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White Paper on Science and Technology

(2007–2010)

Innovative Capabilities and Citizens' Quality of Life will Reach the Level of a Developed Nation by 2015

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Abstract

In the 21st century, nations around the world are all facing the challenges of global competition and a rapidly developing knowledge economy. In order to promote national economic growth and improve the quality of life for their citizens, these countries are devoting great efforts to increasing scientific and technological (S&T) resources, accelerating research and development (R&D) and innovation, cultivating S&T personnel, and developing key S&T and industries. Meanwhile, Taiwan is facing challenges from emerging Asian economies, a declining birthrate, and an aging population. Nevertheless, the nation already enjoys a strong information and communications technology (ICT) infrastructure, excellent R&D capabilities in the academic and research sectors, and a successful transformation from an efficiency-driven industry to innovation-driven industry. Taiwan should make full use of these S&T advantages to provide quality lifestyles for its citizens, merge into the international community, and build a model of sustainable economic and societal development.

In 1999, the government enacted the *Fundamental Science and Technology Act* to set guidelines and principles for the promotion of scientific and technological development. According to Article 9 of this Act, the government shall present a written statement once every two years describing the visions, strategies, and current status of S&T development; and according to Article 10, the government shall also formulate a *National Science and Technology Development Plan* once every four years. Since the promotion of S&T development needs to be planned in detailed measures, the government uses the four-year *National Science and Technology Development Plan* for implementation purposes. But to keep pace with ever-changing developments in science and technology, the government also publishes the *White Paper on Science and Technology* to update the status, visions and strategies of development, and to make rolling revisions to the implementation of the *National Science and Technology Development Plan*. After the enactment of the *Fundamental Science and Technology Act*, the Executive Yuan has successively published the *National Science and Technology Development Plan (2001–2004)*, the *White Paper on Science and Technology (2003–2006)*, the *National Science and Technology Development Plan (2005–2008)*, and the *White Paper on Science and Technology (2007–2010)*, each laying out the current status, visions and strategies of S&T development to guide the promotion of S&T development in Taiwan.

This paper was compiled in consultation with cooperating government agencies and contains four chapters. Chapter One, “Foreword,” describes trends in international S&T development and the challenges that follow globalization. Chapter Two, “Current State of Science and Technology in Taiwan,” describes Taiwan’s S&T developmental framework, policy-forming mechanisms, inputs and outputs of resources, major scientific and technological activities, and the regulatory environment. Chapter Three lays out the overall vision and strategies for S&T development in Taiwan. Chapter Four contains each government agency’s goals for promoting S&T development as implemented through annual budget plans.

The Appendix to this paper provides supplemental information and details, including the methods used to compile this *White Paper on Science and Technology*, current status and trends in S&T development in major countries, main implementation results of the *National Science and Technology Development Plan (2005–2008)*, strategic living S&T industries (Industry Technology Strategy Review Board Meeting), the Industrial Development Package, the Industrial Workforce Package, preliminary review results of 2007 government S&T programs, academic research, the Program for Promoting Academic Excellence at Universities (PPAEU), national science and technology programs, industry-university-research cooperation and successful cases of industry-university cooperation, development of science parks, and S&T development at government agencies.

This paper presents the following vision for scientific and technological development:

Innovative capabilities and citizens' quality of life will reach the level of a developed nation by 2015.

In academic excellence research, Taiwan will enhance the research environment to attract world-class researchers and develop original research fields. Taiwan will also cultivate internationally-known researchers and world-leading teams capable of making outstanding contributions in key fields. Academic research and knowledge creation will be applied to benefit industrial development, improve the public's wellbeing, and contribute to all citizens.

In the growth of the innovation economy, technological innovation and knowledge services will become the main sources of added value, and specialized innovation clusters will be formed in various regions. Personnel from industry, academia, and the research sector will engage in closer interchange as well as international exchange, and Taiwan will become the premier location in Asia-Pacific for nurturing innovation and new ventures.

In sustainable quality living, Taiwan will provide all citizens with a sustainable high-quality living environment that offers safety, security, and fast convenient services. Citizens will be able to enjoy high standards of living thanks to technological innovations. Science and technology will be able to develop harmoniously and sustainably with life ethics, humanities and culture, the environment, and the industrial economy. ICT applications will be expanded to improve the quality of work, learning, recreation, and living, and Taiwan will become a "quality Internet society" where services are readily available and knowledge creation can take place anywhere.

Taiwan's vision of economic development for the year 2015 is to reach a nominal GDP of US$30,000 per capita. Since R&D is the driving force of industrial innovation and can accelerate economic development, nations around the world are all actively investing in research and development. For instance, the EU and Norway are aiming to raise their R&D expenditures to 3% of GDP by 2010, and Japan plans to devote ¥25 trillion to innovation over five years beginning 2006. In Taiwan by comparison, the government S&T budget grew less than 10% per year during most of the past five years, and 2005 gross domestic expenditure on R&D accounted for merely 2.52% of GDP, still lagging behind Japan, South Korea, and the US. For R&D expenditure to reach 3% of GDP at a quicker pace, Taiwan's **government will steadily increase its spending on R&D and also induce the private sector to devote greater inputs into R&D, in the hopes that gross domestic expenditure on R&D as a percentage of GDP will continue to grow toward the fixed target of 3%. The nation also hopes that the manufacturing industry's expenditure on R&D as a percentage of sales will reach 2.5%**. In order to strengthen ties between scientific R&D and industrial innovation, **enterprise-financed R&D expenditure in the higher education sector will reach 9.1% by 2009** so as to apply academic R&D capabilities to industries. Since an R&D workforce is central to S&T development, the R&D personnel density of a nation can be measured by the number of researchers per 1,000 employed persons; in this regard Taiwan has enjoyed an upward trend over the past five years and aims to **increase the number of researchers per 1,000 employed persons to 10.9 person-years** (including Ph.D. students engaged in R&D).

The recent boom in the number of Taiwan colleges and universities has diluted the distribution of educational resources, and schools are now facing declines in education quality, staff, and funding. To build a more competitive academic environment, Taiwan aims to have **at least one university place among the top 100 universities in the world**, and to develop **at least 10 Asian-leading research centers in fields where Taiwan has performed exceptionally well**. Over the past five years, Taiwan has ranked among the top four countries for patents granted by the US; in terms of rank, the nation has already reached the top. In terms of percentage, Taiwan accounted for 3.6% of all patents granted by the US in 2005, and aims to **continue placing among the top four countries for US patents granted (excluding new design)**. The nation will strive to improve the quality of patents, and rising patent capabilities will in turn generate greater economic prosperity.

To achieve the visions described above, the following strategies have been formulated:

1. Strengthening the formulation of policies; refining controls and regulations.
2. Developing the S&T workforce; managing the supply and demand of personnel.
3. Cultivating distinguished fields; pursuing academic excellence.
4. Encouraging industry-university cooperation; developing industry clusters.
5. Nurturing innovative enterprises; fostering emerging industries.
6. Improving citizens' wellbeing; raising the quality of life.
7. Boosting defense science and technology; promoting military-civilian technology transfers.

Following discussions at the next (8^{th}) National Science and Technology Conference, the methods for carrying out these strategies will be incorporated into the implementation policies of each government agency and integrated with the nation's overall S&T policies. Thereafter, the specific measures for implementing and promoting these strategies will be formulated. Looking ahead, government agencies will follow the essence of the White Paper to modify their existing S&T measures, make rolling revisions to the implementation of the *National Science and Technology Development Plan (2005–2008)*, and guide the assessment and allocation of resources for future S&T programs.

Chapter 1 – Foreword

The growth of the knowledge economy has raised the standards of human material civilization to unprecedented levels. Nevertheless, rapid developments in science and technology also have led to accelerating lifestyles and changes in society and culture, creating serious problems that must be addressed. Some of these problems include the decline in environmental quality, depletion of natural resources, ethical issues in genetics, invasion of personal privacy, Internet crimes, a digital divide in developing countries, and the widening gap between the rich and the poor. In order to deal with these issues, nations around the world are all injecting more resources into research and development, training the S&T workforce, and developing key areas of science and technology.

In Taiwan, apart from facing the challenges of globalization, the island's own geopolitical and cultural situations have also given rise to unique problems during the course of its S&T development, including an aging society, changing population composition, and increasingly competitive Asian economies. In response, the government in recent years has been placing exceptional emphasis on S&T development, adding greater resources into science and technology, and actively cultivating S&T personnel. And by applying strengths and capabilities in innovation, Taiwan hopes to generate more economic value, mitigate threats from Asia's emerging countries and rising economies, and greatly improve the welfare of its own citizens.

Investing in research and development

To encourage research and development, countries around the world have set funding targets and are vigorously pouring funds into R&D to promote innovation. Governments are strengthening R&D environments, offering incentives, encouraging enterprises to invest in R&D, and participating in international cooperation to stimulate domestic S&T development. To accelerate innovation, many countries are also using special programs to promote innovation; creating research institutions or centers of academic excellence; providing services for technology diffusion, transfer and commercialization; creating integrated mechanisms by linking industry, government, academia and research communities; and transferring the results of research over to industries. Many countries have also set specific targets for R&D spending; for instance, the EU countries are aiming to raise R&D expenditures to 3% of GDP by 2010, and Norway is also targeting for 3% of GDP by 2010. Denmark will be spending hundreds of billions of krones by 2010 to boost education, innovation and research. Ireland will increase its overall R&D investment to 2.5% of GNP by 2010, and South Korea's basic research funding will account for 25% of the government's total R&D expenditures by 2008.

Cultivating scientific and technological personnel

In terms of S&T workforce training, world nations are actively improving basic education (particularly science education) to cultivate future S&T talent, establishing world-class universities or academic research centers to groom high-caliber professionals, training and recruiting talent in key industries to meet the needs of industries or important future S&T fields, and encouraging women to enter research and development careers. In the EU, faced with widespread declining birthrates and aging populations, many countries are attempting to lure retired professionals back to work by improving mechanisms for finding jobs, easing regulations, developing key areas (especially ICT), and improving the working environment to make it easier for aged persons to return to the workplace.

Developing priority S&T/industries

In priority S&T and key industries, many countries are focusing on the development of biotechnology, nanotechnology, and ICT. Advanced countries are concentrating on the R&D and application of key S&T areas, but also emphasizing innovation and new products and employing different policies to achieve their goals for innovation. Meanwhile, developing countries are aiming to close the technology gap with developed countries and raising national levels of S&T development. Many countries have formed policies and plans for developing specialized industries, and are taking active steps to develop healthcare and intelligent robots industries ahead of an aging population and declining birthrates. With the passage of the Kyoto Protocol and a growing awareness of environmental conservation, all nations are emphasizing energy conservation, recycling and renewing natural resources, developing green environment industries, and striking a balance between economic growth and sustainable development.

Aging population and changing composition

In recent years, the trend toward delaying marriage and childbirth have led to a decline in Taiwan's birthrate and is creating a society with fewer children and more elderly persons. As this trend becomes more severe, it will create broader problems such as shortages in overall labor and professional personnel, heavier burdens on younger people supporting the elderly, strains on national finances and income allocation, changing market consumption behavior and structure, greater social welfare costs, and slower economic growth.

According to data from the MOE, the children of foreign spouses accounted for approximately 2.16% (or 60,258) of all students attending elementary and junior high school in 2005, and the number of babies born to foreign spouses is expected to grow steadily. For this reason, new immigrants and children of foreign spouses will become important sources for population growth affecting the overall composition of Taiwan's population.

To prepare for an aging society and changing population, the government should have a comprehensive education policy as well as policies for cultivating and recruiting S&T personnel. More than just increasing the quantity of the population, the government should integrate Taiwan's cultural qualities and social values to cultivate an outstanding workforce that will boost and strengthen the nation's overall capabilities.

Rising Asian economies

Asia plays a very important role in the 21st century. In terms of land, Asia occupies 30% of the world's surface area and supports 42% of the global population. In terms of economy, the region contributes to 57% of the world's GDP and 46% of global trade value, and has already become a major driving force for world economic growth. Individual economies within Asia are also placing greater importance on mutual cooperation and integration in order to build collective advantages. The integration of Asian economies (especially those of East Asia) will have a significant impact on Taiwan. Currently, China, Japan and Korea are taking active steps to integrate with the ten ASEAN members of Vietnam, Cambodia, Laos, Thailand, Myanmar, Malaysia, Singapore, Indonesia, Brunei, and the Philippines. Their efforts to develop "ASEAN-plus-one," "ASEAN-plus-three," or other bilateral or multilateral trade collaborations will stimulate trade growth and investments in the region. It is clear that this trend toward East Asian economic integration can no longer be ignored. Although Taiwan is one of the region's major economies, it has been excluded from integrated trade organizations due to opposition from Mainland China. To overcome this problem, Taiwan must learn to adapt to current trends, boost industrial competitiveness, integrate domestic resources, aggressively participate in regional economic cooperation, break through political barriers, and do all it can to avoid being marginalized.

The low cost of labor and vast market potential in emerging Asian countries such as China and India have shifted the distribution of labor in the global industry. China has also grown into a huge magnet for global businesses by using incentives and other measures to attract foreign investment. Consequently, Taiwan's geocultural situation makes it particularly vulnerable to these trends, which have resulted in major problems such as the outward migration of local manufacturing industries, massive outflow of capital or talent and technology, shift in industrial advantages, slowdown in economic growth, and increase in unemployment rates. Moreover, India's advantages in software R&D products and labor are posing threats to Taiwan's high-tech industry and its position in the global value chain.

Using innovation to create economic value and improve the wellbeing of citizens

Innovation plays varying roles in the development process of different countries because each country is at a different stage of economic development. In the past, developing countries have tended to use S&T to pursue economic growth, whereas developed countries have mostly used S&T to address employment problems or pursue sustainable development, and technologically advanced nations have mainly concentrated on basic research and academic excellence to retain their leading positions in S&T. And with the spread and growth of innovative capabilities, more countries are setting their S&T targets toward the improvement of citizens' wellbeing, and placing greater attention on developing the type of innovation that meets local needs and conforms to their unique cultures.

After achieving globalization, Taiwan has been using its local scientific and technological advantages to create economic value and improve the welfare of its people. Many successful cases have already been produced over the past few years. For instance, the government's S&T programs have integrated upstream and downstream textile businesses and developed key technologies for different types of high value-added textiles. During the 2003 SARS outbreak, Taiwan immediately developed facial masks and protective clothing to significantly prevent the spread of the epidemic. In addition, Taiwan is combining textile technology with tradition, culture and art by using digital inkjet fabric printing technology to imprint local artwork onto clothing and designs. This integration of technology and creativity into textile production has sustained Taiwan's textile output value at more than NT$500 billion each year, and businesses continue to thrive. Another example of innovative success comes from ergonomics of the arm: oval-shaped gears fitted onto fishing reels are a great success among world fishing enthusiasts and can be sold at nearly twice the price; this may appear to be a small innovation but has already made great contributions.

As Taiwan's high-tech businesses continue to improve their manufacturing technologies, many low-priced electronic products have quickly spread to lower-income countries. For instance, inexpensive cell phones make it possible for underdeveloped countries to enjoy the same conveniences as advanced countries. Also, Taiwanese notebook PC firms are cooperating with the UN and other nonprofit organizations to make inexpensive notebook PCs for children in poorer regions of Asia, Africa, and South America to link them to the world; the success of this program has been made possible by the world's leading center for computer-making – Taiwan. These examples describe how Taiwan is using innovation to create economic value and raise the quality of life, at the same time narrowing the digital divide of third-world nations, improving the wellbeing of their people, and giving back to the international community.

In order to optimize the benefits of Taiwan's S&T development, the Executive Yuan has been promoting the development of high-tech living industries through forward-looking strategies, and has also mapped out strategic living industries at the Industry Technology Strategy Review Board Meetings. From 2006 to 2010, nearly NT$32 billion will be allocated to the development of soft electronics, radio frequency identification (RFID), nanotechnology, intelligent robotics, intelligent vehicles, and intelligent homes. These six major industries will help achieve futuristic visions of “convenient new technologies” and “intelligent living” for the benefit of all citizens.

Taiwan’s industrial development during its early stages had mostly been based on manufacturing, production, and technologies imported from abroad, but after several decades of hard work, the people of Taiwan have accumulated excellent capacities in innovation. Looking ahead, the nation will concentrate on “forefront innovation,” “humanistic R&D,” and “simplicity” as overall themes for S&T development and will continue to generate new products and services to provide better health, wealth, convenience, and happiness to all citizens.

Over the past years, the government has placed exceptional emphasis on S&T development, increased inputs into S&T resources, actively cultivated S&T personnel, and achieved outstanding results. Moreover, Taiwan has built a strong ICT infrastructure, accumulated excellent R&D capabilities in the academic and research sectors, and laid solid foundations in R&D and product innovation for local enterprises. These are all advantages that Taiwan enjoys and should be harnessed for their full benefits. In academic research, Taiwan should pursue academic excellence, develop original fields of research, and cultivate great researchers capable of outstanding contributions. In industrial development, pursue innovation, develop the emerging industries, form specialized regional clusters of innovation, and make technical innovation and knowledge services the main sources of added value. In public wellbeing, pursue high-quality living; allow S&T to develop harmoniously and sustainably with life ethics, humanities and culture, the environment, and the industrial economy; provide quality lifestyles for all citizens; merge into the international community, and build a model of sustainable economic and societal development.

Chapter 2 – Current State of Science and Technology in Taiwan

2.1 S&T Development Framework and Policymaking Mechanism

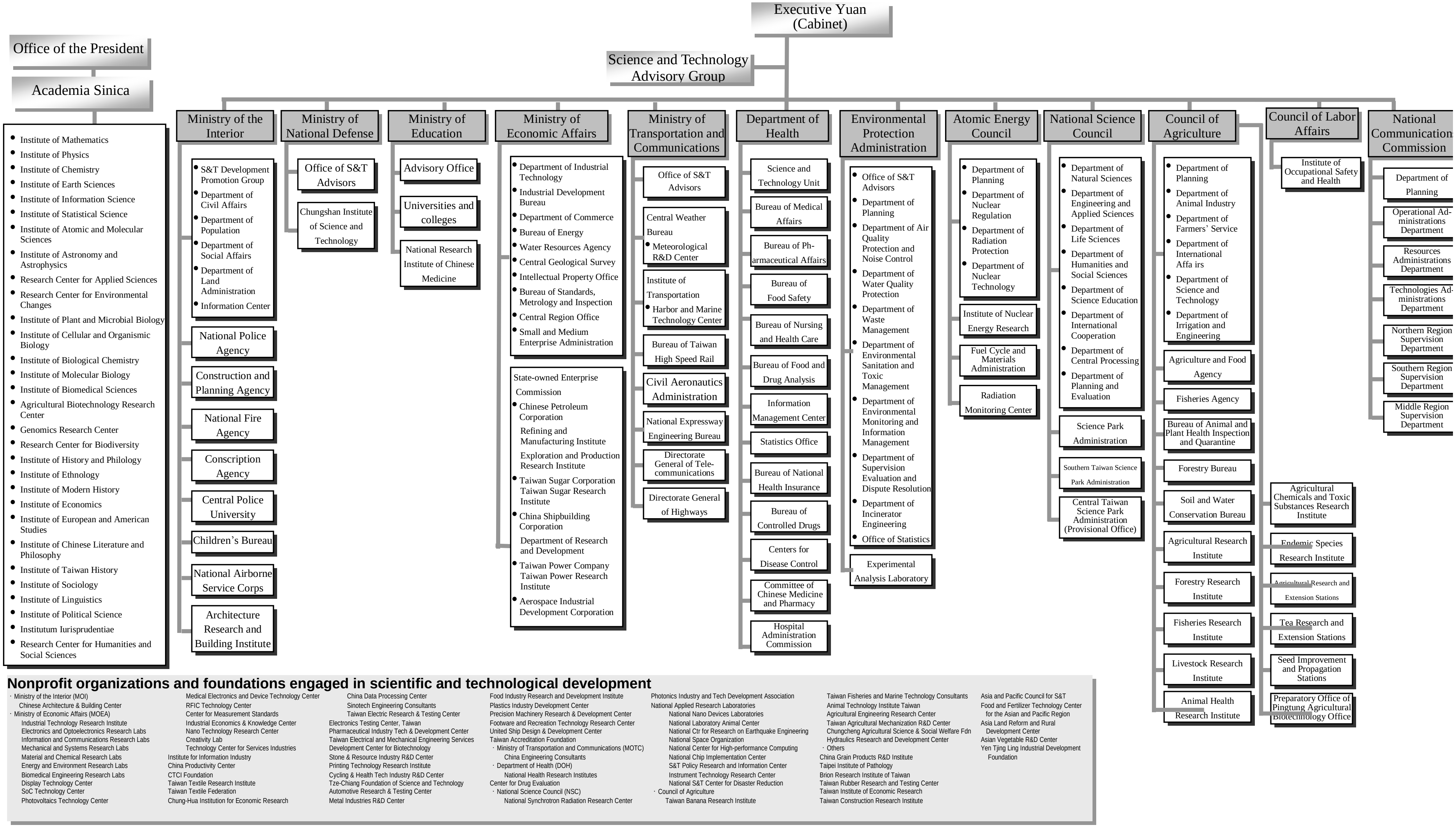
In 1959, the Executive Yuan established the "National Council on Science Development" (predecessor to the National Science Council) to be in charge of promoting scientific and technological development. Over many years, the organization has undergone restructuring and change while establishing and refining Taiwan's S&T development framework and mechanisms for policymaking. In 1999, the government enacted the *Fundamental Science and Technology Act*, which lays out the directions and principles for promoting S&T in Taiwan and has become an important reference for S&T development.

The responsibilities for promotion of scientific and technological development in Taiwan are delegated among various government agencies: Academia Sinica under the Office of the President, and various agencies under the Executive Yuan including the Ministry of the Interior (MOI), Ministry of National Defense (MND), Ministry of Education (MOE), Ministry of Economic Affairs (MOEA), Ministry of Transportation and Communications (MOTC), Department of Health (DOH), Environmental Protection Administration (EPA), Atomic Energy Council (AEC), National Science Council (NSC), Council of Agriculture (COA), Council of Labor Affairs (CLA), and National Communications Commission (NCC). The government guides and implements policies on scientific and technological development though budget planning and execution at each agency. Additionally, the Minister-without-Portfolio in charge of S&T affairs is responsible for coordinating efforts across different agencies.

The first Executive Yuan agencies to designate specialized S&T administrative units were the MOE, MOEA, MOTC, and MND. In 1979, the Science and Technology Advisory Group (STAG) was established separately, and agencies thereafter began designating their own S&T promotion units such as the EPA's Office of Science and Technology Advisors, DOH's Science and Technology Unit, AEC's Department of Planning, and COA's Department of Science and Technology – each is responsible for coordinating and integrating programs within their respective organization. As for agencies that have not yet designated S&T units, the work of S&T development is undertaken by different units depending on the nature of the operation. Responsibilities for actual implementation of S&T development are shared by the research units of universities, research organizations, nonprofit organizations, and public and private enterprises, see Figure 2-1.

Scientific and technological development can be divided according to the level of research into basic research, applied research, experimental development, and commercialization. Apart from playing the key role in directing S&T policy, the government also serves an important function in conducting upstream and midstream research in S&T development. Upstream research consists primarily of basic research conducted by Academia Sinica and colleges/universities under the MOE; midstream research mainly consists of applied research and experimental development conducted by the research units of government agencies under the Executive Yuan, the R&D departments of state-run businesses, and specially commissioned nonprofit research institutes; downstream research consists of experimental development and commercialization as conducted by private enterprises.

Currently in Taiwan, S&T policies are mainly formulated through important conferences such as the Science and Technology Meetings of the Executive Yuan, NSC Council Meetings, National Science and Technology Conferences, Science and Technology Advisory Board Meetings of the Executive Yuan, and the Industry Technology Strategy Review Board Meetings. The consensus reached at these meetings are used to guide the formation of S&T policies.



Source: Government agencies.

Note: Data current as of December 2006.

Figure 2-1 Organizational Framework for S&T Development in the ROC

2.2 Resources and Outputs of Scientific and Technological Development

I. Expenditure

(1) Central government's scientific and technological budget

Taiwan government's S&T budget grew from NT$47.083 billion in 2000 to NT$77.604 billion in 2006, representing an average growth rate of 8.7% per year. The annual growth rate was highest in 2006 at 10.2%, followed by 9.8% in 2001 (see Table 2-1).

Table 2-1 Taiwan Central Government S&T Budget, 2000–2006

Unit: NT$ millions

Agency	2000	2001	2002	2003	2004	2005	2006
National Science Council	17,424	18,709	22,050	21,384	23,051	25,773	28,226
National S&T Development Fund Management Board (for inter-agency S&T programs)	---	---	---	3,126	3,232	3,447	3,483
Executive Yuan	---	---	---	---	---	---	43
Ministry of Economic Affairs	19,478	19,990	20,960	22,685	24,735	23,318	25,883
Academia Sinica	4,164	4,481	4,728	5,843	6,592	7,402	8,531
Council of Agriculture	1,933	3,292	3,132	3,197	3,556	3,707	3,995
Department of Health	1,529	2,382	2,651	2,832	3,146	3,609	4,215
Atomic Energy Council	700	713	735	646	718	936	827
Ministry of Education	1,023	1,063	943	774	725	852	839
Ministry of Transportation and Communications	436	595	566	672	726	693	711
Ministry of the Interior	171	184	164	197	239	232	270
Council of Labor Affairs	142	132	135	144	137	171	184
National Palace Museum	---	22	31	36	103	107	105
Environmental Protection Administration	53	49	51	59	82	78	55
Public Construction Commission	30	53	62	55	46	35	31
Academia Historica	---	---	19	36	40	35	38
Council for Cultural Affairs	---	---	15	20	24	23	---
Ministry of Finance	---	6	3	4	9	3	---
Council of Indigenous Peoples	---	---	2	2	2	---	---
Council for Economic Planning and Development	---	---	---	---	---	---	50
Research, Development and Evaluation Commission	---	---	50	---	---	---	94
Coast Guard Administration	---	14	---	---	---	---	---
Historical Research Commission of Taiwan Province	---	13	13	---	---	---	---
Ministry of Justice	---	---	---	---	---	---	24
Total	47,083	51,698	56,311	61,712	67,163	70,421	77,604
Annual growth rate	5.08%	9.80%	8.92%	9.59%	8.83%	4.85%	10.20%

Source: National Science Council Task Force for Reviewing Governmental S&T Projects.

Notes: 1. Government S&T budget refers to the portion of the central government's budget that is reviewed by the NSC.
2. The 2000 S&T budget has been divided by 1.5 because the government's 2000 accounting year spanned from July 1999 to December 2000.
3. Since the establishment of the Financial Supervisory Commission in July 2004, the budget originally listed under the Ministry of Finance has been relisted under the Financial Supervisory Commission.

(2) Gross domestic expenditure on R&D (GERD)

Taiwan's gross domestic expenditure on R&D (GERD) grew consistently during the past five years. Aside from lower growth in 2001, the nation's R&D spending grew substantially in 2002 and after. The high growth of 9.5% in 2002 was due to the inclusion of defense R&D spending; if excluding defense spending, 2002 would still have seen a solid growth of 5.1%. Taiwan's GERD as a percentage of GDP continues to rise, this figure reached 2.52% in 2005 and is demonstrating stable growth (see Table 2-2). However, Taiwan still lags behind Japan, South Korea, the US and others in this regard (see Figure 2-2).

In historical spending by sector of performance, the highest level of R&D expenditure was seen in the business enterprise sector, followed by the government, higher education, and the private nonprofit sector. Clearly, business enterprises are becoming a major force in Taiwan's research and development activities (Table 2-2).

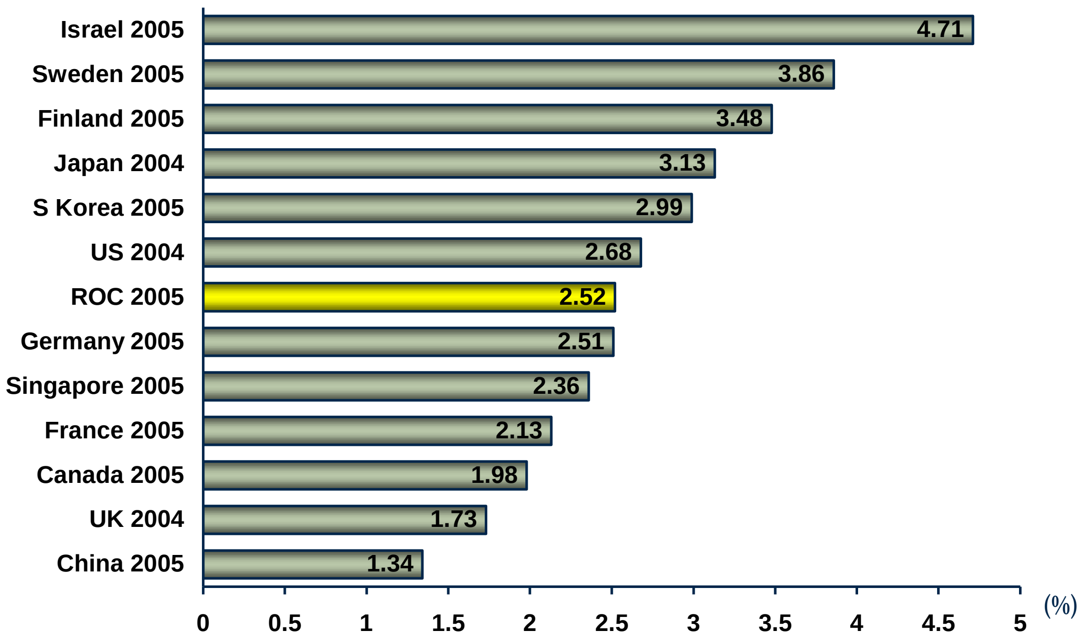
Table 2-2 Taiwan R&D Expenditure by Sector of Performance, 2001–2005

Unit: NT$ millions

Item	2001	2002	2003	2004	2005
Gross domestic expenditure on R&D	204,974	224,428	242,942	263,271	280,980
Growth rate (%)	3.7%	9.5%	8.2%	8.4%	6.7%
As a percentage of GDP (%)	2.08	2.20	2.35	2.44	2.52
Sector of performance					
Business enterprise sector	130,296	139,569	152,614	170,293	188,390
Government sector	47,732	55,693	59,928	61,144	59,143
Higher education sector	25,521	27,637	28,890	30,350	32,092
Private nonprofit sector	1,425	1,530	1,510	1,484	1,355

Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

Note: Defense R&D expenditures were added beginning 2002, and other new industries were added starting 2003.



Sources: 1. ROC: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.
2. All other countries: *Main Science and Technology Indicators*, February 2006, OECD.

Figure 2-2 R&D Expenditure as a Percentage of GDP in Various Countries

1. Sources of funding for R&D expenditure

In Taiwan, the business enterprise sector contributed the highest percent to GERD, followed by the government sector. Prior to 2001, national defense R&D spending was not included in Taiwan's GERD totals but was only added starting 2002. Since the outlays for defense R&D come primarily from the government, the percent of government contribution to GERD in 2002 showed a marked increase; if defense R&D were excluded, the percentages of enterprise and government contributions to GERD would have remained steady from 2001 through 2003, and the percentage from business enterprises would have appeared relatively higher in 2004 and 2005. Government's contribution to GERD as a percentage of GDP peaked in 2003 and has gradually declined in the two years following (Table 2-3).

Table 2-3 Taiwan R&D Expenditure by Source of Funding, 2001–2005

Unit: NT$ millions

	2001	2002	2003	2004	2005
	Amount	Amount	Amount	Amount	Amount
Business enterprise sector	132,950	141,695	153,664	170,469	187,853
(percent)	(64.9)	(63.1)	(63.3)	(64.8)	(66.9)
Government sector	68,339	79,004	85,587	88,499	88,633
(percent)	(33.3)	(35.2)	(35.2)	(33.6)	(31.5)
Higher education sector	2,719	2,762	2,777	3,130	3,147
(percent)	(1.3)	(1.2)	(1.1)	(1.2)	(1.1)
Private nonprofit sector	931	930	854	1,113	1,204
(percent)	(0.5)	(0.4)	(0.4)	(0.4)	(0.4)
Overseas	35	38	60	60	144
(percent)	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)
Gross domestic expenditure on R&D (GERD)	204,974	224,428	242,942	263,271	280,980
Government's contribution to GERD as a percent of GDP (%)	0.69%	0.77%	0.83%	0.82%	0.80%

Source: *Indicators of Science and Technology, Republic of China (2006),* National Science Council.

Note: Defense R&D expenditures were added beginning 2002, and other new industries were added starting 2003.

2. R&D expenditure by type of R&D

Looking at the types of R&D in Taiwan, experimental development accounted for the greatest percentage of national R&D spending in 2005 at 63.3%, followed by applied research at 26.4%, and basic research with the smallest percentage at 10.3%.

Looking at sectors of performance, business enterprises spent the most on experimental development, which accounted for 78.8% of the sector's R&D expenditure in 2001 and rose to 79.7% in 2005. In the government sector, applied research and experimental development each accounted for approximately two-fifths of the sector's expenditure on R&D, with experimental development outweighing applied research over the past four years. In the higher education sector, basic research was the primary activity for R&D (see Table 2-4).

Table 2-4 Taiwan R&D Expenditure by R&D Type and Performance Sector, 2001–2005

Unit: NT$ millions

Sector of performance	Type of R&D	2001	2002	2003	2004	2005
National total	Basic research	10.80%	11.02%	11.73%	11.25%	10.31%
	Applied research	29.23%	26.91%	26.37%	25.33%	26.41%
	Experimental development	59.97%	62.07%	61.90%	63.41%	63.28%
	Total R&D expenditure	204,974	224,428	242,942	263,271	280,980
Business enterprise sector	Basic research	0.71%	0.78%	0.68%	0.66%	0.46%
	Applied research	20.50%	18.53%	19.08%	18.08%	19.79%
	Experimental development	78.80%	80.69%	80.24%	81.26%	79.75%
	R&D expenditure subtotal	130,296	139,569	152,614	170,293	188,390
Government sector	Basic research	18.09%	15.98%	19.97%	21.03%	20.48%
	Applied research	44.40%	40.45%	37.82%	37.25%	38.70%
	Experimental development	37.51%	43.57%	42.21%	41.72%	40.83%
	R&D expenditure subtotal	47,732	55,693	59,928	61,144	59,143
Higher education sector	Basic research	48.08%	51.92%	52.35%	50.72%	49.07%
	Applied research	43.84%	40.00%	39.31%	39.71%	40.74%
	Experimental development	8.07%	8.08%	8.35%	9.57%	10.19%
	R&D expenditure subtotal	25,521	27,637	28,890	30,350	32,092
Private nonprofit sector	Basic research	22.17%	25.48%	25.24%	16.55%	16.73%
	Applied research	57.88%	62.40%	60.87%	72.59%	72.16%
	Experimental development	19.96%	12.12%	13.89%	10.86%	11.11%
	R&D expenditure subtotal	1,425	1,530	1,510	1,484	1,355

Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

3. Business enterprises expenditure on R&D (BERD)

Business enterprises expenditure on R&D (BERD) in Taiwan has gradually increased in the past five years; its rate of growth continues to rise and has exceeded 10% over the past two years. Moreover, BERD as a percentage of value added in industry grew from 1.75% in 2001 to 2.26% in 2005, indicating that Taiwan businesses are placing increasing emphasis on R&D (Table 2-5).

Looking at the types of industries, business R&D expenditure is mostly concentrated on the manufacturing industry – during the past five years, manufacturing expenditure on R&D accounted for approximately 92% of BERD while the services industry only accounted for roughly 7%, and electricity/gas/water, construction, and other industries accounted for less than 1%.

In Taiwan's high-tech and information and communication technology (ICT) industries, expenditures on R&D have grown steadily over the past five years. As a percentage of BERD, spending by the high-tech and ICT industries have also increased consistently, respectively accounting for 72.35% and 73.35% in 2005 (see Table 2-5).

Table 2-5 Taiwan Business Enterprises Expenditure on R&D, 2001–2005

Unit: NT$ millions

Indicator	2001	2002	2003	2004	2005
Business enterprises expenditure on R&D (BERD)	130,296	139,569	152,614	170,293	188,390
Growth rate	3.66%	7.12%	9.35%	11.58%	10.63%
As a percentage of value added in industry	1.75%	1.82%	1.98%	2.11%	2.26%
Manufacturing industry R&D expenditure as a percentage of BERD	92.02%	92.39%	91.78%	91.59%	92.25%
Service industry R&D expenditure as a percentage of BERD	7.40%	6.99%	7.62%	7.68%	7.16%
High-tech industry R&D expenditure as a percentage of BERD	65.98%	68.85%	69.60%	70.03%	72.35%
ICT industry R&D expenditure as a percentage of BERD	68.31%	70.63%	71.25%	71.42%	73.35%

Source: *Indicators of Science and Technology, Republic of China (2006),* National Science Council.

Note: The scope of high-tech and ICT industries is set in accordance with OECD definitions.

4. Higher education expenditure on R&D (HERD)

Over the past five years, Taiwan's higher education expenditure on R&D (HERD) has maintained growth rates of more than 4.5% each year. Looking at the source of funding, the government was the main provider and contributed more than four-fifths of the funds for R&D. Also, enterprise contributions rose from 3.2% in 2001 to 5.8% in 2005, showing that industry-university collaborations are becoming more important (Table 2-6).

Table 2-6 Taiwan Higher Education Expenditure on R&D, 2001–2005

Unit: NT$ millions

Source of funds	2001		2002		2003		2004		2005	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Enterprises	825	3.2%	899	3.3%	1,217	4.2%	1,565	5.2%	1,854	5.8%
Government	21,631	84.8%	23,628	85.5%	24,573	85.1%	25,316	83.4%	26,738	83.3%
Higher education	2,711	10.6%	2,739	9.9%	2,754	9.5%	3,068	10.1%	3,103	9.7%
Private nonprofit	328	1.3%	348	1.3%	301	1.0%	380	1.3%	379	1.2%
Abroad	26	0.1%	22	0.1%	45	0.2%	20	0.1%	18	0.1%
Total	25,521	100%	27,637	100%	28,890	100%	30,350	100%	32,092	100%
Growth rate	6.1%		8.3%		4.5%		5.1%		5.7%	

Source: *Indicators of Science and Technology, Republic of China (2006),* National Science Council.

II. Workforce

(1) Human resources

Personnel cultivated by higher education represent a long cumulative pool of talent for Taiwan's scientific and technological development. In recent years, the number of persons enrolled in universities and above has increased rapidly, reaching 1,115,672 persons in academic year (AY) 2005. Whether in doctoral, master's or bachelor's programs, students majoring in science and technology represent the highest proportion, followed by those in social sciences, and the humanities (see Table 2-7).

Table 2-7 Taiwan Students Enrolled in Higher Education by Field, 2001–2005

Unit: Persons

Program	Field	Academic year (AY)				
		2001	2002	2003	2004	2005
Ph.D. program	Humanities	14.28%	14.39%	14.11%	14.20%	14.23%
	Social sciences	14.84%	15.67%	15.99%	15.78%	15.55%
	Science and technology	70.88%	69.94%	69.90%	70.02%	70.22%
	Persons subtotal	15,962	18,705	21,658	24,409	27,531
Master's program	Humanities	22.94%	23.21%	23.30%	23.37%	23.27%
	Social sciences	27.28%	28.02%	28.81%	29.36%	29.40%
	Science and technology	49.37%	48.77%	47.89%	47.27%	47.33%
	Persons subtotal	87,251	103,425	121,909	135,992	149,493
Bachelor's program	Humanities	16.83%	16.30%	16.26%	16.20%	16.17%
	Social sciences	35.72%	36.12%	36.10%	36.12%	33.64%
	Science and technology	47.45%	47.58%	47.64%	47.68%	50.19%
	Persons subtotal	677,171	770,915	837,602	894,528	938,648
Total persons		780,384	893,045	981,169	1,054,929	1,115,672

Source: Ministry of Education.

Notes: 1. Humanities include education, arts, humanities and other fields (including physical education).
2. Social sciences include economic and social psychology, business and management, law, tourism and services, mass communication, and home economics (excluding food/nutrition).
3. Science and technology include natural sciences, mathematics and computation, medicine and public health, industrial crafts, engineering, architecture and urban planning, agriculture/forestry/fishery/animal husbandry, transportation and communications, and food/nutrition.

The number of Taiwan students graduating from higher education rose from 139,645 persons in AY 2001 to 255,262 in AY 2005. Compared to AY 2004, the AY 2005 total represents an overall increase of approximately 10.6%, and Master's graduates in particular grew fastest at 17.7% (see Table 2-8).

Table 2-8 Taiwan Students Graduating from Higher Education, 2001–2005

Unit: Persons

Program	Field	Academic year (AY) 2001	2002	2003	2004	2005
Ph.D. degree	Humanities	235	216	249	252	305
	Social sciences	218	192	246	301	335
	Science and technology	1,010	1,093	1,265	1,411	1,525
	Persons subtotal	1,463	1,501	1,759	1,964	2,165
Master's degree	Humanities	2,788	3,986	4,949	6,034	7,002
	Social sciences	4,912	6,472	8,225	9,850	12,149
	Science and technology	13,052	15,442	17,682	20,097	23,183
	Persons subtotal	20,752	25,900	30,856	35,981	42,334
Bachelor's degree	Humanities	21,285	23,600	26,595	29,440	31,729
	Social sciences	38,750	67,363	62,614	70,378	77,932
	Science and technology	57,395	72,308	86,835	93,036	101,102
	Persons subtotal	117,430	146,166	176,044	192,854	210,763
Total persons		139,645	173,567	210,418	230,799	255,262

Source: Ministry of Education.

Notes: 1. Humanities include education, arts, humanities and other fields (including physical education).
2. Social sciences include economic and social psychology, business and management, law, tourism and services, mass communication, and home economics (excluding food/nutrition).
3. Science and technology include natural sciences, mathematics and computation, medicine and public health, industrial crafts, engineering, architecture and urban planning, agriculture/forestry/fishery/animal husbandry, transportation and communications, and food/nutrition.

(2) Total R&D personnel

Personnel engaged in research and development include researchers, technicians, and support staff. All three types have progressively increased over the past five years with researchers growing fastest in particular – researchers as a percentage of total R&D personnel grew to 59.6% in 2005 while the percentage of technicians and support staff declined. In order to conform to international definitions, Taiwan in 2002 began adding Ph.D. students involved in R&D work to the number of researchers. If Ph.D. students were excluded, researchers as a percentage of R&D personnel would still be highest and still demonstrate a growing trend (see Table 2-9).

Since population sizes vary greatly from country to country, simply counting the number of researchers would not sufficiently reflect the condition of a country's R&D personnel. Therefore, most international comparisons look to the number of researchers per 1,000 employed persons as a more appropriate indicator of a country's R&D personnel density. In Taiwan, this indicator grew steadily over the past five years and rose to 8.9 person-years in 2005, or 8.0 person-years if excluding Ph.D. students. Compared to other countries, Taiwan's full-time equivalent researchers per 1,000 employed persons measured lower than Finland, Sweden, Japan, and the US, but higher than France, Canada, Russia, Germany, South Korea, the UK, and China (see Figure 2-3).

The number of female researchers climbed steadily from 10,744 persons in 2001 to 16,563 in 2005. As a percentage of total researchers, females accounted for more than 18% in all years and grew slightly to 18.6% in 2005 (see Table 2-9).

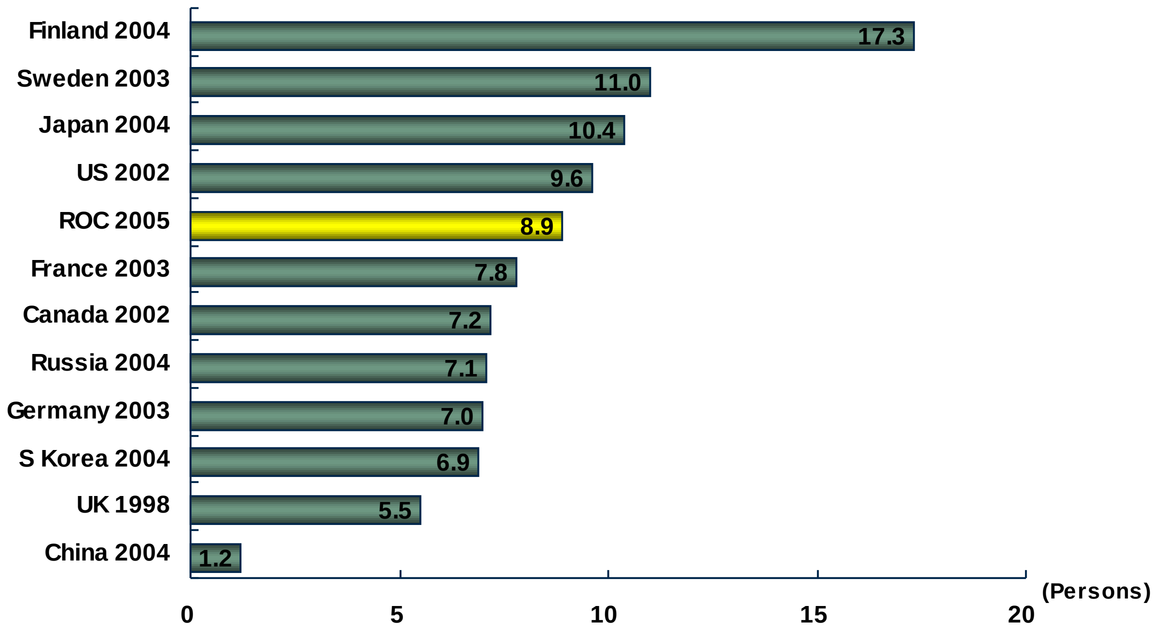
Table 2-9 Taiwan R&D Personnel, 2001–2005

Unit: Full-time equivalents

Item	2001	2002	2003	2004	2005
R&D personnel	107,757	120,013	127,628	138,604	149,154
Researchers	59,656	69,887	75,111	81,209	88,859
As a percentage of R&D personnel	55.36%	58.23%	58.85%	58.59%	59.58%
Technicians	39,296	40,972	43,077	47,568	49,471
As a percentage of R&D personnel	36.47%	34.14%	33.75%	34.32%	33.17%
Supporting staff	8,805	9,154	9,440	9,828	10,824
As a percentage of R&D personnel	8.17%	7.63%	7.40%	7.09%	7.26%
Researchers per 1,000 employed persons	6.4	7.4	7.8	8.3	8.9
Researchers per 1,000 employed persons (excluding Ph.D. students engaged in R&D)	6.4	6.8	7.2	7.5	8.0
Total number of female researchers	10,744	12,766	13,566	14,683	16,563
Female researchers as a percentage of total researchers	18.01%	18.27%	18.06%	18.08%	18.64%

Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

Notes: 1. R&D personnel is expressed in full-time equivalents (FTE), which measures the number of persons engaged in R&D work converted to a full-time working basis; the units are in person-years.
2. Starting 2002, data includes defense R&D personnel and Ph.D. students engaged in R&D.



Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

Figure 2-3 Researchers per 1,000 Employed Persons in Various Countries

1. R&D personnel by sector of performance

In all sectors of performance, researchers consistently comprised the largest proportion of R&D personnel, followed by technicians, then support staff. For the year 2005, researchers accounted for 90% of R&D personnel in the higher education sector, 67.8% in the private nonprofit sector, 53.7% in the government, and 52.9% in business enterprises. Also, the proportion of technicians was highest in business enterprises at 41.0% of that sector, followed by 31.2% in the government sector, 21.3% in private nonprofit, and only 6.2% in higher education. Finally, support staff comprised less than 16% in every sector in 2005 (see Table 2-10).

Table 2-10 Taiwan R&D Personnel (by Sector of Performance), 2001–2005

Units: Full-time equivalents; %

Sector of performance	Type of personnel	2001	2002	2003	2004	2005
Business enterprises	Researchers	48.71%	50.36%	51.48%	51.89%	52.94%
	Technicians	44.35%	43.19%	42.42%	42.32%	41.01%
	Support staff	6.95%	6.45%	6.11%	5.79%	6.04%
	Personnel subtotal	72,469	74,514	80,525	89,882	96,714
Government	Researchers	57.84%	56.51%	55.99%	53.83%	53.71%
	Technicians	28.01%	29.50%	29.41%	31.63%	31.17%
	Support staff	14.14%	13.98%	14.60%	14.54%	15.12%
	Personnel subtotal	20,429	24,298	24,449	24,674	25,673
Higher education	Researchers	85.69%	89.41%	89.34%	84.56%	90.01%
	Technicians	8.76%	6.53%	6.83%	9.77%	6.16%
	Support staff	5.56%	4.06%	3.82%	5.67%	3.83%
	Personnel subtotal	13,840	20,066	21,643	23,017	25,752
Private nonprofit	Researchers	66.93%	60.44%	62.41%	65.54%	67.79%
	Technicians	21.79%	27.05%	25.12%	19.29%	21.26%
	Support staff	11.19%	12.51%	12.46%	15.17%	10.94%
	Personnel subtotal	1,019	1,135	1,011	1,031	1,014

Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

Note: Starting 2002, data includes defense R&D personnel and Ph.D. students engaged in R&D.

2. Researchers by qualification

In Taiwan, researchers of all qualification levels grew throughout the past five years. Specifically, researchers holding master's degrees have been outnumbering bachelor-level researchers since 2001 and are now the mainstay of Taiwan's research force. Those with doctoral degrees have also grown each year, but their proportion among all researchers has been gradually declining (see Table 2-11).

Table 2-11 Taiwan Researchers by Qualification, 2001–2005

Unit: Full-time equivalents

Qualification	2001	2002	2003	2004	2005
Ph.D. degree	12,797	13,448	13,944	14,655	15,450
As a percentage of researchers	21.45%	19.24%	18.56%	18.05%	17.39%
Master's degree	24,825	33,787	37,748	41,657	47,056
As a percentage of researchers	41.61%	48.35%	50.26%	51.30%	52.96%
Bachelor's degree	22,034	22,651	23,419	24,898	26,353
As a percentage of researchers	36.93%	32.41%	31.18%	30.66%	29.66%
Total researchers	59,656	69,887	75,111	81,209	88,859

Source: *Indicators of Science and Technology, Republic of China (2006)*, National Science Council.

Note: Starting 2002, data includes defense R&D personnel and Ph.D. students engaged in R&D.

III. Output

(1) National competitiveness

The World Economic Forum (WEF) and International Institute for Management Development (IMD) publish two major reports for comparing the relative strengths of S&T development of world nations.

In the WEF *Global Competitiveness Report* released in September 2006, Taiwan ranked 13th in the overall Growth competitiveness index, 7th in Higher education and training, 14th in Technological readiness, and 8th in Innovation. Clearly, Taiwan's S&T strengths are being recognized around the world (Table 2-12).

According to the IMD *World Competitiveness Yearbook* released in May 2006, Taiwan placed 18th in the overall ranking and 20th in Infrastructure. Under the Infrastructure factor, Taiwan ranked 4th in Technological infrastructure and 5th in Scientific infrastructure – two indicators of the nation's true scientific and technological capabilities.

Table 2-12 WEF's Global Competitiveness Rankings

Factor	Switzerland	Finland	Sweden	Denmark	Singapore	United States	Japan	Taiwan	Ireland	Korea	Thailand	India	China
Global competitiveness index rank	1	2	3	4	5	6	7	13	21	24	35	43	54
1. Basic requirements	5	3	7	1	2	27	19	21	23	22	38	60	44
(1) Institutions	5	1	12	2	4	27	22	32	17	47	40	34	80
(2) Infrastructure	2	10	9	5	6	12	7	16	31	21	38	62	60
(3) Macroeconomy	18	12	15	14	8	69	91	27	20	13	28	88	6
(4) Health and primary ed	29	7	9	4	20	40	1	25	24	18	84	93	55
2. Efficiency enhancers	5	4	2	6	3	1	16	14	18	25	43	41	71
(1) Higher ed and training	6	1	3	2	10	5	15	7	16	21	42	49	77
(2) Market efficiency	5	17	19	6	4	2	10	22	13	43	31	21	56
(3) Technological readiness	5	12	1	10	2	8	19	14	24	18	48	55	75
3. Innovation factors	2	6	5	7	15	4	1	9	19	20	36	26	57
(1) Business sophistication	3	11	5	9	23	8	2	15	16	22	40	25	65
(2) Innovation	3	4	6	10	9	2	1	8	20	15	33	26	46

Source: *Global Competitiveness Report 2006-2007*, World Economic Forum.

Table 2-13 IMD's World Competitiveness Rankings

Factor	United States	Hong Kong	Singapore	Iceland	Denmark	Ireland	Japan	Taiwan	China	India	Thailand	Korea
Overall rank	1	2	3	4	5	11	17	18	19	29	32	38
1. Economic performance	1	5	4	6	31	9	15	27	3	7	21	41
2. Government efficiency	14	1	2	4	3	7	31	24	17	35	21	47
3. Business efficiency	4	1	7	2	3	6	23	14	30	19	28	45
4. Infrastructure	1	16	5	11	3	27	2	20	37	54	48	24
(1) Basic infrastructure	2	3	1	27	10	37	17	24	20	33	38	29
(2) Technological infrastructure	1	2	3	17	7	27	10	4	33	43	48	6
(3) Scientific infrastructure	1	32	16	20	15	27	2	5	17	26	53	12
(4) Health & environment	22	23	15	4	10	34	11	38	51	57	48	32
(5) Education	11	24	13	3	2	14	23	19	51	59	48	42

Source: *World Competitiveness Yearbook 2006*, International Institute for Management Development.

(2) S&T development output indicators

The output of S&T development is primarily measured by several indicators: academic papers, patents, technology balance of trade, information readiness, and the output value of technology commodities.

1. Academic papers

Academic paper performance can be measured by the number of papers written by Taiwanese authors that are published in *Science Citation Index* (SCI) and *Engineering Index* (EI) journals. The indicators for SCI and EI papers have gradually risen over the past five years (Table 2-14).

2. Patents

Regarding the number of patents, Taiwan has consistently ranked 4th place for number of US patents granted (excluding new design) in the previous five years. Apart from a small dip in 2003, patent performance is showing an overall increase. As a percentage of all US patents, those granted to Taiwan grew from 3.2% in 2001 to 3.6% in 2005 (Tables 2-14 and 2-15).

The Current Impact Index (CII) shows the degree of significance or impact of a patent and is measured by the frequency of citations to the patent. Taiwan's CII for 2004 was 0.85, slightly below 0.88 of the prior year. The CII has been diminishing for the last three years mainly due to fewer patents in semiconductor manufacturing processes and more patents in fields of low originality (Table 2-16).

3. Technology balance of payments

In technology balance of payments, imports showed stable growth while exports showed more variation, resulting in larger fluctuations in the coverage ratio (Table 2-14).

Table 2-14 Taiwan S&T Development Output, 2001–2005

Item	2001	2002	2003	2004	2005
Papers in academic journals					
SCI journals (papers)	10,635	10,831	12,392	12,939	15,661
EI journals (papers)	5,768	5,786	8,011	10,980	11,661
Patents (excluding new design)					
US patents granted to Taiwan nationals (cases)	5,371	5,431	5,298	5,938	5,118
As a percentage of all US patents granted	3.2%	3.2%	3.1%	3.6%	3.6%
Technology balance of payments					
Exports (NT$ millions)	..	11,261	8,941	8,942	..
Imports (NT$ millions)	..	45,246	51,954	52,156	..
Coverage ratio (%)	..	0.25	0.17	0.17	..

Source: *Indicators of Science and Technology, Republic of China (2006),* National Science Council.
Note: Technology balance of payments is unavailable for 2001 and 2005 because the MOEA's "Factory Adjustment and Operation Survey" was suspended in 2001, and data for 2005 has not yet been released.

Table 2-15 US Patents Granted (Excluding New Design), 2001–2005

Country	2001			2002			2003			2004			2005		
	Cases	Rank	%	Cases	Rank	%	Cases	Rank	%	Cases	Rank	%	Cases	Rank	%
US	87,607	1	52.8%	86,977	1	52.0%	87,901	1	52.0%	84,271	1	51.3%	74,637	1	51.9%
Japan	33,223	2	20.0%	34,859	2	20.8%	35,517	2	21.0%	35,350	2	21.5%	30,341	2	21.1%
Germany	11,260	3	6.8%	11,277	3	6.7%	11,444	3	6.8%	10,779	3	6.6%	9,011	3	6.3%
ROC	5,371	4	3.2%	5,431	4	3.2%	5,298	4	3.1%	5,938	4	3.6%	5,118	4	3.6%
S Korea	3,538	8	2.1%	3,786	7	2.3%	3,944	5	2.3%	4,428	5	2.7%	4,352	5	3.0%
UK	3,965	6	2.4%	3,838	6	2.3%	3,627	7	2.1%	3,450	6	2.1%	3,148	6	2.2%
Canada	3,606	7	2.2%	3,431	8	2.1%	3,426	8	2.0%	3,374	8	2.1%	2,894	7	2.0%
France	4,041	5	2.4%	4,035	5	2.4%	3,869	6	2.3%	3,380	7	2.1%	2,866	8	2.0%
Italy	1,709	10	1.0%	1,750	9	1.0%	1,722	9	1.0%	1,584	9	1.0%	1,296	9	0.9%
Sweden	1,743	9	1.0%	1,675	10	1.0%	1,521	10	0.9%	1,290	10	0.8%	1,123	10	0.8%
……															
Total	166,036		100%	167,331		100%	169,023		100%	164,291		100%	143,806		100%

Source: US Patent and Trademark Office (USPTO).

Table 2-16 Current Impact Index of Various Countries, 2000–2004

Country	2000	2001	2002	2003	2004
ROC	1.19	1.14	1.00	0.88	0.85
US	1.14	1.15	1.18	1.18	1.18
Japan	0.93	0.91	0.91	0.89	0.90
Germany	0.59	0.62	0.82	0.81	0.59
France	--	--	0.64	0.61	--
UK	--	--	0.74	0.76	--
Italy	--	--	0.55	0.54	--
Canada	--	--	0.88	0.79	--
S Korea	0.87	0.85	0.82	0.79	0.85

Source: "Capabilities and competitiveness of industrial innovation systems – Analysis based on patents," Taiwan Institute of Economic Research (TIER), 2005. This research report was based data from the USPTO and calculated by TIER.

4. Information readiness

In the WEF *Global Information Technology Report 2005–2006* released in 2006, Taiwan's Networked Readiness Index (NRI) improved from 15th place in 2004 to 7th place out of 115 countries worldwide, and ranked second in Asia only behind Singapore (Table 2-17).

This report utilizes three component indexes: Environment, Readiness, and Usage. Under Environment in the Infrastructure Environment subindex, Taiwan advanced from 23rd to 10th place, and under Usage in the Individual Usage subindex, Taiwan jumped from 27th to 9th place. These rankings demonstrate Taiwan's excellence performance overall.

Table 2-17 Networked Readiness Index Rankings

Country	2004 rank	2005 rank	Change
United States	5	1	4
Singapore	1	2	-1
Denmark	4	3	1
Iceland	2	4	-2
Finland	3	5	-2
Canada	10	6	4
Taiwan	15	7	8
Sweden	6	8	-2
Switzerland	9	9	0
United Kingdom	12	10	2

Source: *Global Information Technology Report 2005–2006*, World Economic Forum (www.weforum.org).

5. Output value of technology commodities

In terms of output value, Taiwan led the world in ICT industries in 2005. It is clear that the high levels of R&D spending and manpower invested in ICT by Taiwan enterprises are already producing excellent results. Moreover, R&D and innovation have generated higher value-added technical textiles and related technologies, transforming traditional industries such as glass fibers into major national industries. Table 2-18 shows Taiwan-made products that placed among the world's top three for output value in 2005.

Table 2-18 Taiwan Products Ranked Among World's Top Three, 2005

(Excluding Overseas Production)

Units: US$ millions; quantity

Products ranked #1			Products ranked #2			Products ranked #3		
Item	Output value	Global market share	Item	Output value	Global market share	Item	Output value	Global market share
Foundries	11,297	67.4%	IC design	7,966	19.9%	Small, medium TFT-LCD panels	2,123	15.6%
IC packaging	5,528	44.8%	DRAM	5,640	22.0%	Notebook PC	2,212	5.8%
IC testing	2,096	60.0%	WLAN	517	23%	Polyester staple fiber(※)	0.705 mn tons	6.9%
Mask ROM	280	91.2%	xDSL CPE	115	8%	Nylon fiber(※)	0.411 mn tons	10.6%
CD-R discs	4,819.2 mn discs	44%	Cable CPE	61	5%	LED	713.4	12%
CD-RW discs	176.0 mn discs	77%	SOHO routers	411	15%	Polyurethane synthetic leather(※)	64.492 mn yards	8.6%
DVD-R discs	3,496.3 mn discs	71%	Analog modems	31	12%			
DVD-RW discs	186.4 mn discs	59%	Large TFT-LCD panels	17,787	41.1%			
Glass fiber	485	47.5%	TN/STN LCD panels	1,248	20.0%			
Electrolytic copper foil	519	36.2%	OLED panels	144	25.9%			
ABS(※)	1.211 mn tons	15.4%	IC substrate	1,328	23%			
			Motherboards (incl. system exports)	620.8	7.7%			
			PTA(※)	4.597 mn tons	15%			
			Polyester filament(※)	1.308 mn tons	9.1%			
			TPE(※)	0.375 mn tons	13.8%			

Source: Industrial Technology Intelligence Services of the Department of Industrial Technology, MOEA.

Note: (※) Rankings for these items are based on output quantity.

2.3 Major Scientific and Technological Activities

I. Strategic High-Tech Living Industries (Industry Technology Strategy Review Board Meeting, BioTaiwan Committee Meeting)

To map out the development of advanced high-tech living industries, a resolution was passed at the Executive Yuan S&T Meeting in March 2006 to devote NT$32 billion from 2006 through 2010 to the development of six major industries: soft electronics, radio frequency identification (RFID) systems, nanoscience and nanotechnology, intelligent robotics, intelligent vehicles, and intelligent living space. These technologies will create more convenient and intelligent living environments for all citizens, ultimately boosting Taiwan's technological advantages and competitiveness (see Appendix 4).

To promote Taiwan's next star industry, the Executive Yuan convened the 2006 "BioTaiwan Committee Meeting" in October 2006 and selected three priority fields for development: agricultural biotechnology, medical equipment, and biotech pharmaceuticals. These industries will build Taiwan into a "major base for genomic medicine research" and "center of clinical research" for the Asia region.

II. Early-Stage Reviews of Government S&T Programs

Several major changes have been made to the government S&T program review system to ensure that public R&D expenditures will closer match government policies and better meet the needs of national socioeconomic development (see Appendix 7). Primary changes include the following:

(1) To build stronger policy connectivity and foster mission-oriented research, the evaluation process will include a review of proposal abstracts and the assessment of priority programs.

(2) For better integration of programs, reviews will be conducted in five major groups instead of 37 individual fields. This will allow program goals to emerge more cohesively rather than appear fragmented or obscured for the sake of field reviews.

(3) Group review committee members will collaborate with experts in the review process; the committee members will concentrate on policy aspects while experts focus on professional aspects.

(4) Funding for programs will be approved on the basis of wholeness and reasonability, that is, it will not be necessary to divide funds into meaningless partitions to fit the order or sequence of programs.

III. Academic Research

In Taiwan, academic research is primarily conducted at such organizations as Academia Sinica, colleges and universities, and research institutes. Funding for academic research comes mostly from government outlays or other commissions by publicly or privately-owned organizations. The government outlays are distributed in two forms: one is self-planned budgets (such as at Academic Sinica), and the other is National Science Council subsidies, which are allocated through discipline planning, a review mechanism, and then distributed to colleges, universities, and research institutes.

(1) Academia Sinica

Academia Sinica has actively restructured its organization in the past few years and now supports approximately 4,500 employees, 21 research institutes, four institute provisional offices, and five research centers including the Research Center for Humanities and Social Sciences, Research Center for Applied Sciences, Genomics Research Center, Research Center for Environmental Changes, and Research Center for Biodiversity. To help personnel concentrate fully on research work, Academia Sinica has improved its review system to become even more stringent and equitable. In addition to conducting multi-year projects, the institution also implements various reward systems such as the "Academia Sinica Investigator Award" to encourage greater innovation and longer research. Appendix 8-1 describes Academia Sinica's major research results, divided into the three areas of mathematics and physical sciences, life sciences, and humanities and social sciences.

(2) Major research results of colleges and universities

Most of the research activities conducted at Taiwan's universities and colleges are primarily funded or commissioned by relevant organizations, and the National Science Council is the largest source of funding for academic research. The NSC plans the development of various disciplines, prepares government budgets, conducts rigorous project reviews, and provides research funding. Additionally, the NSC also implements many schemes to raise the standards of academic research, such as encouraging collaborative exchange and resource integration, promoting multidisciplinary integrated research, attracting outstanding overseas scientists to lead research teams in Taiwan, promoting industry-university-research cooperation, encouraging universities to participate in commercial applied research, and training workers with potential for industrial R&D. The number of NSC research projects and funding amounts approved in recent years are shown in Table 2-19; major results described separately in Appendix 8-2.

Table 2-19 NSC Approved Funding for Research Projects

Unit: NT$ thousands

Field	2001		2002		2003		2004		2005	
	Projects	Amount	Projects	Amount	Projects	Projects	Amount	Projects	Amount	Projects
Natural sciences	1,635	1,824,507	1,576	2,177,583	1,694	2,644,312	1,811	2,790,014	1,882	3,363,823
Engineering and applied sciences	5,182	3,201,145	5,931	3,946,066	6,535	4,285,699	6,894	4,781,049	6,929	5,105,505
Life sciences	3,160	2,790,780	3,352	3,427,057	3,502	3,443,737	3,756	3,849,425	3,688	4,054,218
Humanities and social sciences	2,580	1,066,468	2,984	1,481,346	3,133	1,498,826	3,372	1,682,216	3,403	1,771,389
Science education	629	461,913	643	457,410	660	542,798	607	524,655	650	566,345
Cooperative applied research	254	142,104	243	168,362	214	169,498	214	183,028	221	184,326
Sustainable development	289	167,348	258	157,634	253	172,501	317	224,957	337	239,519
Electro-optics Unit	13	31,148	11	37,327	12	26,278	10	14,742	0	0
Planning and evaluation	4	8,982	8	188,257	5	22,933	2	3,125	2	6,000
Total	13,746	9,694,395	15,006	12,041,042	16,008	12,806,580	16,983	14,053,211	17,112	15,285,725

Source: NSC Research Projects Statistics Database, February 16, 2006.

IV. Pursuit of Academic Excellence

To encourage universities to pursue academic excellence, the National Science Council and Ministry of Education joined forces to promote the Program for Promoting Academic Excellence of Universities (PPAEU) to guide and encourage universities in developing specialties as well as to raise the overall standards of collegiate academics. Through prioritized funding, PPAEU aims to improve the "infrastructure" of university academic development, guide schools in developing priority areas, and integrate resources more effectively. The first batch of PPAEU projects was completed in March 2004 and the second batch in March 2006, totaling to 28 projects with NT$6.5 billion funding and already producing outstanding results (see Table 2-20). Several of these projects are still ongoing and have been selected for the "Program for Developing Internationally-Renowned Universities and Top Research Centers," while others generated results that have surpassed international standards. See Appendix 9 for details.

Table 2-20 Results of the Program for Promoting Academic Excellence of Universities

Results	Total
Papers published	11,452
Patent rights (utilized and applied for)	572
Seminars	1,075
Research teams	28
Books	178
Research reports	660
Technology transfers	17
Industry-university collaborations	160
Awards and honors	214

Source: Ministry of Education.

In order to continue conducting research using the infrastructure, personnel, research results, and outstanding research teams formed during PPAEU, the NSC established the "Guidelines for Funding PPAEU–Phase II" in January 2003 and set aside additional funding for the continuation of the program. The NSC accepted applications from 2003 through 2005 and approved four-year integrated projects in each year after applications were received. From 2004 to 2006, a total of 29 group projects were approved with combined funding of NT$2.954 billion (Table 2-21). The projects approved each year are described as follows:

Thirteen projects were approved in 2004: Projects in the natural sciences focused on space physics and nanomaterial science. Engineering and applied sciences included research on advanced telecommunication microwave technology, digital content, cutting-edge Internet technology, and optoelectronics. Life sciences consisted of research on human cognition and social processes of neurological mechanisms, as well as indigenous psychological research.

Eight group projects were approved in 2005: Natural sciences projects included impulse laser and quantum electronics, strata structure and climate change, and research on environmental assessment systems. Life sciences projects focused on plant toxin research, research on cancer cell molecular targets, and explorations into neurological functions. Humanities and social sciences included studies on cerebral neurological mechanisms for multilingual environments and research on derivative financial assets.

Eight group projects were approved in 2006: Natural sciences included the development of new technologies in magnetic resonance research and projects on organic molecular chemistry. Engineering and applied sciences included continued research on macromolecule semiconductors and new research on intelligent transport systems. Life sciences consisted of research on vascular biology and cellular function, and projects on brain function. Humanities and social sciences included advanced studies on currency and exchange, and advanced research on knowledge management.

Table 2-21 Approved Funding for PPAEU–Phase II Projects

Unit: NT$ millions

Field	2004		2005		2006	
	Approved projects (groups)	Approved funding	Approved projects (groups)	Approved funding	Approved projects (groups)	Approved funding
Natural sciences	3	386	3	470	2	140
Engineering and applied sciences	4	729	---	---	2	180
Life sciences	4	364	3	234	2	160
Humanities and social sciences	2	111	2	96	2	84
Total	13	1,590	8	800	8	564

Source: National Science Council.

V. National Science and Technology Programs

Taiwan's government established the national science and technology programs for the main purpose of addressing the country's major socioeconomic issues. These programs integrate the country's R&D resources across up-, mid-, and downstream levels and aim to boost national competitiveness. Nine such programs are currently being implemented. Table 2-22 shows the phases, funding, and participating agencies of each program, and Appendix 10 contains their brief descriptions, important results, and overall benefits.

The national S&T programs have so far achieved excellent results and Table 2-23 shows the quantitative results. Each year on average, the programs result in approximately 5,000 papers published, 5,000 graduate students trained, 500 patents received, 200 technology transfers, and more than NT$30 billion investments received from corporations.

Table 2-22 Phases, Funding, and Participating Agencies of National S&T Programs

	Program	Phase	Years	Funding (NT$1000)	Managing agency	Participating agencies
1	National S&T Program for Hazards Mitigation	First Second	1999–2001 2002–2006	1,038,300 3,006,700	NSC	National Science Council, National Disaster Prevention and Protection Committee, Council of Agricultural Affairs, Public Construction Commission, Ministry of Finance (Financial Supervisory Commission), Council of Indigenous Peoples, Department of Health, Environmental Protection Administration, Ministry of the Interior, Ministry of Economic Affairs, Ministry of Transportation and Communications, Ministry of Education
2	National Digital Archives Program	First	2002–2006	2,882,132	NSC	Academia Sinica, Academia Historica, National Palace Museum, Ministry of Education, National Science Council, Council for Cultural Affairs
3	National S&T Program for Biotechnology & Pharmaceuticals	First Second	2000–2002 2003–2006	1,688,587 5,993,643	NSC	National Science Council, Ministry of Economic Affairs, Department of Health
4	National S&T Program for e-Learning	First	2003–2007	3,699,000	NSC	National Science Council, Council for Cultural Affairs, Ministry of Economic Affairs, National Palace Museum, Council of Labor Affairs, Department of Health, Council for Hakka Affairs, Council of Indigenous Peoples
5	National S&T Program for Nanoscience & Nanotechnology	First	2003–2008	22,307,075	NSC	National Science Council, Ministry of Economic Affairs, Ministry of Education, Atomic Energy Council, Environmental Protection Administration, Department of Health, Council of Labor Affairs
6	National S&T Program for Telecommunications	First Second	1998–2003 2004–2008	10,672,934 13,350,160	NSC	Ministry of Economic Affairs, Ministry of Transportation and Communications, Ministry of Education, National Science Council, National Communications Commission
7	National S&T Program for Agricultural Biotechnology	First Second Third	1998–2001 2002–2004 2005–2008	801,000 1,991,500 4,048,000	NSC	Academia Sinica, Ministry of Economic Affairs, Council of Agriculture, Department of Health, National Science Council
8	National S&T Program for System-on-Chip	First Second	2003–2005 2006–2010	5,605,439 14,468,000	NSC	Ministry of Economic Affairs, Ministry of Education, National Science Council
9	National Research Program for Genomic Medicine	First Second	2002–2005 2006–2010	6,876,965 9,604,164	NSC	National Science Council, Department of Health, Ministry of Economic Affairs

Source: National Science Council.

Notes: 1. The National S&T Program for Hazards Mitigation concluded and was discontinued in 2006.
2. Since the establishment of the Financial Supervisory Commission in July 2004, the budget originally listed under the Ministry of Finance has been relisted under the Financial Supervisory Commission.

Table 2-23 Results of National Science and Technology Programs

Type	Indicator	Unit	2004	2005	Jan-Jun 2006
Economics programs	Publications	Papers	2,742	3,213	1,131
	Graduate students trained	Persons	2,092	2,508	128
	Patents received	Cases	433	421	198
	Technology transfers	Cases	162	143	81
		Contract amount (NT$1,000)	179,813	238,599	92,763
	Corporate investments	Investment amount (NT$1,000)	33,540,569	33,599,830	9,139,659
Biotechnology programs	Publications	Papers	1,143	1,451	463
	Graduate students trained	Persons	1,181	1,191	1,483
	Patents received	Cases	44	68	26
	Technology transfers	Cases	43	46	27
		Contract amount (NT$1,000)	23,743	62,929	20,398
	Corporate investments	Investment amount (NT$1,000)	242,600	667,488	48,454
Civilian programs	Publications	Papers	950	941	725
	Graduate students trained	Persons	1,595	1,328	706
	Patents received	Cases	11	12	2
	Technology transfers	Cases	25	33	10
		Contract amount (NT$1,000)	6,380	624	2,828
	Corporate investments	Investment amount (NT$1,000)	16,518	30,453	49,531
Total	Publications	Papers	4,835	5,605	2,319
	Graduate students trained	Persons	4,868	5,027	2,317
	Patents received	Cases	488	501	226
	Technology transfers	Cases	230	222	118
		Contract amount (NT$1,000)	209,936	302,152	115,989
	Corporate investments	Investment amount (NT$1,000)	33,799,687	34,297,771	9,237,644

Source: National Science Council.

Notes: 1. Economics programs include National S&T Programs for Telecommunications, System-on-Chip, and Nanoscience & Nanotechnology.
2. Biotechnology programs include Agricultural Biotechnology, Biotechnology & Pharmaceuticals, and Genomic Medicine.
3. Civilian programs include Hazards Mitigation, e-Learning, and Digital Archives.

VI. Industry-University-Research Cooperation

In the knowledge-based economy, knowledge innovation is an important means for creating economic value as well as improving people's wellbeing. Taiwan is currently transforming into an innovation-based economy, and knowledge innovation is rapidly becoming the driving force behind industrial upgrading and economic growth. For Taiwan to succeed, the key lies in promoting knowledge innovation through industry-university-research cooperation.

To promote cooperation among industries, universities, and research institutes, many government agencies such as the National Science Council, Ministry of Education, Ministry of Economic Affairs, and Atomic Energy Council have created their own strategies for promoting up-, mid-, and downstream S&T development. These strategies are designed to enhance Taiwan's industrial innovation capabilities and cultivate the type of personnel needed by industries:

(1) National Science Council

The NSC promotes many diversified industry-university cooperative programs that redirect abundant university R&D resources into industries for the purposes of raising industrial innovation capabilities, training S&T personnel through practical work experiences, and increasing personnel flow between industries and academia. The NSC has already implemented many funding schemes including the “Guidelines for Funding Industry-University Cooperative Research Projects” (large industry-university projects), “Guidelines for Funding the Program to Upgrade Industrial Technology and Enhance Human Resources” (small industry-university projects), and the “Guidelines for Funding Digital Content Industrial-University Cooperative Research Projects” (digital content industry-university projects). These projects make use of existing capabilities from universities to lower the R&D risk of industries. A total of 4,153 such projects have been executed over the past four years with excellent results: 89 patents were received, technology transfers jumped in 2004 to a cumulative total of 3,829 cases, and 7,000 graduate students received practical hands-on training (see Table 2-24). These projects have already made significant contributions to Taiwan’s industry-university cooperation and workforce training.

Looking ahead, the NSC will place greater emphasis on boosting technological innovation. Aside from committing long-term investments into basic research, the NSC will also strengthen high-level “applied science” cooperative projects that meet the needs of industries, encourage businesses and academic research institutes to participate in high-innovation research projects, reinforce mechanisms for industry-university-research cooperation, and collaborate with other government agencies to promote joint research between universities, enterprises, and the research community.

Table 2-24 Results of NSC Industry-University Cooperative Research Projects

Item	2002	2003	2004	2005	Total
Research projects (number)	950	1,018	1,144	1,041	4,153
Personnel trained (M.S., Ph.D. students)	1,710	1,691	1,847	1,752	7,000
Patents earned (cases)	23	15	24	27	89
Technology transfers (including early-stage transfers) (cases)	454	852	1,274	1,249	3,829
Royalty income (including early-stage TT fees) (NT$1,000)	30,000	57,000	75,000	84,000	246,000

Source: National Science Council.

(2) Ministry of Education

To promote industry-academia-research cooperation, the MOE established the “Industry-Academia Cooperation Steering Committee for Technical Colleges and Universities.” This committee set up six Centers for Regional Industry-Academia Cooperation (CRIACs) to match the resources of local industries, governments, universities, and research institutes, and also established Technology Development Centers (TDCs) to develop and reform technical and vocational education. The MOE is training professional manpower through vocational education, effectively utilizing resources through strategic alliances, and ultimately boosting industrial competitiveness.

Table 2-25 shows the results of industry-academia cooperation in 2005. The MOE provided funding for six CRIACs and thirty TDCs, supported 2,041 industry-academia-research cooperation projects worth NT$1.043 billion, and successfully promoted 177 technology transfers. The MOE also initiated various measures and programs for full-time teachers working concurrently at CRIACs or TDCs, drafted the bill “Regulations for Implementing Industry-Academia Cooperation at Colleges and Universities” in accordance with the *University Act*, promoted partnerships between technical colleges/universities and well-known businesses, revamped the Industry-Academia Cooperation Information website, registered information and results from industry-academia-research cooperation projects, and enabled 22 schools to implement the Last Mile Project, which trains specialized technicians to meet industrial needs and has already yielded excellent results.

In the future, the MOE will aim to strengthen relevant laws and regulations, formulate a comprehensive set of measures, integrate the industry-academia-research cooperation mechanism, encourage teacher participation in industrial R&D, guide and plan cooperative education programs, implement student practical training, promote performance-based evaluations, provide open access to university R&D resources, and improve the efficiency of industry-academia cooperation.

Table 2-25 Results of MOE Industry-Academia Cooperation, 2005

Outcome	Item		Total
Funding results	Centers for Regional Industry-Academia Cooperation (6 centers) Technology Development Centers (30 centers)	Industry-academia cooperation	2,041 projects
		Cooperation amount	NT$1.043 billion
		Patent applications	617 cases
		Technology transfers	177 cases
		Industry consultations	539 cases
		Factory visits	1,173 cases
		Industry-academia forums	146 forums/16,506 person-times
		Education training and seminars	324 seminars/15,127 person-times
		Promotional or demo conferences	79 conferences/16,574 person-times
	Cooperation with industrial parks	Funded projects	225 cases
		Funding amount	NT$84.218 million
Industry-academia alliances	Renewed projects		12 cases
	New projects		8 cases
	Future cooperation projects		15 cases
Last Mile Project	Schools receiving funding		22 schools
	Funding amount		NT$11.562 million

Source: Ministry of Education.

(3) Ministry of Economic Affairs

The MOEA promotes industry-academia-research cooperation for the purpose of raising the level of industrial technology from “technological innovation” to “cutting-edge innovation.” Aside from promoting Technology Development Programs for Academia (TDPA), the MOEA also encourages industries to make use of university R&D capabilities through programs such as the “Industrial Technology Development Alliance Program,” which brings universities and industries together for R&D collaborations. The MOEA also promotes the “Industrial Technology Innovation Center Program,” which encourages domestic and foreign businesses to establish R&D centers in Taiwan, for the purposes of disseminating Taiwan R&D throughout the world and broadening the scope of the nation’s industrial R&D. These programs have already achieved excellent outcomes through the end of 2005 (Table 2-26).

To achieve “cutting-edge innovation,” the MOEA will continue promoting theme-based industrial technology cooperation projects, develop applications with significant impacts for the industry, and sponsor the “A+ Program for Building Common Infrastructure and Technologies” for encouraging universities and industries to collaborate on R&D of common technologies, increasing added value of products, and raising the standards of industrial technology.

Table 2-26 Results of MOEA Technology Development Program for Academia, 2005

Item		Total
Applications for projects		126
Approved projects		49
Number of project topics		48
Patents	Applications	533
	Received	70
Industry-academia-research cooperation		35 projects, NT$10.607 million
Technology transfers		65 cases, NT$24.317 million
Transferable industrial technology		272 technologies
Subcontracted research projects		114 cases, NT$89,112 million
International cooperation		60 cases

Source: Ministry of Economic Affairs.

(4) Atomic Energy Council

The AEC's Institute of Nuclear Energy Research conducts R&D benefiting the lives of citizens, ensures the safe operation of Taiwan's nuclear facilities, develops nuclear medicine and drugs, enhances the quality of public medical and health products, and explores new energy research fields to develop renewable resources from atomic energy. Currently the AEC has already developed more than ten types of nuclear medicine as well as plasma incinerators, solar power optoelectronics, bioenergy conversion technologies, fuel cells, and other world-leading products. The AEC is also promoting basic and advanced research in atomic energy technology for civilian applications, and has entered into strategic alliances with corporations to develop technologies with practical industrial applications. The results of AEC's industry-university-research cooperation from 2003 to 2005 are shown in Table 2-27.

Table 2-27 Results of AEC Industry-University-Research Programs, 2003–2005

Sector	Item		2003	2004	2005	Total
Academia	Patents received		2	2	2	6
	Professional papers		131	74	76	281
	Research reports		13	17	25	55
	Conference papers		120	107	108	335
	Conferences		1	1	1	3
	Technology transfers		-	2	-	2
	Persons trained		67	63	72	202
Industry	Technology transfer or licensing cases		13	15	16	44
	Technology license fees and royalties (NT$)		9,962,491	18,709,734	39,015,394	67,687,619
	Patents applied for		30	55	113	198
	Patents received		8	26	41	75
	Patent application spin-offs	(cases)	4	3	3	10
		(NT$)	70,051,134	42,973,715	79,081,000	192,105,849

VII. Development of Science Parks

Taiwan's science parks are major high-tech industrial centers established in accordance with the nation's overall industrial policies. The Hsinchu Science Park (HSP), Central Taiwan Science Park (CTSP), and Southern Taiwan Science Park (STSP) are respectively located in the northern, central, and southern regions of the island and have already spawned numerous high-tech industrial clusters. As part of the government's "Two Trillion and Twin Stars" industrial policy, the science parks are also focusing on the development of biotechnology and have become a major driving force in this effort. By leading the development of Taiwan's biotech industries, the science parks are taking full advantage of new opportunities for economic development and will boost national competitiveness in the long run.

Among companies within the science parks, R&D expenditures as a percentage of sales declined gradually from 6.5% in 2001 and rose in 2005 to 5.1%. Overall, science park companies still devoted a greater percentage of sales into R&D expenditures than compared to the 1.33% of manufacturers nationwide. The number of employees at science parks increased from 105,782 in 2001 to 159,048 in 2005 (see Table 2-28).

Table 2-28 R&D Expenditure and Employees at Taiwan's Science Parks, 2001–2005

Item	2001	2002	2003	2004	2005
R&D expenditure (NT$ millions)	46,000	46,530	50,404	57,090	71,002
Sales (NT$ millions)	711,583	807,300	1,011,658	1,343,874	1,398,919
R&D expenditure / sales (%)					
among science park firms	6.5	5.8	5.0	4.2	5.1
among all manufacturers nationwide	1.26	1.30	1.28	1.24	1.33
Employees	105,782	113,105	122,004	146,613	159,048

Source: *Indicators of Science and Technology, Republic of China (2006),* National Science Council.

Note: Sales data from 2001 to 2003 included the Hsinchu and Southern Taiwan science parks only. Beginning 2004, sales included data from the Hsinchu, Southern Taiwan, and Central Taiwan science parks.

Currently in Taiwan, industrial clusters are growing rapidly all around the science parks. The Hsinchu Science Park has already expanded eastward to Ilan County and the Southern Taiwan Science Park has spread down to Luchu in Kaohsiung County. The next phase of development is to turn those industrial clusters surrounding science parks into "science park clusters," not only to balance the industries but also to build closer links up and down the industrial chain. Future plans include expanding the Southern Science Park up towards Chiayi County and the Central Science Park towards Huwui Township in Yunlin County. When the time comes, the entire western length of Taiwan will be transformed into a "Corridor of Technology." The development status of all science parks is described in Appendix 12.

For the purpose of building a solid infrastructure for the biotech industries, 13 biotechnology parks have been established throughout the island so far. These parks can be separated by field into three categories:

(1) In agricultural biotechnology (five parks): "Pingtung Agricultural Biotechnology Park," "Chiayi Spice and Medicinal Herb Biotechnology Park," "National Floriculture Park" in Changhua County, "Taiwan Orchid Biotechnology Park" in Tainan County, and "Ilan County Marine Biotechnology Park."

(2) In pharmaceuticals and medical products (four parks): Nankang Biotechnology Building, Hsinchu Biomedical Park, Kaohsiung Biotechnology Park, and Ilan Biomedical Park (in planning).

(3) Special zones designated for biotech development within science parks (four zones): The biochemical technology zone at HSP's Jhunan Site, the biotechnology zone at CTSP's Yunlin Site, the biotechnology zone at STSP's Tainan Science Park, and the biotechnology and medical equipment zone at STSP's Kaohsiung Biotechnology Park.

2.4 Regulatory Environment

The government enacted the *Fundamental Science and Technology Act* to lay down fundamental guidelines and principles for promoting scientific and technological development. Portions of this Act have been amended twice since enactment in 1999, primarily in response to evolving needs in S&T development and to remove restrictions no longer deemed necessary.

1. Article 6 of the *Fundamental Science and Technology Act* originally provided that a juristic person or entity receiving government subsidies to perform procurement for S&T development shall not be subject to the regulations of the *Government Procurement Act*. After the *Fundamental Science and Technology Act* was implemented however, it was discovered that more than two-fifths of the public agency R&D units conducting government S&T projects were unable to qualify for this exemption. To uphold the spirit of the Act, this provision has been amended to include public universities, public research agencies (organizations), state-owned businesses, and juristic persons or entities. Moreover, all S&T procurements by these entities are now exempt from the *Government Procurement Act*, regardless of the size of procurement.
2. Article 17 of the *Fundamental Science and Technology Act* originally specified that, in order to recruit outstanding scientific and technological personnel from abroad, necessary measures shall be taken to ensure the quality of living and working conditions for an appropriate period of time. But since these provisions did not cover education benefits for the children of foreign professionals, many were still reluctant to relocate to Taiwan. Therefore, the article was amended allowing the Ministry of Education to pass regulations and create suitable education environments for these children, thereby providing more attractive incentives for outstanding foreign scientists and professionals to work in Taiwan.

To protect the nation's sensitive scientific technologies while ensuring national security and industrial development, the National Science Council drafted the "Sensitive Scientific Technologies Protection" bill, currently in review at the Legislative Yuan. After ratification, this law will be able to guard national security and public interest while maintaining Taiwan's competitive advantages in science and technology. Under this bill, information on sensitive scientific technologies that are critical to national security and public interest shall be managed by the competent authorities, and may be publicly disclosed after approval by the Executive Yuan. And in case of unlawful infringement on sensitive scientific technologies, the rights owner may report the matter to appropriate authorities for assistance.

In order to achieve the full spirit of the *Fundamental Science and Technology Act*, the regulatory environment still needs to overcome various bottlenecks. For instance, Taiwan needs to loosen the personnel affairs system at colleges and universities, create regulations to oversee researchers at government research institutes working concurrent jobs, transform government sector research institutes into administrative corporations, and build more flexibility into the S&T personnel hiring system. Breaking through these barriers will help improve the flow of S&T talent among industry, government, academia and the research community.

Chapter 3 – Visions and Strategies for Scientific and Technological Development

After considering the trends in international S&T development, along with the status of Taiwan's development and objectives of government agencies, this paper will now present the visions for Taiwan's S&T development, with regard to academic excellence, innovative economic growth, and sustainable quality living. On the whole, Taiwan's vision is to raise innovative capabilities and citizens' quality of life to the level of a developed nation by 2015. The targets for S&T input and output will also be presented.

To achieve the visions described above, the following strategies have been formulated: (1) Strengthening the formulation of policies; refining controls and regulations. (2) Developing the S&T workforce; managing the supply and demand of personnel. (3) Cultivating distinguished fields; pursuing academic excellence. (4) Encouraging industry-university cooperation; developing industry clusters. (5) Nurturing innovative enterprises; fostering emerging industries. (6) Improving citizens' wellbeing; raising the quality of life. (7) Boosting defense science and technology; promoting military-civilian technology transfers.

Individual government agencies should follow the spirit of this paper to modify their current S&T measures, make rolling revisions to their plans for implementing the *National Science and Technology Development Plan*, and assess the allocation of resources for future S&T programs. As to specific measures for carrying out each strategy, these will be formulated in view of the overall conditions and needs of national S&T development – that is, after discussions at the next (8^{th}) National Science and Technology Conference, each agency's implementation plans for future S&T development will be integrated into the nation's overall policies in order to formulate the specific measures.

3.1 Visions

Innovative capabilities and citizens' quality of life will reach the level of a developed nation by 2015.

I. Academic Excellence Research

(1) The research environment will be enhanced to attract world-class researchers.

(2) Original fields of academic research will be developed.

(3) In key fields of research, Taiwan will cultivate internationally-known researchers and world-leading research teams capable of making outstanding contributions.

(4) Academic research and knowledge creation will benefit industrial development, improve the public's wellbeing, and contribute to the benefit of all citizens.

II. Growth of the Innovation Economy

(1) Taiwan will become the premier location in the Asia-Pacific region for nurturing innovation and new ventures.

(2) Technological innovation and knowledge services will become the main sources of added value, and Taiwanese firms will have self-owned brands for global marketing.

(3) Each region will form its own unique innovation cluster built from the region's industrial specialties, R&D resources, and cultural environment.

(4) Personnel from industry, academia, and the research sector will engage in closer interchange as well as international exchange, and participate in the formulation of international industry standards.

III. Sustainable High-Quality Living

(1) Technology and innovation will be used to create a sustainable high-quality living environment that offers safety, security, and fast convenient services to all citizens.

(2) Society's development needs will guide the direction of R&D investments and new S&T applications, and technological innovation will enable citizens to enjoy high standards of living.

(3) Science and technology will be able to develop harmoniously and sustainably with life ethics, culture and society, the ecology, and the industrial economy.

(4) All citizens will have higher science literacy and science will become a part of everyday life.

(5) ICT applications will be expanded to improve the quality of work, learning, recreation, and living. Taiwan will become a "quality Internet society" where services are readily available and knowledge creation can take place anywhere.

Targets for S&T Input and Output

Input Targets

- The government will steadily increase its spending on R&D and also induce the private sector to devote greater inputs into R&D, in order that gross domestic expenditure on R&D as a percentage of GDP will continue to grow toward the fixed target of 3%.
- The manufacturing industry's expenditure on R&D as a percentage of sales will reach 1.7% by 2009 and 2.5% by 2015.
- Enterprise-financed R&D expenditure in the higher education sector will reach 9.1% by 2009.
- The number of researchers per 1,000 employed persons will increase to 9.7 person-years by 2009 and 10.9 person-years by 2015 (including Ph.D. students engaged in R&D). The number of researchers per 1,000 employed persons will increase to 8.7 person-years by 2009 and 9.7 person-years by 2015 (not including Ph.D. students engaged in R&D).

Output Targets

- At least one university will place among the top 100 universities worldwide; the nation will develop at least 10 Asian-leading research centers in fields where Taiwan has performed exceptionally well.
- Taiwan will continue placing among the top four countries for US patents granted (excluding new design.

3.2 Strategies

To achieve the aforementioned visions and targets, the following strategies for overall S&T development have been established:

Strategy 1: Strengthening the formulation of policies; refining controls and regulations.

Strategy 2: Developing the S&T workforce; managing the supply and demand of personnel.

Strategy 3: Cultivating distinguished fields; pursuing academic excellence.

Strategy 4: Encouraging industry-university cooperation; developing industry clusters.

Strategy 5: Nurturing innovative enterprises; fostering emerging industries.

Strategy 6: Improving citizens' wellbeing; raising the quality of life.

Strategy 7: Boosting defense science and technology; promoting military-civilian technology transfers.

I. Strengthening the Formulation of Policies; Refining Controls and Regulations

(1) Promote forward-looking technological research, seek public consensus on the long-term needs of S&T and social development

1. Conduct research on forward-looking technologies that will meet society's development needs. Plan out the technologies required for Taiwan's S&T development.
2. Within the scope of important industrial technologies selected for forward-looking technological research, identify the key technologies to be developed and propose timetables for development.
3. Encourage basic research and cutting-edge innovation, and devote appropriate resources to fields or key technologies that possess world-leading potential.

(2) Emphasize long-term planning of S&T programs and performance-based evaluations

1. The review and assessment of government S&T projects should be conducted in line with national S&T policies, targets, and strategies, as well as those of government agencies.
2. Improve the efficiency of S&T expenditure reviews, management, and evaluations.
3. Develop appropriate performance indicators to ensure S&T development is meeting the needs of society and industries.
4. Strengthen the management of results from national science and technology programs.

(3) Ease regulations and reform legal systems to create a more conducive environment for S&T development

1. Advocate looser regulations on personnel affairs at colleges and universities, encourage teachers and graduate students to cultivate practical capabilities as well as industrial applications research.
2. Design effective mechanisms and flexible S&T personnel hiring systems to foster greater personnel flow among industries, government, universities and research institutes.
3. Promote the reformation of government research institutes into administrative corporations.
4. Loosen regulations on government research institute personnel working concurrent jobs.

II. Developing the S&T Workforce; Managing the Supply and Demand of Personnel

(1) Effectively train, recruit, and utilize S&T personnel

1. Working across government agencies, draft long-term recruitment and training strategies for personnel in important S&T fields.
2. Systematically recruit foreign S&T personnel and technology teams, and break through legal restrictions that bar foreign nationals from working in Taiwan.
3. Provide attractive incentives and build quality research and living environments to draw outstanding overseas scholars and researchers to Taiwan for the long-term.
4. Establish an education accreditation system with international standards, build a globalized education and research environment, and implement a macro management plan for higher education.
5. Create internationally-recognized research awards to confer to foreigners, attract top researchers to Taiwan, expand and promote new international cooperative partnerships for domestic researchers.

(2) Strengthen S&T ethics and creativity education, cultivate personnel for systems integration and innovation

1. Through creative education, integrate S&T knowledge with humanistic qualities and social values to build a style and culture unique to Taiwan.
2. Systematically cultivate researchers and innovation services personnel in the areas of multidisciplinary systems integration, design, R&D, globalization, and specialization.
3. Expand science activities to reach all citizens. Popularize science through the media, museums, and other mass channels. Integrate science into every day life in order that citizens will better understand and support S&T development.
4. Strengthen research on teaching and learning in mathematics and science education. Enhance the quality of basic science education by joining large-scale programs and international comparisons. Cultivate a highly science-literate citizenry.

(3) Plan for the long-term needs of S&T industries, balance the demand and supply of S&T personnel for various fields

1. Cultivate the type of workforce needed by industries. Link the concept of career development with industrial development and the training system, thus creating an all-win situation for individual, industrial, and national competitiveness.
2. Develop a robust mechanism for forecasting the supply and demand of professional workers in the job market and use as reference for planning response strategies. Strengthen and promote industry-university cooperation, accelerate industrial innovation to enhance added values. Promote mechanisms for certifying important professional workers and skills needed by the knowledge innovation economy. Continue integrating the recruitment resources of the Executive Yuan and government agencies, actively recruit S&T personnel from abroad.
3. Create a core knowledge and skills framework for training important industrial personnel. Establish mechanisms for testing and assessing professional skills, and actively promote digital learning in important industries. Expand S&T personnel training across multiple fields to improve the efficiency of employee training.
4. Integrate the training resources of local industries, governments, universities, and research institutes, and then organize industry-university-research cooperative training and form regional training alliances. Adopt diversified, localized, job-oriented, and

flexible principles to conduct professional job-specific training courses and cultivate the type of technical personnel needed by businesses.

III. Cultivating Distinguished Fields; Pursuing Academic Excellence

(1) Build a quality research environment and dynamic research community, strive toward world-class standards

1. Develop distinguished research fields by encouraging forward-looking research and multidisciplinary cooperation. Cultivate world-class researchers and teams.
2. Encourage multi-year and integrated research projects. Provide generous long-term financial support to outstanding researchers.
3. Encourage research-type universities and research centers to map out long-range visions and set phased targets for developing unique academic programs. Provide long-term financial support and develop world-class universities and top academic research centers.
4. Create databases and allow open access for the public. Build marine research vessels, photon source synchrotrons, and other large research facilities for shared use.
5. In academic research, focus on both future industries and current market needs. Help research institutes establish platforms for commercializing technology. Draft mission-oriented research strategies to develop basic research in step with industries.

(2) Encourage international research cooperation, participate in major international academic activities

1. Provide funding for graduate students, postdoctoral candidates, and young researchers to study abroad or participate in international cooperative research.
2. Boost Taiwan’s competitiveness by encouraging domestic research centers to form alliances with internationally known research centers.
3. Encourage the globalization of research teams, and provide subsidies for world-renowned scholars to visit Taiwan as lecturers or guest researchers. Build mechanisms for cooperation or scholar exchange with foreign academic research institutes.
4. Through government-established agreements on bilateral S&T cooperation, foster bilateral exchange and collaboration in fields where the countries possess advantages.

IV. Encouraging Industry-University Cooperation; Developing Industry Clusters

(1) Foster closer industry-university-research cooperation, form a shared system for exchanging knowledge innovation

1. Enliven industry-university-research cooperation and reinforce personnel flow. Provide R&D incentives, reward industry-university cooperation, and make industry-university cooperation an important evaluation criterion. Create a support system for industry-university-research cooperation, implement large industry-university-research projects.
2. Encourage industries, universities, and research institutes to jointly build professional personnel training mechanisms. Establish mechanisms for resource integration and utilization at academic research organizations.
3. Integrate R&D alliances and cooperation among industries, universities, and the research community. Promote joint development of basic technologies and common products.
4. Increase incentives for academic research institutions to transfer technologies. Integrate and apply R&D capabilities to the industrial sector, and encourage academic research institutes to conduct technology development for advanced innovative industries. Create

mechanisms for technology cooperation and dissemination, systematically nurture spin-off industries from new technologies.

5. Reward technology entrepreneurship and provide financial assistance for technological innovations. Encourage the development of university spin-off companies, and attract international professionals for technology transfers.
6. Encourage industries, universities, and research institutes to emphasize protection of intellectual property rights (IPR) and create a system for managing the utilization of IPR. Build a mechanism to foster technological exchange and R&D alliances while balancing industrial needs with the protection of IPR.
7. Encourage industry-university-research alliances to join international R&D collaborations, strengthen cross-national R&D cooperation. Establish overseas R&D centers and promote mechanisms to attract overseas Taiwanese to establish businesses in Taiwan.

(2) Develop distinguished regional industry clusters, build local innovation systems

1. Within each region, link academic research institutes to local industry associations, manufacturing zones, industrial zones, and science parks. Integrate their R&D resources to build distinguished innovation clusters possessing global competitiveness. Accelerate the upgrading of traditional industries.
2. Import and utilize information communication technology. Develop uniquely regional services industries.

V. Nurturing Innovative Enterprises; Fostering Emerging Industries

(1) Cultivate services industries to possess innovation, cultural values, global competitiveness, and technological integration

1. Integrate the competitive advantages of manufacturing and services industries and aggressively develop high value-added knowledge services industries. Reinforce advantages in R&D design, production, operations, and brand name so as to enhance the added values of Taiwan’s industries.
2. Develop knowledge-intensive and high employment effect industries. Actively promote technological R&D for market innovation and life-oriented industries, creating high-quality living environments.
3. Add the value of technology services to domestic manufacturing industries and expand to overseas markets. Establish a quality environment for developing R&D services.
4. Consulting the practices of advanced countries to formulate internationally-comparable statistics on services industries, and use as reference for policymaking and industrial research.

(2) Raise traditional industrial standards through revolutionary technologies, strive for high-value strategic living industries

1. Develop strategic industries for high-tech living: soft electronics, radio frequency identification (RFID) systems, nanoscience and nanotechnology, intelligent robotics, intelligent vehicles, and intelligent living space.
2. Systematically integrate and map long-term strategies for emerging industries related to people’s wellbeing, including the safety industry, elder care, mobile communications, digital lifestyle, and new industries responding to climate change.
3. Develop strategic industries in the life sciences: agricultural biotechnology, high-level medical equipment, and the biotech pharmaceuticals.

(3) Enliven the flow and utilization of intellectual property, establish a sound environment for nurturing innovation and entrepreneurialism

1. Promote the Taiwan Intellectual Property Management System (TIPS), create technology exchange mechanisms, and reinforce the management of intellectual property. Stimulate IP innovation, circulation, application, and added values. Strengthen IP competitiveness and increase industrial added value.
2. Create an environment suitable for high-tech industrial development, encourage corporate innovation, build models that link market needs to innovative operations. Offer tax incentives to support investment write-offs, R&D subsidies, R&D loans, etc.

(4) Systematically study the global market to identify trends in product and service R&D

1. Systematically study the global market to identify trends in industry-university-research cooperative research.
2. Actively promote the establishment of international and domestic business R&D centers in Taiwan.
3. Grasp Taiwan's position in the high value-added chain for R&D, design, certification, marketing, and aftermarket services. Understand client needs, participate in the formulation of international standards, and strive for leading positions in technological and product development.

(5) Encourage businesses to invest in R&D, create self-owned brands, and develop global marketing capabilities

1. Raise product added value through technological and service innovation. Exploit advantages in information electronics industries to develop new products and services for industrial application. Help quality businesses create their own name brands.
2. Establish strategic division-of-labor models for emerging industries. Help industry-leading businesses to invest in R&D, promote innovation, and develop capabilities to market their own brands globally.
3. Assist mature industries in using new technologies, enhancing product added value, and developing high-grade materials, key components, and R&D services for emerging industries.

VI. Improving Citizens' Wellbeing; Raising the Quality of Life

(1) Make full use of the advanced communication and communication network environment, develop innovative services

1. Plan and promote important applications to meet people's lifestyle needs. Establish a "ubiquitous network" infrastructure and create a sound environment for an Internet society. Build a quality Internet society where service is always readily available.
2. In promising new fields, develop model applications that meet people's lifestyle needs and turn Taiwan into a global showcase of Internet society applications. Lower risks for domestic technology services companies and increase industrial added values. Take advantage of the Chinese market around the world to engage in global services.
3. Integrate mobile communications with digital living technology, expand digital technology to all areas of life, and provide citizens with maximum freedom to enjoy high quality living.

(2) Emphasize environmental protection, pursue sustainable development

1. In energy technology, focus on promoting renewable resources, new energy uses, and energy conservation technologies.

2. Strengthen recycling campaigns and create green industries. Devise key technologies, early warning systems, and risk management mechanisms for industrial use, daily living, and the environment. Minimize ecological impact and counter global change in order to achieve sustainable development.
3. Regulate the amount of water resource development, establish systems to control and monitor the sustainable development of water resources.
4. In water technology, focus on countering climate change, using new technology to monitor real-time water levels, and modernizing disaster prevention technology. Create diversified environments that conserve and sustain water resources. Develop technologies for conserving water resources, recycling water, and upgrading existing reservoirs.
5. Strengthen applications and development of residential renovation/construction technology, raise the quality of living, and enhance industrial competitiveness.

(3) Develop technologies and applications for the changing population and aging society

1. Integrate medical health information and care services resources. Reinforce preventive health protection, develop tourism medical services. Develop a high-quality healthcare system where all citizens can easily access medical care and health consultation.
2. Harness Taiwan’s industrial and technological advantages to develop intelligent high-tech living industries. Construct a safe, healthful, convenient, comfortable, efficient, and sustainable quality living environment.
3. Cultivate an environment to develop the intelligent living space and elder care industries. Link services with manufacturing and R&D, and encourage industries to participate in R&D projects of academic research institutes.

VII. Boosting Defense S&T; Promoting Military-Civilian Technology Transfers

(1) Develop military and civilian dual-use technologies, create an autonomous defense industrial system

1. Establish major hardware systems capable of supporting defense forces for the next 30 years, create an international industry for military/civilian dual-use technologies.
2. Promote short, mid, and long-term strategic plans for defense technology in order to maintain long-range and sustainable development of national defense S&T.
3. Create a niche in national defense S&T and armament development. Build a defense information communications electronic industry incorporating national industrial objectives with a view to global trends.

(2) Promote mutual technological exchange between defense and civilian industries

1. Make use of S&T education capabilities in the military and at universities. Attract outstanding graduates with domestic or foreign graduate degrees to enter defense R&D and industrial development. At the same time, ensure fairness and reasonability in the military service system.
2. Establish an organizational platform for Taiwan’s “Defense Technology Advanced Research System.” Apply industry, university, and research capabilities to the development of advanced defense technologies.
3. Create a decision-making system and industry operation model that will sustain and uphold democratic values in defense armament development and global industrial sales.
4. Release military technology to civilian manufacturers and perform military R&D procurements, transfer the results of defense research, guide the transformation and upgrading of civilian industries.

Chapter 4 – Objectives of Government Agencies for Promoting S&T Development

Based on the nation's overall visions and strategies for scientific and technological development, each government agency will plan its own S&T objectives and strategies and implement these efforts over the next few years through appropriate resource planning.

4.1 Objectives of Government Agencies for S&T Development

The scientific and technological development objectives from 2007 through 2010 for each agency are presented below. Detailed strategies and resource plans for the next four years (2007 through 2010) are described in Appendix 13.

I. Academia Sinica

(1) Strengthen basic academic research, promote interdisciplinary cooperation, pursue academic excellence, and raise the level of academic research to world-leading standards.

(2) Create a world-class research environment and cultivate leaders of academic excellence.

(3) Foster international cooperative exchange, promote technology transfers, and use research results to contribute to the benefit of society.

II. Science and Technology Advisory Group

(1) Grasp domestic and foreign trends in S&T development, deliberate on national S&T policies.

(2) Coordinate and integrate the resources of S&T-related government agencies, implement S&T policies.

(3) Coordinate and promote major S&T initiatives and programs, create a favorable environment for S&T industrial development.

III. Ministry of the Interior

(1) Using advanced construction methods and technologies, raise the quality of engineering construction, promote green and sustainable public construction, upgrade the construction industry, and stimulate economic development.

(2) Strengthen innovation and research on buildings and urban environments in order to ensure public safety, improve architectural standards, use resources more appropriately, and enhance residential quality. Develop intelligent living space technology and create a safe, healthy, convenient, comfortable, energy efficient, and sustainable quality living environment.

(3) Enhance aerial remote sensing technology and capabilities. Strengthen the integration and circulation of survey and mapping information, and upgrade the survey industry. Promote quality management and utilization of Taiwan's land.

(4) Actively develop public/private disaster rescue resources and coordinate the overall use of rescue capabilities. Increase the effectiveness of rescue command and notification systems, strengthen disaster prevention and rescue systems, and protect lives and property.

(5) Create a sustainable model of forensic R&D and increase forensic quality and standards. Strengthen border management, upgrade public safety and crime prevention capabilities, and maintain social peace and public order.

(6) Formulate diversified care and counseling measures and design a holistic care service system. Establish balanced and equitable social welfare policies. Create a harmonious new society and new civilization.

IV. Ministry of National Defense

(1) Establish a database of national defense S&T capabilities, combine future military force needs with overall national S&T development plans, and draw up a complete blueprint for the development of defense science and technology.

(2) Integrate domestic resources in military armament science and technology. Strengthen mechanisms for developing military and civilian shared technologies, and help civilian industries improve their scientific and technological R&D capabilities.

(3) Following the defense S&T development blueprint, establish an advanced defense S&T foundation and plan the direction of applied research fields. Also, map out the long-term development of key technologies, promote mid-term research projects on systems engineering, and conduct short-term R&D on functional improvements. These efforts will build mechanisms for a long and sustained development of defense S&T.

V. Ministry of Education

(1) Pursue world-class research and teaching, and build international academic reputations.

(2) Promote industry-university-research cooperation and train personnel for industrial demand. Combine "career development" with the "training system" and "industrial development." Construct a nationwide knowledge innovation system to promote closer interchange among industrial, academic, and research personnel. Create an all-win situation in terms of individual, industrial, and national competitiveness.

(3) Cultivate an abundant supply of high-quality, high-tech personnel. Train personnel for the integration, design, R&D, and innovation services of multidisciplinary systems.

(4) Increase basic science literacy among students and provide a balanced education of humanities and S&T. Cultivate a modern citizenry that is attentive to the needs of human society and the environment, and possesses international competitiveness.

VI. Ministry of Justice

(1) Strengthen R&D in scientific evidence collection and new forensic technologies. Reinforce scientific evidence collection and criminal investigation capabilities. Make full use of forensic equipment and facilities, and enhance forensic crime proof capabilities. Promote forensic laboratory certification, improve forensics quality, and safeguard human rights.

(2) Use cutting-edge science and technology to raise medical and judicial forensics to world-class standards. Train scientific evidence collection and forensics personnel. Strengthen the integration and use of medical forensic resources, and create a medical forensic database.

VII. Ministry of Economic Affairs

(1) Taiwan's visions for the manufacturing industry in 2009 and 2015 are as follows (shown respectively): manufacturing industry's added value will rise to US$97.4 billion and US$141.2 billion; average added value per employee will reach US$40,000 and US$59,000; manufacturing export value will increase to US$240.1 billion and US$310.7 billion; and manufacturing R&D as a percentage of sales will grow to 1.7% and 2.5%.

(2) Turn Taiwan into a base for innovative research and development, and transform the island from an economy based on industrial R&D to one of cutting-edge innovation. Develop industrial core technologies, establish a comprehensive foundation for industrial development, and actively promote the research and development of strategic services.

(3) Promote the use of renewable energy sources in order that 10% of the country's generation capacity will come from renewable sources by the year 2010. Promote energy conservation and increase efficiency to lower Taiwan's energy intensity (liters of oil equivalent / NT$1,000 GDP) from 10.1 in 2005 to 8.7 in 2010.

(4) Promote the five major water policies of water regulation, water utilization, water preservation, water rapprochement, and water revitalization.

(5) Build an environment to foster the start and growth of small and medium enterprises.

(6) Establish firm strategies for the development of national standards and assign priority to developing standards in important industries first. Establish and maintain the highest national standards of measurement and create an internationally recognized certification system.

(7) Firmly grasp geologic environmental problems and prepare for future environmental changes.

(8) Strengthen and cultivate intellectual property specialists. Increase the professional knowledge of law officials and patent and trademark agents. Increase the professional knowledge of patent and trademark application reviewers. Raise the quality of application reviews.

(9) Promote the development of commercial science and technology.

VIII. Ministry of Transportation and Communications

(1) Promote operation and management technologies for transportation and communications in order to enhance the quality, safety, and sustained development of transport systems.

(2) Promote and complete intelligent transport systems (ITS) research, and implement in actual transport use. Strive to become one of the world's leading centers in transport S&T.

(3) Research and develop new harbor technologies, improve harbor environments, and increase harbor functionality and operating efficiency.

(4) Improve the service quality of transportation and communications facilities by promoting technologically- and people-oriented transportation and communications engineering as well as maintenance and management R&D.

(5) Integrate roadway engineering into the ecology and prevent public construction from interfering with environmental conservation.

(6) Provide the best available meteorological, seismological, and marine meteorological information with modern technology. Improve society's quality of life and mitigate damage from natural disasters. Actively promote the use of meteorological information to create practical economic benefits.

IX. Overseas Compatriots Affairs Commission

(1) Enrich contents of the "Global Chinese Language and Culture Center" website and promote the digitization of education for overseas Chinese. Improve the efficiency of e-services.

(2) Create a web portal for Chinese-language digital learning. Build up the "Taiwan Internet School of Mandarin" name brand and actively attract Chinese-language learning communities.

(3) Encourage industries, government, and schools to develop digital contents specifically for overseas communities to learn Chinese language and culture. Aggressively pursue overseas markets for Chinese digital learning.

(4) Help overseas Chinese schools transform into Chinese digital learning centers as well as marketing points to promote Taiwan's outstanding resources for Mandarin learning.

X. Government Information Office

(1) Digitize images of activities from early Taiwan and establish the relevant working procedures. Display and present the cultural and social diversity of Taiwan.

(2) Establish research teams, create multimedia websites and movie databases, and analyze the future of motion picture digitization.

(3) Unite colleges, universities, or academic groups and convene special-topic seminars or workshops to promote high-quality contents for motion picture digitization.

XI. Department of Health

(1) Establish high-quality healthcare S&T policies, reinforce healthcare research and development.

(2) Strengthen research on life sciences and technologies, stimulate biomedical S&T industries.

(3) Promote healthcare S&T services and enhance capabilities for researching and developing applications.

XII. Environmental Protection Administration

(1) Preserve the environment and promote sustainable development.

(2) Build a comprehensive disaster mitigation and emergency response system.

(3) Raise environmental monitoring and testing standards.

(4) Research and develop cutting-edge science and technology. Promote industry-university cooperation on environmental science and technology.

XIII. National Palace Museum

(1) Under the National Digital Archives Program, create a digital museum and knowledge database of exquisite cultural artifacts from the NPM, promote a cultural and socioeconomic industries development project, and implement an international cooperation Internet project.

(2) Under the National Science and Technology Program for e-Learning, establish a museum digital learning demonstration center, create teaching materials for digital learning of artifacts, and develop a wireless personal museum guide system.

XIV. Atomic Energy Council

(1) Make full use of the country's unique resources for atomic energy S&T and accelerate the integration of these resources into local civilian industries. Promote social benefits and pursue excellence.

(2) Strengthen control technology and service efficiency, ensure nuclear safety. Progress to radioactive waste disposal technology and safety management, and improve environmental quality. Initiate clean energy sources R&D and nuclear medicine manufacturing.

(3) Integrate upstream and downstream demands. Develop atomic energy, plasma engineering, new energy sources, recyclable energy resources, and other industries as needed by the nation. Establish necessary interdisciplinary core technologies and systems such as nanotechnology, high-speed computing, biotechnology, and systems integration.

(4) Promote technology transfers and expedite the application of research results in industries.

(5) Actively promote international exchange, attract international experience, accelerate the pace of globalization, and promote Taiwan's research results around the world.

XV. National Science Council

(1) Effectively promote overall national S&T development, promote cross-agency integrated S&T programs. Implement the National Science and Technology Programs to meet the country's major socioeconomic needs.

(2) Support academic research, improve the research environment, and promote multidisciplinary integration. Raise academic research standards, develop research fields that will give Taiwan competitive advantages, and pursue academic excellence.

(3) Develop the science parks and establish core parks in northern, central, and southern Taiwan. Foster an attractive investment environment. Using the industrial cluster spreading effect, build a high-technology corridor that will span the length of western Taiwan. Establish infrastructure for a "Green Silicon Island."

XVI. Research, Development and Evaluation Commission

(1) Promote research on social development policies.

(2) Promote digital added-value services for Taiwan's industry metadata.

XVII. Council of Agriculture

(1) Expedite agricultural innovation, transformation, and marketing efforts. Build an innovative agriculture industry.

(2) Strengthen health care for farmers and fishermen, cultivate vigorous farmers.

(3) Revitalize rural environments and build charming rural communities.

XVIII. Council for Cultural Affairs

(1) Promote the digitization of art and cultural resources and establish a digital learning university for all the arts and humanities. Cultivate a new generation of cultural and arts personnel. Combine industrial development with the training of creative arts personnel. Enhance teaching effectiveness using modern technology media tools.

(2) Promote international digital cultural exchange. Create and maintain a Taiwan cultural web portal that introduces Taiwan's diverse cultures and related industries to the world.

XIX. Council of Labor Affairs

(1) Under the policy theme of "Safety, Happiness, and Dignity," the CLA is focusing current research and technology efforts on maintaining occupational safety and protection. These efforts will ensure job safety and health, raise competitiveness of the labor force, improve working and living quality, and protect the rights and interests of workers.

(2) Under the policy vision of "Healthy Taiwan, Happy Workforce," the CLA is actively helping workers find employment, enhancing occupational skills, creating comprehensive foreign labor policies, implementing the new labor retirement system, strengthening employee assistance, and reducing occupational hazards.

XX. Public Construction Commission

(1) Raise the quality of life, advance the wellbeing of citizens.

(2) Infuse regional characteristics, promote economic development.

(3) Protect the natural environment, strengthen the safety of facilities.

(4) Balance the ecological landscape, promote sustainable use of resources.

(5) Increase construction efficiency, ensure engineering quality.

XXI. Council of Indigenous Peoples

(1) Create digital archives to rescue Taiwan's Indigenous cultural assets from extinction. Preserve Taiwan's Indigenous cultures, harness their dispersed resources, and strengthen usage and preservation of such resources.

(2) Use digital learning to narrow the digital gap of Indigenous peoples. Create a digital learning website for Taiwan's Indigenous tribes and display cultural contents from the tribes.

XXII. Council for Hakka Affairs

(1) Promote the integration and digitization of Hakka books, documents, and other materials. Expand and provide Hakka research data for public use. Establish a solid foundation for Hakka research.

(2) Establish a digital learning database and Internet school for Hakka language and culture, and use digital learning platforms to develop curricula. Train seed teachers for Hakka digital learning and create a website for Hakka language and culture digital learning.

XXIII. National Communications Commission

(1) Enhance the efficiency and competitiveness of digital convergence.

(2) Establish a communication transmissions supervisory system.

(3) Protect the rights and interest of citizens and consumers.

(4) Promote cultural diversity and emphasize respect for the disadvantaged.

XXIV. Academia Historica

(1) Integrate S&T and cultural resources and strengthen basic research. Promote digitization programs for national archives, important historical documents, and presidential collections. Create a sustainable archive to preserve the wisdom of Taiwan's forebearers.

(2) Make use of digital data to enliven historical treasuries and develop new systems. Pursue excellence and knowledge innovation by promoting knowledge database development programs on national history, important Taiwan documents, and presidential collections.

(3) Improve the wellbeing of citizens by sharing and applying R&D results to academic research, education expansion, and the adding of industrial value.

(4) Foster international exchange, promote the globalization of digital archiving results, and secure copyrights for use of files.

4.2 Scientific and Technological Resource Plans of Government Agencies

Government agencies have budgeted a total of NT$437.837 billion for 2007 through 2010. Each agency's S&T resource plan is listed on Table 4-1.

Table 4-1 Government S&T Resource Allocations (2007–2010) – by Agency

Unit: NT$ millions

Agency	2007	2008	2009	2010	Total
Academia Sinica	9,288	9,473	9,663	9,857	38,281
Ministry of the Interior	426	530	585	641	2,182
Ministry of National Defense	9,000	9,000	9,000	9,000	36,000
Ministry of Education	1,447	1,592	1,751	1,926	6,716
Ministry of Justice	47	72	83	97	299
Ministry of Economic Affairs	26,883	30,626	31,545	32,491	121,545
Ministry of Transportation and Communications	874	931	985	1,011	3,801
Overseas Compatriots Affairs Commission	6	25	25	25	81
Government Information Office	38	38	38	44	158
Department of Health	4,615	5,197	5,415	4,882	20,110
Environmental Protection Administration	92	110	132	158	492
National Palace Museum	65	96	100	105	366
Atomic Energy Council	1,022	1,124	1,226	1,328	4,701
National Science Council	36,193*	47,243	47,816	49,401	180,653
Research, Development, and Evaluation Commission	109	112	113	113	447
Council of Agriculture	4,563	5,005	5,269	5,595	20,432
Council for Cultural Affairs	25	18	18	14	75
Council of Labor Affairs	225	264	278	291	1,058
Public Construction Commission	30	36	36	36	138
Council of Indigenous Peoples	24	22	24	27	97
Council of Hakka Affairs	11	0	0	0	11
National Communications Commission	4	7	8	9	28
Academia Historica	11	49	53	53	166
Total	95,000	111,570	114,163	117,104	437,837

Source: Provided by government agencies.

Notes: 1. (*) Only the 2007 figure includes the S&T Development Fund.
2. The 2007 figures are estimates, while 2008 through 2010 figures are projected expenditures.

Table 4-2 shows government S&T resource allocations as listed by major strategy.

Table 4-2 Government S&T Resource Allocations (2007–2010) – by Strategy

Unit: NT$ millions

Strategy	2007	2008	2009	2010	Total
1. Strengthening the formulation of policies; refining controls and regulations	4,358	16,514	17,020	17,631	55,523
2. Developing the S&T workforce; managing the supply and demand of personnel	21,005	20,032	20,360	20,994	82,391
3. Cultivating distinguished fields; pursuing academic excellence	20,195	21,422	21,777	22,373	85,767
4. Encouraging industry-university cooperation; developing industry clusters	21,782	3,734	3,807	3,935	33,258
5. Nurturing innovative enterprises; fostering emerging industries	8,033	23,671	24,129	24,916	80,748
6. Improving citizens' wellbeing; raising the quality of life	10,626	17,195	18,067	18,253	64,141
7. Boosting defense science and technology; promoting military-civilian technology transfers	9,000	9,003	9,003	9,003	36,009
Total	95,000	111,570	114,163	117,104	437,837

Sources: 1. Data for 2007 is provided by the National Science Council Task Force for Reviewing Governmental S&T Projects.
2. Data for 2008 through 2010 are projections provided by individual government agencies.

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