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National Science and Technology Development Plan

(2009-2012)

(approved version)

National Science Council, Executive Yuan

http://www.nsc.gov.tw/tc

National Science and Technology Development Plan

Contents

Comparative Table of Central Government Agencies' Abbreviations and Full Names

Abbr.	Full Name
AH	Academia Historica
AS	Academia Sinica
AEC	Atomic Energy Council
CPA	Central Personnel Administration
CCA	Council for Cultural Affairs
CEPD	Council for Economic Planning and Development
COA	Council of Agriculture
CHA	Council of Hakka Affairs
CIP	Council of Indigenous Peoples
CLA	Council of Labor Affairs
DOH	Department of Health
EPA	Environmental Protection Administration
FSC	Financial Supervisory Commission
GIO	Government Information Office
MOEA	Ministry of Economic Affairs
MOE	Ministry of Education
MND	Ministry of National Defense
MOI	Ministry of the Interior
MOJ	Ministry of Justice
MOTC	Ministry of Transportation and Communications
NPM	National Palace Museum
NSC	National Science Council
OCAC	Overseas Compatriot Affairs Commission
PCC	Public Construction Commission
RDEC	Research, Development and Evaluation Commission
STAG	Science and Technology Advisory Group

Chapter 1 Introduction

The 8th National Science and Technology Conference was held by the Executive Yuan in January 2009 in accordance with the Fundamental Science and Technology Act. This conference reviewed and discussed the state of sci-tech development in Taiwan, overall sci-tech development goals, strategies, and resources, and goals, strategies, and resources for specific government agencies and in each area of science and technology, and other important matters connected with the development of science and technology. This "National Science and Technology Development Plan" has been drafted on the basis of the consensus and conclusions reached at this conference, and will serve as a basis for Taiwan's drafting of S&T policies and the promotion of scientific and technological research and development during the next four years.

This plan has been jointly drafted by the National Science Council (NSC), Academia Sinica, Science and Technology Advisory Group (STAG), 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), Council for Economic Planning and Development (CEPD), Environmental Protection Administration (EPA), Public Construction Commission (PCC), and Council for Cultural Affairs (CCA) on the basis of information from and the final report of the 8th National Science and Technology Conference; the plan will serve as the basis for the government's science and technology development policies during the coming four years.

This plan contains seven chapters: Chapter 1 is an introduction, and Chapter 2 – "Overall Goals" – sets forth the six key overall goals of strengthening the knowledge innovation system, create an industrial competitive advantage, enhance citizens' quality of life, promote national sustainable development, boost citizens' scientific and technological qualifications, and strengthen autonomous defense technology. Chapter 3 – "Strategies" – lays out the following six strategies, and Chapter 4 lists important measures:

Strategy 1: Uniting the humanities and technology, improving the quality of life

Strategy 2: Training sci-tech manpower, making full use of talent

Strategy 3: Putting the legal and regulatory system on a sound footing, integrating sci-tech resources

Strategy 4: Pursuing academic excellence, strengthening social concern

Strategy 5: Enhancing technological innovation, improving the industrial environment

Strategy 6: Linking technological capabilities, promoting sustainable development

Chapter 5 – "Sci-tech Development at Government Agencies" – describes the sci-tech goals and strategies drafted by individual agencies in line with the government's sci-tech development strategies and vision, as well as these strategies' multi-year implementation following resource deployment. Chapter 6 – "Sci-tech development in various areas of science and technology" – explains how government sci-tech projects are reviewed in accordance with their respective characteristics as national and non-natural science and technology projects. Chapter 7 – "Implementation and control" – describes how responsible agencies will draft implementation plans for this plan's key measures, and these implementation plans will be included within the respective agency's administrative plan for implementation. In addition, the NSC shall report to the Executive Yuan concerning the state of implementation on an annual basis.

More detailed information concerning the following subjects is provided in this plan's appendix: current state and review of the country's scientific and technological development, sci-tech development at government agencies, preliminary review of government science and technology projects, academic research, cooperation between industry, academia, and research organizations and successful cases of sci-tech innovation, development of science parks, national science and technology programs, and the Program for Promoting Academic Excellence of Universities.

Chapter 2 Overall Goals

After weighing domestic and foreign sci-tech development circumstances and trends, the government has determined the following overall national sci-tech development goals:

Goal 1: Strengthening the knowledge innovation system

Goal 2: Creating an industrial competitive advantage

Goal 3: Enhancing citizens' quality of life

Goal 4: Promoting national sustainable development

Goal 5: Boosting citizens' scientific and technological qualifications

Goal 6: Strengthening autonomous defense technology

Chapter 3 Strategies

The following six strategies have been drafted in order to achieve the foregoing goals:

Strategy 1: Uniting the humanities and technology, improving the quality of life

Strategy 2: Training sci-tech manpower, putting talent to good use

Strategy 3: Putting the legal and regulatory system on a sound footing, integrating sci-tech resources

Strategy 4: Pursuing academic excellence, strengthening social concern

Strategy 5: Enhancing technological innovation, improving the industrial environment

Strategy 6: Linking technological capabilities, promoting sustainable development

The measures drafted in line with the foregoing strategies are listed in the appendix, and the most important measures are described in Chapter 4. These measures shall be implemented as part of individual agencies' annual administrative plans.

Chapter 4 Vision and Important Measures

Section 1 Uniting the Humanities and Technology, Improving the Quality of Life

I. Current Situation and Review

The following demographic changes will affect society and cause challenges for future national policies: The birth rate will continue to fall, young people will delay the age of marriage, the average life expectancy will increase, the elderly will account for a growing percentage of the population, the immigrant population will gradually grow, and emigration will gradually slow. In addition, relationships with their neighborhood and other people, trust in the social system, political attitudes, and environmental, social, and ethical values are all changing, both in degree and direction, among the people of Taiwan. At the same time, Taiwan's society has long lacked visionary forward-looking programs or education based on the sciences and liberal arts, and the current educational system does not provide students with the knowledge, skills, and attitudes that they will need to confront and deal with the problems of a fast-changing society. As a consequence, the future development of science and technology should be shaped by demand pull and a vision of Taiwan's future, and this vision should be realized, examined, and assessed in the form of works, video, or localized experiments. The development of the sciences and liberal arts in Taiwan currently faces the following problems:

1. The development of liberal arts has encountered the following problems connected with citizens' qualifications and the public knowledge infrastructure:
 (1) According to such international assessments as PISA, TIMSS, and PIRLS, the attainments of Taiwan's schoolchildren in science, technology, and

language are as follows: While overall science scores are among the world's highest, the highest scores are for comprehension, and application and reasoning abilities require strengthening; students' overall reading scores are mediocre, which reveals that they have insufficient ability to reflect on and think critically about what they read. These circumstances will hamper efforts to boost citizens' scientific and technological qualifications and national competitiveness.

(2) Investment in and use of libraries are insufficient; book purchase and collection budgets and hiring of professional manpower are inadequate.

(3) The educational system and university entrance examinations initiate tracking of students at an early date, which has resulted in poor scientific and technological qualifications among liberal arts students and poor liberal arts qualifications among science and engineering students.

(4) There is too little emphasis on citizens' participation in discussion concerning technological issues affecting society: Technology extension efforts and the discussion of technological issues emphasize technological aspects, but neglect discussion of technological ethics and technology policies. Insufficient citizen participation in these discussions will inevitably affect efforts to enhance citizens' technological qualifications.

2. We also hope that the innovative blending of the liberal arts, fine arts, science, and technology will promote the emergence of internationally competitive culture and art; the many problems currently hampering attempts to do so include the following:

(1) There has been long-term neglect of basic education in the humanities and social sciences (including art).

(2) Arts and humanities education is cut off from everyday issues.

(3) General education is often shallow or piecemeal.

(4) Interdisciplinary courses involving the arts and humanities/science and technology still await development.

(5) Due to entertainment and economic trends, Taiwan's culture and art industry faces development difficulties.

(6) The upstream segment of the culture and art industry is suffering from a deteriorating creative environment.

(7) The midstream segment of the culture and art industry lacks professional administrative, managerial, and curating manpower.

(8) The downstream segment of the culture and art industry has weakly developed sales channels and a poor market.

3. In keeping with a human-centered philosophy, the use of technology to prevent and mitigate natural disasters and accidents will improve public safety and the quality of life. The following problems have been encountered in the areas of workplace safety, public safety (crime detection), and architectural and urban safety:

(1) Taiwan's death rate from occupational accidents was 0.040 per 1,000 persons in 2007, which was higher than the in the US, Japan, and Britain. Total payments for occupational accidents were NT$4.0 billion during that year. Occupational accidents cause more than NT$47 billion in economic losses each year. According to the five targets in the WHO's "Workers' Health: Global Action Plan 2008-2017," and in line with world trends, Taiwan should have a safer working environment.

(2) Although Taiwan has effective law enforcement and judicial systems, many crime detection and prevention problems are difficult to resolve; key issues include the following:

a. Detection and prevention technology R&D systems are lacking.

b. Low-level detection systems must be established.

c. Prevention and detection quality assurance systems are incomplete.

d. The continued development of a forensics practice and R&D environment is urgent.

e. The compilation of detection and prevention databases has encountered difficulties.

f. High-tech parolee monitoring equipment must be improved and extended.

(3) Taiwan is located in the circum-Pacific earthquake belt, is mountainous with many swiftly-flowing rivers, and is in the path of many typhoons each year. In addition, Taiwan also has a high population density and many build-up areas. Such new threats as terrorism, emergent diseases, and the arrival of an aging society with few children will require the determination of risk factors using quantitative and qualitative methods, followed by the formulation of policies and action plans. In addition, Taiwan must maintain interchange with international research organizations, and learn from the policies and strategies of the world's leading nations, in order to be prepared to jointly respond to all kinds of urban disasters.

4. We hope to rely on humanistic science and technology to create an "even better humane life." This effort currently faces the following circumstances:

The development of localized living systems faces uncertain intelligent living technology industrial development and market prospects, the lack of an interdepartmental organization to perform planning and implementation, the absence of policy planning, standard protocols, an integration environment, commercial models, and interdisciplinary manpower, the difficulty of integrating different industries, and insufficient industry participation. Overall problems include insufficient consumer interest and differing consumer needs, failure to achieve economies of scale, uneven distribution of resources in urban and rural areas, inadequate medical care and living support integration and range of options, poor residential energy use efficiency, lack of planning and standard procedures for the integration of information and communications with buildings, high energy dependence and carbon dioxide emissions, and poor power use management.

With regard to the construction of intelligent transportation systems (ITS) meeting local living needs, the construction and use of transportation systems must be diversified in order to respond to different types of needs and the needs of different areas. ITS applications must be able to achieve synergy. Taiwan's ITS system development and promotion mechanisms do not have any support from dedicated laws or regulations, and there is no dedicated organization responsible for implementation, supervision, coordination, and integration. Since individual agencies are hampered by limited funding and the regulations of the Government Procurement Act when implementing ITS projects, overall effectiveness is inadequate, and project impact is limited. There has been a generally failure to local living needs into consideration, and no localized new-generation intelligent transportation systems have been developed. The government has also failed to implement full-scale dynamic auditing and management of commercial truck fleets throughout Taiwan, which could strengthen the breadth and depth of real-time transportation information. Furthermore, there is a shortage of ITS manpower, no ITS knowledge management system, and no stable, long-term ITS industrial development policy.

II. Vision

1. To establish humanistic sci-tech development strategies on the basis of a sound understanding of Taiwan's social and historical context and direction of social change.
2. To promote the development of an intelligent living technology industry and establish demonstration localized intelligent living systems, and incorporate information and communications technology in citizens' everyday applications on a large scale, in order to dramatically improve citizens' quality of life, and meeting citizens' safety, health, comfort, and convenient needs.

3. To construct intelligent transportation systems meeting local living needs, transforming Taiwan into an island of intelligent transportation, and place balanced emphasis on human concern and industrial development.
4. To develop and promote safety technology in order to alleviate workplace risk factors and create humane and safety working environments. To appropriately use technology to enhance the effectiveness of crime detection and prevention, and protect people's lives and safety. To promote the development of architectural and urban safety technologies.
5. To improve citizens' qualifications, expand the body of public knowledge, boost literacy among children, improve schoolchildren's reading environment, expand public library collections, establish public knowledge resources, and enhance citizens' interest in, understanding of, and support for science and technology.
6. To employ the popular applied aesthetics movement to boost the public's cultural and artistic qualifications, and seek to give society a correct attitude and perception of culture and art. To rely on ties between technology and cultural and art industries to stimulate Taiwan's economic transformation.

III. Important Measures

1. Development of humanistic technologies in response to social changes:

(1) Promotion of universal design:

Promotion of an integrated universal design industry, analysis of user characteristics, establishment of a localized ergonomics database for Taiwan, and drafting of relevant technological standards; reliance on the functioning of community experimental platforms to extract knowledge and technology from practical experience, and obtain a basis for the full-scale promotion of a humanistic architectural environment.

(Implemented by: Ministry of the Interior, Council of Labor Affairs)

(2) Promotion of visionary education:

a. With regard to visionary education, planning of heuristic methods for the reform of basic education, and strengthening of science education research, in order to enhance citizens' research skills.

(Implemented by: NSC)

b. Use of visionary education to induce students to think about the future from the angle of the humanities, social sciences, science, and technology, and thereby enhance their imagination.

(Implemented by: MOE) (Assisted by: NSC)

2. Planning and design of localized living systems:

(1) Integrated promotion of the planning and design of localized living systems

Formulation, planning, and implementation of intelligent living technology industry policies, development of commercial models, research and development of supply and demand and control and assessment methods.

(Implemented by: MOEA)

(2) Development and extension of localized living system applications

a. Use of Taiwan's information and communications technology advantages to establish and promote localized public service, health care, intelligent living, and intelligent energy systems in order to satisfy citizens' need for a superior living environment with regard to safety, health, energy conservation, comfort, and convenience, and respond to the problems of an aging society with few children and energy shortages.

(Implemented by: Ministry of the Interior, Department of Health, MOEA)

b. Improvement of the quality of urban life, and active promotion of community reconstruction, urban renewal, and building reuse in order to stimulate demand. (Implemented by: Ministry of the Interior)

3. In response to diverse public needs and industrial development, there is an urgent need to construct intelligent transportation systems (ITS) meeting local needs and transforming Taiwan into an island of intelligent transportation.

(1) ITS organizations, laws and regulations, systems, finances, and manpower training aspects:

Urging the Executive Yuan to announce a "National Intelligent

Transportation System Development Program," establishment of an interdepartmental promotion organization and ministry-level "ITS integration promotion" organization, boosting of the government's ITS funding level, enhancement of the training of ITS professionals, and establishment of a dedicated ITS knowledge management system organization.

(Implemented by: MOTC, Science and Technology Advisory Group of the Executive Yuan) (Assisted by: MOEA)

(2) Intelligent transportation system (ITS) deployment and applications:

Planning and construction of island-wide intelligent "backbone transportation network" and "public transportation service" infrastructure and people-oriented service platforms, deployment of strategic incentive mechanisms, and promotion of development of ITS-related "city/town/township transportation improvement projects" by city and county governments.

(Implemented by: MOTC)

(3) ITS industrial development:

Inclusion of ITS among new technology and industry items in the nation's industrial development policy, strengthening of ITS industrial development policy, and promotion of joint development models involving industry, academia, and research organizations.

(Implemented by: MOTC, MOEA)

4. Development of safety-promoting technologies:

(1) Eliminate of workplace risk factors, establishment of safe and humane working environments:

Adoption of workplace health and safety and health risk assessment and guidance improvement technology; establishment and integration of multi-dimensional occupational health and safety and occupational sickness and injury monitoring systems and worker sickness and injury databases; establishment of information platforms; use of ergonomics and environmental control technology to establish humane working environments; strengthening of workplace accident prevention laws and systems, and enhancement of implementation.

(Implemented by: Council of Labor Affairs) (Assisted by: NSC, MOEA, MOEA, Department of Health)

(2) Protecting citizens' lives and safety by making better use of technology to improve the effectiveness of crime detection, prevention and prosecution:

Establishment of advanced crime detection, prevention, and forensics R&D systems, improvement of R&D quality and application effectiveness; research and establishment of appropriate primary-level detection systems; implementation of forensic identification systems; research and legal systematization of a personal identification database and crime prevention database; improvement of the quality and efficiency of prosecution and criminal justice policy in order to safeguard citizens' judicial rights.

(Implemented by: Ministry of the Interior, MOJ)

(3) Promotion of the development of architectural and urban safety technology:

Proposal of mitigation and adaptation technology strategies and implementation plans addressing potential architectural and urban disaster characteristics, strengthening of certification technologies, establishment of full-age habitability architectural and urban safety technologies, integration of spatial planning, risk management, accident prevention and rescue system technologies, and establishment of information exchange platforms for accident prevention systems and spatial planning systems. These technologies shall be provided to public and private sector planning and accident mitigation organizations for implementation and extension of accident prevention research results.

(Implemented by: Ministry of the Interior)

5. Boosting citizens' scientific and technological qualifications and the public knowledge infrastructure is an important means of uniting the humanities and technology, and improving the quality of life:

(1) Active development of indicators of technology and linguistic qualifications suitable for use in Taiwan:

Drafting mechanisms for defining and testing qualification indicators, training R&D manpower specializing in relevant issues, establishment of research teams, promotion of multinational collaboration, implementation of comparative research.

(Implemented by: NSC)

(2) Promotion of school reading campaigns and utilization of technology to establish digital reading environments:

Strengthening of school books and equipment, and establishment of a superior reading environment in schools; reform of language courses; hiring of dedicated librarians to manage books and utilize teaching resources; deployment of digital resource sharing and reading service platforms, and exploration and extension of reading resources.

(Implemented by: MOE)

(3) Training of personnel possessing both technological and humanities qualifications, development of digital teaching materials uniting technology with the humanities.

Integration of instructional content and instructional methods in university liberal arts education, basic courses, and practicum courses in order to impart core abilities and interdisciplinary integration skills to students.

(Implemented by: MOE)

(4) Encouragement of concern for and understanding and support of science, full-scale improvement of citizens' scientific knowledge:

Holding of various popular science activities; implementation of the "Integrated Project for Facilitating Science Communication," training of professional popular science manpower; request for a national-level program or other major sci-tech research project on popular science, and addition of scientific knowledge promotion and extension projects geared to boosting citizens' interest in science.

(Implemented by: NSC)

6. Union of the arts and humanities with technological innovation, promotion of international-competitive culture and art:

(1) Implementation of a Taiwan applied aesthetics campaign program to enhance citizens' aesthetic endowment starting from the level of everyday life. Improvement of art education in schools, and encouragement of the establishment of interdisciplinary art & culture/technology degree programs and for-credit courses.

(Implemented by: MOE, CCA)

(2) Strengthening of art learning resource digitization during the course of the National e-Learning and Digital Archives Program, outreach to artists, art groups, art exhibition organizations, teachers and educational groups, development of art learning and instructional materials, and use of technology via the integration of web sites to compensate for the uneven distribution of art learning resources.

(Implemented by: CCA, NSC)

(3) Implementation of a large flagship art exhibition program combining technology and art; this program will show off Taiwan's technological and artistic prowess to the world.

(Implemented by: CCA)

(4) Implementation of joint research projects spanning economics, social issues, education, business management, art, and culture in order to determine the effect of government investment in art and culture on socioeconomic development, perform statistical analysis of cultural development needs, and investigate influence on inputs and outputs and the country's future development.

(Implemented by: CCA)

Section 2 Training Sci-Tech Manpower, Making Full Use of Talent

I. Current Situation and Review

In the face of the knowledge economy age and global competitive pressure, the quality and quantity of technical and industrial and power have become key factors affecting a country's industrial development and international competitiveness. Taiwan's demand for technical and industrial manpower has increased sharply as the country's industries have upgraded and transformed themselves, and there is especially great need for interdisciplinary and high-level personnel and specialists in certain technical areas. And beyond needing more technical manpower, Taiwan's industries also need technical personnel possessing the ability to innovate. Unfortunately, traditional teaching in Taiwan relies heavily on "spoon-feeding" instruction, and seldom uses heuristic methods. Because of this, most technical personnel have insufficient creative ability.

A considerable number of students have returned to Taiwan after obtaining higher degrees overseas during the past 20 years, and a growing proportion of these persons have obtained employment as university professors. These individuals have acquired new concepts, methods, and heuristic teaching skills, are gradually training local manpower, and are contributing to the improvement of student creativity. On the other hand, the effects of this trend are still quite limited. In order to provide the primary-level, mid-level, and creative R&D manpower needed for industrial development, it will be necessary to review current collaborative relationships between businesses and vocational schools, and draw on the resources of domestic and foreign industry, academia, and research organizations to train technical personnel possessing practical skills.

Although Taiwan's higher education system has expanded rapidly over the last few years, it still cannot meet businesses' manpower demands. In this situation, the recruiting of overseas technical and industrial manpower has become an inevitable policy option. In addition, as industry and organizations compete to recruit manpower, a growing number of personnel are seeking employment overseas or in China. As the state of coexistence between industry in Taiwan and China shifts, Taiwanese personnel in China are being promoted from production departments to R&D departments. Because current domestic laws and regulations still impose many restrictions on Chinese personnel who wish to work in Taiwan, there is no way to balance the flow of technical and industrial manpower between Taiwan and China. This situation has unfavorable implications for Taiwan's long-term industrial development.

The following is an analysis of technical manpower training and high-level human resource utilization:

1. Technical manpower training:

The training of technical manpower in Taiwan faces many problems and challenges. These problems involve the amount of technical manpower, positioning and characteristics, and quality control, etc. The following is a review of the drafting of sci-tech education policy, formulation of technical manpower training strategies, and efforts to enhance the effectiveness of manpower training:

(1) While the number of universities in Taiwan has increased dramatically, the average qualifications of graduating students has not improved much. The greatly expanded graduate school system must tackle the challenges of unevenly-developed fields of study and uneven student qualifications.

(2) With regard to their educational goals and developmental directions, universities, especially vocational universities, must make a greater effort to formulate distinctive areas of specialization corresponding to diverse areas of industrial development. Vocational universities still offer insufficient

practicum courses, and are failing to train the practical manpower needed for economic expansion and industrial development.

(3) Greater efforts must be made to impart all-round skills and international competitiveness to technical manpower.

(4) Existing manpower training mechanisms tend to emphasize question answering ability and neglect the ability to uncover and define problems; training in innovation skills must therefore be improved.

(5) The following problems affecting technical manpower training measures still exist:

a. Difficulty of integrating varied government inputs.

b. Laws and regulations must be made more flexible.

c. Funding sources are dispersed; funding does not flow freely.

d. Specialization is emphasized; well-roundedness receives inadequate attention.

e. A greater effort must be made to enhance international perspectives.

2. High-level human resource utilization:

Government agencies have made active efforts to revise relevant laws and regulations over the last few years, have instituted measures governing utilization of overseas technical and industrial manpower, and have achieved much tangible progress. However, there are still many aspects of government policy directions and measures that require review and improvement. The following is an overview of the three aspects of construction of a global technical manpower network, recruiting of foreign technical and industrial manpower, and recruiting of Chinese technical and industrial manpower:

(1) Construction of a global technical manpower network:

a. Insufficiently clear positioning and definition of manpower scope.

b. Manpower networks are excessively oriented towards Chinese communities.

(2) Recruiting of foreign technical and industrial manpower:

a. Taiwan's efforts to recruit foreign technical and industrial manpower lack planning of forward-looking human resource development strategies.
b. Taiwan's salaries and incentives are insufficient to attract foreign technical manpower.
c. Ordinary companies universally lack the knowledge and skills needed to recruit foreign technical and industrial manpower.
d. Review mechanisms for foreign technical personnel wishing to work in Taiwan emphasize preventing possible misconduct at the expense of promoting benefit.
e. There has been a lack of survey research concerning the current state of foreign technical personnel working in Taiwan and their influence.

(3) Recruiting of Chinese technical and industrial manpower:

a. Restrictions imposed by domestic laws and regulations have hampered the exchange of technical manpower and establishment of substantive R&D collaboration between Taiwan and China.
b. Taiwan has lagged behind other countries, such as Japan, in the area of recruiting Chinese technical and industrial manpower. Chinese technical and professional personnel are not have high willingness to work in Taiwan.
c. There has been no pre-assessment of the impact of recruiting Chinese technical and industrial manpower on Taiwan's employment market.

3. Increasing the international competitiveness of Taiwan's academic research and manpower:

Taiwan's past OEM industry model emphasized progressive innovation and economies of scale. But in the face of the knowledge economy age and the threat posed by large emerging economies, Taiwan must find new engines of growth if it is to accelerate its slowing economic development. Innovation is unquestionably the key to Taiwan's sustained economic growth. In particular, Taiwan must direct its efforts pioneering technology R&D at the front end of the value chain and various non-technological innovations at the back end (such as service, business model, and marketing innovations). The role played by science and technology in Taiwan's rise to prosperity is seldom questioned, and "high-tech" is practically synonymous with Taiwan's industrial foundation. Nevertheless, there is convincing evidence suggesting that continued efforts to strengthen the technologies supporting Taiwan's current major industries will not, by themselves, be sufficient to maintain a healthy economic growth rate. The facts indicate that Taiwan's economic growth peaked during the 1980s, and then began a steady decline. The period of high-tech dominance was no exception to this trend. Taiwan must therefore strengthen value chain linkage of its previously piecemeal sci-tech development, learn how to transform groundbreaking innovative R&D into high added-value products and industries by taking advantage of its manufacturing strengths, and increase the contribution of science and technology to society, life, and economic development.

Taiwan has committed large amounts scientific research funding to universities and research organizations. Although, this investment has yielded numerous benefits (such as the training of high-level technical manpower), most of the basic technologies used by domestic industry still did not originate in Taiwan. As a result, how to use innovative research results to develop innovative technologies and industries, and thereby recover the country's investment in scientific research, remains a very important question. To achieve these results, it will be necessary to rethink the country's focus on scientific research, lengthen R&D chains, and strengthen the conversion of R&D results into innovative technologies and industrial capabilities. It will not be enough to merely improve technologies and raise efficiency, as has been done over the past few decades. The many ordinary projects, focal projects, and national science and technology programs funded by the NSC every year have yielded a rich harvest of far-reaching results. Unfortunately, although a high percentage of projects have generated groundbreaking innovations and results with high application potential, there are no subsequent mechanisms to transform project results into innovative products or industries yielding socioeconomic benefits. In other words, there is currently no powerful and effective mechanism for assessing research results, nor are there any intellectual property management and guidance measures.

Institutions of higher education are major centers of knowledge creation and transmission; they bear responsibility for developing a knowledge innovation society and are closely linked the quality of technical manpower. The number of universities participating in the MOE-funded "Project of Promoting Academic Excellence & Developing World Class Research Centers" seems to be out of proportion to Taiwan's population. An excessive number of universities and departments will dilute limited research resources and funding, making the goal of increasing international competitiveness harder to reach. Furthermore, most current Ph.D. students have the ultimate goal of embarking on academic career or teaching at a national University. As described previously, the nation's research results should contribute to improving people's lives and fostering economic development. Cloistering high-level research manpower at academic institutions and research organizations cannot effectively boost national competitiveness. In addition, the training of Ph.D.-level research manpower should go beyond the traditional concept of training students in narrowly-defined subjects and fields, and instead attempt to break down the barriers that separate research domains. The new generation of Ph.D. students should have broad international perspectives and the ability to engage in lifelong interdisciplinary learning. They should also possess the ambition and ability to make pioneering contributions to new fields of research and new industries.

The world situation is currently extremely volatile, and Taiwan has been unable to escape the effects of the global recession. Some companies have reduced working hours or forced employees to take leave, and spending on manpower training seems destined to fall, even as employees have more spare time. During the next few years, the government and schools should certainly consider taking prompt action to enhance the qualifications of industrial manpower and show business and the public that government resources are being used in the most effective manner.

II. Vision

1. To train sci-tech personnel possessing innovative thinking, professional ethics, liberal arts qualifications, and social concern.
2. To effectively promote the development of characteristic features and knowledge innovation at schools and departments; to strengthen interdisciplinary, inter-field collaboration and international competitiveness.
3. To bring schools closer to industry; impart practical skills and innovation industrial perspectives to sci-tech manpower.
4. To strengthen learning mechanism, and fully meet the needs of in-service continuing education and lifelong learning.
5. To implement meritocratic policies with regard to persons from different places and belonging to different ethnic groups.
6. To promptly recruit and effectively utilize foreign technical and industrial manpower in order to re-energize Taiwan's economy.
7. To utilize technical and industrial manpower from China in a strategy of simultaneous collaboration/competition, and thereby broaden access to manpower and knowledge.
8. To assess the realization and application of university R&D results in order to enhance the competitiveness of Taiwan's academic research and manpower.

III. Important Measures

1. Establishment of university departments and graduate schools possessing distinguishing features:
   (1) All universities should clarify their features or positioning and use resources with strategic goals in mind; adoption of a university classification system

and promotion of diversified university development and cooperative alliances. (Implemented by: MOE)

(2) Improvement of the instructor promotion system, and increase of emphasis on university features. (Implemented by: MOE)

2. Strengthening of overall planning of industry-academic interaction.

(1) Encouragement of the development of sci-tech courses with distinctive orientations at vocational schools; further implementation of department-based course development mechanisms instead of instructor-based course development mechanisms. (Implemented by: MOE)

(2) Improvement of vocational school evaluation systems in order to boost the quality of distinctive sci-tech courses; development of distinctive features at vocational schools. (Implemented by: MOE)

(3) Encouragement of the development of industrial/academic collaboration mechanisms by universities on the basis of R&D potential, R&D features, industrial service potential, and regional economic potential. (Implemented by: MOE)

3. Promotion of sci-tech education quality control:

(1) Promotion of a systematic quality control mechanism focused on student learning results, and determination of professional skills students should possess at graduation. Emphasis should be placed on core courses, laboratory course content and teaching materials reviewed regularly, and basic laboratory course equipment strengthened in order to strengthen students' basic subject abilities. (Implemented by: MOE)

(2) Research on and improvement of sci-tech education; promotion of liberal arts education and ethics education, and strengthening of students' fraternal consciousness, professional ethics, humane qualities, and social concern. (Implemented by: MOE)

4. Improvement of the international competitiveness of Taiwan's academic research and manpower:

(1) Training of technical manpower possessing international competitiveness:

a. Promotion of large research projects, training of personnel possessing interdisciplinary integration skills, and reliance on common long-term goals and collaboration to gather interdisciplinary manpower and leaders possessing integration ability. (Implemented by: NSC)

b. Improvement of the graduate school entrance examination system in order to facilitate the training of interdisciplinary manpower. (Implemented by: MOE)

c. Strengthening of university students' practical, innovation, and design skills, and enhancement of students' interdisciplinary knowledge and ability in the fields of information/nanotechnology/biotechnology/energy, enabling them to help resolve the major problems facing society in the 21st century. (Implemented by: MOE)

(2) Assessment of university R&D results and promotion of subsequent follow-up projects:

Implementation of an inventory of R&D results and formulation of follow-up project mechanisms; determination of major research results with further translational research potential. Request for funding of NT$50 billion over a five-year period for priority implementation of follow-up projects by universities, top-level research center, and national science and technology programs. (Implemented by: NSC, MOE)

(3) Establishment of a research results assessment mechanism and system at the university department level:

In order to centralize resources and strengthen the international competitiveness of Taiwan's research and manpower, it is recommended that university department evaluation systems, especially Ph.D. evaluations, be reviewed. Such items as research output and influence may be included in evaluation content, and the quality and quantity of results, and graduates' achievements may serve as indicators for the evaluation of instructional performance. (Implemented by: MOE)

(4) Assisting the professional development of Ph.D. personnel:

a. Use of a system or funding planning to support neophyte instructors and researchers during a 3-5 year protected period, allowing them to perform innovative research. (Implemented by: MOE, NSC)

b. An interdepartmental review of the development system encompassing Ph.D. students and post-doctoral researchers will assist the professional development of Ph.D. manpower. (Implemented by: MOE, NSC)

5. Innovative and pioneering educational mechanisms:

(1) Establishment of a campus culture friendly to industry, encouragement of industrial-academic invention and start-up competitions, implementation of measures providing sufficient incentives and awards to instructors and industrial-academic collaboration promotion personnel, and establishment of start-up mechanisms for students and teachers in order to inspire greater entrepreneurial spirit among students and instructors. (Implemented by: MOE)

(2) Establishment of a linked technical manpower training model involving industry, government, academia, and research organizations, and expanding the innovative knowledge and social functions of technical manpower. (Implemented by: MOE)

6. Expansion of Taiwan's global technical and industrial manpower network:

(1) Clear determination of types of technical and industrial manpower needed on the basis of Taiwan's industrial development strategy, and use of this knowledge to determine foreign technical and industrial manpower selection and classification mechanisms. (Implemented by: CEPD, NSC, MOEA)

(2) Strengthening of the functions of the existing Hirecruit information platform, and encouraging private and government units to send information to this platform in order to achieve the benefits of information sharing. (Implemented by: MOEA)

7. Review and improvement of existing foreign technical and industrial manpower recruiting:

(1) Increasing the flexibility of the salary system for university teaching and research personnel in order to increase competitiveness by achieving international standards, and attract more outstanding talent to Taiwan. (Implemented by: MOE) (Assisted by: Central Personnel Administration, Directorate General of Budget, Accounting & Statistics)

(2) Increasing the flexibility of the salary structure for research personnel at research organizations so as to ensure that such personnel receive internationally-competitive levels of compensation, boost morale, and attract outstanding talent to Taiwan.
(Implemented by: Academia Sinica) (Assisted by: NSC, Council of Agriculture (COA), Department of Health (DOH), Central Personnel Administration, Directorate General of Budget, Accounting & Statistics)

8. Recruiting of Chinese technical and industrial manpower and cross-strait exchange of technical manpower:

(1) Implementation of a survey of the Chinese technical and industrial manpower needs of various industries and academic fields, and assessment of the effect of allowing more Chinese technical and industrial manpower to work in Taiwan. Early assessment results can guide the decision of whether to further revise relevant laws and regulations and appropriate draft measures governing the recruiting of Chinese technical and industrial manpower for work in Taiwan. (Implemented by: Mainland Affairs Council, NSC, MOEA)

(2) Boosting the willingness of students in Taiwan and China to participate in short-term academic exchanges. (Implemented by: MOE)

9. Training and utilization of human resources in order to accumulate the talent needed for Taiwan's next surge of industrial development:

(1) Improving manpower training:

Expansion of government training funding, encouragement of universities and training organizations throughout Taiwan provide practical courses, improvement of the quantity and quality of adult skills (or second specializations).

(Implemented by: MOE, National Youth Commission, Council of Labor Affairs)

Section 3 Putting the Legal and Regulatory System on a Sound Footing, Integrating Sci-Tech Resources

I. Current Situation and Review

1. Putting the legal and regulatory system on a sound footing, promoting the synergistic utilization of R&D results by industry, academia, and research organizations

In general, government-funded technological R&D results may be used in accordance with the utilization regulations of the Fundamental Science and Technology Act, which allow the competent authorities under the Executive Yuan with science and technology related responsibilities to draft relevant laws. Management regulations currently prescribe such items as key elements, deadlines, scope, ratios, registration, management, distribution of profits, funding agencies' rights to authorize implementation by a third party, recovery of national share, and other relevant procedures.

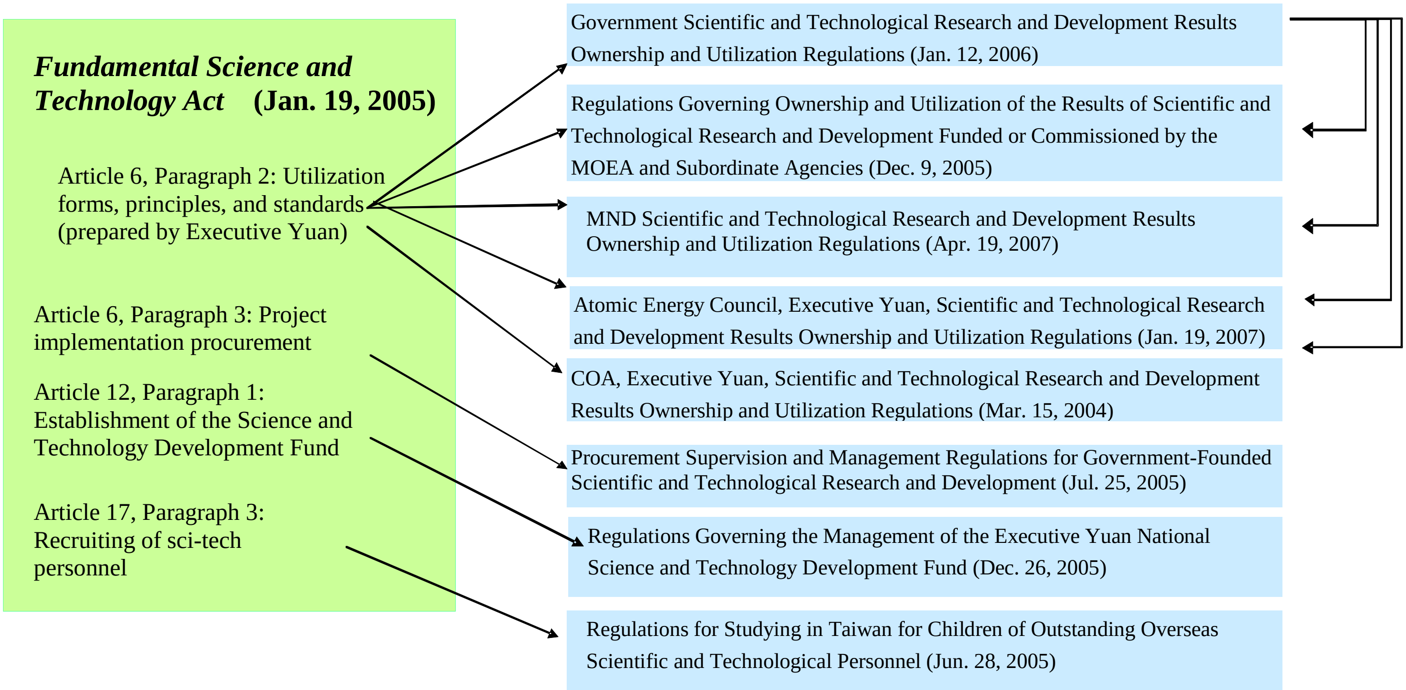

Figure 1 Structure of the Legal System Governing Utilization of Government R&D Results

The existing legal system governing the utilization of the results of government-funded R&D includes the original law Fundamental Science and Technology Act, and the Government Scientific and Technological Research and Development Results Ownership and Utilization Regulations (hereafter, Executive Yuan Regulations) drafted by the Executive Yuan in accordance with Article 6, Paragraph 2 of the Fundamental Science and Technology Act. Similarly, four agencies have drafted regulations governing the ownership and utilization of research results, including the MOEA' Regulations Governing Ownership and Utilization of the Results of Scientific and Technological Research and Development Funded or Commissioned by the MOEA and Subordinate Agencies" (hereafter, MOEA Regulations), the MND's MND Scientific and Technological Research and Development Results Ownership and Utilization Regulations (hereafter, MND Regulations), the COA's COA, Executive Yuan, Scientific and Technological Research and Development Results Ownership and Utilization Regulations (hereafter, COA Regulations), and the Atomic Energy Council's Atomic Energy Council, Executive Yuan, Scientific and Technological Research and Development Results Ownership and Utilization Regulations (hereafter, AEC Regulations). (Fig. 1)

After being implemented for many years, this legal system has yielded two important results: In keeping with world trends, results can be released to users, and the government can authorize use, which greatly facilitates the efficiency of utilization. Nevertheless, due to the government's recent efforts to boost the performance of the country's innovation and R&D system, and promote various types of collaborative projects involving industry, academia, and research organizations, after reflecting on the actual implementation experiences of academic and research organizations, the government has concluded that, in view of changes in technology and the operating environment, the wording of laws and regulations may have become excessively vague, which has given rise to the following issues currently awaiting resolution:

(1) Necessity of revising the Fundamental Science and Technology Act：

The only form of R&D result utilization specifically sanctioned by the Fundamental Science and Technology Act is "authorization to a third party for implementation." Other forms of utilization are questionable, and require further examination of individual agencies' regulations, such as assignment (including trusts) and termination of rights in the Executive Yuan Regulations, and assignment of rights requirements in the Government Procurement Act. The Fundamental Science and Technology Act does not explicitly list feasible utilization methods, but only states that the principle of fair benefit should apply; this is insufficient to clearly express a policy of complete release of rights and permission for free use.

(2) Conflicting applicability of the Fundamental Science and Technology Act and National Property Act, which limits the utilization of R&D results from public academic and research units:

Subject and object applicability problems affect the Fundamental Science and Technology Act and the National Property Act. Although Article 6 of the Fundamental Science and Technology Act excludes the applicability of the National Property Act, it does not explicitly state whether both national universities and government research organization are applicable; because of this, although subjects not subject to the restrictions of the National Property Act are specified in Article 6, Paragraph 1 of the Fundamental Science and Technology Act, there is no agreement concerning whether, after implementation by various agencies, national universities and government research organizations are in fact not subject to the regulations of the National Property Act. Because of this, the relationship between the Fundamental Science and Technology Act and the National Property Act must be clarified in order to provide agencies with a basis for revising their existing research results management regulations.

(3) Termination and assignment of rights

With regard to regulations governing the form of utilization, the final section of Article 6, Paragraph 1 of the Fundamental Science and Technology Act states, "Any intellectual property rights and results that it has obtained may be owned wholly or in part by the unit implementing research and development, or may be licensed for use, and the restrictions of the National Property Act shall not apply." Article 5, Paragraph 1 of the Executive Yuan Regulations specifies management and utilization responsibilities, "When a funding agency or unit implementing research and development obtains R&D results as prescribed in Article 3, Paragraph 1, it shall bear responsibility for management and utilization." Article 5, Paragraph 2 prescribes the forms of management and utilization, "The management and utilization of R&D results in the foregoing paragraph shall include application for and protection of domestic and foreign rights, licensing, assignment, benefit, commissioning, trusts, lawsuits, and any other actions connected with management and utilization of R&D results."

The foregoing statements lead to a problem: While the Fundamental Science and Technology Act clearly specifies the permitted forms of utilization, can the forms of utilization stated in the Executive Yuan Regulations and the subsequent four agency management regulations, specifically "assignment, benefit, commissioning, trusts, lawsuits, and any other actions connected with management and utilization of R&D results," be included in an expanded explanation in the Fundamental Science and Technology Act?

(4) Termination of rights

With regard to terms for termination of maintenance of rights, Article 7 of the Executive Yuan Regulations clearly prescribes, "A funding agency or unit implementing research and development may terminate the payment of maintenance expenses such as annual fees for intellectual property rights with no utilization value that have not been assigned to any third party."

All agencies that have drafted management regulations prescribed requirements for the termination of rights. Apart from the MOEA, which prescribes a minimum maintenance period of three years, the other three agencies prescribe periods of five years. In all cases, when it is believed that R&D results do not possess utilization value, maintenance of rights may be terminated after requesting and obtaining the competent authority's approval.

Since technological value may not necessarily be obvious, however, a more thorough method of finding utilization value may be needed. Since an observation period may be needed to allow relevant factors to mature or market opportunities to appear, relinquishing rights too early may cause losses.

Secondly, since applying for patents or other intellectual property rights on the basis of R&D results requires the expenditure of time and funds, utilizing units should make carefully thought-out decisions concerning whether to secure rights; the situation where units apply to patent results with no value in order to boost their patent application performance indicators should be avoided.

With regard to both assignment and termination of rights, except for when licensed for use, R&D results originally constituting publicly-owned property must be changed to non-publicly-owned property in the case of other forms of utilization that are still subject to the regulations of the National Property Act. Because changing publicly-owned property to non-publicly-owned property is a time-consuming, costly, and complicated process, it might impede commercialization and not facilitate the derivation of benefit from R&D results.

(5) Need to bring conflicting agency regulations into agreement

Furthermore, as prescribed in Article 6, Paragraph 2 of the Fundamental Science and Technology Act, the R&D results ownership and utilization regulations of the four agencies specify more specific results utilization requirements, but also give rise to differences in management mechanisms. In addition, the lack of clarity in the regulations of the proviso to Article 8 of the Executive Yuan Regulations ("But this may be performed using other methods that comply more closely with the intent or goals of this Act.") may influence the effectiveness of R&D results utilization. This also requires review and discussion.

a. Exclusive licensing: Article 15 of the MND Regulations, Article 14 of the COA Regulations, and Article 12 of the AEC Regulations all allow only non-exclusive licensing as a rule; the MOEA Regulations does not impose any restriction, and provides actual applications cases.

b. Gratis use: Article 14 of the MND Regulations, Article 12 of the COA Regulations, and Article 11 of the AEC Regulations all prescribe a non-gratuitous principle, but if "this may be performed using other methods that comply more closely with the intent or goals of this Act, and the implementing unit has requested and obtained the approval of this Ministry, the case shall not be subject to this restriction"; furthermore, according to Article 18 of the MOEA Regulations, gratis use is allowed following the

MOEA's approval when the case is intended to "achieve public interest goals or promote overall industrial development."

c. Overseas utilization: The MOEA has drafted the thorough Operating Guidelines Governing Manufacture Involving or Use of Research and Development Results from MOEA Scientific and Technological Research and Development Projects in Areas Outside the Jurisdiction of the Republic of China. However, the COA, Atomic Energy Council, and MND have not formulated clear regulations governing review procedures for overseas utilization.

d. Non-public use: The MOEA, COA, Atomic Energy Council, and MND all specify that non-public use may be allowed only when "separately prescribed in accordance with the results' characteristics or pursuant to statute." The COA also requires COA approval and review by the COA intellectual property review committee.

e. Putting the incentive system on a sound footing: While Article 11 of the Executive Yuan Regulations prescribes that a certain percentage of income derived from the management and utilization of R&D results shall be granted to the "creator," apart from creators (inventors), it should perhaps explicitly specify incentives for technology transfer teams and industry-academic bridge projects responsible for R&D results.

(6) Complicated restrictions on overseas utilization

With regard to regulations governing the overseas utilization of government-funded R&D results, the Fundamental Science and Technology Act does not prescribe that a third party licensed to perform utilization must be a citizen, nor that the manufacture or use must occur within an area under the jurisdiction of the Republic of China. On the other hand, Article 8, Paragraph 1, Subparagraph 3 of the Executive Yuan Regulations specifies that the utilization of R&D results must comply with the principle of "manufacture or use within the area of jurisdiction of the Republic of China"; any overseas utilization that occurs must comply with the prescription in the same article: "But if this may be performed using other methods that comply more closely with the intent or goals of this Act, the case shall not be subject to this restriction." All agencies employing overseas utilization must undergo review within the agency. Furthermore, apart from the foregoing government-funded R&D results management regulations, utilization of R&D results shall be subject to the restrictions of other laws and regulations, such as foreign investment and technological collaboration assistance and guidance regulations, and regulations governing investment and technological collaboration in China. (see Fig. 2)

The fact that laws and procedures connected with the overseas utilization of R&D results are excessively complicated has meant that promising technologies developed at universities in Taiwan lose many opportunities assume their rightful position in international markets.

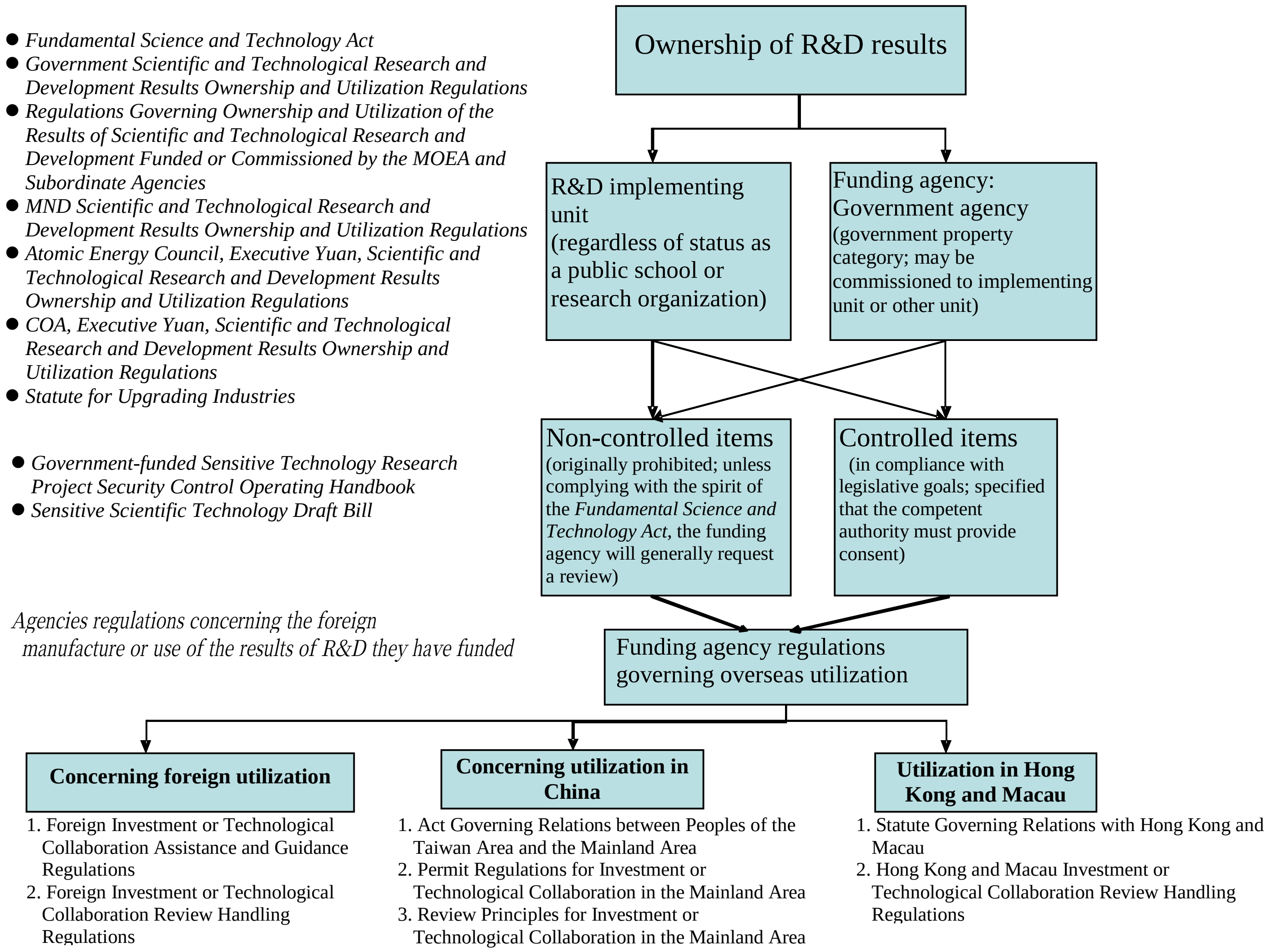

Figure 2 Structure of legal system governing the overseas utilization of government-funded R&D results

(7) Problems concerning university spin-off companies:

Universities are centers of knowledge, and Taiwan has developed a university system providing widespread access to higher education. Encouraging young people to establish their own businesses, and thereby transforming R&D capabilities into spin-off companies, will be a key method of fostering entrepreneurial innovation. Nevertheless, universities wishing to transform their R&D efforts into spin-off companies still face the following difficulties:

a. Insufficient entrepreneurial formative education at universities: Since entrepreneurial skills on university campuses are insufficiently mature, entrepreneurial formative education should be used to reinforce entrepreneurial concepts and practical skills. The leading countries of Europe and North America have actively promoted entrepreneurship education and relevant activities on universities in order to boost entrepreneurial interest and skills. Taiwan should keep up with this global trend by strongly promoting entrepreneurship education and related entrepreneurial activities at universities.

b. Insufficient measures supporting entrepreneurial activity at universities: Because the entrepreneurial environment at universities is insufficiently mature, in order to overcome current obstacles and establish an entrepreneur-friendly environment, universities should draft internal regulations and incentive measures promoting entrepreneurship, including incentive measures for personnel, positive feedback mechanisms, mechanisms for avoidance of conflict of interest and personal benefit, and university investment participation methods and entry/exit mechanisms.

c. Lack of successful benchmark start-up cases at universities: Since there are too few successful benchmark start-up cases on campuses, there is a need to actively encourage the discovery and cultivation of benchmark startups, and publicize the entrepreneurial mechanisms and models of these benchmark cases. It is hoped that successful entrepreneurial models and benchmark cases can be replicated in order to establish even more innovation-oriented university spin-off companies.

d. Lack of financial and investment deregulation strategies

i. According to Article 128 of the Company Act, the government or a juridical person may both serve as the founder of company. However, because public universities are not independent juridical persons, there is still doubt concerning whether universities may serve as founders when establishing spin-off enterprises.

ii. There are currently no regulations governing a university's use of its stock holdings, and different universities have adopted different standards and strategies.

iii. Although Article 7-1 of the National University School Fund Establishment Statute prescribes that universities may invest in "companies or enterprises connected with scholastic affairs or research," there is not concrete basis for determining what is meant by "companies or enterprises connected with scholastic affairs or research."

(8) Problems concerning public sector spin-off companies:

Public units including 16 experimental research organizations under the COA, the Chung Shan Institute of Science and Technology under the MND, and the Academia Sinica have achieved very impressive R&D results. If it is desired to encourage the establishment of innovative spin-offs and utilization of R&D results in order to maximize added value, the legal framework and accompanying regulations must overcome the following problems:

a. Restrictions on the personnel system: For example, the requirements of the Public Functionary Service Act concerning temporary loan of personnel and leave without pay still await effective deregulation.

i. Articles 14, 14-1, 14-2, and 14-3 of the Public Functionary Service Act restrict civil servants from working part-time or holding positions at private enterprises. Failure to ease the restrictions in these articles will impede cooperation between industry, government, academia, and the research community, and would be in conflict with the government's current promotion of industrial/academic collaboration and technology commercialization.

ii. Although some government agencies have eased restrictions, such as the MOE's Principles for Handling the Part-time Employment of Full-time Instructors at Public Schools at all Levels and the permission of part-time employment by Article 11 of the Biotech and New Pharmaceutical Development Statute, these regulations cannot be applied to research organizations and research organization personnel under other government agencies, which has resulted in a situation of multiple systems in the same country.

iii. Although there have been plans to deregulate Article 14 of the draft Public Functionary Service Act, the revised act has not yet been passed. It is recommended that the revised Public Functionary Service Act be promptly passed in order to realize a sound legal system and promote the effective utilization of R&D results by industry, academia, and research organizations.

b. Insufficient spin-off enterprise feedback mechanisms and incentives for personnel: According to the Fundamental Science and Technology Act, income from government-funded R&D results must be turned over to the national treasury, and the determination of the value of equity accruing to the treasury remains problematic. If no principles for handling this issue are established, even though a legal basis for establishing spin-off companies is present, relevant personnel will not know how to proceed, and will be unable to enhance the effectiveness of R&D by establishing spin-off enterprises.

c. Inadequate conflict of interest prevention measures and risk control mechanisms: When taking part in intellectual property transactions such as technology licensing and provision of technical services, in order to avoid legal risks associated with the establishment of a spin-off company, the decision whether to take a consideration in the form of equity or cash must reflect the holistic situation of such factors as the maturity of the market, overall investment plan, and industry environment.

d. Accounting and auditing problem: The fact that profit derived from the establishment of a spin-off enterprise is typically not limited to cash has an inevitable impact on financial and accounting handling. New handling regulations must therefore be established in response.

(9) Active differentiation of civil servants, teachers, and government researchers in order to enhance the efficiency and performance of public academic and research organizations:

Taiwan's research capabilities and resources are mostly concentrated at public universities, public research organization, and the Academia Sinica. However, all three are organized as government agencies, and are therefore constrained by the University Act, Central Governmental Organization Fundamental Act, individual organizational regulations and personnel affairs laws, the Budget Act, Accounting Act, Audit Act, and Government Procurement Act, and are further limited by the levels of laws, legal orders, administrative directive, and orders. As a result, the foregoing organizations have insufficient autonomy with regard to decision-making, funding, and performance-based setting of personnel salaries, which hampers the effective utilization of resources and research results at public universities and research organizations.

a. University budgets, accounting, financial statements, and audits are subject to the same system as ordinary government administrative agencies. As a consequence, universities lack necessary flexibility. After the passage of the revised Public University School Fund Establishment Statute, the controls imposed by the foregoing laws and regulations will no longer apply to public universities' donation income, facility and equipment management income, education extension income, school-to-work program income, and investment gains. In addition, individual schools will be free to determine revenue and expenditure management regulations, and will be under the supervision of the MOE (see Article 10 of the foregoing Statute). Another restriction on public universities is the fact that most, or almost all, funding must be appropriated in accordance with MOE budget procedures. This makes it difficult to grow quickly or in accordance with an individual university's expectations. Smaller universities must try to secure funding from various MOE subsidy programs, and upper echelon universities inevitably attempt to obtain funding from the Program for Promoting Academic Excellence of Universities. And since university tuition increases or decreases must comply with the Tuition Fee Regulations for Junior Colleges and Institutions of Higher Education (promulgated on June 13, 2008), individual university do not necessarily have adequate flexibility or autonomy.

b. With regard to university manpower: (1) Article 17 of the University Act prescribes that instructors shall be classified as professors, associate professors, assistant professors, and lecturers; universities may establish chairs, which shall be filled by professors; universities may hire teaching assistants to perform teaching and research work; universities may hire research personnel to engage in research and professional technical personnel to perform teaching; and the MOE shall determine regulations governing the classification, qualifications, hiring, dismissal, discontinuation, non-extension, appeal, compensation, benefits, continuing education, retirement, survivor benefits, severance pay, annual pay increases, and other rights and interests of the foregoing personnel. Universities may hire instructors on an initial employment, continuing employment, or long-term employment basis. (2) University instructors may apply for NSC funding and may participate in various government research bid request cases; in the latter situation, however, an instructor may serve as the principal investigator of at most two projects at the same time. Although schools have established special awards and incentives for instructors demonstrating outstanding teaching or research, such as subsidies for the publication of academic papers in TSSCI periodicals, these awards are not adequate when compared with the amount of effort shown by the instructors. (3) The salaries of university instructors have not been adjusted for several years, and relevant incentive measures are insufficient to reward truly dedicated researchers. (4) The Legislative Yuan should be strongly urge to pass the revised Teacher and Staff Retirement

Pension and Severance Pay Statute to ensure that the time university instructors are temporarily transferred is included in pension and severance pay calculations.

c. Staff at public universities are employed under a civil servant system that lacks flexibility and imposes high employment costs.

In general, while public universities in Taiwan currently enjoy a certain amount of freedom, their personnel affairs, organization, budget, accounting, audits, and purchasing are still subject to relevant legal restrictions, and they lack the flexibility needed to set instructors' salaries and compensation.

2. Strengthening of interagency cooperation mechanisms in connection with government R&D programs in order to establish a national competitive advantage in science and technology:

Generally speaking, Taiwan has consistently provided strong support for the development of science and technology, and the central government's sci-tech budget has grown by an average of 7.16% annually over the most recent five years. In 2006, total nationwide R&D funding was approximately NT$307.0 billion, which accounted for roughly 258% of GDP. After taking office, President Ma Ying-Jeou announced the policy objective of "increasing government R&D funding by 10% annually, and striving to achieve R&D funding accounting for 3% of GDP in 2012." Compared with other countries, the government's R&D funding input is already fairly high.

With regard to the current allocation of the government sci-tech budget, the NSC (42%), MOEA (32%), and Academia Sinica (11%) together account for 85%. Most research is implemented by universities, research organizations, and the Academia Sinica. Operating mechanisms have been established for government academic research, research organization technology development projects, academic technology development projects, and industry technology development projects.

Table 1 Government Sci-tech R&D Inputs, 2001-2008

Units: NT$1,000

Agency	2001	2002	2003	2004	2005	2006	2007	2008
Academia Sinica	4,481,340	4,728,339	5,843,077	6,591,502	7,402,157	8,530,620	8,937,772	9,292,590
MOEA	19,990,471	20,960,355	22,684,559	24,734,502	22,848,186	25,883,157	25,508,868	27,515,351
NSC	18,708,531	22,049,847	24,510,581	26,283,365	30,111,664	31,709,402	35,006,918	35,885,753
Atomic Energy Council	713,461	735,199	645,821	718,415	791,431	827,427	991,948	1,136,551
COA	3,291,952	3,131,868	3,196,671	3,556,060	3,707,481	3,994,633	4,264,456	4,032,654
Council of Labor Affairs	131,753	134,505	143,840	137,330	171,424	184,299	216,668	221,236
DOH	2,381,953	2,651,182	2,831,795	3,146,200	3,389,175	4,215,458	4,396,200	4,709,356
National Palace Museum	22,051	31,174	36,254	103,272	106,743	104,719	64,496	43,362
Ministry of the Interior	183,811	164,079	197,454	239,292	231,519	270,245	373,381	455,968
MOE	1,062,750	943,159	773,923	724,930	795,338	838,892	889,388	1,535,485
Other agencies	729,291	781,011	847,412	928,065	865,399	1,045,355	1,203,127	1,317,788
Total	**51,697,364**	**56,310,718**	**61,711,387**	**67,162,933**	**70,420,517**	**77,604,207**	**81,853,222**	**86,146,094**

Source: Department of Planning and Evaluation, NSC

With the development of the knowledge economy age, the promotion of sci-tech development has shifted from "technology-oriented" model to a "needs-oriented" model, and the desired output of sci-tech development has similarly shifted from "efficiency-oriented" to "innovation-oriented" discoveries. Now that innovation has been established as the goal of sci-tech development, a growing trend towards the fusion of knowledge, technology, and industrial innovation has gotten underway. In the wake of changes in technology development models, the role of government has also been evolving. While the government chiefly supported the stable growth of existing technologies in the past, it has now shifted its focus to the active encouragement of interdisciplinary science and technology fostering the emergence of an innovation-promoting environment. The development of innovative technologies is quite different from the past pursuit of improvements and breakthroughs in existing fields of science and technology. Instead, the pursuit of innovation is grounded on flexibility and the interdisciplinary blending of technologies. Because of this, in a situation of limited government resources, in order to ensure that sci-tech policy goals are met and implementation performance improved in line with trends, the government's past "bottom up" sci-tech resource allocation model must give ground to a "policy-guided top down" approach, and action taken to strengthen the integration of relevant sci-tech strategies, and institute interagency coordination and cooperation mechanisms. Furthermore, as conventional industries upgrade themselves, and high-tech industries such as electronics and computers flourish in Taiwan, the country must position itself as an innovative R&D center in the global industrial division of labor system. Domestic firms have come to appreciate the importance of R&D in recent years, and private R&D funding has grown at an average of 9% annually during the most recent six years. Many international companies have established R&D centers in Taiwan. Guidance from the government's sci-tech policies will still be needed, however, if Taiwan's private R&D investment is to continue to pursue innovative, forward-looking goals in the future. In light of the current situation, further efforts must be made to strengthen the linkage between sci-tech resources and national sci-tech policies and goals, and enhance interagency cooperation mechanisms, so as to achieve maximum innovative R&D synergy between industry, academia, and research organizations, and enable the government's sci-tech budget to be utilized in the most efficient and efficient manner.

In addition, in order to boost the country's national competitive advantage and respond to major nationwide socioeconomic problems and needs, the government has continued to implement national science and technology programs targeting carefully-selected issues reflecting the country's cross-century development strategies and drawing on up-, mid-, and downstream sci-tech R&D resources. Since 1998, the government has successively initiated national science and technology programs in the nine areas of hazards mitigation, telecommunications, agricultural biotechnology, biotech pharmaceuticals, digital archives, genomic medicine, chip systems, nanotechnology, and e-learning. Total funding for these programs has ranged from NT$11.0 billion to NT$12.8 billion, and has accounted for 12%-19% of the total government sci-tech budget (see Fig. 3).

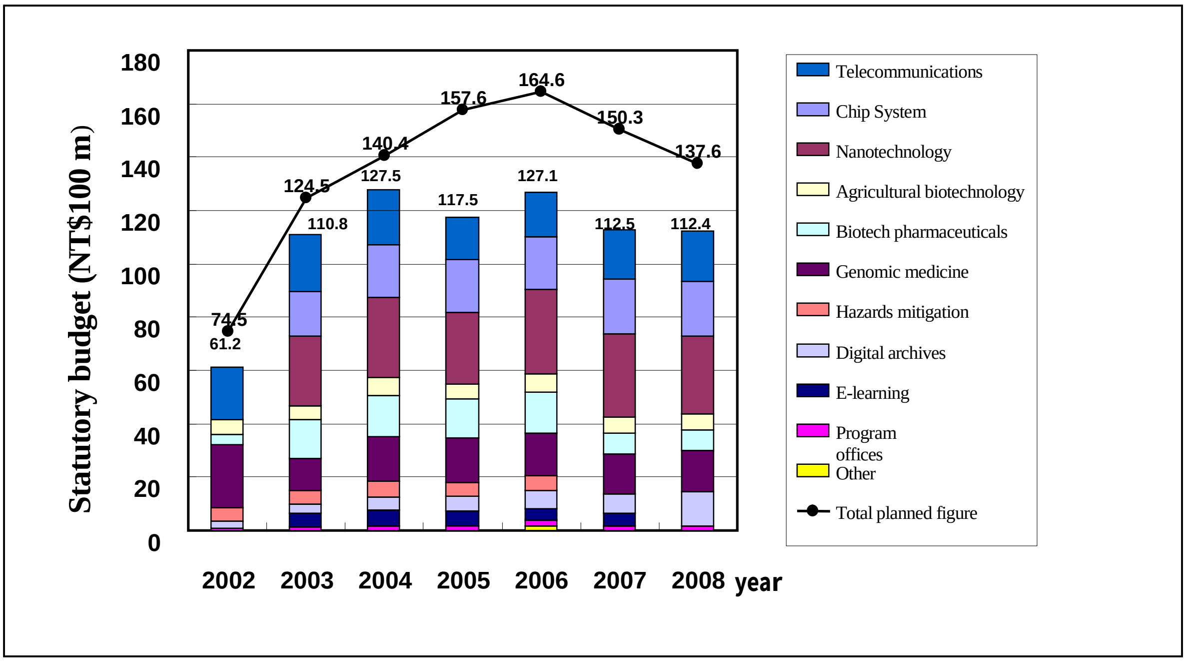

Figure 3 Funding for national science and technology programs

In summary, the government's sci-tech policies must overcome the following challenges:

(1) Disconnect between up-, mid-, and downstream technology development performance results:

While the existing diversified conference-based sci-tech policy operating mechanism is a necessity in the current fast-changing environment, the various types of policy conferences tend to develop "unit issues" reflecting the current "Executive Yuan-level administrative plans, strategies, and goals," which inevitably leads to a situation of not being able to see the forest for the trees when it comes to inter-unit issues. Furthermore, agencies habitually favor incremental, imitative policies and technologies. Because of this, over the past few years the government has striven to overcome the up-, mid-, and downstream disconnect between overall national sci-tech development goals, policy goals at individual agencies, project content, and national sci-tech development performance and results. In today's democratic society, the only solution for this problem is to strengthen the functioning of mechanisms ensuring the flexibility of "centralization and division of labor," where strategic planning and performance evaluation are centralized, but R&D is implemented cooperatively through a division of labor. The government is therefore working to ensure the close linkage of overall development objectives and the sci-tech development goals of each agency and R&D unit, and develop independent performance evaluation mechanisms intended to guide the adjustment of policy goals.

(2) Government investment in science and technology has given insufficient impetus to the private development of innovative technologies

In the past, Taiwan's sci-tech policy focused on incremental, imitative modes of sci-tech development. Although many OEM firms in Taiwan have gradually developed in the direction of design, R&D, and even systems integration, basically industry in Taiwan is still highly dependent on multinational companies from the leading nations. Because of this situation, Taiwan's government lacks bargaining chips when engaged in technology-related negotiations and discussions with other countries (especially the most advanced nations. Taking Japan and South Korea as examples, these two countries are led by governmental elites acting in conjunction with industries and professional groups through intensive communication, negotiation, and consultation; both countries are pursuing policies involving the development of large-scale, highly-integrated technologies and industries, and both have achieved highly positive results. As revealed by the experiences of Japan and

South Korea, it is not enough to depend solely on increased government or private sector funding to boost sci-tech development. To achieve the greatest effectiveness, the government and companies must also reform and coordinate organizational, management, and resource allocation aspects.

If civil servants at government agencies, corporate personnel, and members of professional groups can consult and integrate their views, create a shared sci-tech development vision, and form a feasible policy basis linking different sci-tech policies and projects, it is still possible to establish an innovative, integrated sci-tech policy that encompasses different agencies and different fields, spans industry, academia, and research organizations through "lateral diffusion from agencies and spontaneous communication and coordination."

The government's support for R&D often fails to yield results that can be widely used by industry. For many reasons, this tends to result in a lack of engagement between government and industry. For instance, the government and industry have not established a consensus concerning mechanisms for formulating policy visions and long-term goals, and sci-tech program planning mechanisms generally fail to incorporate recommendations from industry, which leads to poor linkage between government R&D results and the needs of industry, while also impeding the implementation of sci-tech policies.

(3) Strategic planning and development of overall cooperation mechanisms in such areas as establishment of global intellectual property rights, drafting of international standards, and implementation of sci-tech diplomacy:

In order to transform Taiwan into a center of R&D and innovation, and will be necessary to protect, manage, and utilize intellectual property created by industry, academia, and research organizations, and actively participate in the drafting of international standards. This is the only effective strategy of boosting the added value and competitiveness of Taiwan's industries.

In today's knowledge economy, what role does Taiwan play, or should play, in the global knowledge system? Should Taiwan strive to achieve greater influence in the areas of intellectual property and the drafting of international standards? Can technology have a complementary strategic relationship with diplomacy? These questions have all been neglected in the past. Taiwan should have concrete strategic plans and coordination/communication functions in the areas of global intellectual property, drafting of international standards, and sci-tech diplomacy. This will greatly facilitate the formulation of long-term, holistic, effective sci-tech national development policies.

(4) The functions of national science and technology programs are in great need of strengthening; exit mechanisms must be implemented:

Since 1998, the government has successively initiated national science and technology programs in the nine areas of hazards mitigation, telecommunications, agricultural biotechnology, biotech pharmaceuticals, digital archives, genomic medicine, chip systems, nanotechnology, and e-learning. Total funding for these programs has ranged from NT$11.0 billion to NT$12.8 billion, and has accounted for 12%-19% of the total government sci-tech budget (see Fig. 3). Table 2 shows output indicators for eight national science and technology programs between 2004 and 2007, specifically papers issued, Ph.D. and Master's students receiving training, patents received, technology transfer licensing fees, and corporate investment promoted.

Table 2 Output indicators for eight national science and technology programs, 2004-2007

Performance indicator	Units	2004	2005	2006	2007
Papers issued	Papers	4,806	5,609	6,008	5,420
Ph.D. and Master's students	Persons	5,031	5,065	8,405	8,135
Patents received	Cases	477	442	599	575
Technology transfer income	Cases	314	285	324	291
	Contract amount (NT$1,000)	259,836	449,841	473,393	456,282
Corporate investment promoted	Amount of investment (NT$1,000)	36,404,337	37,062,222	34,262,218	54,112,042

Note: Output indicators were proposed by the Legislative Yuan Budget Center

Although national science and technology programs have been highly effective, the following points concerning the achievement of overall sci-tech research value chain synergy are deserving of examination and improvement:

a. Up-, mid-, and downstream resource planning and research integration in national science and technology programs was inadequate due to limited budgetary resources and insufficient participation in industry guidance.

b. Differing agency procedures have impeded cooperation and division of labor between industry, academia, and research organization personnel: Although national science and technology programs feature overall planning and division of labor in implementation, the fact that budget funding is provided by individual agencies has made it difficult for research personnel from industry, academia, and the research community to engage in collaboration and division of labor in interdepartmental organizations. Because of such problems as the programs' inability to provide interagency funding and differences in accounting procedures, it has been difficult to implement integrated cooperation and division of labor, which has had a negative impact on R&D performance.

c. The proposal of programs should be accompanied by the formulation of performance assessment plans: Because of their size and complexity, national science and technology programs must have performance assessment plans providing a basis for fair and objective assessment of program performance.

d. The following two main problems arise at the conclusion of a national science and technology: (1) The reconstruction of organizational and agency project resource integration and management regulations following conclusion and exit, including the best time for conclusion and exit. Following the conclusion of a national science and technology program, how should agency project resource integration and management regulations be reconstructed? (2) How should existing project R&D capabilities be effectively utilized? Should R&D teams established in the program be preserved? How should completed R&D results be extended and applied? How should completed R&D information databases be maintained and used? How should common core instruments and facilities established in the program serve research and be maintained and used? How should research personnel who changed fields to join the program be steered to research projects?

II. Vision

1. Deregulation and reconstruction of the R&D results utilization regulations of relevant government agencies in order to improve the utilization of research results by industry, academia, and research organizations.
2. Establishment of a legal environment encouraging universities and public research organizations to spin-off new ventures.
3. Differentiation of civil servants, teachers, and government researchers in order to enhance the efficiency and performance of R&D results utilization by public academic and research organizations:

4. Development of interagency cooperation mechanisms strengthening the effectiveness of national scientific research resource utilization.
5. Strengthening of national-level program promotion strategies, and acceleration of the industrial utilization of R&D results.

III. Important Measures

1. Clear definition of exceptional forms of utilization, including "exclusive licensing," "gratis use," and "non-public use," drafting of allowed overseas utilization methods, and revision of laws and regulations governing overseas utilization in order to clarify questions concerning laws and regulations governing the ownership and utilization of R&D results.
   (Implemented by: NSC) (Assisted by: Science and Technology Advisory Group of the Executive Yuan, MOEA, MOE, COA, Atomic Energy Council, MND, Ministry of Finance, Mainland Affairs Council)
2. Clear statement that the management and utilization of the R&D results of universities and government research organizations shall not be subject to the requirements of the National Property Act, and addition of R&D results assignment (with or without compensation) and rights termination and maintenance regulations. (Implemented by: NSC) (Assisted by: MOE)
3. Drafting of the University Spin-off Enterprise Operating Principles, including principles for stock holding and participation in company operations, avoidance of conflict of interest and recusal, feedback mechanisms, and personnel incentive measures. (Implemented by: MOE) (Assisted by: MOEA)
4. Establishment of an entrepreneurial campus culture: Encouragement of the establishment of university R&D teams possessing product development frameworks characterized by effective division of labor and systems integration, facilitating the creation of spin-off companies. Discovery of benchmark cases, from which more R&D- and innovation-oriented university spin-off companies can be incubated.

(Implemented by: MOE) (Assisted by: MOEA)

5. Drafting agricultural research organization spin-off company operating principles and other relevant regulations.

   (Implemented by: COA)

6. Promotion of a flexible university personnel affairs system:

   (1) Drafting changes to the university instructor salary system.

   (2) Easing of restrictions on number of teaching and research personnel and teaching and research personnel with part-time administrative duties, and relaxation of the upper limit on the part-time pay for such personnel.

   (3) Easing of restrictions on the ratio of research personnel and professional technical personnel to teachers in an organization, and allowing schools to pay the base salaries (including merit pay) of the former personnel from their own funds, which can be supplemented with external income sources.

   (4) Enhancement of school heads' authority to hire personnel affairs and accounting managers.

   (Implemented by: MOE) (Assisted by: Central Personnel Administration, Directorate General of Budget, Accounting & Statistics)

7. Granting of internal decision-making autonomy to universities in order to make university organizational systems more flexible: The revision of the University Act Enforcement Rules (Article 15) will allow universities to determine their own administrative and organizational levels and names in accordance with their teaching and research needs.

   (Implemented by: MOE)

8. Review of the revised School Fund Management and Supervision Regulations and other administrative regulations in order to eliminate any unnecessary requirements.

   (Implemented by: MOE)

9. Improvement of sci-tech budget deliberation mechanisms in order to facilitate interagency sci-tech policy and sci-tech program cooperation and division of labor, which will increase synergy in the national scientific research system.
(Implemented by: NSC)

10. Formulation of regulations governing industry participation in national science and technology programs, and strengthening of national-level program promotion strategies.
(Implemented by: NSC)

11. Institution of national-level program conclusion and exit mechanisms, assessment of the functions of national-level research organizations, and establishment of function-strengthening and exit/elimination mechanisms.
(Implemented by: NSC)

Section 4 Pursuing Academic Excellence, Strengthening Social Concern

I. Current Situation and Review

1. Establishment of a superior academic research environment, strengthening utilization of research resources

The MOE is providing NT$50 billion in special funding to first-rate universities and top-notch research centers over a five-year period. One of the goals of this program is the hope that at least one university will enter the world's top 100 and the Asia-Pacific's top ten, which will show the way to boosting the international academic and educational status of Taiwan's universities.

On the basis of the subarea and collective evaluation aspects, indicators, and weights proposed by Taiwan's Higher Education Rating Center in 2008, Taiwan's top five research universities were National Taiwan University (141), National Cheng Kung University (328), National Tsinghua University (366), National Chiao Tung University (463), and National Yang Ming University (475), in that order. These universities are all lagging far behind Tokyo University (12), Kyoto University (28), Osaka University (38), Tohoku University (51), Seoul University (84), Singapore University (86), Nagoya University (117), and Kyushu University (127). It is clear that, in the face of intense competition, Taiwan's higher education has much room for improvement.

The establishment of a superior academic research environment must start from the improvement of manpower, funding, equipment, and systems. The following points summarize the biggest difficulties facing current efforts to improve the academic research environment at Taiwan's universities:

(1) The number of universities in Taiwan has increased rapidly, leading to the dispersal of educational resources. This situation is led to universal

shortages of educational funding at universities, and made it much harder to continue to improve research manpower, equipment, and books.

(2) The division of labor between universities is very vague. Although there are nominally differences between general universities and universities of science and technology, their educational goals, educational content, academic departments, Master's and Ph.D. programs, faculty sources, facilities and equipment, and upgrading systems are poorly differentiated. Furthermore, there are no classification or grading systems to distinguish between general universities. As a result, individual universities have unclear research, teaching, and service goals, and play poorly differentiated roles. This situation has impeded academic research progress.

(3) University faculty salaries still lag significantly behind those in such neighboring countries as Hong Kong, Singapore, Japan, and Korea. This is detrimental to the competitive status of Taiwan's universities, and makes it harder for research teams to attract outstanding talent.

(4) The university instructor research and teaching evaluation system has been functioning for a number of years, and is gradually proving beneficial. However, the evaluation systems for the natural sciences, humanities, and social sciences do not reflect the academic characteristics of the subjects in question; this situation introduces biases through excessive standardization and unification, and does not facilitate academic development in specific fields.

(5) Universities have universally low levels of internationalization, and percentages of international undergraduate and graduate students are very low. Although growing numbers of international seminars are held, very few of these actually have high standards.

(6) Although the transformation of universities into nonprofit juridical persons has been underway for some time, progress has been slow, and university students and instructors still have doubts concerning the merit of this

change. Universities are still subject to many of the administrative constraints of the civil service system, and it will be difficult to overcome restrictions involving organizational structure, salaries, purchasing, and manpower acquisition.

(7) Due to the weak links between universities, on one hand, and industry and the community, on the other, there is insufficient resource sharing and positive interchange. As a result, universities fail to effectively drive sci-tech research and development, and industry fails to contribute significantly to university research resources.

National-level research organizations play an important role in supporting university and industry research and development, and thereby boosting the country's sci-tech competitiveness. In particular, the Academia Sinica, Industrial Technology Research Institute (ITRI), National Health Research Institute, Chung Shan Institute of Science and Technology, Institute of Nuclear Energy Research, National Synchrotron Radiation Research Center, and the 12 national laboratories under the National Applied Research Laboratories all make significant contributions to industry and academic research.

Although national laboratories possess plentiful research resources and equipment, as a result of rapid technological progress and the increasingly important role of technological integration, the goal-oriented research resources at these laboratories often fail to function as effectively as possible due to systemic limitations or lack of integration.

2. Promotion of basic science and pioneering research

Although growing numbers of personnel are engaged in basic science research in Taiwan, insufficient training for seed personnel possessing scientific innovation skills remains a key problem. The quality and quantity of research papers is an important international indicator of basic science research performance. While the improving quality and quantity of research papers shows that Taiwan has already made great strides in scientific research, the limited academic research population and other restrictions suggest that an upper limit to the number of papers has already been reached. On the other hand, greater efforts must be made to improve quality. Because of this, funding for superior individual research projects and innovative interdisciplinary integrated research projects should be strengthened even further. It is also urgent that various types of research platforms and facilities be improved and expanded. Finally greater efforts should be made to promote interchange within interdisciplinary research teams as a means of compensating for knowledge deficiencies and deepening research content.

Among the challenges currently faced by advanced pioneering sci-tech research in Taiwan are how to secure an economic competitive advantage, how to establish the ability to compete economically, and how to use sci-tech research capabilities to strengthen social concern and enhance citizens' welfare. In R&D areas where Taiwan already has an advantage, such as semiconductors, communications systems, and agricultural biotechnology, the country must strengthen innovation and foresight, participate actively in the drafting of international standards, and strive to maintain its international competitive advantage. Social concern items include maintaining ecological sustainability, exploring sociocultural development, and improving citizens' health and welfare. How to maintain ecological sustainability is currently an important issue in ecology and environmental science. Apart from its distinctive local cultural features, Taiwan also played a major role in the origin of Austronesian language-speaking cultures; if interdisciplinary research involving technology and the humanities is performed on this subject, it is likely to make new discoveries and develop pioneering theories. Taiwan has established a strong technological foundation in the fields of semiconductors and electronics; if this capacity is linked with biomedical R&D capabilities, Taiwan can make further progress in medical engineering and post-genomic biomedical technology R&D, which will improve medical efficiency for Taiwan's aging population, reduce medical costs, and provide the tools needed to respond to emerging infectious diseases.

The humanities and social sciences deal with human lifestyles and modes of thought, and provide an important basis for instilling core skills in modern citizens and developing a healthy society. Although, in comparison with the natural sciences and engineering, attention paid to the humanities and social sciences will not yield immediate benefits, knowledge in these areas is an indispensable element promoting high economic value in today's knowledge economy age, which is a time of service industries and innovation. The world's leading countries are making large investments in the development of the humanities and social sciences, and are aware of the importance of integration of the humanities and social sciences with technical professions. Higher education in Taiwan, however, has long favored engineering and science over the humanities, which has led to a very unequal allocation of resources between these two areas. In addition, humanities and social sciences instructors often have excessively heavy teaching burdens, and the humanities and social sciences evaluation system has questionable effectiveness. Furthermore, because of the large differences between individual subjects, the humanities and social sciences have thus far been unable to establish integration and dialog mechanisms. There is little interdisciplinary dialog between the humanities and social sciences and other fields of study, and Taiwan's humanities and social sciences researchers and scholars have yet to establish dialog with their counterparts in other countries. These circumstances pose obstacles to the development of individual subjects, and make it difficult to improve research quality.

3. Application of ethics, law, and social governance to new technologies

(1) Sci-tech development and the public trust

Risks and ethical disputes engendered by sci-tech development inevitably cause public qualms concerning technology. For instance, petrochemical technology is associated with environmental pollution, nuclear energy is associated with nuclear waste disposal and radiation problems, and biotechnology may affect family relationships, human dignity, and biodiversity. Furthermore, such issues as the safety of genetic products, the information technology on personal privacy, computer software, cell phones, the Internet, and ubiquitous base stations not only may have huge effects on people's lives, but also put the public in a state of negotiation and information asymmetry relative to corporations. As a result, people lack trust in sci-tech development.

The public's distrust of science and technology is at least partially attributable to insufficient relevant information and awareness. Appropriate ethical and legal responses may be needed to deal with the risks posed by new technologies to life and the environment, and the ethical conflicts they cause.

Article 8 of the Fundamental Science and Technology Act prescribes: "Scientific and technological research organizations and personnel must uphold their duty to preserve the ecology, the dignity of life, and humane ethics during the course of furthering or performing scientific and technological research." Unlike such areas as medical biotechnology, where ethics committees have been established, little has been done thus far to address research ethics in many new technological fields in Taiwan (such as genetic technology and nanotechnology).

Furthermore, the development of new technologies often involves the jurisdictions of different agencies. As a result, due to the structure of the current government system, the government cannot respond promptly to risks or ethical conflicts caused by emerging technologies. It is often difficult to prove a causal relationship between a new technology and harmful effects, which may influence the public's ability to seek redress through litigation. As a consequence, the government should actively address the question of how to establish a set of laws that can overcome problems with existing statutes and systems, and can win the public's trust.

(2) Establishment of channels through which the public and citizens' groups can participate in disputes connected with science and technology:

The specialization of many areas of science and technology has insured that sci-tech policy and affairs have long been the domain of specialists. In addition, since it often thought that citizens who lack scientific or technological expertise cannot grasp the complexity of sci-tech matters, ordinary citizens are seldom invited to participate in policy decisions or the resolution of disputes. We therefore hold that a system of "sci-tech democracy" can be developed, and will lead to the establishment of two-way communication channels. According to the conventional view, sci-tech decision-makers believe that the public resists new technologies because of their lack of understanding of and knowledge about these technologies. This thinking has recently been challenged. In fact members of the public may often be able to assess risk on the basis of their "lay perspective" or local knowledge, and citizens' assessments of new technological risks may sometimes uncover facts overlooked by scientists employing "laboratory models." The government should therefore employ a deliberation model involving "multi-directional dialog" with citizens, and establish public discussion platforms.

(3) The active role of legal and ethical guidelines in the development of science and technology:

Responding to possible risks and public distrust, or even public alarm, during the new technology development and application process, the government should design mechanisms for citizen participation, and should also formulate legal and ethical guidelines, so as to ensure the successful development of science and technology and achievement of the goal of improving people's quality of life. In addition, the use of ethical guidelines for professional personnel, management procedures, mechanisms for communication between professional and non-professional personnel, risk precautions, and mechanisms for communication and coordination with the public can minimize the risks of new technologies and inspire better public trust. Nevertheless, Taiwan currently lacks well-designed mechanisms for management of technological risks and resolution of technological disputes.

Taiwan's main guidelines concerning new technologies are currently contained in the Fundamental Science and Technology Act. Article 10 of the Act specifies mechanisms for advance planning and corruption prevention, and

Article 11 states: "The National Science and Technology Development Plan, … ." Since these two articles are too general, there is a need to employ legal revision, legal authorization, and the drafting of enforcement rules and accompanying regulations to ensure that the foregoing regulations can be applied effectively.

II. Vision

1. Establishment of a superior academic research environment, strengthening utilization of research resources:

In academic research at universities, at least one university in Taiwan will surpass the University of Nagoya within five years, and surpass the University of Singapore and University of Seoul within ten years, research universities with various areas of specialization will enter the top 150 worldwide, and the international competitiveness of promising universities and research topics will increase.

With regard to the utilization of research resources, Hsinchu Science Park will be linked with nearby universities to create a new hub of the semiconductor and biomedical pharmaceutical industries; the central and local governments will construct large national laboratories at the Southern Taiwan Science Park, and these national laboratories will gradually established ties with nearby universities, forming a new technology research and development hub, and leading the next wave of sci-tech R&D development in Taiwan.

2. Promotion of basic science and pioneering research

(1) The government's near-term goal with regard to the promotion of superior basic science research is to establish an outstanding research environment, promote focused research, encourage international collaboration and interdisciplinary integrated research, and implementing programs similar to the "Academic Summit Program." Long-term goals include reliance on the mid- and long-term technology development framework plans to strengthen outstanding research in basic science, and

eventually make major breakthroughs in the quantity and quality of research results. Taking the social contribution index as a truthful indicators, the government will encourage sci-tech research personnel to live up to their social responsibilities, promote ubiquitous education in science and technology, foster active concern for society, and stress environmental protection and the pursuit of sustainable development.

(2) With regard to strengthening pioneering sci-tech research, the government hopes to boost Taiwan's expertise in key high-tech industrial areas to the point where the country possesses key intellectual property and can participate in the drafting standards, establishing the country's ability to compete in an innovation economy. Taiwan will also create new industries on the basis of locally-oriented agricultural biotechnology, making Taiwan the second most important biotech stronghold in East Asia, after Japan. The government will strengthen social concern and promote pioneering sci-tech research aimed at improving citizens' welfare, such as R&D targeting emerging infectious diseases, the establishment of advanced biomedical engineering and early diagnostic technologies, and the improvement of citizens' medical care. Domestic academic research in such areas as environmental sustainability and community colleges, such as research on biodiversity gradients, will continue to stimulate ecological research in Europe and the United States. Sociocultural development research will confirm Taiwan's link with the origins of Austronesian-speaking peoples.

(3) In research on the humanities and social sciences research, improvement of humanities and social sciences hardware and software equipment, balancing of the student and faculty structure, quantitative and qualitative research improvements, training of outstanding research manpower, and strengthening of internal integration and interdisciplinary alliances within the humanities and social sciences will ensure that

workers in the humanities and social sciences increasingly achieve excellence. Other efforts will include establishing diversified research directions in specific fields, establishment of dense research networks, expansion of international perspectives, and enhancement of research capabilities. When the time comes, Taiwan will announce its excellent, highly-distinctive humanities and social science research results to the world, which will boost the country's international profile.

3. Application of ethics, law, and social governance to news technologies:

(1) Establishment of a "scientific and technological issue public participation steering committee" under the Executive Yuan.

(2) Provision of incentives for science education courses aimed at ordinary citizens, participation in government-funded in-service training, and other courses intended to boost citizens' scientific knowledge.

(3) Selection of major sci-tech issues, and holding of public hearings, vision workshops, and citizens' review meetings.

(4) Selection of major national science and technology programs, and assessment of the ethical, legal, and social implications of science and technology.

(5) University natural science departments will offer general knowledge courses and other specialized courses intended to improve students' ability to communicate, coordinate, and explain sci-tech knowledge; universities will ensure that students are familiar with professional ethics and the social responsibilities of professional sci-tech personnel.

(6) Relevant government agencies will sponsor classes and ensuring that their personnel possessed the ability to communicate, coordinate, and explain sci-tech knowledge, and are familiar with professional ethics.

(7) Establishment of research ethics consulting centers or committees for major sci-tech programs, and evaluation and management of the various types

of research ethics committees.

(8) Regular publication of white papers on the ethical, legal, and social impacts and disputes of new technological applications.

(9) Completion of relevant sci-tech ethics- and research ethics-related courses and teaching materials.

(10) Completion of the revision of the *Fundamental Science and Technology Act*, school education-related laws and regulations, and course outlines.

(11) Establishment of a "science and technology commission" similar to that of Denmark, or establishment of a "science and technology development foundation" with government donations.

III. Important Measures

1. establishment of a superior academic research environment, strengthening utilization of research resources:

(1) Establishment of a superior academic research environment, enhancement of academic research standards and quality:

a. Establishment of effective assessment and fair competition mechanisms, and a strict elimination system, for various types of research funding, ensuring the full assessment of research performance and the rational allocation of resources. (Implemented by: NSC, MOE)

b. Strengthening of participation in international sci-tech organizations and first-rate international research teams, implementation of international collaborative projects, and training of seed personnel simultaneously possessing scientific innovation skills and international perspectives. (Implemented by: NSC, Academia Sinica)

(2) Strengthening of resource sharing and research and service functions at national-level research organizations.

Utilization of R&D clusters and the existing resources of national research organizations near the Hsinchu Science Park to establish trial research parks.

(Implemented by: NSC) (Assisted by: MOEA, CEPD, MOE)

2. Promotion of basic science and pioneering research:

(1) Strengthening of outstanding basic scientific research:

a. Support for long-term and outstanding academic research, improvement of basic facilities, integration of limited domestic resources, purchase or upgrading of research equipment or mid-sized instruments for common use, and active improvement of the research environment.

(Implemented by: NSC) (Assisted by: MOE)

b. Encouragement of collaborative research teams, and establishment of pioneering common research platform, such as high-speed network and computing research platforms.

(Implemented by: NSC)

(2) Strengthening of pioneering sci-tech research:

a. Promotion of research with distinctive characteristics in areas where Taiwan possesses advantages, such as semiconductors, communications systems, agricultural biotechnology, and emerging infectious diseases affecting Taiwan.

(Implemented by: NSC) (Assisted by: MOEA, DOH, COA, MOTC, Academia Sinica)

b. Promotion of innovative pioneering interdisciplinary research in such areas as post-genomic research, interdisciplinary neuroscience research, interdisciplinary medical engineering research, interdisciplinary bioinformation research, interdisciplinary research in computer science and engineering, and interdisciplinary research concerning Taiwan and Austronesian archeology.

(Implemented by: NSC) (Assisted by: DOH, Academia Sinica)

c. Promotion of forward-looking, outstanding, interdisciplinary basic research in science and environmental science, biology, and engineering, etc.

(Implemented by: NSC)

(3) Promotion of outstanding humanities and social sciences research:

a. Establishment of assessment mechanisms fostering the academic development of the humanities and social sciences.
(Implemented by: MOE, NSC)

b. Increasing support for research in the humanities and social sciences, easing the teaching burden on humanities and social sciences teachers. (Implemented by: MOE, NSC)

c. Strengthening of the Ph.D. training system, raising the qualifications of humanities and social sciences manpower.
(Implemented by: MOE, NSC)

d. Strengthening of distinctive locally-oriented research and channels for international dialog.
(Implemented by: NSC) (Assisted by: MOE)

3. Application of ethics, law, and social governance to new technologies:

(1) To increase public trust in new sci-tech applications, the government will actively establish a system to respond to the possible effects of new technologies on society.

a. Agencies funding or commissioning research projects involving human subjects must require the projects to undergo review and obtain approval from an institutional review board.
(Implemented by: NSC) (Assisted by: MOEA, DOH, MOE)

b. The government will encourage universities and research organizations to establish institutional review boards (IRBs) (also reviewing behavioral science research), and strengthen personnel training and guidance in order to ensure review quality.
(Implemented by: MOE, NSC, Academia Sinica, MOEA, DOH, COA)

c. Provision of funding for research on ethical, social, and legal implications within national science and technology programs, and issuance of annual reports.
(Implemented by: NSC)

d. Promotion of sci-tech ethics education for citizens, training of sci-tech ethics and research ethics faculty, and development of relevant courses and teaching materials covering major sci-tech issues; writing of easily-understood explanations of basic sci-tech facts, including introduction of varied points of view, including that the public understands specific sci-tech knowledge.

(Implemented by: NSC, MOE)

(2) Participation of the public and citizens' groups in sci-tech disputes:

Establishment of a "biotechnology development and ethical issues social communication group."

(Implemented by: Science and Technology Advisory Group, Executive Yuan)

(3) Legal governance of new sci-tech applications:

Implementation of research on an accountability system regulating technological risk.

(Implemented by: NSC)

Section 5 Enhancing Technological Innovation, Improving the Industrial Environment

I. Current Situation and Review

One of the most urgent questions facing Taiwan is how, in the face of intense international competition and economic and environmental changes, it can build on its existing advantages and strengthen its capabilities for the next round of competition. It is certain the industry must actively enhance its technological expertise if it is to move up to the next level of high-tech development and create new opportunities for Taiwan's economic growth. Enhancing sci-tech innovation must be accompanied by efforts to strengthen the domestic innovation system and forge links with international R&D resources, which will enable industry to leverage domestic and overseas R&D capabilities. In addition, interdisciplinary, integrated technologies and applications can be used to provide innovative services and added value. Companies in Taiwan and abroad are very concerned about their innovation ability, which is seen as a key element enabling a competitive advantage and continued growth. In summary, how to provide a superior industry environment and boost companies' motivation and ability to innovate is an important link in Taiwan's current industrial development strategy.

The following is a review of five issues connected with enhancing sci-tech innovation and improving the industrial environment:

1. Development of new-generation high-tech and knowledge-based service industries:

High-tech industries are currently very polarized: While industries centered on "soft manufacturing" enjoy high profits, "hardware manufacturing industries" face strong competition, and find it difficult to increase their profit. Efforts to promote the development of new-generation high-tech and knowledge-based service industries face the following challenges: A lack of originality among Taiwan's high-tech industries, how to perform interdisciplinary integration in order to link existing advantages, and how to establish new-generation competitive advantages. At furthermore, industrial development has failed to shape distinctive and innovative service models, and there is a need to promote new service networks and the application of technology to services.

2. Development of an aesthetics economy and promotion of a balance between output and quality of life:

Taiwan's industries lack "content" that they can use as a basic competitive advantage, and the country still lacks diversity of creative expression and distinctiveness of cultural elements. Creative industries still account for a small share of GDP. Taiwan currently faces such question as how to use technology to drive industrial development, how culture and aesthetics can promote design innovation, and how to encourage the growth of emerging industries based on aesthetic design and enable them to achieve a competitive advantage. At the same time, industries emphasizing cultural creativity and brands must understand foreign markets and consumers' lifestyle needs if they are to create global brands and competitive products and services.

3. Strengthening of innovation systems, establishment of an industrial innovation environment:

Unfavorable phenomena occurring in Taiwan's contemporary innovation environment include poor effectiveness of R&D inputs, difficulty in initiating forward-looking research organizations, difficulty in implementing academic technology development projects, need for more attention to innovative activities in industrial technology development projects, need to make faster progress if Taiwan is to reach the goal of R&D funding accounting for more than 3% of GDP, as in the developed countries, and systemic failures in Taiwan's innovation system. Taiwan faces the following four challenges in connection with strengthening the innovation system and establishing an effective industrial innovation environment: The extension of technology is restricted by a dispersed multi-point development pattern, which impedes the effective integration of the government's sci-tech plans; Taiwan's sci-tech development system suffers from the problems of "path-dependence" and "lock-in," which leads to the problem of inconsistent development strategies and resource allocation; there is insufficient linkage between accompanying measures at the time of implementation, and the R&D financing environment awaits improvement; and Taiwan's innovation lacks mutual participation mechanisms and ex ante intellectual property strategic planning methods. In the face of these challenges, Taiwan can establish multi-stage mechanisms for energizing the integrated utilization of R&D results in industry, academia, and research organizations.

4. Connecting with global innovative R&D resources

With regard to connecting with global innovative R&D resources, at present Taiwan lacks a focused strategy for inducing multinational firms to establish R&D centers in Taiwan, Taiwan's international R&D linkage levels and models await improvement, and Taiwanese firms have few opportunities to participate in international industrial innovation and R&D activities. In this situation, Taiwan must answer the following questions: How to induce multinational corporations to establish their R&D centers in Taiwan? How to prioritize efforts to attract the R&D areas and industries that Taiwan will need in the mid-term and long term, and how to achieve complementarity between these areas and industries, and ensure that key technologies needed by industry chains are available? How to strengthen the deployment of networks and international collaboration platforms linked with innovative R&D in the leading countries? How to actively encourage participation in international innovative R&D activities, and how to deregulate policies governing the recruiting of foreign manpower? How to enable overseas Taiwanese firms to utilize Taiwan's R&D capabilities and information channels and platforms?

5. Strengthening of homeland security and development of defense technology R&D capabilities

With regard to strengthening homeland security and development of defense technology R&D capabilities, since Taiwan is located in strategic waters between the Asian continent and the western Pacific Ocean, it enjoys an advantageous geographical location and unique maritime environment. The armed forces bear the largest responsibility for strengthening national information security research and digital monitoring capabilities. In view of government budget cuts and the soaring cost of weapons R&D, the conversion of defense technology to civilian technology and transfer to private firms is an inevitable trend. Based on homeland security considerations, Taiwan's location in a highly complex marine environment, and the difficulty of undersea surveillance, Taiwan should actively develop marine surveillance technology. In addition, challenges encountered by the armed forces' information and communications networks have included the leakage of classified information by personnel performing official business from their homes, the continued evolution of evasive Trojan horse malware threats, and poor awareness of information security safeguards among users. In addition, with regard to the challenge of converting defense technology to civilian technology, the government's defense industry implementation strategy is vague and is not accompanied by supporting actions; this has impeded implementation and resulted in poor overall effectiveness.

II. Vision

1. To employ science and technology to shape knowledge-based service industries, and create a high-value employee population and output value. To utilize ICT to make Taiwan a model of use of value-added applications in conventional manufacturing industries. To shift thinking about agricultural technology towards a demand orientation and improvement of production

efficiency. To promote the globalization of Taiwan's medical service industries, and establish a globalized medical service industry operating model, administrative system, and service standards suitable for Taiwan.

2. To support the establishment of complete brand value chains and global brands by firms. To promote new directions in crafts design to enrich the monotonous lives of modern people. To rely on value-adding cultural creativity industries to initiate another economic miracle. To transform Taiwan into a "superior living center for the Chinese world," and upgrade "manufacturing Taiwan" into a Taiwan of design, brands, and innovation.
3. To strengthen the innovation system, establish effective risk management mechanisms, promote the industrialization of forward-looking technologies, foster an environment favorable to high-tech ventures, and further re-orient Taiwan's industries from manufacturing to innovation. The first step to realize R&D innovation will be to promote the establishment of internationally-competitive intellectual property rights value-added distribution mechanisms and units; the second step will be to encourage private parties to establish intellectual property management firms.
4. Sci-tech cooperation with China helping Taiwan to establish links with international innovative R&D networks. To encourage Taiwanese firms overseas to establish R&D departments in Taiwan, and promote Taiwan as an R&D headquarters location for Taiwanese firms. To help firms to participate in international industrial R&D alliances, recruit international manpower, and accelerate technological upgrading and corporate transformation. To share intellectual property assets created by the R&D centers of major international firms with government funding, so that such results will contribute to Taiwan's industrial revenue.
5. With regard to the development of the defense industry, in order to go to the root of problems, the government should establish an interdepartmental (MOEA and MND) steering committee/task force with the mission of

integrating resources, and drafting development goals, assessment indicators, implementation strategies, and development programs. To harness the information and communications security R&D capabilities of industry, academia, and the research community in order to continuously improve the security of the armed forces' information and communications networks. To promote the development of several promising defense industry contractors, and ensure that defense technologies can be released to private industry.

III. Important Measures

1. Development of new-generation high-tech and knowledge-based service industries:

(1) Promotion and interdisciplinary links between high-tech industries, and development of new-generation high-tech industries.

a. Assisting industry to train high-level personnel with technological backgrounds. (Implemented by: MOEA)

b. Active participation in the drafting of international standards. (Implemented by: MOEA)

c. Implementation of key industrial technologies, boosting industrial added value. (Implemented by: MOEA)

d. Continued improvement of the industrial service environment. (Implemented by: MOEA)

(2) Creation of distinctive, innovative service models, promotion of the use of technology by industrial services and development of new service networks:

a. Strengthening of research on the technological capabilities of service industry, implementation of demonstration projects verifying service content and business models, enhancement of service industry development and added value. (Implemented by: MOEA)

b. Promotion of technology R&D and applications connected with the service-ization of industrial technologies. (Implemented by: MOEA)

(3) Effective utilization of Taiwan's information/communications advantages and industry clusters to promote value innovation in conventional industries:

a. Encouragement of cooperation between conventional industries and information service industries, and helping firms to extend their superior manufacturing capabilities towards both ends of their value chains. (Implemented by: MOEA)

b. Helping SMEs to utilize innovative business models and technological applications, development of innovative service SMEs, and encouragement of firms to form clusters and apply innovative knowledge-service models, enhancing cluster value and competitiveness. (Implemented by: MOEA)

c. Assisting conventional industries to improve their ICT applications ability and strengthen their international business relationships. (Implemented by: MOEA)

d. Use of technological R&D to enhance the value innovation of conventional industries. (Implemented by: MOEA)

(4) Use of new technology to enhance SMEs' innovative R&D capabilities:

a. Increasing the proportion of industrial technology information service projects helping SMEs to commit to new technologies. (Implemented by: MOEA)

b. Requiring state-owned enterprises to set aside appropriate amounts of R&D funding, implement R&D projects developing high-value technologies and products, and share R&D results with mid-stream and downstream firms. (Implemented by: MOEA)

(5) Promotion of technological improvement and innovative models in agriculture in order to boost agricultural value and industrial development:

a. Implementation of forward-looking projects, guidance of technology development; implementation of policy mechanisms, deployment of sci-tech resources; formulation of an R&D vision, accelerating the upgrading of agriculture. (Implemented by: COA)

b. Establishment of platform mechanisms, creation of links with industry, government, academia, and the research community; promotion of collaborative R&D, encouragement of technological integration; strengthening of industry-academic cooperation and venture incubation. (Implemented by: COA)

(6) Fostering a medical service industry with an international outlook

a. Establishment of internationalized operating models and marketing strategies for the medical services industry. (Implemented by: DOH)

b. Establishment of medical service forecasting mechanisms, development of innovative service items. (Implemented by: DOH)

2. Development of an aesthetic economy promoting a balance between output and quality of life:

(1) Fusion of culture with the aesthetic economy to promote the emergence of aesthetic design-related industries:

a. Reliance on design progress in conjunction with international exhibitions to inspire a nationwide aesthetics movement and boost Taiwan's overall design image. (Implemented by: MOEA)

b. Implementation of research on international design trends and original design work in Taiwan, international collaboration providing access to design resources, and promotion of innovative applications of design research. (Implemented by: MOEA)

c. Assisting conventional industry and high-tech industry to utilize design to enhance added value, promotion of the establishment of inter-area/inter-industry cooperation networks, and expansion of the domain of design applications in Taiwan. (Implemented by: MOEA)

d. Promotion of the ideas of creative lifestyle enterprises, driving superior industrial innovation. (Implemented by: MOEA)

(2) Strengthening of innovation and international brand marketing, enhancing the international image of Taiwan's industries.

a. Establishment of an effective brand development and guidance environment, providing brand consulting and guidance services.
(Implemented by: MOEA)

b. Training of specialist international brand development manpower, promotion of training of public relations and image personnel by industry associations/organizations.
(Implemented by: MOEA)

c. Assisting village industries to establish collective brands, and thereby enhance the international image of Taiwan's industries.
(Implemented by: MOEA)

(3) Use of ICT to construct innovative integrated inter-industry applications and services, striking a balance between economic output and quality of life.

a. Reliance on broadband technology to drive the development of peripheral applications products, and, in conjunction with aesthetics and design, boost product added value. (Implemented by: MOEA)

b. Establishment of demonstration points promoting and diffusing innovative applications services and fostering the globalization of industrial operation.
(Implemented by: MOEA)

3. Strengthening of the innovation system, establishment of an industrial innovation environment:

(1) Establishment of forward-looking technology development mechanisms:

a. Continued support for forward-looking industrial technology research projects intended to secure the intellectual property rights needed for future industrial development. (Implemented by: MOEA)

b. Forward-looking technology development efforts in national-level programs should be characterized by innovative methods, broad industry participation, and consensus among industry, academia, and research organizations, and should promote collaborative R&D activities. (Implemented by: NSC)

c. Strengthening of long-term research on prospective industrial technology development opportunities in Taiwan. (Implemented by: MOEA)

(2) Establishment of effective innovative industrial R&D mechanisms:

a. Encouragement of industry to engage in innovative R&D and up-, mid-, and downstream inter-industry or interdisciplinary innovative R&D activities. (Implemented by: MOEA)

b. Strengthening of the credit guarantee fund system. (Implemented by: MOEA)

(3) Strengthening of mechanisms linking technology creation and utilization:

a. Strengthening of the establishment of technology R&D patent databases, and facilitating use by industry, academia, and research organizations. (Implemented by: MOEA)

b. Establishment of intelligent decision-making support mechanisms facilitating supervision and management of financial markets. (Implemented by: FSC)

c. Multi-stage establishment of integrated utilization mechanisms promoting the use of R&D results from industry, academia, and research organizations. (Implemented by: MOEA)

(4) Establishment of pioneering demonstration mechanisms for innovative R&D results:

Selection of fields and application items for verification projects should be more focused and appropriately reduced in scope; applications should have relevance to living needs and cultural features; key firms should be selected to perform cooperative field experiments. (Implemented by: MOEA)

(5) Establishment of energy-conserving carbon emission reduction industrialization mechanisms:

a. Utilization of advanced foreign technology, and promotion of collaboration among domestic industry, academia, and research organizations. (Implemented by: MOEA)

b. Completion of industry value chains, development of energy-conserving carbon emission reduction industry clusters. (Implemented by: MOEA)

4. Linkage with global innovative R&D resources:

(1) Reliance on multinational R&D centers to focus international R&D investment:

Encouragement of large international firms to establish R&D centers in Taiwan when doing so benefits the country's R&D advancement. (Implemented by: MOEA)

(2) Acceleration of use of international innovation to leverage international R&D resources:

Strengthen participation in regional and global international cooperation campaigns. (Implemented by: MOEA)

(3) Encouragement of overseas Taiwanese firms to use Taiwan as their knowledge headquarters:

a. Promotion of cross-strait cooperation connected with important product specifications and industry standards. (Implemented by: MOEA)

b. Promotion of industry participation in the EU's FP7 Framework Program. (Implemented by: MOEA)

5. Strengthening of homeland security and development of defense technology R&D capabilities:

(1) Development of maritime surveillance technology, effective utilization of marine resources:

a. Long-term collection of marine observation data, and use in conjunction with numerical modeling results to develop maritime surveillance technologies needed for homeland security. (Implemented by: MND)

b. Development of advanced underwater monitoring technologies that can be used to rapidly, automatically collect large amounts of marine data. (Implemented by: MND)

c. Improvement of maritime weather forecasting capabilities, strengthening of guidelines for sea state database applications. (Implemented by: MND)

(2) Encouragement of information and communications security technology R&D to ensure national defense security:

a. Forecasting of future information security threat and prevention trends, revision and drafting of information security laws and regulations, and establishment of a military/civilian information security protection mechanism strategic conversion platform for peace and wartime. (Implemented by: MND)

b. With regard to information security issues, implementation of research focusing on important developing areas. (Implemented by: MND)

c. Overall strategic planning concerning information security and adoption of information security assessment methods in order to enhance the effectiveness of information service management and oversight. (Implemented by: MND)

d. Promotion of information security education and training and professional manpower training management mechanisms in line with the three principles of "promotion of ubiquitous information security education," "deepening of professional training," and "long-term implementation of manpower training." (Implemented by: MND)

(3) Encouragement of private firms to participate in development of defensive weapons, promotion of defense industry development, and enhancement of defense technology standards:

a. Emphasizing forward-looking research and establishment of core technologies, harnessing the strengths of academic and research organizations, training sci-tech manpower, and effectively promoting overall technological development. (Implemented by: MND)

b. Integration of relevant departments of the MOEA, MND, and defense firms; formulation of development goals, assessment indicators, and implementation strategies; and proposal of specific implementation plans. (Implemented by: MND)

c. Integration of the Chung Shan Institute of Science and Technology's defense technology capabilities, focusing R&D efforts on advanced key technologies with dual-use potential, such as energy and nanotechnology, etc., and strengthening of development of dual-use technologies. (Implemented by: MND)

d. Coupling the R&D results of the MOEA's technology development programs and the MND's scientific research projects to promote the development of defense technology industry clusters and stimulate the development of the defense industry. (Implemented by: MND)

Section 6 Linking Technological Capabilities, Promoting Sustainable Development

I. Current Situation and Review

The heavily-populated island of Taiwan possesses a unique geographical environment. Resources are limited, natural disasters such as typhoons, torrential rains, and earthquakes are common, and the country has a special international status. In addition, due to the rapid growth of society, ecological fragility, and the aging of existing public facilities, and suboptimal maintenance mechanisms, many public facilities are deteriorating or are the object of safety concerns. Furthermore, the poor state of public facilities has contributed to the growing number and extent of disasters. According to the World Bank's 2005 Natural Disaster Hotspots–A Global Risk Analysis, Taiwan's land area vulnerable to at least three types of natural disasters and the percentage of the population threatened by natural disasters are both 73%, making Taiwan first in the world in vulnerability to natural disasters. On September 29, 2008, UN Secretary-General Ban Ki-moon strongly appealed to the world's countries to quickly take active steps to mitigate future natural disasters in the form of continued global warming. The rising sea level and extreme weather phenomena caused by global warming in the greenhouse effect are giving rise to increasingly significant impacts. In particular, vast low-lying coastal areas are threatened with inundation, and water resources and the environment are in jeopardy. These trends threaten public safety and industrial development, and are especially severe in island nations such as Taiwan. Facing a future of uncertain climate change, natural resources connected with national sustainable development, including water, soil, and living organisms, will face supply and demand imbalances.

The most important sustainable development issues confronting human in the early 21st century involve energy, water resources, food, at the environment. Energy ranks first among these issues in terms of importance. Surging fossil fuel prices have recently induced steep hikes in global commodity prices, which have had severe ripple effects on economic development. Furthermore, climate change deriving from the greenhouse effect threatens the survival of civilization. In order to maintain global sustainable development, the world community must lie on international conventions and energy policies to accelerate the development of energy technology and promote new energy applications. The "Framework of Taiwan's Sustainable Energy Policy" issued by the Executive Yuan on June 5, 2008, lays out the following three policy goals for the year 2025: (1) improvement of energy efficiency and reduction of energy intensity by at least 50%; (2) development of clean energy, reduction of nationwide carbon dioxide emissions to the 2000 level, and use of low-carbon fuels to generate at least 55% of power; and (3) ensuring a stable energy supply. Whether these challenging goals can be met will depend on whether a sustainable energy system has been implemented and can be used effectively. The growing body of information concerning Taiwan's rich stores of marine organisms and non-biological marine resources suggests that marine resources are vastly more abundant than those of the same type on land in Taiwan. As a consequence, the development of marine industrial technologies will play a major role in the country's development of new energy sources and new resources.

Because of this, appropriate scientific research must be performed in order to clarify and remedy various problems affecting efforts to prevent and alleviate natural disasters, and applications closely linked with the government's administrative goals developed. Aggressive and effective actions along these lines will ensure that the country and society will have a robust ability to prevent and withstand natural disasters. Efforts to improve public infrastructure and sustainable development will shift from "quantitative increase" to "qualitative improvement." Better maintenance and management of existing public facilities will enhance effectiveness and provide better service quality. The implementation of an effective energy technology policy will depend on sound energy technology development strategies and adequate planning. The government can consider use of international cooperation to strengthen Taiwan's energy technology R&D and compensate for Taiwan's energy technology development lag. With regard to the conservation and utilization of water, soil, and biological resources, while the total amount of watershed land subject to development must be controlled, relevant information should be collected and analyzed, and integrated resource management employed to achieve optimal management of water, soil, and biological resources. In addition, since the sea will play an extremely important role in Taiwan's future development, correct maritime policies and management actions must be implemented. The country must accelerate the establishment of relevant databases and monitoring systems in order to protect and effectively develop marine resources. Even more importantly, is the assessment of relevant indicators assisted by effective monitoring technology and database systems, and the establishment of localized decision-making and warning models. These efforts will enable Taiwan to realize the vision of a high quality of life in the 21st century.

II. Vision

1. Assessment of climate change and alleviation of natural disasters:

(1) The key problem faced in the area of typhoon, flooding, and drought mitigation is how to improve early warning ability for typhoons, floods, and droughts. A long-term goal is establishment of a dedicated unit to perform routine operations, which will include long-term monitoring of environmentally-sensitive and disaster-prone areas, and the appropriate utilization of monitoring data and early warning technology.

(2) Large-scale earthquake mitigation strategies focusing on the levels of public construction, urban structures, urban planning, and response systems will reduce earthquake risk and enhance ability to avoid earthquake damage.

(3) In the area of infrastructure risk control, the development of risk-based facility management methods will avoid the recurrence of disasters, and assessment of risk levels will facilitate evaluation of infrastructure maintenance costs and the impact of potential disasters, enabling the reduction of disaster risk.

(4) A dedicated unit will draft an "Environmental Change and National Adaptation Policy Framework" encompassing the climate change, water, soil, biological resources, the marine environment, human facilities, public construction, and socioeconomic structures, and establish dialog mechanisms in the areas of "agency mission needs and scope of duties" and "technological R&D integration and implementation" in order to integrate needs and clarify problems, and further draft adaptation policies and strategies for resource management, national land conservation, disaster mitigation, and sustainable construction, etc. The dedicated unit will also implement, track, and observe tasks in order to ensure that overall national land planning goals are achieved in an effective and sustainable manner.

2. Boosting the performance and extending the life of public facilities:

(1) Establishment of various types of information and technology integration platforms for public facilities in order to meet the needs of facility planning, design, construction, operation, and maintenance.

(2) Establishment of new technologies, new working methods, product functional assessment mechanisms, and operating models, and incorporation within the government purchasing system.

(3) In conjunction with the globalization of the construction industry, review Taiwan's various technological standards, and harmonize them with international engineering norms.

(4) Increased attention to public facility safety testing, assessment, maintenance, life extension technology R&D and application of results.

(5) Comprehensive review of the harmonization of public construction and sustainable development, emphasis on the overall balanced development of society, and formulation of a blueprint of true sustainability.

(6) Awareness that public facility safety, performance improvement, and life extension will be among the most important administrative goals and missions in the 21^{st} century.

3. Resource/energy conservation and development:

(1) Energy efficiency will be improved by at least 2% during each of the next eight years, causing energy intensity in 2015 to fall by at least 20% relative to 2005. Use of technological breakthroughs and supporting measures to cause energy intensity to fall by at least 50% in 2025 relative to 2005.

(2) With regard to the development of clean energy and reduction in overall carbon dioxide emissions, carbon will be reduced to the 2008 level between 2016 and 2020, and reduced to the 2000 level by 2025. The power generation system will increase its use of low-carbon energy sources by 40%, and reach a reliance level of 55%, by 2025.

(3) Establishment of an energy security supply system able to ensure a stable supply of energy and meet the needs of 6% economic growth during the next four years and the economic development goal of an average annual per capita income of US$30,000 by 2015. Enhancement of reliance on potentially self-produced energy sources, including nuclear energy.

(4) Promotion of the effective utilization of resources, establishment of resource/energy recycling/regeneration systems for individual industries, and enhancement of the competitiveness of the recycling industry.

4. Terrestrial resource conservation, planning, and management:

(1) "Living with a Changing Climate"—Climate will change in the future, and will change continuously. We must therefore understand how the

environment to load will change in the future, and actively plan socioeconomic development strategies to take environmental load limits into consideration. Near-term goals include understanding the environment and mitigating the effects of natural disasters; long-term goals include effectively utilizing and actively developing resources.

(2) Establishment of sustainable development indicators as a basis for planning the utilization of resources on national land. Key elements affecting the sustainable development of resources must be quantified, and integrated management techniques developed which can be used to ensure the representativeness of sustainability indicators, and thereby provide a basis for the determination of sustainability indicators.

(3) Global climate change has increased the vulnerability of national land. In order to transform potential crisis into opportunity, the government should adjust the spatial structure of national land, and establish a sustainable development environment placing balanced emphasis on living, production, and the ecology.

(4) Near-term goals connected with the assessment and promotion of biodiversity include the establishment of unified national standard data format, implementation of a biodiversity indicator system, and creation of integrated biological databases. Long-term goals include establishment of an organization or agency responsible for managing biodiversity-related information on a nationwide basis, and supporting long-term sustainability survey and monitoring projects to provide a scientific basis for the sustainable utilization of biological and other relevant resources.

5. Marine resource conservation and utilization:

(1) Establishment of a marine community and development of marine life and culture reflecting regional features, and eventual development of undersea living areas. Formulation of relevant forward-looking sci-tech R&D goals.

(2) Utilization of the strengths of various agencies and the establishment of a dedicated agency responsible for long-term promotion efforts, and promotion of legislation and drafting of strategies. Relevant agencies will sign development cooperation agreements during the transition period.

(3) Acceleration of legislation, ensuring the development and security of economic activity: Legislation will confirm the duties and powers of marine agencies, facilitating promotion of marine conservation, oceanographic research, and protection of economic development. Maritime protection zones will be established and vehicles needed for maritime development increased.

(4) Investigation of existing industrial advantages, support for key strategic development goals: Because of Taiwan's limited national resources, strategic methods must be employed to analyze existing marine advantages, select focal points for policy promotion efforts, and draft industrial development priorities.

(5) Integration of basic information, strengthening of basic research: Strengthening of research on coral reef and marine ecology, improvement of ecological fish-raising technologies.

(6) Training of human resources, integration of existing organizational manpower: Inclusion of human resource development, integration, and training measures in relevant maritime development plans, strengthening horizontal integration between subitems, and proposal of joint planning of integrated technology R&D efforts.

(7) Strengthening of marine energy and resource utilization, development of industry clusters: Development of marine resources; acquisition of foreign technologies, which can be used to establish strategic objectives for industry reflecting local characteristics; development of industry clusters.

(8) Deliberation of a national strategy for adaptation to marine global changes: deliberation of the nation's marine adaptation strategy in the face of global

changes, and assessment of the impact of global changes on fisheries development. Deployment of marine earthquake and tsunami monitoring stations in response to the possible intensification of natural disasters.

(9) Strengthening of integration of marine/terrestrial resource, energy, and environment management information: Strengthening of marine/terrestrial environmental management information, confirmation of marine resource management and conservation goals, strengthening of R&D team capabilities, and promotion of manpower interchange between different organizations.

(10) Long-term physical and biological oceanographic monitoring: Long-term physical and biological oceanographic observation and reporting, strengthening of marine forecasting services, assisting the development of marine resources. Establishment of a win-win basis for marine conservation and the development of maritime industries.

6. Monitoring and assessment of the environment and public facilities:

(1) Establishment of an environment and public facility monitoring system to perform long-term observation, and establishment of basic databases.

(2) Improvement of monitoring and analysis technology and equipment for the environment and public facilities.

(3) Establishment of an environment and public facility management decision-making support system.

(4) Use of management science techniques to improve the environment and public facility maintenance system and its performance.

III. Important Measures

1. Assessment of climate change and disaster mitigation:

(1) Improvement of climate change forecasting capabilities, and assessment of the effect of climatic and environmental changes on environmental fragility and incidence of natural disasters.

Improvement of climate change simulation and forecasting technology and capabilities; systematic establishment of climatic and environmental change fragility and risk analysis technologies with a scientific and quantitative basis; assessment and confirmation of the possible fragility of existing hazard mitigation systems in the face of climatic and environmental changes; and determination of the priority of items requiring improvement.

(Implemented by: CEPD, NSC, MOTC, Ministry of the Interior, MOEA, Academia Sinica)

(2) Improvement of typhoon, flooding, drought, and earthquakes monitoring and early warning technology:

Strengthening of meteorological, hydrological, sea state, and geological environment monitoring technologies, improvement of typhoon, torrential rain, flooding, and landslide/mudflow early warning and hazard potential forecasting technologies, and R&D and application of real-time earthquake warning systems.

(Implemented by: MOEA, COA, MOTC, Academia Sinica)

(3) Drafting of typhoon, flooding, drought, and major earthquake mitigation strategies:

Drafting of integrated watershed control and disaster prevention strategies taking into consideration water resource management, landslide/mudflow control, and reduction of urban and river flooding potential; drafting of urban earthquake mitigation strategies.

(Implemented by: Ministry of the Interior, MOEA, COA, NSC, MOTC, MOE, Academia Sinica)

(4) Establishment of key infrastructure hazard risk assessment and safety management mechanisms:

Establishment of risk assessment models for key infrastructure and public safety systems, drafting of objective and fair investigation mechanisms, and use of information sharing and knowledge management applications to perform risk management and effectively control disaster risk.

(Implemented by: MOTC, MOEA, Ministry of the Interior, Atomic Energy Council)

(5) Drafting of the Environmental Change and National Adaptation Policy Framework and related tasks:

Drafting of the "Environmental Change and National Adaptation Policy Framework" encompassing the climate change, water, soil, biological resources, the marine environment, human facilities, public construction, and socioeconomic structures. Other related tasks include the establishment of dialog mechanisms in the areas of "agency mission needs and scope of duties" and "technological R&D integration and implementation" in order to integrate needs and clarify problems, and drafting of adaptation policies and strategies for resource management, national land conservation, disaster mitigation, and sustainable construction, etc. in order to ensure that overall national land planning goals are achieved in an effective and sustainable manner.

(Implemented by: EPA)

2. Public facility effectiveness improvement and life extension:

(1) Development of sustainable public facility strategic planning and decision-making mechanisms, improving the effectiveness of national facility maintenance and management:

Establishment of a rational public facility maintenance and management system in line with the life cycle and risk management concepts, integration and drafting of sustainable public facility policies and strategic plans, and drafting of the "public facility effectiveness enhancement and maintenance promotion plan" and corresponding accompanying measures.

(Implemented by: PCC, MOTC, Ministry of the Interior, MOEA, COA, Atomic Energy Council, CEPD)

(2) Enhancement of public facility effectiveness, R&D of life extension technologies, and promotion of applications:

Research on public facility deterioration and damage mechanisms, R&D of testing tools and a long-term early warning system, analysis of the current public facility data storage and database situation, study of the effect of climate change on public facilities, and drafting of response measures.

(Implemented by: PCC, Ministry of the Interior, MOTC, MOEA, COA, Atomic Energy Council, CEPD)

(3) Development and implementation of a sustainable public facility system, strengthening management of national resources:

Planning, establishment, and operation of a public facility effectiveness information system, establishment of quantitative benchmarks, evaluation mechanisms, and incentive measures for public facilities, promotion of sustainable project guidance and demonstration projects, and support for development of a sustainable public facility industry.

(Implemented by: PCC, Ministry of the Interior, MOTC, MOEA, COA, Atomic Energy Council)

3. Resource/energy conservation and develop:

(1) Sustainable energy technology development strategies:

It is recommended that the government foster the establishment of a national energy think tank and research organizations meeting international standards and able to assist in resolving key issues, establishing databases, and providing recommendations at different levels. It is also recommended that substantive international collaboration be strengthened, which will accelerate the improvement of energy technology to international standards, boost the development of new energy industrial technology, and enhance the value of industrial output.

(Implemented by: MOEA, Academia Sinica, NSC, Atomic Energy Council)

(2) Development of technologies meeting low-resource consumption, energy-conserving and energy-conserving carbon emission reduction needs:

Strengthening energy-conserving carbon emission reduction technology development, including low-resource consumption, energy-conserving lifestyle applications, and energy-conserving carbon emission reduction green design and production technology; development of forward-looking energy technologies, including thermoelectric materials and micro-heat diffusion modules, etc.

(Implemented by: MOEA)

(3) R&D of renewable energy and industrial energy supply technology:

Strengthening of the development renewable energy utilization and industrial technology, includes photovoltaic energy, biomass energy, and wind power, etc. It is recommended that the government develop a diverse range of energy technologies, assess new-generation nuclear energy applications, and develop nuclear waste volume reduction and decommissioning technologies. Development of forward-looking energy technologies, and vigorous commitment to carbon emission reduction, sea energy, hydrogen energy, and fuel cell technology, etc.

(Implemented by: MOEA, Atomic Energy Council, Academia Sinica)

(4) Improvement of resource recycling and reuse technology:

Development of resource/energy recycling/regeneration systems for various industries, and development of key resource regeneration technologies, which will boost the competitiveness of the recycling/regeneration industry and achieve progress toward the goal of zero industrial waste.

(Implemented by: MOEA)

4. Terrestrial resource conservation, planning, and management:

(1) Assessment of the effect of climate change on terrestrial resources and formulation of risk and response strategies:

Establishment of an integrated information platform, strengthening of basic scientific research and promotion of applied research geared towards product development, assessment of the impact of climate change, strengthening of adaptation ability reporting and specific measures, establishment of an interdepartmental integration organization, active development of substantive international collaborative relationships, strengthening of hazards mitigation education, and establishment of a continuing research and development environment.

(Implemented by: EPA, NSC, MOTC, Academia Sinica, COA, MOE)

(2) Development of water/soil/ biological resource conservation and management technologies:

Selection of representative water, soil, and biological resource monitoring zones, establishment of water, soil, and biological resource monitoring networks, promotion of monitoring data analysis technology R&D, establishment of regional resource conservation demonstration areas, and development of various new technologies and new ideas concerning resource conservation.

(Implemented by: COA, MOEA, EPA)

(3) Strengthening of overall planning of technological content needed in the areas of national land planning and ecological engineering:

Establishment of an ecological network with river watersheds as units on offshore islands and along the conservation axis of the Central Mountain Range, encouragement of agriculture, revitalization of rural villages, protection of major farmland resources, active conservation of coastal areas, and planning and establishment of three major ecological networks in urban areas.

(Implemented by: Ministry of the Interior, CEPD, EPA, COA)

(4) Assessment and preservation of biodiversity:

Establishment of integrated biological databases, and implementation of thoroughgoing analysis and application; establishment of systematic scientific tools, assessment of biodiversity, monitoring of changes in biodiversity, active participation in international organizations, bilateral cooperation, strengthening of biodiversity manpower training.

(Implemented by: COA, NSC, EPA, Academia Sinica)

5. Marine resource conservation and utilization:

(1) Acceleration of the establishment of a long-term marine observation network and forecasting service platform:

Completion of basic frameworks for early warning of natural disasters, marine resource utilization, and environmental conservation; enhancement of typhoon monitoring and wave forecasting capabilities, and improvement of coastal flooding forecasting capabilities.

(Implemented by: MOTC, Ministry of the Interior, COA)

(2) Strengthening of marine technology development, implementation of a "national marine database":

Acceleration of the construction and replacement of marine research vessels and submersibles; investment in on-board exploration equipment, particularly deep-sea and open-ocean instruments and submersibles; promotion of the exchange and integration of marine information in Taiwan, and promotion of marine information sharing and application.

(Implemented by: NSC, COA, MOTC)

(3) Promotion of the development of promising new marine industrial technologies:

Utilization ocean physical energy, development of alternative and new ocean energy, and promotion of the sustainable utilization of marine resources.

(Implemented by: MOEA, NSC) (Assisted by: MOE)

6. Management of environmental and public facility monitoring and assessment:

(1) Establishment and development of environment monitoring and analysis technologies:

Prioritized improvement and strengthening of domestic basic monitoring data, and establishment of a data checking and grading system for similar monitoring data in order to facilitate data integration and management. Since Taiwan currently lacks operating standards for management of monitoring data and applications, the agencies responsible for integration should quickly draft or revise relevant operating standards in order to provide a basis for the expansion of monitoring systems, and should train dedicated monitoring personnel.

(Implemented by: MOTC, Ministry of the Interior, MOEA, EPA, COA, Atomic Energy Council, DOH)

(2) Development of decision-making support systems for public facility monitoring, safety management, and operation assessment:

Assessment of public facilities, determination of the priority of monitoring items, planning and establishment of monitoring systems, and establishment of a public facility monitoring data sharing platform; formulation of a data disclosure mechanism, establishment of standard monitoring technology processes and unification of monitoring data formats, strengthening of establishment of the analytical models needed for decision-making, and development of public facility safety management and operation assessment decision-making support systems.

(Implemented by: MOTC, Ministry of the Interior, MOEA, EPA, COA, Atomic Energy Council, NSC)

Chapter 5 Sci-tech Development at Government Agencies

In accordance with the foregoing sci-tech development strategies and visions, government agencies have formulated sci-tech objectives and strategies in line with their organizational missions, and have embarked on implementation in conjunction with deployment of resources. Please refer to Table 3 concerning the planned sci-tech development funding resources of 26 government agencies during the period from 2009 to 2012. Individual agencies' objectives and strategies are as described in the appendix.

Table 3 Planned sci-tech development funding resources of government agencies, 2009-2012

Units: NT$1 m

Agency	2009	2010	2011	2012	Total
Academia Sinica	9,857	10,522	11,152	11,821	43,352
Academia Historica	25	26	28	29	108
STAG	45	50	50	50	195
Office of Homeland Security, Executive Yuan	28	30	30	…	88
MOI	363	386	429	474	1,652
MND	…	…	397	381	778
MOE	1,560	1,716	1,888	2,076	7,240
MOJ	85	105	126	113	429
MOEA	29,364	32,468	35,407	37,612	134,851
MOTC	889	1,085	1,147	1,191	4,312
OCAC	13	15	16	17	61
CPA	19	21	21	21	82
GIO	32	47	53	55	187
DOH	5,089	5,319	5,585	5,864	21,857
EPA	66	87	88	89	330
NPM	42	44	46	48	180
CEPD	84	84	100	100	368
AEC	1,292	1,531	1,831	2,191	6,849
NSC	37,577*	41,343	43,222	45,102	167,244
RDEC	107	119	119	119	464
COA	4,141	4,554	5,009	5,512	19,216
CCA	13	12	12	12	49
CLA	241	267	289	314	1,111
PCC	20	23	23	23	89
CIP	20	20	21	22	83
CHA	50	85	55	55	245

Note: 1. "…": indicates no data.

2. Figures for 2009 are statutory budget numbers; figures for 2010-2012 are estimates.

3.*：: indicates that figure does not include the addition of NT$18 million in accumulated surplus to the Science and Technology Development Fund.

Chapter 6 Sci-tech Development in Various Areas of Science and Technology

The review of sci-tech projects is performed using one of two procedural systems, the choice of which depends on whether project content fits into a national science and technology program category. Because they receive earmarked funds, defense technology projects are subject to an independent review. Since the Academia Sinica is subordinate to the Office of the President, Academia Sinica sci-tech projects are reviewed by the Office of the President review.

1. Review of national science and technology programs:

Review procedures for national science and technology programs include:

(1) Communication of program content for the year in question.
(2) Internal review of sci-tech projects at each agency.
(3) Each agency submits its sci-tech projects to the NSC, which forwards projects to the program office for preliminary review.
(4) The program office conducts preliminary review procedures.
(5) Funding coordination conference.
(6) Annual budgetary estimate review conference.
(7) Review results are inspected by the NSC committee and sent to the Directorate General of Budget, Accounting and Statistics.

Table 4 shows national science and technology program review results from 2005 to 2009; see the appendix for further details.

Table 4 National science and technology program review results, 2005-2009

Units: NT$100 million

Name of national sci-tech program	2005		2006		2007		2008		2009	
	Requested amount	Approved amount	Requested amount	Approved amount	Requested amount	Approved amount	Requested amount	Approved amount	Requested amount	Approved amount
1. Hazards mitigation	6.15	5.74	6.18	5.75	Concluded					
2. Telecommunications	21.20	21.20	20.38	18.34	19.70	19.30	18.86	18.86	Changed to Networked Communications Program starting in 2009	
3. Agricultural biotechnology	6.61	6.45	8.15	7.27	6.71	6.67	6.00	6.00	Concluded	
4. Biotech pharmaceuticals	17.79	17.79	19.46	15.80	7.69	7.69	7.70	7.70	9.03	8.57
5. Digital archives (changed to e-Learning and Digital Archives Program in 2008)	6.86	5.85	7.65	6.85	8.14	7.33	14.57	12.76	13.62	12.62
6. Genomic medicine	19.39	17.73	16.58	16.00	14.85	14.85	15.46	15.46	16.20	15.69
7. Chip systems	24.73	24.63	23.05	20.74	21.92	20.90	20.55	20.55	21.64	20.87
8. Nanotechnology	36.11	32.03	37.79	34.01	32.00	31.85	29.40	29.40	36.95	31.22
9. E-learning	6.93	6.24	6.64	5.98	5.80	5.43	Merged with digital archives program			
10. Network communications									19.24	18.86
Program offices	2.02	1.82	2.00	1.94	1.61	1.64	1.67	1.67	1.67	1.67
Total	147.81	139.49	147.87	133.30	118.41	115.65	114.21	112.40	118.36	109.50

2. Non-national science and technology program review procedures:

(1) The review of sci-tech projects in 2005 continued to employ past methods; projects in 39 areas were reviewed.

(2) The review of sci-tech projects in 2006 included projects in 37 areas.

(3) The operating procedures for the review of sci-tech projects changed significantly in 2007: area review was replaced by group review, "abstract review" procedures were added, a policy information platform was established, and the priority grade of project funding amounts was eliminated. Projects were reviewed in the five groups of life technology, global environmental technology, industrial technology, technological services, and technological policies during that year.

(4) Projects were reviewed in the five groups of life technology, global environmental technology, industrial technology, technological services, and technological policies during 2008.

(5) Projects were reviewed in the six groups of life technology, environmental technology, information and communications electronics, engineering technology, technological services, and technological policies during 2009.

Sci-tech project review results from 2005 to 2009 are shown in Tables 5-7; see the appendix for further details.

Table 5 Sci-tech project review results, 2005-2006

Units: NT$1,000

Area or category	2005		2006	
	Requested amount	**Approved amount**	**Requested amount**	**Approved amount**
01. Electronics	1,103,105	1,033,368	1,147,258	964,271
02. Information	1,271,189	1,189,132	1,194,139	1,027,470
03. telecommunications	16,500	12,700		
04. Automation	493,093	462,500	535,145	431,131
05. Machinery	890,321	836,810	1,212,399	1,098,247
06. Aerospace	2,925,455	2,736,944	3,303,824	2,876,902
07. Optoelectronics	1,813,745	1,701,148	2,381,842	1,990,053
08. Materials	775,716	744,317	924,878	837,265
09. Chemical engineering	247,570	233,225	217,340	196,097
10. Environmental protection	973,264	872,704	889,091	761,771
11. Textiles	884,396	789,069	825,621	708,872
12. Resources	176,344	161,269	209,893	168,066
13. Energy	57,970	51,605	409,284	389,324
14. Atomic energy	660,405	615,955	620,496	475,991
15. Civil engineering	515,719	474,914	650,870	546,757
16. Transportation	902,235	845,265	904,530	767,175
17. Biology and biotechnology	1,225,075	1,134,931	1,557,249	1,386,339
18. Foods	539,417	475,208	501,147	441,576
19. Medicine and health	2,447,086	2,284,526	2,892,487	2,475,044
20. Pharmaceuticals	585,979	542,508	649,756	558,665
21. Agriculture	1,487,150	1,388,079	1,622,291	1,406,878
22. Forestry	222,882	200,522	223,159	194,819
23. Fisheries	339,234	306,178	352,270	302,934
24. Animal husbandry	530,611	489,279	580,267	501,946
26. Physics	1,066,613	1,063,613		
27. Chemistry	37,232	35,142		
28. Meteorology	288,170	281,236	320,738	275,126
29. Humanities and social	50,578	36,756		

Area or category	2005		2006	
	Requested amount	Approved amount	Requested amount	Approved amount
sciences				
30. Science education	897,616	844,081	1,066,811	925,401
3A. Information services	1,623,404	1,450,314	1,657,750	1,430,661
3B. Management support	8,098,805	7,270,387	7,720,022	6,555,578
3C. Labor safety	764,771	741,423	225,579	215,773
32. Oceanography	75,518	71,416	100,582	89,224
33. Earth science	437,980	390,736	433,180	363,322
34. Networking	1,242,458	1,077,331	1,067,679	896,334
35. Ecological working methods and biodiversity	627,508	548,015	577,305	491,511
36. Environmental construction projects*1	1,530,592	1,452,389	1,917,949	1,774,023
37. Service industry	120,000	116,000	920,768	759,987
38. National science and technology programs	14,785,584	13,966,711	14,786,962	13,330,130
39.Science and Technology Development Fund*2	3,158,000	2,274,000		1,410,130
40. NSC non-national science and technology projects	19,613,555	18,415,730	20,911,906	18,251,316
41. Policy planning			13,631,522	10,113,005

*1: Name changed to environmental construction and integration in 2006.

*2: Included NT$130 million for major sci-tech policy-related R&D issues in 2005.

Table 6 Sci-tech project review results, 2007-2008

Units: NT$1,000

Area or category	2007		2008	
	Requested amount	**Approved amount**	**Requested amount**	**Approved amount**
01. Life technology group	5,775,322	5,517,571	7,489,712	7,290,948
02. Global environmental technology group	2,940,030	258,759	2,541,885	2,433,554
03. Industrial technology group	16,840,878	11,564,959	17,490,656	16,809,777
04. Technological service group	11,328,222	10,164,474	5,757,725	5,571,760
05. Technological policies group	4,807,136	423,833	2,495,282	2,426,508
06. Other non-national science and technology projects	28,495,727	26,345,385	33,927,099	33,521,554
07. National science and technology programs	11,841,040	11,564,959	11,420,580	11,240,069

※Not including commissioned review of Petroleum and Energy Fund funding.

Table 7　Sci-tech project review results, 2009

Units: NT$1,000

Group or program	**2009**	
	Amount sent for review	**Approved amount**
01. Life technology group	10,730,983	10,168,903
02. Environmental technology group	3,451,000	3,416,066
03. Information and communications electronics group	2,586,611	2,487,518
04. Engineering technology group	12,500,183	12,020,244
05. Technological service group	6,373,960	6,117,381
06. Technology policies group	2,143,265	2,055,590
07. Other　non-national science and technology projects	40,015,581	36,118,677
08. National science and technology programs	11,886,325	10,949,833

※Not including commissioned review of Petroleum and Energy Fund funding

Chapter 7 Implementation and Control

This plan includes six major sci-tech development strategies and 144 important measures, which are to be jointly implemented by 23 agencies. The agency responsible for each important measure shall draft an implementation plan, and submit specific indicators and implementation plan focal points for each year. With regard to sci-tech development work implemented by each government agency and in each area of science and technology, each agency shall draft goals, strategies, and a funding resource plan for the subsequent four years, and shall individually perform implementation tasks.

The National Science Council, Executive Yuan is responsible for the control of this plan. The state of implementation must be reported for all measures (total of 144 items) on an annual basis, and the state of implementation must be reported on a semiannual basis for measures under the Executive Yuan's direct oversight (total of 23 items). The NSC shall report its control views and the results of review in coordination with other agencies, and shall compile an annual report for the Executive Yuan.

The implementing and assisting agencies for each strategy and control methods are listed in this plan's "Assignment of Duties and Control of Important Measures," where the agency listed first among the implementing agencies is the first implementing agency. The first implementing agency may, when necessary, call together all implementing and assisting agencies during a measure's implementation period to perform integration and coordination tasks connected with that measure.

Measures controlled by the Executive Yuan as part of other projects (or programs) shall be controlled under the original project. In order to maintain the completeness of this plan, however, implementation plans and annual implementation reports must be submitted pursuant to this plan.

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