1 INTRODUCTION

Industrial technology has long been considered to be the primary force behind Japan's remarkable economic success. However, it is widely recognized that it is not the groundbreaking innovations that has lead Japan to its success after the post-war era, but most of all Japan's extraordinary ability to adopt foreign technologies and develop them further into goods of superior quality. It has often been claimed that Japan's ability to produce innovations and technological breakthroughs on its own has been limited, and thus Japan has been strongly relying on foreign innovations in its technological development.

When examining the innovation system in Japan we are faced with the puzzle: how did Japan manage to develop into an advanced high-tech nation leaving most of its Western competitors behind when several weaknesses can be pointed out in its own research activities? And how has it been possible for Japan to evolve into a leading technological nation while its own innovation network has been claimed to be ineffective, particularly when considering that the research cooperation between government, industry and academia has long been limited or even discouraged? These questions have been on the background when conducting this report. In order to answer these questions, it is necessary to know the most important actors behind the Japanese innovations' scene. The objective of this report is to introduce the basic framework of the Japanese innovation system and how the participants are networked, with the purpose of providing the reader with basic tools for further analysis.

This report will start by taking a look at the most significant government policies on science and technology in Japan. Currently the guiding government policy influencing the whole science and technology scene in Japan is the Science and Technology Basic Plan, which was first introduced in 1996. Besides the government S&T policy framework this report is also to examine the government administrative structure regarding science and technology, and particularly to introduce the most important research organizations in Japan. The Japanese innovation system is a network formed of several units, including the government policy implementing organizations, research institutes directly responsible for the 'innovation production', and R&D funding organizations. Furthermore, this report will shortly discuss Japanese science parks, technology licensing offices (TLOs), and incubators, whose function is particularly important to the regional development of Japan.

Moreover, the focus of this report will particularly be on the financing of the research and development in Japan. A vast majority of all R&D financing in Japan is conducted by the private sector. Government in Japan is not a major constituent in R&D funding, but it does influence the R&D funding as a guiding force with its science and technology policies. In addition, this report will shortly take a look at the scientific exchange that Japan has with Finland.

2 Overview of Japan's Economy

2.1 Historical Perspective

Until 1980s Japan's economy was viewed as an 'economic miracle', leaving the rest of the world to stand in awe. Various reasons for the remarkable economic performance were given; some saw the Japanese social structure and highly educated and ample workforce as the fact that contributed to the rapid growth after the war. Others claim that it was the government industrial policy that gave boost to Japan's economy; the government that targeted particular industries for investment and growth was strongly influencing the technological development of the country.

After recovering from the post-war period, the Japanese economy grew rapidly from the mid-1950s throughout the 1960s, during which there were only two small recessions. The growth rate was an astounding average of 11 percent during the whole of 1960s. A major reason of the rapid expansion of the Japanese economy was the aggressive investments to new plants and equipment by Japanese private corporations. New technology was brought from abroad, which made it possible for the Japanese companies to quickly pick up new technologies and improve them into goods of superior quality. The Japanese labor force was abundant and highly educated, which also benefited to the remarkable growth. At this time, Japan's main industries such as steel, aluminum, petrochemicals, cement and other heavy industries were experiencing spectacular growth.[1]

By year 1968 Japan had already ranked second in GDP just after the United States. However, the increased prosperity brought about new imbalances too, such as the upward trend in pollution, insufficient housing and infrastructure, and the depopulation of rural areas. As the industries were advancing, the 'hollowing-out'- effect became evident in the Japanese manufacturing sector. Japanese companies started to direct investment to overseas locations already in late 1960s, with the purpose of searching inexpensive labor.

The two oil crises in the 1970s worsened the economy significantly, which accelerated the inflation to high levels. The oil crises demonstrated Japan's dependency on imported oil as a source of energy. The significantly increased energy and labor costs pushed Japan to develop more energy- and labor-saving production techniques, which both had an effect on increasing Japan's international competitiveness.[2]

As the Japanese market matured and diversified, other reasons started to effect the transferring of production facilities to overseas. Since the domestic market could not provide that much growth potential for manufacturing products anymore, moving the production to other areas closer to markets with high growth potential became increasingly tempting. In addition, managing the production facilities became increasingly easy, as the Japanese developed leadership and human resource practices suitable for foreign situations, and created appropriate distribution systems.

[1] Japan Information Network. http://www.jinjapan.org
[2] Japan Information Network.

In the mid-1980s, the Japan's economy was in a slump. The Japanese government started to take measures in order to improve the economy, of which the most significant ones were the lowering of the official discount rate to 2,5 %, the additional 5 trillion yen allocated to public works, and income tax reductions of over 1 trillion yen. However, in mid-1980s the economy started to recover, led by a boost in demand. As the demand continued to grow, the economy started to swell up. This resulted in skyrocketed stock and land prices and private sector over-investment in equipment and personnel in late 1980s.

The overheated situation led to the burst of the bubble economy in the latter part of 1980s. The rapidly worsening economic situation was a combination of a number of factors; in the background were the general harsh global economic conditions, which were accompanied by a number of domestic problems. The swelling-up of the economy led to massive inflation of stock and real estate prices in the end of 1980s. During the period of 1991-1996 the real estate prices actually halved. Furthermore, Japan was also forced to face the massive task of handling the non-performing loans (NLPs), and to deal with the challenge of keeping the banks afloat. The prolonged bank crisis still remains as a major issue in Japan. [3]

The situation was worsened by the fact that traditionally the Japanese Ministry of Finance had been performing a rather strict 'administrative guidance' on the country's financial affairs, but as it came to be seen, the 'guidance' started to lose effect in monitoring new risks in the significantly altered economic conditions. As the Japanese government has been extremely slow to respond to the situation, the recession has lasted already for more than a decade. There were several reasons for the government's slow response, including the fact that Japan lacked political leadership to deal with the crisis, and over-optimism that led to a failure to recognize the severity and extent of the crisis. Towards the end of 1990s, however, it became apparent that Japan could not survive without significant structural reforms to put the economy back on track.[4]

2.2 THE PRESENT SITUATION

Even though some positive signs can be determined, the Japanese economy continues to be in a severe condition throughout 2002. Companies are still wary in investments. The private consumption continues to be low as consumers react to the general insecurity and worsened employment and earnings environment. The situation leads to an increase in private savings rate, which is particularly problematic in Japan since Japanese households already have the highest savings rate in the world. Low private consumption levels contribute to the immobility of the economy, which is why the Japanese government is placing special emphasis on keeping the private consumption vital, by e.g. drawing plans for tax reductions.

[3] Hutchison. Lectures on the Bubble Economy, Burst of the Bubble and Banking and Financial Crisis in Japan.
[4] Hutchison.

The current economic circumstances in Japan are colored by a rather exceptional 'recession-deflation'- combination. The deflation has continued since autumn 1999, with the drop in consumer prices being 0.0 % in 1999, -0.5 in 2000 and –0.8 % in 2001. The decline in prices is first of its kind in the Japanese economy since the end of the World War II.

Several factors can be pointed out to have contributed to the deflation. For example, the imports of textiles and consumer durable goods to Japan have been growing since 1999, and there has also been a notable increase in imports from China. In addition, when the goods produced cheaply by Japanese companies in Asian countries are imported back to Japan, more pressure to push down the prices occur. And, as the weak economic conditions prevail, the consumers' expectations for lower prices continue to rise. All of these factors contribute to the deflationary spiral, which the Japanese government is trying to fight.

It is widely recognized that Japan's economy cannot recover without significant structural reforms. As the economy is losing its vitality and the deflationary pressure on the prices continues, the government is forced to take several initiatives in order to boost the economy. One of the most important tasks in revitalizing the economy is the disposal of non-performing loans (NPLs). According to the official estimates, the amount of NPLs is reaching 6 % of GDP, but others calculate NPLs being as much as close to 20 % of GDP. The Japanese government is taking serious action in order to complete the elimination of NPLs, by e.g. promoting proper examinations of banks burdened with excessive debts and monitoring the major banks on how they proceed in the clearing of NPLs.

The government is in enormous pressure to stick to strict fiscal policies, by e.g. keeping the public investments small throughout 2002. The budget 2002 includes the reallocation of financial support from the declining industries, e.g. agriculture, to industries with high growth potential, such as IT. Moreover, the Japanese government has to face the serious challenge of managing its public debt, which is currently reaching 140 % of GDP. The public debt, though, is for the largest part domestic.

The unemployment record is hitting the all time high, and is expected to reach 5.5 % in 2002. The severe economic conditions have forced corporate restructuring, in addition to the difficulties of export industries in 2001 were also effecting on the unemployment figures. However, the real unemployment rate is expected to be much higher than the official one. This is due to the fact that quite a number of people in Japan have refrained from registering as an 'unemployed person'. In addition, the Japanese industry is estimated to maintain 2,5-7 million 'unnecessary' employees, and if a large part of them were to be restructured, the unemployment rate would jump. As the economic conditions continue harsh, the government is paying increased attention in enhancing the feeling of security in the society, and strengthening the welfare systems. [5]

[5] Finpro. http://www.finpro.fi

However, at least for the time being, Japan has managed not to fall into a state of panic, and has been able to handle the horror scenario in which Japan's economy would deteriorate at an accelerating pace. There are several signs that the Japanese economy is slightly improving; this however, is very much related to the general development of the world economy. One of the positive developments in the Japanese economy is the fact that exports have been slightly improving throughout the first part of 2002, which has caused predictions that the Japanese economy would be bottoming-out from the worst economic crisis since the post-war era. In FY 2001, the Japanese economy grew –1 %. Japan's GDP is expected to reach zero growth in fiscal 2002, and to grow slightly, according to some estimates 1.5 %, in FY 2003.

2.3 MAJOR ECONOMIC INDICATORS

(trillion yen)

				Percentage Changes over the Previous Fiscal Year (at constant prices)	
	FY 2000 (Actual)	FY 2001 (Estimate)	FY 2002 (Forecast)	FY 2001 (Estimate)	FY 2002 (Forecast)
Gross Domestic Product	513.0	500.6	496.2	-1.0	0.0
Private Consumption Expenditure	286.9	280.5	277.9	-0.9	0.2
Government Expenditure	121.5	121.0	121.8	0.3	1.4
Industrial Production (%-change)	4.0	-10.2	-2.4		
Consumer Price Index	-0.5	-0.8	-0.6		
Unemployment Rate (%)	4.7	5.2	5.6		
Exports of Goods and Services	55.6	50.8	50.7	-9.7	-0.3
Imports of Goods and Services	49.4	47.7	46.1	-6.5	-3.0
Exchange Rates (yen/dollar)	110.5	122.2	122.3		

(source: Ministry of Finance: Financial Statistics of Japan 2002)

3 RECENT DEVELOPMENTS IN THE JAPANESE SCIENCE AND TECHNOLOGY POLICY

The key determinant in Japan's success in achieving spurring economic growth after the post-war period can easily be claimed to be industrial technology. As the economy expanded, industrial technology sparked new investments and further development. Japan's ideology to provide high-quality industrial goods at low cost was tremendously successful. This was the time of the 'catch-up -period', when the Japanese imported technology from the West, further developing it into goods of superior quality with significantly increased efficiency in production techniques. In addition, the goals of the technological innovations were clear, and the educational system worked in order to produce a highly motivated workforce with high academic standards.

USA and Europe had started to sense a crisis as Japan continued to push through with superior products and process innovations. However, the ‘catch-up -strategy’, which gave the Japanese a lead in industrial technology, started to lose its’ effect in late 1980s. At that time USA and Europe began offering stiffer competition, and reducing the gap to Japan. With stricter competition, declining productivity rate and the collapse of the bubble economy, Japan found itself in a difficult position. The situation grew even worse with the Japanese government being extremely slow in carrying out the deeply needed reforms.

Japan is facing a challenging task in maintaining and improving its’ industrial competitiveness, and thus government is pushing through major reforms regarding the entire science and technology system. The Japanese government considers science and technology as a key factor in revitalizing the economy. Despite the serious fiscal constrains that Japan is experiencing at the moment, the Japanese government has continued strong support for science and technology. The importance of R&D activities is now widely recognized as the primary factor behind Japan’s success in achieving the remarkable economic growth in the post-war period, and equally or even more important for the future of the country.

The cooperation between the industry, the government institutions and the academia has been widely neglected in the past, which has been hindering the growth in the Japanese innovations. Japan has also had only few start-up companies based on research conducted at universities, and only few venture companies that serve as a driving force behind technological innovations.

The noticeable developments in Japanese S&T policy that have occurred in recent years include:

-Promoting industry, government and academia interaction in generating technological innovation. Innovation in Japan has traditionally been divided into sectors that are somewhat isolated from one another. The lack of information flow between the sectors has been one of the main hindrances in the advancement of Japanese technological innovation. In the past few years, however, the government has made several initiatives to foster effective tri-sector cooperation. These include e.g. establishing of joint research institutes, promoting commercialization of R&D results from public research organizations and improving the information-exchange channels between the three sectors.

By far, universities have been concentrating quite much on their own theoretical basic research, with often little interest in the utilization of research results, while corporations have been sticking to research with the purpose of commercializing the research results into finished goods, with little interest in research cooperation. However, as the economic conditions have continued to be severe, corporations have started to acknowledge the importance of joint research projects as a means of increasing research efficiency and sharing the financial risk. Outsourcing some of the R&D has become increasingly common in Japanese corporations as a way to achieve greater effectiveness in research. Joint research projects between private companies are also growing in number.

One of the major reasons contributing to the isolation of universities and the private sector in conducting research is the fact that before the Japanese legislation prohibited university professors to hold positions in private corporations. This is because university professors were regarded as pure civil servants, whose ultimate and only task should be the serving of the society, and not to use time and effort for other purposes, such as to work in the private sector. Professors' participation in companies was considered to hinder the successful managing of the primary task to serve the society. However, in recent years the Japanese government has become increasingly aware of the necessity to foster the utilization of university-based research results, and this is why the government has taken a number of measures to increase the professors' entrepreneurship. One of the significant changes was the new legislation, passed in April 2000, which enabled university professors to hold positions in private companies.

-Promoting university spin-offs and facilitating the transfer of technology to industry. Japan has only few start-up -companies based on research results achieved at universities, and only few venture companies that act as the engines of technical innovation. In order to improve the situation, the government has decided to support the birth of university spin-offs and increase the number of patents held by universities on technological innovations. The target is to get 1000 new companies based on university research within the next 3 years from 2002 and a ten-fold increase in the number of university patents in the next five years.

-Fostering vigorous SMEs and enhancing the safety nets. Small- and medium-sized companies are playing a significant role in the Japanese science and technology scene by fostering innovations and technologies that may hold great potential to develop into new industries. Small high-tech firms, in particular, are practically irreplaceable to the technological development of a country. In the harsh economic conditions that Japan is facing now it is especially important to build up support structures for the R&D activities of SMEs. As R&D activities are often expensive for SMEs to acquire and maintain, particularly during difficult economic conditions, the Japanese government has taken active initiative to support R&D in small- and medium –sized enterprises. The government measures to build up a safety net for SMEs include protecting the SMEs from the fallout of disposing non-performing loans, enhancing the lending and loan guarantees to SMEs, and enhancing the system of special small-loan insurance for unsecured, unguaranteed loans.

-Revitalizing regional economies. The government aims to promote strongly the creation of new businesses and start-ups sustaining the regional economies by utilizing the technology development of local SMEs and other local strengths. In order to promote regional development, the government has decided to create 'industrial clusters' that link together the strengths of the local industry, the local governmental agencies and the local academia. The designation of 'industrial clusters' has mainly been administrated by

METI. Currently there are a total of 19 projects designated as ‘METI industrial clusters’ throughout Japan. Industrial clusters are examined in greater detail in Chapter 9.

3.1 THE SCIENCE AND TECHNOLOGY BASIC PLAN (2001-2005)[6]

In recent years, the Japanese government has recognized the importance of fostering new innovations for the creation of new employment in a country that now underlies in a challenging economic situation. The Science and Technology Basic Law was promulgated in 1995, based on which the first comprehensive Science and Technology Basic Plan was formed the following year. The plan put emphasis on structuring new R&D systems, realizing desirable R&D bases and promoting education in S&T. The second Science and Technology Basic Plan for the period of 2001-2005, presented in March 2001, continued the guidelines established in the first Plan.

The Science and Technology Basic Plan functions as the highest S&T Policy in Japan, based on which all other S&T related policies are to be established. Thus, the Science and Technology Basic Plan directs the work of ministries in planning and implementing of all science and technology related programs.

The government R&D expenditure has been steadily increasing as a percentage of GDP in Japan since the implementation of the First Basic Plan. During the period of the Second Basic Plan 2001-2005, the government expenditure on R&D is expected to reach 24 trillion yen (fiscal 2001-2005). The government spending on R&D should reach one percent of GDP in 2005, with the assumption of 3,5% nominal growth for the period.

The Second Science and Technology Basic Plan emphasizes science and technology activities as a key factor in achieving sustainable growth in the world. Science and technology can play an important role in the creation of higher quality of life.

The fiscal conditions in Japan have worsened significantly, which may pose a hindrance to the future development of the country. Thus, in the Second Basic Plan, significant emphasis was placed upon the *strategic priority setting* in allocating funds to fields that have the highest capacity to develop into new industries in the near future. In addition, the Second Basic Plan focused on the reform of S&T systems.

3.1.1 FOCUS POINTS OF THE SECOND SCIENCE AND TECHNOLOGY BASIC PLAN (2001-2005) [7]

-Strategic prioritization in S&T. The First Science and Technology Basic Plan did not set specific and clear goals in the government resource allocation to S&T activities. Despite the worsened economic conditions and severe fiscal constraints, the government decided to continue its strong commitment to support science and technology in Japan. However, because of the tightened economic conditions, priority and goal setting came to be in a much stronger focus in the formulation of the Second Science and Technology Basic Plan. Thus, the second S&T Basic Plan for the period of 2001-2005 introduced

[6] Government of Japan, 2001. The Science and Technology Basic Plan (2001-2005)
[7] Government of Japan, 2001. The Science and Technology Basic Plan (2001-2005)

much stricter areas of focus and target goals for all S&T related research, with the primary purpose of increasing the efficiency in government resource allocation.

-**Promoting basic research**. Basic research, which the Basic Plan defines as '*research that seeks to find new rules and principles, to build up creative theories, and to discover unknown phenomena*', is going to be further emphasized in the future. Basic research is vital for the creation of new, unprecedented R&D breakthroughs and innovative industrial technologies. In order to create an ideal environment for furthering basic research, attention will be paid for the creation of fair and transparent evaluation system for research results.

-Increasing the amount of competitive funds. Traditionally, allocation of funds to S&T activities in Japan has often been based on other than on competitive grounds. This has led to financing projects that may not have great potential in achieving excellent results and new, innovative information. Also, the evaluation system of research results has been insufficient, often even non-existent. The result is poor quality of research in a number of cases. The worsened economic conditions have forced the government to consider how to minimize the ineffective use of research funds. Based on the American model, the Japanese decided to significantly increase the amount of competitive funds in order to improve the research quality. During the period of the Second Basic Plan (2001-2005), *the amount of competitive research funds will be doubled*. In addition, emphasis will be placed on the establishment of clear evaluation procedures and guidelines research projects receiving competitive funds. The improved follow-up evaluation system can also be utilized in the preliminary evaluations for the next competition, and thus increase the effectiveness of R&D activities in the long- term.

-**Improving the human resources in S&T**. The Japanese government has acknowledged the necessity to reform human resource practices related to science and technology. Traditionally the mobility of researchers in Japan has been very low, with a large number of researchers having experienced only one institution. Also, the mobility of researchers even between divisions within one institute is often low. This may have attributed to the strong impact of Japanese traditional employment practices, which are emphasizing the importance of stable employment.

In addition, Japanese research institutes, such as universities, have often very strong traditions of hierarchy, which may hinder the innovation as the achievements of young researchers may be left under the senior professors' names. The Second Science and Technology Basic Plan placed increased focus on encouraging young researchers to be '*creative and have a broad perspective'*. The assistant professors in Japan have traditionally had not so much autonomy in R&D, which has caused a hindrance in advancing innovation. Thus, the positioning of assistant professors will be reviewed in order to promote their autonomy over R&D. The work of young researchers will also be supported by securing sufficient R&D space for them in research institutes and creating awards to innovative young researchers. Topics that concern all research personnel include e.g. the promotion of flexible working style, improving the environment for woman researchers, and developing a variety of career paths in research activities.

-Reforming the evaluation systems for S&T research. The Second S&T Basic Plan acknowledges the significance of reforming the research evaluation practices. Well-established and uniform evaluation processes are essential in advancing the quality of research and increasing the effectiveness of research funds' allocation. The Basic Plan placed increased emphasis on the '*securing fairness and transparency of evaluation, and assuring that the results of the evaluations are reflected in the resource allocation*'. The evaluations should be conducted by independent experts outside of ministries or other public institutions. Evaluation should estimate the social/economic significance of the research, the clearness of the research objectives, and the progress of the research against the goals set in the initial research plan. In addition, '*each ministry should conduct a tracking evaluation of the spin-off effect and impact of R&D results*', which is emphasizing the fact that all research should be based to answer the needs of the society. As the evaluation practices become increasingly well -established and uniform with time, there is a positive effect to the further development of evaluation methods, which will eventually result in improved research quality.

Furthermore, the second S&T Basic placed increased importance on providing the needed resources so that the research evaluations can be conducted properly. These include e.g. securing the required number of highly skilled evaluation personnel. For the selection of a suitable evaluator to each project, a nationwide database of researchers, funds, evaluators, and results should be established.

-Maintaining the infrastructure for S&T research activities. According to studies on R&D facilities in national research institutes and universities in different countries, Japan scored low. Japanese research facilities in national research agencies, even in the most prestigious ones, are often described as insufficient, old-fashioned and even to be in an appalling condition. As the number of doctoral students has been on a rapid increase in recent years, the congestion of R&D facilities in national research institutes and universities is a severe problem. Thus, the government has decided to allocate more funds to solve the deterioration and congestion problems in current R&D facilities in universities and research institutes.

-Enrichment and standardization of intellectual property rights. Concerning the IPR protection, the following points were stated in the Second S&T Basic Plan: the government will promote world-class IPR services and put effort in improving the mechanisms for settling the IPR disputes. The government will also be active in cooperation for preliminary technological investigations with the United States and Europe, in addition to supporting Asian countries in establishing their IPR systems. Japan will be promoting transparency and harmonization of IPR systems in the world to protect IPR related technologies, e.g. biotechnology and IT.

-Promoting R&D in private companies. R&D activities in the private sector play a very significant role in the R&D scene in Japan. Due to worsened economic conditions, private companies have been wary of investing to R&D. The Second S&T Basic Plan acknowledges the importance of private R&D, and thus the government has taken several initiatives to support research in the private sector. The measures to be taken include creating tax reforms to promote R&D investments, and grant and loan systems that reduce the risks inherent in R&D activities.

-Increasing the communication between S&T and the society. Another trend in the Japanese field of science and technology is the recent efforts to strengthen the interaction between S&T and the society. Research activities tend to remain relatively isolated from the public, which is why the Japanese government has decided to place emphasis on increasing the general understanding of science and technology in the society. The objective is to enhance the public understanding of R&D by providing '*accurate information on the present status of S&T, and the anticipated status of S&T in the future*', as stated in the Second S&T Basic Plan. As the S&T grows more complex and more information is continuously provided with higher speed, the importance of briefing the public about the recent developments in S&T is increasing in significance.

Among the objectives of the second Science and Technology Basic Plan was to '*promote R&D to meet social and economic needs'*. There is a growing trend to bring the social aspect into the S&T research. Science and technology should not be considered as totally unrelated to other developments in the society, and therefore the interactive communication between society and S&T should be promoted. In other words, research on S&T should reflect the opinions and demands of the society.

Furthermore, the second S&T Basic Plan stated that '*experts in social sciences and humanities should take an interest in S&T'*. This encourages a more interdisciplinary approach to research on S&T.

-Ethics and responsibility of R&D to the society. The S&T Basic Plan placed emphasis on researcher's responsibility regarding their R&D activities. For example, biotechnology is a field receiving contradictory opinions from the society. On the other hand, biotechnology has widely benefited the society by improving the diagnosis, prevention and treatment of diseases, while at the same time difficult ethical issues remain to be solved, e.g. issues concerning gene therapy and patients' rights. In addition, the Basic Plan placed increased attention on improving researchers' responsibility to share their research results and make them understandable to the public.

3.1.2 PRIORITIZATION OF S&T RESEARCH FIELDS[8]

The Science and Technology Basic Plan (2001-2005) focuses on four prioritized areas of research: 1) life sciences, 2) information and communication technologies (ICT), 3) environmental sciences, and 4) nanotechnology and materials. These fields are considered to possess great potential in creating knowledge that enhances intellectual assets, in having positive economic effects by creating new industries and employment, and in improving people's health and quality of life. In addition to the above mentioned four main fields of focus, funds will be allocated to research in energy, manufacturing technology, infrastructure, and 'frontier' R&D (research in the unclaimed regions; outer space and oceans).

[8] Government of Japan, 2001.

The government's designation of the above-mentioned four main prioritized areas of research is affecting strongly the future development of the science and technology scene in Japan. Funds allocation is coordinated according to the basic guidelines established in the S&T Basic Plan, which gives strong emphasis on financial disbursements to life sciences, IT, environmental sciences and nanotechnology. The emphasis on these fields are reflected in the individual budgets of research institutes, where the above-mentioned fields come out as clear winners when compared to other research areas.

Below the four main fields of research defined in the Second S&T Basic Plan are examined in greater detail:

3.1.2.1 LIFE SCIENCES

Life sciences aims to find solutions to the numerous challenges of the 21st century; these include such global issues as finding solutions to food shortages and to the environmental degradation, managing the challenges that come with the aging of the society, and finding answers to questions that arise with gene technology.

The Second Science and Technology Basic Plan stated Japan's concentration areas in the field of life sciences as follows; Japan will particularly focus on genome science, cellular biology, clinical medicine and medical technology, in addition to which emphasis will be placed on food S&T and brain science. In genome science, Japan's research areas will be e.g. in genetic markers of disease and drug reactions, and in the development of tailor-made medicines and functional foods utilizing genome technologies. In cellular biology, the emphasis will be placed on the development of organ transplantation techniques and regenerative medicines, whereas in the field of clinical medicine and medical technology, Japan will concentrate on advancing the practical medical applications of R&D results. The research areas in food S&T will include food security as well as the promotion of sustainable food production.

Although Japan is quite advanced in research in some fields of life sciences, such as in specific microbe genome analysis and in livestock cloning techniques, in general research on life sciences in Japan is still lagging behind when compared to that of in USA and in Europe.

3.1.2.2 INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

For the development of the society, information and communications technologies has become crucial in advancing not only the knowledge- intensive industries but also the existing industries, such as manufacturing industries. In today's world IT technologies have a strong socio-economic impact on the society at all levels, e.g. in forms of electronic commerce, electronic governance, telecommuting, telemedicine and distance education.

The Science and Technology Basic Plan placed emphasis on the following areas in ICT: *Advanced network technology*, which enables all network activities to be performed with ease and accuracy, *High-performance computing technology* that enables rapid analyzing, processing, storing and searching of vast amounts of distributed information, and *device and software technologies*. *Human interface technology*, on the other hand, concentrates on developing the technologies so that everyone can enjoy the benefits of an IT society without mastering complicated equipment and stress.

3.1.2.3 ENVIRONMENTAL SCIENCES

As the global environment is deteriorating at an accelerating pace, the development of nature preservation technologies is becoming a necessity. Japan has placed increased focus on fighting the global warming. In addition, since Japan has to manage with its scarce natural resources, the government has stressed the importance of R&D regarding domestic environmental challenges, such as developing appropriate recycling and waste-management technologies.

According to the Second S&T Basic Plan, Japan’s focus areas in environmental sciences will include e.g. the development of production systems that minimize both the input of resources and the output of wastes, and waste management and recycling technologies that utilize natural circulative functions and bio-resources. Funding will also be allocated to R&D on developing technologies that minimize harmful chemical substances for human health and natural ecology.

As designated in the Basic Plan, Japan’s main focus in environmental sciences will be on global warming. In this field, Japan’s emphasis will be on the development of global climate change forecast technologies and measuring technologies for environmental monitoring. Moreover, research topics regarding global warming include e.g. the minimizing of the greenhouse gas emissions, and how the forecast results will influence the social-economic circumstances.

3.1.2.4 NANOTECHNOLOGY AND MATERIALS

Materials science analyzes *‘material structures and forms, surfaces, and interfaces in the order of atomic/molecular size’*. Materials science is an interdisciplinary research field, whose results can be applicable e.g. in IT, medical science, developing energy and environmental applications for recycling, and resource saving and reduced energy consumption.

Nanotechnology, as defined in the S&T Basic Plan is *‘manipulating atoms and molecules on a nano scale…the unique material properties in the nano world lead to novel discoveries that can be exploited to innovative technologies in other fields’*. Research in nanotechnonogy includes e.g. examining nano materials that have extremely high strength or extremely low weight. As in materials science, research results in nanotechnology can be utilized in a variety of fields, such as in IT or in medical sciences. The possibilities for application include e.g. information devices that realize extremely high-speed communication and information processing, or medical devices that can be placed inside patients’ bodies to control, diagnose, and directly treat the diseases.

Nanotechnology is currently the field to which the Japanese government is investing the most. Nanotechnology possesses great potential in developing into a field that could foster a great number of innovations and create new industries. The S&T stated that *‘in promoting nanotechnology, Japan must maintain a balance between fundamental/leading* *research and research that aim for industrialization'*. The Basic Plan also placed emphasis on constructing an information exchange channel to increase the interaction between researchers in the field of nanotechnology, and to advance the education of students and young researchers in the emerging fields of nanotechnology encompassing various academic fields.

3.1.2.5 FOUR ADDITIONAL RESEARCH FIELDS OF THE SCIENCE AND TECHNOLOGY BASIC PLAN

In addition to the four key research fields of life sciences, IT, environmental sciences and nanotechnology, the Japanese government is emphasizing research in energy, manufacturing technologies, infrastructure and frontier sciences. The second S&T Basic Plan stated that these additional fields of focus are *'fundamental areas for the nation's existence, hence R&D on these fields should be promoted by the government at a national level'.*

-Energy. As the energy supply is expected to become increasingly insecure in the future, Japan is continuing the efforts to rely less on fossil fuels by strongly emphazising research on energy efficiency and renewable energy sources. These include research e.g. on fuel cells, solar energy, biomass, nuclear fusion technologies and innovative atomic-energy technologies.

-Manufacturing technologies. Manufacturing technologies form the very heart of Japan's economic power. Manufacturing industry was the key force behind Japan's remarkable economic growth; unlike in other industrialized economies, manufacturing sector still accounts for a relatively large percentage of GDP in Japan, currently being around 24 %. Japan's achievements in manufacturing sector include the most advanced technologies, especially in the field of high-precision machining. The Japanese government is also promoting research on fine-parts processing technologies, environmentally friendly technologies, technologies utilizing IT or biotechnology, and medical/welfare apparatus technologies.

-Infrastructure. The research field of 'infrastructure' consists of the basic framework of the society; it includes e.g. research on crisis management technologies, the development of transportation technologies, geographic information systems and fresh water management.

-Frontier is a cutting-edge research field concentrating on unexplored areas, such as outer space and oceans, which are expected to possess great potential for the future technological development. This research field includes e.g. space technologies that utilize space for satellite-based telecommunications, and ocean technologies that concentrate on the utilization of the vast resources of oceans.

4 R&D EXPENDITURE AND FUNDING IN JAPAN

The total R&D expenses as a percentage of GDP doubled during the period of 1975-1990 in Japan. In addition, there has been a significant increase in the number of research personnel during the past couple of decades; in 2001, a total of 1,024,800 people were engaged in R&D in Japan. Regular researchers numbered 728,200, with a reduction of 1.5 % from the previous year. Of the total number of researchers in Japan, male accounted for the vast majority of 89.2 % (649,600), with only 10.8 % (78,700) being female. [9]

The trend that Japan had been mainly incorporating and improving imported technologies, developing them into products with superior quality, had been continuing decades from 1950s. While the Japanese excelled in improving the imported technologies, they have been suffering from a lack of technological breakthroughs on their own. In the past decades the Japanese had been mainly successful in applied research, leaving the necessity to improve the basic research on the background. However, in 1980s the situation started to change as a consequence of internal and external pressures. At that time the United States started criticizing Japan of acting like a free rider and utilizing others' basic research results, while not providing any scientific breakthroughs itself. In saying so, the United States started pressuring Japan to conduct more basic research itself, which led the Japanese government to take a more active approach to improve the state of the basic research in the country. [10]

The continuous growth of R&D expenditure in Japan during the last couple of decades started to stagnate in the 1990s. The total R&D expenditure in Japan remained more or less in 3 % of GDP during the whole of 1990s. The stagnation in the 1990s was mainly because of the private corporations becoming more cautious regarding their R&D expenditure due to the weakened business conditions. Japan experienced a couple of years of decrease in the total R&D expenditure in 1993 and 1994, after which the share of R&D costs returned back to close to 3 % of the GDP.

Even though Japanese government's S&T budget share from total R&D is small when compared to other major nations, the Japanese government is pushing strongly to maintain the R&D activities vital even during the severe fiscal constraints presently facing Japan. The government's dedication to strengthen R&D activities in Japan was emphasized with the introduction of the first Science and Technology Basic Plan in 1995. The introduction of the S&T Basic Plan in 1995 was partly affecting the fact that there has been an obvious increase in the government R&D spending especially in the latter part of the 1990s. For the S&T Basic Plan five-year period of 1996-2000, the government R&D allocation amounted to 17.1763 trillion yen (FY 1996-FY 2000).[11]

The total R&D expenditures in Japan amounted to 16.289 billion yen in 2000, which accounted for 3.18 % of GDP. The percentage of R&D expenditure in relation to GDP has been higher in Japan than in any other major nation, including US, where total R&D expenditure was 2.65 % of GDP in 2000. The private sector R&D in Japan amounted to 12,684 billion yen in 2000, accounting for 77.9 % of the total R&D expenditure, while the public sector provided 3,541 billion yen of the total R&D in Japan. Of the corporate R&D spending, electrical machinery, chemical products industries and transportation

[9] Statistics Bureau and Statistics Center, 2001. Survey of Research and Development, Summary of Results
[10] Harayama, 2001. Japanese Technology Policy: History and a New Perspective
[11] NISTEP, 2001: Science and Technology Indicators 2000. A Systematic Analysis of Science and Technology Activities in Japan

equipment together accounted for 64.4 % of the total corporate resource allocation on R&D. [12]

The electronic industry has long been the industry to obtain the largest proportion of funds allocated to R&D activities in Japan. In 2000 the electronic industry accounted for roughly a quarter of the total R&D expenditure of industry as a whole. The same year, chemicals and pharmaceuticals accounted for 17.4% of the total R&D costs. Funds allocated to research in the pharmaceutical industry have been on a rapid increase in recent years, and the trend is expected to continue. In FY 2002, the automobile industry's share of total R&D costs was 12.7 %, whereas the electric (9.8 %) and machinery industries (8.1 %) both covered roughly the same amount of the total R&D expenditure. Further, transport and telecommunications covered 5.6 %, software 1.9 % and food industries 2.1 % of the total R&D investment by industry. [13]

When examining the distribution of funds between the different research activities in Japan, basic research accounted for 14.3 %, applied research 24.0 %, and development 61.8 % of the total in 2000.[14] Universities have traditionally been focusing strongly on basic research; in 2000, more than half of all research carried out in universities was basic research. In addition to universities, a number of Japanese private corporations are conducting large-scale basic research activities.

When examining the coordination of S&T related funds in different ministries in FY 2002, MEXT (Ministry of Education, Culture, Sports, Science and Technology) covers 64 % (2,264.4 billion yen) of the total government S&T budget. MEXT is the main ministry taking care of a variety of S&T related programs, and its main missions are in space, marine and atomic research, basic research and universities.[15]

In addition to MEXT, METI (Ministry of Economy, Trade and Industry) is the other ministry primarily in charge of the implementation of science and technology related programs in Japan. METI's focus point is mainly in industrial research. In FY 2002 METI was in charge of 597.2 billion yen of the government S&T funds, which covers 17 % of the total government S&T budget. [16]

Other ministries are playing a minor role in coordinating the S&T related programs. MHLW (Ministry of Health, Labor and Welfare) covers 4 % of the total government S&T budget, with the main focus being in supporting medical and pharmaceutical research. MAFF (Ministry of Agriculture, Forestry and Fisheries), on the other hand, covers 3 % of the total government S&T expenditure. MAFF is primarily concentrating on food, forest and agrobio research. Further, MPHPT (Ministry of Public Management, Home Affairs, Posts and Telecommunications) is in charge of a number of S&T related programs, particularly in the field of telecommunications. [17]

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[12] Statistics Bureau and Statistics Center, 2001.
[13] TEKES, 2002. R&D Landscape in Japan; NISTEP, 2001.
[14] Statistics Bureau and Statistics Center, 2001.
[15] TEKES 2002.
[16] TEKES, 2002.
[17] Ibid.

4.1 R&D IN THE PRIVATE SECTOR

Of all R&D activities in Japan, around 75-80 percent has been carried out by the private sector during 1990s. In FY 2000, the private corporations accounted for 68.9 % of the total expenditure on R&D in Japan. The same year, government covered 21.7 % of the total R&D, while the rest was mainly to be covered by private universities. In fiscal year 2000, the total expenditure on R&D in Japan was 16,289 billion yen, of which the private companies covered 10,860 billion. The total expenditure on R&D FY 2000 increased slightly, 1.7 % from the previous year, and accounted for 3.18 % of GDP. [18]

In addition, private corporations have been employing roughly 70 % of all research personnel in Japan. These figures reflect the importance of private R&D to the overall performance of Japanese economy. Some Japanese large corporations run massive R&D budgets; for instance, until the economic recession in 1992, the annual R&D budget for the Japanese company Hitachi alone equaled to the total amount administered by the Ministry of Education allocated to university research.[19]

During the period of 1975-1991 Japanese private R&D investment increased substantially, from $11.4 billion in 1975 to $44 billion in 1991. This represents an average of 8.9-percent growth in R&D for the period. [20] This high growth in the private R&D expenditure started to stagnate during the 1990s. However, despite the severe economic conditions, the Japanese corporations continued the investments to R&D throughout the decade of 1990s, even though it was evident that the pressure to improve the research efficiency and the research results' utilization rate became much stronger than before.

In general Japanese corporations have been able to maintain their R&D activities vital despite the difficult economic conditions. However, streamlining of R&D operations has become more frequent. Japanese companies are increasingly outsourcing the R&D of certain areas of product development to universities or government institutions. Furthermore, joint research projects between private companies are becoming more common. Conducting joint research makes it possible to divide the financial burden and the inherent risk that comes with research activities. [21]

When searching for a partner for joint research operations, there is also a growing tendency among the Japanese companies to find a partner from abroad, not from Japan. In FY 1999, for instance, Japanese private companies disbursed 140 billion yen to foreign organizations for R&D projects, with the corresponding amount to Japanese universities being less than half of that, in 60 billion yen.[22] Even though international cooperation should be increasingly promoted, Japanese companies should also be encouraged to allocate the research tasks to Japanese researchers.

[18] Statistics Bureau and Statistics Center, 2001.
[19] National Science Foundation. The Science and Technology Resources of Japan: A Comparison with the United States
[20] Ibid.
[21] METI, 2000. National Strategies for Industrial Technology
[22] Ibid; Japan Inc. Magazine 08/01. Special Report: TLOs

Japanese corporations and universities have traditionally had vast contact networks, but quite much of the interaction has been informal. Corporate laboratories have been providing donations, such as funds and equipment, to leading Japanese national universities; in contrast, the corporations have been expecting an access to the high top graduates from the particular top universities. Corporations have been very much aware of the importance of keeping good relations to top professors in the related R&D fields; however, there has been no strong involvement of university faculty in the actual corporate R&D projects in the past.[23]

Japanese private corporate R&D activities have strongly been concentrating on the manufacturing industries. However, in recent years, the shift of research has been towards R&D in drugs and medicines, computers, and electronic machinery, while R&D in automotive industries, chemicals and the basic metals industry has been on a decline. The largest proportion of corporate R&D is allocated to communication technologies and electrical machinery, but in particular R&D expenditure on drugs and medicines has been on a rapid increase in the last few years. [24]

When examining the R&D expenditures by different industrial categories in further detail, in 2000 the electronic industry accounted for roughly a quarter of the total R&D expenditure of industry as a whole, chemicals and pharmaceuticals 17.4%, and the car industry 12.7 %. Electric and machinery industries both covered roughly the same amount of the total R&D expenditure; the electric industry 9.8% and machinery 8.1% in 2000. Further, transport and telecommunications covered 5.6 %, software 1.9 % and food industries 2.1 % of the total R&D investment by industrial sectors.[25]

Moreover, when analyzing the R&D financing in private corporations, around 98 %, is financed by the companies themselves.[26] The Japanese government has been very inactive in the R&D resource allocation to the private corporations, even though private corporations are in charge of the vast majority of all R&D in Japan. However, in recent years, the government has started launching programs for supporting R&D in the private sector. The Science and Technology Basic Plan 2001-2005 stated that *'the government should apply incentives which stimulate the private companies to help themselves, such as tax reforms to promote R&D investments, and grant and loan systems that reduce the risk inherent in R&D'*. [27]

One example of the increased government support for the private corporations is the tax incentive of '*Tax Deduction Programs on Experimental and Research Expense Increments'* that was modified in 1999. The new modification increased the number of applicable companies and enhanced the incentives of private companies to continue investing on R&D. According to the Japanese National Tax Agency, the total tax reduction achieved through the new modification amounted to 41 billion yen in 2001.[28]

[23] National Science Foundation.
[24] Ibid.
[25] TEKES, 2002.
[26] National Science Foundation.
[27] Government of Japan, 2001.
[28] OECD. Science Technology and Industry Outlook 2002.

4.2 Comparisons between the R&D Expenditures of Japan and Other Nations

When examining the total R&D expenditure in different nations in absolute terms, other nations cannot compete with that of the United States. For instance, according to OECD statistics, the US R&D expenditure reached 28.5 trillion yen in 2000, while Japan's R&D costs totaled 16.3 trillion yen the same year. The gap in the absolute R&D expenditure between the United States and other nations can partly be explained just by the mere size of the US economy. However, when the R&D expenditure is examined as a percentage of GDP, other nations are surpassing the United States. Throughout 1990s, Japan's R&D share of GDP has been more or less at 3 % of the GDP. In the United States, on the other hand, the respective figure has been less than that of Japan's for quite some time already. However, during the past decade, the US R&D expenditure improved from 2.5 % of GDP in 1993 to 2.76 % in 2000, still lagging behind Japan. [29]

Furthermore, the GDP share of R&D expenditures in other major industrialized nations, such as in Germany, France and the UK, has been relatively small in comparison to Japan in the past few years. In Germany, for instance, the R&D share has been around 2.3-2.4 % of the GDP during 1990s, with a slight increase toward the end of the decade. Conversely, in France and UK, the R&D expenditures have actually been on a decrease during 1990s; in Britain, for instance, the R&D costs plunged under 2 % of GDP in 1995, and continued to stay low during the rest of the decade. [30]

When comparing the R&D costs of Finland and Japan, it can be seen that while Japan's R&D share of GDP remained quite the same throughout 1990s, in Finland the total research and development costs experienced a drastic growth during the decade. Finland's total R&D costs more than doubled during 1990s, reaching an average annual growth rate of 9 %. During 1993-1999, Finland's R&D costs actually grew from 2.17 % to 3.37 % of GDP, reaching one of the highest R&D expenditure levels among industrialized countries. At the same time it can be noticed that for the same period of 1993-1999 the GDP in Finland was also on a growth path, increasing from 82.9 billion euro in 1993 to 120.5 billion in 1999. [31]

Japan's respective growth in R&D expenditure during 1993-1999 was from 2.88 % to 2.93 % of GDP. The growth in R&D costs in Japan during the last decade has been continuous but rather moderate. For the mentioned period, Japan's GDP was experiencing a slight increase, with an approximate growth of 1-2 percent a year, but towards the end of the decade Japan's GDP started to decrease. It also has to be noticed that while Japan has been experiencing growth in its R&D costs, its public debt has been drastically increasing during recent years. The current level of public debt in Japan is reaching 140 % of GDP.

Although the government is not the main constituent in S&T activities in Japan, it has a core function as a regulator of S&T activities between the different sectors. However,

[29] OECD, 2001. Main Science and Technology Indicators Volume 2001/2
[30] Ibid.
[31] OECD, 2001. Statistics Finland: National Accounts

when examining the changes in the government R&D expenditure in different countries during the past couple of decades, there is a clear downward trend in government R&D expenditure in a large part of the major industrialized nations. This reflects the changed role of governments in S&T related activities, in which the government has taken a more coordinating role in the country's R&D activities, placing more emphasis to the private sector. Conversely in Japan, with the introduction of the Science and Technology Basic Plan in 1995, the government funding to R&D has been on the increase for the latter part of the 1990s. This is regardless the fact that the corporate sector has traditionally been covering a vast majority of all R&D financing in Japan, leaving a smaller role to the government in covering the costs of R&D. [32]

Furthermore, when examining the government R&D costs between Finland and Japan, it can be noticed that in Finland the government share of the total R&D expenditure is much larger than of Japan's. In 1999, for instance, the share of public financing of all R&D was 29.2 % in Finland, whereas in Japan the respective figure was 19.5 % the same year. However, even though in Finland the government has traditionally been covering a relatively large part of all R&D expenses, the share of the private R&D financing has been on a rapid increase during the past ten years. [33]

Moreover, when examining the proportion of 'competitive funds' of the total government R&D allocation in different countries, Japan does not rank very high. In recent years Japan's rate of competitive funds of the total government R&D budget has been around 10 %, with the respective figures being over 30 % in the US and UK.[34] However, in recent years, the Japanese government has taken action to substantially increase the share of competitive funds in R&D in contrast to direct disbursements. The aim of the government was to double the share of the competitive funds during fiscal 2002, to reach the level of 20 % as competitive funds of the total government R&D expenditure. The governments' objective to increase drastically the share of competitive funds allocated to R&D is expected to result in improved quality and efficiency of research, since more emphasis is being placed on the evaluation of research.

4.3 The Government R&D Expenditure on the Science and Technology Basic Plan Four Main Fields of Research

4.3.1 Life Sciences

In life sciences, Japan will be placing focus on e.g. genomics-based research on how to promote health in the longer living population, on food research, and on environmental applications and production of materials that utilize biological functions. Budget funds will also be directed to R&D in new and integrated fields of life sciences. In addition, attention will be placed on promoting bioethics and public understanding of life sciences. [35]

[32] NISTEP, 2001; OECD, 2001.
[33] OECD, 2001.
[34] NISTEP, 2001.
[35] Stenberg.

The total government budget for life sciences in fiscal 2002 reached 440 billion yen. The major life science programs include e.g. 'Protein 3000', with the disbursement of 11.8 billion yen. The objective of Protein 3000 is to determine approximately 3,000 protein structures in a period of five years. In order to achieve the goal, Protein 3000 provides funding for protein structure research for both national research institutes and universities. Other major R&D programs in fiscal 2002 related to life sciences include a program for developmental and regenerative biology, with the disbursement of 5.7 billion yen, and a program for '21st century innovative and advanced life science technology', with the budget allocation of 4.3 billion yen. [36]

Japan may have a significant advantage in utilizing life sciences technology because of the fact that the Japanese excel in electronics and nanotechnology materials. These industries serve as necessary tools in developing life sciences and the bioindustry, and thus mastering them may give Japan an edge in life sciences over other nations. However, one of the major weaknesses that Japan has in life sciences is the fact Japan actually has very few real 'bioventures'. Japanese pharmaceutical firms are also relatively late in restructuring and internationalization, and the cooperation in life science research between universities and other research institutes, both public and private, is still insufficient. [37]

4.3.2 INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICT)

Even though the IT bubble in the world has very much burst, one should keep in mind that advancing IT is still crucial for the overall development of the society and industry at large. The Japanese government has underlined the importance of keeping Japan's IT industries vital, by introducing a variety of measures to advance the field. The significance of IT investment is emphasized by the fact in 2000 the IT investments of 20.8 trillion yen created a 38.6 trillion yen economic ripple effect to the Japanese society, creating about one and a half million new jobs.[38]

The Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) is primarily in charge of the implementation of IT related policies. The MPHPT IT budget's main focus areas for the year 2002 include the promotion of high-speed network infrastructure, the advancement of e-government, and the development of human resources. In addition, funds will be allocated to the development of digital devices and the promotion of strategic R&D. [39]

The government IT budget for fiscal 2002 aims to enhance the development of necessary network infrastructure, particularly in the low-density population areas. The purpose is to make reasonably priced high-speed Internet access within the reach of all citizens. Attention will be placed on increasing Internet usage at schools, and raising the level of Internet usage among individuals to more than 60 % by 2005. Further, the MPHPT IT budget aims to advance information technologies in both local and central government

[36] Ibid.
[37] Ibid.
[38] MPHPT, 2002. White Paper 2002 Information and Communications in Japan (Summary)
[39] MPHPT, 2001. Outline of IT Policy Principles

offices, with the introduction of the e-government program. In addition, emphasis will be placed on furthering the regulatory reforms related to IT. [40]

Data by a MPHPT Report shows that even during the dismal economic conditions, the corporate investment on IT has continued to be strong. In 2000, of all private sector investments 23.5 % were allocated to IT. This amounted to 20.8 trillion yen. A study conducted in 2002 showed that the basic infrastructure investments (PCs, LANs and the Internet) were well under way in private corporations. The study showed that approximately 90% of all Japanese corporations had already completed the basic IT infrastructure. Further, IT investments for reducing costs of operations, such as accounting/personnel management systems or enterprise resource planning, was less common in Japanese corporations; the proportion of corporations utilizing them being somewhere between 40 % and 70%. The share of companies having made IT investments with the purpose of opening up new markets (e.g. investments in e-commerce and customer relations' management) is relatively small in Japan, being somewhere around 20 % to 40 %. [41]

The total investments to IT amounted to a total of 20,816.3 billion yen in FY 2000. Of this, close to half were allocated to computers and peripherals, a quarter to software, with the rest being used for wireless communication devices (17.3 %) and wired communication devices (11.5 %). [42]

4.3.3 ENVIRONMENTAL SCIENCES

Ministry of Environment (MOE) is primarily in charge of the steering of environmental sciences related research activities in Japan. The total S&T budget of Ministry of Environment in fiscal 2002 amounted to 30,605 million yen. The budget was basically divided into two parts, to promote R&D in environmental sciences (based on e.g. competitive funds), and directly to certain environmental science institutes to support their research and operational expenses. [43]

In fiscal 2002 Ministry of Environment allocated a total of 20,193 million yen to a variety of programs supporting the promotion of R&D. These included the disbursement of 4,710 million yen as 'competitive funds' for research projects in the fields of global environment, environment technology and waste treatment. Funds allocated directly to research projects in pollution protection and global environment related themes amounted to a total of 2,301 million yen in fiscal 2002. In addition, expenditure on research on pollution survey and monitoring totaled 13,181 million yen in fiscal 2002. [44]

The MOE budget allocation directly to research institutes conducting research on environmental sciences amounted to 10,411 million yen in fiscal 2002. The disbursement

[40] Ibid.
[41] MPHPT, 2002.
[42] Ibid.
[43] Japanese Scientific Monthly Vol.55. No.6. 2002
[44] Ibid.

was directed to support the research and operational expenses of environmental research institutes, such as *the Institute for Environment Studies* and *Minamata Disease Center*. [45]

4.3.4 NANOTECHNOLOGY

Nanotechnology, one of the key priority areas stated in the S&T Basic Plan, was being given a substantial budget increase (15 %) from the central government for the fiscal year 2002. The funding to the field amounted to 74.6 billion yen in FY 2002, which were mostly directed to the two ministries of MEXT (Ministry of Education, Culture, Sports, Science and Technology) and METI (Ministry of Economy, Trade and Industry). In fiscal 2002, the nanotechnology projects aim to promote an interdisciplinary approach in research, to improve the technology transfer, and to foster closer interaction between academia and industry in nanoscience and technologies. [46]

Even though the Japanese government is in great pressure to cut down on public spending, it continues to invest strongly on the four key areas of research. In particular, nanotechnology is the field in which the government funding has been increased the most. Within the specific fields of nanotechnology, materials development and nanoscale fabrication continue to receive the most ample funding. Japan's current strengths are in electronics and materials; these fields are expected to hold great potential as the IT and telecommunications sector is likely to become one of the largest markets for nanoscale devices and materials. [47]

Of the total government nanotechnology budget of 74.6 billion yen for fiscal 2002, MEXT covers 56%. The MEXT budget allocation in 2002 to nanotechnology increased substantially from the previous year, reaching 30.1 billion yen. The actual disbursement may become even bigger if the competitive grants allocated to basic research in nanotechnology are included. Among the new MEXT nanotechnology programs are e.g. the Virtual Laboratory, where researchers from a variety of fields conduct interdisciplinary research in 10 nanotechnology related themes, and the Nanotechnology Support Program, whose purpose is to enhance the information flow between researchers and open up specialized laboratory facilities. In addition, MEXT is building up an information database that collects all the research results related to nanotechnology from both private and public institutions. [48]

METI's nanotechnology budget for fiscal 2002 amounted to approximately 31.7 billion yen, which covers 42 % of the total government funding to nanotechnology in 2002. When examining the growth in nanotechnology budgets of different ministries, METI's budget has been increased the most, by an astounding 80 % in FY 2002.

Around 8.32 billion yen of the METI nanotechnology funds is being allocated to the 'Nanotechnology Program (NP)', which covers research projects in multiple fields, such as in nano-fabrication and metrology. Further, the existing program of 'Materials

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[45] Ibid.
[46] Meakin, 2002. Nanotechnology in Japan- A Guide to Public Spending in FY 2002
[47] Ibid.
[48] Meakin, 2002.

Nanotechnology Project (MNP)' is being expanded. MNP is a large-scale program covering a number of nanotechnology fields and involving over 80 private corporations, over 50 universities and 17 independent administrative institutions. In 2002, METI financed MNP with a total of 5.65 billion yen. [49]

When considering the public expenditure on nanotechnology in Japan, other ministries are playing a minor role. Beside METI and MEXT, the other ministries are covering only 2 % of the total government nanotechnology allocation. Among the notable nanotechnology programs coordinated by other ministries, MHLW (Ministry of Health, Labor and Welfare) is managing a program with a focus on the development of nanomedicine. The MHLW financing to this program amounted to 1.4 billion yen in fiscal 2002. [50]

5 GOVERNMENT REFORM 2001

5.1 THE PROGRESS OF THE GOVERNMENT REFORM

A vast government reform took place in Japan in the beginning of 2001. The preparation for the reform had started during the Hashimoto Administration in 1996. In fact, the administrative reform was one of the Liberal Democratic Party's campaign pledges in the 1996 House of Representatives election. Soon after entering the office in January 11th 1996, Prime Minister Hashimoto declared in his speech his determination to review the role of the central government. The administrative reform was to become the focus for the Hashimoto administration.

In November 1996, The Government Administrative Reform Council, chaired by the Prime Minister, was established. The aim of the Administrative Reform Council was to simplify the administration and increase its efficiency, and to improve integrity, maneuverability and transparency within the Japanese administration.

The work of the Administrative Reform Council was completed in December 1997, when the Council submitted its Final Report on the suggested reforms. The Final Report consisted of four pillars: establishing a system with more effective political leadership, restructuring of national administrative organs, more transparent administration, and drastic streamlining of the central government. Soon after the submission of the report, the Cabinet announced its' decision to give the highest priority to the government's Administrative Reform Council.

In 1998, the Diet passed legislation 'Basic Law on Administrative Reform of the Central Government', which came into effect in January 1st 2001. The contents of the law highly reflected the Final Report submitted by the Administrative Council.

[49] Ibid.
[50] Ibid.

5.2 THE CENTRAL GOVERNMENT REFORM

A number of laws related to the administrative reform came to follow the outlines stated in the Final Report by the Administrative Reform Council. The main objectives of the new legislation were to strengthen the function of the Cabinet, to reorganize the central government, to make the administration more transparent, and to streamline the government.

5.2.1 ESTABLISHING A SYSTEM WITH MORE EFFECTIVE POLITICAL LEADERSHIP[51]

The revised 'Cabinet Law' strengthened the role of the Cabinet and the Prime Minister. In the law the Prime Minister's authority to submit proposals to the Cabinet on 'basic principles' was clarified. These basic principles include '*external policies and national security policies, administration and financial management, the management of the entire economy and the planning of the budget, the organizational and personnel affairs of administrative organs'.*

In the amended Cabinet Law the role of the Cabinet Secretariat, which directly assists the Prime Minister, was also clarified. The Cabinet Secretariat is in charge of 'planning and drafting' of proposals on issues mentioned in the 'basic principles', and also the function for 'the comprehensive coordination' of related issues. This allows the Cabinet itself to consummate a more 'comprehensive strategic function'.

In order to emphasize the strengthened role of the Cabinet Secretariat in 'planning and drafting', new positions in the Cabinet Secretariat were introduced. Also, the Cabinet Secretariat's posts were opened to individuals from both inside and outside the government. In the past, it was more a rule than an exception that particular posts in the Cabinet Secretariat were assigned to officials from particular Ministries.

The Cabinet Office was established to support the Cabinet Secretariat in forming the basic strategies of the Cabinet. The Cabinet Office is under the direct control of the Prime Minister. The Office will especially function as a unit of interministerial planning and coordination on issues including *economic and fiscal policies; arts, science and technology policies, disaster prevention, gender equality and consumer policies, matters relating to Okinawa and the northern territories of Japan, and public relations.* The following agencies are established within the Cabinet Office as collegial bodies: Council on Economic and Fiscal Policy; Council on Art, Sciences and Technology; Central Disaster Prevention Council and Council for Gender Equality.[52]

The administrative reform increased the administrative leadership of the Prime Minister and the Cabinet, and thus is emphasizing a more centralized administration.

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[51] Prime Minister of Japan and His Cabinet, 2001. Central Government Reform of Japan

[52] Cabinet Office. http://www.cao.go.jp

5.2.2 RESTRUCTURING OF NATIONAL ADMINISTRATIVE ORGANS[53]

One of the major reforms carried out in 2001 was the significant reduction in the number of government ministries and other agencies. One office and 22 ministries were halved into one Cabinet Office and 12 ministries. In addition, a large number of governmental agencies were also merged with the new ministries. The aim of the reform was to organize ministries into larger entities by functional objectives, while giving consideration to conflicts of interest. Interministerial balance and mutual coordination issues were also emphasized.

Furthermore, the new administrative reform introduced the Inter-Ministerial Coordination System, whose principles were set in the revised 'National Government Organization Law'. The basic principle is that each office and ministry must coordinate its policies. The comprehensive coordination will be conducted by the Cabinet Office, where the coordination will be of higher level than the policy coordination between individual Ministries.

5.2.3 MORE TRANSPARENT ADMINISTRATION [54]

The administrative reform introduced a new system of Independent Administrative Institutions (IAI), which was created to enhance 'the effectiveness, quality, and transparency' of certain administrative services. The reform divides administrative tasks into two categories: 1) the implementing function and 2) the planning and drafting functions. IAIs act as independent judicial entities, and are designed to take part of the implementation of the administrative tasks.

IAIs are autonomous with limited prior control from the outside. However, the competent Minister of State presents to a mid-term objective to each of the IAIs, which the IAI is to achieve during the term (3 to 5 years) set by the Minister. The mid-term objective includes issues such as improving the financial performance, improving efficiency, and improvement of the quality of services. The mid-term objective also includes the budget, the plan concerning revenues and expenditures, the plan concerning facilities and equipment and also personnel affairs.

In addition, each IAI is also to make a one-year-plan, which together with the mid-term objective plan will make the frame for evaluation of the performance for each IAI. The evaluation will be conducted by the *IAI Evaluation Committees* established under ministries and by *the Committee for the Evaluation of Policies and IAIs* established in the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT). The members for both committees will be selected from experts in the related field outside the public sector. After the evaluation conducted by the IAI Evaluation Committee is completed, the Committee can propose to certain modifications in operations to the concerned IAI. The Committee for the Evaluation of the Policies and IAIs will review the evaluation made by IAI Evaluation Committee, so the final

[53] Prime Minister of Japan and His Cabinet, 2001.
[54] Prime Minister of Japan and His Cabinet, 2001.

evaluation will be double-checked by two organizations in order to maintain neutrality and objectivity.

The new system of IAIs enhances greatly the performance requirements for the public institutions. In the past, the government would be allocating resources to public institutions with often relatively non-existent control of the usage of the funds. The new system forces organizations to do constant performance evaluation and adjustment of operations in order to achieve the goals set in the mid-term objective plan.

Since the implementation of the system in 2001, over 40 institutes have been granted the status of an Independent Administrative Institute. These include a great number of public research institutes, especially in the fields of agriculture, fisheries and food research. Also, the National Institute of Advanced Industrial Science and Technology (AIST) acts currently as an Independent Administrative Institute. AIST is an organization comprising of 15 research institutes previously under the former Agency of Industrial Science and Technology (the former AIST) and the Weights and Measures Training Institute. The current AIST is Japan’s largest public research organization, employing around 3200 employees in total.[55]

In March 2002 *The Evaluation Panel for Incorporation of National Universities and Other Units* under MEXT presented a final report on the transformation of all national universities into Independent Administrative Institutions (IAIs). The government plans to implement the reform by 2004, which means that the national universities will be independent from the country’s administration from then on. The initial reaction of the Japanese media was acclaim; the universities would finally have the long-awaited academic freedom. But, the academic world remained more skeptical. The reform to make universities into IAIs mean that universities have to bear a heavy responsibility of the ‘performance’, which is related to their funding. This means that the financing of the universities is very much connected to their perceived performance evaluated by the Committees in MEXT. Criticism against the government plan to turn national universities into IAIs quickly increased in the academic world after the presentation of the final report.

5.2.4 DRASTIC STREAMLINING OF THE CENTRAL GOVERNMENT

Streamlining the government has been one of the main focus points when implementing the administrative reform. Streamlining includes e.g. measures to significantly reduce the number of civil servants and the number of bureaus. The number of national civil servants will be cut by 25% over the next ten years. The total number of bureaus will be decreased from 128 to 96 (by 25%) and that of divisions from approximately 1200 to 1000 (by 20%). The reform will not only concern the re-organization of ministries and other large entities, but also the number of national universities, national hospitals and clinics, research institutes, and other government agencies will be reduced. [56]

[55] AIST. http://www.aist.go.jp
[56] MOFA, Gist of the Central Government Reform.

Streamlining will be applied ‘from the public sector to the private sector’ and ‘from the central government to the local governments’. The aim is to ‘abolish, privatize, deregulate, or delegate to local governments jobs not necessarily performed by the State’.

Outsourcing to the private sector will be promoted, while the State will still continue to act as the administrator of the outsourced activities. Fields that could be outsourced include social capital consolidation, data processing, statistics and the management of national properties.

Furthermore, the deregulation and delegation to local governments will be thoroughly reviewed to become more efficient. The functions of certain government enterprises will also be re-evaluated; including the transformation of the postal services into newly-established Postal Public Corporation. The reform will also cover the more efficient implementation of the undertakings of national forests.

6 GENERAL S&T POLICY FRAMEWORK

6.1 THE STEERING OF S&T POLICIES

Prime Minister and the Cabinet act as the supreme and ultimate decision-making and coordination units concerning science and technology policies in Japan. In the government reform that took place in 2001 the roles of the Prime Minister and the Cabinet were further strengthened in relation to other government agencies.

Cabinet Office is a new administrative organ established after the administrative reform that functions directly under the Prime Minister and the Cabinet. Cabinet Office acts as a key planner and coordinator regarding major Cabinet policies, in addition to which it also handles important administrative tasks.

Prime Minister is the head of the Cabinet Office. Prior to the reform, the role of the Prime Minister was merely just to chair the Cabinet Office meetings. There were significant limits in the Prime Minister’s leadership, which was a major reason to the perceived inefficiency in Japan’s administration. The reform brought about a change to the role of the Prime Minister, so that with the new legislation Prime Minister could take initiative in proposing government policies in certain key areas, such as the state economic and fiscal policy and the science and technology policy. However, not only did the Prime Minister gain in power, but also the functions of the Cabinet and the Cabinet Office were strengthened in relation to ministries.

Council for Science and Technology Policy (CSTP), under the administration of the Cabinet Office, is in charge of the steering of the S&T policies mentioned in the Science and Technology Basic Plan. The Science and Technology Basic Plan has a role as a highest S&T Policy in Japan, and thus as forms a foundation based on which all the S&T related measures and programs are to be drafted and realized. Since CSTP is the primary organization supervising the implementation of the Basic Plan, it is the highest administrative organ regarding S&T issues in Japan.

Furthermore, various ministries are in charge of the actual implementation of the science and technology programs. Cabinet Office acts as the overall coordinator of the ministries' S&T programs. Two of the most important ministries implementing S&T related programs are MEXT *(The Ministry of Education, Culture, Sports, Science and Technology*) and METI *(The Ministry of Economy, Trade and Industry).* When examining the total S&T budget of all ministries combined, MEXT covers 64% and METI 17% of the total resource coordination, and thus their role is significant in the Japanese science and technology scene.[57]

Further, ministries act as coordinators of the various government S&T organizations, including universities, research institutes, public corporations, independent administrative institutions, etc. The administrative reform in 2001 brought about major reforms in the coordination of these national institutes. The reform increased the freedom and responsibility of national agencies to operate quite independently from central government's supervision. However, in turn, the agencies must provide the ministries clear performance plans, do constant evaluation and make adjustments to operations when necessary in order to increase effectiveness and achieve improved results. In the case of IAIs (independent administrative institutes), for instance, the evaluation will be conducted by the IAI evaluation committees that work under various ministries.

6.2 CABINET OFFICE[58]

Cabinet Office is a new administrative organ established after the government reform in 2001. Cabinet Office was established to reinforce the support system for the Cabinet and the Prime Minister. Cabinet Office is taking charge of the highest level *'planning and drafting'* and *'comprehensive coordination'* functions within the Japanese government.

Cabinet Office forms policy initiatives concerning e.g. the state economic and fiscal policy, the state science and technology policy, and other important matters effecting the whole of the society, such as the promotion of gender-equality. In addition to the policy formation, Cabinet Office also handles matters regarding national safety, such as planning the disaster management, issues relating to Okinawa and the northern territories, and public relations. Cabinet Office also acts as a coordinator between different ministries, and oversees the policy formations that take place in two or more ministries.

With the reform in 2001, four councils were created within the Cabinet Office with the purpose of strengthening the policy formation. The current Cabinet Office councils are: Council for Economic and Fiscal Policy, Council for Science and Technology Policy, Central Disaster Management Council and Council for Gender Equality. The Councils are led by the Prime Minister, and comprise of related ministers and professionals from the specific field of expertise.

The statements and opinions of the Councils regarding their field of expertise are having a strong effect to the Japanese society, as the Councils' official statements are reflected e.g. to the work of ministries. The importance of the Councils is also underlined by the

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[57] TEKES, 2002.
[58] Cabinet Office.

fact that they act as information providers and advisers to the Prime Minister and the Cabinet concerning their specific fields.

It can be said that the government reform and the establishment of the Councils altered the power distribution within the Japanese administration. When examining the Councils in closer detail, it can be pointed out that with the reform, the Councils gained in power in relation to ministries. For instance, in determining the macroeconomic policies, some of the power of Ministry of Finance has clearly been transferred to the Council on Economic and Fiscal Policy within Cabinet Office. This has been seen to diminish the role of Ministry of Finance in determining the future guidelines of the country's fiscal and economic policies. [59]

6.3 COUNCIL FOR SCIENCE AND TECHNOLOGY POLICY (CSTP) [60]

Council for Science and Technology Policy (CSTP) is the highest authority in formulating the science and technology policies and coordinating the work of ministries in science and technology related programs. The Second Science and Technology Basic Plan stated the core missions of CSTP as the steering of '*S&T policies in Japan with foresight and mobility, acting as a control tower under the prime minister's leadership, eliminating administrative sectionalism, and steadily implementing the policies described in the Basic Plan'*. Further, the Basic Plan defined the tasks of CSTP as to *'draw up promotion strategies for prioritized areas that define important fields, as well as for R&D targets and implementing measures, and to express its opinions to the Prime Minister and the other related ministries*'. [61]

The current Council for Science and Technology Policy (CSTP) was established in 2001 as a part of the central government reform, to operate directly under Cabinet Office. The administrative reform in 2001 drastically increased the power of CSTP in drafting and coordinating the science and technology related policies. The strengthened role of CSTP is further emphasized by the fact that the reform brought a significant growth in the number of members in the CSTP Secretariat, from less than ten to the current 100 employees. The significant growth of CSTP Secretariat reflects the increased importance given to CSTP by the Japanese government.

CSTP is chaired by the Prime Minister, and has 14 other members, including the Chief Cabinet Secretary and the Minister of State for the Science and Technology Policy, with the rest of the members being ministers, university professors and representatives from private companies.

CSTP carries out S&T policy formation according to the guidelines of the Science and Technology Basic Plan. The Basic Plan guidelines are affecting greatly the whole Japanese science and technology scene, since the S&T Basic Plan is directing the e.g. the distribution of government funds between different scientific fields. Since more emphasis

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[59] Foreign Press Center/Japan. Sweeping Changes for Ministries and Agencies
[60] Cabinet Office.
[61] Government of Japan, 2001.

will be placed on the four prioritized fields of research mentioned in the Basic Plan, the Basic Plan is greatly affecting the future of the Japanese technological development.

CSTP has an important role in providing the Prime Minister and other ministers with information regarding the developments in science and technology. CSTP also gives opinions to the Prime Minister on important issues relating to S&T, which are directing the formation of science and technology policies and their implementation. In contrast, NISTEP (The National Institute of Science and Technology Policy) is providing CSTP with information concerning the recent developments in the Japanese S&T scene. NISTEP is the primary organization conducting large-scale surveys on the future development of S&T. The future S&T trend reports compiled by NISTEP act as an information source to the highest decision-making authorities regarding the future predictions on science and technology in Japan.

CSTP also controls the work of different ministries in order to eliminate the administrative sectionalism in implementing the S&T programs. Furthermore, CSTP draws plans for S&T budgets, decides of the allocation of researchers, and evaluates important governmental and large-scale R&D projects. CSTP ascertains each ministry's S&T policies, to make sure that they are formed according to the guidelines of the S&T Basic Plan. CSTP will also evaluate the implementation of each ministry's S&T policies, while coordinating the process to avoid harmful sectionalism, such as unnecessary duplication of policies. CSTP also expresses its opinions to each of the related ministries about the basic concepts of the resource allocation when forming the S&T budget for the next fiscal year.

7 JAPAN'S S&T SUPPORT AND POLICY INSTITUTIONS

7.1 MEXT, MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY [62]

The central government reform implemented in 2001 changed drastically the administrative system, including the science and technology administration, in Japan. Several ministries were reorganized in order to achieve greater effectiveness and transparency in governance; the new Ministry of Education, Culture, Sports, Science and Technology (MEXT) was established by integrating the former *Ministry of Education* and *the Science and Technology Agency (STA).* MEXT is the primary ministry making concrete R&D plans and implementing the government S&T programs in Japan.

The main tasks of MEXT in S&T include '*designing, planning, promoting, and coordinating basic policies on science and technology, promotion and evaluation of research and development in important fields mentioned in the Second S&T Basic Plan, and making concrete efforts toward reforming the science and technology system'.* MEXT is also overseeing the transformation of a number of national research institutes and national universities into Independent Administrative Institutions. Currently there are 16 IAIs under the supervision of MEXT. MEXT sets up mid-term objectives for each of

[62] MEXT, Mombukagakusho. http://www.mext.go.jp

these institutes, while the final performance evaluation of each IAI will be conducted by a third party.

The reform of making a number of national research and educational institutes into IAIs require careful implementation of changes in finance, organizational structure, and human resources management. MEXT is also putting attention to the improving of the research quality and environment in universities, in addition to fostering a competitive environment to place the Japanese universities on a path that leads them into becoming world-class educational institutions. [63]

The general account budget of the national government was a total of 81,230 billion yen in FY 2002. The MEXT budget allocation in 2002 amounted to 6,579.8 billion yen, which accounts for 8.1% of the national government budget. The main S&T policies of MEXT in FY 2002 include the promotion of basic research, the promotion of R&D in the important strategic research areas, fostering a competitive research environment, enhancing the S&T infrastructure, and promoting broader application of research results to create new industries. [64]

7.1.1 JSPS, Japan Society for the Promotion of Science [65]

Japan Society for Promoting Science (JSPS) was originally founded in 1932, and is currently under the auspices of MEXT. JSPS main function is to coordinate and develop a number of scientific and academic exchange programs, both domestic and international. The scientific cooperation that JSPS is advancing takes various forms, such as scientist exchanges and joint research/scientific seminars, both between Japanese and international participants. JSPS has overseas offices in USA, Germany, UK, Sweden, Thailand, Egypt and Kenya.

The main functions of JSPS include awarding Grants-in-Aid for scientific research, supporting young researchers, promoting international scientific cooperation, supporting scientific cooperation between the academic community and industry, and to collect and distribute information on scientific research activities. [66]

The former STA Fellowship Program for scientists' exchange, previously administered by the Japan Science and Technology Agency (STA) and Japan Science and Technology Corporation (JST), was transferred to JSPS as a result of the administrative reform in 2001. The transfer of the STA Fellowship Program from JST to JSPS further strengthened the role of JSPS as the primary organization administrating scientific exchange in Japan. JSPS and JST were previously conducting similar tasks, but with the administrative reform the roles of the two organizations became a bit more clarified. It seems that as a result of the reform, JSPS gained more importance in the administration of scientific exchanges in relation to JST.

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[63] MEXT, 2001
[64] Ibid.
[65] JSPS, Nihongakujutsushinkoukai. http://www.jsps.go.jp
[66] Japan Society for the Promotion of Science, 2002. JSPS 2002.

The budget of JSPS in FY 2002 totals 115,9 billion yen, of which 99,5% comes in some form of funding from the Japanese government. These include 29,9 billion yen from the National Treasury as subsidies to support the JSPS programs; 85,3 billion yen as governmental subsidies to promote the 'Grands-in-Aid for Scientific Research program'; and 100 million yen dedicated to the 21st Century COE Program. Chapter 8 examines the Centers of Excellence in more detail.

As of April 2000, JSPS had 62 counterpart institutions in 38 countries and one region. When examining the Japanese-Finnish scientific exchange, JSPS has a cooperation agreement with Academy of Finland. The scientific exchange between Japan and Finland will be further discussed in Chapter 10.

7.1.2 JST, The Japan Science and Technology Corporation [67]

The Japan Science and Technology Corporation (JST) is an organization supporting individual researchers in basic research programs, and providing flexible research set-ups for innovative research initiatives. JST works in order to promote the commercialization of excellent research results from universities, national laboratories and other research institutes. JST supports strongly 'the new technological concepts', which refers to certain technological concepts and production ideas that have potential to gain great demand if introduced to finished goods. Hence, the primary function of JST is to enable innovation by providing necessary resources for R&D activities, and thus a possibility to create new markets and new branches of industry. The Japan Science and Technology Corporation is currently under the supervision of MEXT.

JST plays also an important role in the distribution of scientific and technological information both domestic and overseas. JST builds and distributes one of the largest bibliographic databases in the world on all aspects relating to S&T. JST also works to promote regional research activities, such as joint regional research projects and to support local governments' efforts to upgrade the structures relating to science and technology. In addition, JST is supporting the efficient transfer of university research results to private enterprises.

7.2 METI, Ministry of Economy, Trade and Industry[68]

The Ministry of Economy, Trade and Industry (METI) is in charge of the administration of various policies covering a broad area of economy, trade and industry. In addition, METI is one of the main actors in formulating Japan's science and technology policies and in the organization and implementation of S&T related programs.

The METI budget allocated to science and technology in FY 2002 amounted to 618,3 billion yen. The METI S&T budget for FY2002 focuses particularly on supporting the commercialization of joint university-corporate R&D research results, and increasing the academia-industry interaction. METI is also increasing the competitive venture capital to support the commercialization of new technologies and innovations. In promoting

[67] JST, Kagakugijutsushinkoujigyodan. http://www.jst.go.jp
[68] METI, Keizaisangyosho. http://www.meti.go.jp

regional development, METI launched a program of 'innovative clusters', whose primary purpose is to increase the interaction between local academia, industry and government agencies, with the purpose of enhancing the vitality of regional economies.

In FY 2002, METI has chosen 15 programs from the four main fields of research mentioned in the second Science and Technology Basic Plan. The METI allocation to research on 'Nanotechnology and Materials' amounted to 11.9 billion yen in FY2002, whereas the same year METI budget allocation to research on 'Environmental Sciences' totaled 46.2 billion yen, to 'Information Communication' 27.2 billion, and to 'Life Sciences' 17.8 billion yen.

In fiscal 2002, METI is particularly supporting R&D in small- and medium-sized corporations. During sever fiscal conditions, a number of SMEs are facing difficulties in acquiring and maintaining their R&D facilities vital. The Japanese government has traditionally been quite inactive in supporting the R&D in private corporations. However, some changes have already been on the way; in fiscal 2002 METI is subsidizing R&D technology of small and medium-sized companies with 3,5 billion yen in FY 2002. In addition, the METI allocation for supporting fundamental R&D in the private sector amounted to 12,5 billion yen the same year. In fiscal 2002, METI also supported the 'Commercialization of Pre-competitive Technologies' with 6,2 billion yen.

7.2.1 NEDO, New Energy and Industrial Technology Development Organization [69]

The New Energy and Industrial Technology Development Organization (NEDO) was established in 1980. The organization currently functions under Ministry of Economy, Trade and Industry (METI). As a result of the government reform in 2001, a number of research institutes belonging to NEDO were transferred into independent administrative institutions (IAIs). The reform altered the role of NEDO towards more of a coordinating agency, and it takes a part in the distribution of METI funds to S&T research projects under METI's supervision.

NEDO's original task was to conduct R&D on oil-alternative energy technologies, and since its establishment NEDO took a role as a primary organization concentrating on research on alternative energy usage. NEDO has contributed greatly to the introduction and dissemination of new energy sources and technologies in Japan. Even though a number of NEDO research organizations now operate independently as IAIs, NEDO continues to conduct significant research on a variety of fields. To date NEDO has expanded its research areas to include also e.g. environmental sciences, biotechnology, information technology and new materials. NEDO's approach is basically in the promotion of industrial application research.

NEDO has also an increasingly significant role in taking care of a range of activities as one of the core organizations in implementing Japan's industrial technology policy. NEDO is contributing to the evaluation processes of industrial projects together with the Ministry of Economy, Trade and Industry (METI). Regarding the evaluation of S&T

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[69] NEDO, Shin-enerugii sangyogijutsusogokaihatsukiko. http://www.nedo.go.jp

projects under METI's supervision, METI is in charge of the overall planning, while NEDO functions under METI to take part in the management tasks of the evaluation processes. To be more precise, NEDO takes part in the *project* evaluations, while METI is in charge of the overall evaluation, including *organization, field and R&D grant system* evaluations.

7.2.2 JPO, JAPAN PATENT OFFICE) [70]

Japan Patent Office (JPO) has the primary responsibility of the development of the Japanese intellectual property system from all related aspects. JPO has the authority to handle patent procedures, and carry out related examinations and trials. Japan Patent Office is under the jurisdiction of Ministry of Economy, Trade and Industry, METI.

Japan Patent Office is the authority to grant exclusive rights to patents, and to handle the application procedures regarding e.g. designs and trademarks. After receiving a patent application either from Japan or overseas, JPO conducts a strict examination of the filed documents, based on which the decision on the granting of the patent is made. In case there is objection to the decision, a trial hearing is conducted.

Japan Patent Office plays a significant role in the planning and designing of policies relating to intellectual property rights. JPO is aiming to provide a broader protection of IPR and to revise the amounts of damage compensation in order to foster better IPR protection. In addition, Japan patent office is promoting IPR related research activities in universities and other research institutions.

Furthermore, the Patent Office is active in the various international initiatives for promoting the harmonization of the world- wide IPR systems. JPO is also actively involved in other international cooperation activities, such as information exchange on IPR related matters, cooperative examinations, exchanges related to patent disputes and further education of IPR professionals.

7.3 MAFF, MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES) [71]

Ministry of Agriculture, Forestry and Fisheries (MAFF) is primarily in charge of the agricultural research in Japan. Biotechnology in particular is playing a key role in the development of new technologies in improving the productivity and quality of agriculture, forestry and fisheries and the food industry. The role of MAFF in the Japanese S&T research scene is further emphasized by the fact that the Japanese government designated life sciences (including food research) as one of the four main research areas in the second S&T Basic Plan.

MAFF S&T budget for fiscal 2002 amounted to 112,408 million yen, with a 1.2 % -rise from the previous year. Out of this, close to 80 % was allocated to support the research basis in agricultural and food research. The budget included also 8,436 million yen to research on life sciences, which covers 7.5 % of the total MAFF S&T budget. The

[70] JPO. Tokkyocho. http://www.jpo.go.jp
[71] MAFF. Nourinsuisansho. http://www.maff.go.jp

disbursement to support the agricultural system reform was almost as large (8,221 billion), covering 7.3 % of the total MAFF S&T budget. In addition, MAFF designated funds to promote R&D in agricultural and food research (4 % of the MAFF S&T budget), and to research on environmental sciences (1.5 %), in fiscal 2002.[72]

Most of the agricultural and food research institutes under the supervision of MAFF have been transferred into independent administrative institutions (IAIs), which gives them more flexibility and mobility in terms of budgets and staffing. *The Agriculture, Forestry and Fisheries Research Council (AFFRC)* under MAFF is in charge of the overall coordination of the IAIs conducting agricultural and food research. In particular, AFFRC is playing a significant role in establishing the basic targets and guidelines regarding agricultural and food research. [73]

7.4 MHLW, MINISTRY OF HEALTH, LABOR AND WELFARE[74]

Ministry of Health, Labor and Welfare (MHLW) is primarily supporting research in the fields of medicine and pharmaceuticals. The MHLW budget allocation to research totaled 128.1 billion yen in fiscal 2002, with a 3.4 % rise from the previous year.

Out of the total MHLW research budget, 13,590 million yen were allocated directly to support a number of medical and pharmaceuticals research projects. Disbursements were particularly made to support clinical research for the establishment of more effective health and medical care technologies.

In 2002, MHLW supported a number of research projects in innovative health and welfare sciences with 13,555 million yen. The disbursements were directed to research on emerging innovative medical care technologies, to the promotion of clinical application of basic research results, to the prevention and treatment of immuno-allergic diseases, and to brain science and neurophysiatric diseases. Other fields receiving funds from the MHLW budget included general research on industrial safety and health, and research on the formation of wholesome water recycling. [75]

Moreover, MHLW S&T budget 2002 included 10,084 million yen to support fundamental research on health and medical care, such as the development of medicines and medical equipment. The funding to fundamental research was primarily directed to support the research conducted by the Organization for Pharmaceutical Safety and Research, which is cooperating with a number of national research institutes an universities. In addition, the MHLW allocation to assist directly the operation of medical and pharmaceutical institutes that conduct testing and research activities amounted to 20,314 million yen in fiscal 2002.[76]

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[72] Japan Scientific Monthly, 2002.
[73] AFFRC. http://www.s.affrc.go.jp/index-e.html
[74] MHLW, Kouseirodosho. http://www.mhlw.go.jp
[75] Japan Scientific Monthly, 2002.
[76] Ibid.

7.5 MPHPT, Ministry of Public Management, Home Affairs, Posts and Telecommunications

Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) is responsible for a variety of administrative functions in Japan, such as the administrative organizations, public service servant systems, local administration and finance, elections, fire/disaster prevention, administrative communications, and postal services. Regarding the implementation of science and technology related programs, MPHPT is in charge of the telecommunications field. [77]

MPHPT budget request to IT for fiscal 2002 amounted to 42.8 billion yen. The main focus areas of MPHPT regarding the promotion of IT usage and technologies include the following: the development of necessary IT infrastructure particularly to low population density areas, implementing further regulatory reforms regarding IT, and advancing IT technology usage in both central and local government institutions. In addition, FY 2002 MPHPT concentrates on promoting Internet access at schools and universities, and supporting the strategic R&D in information technologies.[78]

8 R&D Organizations

8.1 Key Research Institutes

8.1.1 RIKEN, The Institute for Physical and Chemical Research [79]

RIKEN, the Institute for Physical and Chemical Research, conducts research on a variety of fields in physical, chemical, engineering and biological sciences. It was established in 1917 as a private research organization, but operates currently with 100 % government funding. Since its establishment, RIKEN has contributed greatly to Japan's industrial and scientific development, and is one of the most influential research organizations in Japan today. RIKEN also plays a significant role in implementing the government's science and technology policies by conducting research in the focus fields designated by the government.

RIKEN conducts basic and applied research, with a special focus on brain, genome, SNP, tissue engineering, plant biotechnology, immunology and allergy fields.[80] The budget of RIKEN for fiscal 2002 totaled to 79.860 billion yen, of which 15.490 billion yen was allocated to basic research. When examining the RIKEN funding for different fields of research, brain science comes out clear as a winner in terms of financial backing with the disbursement of 10.290 billion yen in FY 2002. Much emphasis is also placed on research on genomic sciences with the allocation of 8.377 billion yen in FY 2002. The same year, funding to nuclear and atomic sciences amounted to 7.307 billion yen.

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[77] MPHPT, Soumusho. http://www.soumu.go.jp
[78] MPHPT, 2001.
[79] RIKEN, Rikagakukenkyosho. http://www.riken.go.jp
[80] TEKES, 2002.

RIKEN has also been a reformer of Japanese research practices by e.g. promoting the mobility of researchers and increasing the flexibility of research organizations. RIKEN did also alter the Japanese R&D scene by introducing fixed term employment for researchers, and is placing increasing emphasis on international cooperation. Currently there is a growing number of visiting researchers working in RIKEN, both from Japan and overseas. In fact, the number of visiting researchers is 4.5 -fold in comparison to that of RIKEN's permanent staff. RIKEN has currently approximately 3,700 researchers in total.

In 1986, RIKEN established *the Frontier Research Program (FRP)* for the purpose of conducting basic research in hitherto unexplored areas, i.e. frontier research. The current FRP programs cover a variety of fields, such as biosubramolecules. The Frontier Research Program is designed to create a flexible organizational framework to bring together scientists from both Japan and overseas, for the purpose of conducting cutting-edge research activities.

At the moment RIKEN has approximately 50 research laboratories in a number of geographical locations. The main facilities of RIKEN are located in Wako, Saitama prefecture, where also *the Brain Science Institute* is located. The RIKEN Brain Science Institute conducts research e.g. on neuronal functions, aging, molecular neuropathology and other related themes. The RIKEN Genomic Sciences Center in Yokohama, on the other hand, concentrates on research on genomic illnesses, on the preservation of the environment, and on fostering new industries utilizing genome based research.

8.1.2 AIST, THE NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY [81]

The National Institute of Advantaged Industrial Science and Technology (AIST) comprises of *the Weights and Measures Institute* and 15 research institutes. AIST is now an IAI under the supervision of Ministry of Economy, Trade and Industry. AIST is Japan's largest public research institute with more than 2,300 employees, and its annual budget reaches 21 billion yen. [82]

The central government reform in 2001 brought about a new system of independent administrative institutions, into which AIST was also transferred. The change affected the funding and administration of AIST. As an independent administrative institution AIST now enjoys judicial autonomy with limited government control. In addition to government funding, AIST currently receives financial backing also from private sector corporations.

The research fields of AIST include biotechnology, chemistry, energy, environment, electronics, geology, IT, machinery, materials and metrology. AIST focuses on *'interdisciplinary and broad-spectrum research activities to promote innovation and reinforce competitive strengths of Japanese industry and encourage the creation of new industries'*. AIST has a variety of research groups in a number of locations throughout

[81] AIST, Sangyogijutsusogokenkyusho. http://www.aist.go.jp
[82] TEKES, 2002.

Japan, such as in Hokkaido, Tohoku, Chubu, Chugoku, Shikoku, Kyushu, in addition to the Tsukuba Central Research Base and the newly implemented Tokyo Waterfront Research Base. AIST has also wide networks to other research agencies in Japan and promotes intensively international collaboration with overseas research institutes.

Of the total AIST research budget of 21 billion yen, equally large amounts of funds, (16 % of the total budget), were allocated to each of the research fields of life sciences, IT, nanotechnology and materials, and energy. The importance placed on these fields of research emphasizes the guidelines established on the second S&T Basic Plan. Furthermore, research on geological survey amounted 15 % of the total AIST budget, in addition to which smaller disbursements were made to metrology, environment and manufacturing. [83]

8.1.3 NISTEP, NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY POLICY [84]

NISTEP, National Institute of Science and Technology Policy, was founded in 1988 for the purpose of conducting research with a more social aspect on science and technology. NISTEP plays a significant role in assisting the government in formulating S&T related policies by '*promoting S&T policy research with a comprehensive and long-term perspective*'. NISTEP research topics relating to this field include domestic and international trends in S&T, fostering and securing R&D personnel, R&D funding, and research evaluation. The NISTEP budget for FY 2001 accounted for 940 million yen; the budget has been on a constant increase during the past ten years.

Possibly as its most important function, NISTEP is compiling a massive report '*Technology Foresight Survey*' every five years. The Survey is determining the long-term trends in a number of S&T field in Japan for the next 30 years, pointing out the most significant focus areas in S&T, to which Japan has to place increased emphasis on in order to maintain vitality in its technological development.

The latest Survey, '*the Seventh Technology Foresight Survey*', was published in 2001, projecting the trends in science and technology for the coming 30 years. The Survey was conducted in a close cooperation with over 4000 highly respected scientists from a wide range of S&T research fields. The Survey was using the Delphi Method, to conduct a synthetic investigation on more than 1000 technology topics. The scientists involved were asked questions e.g. about the realization time (within the next 30 years), the importance, and the impact after realization, etc. regarding each of the 1000 technology topics. As a result of the research, IT, environment technology and life sciences emerged as fields to which it is necessary to place emphasis for the coming 10 years. Further, information technology seems to deepen its characteristic as a generic technology supporting and covering all other areas of science and technology, as IT will continue its fusion with other technology fields.

In addition to the policy research, NISTEP conducts research on the relationship between S&T and the society. This field includes research e.g. on how to strengthen the ties

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[83] TEKES, 2002.
[84] NISTEP, Kagakugijutsuseisakukenkyusho. http://www.nistep.go.jp

between R&D and the public, and on how to reflect the opinions and concerns of the society to R&D. Further, NISTEP carries out research on the economic and societal needs regarding the development of new technologies. Other research areas include e.g. what kind of interaction R&D, technological processes and economic growth have, and how to promote innovation in the society.

8.1.3.1 THE SCIENCE AND TECHNOLOGY FORESIGHT CENTER

In 2001 a new S&T administrative organ, the Science and Technology Foresight Center, was established under the supervision of NISTEP. The Science and Technology Foresight Center has a key role serving the highest S&T administrative institutions in Japan, such as CSTP and MEXT, as an information provider on the expected developments in S&T in Japan.

As one of its key functions, the Center coordinates an S&T information network of approximately 2700 experts from a variety of S&T fields in the industrial, government and academic sectors. The Center collects and analyses information obtained from the network, and utilizes it in order to create the report on '*Science and Technology Trends*', which is published on a monthly basis. The "Science and Technology Trends' report is covering key developments and foresights on different fields of science and technology, and is regularly utilized by both CSTP and MEXT in decision-making and policy-formulating processes relating to science and technology.

In addition, the Science and Technology Foresight Center carries out research on S&T trends for the purpose of clarifying the important matters in R&D that Japan should concentrate in the future. The Center also estimates how well Japan's currently performs on key technologies compared with those in the US and major European nations, and how the future seems for Japan's key technologies. [85]

8.2 UNIVERSITIES

8.2.1 NATIONAL UNIVERSITIES

As of July 2001, there were 99 national, 72 public and 478 private universities in Japan. In all of these, there were a total of 470 graduate schools, with 346 Ph.D. courses. [86]

The main objectives of universities are to provide higher education and to conduct research activities. In providing education Japanese universities can be considered effective; they have been able to produce undergraduate diplomas in large quantities with rather limited resources. At the same time Japanese universities have been accused of ineffectiveness and poor performance in their research. They have mainly been conducting basic research, with often rather theoretical approach and with few possibilities of utilizing the research results outside academia. However, in recent years as the government has started to push through some major reforms concerning the whole university system, concrete improvements can already be pointed out.

[85] NISTEP. http://www.nistep.go.jp
[86] MEXT, 2001. Ministry of Education, Culture, Sports, Science and Technology 2001.

One of the reasons hindering innovation at universities in Japan is the fact that the Japanese universities have strong traditions of seniority, and thus the achievements by young skilled researchers have often been left behind the senior professors' names. The Japanese government has been placing increased emphasis on supporting the work of young researchers. The second S&T Basic Plan stated that the '*position of assistant professors should be reviewed…and efforts (should be) made to encourage young researchers to be creative and have a broad perspective'*. Further, the Basic Plan stated that research funds for young researchers are to be expanded, and research awards especially designated to young researchers are to be increased.[87] In addition, the government is currently being active in promoting the professors' entrepreneurship, which was very much discouraged in the past.

Among the most significant changes concerning the whole university system in Japan, is the government plan to transfer all national universities into independent administrative institutions (IAIs). The Second Science and Technology Basic Plan (2001-2005) stated that '*National universities and national research institutes should function as independent administrative institutions by promoting organizational reforms to be carried out autonomously under the president's leadership'*.[88] The transformation of national universities into IAIs is a part of the central government reform taken place in 2001. In June 2001, 'The Policy on the Structural Reform of University', was presented with the aim to strengthen the universities to become more internationally competitive in scientific research and educational activities.[89] The transformation of national universities into IAIs means that universities begin to function independently from the central government's control as separate judicial entities. The central government will only participate in the coordination and evaluation processes concerning the IAIs. The government plans to implement the transformation by 2004.

The national university reform includes also the 'reorganizing and merging' of universities, which means that the number of national universities will be reduced. The aim of the reform is to reorganize the academic institutions in order to make the Japanese national universities internationally more competitive, and '*expanding the depth and width of the education and academic research & study'*. Each university is encouraged to build up 'a distinctive identity' based on the individual strengths and special characteristics, in order to foster the development of each university into a world-class educational institute in a certain chosen field. MEXT is taking a leading role in the consultation of the reform with the national universities, and giving assistance and advice to universities on the theme. The reform will be conducted in close cooperation with the national universities, allowing each concerned university ample time to discuss the issue.[90]

However, even though the objectives of the reform- such as improving the quality and effectiveness of research and education- are widely recognized as necessities, great concern and resistance arose from the academic circles on the reform. Even though the

87 Government of Japan, 2001.
88 Ibid.
89 MEXT. http://www.mext.go.jp
90 MEXT. http://www.mext.go.jp

transformation of national universities into IAIs should in fact increase the independence of universities, some academic circles perceive the transformation as a strengthened control from the central government. The introduction of the IAI system means that each national university must achieve the ‘intermediary objectives’ that MEXT has imposed on each university. Actually, with the transformation of national universities into IAIs, MEXT holds also a power to shut down schools if the perceived performance of a certain school does not meet the requirements. Some circles in the Japanese academia see the ‘intermediary objectives’ as an increased central government control and ‘orders from the bureaucrats’.

In order to carry out the reform properly, MEXT set up ‘the Research and Discussion Council’ to discuss the necessary measures to be taken when implementing the IAI system to universities. The Council presented a report on the theme, which included the following suggestions: 1) it should be made sure that each university secures its own status and autonomous management, 2) management techniques of private-sector conception should be introduced, and 3) a concrete outline of the management system with outside members should be introduced. [91]

The reform will introduce a new system for the evaluation of the performance of national universities, with accurate and fair evaluation procedures. In the past, the evaluation of Japanese national universities has been incomplete and sometimes even close to non-existent, which has been a major cause to the ineffectiveness and poor performance levels of universities. The increased evaluation is aimed to enhance the competition amongst national, public and private universities, and thus lead to the upgrade of universities into a world-class level. As a part of the new evaluation system, the system of COEs (Center of Excellence) program was introduced and put into practice from the beginning of FY 2002. In the system of COE, after careful evaluations, the status of COE can be granted to outstanding research institutes, including national universities. The COE system was created to advance of Japanese research and education institutions in their progress towards the level of highest excellence. The designation and nomination of COEs will be conducted by the 21st Century COE Program Committee, which consists of knowledgeable and expert members from a variety of fields and unrelated to MEXT. The Committee is managed by *Japan Society for the Promotion of Science*, which bases the COE nominations on a careful and unbiased examination that takes into consideration the past academic and educational performances and future plans of each research and educational institute. [92]

8.2.2 NATIONAL INTER-UNIVERSITY RESEARCH INSTITUTES

The administrative reform that took place in January 2001 put emphasis on the reorganization of government research institutes. Prior to the reform, the government research agencies were functioning very much isolated from one another, with minimal interaction and information exchange. This was seen to cause major ineffectiveness in research, and thus hinder innovation. Because of the increased importance of R&D

[91] Ibid.
[92] MEXT. http://www.mext.go.jp

activities and the necessity for cooperation in research activities in today's world, it was seen essential to significantly increase the interaction between different research institutes. Based on that several adjustments were to be taken in the organization of Japanese research units, which led to the increased role of the national inter-university research institutes in Japan.

National inter-university research institutes are set up as governmental research centers and are not affiliated with specific universities. They are open for joint use to all university researchers in Japan. The inter-university institutes are contributing to the promotion of scientific research in their respective specialties, providing university researchers throughout Japan with places for conducting joint research in specific fields as well as joint use of scientific publications, equipment, and large-scale research facilities.

The national inter-university institutes include e.g. the National Institute of Genetics, National Institute of Informatics, Research Institute for Humanity and Nature, and Okazaki National Research Institutes.

8.2.3 PRIVATE UNIVERSITIES

A vast majority of higher education institutions in Japan is private. As of 2001, there were 478 private universities in Japan, which accounted for approximately 75 % of all universities in Japan.[93] Private universities in Japan are suffering from constant underfunding and heavy reliance on tuition fees, which are forced to keep high. Government support to private universities has always been insufficient; the private universities enroll 70 % of the students but receive only 40 % of the government funding allocated to higher education. In addition to the inadequate government support, private universities have experienced difficulties in retaining their autonomy from the government, since a variety of government administrative restrictions has been imposed on them.

The government funds are allocated primarily for covering some of the running costs of private universities, such as maintenance and expansion of university facilities and equipment. Fiscal year 2002 the government allocation to private universities amounted to 3,196 billion yen. During the latter part of 1990s, the annual government disbursements were more or less 3,000 billion yen, with the trend being slightly upwards.

In FY 2002 MEXT launched a program 'Special Assistance for Promoting the Advancement of the Education and Research of the Private University', which is focusing in supporting excellent private universities that possess potential and strong motivation to develop into world-class educational institutions. MEXT is also supporting private universities in the 'Project for Promoting the Industry-University Joint Research', which includes financial support for joint research projects between private universities and corporations. [94]

[93] MEXT, 2001.
[94] MEXT.

The most prestigious private universities in Japan include the Universities of Waseda and Keio.

8.3 SCIENCE PARKS AND SCIENCE CITIES

The definitions of a science park are varied, but most often a science park is considered as an organization, which comprises of a number of institutes located close to each other that conduct extensive R&D activities. According to a definition by International Association of Science Parks (IASP), *' a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities'*.[95] A science park has a special significance in promoting regional development, as it fosters the competitiveness of a certain region, and thus results in increased welfare in the region. In this chapter, the definition of a science park is also encompassing terms such as a 'technology park' and a 'research park'.

The Japanese science parks are very diverse. They vary greatly in their activities and size; some may focus strictly on research, while others also conduct incubation, licensing and spin-off processes. Currently there are about 150 science parks in Japan, including those that are planned or under construction. A study by Shigeki Sadato (1996) showed that more than fifty percent of Japanese science parks are of size 1-50 ha. Parks under 1 ha are practically buildings where R&D institutes and companies have their research laboratories or offices. Science cities are, according to Sadato (1996), science parks of size with more than 100 ha that also include universities, public and corporate research centers, and housing.[96] The most well-known science cities in Japan are Tsukuba Science City and Keihanna Science City. Both Tsukuba and Keihanna Science Cities have a population of about 200,000, of which 8% are research professionals in Tsukuba and 5% in Keihanna.

The history of Japanese science parks can be described as relatively short, in comparison with other industrialized nations. Most Japanese research parks started operating only after the late 1980s. Before 1984, there were only four research parks in operation. The relatively short history of science parks in Japan may have had an impact on the fact that in international comparison, Japanese science parks do not score very highly regarding incubation, coordination and technology transfer activities. [97]

About 86% of the Japanese science parks are financed by the government. Private science parks do exist, but they are relatively small in number. Likewise many of the public science parks, a number of the private parks in Japan have not by far managed to gain much success either. As examples of the better functioning private parks, Kyoto Research Park (KPR) and Kanagawa Science Park are worth mentioning.

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[95] IASP. http://www.iaspworld.org
[96] Sadato, 1996. The Function of Research Parks in Regional Development: A Case Study of the Network Development of Kyoto Research Park (KRP).
[97] Sadado, 1996.

Since most Japanese science parks are publicly financed, and the planning of the parks has been primarily left to the municipal governments, the outcome leaves often to hope for. The primary focus of the science park planners has often been on the construction or logistics support, far away from the original purpose of building a community that could foster new innovations. Thus, relatively many of the Japanese science park projects can be described as unsuccessful. The basic problem of Japanese science parks is that they have been able to foster only a limited number of achievements, such as the creation of new innovations or fostering new local SMEs. Below are some examples of better functioning science parks in Japan.

8.3.1 Kyoto Research Park (KRP)[98]

Kyoto Research Park (KPR) was established in 1989 as a privately owned science park to an area west of Kyoto City. Since its establishment in late 1980s, Kyoto Research Park became financially profitable in 1996 and recovered all accumulated losses in 1999. Even though KRP is managed strictly on profit-basis with no government funding, the Kyoto City government was actively involved in the planning of the Park. Since its establishment, KRP has maintained a strong local focus; the Park was not established with the goal of attracting high-tech companies from outside the region, but rather with a purpose of fostering local industries, especially in the field of IT technologies.

In late 1970s, Osaka Gas Co. closed down its production facilities at the current KPR site, after which the company began to search for new utilization means for the site. Eventually Osaka Gas Co. decided to designate the area for the development of a profit-based and privately-owned research park, which led to the establishment of the current KPR. To date Kyoto Research Park has developed into a research center comprising of 177 institutions, out of which seven are government institutions supporting new ventures and SMEs, and 170 being private companies varying from small start-ups to well-established large enterprises. 45 % of the companies in Kyoto Research Park fall into the categories of new media and IT.

Kyoto Research Park provides its client corporations office space and research facilities, and organizes a number of joint seminars, conferences and projects in cooperation with the local academia. KRP and local universities also established Kansai TLO in 1998 as a KRP subsidiary with the purpose of conducting technology-licensing activities. Kansai TLO plays an important role in transferring local university-based new technical innovations to companies in the Kyoto region for the potential commercialization.

Kyoto Research Parks runs a program of *the Center for Entrepreneurship Education*. The Center is a joint program of Kyoto Research Park and the two city-government agencies, whose purpose is to spread entrepreneurship education in high schools and colleges in the Kyoto region. The program aims to secure the entrepreneurship spirit of the younger generation in the Kyoto region, and thus tries to take part in the creation of the basis for future innovations.

[98] KRP. http://www.krp.co.jp

8.3.2 KANAGAWA SCIENCE PARK (KSP) [99]

Kanagawa Science Park (KSP) was established in 1989 to a location in Kawasaki City, Kanagawa Prefecture, about 15 kilometers south of Tokyo. Kanagawa Science Park is a result of a joint prefectural, city and private initiative with the objective of creating local businesses in the new fields of economy. The establishment of the Science Park played a particularly important role in keeping the region vital, because until 1970s Kanagawa was a home for a large number of declining heavy industries. With the hollowing-out of the heavy industries and increasing unemployment problems, the Kanagawa Prefectural Government employed new industrial policies with the focus on the knowledge- and technology- based industries, which also influenced positively to the establishment of KSP.

Currently Kanagawa Science Park includes approximately 80 corporations, varying from large multinationals to small start-up companies, and a couple of laboratories under its premises. The main function of KSP is to provide a variety of support programs to new start-up companies, including financial incentives, reasonably- priced office space and other facilities, technical guidance and business and administration support services. KRP also runs multi-tenant large-scale research laboratories, with the emphasis on increasing the research cooperation between the different institutions located in the Park. In addition, KSP offers a range of training programs and seminars in business management to support the start-ups in getting on a steady path of growth.

A semi-public corporation, KSP Inc. is primarily in charge of the overall management of the Kanagawa Science Park, and acts as an incubator to *'support entrepreneur development and business start-up'* in the Kanagawa region. KSP Inc. has a capitalization of approximately 4.5 billion yen, of which 1.5 billion is from the public sector and 3 billion from private corporations. The public funds were invested by Kanagawa Prefecture, Kawasaki City, and the Japan Development Bank. The private allocations, on the other hand, came from a number of corporations, such as the Tobishima Corporation (which holds about 30 % of KSP's equity), Meiji Mutual Life Insurance, and Nippon Life Insurance and Nippon Landic, to name a few.

In addition to the KSP Inc., Kanagawa Science Park includes two other major organizations: KFT (The Kanagawa High Technology Foundation) and KAST (The Kanagawa Academy of Science and Technology). KFT works e.g. for the promotion of technology and products on behalf of client companies, and provides information regarding patents and technology transfer procedures. Since KFT is working actively for the promotion of intellectual property rights, it was authorized in 1996 by the Japan Patent Office as a branch office of the JPO's Intellectual Property Center. In addition, KFT offers testing and material characterization services, with the purpose of addressing the specific technical problems and other challenges that arise in the product development and manufacturing processes of client companies.

[99] KSP. http://www.ksp.co.jp; Shapira, 1995. Kanagawa Science Park.

KAST (The Kanagawa Academy of Science and Technology), on the other hand, focuses on research promotion in a close cooperation with the local business community and academia. KAST is promoting R&D particularly in the small-and medium- sized corporations.

8.3.3 TSUKUBA SCIENCE CITY[100]

The first science city was envisioned in Japan in 1961 with a purpose to relocate government institutes out of the densely-populated capital area. A few years later a site in Tsukuba, Ibaraki prefecture, 50 kilometers northwest of Tokyo was selected, and to date the area has grown tremendously into a well-advanced technological center. Tsukuba Science City is presently the leader in scientific research in Japan. Approximately 40 % of the total government budget allocated to national research institutes is concentrated in Tsukuba.

Tsukuba Science City area comprises of 2,700 hectares, and has a population of 188 000 (of which 8 % is research personnel). The population is expected to reach 350,000 in the near future. Tsukuba Science City comprises today of approximately 200 research institutes, including about 50 national research institutes, a number or corporate R&D institutes, labs of multinational corporations and a couple of national universities.

8.3.4 KEIHANNA SCIENCE CITY

Keihanna Science City, also referred as Kansai Science City, comprises of an area stretching to the three prefectures of Kyoto, Osaka and Nara. Keihanna Science City was launched as a national project, in which the local government and Kansai industry were strongly involved from the beginning. This is in contrast to the formation of Tsukuba Science City, in which the planning was mainly taken care by the central government, with little locals involved.

Kansai Science City Promotion Act was enacted in 1987, with the objectives of *'creation and exchange of various cultures, promotion of new and innovative science and technology, and construction of a pilot model city for 21st century'*. This led to the establishment of Keihanna Science City, which aims to strengthen the cooperative networks of industry, academics, and the government in the region. The objective is to foster new innovations and creation of new industries, and increase employment opportunities and welfare in the Kansai region. Keihanna Science City's research fields do not only include fields in natural sciences, but also humanities and social sciences.

Keihanna Science City has today more than 200 000 residents (of which 5% research personnel), and comprises of an area of 154 square meters. The development of Keihanna Science City is still underway, with the target of 410 000 residents to be reached. The institutes of Keihanna Science City include for example: the national Nara Institute of Science and Technology, the Advanced Telecommunication Research Institute International (ATR), and the Research Institute of Innovative Technology for the Earth (RITE).

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[100] Tsukuba Science City. http://www.info-tsukuba.org

8.3.5 YOKOSUKA RESEARCH PARK (YRP)[101]

Yokosuka Research Park (YRP), located in Kanagawa prefecture, was established in October 1997. The former Ministry of Posts and Telecommunications, the Yokosuka City municipality and other related organizations initiated Yokosuka Research Park as a joint project, with an aim to develop the Yokosuka area into an international R&D center on wireless communications technologies. Yokosuka Research Park has its primary objectives in fostering the collaboration between industry, academia and government in the field of telecommunications, in undertaking strategic R&D from an international viewpoint, such as seeking global standards and user -oriented applications, and in promoting international collaboration. Yokosuka Research Park provides its client corporations joint-use research facilities for telecommunications research, in addition to which YRP offers personnel training and information support.

Yokosuka Research Park comprises of top-of-the-line national and private, both domestic and foreign research organizations engaged in radio telecommunication technologies. The number of companies/institutes is presently 42, with the working population exceeding 9 500 people. The tenant institutions of YRP include the R&D centers of the most notable corporations in the field of telecommunications, both Japanese and foreign. The YRP institutions work in a variety of fields in communications technologies, including mobile communications, satellite communications, and wireless optic communications. Yokosuka Research Park organizations are placing special emphasis on the standardization of technical standards, terminals and personal digital communications of radio and telecommunication technologies.

CRL Yokosuka was established within YRP as a national research institute conducting joint research on wireless communications technologies. After the government reform in 2001, CRL Yokosuka was transferred into an independent administrative institution, with the purpose of carrying out joint research projects involving several YRP corporations/research institutes. CRL Yokosuka has set up the main research themes as developing the key technologies and systems for advanced mobile communications, and furthering the safe use of electromagnetic waves. CRL Yokosuka has a staff of approximately 90 persons.

8.4 TECHNOLOGY LICENSING OFFICES (TLOS)

One of the most significant reforms designed to foster the industry-academia interaction was the introduction of the Technology Licensing Office (TLO) system in 1998, when the TLO legislation was enforced. The TLOs work for enhancing the utilization of research results from national universities and advance the commercialization of research results into final goods, which could eventually result in the creation of new businesses. TLOs may e.g. assist individual professors in submitting patent applications on professor’s behalf, or search for companies that could be interested in the utilization of the invention. TLOs also take charge of the licensing of the patent. However, there are no legislation or general guidelines on how patent royalties should be distributed between

[101] Yokosuka Research Park. http://www.yrp.co.jp

inventors, universities, and TLOs; the decision concerning the royalty distribution is left to each TLO to manage.[102]

TLOs in Japan do not restrict themselves only to licensing activities, but also work in other fields relating to the utilization of intellectual property in general, such as consultation or even business incubation. The tasks of TLOs in Japan can be described as diverse and depending on each individual TLO, which is the case also with Japanese science parks and business incubators. Thus it may be difficult or even unnecessary to draw strict lines between Japanese TLOs, science parks and incubators, since they all can carry out similar activities.

Since the enforcement of the TLO Law in 1998, 27 agencies have been granted the status as a Technology Licensing Office in Japan. The government is subsidizing each TLO for a period of five years, after which the TLOs are expected to be financially on their own. At this moment the government is subsidizing each TLO for up to one-third of the previous year's expenditures, with a maximum limit of 30 million yen. However, despite the few successful TLOs, many are under a threat to fall into serious financial difficulties after the five-year-period of government subsidies comes to an end. TLOs have also significance for the regional development in helping the regional communities to foster the local economies. Thus it would be beneficial to the Japanese economy as a whole if a good number of the 27 TLOs could survive the ending of government subsidies and establish themselves on a healthy path of growth. [103]

In Japan, the individual researcher retains the right to the invention. This is when the invention is not categorized as a 'National Invention', in which case the right of the invention goes to the state. However, since handing out the inventions to the government does not provide any incentives, many innovations go unreported.

Further, the transferring of innovations to private corporations has traditionally often occurred informally and unreported. Often there are no contract arrangement regarding the technology transfer between the professor and the company. But, even though technology transfer from universities to companies has been widely happening in the past, evidence shows that the utilization of research results by companies has been limited. The incentive for companies to accept inventions from universities may also have been fueled by the company's wish to maintain long-standing relations with a certain professor and to secure the hiring of top graduates from that professor's university. A METI research, conducted in 2001, supports the perception that a vast majority of university research goes unutilized: *250,000 out of Japan's 730,000 researchers, roughly one third, are employed by universities. Universities use about 20 percent, an average of 3,2 trillion yen, out of the total research spending. However, their patent applications account for only 0,04 % of all patent applications.*[104]

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[102] Japan Inc. Magazine 08/01. Special Report: TLOs
[103] Ibid.
[104] Kneller, Ownership Rights to University Inventions in Japan and China; Japan Inc. Magazine 08/01.

Some of the successful TLOs in Japan include e.g. CASTI, (Center for Advanced Science and Technology Incubation), Kansai Technology Licensing Organization (Kansai TLO), Tama TLO and Keio University Intellectual Property Center (IPC).

8.4.1 CASTI, CENTER FOR ADVANCED SCIENCE AND TECHNOLOGY INCUBATION

CASTI, Center for Advanced Science and Technology Incubation, was established in 1998 and is currently Japan's most profitable TLO. CASTI became profitable in the latter half of 2000, when it had been in operation for two years. Since CASTI is affiliated with Tokyo University, it has been able to benefit greatly from Tokyo University's legendary reputation and brand value in the Japanese society as a home for the nation's ultimate top professors, researchers and students. In addition, Tokyo University is receiving ample government funds that enable the fostering of a creative research environment.[105]

The founding members of CASTI are basically professors from Tokyo University. The core function of CASTI is to license Tokyo University based innovations, especially in the field of biotechnology. As of August 2001, CASTI had acquired 133 patents, out of which 50 came from Tokyo University Faculty of Engineering and 40 from the university's Research Center for Advanced Science and Technology. CASTI is primarily concentrating on licensing, leaving other activities, such as incubation, on the background.[106]

In 2000, CASTI's revenues included 58 million yen from consulting and 20 million yen from royalties. In addition, CASTI charges relatively high membership fees from its' corporate members, which amounts to 5 million yen. The CASTI practice of collecting high membership fees has caused some annoyance and even jealousy among other TLOs in Japan; triggering criticism that it is not proper for an institute so closely related to a public university to have that strong ties to industry. [107]

8.5 INCUBATORS

The term 'business incubation' is mostly used to describe the dynamic process of nurturing the business development in newly established firms. Incubators are organizations providing assistance in a variety of ways to help the young companies to survive and grow though the start-up period, during which they are most vulnerable. Incubators are also often referred as 'business angels', since they provide the new firms with assistance on a large scale, e.g. management advice, access to financing, and critical business and technical support services. Incubators are providing the new firm office space and facilities under the incubator's premises, with flexible leases. In turn, the incubators expect to get their share of the new firm's equities, in hope of maximum profits in the future.

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[105] The Finnish Institute in Japan, 2001. Report on Japanese Technology Licensing Offices and R&D Intellectual Property Rights Issues; Japan Inc. Magazine 08/01.
[106] Ibid.
[107] Japan Inc. 08/01

To date, Japan has few incubators in a true sense of an 'incubator'. Many of the Japanese 'incubators' are just purely providers of office space and equipment to new companies, with no other support activities. Currently the Japanese incubators can be divided into 3 rough categories: to incubators that have been established by large Japanese corporations, to Japanese entities that have devoted themselves entirely to incubation, and to some foreign groups. Many claim, however, that incubators within large Japanese corporations are just the corporations' solution to transfer the innovation activities somewhere where it is possible to escape from the bureaucracy and time-consuming decision-making processes.

There is a very small amount of risk capital in Japan, which has been contributing to the small number of incubators that Japan has today. The relatively small amount of available risk funding has to do with the fact that Japanese are often risk averse, especially now during the significantly worsened economic conditions. In addition, business in Japan is very much of personal relationships, which means that the funding of new ventures is also often handled through one's own network, not through incubators. The Japanese can also be quite reluctant to offer funding to a new company of an unknown entrepreneur, since they feel much more comfortable to deal with people within their network. [108]

9 INNOVATIVE CLUSTERS

As a part of the policy for promoting regional R&D and fostering cooperation between the local academia and industry, the Japanese government decided to form 'innovative clusters' to a number of regions in Japan. The innovative clusters are designed as networks connecting the local participants together, which would advance regional development and eventually lead to an increase in new employment opportunities in the designated regions. In addition to promoting regional industry-academia interaction, the clusters encourage cooperation between local corporations and subcontractors.

The government initiative to form the industrial clusters has importance particularly in regions that have previously been centers of heavy, declining industries. These regions are facing a challenging task of redirecting their resources to another branch(es) of industry, in order to maintain local employment opportunities and to keep the region vital.

Within the government, both MEXT (Ministry of Education, Culture, Sports, Science and Technology) and METI (Ministry of Economy, Trade and Industry) have formed their own respective programs regarding the establishment of industrial clusters to a number of regions in Japan. In April 2002, MEXT announced 12 projects in 10 regions across Japan as candidates to MEXT- designated industrial clusters. The 12 MEXT candidate projects are particularly in the fields of IT and life sciences.

In the 'Innovation Cluster Creation Project', MEXT is allocating 500 million yen each fiscal year to each of the designated clusters, with the longest possible period for receiving the support being 5 years. MEXT is particularly paying attention to the

[108] Japan Inc. 08/00.

coordination of the clusters, as the Cluster Creation Project includes the establishment of the Innovative Cluster Headquarters and also the arranging of specialists as science and technology coordinators.

In addition to MEXT, METI did also form its own plan for the creation of industrial clusters. The METI plan of ‘Advanced Technology Industrial Clusters’, based on the Law for Facilitating the Creation of New Businesses, was introduced in June 2001. However, it is difficult to point out how the two different cluster plans of MEXT and METI are interacting with each other. In addition, both of the plans of the two ministries are just newly formed, and their success is yet to be seen in the future.

When examining the METI clusters, it was the METI regional bureaus that were the primary forces in the designation process of the clusters. Currently there are a total of 19 projects designated as METI industrial clusters in several prefectures across Japan, and these projects are expected to expand. The present 19 projects involve a total of 3,400 mid-tier and small-and medium –sized companies and 180 universities.[109]

As an example of the designated METI innovative clusters, the Hokkaido Super Cluster Promotion Project is worth mentioning. Hokkaido Super Cluster Promotion Project concentrates on the two fields of IT and biotechnology. Hokkaido has traditionally been relatively dependent on government’s subsidies, therefore the Super Cluster Plan was designed to advance the creation vital industries to the region and moreover lessen the dependency on government assistance. An interesting fact about the Hokkaido project is that it was modeled after Finland’s industrial policies. The concrete objectives of Hokkaido Super Cluster Promotion Project include the establishment of approximately 15 IT and biotechnology-related companies within the next three years, to increase the present sales of IT industry by 1.5 times within the next three years, and to start one large large-scale biotechnology R&D project every fiscal year.[110]

Other METI industrial cluster projects include e.g. projects regarding the promotion of biotechnology and IT start-ups in Kanto area, and projects for the promotion of well-fare and recycling technology businesses in the Tohoku region. Particularly interesting is the well-fare related ‘aging society’- project in Tohoku, which involves participants from various fields, such as the Tohoku University and other educational institutes, the chamber of commerce, the local government and local companies. The project concentrates on fostering new health and welfare businesses in the Tohoku area.

An interesting project that is related to the well-fare cluster in the Tohoku region is the building of a well-being center for elderly people to the city of Sendai. The center is completely based on Finnish expertise in health care and well fare technologies. The Sendai center will have comprehensive services for elderly people, including intensified living facilities, and rehabilitation and care services. In addition, the center will include large-scale R&D facilities for research on elderly care and the promotion of well being. The building of the center was initiated by the Finnish side, involving a number of organizations, such as TEKES, STAKES, City of Oulu, and several Finnish research

[109] METI, 2002.
[110] METI Hokkaido. Hokkaido Super Cluster Promotion Project.

institutes and universities. Most of all, the project involves 20 Finnish companies that are in charge of the planning of the center, its architecture and technological facilities. From the Japanese side the project involves e.g. the City of Sendai, the Development Bank of Japan and the Tohoku Fukushi University Group. The building of the center will be completed by the end of 2003, and it will be opened for use during 2004.[111]

9.1 THE 'BIOCLUSTERS'

The environment for fostering biotechnology start-up firms in Japan has improved considerably in the past couple of years. The government is making efforts to provide necessary funding and enact related legislation in order to create a positive growth environment for the new biotechnology related start-ups. The basic strategy of the government for biotechnology industries is to expand the market to 25 trillion yen and create 1,000 new biotechnology related companies by the year 2010.[112]

Japan has two major bioclusters in Kanto (the Greater Tokyo) and in Kansai (the Greater Osaka) regions, both of which are currently experiencing rapid growth. Kanto's 'Genome Bay' consists of a number of companies located in both Kazusa Academia Park in Chiba Prefecture and in Yokohama's Science Frontier. In Kansai the biotechnology industries are concentrated primarily in Kobe and in Osaka regions. [113]

Kansai area has recently been experiencing economic difficulties. As life sciences and biotechnology have been important to the overall development of the region, the government is increasing efforts to support the development of Kansai biotechnology businesses, hoping that biotechnology would give the long-awaited boost to the Kansai economy. In 2001, the government designated a national urban project for '*the formation of an international base for life sciences in Greater Osaka*', whose primary objective is to create a fruitful environment for the advancement of linkages between universities, research organizations and pharmaceutical businesses in the field of biotechnology.

'The Bio Information Highway Plan' is a large-scale project that aims to link together science parks, universities, research organizations, private pharmaceutical research labs and biotech start-up companies in a broad belt of Harima, Kobe, Osaka, Kyoto and Shiga in the Kansai region. The objectives of 'the Bio Information Highway' include cooperative research on a large number of genes and proteins, coordinated management of the related research organizations, and cooperative effort to nurture the biotechnology start-up businesses and commercialization of biotechnology research results into new medicines. [114]

The main actors in 'the Bio Information Highway' are planned to be Saito Life Science Park (International Culture Park), Kobe Medical Industry Development Project, Kansai Science City and Harima Science City. The building of Saito Life Science Park to northern Osaka is currently closest to completion; the 22-ha Park is scheduled to open in late 2003. Saito Life Science Park aims to promote the seeking and gathering of research

[111] Finpro.
[112] Japan Bioindustry Association. JBL Vol.18, 3-4.
[113] Ibid.
[114] News from Osaka, 2001.

seeds, to promote the technology transfer to businesses, to foster biotech venture businesses, and to carry out industry-academia joint research projects.

10 SCIENTIFIC EXCHANGE BETWEEN FINLAND AND JAPAN

Scientific exchange between Finland and Japan has mainly been coordinated through the two agencies of *Japan Society for the Promotion of Science (JSPS)* and *Academy of Finland*. Basically the cooperation between the two organizations is realized in the forms of scientists' exchange and joint seminars. Cooperation between JSPS and Academy of Finland started unofficially already in 1983, whereas the first official agreement concerning scientific exchange between the institutions was signed in 1988. The agreement was further revised in 1997. The cooperation between JSPS and Academy of Finland is well established, and currently the institutions are drawing plans to further the cooperation by creating a network of top research units from both countries.[115]

In October 2001, Academy of Finland and TEKES (National Technology Agency), as representatives of Finland, signed an agreement concerning scientific exchange with the Japanese research institution of NISTEP (National Institute of Science and Technology Policy). The agreement also included the Finnish organizations of SITRA, VTT (Technical Research Centre of Finland) and HUT (Helsinki University of Technology) as collaborating partners. The agreement concentrates on mutual cooperation in science and technology policy research, regarding topics such as S&T foresight, benchmarking, and evaluation and innovation systems. In addition, the agreement focuses on supporting researcher's visits between the two countries and on promoting active information exchange.

The basic objectives of the scientific programs between Finland and Japan include the promotion and support of scientific cooperation between the two countries, and to increase the mobility in all fields of science.

The exchange of scientists between Finland and Japan is mainly organized through the JSPS programs of *'Invitation Fellowships for Foreign Scientists'*, *'Postdoctoral Fellowships'*, and bilateral programs. The JSPS program of 'Invitation Fellowships for Foreign Scientists', for instance, is designed to bring foreign researchers to Japan for the purpose of conducting research and other academic activities in close cooperation with their Japanese colleagues. 'Invitation Fellowships' are designated to support scientists' exchange on either *a short-term basis*, such as inviting foreign scientists to participate in discussions, to attend seminars or to give lectures, or on *a long-term basis,* to participate cooperative research work with scientists at Japanese research institutes or universities. In general, the long-term JSPS programs designed for foreign researchers cover the living expenses and the travel expenses to Japan. In addition, the programs usually cover research travel expenses within Japan and provide other financial support, such as 'a settling-in allowance'.[116]

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[115] The Finnish Institute in Japan, 2001. The Contacts between Finnish Scientific and Cultural Organizations and Japan.
[116] Japan Society for the Promotion of Science, 2002.

Exchange of Scientists between Finland and Japan (through JSPS Programs)

Finnish Scientists to Japan

	1999	2000	2001
Invitation Fellowships for Foreign Scientists	1	1	
Postdoctoral Fellowships	2	3	5
Bilateral Programs	7	7	4
Total	10	11	9

(Source: JSPS 2002)

Japanese Scientists to Finland

	1999	2000	2001
Fellowships for Research Abroad		1	
Bilateral Programs	12	16	16
Total	12	17	16

The Academy of Finland is primarily financing research trips of Finnish scientists to Japan, when the research trip is related *to a joint-research project with Japanese scientists*. The Academy is covering the travel expenses and living costs of during the research trip. JSPS, on the other hand, is financing similar expenses of the Japanese scientists, when they are on a research trip to Finland, which is related to a joint-research project with Finnish scientists.[117]

The Academy of Finland is also financing the expenses of Finnish researchers regarding *joint seminars*, which are organized in cooperation with Japanese scientists. The Academy is covering some of the organizing costs of the seminar, including for example the rent of the seminar space. The financial support for joint seminars is meant for Finnish researchers, who either have existing research cooperation with the Japanese, or have detailed plans for starting joint research projects with Japanese researchers.[118]

The cooperation between Finnish and Japanese universities is well established and takes many forms. Almost all of the universities in Finland have signed an agreement with a Japanese partner university regarding student exchanges. Also, quite many of the universities in Finland do have staff exchange programs with a university in Japan. In addition, universities in both countries have established strong ties regarding researcher's exchange.

VTT, Technical Research Centre of Finland, is the leading technology research organization in Finland, providing a wide range of technology and applied research services on a contract basis to its clients, both in Finland and overseas. VTT has been building up contacts to Japanese scientists in a variety of fields in technology since 1970s. VTT and TEKES have signed a joint agreement on scientific cooperation with the Japanese NEDO, (New Energy and Industrial Technology Development Organization).

[117] Academy of Finland. http://www.aka.fi
[118] Ibid.

In addition, a number of VTT research units have signed independent cooperation agreements with several Japanese research institutes.[119]

The connections that VTT has to Japan consists mainly of joint research projects with Japanese organizations and direct research assignments from Japanese clients, which usually involve finding a solution to a specific technological problem. In September 2002, for instance, VTT signed a cooperation contract with the Japanese National Institute of Earth Science and Disaster Prevention. The five-year contract includes e.g. the development of remote sensing methods, which are used for the prevention of natural disasters.[120]

TEKES, (National Technology Agency), is the main financing organization for R&D projects in Finland. By November 2001 TEKES had financed 31 Finnish-Japanese research projects. Of these, 39 % were in the field of energy-, environment-, and construction technologies, 29 % in bio- and chemical technologies, and 23 % in the field of production and materials technologies. TEKES is also in close cooperation with VTT when carrying out the Finnish-Japanese joint research projects. TEKES has been financing a large number of VTT projects involving Japanese partners. [121]

However, since the functions of some of the key research organizations in Japan are currently in a process of change, modifications to the current agreements between Finnish and Japanese scientific organizations are likely in the future.

[119] Technical Research Centre of Finland. http://www.vtt.fi; Finnish Institute in Japan, 2001. The Contacts between Finnish Scientific and Cultural Organizations and Japan.
[120] Technical Research Centre of Finland.
[121] The Finnish Institute in Japan, 2001.

For Further Information:

Ministries and other government agencies

Prime Minister of Japan and His Cabinet
    http://www.kantei.go.jp

Cabinet Office
    http://www.cao.go.jp

MEXT
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    http://www.mext.go.jp

METI
    Ministry of Economy, Trade and Industry.
    http://www.meti.go.jp

MAFF
    Ministry of Agriculture, Forestry and Fisheries.
    http://www.maff.go.jp

AFFRC
    The Agriculture, Forestry and Fisheries Research Council
    http://www.s.affrc.go.jp/index-e.html

MHLW
    Ministry of Health, Labor and Welfare.
    http://www.mhlw.go.jp

MPHPT
    Ministry of Public Management, Home Affairs, Posts and Telecommunications.
    http://www.soumu.go.jp

MOFA
    Ministry of Foreign Affairs
    http://www.mofa.go.jp

Science and technology related organizations

RIKEN
    The Institute for Physical and Chemical Research.
    http://www.riken.go.jp

AIST
    The National Institute of Advanced Industrial Science and Technology.
    http://www.aist.go.jp

NISTEP
    National Institute of Science and Technology Policy.
    http://www.nistep.go.jp

JSPS
    Japan Society for the Promotion of Science.
    http://www.jsps.go.jp

JSP
    The Japan Science and Technology Corporation.
    http://www.jsp.go.jp

Academy of Finland
    http://www.aka.fi

Kyoto Research Park (KRP)
    http://www.krp.co.jp

Kanagawa Science Park (KSP)
    http://www.ksp.or.jp

Yokosuka Research Park (YRP)
    http://www.yrp.go.jp

Tsukuba Science City
    http://www.info-tsukuba.org

Japan Patent Office.
    http://www.jpo.go.jp

Japan Association of New Business Incubation Organizations
http://www.janbo.gr.jp

Other Organizations

Japan Information Network
http://www.jinjapan.org

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http://www.finpro.fi

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