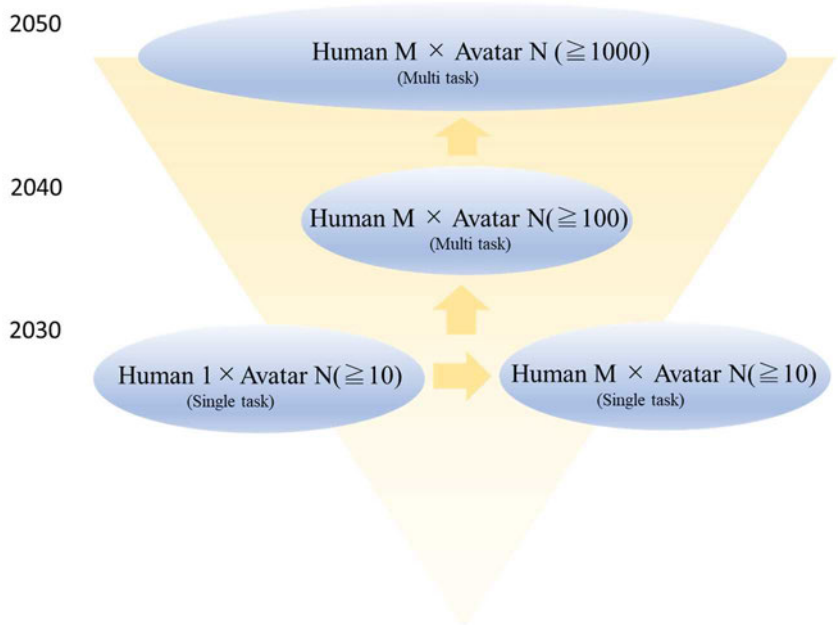


Fig.2 An example R&D process toward the realization of Cybernetic Avatar Infrastructure

＜Reference : Analysis for realization of the Goals＞

Summary of content which is analyzed in the Initiative Report presented in Moonshot International Symposium is shown, as follows:

(1) Structure of research fields and technologies

Fig. 3 shows the basic technologies required to realize the Cybernetic avatar infrastructure and Cybernetic avatar life, which are listed under “Freedom from Body Limitations”, “Freedom from Brain Limitations”, “Freedom from Space Limitations and Time Limitations”. As described above, it is necessary to research and develop necessary technical elements in various research fields such as materials, robotics, artificial intelligence, and life sciences, and to integrate them. Challenging R&D is therefore required.

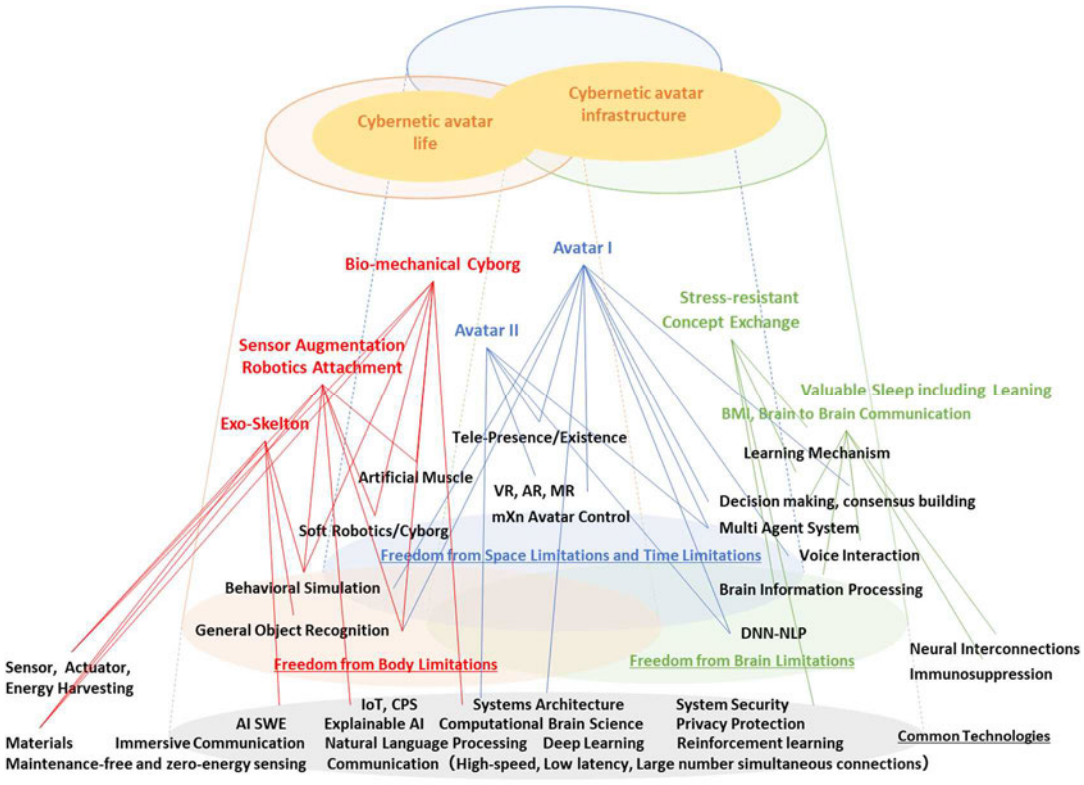


Fig.3 Structure of research fields and technologies mainly related to Cybernetic Avatar Infrastructure and Cybernetic Avatar Life

(2) R&D trends in related fields

The related R&D trends are shown in Fig.4. These technologies have been invented and developed to help human’s computational and memory skills, to

cross space and time barriers and to compensate for limitations of the human body.

Based on these basic and general-purpose common technologies, more advanced technologies that reduce body, brain, time, and space constraints and further augment these capacities, as well as related systems and services, have been introduced to society.

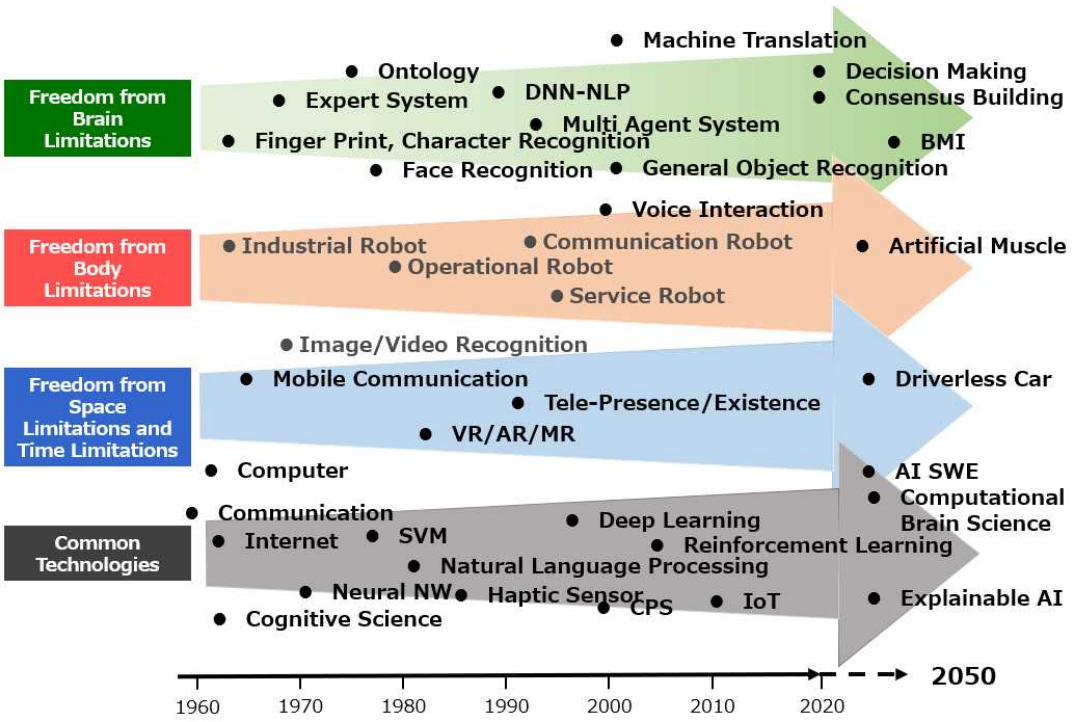


Fig.4. Related R&D trends so far

New theories of computational brain science and machine learning are particularly important from the perspective of augmenting human capabilities and freeing humans from the limitations of the body, brain, time, and space; hence, the development of new applications backed by these theories is essential. In addition, as the relation between man and machines is considerably strong, it is necessary to focus on social relationships, decision-making and consensus building, and the safety of artificial intelligence.

Furthermore, from a similar perspective, life support, welfare, and medical robots are also important. Unlike industrial robots that have been at the forefront of the robotics world in the past, service robots that deal with humans should have new characteristics such as kindness, softness, and flexibility. Therefore,

basic research areas such as soft robotics and biologically inspired robots are important.

(3) Strengths of Japan, trends in global research community

Fig.5 depicts the annual trends in the number of conference papers with respect to countries, at the Augmented Human International Conference*, which is an international conference on human augmentation.

As shown in the figure, Japan has a high presence and continuous formation and enhancement of the research community.

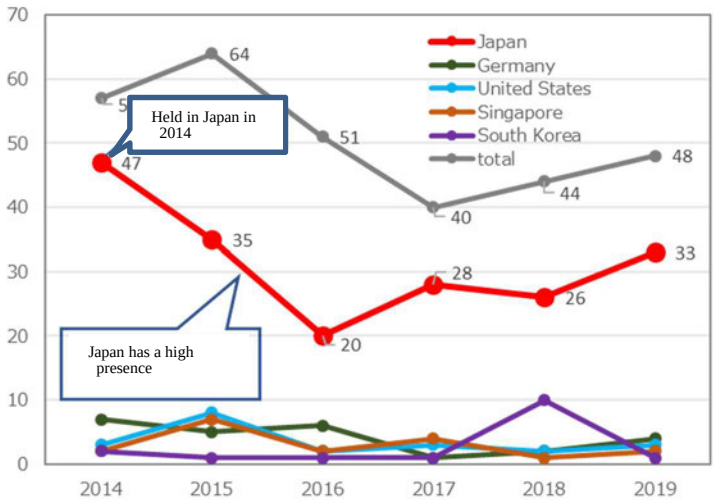


Fig.5. Number of conference papers by country at Augmented Human International Conference

＊Counts are duplicated for international joint presentations.

(Source) Calculated by JST based on Elsevier's Scopus custom data.

In Fig.6, considering the individual elemental technologies related to human augmentation as the keywords, the number of documents worldwide (i.e., the number of presentations at the proceedings of this international conference) is plotted on the horizontal axis, and the share of Japan is plotted on the vertical axis; thus, Japan's strengths and weaknesses are extracted. In particular, the areas surrounded by dotted lines indicate the five areas where Japan has strengths. Japan is also leading the world in terms of research quality, including receiving international science awards. These elemental

technologies are considered to be an important basis for achieving this MS goal.

Fig. 7 summarizes the annual trends in the number of the announcements in each country (the top 4 countries for each elemental technology) for a total of six fields, including BMI, which is considered to be an important elemental technology for human expansion.

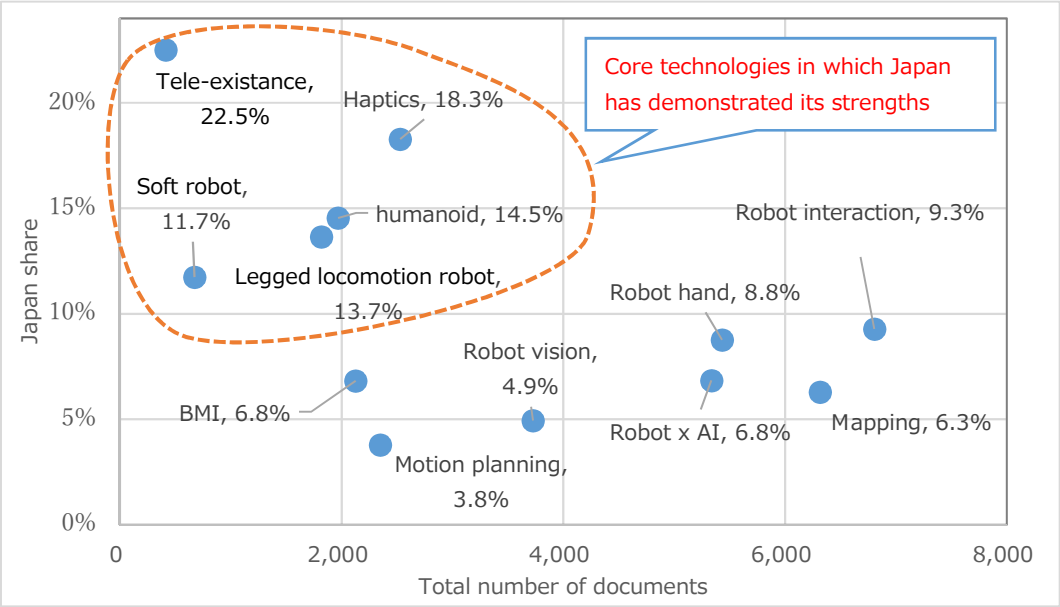


Fig.6. Japan's share in the number of conference papers for International Conference (2016-2018)

(Source) Calculated by JST based on Elsevier's Scopus custom data.

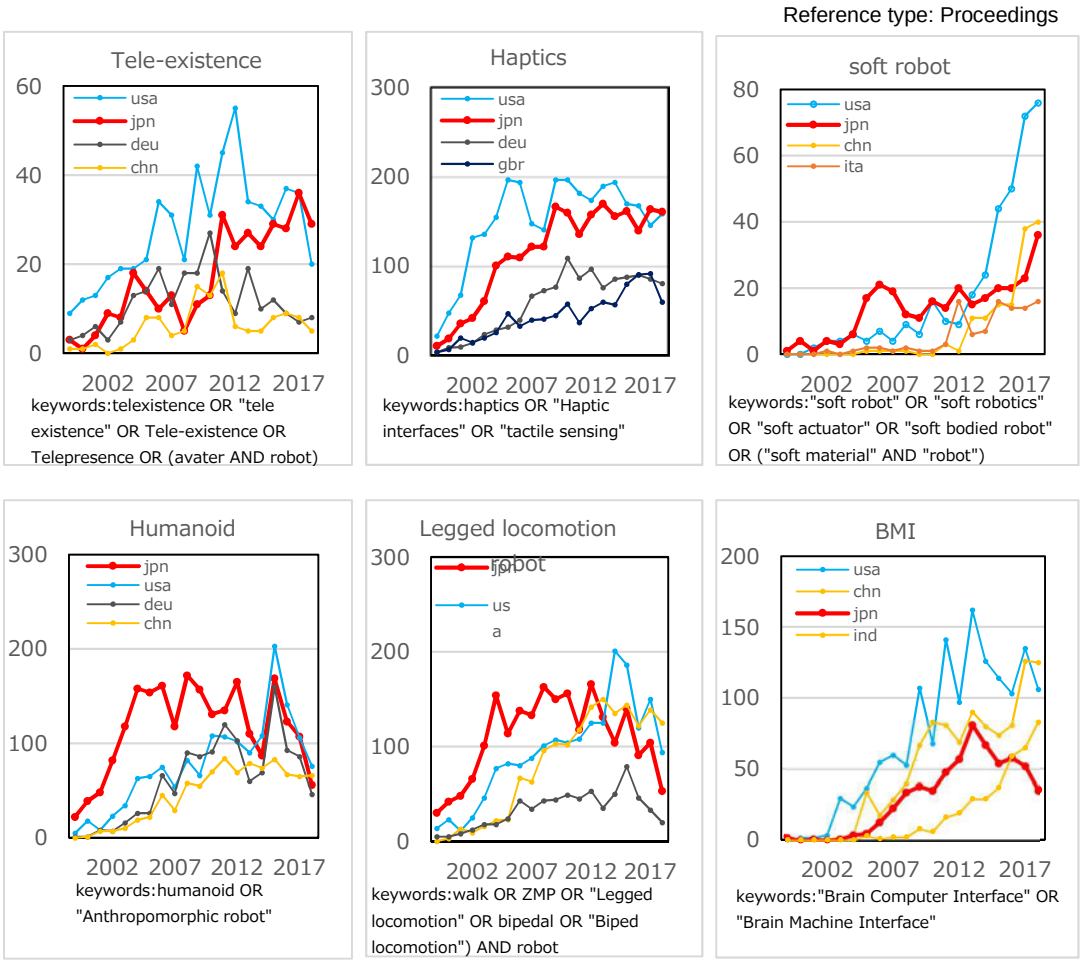


Fig.7. keywords Trends related to human augmentation

(Source) Calculated by JST based on Elsevier's Scopus custom data.

Table 1 shows that an international comparison of related technical fields was compiled based on the CRDS overview report. Regarding "Computational Brain Science", which is the foundation of BMI, Japan has demonstrated its strength in basic research. Japan is at the forefront in creating basic methods for measuring and understanding the processing of brain information, such as the DecNef method and the whole brain simulation by K computer. The country promotes basic research projects pertaining to brain science at multiple levels, and it is recognized internationally as Brain / MINDS.

'Life Support Robots' need to be organically linked with robot technology, which has traditionally been a strength of Japan, along with interaction technologies which enable understanding of human behavior and appropriate interventions.

Japan has demonstrated a strength in basic research, such as improving interpersonal affinity and developing robot element technology using new materials.

'Soft robotics' is expected to be the fundamental technology to ensure that future tele-existence robots have the same degree of freedom and flexibility as humans and are capable of sharing living spaces with humans. Launched in 2014, the Softrobotics magazine presents the top impact factor in robot-related magazines. Similarly, the international conference IEEE RoboSoft was launched in 2018. Hence, this field is developing rapidly worldwide.

However, Japan has not been able to keep up with the current, rapid expansion of research in the United States and Europe, despite pioneering research in the 2000s. However, research is expected to accelerate in the future due to the establishment of the Robotics Research Special Committee of the Robotics Society of Japan in 2017 and the launch of the new scientific area "Soft Robotics" (2018-2022).

Table1. International comparison of related fields

	Country or region	Japan		United States		EU		China	
	Phase	Basic research	Applied research/ development	Basic research	Applied research/ development	Basic research	Applied research/ development	Basic research	Applied research/ development
Computational brain science	Current level	◎	○	◎	◎	◎	◎	○	○
	Trend	→	→	→	→	→	→	↗	↗
Life support robot	Current level	◎	○	○	◎	◎	◎	△	○
	Trend	↗	↗	→	↗	↗	↗	↗	↗
Soft robotics	Current level	○	○	◎	◎	○	○	△	×
	Trend	→	→	↗	→	→	→	→	→

(Note 1) Phase

Basic research phase: Range of basic research by universities, national laboratories, etc.

Applied research/development phase: Range of technology development (including development of prototypes)

(Note 2) Current level

*Absolute evaluation, not a relative evaluation based on the current level in Japan.

◎: Particularly remarkable activities and results ○: Remarkable activities and results

△: No remarkable activities or results ×: No activities or results.

(Note 3) Trend

↗ : Upward trend → : Maintaining current level ↘ : Downward trend

（Source）Panoramic View of the Systems and Information（2019）

【Moonshot Goal 1】
PD's Supplements

PD: Dr. HAGITA, Norihiro (Professor, Art Science Department, Osaka University of Arts)

1. Policy for Selection and Proposal content

(1) Policy for Selection

Please submit a proposal of a scenario for the set MS Goal, "Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050." Including both the concept of “forecasting” that predicts the future from current society and technology, and the concept of “backcasting” that suggests what to do now considering 2050 society as a reference point, the proposal should contain an outlook for 3 years, 5 years and 10 years after PM selection, and an outlook for 2050. Please elaborate on feasibility in terms of achieving the MS Goal by 2050, implementing and adapting to society, being challenging and innovative, and integrating ELSI considerations for societal acceptance.

(2) Proposal content

As indicated in the R&D Concept, two targets are set to achieve the Moonshot Goal 1: ‘1) Cybernetic avatar infrastructure’ and ‘2) Cybernetic avatar life’. The proposal can choose one of the targets or both.

For the selected target(s), please describe the content of the task, the research approach to achieve it, the specific achievement goals of each milestone, and the excellent R&D team that can operate internationally. A multidisciplinary research approach that incorporates not only ICT and robotics, but also biotechnology and cognitive science, is welcome but not mandatory.

Since we expect the development system (connection of core technologies such as hardware, software, and interfaces) to be used in the international Internet community, it is necessary for proposals to include international standardization or activities for that purpose.

R&D of the development system must be promoted not only from the perspective of the supplier, but also by considering acceptability to users in future society. The proposal should state how changes in societal acceptance at each

milestone, regarding ELSI and security factors, are being accounted for.

2. Policy for promoting R&D

(1) Portfolio management

Taking into account the relationship between multiple R&D projects, portfolio management requires collaboration and competition between PMs. Therefore, for the period after being selected as a PM, the milestones to be achieved 3, 5 and 10 years from the time of being selected will be made clear, and a review of the progress and budget plan shall be conducted in consultation with the PD.

In addition, different research approaches can be taken during the R&D period.

(2) Collaboration with other MS Goals

Depending on the technology to be researched and developed, it may be desirable to collaborate with other R&D projects. When necessary, the PM should conduct R&D efficiently and effectively while sharing information with other related R&D projects. The PM and their performers (researchers) are expected to undertake groundbreaking synergy initiatives in cooperation with other projects, not only in R&D, but also in effective information transmission and outreach activities both in Japan and overseas.

(3) Industry - academia - government collaboration

We expect the progress of R&D to have beneficial ripple effects on various industries. Therefore, the PM should engage in activities that allow private companies, governmental organizations, and other cooperative organizations to participate in the project.

【Moonshot Goal 2】

R&D Concept of “Realization of ultra-early disease prediction and intervention by 2050.”

February 2020
Ministry of Education, Culture, Sports, Science and Technology

1. Moonshot Goals

Within the Moonshot Goals (decided on January 23rd, 2020, by Plenary session of Council for Science, Technology and Innovation), the Ministry of Education, Culture, Sports, Science and Technology (“MEXT”), with Japan Science and Technology Agency (“JST”) as a research and development promotion agency, will undertake research and development activities for achieving of the following Goal.

＜Moonshot Goal＞
“Realization of ultra-early disease prediction and intervention by 2050”

- Establishment of a system for disease prediction and evaluation of pre-symptomatic states through integrated analysis of the entire functional network between human organs, and suppression and prevention of disease onset, by 2050.
- Establishment of a strategy that enables the conversion of a pre-symptomatic state to a healthy state, by clarification of functional changes in human physiology along life course considering the comprehensive network between organs, by 2050.
- Identification of disease-related network structures and establishment of innovative prediction and intervention methods by 2050.
- Understanding of the comprehensive network between human organs by 2030.

2. Direction of research and development

Based on the discussion and proposal made in the Moonshot International Symposium (held in December 17, 18, 2019), direction of research and development at present is shown as follows.

(1) Area and field to promote challenging R&D

Particularly considering Japan's decreasing birthrate and aging population, it is important to increase healthy lifespan expectancy. To do this, it is necessary to go a step further than the conventional approach of treating the disease after the onset and start an innovative research program with the new concept of disease prevention by identification at extremely early disease stage or before becoming symptomatic.

To realize ultra-early disease prediction and intervention, it is necessary to promote R&D on the technologies as shown in Fig.1 (observation, manipulation, measurement, analysis, database creation), and advance understanding of the comprehensive network between human organs through integrating these technologies. In these research fields and areas, challenging R&D should be promoted.

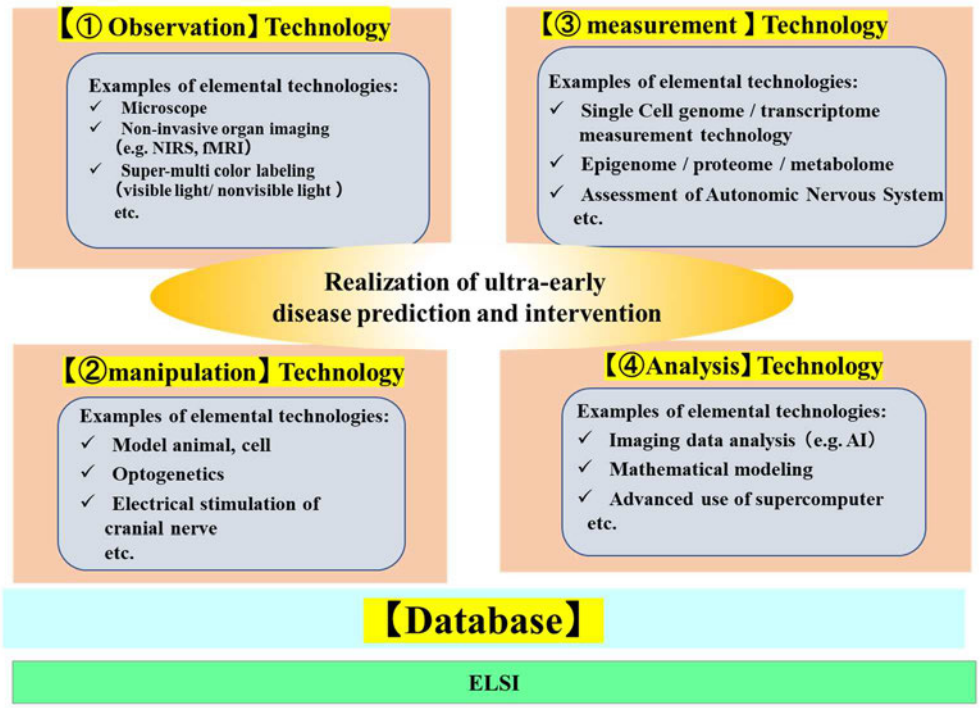


Fig.1 Main fields and areas of R&D required for realization of ultra-early prediction and intervention.

(2) Research subject for realization of MS Goal

The image in Fig.1 is the area and field for challenging R&D to be promoted under the Moonshot Research & Development Program. R&D that contribute to the achievement of this MS goal ”realization of ultra-early disease prediction and intervention by 2050” should proceed. In order to have the most effective and efficient countermeasure, the most cutting edge scientific trends shall be researched and used for R&D.

And in concrete terms, the aim is to perform an integrated analysis of the networks between organs and based on this develop a system that simulates these networks. Development of such a system will also contribute to predicting and preventing diseases at an early stage.

In conducting R&D, various sources and types of knowledge and ideas will be adopted, stage gates will be established. And evaluation will be conducted to promote R&D to achieve Goal.

In addition, from the viewpoint of smoothly implementing research results in society, a system that enables researchers in various fields to participate in ethical, legal, and social issues will be considered.

(3) Direction of research and development for realization of the Goals

○ By 2030

Understanding of the comprehensive network between human organs by 2030.

○ By 2050

Establishment of a system for disease prediction and evaluation of pre-symptomatic states through integrated analysis of the entire functional network between human organs, and suppression and prevention of disease onset, by 2050.

Establishment of a strategy that enables the conversion of a pre-symptomatic state to a healthy state, by clarification of functional changes in human physiology along life course considering the comprehensive network between organs, by 2050.

Identification of disease-related network structures and establishment of innovative prediction and intervention methods by 2050.

Understanding of the comprehensive network between human organs by 2030.

In order to realize ‘ultra-early disease prediction and intervention’, first of all, we need a comprehensive understanding of the network between human organs. In addition, we need to establish a database containing comprehensive information about the network between all organs at the cellular level. Finally, it is necessary to develop and commercialize ultra-early disease prediction and intervention technologies based on a simulation system. Therefore, we aim at understanding the comprehensive network between human organs by 2030. Fig. 2 shows how to proceed with R&D to achieve the Moonshot Goal by realizing the ambitious R&D plan.

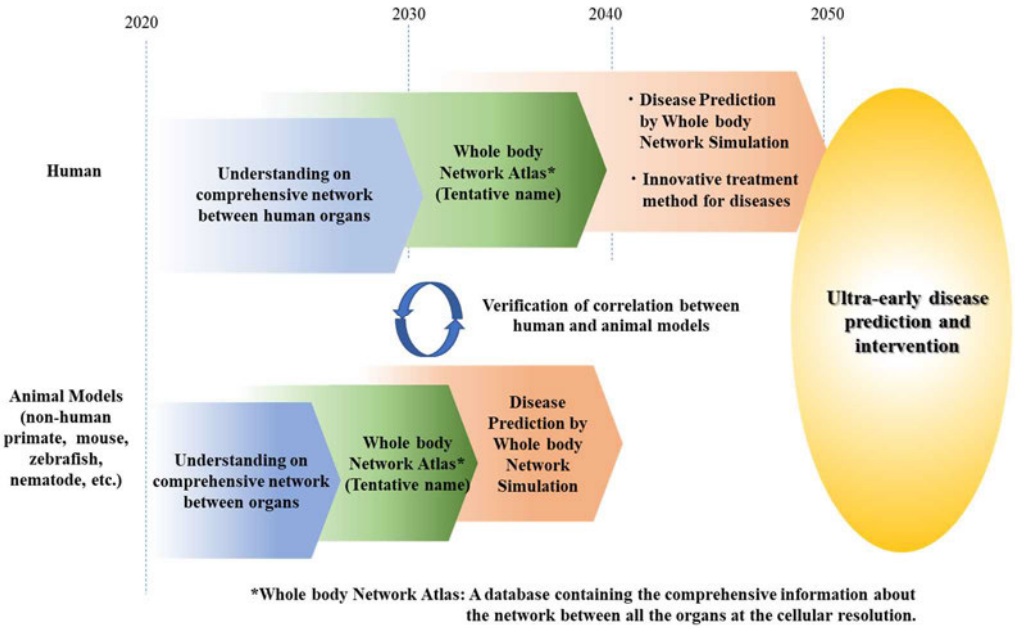


Fig.2 R&D process toward the realization of ultra-early prediction and intervention

＜Reference : Analysis for realization of the Goals＞
Summary of content which is analyzed in the Initiative Report presented in Moonshot International Symposium is shown, as follows:

(1) Structure of research fields and technologies

The MS goal will be driven by data research, which has rapidly increased its presence in recent years, and develop and use innovative basic technologies (observation, manipulation, measurement, analysis) to increase understanding of health and disease and ultimately detect and prevent disease onset early through analyzing the comprehensive networks between organs. Ambitious R&D is required.

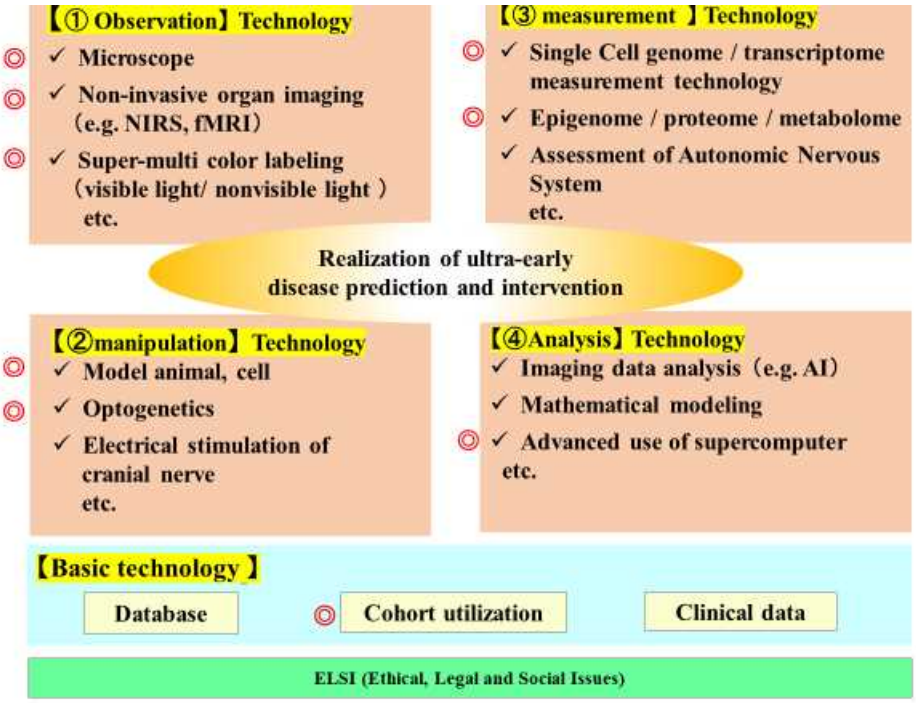


Fig. 3 Structure of research fields and technologies mainly related to ultra-early prediction and intervention

In Fig. 3, the strength areas of Japan are indicated by double circles. In general, Japan holds a leading position in various core technologies and life phenomena research, that lead to health and medical technology improvements. Regarding databases and clinical data, there is a world shortage of these assets, and they are in particular demand in Japan. However, regarding cohort usage, a relatively large cohort composed of super elderly persons only exists in Japan, and Japan

has the world's largest scale and highest quality genome cohort.

By expanding these advantages and performing strategic integration, we expect to create results with great impact.

(2) R&D trends in related fields

Here we describe existing large scale projects that are relevant to MS goal.

① Large US projects『Brain Initiative』

・In April 2013 the former US president Mr. Barack Obama announced the "Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative", and the project started in 2014.

・The project mission is the "development and application of technology for understanding human brain function". The project is aimed at the development and application of new technologies to elucidate how the brain functions through the interaction of individual brain cells and neural circuits. It also aims to elucidate the complex relationship between the brain and behavior that enables the recording, processing, use, storage, and withdrawal of a large amount of information.

Table1. Overview of the US Brain Initiative

Research area	**Participating research institutions**	**Implementation period and Budget etc.**
1. Technology development by utilizing the results of nerve and brain research 2. Brain function visualization by promoting dynamic imaging 3. Brain function research 4. An integrated understanding of brain function and behavior 5.Promotion of use to patients	・Federal government agency NIH, NSF, DARPA, IARPA, FDA, DOE ・Private foundation, research institute, and private company National Photonics Initiative, Brain & Behavior Foundation, Simmons Foundation, The Kavli Foundation, Allen Institute for brain, Janelia Research Campus, Salk Institute for Biological Studies, Google, GlaxoSmithKline, GE, etc.	・From 2014 to 2025 ・Approx. $430 million in FY2019 ・21st Century Cures Act will contribute to approx. $ 1.5 billion in FY2017-FY2026 ・Budget in FY2019 includes $120 million under this bill

② Large European Union research project『Human Brain Project』

・The Human Brain Project started in 2013 as EU-FET（Future and Emerging Technologies）.

・ Its purpose are: — integration of brain science, information and communication technology, and medical treatment
— construction of ICT integrated infrastructure research platform, and data integration.

・Experimental basic research has been performed to provide data for this purpose.

Table2. Overview of EU Human Brain Project

Research area	**Participating research institutions**	**Implementation period and Budget etc.**
1.Mouse Brain Organization 2.Human Brain Organization 3.Systems and Cognitive Neuroscience 4.Theoretical Neuroscience 5.Neuroinformatics Platform 6.Brain Simulation Platform 7. High-Performance Analytics and Computing Platform 8.Medical Informatics Platform 9.Neuromorphic Computing Platform 10.Neurorobotics Platform 11.Central Services 12. Ethics and Society	・EU-FET（Future and Emerging Technologies）Flagship program 112 organizations in 24 countries ・In Japan, Okinawa Institute of Science and Technology and RIKEN participate in this project.	・From 2013 to 2023 ・ $11 billion / 10 years

③ Large Japan research project『Brain/MINDS』

（Brain Mapping by Integrated Neurotechnologies for Disease Studies）

・The purpose is to map brain structures and functions at various levels and to improve the efficiency and sophistication of primate (marmoset) genetic manipulation technology and optical system technology. In addition, through these technologies, the project will elucidate the whole aspect of neural

circuits that perform higher-order functions in the brain of primates at the neuron level, and to contribute to overcome mental and neurological diseases and enhance information processing technology.

Table3. Overview of Japan『Brain/MINDS』

Research area	Participating research institution	Implementation period and Budget etc.
・Acquisition and aggregation of image data such as schizophrenia / depression / dementia / Parkinson's disease / autism ・ Comparison with human disease image data / Correspondence between differences and similarities between humans and monkeys ・ Identification of neural circuits important for human mental activity ・ Development of translatable indicators for brain behavior linked to humans ・Elucidation of the brain and neural circuit using marmoset	【Representative organization】 ・RIKEN ・Kyoto Univ. ・Keio Univ. 【Clinical Research Group】 ・The Univ. of Tokyo ・Kyoto Univ. ・Tokyo Medical and Dental University etc.	・From FY 2014 to FY 2024 ・Government budget: 3,225 million JPY （FY2019）

④ International project『Human Cell Atlas』

- The purpose is to categorize and catalog the type, state, and lineage of all human cells.
- The project aims to construct a map of human cells including cell types, 3D locations, geographical and racial differences, using a single-cell transcriptome in all major human tissues.
- Advances in measurement technology allowed this project to start. (single-cell analysis made the detailed profiling of each cell possible)

Table 4. Overview of International Project『Human Cell Atlas』

Research area	**Participating research institution**	**Implementation period and Budget etc.**
・Sample adjustment / analysis technology of Brain / Immune / Gastrointestinal (Gastrointestinal) / Skin / Tissue ・Software tools, etc.	The United States globally directs this project. ・UK EMBL-EBI, US Broad Institute, US UCSC, Genomics Institute, etc. ・In Japan, RIKEN participate.	・From 2017 ・Supported by the various public and private projects, directed by the Zuckerberg Foundation.

(3) Strengths of Japan, trends in global research community

Table5 shows how Japan currently compares with other major nations in research and technical areas that are relevant to this Working Group. In basic research Japan has established its strengths in:

- “Brain and neuroscience”

Japan is a world leader in this field. For many years Japan has carefully maintained both human resource and research resource among universities and research institutes. As a result, physiological technologies for analyzing the nervous system were developed to a high standard. Forming cross-functional research groups for integrated research was also beneficial to pursue specific areas and new academic interests. In recent years, Japan’s “marmoset (primate) brain clarification project” was internationally recognized especially for investigating functional brain molecules through sedated animal analysis. -“Optics / Imaging” and “Bioimaging”

Japan’s leadingposition is exemplified by successful development of small organic moleculebased probes for imaging – a fruit of historical strength in synthetic organic chemistry. In addition, Japan is a pioneer in the area of imaging technologies such as PET, MRI, and NMR. For example, fMRI, an important tool that directly measures the blood flow in the brain to observe brain activity, was invested in Japan.

-“Data analysis and artificial intelligence (AI) “

Regarding measurement data analysis, basic research such as medical image processing is active in Japan, but there are restrictions on the data that can be handled and the absolute number of participating researchers is

insufficient. Historically, Japan's researchers were quite active in this field making considerable contributions. However, in recent times, the amounts of financial investment in other countries have been greatly surpassing that of Japan. Consequently, at present, Japan is not in a position to claim Data analysis and AI as its strength. Strategically promoting this field is essential for the future.

Table 5. International comparison of related research and technical fields

Country, Region	Phase	Brain and neuroscience		Optics Imaging		Bioimaging		Data analysis (AI)	
		Current status	Trend	Current status	Trend	Current status	Trend	Current status	Trend
Japan	Basic research	◎	→	◎	→	◎	↘	○	↗
	Applied research	○	→	○	→	○	→	△	→
US	Basic research	◎	→	◎	↗	◎	→	◎	↗
	Applied research	◎	→	○	↗	◎	→	◎	↗
EU	Basic research	○	→	◎	→	◎	→	○	↗
	Applied research	○	→	◎	→	◎	→	○	↗
China	Basic research	△	↗	○	↗	○	↗	◎	↗
	Applied research	△	↗	△	↗	○	↗	◎	↗

（Source）Panoramic View of the Systems and Information（2019）

(Note 1) Phase

Basic research phase: Range of basic research by universities, national laboratories, etc.

Applied research/development phase: Range of technology development (including development of prototypes)

(Note 2) Current level

*Absolute evaluation, not a relative evaluation based on the current level in Japan.

◎: Particularly remarkable activities and results

○: Remarkable activities and results

△: No remarkable activities or results

×: No activities or results.

(Note 3) Trend

↗ : Upward trend → : Maintaining current level ↘ : Downward trend

【Moonshot Goal 2】
PD's Supplements

PD: Dr. SOBUE, Gen (Chairperson, Aichi Medical University)

1. Policy for Selection and Proposal content

(1) Policy for Selection

Please submit a proposal of a scenario for the set MS Goal, "Realization of ultra-early disease prediction and intervention by 2050". Including both the concept of “forecasting” that predicts the future from current society and technology, and the concept of “backcasting” that suggests what to do now considering 2050 society as a reference point, the proposal should contain an outlook for 3 years, 5 years and 10 years after PM selection, and an outlook for 2050. Please elaborate on feasibility in terms of achieving the MS Goal by 2050, implementing and adapting to society, being challenging and innovative, and integrating ELSI considerations for societal acceptance.

(2) Proposal content

As indicated in the R&D Concept, considering that disease state is formed by a breakdown of the interactive network of organs, the aim here is to enable foresight of network breakdown and the conversion of pre-symptomatic state to healthy state again for chronic diseases such as diabetes and dementia.

In order to comprehensively understand the interdependent networks of each organ, it is important to use mathematical methods such as AI. Please include in the R&D framework ‘2) approaches using mathematical data analysis techniques such as AI and mathematical modeling’ in addition to ‘1) molecular cell / biochemical / physiological approaches’. We seek proposals that focus on networks between organs, rather than focusing only on individual organs.

1) Regarding molecular cell / biochemical / physiological approaches, we are basically considering R&D to clarify the relationship between diseases and interorgan networks. Because there are various strategies to clarify the relationship, we welcome ambitious and innovative ideas not bound by existing examples. The following R&D examples are given for reference. In addition, since data acquisition and analysis related to networks between organs by using conventional data acquisition and analysis techniques alone can be difficult,

proposals that include the development of innovative technologies based on entirely new principles are also welcome. Example R&D includes:

- ✓ Elucidating the state of normal network of organs and elucidate the mechanism leading to failure and disease.
- ✓ Elucidating the relationship between physiological phenomena and organ changes and diseases.
- ✓ Elucidating the relationship between diseases using small model animals that are easier to analyze than humans, understanding the process of outbreak, development and aging as a network change between organs.

2) Regarding mathematical data analysis techniques such as AI and approaches using mathematical modeling, similar to 1) molecular cell / biochemical / physiological approaches, the contents should take into account the interdependent network structure of each organ. We are imagining R&D for extracting, integrating and analyzing big data related to networks between organs, and R&D for constructing mathematical models based on big data. Since these are data-driven R&D, they largely depend on the presence or absence of the data to be analyzed. Therefore, we would like to request research proposals that promote effective and efficient R&D based on the results of existing research or data published in large projects.

2. Policy for promoting R&D

(1) Portfolio management

Taking into account the relationship between multiple R&D projects, portfolio management requires collaboration and competition between PMs. Therefore, for the period after being selected as a PM, the milestones to be achieved 3, 5 and 10 years from the time of being selected will be made clear, and a review of the progress and budget plan shall be conducted in consultation with the PD.

(2) Whole Body Network Atlas (tentative name)

The goal is to have a comprehensive understanding of the interorgan network. In the future, we will capture the comprehensive network state between human organs, build a database (Whole Body Network Atlas (tentative name)) describing the state of the network between human organs, and utilize mathematical models, etc. We aim to develop a simulation system for predicting unstable health

conditions. The specific methodology will be considered after project selection.

(3) Industry – academia collaboration

We expect the progress of R&D to have beneficial ripple effects on the medical industries.

【Moonshot Goal 3】

R&D concept of “Realization of AI robots that autonomously learn, adapt to their environment, evolve itself in intelligence and act alongside human beings, by 2050.”

February 2020
Ministry of Education, Culture, Sports, Science and Technology

1. Moonshot Goals

Within the Moonshot Goals (decided on January 23rd, 2020, by Plenary session of Council for Science, Technology and Innovation), the Ministry of Education, Culture, Sports, Science and Technology (“MEXT”), with Japan Science and Technology Agency (“JST”) as a research and development promotion agency, will undertake research and development activities for achieving of the following Goal.

＜Moonshot Goal＞

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

- By 2050, development of AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life.
- By 2030, development of AI robots that behave well with humans under certain conditions, and allow over 90% of people to feel comfortable with them.

- By 2050, development of an automated AI robot system that aims to discover impactful scientific principles and solutions, by thinking and acting in the field of natural science
- By 2030, development of an automated AI robot system that aims to discover scientific principles and solutions for specific problems

- By 2050, development of AI robots that autonomously make judgements and act in environments where it is difficult for humans to act.
- By 2030, development of AI robots that operate unattended under human supervision in specific circumstances.

2. Direction of research and development

Based on the discussion and proposal made in the Moonshot International Symposium (held in December 17, 18, 2019), direction of research and development at present is shown as follows.

(1) Area and field to promote challenging R&D

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 lives. For that purpose, the key is to realize a robot that learns and acts on its own through co-evolution of AI and robots.

In order to realize an AI robot that learns and acts on its own, it is necessary to realize a series of cooperative actions between the AI and the robot as described below.

AI receives the sensory information, obtained by the robot through sensors, as emotion, caution, and empathy information. AI stores it as knowledge, intention, and learning. The AI performs recognition/decision/control accordingly, and outputs motion information. With this information, the robot performs the actuation.

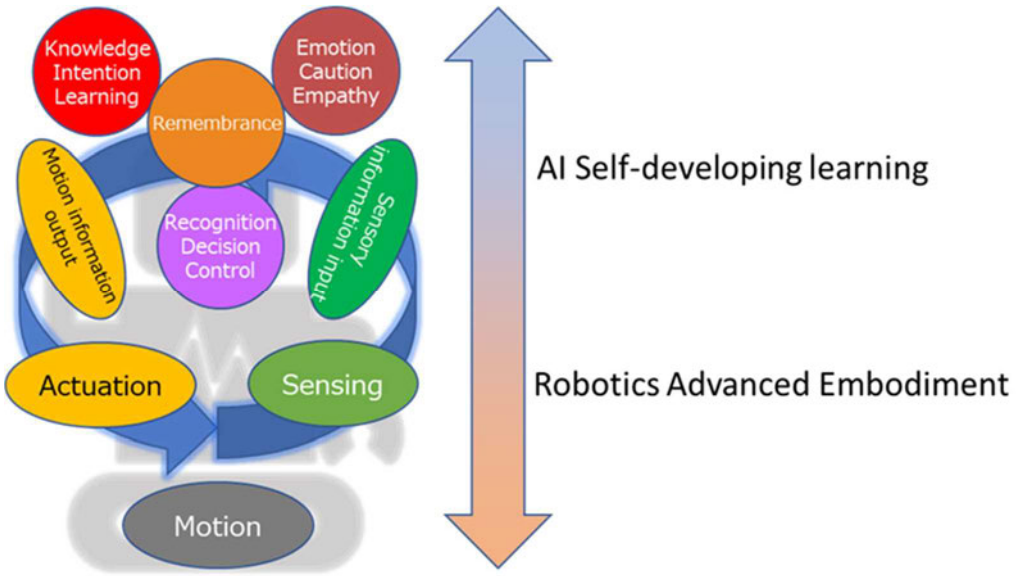


Fig.1 Concept of co-evolution AI and Robot

In order to achieve this, it is necessary to fuse and co-evolve the technological elements shown in Fig.2 while researching and developing them.

These are the fields for challenging R&D to be promoted in the Moonshot Research & Development Program.

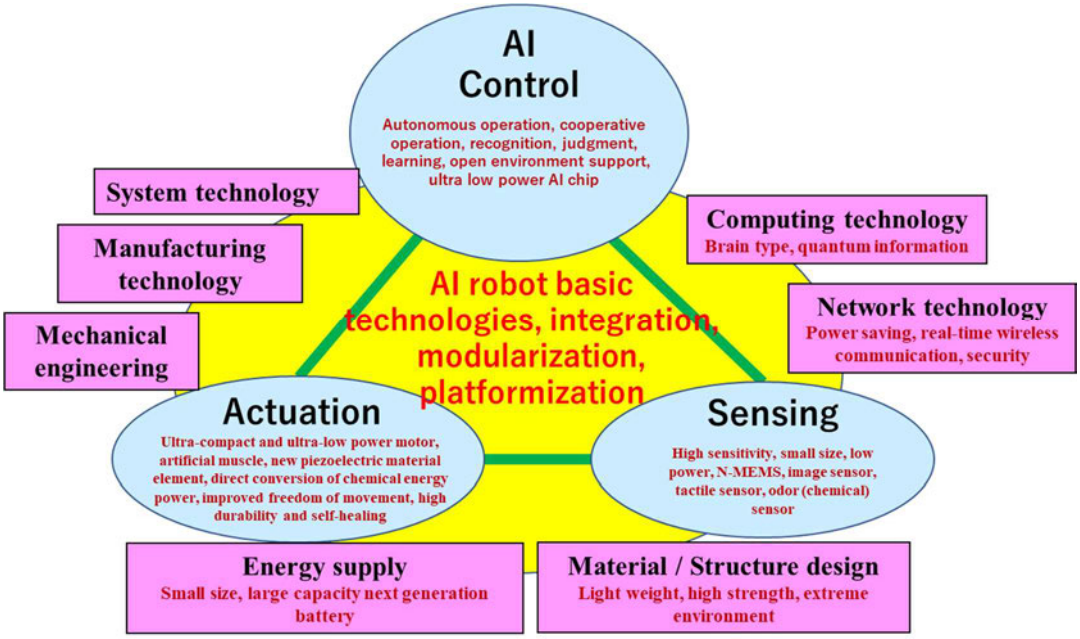


Fig.2 Main field and area of R&D that is required for Realization of a robot that can autonomously learn, adapt to the environment, evolve itself in intelligence

(2) Research subject for realization of MS Goal

The image in Fig.2 is the area and field for challenging R&D to be promoted under the Moonshot Research & Development Program. R&D that contribute to the achievement of this MS Goal ”realization of a robot can autonomously learn, adapt to the environment, evolve itself in intelligence and act with human beings” should proceed. In order to have the most effective and efficient countermeasure, the most cutting-edge scientific trends shall be researched and used for R&D.

Specifically, the following research and development will be promoted.

< [1] AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life.>

Develop AI robots that allow people to interact with them without any discomfort, that learn, act and grow on their own, provide optimal support for each individual, and improve human QOL.

< [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.>

Develop an AI robot system that autonomously discovers scientific principles and solutions by exploring and selecting from a large range of possibilities very quickly, substituting the experiments and tasks traditionally done by humans. The AI technology developed here should be used to realize AI robots [1] and [3].

< [3] AI robots that autonomously make judgements and act in environments where it is difficult for humans to act.>

Develop AI robots that work on behalf of people in places that are dangerous for human activities (space, disaster sites, high places, deep seas, etc.) or places where human resources will become insufficient in the future (construction, agriculture, forestry, fisheries, etc.).

[1] to [3] are all research and development aimed at the fusion and co-evolution of AI and robots, and research and development of basic AI and robot technology should be advanced in full cooperation.

In conducting R&D, various sources and types of knowledge and ideas will be adopted, stage gates will be established. And evaluation will be conducted to promote R&D to achieve Goal.

In addition, from the viewpoint of smoothly implementing research results in society, a system that enables researchers in various fields to participate in ethical, legal, and social issues will be considered.

(3) Direction of research and development for realization of the Goals

○ By 2030

[1] Development of AI robots that behave well with humans under certain conditions and allow over 90% of people to feel comfortable with them.

[2] Development of AI robots that autonomously and exploratively propose solutions to specific problems and aim to discover scientific principles and solutions.

[3] Development of AI robots that can autonomously operate under human supervision in specific situations, such as outer space and disaster sites, and achieve given tasks.

○ By 2050

[1] Development of AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life.

[2] Development of an automated AI robot system that aims to discover scientific principles and solutions for specific problems

[3] Development of an AI robot that can make autonomous decisions, and act and grow by itself in an environment where it is difficult for people to work.

To realize a robot that learns and acts and grows by itself by 2050, it is necessary to develop technical elements and achieve modularization and systematization through their fusion and co-evolution.

In order to achieve these speedily, and in response to the demands on robot technology and robot functions required by service sites and industries, we gather technology elements that considered promising to realize them, promote R&D on their fusion and co-evolution and build a platform to confirm functionality.

Fig. 3 shows how to proceed with R&D to achieve the Moonshot target by realizing the R&D concept.

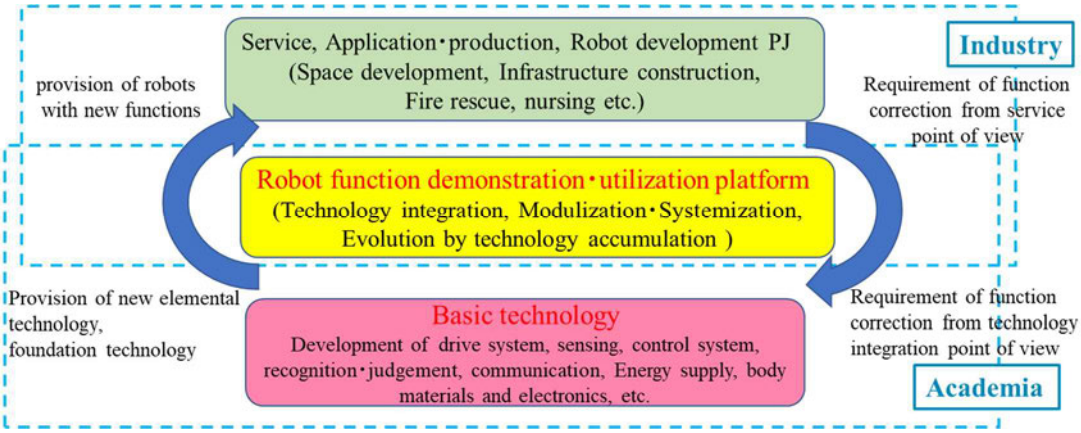


Fig.3 How to proceed with research and development to realize a robot can autonomously learn, adapt to the environment, evolve itself in intelligence

＜Reference : Analysis for realization of the Goals＞

Summary of content which is analyzed in the Initiative Report presented in Moonshot International Symposium is shown, as follows:

(1) Structure of research fields and technologies

Fig.4 shows a group of technologies related to the realization of an AI robot that learns and acts by itself.

In this Goal, it is necessary to conduct research and development of necessary technical elements and integrate and utilize them, requiring challenging R&D.

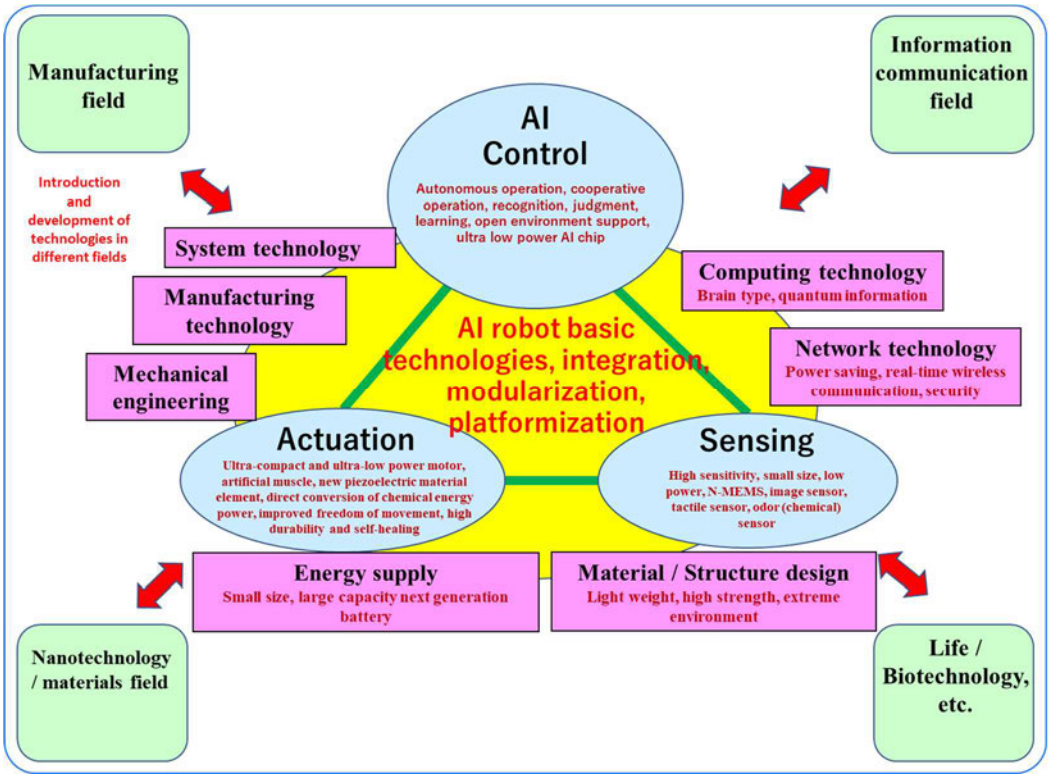


Fig.4 The structure of research fields and technologies mainly related to AI robots that learn and act on their own

(2) R&D trends in related fields

Fig. 5 shows the progress of AI technology and robot technology.

Basic concepts related to AI were proposed in the first AI boom (from the late 1950s to the 1960s), and AI was launched as a new academic field. In the second AI boom (1980s), the approach to constructing and utilizing dictionaries and rules manually became the mainstream, and expert systems, fingerprints and

character recognition, and dictionaries and rule-based natural language processing (kana-kanji conversion, etc.) were put into practical use. Currently, with the third AI boom, some tasks have been able to catch up with and outperform humans in the context of the expansion of the Internet and computing power and have begun to spread to society as various AI application systems. In addition, with the advancement and spread of sensors and Internet of Things (IoT) devices, real-world big data can be obtained in various situations. Such real-world big data collection and analysis technology is being used to precisely grasp and predict the state of phenomena and activities occurring in the real world in real time.

Beginning with industrial robots in 1962, robots have reached the level where routine work can be carried out accurately and without a break, by implementing image recognition and learning functions with the aim of realizing automation of processes in the factor. In addition, robots that imitate the exercise capacity of humans and animals also appeared, and in the 90s, research and development of not only industrial robots but also intelligent robots that work in general society and the home became active. In the 2000s, the application of robots expanded further, and surgical support robots and robot cleaners were also developed. Moreover, intelligent robots that are equipped with artificial intelligence that judge, determine, and operate their own behaviors and are expected to intelligently interact with humans as home robots made further progress in the 2010s.

The Moonshot R&D program aims to achieve the Moonshot target by 2050 by promoting R&D in the fusion and co-evolution of AI and robot technologies.

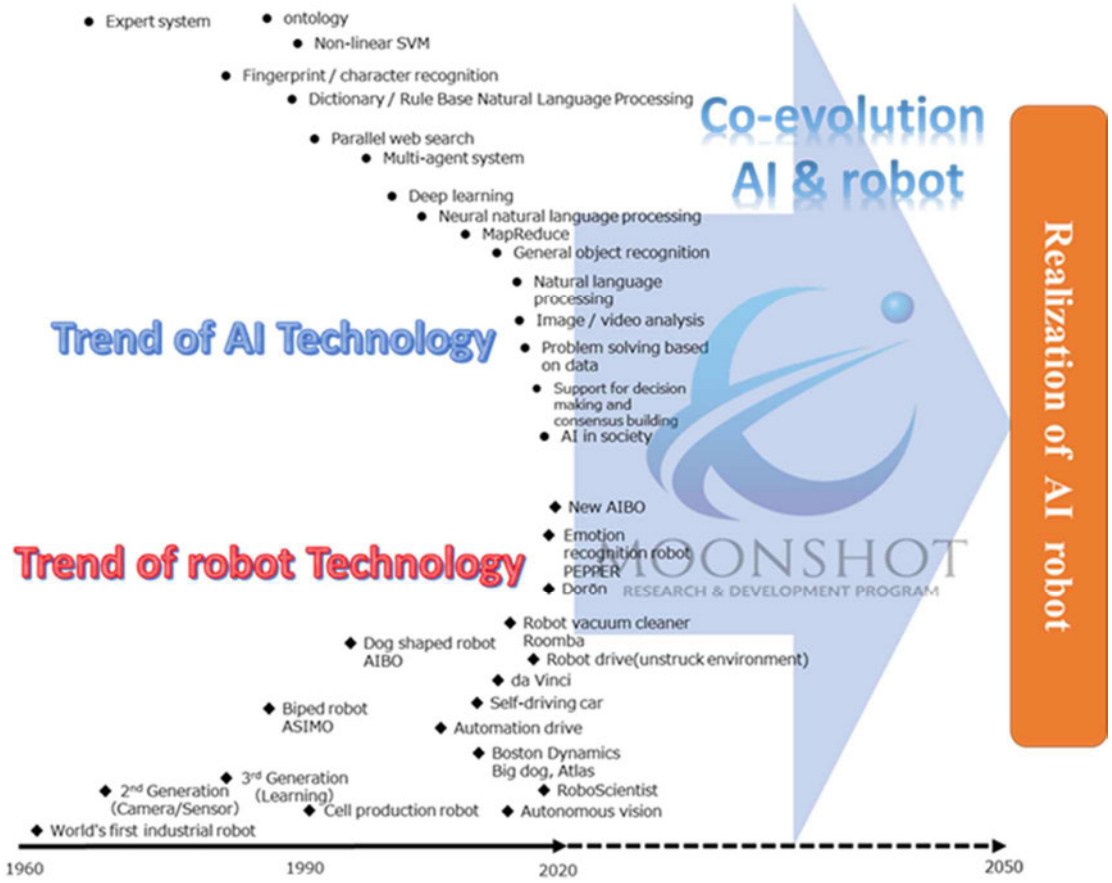


Fig.5 Technical trend related AI and robot
(Panoramic View of the Systems and Information Science and Technology Field(2019), produced by CRDS, JST)

(3) Strengths of Japan, trends in global research community

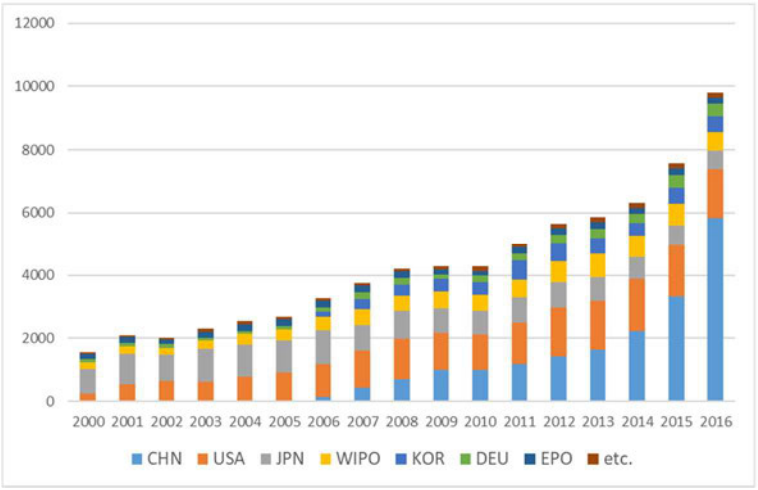
[1] Trends of patent applications and paper publications in the field of AI robot.

Fig.6 shows the number of patent applications by region including both AI and robot technologies.

The number of applications has been increasing globally since 2000. Looking at the number of applications in 2015 and 2016, the rate of increase is higher than in 2014.

Therefore, this field is attracting attention in industry

In recent years, the number of applications in Japan has decreased, but Japan has the third largest number of patent applications after China and the United States, and it is thought that Japan's industrial competitiveness is still high in this field.



RANK	Country / Institution	Number
1	CHN	18,956
2	USA	18,721
3	JPN	14,255
4	WIPO	8,022
5	KOR	4,775
6	DEU	3,398
7	EPO	3,207

Cumulative numbers from 2000 to 2016

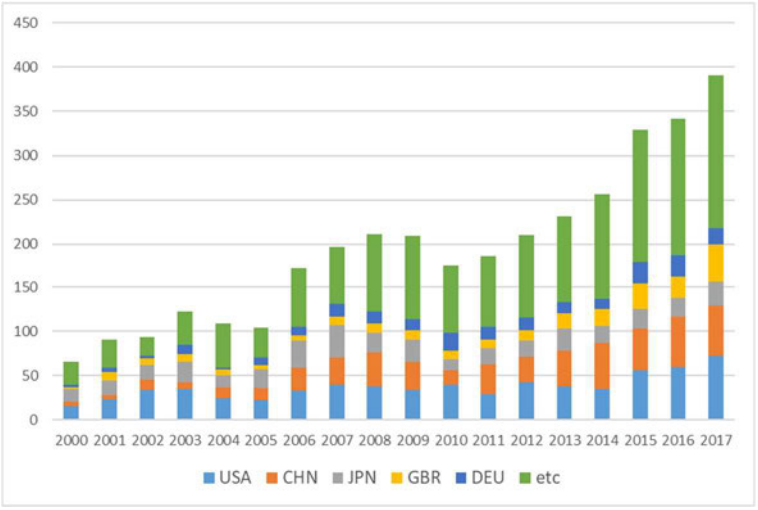
Fig.6 Number of patens by region

(Source) Created by NEDO TSC based on search results on Derwent Innovation™ (2018)

Figure 7 shows the paper publication trends that include both AI and robot technologies. Although the number of papers began decreasing from 2007, it increased again from 2010.

As with intellectual property rights, this field is one that is attracting attention in the scientific community.

The cumulative number in Japan by region is the third as well as intellectual property rights.



RANK	Country / Institution	Number
1	USA	670
2	CHN	513
3	JPN	384
4	GBR	240
5	DEU	221

Cumulative numbers from 2000 to 2017

Fig.7 Number of papers by region

(Source) Created by NEDO TSC based on search results on Web of Science™ (2018)

Both the number of papers and the number of patent applications are increasing in the field of AI robots, and it can be said that this is one of the fields that is attracting worldwide attention.

[2] International comparison of elemental technology

In the United States, it is remarkable that there is generally an advantage in both basic research and applied research and development. This seems to be because there are a large number of researchers who can receive large-scale research and development investments such as the industries centered on AI, DARPA, and NSF.

In Europe, basic research is strong albeit local. Applied research and development are weak, because there is no huge IT company like in the United States.

In recent years, China's growth has been remarkable. Investments in research and development under the Chinese government’s national policy and the domestic giant IT industry are steadily increasing capabilities in both basic research and applied research and development by sending foreign students to the United States.

On the other hand, it seems to be behind in terms of technological innovation in AI over recent years.

However, although not shown in this table, especially in the field of industrial robots and commercialization, these technologies are fine-tuned to each other to achieve their original performance, and through so-called combination technologies become overwhelmingly competitive.

Table 1 Technical trend for AI and Robot

		Sensing	Sensory information input Emotion, attention, empathy		Knowledge / Intention / Learning		Recognition / Judgment Exercise information output		control	Actuation / Power
	Phase	MEMS	Image / video analysis	Natural language processing	Machine learning	Problem solving based on data	Biological normative robotics	Support for decision making and consensus building	System technology	Robot basic technology
JP	Basic research	○→	○↗	○→	○↗	○→	△↗	○↗	◎→	○→
	Applied research and development	○→	◎→	○↗	○↗	○↗	△→	○↗	○↗	○→
US	Basic research	◎→	◎→	◎→	◎↗	◎→	△↗	◎↗	◎→	◎↗
	Applied research and development	◎↗	◎↗	◎↗	◎↗	◎↗	○↗	◎↗	◎↗	◎→
EU	Basic research	○→	◎↗	○→	○→	○→	○↗	◎↗	◎→	○→
	Applied research and development	◎↗	○↗	○→	○↗	○→	○↗	◎↗	○→	○→
CN	Basic research	○↗	○↗	◎↗	○↗	○→	△→	○↗	○↗	△→
	Applied research and development	○↗	◎↗	◎↗	◎↗	◎↗	○↗	△→	○↗	△→

(Source) Panoramic View of the Systems and Information Science and Technology Field (2019), CRDS, JST(CRDS-FY2018-FR-02)

(Note:1) phase
Basic research phase : Scope of basic research at universities and national research institutions
Applied research and development phase : Scope of technology development (including prototype development)
(Note:2) current situation
※It is an absolute evaluation, not a relative evaluation based on the current situation in Japan.
◎ :Particularly remarkable activities and results are visible、○:Remarkable activities and results are visible,
△ :I can't see any significant activities / results、×:I can't see the activity / results
(Note:3) Trend
↗ :Upward trend、 →:Maintain the status quo、 ↘:Downward trend

【Moonshot Goal 3】
PD's Supplements

PD: Dr. FUKUDA, Toshio (Professor, Meijo University)

1. Policy for Selection and Proposal content

(1) Policy for Selection

Please submit a proposal of a scenario for the set MS Goal, "Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050." Including both the concept of “forecasting” that predicts the future from current society and technology, and the concept of “backcasting” that suggests what to do now considering 2050 society as a reference point, the proposal should contain an outlook for 3 years, 5 years and 10 years after PM selection, and an outlook for 2050. Please elaborate on feasibility in terms of achieving the MS Goal by 2050, implementing and adapting to society, being challenging and innovative, and integrating ELSI considerations for societal acceptance.

(2) Proposal content

① Thoughts on co-evolution of AI and robots

As indicated in the R&D concept, our aim is to fuse AI technology and robot technology so that they can co-evolve.

For this reason, please present issues for both AI technology and robot technology and propose efficient solutions for co-evolving them.

In addition, the proposal should address the co-evolution of AI and robots from the following two viewpoints in addition to the conventional viewpoint.

[Viewpoints]

✓ (AI technology and robot technology cooperate to improve their own performance)

✓ (AI technology and robot technology self-modify their own knowledge and functions to adapt to the environment, etc.)

②Regarding the proposal.

To achieve the MS Goal, I am considering R&D subjects 1, 2, 3 as follows. Proposals can be based on one R&D subject, but I will also accept content that

spans multiple subjects. While the below points describe example achievements of each R&D subject by 2030, proposals need not be limited to this, and I would like to welcome challenging and innovative ideas. Furthermore, I hope that the generality will become wider depending on the time, such as 2030, 2040, and 2050. As indicated in the R&D concept, the AI technology developed in subject 2) should be used to realize AI robots in subject 1) and 3).

1) AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life.

[Example accomplishments.]

In a specially prepared environment (without auxiliary sensors, markers, etc.), an AI robot that will be able to serve customers while communicating with people in stores, for example, will be realized. Based on information obtained from the five-sensory sensors equipped on the robot, we will achieve a technology that can learn and memorize human behavior patterns and understand human gestures and the meaning of facial expressions by image processing. By performing AI processing on this information, in a given environment, the created AI robot will intelligently interact and perform conversations and actions that do not cause feelings of unease in its human partner. By 2050, AI robots will be able to “grow” by advancing their knowledge structures to the next level through intelligent interaction with the environment and humans.

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.

[Example accomplishments.]

In the future, in a wide range of fields from natural sciences to humanities to social sciences, AI robots will intelligently construct their own experiments (planning) and autonomously perform a small number of experiments (trials) to find laws and rules (evaluation). In the process of developing, we will realize an AI robot that can discover scientific principles and solutions for specific problems given by humans (such as the development of new drugs and materials) by 2030.

(A) The AI robot formulates a hypothesis and an experiment plan for verification from a vast amount of past papers and experimental data. (B) A human constructs a complex experimental system according to the experimental plan, and the AI robot performs a simplified experiment (preferably, the AI robot also constructs the experimental system). (C) We obtain and analyze

experimental results, verify hypotheses, and establish further hypotheses.

By repeating the loop from (A) to (C) above, the AI robot does not simply support the ‘parameter search’ of the experiment, but also constructs and interprets the experiment and model itself, and has the intellectual capacity to continue the experiment and identify the ‘structure of the issue’ to solve the problem efficiently.

3) AI robots that autonomously make judgements and act in environments where it is difficult for humans to act.

[Example accomplishments.]

The development of AI robots that, on level ground and in calm conditions where weather and other factors do not change suddenly, autonomously perform construction work, agricultural work, logging work, or work in outer space that is difficult to remotely control. By 2050, the AI robots intelligently interact with the environment and other robots and humans to advance their knowledge structures to a higher level and quickly and safely plan and execute work in a dynamic environment. By 2030, the AI robots will decide their behavior by judging their surroundings and accurately predicting what will happen as a result of their motion. Instead of simple automation, multiple units cooperate to learn how to work. Through this learning, we will realize AI technology that can configure more efficient work procedures by itself.

2. Policy for promoting R&D

(1) Portfolio management

Taking into account the relationship between multiple R&D projects, portfolio management requires collaboration and competition between PMs. Therefore, for the period after being selected as a PM, the milestones to be achieved 3, 5 and 10 years from the time of being selected will be made clear, and a review of the progress and budget plan shall be conducted in consultation with the PD.

(2) International collaboration

In order to develop AI robots efficiently and promptly, I hope to keep consistent track of R&D trends in Japan and overseas, and if necessary conduct active R&D cooperation with overseas organizations.

(3) Industry – academia collaboration

We expect the progress of R&D to have beneficial ripple effects on industry. For this reason, we expect to build a cooperative system that will encourage the participation of industry groups in R&D projects.

(4) ELSI (Ethical, Legal, and Social Issues)

In the next 30 years until 2050, we expect the structure of society to change significantly. To ensure societal acceptance, some development issues may need to be handled delicately. We therefore encourage the participation of researchers investigating ethical, legal, and social issues related to AI technology, including robot technology.

(5) Collaboration and/or competition with other MS Goals and projects

Regarding AI technology and robot technology, there may be common R&D issues with other MS Goals. In this case, collaboration and competition with other R&D projects may be encouraged during the program.

【Moonshot Goal 6】

R&D concept of “Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.”

February 2020
Ministry of Education, Culture, Sports, Science and Technology

1. Moonshot Goals

Within the Moonshot Goals (decided on January 23rd, 2020, by Plenary session of Council for Science, Technology and Innovation), the Ministry of Education, Culture, Sports, Science and Technology (“MEXT”), with Japan Science and Technology Agency (“JST”) as a research and development promotion agency, will undertake research and development activities for achieving of the following Goal.

＜Moonshot Goal＞

“Realization of a fault-tolerant universal quantum computer [1] that will revolutionize economy, industry, and security by 2050.”

・Achieve the large-scale integration required for fault-tolerant universal quantum computers by 2050.

・Develop a certain scale of NISQ computer[2] and demonstrate the effectiveness of quantum error correction by 2030.

2. Direction of research and development

Based on the discussion and proposal made in the Moonshot International Symposium (held in December 17, 18, 2019), direction of research and development at present is shown as follows.

[1] In this plan, “fault-tolerant universal quantum computer” refers to a general-purpose digital quantum computer with a capability of converting any quantum state to a desired state (universal) with a guarantee on sufficiently high accuracy (fault-tolerant) that can be used in various applications.

[2] The NISQ (Noisy-Intermediate Scale Quantum) computer is a small- to medium-scale quantum computer without an error correction function.

(1) Area and field to promote challenging R&D

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 various information processing demands for the realization of Society 5.0. The key is to realize a fault-tolerant universal quantum computer that will revolutionize our economy, industry, and security.

In order to realize a fault-tolerant universal quantum computer, it is necessary to promote research and development of hardware, software, networks, and related quantum technologies shown in FIG. 1 widely and to integrate them appropriately. These are the areas and fields for challenging R&D to be promoted in Moonshot Research & Development Program.

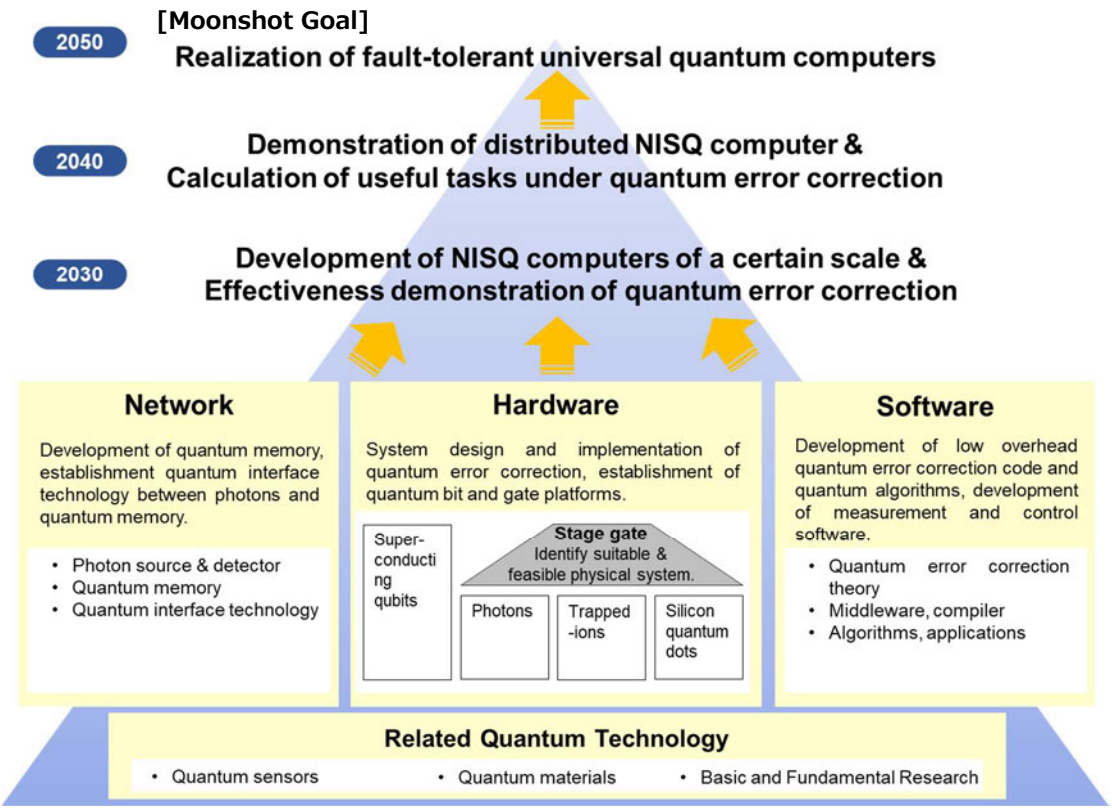


Fig. 1 Main fields and areas of R&D that is required for Realization of a fault-tolerant universal quantum computer

(2) Research subject for realization of MS Goal

The image in Fig.1 is the area and field for challenging R&D to be promoted under the Moonshot Research & Development Program. R&D that contribute to the achievement of this MS goal ”realization of a society in which human beings can be free from limitations of body, brain, space, and time” should proceed. In order to have the most effective and efficient countermeasure, the most cutting edge scientific trends shall be researched and used for R&D.

Specifically, we will conduct R&D on hardware such as a qubit / quantum gate infrastructure, software such as that for quantum error correction theory, and networks such as quantum interfaces.

Regarding R&D on hardware, along with the superconducting qubit method, we will proceed with R&D in parallel on multiple promising methods including optical qubits, ion traps, semiconductor qubits, etc. At an appropriate time, such as at a stage gate, we will determine the most suitable method from the viewpoint of feasibility and possibility of upscaling.

In conducting R&D, various sources and types of knowledge and ideas will be adopted, stage gates will be established. And evaluation will be conducted to promote R&D to achieve Goal.

In addition, from the viewpoint of smoothly implementing research results in society, a system that enables researchers in various fields to participate in ethical, legal, and social issues will be considered.

(3) Direction of research and development for realization of the Goals

○ By 2030

・Develop a certain scale of NISQ computer and demonstrate the effectiveness of quantum error correction.

○ By 2050

・Achieve the large-scale integration required for fault-tolerant universal quantum computers.

To realize a fault-tolerant universal quantum computer by 2050, we will first develop a certain scale of NISQ computer and demonstrate the effectiveness of quantum error correction. On top of that, it is necessary to demonstrate a distributed processing type NISQ computer and calculate useful tasks under quantum error correction, and work on a large scale. Thus, the target by 2030 is

to develop a certain scale of NISQ computer and effectively demonstrate quantum error correction. Fig. 2 shows how to proceed with R&D to achieve the Moonshot target by realizing the R&D concept.

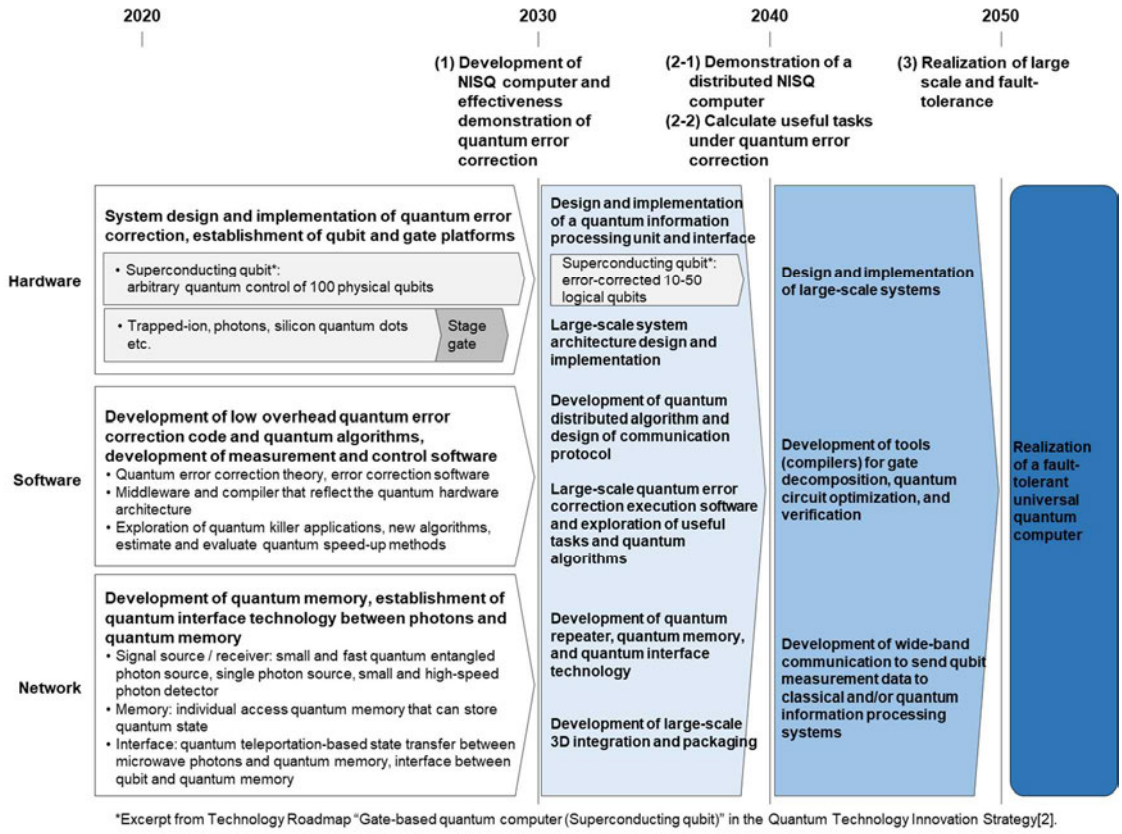


Fig. 2 The R&D process toward the realization of a fault-tolerant universal quantum computer

＜Reference : Analysis for realization of the Goals＞

Summary of content which is analyzed in the Initiative Report presented in Moonshot International Symposium is shown, as follows:

(1) Structure of research fields and technologies

The quantum computer is a representative example of quantum technology that manipulates, controls, and utilizes quantum mechanical properties such as quantum coherence and quantum entanglement.

Figure 3 presents a panoramic view of quantum technology. This includes the four main areas: quantum computing and simulation, quantum measurement and sensing, quantum cryptography and communication, and quantum materials, as well as the areas of common principles and common tools that deepen and enable them, and common quantum technology platforms that include new scientific discoveries and new technologies that will become the seeds for new quantum science and technology developments that cannot be covered by the above areas alone.

In developing a fault-tolerant universal quantum computer, in addition to the above, it is necessary to combine various technical elements such as materials, microwave technology, process technology, design, and peripheral circuit technology developed for semiconductor integrated circuits and so, challenging R&D is required.

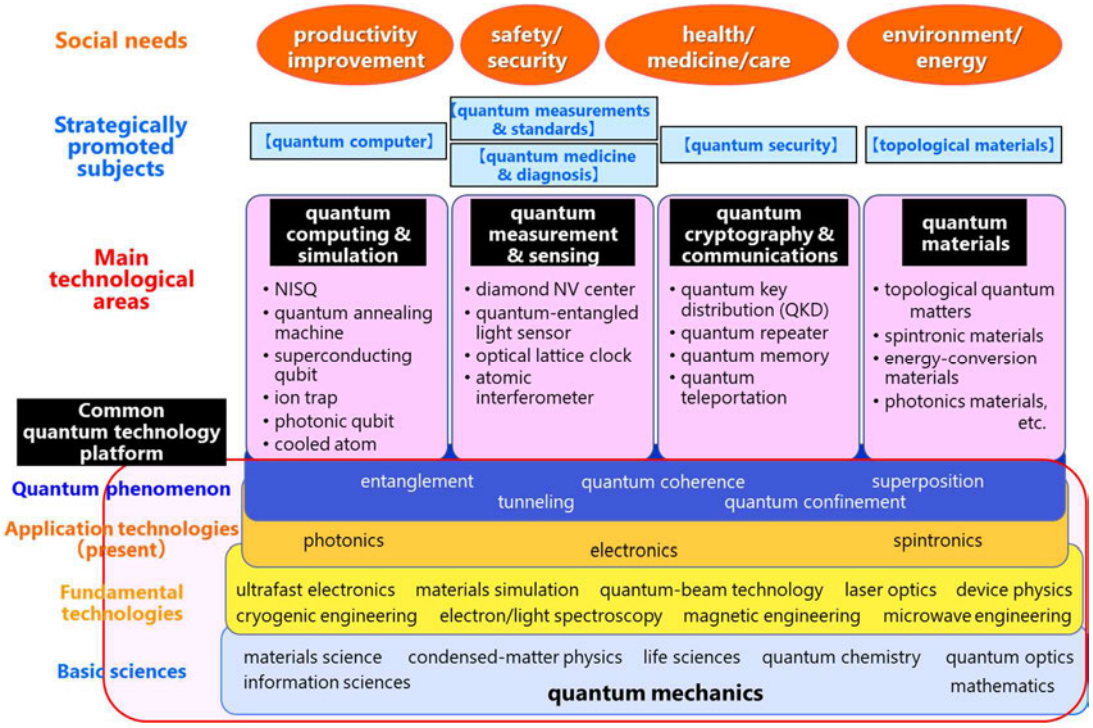


Fig. 3 The structure of research fields and technologies mainly related to a fault-tolerant universal quantum computer

(Source) Japan Science and Technology Agency, Center for Research and Development Strategy, “(Strategic Proposal) Quantum 2.0 ~Towards new horizons of quantum applications ~”, CRDS-FY2019-SP-03, 2019. *(in Japanese)*

(2) R&D trends in related fields①Patent Map

The similarity of 4,088 related patents was evaluated using topic models and mapped on a two-dimensional plane by applying manifold learning (Fig. 4) to assess the development status of quantum technology to date. Based on the similarity of the patent documents, 30 clusters are indicated by dotted lines, and "quantum computer," "quantum bit and gate," "quantum communication and cryptography," and "quantum device" are identified as additional global structures.

The “quantum computer” category includes 173 patents and clusters for “quantum information processing unit” and “superconducting quantum computers.” The “quantum bit and gate” category also includes patents for quantum computer applications.

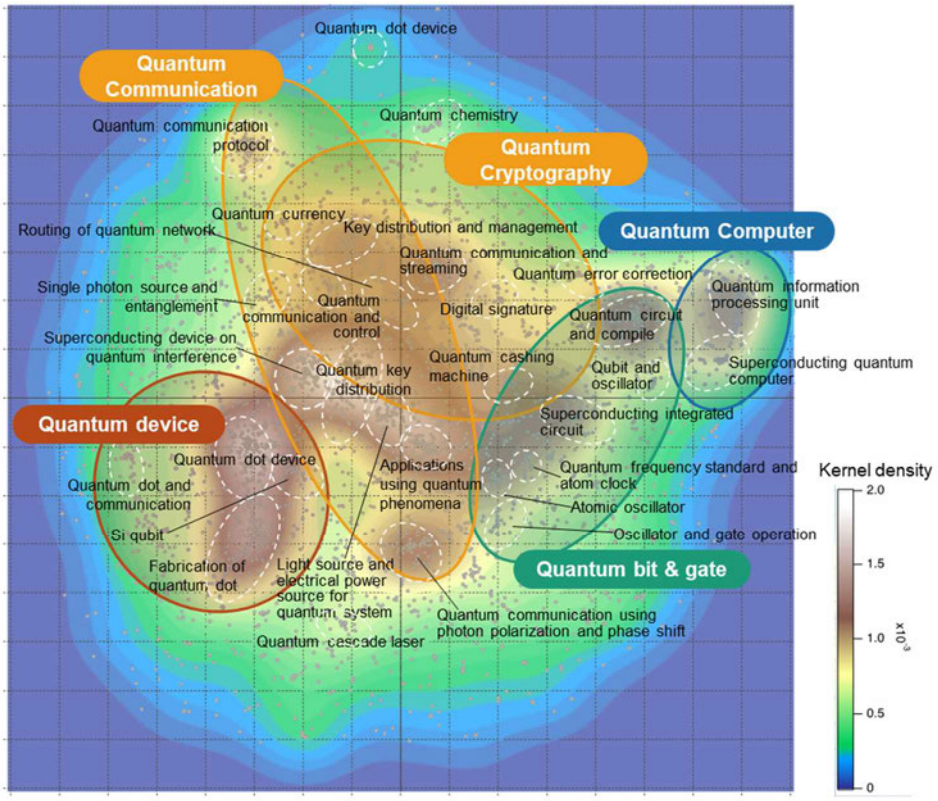


Fig. 4 Patent map related to quantum technology (kernel probability density estimation)

(Source) Japan Science and Technology Agency, Center for Research and Development Strategy, "(Research Report) Quantum technology 2.0 in the world patent map", CRDS-FY2018-RR-04, 2019. *(in Japanese)*

In Fig. 5, the 29 years from 1990 to 2018 are divided into six periods, and the number of patents applied for within each period is plotted by technology area.

Although the 2015 to 2018 timeframe is shorter compared to other the periods mentioned, this period represents the highest number of patents in all technology categories.

In particular, very active patent/publication activities are observed in the "Quantum communication and cryptography" category in the patent map, represented by the "Quantum key distribution" area. Multiple patents have also been pursued in the "Quantum computer" category, such as "Quantum information processing unit," "Quantum circuit and compiler," and "Superconducting integrated circuits."

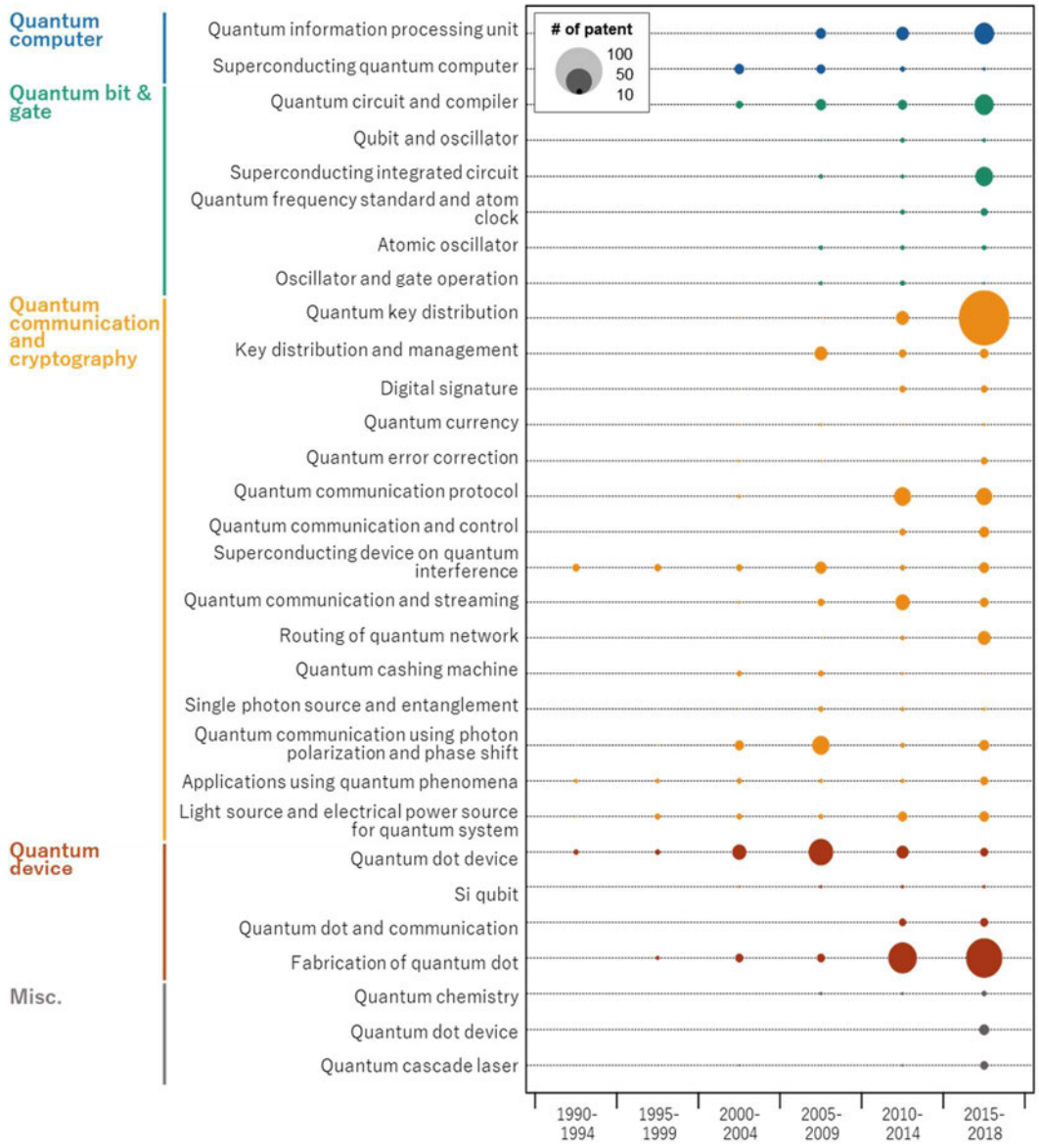


Fig. 6 Trends in the number of patents related to quantum technology

(Source) Japan Science and Technology Agency, Center for Research and Development Strategy, "(Research Report) Quantum technology 2.0 in the world patent map", CRDS-FY2018-RR-04, 2019. *(in Japanese)*

② Trend in the number of academic papers

The macroscopic trends of papers related to quantum technology were investigated using the Scopus database.

Papers/proceedings/reviews that contain "quantum computer," "quantum communication," "quantum sensor" or "quantum sensing," and "quantum

simulation” or “quantum simulator” in the title, abstract, or keywords were extracted and the annual changes in the number of publications are shown in Fig. 6.

The results indicate that the activities of the quantum technology research community have become more dynamic around the globe. In particular, papers on quantum computers began to increase in 1994, and inflection points are observed in 1999 and 2010, where the rate of increase in the number of documents changed noticeably. The publication of superconducting qubits by Nakamura and Tsai et al. appeared in 1999, and papers on superconducting qubits began to increase from this year forward.

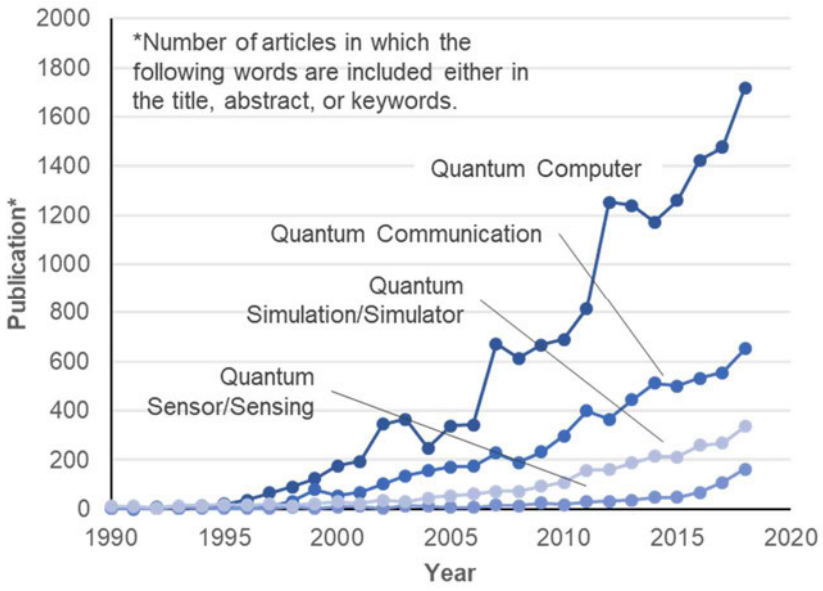


Fig. 6 Trends in the number of quantum technology-related papers

Furthermore, within documents containing “quantum computer” as the general category, documents that explicitly contain terms related to computer science (algorithm, software, compiler, programming, architecture, instruction, device, and network) were extracted and the annual trends are shown in Fig. 7. From the viewpoint of hardware and software, as compared to “device” and “algorithm,” there are relatively few papers on “software” and “compiler,” which are essential for computers. As a whole, the publishing trend is one of increase; in particular, the increase in the slope beginning in 2010 is a behavior common to many technology categories.

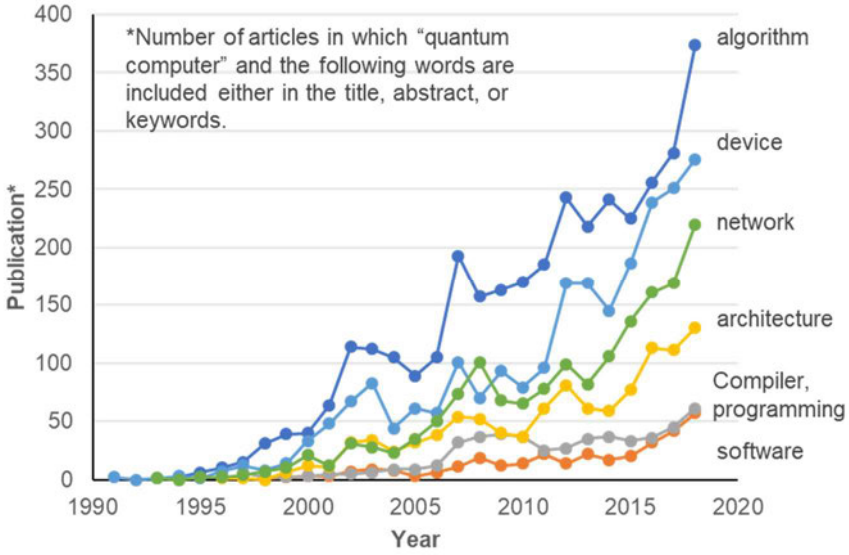


Fig. 7 Trends in the number of quantum computer-related papers

③ Trend in the number of qubits

The annual trends of qubits numbers and presenters published from 2014 to date are plotted in Fig. 8. The main focus of the current quantum computer research and development community is the implementation of quantum error correction codes and the realization of medium-scale quantum computers. There are also efforts to use NISQ computers, which have become feasible in terms of hardware, for some computational tasks, such as the demonstration of quantum supremacy (generally more than 50 qubits and the accuracy of the gate error rate must be less than 0.1%) and quantum/classical hybrid algorithm trials. Overall, the effectiveness of quantum error correction code verification and the execution of computational tasks represent an important milestone leading to the ultimate goal of fault-tolerant universal quantum computers.

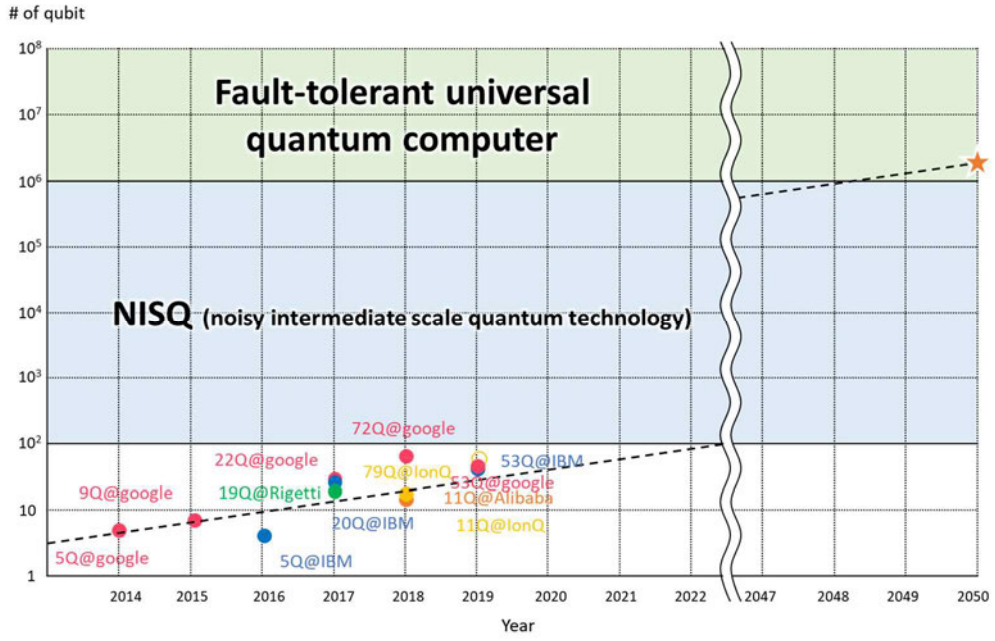


Fig. 8 Quantum version of Moore's Law

(3) Strengths of Japan, trends in global research community

In carrying out research and development, in order to collaborate and share roles with overseas research institutions, it is important to promote specific cooperation with countries and regions such as the United States and Europe that have high levels of research dedicated to quantum technology, taking account of Japan's strengths, competitiveness, and the pros and cons of international R & D collaboration. Therefore, the effort status regarding domestic and international research and development of hardware, software, and networks in Japan and overseas is summarized as follows.

①Hardware

Overseas, led mainly by global IT companies and universities, the United States is strong in both hardware and software, and research and development of superconducting qubits and trapped ions is in progress by multiple teams. China is following the superconducting qubits method within industry, academia, and the government, and development competition is intensifying. Overall, quantum gates have been realized overseas in all qubit implementation methods.

As for domestic efforts regarding superconducting qubits, Japan was the first country in the world to conduct a successful experiment (in 1999) involving controllable qubits [17], and although the research studies are led by world-class researchers, it is necessary to overcome engineering issues to achieve multi-qubits, including the associated design and architecture, such as miniaturization of qubits, wiring, and elimination of irregularities in bit accuracy. Regarding trapped ion qubits, the number of researchers in Japan is very small; therefore, it is particularly important to develop and secure researchers to focus on this area. At the same time, it is recognized that basic research such as the establishment of a qubit control method based on an understanding of many-body physics is also necessary. With regard to photons, research aims at a universal photon quantum computer that enables error correction by generating large, stable qubit entanglement in a looped optical circuit at room temperature. The silicon quantum dot system is well-matched to conventional CMOS circuit technology and is expected to be compatible with the existing, abundant CMOS technology platforms toward the development of quantum computers. The implementation of high-fidelity 2-qubit gates is one of the key research areas currently in progress.

② Software

In the United States, both software and hardware development has been promoted, mainly in universities and global IT companies. A project supported by the US National Science Foundation has begun research on practical-scale quantum computer systems and trapped ion architectures. Various IT companies have released quantum software development platforms and have expanded their open source software libraries. Furthermore, Europe announced the Quantum Software Manifesto in 2017, and is conducting integrated research on hardware and on quantum software, developing quantum software and algorithms, as well as developing new communication protocols.

In Japan, research on quantum information theory and algorithm is being carried out at universities and national research institutes. Quantum computer emulators have been developed by universities and start-up companies and have been publicly released and are available for use. Furthermore, having entered into user license agreements with hardware development companies, start-up companies are working on software development and consultation, aimed toward social implementation. Although the number of domestic researchers and engineers is not enough, there are excellent Japanese researchers with a high international

reputation, have research achievements such as a fault-tolerant theory.

③ Networks

Overseas, research and development related to quantum networks has been carried out, such as establishing the Quantum Internet Alliance in Europe and systematically conducting experiments on inter-city quantum communication. China also succeeded in satellite-to-ground QKD experiments using artificial satellites.

In Japan, the Tokyo QKD Network, a test bed with a total length of approximately 100 km, was built in 2013, and its operation and evaluation are ongoing to lead the world in integration with distributed storage, etc. A Japanese research team has succeeded in an experiment to generate entanglement between cooled atomic quantum memory and a communication wavelength photon for the first time, which has received worldwide attention. A single photon source using a diamond NV center or the like, for which Japan has high fabrication capabilities, has also attracted attention. As a basic technology for quantum repeaters, successful transfer of information has been achieved without the possibility of eavesdropping while maintaining the quantum states of photons using carbon isotopes in diamond as the quantum memory and applying the principle of quantum teleportation. In addition, a demonstration experiment of an all-photonic quantum relay has succeeded for the first time in the world.

【Moonshot Goal 6】
PD's Supplements

PD: Dr. KITAGAWA, Masahiro (Professor, Institute for Open and Transdisciplinary Research Initiatives, Osaka University)

1. Policy for Selection and Content of Proposal

(1) Policy for Selection

Please submit a proposal of a scenario for the set MS Goal, “Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050". Including both the concept of “forecasting” that predicts the future from current society and technology, and the concept of “backcasting” that suggests what to do now considering 2050 society as a reference point, the proposal should contain an outlook for 3 years, 5 years and 10 years after PM selection, and an outlook for 2050. Please elaborate on feasibility in terms of achieving the MS Goal by 2050, implementing and adapting to society, being challenging and innovative, and integrating ELSI considerations for societal acceptance.

(2) Proposal content

In order to realize the MS Goal’s fault-tolerant universal quantum computer, we think it necessary to integrate a huge number of qubits, provide redundancy using quantum error correction codes, and reduce the quantum error to below the fault-tolerant threshold.

Therefore, as shown in the R&D concept, as a 2030 milestone we aim to develop a certain scale of quantum computer and demonstrate the effectiveness of quantum error correction. We assume that 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 on ‘2) communication networks’ and ‘3) theory and software’ to work together to determine the feasibility of multiple promising 1) ‘hardware’ R&D projects, and conduct R&D to achieve the MS Goal.

Therefore, please make an R&D project proposal in any of the categories 1) to 3) as follows.

1) Hardware

We call for multiple R&D projects based on different physical systems as promising hardware for realizing a fault-tolerant universal quantum computer.

2) Communication network

We call for a R&D project for a quantum communication network required to realize a distributed large-scale quantum computer by quantumly combining hardware of a quantum computer that is not necessarily a large-scale one.

3) Theory and software

We call for a R&D project on theory and software for realizing a fault-tolerant universal quantum computer.

Milestones aimed to be achieved at 3 years, 5 years and 10 years from the time of PM adoption can be set in the category of hardware, communication networks, or theory and software. However, in the proposal please reflect on what developments you expect from the other categories, and how your research will contribute to realizing a fault-tolerant universal quantum computer by 2050.

2. Policy for promoting R&D

(1) Portfolio management

Taking into account the relationship between multiple R&D projects, portfolio management requires collaboration and competition between PMs. Therefore, for the period after being selected as a PM, the milestones to be achieved 3, 5 and 10 years from the time of being selected will be made clear, and a review of the progress and budget plan shall be conducted in consultation with the PD.

In particular, during the elaboration period of each R&D project, each R&D project in the three categories described in section 1.(2) will cooperate with each other to coordinate R&D project plans so that R&D can make steady progress to achieve the MS Goal. During the implementation of R&D projects, please carry out R&D in close cooperation with each other.

R&D will be conducted effectively toward the realization of a fault-tolerant universal quantum computer by promoting complementary R&D, while taking into full account of the results of related domestic major R&D projects such as the Optical and Quantum Leap Flagship Program (Q-LEAP).

(2) Industry – academia collaboration

To realize a fault-tolerant universal quantum computer, I think that it is also

necessary to combine various technological elements from materials, microwaves, optics, processes cultivated in semiconductor integrated circuits, design, packaging, and peripheral circuits. Therefore, we welcome proposals that from the early stages of R&D work closely with private companies that possess these kinds of technologies, know-how and human resources.

(3) Development of human resources in science and technology

In order to achieve the goal "Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050", it is essential from now on to build a long-term vision and increase the number of human resources. Therefore, in addition to promoting R&D, we call for active contributions to human resource development.

Provisional translation

February 4, 2020
Director General for Science, Technology and Innovation Policy, Cabinet Office
Director General, Science and Technology Policy Bureau, MEXT
Director General, Industrial Science and Technology Policy and Environment Bureau, METI

Guidelines for Operation and Evaluation of the Moonshot R&D Program

1. Program Features

○ The government presents ambitious goals, Moonshot Goals (hereinafter referred to as MS Goals), which attract people, and R&D concepts, from the perspective of looking toward a future society, and solving domestic and overseas social issues that will arise.

○ Challenging R&D concepts by being based more on bold ideas that will not just be extensions of conventional technology, and which are promoted by maximizing knowledge and ideas in the basic research phase.

○ To achieve the MS Goals, multiple project managers (hereinafter referred to as PMs) are, in principle, selected under respective MS Goals, and a program director (hereinafter referred to as the PD) is appointed to direct and supervise, in a unified manner, the program that is comprised of multiple R&D projects (hereinafter referred to as projects) that PMs promote.

○ Authority for promoting the project is granted to PMs. Flexible management is promoted under the direction of each PM, while bringing together the wisdom of researchers from all over the world.

○ The PD drafts a portfolio (the management plan that summarizes the project components (combination) and resource allocation, etc., (hereinafter referred to as portfolio) to strategically achieve the MS Goals, and the research promotion agencies (funding agencies, hereinafter referred to as FAs) make a final decision on the portfolio based on this. The PMs apply diverse knowledge and ideas in the basic research phase, undertake challenging research without fear of failure, and discover and foster innovative research results.

○ While utilizing the benefits of the multiple-year funding system and repeatedly restructuring the portfolio, we implement R&D that allows for support for up to 10 years from the start of the research.

○ As well as always sharing relevant domestic and overseas R&D trends, we establish the most advanced research support system through which researchers can challenge leading-edge research through cooperation.

○ To promote the use of research data[1] generated through research activities and to support advanced research management, we pursue advanced data management, by means such as proactively utilizing the Research Data Infrastructure System (NII Research Data Cloud)[2].

○ Looking ahead to practical use of the R&D results in society in the future, we actively encourage utilization of the R&D results and examine the open and close strategy involving industry from the R&D phase.

2. Determination of the Moonshot Goals and Formulation of the R&D Concept

○ The Visionary Council consisting of experts was established to discuss drafted MS Goals, from the perspectives of looking toward a future society and solving domestic and overseas social issues that will arise.

○ The Council for Science, Technology and Innovation (hereinafter referred to as CSTI) determines the MS Goals in light of advice from the Visionary Council. When MS Goals are determined, we make sure to establish a research support system to maximize ideas and knowledge from researchers.

○ Relevant ministries and agencies formulate the R&D concept (hereinafter referred to as the concept) to achieve the MS Goals. Consideration is given to incorporating ideas for achieving the MS Goals and international strategy perspective.

○ According to changes in the social environment and advances in science and technology, if deemed necessary, CSTI adds and/or changes the MS Goals after evaluating their technical feasibility and listening to domestic and overseas opinions.

3. The R&D Promotion System

[CSTI/CSTI Members]

○ CSTI determines the MS Goals.

○ CSTI members receive a report on the progress of R&D every year from the Strategy Council (tentative name), and advise on the promotion of this entire program from a broad perspective.

[Strategy Council] (tentative name)

○ A Strategy Council (tentative name) comprised of people from industry, relevant ministries and offices, and researchers, is established to strategically promote R&D, to accelerate the practical use of the R&D results in society, and to achieve effective cooperation and coordination among the relevant ministries/offices and the relevant FAs.

○ The duties of the Strategy Council (tentative name) are listed below:

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[1]Research data means data generated in the R&D process, which is manageable in an electromagnetic form. (Source: the Cabinet Office Report, “Research data infrastructure development and international cooperation working group” October 2019)

[2]The NII Research Data Cloud is being developed for full-fledged operation during FY2020 as a research data infrastructure system to promote research data management, disclosure, and retrieval based on the Integrated Innovation Strategy 2019 (the Cabinet approval in June 2019).

1) Receive a report of progress and other matters from the relevant FAs every year in principle, and give advice and approval on the concept of project components and fund allocation, etc., from a global and comprehensive perspective to achieve the MS Goals.
2) Advise on the ways and means for the practical use of the R&D results in society. This involves bridging the gap between the R&D and practical use in society, collaborating with the private sector, and attracting well-timed private investment based on role-sharing at the different stages of R&D activities between the public and private sectors. Also provide support for the practical use of the R&D results in society. In addition, give advice to promote international cooperation.

○ Progress reports and the minutes of meetings of the Strategy Council (tentative name) are, in principle, disclosed to give maximum consideration to the transparency of the program's operation and accountability.

[Relevant Ministries and Agencies]

○ The relevant ministries and agencies formulate the concept with the aim of achieving the MS Goals, and strategically and collectively promote related R&D, cooperating with other ministries and offices.

[FAs]

○ FAs are responsible for realizing the concept that achieves the MS Goals.

○ The duties of FAs are listed below:

1) Appoint a PD who is deemed qualified for each MS Goal, then manage and supervise them. One or more sub-PDs who assist the PD may be appointed, as necessary.
2) After discussions with the PD, openly recruit and select, in principle, more than one PM.
3) Determine a portfolio based on the PD`s draft.
4) Instruct the PMs to draw up a project plan under the direction of the PD.
5) Collect and analyze information on domestic and overseas R&D trends and the challenges for the practical use of the R&D results in society, with incorporating the opinions of outside experts, including researchers in humanities and social sciences.
6) Hear from the PD and PMs about the status of the project's progress, the resource allocation and the role-sharing between the public and private sectors, according to the progress of the R&D, and report the details to the Strategy Council (tentative name) every year.
7) Provide support for the management of intellectual property, international standardization, public relations, and technical trends surveys, so that the PD and PMs can properly manage these. In addition, identify a promising project (or a part of the project) in an early stage from the perspective of the practical use of its R&D results in society, and ensure that support from specialists can be acquired as necessary so that the capability to identify a project that will be practically used in society in the future can be effectively demonstrated. To gain public understanding and support, help the PD and PMs to smoothly conduct bi-directional communication activities (public dialogue on science and technology) through which they can explain to society their research activities.
8) Since crosscutting support such as ELSI (Ethical, Legal and Social Issues) /mathematical science is also important for R&D acceleration and its practical use in society, provide an opportunity for the PD and crosscutting researchers to exchange their opinions, and establish a system through which a PM can acquire the support of crosscutting researcher(s), if the PD deems it necessary, and if the PM requires it.
9) Promptly appoint a new PD when an accident occurs or a vacancy arises, or when it is deemed that the PD is not fulfilling their duties.

10) Decide the details of PDs', sub-PDs', and PMs' working conditions.
11) Construct an environment in which young researchers with bold and flexible ideas, who will define future society, can actively participate in a project.
12) The relevant FAs cooperate and share related domestic and overseas R&D trends to build the most advanced research support system.
13) To pursue advanced data management, manage a data catalogue comprised of metadata[3] submitted by PMs and researchers by utilizing system such as the Research Data Infrastructure System.

○ When performing these duties, FAs strive to create an environment in which researchers can focus on research by improving the efficiency of evaluation work, as well as continue their efforts in cooperation with the relevant ministries and offices, and other research promotion organizations. Also FAs utilize advanced data management to ensure fairness of research, and engage in efforts to prevent a contractor from committing a wrongful act and misapplying research funding.

[PD]

○ The terms of the PD and sub-PD are, in principle, five years, and they may also be reappointed.

○ Any nationality is welcome to be the PD, but the PD is principally based in Japan after being appointed.

○ The duties of the PD are listed below:

1) To realize the concept and achieve the MS Goals, strategically build a draft of portfolio, and promote R&D in a challenging and systematic way.
2) When building a draft of portfolio, in principle, combine multiple projects that take different research approaches by taking into account their R&D innovation and originality, and future economic and social ripple effects, since the chance of success (or failure) and their research results (return) will vary according to their respective research approaches, even among the research projects that aim for the same goal. For example, let's assume there is a project through which significant research results can be achieved, but with a limited chance of success, while there is another project through which a certain level of research results can be achieved with a high chance of success. In such case, funds will be allocated by comprehensively considering the chance of success and research results. In the case of a project that requires technical examination, although research results can be anticipated if successful, the project starts as its feasibility study with a small start. Thereafter the allocation of funding fluctuates according to the progress status.
3) Always understand the progress of R&D based on the portfolio, and manage and supervise in a unified manner the PMs who oversee the relevant projects while constantly reviewing the portfolio, such as allocating resources with a focus on research that is steadily progressing, and discontinuing a project if it is deemed to be unlikely to produce results.
4) Lead the portfolio review based on advice from external evaluators and the Strategy Council (tentative name).
5) Objectively evaluate the research content and lead the utilization of private funding, as well as indirectly support PM activity by pursuing the practical uses of the R&D results in the society and collaboration with the private sector, and promoting international cooperation. In addition, conduct bi-directional communication activities (public dialogue on science and technology) to explain the research activities to society.
6) Conduct other actions necessary to promote the research for which the PD is responsible.

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[3] Metadata provides explanatory information about research data, such as data name, content, administrator, location of storage, contact of administrator, and policy for closure, sharing, and disclosure of research data.

[PM]

○ All nationalities are welcome to be a PM, but PM is principally based in Japan after being appointed.

○ Allow PM to concurrently engage in other work. The time allocated for research (effort rate) is set by FAs.

○ The duties of a PM are listed below:

1) Under the direction of the PD, refine a proposed project during an open call to improve it, draw up a project plan (target setting of project, preparation of R&D details and implementation schedule, establishment of an R&D system to implement the project, and formulation of a plan to allocate research funding to participating R&D institutions in the project), and strategically implement the project. Moreover, flexibly and nimbly implement project modifications and changes in direction, including practical use of some research results in society.
2) Properly manage intellectual property and information, and actively and strategically promote international cooperation.
3) Objectively evaluate the research content, seek sponsors from private enterprises if R&D is at the phase at which private funding can be used, and also try to draw on private funding. In addition, conduct bi-directional communication activities (public dialogue on science and technology) to explain the research activities to society.
4) Develop a data management plan (DMP) that defines the data to be managed, and also aggregate metadata about the data to be managed from researchers based on DMP, and submit that to FAs. In addition, with system such as the Research Data Infrastructure System, store and share the data to be managed, and publish the data to the extent necessary.

4. The R&D Implementation Method

[Open Recruitment and Selection]

○ After discussions with the PD, FAs openly recruit and select, in principle, more than one PM inside and outside Japan. On this occasion, establish an evaluation system comprised of outside experts, and ask for the opinions of outside experts to recruit PMs from a comprehensive perspective. Furthermore, when establishing an evaluation system, it should be taken into consideration that the Moonshot R&D Program aims at challenging R&D concepts by being based more on bold ideas that will not just be extensions of conventional technology.

○ The following points should be taken into consideration when selecting a PM:

・They have expert knowledge and a wide human network such as relevant researchers inside and outside Japan, to promote cutting-edge research.
・They have management and leadership skills such as the ability to establish an optimal R&D system, and nimbly review the system according to the status of progress.
・Project targets and contents proposed by the PM (hereinafter referred to as proposal details) are challenging and based more on bold ideas than existing proposals, and comprise innovative proposals from which a substantial impact on future industry and society is expected.
・From the perspective of technical feasibility and practical use of its R&D results in society, appropriate scenarios (hypothesis for success) for achieving the MS Goals by 2050 can be clearly explained.
・The proposals contain top-level R&D capabilities, knowledge, and ideas, regardless of whether they come from inside or outside Japan.

[Building a Portfolio/Drawing up of a Project Plan]

○ FAs instruct the PMs to refine a proposed project during an open call to improve it and draw up a project plan under the direction of the PD.

○ To realize the concept and achieve the MS Goals, the PD strategically builds a draft of portfolio.

○ FAs determine the portfolio based on a draft of portfolio built by the PD.

○ FAs establish a system to check the PD and PMs do not have conflicts of interest during the course of drawing up a project plan and R&D implementation, so as to promote R&D in a fair and appropriate manner.

[R&D Implementation]

○ Under the direction of the PD, the PMs flexibly and nimbly promote acceleration and deceleration of individual R&D challenges in the projects according to the progress of R&D, and changes in direction, including practical use of some research results in society, with their own authority and responsibilities.

○ The PD and PMs always understand domestic and overseas R&D trends, and nimbly review the portfolio and projects according to the progress of R&D. In particular, they strive to understand similar R&D trends overseas, actively attract high-profile overseas researchers, and promote joint research.

○ The PD and PMs pursue advanced data management, such as encouraging information exchange among researchers, and data storage, sharing, and disclosure.

○ FAs actively support management activities of the PD and PMs, and develop an environment in which outside experts can advise the PD and PMs as required.

[Report on the Status of Progress to the Strategy Council] (tentative name)

○ FAs report on the status of the program's progress and other matters every year to the Strategy Council (tentative name), and improve the program (project components and fund allocation, etc.) by receiving the Council's advice and such.

[Implementation Period]

○ Support is available for up to 10 years from the start of the research (the start of the first project among multiple projects), while the portfolio is repeatedly reviewed.

○ FAs report on the results of external evaluations and self-evaluations to the Strategy Council (tentative name). After discussing with the PD, they rule on project continuation, acceleration, deceleration, modification, and termination (such as a portfolio review), based on the Council's advice.

○ CSTI evaluates the status of progress of the program's R&D aimed at achieving the MS Goals, and the prospects of achieving the MS Goals in the fifth year after the start of research, and decides whether to continue or terminate the program aimed at achieving the MS Goals.

5. R&D Evaluation

[Evaluation]

○ FAs establish an evaluation system comprised of outside experts, and implement external evaluations.

○ External evaluations are, in principle, implemented in the third and fifth years from the start of research. If it is decided that a program will continue for more than five years, it will then be evaluated in its eighth and tenth years. If FAs find it necessary to accelerate the evaluation period according to the project features, an appropriate schedule shall be established in advance.

○ FAs implement a self-evaluation based on the evaluation criteria specified in the following section every year (other than those years in which external evaluations are implemented) and report the results to the Strategy Council (tentative name) and the relevant ministries and agencies that formulate the concept. They will also consult with outside experts as necessary. In that case, they will also report the details of their opinions and how they are reflected in the self-evaluation.

[Evaluation Perspectives]

External evaluation is mainly based on the following perspectives, through which FAs specify detailed evaluation criteria in cooperation with the relevant ministries and offices.

<Evaluation of the program>

・The appropriateness of the portfolio aimed at achieving the MS Goals
・The status of progress of the program's R&D aimed at achieving the MS Goals
・The future prospects for the program's R&D aimed at achieving the MS Goals
・PD's management status (including portfolio management, direction to and supervision of PMs, flexibility and nimbleness)
・Cooperation with industry and the status of bridging the gap between the R&D and practical use in society (including the status of acquiring private funding [matching] and spin-out)
・Effective and efficient R&D promotion through international cooperation
・Challenging and innovative efforts based on bold ideas
・Effective and efficient use of research funding (including role sharing between the public and private sectors, and stage-gates)
・Bi-directional communication activities (public dialogue on science and technology)
・FAs' support for PD/PM activities

<Evaluation of the project>

・The appropriateness of project targets and contents aimed at achieving the MS Goals
・The status of progress toward project targets (particularly comparisons of both domestic and overseas)
・The future prospects of project targets
・The status of establishing an R&D system
・PM's project management status (including flexibility and nimbleness)
・Status of research data storage, sharing, and disclosure
・Cooperation with industry and the status of bridging the gap between the R&D and practical use in society (including the status of acquiring private funding [matching] and spin-out)
・Effective and efficient R&D promotion through international cooperation
・Challenging and innovative efforts based on bold ideas
・Effective and efficient use of research funding (including role sharing between the public and private sectors, and stage-gates)
・Bi-directional communication activities (public dialogue on science and technology)

[Handling Evaluation Results]

○ FAs report on the results of external evaluations and self-evaluations to the Strategy Council (tentative name) and relevant ministries and agencies that formulate the concept. The results of external evaluations and self-evaluations are made public in principle.

○ FAs report on the results of external evaluations and self-evaluations to the Strategy Council (tentative name). After discussing with the PD, they rule on project continuation, acceleration, deceleration, modification, and termination (such as a portfolio review), based on the Council's advice.

○ If a project, or some part of a project, is discontinued after a review of the portfolio, FAs, the PD and PMs will provide the necessary support so that the secondary research results obtained to that point can be utilized in other businesses and R&D projects, with help from the Strategy Council (tentative name).

○ FAs will announce publicly how the results of external evaluations and self-evaluations were reflected in the project continuation, acceleration, deceleration, modification, and termination (such as a portfolio review).

○ FAs will make a follow-up evaluation after a certain period of time has elapsed after R&D termination, and conduct a follow-up of the achievements of PMs' projects.

6. Eligible Project Costs

○ Costs necessary to promote the projects are taken care of by making withdrawals from the funds established by FAs for this program.

○ Eligible project costs include the following, with details of costs determined by FAs. The indirect cost ratio is 30% for universities and 10% for private enterprises (but 20% for SMEs), the ratio for others is established respectively by FAs. The following R&D may include verification up to POC (Proof of Concept) as necessary.

1) Costs required to implement R&D
2) Costs required for project management

○ Costs associated with an application for intellectual property rights (hereinafter referred to as costs for intellectual property rights) may be paid as R&D expenses (direct costs) in a commissioned research contract. If it is difficult to pay the costs for intellectual property rights through direct costs, FAs may pay such expenses through a contract executed separately from the commissioned research contract. Costs for intellectual property rights after project termination are borne by the R&D institution.

7. Handling Intellectual Property, etc.

○ Intellectual property rights, in principle, belong to the R&D institution that is a contractor, or a researcher belonging to the said institution, by applying Article 17 of the Industrial Technology Enhancement Act. The PMs place importance on utilizing intellectual property rights to achieve the MS Goals, and determine the policy for utilizing intellectual property rights. Procedural details are defined by FAs.

○ In the case of the participation of a foreign R&D institution, more than 50% of the foreign R&D institution's ownership interests of the intellectual property rights obtained by carrying out the research, is compelled to belong to FAs.

○ The transfer of intellectual property rights obtained by carrying out the research, and the establishment and transfer of an exclusive license, shall all require the prior approval of FAs.

○ Data to be managed shall be managed by the R&D institution that is a contractor, or by researchers belonging to the said institution under their responsibilities in accordance with the data policy of each institution. The categories of storage, sharing, and disclosure of data to be managed shall be clarified based on the open and close strategy, and research data are disclosed to the extent necessary by utilizing system such as the Research Data Infrastructure System.

8. Handling Conflicts of Interest

○ Since the PD is responsible for selecting PMs and for building and managing a portfolio, the PD is not allowed to participate as a PM or as a researcher. On the other hand, it is not appropriate to judge conflicts of interest between the PD or PMs and participating R&D institutions by a one-size-fits-all criteria, if that prevents Japan from attaining top-level capabilities in R&D and diverse knowledge as a result. Therefore, FAs will render proper judgment on permitting participation or not, in the light of necessity, reasonability, and appropriateness of the respective relationships, with respect to conflicts of interest between the PD and participating R&D institutions in the portfolio that the PD is responsible for building, and between the PMs and participating R&D institutions in projects that the PMs are responsible for drawing up. The results will be published as necessary. The details are defined in documents such as the application guidelines by FAs.

Moonshot Research and Development - website

https://www.jst.go.jp/moonshot/en/application/

See also this site for the latest information and FAQs.

[Inquiry Office]

Make sure to email us your inquiries (unless you are in a hurry).

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[We may ask you to email us if you call to make an inquiry.]

For the call of the research and development managed by NEDO (Moonshot Goal 4), contact us to the address below.

Inquiry Personnel, Moonshot Research and Development Program Promotion Office, Innovation Promotion Department, NEDO

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