Summary of White Paper On Science and Technology 2013
Science and Technology as the basis of Innovation
(Provisional Translation)

Provisional Translation

This White paper reports on the measures implemented by the Japanese government to promote science and technology (S&T); submitted to the National Diet as stipulated in Article 8 of the Science and Technology Basic Law (Law No.130 of 1995)

Part 1 : Science and Technology as the basis of Innovation

Recently, achieving innovation, which creates new values through S&T, new industries and job opportunities, has become an important policy issue with the aim of revitalizing the Japanese economy. Under these circumstances, this year's white paper clarifies the problems and reform directions of Science and Technology as the basis of innovation.

Part 2: Measures that have been implemented to promote S&T

-This part shows the measures taken by the government in FY 2012 on the basis of the 4th Science and Technology Basic Plan.

Feature 1: Recovery and reconstruction from the Great East Japan Earthquake through S&T

Recovery and reconstruction efforts by the government based on the Basic Act and Guideline for Reconstruction in Response to the Great East Japan Earthquake

Current situation and Government efforts ※Mainly in disaster-hit Iwate, Miyagi, and Fukushima Prefectures

① Full-fledged restoration of the transportation network is on-going. Approximately 40%-60% of the debris has been disposed (as of the end of March 2013). Acceleration of these process is required.
② Of the 24,000 reconstruction housing units needed, 248 have been completed (as of the end of March 2013). Further acceleration is necessary.
③ Approximately 40% of the farmland devastated by the tsunami has been recovered (as of the end of Jan. 2013). The problem is how to restart farming in the salt-damaged areas. Except for test-runs, coastal fishing has not been resumed (as of the end of May 2013).
④ Decontamination of the areas affected by the nuclear accident is carried out. Formulation of guidelines and mediation to provide compensation for damages due to the nuclear accident are in progress. Information on radiation monitoring has been provided. Plans for the decommissioning of Units 1-4 of the TEPCO Fukushima Daiichi Nuclear Power Station are being implemented.

Tube for heating and cooling the base of strawberry plants

Provided by: National Agriculture and Food Research Organization

Examples of efforts toward recovery and reconstruction through S&T

① Achievement of prompt relocation to higher ground through speeding-up of cultural assets surveys by new digital equipment
② Verification, establishment, and spread of advanced technology that enables high quality, labor-saving protected cultivation of strawberries, etc. in the salt-damaged farm areas
③ Investigation and research of marine ecosystems, and technology development that will lead to the creation of new industries utilizing Tohoku's marine resources
④ More effective decontamination through development of new decontamination technology of spraying high-pressure water to pollutants, recovering the used water, and reusing it after the process of decontamination
⑤ Development of equipment for high-speed and high-sensitivity radiation inspection of food permitting fast inspection of bags of rice

Feature 2: New Developments in Regenerative Medicine and Innovative Drugs using Human iPS Cells

- The International trend is that life science innovation through stem cells including iPS cells※ is intensively promoted aiming at the development of innovative drug and regenerative medicine. ※ iPS cells: Induced pluripotent stem cells
- Japan is the world leader in stem cell and regenerative medicine research, but is not dominant internationally in clinical and industrial applications and is facing keen competition.

Shinya Yamanaka, MD, PhD, receiving his Nobel Prize from His Majesty King Carl XVI Gustaf of Sweden

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Photo: Alex Ljungdahl

① Current situation

- MEXT, MHLW, and METI establish strategic research framework which covers from basic research to clinical research. In this framework, researches with the collaboration between academia, industry and government have to be accelerated.
- In order to promote practical and industrial applications, the revision of the Pharmaceutical Affairs Law and the formulation of legislation to ensure the safety of stem-cell products are ongoing.

② Future direction

Creating a nationwide support system for those researches promptly, accelerating the development of new drug and the creation of new industry and returning the results of regenerative medicine research to the society as soon as possible.

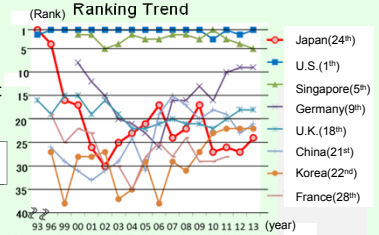
Chapter 1 Trends and Issues in S&T Policy

◯ Building "the most innovation-friendly country in the world" -- Overview of trends in science, technology and innovation through an international comparative analysis

1 Trends in Japan's economic growth and competitiveness

- International competitiveness has declined as economic growth has stagnated. (IMD: 24th/60 economies)
- Input/output indices for R&D are at the top global levels (e.g., 2nd place for scientific infrastructure). However other indices with regard to the commercialization of new technologies and the environmental enhancement for it remain stagnant.

IMD International Competitiveness Ranking Trend



Source: Created by MEXT based on the IMD *World Competitiveness Yearbook 2013* www.imd.org/wcc

2 Trends in Japan's science, technology and innovation

① Results of research activities

While Japan has produced outstanding research results, e.g. Dr. Yamanaka's work, generally speaking, quality and quantity of scientific papers has been decreasing. ⇒It shows that the Japan's presence in the scientific activities has been declining.

② Resources for research activities

- R&D expenditure in Japan is increasing, but that in the U.S., China, etc. are increasing at a higher rate.
- The number of new doctorate holders is low and the share of female researchers is also small compared to other countries.

③ Basis of research activities

- The activities in U.S. and U.K. universities are highly appreciated internationally, while those in Japanese universities is not so appreciated.
- The Japan's ranking of academic performance in primary and secondary school is high, but there are problems as to how to increase the number of human resources for S&T and promote scientific literacy.

	Quantitative Index of Research				Qualitative Index of Research			
	"Number of papers"				"The number of adjusted top 10% papers "			
Country	Share(%)		Rank		Share(%)		Rank	
U.S.	26.8	(31)	1	(1)	41.0	(48.9)	1	(1)
China	12.0	(3.9)	2	(8)	10.4	(2.5)	4	(13)
Japan	6.6	(9.5)	5	(2)	5.8	(7.6)	7	(4)
	2009-2011 (avg.)				1999- 2001 (avg.)			

Source: Created by MEXT based on materials of theNational Institute of Science and Technology Policy

Chapter 2 Opening up Possibilities for Innovation through S&T

Section 1 Activating S&T activities for achieving innovation

1. Activating R&D activities

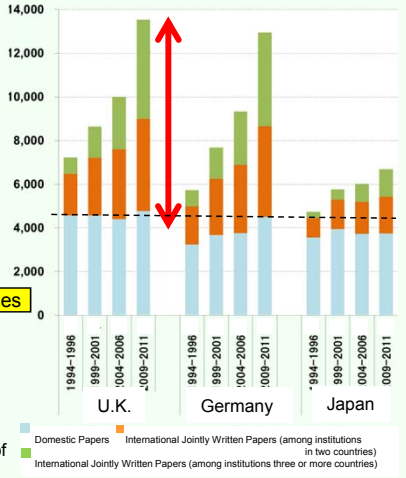
Problems in Japan regarding quality of research activities

① The citation of papers written jointly by an international group of researchers is high and those papers are considered to be high quality research papers. In comparison with other advanced countries, Japan has a lower percentage of such co-written papers.
② Japan doesn't carry out interdisciplinary and multidisciplinary research actively, while many other countries conduct them intensively.
③ Japan is not very active in high-risk research efforts, which challenge existing notions, although such research would have enormous social and economic impact.
④ The evaluation method for R&D should be reviewed.

Efforts to raise the quality of research activities and revitalize R&D activities

① Promoting R&D in emerging and interdisciplinary areas through strategic competitive funds while respecting researchers' inherent motivations
② Making efforts for high-risk research by COI (Center of Innovation) Program
③ Making further efforts to promote spin-off from researches
④ Considering an R&D evaluation system that includes the perspective of the social and economic impact of research outcome as well as the perspective of indices of papers

Changes in the timeline for domestic and international jointly written papers in Japan, U.K. and German, for the top 10% of papers.



Source : National Institute of Science and Technology Policy's *Science Research Benchmarking 2012*

2. Research environment suitable for creative research for achieving innovation

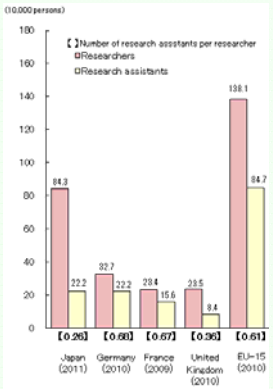
Problems in the research environment in Japan

① Research environment that offers properly the chance for young researchers to research independently and actively has not been established yet.
② The result of evaluation is not considered sufficiently in researcher's treatment and funding.
③ Collaboration among various fields and among research organizations is not so active.
④ Time which researchers can spare for their research decreases due to shortage of research assistants and increase of non-research duties.

Problems in achieving innovation based on S&T

① Decrease in R&D expenditures and long-term research (more than 5 years) at private enterprises →Private enterprises focus on research that brings about results in a short period of time.
② Inadequate utilization of research results by universities
・There is a gap between recognition of industries and of academia for their cooperation.
・Scale of industry-academia partnership is too small for commercialization.
→Industry-academia partnerships are gaining momentum but still insufficient.

Number of research assistants per researcher in selected countries



"Indicators of Science and Technology", 2012 (*Ministry of Education, Culture, Sports, Science and Technology*)

Efforts to create a research environment which facilitates creative research

① Independent research environment for young researchers
・Enhancing and establishing the "Tenure Track System", increasing Grant-in Aid for Scientific Research (Young researchers (A)) for high-risk research
② Active research environment by adopting a merit-based treatment
・Introduction of a merit-based treatment of researchers and a merit-based funding
③ Interdisciplinary collaboration which produces innovative ideas
・Acceleration of the shared use of facilities, promotion of interdisciplinary collaboration and researcher's mobility
④ Research environment which assures sufficient time for research
・Increase in the number of research assistants by means of "Program for training and securing research administrators"
⑤ Formulation of research hubs which attract researchers from all over the world and reform of the R&D agency system

World Premier International Research Center (WPI) Initiative; Institute for the Physics and Mathematics of the Universe, Tokyo University, Institute for Cell-Material Sciences, Kyoto University, etc	Specified Large-Scale High Technology Research Facilities; SPring-8, SACLA, supercomputer "K", J-PARC	COI (Center of Innovation) Program

Efforts to create an environment which achieves innovation based on S&T

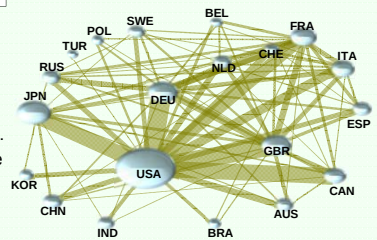
①Promotion of COI Program
A program that strongly supports R&D with large-scale cooperation among government, industry and academia in order to achieve commercialization of research and innovation with a vision based on estimated future need
② Efforts to promote R&D by regulatory reform, funds for commercialization of research at universities, and tax break for R&D

3. Building international networks

Problems in building an international research network through vitalization of international brain circulation

① International mobility of Japanese researchers is low.
② The number of both incoming and outgoing students in Japan remains at a low level.
③ While the production of international joint papers among countries in Europe and the U.S. increases, Japan is getting left behind.
→There is concern that Japan will be left behind in the international intellectual networks.

Scientific articles and co-authorship



The thickness of the link indicates the intensity of the collaboration i.e. co-authorship
Source：「OECD Science, Technology and Industry Outlook 2010」(OECD, 2010)

Efforts to build an international network through vitalization of international brain circulation

① Increasing the status of researchers in society and academia who have achieved admirable results in foreign countries
② Removing the concern about whether the researchers can acquire an appropriate positions when returning from abroad
③ Creating appealing research environment and raising research level in order to attract highly skilled foreign researchers

4. Human resource development to achieve science, technology and innovation

○Efforts to develop human resources for science, technology and innovation

(Overseas examples) Stanford University in the U.S. (d. school), Olin College in the U.S.
(Domestic examples) The University of Tokyo (i. school), Keio University (SDM), Kyusyu University (QREC)

Although the standards for required ability or methods of development for personnel who promote science, technology and innovation has not yet been clarified, there are some common features in present efforts.

Some examples of efforts to develop human resources for science, technology and innovation

・Aiming to solve problems over broader field than a researcher's major and taking actions to realize it
To this purpose, following skills as well as highly specialized abilities are developed.
・Understanding the various factors needed for problem solving such as human needs, business and social problems
・Discovering problems that have yet to emerge and set tasks based on the understandings
・Working out creative solutions in cooperation with a wide range of people in multiple disciplines
(Method of developing above skills and abilities)
・Focusing on efforts to recognize and set issues
・Trying to integrate various fields beyond disciplines
・Offering practical experience such as collaborating with companies or experts in different fields
・Aiming at active-learning rather than classroom lecture
→(Example of such efforts) Education based on design thinking

From a different point of view

It is necessary to develop not only abilities required for R&D activities but also skills that can be applicable in various areas throughout society.

Taking account of the recent social request for innovation, the basic principle is to develop human resources who have freedom and a broad range of ideas, regardless of their disciplines, take leadership aiming at solving social problems, and think strategically to work out creative solutions in order to overcome social challenges and reform society.

Section 2 Trend of Japan's Science, Technology and Innovation Policy

1. Discussion at the Council for Science and Technology Policy (CSTP)

・In order to create "the world's most innovation friendly country", Prime Minister Abe gave following three instructions, (1) formulating "Comprehensive Science , Technology and Innovation Strategy", (2) developing the policy which makes contribution to the formation of Growth Strategy, (3) embodying measures to strengthen the headquarters function of CSTP

Comprehensive Strategy on Science, Technology and Innovation

・Increasing the role of science, technology and innovation (the current biggest issue is "economic revitalization")
① Challenges to be overcome by science, technology and innovation
Realization of a clean and economical energy system, realization of a healthy and active aging society, etc.
② Environment suited for science, technology and innovation
Nurturing innovation sprouts, activating the innovation system and fructifying into innovation
③ Reinforcement of headquarters function of CSTP
・Establishment of S&T budget strategy meeting (tentative name), Establishment of cross-ministry programs to promote innovation, new development of measures succeeding to FIRST (Funding Program for World-Leading Innovation R&D on Science and Technology) etc.
・Activation of CSTP

2. Basic Policy to Drastically Strengthen R&D Capacity in Japan (Determined at Council for Science and Technology)

・Each section of the Council develops the concrete policies to drastically strengthen R&D capacity in Japan based on "State of S&T Policy Based on the Great East Japan Earthquake" and "Basic Policy to Drastically Strengthen R&D Capacity in Japan", which were determined by Council for Science and Technology.